



JOINT GLOBAL OCEAN FLUX STUDY
A Core Project of the International Geosphere-Biosphere Programme

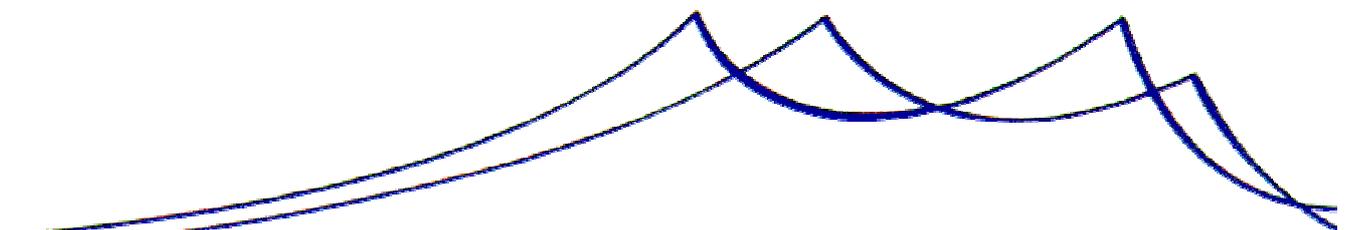
JGOFS REPORT No. 31

**THIRTEENTH MEETING OF THE JGOFS
SCIENTIFIC STEERING COMMITTEE**

**FOURTEENTH MEETING OF THE JGOFS
SCIENTIFIC STEERING COMMITTEE**

**FIFTEENTH MEETING OF THE JGOFS
SCIENTIFIC STEERING COMMITTEE**

OCTOBER 2001



**SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS**

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The JGOFS Report Series includes the following:

- 1 Report of the Second Session of the SCOR Committee for JGOFS. The Hague, September 1988
- 2 Report of the Third Session of the SCOR Committee for JGOFS. Honolulu, September 1989
- 3 Report of the JGOFS Pacific Planning Workshop. Honolulu, September 1989
- 4 JGOFS North Atlantic Bloom Experiment: Report of the First Data Workshop. Kiel, March 1990
- 5 Science Plan. August 1990
- 6 JGOFS Core Measurement Protocols: Reports of the Core Measurement Working Groups
- 7 JGOFS North Atlantic Bloom Experiment, International Scientific Symposium Abstracts. Washington, November 1990
- 8 Report of the International Workshop on Equatorial Pacific Process Studies. Tokyo, April 1990
- 9 JGOFS Implementation Plan. (also published as IGBP Report No. 23) September 1992
- 10 The JGOFS Southern Ocean Study
- 11 The Reports of JGOFS meetings held in Taipei, October 1992: Seventh Meeting of the JGOFS Scientific Steering Committee; Global Synthesis in JGOFS - A Round Table Discussion; JGOFS Scientific and Organizational Issues in the Asian Region - Report of a Workshop; JGOFS/LOICZ Continental Margins Task Team - Report of the First Meeting. March 1993
- 12 Report of the Second Meeting of the JGOFS North Atlantic Planning Group
- 13 The Reports of JGOFS meetings held in Carqueiranne, France, September 1993: Eighth Meeting of the JGOFS Scientific Steering Committee; JGOFS Southern Ocean Planning Group - Report for 1992/93; Measurement of the Parameters of Photosynthesis - A Report from the JGOFS Photosynthesis Measurement Task Team. March 1994
- 14 Biogeochemical Ocean-Atmosphere Transfers. A paper for JGOFS and IGAC by Ronald Prinn, Peter Liss and Patrick Buat-Ménard. March 1994
- 15 Report of the JGOFS/LOICZ Task Team on Continental Margin Studies. April 1994
- 16 Report of the Ninth Meeting of the JGOFS Scientific Steering Committee, Victoria, B.C. Canada, October 1994 and The Report of the JGOFS Southern Ocean Planning Group for 1993/94
- 17 JGOFS Arabian Sea Process Study. March 1995
- 18 Joint Global Ocean Flux Study: Publications, 1988-1995. April 1995
- 19 Protocols for the Joint Global Ocean Flux studies (JGOFS) core measurements (reprint). June, 1996
- 20 Remote Sensing in the JGOFS programme. September 1996
- 21 First report of the JGOFS/LOICZ Continental Margins Task Team. October 1996
- 22 Report on the International Workshop on Continental Shelf Fluxes of Carbon, Nitrogen and Phosphorus. 1996
- 23 One-Dimensional models of water column biogeochemistry. Report of a workshop held in Toulouse, France, November-December 1995. February 1997
- 24 Joint Global Ocean Flux Study: Publications, 1988-1996. October 1997
- 25 JGOFS/LOICZ Workshop on Non-Conservative Fluxes in the Continental Margins. October 1997.
- 26 Report of the JGOFS/LOICZ Continental Margins Task Team Meeting, No 2. October 1997
- 27 Parameters of photosynthesis: definitions, theory and interpretation of results. August 1998
- 28 Eleventh meeting of the JGOFS SSC; Twelfth meeting of the JGOFS SSC; and the Second meeting of the North Pacific Task Team. November 1998
- 29 JGOFS Data Management and Synthesis Workshop, 25-27 September 1998, Bergen, Norway. Meeting Minutes. January 1999
- 30 Publications 1988-1999. January 2000

The following reports were published by SCOR in 1987 - 1989 prior to the establishment of the JGOFS Report Series:

- The Joint Global Ocean Flux Study: Background, Goals, Organizations, and Next Steps. Report of the International Scientific Planning and Coordination Meeting for Global Ocean Flux Studies. Sponsored by SCOR. Held at ICSU Headquarters, Paris, 17-19 February 1987
- North Atlantic Planning Workshop. Paris, 7-11 September 1987
- SCOR Committee for the Joint Global Ocean Flux Study. Report of the First Session. Miami, January 1988
- Report of the First Meeting of the JGOFS Pilot Study Cruise Coordinating Committee. Plymouth, UK, April 1988
- Report of the JGOFS Working Group on Data Management. Bedford Institute of Oceanography, September, 1988

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13th Meeting of the JGOFS Scientific Steering Committee

Cape Town, South Africa, 25-28 April 1998

Introduction

Opening Remarks

The JGOFS Chair, Michael Fasham, opened the 13th Meeting of the JGOFS Scientific Steering Committee at Breakwater Campus, Cape Town, South Africa at 09:00, 25 April 1998. Fasham welcomed all SSC members, national chairs, and guests (**Appendix A**). He noted especially the new members, Huasheng Hong and Renato Quiñones; the national chair from Japan, Nobuhiko Handa; the Canadian JGOFS representative, Alain Vézina, and the GAIM OCMIP representative, Patrick Monfray.

On behalf of the Scientific Steering Committee, Fasham thanked John Field for an excellent job in arranging the meeting. Field expressed his own gratitude to the SSC for their support throughout his term in office. He had found it most rewarding working with this distinguished scientific group. Field also commended the Committee on their foresight in choosing Fasham to succeed him and stressed the importance of rotating Chairs to give new vitality to the Committee and to promote good leadership. Field informed the meeting that The University of Cape Town as well as the Scientific Foundation of South Africa was sponsoring, in part, some of the social activities being organised in conjunction with the SSC meeting. Field also acknowledged the International Project Office and his own secretary Heidi Winckler for their help in organising the meeting.

Approval of the Agenda

The SSC accepted the agenda and timetable for the 13th meeting.

Programme Direction for the Future

Fasham briefly reviewed JGOFS synthesis issues and objectives and the need to determine how to reorganise in order to meet those objectives. He hoped that discussions on future synthesis and modelling should result in a skeleton plan of action. Since the NAPG (North Atlantic Planning Group) has already restructured into a North Atlantic Synthesis and modelling Group (NASG), the group could function as a model for others, *e.g.* Terms of Reference (TOR), goal and objectives, and membership structure. Fasham thus asked for a discussion around the NASG TOR, so that it could be used as a template. However, it became clear that the SSC had to discuss a number of synthesis topics in the following days first. For example, (i) what is meant by synthesis; (ii) how do we restructure, and (iii) how do we co-ordinate the synthesis groups, *e.g.* through the IPO or by forming an overall synthesis' group.

The SSC agreed on the initial products for synthesis: (1) the production of a glossy brochure, (2) a textbook and (3) an open science conference. The brochure must show JGOFS achievements thus far and its major synthesis goals for the future. Fasham asked the SSC to think about what else they see as JGOFS future synthesis efforts for discussion later.

Swanberg informed the SSC that IGBP might provide extra funds in support of core project synthesis efforts. JGOFS should send a proposal with an outline of its synthesis scheme so that IGBP can target money for these activities (see Fasham's report on the 13th Meeting of the IGBP-SC).

Organization

Meeting Minutes

The minutes of the 12th Meeting of the JGOFS SSC in Oban, Scotland, 17-19 May 1997 were circulated earlier and approved with minor changes. The Executives in attendance from the 1997 Executive Meeting (Williamsburg, Virginia, USA, 30-31 October) approved the minutes without changes.

Member rotations and nominations

The SSC will not make many new nominations but will continue the rotations of the at-large members. With justification, IGBP and SCOR will consider extending at-large member terms up to a maximum of 6 years. Deadline for nominations is June 30, in order to present nominees to the Sponsors for approval in the fall.

Groups and Teams (members rotations)

Memberships will change for most planning groups in the near future to incorporate synthesis needs. Before recommending new group members, chairs are requested to confirm the status of its groups, as there are a number of discrepancies in current lists.

Synthesis Groups Reports

North Atlantic Synthesis and Modelling Group (NASG)

Fasham reported on NAPG activities (**Appendix B**). NAPG has restructured into the North Atlantic Synthesis and Modelling Group. The membership has been revised and the first meeting will be at the Southampton Oceanographic Centre, UK, in May 1998. He announced only one change in the nominations: the replacement of Emilio Fernandez from the Universidad de Vigo by Fiz Perez from the Instituto de Investigaciones Marinas, CSIC, Vigo. Fasham asked for approval. The SSC agreed with Fasham's recommendations (TOR and membership) and approved the NASG TOR as template for other synthesis groups and Perez as a member of the NASG, replacing Fernandez.

ACTION 1: The SSC approved the NASG nomination of Perez.

Equatorial Pacific Synthesis and Modelling Group (EPSG)

Murray reported on the EPSG and the status of publications from the Equatorial Pacific study: third special volume of Deep-Sea Research (DSR) (in press) and a special volume in Journal Geophysical Research with Landry and Bidigare as guest editors on FLUPAC cruises (in prep.). Murray will compile the relevant bibliography that is not included in the DSR volumes. In addition, he informed the SSC about the approval of US Synthesis and Modelling Program (SMP) proposals.

The EPSG revised their Terms of Reference to include the activities of HOT (Hawaiian Ocean Time-series station). These will be revisited during the general discussion on regional synthesis. Nominations for the membership of the restructured EPSG were then discussed. SCOR pointed out the USA dominance in the list. Murray argued that the list reflects the heavy representation from the USA and France during this Process Study. He preferred pragmatism rather than equal national representation, *i.e.*, these scientists are the ones that have the data and are actually going to produce the results. Robert Toggweiler from the USA was nominated during the meeting.

ACTION 2: SSC approved the membership of the EPSG with the addition of Robert Toggweiler.
ACTION 3: SSC approved the first meeting of the EPSG, which will take place 10-11 September in Seattle, USA.

Indian Ocean Synthesis and Modelling Group (IOSG)

Burkill reported on the activities of the IOSG (**Appendix C**). The SSC reviewed the recommendations of the IOPG and actions that followed from the last SSC meeting.

Recommendation 1: SSC approved

Recommendation 2: There are two issues, according to Lowry, that concerns the politics of the accessibility of GLOBEC data for JGOFS scientists. There is a need for SSC co-operation between the two core projects and the political intricacies need clarifying.

ACTION 4: Lowry will clarify the politics concerning accessibility of GLOBEC data to JGOFS scientists.

ACTION 5: Fasham will write a letter to GLOBEC chair to enhance data sharing.

Recommendation 3: There are problems in acquiring Indian and Pakistani data from the Arabian Sea Process Study. Lowry explains that some of the problems faces JGOFS data organisation. Lowry should be made aware of what data sets are NOT available through India. This is perhaps more of a conceived problem than a factual problem. Would it be possible to post data on IPO homepage? Determining who already has a homepage could solve the problem. Roy has previously tried making contact with Pakistan, and Gross has tried her connections without success. Baliño has had contacts with Pakistan through Shahid Amjad, who is located at the National Institute of Oceanography, and will pursue it.

ACTION 6: Lowry will take up the issue through either Indian Data Management or the Indian JGOFS Chair.

ACTION 7: Baliño/Lowry asked to help set up homepage connections with India and Pakistan.

ACTION 8: Baliño asked to formally request Amjad, NIO, to deliver Pakistani data sets gathered during the Arabian Sea Process Study. Copy IGBP and India START centres to enhance compliance.

Recommendation 4: SSC approved, but request that IOSG expands its synthesis efforts to include the entire Indian Ocean and related research (*e.g.* WOCE data).

ACTION 9: Hanson asked to write Burkill and request that IOSG expand its synthesis efforts to include the entire Indian Ocean and to liaise with related research programmes.

Recommendation 5: A message from Karin Lochte requested Tim Rixen join the IOSG.

The following JGOFS members plan to be at the Indian Ocean Synthesis Group Meeting and Symposium in Bangalore: Fasham, Denman, Oschlies, Evans, Garçon, Vézina, Sathyendranath and Platt.

ACTION 10: The SSC moved to include Rixen's name on the IOSG membership.

Recommendation 6: SSC approved

Southern Ocean Planning Group (SOPG)

Bathmann reported on the activities of the SOPG. The planned SOPG meeting in May has been postponed to September 3-5, 1998, in Bremerhaven, Germany. Since the field programme has yet to be completed, the SOPG has not entered its synthesis and modelling phase. Therefore, the agenda of the September meeting includes discussions on membership nominations, rotations and TOR. Bathmann also requested funds for two foreign representatives to attend the US JGOFS Workshop in Tennessee this June.

There are difficulties in getting research funds for fieldwork. Seeking funds from EU has its limitations; the main problem is that research teams are only allowed to use European expertise. USA field programmes are expected to continue. With reference to the Executive statement that JGOFS should include UV in their programme, Bathmann mentioned that the SOPG will be looking at the issue, but it is not certain that work will be done. Field pointed out that dealing with the UV problem appeals to the public, giving a high profile and good public relation, and JGOFS could provide advice to ICSU. Bathmann mentioned that although UV does not fall directly in the JGOFS profile, work could be carried out at the same time with little added effort. Bathmann reported that there are plans under way to pursue iron issue in the Southern Ocean next year. Fasham mentioned that the issue of iron calibration was discussed at the 1997 JGOFS Executive meeting, and there are going international concerns over Fe inter-calibrations and field studies. Swanberg reported that an iron meeting will take place in Amsterdam in November and that SCOR is also be looking at the issue and has established Working Group 109: Biogeochemistry of Iron in Seawater (with IUPAC) 1997 (David Turner and Keith Hunter, Co-Chairs).

The SSC discussed the strategies for inter-calibration: (i) several groups to do sampling and measurements in parallel on a research vessel or (ii) two or three groups to collect water and distribute among scientists. There are ongoing programmes with more than one team. Both have disadvantages: Iron people are specialists in their field and having all on one ship may cause problems. On the other hand, allowing measurement by a limited number of labs might annoy others. Inter-calibration exercises require careful planning and organisation. This sensitive issue needs careful work to repair poor relationships with different groups. Hard feelings are apparent. Swanberg suggested that since IUPAC is sponsoring a chemical meeting soon, perhaps we could use them to resolve the issue. IUPAC contact could be Dave Turner. Some pressure should be applied to help settle this issue and JGOFS should definitely have a view on this and register their concern.

With regards to data handling and modelling, SOSG recommends an inventory of SO data specified by country. This is necessary as *e.g.* German Southern Ocean data falls under the Antarctic Research Group and it is therefore NOT flagged as JGOFS data. The modelling activities in the SO should move from 1D to 3D modelling, which is being developed in Kiel.

ACTION 11: Fasham will make known JGOFS view concerning the importance of iron calibration to SCOR and IUPAC. He will also make a formal approach to IGAC and others.

ACTION 12: Bathmann will build an inventory of SO cruises and principal investigators and send this inventory to Baliño at IPO.

ACTION 13: Bathmann asked to recommend new nominations for the Southern Ocean Synthesis and Modelling Group (SOSG) for Executives approval.

ACTION 14: SSC approved the SOPG request for foreign representation at the US workshop. Hanson will arrange funds.

ACTION 15: SSC asked Bathmann to present a Synthesis report at the IGBP meeting next year.

Task Team Reports

Data Management Task Team (DMTT)

Lowry emphasised the need for an additional data manager at the IPO. A previous attempt to finance a position through EU failed. Hall suggested asking START; they have previously helped LOICZ data management issues. Baliño thought that IGBP-DIS might also provide some assistance.

The DMTT and the IPO are organising the first JGOFS Data Management and Synthesis Workshop. Dates are set for September 24-25, 1998. The IPO in Bergen will host the workshop.

The aim of the workshop is to establish a channel of communication between the DMTT and modellers so that DMTT can assist in the synthesis and modelling phase of JGOFS.

Lowry thanked Baliño for her assistance in the updating of the cruise inventory and the organisation of the workshop in Bergen. Fasham in turn thanked Lowry for his efforts in leading the important work of DMTT.

ACTION 16: Baliño will approach DIS and Fasham will contact START regarding the JGOFS data management issue.

Continental Margin Task Team (CMTT)

Hall presented an update from the CMTT meeting in The Netherlands in October 1997. The Report is now completed and distributed to the SSC. Due to lack of available material, the Synthesis paper that came out of the Workshop lacks depth. At present, there is a dilemma in finding a publisher for the modelling paper. Atkinson is no longer editor of The Oceanography Society journal, where the article was to be published, and there is a possibility that the journal may not exist any longer.

The Task Team has fulfilled specific TOR requirements. It is now time to review CMTT direction and membership. CMTT is thus currently evaluating past and future research. As for membership, Hall and Smith have been asked to present their respective SSCs (LOICZ and JGOFS) of an expansion to the membership to include representatives from GLOBEC. The argument is that although existing primary issues in terms of reference should remain, the tasks need changing in order to accommodate GLOBEC interests. A number of SSC members were reluctant to involve GLOBEC at this stage. They emphasised that JGOFS should concentrate on acquiring the boundary conditions needed from LOICZ, *e.g.* the coast-ocean carbon flux. Those in favour emphasised the impact that the zooplankton data from GLOBEC will indeed have on JGOFS modelling.

Hall mentioned that there is a problem with amount of data available for Continental Margin synthesis; *i.e.* there is not enough to carry out synthesis. An important issue is to find out how much currently exist. The SSC emphasised that data acquisition should be acquired from other research programmes as well as LOICZ, and that this process should be carried out in close collaboration with JGOFS IPO and DMTT.

The importance of the carbon cycle in CMTT research was emphasised, something LOICZ acknowledges as well. In addition, there is a need to include CO₂ in CMTT research; *e.g.*, what is the role of the continental margins in the exchange of CO₂. Fasham stressed the modelling issue that it is difficult to make progress without models. Nesting modelling might be appropriate for CMTT synthesis purposes. Asked GAIM if they could contribute to this issue but Monfray was not aware of this type of modelling.

Fasham advised the CMTT to focus on the carbon cycle and synthesis in the future. There was general agreement that the group should have new members. Hall expressed her desire to step down as co-chair by the end of the year. However, Liu and Quiñones pointed out that leadership of Hall was important for the continuity of the process until the new co-chairs are appointed. Hall agreed to remain as co-chair until the next CMTT meeting. Regarding the expansion of the group to include GLOBEC representatives, the SSC advised the CMTT to reconsider this action. They were not entirely opposed to the idea and would agree to include GLOBEC in the CMTT as observer in the first round.

ACTION 17: Hall and Liu will draft new TOR for discussion and JGOFS and LOICZ SSCs approval

Hall recognized the work that K.K. Liu has contributed to developing the CMTT homepage.

North Pacific Task Team (NPTT)

Bychkov reported on the NPTT meeting held in March 1998. Several recommendations were made: 1) Nojiri to present preliminary results from KNOT time series at the next NPTT meeting, 2) Saino and Bychkov to bring the Implementation Plan for the North Pacific Process Study to the PICES Science Board/Governing Council meetings for adoption and endorsement as a valuable scientific component within PICES framework, and 3) NPTT to draft a statement recommending continuation of stations in the eastern sub-arctic and subtropical Pacific. This is an appeal to funding agencies for allocation of funds extending stations support to 2005. There has been no response from Japan yet, while USA has indicated the continuation of HOT.

PICES has endorsed several proposals generated through the NPTT. A joint POC (Physical Ocean Committee) and BIO (reference to PICES group) session (co-sponsored by JGOFS) on "Carbon Cycle in the North Pacific Ocean" was included in the programme of the PICES Seventh Annual Meeting (Fairbanks, USA). The Implementation panel selected an observer to NPTT for PICES-GLOBEC CCCC (Climate Change and Carrying Capacity) Programme and vice versa.

Global Synthesis Modelling Task Team (GSMTT)

Platt reported on the success of the first JGOFS Modelling symposium in Oban, May 1997. Work is now progressing for the combined International Scientific Symposium and Training Course in Biogeochemical Modelling of the Ocean for Bangalore, India in January 1999. The first meeting of the Indian Ocean Synthesis Group will be held with these events. Peter Burkill will be responsible for the Symposium. The list of instructors to the course is now complete.

There is a need for the re-evaluation of the GSMTT status. This group has not previously co-ordinated research but has rather provided a forum where people could meet. Much of the energy in JGOFS has been in fieldwork while this task team existed so that synthesis would not be forgotten. However, as the whole programme is entering its overall synthesis, JGOFS needs a structure to include a suite of regional synthesis teams. In addition, as SSC takes on the role of co-ordination of the regional teams, they felt that there was no need in maintaining life in GSMTT. Monfray mentioned that whatever new synthesis body forms in JGOFS, it should liaise with GAIM. In addition, activities of GSMTT such as organisation of training courses should be continued by the SSC as well. However, Swanberg ensured that IGBP is keen on training that fosters a science that is beneficial in achieving its goals. START effectively covers this function and encourages capacity building in specific projects.

The SSC thanked Platt for his leadership of the GSMTT.

ACTION 18: Hanson/Fasham will write a letter of thanks to the chair and members for their excellent contribution to JGOFS and to disband the GSMTT by the end of 1998.

Deep Ocean Flux Task Team (DOFTT)

Shimmiel mentioned the intention to form a joint DOFTT with PAGES dates back to the Villefranche meeting in 1995. The main goal of this task team is the closing of the bottom boundary of JGOFS modelling. However, the liaison with PAGES is nowadays based mainly on individual efforts. Shimmiel attended a PAGES meeting recently and said that Executive Officer Frank Oldfield of the project office took up the issue at SSC meeting. He tried to find nominations from PAGES to join members of JGOFS but no nominations have arrived yet. There is obvious some reluctance because PAGES activities are mainly terrestrial and a very small part is devoted to marine systems. When asked if there should not be instead a liaison with IMAGES, Shimmiel said that IMAGES is a working activity, a focus only. IGBP will strive to ensure maximum co-operation between PAGES and JGOFS. In the coming year, a new Chair Tom Pedersen is stepping in with a broader approach to IGBP Science Plan. PAGES is planning

an Open Science meeting along with its SSC meeting in June 1998. Shimmiel will keep JGOFS updated.

Lochte informs the Committee that ADEPD (Atlantic Deep Database Project) has started the building of the database and will have their first meeting this year. ADEPD is a EU project for the collection and organisation of data from the DOFTT. Lochte is the contact person. The SSC asked that the new TOR be drafted soon, something on the lines of the CMTT. The SSC asked Liu to assist Shimmiel.

ACTION 19: Shimmiel will present DOFTT TOR to PAGES with a list of suggested members, approved by the Executive Committee.

Remote Sensing Task Team (RSTT)

Platt reported for Yoder on satellites with ocean colour sensors. He mentioned that SeaWiFS as well as the Japanese OCS are contributing routine data to public domain. There are plans to launch several sophisticated satellites by the year 2000 (Europeans and Japanese). The German satellite will be giving data for European and Indian waters only.

Co-ordination

- Within NASA's SIMBIOSE to examine and enhance the compatibility of optical signals originating from a number of devices to build a time-series.
- Plans for an international optics cruise on a world scale. Funds are being raised to involve a Russian oceanographic ship, and to launch the cruise for the year 2000.
- International Ocean Colour Co-ordinating Group (IOCCG): (i) to evaluate and assess the compatibility of information. This is needed because there is some perception of redundancy among the Earth Observing Satellites community; (ii) to prepare a report to make a case for having an appropriate number of ocean colour devices in orbit; (iii) the validation of sensors towards chlorophyll concentration; (iv) promote training courses, such as the one in Chile, in November 1997 and the upcoming in Bangalore, January 1999.

Regarding the existence of the IOCCG, the SSC questioned whether JGOFS needs the Remote Sensing Task Team any longer. Although the SSC raised the issue of disbanding this task team more than once, RSTT activities go beyond ocean colour. There was now consensus to disband if IOCCG liaises with JGOFS. The SSC asked Platt to act as the liaison until a representative is found.

ACTION 20: Hanson/Fasham will write letters of acknowledgement to the chair and members for their excellent contribution to JGOFS and to disband the RSTT by the end of the year.
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Photosynthesis Measurements Task Team (PMTT)

Sakshaug announced the publication of the first part of the PMTT work: "*Parameters of photosynthesis: definitions, theory and interpretation*", has been published in Journal of Plankton Research, 19(1), 1997. Negotiations with Cambridge Inc. are in progress to include the document in the JGOFS Report Series. The second part of the paper, which will appear soon, will be more practical. Three members from the task team plan to meet in late 1999.

ACTION 21: SSC approved financial support for three members to meet and finalise the last paper.

JGOFS/IOC CO₂ Advisory Panel

Watson mentioned that the Terms of Reference, which were written in 1990, are out of date and that the Panel discussed modification of the TOR at the last two CO₂ Advisory Panel meetings. Watson reported that the panel has been much involved in Terms I, II and IV (large scale CO₂ fluxes) and this is currently their main activity. On the other hand, little interest has been devoted

to Term III. Regarding the membership, present members have been acting for too long and there is consensus for 'new blood' in the group.

Current issues that the Panel is involved in:

1. Acquisition of the global oceanic carbon data set, variability of the system. It is largely complete at the basin scale but not at the mesoscale and it needs development of new instrumentation that is largely encouraged, *e.g.* ships of opportunity.
2. Measurement strategies for DIC systems and calibration exercises. Discussions have started on how to get adequate measurements.
3. Integration of the pCO₂ global data set. A sub-panel lead under Poisson direction has been tasked with these efforts. There are not large quantities of data, and we are trying to get all available data from investigators to build a comprehensive database. At present, Takahashi has published the most comprehensive CO₂ climatology, but there are crucial gaps in it. More data is needed to get a realistic picture and letters have been sent to the community asking for inventories of data. Data is gradually arriving at CDIAC, under the leadership of Poisson. Weiss/Noah measurements together produce a large database, not an easy task.
4. Disposal of CO₂ in the ocean. Japan, Norway and Canada are monitoring research on ocean disposal. The panel is watching this.
5. Development of models for the Carbon System and anthropogenic CO₂ uptake. Available data limit this activity, but they expect progress some time next year. The role the coastal zone in the flux of CO₂ was drafted. The available data suggest that coastal zones act as a sink for CO₂ and one of the mechanisms is sediment export. However, the flux is very season dependent and winter data are lacking.

Future Options of the Panel:

1. To diversify the panel. IOC suggested the panel diversify into other greenhouse gases. However, the panel is not keen on this, and Field suggested that if this happens, then the IOC should form another group.
2. To remain status quo. The panel will continue to meet every 18 months. Next meeting is planned with the CO₂ Symposium in Japan in January 1999.
3. To disband the panel.
4. To re-structure the group into a synthesis group with new TOR to encompass JGOFS development. Watson supports this idea and re-structuring the panel with a focus on 3-D modelling to feed into the new synthesis phase in JGOFS.

The SSC was in favour of the latter and argued that there is a need to maintain the group to feed into JGOFS synthesis and place more effort into validating CO₂ models.

There has not been progress in GOOS. Merlivat was associated with GOOS and now that she is not on the SSC, this connection has been lost. Field reported of a recent GOOS meeting and that they are more receptive now because they are impressed by the suite of long-term measurements that BATS and HOT have available. Hall, Quiñones and Swanberg confirmed Field's impression as GOOS is focusing on the biological chemical side of global change and the role of the coastal zone. Watson also remarked that new instrumentation is making work easier.

There was a consensus from JGOFS to continue the panel. Fasham then asked Watson to write new TOR and revise its membership to reflect the panel's new direction and submit them to IOC and SCOR for approval.

ACTION 22: The CO ₂ panel will present new TOR and membership to IOC and JGOFS/SCOR for approval.

New Business

IGBP-Wide Synthesis

Swanberg reported that the synthesis process would be a challenge for all Core Projects, including JGOFS. The process of synthesis goes beyond that of comparison and interpretation of information gathered during fieldwork and/or experiments. Swanberg recalled that the GCTE experience during their first synthesis exercise, which took 18 months and two workshops to published its first GCTE Synthesis book.

The results from the IGBP-wide synthesis (composite of inter-project and intra-project syntheses) will set the path for IGBP's new direction. He emphasised that the synthesis product should be primarily targeted to the scientific community, but certainly orientated, especially in the executive summary, somewhat towards the user community, policy sector, research councils and the non-scientific public. JGOFS and other core projects should commit themselves with statements to attract the attention of the public. JGOFS researchers should be more proactive, and modelling exercise should reach the political sphere. It is important to use direct speech. Synthesis statements should be projections based on solid science. Fasham mentioned that this approach was useful for securing new funding and a necessary process in order to show how JGOFS is achieving its objectives.

Swanberg reported that the draft five-year plan that the SSCs received earlier needed extensive revision. Although there is a need to produce another working document, the IGBP-SC decided not to do the five-year plan, and suggested to IGFA that it would be better to focus on the synthesis, which IGFA agreed.

13th SC-IGBP Meeting

Fasham reported that the IGBP plans to initiate a series of synthesis exercises in the Core Projects. This effort should ultimately lead to a programme-wide synthesis, published volumes in the CUP series and a series of glossy brochures in the new IGBP Science series, of which the GCTE document is the first. To launch this effort the IGBP Officers decided to allocate \$160 K to support synthesis-specific activities based on proposals from JGOFS, BAHC, IGAC and PAGES. The Core Project synthesis should build towards the IGBP Congress in Yokohama, May 1999 where synthesis within IGBP will be the major theme. Each Core Project synthesis should produce a CUP book and a volume in the new IGBP Science Series. IGBP invites the four Core Projects to bid for funds up to \$40K each to aid the task and to present their plans for synthesis at the IGBP Congress.

Second IGBP Congress, Yokohama, May 1999

Swanberg briefed the SSC on the second IGBP Congress. The venue will be Shonan Village, near Yokohama, Japan. All are strongly encouraged to attend the entire Congress. The suggested arrival is 6 May 1999 and departure on 14 May 1999. The agenda is not ready yet, but we tentatively plan:

May 6 th	Arrival
May 7 th	SSC meetings
May 8 th	Overview: Programme
May 9 th	Plenary on Synthesis
May 10 th -12 th	Synthesis sessions
May 13 th	SSC meetings
May 14 th	Departure

He urged each SSC to use the next SSC meeting to discuss the Congress, develop suggestions for its content and a list of participants from the Programme Element.

IGBP is planning this event so that approximately half of the participants will be members of IGBP SSCs and the SC-IGBP, and half will be focus, activity and task leaders of Programme Elements. The event will be partly subsidised by the host, but the host needs to seek funds in Japan for the event, and they need to do so for an agreed number of participants. It is thus essential that IGBP know as soon as possible who will be attending, or at least how many from each programme element and who is being asked to pay for their participation. There is a risk that last minute ad-ons over the agreed number of participants will have to pay the full cost of their participation (*i.e.* no subsidy).

There is a major Japanese holiday just before the Congress, so it is essential that everyone plan well in advance for airline tickets. Last minute tickets to Japan can be very expensive and we will not be in a position to pay above the apex rates.

IGBP expects that the full JGOFS SSC will attend and other designated members involved with the implementation of JGOFS Synthesis. There will be some constraints and a few closed meetings for the different programme elements, probably at the beginning and end of meeting dates. The SC-IGBP expects groups to present summaries of synthesis programmes.

IGBP Secretariat asked that JGOFS provide an indication of the number of people who will be applying for subsidy funds from the Japanese Agencies. JGOFS SSC estimated that 35 participants would attend. Fasham asked for suggestions to the Congress agenda. Agenda suggestion: JGOFS proposed that the international SSCs meet together with the Japanese steering committees or have “opened” SSC meetings for national committees.

ACTION 24: Hanson will inform IGBP secretariat as quickly as possible the total number of JGOFS participants attending the IGBP Congress.

IGBP Open Science Meeting

Swanberg reported on IGBP Open Science Meeting, which would be open to the entire scientific community. This could entail an Open Science Meeting of ALL Core Projects. However, this is not envisioned as a regular event. It is expected the attendance of several thousand people and could be of sufficient high profile to attract considerable media attention. IGBP proposed to hold this meeting concurrently with SAC VI in the fall 2000 in, *e.g.*, Washington, DC. This would provide a substantial, global science agenda for SAC and serve to mark decisively the importance of Global Change Science at the beginning of the next century.

JGOFS synthesis plans and future meetings

After the SSC discussed the draft synthesis plans prepared by Fasham (**Appendix D**), they broke into sub-groups to discuss the plan, the basis for the JGOFS synthesis book and the glossy brochure. Swanberg stressed that the discussion on synthesis should be internally consistent with chapters in the book. It was forthcoming in the discussion that the book would not only be aimed at the oceanographic community, but also scientists interested in global change and terrestrial issues. There was also an agreement that in the preparation of a glossy brochure, that it should contain JGOFS achievements and highlights for obtaining funds for the synthesis phase. The groups adjourned and came up with the final version of the JGOFS synthesis plan for the SSC Synthesis Workshop (October, Southampton, UK)

ACTION 25: SSC will prepare 'white papers' for the building of a brochure in time for the Synthesis Workshop in October

Second JGOFS Open Science Conference (Plans)

Hanson presented the initial plans for the conference in Bergen, Norway. Briefly,

Time: mid April 2000

Duration: 5-6 days

Convention Centre: 300 to 350 participants
Hotel Arrangements: 350 rooms (\$75-150 USD/night) (Attendees)
Coffee/Tea All mornings and afternoons (Conference Fees)
Luncheon: one day (Sponsor)
Conference Dinner: one night (co-Sponsor)
First Night Social: Arrival reception (Sponsor)
Evening Receptions: Conference Reception (Sponsors)
Mayor's Reception: during conference (Mayor)
SAS Special Fares: Conference Participants (?)
Conference Materials: Handbags, etc. (Conference Fees)
Conference Announce: Convention Plus (IPO Funds)
Transportation: Local (Attendees)
Excursion: Norway in a Nutshell (*ca.* \$60/person)

There is a need to set up an organising committee soon for further planning. This committee should include Fasham (JGOFS chair), Hanson (IPO) and a representative from JGOFS-Norway. Further appointments for the committee and programme development should be carried out at the next Executive meeting (October 1998). Bathmann stressed the importance of arranging Conference hotels for students.

ACTION 26: IPO will ensure a good number of inexpensive rooms for students.
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SOLAS (Surface Ocean and Lower Atmosphere Study)

Watson reported on SOLAS, a potential project of SCOR and IGBP, which has come from the scientific community. The goals of SOLAS address the important interactions of the marine biogeochemical system, the atmosphere, and climate, and how this system affects and is affected by past and future climate and environmental changes. To ensure that observations are relevant to understanding important interactions, the project will be hypothesis driven and experimentally tested. For example, SOLAS may test the hypothesis that "marine sulphur emissions have a substantial effect on climate by influencing cloud albedo". Other possible hypothesis are "atmospherically derived iron stimulates diatom and other phytoplankton growth in "high-nitrate low-chlorophyll" regions of the ocean, which may exert significant feedback effects on climate" and "changing patterns of atmospheric nitrogen deposition consequent on increasing industrialisation will significantly influence the marine biota in some parts of the ocean". Both perturbation studies and studies of ongoing variations will be use to test these hypothesis by exploiting the variation of natural and man-made released of sulphur in the atmosphere, controlling the release of sulphur in the atmosphere, and controlling the release of nutrients in the ocean.

A discussion followed Watson's report on the relationship of SOLAS science to JGOFS ocean biogeochemistry, IGAC atmospheric chemistry and WOCE physical oceanography. Watson stated that he does not see how a project like SOLAS could begin without building on the programmes of IGAC, JGOFS and WOCE. The SSC also queried the timelines of SOLAS and that of IGBP future.

Swanberg commended Watson for his brief and clear representation of SOLAS and its near exclusive link to climate. As for the discussions of SOLAS within IGBP, they are sensitive and strategy unclear. First, if there is a SOLAS, IGBP anticipates a problem for future ocean-related programmes in global change research. Second, IGBP is shifting to IGBP-wide synthesis, and we may need to wait on synthesis. Third, it is too early to say anything about IGBP future. In conclusion, the IGBP SC recommended and encouraged SOLAS to develop stronger links to JGOFS.

IGBP Liaisons and Joint Projects

IGBP-DIS

Baliño reported on the 9th Meeting of the IGBP-DIS SSC in March 1998. One of the purposes of the meeting was to define the role of IGBP-DIS. To define DIS priorities over the next 3 years, the group established a set of criteria and priorities, which encompassed IGBP framework activities between 1998 and 2000. IGBP-DIS activities are divided in three foci: Data Set Development (Focus 1), Data Management and Dissemination (Focus 2) and Data Co-ordination in an International Context (Focus 3).

Focus 1: DIS has produced a series of global data sets (mostly related to terrestrial systems). The main recommendation was that DIS would assist in the IGBP synthesis phase by (i) ensuring that synthesis is one of the driving forces for data set production by IGBP-DIS; (ii) ensuring that the data for synthesis is being made public by helping Core Projects to get their data on-line; (iii) supporting the new GAIM synthesis phase oriented towards the 4 fundamental questions. Within this focus, Baliño took up the global CO₂ database issue to survey what sort of assistance they could provide to JGOFS. IGBP-DIS was positive to this and is open to discussions if JGOFS submits a concrete inquiry. The DIS-contact would be Ichtiague Rasool who indeed volunteered for the task.

Focus 2: This activity remained at an embryonic stage until recently due to lack of a leader. The newly appointed leader, Günther Schreier, prepared a draft document on future activities within Data Management. This document discussed in a sub-group with Baliño's participation. The rationale and recommendations formulated therein are succinctly presented below:

Rationale: The scope of metadata¹ in IGBP needs improvement, as data searches from IGBP Programme Elements (PE) are cumbersome. The existence of a central catalogue for IGBP data, on the other hand, would provide an outlet for IGBP scientists, the general research community and public. This is particularly important regarding synthesis and modelling phase within IGBP framework of activities for 1998-2000, e.g. facilitating inter-PE science, especially with regard to synthesis activities and by providing accountability of IGBP data sets and synthesis products. In addition, there is a need for data sets becoming available to back-up the assessment from the scientific community.

Recommendations:

- Create a dedicated search engine that harvest IGBP data information by accessing the www sites from all PE. The search engine will retrieve information on (i) data, e.g. metadata, data and products from synthesis and modelling activities (data set generation); (ii) development of application tools, e.g. models, (iii) Activities, e.g. meetings, workshops.
- Develop a set of standards for the display of the metadata at each PE www site ("template pages"). These standards will be defined by a so-called Expert Group with representation from DIS and each PE, tentatively, the Data Co-ordinators at the IPO
- Prepare a deliverable, e.g. a CD-ROM with information about data and synthesis products from each PE.

Regarding JGOFS data, the planned JGOFS Data Index (JDI) will connect directly to this search engine. The DMTT chair suggests that Baliño's participation in the Expert Group meetings would be as a truly liaison and that final JGOFS input would require DMTT ratification.

Focus 3: IGBP-DIS is an affiliate member of CEOS (Committee on Earth Observation Satellite). CEOS established WGISS (Working group on information systems and services) of which Gérard Szejwach is vice-chair and acts as liaison between space agencies and the user

¹Definition of metadata in this context: the information describing the availability and most important features of a data set, aiming to get a quick overview and support in the data selection process

community. The main activity of focus 3 is thus to map Core Project requirements of satellite data. The interaction with JGOFS has been limited because the function of Remote Sensing Task Team overlaps with that of DIS, in that it lobbies with space agencies to provide JGOFS scientists with satellite data. However, a liaison has been established through the IOCCG (International Ocean Colour Co-ordinating Group), a CEOS/IGBP-DIS activity, chaired by Trevor Platt. Specific tasks are currently taking place, such as an IGOS² demonstration projects: "Long-term Ocean Biology Measurements". Apart from this, it is not clear to IGBP-DIS what else they can do for JGOFS.

GAIM

Fasham reported on the Task Force meeting in Barcelona. The Task Force considered and discussed GAIM efforts and focus. They agreed that there was too much modelling and that GAIM functioned as a Task Team. They therefore decided to change its structure. GAIM SSC is now composed with a core group of people who are not members of the Executive group. They are asking people in strong positions to write papers that the SSC will review in February 1999. IGBP sees the need for a JGOFS and GAIM interaction. If it is not Fasham, then they suggest that a deputy be appointed.

ACTION 27: The Executives will recommend a JGOFS SSC representative to meet with the GAIM Task Force.

JGOFS and GAIM OCMIP activities

Monfray reported on the activities of the Ocean Carbon Modelling Inter-comparison Project (OCMIP), a task force of GAIM. Its main goal is to stimulate the development of carbon models. *Phase I (1995-1997)*

This was an IGBP/GAIM project. There are significant differences among models, especially models driven by simulated circulation models using different heat fluxes. Comparison of data and the results from four model predictions show that there are differences in the north-south structure. The differences on the east-west structure are, on the other hand, much larger than in the N-S structure. There are not only large discrepancies among models, but also between model prediction and observations. They expect that these differences will increase when long-term predictions are attempted. Until recently, the biology was simplistic represented and based on NPZD models: Michaelis-Menten dynamics and re-mineralisation in the deep dominated the forcing of the atmosphere over the biology of the euphotic zone. Biology has gained complexity but there is the difficulty between the biological world *versus* the physical world. Simulations from the equatorial Pacific show that there is a change in the biological scheme. Determining what is the dominant process, *e.g.* biology or physics is extremely important for the tuning of the models. The validation of the carbon modules was also emphasised.

Phase II (1998-2000)

This phase emphasis the importance of having a wide range of models to compare. The comparison exercise thus includes seven models: four from Europe (GOSAC), two from US OCMIP, 1 from Japan and 1 from Australia. OCMIP 2 is considered. Comparisons are important for inter-calibration and for the plausible future CO₂ disposal in deep sea. Models are able to simulate the disposal plume of the CO₂ injection.

Phase II have identified the following tasks:

²IGOS, Integrated Global Observation System, one of CEOS Analysis Group

- Study of inter-annual & decadal variability (ocean *versus* biosphere; natural *versus* anthropogenic impact)
- impact of changing the ocean circulation (atmosphere-ocean coupled runs)
- isolate the sensitivity of the ocean circulation and the biogeochemistry

The SSC agreed that these exercises are extremely important for JGOFS synthesis. However, they warned that although the inter-comparison would converge to models that would decrease discrepancies, they would not necessarily converge to reality, *i.e.* the real world. This is the major problem with model tuning.

Monfray proposed a joint task team between GAIM and JGOFS and for this team to organise an OCMIP workshop for early 1999. Communication with scientists having data was emphasised. Watson suggested to co-ordinate this activity with the CO₂ Symposium.

ACTION 28: SSC will form a joint task team on ocean carbon modelling between GAIM and JGOFS with full Terms of Reference and membership.

GLOBEC

Bathmann reported on GLOBEC, which published its Science Plan (IGBP Report #40) and has a web site. There is a major concern towards sharing and merging with GLOBEC data set. Fasham will talk with Harris about data management within GLOBEC. Bathmann proposed a formal link with GLOBEC with a proposed joint session (JGOFS/GLOBEC) at the IGBP Congress.

ACTION 29: Fasham will propose a joint session with GLOBEC (PICES) at IGBP Congress

BAHC/LOICZ/CMTT

Liu reported that the liaison between BAHC and JGOFS needs improvement. Sharing results from BAHC and LOICZ is possible since both are interested in nutrients.

ACTION 30: Hall/Fasham will look into BAHC programme, for shared data opportunities and consider proposing a joint session with BAHC/CMTT during IGBP congress.

START – No report provided **GCTE** – No report provided **IGAC** – No report provided
PAGES – No report provided **LUCC** – No report provided

National JGOFS Reports

Canada

Vézina reported good progress in synthesis after Phase I (92-95) with participation in international studies and regional process studies. Phase II, 95-98, concentrated on NE Pacific, and developed prognostic models of carbon flow in both systems (Phase I & II). Results communicated in a series of meetings during 97-98, and scientific publications in special volume of DSR are underway. Data Management of field data was re-organised and one person was assigned to archive and re-format the data for transfer to MEDS.

Preparing Phase III (1998-2001): plans to concentrate on the Labrador Sea. This phase will contribute substantially to our understanding of the biogeochemistry of carbon and related biogenic elements in this and similar ocean regions that are characterised by high biological productivity and deep convection. Such regions are often important for anthropogenic carbon sequestration and at the same time, are thought to be highly sensitive to climate change. Unfortunately, the government denied funds for the proposal to support Phase III, although they acknowledged the quality of the proposals. We will try again but if there are no funds available, Canada JGOFS will then concentrate in finishing the collection of the North Pacific data.

Platt warned the SSC of the seriousness of this defeat for the Canadian JGOFS. Unless there is a re-consideration, all infrastructures will disappear rapidly.

ACTION 23: Fasham will write a letter of support for Canadian JGOFS, stating that SSC profoundly regrets the decision that was made not to support the synthesis phase.

United Kingdom

Shimmiel reported that the UK has no longer a formal JGOFS project in operation now and all financial support for the national committee has ceased. However, there are a number of national programmes at various stages of the development that relate to JGOFS objectives, which allow us to continue the UK intellectual contribution to the international programme. The programmes listed below are principally supported at the national level by the Natural Environment Research Council with details and pointers on their web site and on the host institution sites of the programme co-ordinators.

- *ARABESQUE '94-'97*: The UK contribution to the JGOFS Arabian Sea Process Study. The UK carried out two cruises in 1994 that produced a substantial set of multidisciplinary data that will be published soon in a CD-ROM and available *via* BODC.
- *PRIME '94-'99*: Plankton Reactivity In the Marine Environment (Williams), studies a variety of biogeochemical processes associated with plankton, particularly in the north Atlantic where one major experimental cruise has taken place. Extensive use of meso-scale experiment supports this study. The programme is nearing completion with an annual science meeting having taken place in April 1998.
- *SES '95-'98*: Shelf Edge Study (Simpson and Huthnance) is carrying out work to the west of Scotland on the shelf break and slope. Although primarily driven by complex physics at this margin, substantial investment in a sediment trapping programme and water column/sediment biogeochemical coupling allows a range of JGOFS objectives to be addressed. Considerable cruise-based and remotely deployed instrument data is available. The programme is in synthesis stage with publication volume(s) due soon and accompanying CD-ROM data *via* BODC.
- *AMT '96*: Atlantic Meridional Transect (Aiken) is using passage on the James Clark Ross to and from the Falklands from the UK. A range of multidisciplinary studies that can be performed whilst the ship is underway are being completed. One principle objective is the gathering of instrumental data across biogeochemical ocean provinces to aid development of satellite algorithms of primary production.
- *BENBO '97-'00*: BENthic Boundary layer (Shimmiel) is examining three sites in the NE Atlantic characterised by strong seasonal export production under a variety of hydrographic regimes and water depths. Emphasis is placed on the bottom nepheloid layer, fluff layer and upper sediment mixed layer using sediment traps, current meters, bottom ADCP, benthic landers, and pressure incubation experiments. One "survey" cruise completed in July 1997, with two process studies at sea during pre- and post-bloom conditions in 1998.
- *MARINE PRODUCTIVITY '99* (Harris) is undergoing approval process now. Objectives include a range of studies on plankton, fish and pre-operational oceanography in the shelf seas of NW Europe to complement the GLOBEC programme.

The following are international projects (contact people in parenthesis):

- *OMEX I and II*: Ocean Margin Exchange (Wollast) is a EU programme under the MAST initiative studying the Goban Spur and Iberian margin areas. A multidisciplinary approach between member nations has produced considerable detailed data sets from a variety of

process study cruises over the past five years. A first set is now available on CD-ROM *via* BODC.

- *ASGAMARGE*: (Oost) Studies are gas exchange measurement at the ocean air-sea interface.
- *LUMINY*: (Nightingale) Lab experiments are using wind-wave tanks to examine gas exchange coefficients.
- *IMCORP*: (Watson/Merlivat) New instrumentation is for gas exchange measurements.

Discussions

Shimmiel stressed that the lack of financing makes it difficult for people to meet and therefore JGOFS related activities suffer from co-ordination. However, there is a lot of modelling work going on. Bathmann asked whether there is a possibility of setting up a new programme which is basically doing JGOFS work but with a new name, in order to receive funding for modelling and synthesis? Fasham agreed that that could be a possibility in getting around the funding agencies.

Germany

Bathmann reported that the fieldwork is winding down and German JGOFS is starting the synthesis and modelling phases of its programme. The German JGOFS programme has activities in three ocean basins: North Atlantic, Indian Ocean and Southern Ocean with secured funding until year 2000. The data management position in the German JGOFS office was also extended until 2000. If the process of synthesis goes beyond this, the national JGOFS programme will have to seek new funding. There are three working groups: (i) CO₂ exchange between atmosphere and the ocean; (ii) pelagic carbon budget; and (iii) budget of carbon flux between surface water and sediment. There will be a model of the nitrogen cycle in the Arabian Sea available, which will be developed further by the IO group in Warnemünde. The Deep Ocean Flux task team maintains contact with PAGES, with plans for the first meeting. We are presently working on benthic boundary layer in the Atlantic and a 2-year project for compilation and analysis of data (ADEPD). A web page is being implemented and it will be link to the JGOFS international homepage.

The German JGOFS committee led by Wefer meets once a year (November) at Bremen University and is attended by German funding Agencies.

China-Beijing

Hong reported that the Chinese JGOFS committee was formed in 1989 and presently active in JGOFS as well as in LOICZ research. These two committees will be combined later this year to reflect the focus of Chinese research on marginal sea flux study.

Highlights of the JGOFS programmes

- Margin Flux in the East China Sea (MFLECS), key project for the 8th Five-year of the China State Planning (1992-1995)
- Material Flux in the East China Sea (MAFLECS), a China-Japan joint programme was developed for a six year period (1992-1999)
- Key Processes of Ocean Fluxes in the East China Sea (POFLECS), National Science Foundation of China (NSFC) key project (1996-1999), as the first oceanographic key programme for the 9th Five-year of the State Planning
- Primary productivity and its controlling mechanisms in the Taiwan Strait, another NSFC key project (1994-1996)
- Biogeochemical processes of Biogenic elements in the Taiwan Strait, another NSFC key project (1997-2000)
- More than 20 NSFC smaller projects related to JGOFS have been funded since 1992. Moreover, two international workshop/symposiums were held in Qingdao, China

Hong stressed that it was important to co-ordinate and share information between the China, Japan, Korea and Taiwan.

USA

Ducklow reported that the USA field programmes are winding down, and a major new initiative, the US Synthesis and Modelling Project (SMP), started in 1998. Its central objective is to synthesise knowledge gained from US JGOFS and related studies into a set of models that reflect our current understanding of the ocean carbon cycle and its associated uncertainties. Emphasis will be given to processes that control partitioning of carbon among oceanic and the implications of this partitioning for exchange between the ocean and the atmosphere.

Chile

Quiñones presented a summary of the JGOFS-activities in the Humboldt Current System off Chile. From 1992 to 1997, JGOFS research was conducted mostly in central/north Chile (Coquimbo, 30°S; 15 short cruises) and was funded by SAREC (Sweden) as a joint Chilean/Swedish initiative. Scientists from Germany were also involved in this effort. In 1997, the National Commission of Scientific and Technological Research (CONICYT, Chile) funded a special programme (FONDECYT Sectorial N° 5960002) to conduct a study on carbon fluxes off the coast of northern Chile (Antofagasta, 23° S). Two cruises were conducted in 1997 during pre-El Niño (January/February), and El Niño (July) conditions.

Recently, Chilean JGOFS scientists have obtained financial support from CONICYT for a 3 year grant (1998-2000; 1.7 million dollars), called "Circulation and physical-biological interactions in the Humboldt Current System and their impact upon regional biogeochemical cycling" (FONDAP-Humboldt). The research sites are located at the shelf and deep water off central/south Chile (36° S) and northern Chile (20°S). This comprehensive biogeochemical study will put special emphasis on: (i) the subsurface oxygen minimum layer, (ii) the benthic-pelagic coupling, (iii) the fate of primary production, (iv) the dynamics of benthic communities dominated by bacterial mats (*Thioplaca*) and (v) the remote *versus* local physical forcings in the Humboldt Current System.

The research is multidisciplinary and will combine cruises, permanent moorings and remote sensing. Three major pelagic research cruises are planned for the period 1998-1999. Scientists from seven countries have committed additional scientific and financial support to the FONDAP-Humboldt. It is expected that this research programme will also generate links with LOICZ and GLOBEC.

Japan

Saino reported that Japan has begun a North Pacific Process Study (NPPS) and that it will continue for the next 4 years. Research projects include:

- Study of the Sub-arctic Gyre Experiment (SAGE) 1997 -;
- A monitoring programme with Canada;
- Northwest Pacific Carbon Cycle Study (NOPACCS) 1990-1996;
- Ocean Fluxes: their Role in the Geosphere and Biosphere (1991-1993);
- Marginal Sea Flux Experiment (MASFLEX) 1992-1997; and
- The time series station KNOT (Kyodo Pacific Ocean Time Series) in the western North Pacific. KNOT activities started in 1998 and have funds throughout 2000.

Japan JGOFS implemented a web site at Nagoya University: <http://pon.ih.s.nagoya-u.ac.jp/>. The committee also established the Data Management Office at the Japan Oceanographic Data Centre (JODC, web site: http://www.jodc.jhd.go.jp/JGOFS_DMO/index.html). Handa informed the SSC that Japanese CO₂ data are at NOAA, not CDIAC (Carbon Dioxide Information Analysis Center).

Spain

In a message from Duarte, Hanson reported that Spain is trying to bring the JGOFS community back to life. Due to lack of resources, the first National IGBP Committee was totally non-functional and a new Committee has been set up. There are hopes that this time, resources will be targeted to ensure Spanish participation in JGOFS, at least for a minimum contribution to the JGOFS data set.

China-Taipei

Liu reported that the Kuroshio Edge Exchange Process (KEEP) project started its third phase in August 1997 and will continue until July 2000. After KEEP, scientists are planning a new biogeochemistry programme of the South China Sea, which can be coupled to PAGES. In addition, scientists are considering a long-term observation programme of the South China Sea and its biogeochemical parameters. There is a close link between KEEP and the CMTT, and KEEP maintains the CMTT homepage in its own web site. Biogeochemical modelling project for the East and South China Seas has been developed in the KEEP project, and it will continue after the fieldwork is completed in 2000.

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Norway

From the Norwegian JGOFS Committee Meeting, Hanson reported that the committee was revitalized by appointing a new chair (Prof. Ulf Lie) and members. In March, the committee put together a series of funding proposals to the Norwegian Research Council for the synthesis of the Norwegian-JGOFS data sets until 2002. The IPO has also assisted in the process towards the centralisation of the JGOFS data in one database. The database with interface to the WWW will be developed by the Institute of Marine Research in Bergen (proposal), who agreed to function as a topical data centre for JGOFS-Norway. A proposal for a pilot project in 1999 will be sent in June.

Australia

Tilbrook reported that the Australian JGOFS programme has a field programme to study the development of a large seasonal drawdown of CO₂ in the sub-Antarctic zone. This is the largest sink for CO₂ in the oceans. The major part of the works will be carried out on a cruise in March 1998 with participation of scientists from USA, France, Belgium, New Zealand and South Africa. The region is of some significance because the water mass formation in the region (Antarctic Intermediate Water and Mode Water) is likely to be significant for pumping CO₂ from the surface ocean to the deep sea. There are also efforts devoted to the developing of 3D-carbon models

New Zealand

Hall reported that a New Zealand scientist took part in an Australian-led voyage to the Subantarctic Pacific south of Australia in March 1998. The two-ship programme aimed to investigate the physics, and biogeochemistry of the Subantarctic Frontal Zone. One vessel, the Southern Surveyor carried out a detailed physical survey of the SAF, while the Aurora Australis conducted time-series process stations to the N and S of the SAF. Deep-moored sediment traps

were recovered from each site. Deck board perturbation experiments were conducted in order to investigate the effects of Fe supply/light climate on phytoplankton processes and Fe/Silicate supply on phytoplankton processes.

In April, a cruise was conducted in the subtropical convergence region to the east of New Zealand to investigate the relationship between the physics and the distributions of macro-, micronutrient, chlorophyll *a* and phytoplankton physiological status.

A winter process cruise was conducted in August in the sub tropical and sub antarctic waters in the subtropical convergence region to the east of New Zealand. This was one of a series of cruises in this region to evaluate the seasonal changes in carbon fluxes in the region. A final cruise in this series is planned for February 2000. A synthesis of earlier studies has just been published in JPR.

Intercomparison of pCO₂ equilibrators was conducted in Japan. The experiment was organised by the Japanese National Institute of Environmental Studies and involved groups from NIES, GEF, NMRL, NRIFS, Kimoto Electric (Japan), NOAA-PMEL (USA), and NIWA (NZ). The accuracy and response times of each system were compared under a range of conditions.

Monthly transects across the sub tropical convergence off the coast of Otago have been conducted with measurements of pCO₂, pH, alkalinity, nutrients and fluorescence. It is anticipated that this time-series will continue for at least several more years. A mixed-layer model is being developed to assist with data interpretation and future experimental design.

Two cruises studying Ocean/atmosphere interactions in the southern ocean to the Southeast of NZ have been completed in the past year. In particular, continuous measurements of surface water pH and pCO₂ are being made with samples taken regularly for measurement of alkalinity and nutrients. Additionally nutrients, alkalinity and pH are measured on-station for samples taken through and beyond the fully mixed layer. Total inorganic carbon will be measured on selected samples. Two further cruises are planned for 99/00.

South Africa

Field reported that there is no special funding devoted for JGOFS research. Current JGOFS-related projects are Benguela Ecology Programme (1992-2000), Southern Ocean (1991-1996 and 1997-2000), and Benguela Current Large Marine Ecosystems (BCLM).

France

Monfray reported that the JGOFS programme in France is now called PROOF (**P**rocessus biogéochimiques dans l'**O**céan et **F**lux) and will be active in the coming 5 years. This is a break up from the regional focus that the previous JGOFS programme had.

Kerfix Time Series station

Jeandel updated the IPO on the activities at Kerfix: The future of the French Kerguelen Time-Series Station looks good. The French Polar Institute (IFRTP) founded Park's proposal. The project's name is CLIOKER and its will focused on the hydrological properties of the water column over 10 years. The plan is to occupy the Kerfix station monthly and a second site, located closer to Kerguelen, which is also in the Polar Front itself. The IFRTP scientific committee examined the project on 16-17 December 1997.

JGOFS International Project Office (IPO)

Villefranche book (status)

Hanson reported that the review and chapter editing would be completed by June and then sent to Cambridge University Press for production and publication.

Future Plans

Hanson reported that the closing date of the IPO is 31 Dec 1999. Next month, Hanson, Lie and Johannessen will ask the Norwegian Research Council to consider support through the synthesis phase (2003). Hanson asked the SSC if JGOFS should seek an alternative host country or wait for a decision from Norway before we approach other countries. LOICZ had just managed to extend the support of the IPO in the Netherlands for a second term. It would be an idea for Hanson to visit LOICZ IPO and to draft JGOFS plans after theirs and also cover the issue of coastal CO₂ sinks/sources in LOICZ.

ACTION 31: Hanson will visit the LOICZ IPO this summer. Issues to be address are LOICZ IPO strategy for a second term in The Netherlands and LOICZ plans to address the role of the continental margins in the CO₂ flux.

Support for future meetings

Executive will discuss and allocate funds at the next Executive meeting in Southampton. Any requests for meetings must be sent to the IPO before 25 October.

Adjourn

Fasham closed the 13th JGOFS SSC, extending his gratitude for their patience. He emphasised that the SSC achieved a major break through in refocusing JGOFS efforts toward synthesis and modelling. In the coming months and years, their efforts will be well noted. Fasham thanked especially John Field for arranging the science talks during the meeting and the dinner at his home, and assisting those participating in the field trip to Kruger National Park, which will provide special memories of South Africa. Once again, he thanked the assistance of the IPO and Heidi Winckler during the meeting and all those involved and declared the meeting adjourned on April 28 at 18:00.

Appendices

Appendix A: Participants List and Addresses

Participants

Graham Shimmield (UK)
Andrew Watson (UK)

Scientific Steering Committee

Michael Fasham (Chair, UK)
Ulrich Bathmann (Germany)
Alex Bychkov (Russia)
Hugh Ducklow (USA)
John Field (RSA)
Julie Hall (New Zealand)
Huasheng Hong (China-Beijing)
Kon-Kee Liu (China-Taipei)
Roy Lowry (UK)
James Murray (USA)
Trevor Platt (Canada),
Renato Quiñones (Chile)
Toshiro Saino (Japan)
Egil Sakshaug (Norway)

International Project Office

Roger B. Hanson (EO)
Beatriz Baliño (AEO)
Judith R. Stokke (AO)

Guests

Neil Swanberg (IGBP Secretariat)
Patrick Monfray (GAIM Representative)
Nobuhiko Handa (Japan Chair)
Alain Vézina (Canada Representative)

Regrets

Peter Burkill (UK)
Karin Lochte (Germany)

Addresses

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Appendix B: North Atlantic Synthesis Group

Report by Fasham

First Meeting of the JGOFS North Atlantic Synthesis Group
Southampton Oceanography Centre
Southampton, United Kingdom
11-13 May 1998

In Attendance

North Atlantic Synthesis Group

Michael Fasham	Southampton Oceanography Centre, UK (Chairman)
Helge Drange	Nansen Centre, Norway
Hugh Ducklow	The College of William and Mary, US
Véronique Garçon	Groupe de Recherche de Géodésie Spatiale, Toulouse, France
Wolfgang Koeve	IfM, Kiel, Germany
Roy Lowry	British Oceanographic Data Centre, UK
Laurent Mémery	LODYC, Paris, France
Fiz F. Pérez	Instituto Investigaciones Mariñas, Vigo, Spain
Dave Siegel	Univ. of Santa Barbara, US
Doug Wallace	Brookhaven National Laboratory, US

Guests

Richard Lampitt	Southampton Oceanography Centre
Tom Anderson	Southampton Oceanography Centre
Philippe Pondaven	Southampton Oceanography Centre
Ian Totterdell	Southampton Oceanography Centre

Monday 11 May

Howard Roe, Deputy Director of the Southampton Oceanography Centre, welcomed the group members.

The history of the development of the group was summarised by Fasham and there was a general discussion of the aims of the meeting and the longer-term aims of the group. The Group Terms of Reference were considered and were thought to be an acceptable framework apart from the references to the Global Synthesis and Modelling Task Team, which was disbanded at the last SSC meeting.

Presentations of national programmes were given describing work on synthesis and modelling but also providing the latest information about ongoing and planned cruise programmes and time series observations. Summaries of these talks are given in Appendix 1.

Doug Wallace gave an update on the status of the JGOFS/WOCE global CO₂ survey. Much of the data has now been worked up and is being deposited in a database run by the Carbon Dioxide Information and Analysis Center, Oak Ridge National Laboratory, US. Full information and data can be accessed on the web (<http://cdiac.esd.ornl.gov/oceans/home.html>).

Tuesday 12 May

Discussion: The carbon balance in the North Atlantic

Doug Wallace gave a talk showing how the results from the JGOFS/WOCE global survey could be used to calculate the transport of total and anthropogenic CO₂ within the North Atlantic. Using data from 5 zonal sections occupied in the South Atlantic Ocean between 10°S and 30°S, including three new WOCE-era (JGOFS CO₂ Survey) sections, the meridional transport of TCO₂ was estimated. Transports were calculated based on the geostrophic velocity field derived from the section data, the geostrophic Ekman transport derived from climatological wind-stress data and from the barotropic velocity field derived from an inverse model analysis. The overall transport of TCO₂ is very sensitive to the detailed specification of the barotropic velocity field, and at some latitudes, the specification of the Ekman transport introduces a significant uncertainty.

Separate calculations were made for the transport of contemporary levels of total inorganic carbon, and the transport of the anthropogenic, or "excess" component of the TCO₂. The inverse model analysis suggests the following:

1) There is net southwards transport of TCO₂ across all ocean sections. A large portion of this transport is associated with the net mass (water) transport across each section required to balance the Bering Strait transport minus the cumulative (E-P) for the North Atlantic Ocean;

(2) The local storage term for anthropogenic CO₂ can be estimated from time-series observations of CO₂ inventories and by preformed CO₂ calculations;

(3) There is no significant convergence or divergence in the contemporary TCO₂ transport between 10°S and 30°S. Hence the local storage term is approximately balanced by local air-to-sea CO₂ transfer. Within the (large) uncertainties, this is consistent with a completely independent estimate of the net sea-to-air CO₂ flux for this region estimated by Takahashi *et al.* (1997) based upon surface pCO₂ data;

(4) There is an opposing, northwards transport of anthropogenic CO₂ at these latitudes. This northwards transport increases towards the north. Together with the net storage term for anthropogenic carbon in this region, this implies that there is a considerable net uptake of anthropogenic CO₂ from the atmosphere between 30°S and 10°S;

(5) Subtraction of this anthropogenic component of the transport from the total, and assuming a zero CO₂ storage term (steady state) for the pre-industrial ocean, implies that this region was a moderate source of CO₂ to the atmosphere during pre-industrial times;

(6) Comparison of the net transport through the South Atlantic with that through the Bering Strait gives strong evidence for a net divergence of the southwards TCO₂ transport within the North Atlantic and Arctic Oceans. The divergence and the local storage term are balanced by net air-to-sea CO₂ transfer across the air-sea interface and partly by riverine inputs. The net air-to-sea CO₂ exchange inferred from this closely matches that estimated by Takahashi *et al.* (1997) based upon surface pCO₂ data;

(7) The northwards transport of anthropogenic carbon across 10°S supplies ~50% of the anthropogenic CO₂ that is currently accumulating in the North Atlantic Ocean. This implies that the net air-to-sea transfer of anthropogenic CO₂ locally within the North Atlantic basin is significantly lower than has been suggested by some model simulations;

(8) The pre-industrial budget for the North Atlantic suggests that this region was a strong sink for CO₂ in pre-industrial times.

The significance of this research lies in its demonstration that a coupled analysis of oceanic CO₂ data and mass transports allows for independent estimates of the net air-to-sea flux of CO₂ in the present-day ocean and for the pre-industrial ocean. To the best of my knowledge this is the only method available to separate out the anthropogenic perturbation of the air-to-sea flux from the natural' (*i.e.* pre-industrial situation). This type of separation into a natural and perturbed air-to-

sea flux is critical to an assessment of the fate of anthropogenic CO₂ globally using inverse models of the atmospheric transport.

The transport calculations and inverse models are non-trivial and prone to significant uncertainty. Issues such as seasonality and sensitivity to model constraints and complexity need to be thoroughly explored. There is a wealth of data and models available for the North Atlantic that could be used to further explore these calculations and their associated problems. However to make progress requires strong co-operation between physical oceanographers who are familiar with the necessary tools, and the ocean CO₂ community who are aware of the important questions and may have insight into additional constraints that can be used. This area therefore requires crosscutting synthesis between WOCE and JGOFS.

A more detailed discussion of the underpinnings for the arguments summarised below can be found in a manuscript by Holfort *et al.* (Global Biogeochemical Cycles, In Press). Preprints are available on request from me (wallace@bnl.gov, now dwallace@ifm.uni-kiel.de).

Hugh Ducklow gave an update on attempts to develop carbon budgets for selected sites. Since completion of the JGOFS NABE Pilot Study, and with ongoing time series observations at the BATS site off Bermuda, there have been several attempts to budget observations of carbon flux in North Atlantic waters (Bender *et al.*, 1992; Michaels *et al.*, 1994; Ducklow *et al.*, 1995). Two general approaches have been attempted: Bender *et al.* estimated net production from observed changes in nutrient inventories at the NABE site, and tried to balance the production with observed or estimated POC accumulation and sediment trap export. Michaels *et al.* and Ducklow *et al.* tried to balance observed changes in the TCO₂ inventory at BATS and NABE respectively, with accumulation, export and transport of DOC as well as POC. All attempts suggest tantalising degrees of success but overall, indicate shortcomings in both observational and analytical capability, and in conceptual understanding of the carbon cycle in the NA region. Budgeting the NABE site has been hampered by a lack of reliable DOC data. BATS budgets have been complicated by uncertainties in particle export estimates and the importance of net physical transports (particularly mesoscale processes). New observational and modelling techniques made in conjunction with the ongoing BATS operations should be a component of JGOFS synthesis as well as future ocean biogeochemical research. DOC measurements in the NABE region remain a key priority for better understanding of the North Atlantic carbon cycle.

Véronique Garçon presented some results from a basin-scale 3D eddy-resolving ecosystem model that has been used to quantify the impact of mesoscale eddies on primary production in the North Atlantic. In a steady state, the export of photosynthetically fixed organic matter to the deep ocean has to be balanced by an upward flux of nutrients into the euphotic zone. Particularly in the subtropical ocean, geochemical estimates of nutrient supply have been substantially higher than direct biological and physical measurements. A possible explanation for the apparent discrepancy is that the sampling of *in situ* measurements has under-represented episodic nutrient injections by mesoscale eddies, whereas geochemical tracer budgets provide flux integrals over long time and space scales. We have investigated the eddy-induced nutrient supply by combining remotely sensed surface observations and numerical modelling, two methods potentially capable of delivering synoptic descriptions of the ocean state on a basin scale. The eddy-resolving coupled ecosystem-circulation model used here is a nitrogen based, four component (N-nitrate, P-phytoplankton, Z-zooplankton, and D-detritus) pelagic ecosystem coupled with a 1/3° resolution model of the North Atlantic derived from the WOCE Community Modelling Effort. Sea-surface height data from the simultaneous TOPEX/Poseidon and ERS-1 altimetric missions are assimilated into the coupled ecosystem-circulation model of the North Atlantic Ocean. Our results indicate that mesoscale activity accounts for about one third of the new primary production in the subtropics and mid-latitudes. This is not sufficient to

maintain significant levels of primary production in parts of the subtropical gyre, where alternative routes of nitrogen supply will have to be considered.

To investigate how well we can describe and explain the seasonal cycle of production in the different domains of the North Atlantic ocean, a rough preliminary comparison between simulated nitrate, phytoplankton (as chlorophyll), zooplankton and primary production levels from the 3D coupled model and observations collected along the Atlantic Meridional Transect (AMT, 20°W, from 10°N to 47°N, boreal spring and autumn) was presented.

A means of assimilating satellite ocean colour data in the coupled 3D ecosystem-circulation model has been developed to achieve the following three objectives: 1) to determine the relative sensitivities of different biological parameterisations to surface chlorophyll concentration data, 2) to make better estimates of poorly known biological model parameters in the various dynamical biogeochemical provinces, and 3) consequently to improve our estimates of oceanic primary and export production. A cost function measures the misfit between observed surface chlorophyll and modelled surface phytoplankton concentration. The control variables for the minimisation of the cost function are biological parameters. Simulated observations are taken while following several floats over a six-month period seeded in different regions of the North Atlantic model domain (trade wind, westerly wind and polar domains). Twin experiment results show some geographical dependence of the sensitivity of the parameters to surface chlorophyll data: relative insensitivity of Z parameters at low latitudes, relative insensitivity of N, D parameters at high latitudes due to light-limited P growth and high sensitivity of P mortality rate over the whole domain.

A more detailed discussion of some of the results presented below can be found in manuscripts by Oschlies and Garçon (Nature, in press) and Gunson *et al.* (draft manuscript). Both are available on request (garcon@pontos.cst.cnes.fr).

Ian Totterdell gave a presentation of preliminary results from the SOC/Hadley Centre 3D ocean carbon cycle model. This model explicitly models the biological pump using a four-component ecosystem model (phytoplankton, zooplankton, detritus and dissolved inorganic nitrogen). The model results were compared with global estimates of primary production derived from satellite ocean colour data, and GEOSECS/TTO nutrient and TCO₂ data. Overall considering the coarse resolution of the model (2.5°x3.75°), the results are encouraging. However, the model does have a serious drawback in that, over long timescales, nutrients in the northern North Atlantic become seriously depleted compared to observations. This problem is under investigation but may be related to the model circulation pattern.

Richard Lampitt described some recent work on synthesising published data on deep ocean particle fluxes to determine regional trends and seasonal variability (Lampitt & Antia, 1997). Organic carbon flux data normalised to a depth of 2000m exhibits a range of an order of magnitude in areas outside the polar domains (0.38 to 4.2-g m⁻² y⁻¹). In Polar Regions, the range is wider (0.01-5.9 g m⁻² y⁻¹). Latitudinal trends are not apparent for most components of the flux although calcite flux exhibits a poleward decrease. Limited data from Polar Regions show fluxes of opaline silica are not significantly higher than elsewhere.

The variability of flux over annual cycles was calculated and expressed as a Flux Stability Index (FSI) and the relationship between this and vertical flux of material examined. Somewhat surprisingly, there is no significant relationship between FSI and fluxes of dry mass, organic carbon, inorganic carbon or opaline silica. At each site, net annual primary production was determined using published satellite derived estimates. There is a negative but weak relationship between FSI and the proportion of primary production exported to 2000m (e₂₀₀₀ ratio). The most variable of the non-polar environments export to 2000m was about twice as much of the

primary production as the most stable ones. Polar environments have very low e_{2000} ratios with no apparent relationship to FSI but there are large uncertainties about the level of primary production in these regions.

At primary production levels below $200 \text{ g C m}^{-2} \text{ y}^{-1}$ there is a positive correlation between production and organic carbon flux at 2000m but above this level, flux remains constant at about $3.5 \text{ g C m}^{-2} \text{ y}^{-1}$. A curve derived to describe this relationship was applied to estimates of annual primary production in each of 34 of the open ocean biogeochemical provinces proposed by Longhurst *et al.* (1995). Globally, open ocean flux of organic carbon at 2000 m is 0.32 Gt yr^{-1} which is 1% of the total net primary production in these regions. This flux is nearly equally divided between the Atlantic, Pacific and Southern Oceans. The Indian and Arctic oceans between them only contribute 5% to the total.

The eight planktonic climatological categories that were proposed by Longhurst (1995) provided a most useful mean of examining the data on flux and its variability. A characteristic level of FSI was found in each category with highest levels in the tropics and lowest levels in the Antarctic. There is also a characteristic level of export ratio in each category with the highest in monsoonal environments (1.9%) and the lowest in Antarctica (0.1%).

Update on Data Management and availability

Roy Lowry summarised the present status of data availability and discussed future developments.
JGOFS North Atlantic Data

a) North Atlantic Bloom Experiment

A merged water bottle data set is available from BODC. Note that the German data have been reworked since this product was prepared.

National data sets are available as follows:

USA	Available on the Web (http://usjgofs.whoi.edu/research/nabe.html)
UK	Available on CD-ROM from BODC
Germany	Available from German JGOFS DMO
Netherlands	Available via Netherlands Oceanographic Data Committee (NODC)
Canada	Available from MEDS

Note that the NODC is a fledgling organisation and their capability to deliver data has yet to be tested.

b) Other Data Sets

BODC data holdings include several North Atlantic data sets besides NABE that may be of interest to JGOFS:

1990 and 1991 BOFS cruises
1991 VIVALDI North Atlantic survey
IfM Kiel Sea Rover data set
1996 and 1997 ACSOE cruises
PRIME data set including OWS India time series
OMEX I project data set

Germany, the Netherlands and Canada also undertook post-NABE national JGOFS cruises in the North Atlantic. Data sources are as given for NABE. The majority of the data from the BATS time series are available on the Web (<http://www.bbsr.edu>).

Data from the French EUMELI and MEDATLANTE projects are to be managed through the newly formed French JGOFS data management committee. Their current capability to deliver data is not yet known. EUMELI CTD data have been lodged with SISMER and are therefore readily available.

National JGOFS Data Management Contacts

USA	Chris Hammond, WHOI
UK	Roy Lowry, BODC
Germany	Thomas Mitzka, IfM Kiel
Canada	Graham Glenn, MEDS
France	Marie-Paule Labaied, Villefranche
The Netherlands	Cok van Bergen Henegouw, NIOZ

JGOFS Data Location Systems

JGOFS currently has a cruise inventory, a list of JGOFS and JGOFS-related cruises by field area, mounted on the IPO Web site (<http://ads.smr.uib.no/jgofs/jgofs.htm>). The cruises are hot linked to the home pages of the data holding organisations wherever possible.

The weakness of the Cruise Inventory as a data location tool is that it is cruise-based. Following up the data from several hundred cruises one by one is a laborious process. Consequently, it has been proposed that the Cruise Inventory be replaced by a relational parameter-level inventory, christened the JGOFS Data Inventory (JDI). Progress developing this has been disappointingly slow due to resource problems.

Prognosis for All JGOFS Data on the Web

The prognosis depends upon what is meant by 'one the Web'. If this is taken to mean all JGOFS data served over the Web through a uniform interface then the prognosis is a very definite no. The only way such uniformity could be brought to fruition is by putting resources into JGOFS data management at the international level that simply are not there.

An alternative definition of 'on the Web' is to have a number of sites with disparate interfaces and delivery systems. This scenario is certainly feasible and is developing. Indeed, if one extends the definition to include delayed mode data delivery through communication initiated over the Web then the necessary infrastructure is virtually in place.

Wednesday 13 May

Discussion: What has JGOFS learnt about the processes controlling the seasonal cycles of biological production

Dave Siegel presented an overview of the U.S. JGOFS BATS programme and the other time series programmes being conducted around it. Data includes Tommy Dickey's Bermuda Testbed Mooring [BTM] programme, Maureen Conte's and Werner Deuser's Ocean Flux Programme, the AEROCE aerosol sampling, Norm Nelson's satellite imagery acquisition and analysis programme and the Siegel/Nelson Bermuda BioOptics Program [BBOP]). BBOP optical results showing a strong and rather puzzling seasonal signature of coloured dissolved organic material (CDOM) concentrations were presented. This CDOM signal appears to be little related to DOM measurements made at BATS, and Nelson and co-authors (DSR, in press) have hypothesised that it is regulated by microbial processes. Understanding this signal might prove important as CDOM can be sensed from satellite ocean colour imagery such as SeaWiFS.

An overview of the prediction of primary production rates at BATS using satellite-retrievable variables was also presented. This work so far was not very encouraging in that neither complicated primary production models nor more simple ones predict much of the observed

variance in integrated primary production (hindcast skills were always less than 45%). Further, the best correlate with the values of many retrieved primary production parameters (P_{sat}*, I_k, etc.) was day-length.

Lastly, Some estimates of the eddy pumping flux of new nitrogen into the euphotic zone made by Dennis McGillicuddy [WHOI] and colleagues (Nature, in press) were shown. Modelling and a statistical analysis of satellite altimetry data clearly demonstrate that eddy-pumping flux is the dominant source of new nitrogen into the summer-time euphotic zone (much greater than the diffusive fluxes or Ekman transport). This source of nutrients is necessary to balance observed new production estimates from tracer analyses. Evidence of the role of eddy pumping is seen in an interdisciplinary mesoscale survey made by BATS personnel and in the BTM moored record of nutrients and bio-optics.

Véronique Garçon gave a presentation of the EUMELI programme. Within the French-JGOFS programme, an ocean flux study in EUtrophic, MEsotrophic and oLIgotrophic situations was carried out from 1989 until 1992. The general objective of the programme was the study of the main processes that govern particle fluxes, from their creation within the upper layers by photosynthetic activity to their burial in the bottom sediments. Three sites, typical of three trophic regimes were selected. The selected sites, all located in the tropical Northeast Atlantic at approximately 20°N, are characterised by roughly similar climatic conditions and a reduced seasonal variability. The eutrophic site is within the quasi-permanent Mauritanian upwelling area, the mesotrophic site close to the Cape Verde Frontal Zone, and the oligotrophic site at the periphery of the North Atlantic gyre within the North Equatorial Current. These sites strongly differ in phytoplankton abundance at all seasons. The large differences in primary production between the three sites, which presumably result in different ecological chains and biogeochemical processes, can help in the understanding of the mechanisms controlling the fate of the organic carbon (and associated elements) throughout the water column and also across the air-sea and water-sediment boundaries. A brief overview of the five EUMELI cruises performed along with the sediment trap deployment programme was presented. More details can be found in Morel *et al.* (1996) and Morel (1998).

Wolfgang Koeve described work on a synthesis of observations covering almost a decade for the German JGOFS Quasi Time Series Station in the temperate North East Atlantic, the Biotrans/NABE site at 47°N, 20°W. Data from the epipelagic surface ocean (upper 500 m) collected during cruises conducted as part of the international NABE study (1989), the BOFS programme (1990) and the German JGOFS programme between 1992 and 1997 have been combined and collected into one data base. From this data collection, a year round composite data set with half-monthly resolution has been composed and analysed. The collection currently covers ten of the most important variables relevant to the understanding of the biological pump (namely temperature, salinity, oxygen, nutrients (N, P, Si), chlorophyll *a*, POC/N and biogenic silicate). A complementary database with rate measurements (*e.g.*, PP, NP) is planned as well as the addition of carbon system variables to the standing stock data set.

A comparison between temperature fields from the composite data set and the Levitus climatology reveals small to moderate differences between both data sets, although the composite data set covers fewer observational years. Similarly, estimates of mixed layer depths from both data sets agree over most of the year. Surface chlorophyll *a* maximum concentrations during the spring bloom are more pronounced in the composite data set than in the CZCS-pigment climatology. An autumn bloom that is obvious from the CZCS seasonality is not observed in the composite data set.

The most surprising feature of the Biotrans composite seasonal chlorophyll *a* distribution are significant concentrations prior to the spring bloom dispersed over the upper 200 to 300 m. Integrated chlorophyll *a* stocks during this part of the year make up a remarkable portion of maximum integrated chlorophyll stocks observed during May. Much of this wintertime

chlorophyll is found well below the euphotic zone. This and related findings are discussed in relation to bio-optical properties calculated from climatological and composite data and the open question to what extent Sverdrup's critical depth theory is appropriate for the understanding the spring bloom phenomena in the North Atlantic Drift Region.

Philippe Pondaven gave a talk on modelling the seasonal cycle of diatoms and other phytoplankton at the time-series station KERFIX (51S, 68E). Although this station is in the Southern Ocean, it was thought that the experience of modelling diatoms and silica could be very relevant to the North Atlantic situation.

Although the ice-free region of the Southern Ocean is a typical HNLC system, the underlying sediments of this area are especially opal-rich, supporting the idea of an effective export of biogenic matter in this sub-system. In order to study the coupled Si, N and C cycles of this region, a 1D physical-biological model has been developed (Pondaven *et al.*, 1998) and calibrated using the data collected at KERFIX. The biological model consists of nine compartments (diatom, non-diatoms, microzooplankton, mesozooplankton, two types of detritus, nitrate, ammonium and silicic acid) forced by irradiance, temperature, mixing and deep nitrate and silicic acid concentrations.

The model correctly reproduces the main HNLC feature of the studied area. Thus, in a region where the spring-summer mixed layer depth is usually deeper than 60 m, a little bloom is predicted in December, but its magnitude never exceeds 2 mg m^{-3} . This bloom is mainly due to diatom outburst, and an associated increase in export flux of Si/N/C is predicted in January-February; export flux, which is mainly, sustained by mesozooplankton faecal pellets (50-60%) and senescent diatoms (40-50%). In parallel to phytoplankton development in spring, a drawdown of nutrient is observed. However, nitrate is never exhausted (range: 23 to 28 mmoles m^{-3}), while silicic acid shows strong seasonal variations (range: 2 to 20 mmoles m^{-3}).

Although small phytoplankton (non-diatom) sustains ~60% of the annual Primary Production (PP), this size-class, which grows faster than large diatoms, is however prevented from blooming because of microzooplankton grazing pressure. For micro-size diatoms (~40% of the annual PP), the main limiting factors are both an unfavourable light-mixing regime in spring-summer and a silicic acid limitation in late summer. Mesozooplankton grazing pressure exerts its influence especially in late spring. It was argued that the silicic acid limitation is induced by high Si/N uptake ratio in this region (Si/N=3-4). Such a high Si/N uptake ratio is likely due to both light and iron stress which are known to affect more strongly nitrogen or phosphate uptakes than silicic acid uptake. In addition, because of the lower specific remineralisation rate of biogenic silica ($\sim 0.01 \text{ d}^{-1}$) compared to particulate organic nitrogen remineralisation rate ($\sim 0.05\text{-}0.20 \text{ d}^{-1}$), biogenic silica is rapidly exported out of the surface layer: 50-60% of the biogenic silica that has been synthesised in the photic layer is exported towards the deep ocean, while only 10-15% of the particulate organic nitrogen escapes remineralisation in surface layer.

General Conclusions and Future Plans

There was a lengthy discussion on how best the group could further the aims of JGOFS synthesis in the North Atlantic. The main conclusions were:

- 1) It was agreed that we should approach DSR to publish a special issue on JGOFS North Atlantic synthesis. This would be a mixture of papers submitted in response to an announcement plus papers commissioned by the NASG. We identified about 13 of the latter plus possible lead authors; these are given in Appendix 2. There was also a discussion about a general set of crosscutting questions that might guide the whole JGOFS synthesis process. These questions are given in Appendix 3.

- 2) In the course of producing papers for this special issue, it was hoped that a number of synthesis data sets would be produced and these could be included on a CD-ROM to be published with the special issue (and perhaps made available at the IPO website).
- 3) It was thought that the group could find about 3-4 speakers for the IGBP congress but we have not finally identified topics and speakers. Logically these choices are best made once we have identified lead authors for the commissioned papers.
- 4) A need for WOCE/JGOFS joint meeting on inverse modelling of the DIC and nutrient data sets from the global survey was identified. Since the meeting, Doug Wallace has been following this up and is shortly to produce a proposal that can be considered by the WOCE and JGOFS communities.

Chairmanship

Fasham pointed out that as he is now Chair of the JGOFS SSC it would be helpful for him and for the future progress of the group if another member of the North Atlantic Synthesis Group took over the chair. Véronique Garçon was asked if she would be willing to do so and has since agreed to take the chair (pending ratification by the JGOFS EXEC).

Next Meeting

An idea for the venue for next year's meeting was the Canaries. This would give an opportunity the ESTOC group to present their data to the JGOFS community. Fiz Perez is investigating the possibilities for this meeting.

References:

- Bender M, Ducklow H, Kiddon J, Marra J, Martin J. 1992. The carbon balance during the 1989 spring bloom in the North Atlantic Ocean. *Deep-Sea Res.*, 39, 1707-25.
- Ducklow, H. W., C. A. Carlson, N. R. Bates, A. H. Knap and A. F. Michaels. 1995. Dissolved organic carbon as a component of the biological pump in the North Atlantic Ocean. *Phil. Trans. Royal. Soc. London B*, 348, 161-167.
- Lampitt R.S. and Antia A.N., 1997. Particle flux in Deep Seas: regional characteristics and temporal variability. *Deep-Sea Research* 44, 1377-1403.
- Longhurst, A. R., 1995. Seasonal cycles of pelagic production and consumption. *Progress in Oceanography*, 36, 77-167.
- Michaels, A. F., N. R. Bates, K. G. Buesseler, C. A. Carlson and A. H. Knap, 1994, Carbon-cycle imbalances in the Sargasso Sea. *Nature*, 372:537-540.
- Morel, A., 1996. An ocean flux study in eutrophic, mesotrophic and oligotrophic situations: the EUMELI program. *Deep-Sea Res.*, 43, 1185-1191.
- Morel, A., 1998. Process studies in eutrophic, mesotrophic, and oligotrophic oceanic regimes within the tropical northeast Atlantic. In *The dynamic ocean carbon cycle: A midterm synthesis of the Joint Global Ocean Flux Study*, eds. R.B. Hanson, H.W. Ducklow and J.G. Field, pp. 338-374. Cambridge University Press.
- Pondaven, P., C. Fravallo, D. Ruiz-Pino, P. Tréguer, B. Quéguiner & C. Jeandel, 1998. Modelling the silica pump in the permanently open ocean zone of the Southern Ocean, *J. Mar. Sys.*, in press.
- Takahashi, T., Feely, R. A., Weiss, R. F., Wanninkhof, R. H., Chipman, D. W., Sutherland, S. C., & Takahashi, T. T., 1997. Global air-sea flux of CO₂: an estimate based on measurements of sea-air pCO₂ difference. *Proceedings of the National Academy of Science*, 94, 8292-8299.

Appendix B1: National Reports

France (Laurent Mémer)

During the coming years, French JGOFS activities in the North Atlantic Ocean will be dedicated to three main issues.

At Villefranche-sur-mer, a JGOFS data centre has been created on a WEB site ([http://www.obs-
vlfr.fr/jgofs/html/html/acces_base.html](http://www.obs-vlfr.fr/jgofs/html/html/acces_base.html)), and the data obtained during JGOFS cruises in the North Atlantic (mostly EUMELI) are beginning to be included.

Different basin scale simulations of the carbon cycle have already started, and will be developed in the near future, with strong emphasis on the mesoscale coupling with ocean dynamics, and on data assimilation of satellite data (ocean colour: SeaWiFS, Meris/Envisat).

Lastly, in 2000-2001, an important programme is planned in the northeastern Atlantic Ocean between 38°N and 46°N, and 24°W and 18°W (POMME: Programme Océan Multidisciplinaire Méso Echelle). Its main goal is to understand the role of the eddies and the mesoscale dynamics on the subduction rate of the mode waters, on the onset and intensity of the bloom, and on the CO₂ fluxes between the ocean and the atmosphere. It will be based on *in situ* multidisciplinary (dynamics, chemistry, biology) studies with two ships during different periods in the winter and spring, numerous (around 80) buoys and floats, four or five moorings of sediment traps, and on eddy resolving numerical simulations, with data assimilation of altimeter and sea colour data. One of the objectives of this programme is also to understand the processes controlling the timing of the subduction and of the bloom, as this point is crucial in estimating the fate of the organic carbon in the main thermocline. Moreover, the French JGOFS community wishes to extend the period of study on the whole year to obtain the whole seasonal cycle and to estimate the export fluxes of particulate (by sediment traps) and dissolved (during deep mixing in winter) organic matter.

Germany (Wolfgang Koeve)

Overview of the major German JGOFS field activities in the North East Atlantic

Particle flux studies have been carried out as part of JGOFS funded research and in the framework of two German Joint Research Projects (SFB's). As part of the German JGOFS synthesis and modelling effort published, data are currently compiled together with more recent German particle flux data. Synthesis of the large particle flux data set is one of the primary aims of German JGOFS synthesis (contact: A. Antia, K. Kremling).

German contributions to the international CO₂-survey in the North Atlantic have mainly been carried out in the framework of the WOCE program. Some additional sampling has been carried out in relation to some, but not all, cruises of the Biotrans Quasi Time Series effort. CO₂-data are however only available from a limited number of cruises of this program component (maps with cruise tracks and stations are available on request from L. Mintrop, IfM-Kiel).

The Biotrans Region around 47°N, 20°W is one of the five most frequently sampled stations in the North Atlantic Ocean south of Iceland. After intensive observations during the 1989 and 1990, international JGOFS field campaigns the German JGOFS started in 1992 with a five year sediment trap mooring program and additional observations of upper ocean biogeochemical processes. Since most data from the 1989 and 1990 field studies were from spring and early summer, the German JGOFS work emphasised the study of the area during winter and autumn. A composite data set is currently under construction. A preliminary version of this data set has recently been used in the framework of a 1D-model comparison effort. The full version will be used for parameter optimisation studies, model evaluation and joint synthesis activities of modellers and field scientists (contact W. Koeve). Among many other data sets the DOM data set from this program will be of great interest to JGOFS synthesis (contact P. Kähler)

German JGOFS contributions to ESTOC, the European time series station at the Canary Islands, are particularly concerned with hydrographical and particle flux studies (contact: S. Neuer).

Additional related work in this region is carried out within the framework of CANIGO. ESTOC is also a very important component of the German JGOFS modelling effort. It has been decided to be the centre of a co-ordinated modelling activity covering a suite of different models such as 1D, mesoscale resolving 3D and large scale integrating 3D models (contact: K. Herterich). There have been a number of additional JGOFS related activities in the North Atlantic that may not be summarised by the previous four topics. These include additional transect studies that had a more detailed sampling (than just those for the CO₂ survey), intensive process studies carried out north of Iceland (SFB 313, contact R. Peinert) and very intensive studies on abundance, reproduction biology and export flux of foraminifera (contact C. Hemleben). Overall, the field campaign of the German JGOFS started early 1992 and was finished about five years later in summer 1997. Since Oct. 1997, funding for a synthesis campaign started which will last until about March 2000.

Current modelling effort of the German JGOFS

(a) Co-ordinated modelling effort centred around ESTOC:

1D, local-POM, 3D-1/3°-North Atlantic, global model.

(b) 1D-model comparison at Biotrans:

various modified FDM-type models; aggregation models; output from 3D-models, observations/composite

(c) 3D-biogeochemical models of the North Atlantic

More information about the German observational programmes can be obtained at website:

http://www.ifm.uni-kiel.de/pl/jgofs-na/nasme/soc_98a.htm

and on the synthesis programme at:

<http://www.ifm.uni-kiel.de/pl/dataman/INFO/synthesis.html> .

Norway (Helge Drange)

The Norwegian JGOFS community (NGOFS) is focusing their activity on the cycling of plant nutrients and dissolved inorganic and organic carbon in the Nordic Seas. Over the last 8 years, extensive cruise and sample programmes have been conducted in the region, in particular at Ocean Weather Station 'Michael' in the Norwegian Sea (66°N, 2°E), in the central Greenland Basin (75°N, 0°E), and along the 75°N meridian. The measurements include the basic carbonic acid system parameters, plant nutrients (mainly nitrate and phosphate, but also silicate), dissolved organic material, sediment trap data, and some plankton biomass observations. The observations are currently synthesised together with the carbon cycle groups in Gothenburg, Sweden, and Reykjavik, Iceland (see below). In addition to the data synthesis work, numerical box models, 1-dimensional turbulence modelling and fully prognostic 3-dimensional physical-biogeochemical modelling are carried out in the Nordic Seas and the adjacent waters. Special attention is paid to the exchange of CO₂ across the air-sea interface, new and regenerated production, and export production, including the natural variability of these quantities in relation to high and low NAO years.

Norwegian and other Scandinavian institutes involved in JGOFS activities are (Principal Investigators in parentheses)

Measurements:

Geophysical Institute, Univ. of Bergen (Truls Johannessen, truls.johannessen@gfi.uib.no)

Geological Institute, Univ. of Bergen (Eystein Jansen, eystein.jansen@geol.uib.no)

Marine Research Institute, Bergen (Francisco Rey, Francisco.Rey@imr.no)

Norwegian College of Fishery Science, Univ. of Tromsø (Paul Wassmann, paulw@nfh.uit.no)

Trondheim Biological Station, Univ. of Trondheim (Egil Sakshaug, egil.sakshaug@vm.ntnu.no)

Lab. of Biotechnology, Univ. of Trondheim (Knut Yngve Børsheim, borsheim@kjemi.unit.no)

Modelling:

Nansen Environmental and Remote Sensing Centre (Helge Drange, helge.drange@nrsc.no)

Sintef, Norw. Institute of Technology, Trondheim (Dag Slagstad, Dag.Slagstad@civil.sintef.no)

Iceland:

Marine Research Institute, Reykjavik (Jon Olafsson, jon@hafro.is)

Sweden:

Dept of Analytical + Marine Chem., Univ. Göteborg (Leif G. Anderson, leif@amc.chalmers.se)

Dept of Oceanography, Univ. of Gothenburg (Gøran Broström, gobr@oce.gu.se)

Spain (Fiz Perez)

During 1997, the Spanish IGBP Committee was re-formed and the JGOFS contributions of many scientific groups began to be co-ordinated. Many national programs related to JGOFS have developed during the years 1996-1999. Several of them are in the North Atlantic, such as GIGОВI in the Gulf of Biscay and studies in the northwest African upwelling. In other areas, studies are focused on productivity in the Antarctic Ocean and in the Mediterranean Sea. Several national projects are being conducted to determine the water and matter exchanged between Mediterranean and Atlantic Ocean.

The most interesting project in the North Atlantic was developed as part of the EU MAST III programme. OMEX and CANIGO are involved in the Iberian Ocean margin and in the subtropical region embraced by the Canary and Azores Islands. In these subprogrammes, the Spanish groups are involved in the measurement of basic variables of carbon cycle (CO₂, primary production, dissolved organic matter pool and production, grazing and sedimentation rates, trace metals, etc.). In addition, several team are involved in international projects with other countries, such as the ESTOC time series station in the Canaries (Germany-Spain) or the Atlantic Meridional Transect AMT (UK). Biological and chemical measurements, such as primary production by size class and DOM, are being measured in AMT sections by a Spanish team. Other collaborations are long track cruises, such as FOUREX and KAOS UK cruises, where CO₂ measurements were made by scientific teams from Vigo and Las Palmas.

United Kingdom (Michael Fasham)

The formal UK JGOFS programme ended with the Arabian Sea cruises in 1994. However since that time there have been a number of cruises in the North Atlantic as part of either British research programmes (*e.g.* PRIME), EEC programmes (OMEX), or WOCE that have measured many of the JGOFS core variables. These cruises are all recorded in the JGOFS cruise inventory. There is a strong feeling among the UK JGOFS community that the UK should pay an active part in the JGOFS synthesis stage. Fasham recently contacted the Chair of the Marine Science Board of NERC to explore the possibilities for funding such a programme. The initial response is encouraging and a proposal will be submitted in the autumn.

USA (Hugh Ducklow)

US JGOFS initiated a comprehensive program of synthesis and modelling of JGOFS and related data in 1996 with a Workshop and subsequent report (Sarmiento and Armstrong, 1997), which resulted in a joint Announcement of Opportunity in early 1997 for submission of proposals seeking support for individual and joint research projects. Thus far, about 20 projects have been funded. Further AO's are anticipated in 1998-2000, with support for some synthesis activities extending through 2003. Although the majority of support is for individual or small-group projects, the SMP is a co-ordinated program of US JGOFS similar in structure to the JGOFS process studies. Jorge Sarmiento (Princeton) and Scott Doney (NCAR-Boulder) are serving as

co-ordinators of the project. They are aided in this effort by an SMP Co-ordinating Committee, which has been charged by the US JGOFS Steering Committee with the implementation of the SMP Program as described in the original workshop report. There will be annual or semi-annual PI meetings at which research results will be communicated and new collaborations initiated. There will also be annual thematic summer workshops at which SMP PI's and other interested scientists (including invited guests from outside the USA) can explore particular topics chosen by the co-ordinating committee and SC. The first summer workshop held in July 1997 explored the role of time series data for modelling and synthesis activity. The next workshop (July 1998) will examine potential responses of ocean biogeochemistry to global warming.

Sarmiento, JL and RA Armstrong. 1997. U.S. JGOFS Implementation Plan for Synthesis and Modelling. The Role of Oceanic Processes in the Global Carbon Cycle. US JGOFS Implementation Report.

Available in hardcopy from US JGOFS Planning and Implementation Office, Woods Hole or at:
<http://usjgofs.whoi.edu/mzweb/smp/smpimp.htm>).

Further information about the US JGOFS SMP can be obtained at:
<http://usjgofs.whoi.edu/mzweb/syn-mod.htm>.

Appendix B2: Provisional titles of papers to be commissioned for the Deep-Sea Research special issue on North Atlantic synthesis

Possible lead author(s) are given in parentheses.

1. History of JGOFS activity in the North Atlantic (editors/NASG).
2. Carbon budgets derived from JGOFS/WOCE CO₂ survey and pCO₂ database (Wallace & Goyet).
3. Basin-scale synthesis of deep sediment trap data (Antia).
4. The role of DOC in bacterial production and export from the euphotic zone (Carlson, Bianchi & Kahler).
5. Synthesis of the SeaWiFS data for the North Atlantic (Siegel).
6. The role of mesoscale variability (Garçon & McGillicuddy).
7. Basin-scale 3D modelling (Drange).
8. Regional Analyses. The choice of these regions has been based roughly on the biogeographical regions of Longhurst (1995).
 - (a) GIN Seas (Peinart & Johanassen)
 - (b) North Atlantic Drift Region (Koeve, Savidge & Ducklow)
 - (c) Sub-Arctic (Marra & Fasham)
 - (d) North-west Atlantic (Harrison & Li)
 - (e) Eastern subtropical gyre (Octavio Llinas & ?)
 - (f) Western subtropical gyre (Debbie Steinberg)
 - (g) Trade winds region (Morel)

Appendix B3: Some crosscutting questions that might help guide the overall JGOFS synthesis exercise.

1. What is the large-scale carbon budget?
2. What fraction of primary production is grazed and what are the dominant grazers?
3. How does export production vary geographically and what controls it?
4. What controls the seasonal cycle of DOM and how does it interact with bacterial production and the carbon cycle?
5. How good are our models at predicting the seasonal cycle of production?
6. What are the remineralisation depth-scales for C and N in the deep ocean?
7. What are the main physical processes controlling primary production?
8. Do the 3D models predict the observed basin-scale distribution of pCO₂, TCO₂ and phytoplankton chlorophyll?
9. What role does nitrogen fixation play in the nitrogen budget?
10. Is atmospheric deposition of nitrogen or iron important?

Appendix C: Indian Ocean Planning Group

Report by Burkill

JGOFS Indian Ocean Planning Group Sub-Group Meeting
Town and Country Convention Center
San Diego, California
Sunday, 8 February 1998

Attendees: Peter Burkill (Chair: UK), Bernt Zeitzschel (Germany), Cas Wiebinga representing Martien Baars (The Netherlands), Sharon Smith (USA), Roger Hanson (Norway) and Ute Zeller (guest from Germany).

Background

Several members of the Indian Ocean Planning Group (IOPG) and a guest met prior to the January 1998 AGU Ocean Science Meeting in San Diego, California. The Group meeting was held because some important IOPG issues needed airing before the JGOFS SSC 1998, to ensure timely evolution of IOPG towards an IO Synthesis and Modelling Group (IOSG), which is scheduled to meet first in January 1999. The San Diego IOPG meeting was opportunistic (*i.e.* without JGOFS funding), and so attended only by a limited number of IOPG members.

Four items were discussed

- I. Data Management Update, Issues and Problems;
- II. Terms of Reference of Indian Ocean Synthesis Modelling Group (IOSG);
- III. Composition and Nominations for IOSG membership;
- IV. First IOSG Meeting and associated activities.

I. DATA MANAGEMENT UPDATE, ISSUES AND PROBLEMS

Burkill explained that the main heritage of IOPG and its key product were the data sets generated by the Arabian Sea Process Studies. As IOPG evolved towards IOSG, it was important that data was available for the JGOFS Community. This involved ensuring the adequate curation of data, preferably within recognised JGOFS Data Centres.

General Information Update:

Before discussing the Arabian Sea data, Smith wanted to inform IOPG that the US JGOFS Data Management Office had only 3 years remaining at Woods Hole before it closes. It would then transfer its data inventory and catalogues to the National Ocean Data Center. She expressed a concern about that DMO funding ended before the end of US JGOFS Synthesis and Modelling Project (SMP). She feared that this would compromise the US JGOFS SMP from achieving their goals, and stresses that US funding agencies should commit funds to the DMO beyond the expected time line of the US JGOFS SMP. The cost of the US JGOFS SMP is planned for about \$10M over 5 years. IOPG considered this was a generic issue relevant to JGOFS as a whole and should be referred to JGOFS SSC

Recommendation 1: IOPG suggests JGOFS SSC provide general guidelines on phasing of funding of data management in relation to synthesis and modelling. If requested, JGOFS should provide letters of support, if requested by national committees seeking funding to follow these guidelines,.

Smith also identified that the GLOBEC data set was another issue of concern. There are now relevant regional data sets emerging from GLOBEC that need to be accessible and possibly merged with JGOFS data for synthesis and modelling. The group asked whether relevant GLOBEC data sets were going to be included in JGOFS data inventory and/or accessible to JGOFS scientists. This was felt to be generic issue that should best be tackled by the JGOFS SSC perhaps *via* DMTT.

Recommendation 2: IOPG asks that JGOFS SSC recommend National JGOFS Data Managers to establish links/access to GLOBEC data sets if these are considered important.

Status of the Indian Ocean Databases:

- i) *Germany*: The German program in the Indian Ocean/Arabian Sea comprised five cruises and the all the data (hydro- and bio-data) is now available on WWW or on CD-ROMs. In conjunction with DMTT, Dr Mitzka is assembling all the Arabian Sea CTD data into a CD-ROM.
- ii) *India*: Several members mentioned problems with accessing Indian JGOFS data. There seems to be concern whether India will release JGOFS data to the international JGOFS scientific community.
- iii) *Netherlands*: The Dutch program in the Arabian Sea comprised three cruises, and most of the pelagic work is available on an international CD-ROM. This data and other data are not yet available on the web. The web data will be the most up to date when it is released.
- iv) *Pakistan*: Status of JGOFS data from the NASEER programme was unknown. Smith mentioned that although they have data, it might not be integrated into a database. It was possible that Pakistan was not living up to its agreement under the JGOFS Data Policy. Burkill will seek information informally from the new Director of NIO; Dr Amjad, about this and if necessary team up with Chair DMTT to pursue this formally. Hanson mentioned that the JGOFS IPO no longer has a contact listed for Pakistan Data Management.
- v) *UK*: The British Ocean Data Centre (BODC) supports and handles the UK JGOFS data management. The BODC has now archived data from four UK Arabian Sea cruises. Two were concerned with microbial biogeochemistry (ARABESQUE), one was a benthic cruise and another a pelagic cruise. The ARABESQUE data will be available on CD-ROM by mid-1998. All BODC data can be accessed *via* WWW by authorised users.
- vi) *USA*: In 2 years, all US JGOFS data should be accessible at the National Ocean Data Center and much of it will be appearing on CD-ROMs as data now comes available. Moreover, an Indian Ocean Atlas with a CD-ROM will appear soon (summer 1998). Smith mentioned that it is not known who will publish the Atlas or how many copies will be printed.

SUMMARY. The JGOFS Arabian Sea databases are in reasonable shape although the situation with Pakistan and India needs clarification and possibly some formal correspondence. The role of DMTT in quality assurance and control of the data for all data sets was identified.

Recommendation 3: IOPG recommends the Chairs of DMTT and IOPG liaise on a) Indian and Pakistan data basing and liase with National Scientists on how best to resolve this and b) adequate quality assurance and quality control of National Data Sets derived from the Arabian Sea.

II. TERMS OF REFERENCE FOR THE SYNTHESIS AND MODELLING GROUP

IOPG reviewed the “generic” Terms of Reference for Synthesis and Modelling Groups and modified these to the specific needs of the Indian Ocean. These are given in Annex 1.

Recommendation 4: IOPG requests JGOFS SSC approval for Terms of Reference for the new IO Synthesis Group.

III. NOMINATIONS FOR THE INDIAN OCEAN SYNTHESIS AND MODELLING GROUP

The meeting reviewed the expertise, disciplinary, gender, national and overall structure for the Indian Ocean Synthesis and Modelling Group (IOSG). The fundamental philosophy, as advocated in the TOR, was accepted and that IOSG should comprise members representing a mix of nations reflecting those involved in Arabian Sea biogeochemistry, a mix of biogeochemical subjects and a range of modelling skills. IOSG would be biased initially in observationalists, particular those involved in JGOFS Report 17, in order to point in the right direction. With time, the membership would become biased towards those with outright modelling skills. To ensure IOSG success, the committee should always have a broad mix of skills.

Recommendation 5: IOPG requests JGOFS SSC approves 10 nominees (Annex 2) as members of the Indian Ocean Synthesis and Modelling Group.

IV. FIRST MEETING OF THE INDIAN OCEAN SYNTHESIS AND MODELLING GROUP

The First Indian Ocean Synthesis and Modelling Group Meeting is planned to be held in Bangalore, India in January 1999. This meeting will be held in conjunction with the International Scientific Symposium on *the Biogeochemistry of the Arabian Sea* and the Training Course on *Biogeochemical Modelling of the Ocean*. Travel funds were approved by JGOFS Exec for this meeting in 1998. However, the meeting has been put back by a few months into 1999, so falling into a separate funding year. Hanson felt there would be no problems requesting fund carry over.

Recommendation 6: IOPG requests JGOFS SSC approval to carry forward the 1998 agreement for travel funds for 10 members of the Indian Ocean Synthesis and Modelling Group to attend its First Meeting (3 days) in Bangalore, India., January 1999.

ANNEX 1:

JGOFS Indian Ocean Synthesis & Modelling Group:
Draft Terms of Reference

1) The JGOFS Scientific Steering Committee (SSC) will appoint the chair of the Indian Ocean Synthesis and Modelling Group, hereafter referred as IOSG. The IOSG chair will assemble a committee whose membership will need to be approved by the JGOFS Executive Committee. In assembling the IOSG membership, the chair should consider national representation along with gender, discipline and experience. Relevant experience includes generation, synthesis and modelling of JGOFS data sets derived from the Arabian Sea.

2) Main tasks of the IOSG are:

a) To prepare a report of regional synthesis activities for the Scientific Steering Committee annually. This report will also be presented to the Global Synthesis and Modelling Task Team (GSMTT) for a global perspective. The SG report will be a synthesis of the JGOFS science conducted within the region. The approved report(s) with documentation will be published in the JGOFS Report Series. It is expected that the final publication will be peer-reviewed and published in the open literature.

b) To present a full report on the modelling and synthesis activities of the group at the JGOFS Open Science Conference in early 2000.

c) To liaise with the Data Management Task Team (DMTT) to encourage the submission of JGOFS data sets to a national ocean data centre with the provision of easy access *via* the Internet, CD-ROMs and other media.

- d) To enhance synthesis activities, particularly by organising open meetings, and to produce JGOFS Reports and review articles throughout the remaining JGOFS synthesis period.
- 3) IOSG is encouraged to organise regional synthesis meetings. Funds will be limited for these meetings, which require prior approval from the JGOFS Executive Committee. Members may seek further support from their national programs, host institutions and other sources.
- 4) IOSG will address the scientific aims of the Arabian Sea Process Study JGOFS Report No 17.
- 5) Additional Terms of Reference specific to IOSG may be included with SSC approval.

ANNEX 2:

JGOFS Indian Ocean Synthesis & Modelling Group (Membership)

Skill	Name	Country
Basin Scale Modelling	John Kindle	USA
Biophysical Modelling	Yajnik	India
Bio-optical Modelling	Shubha Sathyendranath	Canada
Biological Synthesis	Karl Banse	USA
NPC & export	Venu Ittekkot	Germany
NPC & chemistry	Wajih Naqvi	India
NPC & zooplankton biogeochemistry	Martien Baars	Netherlands
NPC & phytoplankton biogeochemistry	Shahid Amjad	Pakistan
NPC & microbial biogeochemistry	Peter Burkill	UK
NPC & zooplankton biogeochemistry	Sharon Smith	USA

NPC: National Programme Co-ordinator

Appendix D: JGOFS Synthesis Plan (1998-2001)

Strawman for SSC Discussion (Fasham reported)

1. Objectives

Overall Objective

Develop an integrated, quantitative view of the carbon cycle in the ocean, indicating the roles of biota, physical transport, air-sea exchange and gravitational settling, and including estimates of precision and uncertainty.

Specific Objectives

- i) Provide a web-based data retrieval system for all the JGOFS observations.
- ii) Make a synthesis of the data from the major regional areas studied by JGOFS (N. Atlantic, Equatorial Pacific, N. Pacific, Southern Ocean, Arabian Sea, and Asian continental margin) with special emphasis on food webs and the factors controlling primary production, carbon cycling, macro- and micro-nutrient cycling, and the relationship between primary production and carbon export.
- iii) Assess the ability of 3-dimensional ocean carbon cycle models with biology to simulate the observed global inventories and fluxes of carbon and nutrients, and to reproduce past oceanic changes associated with paleoclimatic changes. Data to be used would be: WOCE/JGOFS global survey of total inorganic carbon, nutrients, and other tracers; global pCO₂ database; satellite estimates of primary production and phytoplankton biomass; particle flux data; and deep sea core data.
- iv) Develop a hierarchy of biogenic carbon flow models and use them to predict how the role of the marine ecosystem in the carbon cycle might alter under climate change scenarios over the next 50-200 years.
- v) Quantify the contribution of continental margins and seas to CO₂ sequestration and the horizontal flux of carbon across the ocean-continental margin boundary.
- vi) Utilise CZCS and SeaWiFS data to provide a global picture of the seasonal cycle of phytoplankton biomass and production.

The first results of this synthesis will be published in a Cambridge University Press IGBP series book (2001) and also in a 'plain-language' brochure for the wider public (2000).

Notes:

- a) Objectives (iii) and (iv) would be joint projects with GAIM/OCMIP.
- b) Objective (v) would be a joint project with LOICZ.

2. Time lines

1998

- | | |
|-------------|---|
| April 25-28 | JGOFS SSC, Cape Town. <i>Discuss, develop and approve JGOFS synthesis plan</i> |
| May 11-13 | <i>first Meeting of the North Atlantic Synthesis & Modelling Group, Southampton.</i>
Plan chapter(s) for synthesis book (deadline summer 2000) and presentation for IGBP congress |
| June | IGBP Newsletter Issue (#34). Normal issue with articles relating to the synthesis exercise (Polished articles from National Committees, IGAC, GCTE, JGOFS and LUCC). DEADLINE: 11 MAY!!!!!! |

Sept 9-11	first Meeting of the Pacific Synthesis & Modelling Group, Seattle. <i>Plan chapter(s) for synthesis book (deadline summer 2000) and presentation for IGBP congress</i>
Sept 24-25	JGOFS Data Management & Synthesis workshop, Bergen. <i>Review data requirements for JGOFS synthesis and plan development of web-based data archive.</i>
Oct/Nov	1st Meeting of the JGOFS Synthesis Co-ordination Group, Southampton, UK?. <i>Develop implementation of JGOFS synthesis plan. Plan production of a synthesis brochure (2000) and book (2001). Plan presentations for IGBP congress, and future meetings (JGOFS & IGBP 2000)</i>
	Meeting of JGOFS/GAIM/OCMIP group,?. <i>Prepare plans for 3D modelling and analysis. Plan chapter(s) for synthesis book (deadline summer2000) and presentations at future meetings</i>
1999	
January	First Meeting of Indian Ocean Synthesis & Modelling Group, Bangalore, India. <i>Plan chapter(s) for synthesis book (deadline Summer 2000) and presentations at future meetings</i>
May 6-13	Second IGBP Congress/JGOFS SSC meeting, Yokohama, Japan. <i>JGOFS will present papers on overall synthesis plan and progress reports on North Atlantic and Equatorial syntheses</i>
To be determined	First Meetings of Southern Ocean Synthesis Modelling Group, Continental Margins, Deep Sea Flux, and North Pacific Task Teams. <i>Plan chapters for synthesis book (deadline Summer 2000) and presentations at future meetings</i>
To be determined	Meeting of Remote Sensing TT. <i>Plan analysis of SeaWiFS, and CZCS archive. Plan chapters for synthesis book (deadline Summer 2000) and presentations at future meetings</i>
2000	
April	Second JGOFS Science Conference, Theme: Global Synthesis, Bergen. <i>Presentation of synthesis progress by all SMGs and TTs</i>
Summer	Second Meeting of JGOFS Synthesis Co-ordination Group <i>Final editing of brochure and review of mss for book</i>
October	IGBP Millennium Conference. <i>Keynote talks on JGOFS synthesis. Distribute brochure.</i>
2001	
Summer	Publication of JGOFS Synthesis Book (CUP Press)

Notes

1. The regional groups may require second meetings.
2. We will need to appoint editors for the book and brochure as soon as possible.
3. The Super Synthesis Group could consist of members of the Global Synthesis and Modelling TT, and representatives from SSC, the SMGs and other TTs.

14th Meeting of the JGOFS Scientific Steering Committee Yokohama (Shonan Village), Japan, 7 & 13 May 1999

Welcome and Introduction

Kon-Kee Liu, SSC Vice Chair, opened the 14th Meeting of the Scientific Steering Committee (SSC) on Friday at 09:00 and welcomed all members, lead-authors, guests, and IPO staff to the meeting. The list of participants and addresses appears in Annex 1. Liu informed everyone that Michael Fasham, SSC Chair, was unable to attend because of medical reasons. Hanson briefed everyone on Fasham's health and his plans to continue as JGOFS Chair. As there were many new members and guests present for the first time, Liu recognised Paul Falkowski (SSC, USA), Robert LeBorgne (NASG Chair, France), Paul Harrison (Guest, Canada), Paul Tréguer (SOSG Vice Chair, France), and Michael Landry (Guest, USA). Liu then asked participants to introduce themselves along with a short biography. The attendance on the last day included Neil Swanberg and Elizabeth Gross, while Falkowski, Ducklow, Harrison, and Shimmiel sent their regrets for an early departure.

Approval of the Agenda

Liu asked for comments on the agenda. Due to the limited time for this meeting, Hanson reminded everyone to keep his or her reports brief and full-written report may be included in the minutes. The 1999 SSC approved the agenda and timetable without changes.

Old Business

Minutes of the 13th Meeting of the Scientific Steering Committee

Liu asked for final comments on the Minutes from Cape Town, South Africa. The SSC changed the wording under Recommendation 5 for the IOSG, to read "A message from Karin Lochte requested Tim Rixen join the IOSG" and Action #10 to read, "the SSC moved to include Rixen's name on the IOSG membership". Ducklow noticed that Andrew Watson's report on SOLAS was missing from the minutes. Hanson will add his report to the SSC minutes. Lastly, Julie Hall mentioned that she would send addition national information on New Zealand to be included in the minutes.

The SSC reviewed each Action item from the 13th Meeting and noted that several actions remain. For Action #2 (Pakistani data sets), Baliño reported that all efforts have failed to acquire Pakistani data from the NASEER program in the northern Arabian Sea for the CTD CD-ROM. At the Arabian Symposium in India this year, Burkill reported that Bernard Zahuranec from the U.S. Office of Naval Research might be able to help with obtaining the NASEER data for the IO database. For Action #3 (national data acquisition), Baliño informed the SSC that the DMTT is handling this action. For Action #7 (resources for an assistant JGOFS data manager), Baliño reported that DIS does not have the capacity to help.

The Minutes of the 13th Meeting of the SSC were approved with modification.

Synthesis Overview and Timeline

Villefranche Book

Hanson reported that the editors were in the final stage of editing the Conclusion Chapter. Cambridge University Press has pushed back the book's publication date to late 1999. The

master galleys set (book) will be submitted to CUP in late May or early June. Then Falkowski asked how this book differs from the planned synthesis textbook. Hanson mentioned that the Villefranche book represented a mid-term synthesis: a collection of invited papers and manuscripts from the Symposium. While the synthesis textbook will represent JGOFS's interpretation of published JGOFS results and relevant ocean biogeochemical studies over the past 10 years. In addition, considerable thought has gone into the organisation and themes in the synthesis textbook, much more than in the Villefranche book. These two books will not overlap or resemble each other, as the lead authors of the synthesis textbook will focus on ocean biogeochemical themes and reaching out to a larger audience.

Science Brochure

Hanson reported that all contributions have been received and that Fasham, Baliño, and Hanson met in February to draft a brochure for distribution to the SSC and guests at Yokohama. This draft needs a thorough revision and Baliño asked that the brochure editors (Executives), the SSC and guests to send comments to Fasham and copy Baliño by June 15 for the next version.

Synthesis Textbook

Hanson reported that Fasham has received confirmation from all lead authors on the themes selected at the SSC Synthesis Workshop. Falkowski emphasised that the book should address the non-JGOFS audience and cut across IGBP Program Elements. Ducklow agreed and added that it needs to function as well as a textbook in ocean biogeochemistry. Lead authors are aware of these points and those chapters (drafts) are due in time for the Open Science Conference. The expected publication date is summer 2001. Hanson also mentioned that that IGBP Secretariat is now discussing contract possibilities with two publishers: Springer-Verlag and Academic Press. Falkowski objected to Springer as the publisher because they publish very expensive books. He suggested that alternative publishers should be sought, as many are eager to take on this type of publication. Hanson noted that this contract is for the IGBP book series and we are a core project of IGBP. The SSC asked must this book be a part of the IGBP book series, what are the advantages for JGOFS? Swanberg was not present to respond. Liu will confer with Swanberg and he or Swanberg will inform the SSC on Thursday 13 May.

Synthesis Timeline

While reviewing the synthesis timeline, there was a comment that the SSC needs to address the future timeline seriously. Ducklow felt that JGOFS must develop a strategy that fits with the overall IGBP-wide synthesis goal. As it is now, most of IGBP talks about the biosphere without reference to the oceans, and JGOFS appears "outside" of IGBP-wide synthesis. Therefore, JGOFS needs to develop a strategy to integrate its synthesis with IGBP-wide synthesis. Burkill suggested that the SSC should set up three parallel timelines: 1) regional synthesis groups and task team timelines, 2) global synthesis timeline, and 3) JGOFS – IGBP-wide synthesis timeline.

Open Science Conference 2000

Stokke presented a preliminary budget estimate for the conference. The SSC noted that the conference seems expensive and that it might be difficult to get 300 people to Bergen. Hall added that the Southern Ocean meeting planned for July 2000 might have a negative impact to the attendance in Bergen due to the proximity of the dates. There is an urgency to get the First Announcement out soon and it is therefore important that the Science Program Committee discuss this science program while in Japan. Hanson noted that a rough guideline was set up in Southampton, which provides a model for the Open Science Conference. Saino reminded the SSC of the need to support young people wishing to attend the conference. Lochte suggested a proposal to the European Union for student support. The deadline is 1 June 1999. In addition, Ducklow promised to look into student support from US JGOFS. Hanson mentioned that the IPO would also seek support for developing country's scientists from SCOR, IOC, the Research

Council of Norway and the local community. The SSC suggested that perhaps SCOR/JGOFS funds could help cover costs for participants from developing countries. Hanson mentioned that the IPO would check with START for assistance with scientists from developing countries. Bychkov added that PICES might also help and offer some travel money for scientists.

ACTION #1: Lochte will seek funds from the EU; Ducklow will seek funds from US JGOFS; Hanson will seek funds from NRC, etc., and Bychkov will seek funds from PICES, while other members of the SSC will look into funds from their national agencies.

ACTION #2: The Science Program Committee will meet during the Congress and Lochte will report to the SSC on the last day of the Congress.

New Business

IGBP Congress and Joint Discussion Sessions

The SSC reviewed its role during the Joint Discussion Sessions. Tilbrook asked what is expected of the people who will attend the different sessions. Field voiced the opinion that individuals should provide some input from JGOFS as well as bring information back to JGOFS. Thereafter, the Chair should be informed of the varied information. In addition, Hanson asked that session highlights that address issues relevant to JGOFS and/or JGOFS future should be sent to the IPO for inclusion in the minutes. Hanson also reminded all session organisers that they must submit a one or 2-page synopsis of the session to the IGBP Secretariat by the end of each day and to please send a copy to the IPO as well.

ACTION #3: All session leaders and discussion representatives will send a session summary or highlights to the IPO for inclusion in the SSC minutes.

Lochte distributed the summary of the JGOFS/PAGES Session J6 (Day 5, 11 May) entitled: *The paleo-CO₂ record in the oceans*. Since PAGES has a major session that day, people will probably be walking in and out of the session. She appealed to SSC members to attend because JGOFS plans to establish a link with PAGES on Deep Ocean Flux and form a Deep-Ocean Flux Task Team. Field suggested that the two groups meet off line perhaps one evening to promote future co-operative efforts. It is necessary to find out if certain topics are common to both JGOFS and PAGES. For example, have changes occurred in iron dynamics in areas with different nutrient levels, both past and present.

Falkowski announced the Session CT2/J2 on the global carbon cycle (Day 5, 11 May) and asked for JGOFS representation at this session. He then expressed that there is a need to revise the relationship between new production and the variability of the CO₂ content in the atmosphere. There seems to be a consensus among ocean biologists that systems are in a steady state. That is, net perturbation of oceanic CO₂ is minor due to variation in new production. However, geological records argue against this assumption. Now, as ice-age theories include ocean biology, it is becoming evident that the ocean is not in steady state on geological time scales. Then the question is, on which time scale is ocean biology in steady state? Decades? Centuries? Millennium? The available data cannot answer this question and the increase in anthropogenic CO₂ may change pathways in the oceans in the future. If we assume that the ocean biology is not in steady state, then one should develop themes with the terrestrial community in IGBP to show, e.g. how changes in the oceanic circulation and in the hydrological cycle may alter the carbon cycle. Falkowski emphasised that JGOFS should not make a case for the ocean biology and its impact on CO₂ sinks and sources when ocean circulation might be the real important factor or

driving force in the overall picture. This comment prompted the suggestion to merge CT2/J2 and J6 (see above), pending IGBP approval. However, the request was denied because of the already complexity of the present program.

Liu asked the SSC for representatives to attend the different sessions and time permitting to report to the SSC on the last day. The representatives follow:

- CT2/J2 The global carbon cycle: Monfray
- CT3 Water Initiative: Falkowski (½ day)
- I1 Atmosphere and ocean biogeochemical coupling: Falkowski (½ day)
- J7 Continental Margins: Liu and Hong
- GL2/J5 Developing a strategy for GLOBEC: Quiñones
- LU2/B1/G2 Landscape disturbance: Liu (½ day)
- B4 Linking BAHC, LOICZ and PAGES: Hall
- GM1 Paleo trace gas challenge: Tilbrook
- J3/G4 Community structure: Harrison + Landry
- J6 The paleo record in the oceans: Lochte and Shimmiel
- S1 Regional Synthesis: Field
- P1 PAGES process studies: Shimmiel and Lochte
- GM2 Earth system models: Monfray
- GL3 Japan GLOBEC: Bychkov
- D1 Data Management: Baliño

Because of a lack of time for Session representatives to report to the SSC, Liu asked representatives to send their written reports to Hanson for inclusion in the minutes (Annex 4).

Scientific Steering Committee

SSC Membership

Liu opened discussion on the upcoming terms of SSC members, rotations, and future nominations. The list of SSC members and terms appears in Annex 2. Hanson mentioned that at-large members serve 3-year terms and may sit for a second term with SCOR and IGBP approval. JGOFS function leaders (chairs) also sit on the SSC for 3-year terms, as ex-officio members, and may hold the position longer with Executive approval or until the SSC disbands the function. Liu suggested that the SSC review the status of the at-large members and function leaders in view of nominations for Year 2000. If a rotation is due to occur, then at-large members and function leaders must send recommendations to IPO for Executive action. Concerning SSC costs, Hanson mentioned that the cost of JGOFS SSC meetings are running between \$45-50, 000 USD annually and IGBP funds cover only \$20,145.

ACTION #4: Liu asked the SSC to send nominations for at-large members to the IPO this summer. Year 2000 nominations for at-large SSC members are due at the two secretariats by early September.

Function Leaders: Rotations and Changes

Liu opened discussion on SSC membership, rotations and pending changes in the groups and teams. Burkill (IOSG Chair) mentioned that he plans to take up the question of new chair at the next IOPG meeting. Bychkov and Saino (NPTT co-Chairs) mentioned that they would discuss the co-chairmanship at the next NPTT meeting. Hall (CMTT co-Chair) announced that Liu would take over as CMTT co-Chair immediately after the Congress and that she will rotate off at the end of the year. Baliño announced that Lowry (DMTT Chair) plans to step down this year. A successor will likely come from the World Data Center-A for Oceanography. Sakshaug (PMTT Chair) mentioned that a manual remains and is due in 1999.

Representative Changes

Monfray (OCMIP Representative) proposed that a joint task team between GAIM and JGOFS would be proposed shortly. Hanson encouraged him to send a proposal (recommended members, terms of reference, and GAIM intentions) for a joint task team to the IPO soon for Executive consideration at their next meeting.

SSC Meeting Attendance

Liu raised a major concern of SSC members not attending annual meetings due to either schedule overload or personal reasons. This year alone, Hanson listed ten members who were unable to attend. This seriously jeopardises information exchange, the effectiveness of the SSC and decision processes. Falkowski voiced the opinion that if people cannot attend, they should appoint somebody to represent them. The SSC agreed but for at-large members there is no alternative for the absentee. Their expertise and knowledge is lost when absent. The functions are nearly always represented (*e.g.*, Tréguer representing the SOSG). Liu emphasised the importance of all at-large members and function leaders to attend annual SSC meeting.

International Project Office

Report

As everyone has heard, the Research Council of Norway renewed its commitment to JGOFS and financial support of the IPO staff, and that the University of Bergen will provide facilities, operation expense, and infrastructure until 31 December 2003. Continuity is now insured and the IPO will now see the synthesis phase through to the end.

Quiñones expressed a concern regarding the timelines of national programmes that are not in phase with JGOFS synthesis phase, *e.g.* NPTT. Should these programs start thinking about other venues? Liu asked for a discussion that focussed on JGOFS involvement in the future. For instance, what started, as joint adventure, might not end up that way. Liu reported that there is a discussion now in CMTT on how it will fall under LOICZ after 2003.

Quiñones asked, besides the synthesis phase, what are JGOFS plans for the future? Will it be closing business or will there be a successor? Liu sympathised, said that many hold these concerns and referred to the two letters in the agenda book on the future of ocean biogeochemical studies. He suggested that if these letters had not already been reviewed, to review them during the Congress and be ready to discuss this issue later. Hanson informed the SSC that SCOR has initiated a luncheon to discuss the politics on the future of ocean biogeochemical studies later in the week. Several representatives from the elements (*e.g.*, IGAC, JGOFS, SOLAS, IGBP, and SCOR) were invited. Field informed the SSC that luncheon discussions would only deal with the political and scientific issues.

During the discussion, the SSC expressed many views regarding SOLAS and JGOFS plans for the future. Liu felt that the SSC needed to develop a proposal for IGBP and SCOR; however, there is not enough time allocated at this meeting to discuss this issue fully. On the last day, the issue shall be discussed with representatives from SOLAS (Bob Duce), who have been asked to attend and inform the SSC on SOLAS plans.

Budget

Hanson reviewed the funds from IGBP, SCOR and NRC/UiB and expenses incurred in 1998. The NRC/UiB balance (1998 residual) of \$11, 122 USD was carried to 1999. In 1999, many of the early activities have stayed within their allocations and based on estimated expenses, the IPO should have a small residual to cover the early miscellaneous expenses for the science brochure

and the Open Science Conference. In 2000, JGOFS is again expecting a small reduction in SCOR funds for JGOFS activities. With the Conference approaching fast, Hanson advised that function leaders submit requests for meetings early for Executive consideration.

ACTION #5: Chairs of Task Teams and Synthesis Groups must submit requests for Year 2000 meetings by 31 August.

Information and Data Management

Baliño reviewed briefly the information systems and data management policy at the IPO. Falkowski expressed concerns about data availability to public domain and easier ways to access JGOFS data. He cautioned that the core-measurement data set was to be a legacy of JGOFS. If it is not easily accessible, then it is not a legacy. Will there be a "one-stop" shop for JGOFS data? Baliño answered that a "one-stop shop" is most unlikely because every country is responsible for the management of its JGOFS data sets. The JGOFS data management model relies on a distributed system where national centres play the major role. Although a number of JGOFS countries comply with this model, the data in many other countries still reside with the chief investigators. When the IPO was established in Bergen in 1996, one of our tasks was to survey the whereabouts of JGOFS data and to assist scientists in accessing JGOFS data, mainly through the IPO web site. The cruise inventory was the first step, while a metadata catalogue for JGOFS data sets and data products is now under construction.

Although the DMTT encourages participating countries to assimilate and make data accessible *via* the web, the reality is, however, that not all JGOFS data will be available this way. With existing resources at the IPO, the main goal is to complete the metadata catalogue, which will provide information about what data have been collected, where the data sets are located and how to access them. In addition, nations are encouraged to send their JGOFS data to World Data Centres and to publish them on CD-ROMs to secure the long-term stewardship of the JGOFS data set. Regarding data products on CD-ROMs, the SSC plays an important role in promoting this activity in the respective countries.

Synthesis Group Reports

Indian Ocean Synthesis Group (IOSG)

Burkill reported on the meetings and Symposium in Bangalore 17-20 January 1999 in connection with GSMTT Training Workshop. At the symposium, India was very active while Pakistan was obviously absent, a matter of great concern, which needs rectifying. To date, the IOSG supported the production of several CD-ROMs: Arabesque (UK contribution), NIOZ (Netherlands contribution), and the JGOFS International Collection (contributions from 5 of 6 participating countries). Pakistan is the only country holding back JGOFS data. Future tasks and publications include:

- A report on recent advances in the Arabian Sea (December 1999),
- A list of national data centres for JGOFS core measurements obtained on JGOFS cruises,
- A brochure on highlights of the Arabian Sea Process Study, and
- A synthesis volume to be published in either *Deep Sea Research* or *Progress in Oceanography*.

Burkill plans to request funds for an IOSG meeting at the JGOFS Open Science Conference in Bergen, April 2000.

Southern Ocean Synthesis Group (SOSG)

Tréguer presented the status of the Southern Ocean carbon cycle. Fe and Si are key chemical limiting factors in HNLC (High Nitrate-Low Carbon) regions. The Southern Ocean is a net CO₂ sink; estimated to be about 10-20 % of the total marine sink but it may be significantly higher if the Polar Frontal Zone is included. In addition, new estimates of primary production from satellite data (ocean colour) indicate that production might be 2-4 times higher than previously estimated from ¹⁴C measurements. In the future, tasks should include the use of time series observations instead of snapshots (cruises) to try to reconcile these estimates of primary production, and future biological models should include Fe as a limiting factor. The workshop in Bremerhaven (3-5 September 1998), redefined the original biogeographical provinces in the Southern Ocean as functional units. It also proposed an international symposium in France, July 2000. Falkowski expressed a concern about the practice of assembling phytoplankton into one group. Models should differentiate between major groups, *e.g.* diatoms, especially since opal seems to play an important role in the Southern Ocean. Tréguer agreed. Tréguer then presented new Terms of Reference and nominations for SOSG membership for Executive approval at their next meeting.

North Atlantic Synthesis Group (NASG)

Hanson reported for Garçon. Garçon arranged financial support for a second meeting of NASG in Toulouse, France, September 1999, from national sources. A synthesis volume on the North Atlantic is progressing on schedule for publication in Deep-Sea Research in early 2000. Regarding a joint workshop with JGOFS-WOCE on CO₂ transport in the North Atlantic, Tilbrook informed the SSC, that WOCE is not yet ready for this workshop and organisers have postponed the workshop to Year 2001.

Equatorial Pacific Synthesis Group (EPSG)

LeBorgne reported on the last meeting held in Seattle, September 1998. The main EPSG activity was the edition of a synthesis volume on the equatorial Pacific for Deep-Sea Research. The guest editors are Le Borgne, Feely, and Mackey with 16 chapter leaders, who will organize the synthesis in their own fields. Beside the quality of their expertise, the group sought international diversity of the leaders and of their co-authors. There was, however, some overlap of topics, *e.g.* pCO₂ and remote sensing. The deadline for manuscripts is April 2000 for publication in 2001. Landry suggested that manuscript be cross-referenced and that the SSC review the manuscripts before submitting them to peer-review.

Although no EPSG meetings are planned for 1999, several workshops or meetings will be organised totally or partly in the framework of the Equatorial Pacific. These are:

- EBENE cruise meeting. Marseille, July 6-7 1999. Leader: R. Le Borgne. The workshop will deal with results of a cruise devoted to the grazing process in the equatorial HNLC system.
- US JGOFS Synthesis and Modelling Project workshop. Keystone, Colorado, July 12-16 1999. Leader: J. Sarmiento and S. Doney.
- NASA meeting. Old Dominion University, Virginia, 4-5 November 1999. Leader: C. McClain.

Data collections are generally complete, except for a few countries. All core parameters are expected to be stored on CD-ROMs when ready. The way that this process should be done is still debated. In the US, all JGOFS data are online in Woods Hole. In France, some data remain with the chief investigators. In Japan, accessing data is difficult. Baliño made a first attempt in cataloguing the Japanese data sets, but it is far from complete and she will continue the chase. Saino mentioned that JODC is responsible for these data. In Australia, only JGOFS metadata is

available. Baliño mentioned that information could be obtained through the Australian DMTT representative, Brian Griffiths. Baliño promised to bridge the problem with Griffith and later put the two in contact.

The SSC asked if EPSG was on target with their synthesis volume. Le Borgne replied that it is and that the review process would be done by April 2000. LeBorgne requested funds for an EPSG meeting at the Conference in Bergen 2000.

Hanson addressed the entire SSC on the issue of funds for synthesis groups and task teams meetings at the Conference. Those who are considering a meeting here must be aware that the SSC will meet the two days before. This means that the chairs will be sequestered from the groups and that meetings should be planned during or after the Conference. Landry commented that JGOFS should maximise everyone at the Conference, get groups together ahead of the Open Science Conference in Bergen. This is a Conference where as many JGOFS people as possible should attend.

ACTION #6: Baliño will contact Brian Griffiths on the Equatorial Pacific data sets and facilitate the communication with the EPSG.

Task Team Reports

Global Synthesis and Modelling Task Team (GSMTT)

Hanson reported that the GSMTT has been disbanded. GSMTT held its last meeting in India, January 1999, during the IOSG Symposium and GSMTT Training Course. In the future, the SSC Synthesis Group will promote similar training activities. Hanson briefed the SSC on the success of the training course, a success due to the combined efforts and economic support of several organisations, groups, and individuals. SCOR, START, IOC US-JGOFS, India JGOFS, and International JGOFS provided program and financial support, and Hanson especially thanked Elizabeth Gross and Shubha Sathyendranath for their time and effort in the activities. Burkill added that capacity building was very valuable part of the Symposium and Training Course.

Liu suggested that JGOFS needs to approach START for future projects. Field also mentioned that once specific proposals are developed, they could then be coupled with SCOR for further development. Hanson informed the SSC that START is looking critically at the mode of training courses. There is a need to ensure that skills developed during a training course be part of an on-going partnership between developing and developed countries, *e.g.*, more focus should be on the individual and enhanced through guidance. There is also a need for a definite product or publication. Quiñones cautioned that this individual treatment would be very difficult to guarantee and that most instructors at training courses are already on over-load.

Gross offered to help in approaching START for future projects. CMTT is probably the group that would be most likely to be involved in this type of program in the future.

Liu asked if the training course material is available to other students and scientists who could not attend the training courses, and who should they ask for information. Liu suggested that it would be nice to include this material on the IPO website. The SSC supported this suggestion.

ACTION #7: Baliño will request material from Sathyendranath and implement workshop material from Bangalore in the homepage. It will also be link to START to promote capacity building activities within JGOFS.
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Continental Margins Task Team (CMTT)

Hall briefed the SSC on CMTT five-major geographical areas: eastern boundary currents, western boundary currents, marginal seas, polar margins, and tropical coasts. For the polar margins, the CMTT lacks the expertise necessary to cover this area and asked for suggestions. Lochte asked should this area include the Siberian shelf area. Hall said that yes it does. Lochte could provide some scientist names, who could look at nutrient fluxes and CO₂, and also help in organising and compiling data from polar margins. She suggested that a candidate from the Norwegian Polar Institute in Tromsø could be nominated to fill two needs: supply expertise for the CMTT and provide a Norwegian representative on the SSC.

Data Management Task Team (DMTT)

Baliño reported on the DMTT meeting and JGOFS Data Management and Synthesis Workshop, both held in Bergen in September 1998. The DMTT discussed the following points.

- Ensure that all JGOFS observations are lodged with organisations, which can guarantee long-term stewardship,
- Provide Web-based information on the availability and access mechanisms to all JGOFS data, and
- Encourage the development of Web-based data delivery systems.

Afterwards, DMTT representatives reviewed the status of JGOFS data from their respective countries. One action item from this meeting was for the IPO (Baliño) to write to JGOFS chairs of the “unrepresented nations” at the DMTT to ask what plans they have to assure the long-term stewardship of their national data sets. The planned JGOFS Inventory Index (JDI) project was abandoned due to lack of resources. Instead, Baliño would investigate existing metadata search technology to see whether they can deliver JGOFS requirements.

Two new members were nominated to the DMTT: Ms. Marie-Paule Labaied in charge of the French database initiative, and Brian Griffiths, from Australia, who will be responsible for centralising the Australian data sets in a databank. Regarding the venue of the next DMTT, the German-JGOFS data management office kindly extended an invitation to host the meeting in Kiel in Year 2000, which was accepted.

The goal of the Data Management and Synthesis Workshop was to establish communication between the DMTT and scientists actively working in the synthesis and modelling phase. They addressed the following issues: the JGOFS metadata catalogue, communication, management of synthesised data sets, management of model data, timeliness of data delivery, relational database technology and protocols for data citation. Eileen Hoffman, who was representing GLOBEC at the workshop, mentioned that GLOBEC is beginning to address data issues and wants to learn about JGOFS experience in data management. The workshop minutes are published in the JGOFS Report Series (Report Nr. 29), distributed to the JGOFS community and available on-line at the IPO website (<http://ads.smr.uib.no/jgofs/publications/on-line/jgofs29.pdf>)

Data products

The CD-ROM, *JGOFS International Collection: CTD, XBT and SeaSoar data, Arabian Sea Process Study 1990-1997*, was released in March 1999. This CD-ROM contains nearly 2,500 temperature profiles plus, in most cases, salinity and, in some cases, a subset from chlorophyll, dissolved oxygen and optical attenuation. Ships from six nations collected the data during 42 research cruises. The German JGOFS Data Management Office, Kiel, produced the data set supported by the data assembly efforts of the members of the JGOFS DMTT. The University of

Bergen through the JGOFS IPO supported the production of the CD-ROM. Copies of the CD-ROM are available, free of charge, from the IPO upon request.

JGOFS metadata catalogue

The JGOFS metadata catalogue is being implemented on the IPO web site. The metadata follows the DIF (Directory Interchange Format) technology, a de-facto standard used to create directory entries, which describe a group of data, developed by the NASA's Global Change Master Directory (GCMD). The main goal of the catalogue is to assist in the synthesis and modelling phase that JGOFS is launching into. This catalogue provides an overview of available JGOFS data sets and related data sets available. The catalogue is sorted by ocean basin, *e.g.* North Atlantic, Equatorial Pacific, Arabian Sea, and Southern Ocean. The data sets are also sorted by participating country. The hyperlinks will take the user to the documentation of the data (= metadata) that is, what, where, who and how the data were measured/collected and where/who to contact to acquire them. The JGOFS metadata catalogue is a complement to the cruise inventory and is located in the Data inventory page at <http://ads.smr.uib.no/jgofs/inventory/index.htm>.

IGBP-Data and Information System (DIS)

Baliño, as JGOFS liaison with DIS and newly appointed member of the new Steering Group, informed the SSC about the latest developments. The search tool or web crawler envisioned in May 1998 is now operational. DIS built the tool while the IPOs were in charge of indexing their homepages with metatags to be harvested by the web crawler. DIS will present a demo of the prototype at the Congress. All core projects will eventually be link to this search tool through their IPO homepages (look for a "search" button). This will enable scientists to gather Core Project's general information and existing data sets (metadata) within IGBP. As of the Congress, JGOFS is the only core project that has indexed its web site for metadata. The new mandate of DIS will be to assist inter-core project science by, *e.g.* facilitating and co-ordination the generation of global and regional data sets. Baliño remarked that if JGOFS needs to generate data sets to get in contact with the IPO, so that the request can be forwarded to DIS. She emphasised however that DIS would address only inter-project needs (2 or more) and not individual project requirements. Liu mentioned that the CMTT might have some requests in this regards, as they will start compiling data from all over the world, government reports and local reports since they don't actually have data themselves.

North Pacific Task Team (NPTT)

Bychkov reported on the fourth NPTT meeting held during the JGOFS North Pacific Workshop and SEATS Planning Meeting in Taipei, March 1999. He announced that plans are underway to launch the South-East Asia Time-series Station (SEATS) in South China Sea. Bychkov asked that the SSC to endorse this undertaking.

ACTION #8: Bychkov asked the SSC to endorse the SEATS project.

Bychkov proposed a fifth NPTT meeting in conjunction with JGOFS North Pacific Synthesis Workshop in Nagoya, Japan in February 2000. The NPTT may request JGOFS financial support for the NPTT meeting and 2-3 scientists to attend the synthesis workshop. Saino is presently seeking financial support from Japan. In addition, Bychkov informed the SSC that although it is premature for the synthesis of the North Pacific Process Study, they must contribute to the JGOFS Synthesis in other ways. In the near future, the co-Chairs plan to strengthen the modelling in NPTT and to propose a restructured membership to match its new Terms of Reference (approved October 1998). A product of the synthesis workshop is a synthesis

volume(s) on the North Pacific Process Study. There are plans to publish a synthesis volume in 2003.

ACTION #9: SSC deferred to consider support for the NPTT and 2-3 additional scientists for the synthesis workshop (February 2000).

Bychkov proposed a sixth NPTT meeting in conjunction with the NPTT-PICES North Pacific CO₂ Data Workshop, planned for October 2000. The proposal requests financial support to co-sponsor of the CO₂ Data Workshop. Because the workshop organisers plan to release a CD-ROM, they request Baliño's participation at the workshop. Finally, the sixth NPTT meeting will follow the proposed workshop.

ACTION #10: The SSC deferred to consider financial support the NPTT members and two scientists to the NPTT-PICES North Pacific CO₂ Workshop (October 2000).

JGOFS-IOC CO₂ Advisory Panel (CO₂ Panel)

Alexiou (IOC Secretariat) suggested disbanding the CO₂ Panel as it is presently, while Watson proposed new Terms of Reference (TOR). The SSC asked whether JGOFS needs this advisory panel and if so, would the membership include a different group of CO₂ scientists. Field mentioned that although SCOR was not impressed with the new TOR, it still needs JGOFS recommendation about the panel. Tilbrook felt that although the panel had served its purpose there is still a need for some continuity. Monfray would like to see a network of people working on pCO₂ issues, in order to improve the quality of existing and future data sets for modelling purposes. The improvement of the data quality is inherently connected with the calibration problem and the need to quantify CO₂ in the oceans. Quiñones felt that if the panel is disbanded that this might send a wrong signal to the CO₂ community and possibly thwart future funding. Lochte asked if there were any on-going field programs and Tilbrook mentioned the on-going JGOFS time-series stations.

Liu read the new Terms of Reference of the CO₂ Panel. The goals are to synthesise knowledge, to be a forum for modelling efforts and to ensure that data are properly calibrated and archived. Tilbrook added that the panel has done much regarding instrumentation while new instruments were being developed. Until the data are synthesised, there is a need for the panel to address methodological issues.

Hanson reminded the SSC that the discussion of CO₂ Panel occurred in Cape Town. If it is not the intention of this group to recant the previous action to continue the CO₂ Panel, then time should be spent reviewing the new TOR and provide our input. Tilbrook suggested that the terms also include a passage on the value of new sensor technology and calibration. Field again asked that people knowledgeable should speak. Are these terms of reference relevant? Hall stated her disappointment and mentioned the Earth observing system groups' decision to propose an observing system to cover CO₂ comprehensively. Therefore, the CO₂ Panel needs to be reformed to involve people in wider field with a broader mandate. The SSC feels strongly that JGOFS needs more feedback and input from the CO₂ Panel.

ACTION #11: Bronte will draft JGOFS recommendations to redraft the terms of reference before the end of meeting. The Executives would review these recommendations at the next meeting and send a copy to SCOR and IOC.

Deep Ocean Flux Task Team (DOFTT)

Lochte announced that there were two meetings, one in January 1998 and the other March 1999 of the EU/MAST project: “Atlantic Database for Exchange Processes at the Deep-Sea Floor (ADEPD)”. The main objective of the project is to establish a network of European researchers involved in geochemical and biological processes in the deep sea of the Atlantic. In the current project phase, geochemical and biological data are being compiled and archived in the PANGAEA data information system. The database is on-line at <http://www.io-warnemuende.de/public/bio/adepd/adepd.html> and it will be hyperlink to the JGOFS website.

Lochte, Shimmield, and Roger François have made great progress towards forming a joint JGOFS-PAGES DOFTT at the IGBP Congress (*Session J6*). The next steps will be to

- nominate members and propose Terms of Reference to JGOFS and PAGES in 1999 and
- organize a meeting and workshop in 2000.

The workshop will involve about eight people (4 from each core project) and funds will be needed for the workshop. Lochte felt that the Open Science Conference in Bergen might be too short a time to organize a meeting at the Conference.

Photosynthesis Measurement Task Team (PMTT)

Sakshaug reported that there has been little progress on the manual the last year and apologised for the delay. The manual will be printed as a JGOFS Report and will be available online at the JGOFS web site in early 2000.

Joint JGOFS-LOICZ SSC Session on the Continental Margins Task Team

On the last day of the Congress, the SSCs from both JGOFS and LOICZ convened to review and comment on the CMTT future synthesis plans. Hall reported that the SSCs recently approved the new Terms of Reference, which were broadened to focus on synthesis and the new membership of the task team. The overarching synthesis framework is focused on CO₂ sources and sinks, and C, N, and P fluxes across continental margins, including polar margins. The objective now is to identify key processes within these margin typologies. In support of CMTT and its future synthesis activities, the team established a website at <http://keep.oc.ntu.edu.tw/cmtt>, which lists continental margin projects, principle investigators, bibliographies, and regional synthesis reports.

In the future, the team identified meetings where future continental margin sessions will occur: the LOICZ Open Science Meeting (Argentina, 1999), the AGU Ocean Science Meeting (USA, 1999), the JGOFS Open Science Conference (Norway, 2000) and the IGBP Open Science Meeting (The Netherlands, 2001). Finally, the CMTT plans to organise a synthesis volume (book). In this regard, there are concerns about the commitment of resources, the tremendous amount of work involved and the number of people required to draft and publish the volume. The CMTT estimated that the synthesis volume would require a dedicated support staff and a group of 45 people over 2-3 years to complete it.

The SSCs approved CMTT future synthesis plans with comments on the synthesis volume and staff support. Crossland (LOICZ IPO) mentioned that since LOICZ is organising their Open Science Meeting in Argentina in 1999, there might not be large amount of funding available. Hanson shared Crossland view on available project funds in 2000 because JGOFS is organising their Open Science Conference in Norway. Each core project is stretched financially each year. Therefore, we need to think of alternative revenue sources for the synthesis volume/assistant staff person. Crossland offered a suggestion to exploit the IGBP system by using the START

fellowship in certain areas of the world. In regards to plan workshops and meetings for synthesis, the IPOs will continue to share the burden of the CMTT as set forth by the SSCs.

ACTION #12: IPOs of both JGOFS and LOICZ will discuss the practical issues of sharing meeting costs as they arise. As for synthesis volume, infrastructure, and costs, other options need to be explored.

Open Science Conference Programme

Lochte presented a program plan and lead a discussion on the Conference's Science Program. Members of the science committee suggested that lead authors provide the keynote talks on the themes of the synthesis textbook. The committee allocated 50 min (30 minutes talk with 20 min discussion) for the keynotes. In addition, they suggested parallel discussion sessions. The organising committees will determine the function or use of the parallel sessions. Posters need to be seen as important and emphasised at the conference, and not left too late in the afternoon. Field mentioned that he preferred poster presentations after lunch. However, the SSC emphasised that the book chapters should receive emphasis after lunch.

The schedule is tight. With all textbook elements included in the program, the SSC wanted to avoid any impression that Conference overlaps with the Villefranche Symposium, referring especially to the element on time series stations and the nitrogen cycle. Hall suggested that the SSC redefine time-series stations in other terms. Lochte agreed and she suggested ocean biogeochemical variability. All research topics in JGOFS deal with description except time series stations, which deals with whether major changes occur. The SSC supported Lochte's suggestion and agreed on "Temporal Variability of Biogeochemical Processes" as the new title for time-series studies and the textbook. However, the SSC recommended dropping the nitrogen cycle at Open Science Conference, since it would be included in other themes. Burkill suggested that Fasham ask the authors/lectures to include nitrogen cycle in their talks where relevant.

The SSC emphasised that the Conference must recognise the importance of ocean carbon modelling and present a strong statement for their use, especially what we have learned and what ocean carbon models suggest for the future. Many countries are making a major financial commitment to ocean carbon modelling.

Quiñones suggested that there should be an incentive for poster work. For example, one could select 20 of the best posters and publish them in a journal. Hanson suggested that JGOFS recognise or award the students of the best-poster paper as well as the best-contributed paper. The publication of the research papers adds another layer of effort on an already stretched conference staff.

Synthesis Book/Lead Author Meeting

Field reported on the evening meeting that the lead authors for the JGOFS synthesis textbook held. The editors are Fasham (lead editor), Zeitzschel, Platt, and Field. The authors agreed that the textbook must be available at a reasonable price. Swanberg informed the SSC that Springer book are less expensive than Cambridge University Press books. Other considerations focussed on the details of advertising and marketing. Because of changes that occurred in the timeline, the participants recommended:

Recommendation 1: 31 July 1999, a 1-page outlines is due at the IPO. The chapter outlines will be circulated among the lead authors and the SSC to identify overlap, gaps and cross-referencing.

Recommendation 2: 28 February 2000, drafts are due at the IPO. The chapter drafts will be circulated among the Lead Authors and the SSC for review.

Lead authors offered advice on modifying the content of chapter outlines as follows:

- Ocean biogeochemical regimes: Ducklow agreed to the scope of the chapter.
- Physical context: Lead author was absent. It should be related to chapter I.
- Continental Margins: Chen, Liu, and Smith presented a detailed outline.
- Primary production: Falkowski agreed to include the nitrogen cycle.
- Carbon dioxide Flux: Watson was absent; little information available.
- Community structure. Landry provided a detailed outline.
- Water column biogeochemistry: Tréguer agreed to the scope of the chapter.
- Feedback processes: Boyd was absent. Sakshaug to bring in subheadings.
- Benthic processes: Lochte presented an outline (needs more topics included)
- Global perspective: Doney was absent.
- Title to be revised. How well have we done? Title needs to look forward.

Quiñones questioned whether the book was an interaction or end product of JGOFS. He would like to include a list of cruises, developments, and contributing countries. However, Field reminded the SSC that when this was previously discussed it was recognized that the JGOFS community wanted something different from the Villefranche book, more dynamic and more advanced saga. The book should not be an encyclopaedia on JGOFS; rather it should be more of a textbook displaying new ideas. This book is not a final product of JGOFS.

Lochte and Hall felt that the book should also include a chapter on time series to highlight the importance of temporal variability in the ocean. Time series stations have proven to be essential in the monitoring the ocean. These activities are very expensive to maintain and therefore it is therefore very important to point out this message, not only to the scientific community but also to governmental funding agencies. Field expressed reluctance to make changes in the chapters in the absence of the all editors and authors. In addition, the book may not be the best forum to include this topic while the brochure might be the right place because it is oriented, among others, to policy makers. Baliño added that the brochure would include a section on JGOFS field programs, cruise structure and inventory, technological developments, and other topics. The SSC recommended that Fasham and the lead authors include temporal variability in the synthesis book.

ACTION #14: Hanson will forward the recommendation to Fasham who will make the final decision. Fasham would also decide whether the nitrogen cycle would be included in Chapter IV.

National Reports

France

Tréguer reported that one of the major issues of JGOFS is to understand the role of siliceous phytoplankton in the transfer of carbon from the upper ocean to the deep waters and seafloor. Diatoms contribute with about 50 % of the "biological pump" of the greenhouse gas CO₂. This leads scientists of the modern and of the past oceans to gather their efforts within the umbrella of a new international program: OPALEO. The scientific objectives of OPALEO are:

- To quantify the coupling and decoupling between the cycles of silicon, carbon and nitrogen in the modern ocean, and
- To develop a better use of opal as a proxy of paleoproductivity.

The Scientific Committee of OPALEO comprises: Paul Tréguer (CNRS, UBO, France) chair, David J. DeMaster (NCSU, Raleigh, USA), Roger François (WHOI, USA), Gerhard Fischer (Universität Bremen, Bremen, Germany), Christoph Heinz (Max-Plank Institute, Hamburg, Germany), David M. Nelson (OSU, Corvallis, USA), and Olivier Ragueneau (CNRS, UBO, France). The European component co-ordinated by O. Ragueneau received its first support from the European Union to develop global modelling of the C and Si cycles, and to build a world data bank on the silica cycle (SINOPS: 1998-2002, Leader: E. Meier-Reimer, MPI, Hamburg, Germany). The US component (Co-ordinators: D.M. Nelson and D.J. DeMaster) has submitted a proposal to NSF for a joint study with K. Bruland on the equatorial Pacific ecosystem (2000-2001).

New Zealand

An *in situ* test of the iron limitation hypothesis in the Southern Ocean was completed in February 1999. The New Zealand research vessel Tangaroa left Wellington in late January with 26 scientists from six countries on board for the Southern Ocean Iron Release Experiment (SOIREE). The experimental site was located 2,500 kilometres (km) Southwest of New Zealand and 500 km from the Antarctic ice. The iron release took place south of the Antarctic Polar Front and north of the southern Antarctic Circumpolar Current near 141°E, 61°S. Upon arrival at the site, a 72-hour hydrographic survey was conducted that confirmed the desktop choice of site. The survey was carried out with CTD and XBT profiles that provide vertically resolved survey data for temperature, salinity, chlorophyll fluorescence, and biophysical characteristics of algal populations.

The release of iron and SF₆ as a tracer occurred on Feb. 10. The site chosen had a mixed layer roughly 65 meters deep and low chlorophyll *a* levels, and the dissolved iron concentrations were raised to levels considerably greater than ambient over 50 square kilometres. The added dissolved iron was removed quickly, necessitating three more infusions during the 13-day experiment. Conditions on deck were cold, with air temperatures between 0° and 3° C and occasional showers of sleet and snow. Despite winds up to 60 knots and seas up to 10 meters, a coherent iron-enriched patch was maintained over the period of the experiment. The patch moved about 40 nautical miles, generally east- southeast, and expanded in size to about 150 square kilometres over this period. As we expected, the response of the biota to iron fertilisation was slow in comparison to that encountered during IronEx I and II. Five days elapsed before significant increases in algal photosynthetic competence and then algal biomass was observed.

Chlorophyll *a* levels increased markedly, and macronutrient levels and the partial pressure of CO₂ decreased from the levels observed at the beginning of the experiment. In contrast, upper-ocean levels of dimethyl sulfide increased during the experiment. Daily underway surveys and

sampling outside of the patch indicated little change in biomass, photosynthetic competence or macronutrient concentrations. Preliminary results suggest that, at least in this part of the Southern Ocean, iron availability plays a fundamental role in controlling the photosynthetic competence of the algae. An increase in available iron appears to bring about a substantial elevation of phytoplankton biomass, despite a relatively deep mixed layer, low seawater temperatures and the presence of grazers.

Canada

Harrison informed the SSC that the Canadian JGOFS proposal for Phase III (fieldwork and synthesis) was declined. Had it focused on synthesis only, it might have been funded. Therefore, synthesis is continuing without funds. A special volume in Deep-Sea Research II on the North Pacific will contain 25 papers and colleagues are presently receiving galley proofs. This special volume should appear in the early fall of 1999. Papers that did not make this volume will be published in a second, smaller, volume along with possibly several synthesis papers in 2001/2.

Germany

Two groups are presently funded by a government project to bring together and synthesise the research carried out in the North Atlantic Ocean and in the Indian Ocean, two major study regions of German JGOFS. Synthesis work for the Southern Ocean, the third area of intensive studies, is carried out at the Alfred Wegener Institute for Polar and Marine Research. Furthermore, within the German JGOFS science community five small groups have been established addressing several overarching topics:

- Exchange of CO₂ between atmosphere and ocean,
- Pelagic carbon fluxes,
- Vertical flux,
- Fluxes between water and sediment, and
- Modelling biogeochemical fluxes and processes.

These groups are working on a small level, but may form a nucleus for more advanced analysis of ocean biogeochemical processes.

Japan

ACTION #15: Saino requests that JGOFS endorse the new Japanese programme on Global Carbon Budget (JAMSTEC).

Taiwan

For the past 10 years, Taiwan's major contribution to JGOFS has been the Kuroshio Edge Exchange Processes (KEEP) project. As KEEP is reaching its final phase, oceanographers on Taiwan are contemplating new projects that may contribute to the understanding of ocean biogeochemistry. Two promising projects are emerging. The first is the South-East Asia Time-series Station (SEATS) and the other is the Long-term Observation and Research of the East China Sea (LORECS). A pilot study for the SEATS project was initiated by the National Centre of Ocean Research (NCOR) in August 1998 through the support from the National Science Council of Taiwan. At the JGOFS North Pacific Workshop held in Taipei, March 1999, the planning of SEATS was a focal point for discussion.

United Kingdom

The UK JGOFS has no formal national committee or funding. The new core strategic science programmes in the UK are at the Centre for Coastal and Marine Science (CCMS), Southampton Oceanography Centre (SOC), and the British Antarctic Survey (BAS). Funded UK projects with links to JGOFS are DYME (Dynamics of Marine Ecosystems, project leader Burkill at CCMS), and Higher Trophic Level Production and Physics (project leaders Priddle and Murphy at BAS). In addition, there are several other national thematic and individual projects that are current, proposed, and in the planning stages.

International Reports

International Ocean Colour Coordinating Group (IOCCG)

Gross reported on some recent IOCCG activities not covered in the Annual Report (attached). Recent scientific activities include:

- A report has just been published on “Status and Plans for Satellite Ocean-Colour Missions: Considerations for Complementary Missions,” as a product of a workshop held in 1998. It is now available from the IOCCG Project Office at BIO.
- An IOCCG Workshop on algorithms for ocean colour data from Case 2 waters will take place in Ispra from 14-18 June 1999.
- A Training Course on “Applications of Marine Remote Sensing” in Thailand from November 1-12.
- Other IOCCG groups are considering, *e.g.*, calibration of ocean-colour sensors to common standards, validation of standard data sets and radiometric calibration of ocean-colour sensors.
- The IOCCG Homepage at <http://www.ioccg.org> is continuously updated and contains information on the group's activities, status of ocean colour missions, training courses, sources of ocean colour data sets, etc. Send message to Platt if not on mailing list for IOCCG.

Saino recommended that in the future, if Platt is unable to participate, another way to maintain proper communication is to send JGOFS representative, such as Falkowski, Monfray, or Saino, to attend IOCCG meetings. Platt being the only link is not good for either JGOFS or IOCCG. Platt and IOCCG need to develop alternative arrangements.

ACTION #16: Platt or an IOCCG representative must attend all future SSC meetings.
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Global Ocean Observing System and OOPC Representative

Field advised JGOFS SSC of the need to address the issue of an OOPC panel representative. The past representatives were Lillian Merlivat and Field. Field served until the end of last year, when he rotated off the SSC. JGOFS now needs to recommend a SSC member who can represent carbon, keep carbon on the agenda, and talk to physicists. Hall is on the GOOS Steering Committee but will rotate off the SSC at the end of this year. The GOOS OOPC Panel requests JGOFS representation as part of JGOFS legacy in terms of ocean carbon. It must be made clear to anyone approached that the group is very active and requires their full commitment. The fourth OOPC Meeting is in Woods Hole, 17-20 May 1999.

ACTION #17: Field suggested that the name for the JGOFS representation on the GOOS & OOPC be forwarded to Fasham for consideration.
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SCOR Working Group: Export Production Proposal

Burkill asked for a discussion of an IOSG proposal for a SCOR Working Group on Export Production. The topic came up during the summation of Arabian Sea Symposium in Bangalore in January 1999. Lochte felt that this would be a very important project for SCOR and she could suggest appropriate names for the group. Quiñones emphasised that the dissolved fraction should be incorporated and this needs another school of scientists. Burkill mentioned that both Tim Rixen (Germany) and Seth Krishnaswami (India) agreed to develop a proposal that would be a basis for the formation of a new SCOR Working Group. The SSC endorsed the proposal as a worthwhile endeavour. For a letter of support, Hanson asked Burkill to send a copy of the proposal.

ACTION #18: Fasham will write a letter of support for the SCOR Working Group on Export Production, when Rixen and Krishnaswami are ready with the proposal.

Other Business

Future Research in Ocean Biogeochemistry

John Field reported that there is a perception in the community that IGAC and JGOFS decisions are being made without the SSCs input. To correct this perception, SCOR initiated a meeting during the Congress to expose the scientific and organisational issues involved in the development of future programs in the field of ocean biogeochemistry. Field led the discussion, and Gross prepared the following brief report: "The lunch time meeting included individuals currently involved in the JGOFS and IGAC program of IGBP as well as in the emerging SOLAS initiative. It should be emphasised that no decisions were made at this meeting. It was simply an exchange of views. All participants agreed that the future requires a fully integrated approach, including studies of ocean-atmosphere exchanges, fluxes throughout the entire water column to the sea floor, physical processes, climate interactions, feedbacks and so on. This approach should take advantage of the results of the JGOFS and IGAC syntheses, as well as the scientific directions emerging from the SOLAS Open Science Meeting in February 2000. Lastly, aspects of our understanding of climate variability and of marine ecosystem dynamics will be required from GLOBEC and CLIVAR. We need a new organisational model within the IGBP and in national programs and funding agencies, in order to carry this out. Such a mechanism, which is not constrained by traditional disciplines, should be developed in the next year or so. IGBP, SCOR and WCRP should continue this discussion during the months ahead."

SOLAS Presentation

The SSC invited Robert Duce to present the latest news on SOLAS plans and to discuss future research in ocean biogeochemistry. Before the presentation, Duce thanked the SSC for the invitation and the opportunity to present ideas of programme. SOLAS is still in the developmental stage. It is important for SOLAS to have the support from both IGAC and JGOFS and input during this stage, so that the atmospheric and ocean sciences are properly combined. An overhead of the goals of the programme and interactions were shown. Duce announced that next year, SOLAS will hold its Open Science Meeting (OSM) in Kiel (20-24 February 2000). Duce expects that OSM discussions will lead to a proposed research program, and therefore, JGOFS input is important in this process. The goal is to address key interactions between other marine biogeochemical systems, the atmosphere and climate. The following major questions/themes will be discussed at the meeting:

- Sulphur cycle,
- Iron,
- CO₂ exchange, and
- Physical forcing.

Additional topics to be addressed are:

- Role of remote sensing,
- Role of time series,
- Role of the atmosphere,
- Coastal waters and shelf areas, and
- Paleo records.

It is expected that the presentations and discussions on these topics will help to identify the research approach to answer SOLAS questions. The steering committee plans then to stay a few days after the OSM to synthesise the outcome of the discussions and will prepare a report in six months time.

Discussion

Both Burkill and Landry asked about information exchange of SOLAS with the scientific community. Duce mentioned that a website is under development and that there will be an email list as well as an article in the US JGOFS News. The SSC suggested that the JGOFS and IGAC IPOs also be contacted in this regard.

Quiñones stated that there was a lack of knowledge about fluxes in many ocean areas in the Southern Hemisphere, especially those around third world countries. There is a need to develop a strategy to cover these areas, e.g. time series initiatives, such as HOT or BATS, in coastal and ocean basins in the Southern Hemisphere. Duce advised him to forward names to the SOLAS Office so that we can inform them on how they can get involved in the programme.

Lochte asked about the inclusion of aeolian iron deposition to the ocean. Duce replied that terrestrial inputs would definitively be a part the programme. In fact, IGAC expressed great interest in this topic. In addition, Tom Pedersen has been invited, and it is expected that he might help show how PAGES and IMAGES can get more involved in SOLAS.

Liu thanked Duce for his presentation and for giving JGOFS participants a better appreciation of what to expect from the program.

Recommendations

Regarding future research in ocean biochemistry, Liu referred the SSC to the two letters from Platt and Ducklow in the Agenda Book. He mentioned that Platt (IOCCG Chair) wrote a letter endorsing the effort of SOLAS. However, the program did not cover the ocean or atmosphere fully and that in its present state, it is primarily an interfaced program between ocean and atmosphere. Platt then recommended that the SSC form a study group to explore future research in ocean biogeochemical after JGOFS. Liu suggested that this group should be a joint SCOR and IGBP group with representation from JGOFS and IGAC.

Gross stressed that JGOFS needs to discuss the science. Certainly many JGOFS scientists will join SOLAS but it does not cover all aspects. Swanberg expressed that the proposed SOLAS science plan should not be considered as *fait accompli* and that IGBP and SCOR will work together to develop the idea further.

Hall suggested having a small working group at the JGOFS Open Science Conference. Here they would have the involvement of the wider JGOFS community. In addition, she suggested that Fasham should lead this group and if not, then Platt. The SSC recommended the formation of a small group on the future of ocean biogeochemical studies.

ACTION #19: Hanson will notify Fasham regarding the recommendations to form a small working group on the future of ocean biogeochemical studies.

New Task Team Proposal

Monfray proposed a joint ocean carbon modelling task team with GAIM with the goal to improve global carbon cycle models. At the next GAIM Task Force meeting, it is important to integrate more JGOFS people and more countries, perhaps Japan or Australia. At present, France and USA are the only countries supporting OCMIP meetings. Tilbrook suggested that JGOFS should give their support to the upcoming OCMIP meeting in Paris. Field suggested that somebody with expertise in ecosystem approach should be incorporated in the proposed task team. Landry agreed and that there should be biologists, not only modellers, as well as somebody working on CO₂.

ACTION #20: The SSC welcomes a proposal to form a new task team on ocean carbon modelling. Monfray will propose terms of reference and membership to the Executives for comment and/or approval at the next Executive meeting.

Brochure Editorial Board Change

Baliño asked the SSC to release her from her duties involving the brochure due to an over extended data management and information workload. She felt that her time was better served by supporting data management. She can still help with the brochure process and assist with layout and graphics. The SSC agreed that the Executive should now take on the additional workload.

Science Topics at SSC Meeting

Quiñones expressed concern about the SSC not having time to discuss science, to ask questions about “ What are we focusing on”. There is too much bureaucracy to deal with. Hall also agreed and emphasised that there must be more discussion and input from the SSC to the Executive on decision processes. Several members are concerned that there is a miss-match as to how the SSC is developing and interacting with the Executive and IPO. Possibilities were discussed to improve the flow of information between SSC and Executive branches, the respective roles of these branches should be made clear.

Special thanks

Field congratulated Liu for his excellent leadership of the 14th Meeting of the SSC. All agreed.

Reminders

- 15 June is the deadline for comments on the brochure mock-up to Fasham and the IPO.
- 30 June is the deadline for chapter outlines from all lead authors to Fasham and the IPO.
- 31 August is the deadline to submit requests to the IPO for Executive actions. For example, meeting and workshop proposals for financial support, new or modified Terms of Reference for comment and/or approval, change in group and team membership, and 2000 SSC nominations to Executives *via* the IPO.
- Comments or suggestions concerning the future development of the SSC and Executives, how to improve business, etc. should be sent to Fasham and the IPO. The Executives will take your comments seriously.

Adjourn

Liu adjourned the 14th Meeting of the SSC on Thursday 13 May 1999 at 17:00.

Annexes

Annex 1: List of participants and addresses

Scientific Steering Committee Members

Present:

Peter Burkill
Alexander Bychkov
Paul Falkowski
Julie Hall
Robert Le Borgne
K.K. Liu
Karin Lochte

Patrick Monfray
Renato Quiñones
Toshiro Saino
Egil Sakshaug
Graham Shimmiel
Bronte Tilbrook

Lead-Authors and Guests

Arthur Chen
Hugh Ducklow
John Field

Paul Harrison
Michael Landry
Paul Tréguer

Secretariats

Elisabeth Gross (SCOR)

Neil Swanberg (IGBP)

International Project Office Staff

Roger B. Hanson
Beatriz Baliño
Judith Stokke

Regrets

Michael Fasham
Robert Anderson
Uli Bathmann
Roy Lowry
Trevor Platt

Doug Wallace
Andrew Watson
Huasheng Hong
Véronique Garçon

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Annex 2: List of members on the 1999 Scientific Steering Committee

Name	Country	Position(s)	Function	Executive	Term	1999	2000	2001
Fasham, Michael	UK	JGOFs Chair	At-large	Chair	2000	SSC	SSC	
Anderson, Robert	USA	SSC	At-large		2001	SSC	SSC	SSC
Bathmann, Ulrich	Germany	SOSG Chair			2000	Chair	Chair	
Burkill, Peter	UK	IOSG Chair			1999	Chair		
Bychkov, Alex	Russia	NPTT chair			1999	Chair		
Falkowski, Paul	USA	SSC	At-large		2001	SSC	SSC	SSC
Garçon, Véronique	France	NASG Chair			2001	Chair	Chair	Chair
Hall, Julie	New Zealand	CMTT Chair			1999	Chair		
Hong, Huasheng	China-Beijing	SSC	At-large		2000	SSC	SSC	
LeBorgne, Robert	France	EPSPG Chair			2001	Chair	Chair	Chair
Liu, Kon-Ke	China-Taipei	SSC 2 nd , CMTT chair	At-large,	Vice Chair	2000	SSC	SSC	
Lochte, Karin	Germany	SSC 2 nd , DOFTT chair	At-large,	EXEC	2000	SSC	SSC	
Lowry, Roy	UK	DMTT Chair			1999	Chair		
Monfray, Patrick	France	OCMIP Representative			1999	Repres.		
Platt, Trevor	Canada	IOCCG Representative			1999	Repres.		
Quiñones, Renato	Chile	SSC, CMTT	At-large,		2000	SSC	SSC	
Saino, Toshiro	Japan	SSC, NPTT chair	At-large,		1999	SSC		
Sakshaug, Egil	Norway	SSC 2 nd , PMTT Chair	At-large,	EXEC	1999	SSC		
Shimmield, Graham	UK	DOFTT chair			2000	Chair	Chair	
Tilbrook, Bronte	Australia	SSC 2 nd	At-large	EXEC	2001	SSC	SSC	SSC
Wallace, Douglas	Germany	SSC	At-large		2001	SSC	SSC	SSC
Watson, Andrew	UK	CO ₂ Panel Chair			1999	Chair		

Annex 3: Reports from the Sessions at the 2nd IGBP Congress (Yokohama, Japan)

The Paleo-CO₂ Record in the Ocean (Session J6)

The aim of this session was to explore ways in which the knowledge of the processes in the modern ocean ecosystem can be extended to longer time scales. A very good insight into the factors controlling primary production and export has been gained by JGOFS on a regional scale by the process studies, and on a global scale by the global surveys and remote sensing. However, this basically represents a “snapshot” of the marine system and does not address the climate driven variability of the system. PAGES research has identified rapid changes occurring in the marine system obviously coupled to alterations of ocean circulation, however, it is difficult to connect these changes to biogeochemical processes relating to community structure. An effort to link these two fields of research may, therefore, be an important step in order to understand climatically driven variations in the ocean. The session focussed on selected topics, which were introduced in six short talks.

Peter Burkill: "The effects of monsoonal forcing on export production in the Arabian Sea"

Graham Shimmield: "Evidence of past changes in the monsoonal forcing in the Arabian Sea"

Thomas Stocker: "Atmospheric CO₂ during the Holocene, Younger Dryas and major Heinrich events as reconstructed from ice cores"

Paul Tréguer: "Changes in plankton composition: the role of large grazers on the export production and the fluxes of biogenic matter to the sea floor"

Paul J. Harrison: "Fe Fertilization and phytoplankton responses"

Julie Hall: "The iron fertilisation experiment in the Southern Ocean"

Peter Burkill presented data on long-term sediment trap records of the effect of monsoons on vertical flux in the Arabian Sea. A 10-year record of sedimentation is now available from the western Arabian Sea and gives evidence of interannual variation of export production. One surprising result is that exceptionally strong SW monsoons seem to clearly reduce export production. The mechanisms of this effect are not yet understood. Changes of the intensity of the monsoon are well documented from sediment records on time scales of 100ka and 23ka caused by variation in external orbital (insolation) forcing of the southwest monsoon as shown by Graham Shimmield. He also presented high resolution data from coral records, which record the temperature variations caused by upwelling on short time scales and indicated some cyclicity in upwelling strength and nutrient supply. These presentations showed the sensitivity of this regional productivity regime to wind forcing and evidence of short-term variations.

Thomas Stocker presented data from Arctic and Antarctic ice cores. During the rapid temperature changes of the Dansgaard-Oeschger cycles (2°C) atmospheric CO₂ concentrations varied by 20ppm. In the Younger Dryas, a cooling of the northern hemisphere was observed, but not in Antarctic ice cores where no decrease in atmospheric CO₂ was found. A drop in CO₂ concentrations and concurrent changes in δ¹³C during the Holocene (11ka – 8ka) indicate that a large part of this carbon was taken up by land vegetation. Subsequent rises in CO₂ by 20ppm can be accounted for by a rise in sea surface temperature of 2°C and emission of CO₂ from terrestrial vegetation respiration. These data cannot identify regional changes or the underlying processes. Thus, model simulations are used to investigate the mechanisms causing the changes. They indicate that in the Younger Dryas changes of CO₂ are controlled by interhemispheric solubility and that the carbon cycle has not been in steady state for the last 10 ka.

In his talk, Paul Tréguer concentrated on the major role of diatoms for the export pathway of the biological pump. In order to be able to model present ocean processes and to reconstruct past productivity from sediment records it is of major importance to consider the coupling/decoupling between the cycles of carbon, nitrogen and silica. Data from satellite imagery (primary production) and sediments (carbon and silica concentrations) from the Southern Ocean indicated a decoupling between carbon and silica fluxes. Hence, silica cannot be used as a quantitative proxy of paleoproductivity without knowing the physical and chemical conditions that prevailed during diatom growth. Paul Harrison showed evidence for iron limitation at station P in the North Pacific. Experimental addition of iron resulted in increased growth of large diatoms, which was not controlled by grazing. Fe limitation of diatoms increased their sinking speed. At station P, pulsed input of iron occurs *via* dust transported by storms from the Gobi desert. An observed long-term trend in reducing the depth of the thermocline may also cause a gradual increase in Fe concentrations in surface waters potentially associated with changes in primary production and export flux. Julie Hall presented results of the iron enrichment experiment in the Southern Ocean (SOIREE), which gave clear evidence of increased primary production, a rise in firstly small and then larger phytoplankton cells, drawdown of CO₂ and stimulation of DMS production. These examples of phytoplankton physiology and growth demonstrated the major impact of ocean geochemistry, in particular iron fertilisation, on productivity and the potential effects of change in land cover on the oceanic carbon cycle.

The general discussion stressed the importance to understand the processes in the modern upper ocean and their sensitivity to changes in the chemical and physical environment. This is a basic condition for the interpretation of the historical record as reconstructed from sediment and ice cores or corals. This cannot be restricted to time scales of 200 years but has to be considered on time scales of ocean mixing and deep-water formation. A second issue of importance touched upon were the biogeochemical processes in the deep ocean. As a major progress of this session, a joint task team between JGOFS and PAGES is suggested for approval by the SSCs of both core projects and first members are nominated as a nucleus to develop this task team. A first step is to organise a joint workshop.

Agenda (Synthesis theme J7)

Discussion leaders: Kon-Kee Liu and Huasheng Hong

Time: 9:00-12:30 on 12 May (Wed., Day 6 of the Congress)

Place: International Productivity Centre (P) Seminar Room B 203

1. Introduction (Kon-Kee Liu, Institute of Oceanography, National Taiwan University)

- The aim of this session is to better define the role of continental margins in global carbon cycle, to identify major gaps in current knowledge for global synthesis and to clearly assign responsibilities within IGBP for assessing various carbon fluxes at the margins.
- This session welcomes interested scientists from **JGOFS, LOICZ, GCTE, BAHC, GAIM** and other core projects to explore these issues.

2. Short talks (Chair: Huasheng Hong, College of Oceanology & Environment, Xiamen Univ.)

- Smith, Steve (University of Hawaii): An overview
- Yanagi, Tetsuo (Kyushu University): Nitrogen budget in the East China Sea.
- McManus, Liana (University of the Philippines): Nutrient budgets in the coastal zone of the Philippines.
- Hall, Julie (National Institute for Water & Atmosphere Research, Hamilton): Nutrient budgets for the Hauraki Gulf, New Zealand. Prepared by John Zeldis and Stephen Smith.

- Atkinson, Larry (Old Dominion University, Norfolk): Where are the depositional areas on shelves and slopes?
- Gao, Shu (Institute of Oceanology, Qingdao): Fine-grained material movement on the East China Sea shelf and its relation to CO₂ transport.

Coffee break

- Quiñones, Renato (University of Concepcion): JGOFS experience in the Humboldt Current off Chile.
- Tsunogai, Shizuo (Hokkaido University, Sapporo): Is there a "continental shelf pump"?
- Chen, C. T. Arthur (National Sun Yat-sen University, Kaohsiung): Continental margin fluxes in the North Pacific.

Discussion (Chair: Kon-Kee Liu, Institute of Oceanography, National Taiwan Univ.)

- Which parts of continental margins are sources of CO₂? Which are sinks? Do we have enough information to assess the net CO₂ flux at the margins?
- What controls the "continental shelf pump"? river discharged nutrients? upwelling? shelf burial? carbon export processes?
- Are the continental margins well covered by IGBP projects? If they are, which projects cover which parts of the continental margins?

Continental margins: a sink or source of CO₂? (Session J7)

Discussion leaders: Kon-Kee Liu and Huasheng Hong

Rapporteur: Liana Talaue-McManus

Time: 9:00-12:30 on 12 May (Wed., Day 6 of the Congress)

Place: International Productivity Centre (P) Seminar Room B 203

Total attendance: 21

Aims

- Better define the role of continental margins in global carbon cycle.
- Identify major gaps in current knowledge
- Identify IGBP core projects, which contribute to the assessment of different carbon fluxes at various margins.

Summary

- The continental margins serve as an important part of the CO₂ sequestration machinery in the ocean with an estimated strength of 0.5-1 GtC yr⁻¹, representing 5-15% of the global ocean biological pump.
- In western boundary current systems, such as the Kuroshio, an efficient continental shelf pump may draw down atmospheric CO₂ and transport dissolved inorganic carbon and also organic carbon to the intermediate waters in the open sea. Better understanding of the processes involved in the pump is needed.
- In eastern boundary current systems, both the temporal and the spatial variability of air-sea CO₂ fluxes are very high (fluctuating between strong sources and weak sinks), but new observations are emerging which may shed light on the control mechanism for the carbon fluxes.
- The recently published assessment of the global export production in the coastal ocean raised questions. A more comprehensive assessment is needed. The joint LOICZ-JGOFS Continental Margin Task Team (CMTT) will take on the responsibility to carry out the synthesis in the next 2-3 years, if it gets sufficient support.

Short talks

1. Steve Smith indicated that estimates of the export production in the global coastal ocean in some recent publications might be too high and suggested area-weighted average for assessment. He then gave an overview about the general LOICZ budgeting procedure, which is based on linked water, salt and nutrient budgets to estimate the net organic production. Dissolved organic N and P are ignored due to lack of information in most systems, but could be important.
2. L. Talaue-McManus and J. Hall discussed budgets for coastal areas in the Philippines and New Zealand, respectively. These were constructed using the LOICZ budgeting procedure. In three areas (Linganyen Gulf and Manila Bay in the Philippines, and Hauraki Gulf, New Zealand), the coastal zone was heterotrophic (*i.e.*, CO₂ source) and net denitrifying.
3. Arthur Chen presented carbon estimated for the North Pacific and summarized a number of carbon fluxes from other shelves. In all cases except the Gulf of California, the continental margin acted as CO₂ sink. In the East China Sea, upwelling and river runoff supplied nutrients to support new production, which was exported not only as particulate organic carbon (POC) but also as dissolved organic carbon (DOC). In the Okhotsk Sea and the Bering Sea, formation of the North Pacific Intermediate Water was important to the sequestration of anthropogenic CO₂. Chen agreed with Smith's assessment of the global coastal export production and suggested the value might be too high by a factor of 3. Shizuo Tsunogai described a mechanism he termed the continental shelf pump, which transported mostly dissolved inorganic carbon and to a lesser extent DOC and POC into the deep ocean by isopycnal mixing. If the pump worked the same way everywhere on the shelves, it would have sequestered 1 GtC y⁻¹.
4. Yanagi estimated the nutrient budget of the East China Sea by numerical modelling and showed the significant contribution of the Kuroshio to the nutrient pool. Specifically, it provided 54% of the dissolved inorganic nitrogen influx and 74% of the dissolved inorganic phosphorus influx.
5. Quiñones presented the heterogeneous nature of the eastern boundary Humboldt Current System, which had actively upwelling and quiescent periods over a variable time-scales. In actively upwelling areas, CO₂ release occurred. During slack periods, the CO₂ flux was nearly neutral or slightly downward.
6. Gao and Atkinson both discussed the role of sediment transport in the global carbon cycle. Identification of depositional areas and the concurrent processes associated with the remineralisation of organic matter and/or the sequestration of carbon through burial should be assessed. Gao showed that high concentration of suspended sediments at the shelf break was concurrent with high nutrient regimes, indicating remineralisation.

Discussion

1. Summary of areas reported

Nearshore coastal waters:

- Linganyen Gulf, Philippines CO₂ source
- Manila Bay, Philippines CO₂ source
- Haurakai Gulf, NZ CO₂ source

Eastern boundary current system

- Humboldt Current Systems CO₂ source

Western boundary current system

- East China Sea CO₂ sink

Marginal seas:

- Bering Sea CO₂ sink
- Sea of Okhotsk CO₂ sink
- South China Sea CO₂ sink

2. A more complete assessment of net CO₂ flux will need:
 - a. A better characterization of air-sea interaction to refine pCO₂ estimates;
 - b. Identification of depositional areas in the shelves and slopes;
 - c. Better estimates of calcium carbonate precipitation/dissolution fluxes;
 - d. Vertical and horizontal fluxes of the dissolved organic phase (DOC, DON, DOP).
 - e. Spatial and temporal variability of source/sink signature.

3. Strategy for future synthesis

Julie Hall presented the joint LOICZ-JGOFS Continental Margin Task Team (CMTT) conceptual framework. The latter identified the five typology areas for continental margins: western and eastern boundary currents, marginal seas, tropical and polar margins. CMTT hopes to synthesize the state of knowledge on fluxes and processes in each of these typology areas. To achieve this, draft outline for a synthesis book was shown.

List of participants (Synthesis theme J7)

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15th Meeting of the JGOFS Scientific Steering Committee

Bergen, Norway, 11-12 & 17 April 2000

Prepared in Bergen, Norway, June 2000

Approved in Amsterdam, The Netherlands, July 2001

Introduction

Opening Remarks and Administrative Arrangements

The 15th Meeting of the Scientific Steering Committee (SSC) of Joint Global Open Flux Study (JGOFS) took place at the *Bergen Kongress Senter* in Bergen on the 11th, 12th, and 17th April 2000. The JGOFS International Project Office (IPO) hosted the meeting in conjunction with JGOFS Open Science Conference (OSC) on Ocean Biogeochemistry: A new paradigm, which was arranged by the IPO.

Michael Fasham, Past SSC Chair, opened³ the meeting at 09:00. He welcomed the participants and introduced the two newest members to the SSC, Peter Haugan (Norway) and Margarita Conkright (USA) as well as Robert Anderson (USA) to their first SSC meeting. He also welcomed several guests: Liz Gross (Executive Director, SCOR), Yukihiro Nojiri (Japan JGOFS Representative) and Truls Johannessen (Norway JGOFS Chair). Platt and Shimmield sent regrets. Will Steffen (Executive Director, IGBP) arrived later. The list of participants is given in **APPENDIX A**.

Approval of the Agenda

The Agenda for the SSC Meeting was approved as distributed (**APPENDIX B**), but the timetable was modified to coincide with the presence of members and/or guests. It appears in Approval Meeting Minutes (Old Business)

Minutes of the 14th SSC Meeting (7 & 13 May 1999, Japan)

After the SSC reviewed the status of each action item below, they approved the minutes of the 14th JGOFS SSC Meeting.

ACTION #1: Done. Lochte received *ca.* 20,000 ECU from European Union to support the attendance of young European scientists. Ducklow obtained \$10,000 USD from US-JGOFS to support US scientists. The IPO acquired a total of \$43,000 USD from national and international sponsors to cover direct and indirect costs of the conference. The SSC acknowledged all the efforts to secure OSC funds.

ACTION #2: Done

ACTION #3: Done. Hanson received several summaries and will append to the minutes.

ACTION #4-6: Done

ACTION #7: Not done. Baliño contacted Sathyendranath and Platt, and they explained that the course material resides with each instructor. So there is a need to make personal contacts to gather them. As for Trevor and Shubha's compendium: "Modeling primary production", Trevor declined to have its publication in the homepage as it is intended as a chapter in a book and that it was under copyright with a Japanese publisher. Fasham said that it would be difficult and time consuming to gather all the material, while Gross said that it would be meaningless to implement the workshop material without Platt's contribution. The SSC then advised Baliño to abandon the task.

ACTION # 8: Done

³ Because of severe weather conditions at Chicago International Airport, Hugh Ducklow, JGOFS SSC Chair, could not be present to open the meeting. He arrived that evening and led the meeting on the 12th and 17th April.

ACTION #9: Done. Bychkov will report later.

ACTION #10: To be discussed after the conference.

ACTION #11: Tilbrook will revised later.

ACTION #12: Liu will report later.

ACTION #13: Fasham will report later.

ACTION #14: Fasham decided to include the N cycle in chapter 4 and add a chapter on temporal variability.

ACTION #15: Done

ACTION #16: Tilbrook and Gross attended the IOCCG meeting in Hobart and will report later. Liu commented if JGOFS should send a SSC member(s) to future IOCCG meetings or request an IOCCG member to attend a JGOFS meeting. If held in Japan, for example, Saino could attend, and so on. Hanson advised the SSC to return to this issue during the briefing of the international programmes.

ACTION #17: Done. Haugan will represent JGOFS at future GOOS and OOPC meetings.

ACTION #18: Fasham did not send the letter, but a SCOR Working Group on Export Production was formed.

ACTION #19: Fasham will report later.

ACTION #20: The Executives received a proposal for a new, joint task team. Monfray will report later.

Minutes of the 1999 Executive Meeting (24-26 August 1999, USA)

At the 14th SSC Meeting, members expressed concern that the Executives needed to improve communication with the SSC and to involve the SSC in decision processes of the Executive Committee. The Executives actions included copying SSC on emails of relevant JGOFS and IPO Business, and sending a Chair letter on relevant Executive actions from future meetings. Fasham reported that these actions improved SSC and Executive communication and encumbered the expertise of the SSC in Executive decision processes. The SSC took no action; the Executives will review and approve the minutes at their next meeting.

ACTION #1: Done. Monfray sent a report on the GAIM Task Force meeting.

ACTION #2: Done. Cambridge University Press finally printed the book with a 2000 publication date, which the SSC felt unfortunate. Hanson also informed the SSC that IGBP signed a contract with Springer-Verlag to publish future IGBP books and that similar publication delays will not occur with the new JGOFS textbook.

ACTION #3: Done. Quiñones expressed support for the training initiative in Chile and hosting the next SSC meeting. He emphasised that arranging a training exercise along side of the SSC meeting would increase attendance and decrease costs. Fasham mentioned that an alternative site for the next SSC would be the IGBP Conference in July 2001 in Amsterdam.

ACTION #4: Although the Bangalore material will not be posted on the web, Baliño felt that it could certainly be done for the next course or workshop, keeping in mind that it will be easier to gather material PRIOR to the event than after it.

ACTION #5: Done

ACTION #6: Fasham deferred discussion to the SSC reports on GOOS and OOPC later.

ACTION #7: see Action #6.

ACTION #8: Gross will report later.

ACTION #9: Monfray will report later.

ACTION #10-12: Done. IGBP and SCOR approved Ducklow as JGOFS Chair, Haugan as an at-large member, and Saino for a second 3-year term.

ACTION #13: Synthesis Groups and Task Teams will report later.

ACTION #14-15: Done

ACTION #16: Bathmann will send revised TOR to the IPO.

ACTION #17-18: Done

ACTION #19: Conkright will report later.

ACTION #20: Lochte will report later.

ACTION #21: Sakshaug informed the IPO that 2-3 authors will finish the manual this year and the IPO will print it in the JGOFS Report Series, not as a peer-reviewed publication as originally planned.

ACTION #22: Wallace will report later

ACTION #23: The DMTT will meet in Kiel, hosted by Institut für Meereskunde this June.

ACTION #24: The PJTT will meet in Hamburg this June.

ACTION #25: The Executive discussed the requests for 2000 funds. Due to uncertainties around the real costs of the JGOFS OSC, the Executives decided to postpone financial decisions until after the conference

ACTION #26-27: Done

ACTION #28: Done. The NASG, EQPAC and CMTT will hold parallel OSC sessions.

ACTION #29-32: Done

ACTION #33-36: Done

ACTION #37: Gross did not receive the IPCC Third Assessment Report (TAR). Wallace felt that it was important for the ocean community to have a look at this report and that JGOFS needs to comment officially. Baliño downloaded the document from the Internet and provided a copy for circulation among members.

ACTION #38: Done, but COP-car does not exist anymore as it was replaced by OCTET (Ocean Carbon Transport, Exchange and Transformation) and US CCSP (Carbon Cycle Science Plan)

ACTION #39: Done

Synthesis Plans and Implementation

Synthesis Plan, Implementation, and Timeline

Fasham opened the discussion by saying that the SSC has not lived up to the full global synthesis responsibility that it assigned itself in Cape Town, April 1998 and planned in Southampton, October 1998. We are well underway with the brochure, the Open Science Conference, and the book as outlined in the timeline (**APPENDIX C**). However, we have not yet completed the synthesis and modelling plans for the remaining 3 years. Ducklow stated that JGOFS synthesis and modelling phase must be planned out to 2003 and it must be more than a listing of meetings, workshops and conferences as now represented on the timeline.

Falkowski was sceptic as to how synthesis would be conducted. He mentioned that since model codes have not been made available, it is difficult to see how sensitive models are to initial conditions. He recommends strongly that JGOFS release the source code of the modelling effort so it would be available to everyone. One way of doing this is by implementing model codes on the web. Monfray agreed and added that OCMIP is doing exactly that, *i.e.* rendering models and codes on the web. Falkowski also added that if the goal of the modelling community is to provide hypotheses, it has yet to do so. There are also constraints to testing future hypothesis due to lack of data. He felt that JGOFS synthesis should end by exposing the major gaps to be unravelled by future programmes (discussed further under IGBP Carbon Working Group, Section 6.1 and 6.2).

Watson added that models could only confirm or deny our own assumptions. Most of us do not think about models as a mean in itself but as a tool. He also emphasized the danger of not knowing the limitations or properties of the model. One must ensure a framework to avoid exactly that, *e.g.* one way is to build interactive models. Wallace also mentioned that making model codes available on-line will face similar problems as putting a dataset on-line because the author will be reluctant to expose it until it has been thoroughly checked. Quiñones thought that journal editors could exercise pressure on scientists to publish their model code and/or datasets. He asked whether IGBP could send letters to the main journals to support this, and Steffen agreed to consider it. Ducklow inquired if GAIM is making model code available, but Monfray did not know. Garçon added that national initiatives, *e.g.*, USA and France JGOFS, are keeping a record of the source codes and model outputs on the web.

<p>ACTION #1: The SSC agreed that JGOFS modeller must include source code with models in future synthesis and modelling initiatives.</p>

Ducklow commented that there has not been an international JGOFS synthesis yet and asked for the status of regional synthesis activities. LeBorgne mentioned that the Equatorial Pacific synthesis is almost completed. Lochte felt, however, that it should not stop with the publication of Deep-Sea Research volumes and that all regional synthesis groups should continue to the JGOFS sunset. Garçon agreed and mentioned that the North Atlantic group modelling effort will continue. Anderson urged the SSC to take a larger role in JGOFS synthesis. However, the problem is that it all works at the national level and it needs funds. Nevertheless, international modelling activities will evolve, and we need those models to make predictions. Those predictions will also make a base for future programmes to test. In short, each region will have its own set of predictions.

Ducklow asked the SSC whether each synthesis group should be charged to develop a series of hypotheses and questions for future programmes after JGOFS. Falkowski suggested that JGOFS also should “throw” questions to the atmospheric and terrestrial sciences regarding ocean hypotheses. Ducklow asked the Chairs of regional synthesis groups to meet during the OSC and draft a broader view of the overall synthesis. He appointed Falkowski as the coordinator and asked Fasham, Quiñones, Burkill, LeBorgne, Bathmann, Conkright, Monfray, Saino and Wallace to participate. Lochte emphasised that the discussions should also deal with the issue of transferring knowledge to developing countries, *e.g.*, organizing training workshops.

ACTION #2: The group will meet during the OSC and (1) recommend a cross-synthesis team and (2) identify a series of specific questions from the original, broader JGOFS synthesis and modelling plan.

JGOFS Open Science Conference (OSC)

Hanson reported there was every indication that the OSC would be a successful event with a science programme of 68 oral (10 invited and 58 contributing speakers) and over 100 poster presentations (**APPENDIX D**). The Conference has over 200 registered participants from 25 countries. Of these, JGOFS has provided full support for 12 invited speakers (\$20K), and partial financial support for 18 participants from developing countries with funds from SCOR (\$10K), IOC (\$10K), and the University of Bergen (\$3.75K). In addition, the EU has provided full financial assistance (\$20K) for 15 Ph.D. students and young scientists from member states. The US-JGOFS Planning Office has provided partial travel support (\$10K) for 10 US scientists. Finally, the JGOFS IPO with University of Bergen funds (\$10.7K) has financed the Conference registration fee for five scientists from the USA, two from Germany, and one from Bermuda and UK. In summary, funds raised for participant travel total *ca.* \$87K.

Hanson reviewed the OSC budget. The estimated direct and indirect costs are \$94,425, and the registration fee will cover approximately 50% of the total costs. The remaining costs will be covered with funds from JGOFS (SCOR) budget from 1999 and 2000 (\$12.5K and \$20K, respectively), the Research Council of Norway (\$11.25K), the Institute of Marine Research (\$2.75K), the Nansen Centre (\$1.25K), the Norwegian Polar Institute (\$1.25K), and the Norwegian Directorate of Fisheries (\$2.5K). In summary, funds raised for Conference costs total *ca.* \$96K. In addition, the City of Bergen will also contribute an evening reception at the Bergen Art Museum to the Conference events. The aggregated costs for the Conference and participant travel totalled *ca.* \$183K.

Burkill inquired about an eventual surplus. Hanson said that any surplus would be used to support JGOFS meetings this year.

Regarding the selection process for the awards to best student presentation (both oral and poster), Lochte volunteered to co-ordinate this task by meeting with the science programme committee at lunch. She asked the IPO to provide the list of Ph.D. students with presentations at the conference. Lochte also mentioned that a number of papers have already been reviewed and asked Tilbrook and Monfray to help review the modelling papers. Ducklow thanked Lochte for co-ordinating the student awards.

International Geosphere-Biosphere Programme (IGBP) Science Series

Fasham informed the SSC regarding the status of the JGOFS brochure for the IGBP Science Series. There have been some delays but it is expected that the document will be ready soon and sent to Stockholm for layout this summer and publication this fall. Liu suggested that after publication, the brochure be implemented as a downloadable package from the JGOFS homepage, and Baliño agreed.

ACTION #3: Baliño will implement the JGOFS brochure on the homepage after publication.

IGBP Book Series (Second JGOFS Book)

Fasham informed the SSC that a number of chapters were submitted and that he expected drafts during the Conference. The timeline to ensure its publication in 2001 is as follows: July 2000 is the deadline to submit drafts; fall 2000, book authors and SSC will review Chapters; December 2000-January 2001 final version sent to Springer-Verlag for publication in 2001.

Wallace said that he had good experience with Springer but that the authors had to go through a lot of work to prepare the camera-ready proofs. He also would like to see if Springer could provide fair prices or reduced costs for scientists from developing countries, and whether the book could be implemented in the web. Fasham said that JGOFS has an obligation to IGBP, and it must be published under the IGBP/Springer Verlag contract.

Hanson suggested that a technical editor is needed to handle the final editing (camera-ready copy) of the book. Burkill suggested that the editors identify one person, *e.g.* in Fasham's office at SOC. This will ensure a timely publication process. Fasham thought it was a good idea but questioned whether JGOFS had funds to engage such a person. He would inquire at SOC for interest and support.

ACTION #4: Fasham will seek a technical editor for the JGOFS book.

Quiñones expressed concern regarding the lack of emphasis on the international work of JGOFS. The way the book is designed now mainly reflects the views and scope of national programmes. Fasham said that the bias is due to the choice of authors and their views. Quiñones thought this could be mitigated if the draft is sent to referees to ensure that latest regional literature is included, as a way to ensure a two-fold review for scientific content and overall coverage. Lochte also would like to see reviewers from outside the SSC and the chapter authors. Fasham agreed but pointed out that peer reviewers for books are difficult to find. Hanson also noted that book chapters would be peer-reviewed early in the process.

Watson inquired about another aspect of the book: is this a synthesis of data or regional studies? In the present time frame, a complete synthesis of JGOFS observations would be impossible because it would be an encyclopedia. Hanson reminded authors that the Southampton Synthesis Workshop provided guidelines, where it was emphasized a synthesis of JGOFS views under 10 biogeochemical themes. Fasham asked authors to look for important concepts coming from JGOFS and to add relevant regional/international literature. However, he warns against adding additional burden on an already difficult task of writing the theme chapters.

Fasham proposed to discuss Chapter 12, entitled: *What has JGOFS achieved and what are the lessons for future research*. Gross expressed interest in having a draft of this chapter, but Fasham could not proceed with this chapter until the authors submit their drafts (late summer). However, he raised the question if one should place chapter 12 at the beginning or the end of the book, as it covers JGOFS genesis and scientific plan. Watson suggested dividing the chapter in two, placing sections 12.1-3 at the beginning and 12.4 at the end. He also suggested that JGOFS ask Peter Brewer to write the foreword for the book. Brewer has been with JGOFS since its genesis and he can be considered a *philosophical* contributor to JGOFS. Fasham agreed with both suggestions.

ACTION #5: Fasham will ask Peter Brewer to author a 2-page foreword for the JGOFS book.

Synthesis Group Reports

North Atlantic Synthesis Group (NASG)

Garçon reported that the 2nd meeting of the NASG was held in Toulouse, September 1999. A report is available from the IPO and Garçon. The meeting hosted a wide audience, including scientists from SOMARE (Sampling, Observing and Modelling Atlantic Regional Ecosystems) and ENRICH programmes lead by James Aiken, Victor Smetacek, Andreas Oschlies, G. Herndl and Allan Longhurst. The NASG members reviewed the contribution to the JGOFS brochure and the status of the Deep-Sea Research Special Volume.

Deep Sea Research Special Volume is behind schedule and will not be published in time for the OSC. A more realistic date is prior to the IGBP conference in Amsterdam, July 2001. A number of revised papers are expected soon, but a paper on eastern sub-tropical Atlantic gyre is still needed. A new deadline for paper submissions is May/June 2000 and publication is planned for spring 2001.

Garçon briefed the SSC regarding the implementation of a web site for NASG activities, hosted by LEGOS (Laboratoire d'Études en Géophysique et Océanographie Spatiale) in Toulouse (<http://www.obs-mip.fr/omp/umr5566/english/jgofs/index.html>).

Garçon reported on a particularly valuable Atlantic Ocean data set being generated under the project: Atlantic Meridional Transect (AMT), in operation since 1995. The main objective is gathering instrumental data across biogeochemical ocean provinces to aid in the development of satellite algorithms of primary production. This programme has collected a large data set from the upper 100 m of the ocean along a N-S transect of the Atlantic Ocean between the Falkland Islands and the UK. The contact person is James Aiken. However, AMT is facing financial crisis and field observations may be interrupted due to difficulties in securing EU funds. In order to continue this effort, the NASG recommended other countries to join the project, such as Germany and Spain to take on the cruises. There is also a proposal to develop a data centre in Bremerhaven to collect and manage this dataset.

Conkright informed everyone that the AMT data currently reside at Plymouth Marine Laboratory, but believes that it will be moved to BODC. It is restricted but will have unrestricted access in the near future. Burkill recommended that NASG and JGOFS send letters to Graham Shimmield (UK) and EU highlighting the importance of AMT so as to give support to in the funding issue.

ACTION #6: Burkill and Ducklow will write a letter in support of future AMT activities.
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NASG reviewed its 1999 funds from PROOF (French JGOFS) for synthesis and modelling activities. The expenses covered administration, travel support for NASG members (Fasham, Lowry, Fernandez, Koeve and Siegel) and the development of the web site.

In Year 2000, the NASG had planned to send Siegel to the International Symposium on Carbon Cycle in the North Pacific, Japan 8-10 February 2000, but unfortunately Siegel had to cancel this trip. In addition, the NASG has scheduled a regional parallel session on the North Atlantic Synthesis during the upcoming OSC. Garçon planned to report on the two meetings, but unfortunately, due to family problems, she had to return to France immediately after the SSC. Wallace agreed to lead the OSC discussion in her place. The group requested JGOFS funds last year to hold a meeting during the OSC, but JGOFS declined the request. Instead, the group planned a short informal discussion meeting while in Bergen with those members able to attend. Wolfgang Koeve travel to the OSC will be supported by CNRS funds. The NASG will produce a synthesis product summarising the advances in understanding biogeochemical cycling in the North Atlantic. Expected publication is fall 2000.

The group is planning its 3rd meeting in year 2001 along with either the 2nd Synthesis or Modelling of JGOFS-France (possible venue: Arcachon) or the 1st French SOLAS meeting (possible venue: Paris). The NASG will request JGOFS funds for travel support (\$15,000 USD for 10 members). PROOF will provide cost sharing (30K FF) for meeting logistics. Wallace was impressed with the work progress of the group showing a truly focused synthesis plan.

Garçon also noted that JGOFS has an important role to play in GOOS. The community realises that the carbon cycle is an integral part of the whole, and GOOS is no longer physical in scope. She emphasised that JGOFS has enhanced the development of ocean satellite instrumentation, and therefore JGOFS has a key role to play in GOOS. As proof, GOOS started inviting JGOFS representatives to meetings. Haugan agreed and was pleased to see research and operative mechanisms merging. Watson emphasized that there is a need for GOOS to monitor CO₂ sinks and sources and to follow the Kyoto protocol. Therefore, GOOS needs a sustained effort from the oceanographic community. Fasham agreed but asked what should JGOFS give priority to? Wallace felt that JGOFS should get involved with those groups/communities that already push for operational ocean carbon instrumentation. In addition, regarding future observing programmes, there is a need for improved communication. Quiñones informed the SSC about the establishment of a time series station with buoys in the South Pacific. The World Bank, IOC and GOOS fund the project. Watson asked if NOAA and/or SOLAS should be involved and provide the research umbrella. Fasham advised it would be better to wait and see how they interacted with CO₂ Advisory Panel.

Anderson mentioned that US JGOFS received criticism for not integrating continental margins during the North Atlantic synthesis. Fasham explained that this is simply due to lack of good data sets for the NA eastern continental margin. Anderson mentioned that there are data sets on continental margins in the North Atlantic, but that they are not all JGOFS. He therefore recommends that these data sets be assembled for the synthesis. Liu felt that one could either discuss the major processes on the margins or categorize the different margins and get some estimates, margin by margin. For example, Author Chen has an inventory of 60 different margins (the process issue is difficult because of the diversity of margins). Thus, through the efforts of the CMTT, good estimates will be determined, but there is no directed effort linking ocean basins with margins. Fasham added that there are also the problems of ocean and margin physics and coupling models. Unfortunately, there are yet no solutions to these problems.

Anderson emphasised that future programmes need to know from JGOFS about the margin exchanges. JGOFS should thus try to come up with some synthesis or estimate, regardless how primitive it is; it has to be done one way or another. Fasham recalled that this issue has been debated in every SSC he has attended. He questioned whether SOLAS would take over this topic. Watson said that it can be done, *e.g.* ships of opportunity can be used to collect CO₂ measurements over the continental shelf.

Equatorial Pacific Synthesis Group (EPSG)

LeBorgne reported that the guest editors expect the publication of the next special volume of Deep-Sea Research (DSR) in June 2001. A detailed outline of the chapters was presented. LeBorgne inquired whether JGOFS IPO could pay for additional copies. Gross mentioned that discounted copies were available through the US JGOFS and as DSR has benefited so much from JGOFS, she thought that they should give some discount, if ordered in advance. Fasham congratulated LeBorgne and the other editors for assembling this valuable synthesis volume.

ACTION #7: LeBorgne will inquire with Mary Zawoysky at the US JGOFS Planning Office on how to obtain DSR special volumes at a discount.

LeBorgne announced that the group will hold two parallel sessions during the OSC entitled "Outstanding and unresolved issues of the equatorial Pacific" to be chaired by himself and "Does the equatorial Pacific fit in the future programmes that are being elaborated?" to be chaired by James Murray. In addition, members of an *ad hoc* EPSG attending the OSC held a meeting and a report is included here (**APPENDIX E**)

Future activities in the Pacific include: cruises in the western Pacific by Japan, remote sensing, sampling by ships of opportunities between Japan, Australia, New Caledonia, Panama and the west coast of the USA. With these on going activities, LeBorgne expressed the desire of the EPSG to link with a future ocean biogeochemical programme after JGOFS.

The group plans to publish the data sets of the equatorial Pacific Process Study in a series of CD-ROMs. Marie-Paule Labaied, data manager of JGOFS-France will be in charge of this. She already had plans to approach Australia, Japan and USA in order to access the data. As Japan is concerned, no biogeochemical datasets are available yet, only CTD data. Saino mentioned that there is a paper version but data rescue continues. There is indeed a catalogue in Japanese describing the available data sets, pending translation.

The EPSG plans to organize a modelling workshop and asks the SSC for advice on where to hold it. Anderson recommended that the workshop be held where the modelling activities are taking place, *e.g.* do it in the lab where the models are being developed and held. Fasham asked if any 3D modelling were being developed in the EPSG. LeBorgne stated that Jorge Sarmiento is carrying out this type of modelling.

ACTION #8: LeBorgne will send a proposal for funds for an EPSG modelling workshop.

Gross inquired about the fate of the synthesis groups once they finished their tasks. Will they be disbanded? Garçon mentioned that as for the NASG, it has to finish the synthesis and modelling, and only then will the group be able to ask the important questions. Therefore, the NASG cannot be disbanded. The SSC agreed that it is important to maintain the Synthesis Groups for information on the regions and the chairs at SSC meetings throughout the global synthesis effort.

Fasham inquired about how to proceed during the last stage of the JGOFS synthesis. Watson emphasized that the physics are still poorly represented in biogeochemical models. He thinks one can get more insight with 1D or 2D models rather than 3D, which being too coarse tend to give the "wrong" answer. Monfray felt that constraining the physics first is of utmost importance. Bathmann pointed out that the same applies for the synthesis of the Southern Ocean, *i.e.* they lack essential data and it is not possible to construct 3D models yet.

Wallace expressed doubts that the other groups have the same prospects as NASG for more fieldwork. Burkill mentioned that the IOSG is planning more fieldwork but nothing major. Watson remarked that one has to draw the line on how long synthesis will continue because the physics are not good enough for high-resolution 3D models. One may even realise that we cannot synthesise certain type of data. Fasham cautioned not to discourage the synthesis groups of continuing the synthesis. Therefore, if they want to organise workshops, they should be allowed to do so. However, Wallace emphasized that JGOFS synthesis is two-folded, *i.e.*, new knowledge will be gained through the increased complexity in modelling and improve our basic knowledge of ocean biogeochemistry.

Southern Ocean Synthesis Group (SOSG)

Bathmann reported that the SOSG plans to meet (7-8 July) before the upcoming 3rd SO-JGOFS Symposium in Brest, France, 9-12 July 2000. The symposium programme has 11 invited speakers, 53 oral communications, and 110 poster contributions, spread over 15 sessions and 4 round tables & meetings. The SOSG Symposium Organizers are also planning a Symposium synthesis volume that will merge with the JGOFS global synthesis and modelling. In addition, the SOSG has prepared a DSR Special Volume, which will be out next year, and has plans for two more volumes, one on nutrient regimes in the Southern Ocean and another on ocean carbon modelling, lead by Monfray.

Bathmann also updated the SSC on the Southern Ocean Iron Fertilisation Experiment (SOIREE) in the waters southwest of Australia and mentioned another two experiments that are being planned by the USA in 2001 and by the Germans, Dutch, and British. The SSC inquired about the photosynthesis products of the SO bloom, *i.e.*, whether the products were remineralised or exported. Bathmann mentioned that the SOIRE was not conducted long enough, unfortunately, to document the collapse of the bloom generated by the Fe fertilisation. He also reported on the mesoscale features (biological and salinity) of the Southern Ocean, which generate high and low flux regions. Defining the biogeochemical regions of the Southern Ocean remains problematic, as well as for funding research in the regions.

Bathmann confirmed that the newly structured SOSG membership is operational. However, the group requires another modeller, and the position remains open. The group plans to nominate someone for Executive consideration and approval in the fall. Now that SOSG is nearing completion of its TOR, Bathmann requests SSC advice on whether to continue or disband. He mentioned, however, that SO-JGOFS studies are ongoing, *e.g.*, iron fertilisation, etc. The group plans to meet before the Brest Symposium and needs SSC direction. In 1999, they identified major steps in Southern Ocean synthesis and modelling, developed regional models (22 levels by 1/6°), assisted national data management, and proposed effective links with GLOBEC modelling.

Tilbrook asked how effective has the SOSG been in coordinating national field programme. Bathmann mentioned that the SOSG has been responsive to national needs, *e.g.*, the fertilisation experiment, *via* email connections. Regarding continuing or disbanding, Hanson mentioned that the SSC has not been officially approved the SOSG TOR. Bathmann apologised for the oversight and will submit the revised TOR for approval (**APPENDIX E**).

Anderson emphasised that the SOSG as well as all synthesis groups must continue, as there is much yet to do for regional modelling and global synthesis. SG chairs on the SSC are vital to SSC momentum towards global synthesis and modelling. Bathmann will forward this direction on to the SOSG in Brest. Regarding the SOSG meeting (7-8 July 2000), Bathmann request travel funds of \$10K. The SSC deferred the request until after the OSC debts are known (June 2000).

ACTION #9: Bathmann will submit revised SOSG TOR for SSC approval.

ACTION #10: The SOSG request funds (\$10K) for 8-9 SOSG members to Brest, France. Decision deferred until June 2000.

Indian Ocean Synthesis Group (IOSG)

Burkill reported on the national and international activities from 1999, the IOSG activities in 2000 and beyond, and the strategy forward. There has been limited international activity of the IOSG since the Indian Ocean Symposium, Bangalore, India. In January 2000, Burkill attended the AGU-ASLO 2000 Ocean Sciences Meeting in San Antonio, Texas, and at the meeting, he called an *ad hoc* meeting of the IOSG together to discuss the rotation of the IOSG Chair. He

mentioned that he needed to step down and he asked the group for advice. The group suggested a couple of names, which Burkill pursued, but there was no response. In February 2000, the NPTT invited Burkill to the Symposium on Carbon Cycle in the North Pacific in Nagoya, Japan, where the NPTT discussed the coordination of North Pacific synthesis and modelling with the other four regional synthesis and modelling groups.

Over the past year, there has been a considerable range of national activities. In Germany and USA, Indian Ocean synthesis and modelling activities are nationally funded. In the UK, the synthesis and modelling activities are bootlegged on related science projects. Publication is moving forward on all fronts. In addition to individual manuscripts, four special volumes of DSR (1 from the Netherlands, 1 from the UK, and 2 from the USA), as well as a book on the Russian Arabian Sea Expedition by Karl Banse have or will appear soon. There are now several CD-ROMs available with national (Netherlands, India, Germany, and the UK) and international datasets from the Arabian Sea Process Study.

Plans for 2000 and beyond, Burkill reported that although the activities in Germany end this December, they are seeking funds for two additional years for synthesis meetings and training courses (Germany, Oman and Pakistan). In the USA, S. Smith is editing a 3rd volume of DSR with 16 manuscripts as well as proposing Part 5 and publishing the Atlas of JGOFS data in Elsevier. National fieldwork still continues. The Netherlands has a 5-month cruise in the Indian Ocean and around Africa, January-May 2000. India is proposing studies in the Bay of Bengal. The UK is proposing cruises on upwelling, low CO₂, benthic and mid ridge spreading. The USA is discussing proposals on upwelling and mooring biogeochemistry.

Looking for a way forward, Burkill remarked that he has not been able to recruit anyone to Chair the next three years. He is willing to stay on until someone comes forward. There is still much to do; for example, at the January 1999 meeting, the group designated section authors to write the Arabian Sea Highlights (12 sections), a colour brochure, and lead a synthesis volume for DSR special topics. For the brochure, authors have until February 2001 to complete their sections. Burkill, Kindle, and Smith will edit this brochure early next year and requested funds for a Miami meeting, February 2001.

Regarding disbanding early, Burkill felt that the importance of the synthesis and modelling group is not much in the UK. However, elsewhere it is in order to support national proposal for synthesis and modelling activities. Thus, disbanding the IOSG group early might affect national funding. Burkill recommends consideration for disbanding the IOSG after the publication of the Arabian Sea highlight brochure (*ca.* April 2001).

ACTION #11: The SSC asked Burkill to continue as IOSG chair until he finds a replacement or until the SSC disbands the group.

ACTION #12: The IOSG requests 2001 travel funds (\$6K) for 3 IOSG members to Miami, USA. A proposal for this meeting will be sent later.

Task Team Reports

North Pacific Task Team (NPTT)

Bychkov reported on the activities of the task team that has nine members currently. Bychkov proposed two changes: (1) the NPTT recommends Paul Harrison (Canada) to replace Bruce Frost (USA) who requested to step down, and (2) to strengthen modelling expertise on the team, he recommends Michio Kishi (Japan). In the future, the NPTT plans to publish two special volumes in Deep-Sea Research, one as a collection of commissioned papers and the second as a collection of invited papers. He also mentioned the strong link with PISCES and the upcoming joint activities at its Annual Meetings this fall in Japan:

- PICES Working Group 13 on CO₂ in the North Pacific (<http://pices.ios.bc.ca/wg/wgf.htm>). This group has arranged a CO₂ Data Synthesis Symposium prior to the PICES IX. The NPTT will take advantage of the symposium and hold its 6th Meeting. The symposium will focus on CO₂ data synthesis, data management and exchange, and intercalibration.
- PICES POC (Physical Oceanography and Climate)/BIO (Biological Oceanography). These committees have arranged a 1-day, joint Topic Session (S6) on the North Pacific carbon cycling and ecosystem dynamics, Co-Conveners: Kenneth L. Denman (Canada), Steven R. Emerson (U.S.A.) & Toshiro Saino (Japan). In support of Topic Session (S6), the NPTT request JGOFS co-sponsor and financial support in the form of travel funds for two invited scientists.

ACTION #13: The SSC Executives approved the nominations of Harrison and Kishi.

ACTION #14: The SSC deferred the decision on the financial support for two scientists at the PICES IX Meeting until after the OSC costs are known (June 2000).

Fasham asked Bychkov to elaborate on anticipated data products from the North Pacific. Bychkov mentioned that Japan plans to compile a Japanese dataset for the North Pacific Process Study. However, there is no definitive timeframe for this dataset or other data products. Fasham then asked whether this dataset would include data from Station P. Conkright mentioned that the Station P dataset contains hydrographical and biogeochemical data. Fasham asked if the NPTT should be tasked to collect all relevant data from the region, including Station P. Conkright suggested that Bychkov officially request that Station P data, which resides with C.S. Wong, be delivered to MEDS, Canada or the World Data Center A for Oceanography. NODC will eventually receive the data if sent to MEDS or WDC-A. Watson felt that Wong has provided some data to CDIAC, while Ducklow felt that the latest Station P data probably came from Paul Harrison. The SSC emphasized the importance of North Pacific dataset inventory, and that it is a desired product from the NPTT. The inventory should include information on what is available and where it is held.

ACTION #15: Bychkov will request that C.S. Wong submit Station P data to the NODC.

ACTION #16: The SSC request that the NPTT compile an inventory of datasets generated during the process study and send the inventory to the DMTT/IPO (Conkright/Baliño).

In regards to reducing the number of at-large members on the SSC, Hanson asked if the NPTT plans to continue with co-Chairs. Bychkov mentioned that the NPTT discussed the status change of the co-Chairs, Bychkov and Saino, at their last meeting, and it was recommended that Bychkov continue as Chair and Saino as Vice-Chair on the NPTT.

ACTION #17: The SSC approved the change.

Joint Paleo-JGOFS Task Team (PJTT)

Lochte informed the SSC in Shimmield's absence that the PJTT will hold its first meeting in Hamburg, June 2000, but there has not been much movement on the PJTT membership (8 members). The parent bodies, PAGES and JGOFS have not officially approved the TOR and membership (**APPENDIX F**). Lochte requested funds to support the four JGOFS scientists to the meeting. The same request went to PAGES for four scientists. At this meeting, the group will finalise the TOR, review the membership, PJTT aims and scope, and timeline. The meeting will also serve to discuss new research topics between paleo-climate and oceanography.

Fasham acknowledged the priority given to the formation of this task team in Japan, May 1999, and the Executive approval of meeting funds in the USA, October 1999. Regarding membership, the SSC remarked about the lack of Asian representation. Lochte acknowledged the concern and requested names and disciplines of nominees. Gross mentioned that she would provide names from PAGES, and Liu suggested that the marine paleo group of PAGES (IMAGES) should recommend someone as well.

Fasham noted that the task team has taken a long time to form, and he asked Lochte if she had an idea of what the group plans to achieve (*e.g.*, products) in the coming 3 years. Lochte mentioned that it is essential to define future research, *e.g.* draft an outline of a project and science plan, and to continue building the ADEP database (Atlantic Database for Exchange Processes at the Deep Sea Floor). To aim for more than this would be unrealistic. Regarding the database, there is very little JGOFS data in ADEP database, which contains mostly data from other sources. Liu agreed that PJTT should identify new research topics for future OBGC programmes.

Fasham asked if the group would be able to synthesise the available datasets. Lochte felt that this is prevented because serious gaps exist among the datasets. The SSC suggested that somebody attending the PJTT meeting in June should also attend the meeting of the SCOR Working Group (WG) 116 (Sediment Trap and Thorium-234 Methods for Carbon Export Flux Determination), which is affiliated with JGOFS. Lochte agreed. Gross noted the suggestion and will advise the new SCOR WG.

Burkill expressed his support to both Lochte and the new task team. He also felt that this group is an excellent means to foster stronger interactions within IGBP and PAGES. Anderson remarked that the data on paleo productivity is presently in disarray, and proper resolution and value of the data will come from JGOFS using and working with the data.

Joint JGOFS-GAIM Ocean Carbon Modelling Task Team (JGTT)

Monfray report that the proposed joint JGOFS and GAIM task team will bring together the expertise of JGOFS on ocean biogeochemical processes and GAIM on global carbon budget changes. The aim will be to apply new insights into biogeochemical processes, to improve our representation of global carbon dynamics by models, and to evaluate them with new data from JGOFS synthesis. He requested funds for an Open OCMIP workshop in 2001 and a dedicated meeting in Princeton (only OCMIP).

The SSC expressed great enthusiasm for the proposed task team. Fasham remarked that this task team is the right way to encourage 3D modelling and supports the aims, objectives and membership. Saino mentioned that the NPTT would like to contribute to the proposed open modelling workshop. Monfray welcomed participation of JGOFS SGs and TTs. Liu asked if there was any follow-up on including large river inputs in ocean carbon models. Monfray could

not say. Although the 2nd phase of OCMIP will concentrate on ocean basin, the SSC felt that this was a good point and that land-ocean interactions need to be included in OCMIP modelling. The problem is that there is no concrete crosscut action to connect land use with ocean dynamics through the margins. Tilbrook asked about the interaction with the atmosphere and have they been incorporated in the models? Monfray mentioned that a few people can run coupled carbon-climate models and only a couple of OCMIP members are involved. This could, however, be a goal for OCMIP Phase IV. Quiñones mentioned that in the new generation of biological modelling, the N/P ratio should be included as well as different types of limitation to phytoplankton growth, *e.g.* iron.

Fasham emphasised that the joint task team needs strong TOR for the next 3 years and must formalize the membership soon. Garçon expressed strong concern over the proposed membership. The French and Americans presently dominate it, and there is an obvious geographical imbalance. Membership (national) balance is essential for the group. Monfray said that the present membership would run until 2001, but that the membership will certainly be changed for Phase III. Still, Garçon would like more diversity in the membership until 2001.

Regarding a question on research strategy, Monfray reiterated that they are clearly stated in the present TOR. Watson asked whether the group would examine glacial-interglacial changes. Monfray said no for the moment, while within some groups there will be discussions on glacial-interglacial changes.

The SSC accepted the TOR but asked the group to revisit the issue of membership diversity. Monfray will discuss this with James Orr (co-Chair) and will send a revised membership to Hanson at the IPO for circulation among the Executives and SSC. This will happen after the OCMIP meeting in Princeton, USA, 5-6 July 2000.

ACTION #18: Monfray will submit a revised TOR and membership after the OCMIP Phase II Meeting in the USA, July 2000.

Hanson received the revised TOR (18 May 2000) and these are appended to the minutes for the record (**APPENDIX G**). Proposed membership remains unchanged.

Joint JGOFS-LOICZ Continental Margins Task Team (CMTT)

Liu reported on recent CMTT activities. He mentioned that Shu Gao (China-Taipei) has replaced Liana T. McManus (Philippines) as LOICZ co-Chair. CMTT research highlights include:

1. Documented release of iron from the sediments in the continental margins and its effects on the biota,
2. Results from budget of carbon fluxes are already being used in modelling exercises, *e.g.* by Sarmiento,
3. The margins of the Changjiang (*aka*, Yangtze) River are actually a sink for CO₂, contrary to the general belief that margins are sources of CO₂. Thus, Liu advised that those sinks and sources of CO₂ between the ocean and the atmosphere should be partitioned between the open ocean and the coastal zone, and
4. The discharge of the Changjiang River will be changed dramatically when the hydro electrical plant starts functioning in 2009. KEEP (Kuroshio-Edge Exchange Processes) will monitor the changes in the river plume and the impact on the sediment transport, among other topics.

Finally, Liu presented an overview of current research projects that the CMTT is involved in around the world. Fasham remarked that these highlights emphasise the importance of research in the continental margins and acknowledged CMTT activities and future plans to produce a series of special volumes in *Deep Sea Research*. He emphasised the recently published special volume of Continental Shelf Research on KEEP.

Liu then discussed the budget for the planned CMTT workshops. He mentioned that LOICZ confirmed the funds (\$20K) for the Western and Eastern Boundary Current Workshop in the USA (October 2000) and their request that JGOFS commit funds for CMTT workshops in 2001. The SSC recognised LOICZ commitment to CMTT activities and offered their financial support (\$20K) in 2001. Bychkov requested that the CMTT workshop be held in September instead of October, so as not to interfere with a PISCES meeting planned for October. Liu agreed that the organisers would arrange a non-overlapping time for the workshop.

Joint IOC-SCOR Ocean CO₂ Advisory Panel (ISCO₂ Panel)

Watson reported on the CO₂ Panel that met in Tsukuba, January 1999, at the time of the 2nd International Symposium on CO₂ in the oceans. Since then, he mentioned that IOC and SCOR have revised the TOR (**APPENDIX H**) resulting in a reshaping of the CO₂ Panel. They recently announced the new chair, Doug Wallace.

Watson mentioned that a subset of the original panel met recently at the SOLAS OSM in Germany and discussed the status and options for a CO₂ observing systems in the oceans. Watson reported that there is a sense of urgency within GOOS to obtain input from JGOFS as ocean biogeochemistry is becoming part of the observing systems and the expertise they have is limited. The group drafted a position paper (**APPENDIX I**). It should be considered as a draft since there was no one from Japan, Australia or NZ. Watson felt that a CO₂ system could be developed for a relative low cost and that it would survey both the terrestrial and ocean sinks and sources. To push the needed science forward in support of GOOS CO₂ Observing System, he mentioned that pieces are in place but they must be assembled. With the new TOR, the panel will facilitate the assembly and implementation of a CO₂ Observing System in GOOS.

Haugan asked whether link(s) exist(s) between the new CO₂ Panel and OPCC (Ocean Panel on Climate Change) while Wallace solicited opinions on whether the panel should look beyond OPCC, and Tilbrook questioned the present role of JGOFS in the panel. Watson emphasised that while the panel is a conduit in the CO₂ community, it still needs the scientific and political support from JGOFS and IGBP to address GOOS issues. This is also the reason for the panel connecting with OPCC and in the future, OPCC people could be incorporated either in the panel or in the future CO₂ observing systems.

Ducklow asked how JGOFS could support the panel. Watson indicated that it is of utmost importance to increase the awareness of the role of the ocean in global observing systems. It would be specifically helpful if support letters from IGBP, JGOFS, and OOPC were directed to the chair of the panel stating the importance of the panel and expressing a will to be users and support future proposals. On the other hand, Haugan felt that OPCC and GOOS could also support the JGOFS community. Wallace emphasised that the panel needs modelling activities coming from the remote sensing community, *e.g.* IOCCG, and that a representative from that community would be desirable on the panel.

The SSC then discussed the new membership of the panel. Watson envisioned 12 members for the new CO₂ Panel, but did not know whom IOC and SCOR have invited. Wallace provided no information. The SSC felt that the panel needed OPCC representation. Gross mentioned that she and Field plan to meet during the OSC and discuss the membership. The first Panel meeting under the new TOR is planned for this fall (2000).

Hanson asked Wallace about future ocean CO₂ workshops. Wallace mentioned that a group is revising a 2-year old proposal for a joint WOCE-JGOFS CO₂ Transport Workshop for 2001. The workshop will examine and hopefully explain how carbon transport occurs in the ocean, which will be essential to plan future observing systems.

Ducklow thanked Watson and Wallace for their work in the panel.

Data Management Task Team (DMTT)

The newly appointed chair, Margarita Conkright, reported on the latest developments and future activities of the DMTT. Regarding membership, the DMTT requests approval of the new German JGOFS Data Manager, Joachim Herrmann, replacing Thomas Mitzka. The next meeting is hosted by IFM in Kiel, June 2000. The DMTT will display a poster at the OSC and set out CD-ROMs with JGOFS data.

Future DMTT activities include a NODC proposal to the US National Science Foundation (NSF) to create a CD ROM series with JGOFS data in a common format and to acquire data that are not readily available. Conkright requested SSC support to reach out to the scientists that are sitting on JGOFS data. To encourage scientists to submit data, NODC promises each scientist a copy of the CD-ROM series in thanks of their contributions.

Another activity is data documentation. Data documentation (metadata) and data management help are badly needed. The DMTT requests personnel support for Baliño at the IPO to enter DIF (Data Interchange Format) information at GCMD (Global Change Master Directory) and to make data available on-line. If NSF declines the NODC proposal, then data documentation (metadata) must be given priority, and assistance to the Data Manager at the IPO will be absolutely necessary. Regarding this priority, Conkright requested that Baliño return to her data manager duties once her involvement in administrative issues with the brochure and the OSC are finished. Ducklow emphasised that this is a top priority for the final stage of JGOFS, and without data, there will not be a synthesis.

The SSC inquired about the fate of the CDIAC database. Watson mentioned that CDIAC does not have funds for a CD-ROM series and there is the reiteration of the old problems with the pCO₂ data (proprietary nature of the data). Liu inquired about the existence of coastal pCO₂ data. The DMTT does not have a coordinated field programme to acquire this type of data, and so they need to deal with available datasets. He asked if the DMTT could provide letters to help collect this data. Lochte endorsed the idea but what if NODC does not get the funds? Watson commented that from his experience, working *via* national members is essential, and it is vital that the SSC and national members get this message out to colleagues! We must make it clear that if you collected JGOFS data then you have an obligation to submit to national data centres.

Regarding access to CO₂ datasets, Wallace mentioned that CO₂ Panel organised a workshop once before and invited ONLY those that could bring data, which would be compiled and available to only workshop participants. And it worked. Fasham felt that it is a bad model considering the short time before JGOFS sunset. He strongly supported Conkright's proposal.

Quiñones felt that future ocean biogeochemical programmes after JGOFS should accept the responsibility (a priority) of taking care of JGOFS data legacy. In the UK, Burkill mentioned that the national ocean programmes insure that data collected in their research will be archived in a database at BODC for long-term stewardship. Anderson asked when are the CD going to be published and are there going to be updates? Conkright felt that updates would probably occur on-line, as hardcopies updates take time and funds.

National Programme Reports

At this year's meeting, due to lack of agenda time for national reports, the SSC requested reports from national programmes on present and future synthesis activities and plans. The received reports are appended below.

Australia

Bronte Tilbrook (Chair) wrote that the Southern Ocean process studies have focused on the sub-Antarctic and polar frontal zones, with some work in the seasonal sea ice zone. The most recent cruise associated with this work was completed in February 1999. Sediment trap deployments and some surface underway sampling are continuing. Synthesis of the Southern Ocean data is in progress, and a workshop on results of sub-Antarctic Zone research was held in Hobart in December 1998. The workshop involved researchers from Australia, Belgium, France, New Zealand, and USA. Manuscripts on the sub-Antarctic study have been submitted to the Journal of Geophysical Research. The Hobart workshop was also used to discuss and plan future biogeochemical research in the Southern Ocean.

The field component of a continental margin study on the effects of river inputs on biogeochemical cycling near Papua New Guinea was completed in January 2000.

Repeat sampling for carbon tracers will commence in September 2000, along parts of WOCE sections in the eastern Indian Ocean (IR06 and I9N). Repeat sections are also being planned for the western Pacific Ocean (P15S) and Southern Ocean (SR03 and I9S) in 2001-2003. The SR3 repeat section will also involve process work in the seasonal sea-ice zone and along the section, between Antarctica and Australia.

A workshop to plan and coordinate biogeochemical research among ocean and atmosphere researchers is being planned for 2000.

China-Beijing

Dunxin Hu (Chair) summarised a couple of national programmes:

1. The three NSF-C Key projects:

- Key Processes on Ocean Flux in the East China Sea (1997-2000.6) led by Dunxin Hu
- Biogenic Elements and Biogeochemical Processes in the Taiwan Strait (1997-2000.10) led by Huasheng Hong
- Fluxes in the Yangtze estuary (1998-2001), led by Huanting Shen

2. MAFLECS (China-Japan Joint Programme on Material Flux Study: 1993-1999 with Chinese NSF-C programmes: MFLEC (1992-1995 and POFLECS (1996-2000) and Japanese programme: MASFLEX: 1993-1998) was finished late last year. We had the last Workshop on Material Flux on the East China Sea in Middle December 1999 in Qingdao, China. We are planning to publish the second volume titled "Material Flux in the East China Sea" for MAFLECS in the middle of this year; the first volume of which you have a copy of was published late last year.

We have combined the Chinese JGOFS Committee and LOICZ Committee together as one as Chinese JGOFS/LOICZ Committee chaired by Dunxin Hu. We will continue the work on JGOFS with LOICZ in China Seas associated with the big rivers such as the Yangtze, Yellow and Pearl.

Huasheng Hong (JGOFS SSC) also wrote about the JGOFS China in 2000. A NSF-C programme on Marginal Flux in the East China Sea (MAFLECS) started in January 1992 and was finished in

December 1995, which was followed by another NSF-C key programme on Key Processes of Ocean Flux in the East China Sea (POFLECS) from January 1996 to June 2000. In 1993, NSF-C and STA (the Science and Technology Agency of Japan) signed a joint China-Japan programme named MAFLECS for six years. A number of cruises were carried out during the first three years of this joint programme. In addition, a series of workshops had been held in China and Japan. One of the main outputs of the first phase of this programme is one volume named "Margin Flux in the East China Sea" published in 1999, with five chapters (Physical background, Sedimentation, CO₂ fixation, Particulate and dissolved organic carbon, and Nutrients), 27 papers involved. In this volume, it was reported that the average pCO₂ values of surface water in the East China Sea are 323 and 350 μ atm in spring and autumn, respectively. The East China Sea acts as a sink of the anthropogenic CO₂ in the atmosphere. In addition, the second volume titled "Material Flux in the East China Sea" for MAFLECS will be published in the middle of this year.

A NSF-C project focus on fluxes from the Yangtze River to the Estuary, "Material Flux Study in Yangtze Estuary", was created in 1998. Fluxes, of water and sediment, as well as dissolved nutrients such as carbon, nitrogen, phosphorus and silicon, were estimated, which exhibited considerable seasonal and interannual variability. GIS was utilized in the study to obtain siltation amounts of sediment at the mouth bar during the period of 1840 to 1997. Numerical models have been developed to help study the estuarine material fluxes and the interaction between the Yangtze diluted water and circulation currents in the East China Sea.

An intensive C cycling study in the South China Sea supported by NSF-C, "Organic carbon Transport, transfer and transformation on the Northern South China Sea continental shelf", is undergoing. Two cruises will be carried out in the coming June and next February, respectively. In addition to the measurement of primary productivity, respiration and export production, the role of micro-loop in the organic C cycle will be examined. The C transformation rates within dissolved, colloid and particulate pools will be measured as this transformation represents an important part of C cycling. CO₂ fluxes across the ocean-atmosphere interface, as well as nutrient input and C export from the rivers, will be concerned, too.

The Taiwan Strait is an important channel between the East China Sea and the South China Sea. There is one NSF-C key programme, "Study of Biogeochemical Processes of Bioactive Elements in the Taiwan Strait" (1997 to 2000), going on. Several cruises were conducted in August 1997, February 1998, August 1998 and August 1999, respectively. The most significant results are the obvious annual variation and anomaly of upwelling intensity, primary production and biological community structure, which are suspected to be kind of response of El Niño and La Niña events. Now SeaWiFS ocean colour data and AVHRR SST data in this region are used to help look for further evidence. A new project with the target of developing a numerical ecosystem dynamic model with synthesis of remote sensing data is being drafted in the coming three years.

China-Taipei

K.-K. Liu¹, G.-C. Gong², D.-D. Sheu³ and M.-P. Chen⁴ from 1) Institute of Oceanography, National Taiwan University (kkliu@ccms.ntu.edu.tw); 2) Dept. of Oceanography, National Taiwan Ocean University. (gcgong@mail.ntou.edu.tw); 3) Institute of Marine Geology and Chemistry (ddsheu@mail.nsysu.edu.tw); and 4) National Centre for Ocean Research (minpen@ccms.ntu.edu.tw) wrote that Taiwan launches two new projects devoted to biogeochemical research in the East China Sea (ECS) and the South China Sea (SCS) under the support of the National Science Council. Synthesis work for the past results is under way. A special issue of Continental Shelf Research (Volume 20, Number 4-5) on the Kuroshio Edge Exchange Processes (KEEP) project (<http://keep.oc.ntu.edu.tw>) was published recently. KEEP

has been Taiwan's major contribution to JGOFS for the past ten years. The special issue is the initial product of the KEEP synthesis effort. A second special issue on KEEP with the theme, Material Transport and Biogeochemical Processes in the ECS, has been planned for publication in *Deep-Sea Research II*. The Major findings of KEEP include the identification of nutrient sources for the ECS shelf, the temperature control of biological production in the inner shelf and the substrate control in the outer shelf, active cross shelf exchange facilitated by a permanent shelf edge eddy, and the inner and middle shelves absorb atmospheric CO₂.

As KEEP is approaching its end this year, the Three Gorges Dam across the Changjiang (a.k.a. the Yangtze River) is being constructed with a projected operation date of 2009. Changjiang's discharge is a major forcing function of the biogeochemistry of the ECS. Because the damming may result in changes in the hydrography, circulation and the biogeochemical processes, a new project, entitled the Long-term Observation & Research of the ECS (LORECS), will begin this fall. One major goal is to understand what controls the absorption of atmospheric CO₂ in the ECS and how the process may change in the future. The observations during KEEP serve as the background condition. A hydrodynamic model for the ECS is being developed and will be used for the process study and, possibly, for the prediction of future changes.

The South China Sea Integrated Biogeochemical Experiment (SIBEX) initiated in 1999 is exploring how the physical forcing influences the biogeochemical processes and the sedimentary records. The SCS has been shown to be responsive to many types of physical forcing, such as internal tide, Southeast Asian monsoons, typhoons and ENSO events. In addition, a sizable flux of Asian dust may deposit in this region during the winter monsoon and fuel N-fixation due to supply of Fe by the dust. Semi-annual cruises are scheduled to study the biogeochemical processes under different monsoonal conditions. Moorings with current measurement devices and other physical sensors are being deployed at the South-East Asia Time-series Station (SEATS), which is located at (18°N, 116°E). Bimonthly cruises have been conducted by the National Centre for Ocean Research at this station since September 1999 to study seasonal changes in chemical hydrography. Sediment traps and bio-optical sensors will be deployed later this year.

France

In 2000-2001, an important programme is planned in the Northeastern Atlantic Ocean between 38° N and 46° N, and 24° W and 18° W (POMME, Programme Océan Multidisciplinaire MésoEchelle, PIs: Laurent Mémerly and Gilles Reverdin). Its main goal is to understand the role of the eddies and the mesoscale dynamics on the subduction rate of the mode waters, on the onset and intensity of the bloom, and on the CO₂ fluxes between the ocean and the atmosphere. It will be based on *in situ* multidisciplinary (physics, chemistry, and biology) studies with two ships during different periods in the winter and spring, numerous (around 80) buoys and floats, four of five moorings of sediments traps, and on eddy resolving numerical simulations, with data assimilation of altimeter and ocean colour data (<http://www.ipsl.jussieu.fr/POMME>).

Following the North Atlantic Synthesis Group meeting, a French Synthesis and Modelling meeting took place in Toulouse (September 23-24, 1999) in order to summarize the highlights of the French JGOFS work (please consult http://www.obs-vlfr.fr/jgofs/html/bdjgofs_eng.html, click on Proof Synthesis and Modelling Session September 1999, Toulouse, for resumes of oral presentations and posters).

In Paris, on December 7-8, 1999, the "Journées Scientifiques du programme PROOF" were organized by Drs. Liliane Merlivat (JGOFS-France Chair) and Sauveur Belviso. The programme covered all efforts carried out within several operations: DYFAMED, a time-series station in the

Mediterranean Sea, FRONTAL-ALMOFRONT, ANTARES, and OISO (a permanent observatory along repeated lines occupied twice a year) in the Southern Ocean, OCEAN COLOR, MODELLING, PROSOPE, GEP&CO, etc. All contributions (French text) can be found on <http://www.obs-vlfr.fr/jgofs/html/proof1299/actesjournées1.html>.

The JGOFS-France homepage http://www.obs-vlfr.fr/jgofs/html/bdjgofs_eng.html provides the list of all JGOFS-France operations—past ones, ongoing and future ones—with scientific objectives, cruises planning, implementation plans, data organisation and policy, participants.

Germany

Karin Lochte (Chair) wrote that the present national funding for JGOFS projects in the North Atlantic and Indian Ocean finishes end of this year. Applications are made to continue on a reduced basis the analysis and synthesis in both ocean regions for another 3-year period. The outcome is uncertain.

Japan

Nobuhiko Handa wrote that in geographical and geophysical settings, the North Pacific shows very unique characteristics because of several marginal seas, the East China Sea, the Japan Sea, the Sea of Okhotsk and the Bering Sea, of the basin-wide strong currents, the Kuroshio and Oyashio currents. Vigorous air-sea mixing especially in wintertime and enormous input of terrestrial particles especially in early to late spring is another characteristic features of the North Pacific. All of these factors give strong effects on the biogeochemical cycles of carbon, macro- and micronutrients in the North Pacific, especially in the northwestern North Pacific through controlling both biotic and abiotic processes. Recognizing the lack of JGOFS process studies in the subarctic North Pacific playing an important role in a sink for anthropogenic carbon dioxide, the JGOFS-SSC established the North Pacific Task Team (NPTT) in 1996 to understand the significance of the subarctic basin for the anthropogenic carbon budget on a global scale.

Japanese JGOFS being one of the members of the NPTT consisting of the North Pacific rim countries has been conducting the North Pacific Process Study (NPPS) which is consisting of intensive and extensive field Campaign programmes, time-series observations, strong remote sensing and modelling components.

The extensive shipboard observations in the western Equatorial Pacific (Ocean Flux Programme, 1991-3) were to increase our knowledge on the global biogeochemical cycling of biophilic elements such as carbon, nitrogen and phosphorus, and their associated elements within the ocean, and on the temporal changes through interactions across the major ocean boundaries with land, atmosphere and seafloor. The ship observations focused in the western North Pacific (40°S-44°N, 140°E-160°W) were conducted to determine the regional and seasonal variations of the fluxes of organic and inorganic materials as well as biochemical elements such as carbon, nitrogen, phosphorus and silicon throughout the air-sea boundary, ocean interiors and water-sediment boundary. These works resulted in a great advancement in understanding the long-range transport mechanism of the terrestrial and anthropogenic materials from land to the open ocean. This project also played an important role on understanding the carbon, nitrogen and phosphorus dynamics through air-sea interface, ocean interior and water-sediment interface (access to nozaki@ori.u-tokyo.ac.jp).

Seasonal variation and long-term trend of pCO₂ in seawater (pCO_{2s}) in the western North Pacific have been examined on the basis of the data obtained in the area from the equator to 30°N on 137°E by the Meteorological Research Agency (MRI) Group, their findings showed that 1.8 μatm yr⁻¹ were estimated as the increasing rate of pCO_{2s} in the subtropical areas, while much less

values of $0.5 \mu\text{atm yr}^{-1}$ were observed in the western equatorial areas. From the detailed examination of the thermodynamic factors controlling the oceanic carbonate system in the western North Pacific, the increasing rates of $p\text{CO}_2\text{s}$ in these oceanic areas were concluded to be due to the ocean CO_2 uptake that was equivalent to the TCO_2 increase at the rate of $1 \mu\text{mol kg}^{-1} \text{yr}^{-1}$. The CO_2 outflux from the central and western equatorial Pacific was also examined and found that the outflux tended to decrease during the El Niño event, while it increased during La Niña, suggesting intra- and interannual fluctuations of CO_2 outflux from the central and western equatorial Pacific (for access, contact hyoshika@mri-jma.go.jp).

A research project, NOPACCS (North Pacific Carbon Cycle Study) was conducted to have continuous survey of the carbon dioxide fugacity in the surface sea water and air in the oceanic area of 48°N through 15°S on 175°E in April to June (spring cruise) or August to October (summer cruise) every year from 1992 to 1997. Negative values of the difference between $p\text{CO}_2$ in air ($p\text{CO}_2\text{a}$) and surface seawater ($p\text{CO}_2\text{s}$) $\{p\text{CO}_2\text{s} - p\text{CO}_2\text{a}\}$ were observed in the restricted areas around 40°N whereas very high positive values being almost equilibrated with air, were found in the subtropical areas. However, the negative values were common in whole areas of the ocean in spring time except the area north of 45°N , indicating that the western North Pacific must be preferentially taking up carbon dioxide in air in spring. Yet the $p\text{CO}_2\text{s}$ tended to increase with the seawater temperature in summer (for access, contact harada@nire.go.jp).

The Japanese biogeochemical study of the East China Sea -Marginal Sea Flux Experiments in the West Pacific (MASFLEX)- officially started in 1992 after a year of feasibility study and ended in 1997. The main aims of the project were to investigate the oceanic cycle of the biogenic elements such as carbon and nitrogen, and their exchange between the boundaries of atmosphere/ocean surface, ocean bottom water/sediment, coastal sea/open ocean in the East China Sea and its adjacent areas, and thus to clarify the role of the marginal sea in the global material cycle. The continental shelf was found to be a large sink of atmospheric CO_2 . This was not only due to its intense biological activity but also due to its cooling induced by heat loss. The cooling made the water more CO_2 absorbable and denser than the open seawater. The denser water was introduced into the deeper layer of the open sea by the isopycnal mixing and advection. The isopycnal mixing and advection still continued even in the warming season in the layer below the pycnocline. We named Continental Shelf Pump for this mechanism transporting CO_2 to the open sea. Seasonal changes of hydrographical features over the continental shelf of this sea area, nutrient dynamics, biological productivity and POC and PON dynamics are also conducted to observe and to discuss their probable mechanisms taking part (for access, contact kusakabem@mstkid.jamstec.go.jp).

Extensive observation of the $p\text{CO}_2\text{a}$ and $p\text{CO}_2\text{s}$ were conducted in the northern North Pacific from Japanese ports to North American ports by a cargo ship, Skaugran from March 1995 to present. The data obtained by the monitoring programme made by National Institute of Environmental Science (NIES) group are now compiling and processing, however tentative conclusion of the oceanic uptake of carbon dioxide in this region is 0.2 GtC yr^{-1} . Japanese JGOFS committee is now started to compile all of the data relevant to the biogeochemical studies which are obtained in the western North Pacific for the synthesis and modelling of the carbon cycle in the western North Pacific (for access, contact nojiri@nies.go.jp).

Japan Marine Science and Technology Centre initiative titled "Biogeochemical Study of the Northern North Pacific and its Adjacent Seas" is the most significant projects in NPPS. Aims of this study are 1) to assess the spatial and temporal variations of the CO_2 flux between ocean and atmosphere and the vertical flux of biogenic particles, 2) to understanding mechanisms controlling the biological pump and its role in the carbon cycle in the marine systems, 3) to clarify transport processes of dissolved materials in conjunction with intermediate water formation and to determine past changes in the ocean environment through various chemical and

biological proxies. Shipboard observations including sediment trap mooring, CTD hydrocast, piston coring and the determination of primary production have been conducted by using of "Mirai", which is capable of the winter operation in northern North Pacific. The research vessel has been occupied the western subarctic gyre areas including KNOT station once or twice a year since 1998 to collect the data related to carbonic acid materials, nutrients, dissolved and particulates materials and sediments. The field observation of this vessel will be continued for at least five years. All of the data compiled are also provided to the construction of the carbon cycling model in the North Pacific (for access, contact kusakabem@mstkid.jamstec.go.jp).

One of the major achievements of NPTT is the Kyodo (cooperative) North Pacific Ocean Time Series (KNOT) observation in the northwestern North Pacific off Kuril Islands at 44°N, 155°E. This is a joint effort of Japanese JGOFS and one of the projects of CREST (Core Research for Evolution Science and Technology, Science and Technology Agency; PI: Nojiri, Y, National Inst. Environ. Sci.). Because of the KNOT budget for 1998-2000, which is not long enough for our needs, Japanese JGOFS is now eagerly seeking the research ship of opportunity already funded by other sources. Shipboard observation is now continuing thanks to cooperative efforts of various research vessels from JAMSTEC, University of Tokyo, Tokai University, Hokkaido University and the National Institute for Resources and Environment to have 11, 13, 12 visits to the study site in 1998, 1999 and 2000, respectively.

Major objectives include studies of CO₂ uptake and regeneration processes in relation to the biological activities in the surface through deep waters and achievements of CTD sampling and JGOFS core measurements. Deployment of moored sediment traps at depths of 1, 3 and 5 km and a shallow optical buoy and free-drifting sediment traps were also conducted to determine vertical fluxes of organic and carbonate carbon in the subsurface and deep waters. These data will be supplemented by long-term observations of intra- and internal variability of phytoplankton abundance, photosynthetic CO₂ fixation, air-sea CO₂ exchange that were obtained by Hokkaido University and M/S Skaugran (for access, contact nojiri@nies.go.jp).

The Sub-Arctic Gyre Experiment (SAGE) programme, which is one of the core components of NPPS, started in April 1997 with five-year terms by the multi-agency system. The major goal of SAGE is to understand the relationships between the subarctic gyre and climate systems. The four aims of the project are as follows: 1) extensive observation of the structure and variability of the subarctic gyre, 2) the interaction between the subarctic and subtropical circulation systems, 3) CO₂ dynamics in the subarctic circulation system and 4) numerical modelling of the subarctic circulation including seasonal variability. Shipboard observations consist of the deployment of surface (ARGOS) and mid-depth (ALACE) drifters and one-time and repeated measuring of physical and chemical parameters by CTD, current profilers (ADCP), bathythermographs (XBT) and the JGOFS core measurements. Data are being compiled in the Centre of Climate System Research, the University of Tokyo (for access, contact nobuo@ccsr.u-tokyo.ac.jp)

The ocean physics and chemistry project on Okhotsk Sea has been conducted thanks to the fundings from the CREST programme of the Science and Technology Agency (STA), Japan, with five-year terms since 1998 to M. Wakatsuchi, Hokkaido University. Major goals of this projects is to understand the reasons of the formation of sea ice that occurs in such low latitude areas around 55-60°N in the Okhotsk Sea, and to assess how and how much Okhotsk Sea Intermediate water (OSIW) contributes to the formation of the North Pacific Intermediate Water (PNIW) in terms of transport of total carbon dioxide, nutrients and dissolved oxygen. Field observations include the deployment of ADCP and sediment trap, surface drifters (ARGOS) and one-time and repeated transects with sampling by CTD to measure physical and chemical parameters of the JGOFS core measurements. SeaWiFS data are extensively applied to the Okhotsk Sea and adjacent areas to measure primary productivity. Shipboard observation is partly

operated in the joint works of Japan, Russia and the United States (for access, contact tigersv10@lt.hines.hokudai.ac.jp).

CREAMS-I (Circulation Research of the East Asian Marginal Seas, first phase) is an international cooperative research programme, which is most valuable relevant works to Japanese JGOFS. This programme was initiated in 1993 by a group of scientists from Japan, Korea and Russia who shared the same scientific interests in the Japan Sea and adjacent seas and is now in phase two (1999-2003). The goals of this programme for the first five years were to understand the circulation structure of the Japan Sea and related fundamental processes and to develop numerical models of ocean circulation for application to the Japan Sea and other marginal seas. This programme is also interested in air-sea exchange of carbon dioxide long-term variations of dissolved oxygen and particulate flux in this marginal sea. Shipboard observation includes one-time and repeated transects with sampling by CTD, current profilers (ADCP) and some of the JGOFS measurements. Major contribution of CREAMS-I is now published in *J. Oceanography*, 1999 (for access, contact yoona@riam.kyushu-u.ac.jp).

Finally, most of the field observations of the Japanese JGOFS will be finished within a year, and then all of the data will be compiled together with the data obtained in the North Pacific so far. Our synthesis and modelling works toward 2004 will be focused on solving the following problems: How much amount of carbon dioxide is absorbed by the North Pacific Intermediate Waters? Does the amount vary with long-term, large-scale physical forcings? How much amount of carbon dioxide does the biological pump absorb? What is the regional and temporal variability of the efficiency of the biological pump? What controls the efficiency of the biological pump: iron input, community structure of lower trophic level organisms? In addition, why do blooms occur in the western sub-arctic Pacific, not the eastern sub-arctic Pacific?

USA

Robert Anderson (US JGOFS SSC) prepared the following report on behalf of Mark Abbott (US JGOFS Chair).

1) Field Work: US JGOFS has completed field work in support of the global ocean survey as well as all regional process studies. Field programmes at the Time Series Stations located near Bermuda and Hawaii continue.

2) Publications: The third *Deep-Sea Research Part II* (DSR II) volume describing US results from the Arabian Sea has been published. Manuscripts have been delivered (April, 2000) to the publisher for the first DSR volume on US Southern Ocean results. Manuscripts are currently being received for a second Southern Ocean volume. The US JGOFS newsletter is published four times per year and distributed to approximately 1800 scientists, programme managers, policy makers and educational centres. A searchable subject index for past issues is maintained on the US JGOFS web site.

3) Steering Committee Activities: Mark Abbott (Oregon State University) has been elected as Chair of the US JGOFS Steering Committee, replacing Hugh Ducklow following his appointment as Chair of the International JGOFS SSC. The SC is directing its attention to ongoing management of the Time-Series Stations and to oversight of the Synthesis and Modeling Program (SMP). The entire SC convened last in October 1999, and will meet again in June 2000. A sub-group of the SC assembled during the Ocean Sciences meeting in San Antonio, Texas, to begin drafting of US JGOFS "legacy documents" (see item #6 below).

4) Workshops: The second Southern Ocean process study (AESOPS) data workshop, held in Keystone, Colorado (2-9 August, 1999) was attended by 73 scientists and students. The final Southern Ocean data workshop will be held at Oregon State University, 28-30 June 2000. Principal investigators of the Synthesis and Modeling Program (SMP) held their annual

workshop in Keystone, Colorado (12-16 July 1999) with an attendance of 72. The Woods Hole Oceanographic Institution will host the next SMP Principal Investigator meeting in July 2000. Three mini workshops have been supported under the auspices of the SMP program. These topical workshops have focused on primary production, nitrogen fixation, and the equatorial Pacific Ocean.

5) Research Opportunities: The US National Science Foundation anticipates issuing two more Announcements of Opportunity (tentatively, August, 2000 and August, 2001) for which proposals to carry out research in support of the Synthesis and Modeling Program may be submitted. These represent the final opportunities to obtain support from the US NSF for US JGOFS research.

6) Public Outreach: US JGOFS is preparing two "legacy documents" highlighting JGOFS achievements. The first is a concise well-illustrated brochure designed for the general public, with anticipated completion by the end of 2000. The second is a series of articles designed for non-JGOFS scientists that will be published in the Oceanography magazine (published by The Oceanography Society) in summer/fall 2001.

7) Next Open Science Conference: US JGOFS desires to host the next JGOFS Open Science Conference, in the 2002/2003 time frame, to coincide the completion of the JGOFS funding cycle in the US. Washington D.C. is suggested as the venue. The US JGOFS Planning Office asks that the SSC considers this request during the SSC meeting in Bergen. An endorsement by the SSC is needed to permit the US JGOFS Planning Office to seek funds to host the Conference. A request for funds to support the Conference would be included in the next proposal for continuing support of the Planning Office, which must be submitted to the US NSF in August 2000.

International Geosphere-Biosphere Programme (IGBP)

Executive Director Summary

Will Steffen, Executive Director, briefed the SSC on the latest developments in IGBP. The most significant outcome from the recent SC meeting is the new direction for IGBP research. Although the Core Projects will remain the heart of IGBP, the focus will shift to a fully integrated Earth System Science with strong partnerships from IHDP and WCRP. The global biogeochemical cycles will remain the core of IGBP research. However, it will evolve to a system science with major activities in the three compartments (oceans, land and atmosphere) and their interfaces. To enhance this shift, several meetings are planned to provide a bridge for the Core Projects towards Earth System Science. These meetings will define the main science questions in the three compartments and interfaces for the next decade of research. SCOR and IGBP are taking the lead on the future of Ocean Biogeochemistry (OBGC). Gross reported on the status and plans of the OBGC meeting (see **Scientific Committee on Oceanic Research**).

Global Carbon Cycle Synthesis (GCCS) Workshop

Steffen also mentioned that IGBP-SC is developing three crosscutting activities on carbon, food/fibre and water. These activities are being planned as joint projects with IHDP and WCRP. The carbon activity, when fully developed, will provide the IGBP communities with an international framework for future biogeochemistry programmes for ocean, terrestrial and atmosphere research, which addresses the entire global carbon cycle in an integrated fashion. The date for the Global Carbon Cycle Synthesis (GCCS) Workshop at the University of New Hampshire, USA is 16-20 October 2000. The organizers expect 60 participants.

Ducklow raised the point that IGBP Carbon Working Group (CWG) has so far consisted of the terrestrial and atmospheric communities and little interaction with the oceanic community, e.g. JGOFS or GLOBEC. Ducklow encouraged IGBP to include the marine sciences in IGBP GCCS Workshop and would like to see between 15 and 20 ocean biogeochemists attending the Workshop. Steffen acknowledged the concern and said that one of the reasons for this is that the CWG has been an *ad-hoc* group. However, when the CWG is formalised (as it is currently happening), the group will consist of representatives from ocean, terrestrial and atmosphere sciences. Steffen requested that the SSC recommend 20 participants for the GCCS Workshop, and the SSC encouraged Ducklow to submit a list of names with a blend of mid-career and senior ocean biogeochemists.

ACTION #19: Ducklow will solicit names from the SSC and OSC, and then recommend names to IGBP for the Workshop.

Regarding the issue of how JGOFS might interact better with the terrestrial and atmospheric communities, Watson remarked that the terrestrial and atmospheric communities are historically better linked than the ocean community is. He agreed that the workshop would be an excellent opportunity to link the three communities through ocean CO₂ system (and exchanges), etc. However, he doubts that this will happen. Steffen argued that it is indeed happening within IGBP. Steffen also pointed out that although there are good links between terrestrial and atmospheric communities, there are indeed similar interaction problems as with the oceanic community. Lochte and Quiñones suggested a way to increase interactions by emphasising, what has NOT been achieved yet. For example, what would be new is to highlight gaps in research. Steffen mentioned that the terrestrial community is dealing with this approach, regarding structural saturation on land that is highly controversial. He also ventured to say that there is probably a similar controversy in the oceans. Liu agreed and one should also emphasise the controversy in the interactions between ecosystems, land *versus* oceans, oceans *versus* atmosphere and atmosphere *vs.* land.

Steffen also informed the SSC that the participants at the GCCS Workshop will produce a book volume for the IGBP Book Series, in addition to a draft of an international framework for global carbon cycle research. This document will also include international frameworks for atmosphere, ocean and the paleo communities. Wallace commented that ocean colour is central to this framework because carbon goes to the ocean and then to the atmosphere, *i.e.* there is a missing link here. Fasham agreed and remarked that the process to link ocean colour with carbon in the ocean is modelling. The SSC suggested that representatives from ocean colour and modelling should participate in the GCCS Workshop.

The SSC questioned the production of yet another book on carbon. Steffen mentioned the IGBP-SC also questioned it, and the CWG offered an alternative workshop product through a series of papers in either Science or Nature that will present provocative issues and facts on global change. The group envisioned a paper on oceans and asked if JGOFS would write it. Watson mentioned that he would be reluctant to use Nature, as this journal does not do special issues as *Deep Sea Research* has done. However, Nature would welcome separate papers, but one would risk structure continuity because certain papers may be declined. Thus, the overall series would end up with discipline gaps. Watson felt that Science might be a better alternative than Nature. Steffen agreed.

ACTION #20: Ducklow deferred the action on an ocean paper until the GCCS Workshop when potential author(s) can be selected from those in attendance.

Open Science Conference

Steffen announced that IGBP is planning “A Global Change Open Science Conference” in Amsterdam, The Netherlands, 10-13 July 2001. This conference will present the latest scientific understanding of natural and human-driven changes on our planet. The IGBP-SC is trying to make this Conference as easy as possible and convenient for all Core Projects (CP) to attend and to hold their annual SSC meetings in conjunction with the Conference. To facilitate the process, IGBP will offer meeting rooms free of charge at the Dutch Academy of Sciences and help with expenses of the SSC during the Conferences.

The SSC discussed the possible venues for the 16th SSC Meeting in Amsterdam, The Netherlands or in Santiago, Chile in 2001 together with a JGOFS training course. Several SSC members did not favour Amsterdam because it would be appended to another large IGBP meeting. Gross, on the other hand, argued that failure to meet in Amsterdam would compromise JGOFS representation at the IGBP Open Science Conference. Steffen promised to negotiate the Amsterdam expenses so that the entire SSC could remain during the conference. The SSC viewed IGBP offer as a unique opportunity and agreed to hold the 16th Meeting of the SSC in Amsterdam.

ACTION #21: The SSC suggested that the dates for the 16th SSC meeting at the Dutch Academy of Sciences should be 8-9 July 2001, immediately prior to the IGBP Open Science Conference.

Core Project Interactions

GLOBEC

Bathmann reviewed the areas of GLOBEC activities: ICES, PISCES, SPACC, and Southern Ocean (SO). One can find information about GLOBEC, Regional programmes, Research foci, Countries, Newsletters, and much more on GLOBEC web site (<http://www.pml.ac.uk/globec/>). The new Executive Officer is Manuel Barange from South Africa/Spain. The CCCC programme has a large database and they now ask what they can do for the fisherman? The SO GLOBEC programme or fieldwork will take place (*e.g.* Hoffman leader) and will have a strong link to physical oceanography, *e.g.*, circulation, and how this affects the ecosystem. A strong link exists between SO JGOFS and GLOBEC (Bathmann and Hoffman working together). SPACC regional programme includes research on (1) retrospective analysis--have similar problems as JGOFS looking at historical data, holding with GCTE and IGAC. There remains no link with JGOFS, but there should be one; (2) Process studies--no link but it has potential for JGOFS; (3) Prediction and modelling--interaction with GOOS; (4) feedback from ecosystem change--not established and need input from JGOFS and other IGBP programmes. In the newsletter, there is a series of actions for the future. Ducklow mentioned that Roger Harris expressed concern about support from JGOFS because of JGOFS sunset clause. Bathmann recommends that there should be a formal link between JGOFS and GLOBEC, *e.g.* a representative in the SSC. Ducklow recommended a joint task team for instance, rather than a representation at the SSC meetings.

ACTION #22: The SSC took no action on forming a joint JGOFS-GLOBEC task team.

LOICZ

Liu reviewed the five LOICZ research projects: (i) Coastal typology; (ii) Biogeochemical Budgeting Modelling; (iii) Deltaic Processes; (iv) SARCS/WOTRO/LOICZ Southeast Asia Research; and (v) Continental Margins Task Team. Liu commented on the problem for JGOFS of utilising the coastal typology data elaborated by LOICZ, as its resolution is too small for the purposes of JGOFS. Wallace asked whether LOICZ would deal with biogeochemical cycles other than carbon. Liu felt that LOICZ would not. LOICZ works mainly with nutrient budgets. He also

mentioned that they are not concerned with blooms dynamics of coastal phytoplankton. Fasham asked whether any IGBP CPs would be studying blooms, which indeed are a major issue. Gross mentioned that SCOR supports this type of research through GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms).

GAIM

Monfray reported on the GAIM Task Force. There is a new chair for GAIM, John Schellnhuber (Germany). Fasham asked whether JGOFS chair should continue to participate in GAIM TF meetings. Ducklow felt that it was important, but due to his heavy teaching, research and international JGOFS constraints, he will probably appoint somebody else to attend the next GAIM TF meeting in Potsdam, Germany in the fall (time and place uncertain).

Monfray also mentioned the upcoming OCMIP Phase II Workshop and meeting in Princeton, USA, 5-7 July 2000. Theme sessions include special issues of CO₂ injection and analysis, natural "steady-state" ocean, perturbed ocean, what is the next step? (General Discussion), features and limitations of available software for model comparison; what do we need?

IGAC

Tilbrook reported no action for several years.

PAGES

Lochte mentioned that there was nothing to report.

DIS

Baliño reported on the second meeting of the DIS Steering Group (see **APPENDIX J**).

Scientific Committee on Oceanic Research (SCOR)

Executive Director Summary

Elizabeth Gross, Executive Director of SCOR, briefed the SSC on SCOR projects, working groups and upcoming meetings, in particular the meeting on the Future of Ocean Biogeochemistry. This meeting will be hosted jointly by SCOR and IGBP, and will be held at the Plymouth Marine Laboratory, UK, 23-25 September 2000. John Field (South Africa) and Patrick Buat-Ménard (France) will co-Chair the meeting. The purpose of the meeting is to discuss progress and uncertainties regarding key processes in the ocean carbon cycle emerging from JGOFS, WOCE, PAGES, GLOBEC as well as those being planned for SOLAS, CLIVAR, etc., and identify ocean research priorities for the next decade of global carbon cycle research. Gross mentioned that Ducklow wrote an excellent article on the future of OBGC in US-JGOFS News, which SCOR will use as the document paper for the meeting (**APPENDIX K**).

Other International Programmes

Because of time constraints, the discussions on other international programmes that are affiliated with JGOFS were shortened.

IOCCG (International Ocean Colour Coordinating Group)

Tilbrook attended the IOCCG Meeting in Hobart, Australia. Platt provided a brief report on IOCCG activities resulting from the meeting (**APPENDIX L**). Liu asked who lead the remote sensing activities in coastal waters. Tilbrook mentioned that Shubha Sathyendranath is involved

in coastal activities and that she prepared a draft manuscript on the issue for the modelling workshop in Oban (Liu will contact her for a copy). The SSC asked about the existence of algorithms to detect *Trichodesmium* blooms. Tilbrook answered that algorithms are being developed but had no further information.

SOLAS (Surface Ocean and Lower Atmosphere Study)

Wallace briefed the SSC on SOLAS Open Science Meeting in Damp, Germany, from which Lochte along with other SSC members attending the OSM prepared a report (**APPENDIX M**). Fasham mentioned that while SOLAS has been criticised in the past for being too exclusive, it now seems like it has become too large. In addition, the editorial team that is charged with the elaboration of the science plan resembles the original group and that it might suffer again from individual interests. Watson mentioned that one has to keep numbers low in order to write a science plan. He also recalled that when JGOFS wrote its science plan, it did not include many of the topics that were achieved by national programmes anyway. The same will happen with SOLAS.

The issue of size of the programme and its sponsors was also discussed. Falkowski thought that SOLAS needed to be large internationally in order to attract the necessary funding. Falkowski also commented on the issue of nitrogen fixation, which is dealt by OCTET and other US programme, and how USA will try to get them to embrace a larger programme. If this happens it will certainly embrace issues that concern SOLAS. This means that "similar" projects will be competing for similar funding resources with the risk of both loosing at the international level. In other words, Falkowski emphasised that he wants to make sure that SOLAS has enough ballast to "survive" for a while. If not, he advised SOLAS to provoke and stimulate discussions to develop a more comprehensive programme. Watson mentioned that SOLAS will try to attract US scientists and even if it is a small programme, it will have international importance. Watson also commented that although SOLAS needs to put a strong emphasis on carbon, it would not be exclusively on carbon. Steffen added that one of the reasons for the present discussion is that IGBP has not yet an overall framework to address IGBP research over the next 10 year. Only then, will it be clear what SOLAS should focus on. He thought that the work of the editorial team should also have some feedback from IGBP, *e.g.* through the Carbon Working Group. Conkright warned that SOLAS is mostly a European initiative, and whatever it is left out will not be covered by other programmes.

GOOS (Global Ocean Observing Systems)

Tilbrook briefed the SSC on GOOS (**APPENDIX N**). Haugan emphasised the need of a white paper with some sort of consensus from JGOFS on how GOOS should proceed and define its procedures and mechanisms. A priority list should help as different issues have different funding sources. Ducklow felt that JGOFS is prepared to provide some concrete input on CO₂ observing systems to GOOS, and suggested that Wallace and Watson, as representatives from the CO₂ Panel, and Garçon meet with Haugan to discuss how the pCO₂ issue can be addressed. Quiñones was asked to assist this group with coastal issues.

ACTION #23: A small group will meet with Haugan to discuss how the pCO ₂ issue can be addressed in GOOS.
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POGO (Partnership for Observation of the Global Ocean)

Gross mentioned that POGO aims are to support global observing systems. The group is privately funded but they expect that institutions will pay in the future. Members are from institutions and universities that are active in ocean research and monitoring. At the last meeting, which she attended, no one from JGOFS was invited or present.

Scientific Steering Committee and Membership Rotations

Scientific Steering Committee

Hanson reported that the 15th SSC consist of 22 members, *i.e.*, 12 at-large members and 10 SG and TT chairs, from 12 countries (**APPENDIX O**). The new at-large members are Hugh Ducklow (Chair, USA) and Peter Haugan (Norway). At the end of 2000, 5 at-large members are scheduled to rotate off. One rotating member is the Past Chair (Fasham), 2 are in their second year (Lochte and Liu), and 2 are completing their first term (Hong and Quiñones). Margarita Conkright, DMTT Chair, is attending her first SSC meeting.

ACTION #24: The SSC needs to address these at-large rotations before IGBP and SCOR meetings (September and October 2000, respectively).

Synthesis Groups and Task Teams

Data Management Task Team

Germany informed the DMTT (Lowry and Conkright) that Mitzka left the national programme and that another data manager would be selected and recommended to the DMTT. Conkright confirmed the appointment of a new data manger, Joachim Herrmann, at the German Data Management Office and supports his nomination on the DMTT. Herrmann's CV was attached the meeting agenda. The SSC recognized the appointment of a new German JGOFS Data Manager.

ACTION #25: The SSC approved Joachim Herrmann (Germany, replacing Mitzka) as a new member of the Data Management Task Team.

Joint Continental Margins Task Team (JGOFS-LOICZ)

Liu announced that Julie Hall (New Zealand) rotated off the CMTT, after serving as co-Chair. To replace her, Liu recommended Robie MacDonald (Canada) as a new member of the CMTT. His CV was attached to the meeting agenda. The SSC recognized Macdonald's strong scientific interests in continental margins. Liu also recommended Quiñones as the next JGOFS co-Chair for the CMTT.

ACTION #26: The SSC approved Robie Macdonald (Canada, replacing Hall) as a new member of the Continental Margins Task Team.

ACTION #27: The SSC approved Renato Quiñones as co-Chair of the CMTT. The term runs from 1 January 2001 through 31 December 2003.

North Pacific Task Team

Last year, the SSC requested that task teams consider changing co-Chair status of non-joint task teams to Chair and Vice Chair. Saino mentioned that the NPTT recommended Bychkov as NPTT Chair to maintain the strong link with PICES in support of North Pacific synthesis. The SSC agreed that PICES interests in North Pacific marine sciences (ocean carbon cycling) supports NPTT recommendation.

ACTION #28: The SSC accepted the recommendation of the NPTT to change the status of the NPTT co-Chairs and approved Bychkov (Canada) as Chair for a second term. The term runs from 17 April 2000 through 31 December 2003. The SSC also recognized Saino as Vice-Chair.

New or Restructured Task Teams or Groups

IOC-SCOR Ocean CO₂ Advisory Panel

SCOR and IOC drafted and approved new TOR for the Ocean CO₂ Panel (see **APPENDIX H**). The new Chair of the Ocean CO₂ Panel is Doug Wallace, and he will replace Watson on the

JGOFS SSC as chair of the CO₂ Panel (17 April 2000). Ducklow recognized and thanked Watson for his past contributions to the Panel and the JGOFS SSC.

ACTION #29: The SSC recognized Doug Wallace (Germany, replacing Andrew Watson) as the new Chair of the IOC-SCOR Ocean CO₂ Advisory Panel.

Joint Paleo-JGOFS Task Team (PAGES)

Hanson reported that the joint Paleo-JGOFS Task Team co-Chair, Graham Shimmield, tendered his resignation as task team co-Chair because of increased programme responsibilities in the UK. Shimmield recommended Lochte as the next JGOFS co-Chair of the PJTT and asked that he remain on the task team for continuity.

ACTION #30: The SSC approved Lochte as the co-Chair of the joint Paleo-JGOFS Task Team (PAGES). The term runs from 17 April 2000 through 31 December 2003.

ACTION #31: Shimmield shall retain his position on the task team.

Joint Ocean Carbon Modelling Task Team (JGOFS-GAIM)

The Terms of Reference and membership are in progress and being finalized (see **APPENDIX G**). The Executives discussed the proposed membership and co-Chairs of the task team. They supported the nomination of Monfray as JGOFS co-Chair of the JGTT.

ACTION #32: The SSC approved Patrick Monfray (France) as the JGOFS co-Chair of the joint JGOFS-GAIM TT (JGTT). The term runs from 17 April 2000 through 31 December 2002.

Future SSC Membership Policy

Ducklow advised the SSC that we must maintain membership continuity and synthesis momentum over the next 3-4 years. Therefore, nominating new at-large members at this time may be ineffective in sustaining this momentum. He recommended that future nominations should be rightly justified on maintaining continuity and momentum in the synthesis process.

The SSC agreed that future at-large rotations be based on maintaining the continuity of the SSC synthesis and modelling effort.

International Project Office

Executive Officer Summary

Hanson reported that the International Project Office has completed 4 successful years of JGOFS business at the University of Bergen, and its funding for staff and office has been secured until 31 December 2003. Since the last SSC Meeting in Yokohama, the staff focused a considerable amount of effort and time on the SSC synthesis activities: JGOFS Open Science Conference (OSC), the IGBP Science Series (brochure), and the IGBP book volume. Moreover, the Office maintained the same level of effort on the daily business and activities of the SSC, the Regional Synthesis Groups and Task Teams. The activities of the SSC and other groups have now saturated Office manpower and there are limitations to what the Office staff can additionally support in the future.

Administrative Matters

The 1999 Budget

Hanson reviewed the JGOFS and IPO funding sources and expenses. In 1999, JGOFS had an operating budget of *ca.* \$281K from the Research Council of Norway, SCOR, University of

Bergen, and IGBP (**APPENDIX P**). These funds covered the 1999 administration costs, overhead for the facilities, SSC and group meetings and workshops, publications, and overhead for the project accounts of *ca.* \$281K.

The 2000 Budget

JGOFS expects an operating budget, excluding administration funds, of *ca.* \$110K from SCOR and IGBP. Based on recent information, the SG and TT chairs requested an aggregate budget of *ca.* \$121K, which means an estimated deficit of *ca.* \$11K (**APPENDIX Q**).

The SSC spent considerable time discussing the 2000 Budgets in lieu of JGOFS end-of year activities. In 1999, the SSC and Executives earmarked 2000 Funds (priorities) for the SSC (\$45K), Executive (\$10K), Open Science Conference (\$20K for general expenses and \$20K for invited speakers), the DMTT (\$10K) and PJTT (\$5K) meetings, in particular. At present, the largest unknowns are the SSC Meeting and the Open Science Conference (OSC) in Norway.

At present, it is unlikely that JGOFS will be able to support the aggregated requests of the SOSG, NPTT, JGTT and CMTT activities in 2000. Therefore, the SSC decided to defer discussions on the outstanding request until they knew the cost of the SSC meeting and the Conference. A decision to support these activities will be made this June. In light of JGOFS 2000 finances, the SSC recognized LOICZ commitment to fund CMTT first synthesis workshop at Old Dominion University in 2000, and then they committed financial support (\$20K) for CMTT synthesis workshops in 2001.

The 2001 Budget

The SSC also heard from SG and TT chairs regarding 2001 synthesis activities. Based on the information provided, the chairs have requested an aggregated budget of *ca.* \$121K or deficit of *ca.* \$11K (**APPENDIX Q**). These activities include: the IOSG meeting in Miami to complete the Arabian Sea highlight report; the NASG 3rd synthesis meeting with cost sharing from PROOF in Paris; the CMTT synthesis workshops; the new joint JGTT workshop (50 participants) with cost sharing from GAIM; and the CO₂ Transport Workshop (50 people) with cost sharing from WOCE. After discussion, Ducklow proposed that the SSC set the 2001 priorities so that Executives and the IPO can work out the 2001 budget. Regarding the funding of the WOCE/JGOFS CO₂ Transport workshop in 2001, Steffen suggested that a proposal be sent on behalf of JGOFS to the IGBP Carbon Working Group to support the attendance of scientists.

ACTION #33: The SSC will set the priorities for JGOFS sponsored funding in 2001 (deadline is 31 August 2000).

ACTION #34: The IPO Executive Officer with assistance of the CO₂ Panel Chair will send a proposal to IGBP CWG for support of the workshop participants.

Data Management

JGOFS-Norway database project

Baliño reported that the Institute of Marine Research (IMR) in Bergen would centralise all Norwegian-JGOFS data in a database. This initiative, fostered by the IPO, began last year when the IMR received a grant from the Research Council of Norway for a 3-year project (2000-2002) with the following goals:

- To tailor an existing database system for the archival of Norwegian JGOFS data.
- To develop a Web interface for exchange and presentation of data.
- To produce a CD-ROM containing the whole data suite together with data presentations at the end of the project.

A steering group with members of the Norwegian JGOFS Committee and the IPO will supervise the project. The IPO will also assist IMR in the collection of the data sets

Report of the JGOFS National Activities 1988-1999

This report is a compilation of research projects and cruises and a data status report by B. Baliño (Draft, August 1999). The report contains a compilation of past and present national activities contributing to the Joint Global Ocean Flux Study since its beginning in 1988. It includes lists of research projects and contacts (PIs), and the corresponding fieldwork carried out (*i.e.*, cruises). In addition, aspects of the management, archival and long-term stewardship of the data collected in each country are also specified. The purpose of this report is to provide an overview of the whereabouts of JGOFS data and to assist the DMTT in their pursuit of securing the long-term stewardship of the JGOFS dataset. This document will be published in the JGOFS Report Series.

JGOFS Metadata

Last year Baliño started writing DIF (Database Interchange Format) files for archival of JGOFS metadata at NASA's Global Change Master Directory, the *de facto* metadata catalogue for JGOFS. However, progress has been minimal, mainly due to her involvement in other prioritised issues such as the JGOFS brochure and the Open Science Conference. The writing of metadata was assigned to her by the DMTT and it is considered a high priority for the synthesis phase. After the Open Science Conference, she hopes to devote a good deal of her time in carrying out this task.

Other Issues

- JGOFS Report Nr. 30: *JGOFS Publications, 1988-1999*

A new update of the JGOFS publication list was released early this year, both as a hard copy and as a *pdf* document on the homepage. All scientists are encouraged to browse this list and inform Baliño of missing references and/or updates.

- JGOFS brochure

Last year Baliño devoted a good part of her time in the editing and preparation of all the graphical material for the JGOFS brochure. She also cleared permissions with each publishing agencies.

Other Business Matters

Future of Ocean Biogeochemistry Programmes

Quiñones requested further discussion on where JGOFS is heading to, *i.e.*, about the future of ocean biogeochemistry. Fasham mentioned that the information coming from the SCOR-IGBP “futures” meeting on Ocean Biogeochemistry would be what Quiñones is asking for. Wallace also mentioned that it is now out of the hands of the SSC *per se* and no longer an issue for this SSC to discuss that topic or make plans for the new programmes. Ducklow agreed and felt that JGOFS will contribute significantly to the OBG “futures” meeting in Plymouth, UK, and the GCCS Workshop in Durham, USA this fall.

Regarding the issue of interactions with other programmes, Falkowski emphasised that there is an intrinsic problem or lack of understanding of what the other community is doing because these are unknown fields. For instance, he knows there are inverse models in the atmosphere but he does not understand so he needs a tutorial. He then proposed that JGOFS sponsor and promote training sessions for people that are trying to understand these new approaches and methods. This

action was strongly endorsed by Steffen who says it falls in the cross cutting activities of IGBP and the CWG. While Falkowski thinks JGOFS should lead this activity, Ducklow mentioned that the very first opportunity of this activity would be at the workshop in Plymouth (October 2000).

Next SSC meetings

The SSC agreed to hold the 16th JGOFS SSC in Amsterdam in conjunction with the IGBP Open Science Conference. The proposed dates are 8-9 July 2001.

Next Executive Meeting

In the future, Executives will meet in conjunction with other international meetings. This year, Lochte volunteered to organise the 2000 Executive Meeting at the time of the German International JGOFS Conference in Bremen, that will take place 18-21 September 2000. Since the SSC meeting, the Executive Meeting is now planned together with the GCCS (IGBP) Workshop in Durham, New Hampshire, USA, 16-20 October 2000. The date is tentatively set for 14-5 October.

Next Open Science Conference

Anderson informed the SSC that US JGOFS (**see US-JGOFS Report**) requests international JGOFS support to host the third JGOFS Open Science Conference in the States in 2003. Bathmann endorsed this request not only because two Conferences have already been held in Europe but also because JGOFS developed as a result of GOFS (Global Ocean Flux Study) in the US. It is logical the JGOFS ends up where it began. SSC agreed.

ACTION #35: SSC offered their support to US-JGOFS in organizing the 3rd (and last) OSC for JGOFS.
--

Falkowski emphasized that the structure of the conference should be planned now, in terms of communication towards the broad scientific community, the funding agencies, and the public.

Closing

After expressing thanks to the IPO staff for their work in organizing the venues for the SSC meeting and Open Science Conference, Ducklow summarized several important issues facing JGOFS synthesis. Regarding observational data sets and JGOFS synthesis, Ducklow emphasized that each SSC member has a responsibility to encourage national scientists and programmes to submit their data to ocean data centres. Regarding future synthesis elements, Ducklow reminded all chairs to attend the Saturday meeting to discuss missing elements of JGOFS synthesis and how to integrate the activities across the regional synthesis groups/task teams. Finally, regarding the OSC, Ducklow encouraged everyone to make a special effort to see all posters, attend all oral presentations, and encourage new participation in the JGOFS synthesis phase.

The 15th SSC meeting was adjourned at 17:30 on 12 April 2000.

Appendices

APPENDIX A: List of Participants

Scientific Steering Committee Members

Anderson, Robert, USA
Bathmann, Ulrich, Germany
Burkill, Peter, UK
Bychkov, Alex, Canada
Conkright, Margarita, USA,
Ducklow, Hugh, USA
Falkowski, Paul, USA
Fasham, Michael, UK
Garçon, Véronique, France
Haugan, Peter, Norway
Hong, Huasheng, China-Beijing
LeBorgne, Robert, France
Liu, Kon Kee, China-Taipei
Lochte, Karin, Germany
Monfray, Patrick, France
Quiñones, Renato, Chile
Saino, Toshiro, Japan
Tilbrook, Bronte, Australia
Wallace, Douglas, Germany
Watson, Andrew, UK

International Project Office Staff (Norway)

Hanson, Roger
Baliño, Beatriz
Stokke, Judith

Guests

Gross, Elizabeth, Scientific Committee on Oceanic Research, USA
Steffen, Will, International Geosphere-Biosphere Programme, Sweden
Johannessen, Truls, Chair Norwegian JGOFS Committee, Norway
Nojiri, Yukihiro, National Institute for Environmental Studies, Tsukuba Japan

Regrets

Platt, Trevor, Canada
Shimmiel, Graham, UK

APPENDIX B: JGOFS SSC Agenda, 11-12 (17) April 2000

WELCOME AND OPENING

Opening Statement, Adoptions of Agenda and Timetable, Approval of Minutes of the 14th JGOFS SSC Meeting, Additional Information: Minutes of the 1999 Executives Meeting.

JGOFS SYNTHESIS PLAN AND IMPLEMENTATION

SSC Synthesis & Projects (SSC), JGOFS Role in IGBP-Wide Synthesis, IGBP Science Series (Fasham), IGBP book volume series (Fasham).

Synthesis Groups: Memberships, TOR, Financial Requests, Final Agendas & products: North Atlantic (Garçon), Indian Ocean (Burkill), Equatorial Pacific (LeBorgne), Southern Ocean (Bathmann).

Task Teams: Memberships, TOR, Financial Requests, Final Agendas & Products: Data Management (Conkright and Baliño), North Pacific (Bychkov and Saino), Paleo-JGOFS (Lochte), Continental Margins (Liu), IOC-SCOR CO₂ Advisory Panel (Wallace, CO₂ Transport Workshop Proposal, (PMTT update).

INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME (IGBP)

IGBP-SC Meeting: Evolution of the IGBP (Steffen), Cross-IGBP Carbon Synthesis (Steffen/Hibbard), IGBP Open Science Conference, Amsterdam, July 2001, Core Project Interactions: GLOBEC (Bathmann), LOICZ (Liu), GCTE, BAHC, GAIM (Monfray), IGAC (Tilbrook), DIS (Baliño), PAGES (Lochte), START.

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH (SCOR)

SCOR Business (Gross), IGBP-SCOR Ocean Biogeochemistry Meeting (Gross and Steffen).

INTERNATIONAL PROGRAMMES (Interactions)

Future of Ocean Biogeochemical Research, IOCCG (International Ocean Colour Coordinating Group) (Tilbrook), IOC-SCOR CO₂ Programme (Wallace), GOOS Programmes (Haugan, Neville Smith email), POGO Group (Gross), SOLAS Programme (Watson)--Open Science Conference (Lochte's Report), CLIVAR Programme (Gould e-mail), USCCSP/OCTET (Ducklow).

BUSINESS MATTERS

Scientific Steering Committee (members, rotations, nominations).

INTERNATIONAL PROJECT OFFICE REPORT

OTHER BUSINESS MATTERS

NEXT BUSINESS MEETINGS

CLOSING

Timetable

Tuesday, 11 April 2000

08:30 **Welcome and Opening**

Welcome SSC, new members and guests

Domestic Arrangements and Information (Stokke)

Opening Statements

Matters Arising: Synthesis Plan and Implementation (2001-03), Future OBGC Programme, Ocean Colour, GOOS, IOC-SCOR CO₂ Panel, and IGBP

Adoptions of Agenda and Timetable

Approval of Minutes of the 14th JGOFS SSC Meeting

Additional Information: Minutes of the 1999 Executives Meeting

09:00 **JGOFS Synthesis Plan and Implementation**

SSC Synthesis & Projects (SSC)

Synthesis timeline (2001-2003)

JGOFS Open Science Conference

10:00 Break (Coffee & Cookies)

10:30 IGBP Science Series (Fasham/Bowles)

IGBP book volume series (Fasham)

JGOFS Role in IGBP-Wide Synthesis (*e.g.*, Amsterdam Conference, Speaker)

12:00 Lunch

13:00 Synthesis Groups: Memberships, TOR, Financial Requests, Final Agendas & products: North Atlantic (Garçon), Indian Ocean (Burkill), Equatorial Pacific (LeBorgne), Southern Ocean (Bathmann)

15:00 Break (Coffee & Cookies)

15:30 Task Teams: Memberships, TOR, Financial Requests, Final Agendas & Products: Data Management (Conkright and Baliño), North Pacific (Bychkov and Saino), Paleo-JGOFS (Lochte), Continental Margins (Liu), SCOR/IOC CO₂ Advisory Panel (Wallace, CO₂ Transport Workshop Proposal, (PMTT update)

17:00 Adjourn for the Evening

20:00 SSC Dinner (TBD)

Wednesday, 12 April

08:30 **International Geosphere-Biosphere Programme (IGBP)**

IGBP-SC Meeting: Evolution of the IGBP (Steffen)

Cross-IGBP Carbon Synthesis (Steffen/Hibbard)

IGBP Open Science Conference, Amsterdam, July 2001

Core Project Interactions: GLOBEC (Bathmann), LOICZ (Liu), GCTE, BAHC, GAIM (Monfray), IGAC (Tilbrook), DIS (Baliño), PAGES (Lochte), START

09:30 **Scientific Committee on Oceanic Research (SCOR)**

SCOR Business, Working Groups, Projects, etc. (Gross)

IGBP-SCOR Ocean Biogeochemistry Meeting (Gross and Steffen)

10:00 Break (coffee & cookies)

10:30 International Programmes (Interactions)

Future ocean biogeochemical programmes

IOCCG (International Ocean Colour Coordinating Group) (Tilbrook)

SCOR/IOC CO₂ Programme (Wallace)

GOOS Programmes (Haugan, Neville Smith email)

POGO Group (Gross)

SOLAS Programme (Watson)--Open Science Conference (Lochte)

CLIVAR Programme (Gould email)

USCCSP/OCTET (Ducklow)

12:00 Lunch

13:30 Business Matters

Scientific Steering Committee

2000 Members (List)

At-large Rotations (2000)

Nominations for 2001 Members

Policy for future appointments and rotations

14:00 International Project Office Report

Business Matters (Hanson)

Data Management Matters (Baliño)

Administrative Matters (Stokke or Hanson)

14:30 Break (Coffee & Cookies)

15:00 Other Business Matters

2000 Budget Revisited

Next Business Meetings

Executive Meeting (2000)

Bremen, Germany at the German JGOFS International Workshop, Sept. 2000,
Lochte local organizer)

SSC Meeting (16th)

Amsterdam, IGBP Open Science Conference, July 2001-Discussion, IGBP organizer
– or elsewhere?

16:30 Closing

Chair Summary

NB! Monday, 14:00-16:00, 17 April—Post Executive and OSC Meeting

APPENDIX C: Synthesis Timeline (and Plans for 2000-2003)

(Modified and updated since October 1998)

Year 2000

January	JGOFS Accomplishments (IGBP Science Series): Science Editor's draft prepared for SSC review and comment.
February	JGOFS Accomplishments (IGBP Science Series): Approved draft sent to IGBP for technical layout
February/March	JGOFS Accomplishments (IGBP Science Series): Technical layout sent to SSC for review and comment
8-10 February	5 th Meeting of the North Pacific Task Team and North Pacific Synthesis Workshop, Nagoya, Japan. Contact Toshiro Saino, Institute for Hydrospheric-Atmospheric Science, Nagoya University, Furo-cho, Chigusa-Ku, Nagoya 464-01, JAPAN, tsaino@ihas.nagoya-u.ac.jp
March	Ocean Biogeochemistry: A JGOFS synthesis (IGBP Book Series): First chapter drafts due for SSC review.
March/April	JGOFS Accomplishments (IGBP Science Series): Revised IGBP technical layout sent to IPO.
April	JGOFS Accomplishments (IGBP Science Series): Printed and distributed at the JGOFS Open Science Conference.
11-12 April	15 th JGOFS Scientific Steering Committee, Bergen, Norway. Contact Roger Hanson, JGOFS International Project Office, Centre for Studies of Environment and Resources, Bergen High-Technology Centre, University of Bergen, Norway. Tel: (+47-555) 84244, Fax: (+47-555) 89687, Roger.Hanson@jgofs.uib.no
13-17 April	Second JGOFS Open Science Conference, Bergen, Norway. <i>Theme: Ocean Biogeochemistry: A new paradigm.</i> Contact Roger Hanson, JGOFS International Project Office, Centre for Studies of Environment and Resources, Bergen High-Technology Centre, University of Bergen, Norway. Tel: (+47-555) 84244, Fax: (+47-555) 89687, Roger.Hanson@jgofs.uib.no
June	Ocean Biogeochemistry: A synthesis (IGBP Book Series): Chapters revised for peer review.
5-6 June	Data Management Task Team Meeting, Kiel, Germany. Contact Margarita Conkright, NOAA/NODC, E/OC5, Silver Spring, MD, USA, mconkright@nodc.noaa.gov
9-13 July	Southern Ocean Synthesis Group: Symposium and Meeting, Brest, France. <i>Theme: The Southern Ocean: climatic changes and the cycle of carbon. An international JGOFS symposium,</i> Contact Paul Tréguer, UMR CNRS 6539, Institut Universitaire Européen de la Mer, Technopôle Brest-Iroise, Place Copernic, 29280 PLOUZANE, France, Tel: (+ 33 2) 98 49 86 64, Fax: (+ 33) 2 98 49 86 45, Email: Paul.Treguer@univ-brest.fr
16-17 September	JGOFS Executive Meeting, Bremen, Germany. Contact Roger Hanson, JGOFS International Project Office, Centre for Studies of Environment and Resources, Bergen High-Technology Centre, University of Bergen, Norway. Tel: (+47-555) 84244, Fax: (+47-555) 89687, Roger.Hanson@jgofs.uib.no IGBP-SCOR Ocean Biogeochemistry Workshop (<i>dates to be determined</i>)

16-20 October IGBP Carbon Synthesis Workshop, University of New Hampshire, USA. Contact Will Steffen, IGBP Secretariat
 6th Meeting of the NPTT and North Pacific Carbon Dioxide Workshop, Tokyo, Japan. Contact Toshiro Saino, Institute for Hydrospheric-Atmospheric Science, Nagoya University, Furo-cho, Chigusa-Ku, Nagoya 464-01, JAPAN, *tsaino@ihas.nagoya-u.ac.jp* (TBD)
 Continental Margins Task Team (JGOFS/LOCIZ) Workshop, Virginia, USA. Contact Kon-Kee Liu, Inst. of Oceanography, National Taiwan University, Taipei, Taiwan, ROC. *kkliu@ccms.ntu.edu.tw*, Tel: (886-2) 3631810, Fax: (886-2) 3626092 (TBD)

Year 2001

January Ocean Biogeochemistry: A JGOFS synthesis (IGBP Book Series): Peer review completed.

March/April JGOFS Ocean Biogeochemistry: Synthesis (second IGBP Science Series) Draft

10-14 July IGBP Open Science Conference, Amsterdam, The Netherlands. *Keynote talks on JGOFS synthesis*

July Ocean Biogeochemistry: A JGOFS synthesis (IGBP Book Series): Publication

Spring 16th JGOFS Scientific Steering Committee Meeting

Fall JGOFS Executive Meeting
 Continental Margins Task Team (JGOFS/LOCIZ) Workshop, Taipei, Taiwan, RoC. Contact Kon-Kee Liu (Email: *kkliu@ccms.ntu.edu.tw*), Inst. of Oceanogr., National Taiwan University, Taipei, Taiwan, RoC. Phone: (886-2) 3631810, Fax: (886-2) 3626092 (TBD)
 Second/Third meetings of the Regional Synthesis Groups (TBD):
 Southern Ocean, Indian Ocean, Equatorial Pacific, North Atlantic. All groups plan to produce regional synthesis volumes, e.g., *Deep-Sea Research Part II. Topical Studies in Oceanography*
 1st JGOFS/GAIM 3D Ocean Carbon Modelling Task Team. Prepare plans for 3D modelling and analysis (TBD)

Year 2002

Complete Regional Synthesis Activity. Plan final JGOFS synthesis activities with emphasis on the link to global climate modelling

Spring 17th JGOFS Scientific Steering Committee Meeting

Fall JGOFS Executive Meeting
 JGOFS/WOCE CO₂ Transport Workshop. Contact Doug Wallace, Abteilung Meereschemie, Institut für Meereskunde, an der Universität Kiel, Düsternbrooker Weg 20, D-24105 Kiel, Germany. Tel. 49-(0) 431-597-3810, Fax. 49-(0) 431-565-876, Email: *dwallace@ifm.uni-kiel.de* (TBD)

Year 2003

Complete global ocean carbon synthesis

Spring 18th JGOFS Scientific Steering Committee Meeting

Fall JGOFS Executive Meeting
 Third JGOFS Open Science Conference (TBD)
 Plan archival of all JGOFS data sets at the WDC-A, Oceanography

APPENDIX D: Open Science Conference Programme

Day 1

13-APRIL 2000, THURSDAY

08:15-08:45

Opening Ceremony, Michael Fasham

Session 1

Ocean Biogeochemical Regimes, Chaired by Hugh Ducklow

08:45

Ducklow, Hugh (Invited Speaker). Ocean Biogeochemical Regimes

09:15

Johannessen¹, Truls, Leif Anderson², Eva Falck¹, Eystein Jansen³, Are Olsen¹, Abdirahman M. Omar¹ and Ingunn Skjelvan¹. The carbon cycle in the Nordic Seas: A synthesis of work done during the CARDEEP era

09:30

Olafsson¹, Jon, and Helge Drange². North Atlantic seasonal biogeochemical changes

09:45

Mackey, Denis J., F Brian Griffiths, Harry W Higgins, John S Parslow and Bronte Tilbrook. Physical chemical and biological controls on the carbon cycle in the warm pool of the western Equatorial Pacific

10:00

Coffee

10:30

Prasanna Kumar, S., M. Madhupratap and M. Dileep Kumar. Physical control of biological productivity on a seasonal scale in the central Arabian Sea

10:45

Quéguiner¹, B., S. Blain², P. Boyd³, D. Hutchins⁴ and P. Sedwick⁵. Multiple limiting factors at the first trophic level: iron and silicon interactions control phytoplankton production and particulate matter characteristics in Southern Ocean subsystems

11:00

Yayla, Mehmet K., and Aysen Yilmaz. Photoadaptation and temperature dependency of primary productivity in the Black Sea

Session 2

Continental Margin Exchanges, Chaired by Arthur Chen

11:15

Chen¹, Chen-Tung Arthur (Invited Speaker), Kon-Kee Liu², and Rob MacDonald³. Continental Margin Exchanges

11:45

Broekhuizen, Niall. An oceanic influence upon phytoplankton dynamics in New Zealand's Hauraki Gulf

12:00

Fabrés¹, Joan, Anna Sanchez¹, Antoni Calafat¹, Miquel Canals¹, Nicole Delsault² and Serge Heussner². Annual and time-intensive monitoring of particle fluxes in the Alboran Sea

12:15

Zhao¹, Weihong, and Jiangtao Wang². Dissolved and colloidal organic carbon in the East China Sea

12:30

Wollast, Roland, and Lei Chou. The carbon cycle at the ocean margin in the northern Gulf of Biscay: The OMEX-I Project

12:45

Lunch

Day 1

13-APRIL 2000, THURSDAY AFTERNOON

Session 3 Carbon Dioxide Fluxes in the Global Oceans, Chaired by Andrew J. Watson

- 14:00 Watson
- 14:30 Feely¹, Richard A., Rik Wanninkhof², Catherine E. Cosca¹ and Hisayuki Y. Inoue³.
The impact of El Niño on the air-sea exchange of CO₂ in the Equatorial Pacific
- 14:45 Tsunogai, Shizuo, Watanabe Shuichi, Wakita Masahide, Tanaka Takayuki, Igarashi
Kouji and Nakano Yoshiyuki. Potential sink capacity of the Pacific water in
absorbing anthropogenic CO₂
- 15:00 Metzl¹, N., C. Brunet¹, A. Jabaud¹, C. Pierre², A. Poisson¹ and B. Schauer¹.
Observations of anthropogenic CO₂ in the Southern Indian Ocean
- 15:15 Dickson, A.G., G.C. Anderson, J.D. Afghan, C. D. Keeling, G. Emanuele and P.R.
Guenther. Quality Control of Oceanic Carbon Dioxide Measurements using
Certified Reference Materials
- 15:30 Sarma, V. V. S. S., P. S. Swathi, M. Dileep Kumar, S. Prasanna Kumar, M.
Madhupratap, V. Ramaswamy, M. M. Sarin, M. Gauns, P. M. A. Bhattathiri and N.
Ramaiah. Carbon budgets for the JGOFS (India) study region in the Arabian Sea
- 15:45-1800 Poster Sessions & Refreshments
Little Auditorium "*Sydneshaugen*"
- 19:00-2200 Reception by the City of Bergen at the Bergen's Art Museum

Day 2

14-April 2000, Friday

Session 4 Primary Production and Export, Chaired by Paul Falkowski

- 08:30 Falkowski, Paul G. (Invited Speaker). Primary productivity in the contemporary
ocean
- 09:00 Antoine, David, André Morel, Emmanuel Bosc and Annick Bricaud. Recent
advances in modelling regional and global oceanic primary production from
satellite ocean colour
- 09:15 Buesseler, Ken O. The decoupling between primary production and shallow
particulate export in the worlds ocean
- 09:30 Luz, Boaz and Eugeni Barkan. A novel approach for simultaneous assessment of
gross and net O₂ production
- 09:45 Murray, James W., Anthony K. Aufdenkampe and John P. Dunne. Controls on
variability of new production in the Equatorial Pacific
- 10:00 *Coffee*

- 10:30 Schulz-Bull, D. E., T. Blanz, J. Kuss and K. Kremling. The POC associated flux of organic trace chemical substances in the northeast Atlantic
- 10:45 Lévy¹, Marina, Patrice Klein² Anne-Marie Tréguer². Impact of oceanic small-scale dynamics on primary production
- 11:00 Zhang^{1,2}, Jia-Zhong, Rik Wanninkhof² and Kitack Lee^{1,2}. New production in oligotrophic water: estimation based on diel cycle of nitrate

JGOFS Regional Issues

- 11:15 **EqPAC: "Outstanding and unresolved issues of the equatorial Pacific"**
 Chaired by Robert LeBorgne
NASG: Chaired by Véronique Garçon
CMTT: Chaired by K.K. Liu

12:45 *Lunch*

Day 2 **14-April 2000, Friday Afternoon**

Session 5 Biogeochemistry Below the Euphotic Zone, Chaired by Paul Tréguer

- 14:00 Tréguer, Paul (Invited Speaker). Water column biogeochemistry below the euphotic zone.
- 14:30 Armstrong¹, R. A., C. Lee², J.I. Hedges³ and S.G. Wakeham⁴. A mechanistic model of deep-water remineralization: ballast and protection of organic carbon by mineral constituents
- 14:45 Jeandel¹, C., A. Bory², V. Athias¹ and K. Tachikawa³. What did we learn from the EUMELI sediment traps?
- 15:00 Luo, Shangde, and Teh-Lung Ku. Biogeochemical Cycling of ¹⁰Be in the Ocean: A New Constraint for Deep-Water Ventilation during the Last Millennium
- 15:15 Ruiz-Pino¹, D., and J. J. Taboada². . A deep-water column carbon and mass fluxes model
- 15:30 Sabine, Christopher L., and James C. Orr. Comparison of Model and Measurement-Based Approaches for Estimating Anthropogenic CO₂ Distributions in the Ocean
- 15:45-1800 Poster Sessions & Refreshments
 Little Auditorium "Sydneshaugen"
- 19:30-23:00 Conference Reception at the Bergen Aquarium

Day 3 **15 April 2000, Saturday**

Session 6 Community Structure in Regulating Export, Chaired by Michael Landry

- 08:30 Landry¹, Michael R. (Invited Speaker), Ulrich Bathmann², Paul Falkowski³, Thomas Kiørboe⁴ and Frede T. Thingstad⁵. The role of community structure in regulating export flux from the upper ocean
- 09:00 Barber¹, Richard T., Robert R. Bidigare² and James J. McCarthy³. The two-state paradigm of pelagic food web variability: A product of JGOFS observations
- 09:15- Legendre¹, Louis, and Richard Rivkin². Cycling of biogenic carbon in oceans: regulation by food-web control nodes
- 09:30 Thingstad, T. Frede. What controls the partitioning of bacterial production between protozoan predation and viral lysis?
- 09:45 Jackson, George A., and Adrian B. Burd. Modeling sub-euphotic zone zooplankton dynamics and their impact on falling organic matter
- 10:00 *Coffee*
- 10:30 Priddle, Julian, Angus Atkinson, Andrew S Brierley, Geoffrey C Cripps, Rachael S Shreeve, Peter Ward, Jonathan L Watkins and Michael J. Whitehouse. Variability in zooplankton community composition in a Southern Ocean ecosystem - a tool for studying the carbon and nitrogen cycles
- 10:45 Steinberg, Deborah K., and Laurence P. Madin. Influence of Zooplankton Community Structure on Export Processes at the Bermuda Atlantic Time-series Study (BATS) Site
- 11:00 Quiñones, Renato A., and Yoanna Eissler. The relationship between planktonic community respiration and size in the pelagic system off northern Chile during El Niño 1997-1998

JGOFS Regional and Other Issues

EqPAC: "Does the equatorial Pacific fit in the future programmes that are being elaborated? Chaired by Jim Murray

11:15 **NASG:** Chaired by Véronique Garçon

CMTT: Chaired by K.K. Liu

GAIM: "Cross-IGBP Synthesis of the Carbon Cycle" Co-Chaired by Hugh Ducklow and possibly Kathy Hibbard

12:45 *Lunch*

Day 3 **15 April 2000, Saturday Afternoon**

Session 7 **Deep Ocean Fluxes, Chaired by Karin Lochte**

14:00 Lochte, Karin, *et al.* Deep ocean fluxes

14:30 Gaye-Haake, Birgit, Holger Breul, Jörg Tiemann, Andreas Suthhof, Tim Rixen and Venugopalan Ittekkot. Variation of late Quaternary sedimentation processes in the Arabian Sea

- 14:45 Gobeil¹, Charles, Bjørn Sundby², Robie W. Macdonald³ and John N. Smith⁴. Constraints imposed by redox tracers on carbon fluxes to sediments in the central Arctic Ocean
- 15:00 Hoppe, Hans-Georg, Sören Ullrich, Klaus von Bröckel and Claudia Sellmer. Mismatch between bacterial C-demand and C-supply by settling and suspended POM in the deep Arabian Sea
- 15:15 Totterdell¹, Ian J., Steven A. Spall² and Andrew Yool¹. Atlantic Carbon and Alkalinity Fluxes in an Ocean Carbon Cycle Model (HadOCC)
- 15:30 Heinze, Christoph. An attempt to reconcile systematically a global ocean biogeochemical general circulation model with observations of particle fluxes, water column tracers, solid sediment compounds and pore water tracers simultaneously.
- 15:45 *Coffee*
- 16:00-1800 Poster Sessions & Refreshments
Little Auditorium "Sydneshaugen"
Evening Free

DAY 4

16-APRIL 2000, SUNDAY

Session 8 Global Ocean Carbon and Ecosystem Modelling, Chaired by Scott Doney

- 08:00 Doney¹, Scott (Invited Speaker), Joanie Kleypas¹, Ivan Lima¹, Keith Lindsay¹, J. Keith Moore¹ David Glover² and Dennis McGillicuddy², and Paul Falkowski³. An Emerging Paradigm for Global Ocean Carbon and Ecosystem Modeling
- 09:00 Sarmiento, J. L., R. Armstrong, C. Deutsch, A. Gnanadesikan, N. Gruber and R. Slater. A simple/advanced ecosystem model for biogeochemical studies
- 09:15 Aumont¹, O., E. Maier-Reimer², P. Pondaven³ and S. Blain³. An iron and silicon-based ecosystem model of the global ocean
- 09:30 Friedrichs, Marjorie A. M., and Eileen E. Hofmann Physical Control of Biological Processes in the Central Equatorial Pacific: A Data Assimilative Modeling Study
- 09:45 Sasai, Yoshikazu, and Motoyoshi Ikeda. Carbon cycle in the upper layer of the North Pacific using the three dimensional model
- 10:00 *Coffee*
- 10:30 Christian¹, James R., Mark A. Verschell², Ragu Murtugudde³, Antonio J. Busalacchi⁴ and Charles R. McClain⁴. Modelling Interannual Variability of Plankton and Biogeochemistry in the Tropical Pacific Ocean
- 10:45 Myrmehl, Cathrine, and Helge Drange. 3-D Modelling of the Seasonal Cycling of Carbon and Nitrogen in the World Oceans

11:00 Gregg, Watson W. Seasonal variability of global ocean chlorophyll: Comparison of CZCS and SeaWiFS observations with a coupled general circulation-biogeochemical-radiative model

11:15-12:45 The Future of Ocean Biogeochemistry Research,
Chaired by Cindy Lee

12:45 *Lunch*

Day 4 16-April 2000, Sunday Afternoon

Session 9 Feedback Processes and Climate Change, Chaired by Phillip Boyd

14:00 Boyd¹, Philip (Invited Speaker), and Scott Doney². The impact of climate change and feedback processes on the ocean carbon cycle

14:30 Bopp¹, Laurent, Patrick Monfray¹, Olivier Aumont¹, James C. Orr¹, Jean-Louis Dufresne² and Hervé LeTreut². Potential impact of climate change on marine production

14:45 Matear¹, R. J., A. C. Hirst² and B. I. McNeil¹. Predicted changes in dissolved oxygen in the Southern Ocean with climate change

15:00 Shanmuganandan, Samarajalingam. Climate change and environmental impacts on marine fisheries: A study with reference to understanding the marine ecosystem of Indian Ocean region

15:15 Zondervan, Ingrid, Björn Rost and Ulf Riebesell. Elevated CO₂ concentrations slow down carbonate production in calcifying marine phytoplankton

15:30 Spall¹, Steven A., Ian J. Totterdell², Chris D. Jones¹, Peter M. Cox¹ and Richard A. Betts¹. The role of the ocean in a climate change scenario using an atmosphere-ocean GCM with an interactive carbon cycle

15:45-18:00 Poster Sessions & Refreshments

Little Auditorium "*Sydneshaugen*"

20:00-24:00 Conference Dinner on the "*Statsråd Lehmkuhl*"

Day 5 17-April 2000, Monday Morning

Session 10 Temporal Studies of Biogeochemical Processes, Chaired by David Karl

08:30 Karl¹, David M. (Invited Speaker), Steve Emerson², Paul J. Harrison³, Anthony F. Michaels⁴ and Yukihiro Nojiri⁵. Temporal studies of biogeochemical processes in the world's oceans

- 09:00 Bidigare¹, Robert R., Michael E. Ondrusek¹, Michael R. Landry¹, Karen Selph¹ and David M. Karl¹, and Ricardo Letelier². Seasonal and Interannual Variations in Phytoplankton Community Structure at Station ALOHA
- 09:15 Carlson¹, Craig A., Nicholas R. Bates¹, Deborah K. Steinberg¹, Dennis A. Hansell¹, Rodney J. Johnson¹, Anthony H. Knap¹ and Anthony F. Michaels². An Overview of Biogeochemical Variability at the U.S. JGOFS Bermuda Atlantic Time-series Study (BATS) Site
- 09:30 Dickey, Tommy D. New Insights Gained from High Frequency Interdisciplinary Time-series Observations during JGOFS
- 09:45 LeBorgne¹, Robert, Richard T. Barber², Thierry Delcroix³, Yoshikawa Inoue⁴, Marlon Lewis⁵, Denis Mackey⁶ Martine Rodier¹ and Daniela Turk⁵. Zonal variability of the equatorial Pacific HNLC area
- 10:00 *Coffee*
- 10:30 Machu¹, Eric, Arne Biastoch², Andreas Oschlies³ and Véronique Garçon¹. Phytoplankton distribution seasonality in the Agulhas Current region
- 10:45 Nojiri¹, Yukihiro, Toshiro Saino², Shuichi Watanabe³, Keiri Imai⁴ and Nobuo Tsurushima⁵. Western North Pacific Ocean time series study at 44 N, 155 E (station KNOT) as a JGOFS/NPTT (North Pacific Task Team) activity
- 11:00 Turk¹, Daniela, Marlon R. Lewis¹, Michael J. McPhaden² and Antonio J. Busalacchi³. Variations in new production in the tropical Pacific during 1997-1999 El Niño and La Niña from remotely-sensed observations
- 11:15-12:45 Conference Highlights and Discussion on Future Challenges
- 12:45 **Closing Ceremony, Hugh Ducklow**

APPENDIX E: Equatorial Pacific Synthesis Group

REPORT FROM THE BERGEN MEETING (APRIL 15, 2000)

Attendees: R.T. BARBER, F. CHAI, R. FEELY, D. KARL, R. LE BORGNE, D., MACKEY, and J.W. MURRAY

Absentees: M. LEWIS, Y. NOZAKI

Seizing the opportunity of the JGOFS Open Science Conference (OSC), the Equatorial Pacific Synthesis Group (EPSG) met on April 15, 2000 at 6 p.m. in the "*Bergen Kongress Senter*". The meeting took also advantage of the discussions held at the two parallel sessions on the equatorial Pacific, which were conducted during the OSC on April 14 and 15.

I - DSR II Special Edition of the Equatorial Pacific synthesis (Appendix 1 = chapter list)

A review was made of the 18 planned chapters, which led to the following conclusions:

(1) Although several manuscripts are now ready for review, most of them will not be ready by the end of April. A new and ultimate deadline was therefore set for the end of June 2000.

(2) The editors (LeBorgne, Feely and Mackey) had not received any reply from three chapter leaders (out of 18) at the time of the meeting. These are Neil Price for primary production, Aude Leynaert for the silicon cycle and Marlon Lewis/Daniela Turk for meridional variability. Dick Barber agreed to try to write a short synthesis of primary production in spite of a heavy workload and a short delay. Following the discussion, several suggestions were made: Robert LeBorgne will contact Mary-Elena Carr(*) for the chapter on meridional variability. Aude Leynaert is temporarily out of her lab and will be approached by Paul Tréguer.

(3) Two chapters to be led by Jim Murray have new titles: "Biogeochemical and physical controls on new production in the tropical Pacific" and "Implications of the two path model for export flux". The first was recently submitted for a parallel SMP special issue. Jim will recall that paper and submit it for this volume where it will be more appropriate.

(4) The problem of the availability and presentation of Japanese cruise results and data in the western and central Pacific was discussed. This has become a serious problem. Since the data are not available for others to use and incorporate into other "synthesis" chapters, Robert LeBorgne proposed to Ishio Asanuma in February 2000 that he take the lead on a chapter summarizing the Japanese cruise results separately. He said he could not because of restrictions placed by Marlon Lewis. We have asked representatives of Japanese JGOFS to look at this problem and look for another chapter leader.

(5) The three editors will write an Introduction of the DSR II volume. It will present the main scientific results of the JGOFS Equatorial programme and new theories/paradigms that have emerged from it. A similar "state of the art" article will be submitted to "New Scientist", following recommendations of the JGOFS SSC.

II - On-going and planned activities and the future of equatorial Pacific studies

Some conclusions can be drawn from the two parallel sessions, which were led by Robert LeBorgne on April 14 and, by Jim Murray, on April 15. The first dealt with the main inputs and

unresolved issues of the JGOFS Equatorial Pacific Programme and the second with the inclusion of equatorial Pacific into future national and international programmes. The following points were presented:

(1) On-going activities include monitoring of biogeochemical parameters during specific studies:
- Servicing of the NOAA-TAO moorings (pCO₂, surface nutrient and chlorophyll) and pCO₂/bio-optical sensors set on the moorings at 155W (0°) and 170W (2°S).

PI's: Feely, Chavez and Wanninkhof

- JAMSTEC and MRI cruises have been conducted along the equator from 140E to 170W every year in December-January, since 1994 and will be conducted until, at least, 2002. Surface parameters (pCO₂, SSS, SST) and vertical profiles (hydrology, nutrient, DIC, pigments).

PI: Kawahata (formerly: Asanuma). Cooperation with M. Lewis (Dalhousie University).

- IRD (ex-ORSTOM): Gep&Co programme. Ships of opportunity between Panama and Nouméa collect data four times per year. This includes upward irradiance, surface nutrients, pigments (absorption, flow cytometry, spectrofluorometry), pCO₂, SSS and SST. An extension is planned in 2000 for the Nouméa-Japan line.

PI: Dandonneau.

- IRD: Frontalis cruise on the R/V Alis will be conducted at the end of 2001. This will be a study of the warm pool-HNLC front.

PI: Delcroix.

(2) Cruise projects being considered include a study of zonal variations of iron concentrations along the equator and the origin of iron in the equatorial undercurrent (Jim Murray, Univ. Washington) and physical biological interactions associated with Tropical Instability Waves (Pierre Flament, Mike Landry and others at Univ. Hawaii).

(3) a) The need for more direct observations (*e.g.* from TAO moorings) was stressed because they only recently started. The ocean colour satellite, SeaWiFS, was launched at the end of the JGOFS Equatorial programme and the observational period for interannual variability has been particularly short. b) Study of the biomass conducting diel migrations (which allows calculation of the active flux) is required because existing data only refer to mesozooplankton. Micronekton diel migrations could be studied by echo sounding (including ADCP). d) Additional iron enrichment experiments are necessary in order to improve our understanding of the HNLC functioning and test the "two-state" paradigm. e) We need more data on new production.

(4) EPSG follows the development of new US and International projects *via* some of its members (Barber for SOLAS, Karl and Feely for OCTET). Projects of other nations are only starting for SOLAS. The discussion on an international level dealing with future studies on the Pacific Ocean is needed and should involve EPSG and, possibly, other JGOFS task teams or regional groups.

III - Future of EPSG

Following discussion of future projects, all EPSG participants strongly supported the fact that the Group should not be disbanded and should carry on until the end of JGOFS. The following arguments were presented:

(1) It is important to have an international structure taking care of the interests of the equatorial Pacific community.

(2) EPSG is probably the most appropriate advisory body to supervise collection of all JGOFS data for the region. The process has just started under the leadership of M.P. Labaied from DMTT (and France-JGOFS database) and will likely need a lot of effort and diplomacy.

(3) EPSG is a necessary structure in order to follow the new projects being planned for the Pacific by the different nations. A possible coordination is envisioned with other JGOFS task teams/regional groups working on the Pacific.

(4) The Group can be an efficient mechanism for making data available to young scientists working on the Pacific. It is proposed that a meeting would be organized in which young modellers and observers would meet EPSG members, after the *DSR II* synthesis issue has been published.

IV - Next meeting

Based on the last item (4), we propose that the next meeting could include a workshop with EPSG members and young scientists. Fei Chai suggested it would be more appropriate in 2002. The date, location and number of participants were not discussed. It will be communicated to IPO with the budget demand, to be sent in 2001.

(*) For various reasons, she will not be able to lead on this chapter.

Appendix I: Chapter list of *DSR II* Special Edition of the Equatorial Pacific synthesis

Bio-optical studies during the JGOFS-Equatorial Pacific programme: a contribution to the knowledge of the equatorial system

by Annick Bricaud, CNRS-Villefranche s/m, France, and Ishizaka J., Parslow J., Roesler C.

Satellite ocean color observations of the tropical Pacific Ocean

by Chuck McClain, NASA, USA, and Christian J.R., Signorini S., Turk D., Asanuma I., Lewis M., Hofmann E.

Seasonal and interannual variability of CO₂ in the equatorial Pacific

by Richard Feely, PMEL, Seattle, USA, Boutin J., Cosca C., Dandonneau Y., Etcheto J., Inoue H., Ishii M., Le Quéré C., Mackey D., McPhaden M., Metzl N., Poisson A., Wanninkhof R.

Phytoplankton community structure in the equatorial Pacific

by Denis Mackey, CSIRO, Australia, and Blanchot J., Higgins H.W., Neveux J.

Microbial community dynamics in the open ocean tropical Pacific

by Michael Landry, University of Hawaii, USA and Kirchman D.

Mesozooplankton

by Michael Roman, Horn Point Env. Lab., USA, *et al.*

Primary production

by Neil Price, McGill University, Canada (Now: Richard Barber)

Silicon cycle

by Aude Leynaert, Université de Brest, France, *et al.* (Cancelled)

Diel cycles in the surface waters of the equatorial Pacific

by Brian Binder, University of Georgia, USA, and DuRand M.

Carbon flux through the water column

by Robert Collier, Oregon State University, USA

Warm pool- cold tongue spatial and temporal variability

by Robert LeBorgne, IRD (ORSTOM), France, Barber R.T., Delcroix T., Inoue Y., Mackey D., Rodier M., Turk D.

Meridional variability

(Cancelled)

One-dimensional model of the equatorial Pacific upwelling system, Part I: Model development and silicon and nitrogen cycles

by Fei Chai, University of Maine, USA, Dugdale R.C., Barber R.T., Peng T.H. and Wilkerson F.P.

One-dimensional model of the equatorial Pacific upwelling system, Part II: Sensitivity of the model parameters and comparison with nutrient conditions during the JGOFS EqPac cruises in 1992

by R.C. Dugdale, Barber R.T., Fei Chai, Peng T.H., Wilkerson F.P.

The two state paradigm of pelagic food-web variability: a product of JGOFS observations

by Richard Barber, Duke University, USA, R. Bidigare, Fei Chai and J.J. McCarthy

Implications of the two-path model for export flux

by James Murray, University of Washington, USA, *et al.*

Biogeochemical and physical controls of new production in the tropical Pacific

by Anthony Aufdenkampe, James Murray, University of Washington, USA, *et al.*

Paradox of the particles: biogeochemical response of large and small particles to El Niño forcing during JGOFS equatorial Pacific survey cruises

by James Bishop, EO Lawrence Berkeley National Laboratory, USA, *et al.*

APPENDIX F: Southern Ocean Synthesis Group

Terms of Reference (as of May 2000)

1) The chair of the group will be appointed by the JGOFS SSC. The chair will assemble a group of up to ten people with experience of the observational datasets and modelling activities relevant to the region. The group membership should reflect, but need not be limited to, the countries that have participated in the JGOFS programmes in the region and be approved by the executive committee.

2) The main tasks of the group are:

- Prepare one or more reports for the SSC that summarise the activities of the group and synthesise the JGOFS science carried out within the region.
- Present a paper on the results of the group's activities at the 2000 Science Conference of Biogeochemistry of the Southern Ocean.
- Liaise with the DMTT to encourage the submission of data to the regional/international data centres with the provision of easy access to these data *via* the Internet and CD-ROMs.
- Continue to encourage synthesis activities in the form of open meetings, special issues of scientific journals, and review articles throughout the remaining period of the JGOFS programme

3) Meetings of the group will be funded by JGOFS, funds permitting. The group is encouraged to organise open meetings on regional synthesis but funds from JGOFS for such meetings would necessarily be limited and members might seek funds from their national programmes.

4) Extra terms of reference can be added with JGOFS SSC approval.

APPENDIX G: Joint Paleo-JGOFS Task Team (PAGES)

Terms of Reference (as of May 2000)

The formation of a joint task team of PAGES and JGOFS, the Paleo-JGOFS Task Team (PJTT) was discussed during the IGBP Congress in Shonan Village, May 1999. The aim of the PJTT is to bring together the expertise on the biogeochemical processes in the present ocean, available from JGOFS, with the expertise on oceanic processes under the past climate conditions, available from PAGES.

Objectives

- To foster the integration of JGOFS and PAGES activities in order to extend the knowledge of present day ocean ecosystem functions beyond the scale of direct observation,
- To improve our interpretation of the sedimentary record,
- To achieve an understanding of the oceans reaction and feedback mechanisms to changing environmental conditions in the past and today,
- To address in particular the question of changes in regional oceanic productivity in response to varying environmental conditions,
- To hold regular meetings, improve the exchange of information and data between the scientific communities of JGOFS and the marine branch of PAGES, and publish the results of the joint workshops.

The PJTT will attempt these objectives by building up the connection between JGOFS and PAGES, identifying key issues to be addressed by this group, organizing larger joint PAGES-JGOFS workshops dedicated to these specific topics, and producing reports or publications on the major findings of these workshops.

Membership

From PAGES

Roger François
Laurent Labeyrie
Thomas Stocker
Anne de Vernal

From JGOFS

Karin Lochte
Rick Jahnke
Graham Shimmield
Paul Tréguer

APPENDIX H: Joint JGOFS-GAIM Task Team

Monfray revised and submitted TOR and membership after the 15th Meeting of the SSC.

Terms of Reference (as of May 2000, draft)

Objectives

The objective of this joint task team is to bring together the expertise of JGOFS on ocean biogeochemical processes and GAIM on global carbon budget changes. The aim is to apply new insights into biogeochemical processes, as co-limitations, that we have gained through the JGOFS programme to improve our representation of global carbon dynamics by models, and to evaluate them with new data synthesis. In a broader way, this Task Team will set up bridges between ocean physics and ocean biology to better our knowledge on ocean geochemistry variability and changes induced by human activities. Particularly, focus will be on oceanic CO₂ uptake during the industrial era (past and future) and climate change impact on marine productivity and carbon cycle.

The task team will address this objective by building a link between JGOFS and GAIM; identifying key issues to be addressed by this group; organizing larger joint GAIM/JGOFS workshops dedicated to these specific topics; and producing reports or publications on the major findings of these workshops.

Goals

- Foster interactions between JGOFS and GAIM activities for a global integration of regional aspects;
- Create synergy with WCRP/CLIVAR and others IGBP related projects (GLOBEC, LOICZ, Carbon Synthesis, SOLAS);
- Stimulate improvement of global ocean carbon cycle models (OCCMs), by integrating JGOFS biogeochemical processes in 3-D ocean general circulation models;
- Evaluate OCCMs with available JGOFS-WOCE synthesis datasets, including seasonal to interdecadal variability;
- Inter-compare available OCCMs both for natural cycle and anthropogenic perturbation, using experiments with common boundary conditions and protocols.
- Hold regular meetings, improve the exchange of information and data between the scientific communities of ocean biogeochemistry, and publish the results of the joint workshops.

Proposed Task Team for 2000 and 2001

J. Orr (Chair, GAIM-TF, France)
M. England (WCRP/CLIVAR, AUS)
P. Monfray (JGOFS-SSC, France)
R. Najjar (GAIM-TF, USA)
C. Sabine (JGOFS-WOCE, USA)
J. Sarmiento (JGOFS-SMP, USA)
I. Totterdell (JGOFS, UK,)
Y. Yamanaka (CCSR, Japan)

APPENDIX I: Joint Ocean CO₂ Advisory Panel (IOC-SCOR)

Terms of Reference (recognize and approved by IOC and SCOR as of November 1999)

General Terms of Reference

1. To advise SCOR-JGOFS, GOOS and OOPC on CO₂ observations, data management and modelling needed for studies of the global ocean carbon cycle.
2. To provide an international forum for initiatives to promote good quality observations of CO₂ in the oceans.

Specific Terms of Reference

1. To identify gaps and weak links in the present CO₂ observation system needed for understanding and predicting global change.
2. To identify opportunities that can be used to further develop the observing system (*e.g.* piggy-backing on the climate observing system).
3. To aid the synthesis of JGOFS and IGBP results with respect to marine
4. CO₂ observations, data management and modelling:
 - i. By initiating and facilitating the assembly of CO₂ databases,
 - ii. By interacting with ocean modellers with respect to the weaknesses and appropriate uses of CO₂ data, and
 - iii. By encouraging and facilitating the collaborative analysis of CO₂ datasets and supporting data.
5. To maintain a watching brief to advise IOC and SCOR on CO₂ sequestration into the ocean.
6. To advise GOOS and OOPC on appropriate technology development for CO₂ monitoring.
7. To advise GOOS and OOPC on the observational strategies needed to assess, model and predict global ocean CO₂ fluxes.

Membership

Doug Wallace (Germany, chair, 2000-)

APPENDIX J: Status of an Ocean pCO₂ Observing System (DRAFT)

Watson, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, United Kingdom (*a.watson@uea.ac.uk*) drafted the notes from an ad-hoc meeting of the CO₂ Panel members in attendance at the SOLAS Open Science Meeting.

Introduction

On 21 February 2000, at the SOLAS meeting at Damp, Germany, a sub-set of the SCOR- IOC CO₂ advisory panel met to review the current status of an ocean observing system for sea surface pCO₂. Panel members present were: A.J. Watson, D.W.R. Wallace, L. Merlivat, A. Poisson, A. Dickson, T. Johannessen

Other interested parties present were: L. Dilling (NOAA, Office of Global Programs), S. Doney, N. Lefèvre.

Summary

- 1) Proven technology is now commercially available to enable the measurement of surface ocean pCO₂ and related parameters from drifting buoys and ships of opportunity.
- 2) This equipment could be used to put in place an observing system, which would enable seasonal and high-resolution spatial estimates of air-sea CO₂ fluxes. If such a system was implemented for the Northern Hemisphere oceans, it would greatly contribute towards better monitoring of the distribution of the terrestrial sinks for CO₂, and would thus contribute an important element in making the Kyoto agreement workable.
- 3) Plans are advanced to commission a ship of opportunity network in the N. Atlantic to enable seasonal resolution of CO₂ ocean - air fluxes over this region.
- 4) In the Pacific, one regular ship of opportunity line is being run and others are planned.
- 5) An effort is underway to draw together the substantial existing data for global pCO₂ into a more widely accessible database.
- 6) In the US, a committee has been convened to consider the design criteria for a pCO₂ observing system able to deliver the required resolution of air-sea CO₂ fluxes.

The need for a pCO₂ observing system

At present our knowledge of the distribution of sources and sinks in the ocean is based on models, and on historical data collected over the last 30 years. The data have largely been collected by research ships. Recently, "climatologies of surface ocean pCO₂ have been published in which this data is synthesised into seasonal or monthly pictures of an "average year" using various assumptions and interpolation techniques. The atmospheric pCO₂ has been increasing in a well-documented way during the period in which the data have been collected, but oceanic pCO₂ will not have tracked this atmospheric pCO₂ uniformly everywhere, so inevitably some uncertainty and arbitrariness attaches to these climatologies. Furthermore, atmospheric measurements suggest a large year-to-year variability in the oceanic sink, which the climatologies cannot address at all.

There are important practical reasons for wanting to know more about year-to-year and season-to-season variability in the ocean air-sea CO₂ flux. In order to make the Kyoto agreement verifiable, it is desirable to know how much CO₂ the vegetation of continental regions such as North America and Europe are taking up, and how this changes in response to climate change and policies aimed at reducing net Greenhouse gas emissions. This is very difficult to measure directly; some constraints can be put on continental emissions from inversions of atmospheric measurements of the distribution of CO₂, but these need independent constraints to be usefully accurate. An independent estimate of the air-sea flux across ocean basin regions provides a very

important constraint. Currently, most atmospheric inversions use the oceanic pCO₂ climatologies, despite their known drawbacks. An observing network, which would monitor these fluxes, would be much preferable, with the main regions of importance to Europe and North America being the North Atlantic and North Pacific.

A second reason for wanting such an observing system is that surface ocean pCO₂ is being used as a prime output of ocean GCMs with carbon cycle models. It is a function of the changes in circulation, heat fluxes, changes in upwelling and deep mixing, and biological effects such as increased iron availability. Such a monitoring system would therefore enable us to test the ability of our models with regard to these.

Status of instrumentation

Automated instrumentation for measurement of pCO₂ on ships of opportunity and drifting autonomous buoys has been described in the literature for several years and is now commercially available. See for example, Cooper *et al.*, 1998 and Hood *et al.*, 1999.

Status of the historical data

There is presently underway Historical data remain scattered in the hands of the original investigators. In recent years Takahashi and colleagues have published climatologies made up of the data obtained from a few of the larger data holders. Some of this data is now publicly available through CDIAC (Carbon Dioxide Information Analysis Center, TN, USA). Some remains out of the public domain however. In 1998, an effort was begun by the IOC-SCOR CO₂ panel to inventory the data, which exist. We estimate that less than 20% of the total data is currently at CDIAC.

Two efforts are now underway to further advance the database. (1) NOAA has funded Andrew Dickson (SIO) for two years to advance centralisation of data. (2) In Europe, funds have been requested *via* the EU specifically to compile a North Atlantic database. At present, funds remain insufficient to fully complete and document a global pCO₂ database.

Status of a pCO₂ observing system

Several investigators are now in process of trying to set up observing systems, which would enable the Northern Hemisphere oceans to be monitored with sufficient precision to enable useful season-to-season estimates of pCO₂ fields and CO₂ fluxes. Components of this effort are:

1) In Europe, investigators led by A.J. Watson have applied to the EU for funds to set up four Ship of opportunity lines as follows: Denmark - West Greenland, Hamburg- Halifax, UK- Jamaica and Spain- Antarctica. The first three of these are regularly run (monthly or thereabouts) merchant vessel routes while the last is an Antarctic supply vessel.

2) In the US, NOAA OGP has set up a committee to design an observing system by looking at suitable routes, analysing correlation scale lengths etc. In addition, plans are underway to instrument the AX7 (Miami - Straits of Gibraltar) line, the Norfolk, VA to Bermuda line and possibly other merchant lines in the Atlantic.

3) There is an existing co-operation between Japan (Y. Nojiri, National Institute for Environmental Studies) and Canada (CS Wong, Institute of Ocean Sciences) to collect regular data between Vancouver and Japan using the commercial vessel M/V Skaugran.

References

- Hood EM, Merlivat L, Johannessen T (1999). Variations of fCO₂ and air-sea flux of CO₂ in the Greenland Sea gyre using high-frequency time series data from CARIOCA drift buoys. *J. Geophysical Res. - Oceans* 104: (C9) 20571-20583
- Cooper, D.J., Watson, A.J., and Ling, R.D. (1998). Variation of PCO₂ along a North Atlantic shipping route (UK to Caribbean): a year of automated observations. *Mar. Chemistry*, 60, 147-164.

APPENDIX K: Report on the DIS Steering Group Meeting

Potsdam Institute for Climate Impact Research (PIK), Germany

Highlights of the meeting by Beatriz Baliño

The distributed DIS Project Office

The DIS Project Office located in Toulouse closed in December last year. DIS functions will be distributed between PIK, to attend the data services issue, and the Secretariat in Stockholm, which will focus on information services. PIK kindly provided a working place for the Executive Officer, Gerard Szejwach.

The role of the "new" DIS:

The mandate of DIS was revised. The SG agreed that DIS should be primarily a supporting activity of IGBP requirements of information and data. It should provide advice, guidance, and support in the production of global or regional data bundles. The "S" of DIS was then changed from Systems to Services in order to emphasise the supporting character of this Framework Activity of IGBP.

DIS working plan 2000-2002

A 3-year working plan was drafted for approval at the next IGBP-SC (Mexico, February 2000). This plan will add to the development of IGBP communication strategy and include:

1. *Global Data Initiatives:* Global Carbon Data Bundle (in support of the activities of IGBP Carbon Working Group); Climate data sets (support data requirements by GCTE, GAIM, BAHC and LUCC); River basin initiative (DIS endorsed a proposal on the Joint Edition of the CD-ROM on global river basins by GEMS.WATER (UNEP/WHO) and IGBP)
2. *Regional data initiatives:* Regional aspects of Global Change: RAGC. To support RAGC data effort, *e.g.* help organise workshops and synthesise results once data requirements are defined. Product: regional data bundles elaborated by specific data centres such as ESA/ESRIN or MEDIAS-France
3. *Data and Information:* DIS will assist in the further development of the IGBP search engine which will be now operated at the Secretariat
4. *Outreach activities:* To facilitate capacity building in the use of remotely sensed data by IGBP scientists, *e.g.* proposals for training at Space Agency's Centres (*e.g.* ESA offers to host a series of training sessions at the European Space Agency's Centre in Frascati, ESRIN)

The next meeting of the DIS Steering Group was scheduled for the Fall 2000.

Webmaster Workshop, 15-18 June 2000, Bern, Switzerland

At the IGBP-IPO meeting (Cuernavaca, Mexico, 25-28 February 2000) it was decided to organise of a 3-day workshop for webmasters of each Core Project. This workshop will focus on the harmonization of the web pages from all Core Projects, in light of IGBP web based international communication strategy. The PAGES IPO (Bern, Switzerland) will kindly host the meeting.

APPENDIX L: Ocean Biogeochemistry in the Post-Kyoto World

By Hugh W. Ducklow (28 Feb. 2000 MCB2, *U.S. JGOFS News* 10 (3), international section)

As we, and the societies that we have created, enter the post-Kyoto world, we are still adding carbon to the atmosphere at unprecedented rates. During 1996 alone, human activities released some 6.5 petagrams (6.5 billion metric tons) of carbon. The carbon dioxide (CO₂) content of the atmosphere is still increasing at rates possibly not achieved over the last 25 million years. Because of strong La Niña conditions in the Pacific, the year 1999 was only the sixth warmest in the instrumental record, but 1998 was the warmest year yet measured.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change, signed in Japan in December 1997, obligates participating countries to reduce their aggregate CO₂ emissions to 5% below 1990 levels. In response, national governments, corporations and individuals are now energetically pursuing means of exchanging carbon credits and sequestering carbon, including a plethora of ocean storage options such as nutrient enrichment to enhance the intensity and efficiency of the biological pump.

Where does JGOFS, with its principal focus on the ocean carbon pumps, fit in?

Last autumn, in preparation for succeeding Michael Fasham as chairman of the JGOFS Scientific Steering Committee (SSC) in January, I asked members of our community for their suggestions on what issues mattered to them, to JGOFS, to U.S. JGOFS News readers. Although I received quite a few thoughtful responses, one in particular stood out. Trevor Platt, chairman of the JGOFS SSC from January 1991 to January 94, wrote: "In my view, the most pressing issue for JGOFS right now is planning future programmes in ocean biogeochemistry; how to retain the initiative for the next round. By this, I imply that the synthesis is in good hands." The great accomplishment of Trevor's term in office was placing the issue of global synthesis squarely before JGOFS scientists and funding agencies. Therefore, while it was reassuring to hear that he is confident that the synthesis effort is on track, the other implication of Trevor's message is more serious.

JGOFS will end in less than 4 years. It does not have all the answers, and it will not get them all during its synthesis phase. The achievements of JGOFS include the creation of a comprehensive and accessible database and management system, establishment of time-series observatories, a global survey of CO₂ the ocean, five major process studies, effective use of ocean colour data from satellite-mounted instruments and an ongoing synthesis and modelling effort. These achievements and the goals of the synthesis programme have been reported and discussed elsewhere. Is there a need for another global-scale research programme in ocean biogeochemistry? If so, what are the prospects for it?

To predict the future operation of the ocean carbon system, we need to observe and understand the way it works now. JGOFS made a start. But no matter what the course of fossil fuel-based emissions in the coming decades and whether or not emission controls or carbon storage measures are adopted widely, we need to monitor not only atmospheric CO₂ but also the major carbon sinks and sources on land and in the oceans. The efficiency and intensity of these sinks and sources vary from year to year and decade to decade. We cannot say with much certainty how carbon fluxes will change in response to carbon cycle management or climate change. Will we know if ocean productivity begins to change or the formation of deep water slows or stops?

Responsible and intelligent implementation of the Kyoto Protocol and purposeful carbon sequestration measures demand, first, a monitoring strategy that will enable us to detect

interannual variability and any changes that may occur in the ocean carbon cycle. The international Global Ocean Observing System (GOOS) is just beginning to consider carbon observations that will, if implemented, address the problem of ocean monitoring. However, other key uncertainties remain that cannot yet be resolved with operational observations alone.

Some of these uncertainties and key questions are laid out in a recent U.S. report titled "A U.S. Carbon Cycle Science Plan" (<http://geochange.er.usgs.gov/usgcrp/ccsp/planning.html>). CCSP is a new scientific research initiative designed to extend across U.S. national funding agencies to address carbon cycling within the terrestrial biosphere, the ocean biogeochemical system and the atmosphere in an integrated way. In his editorial in this issue, U.S. JGOFS chairman Mark Abbott has described Ocean Carbon Transport, Exchanges and Transformations (OCTET) and Ecological Determinants of Ocean Carbon Cycling (EDOCC), two planning initiatives that have emerged in the U.S. in response to the CCSP.

Other pertinent research needs are being assessed by the international SOLAS (Surface Ocean Lower Atmosphere Study) planning group under sponsorship of the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR). The focus of SOLAS is on key interactions between the atmosphere, climate and marine biogeochemical processes. The IGBP has also initiated a Carbon Working Group, which has mostly addressed questions in the terrestrial realm so far. There are no international plans as yet for a more comprehensive, top-to-bottom study of ocean carbon biogeochemistry.

As a result, the hiatus in large-scale ocean biogeochemical research that dates from the end of most of the JGOFS field programmes in 1998-99 is likely to continue for several more years. It seems critical to regain momentum, to establish a reliable ocean baseline at the beginning of the post-Kyoto era.

Narrowing uncertainty in the future evolution of the ocean's physical and biological carbon pumps is the most critical need in order to achieve more accurate predictions of ocean carbon storage and a solid scientific basis from which to develop carbon management strategies. Most geochemists assume tacitly that the biological pump is in steady state on the time scale of the anthropogenic perturbation. Some biologists disagree. JGOFS observations at the Hawaii Ocean Time-series (HOT) site suggest that a fundamental, decadal-scale shift from nitrogen to phosphorus limitation is underway in the North Central Pacific Gyre, the largest biome on Earth. The ocean is likely to warm by 2° to 3° C during the next century, with a consequent reduction in the solubility of CO₂, a diminution in the thermohaline circulation, and thus a weakening of the physical carbon pump.

Models also suggest reductions in ocean biological productivity and weakening of the biological pump as the ocean changes. How certain are these qualitative projections of climate-induced changes in the ocean carbon system, and at what rates will they proceed? What new surprises lie waiting for us to find? How will these "passive" changes interact with active modifications of the carbon cycle from iron addition and CO₂ injection? How will ocean biology respond to changes in circulation? What is driving the decade-scale changes observed off Hawaii?

We need a new consensus to plan and implement the next generation of ocean biogeochemical observations, experiments and models. The JGOFS community, the group of scientists best equipped to provide the answers, has an invaluable role to play in designing a new attack on the global carbon cycle.

APPENDIX M: Report on IOCCG Activities

Platt provided a brief outline of IOCCG activities from Hobart, Australia.

During 1999, the IOCCG became an Associate Member of CEOS (Committee on Earth Observation Satellites)

The IOCCG organized and ran a 10-day training course on “Applications of Marine Remote Sensing” for 30 participants at the Asian Institute of Technology, Bangkok in November, 1999

IOCCG Report Number 2, “Status and Plans for Satellite Ocean-Colour Missions: Considerations for Complementary Missions,” was published May 1999.

Active working groups (address scientific issues and draft reports):

- Remote sensing in Case 2 waters (to be published in 2000)
- Calibration of ocean-colour sensors
- Coordination of merged data sets

Newly established working groups:

- Comparison of atmospheric correction algorithms
- Report on “Why ocean-colour?”

Other initiatives:

- Comprehensive, regularly updated homepage covering all aspects of ocean-colour
(<http://www.ioccg.org>)
- Standard chlorophyll validation dataset (accessed from homepage)
- International ocean-colour cruise (proposed, needs additional funding)
- Specialized monograph series on ocean-colour science (proposed)
- New training courses (Turkey, India, South Africa)

Issues:

The IOCCG, advisor on remote sensing to JGOFS, is keen to participate in discussions regarding the future of ocean biogeochemistry, in particular about how ocean-colour remote sensing can be used to address problems in the ocean carbon cycle.

The IOCCG is coordinating with other scientific programmes and international bodies such as SIMBIOS and CEOS to help ensure the development of an uninterrupted long-term time series of ocean-colour measurements. It is also advising GOOS and IGOS on matters relating to ocean colour.

APPENDIX N: Report on the SOLAS Conference, Germany

Brief report written by Lochte with contributions from Bathmann, Burkill, Garçon, Monfray, and Saino, and is an interim report without claim to be complete and is based on the personal impressions of the JGOFS members attending. A description of the scientific framework of SOLAS, the conference programme and (soon) more complete reports from the working groups (see below) are available on <http://www.ifm.uni-kiel.de/ch/solas/main.html>.

I Programme and Content of the Conference

The SOLAS Conference was organized by the Institut für Meereskunde, Kiel, Germany (Doug Wallace) and attended by *ca.* 260 participants from 22 countries Africa, Asia, Australia, Europe and N-America.

The conference was open to all and the scientists present at the SOLAS Open Science Conference was predominantly from marine sciences (*ca.* 75%) as compared to the atmospheric ones (*ca.* 25%). Many JGOFS related scientists attended, both experimentalists and modellers; more biogeochemists were present than scientists from physical or biological disciplines. JGOFS through its intensive field and modelling effort has contributed the fundamental database and knowledge to address the influence of the atmosphere and climate on marine biogeochemistry, but the reverse effect has not been studied sufficiently. It became very clear that the marine science community had a large input into the conference and the scientific topics developed in the working groups. The atmospheric sciences were not adequately represented and need to become more involved in this programme in order to develop a well balanced and novel science plan. Similarly, there were only a limited number of representatives from the physical air-sea interaction community at the meeting although communication with the JRC of the WCRP is ongoing and membership of the air-sea interaction panel of the WCRP was represented at the SOLAS conference.

The SOLAS programme emphasizes a hypothesis driven approach. Part of the tasks of this conference was to discuss and develop such central hypotheses. Key hypotheses defined at the start of the meeting and later refined in the working groups are:

- How might changes in climate-driven physical force affect upper ocean biogeochemistry and sea-air fluxes?
- How much might marine biological sulphur emissions (and other biologically produced reactive gases) change in the future, what would cause such changes and would they have climatic implications?
- Are changes in marine biogeochemistry in the next century likely to have a significant influence on the net oceanic uptake of CO₂?
- Are changes in anthropogenic inputs from the atmosphere are likely to have a significant effect on affect upper ocean biogeochemistry and sea-air fluxes?

The main approaches in SOLAS are:

- Time series stations (atmospheric and marine)
- Perturbation experiments (large scale)
- Detailed process studies of specific aspects
- Full use of all remote sensing capabilities (including those used for atmospheric chemistry studies).
- Strong modelling component

Oral Presentations

- How might changes in climate-driven physical forcing affect upper ocean biogeochemistry and air-sea fluxes? 1. Physical perspective (Speaker: S. Doney, USA)
 - >>> A particular emphasis was on recent knowledge of interannual to decadal climatic oscillations (Arctic, Atlantic, North Pacific, Southern) and their interconnections. Understanding the imprint of such oscillations on biological and geochemical systems is a key issue for the next decades.
- How might changes in climate-driven physical forcing affect upper ocean biogeochemistry and air-sea fluxes? 2. Biogeochemical perspective (Speaker: P Liss, UK)
 - >>> After a broad overview of the subject, some recent results on climate impact on DMS fluxes were presented.
- Observational and modelling aspects of mixed layer physics in SOLAS (Speaker: W Jenkins, UK)
 - >>> Emphasis was on processes at the base of the mixed layer where long term mixing with the thermocline is occurring. This indicates clearly that SOLAS domain must extend to the base of the permanent thermocline (*i.e.* first 500-1000 m).
- Modelling biogeochemistry in the upper ocean (Speaker: V Garçon, France)
 - >>> Powerful assimilation of new satellite data (altimetry and Chl) in 3D biogeophysical models give new constraints on ocean physical and biological dynamics, including a first attempt to quantify the role of eddies.
- How much might the atmospheric delivery of marine nutrients, such as Fe and N, change, and would such changes have global implications? (Speaker: R Barber, USA)
 - >>> The co-limitation of Fe and P had been raised in oligotrophic gyres, because N could be fixed from N₂. A point was made on the effect of environmental changes on community structure and in turn on biogeochemical cycles.
- Are changes in the spectrum and intensity of radiation likely to affect the production of trace gases in the surface ocean? (Speaker: N Blough, USA)
 - >>> Only impact on chemistry had been developed, but not on biological responses
- How much might marine biological sulphur emissions change in the future, what would cause such changes, and would they have climatic implications? (Speaker: M. Andreae, Germany)
 - >>> Understanding the impact and feedback between climate and DMS need a long-term research (>5y) on the decoupling between DMS and Carbon/Chl. This must involve a much better description of the different taxonomic groups, especially dinoflagellates, Phaeocystis, coccolithophores, etc. In addition, role of surfactant (organic compound) on air-sea transfer and of rapid injection of DMS in middle troposphere through clouds must be investigated.
- Are changes in the marine emissions of gases and particles likely to have a significant influence on atmospheric chemistry? (Speaker: C. Leck, Sweden)
 - >>> In arctic summertime, direct organic aerosols control the CCN (=cloud condensation nuclei) distribution instead of the classical sulfate and sea-salt aerosols. The direct injection

of organic compounds (methionine?) as very fine aerosols (subCCN < 10 nm) into the atmosphere could be largely underestimated.

- Are changes in marine biogeochemistry in the next century likely to have a significant influence on the net oceanic uptake of CO₂? (Speaker: A Watson, UK)
>>> Key area for potential change in CO₂ “biological” uptake will be in HNLC area where there are yet nutrients but under-utilised.
- What is the role of remote sensing in SOLAS? (Speaker: M-E Carr, USA)
>>> Beyond the observation of chlorophyll since 1997, new promising sensors or algorithms are emerging. Detection of specific planktons species as blooms of coccolithes or *Trichodesmium* is coming but thresholds are still too high.
- What is the role of marine time series in SOLAS? (Speaker: T. Saino, Japan)
>>> A network of long time series oceanographic stations is needed, especially in productive areas. Frequency of observation should be able to resolve short-term extreme events.
- What is the role of atmospheric time series in SOLAS? (Speaker: G. Pearman, Australia)
>>> A large overview of two decades atmospheric records at Cape Grim shows the clear interest of long time series to follow interannual to decadal variabilities in chemical components in the air. The extension of marine atmospheric layer survey *via* airplane must be emphasised.

Discussion Groups (parallel sessions)

(The reports of these groups will soon be available under the above-mentioned web site. The summary from the discussions is heterogeneous since not all groups were attended by us.)

Issues common to all Discussion Groups include: How sensitive is the system to anthropogenic change? What are the key hypotheses? Can they be tested by perturbation experiments? What measurements are needed to understand large scale and long-term variability?

I. How might changes in climate-driven physical forcing affect upper ocean biogeochemistry and air-sea fluxes? (Chair: J. Aiken, UK; Rapporteur: D. Wallace, Germany)

>>> Emphasis on:

1. Synoptic event changes, as frequency and amplitude of storms;
2. Processes controlling exchange between mixed-layer and main thermocline;
3. Role of eddies;
4. Changes in freshwater input patterns;
5. Are responses deterministic?

II. How much might the atmospheric delivery of marine nutrients, such as Fe and N, change, and would such changes have global implications? (Chair: J. Cullen, Canada; Rapporteur: M. Uematsu, Japan)

>>> Fe fertilisation experiments are proposed in gyres along phosphates gradient to study the co-limitation Fe-P. The respective role of the different sources of bio-available Fe (atmospheric, deep ocean, coastal or riverine) must be clarified.

III. Are changes in marine biogeochemistry in the next century likely to have a significant influence on the net oceanic uptake of CO₂? (Chair: L. Merlivat, France; Rapporteur: M Heimann, Germany)

>>> Long time series in sea and air are urgently needed. In addition, key areas such as Island plumes must be understood, and can be view as natural Fe fertilisation experiment.

IV. Are the accuracy and precision of existing techniques for measuring air-sea exchange fluxes adequate for SOLAS? (Chair: W Oost, Netherlands; Rapporteur: P Schlosser, USA)

V. How much might marine biological sulphur emissions change, and would such changes have climatic implications? (Chair: F. Raes, Italy; Rapporteur: C. Lancelot, Belgium)

VI. Are changes in the marine emissions of gases and particles likely to have a significant influence on atmospheric chemistry? (Chair: F. Dentner, Netherlands; Rapporteur: A. Pszenny, USA)

>>> Emphasis on:

6. Sea salt aerosols and precipitations changes;
7. Halogens (I; Br), nitrogen compounds and ammonium;
8. VOCs.

VII. Are changes in the spectrum and intensity of radiation likely to affect the production of trace gases in the surface ocean? (Chair: W. Miller, Canada; Rapporteur: P. Matrai, USA)

VIII. What is the significance to SOLAS of the paleo record? (Chair: R. Delmas, France; Rapporteur: T. Eisenhauer, Germany)

>>>Emphasis was placed on effects of atmospheric dust and nutrient inputs on biological productivity of the ocean.

IX. What is the significance to SOLAS of coastal waters and shelf seas? (Chair: T. Jickells, UK; Rapporteur: D. Kumar, India)

>>>Strong point was made to consider the coastal zone due to

- High biological productivity and burial rates
- High gas emissions
- High atmospheric N-deposition and denitrification
- Unique biogeochemistry (N₂O, COS, CH₄...)
- Coastal vegetation with production of specific compounds
- High sensitivity to climatic changes (*e.g.* sea level rise, change in fluvial input, methane hydrate destabilization, and many more...)
- Fast and drastic responses to climate changes in ecosystem structure and biogeochemistry
- Societal considerations

X. Issues related to halogen chemistry (extra group).

National activities

Eleven national groups met for discussions and presented current activities and plans to the plenum: USA, Canada, Germany, France, Sweden, Netherlands, Japan, Taiwan, India, Norway, and UK.

The degree of organization in the different national groups was highly variable. Some countries have already a SOLAS Scientific Committee, organized meetings, etc., others are just getting interested. Some groups made scientific topics of specific interest for certain nations clear.

For the European countries, a strong plea was made for a joint EU initiative at the outset. This is necessary partly because the scientific expertise is unevenly distributed, partly due to the funding system.

II. Overall impressions

The SOLAS Conference in Damp reflected a tremendous enthusiasm for this new programme. The discussions were lively, stimulating and very productive and will lead to the formulation of key hypotheses developed by the discussion groups.

From the view of JGOFS science, SOLAS presents a dichotomy and an evolution. The dichotomy concerns the separation of the upper (in SOLAS) from the lower (not in SOLAS) ocean. Discussions about the extent of the „surface ocean“ concluded that it should be defined as the base of the main thermocline or alternatively the depth to which nutrients are extracted to fuel annual production. It is recognized that deep ocean processes play an important role in nutrient and CO₂ budgets and react to atmospheric changes, but need to be dealt with elsewhere. An evolution is obvious due to the consideration of much more than carbon fluxes. There is a considerable interest in sulphur, iron, and nitrogen in their own right and in their impact on global cycles/processes. Other aspects of major interest are the water cycle and transports, and reactions connected to sea salt aerosols. While there is already a significant input from JGOFS to the definition of questions and the SOLAS Science Plan, there is still a need for a better input of atmospheric sciences (physicists, chemists and modellers).

It was obvious that the marine biology component was not strong enough in order to study and understand relevant responses of entire ecosystems as well as specific functional groups to external changes. For instance, the understanding of the fundamental biological processes, such as those which lead to the formation of DMS or other biogenic compounds influencing atmospheric chemistry, are far too little understood. They are the key for marine/atmosphere interactions, but we know too little about rates and controls. Hence, they cannot be modelled to a level that is required to predict changes under future climate scenarios. The effects of atmospheric inputs on marine biogeochemistry is in parts better understood, but also here a great deal of complex interactions on the species level need to be solved. The results from the time series station HOTS clearly showed that the ecosystem really changed with climatic variation and resulted in a shift in the carbon cycle. There was a general agreement that this kind of ecosystem change is a very important issue in SOLAS.

Long-term data sets are a prerequisite to understand the ecosystem response to atmospheric disturbances. Analysis of historical data sets as well as well continued and focused (on clear-cut hypotheses) investigations on time series stations with resolution of short-term events (dust storms, volcano eruptions etc.) are needed. Therefore, the SOLAS programme needs to emphasize the importance of high quality coherent data sets taken in various parts of the earth system in a network fashion. This may need to include terrestrial time series too. A link to GOOS and other observation systems is obvious.

In respect to extending the time scale of observations from decade to centuries and longer, the record-record in sediments and ice cores are important aspects. Interesting suggestions were made to use natural „perturbation experiments“, like past large volcano eruptions, for the analysis of ecosystem response. New proxies for atmospheric processes need to be developed. A link to deep ocean processes is obvious.

So far, the regions of specific interest for SOLAS research were not explicitly discussed or defined. It appeared however, that polar, HNLC and monsoonal regions would be important study areas.

The discussion group VIII on the importance of coastal zone processes for sea – atmosphere interactions, made a strong point. While this point was accepted, it appears that the complexity of coastal systems does not render itself easily for a hypothesis driven, experimental approach. In addition, long-term observations tend to be complicated by many interacting processes. The question of how much emphasis will or can be placed in SOLAS on coastal zone processes remains open. It was also noted that close links to the LOICZ programme should be established in order to pursue SOLAS science goals cooperatively.

Next steps

The reports of the various discussion groups are being summarized and synthesized and will soon be posted on the SOLAS webpage (together with abstracts, participant lists, etc).

An editorial team will meet during May 14-17 in New Mexico in order to write a draft science plan. This writing group is presently comprised of:

Peter Liss	UK	Chemical Oceanographer
Doug Wallace	Germany	Chemical Oceanographer, CO ₂
Dick Barber	USA	Biological Oceanographer
Uli Platt	Germany	Atmospheric Physicist
Barry Huebert	USA	Atmospheric Chemist
Bill Jenkins	UK	Tracer Oceanography and Upper Ocean Physics
David Farmer	Canada	Air-Sea Interaction
Bob Duce	USA	Atmospheric Chemist

This draft science plan will be worked and commented on over the summer and finalized during a small meeting scheduled for August in Norwich. At this point, it will be released and circulated (including presentation to the IGBP and to the JSC of the WCRP).

APPENDIX O: Report on GOOS Activities

Tilbrook wrote a summary of what he heard at the IOCCG meeting in Hobart, Australia (obtained from discussions with Tom Malone and Neville Smith):

1. The GOOS panels (*e.g.* coastal GOOS, Living Marine resources etc) are probably going to be amalgamated within the next year.
2. Based on recommendations from Ocean Observation conference in San Rafael, France, in Oct 1999, the carbon cycle is becoming one of the major goals of GOOS. At the moment, this means primarily carbon measurements (deep and surface), but they are still discussing what other parameters need to be covered. The change of emphasis is primarily the reason GOOS is now keen for input from JGOFS or the CO₂ panel. While they can say that there have not received the information they need on observational requirements for carbon, it is also fair to say that this is a fairly new priority. Before the Ocean Observations meeting GOOS were primarily focussing on physical observations.
3. Coastal GOOS are drawing up plans for future research and would like JGOFS input. Much of the input to date has come from LOICZ and Tom Malone mentioned that nobody from JGOFS has had input. Coastal GOOS are interested in open ocean-shelf exchange and this would merge well with the LOICZ emphasis, which is closer to shore. I understood that Julie Hall was on the JGOFS SSC at the time of the last C-GOOS meeting (April 11-13, 1999), and is listed as a LOICZ-GOOS collaborator. Julie is now on a GOOS panel and if she went, was probably a representative of GOOS rather than JGOFS.

The report of the meeting can be accessed at: <http://ioc.unesco.org/goos/goostoc.htm>. As KK is unable to represent JGOFS at the C-GOOS meetings, careful consideration should be given to who might represent JGOFS at the next SSC. The person that does agree to interface with C-GOOS is going to be very busy.

For the next SSC meeting, the committee may be interested to read the above C-GOOS report and to also access summary papers on the Ocean Observations meeting at: <http://www.bom.gov.au/OCEANOBS99/Program.html>. The papers most relevant are:

- Fine and Merlivat - carbon cycle tracers
- Gould and Toole - WOCE style work, including repeat sections
- Uwe and Weller - time series
- Smith and Koblinsky - draft of conference conclusions
- Bernat and Shaffler - information on POGO

These are quite easy to read. The bottom line is that the physical community is now emphasizing the importance of the carbon cycle in justifying some GOOS work. Much of the work outlined in GOOS is geared more towards WOCE style sections, ship of opportunity studies, and time series, rather than the detailed process studies that characterised a large part of JGOFS. Clearly, GOOS will not cover all aspects of biogeochemical research.

APPENDIX P: Scientific Steering Committee (2000)

Name	Country	Status	Term	1999	2000	2001	2002
Fasham, Michael	UK	Past Chair	2000	SSC	SSC		
Ducklow, Hugh	USA	Chair	2003		SSC	SSC	SSC
Anderson, Robert	USA	At-large	2001	SSC	SSC	SSC	
Falkowski, Paul	USA	At-large	2001	SSC	SSC	SSC	
Haugan, Peter	Norway	At-large	2003		SSC	SSC	SSC
Hong, Huasheng	China-Beijing	At-large	2000	SSC	SSC		
Liu, K.-K.	China-Taipei	At-large	2000	SSC	SSC		
Lochte, Karin	Germany	At-large	2000	SSC	SSC		
Quiñones, Renato	Chile	At-large	2000	SSC	SSC		
Saino, Toshiro	Japan	At-large	2003	SSC	SSC	SSC	SSC
Tilbrook, Bronte	Australia	At-large	2001	SSC	SSC	SSC	
Wallace, Douglas	Germany	At-large	2001	SSC	SSC	SSC	
Bathmann, Ulrich	Germany		2000	Chair	Chair		
Burkill, Peter	UK		1999	Chair	Chair		
Bychkov, Alex	Canada		1999	Chair	Chair		
Conkright, Margarita	USA		2003		Chair	Chair	Chair
Garçon, Véronique	France		2001	Chair	Chair	Chair	
LeBorgne, Robert	France		2001	Chair	Chair	Chair	
Monfray, Patrick	France	OCMIP	1999	Rep.	Rep.		
Platt, Trevor	Canada	IOCCG	1999	Rep.	Rep.		
Shimmield, Graham	UK		2000	Chair	Chair		
Watson, Andrew	UK		1999	Chair	Chair		

At-large Rotations for 2000

Name	Country	Status	Term	2000	2001	2002
Fasham, Michael	UK	At-large	2000	SSC		
Hong, Huasheng	China-Beijing	At-large	2000	SSC		
Liu, K.-K.	China-Taipei	At-large	2000	SSC		
Lochte, Karin	Germany	At-large	2000	SSC		
Quiñones, Renato	Chile	At-large	2000	SSC		

APPENDIX Q: JGOFS and IPO Budgets: 1999 Sources and Expenses

Sources	US Dollars	Subtotals
NRC Fund	150,000	
SCOR Fund	95,000	
IGBP Fund	20,145	
University Fund	15,875	281,020
Expenses	US Dollars	Subtotals
Administration (Bergen)	143,445	
IPO (JGOFS Publications, etc.)	14,822	
DMTT (Silver Springs)	1,484	
Executives (Baltimore)	15,373	
IOSG (Bangalore)	12,899	
GSMTT (Bangalore)	15,000	
NPTT (Taipei)	10,469	
OSC Bergen (Publications)	12,500	
SSC Meeting (Yokohama)	45,902	
SSC Workshop (Southampton)	3,023	
Project Overhead on Funds	2,642	
University Overhead for Offices	3,750	281,308
Overall balance:	(288)	

APPENDIX R: Estimated Budgets for Year 2000 and 2001

Year 2001 Budget /JGOFS SSC, SG, and TT Activities

Status	SOURCES	Funds/year	Purpose
Expected	SCOR (2000-2003)	\$ 90,000	SSC Meeting+Activities
Expected	IGBP (2000-2003)	\$ 20,145	SSC Meeting
Subtotal \$ 110,145			

STATUS	ACTIVITIES	Estimated budgets	Comments	Dates
Obligated	SSC (20) Meeting	\$ 40,000	Bergen Meeting/Norway (IGBP Cost Share)	11-12 April
Obligated	OSC Speakers (12)	\$ 20,000	Conference Speakers/Norway	13-17 April
Planned	SOSG (10)	\$ 10,000	Brest Meeting/France	7-8 July
Committed	DMTT (8)	\$ 10,000	Kiel Meeting (Germany Hotel/Dinner)	C/S: 5-6 June
Committed	Executive Meeting (5)	\$ 10,000	New Hampshire Meeting (IGBP Cost Share)	21-22 October
Committed	Paleo-JTT (4)	\$ 5,800	Hamburg Meeting/Germany (PAGES Cost/S)	13-14 June
Planned	NPTT (2)	\$ 4,000	One Day Session at PICES Meeting/Japan	22-25 October
Planned	JGTT (Carbon Modelling)	\$ 1,500	OCMIP-2 Princeton Meeting/USA	5-6 July
Committed	CMTT	\$ -	Workshop/USA (LOICZ Funds \$20,000)	2000, September
	EPSG, NASG; PMTT	\$ -	Nothing planned	
Subtotal \$ 121,300				
Balance \$ (11,155)				

Year 2001 Budget JGOFS SSC, SG, and TT Activities

Status	ACTIVITIES	Estimated budgets	Comments	Dates
Committed	SSC Meeting (20)	\$ 40,000	Amsterdam, Netherlands (IGBP Cost Share)	8-9 July
Committed	CMTT	\$ 20,000	2 Workshops (LOICZ and NCOR Cost Share)	Jan & April
Planned	JGTT (10) (Carbon Modelling)	\$ 20,000	50, 4-days, Guadeloupe (GAIM Cost Share)	March
Planned	NASG (10)	\$ 15,000	Paris Meeting (PROOF Cost Share)	Open
Committed	Executive Meeting (5)	\$ 10,000	Meeting (TBD)	September
Discussed	WOCE-JGOFS CO ₂ Transport	\$ 10,000	Proposal in process (WOCE Cost Share)	Open
Committed	IOSG (3)	\$ 6,000	Miami Meeting/Edit Report	Open
Proposed	EPSG	Unknown	Modelling Workshop	Open/2002?
	Paleo-JTT	\$ -	Nothing planned	
	SOSG	\$ -	Nothing planned	
	DMTT	\$ -	Nothing planned	
	NPTT	\$ -	Nothing planned	
Subtotal \$ 121,000				
Balance \$ (10,855)				

List of Action Items

- Action #1:* The SSC agreed that JGOFS modeller must include source code with models in future synthesis and modelling initiatives.
- Action #2:* The group will meet during the OSC and (1) recommend a cross-synthesis team and (2) identify a series of specific questions from the original, broader JGOFS synthesis and modelling plan.
- Action #3:* Baliño will implement the JGOFS brochure on the homepage after publication.
- Action #4:* Fasham will seek a technical editor for the JGOFS book.
- Action #5:* Fasham will ask Peter Brewer to author a 2-page foreword for the JGOFS book.
- Action #6:* Burkill and Ducklow will write a letter in support of future AMT activities.
- Action #7:* LeBorgne will inquire with Mary Zawoysky at the US JGOFS Planning Office on how to obtain DSR special volumes at a discount.
- Action #8:* LeBorgne will send a proposal for funds for an EPSG modelling workshop.
- Action #9:* Bathmann will submit revised SOSG TOR for SSC approval.
- Action #10:* The SOSG request funds (\$10K) for 8-9 SOSG members to Brest, France. Decision deferred until June 2000.
- Action #11:* The SSC asked Burkill to continue as IOSG chair until he finds a replacement or until the SSC disbands the group.
- Action #12:* The IOSG requests 2001 travel funds (\$6K) for 3 IOSG members to Miami, USA. A proposal for this meeting will be sent later.
- Action #13:* The SSC Executives approved the nominations of Harrison and Kishi.
- Action #14:* The SSC deferred the decision on the financial support for two scientists at the PICES IX Meeting until after the OSC costs are known (June 2000).
- Action #15:* Bychkov will request that C.S. Wong submit Station P data to the NODC.
- Action #16:* The SSC request that the NPTT compile an inventory of datasets generated during the process study and send the inventory to the DMTT/IPO (Conkright/Baliño).
- Action #17:* The SSC approved the change.
- Action #18:* Monfray will submit a revised TOR and membership after the OCMIP Phase II Meeting in the USA, July 2000.
- Action #19:* Ducklow will solicit names from the SSC and OSC, and then recommend names to IGBP for the Workshop.
- Action #20:* Ducklow deferred the action on an ocean paper until the GCCS Workshop when potential author(s) can be selected from those in attendance.
- Action #21:* The SSC suggested that the dates for the 16th SSC meeting at the Dutch Academy of Sciences should be 8-9 July 2001, immediately prior to the IGBP Open Science Conference.
- Action #22:* The SSC took no action on forming a joint JGOFS-GLOBEC task team.
- Action #23:* A small group will meet with Haugan to discuss how the pCO₂ issue can be addressed in GOOS.
- Action #24:* The SSC needs to address these at-large rotations before IGBP and SCOR meetings (September and October 2000, respectively).
- Action #25:* The SSC approved Joachim Herrmann (Germany, replacing Mitzka) as a new member of the Data Management Task Team.
- Action #26:* The SSC approved Robie Macdonald (Canada, replacing Hall) as a new member of the Continental Margins Task Team.
- Action #27:* The SSC approved Renato Quiñones as co-Chair of the CMTT. The term runs from 1 January 2001 through 31 December 2003.
- Action #28:* The SSC accepted the recommendation of the NPTT to change the status of the NPTT co-Chairs and approved Bychkov (Canada) as Chair for a second term. The term runs from 17 April 2000 through 31 December 2003. The SSC also recognized Saino as Vice-Chair.
- Action #29:* The SSC recognized Doug Wallace (Germany, replacing Andrew Watson) as the new Chair of the IOC-SCOR Ocean CO₂ Advisory Panel.
- Action #30:* The SSC approved Lochte as the co-Chair of the joint Paleo-JGOFS Task Team (PAGES). The term runs from 17 April 2000 through 31 December 2003.
- Action #31:* Shimmiel shall retain his position on the task team.
- Action #32:* The SSC approved Patrick Monfray (France) as the JGOFS co-Chair of the joint JGOFS-GAIM TT (JGTT). The term runs from 17 April 2000 through 31 December 2002.
- Action #33:* The SSC will set the priorities for JGOFS sponsored funding in 2001 (deadline is 31 August 2000).
- Action #34:* The IPO Executive Officer with assistance of the CO₂ Panel Chair will send a proposal to IGBP CWG for support of the workshop participants.
- Action #35:* SSC offered their support to US-JGOFS in organizing the 3rd (and last) OSC for JGOFS.

Acronyms and Abbreviations

ADEPD	Atlantic Deep Database Project
BAHC	Biospheric Aspects of the Hydrological Cycle
CCCC	Climate Change and Carrying Capacity
CEOS	Committee on Earth Observation Satellite
CLIVAR	Climate Variability and Predictability
CMTT	Continental Margins Task Team
CO ₂ Panel	JGOFS/IOC CO ₂ Panel (now ISCAP)
DIF	Directory Interchange Format
DMTT	Data Management Task Team
EPSG	Equatorial Pacific Synthesis and Modelling Group
GAIM	Global Analysis, Interpretation and Modelling
GCTE	Global Change and Terrestrial Ecosystems
GLOBEC	Global Ocean Ecosystems Dynamics
GOOS	Global Ocean Observing System
GSMTT	Global Synthesis & Modelling Task Team (now GSWG)
HOT	Hawaiian Ocean Time-series Station
IGAC	International Global Atmospheric Chemistry Programme
IGBP	International Geosphere-Biosphere Programme
IGBP-DIS	IGBP-Data and Information System
IGFA	International Group of Funding Agencies
IOC	Intergovernmental Oceanographic Commission
IOCCG	International Ocean Colour Co-ordinating Group
IOSG	Indian Ocean Synthesis and Modelling Group
IPO	International Project Office
IUPAC	International Union of Pure and Applied Chemistry
JAMSTEC	Japanese Programme on Global Carbon Budget
JDI	JGOFS Data Inventory
LOICZ	Land-Ocean Interaction in the Coastal Zone
NASG	North Atlantic Synthesis and Modelling Group
NPTT	North Pacific Task Team (now NPSG)
NRC	Research Council of Norway
OCMIP	Ocean Carbon Modelling Inter-comparison Project
PAGES	Past Global Changes
PICES	North Pacific Marine Science Organization
PMTT	Photosynthesis Measurements Task Team (now disbanded)
RSTT	Remote Sensing Task Team
SCOR	Scientific Committee on Oceanic Research
SOLAS	Surface Ocean and Lower Atmosphere Study
SOSG	Southern Ocean Synthesis and Modelling Group
SSC	Scientific Steering Committee
START	Global Change System for Analysis, Research and Training
TOR	Terms of Reference
WGISS	Working Group on Information Systems and Services
WOCE	World Ocean Circulation Experiment