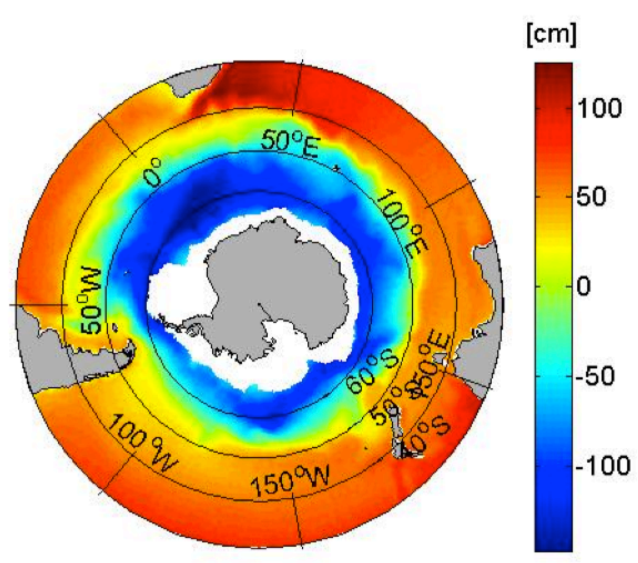
Assimilation of geodetic dynamic ocean topography with an ensemble based Kalman filter

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

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

Mean dynamical ocean topography (MDT)

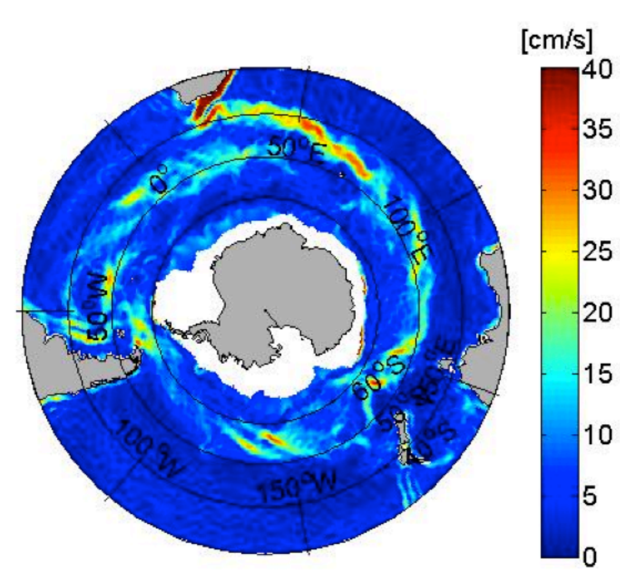
- The geoid is obtained from the gravity model GOCO2s that combines the GRACE and GOCE satellite data.
- The Mean Sea Surface (MSS) DGFI2010 uses altimetric measurements from the ERS-1/2, ENVISAT, TOPEX/ Poseidon, Jason-1 and Jason-2, acquired within the period from October 1992 to April 2010.
- The MSS is extended over land as well as within gaps in the data with values obtained by solving Laplace equation.
- Filtering of the MSS and the geoid in order to obtain the same spectral content is done in spectral domain with Jekeli-Wahr filter to degree 150.



MDT filtered to degree 150 with new approach

Verification of MDT data

- 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.
- The artifacts of the extension of the MDT over land seen in the gradients of the MDT are absent.

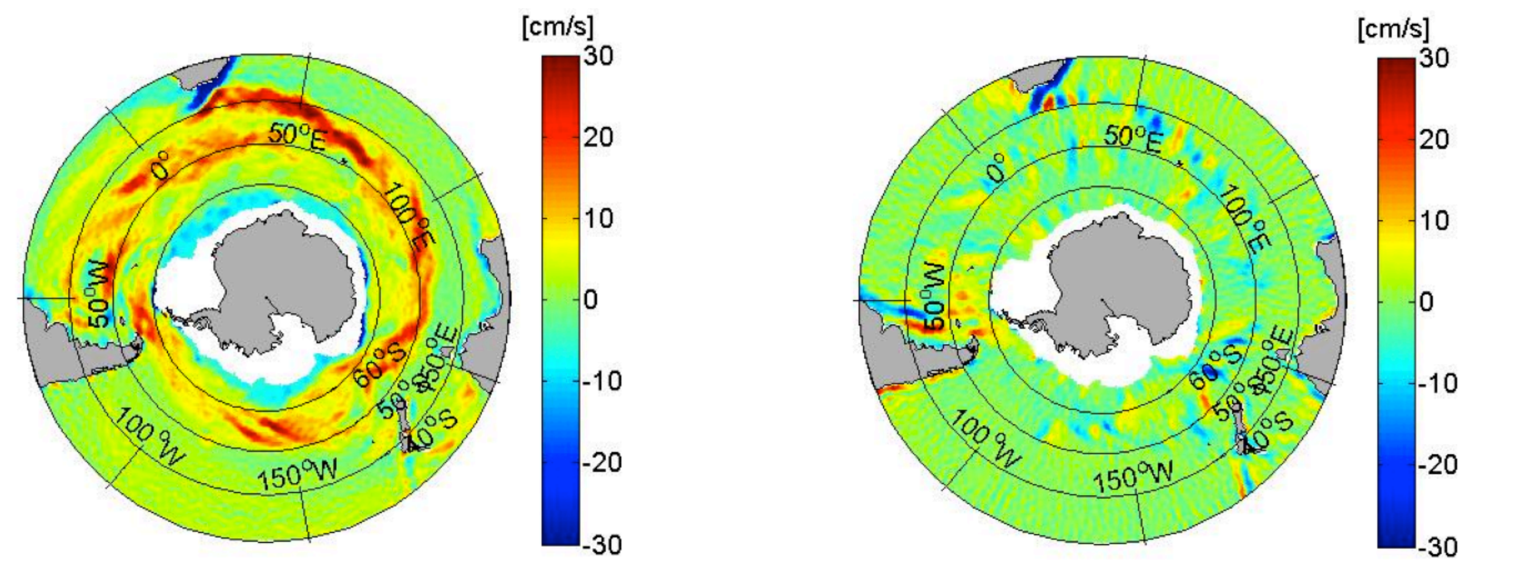


Magnitude of geostrophic velocities calculated from MDT data with our new approach show major currents in Southern Ocean with artificacts of extension of MSS over land minimized

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

ACKNOWLEDGMENTS
This work has been funded under DFG Priority Research Programme SPP 1257 "Mass Transport and Mass Distribution in the Earth System".

The data from the Global Drifter Program of NOAA at www.aoml.noaa.gov/envids are used for validation (Lumpkin and Garraffo, 2005).



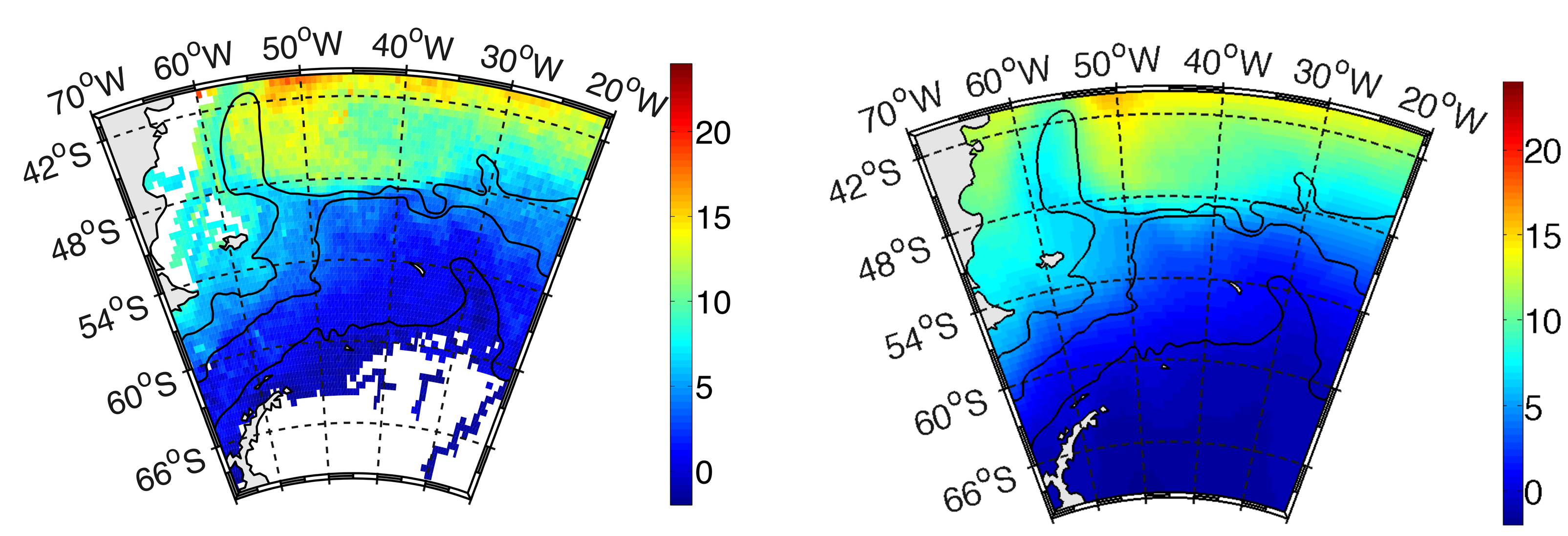
The geostrophic velocities calculated from the MDT agree with RMSE errors of 7.6 cm/s and 6.2 cm/s for u (left) and v (right) with the drifter data in Southern Ocean.

Absolute dynamical topography assimilation

- The assimilation approach follows Janjic et al. (2012) except that here the **MDT is constructed first** and a new MDT filtering technique is used.
- 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.)

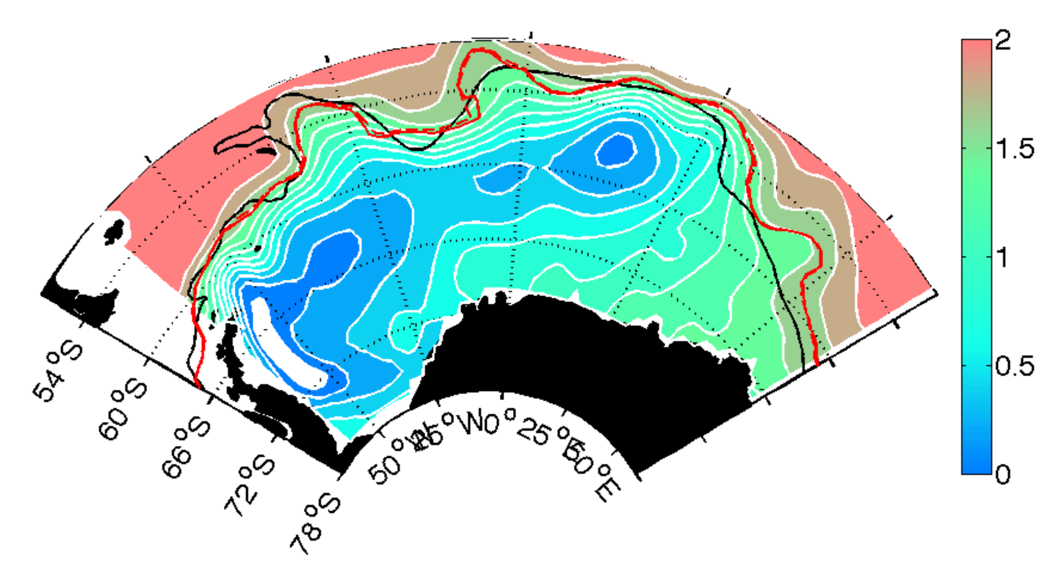
Verification of data assimilation results

- 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 black line is southern boundary of ACC computed from in-situ measurements (Orsi et al., 1995). The red line is the same front from the data assimilation results using criteria of Orsi et al 1995.

tpfander@mit.edu