SOLAS - Links to JGOFS Biogeochemistry

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1. What is SOLAS?

2. Examples of SOLAS links to JGOFS biogeochemistry
The Scope of SOLAS

Atmospheric Chemistry/Physics \(\leftrightarrow\) Climate
- C, Fe, N, S, Halogens, O\(_2\), heat, H\(_2\)O, momentum

Marine Biogeochemistry \(\leftrightarrow\) Marine Physical Processes
- Marine Biological Systems

The Domain of SOLAS

Emissions \(\leftrightarrow\) Oxidation chemistry
- pH regulation
- Radiation
- Ice

Run off \(\leftrightarrow\) Dry and wet deposition
- Sea salt particles
- Gas exchange

Nutrients \(\leftrightarrow\) Photochemistry
- Phytoplankton
- Bacteria
- Zooplankton
- Viruses
- Dissolved organic matter
SOLAS: The Foci

FOCUS 1: Biogeochemical interactions and feedbacks between ocean and atmosphere

FOCUS 2: Exchange processes at the air-sea interface and the role of transport and transformation in the atmospheric and ocean boundary layers

FOCUS 3: Air-sea flux of CO₂ and other long-lived radiatively-active gases

Science Plan and Implementation Strategy

Available online at: www.solas-int.org

- National Reports
- SSC Members
- Join email list
- Submit your research for endorsement

Brochure available
Examples of National Programmes: Canada - $9M, 5 years

Examples of National Activities: Japan

Fe addition in North Pacific
North Atlantic Bloom

Remote Sensing
Field observations (ocean, atmospheric)
Coupled ocean-atmosphere models

http://csolas.dal.ca

SEED-S: Subarctic Ocean Enrichment and Ecosystem Dynamics Study

SNIFFS: Subtropical Nitrogen Fixation Flux Study

STAGE: Studies on the Antarctic ocean and Global Environment by JARE

SNIFFS

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Examples of National Activities: Germany

Meteor 55: Oct-Nov 02
W-E Equatorial Atlantic

Research Areas:

Trace gases (ocean): N₂O, DMS, halocarbons, oxygenated organics, CO₂
- IfM-Kiel, MPI-Mainz
- UEA (UK)

Trace gases (atmos): all of the above + BrO + addl. Halocarbons
- IfM-Kiel, Uni-Heidelberg, NCAR (USA), MPI-Mainz

Trace metals (ocean): IfM-Kiel
(atmos.): UEA (UK)

Nitrogen cycle: stable isotopes, DOC, molecular biology
- IfM-Kiel, IOW-Warnemuende
- Univ. Essex (UK)

Examples of National Programmes: UK and USA

UK: April 3rd 03 NERC announces 5-year £11M programme, UKSOLAS

USA: No programme yet, but large number of SOLAS-related projects
SOLAS in IGBP II

EGS/AGU Nice
7 - 11 April 2003, Nice, France

IUGG Sapporo
1 - 9 July 2003, Sapporo, Japan

Summer School
30 June - 11 July 2003, Corsica, France

SOLAS Science 2004
11 - 14 Oct 2004, Halifax, Canada
Global climatology of the annual net air-sea CO$_2$ flux based on interpolation of air-sea pCO$_2$ differences referenced to the year 1995. (Takahashi et al., 2002)
Transfer velocity \( (k) \) determined by eddy correlation (direct covariance) in GasEx-98 and one \( k \) measurement obtained using the SF\(_6\) - \(^3\)He dual tracer pair, all plotted against windspeed. Also plotted are some widely-used parameterisations of \( k \) versus windspeed. (McGillis et al., 2001)

**Global DMS distribution Jan and July.** (Kettle et al. 1999)
The global mean sea surface temperature as simulated in the Hadley Centre atmosphere/ocean coupled model (HadCM3). The simulation includes a representation of the effect of ocean DMS emissions on cloud properties. Sensitivity experiments show a strong climate response to changes in ocean DMS emissions (MeTO, 2001).
A simple schematic illustrating the cycling of iodine between the ocean and the atmosphere. A simplified version of the chemical pathway from volatile organo-iodine compounds to aerosol production is shown (Chuck and Liss, 2003).

\[
\begin{align*}
\text{CH}_2\text{I}_2 + \text{O}_2 &\rightarrow \text{CH}_3\text{I} + \text{I} - \\
\text{CH}_3\text{I} + \text{I} &\rightarrow \text{I}_2 + \text{H}_2
\end{align*}
\]

Inorganic iodine e.g. OIO, HOI, IONO_2, HI, IX

Aerosol

CCN

Bacteria

Phytoplankton

Macroalgae

Carpenter et al., 2001
Satellite (Global Ozone Monitoring Experiment, GOME, on the ERS-2 satellite) observations of tropospheric BrO “clouds” in the Arctic and Antarctic. Total BrO column densities in the centre of the clouds exceed $10^{14}$ BrO molecules cm$^{-3}$. The clouds are associated with total loss of boundary layer ozone, occur only in springtime, and have a typical lifetime of one to a few days. (Wagner et al., 2001) Copyright 2001 American Geophysical Union.
**$N_2O$ formation across the west Indian shelf** (Naqvi et al., 2000)

**$N_2O$ in the water column at various sites in the equatorial Atlantic** (Walter, Bange and Wallace, 2003)
Fe addition to the ocean

SeaWiFS chlorophyll image (NASA real-time data) for July 29, 2002 showing the SERIES patch.

Enlargement of the patch. On July 29 a 700 km² area shows surface chl greater that 1 mg m⁻³. Patch position and shape agreed well with ship transects.
Surface water carbon dioxide fugacity ($f_{CO_2}$) during SOOEE (Watson et al., 2000)

Surface concentrations (5m) of DMS (nmol l$^{-1}$), methyl iodide (CH$_3$I) (ng l$^{-1}$), bromoform (CHBr$_3$) (ng l$^{-1}$) and chlorophyll $a$ (mg m$^{-3}$) during the EisenEx experiment highlight the varying responses to the iron addition. Measurements taken from within the fertilised patch are shown as filled squares, measurements from outside the patch are shown as open squares. DMS and CH$_3$I concentrations increased within the fertilised patch over the 21 days of the experiment, whilst CHBr$_3$ showed a greater increase in concentration outside of the patch. Chlorophyll $a$ concentrations increased approximately 3-fold during the experiment (Chuck and Liss, 2003).
Changes in various ice core and marine sediment parameters between the Holocene and the end of the last ice age. a) delta^{18}O (a temperature proxy), Fe and MSA (an atmospheric oxidation product of DMS) from Antarctic ice cores. b) CO_{2} from the Vostok ice core; TOC (total organic carbon), alkenones and dinosterol (proxies for surface ocean productivity) in a sediment core from the eastern tropical Pacific Ocean. (Turner et al., 1996)