Sea-air CO_2 flux determined from in situ and remotely sensed data: its variability in the Southern Ocean.

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The Southern Ocean is expected to play an important role in the sea-air exchange of CO_2. But, this role is not known precisely. In this region, the sea-air CO_2 fluxes estimated using atmospheric inversions, ocean biogeochemical models or in situ measurements are still in large disagreement.

In this presentation, we study the sea-air flux of CO_2 in the Sub-Antarctic zone (SAZ) and its spatial and time variability. We combine in situ measurements and remotely sensed parameters (ERS2 and QUICKSCAT wind speed, SeaWiFS chlorophyll (Chl) and AVHRR SST) to extrapolate the sea-air CO_2 fluxes in different regions.

We estimate the local flux as the product of the CO_2 exchange coefficient (K) and of the sea-air CO_2 partial pressure gradient (? P) and then, integrate the flux over given regions.

We use wind speed satellite data (U) to estimate K and its variability, according to the Wanninkhof (1992) K-U relationship.

As for ? P, in situ measurements conducted during JGOFS campaigns were extrapolated in the region south of Australia. We use relationships between sea surface partial pressure (pCO_2) and parameters measurable from satellite. North of SAZ, in situ pCO_2 and Chl are well correlated : pCO_2 rms with respect to pCO_2-Chl linear fit is between 5.5 µatm and 9.3 µatm. South of this chlorophyll rich region, pCO_2 is better correlated with SST. pCO_2 rms with respect to pCO_2-SST fits is between 4.2 µatm and 11.5 µatm. These fits were determined season by season from in situ measurements; then, space and time distribution of pCO_2 was deduced from satellite measurements for different seasons. Distribution of atmospheric CO2 partial pressure (pCO_2a) was deduced from atmospheric CO_2 concentration given by Global View, from temperature to compute saturated water pressure and from atmospheric pressure inferred from ECMWF atmospheric model. Then, we analyse sea-air CO_2 fluxes south of Australia and their variability.

We also use measurements made by CARIOCA drifters deployed in the central Indian ocean (one buoy in November 2001 and two buoys in January 2002 near 45°S-73°E). Buoys are drifting eastward in SAZ. They measure primarily pCO_2, SST, wind speed, fluorescence, atmospheric pressure and air temperature. In addition, one of the buoys deployed in January measures SSS. The buoys trajectories are influenced by ocean dynamics as can be observed from satellite SST images. We study the correlations between pCO_2, SST and SSS. At the beginning of the observing period, pCO_2 computed at 10°C to compensate for the thermodynamic effect correlates very well with SSS, indicating a mixing of different water masses with different mixing lines above and below 34.1 psu, 330 µatm. The possible phenomena causing the mixing (vertical and horizontal) will be discussed. Most of the thermodynamic effect is compensated by other effects, mainly mixing, so that pCO_2 - SST correlations are less clear.