Dynamical ocean topography from satellite measurements and its impact on Southern Ocean circulation estimates

T. Janjic (1,3), A. Albertella (2), J. Schroeter (3), R. Savcenko (4), R. Rummel (2), and W. Bosch (4)

1) Massachusetts Institute of Technology 2) Institute for Astronomical and physical Geodesy, TU Munich
3) Alfred Wegener Institute for Polar and Marine Research 4) Deutsches Geodaetisches Forschungsinstitut

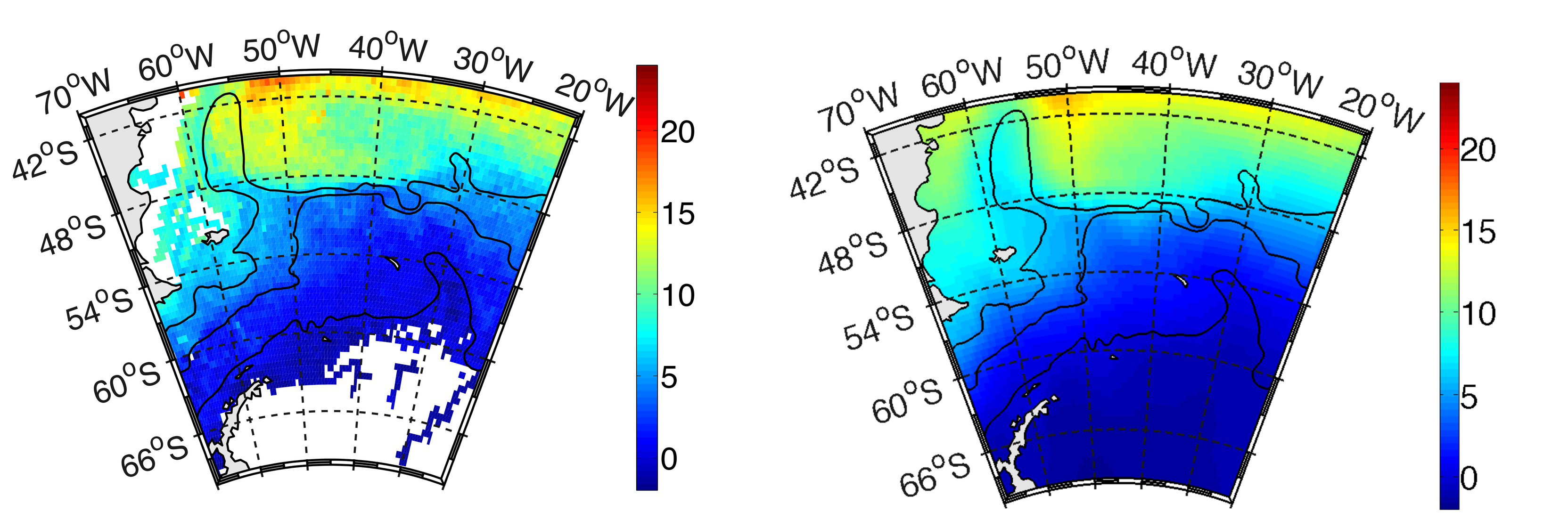
We improve model generated fields in Southern Ocean by assimilating **only absolute dynamical topography** data globally into the finite element ocean model (FEOM) using the ensemble Kalman filter.

Absolute dynamical ocean topography

- The geoid is obtained from the gravity model GOCO2s that combines the GRACE and GOCE satellite data.
- The Mean Sea Surface (MSS) DGFI2010 uses altimetric measurements from the ERS-1/2, ENVISAT, TOPEX/Poseidon, Jason-1 and Jason-2.
- In order to calculate the MDT, one of the central objectives is to obtain the MSS and the geoid spectrally consistent without loss of accuracy and resolution.
- Filtering of the MSS and the geoid in order to obtain the same spectral content is done using profile approach with Jekeli-Wahr filter to degree 60, 120 and 150.

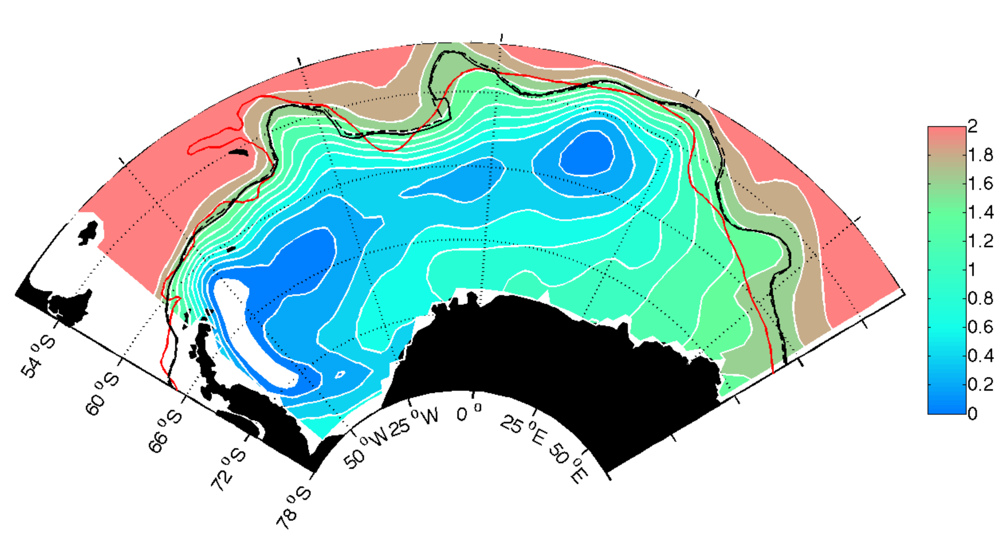
Verification of data assimilation results

- The RMSE compared to the drifter SST reduces from 1.9°C for free model to 1.1°C after assimilation [60°S,42°S]x[58°W,30°W].



The SST from surface drifter data (left) and as result of data assimilation experiment (right). The black lines are the Subantarctic and Polar fronts and southern boundary of ACC computed from in-situ measurements (Orsi et al., 1995).

- The RMSE compared to ARGO temperature data at **800 m depth** reduces from 0.4°C for free model to 0.2°C after assimilation north of 60°S.



***T at 800 m** as result of data assimilation experiment. The red line is southern boundary of ACC computed from in-situ measurements (Orsi et al., 1995). The black line is the same front from the data assimilation results using criteria of Orsi et al 1995.*

Absolute dynamical topography assimilation

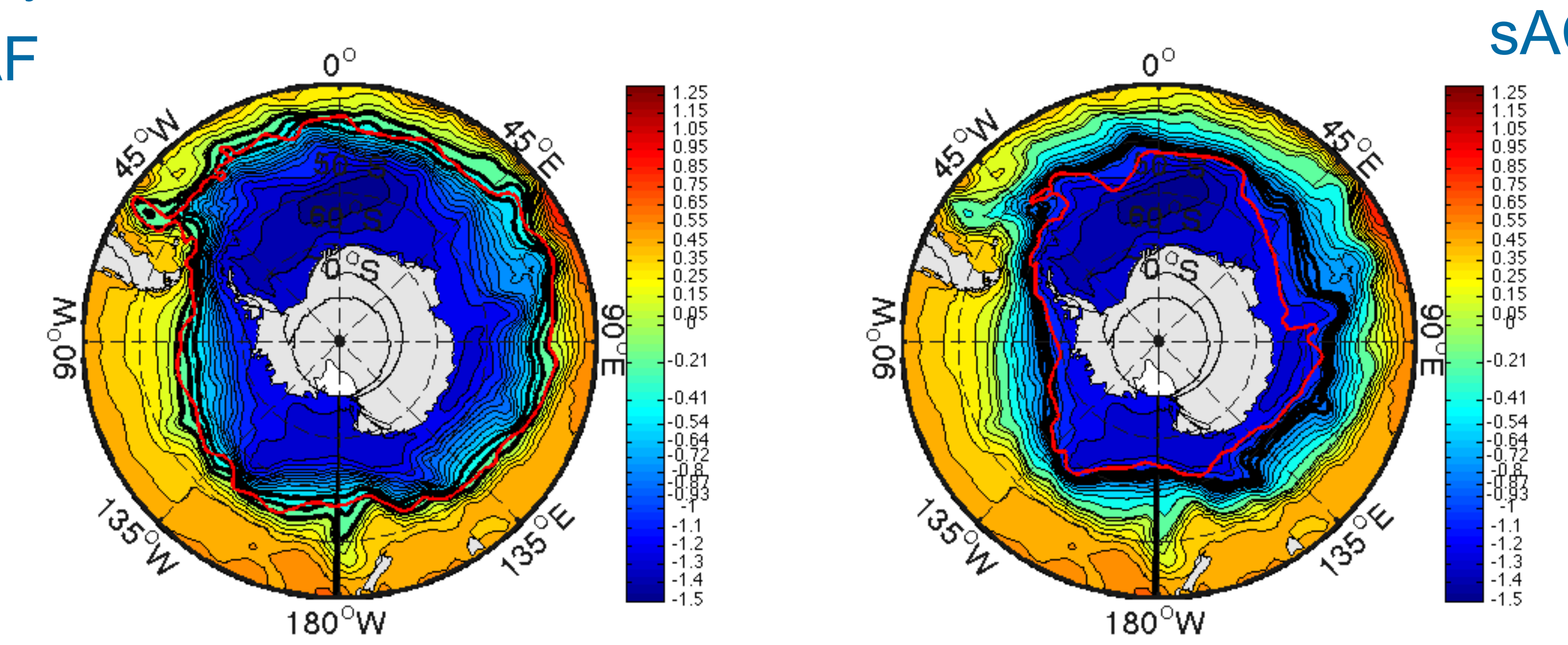
- The assimilation approach follows Janjic et al. 2012 where three data sets filtered to 60,120 and 150 where assimilated.
- The results are closer to observations which were not used for assimilation and lie outside the area covered by the altimetry in the Southern Ocean (e.g. temperature of surface drifters or deep temperatures in the Weddell Sea area at 800 m depth derived from Argo composite, front line locations.)
- Shown here are only the results of assimilation of data sets filtered to degree 150.

Calculating locations of Southern Ocean Fronts

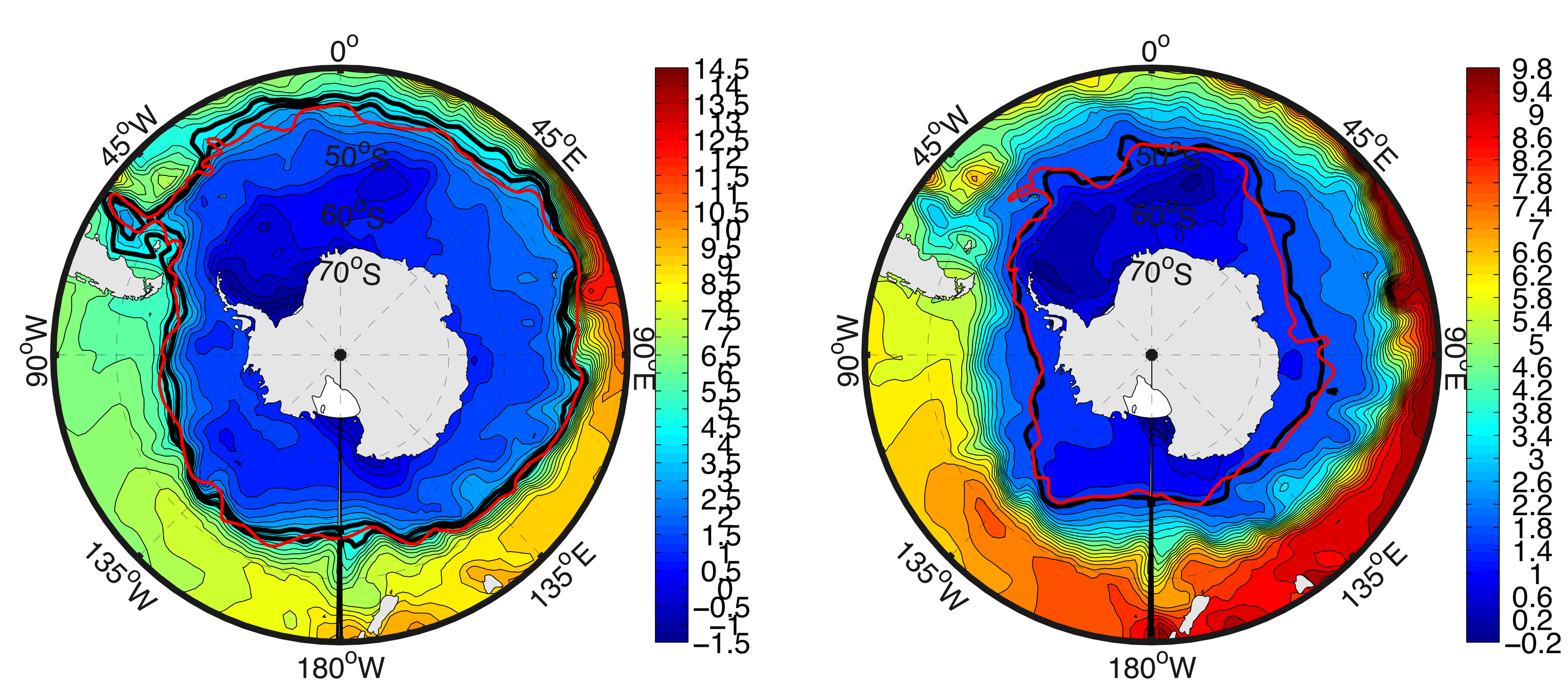
- Data assimilation produces ocean fields consistent with absolute DOT, allowing us to use the subsurface temperature and salinity criteria of Orsi et al 1995 to find mean location of the fronts.
- Location of the fronts calculated this way agree better with locations from in situ measurements (Orsi et al. 1995) then if the locations were calculated from surface data only or only from fields produced by model without data assimilation.

SAF

sACC



The SSH field as result of assimilation of DOT.
Highlighted in black are streamlines following Rintoul and Sokolov 2009 Table 1. Red line is SAF and sACC front from Orsi et al. 1995.
*The **streamline approach** encompasses well SAF and polar front, although both fronts do not follow one particular streamline.*
sACC front is not approximated well by lines of constant SSH.



The potential temperature field as result of assimilation of DOT.
The potential temperature at 400 m (left) and potential temperature maximum surface for Z > 500 m (right).
Highlighted in black are front lines estimated from data assimilation results using criteria specified in Orsi et al. 1995. Red line is SAF and sACC front from in situ measurements (Orsi et al. 1995).

- By assimilating only DOT data into the finite element ocean model we improve the representations of fields in the model itself for both mean field and variability which are now more similar to variability of DOT data set.

References:
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tpfander@mit.edu