Interpretation of CO₂ fluxes using outputs from the OceanFlux Greenhouse Gases project

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Setup and cruise track

During the Meteor cruise, M98 (July, 1st – July, 29th; Forotaleza/Brasil – Walvis Bay/Namibia, figure left), CO₂ fluxes were measured both with the bulk method and the eddy covariance method. Seawater was pumped from 5 m depth and pCO₂ was measured using an equilibrator based system (General Oceanics). For the eddy covariance measurements air was sampled through a ⅛” 15 m tube from the bow mast. The air was pumped at a flow rate of 16 l min⁻¹. A CSAT-3 sonic anemometer was used to measure 3D wind speeds and a GPS and inertial navigation system (INS) were used for motion correction. All met equipment and inlets were placed on a tower approximately 10 m above the sea surface (figure right). All instrumentation and data acquisition systems were housed in a 20 foot container placed on the bow.

Wind data correction

- Measured winds must be corrected for ship motion
- Remove motion contamination with GPS and INS data
- Additionally apply multilinear regression between winds and motion signals

Air sea gas exchange and diapycnal fluxes

Due to the topography and wind regimes off Angola, coastal upwelling was observed. Upwelling transports deeper water with e.g. higher CO₂ levels to the surface and causes supersaturation of CO₂ with respect to the atmosphere, thus triggering fluxes between the mixed layer (ML) and the atmosphere. The ML CO₂ budget is not only driven by biogeochemical process but also by diapycnal mixing (measured by microstructure sonde), which is most pronounced along the shelf break. The diapycnal flux is calculated as follows:

\[
\text{Flux}_{\text{diapycnal}}(\text{CO}_2) = K_p \times \epsilon
\]

Using both the diapycnal flux and the sea to air flux should result in a precise budget of the mixed layer CO₂ content.

Comparing in-situ data with Oceanflux GHG data

The Oceanflux GHG aims to to develop and validate new and innovative products combining field data, satellite observation, and models. Here the field data were compared to monthly mean data that were calculated from 10 years worth of monthly global data (2000-2010) and corrected (were applicable) to the year 2013.

Panel C shows different pCO₂ data for the specific month. The GHG data are based on the climatology of Takahashi et al. (2009) corrected to the SST calculated by the Oceanflux GHG. A significant difference in the various data products is observed. This may be due to the following reasons:
- Problems with in-situ measurements
- Problems with the climatological data
- Interannual variability

The in-situ measurements were made following international standards, including the use of different calibration gases, and have been quality controlled. In addition, atmospheric CO₂ was measured with the same instrument and compared well with the expected values.

During future data workup we will compare the k values derived from direct EC flux measurements with different products from Oceanflux GHG (e.g. waveheight (D), precipitation (E)) to validate our measurements and identify parameters other than wind speed that influence the k value.

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