Estimates of Southern Ocean Carbon Fluxes from Atmospheric Inverse Analyses

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Key Points

- We derive flux estimates using the LETKF-GEOSChem system which combines the 3-D atmospheric transport model GEOS-Chem with the Local Ensemble Transform Kalman Filter (LETKF) data assimilation method.
- We estimate fluxes at the model grid-scale (2° x 2.5°) and at monthly timescales for the period 2002 to 2012.
- The interannual variability of CO_2 fluxes in Southern Ocean estimated from LETKF-GEOSChem is consistent with previous studies

Observations

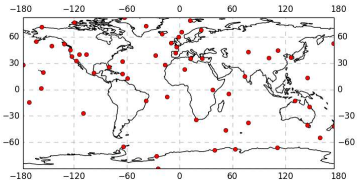

Fig.1. CO_2 observation sites

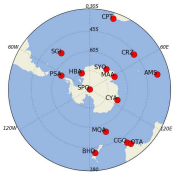

Fig.2. Surface sites in the Southern Ocean

- Observations: ObsPack_GLOBALVIEW CO_2 (Masarie et al. 2014)

Method

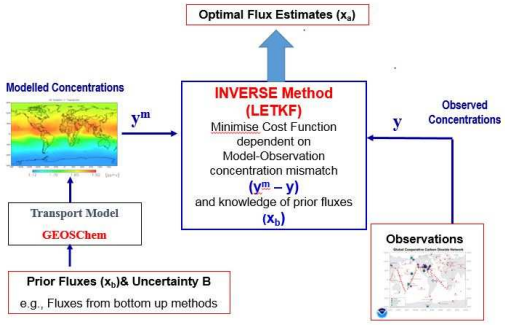

Fig.3. Framework of LETKF-GEOSChem

Table 1: Setup of LETKF-GEOChem for this study

Transport model	GEOS-Chem v11-01
Meteorological forcing	MERRA2
Resolution(degrees)	2*2.5
Optimisation	Local Ensemble Transform Kalman Filter (LETKF) (Hunt et al.2007)
Prior fluxes	
Biosphere and fires	SiB3 (Messerschmidt et al.2013) GFED4 (Akagi et al.2011) Scaled terrestrial sink (Baker et al.2006)
Ocean	Climatology; monthly fluxes (Takahashi et al. 2009)
Fossil fuels	CDIAC (Oda et al.2011)
Observations	obspack_co2_1_GLOBALVIEW-CO2_2013_v1.0.4_2013-12-23

Results

Table 2 :Setup of sensitivity tests

Tests	Description
Pri_taka	**Prior fluxes as in Table 1**
Post1	**Low-level prior flux uncertainty** (grid-scale :200%; regional :10%); Local radius: 2000km; Prior fluxes and observations as in Table 1
Post2	**Higher-level prior flux uncertainty** (grid-scale :400%; regional :20%); Local radius: 2000km; Prior fluxes and observations as in Table 1

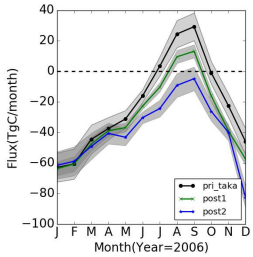

Fig.4 Comparison of model air-sea CO_2 flux estimates in Southern Ocean (south of 30S)

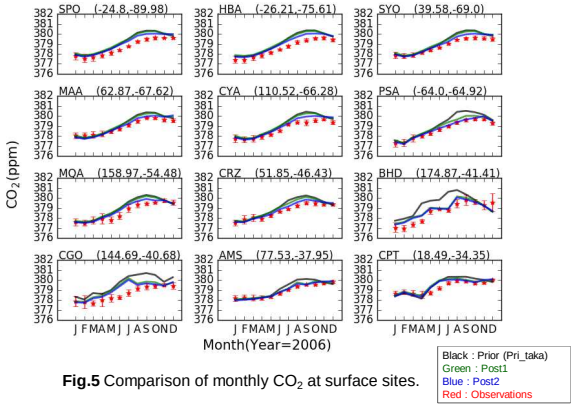

Fig.5 Comparison of monthly CO_2 at surface sites.

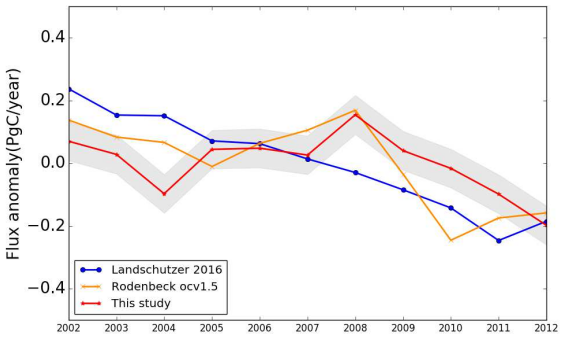

Fig.6 Interannual variability of the air-sea CO_2 flux anomaly in the Southern Ocean. Estimates from LETKF-GEOSChem (this study), and previous analyses.

Flux Data Sources

Landschutzer 2016 (Landschutzer et al.2016):
https://www.nodc.noaa.gov/ocads/oceans/SPCO2_1982_2015_ETH_SOM_FFN.html

Rodenbeck ocv1.5 (Rodenbeck et al.2015):
http://www.bgc-jena.mpg.de/CarboScope/

Conclusions

- We have derived CO_2 flux estimates using the LETKF-GEOSChem inverse analysis system and atmospheric CO_2 measurements from surface sites.
- The interannual variability of Southern Ocean CO_2 fluxes estimated from LETKF-GEOSChem is consistent with previous studies .
- Potential biases from prior flux distributions used for terrestrial sources and sinks have some influence on SO flux estimates. Work is ongoing to update representation of the prior flux distributions used in the LETKF-GEOSChem system.
- We will augment the current sparse network of SO surface observational sites with additional atmospheric CO_2 measurements from mobile platforms (shipboard, aircraft) to assess their value in improving estimation of Southern Ocean CO_2 fluxes.

References

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Oda et al.2011. doi:10.5194/acp-11-543-2011
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