Estimating circulation in Antactic Circumpolar Current via sequential assimilation of multi-mission altimetrv data

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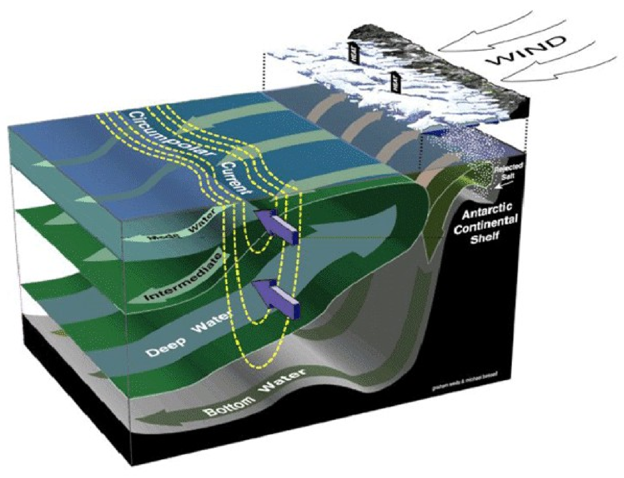
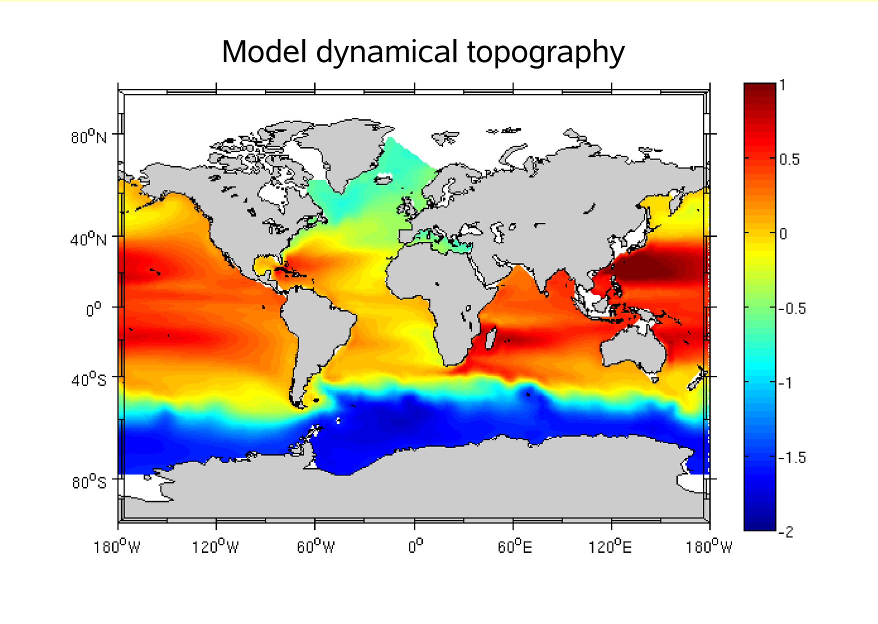
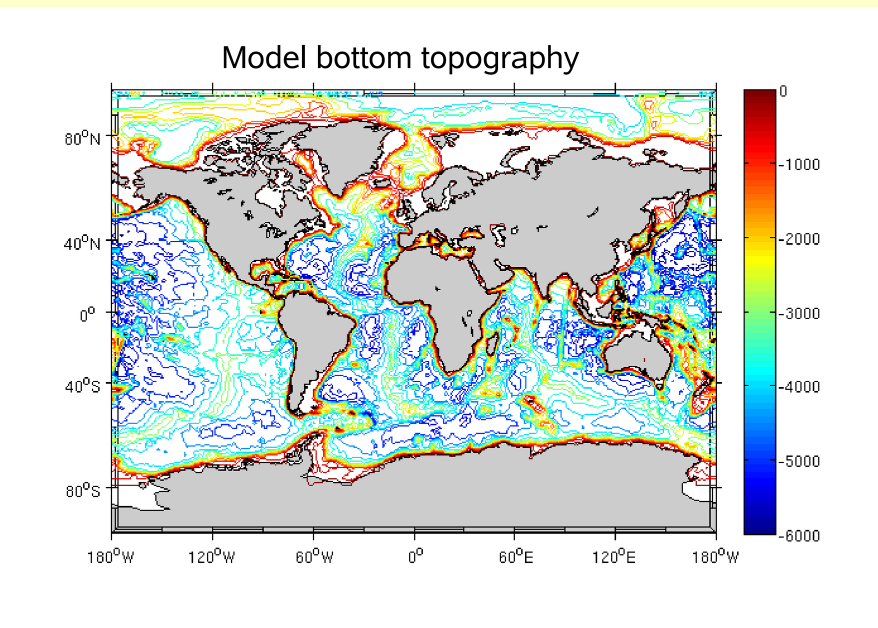


The aim of this study is to estimate the circulation in the Atlantic Sector of the ACC. The work is based on the global finite-element ocean model (FEOM). Sequential assimilation technique is applied to improve the representation of thermodynamical processes. Data used in this study are a complex analysis of multi-mission altimetry data provided by DGFI, Munich. Referenced geoid used is obtained from GFZ Potsdam.
A common problem of assimilation of altimetry data is that covariances between sea surface height and thermodynamical fields at the ocean depth often lead to unrealistic estimations. In this work we use a method of correction proposed by Fukumori where the estimated fields are reduced to a superposition of barotropic and first baroclinic modes. The results of such an approach are discussed.

Model :

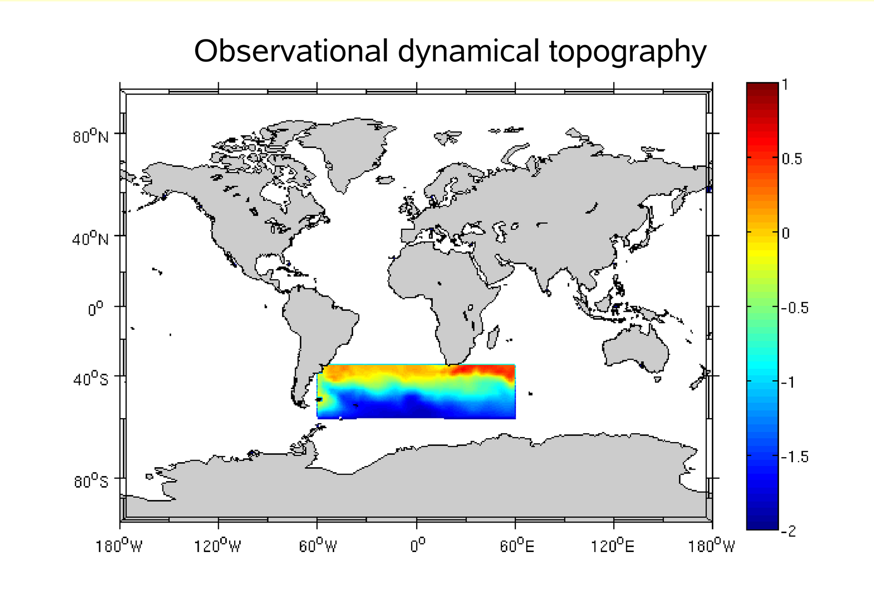
- FEOM global version;
- 1.5º resolution;
- NCEP interannual forcing



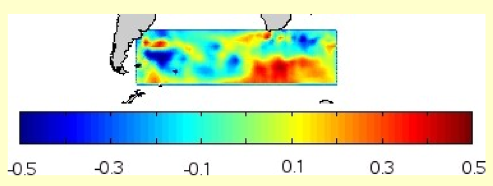


Observations :

multi-mission altimetry data (DGFI, Munich)

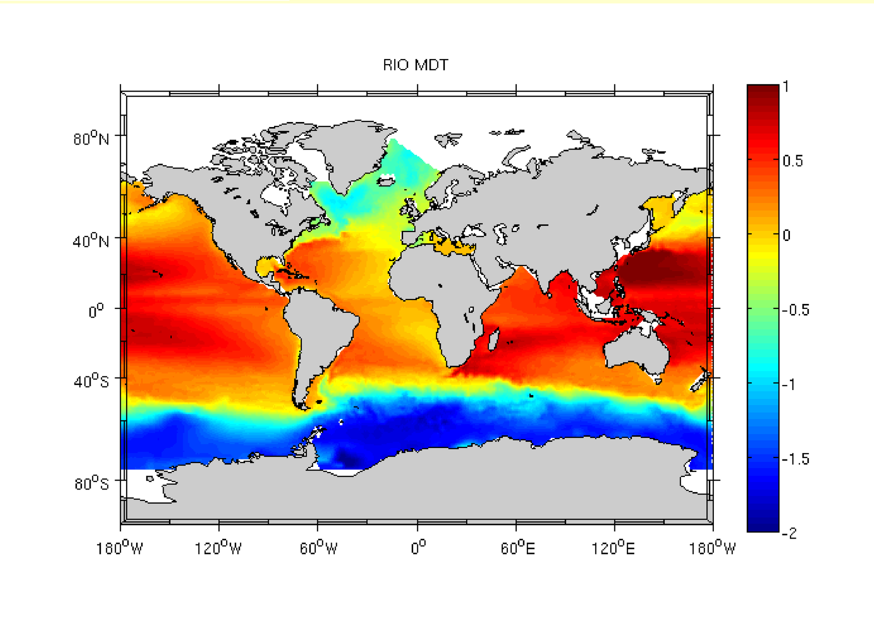


- Anomalies + CLS01 – GL04s1
- Box : -60W,60E; -35S,-60S
- 37 states, 10 day frequency for the year 2004.
- smoothed with gaussian 1.35º filter



Typical difference between model and observational SSH.

Red spot shows the systematic model error due to weak Polar Gyre Transport.



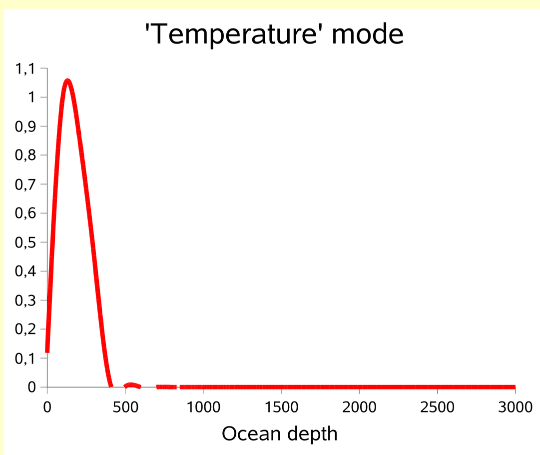
RIO Mean Dynamical Topography

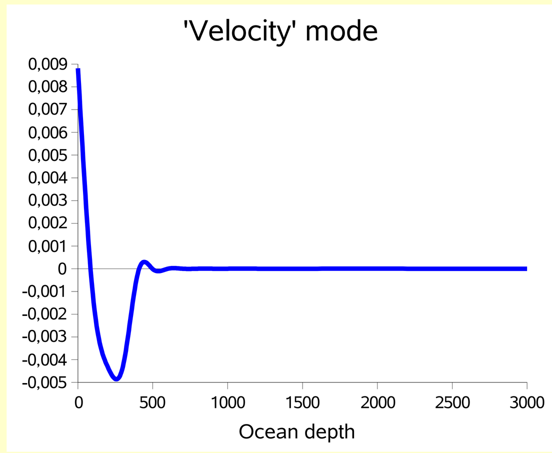
Assimilation system:

- local SEIK filter for observational update of SSH
- Fukumori approach for T, S, u and v

Model forecast :		'Analysis' :
SSH^f	SEIK filter →	SSH^a
T^f, $(u,v)^f$	Fukumori method →	T^*, $(u,v)^*$

A leading approximation for the dynamics of global large-scale circulation is attained in terms of vertical modes



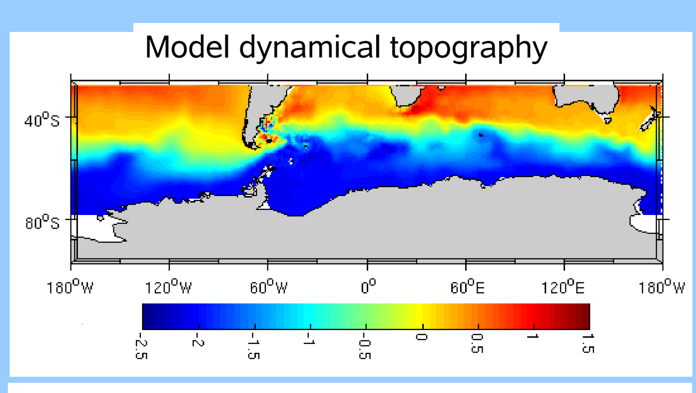


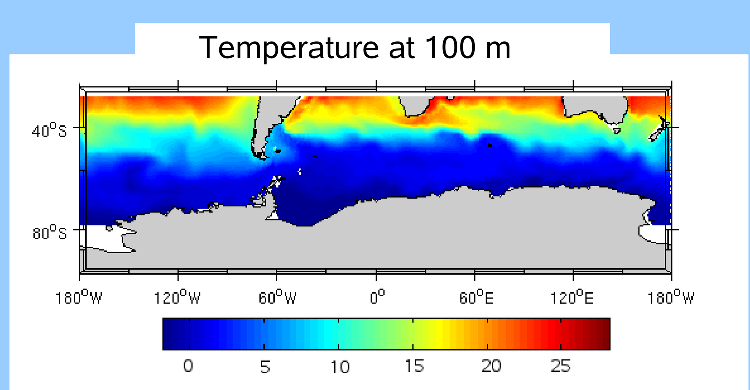
$$T_{BC}=\hat{h}(z)T_z/\rho_0(z)$$
$$S_{BC}=\hat{h}(z)S_z/\rho_0(z)$$
$$h=\eta(x,y)\hat{h}(z)$$

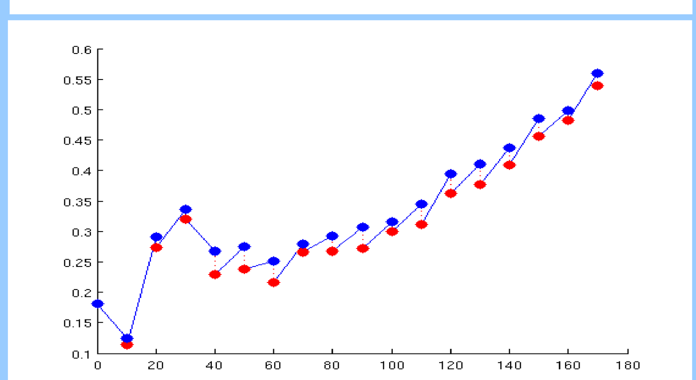
$$u_{BC}=\tilde{u}(x,y)\hat{p}(z)/g\rho_0(z)$$
$$v_{BC}=\tilde{v}(x,y)\hat{p}(z)/g\rho_0(z)$$
$$h=\eta(x,y)\hat{h}(z)$$

Calculation of first baroclinic modes for T, S, u and v

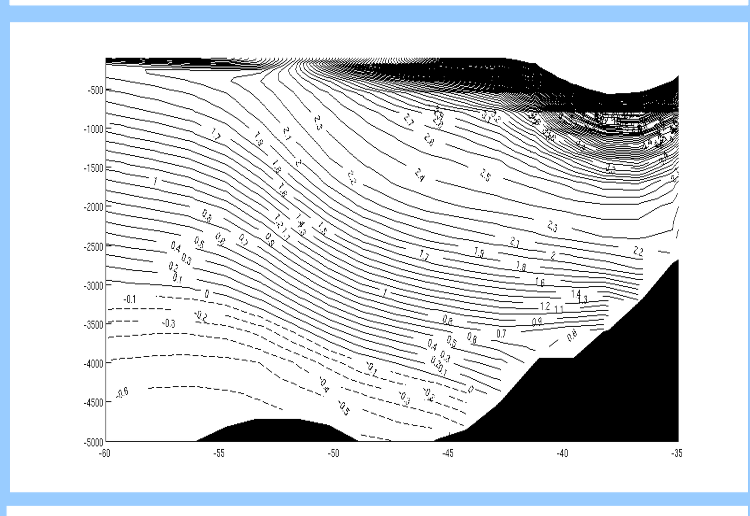
Results



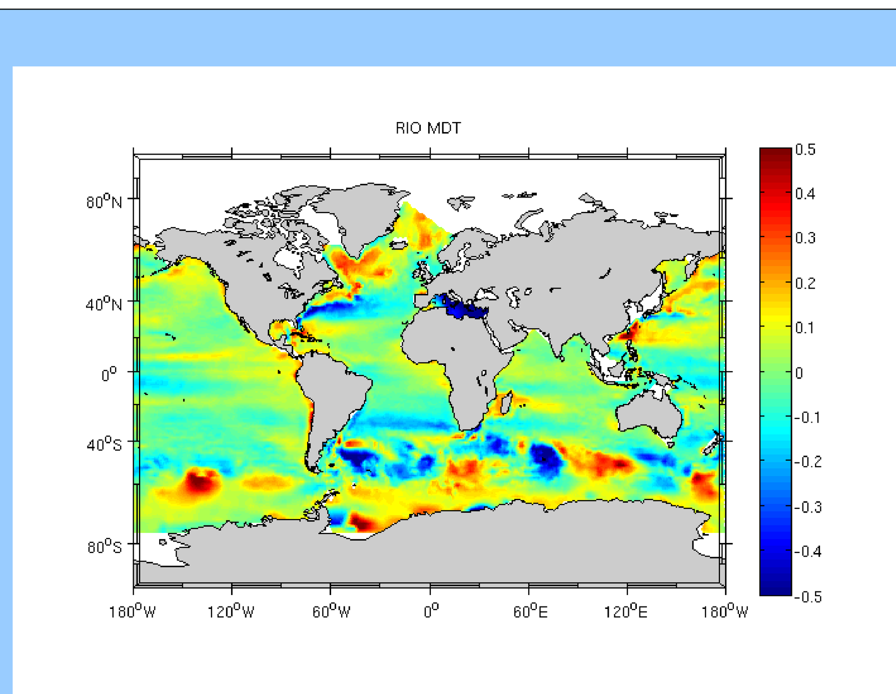




Evolution of RMS error (in m) on Model Dynamical Topography. Blue lines show model forecasts, red lines correspond to observational updates.

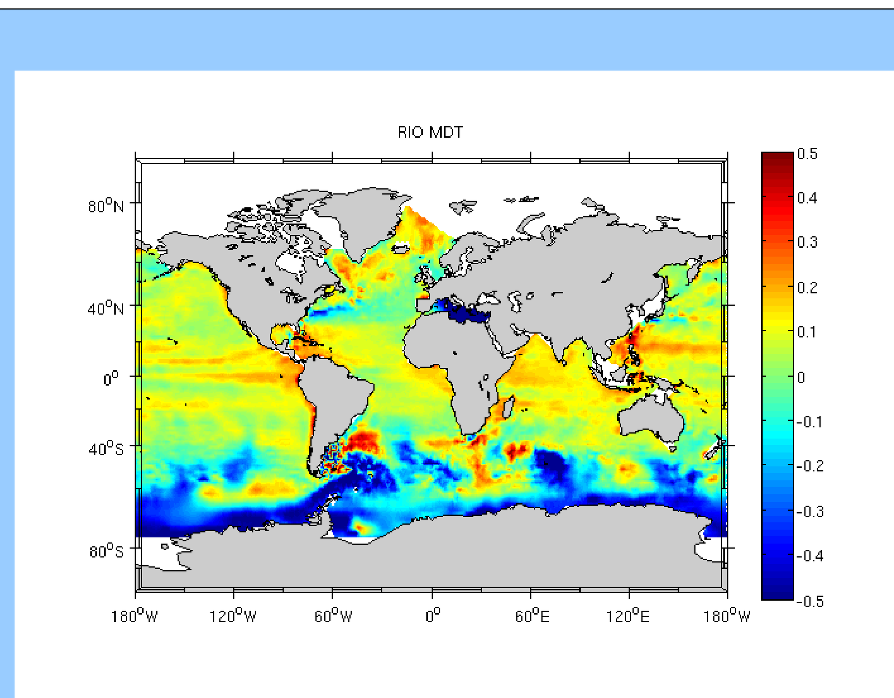


Vertical section of temperature at 25E



Difference between model dynamical topography and RIO MDT, m

Figure is made for MDT obtained due to free model run.



Difference between 'analysed' model dynamical topography and RIO MDT, m

Figure is made for MDT obtained due to 1 year assimilation experiment.

- Conclusions and perspectives :

- In the present study we assimilated MDT into a global ocean model in a limited area, Southern Atlantic sector of ACC;
- we showed that sequential filtering technique can be applied to correct variable part of dynamical topography signal;
- we are going to correct systematical errors of the model by using of another techniques :
  Greatbatch correction on the Dynamical Topography (adding additional term in the momentum equations relaxing model to observations);
  Using of real variance-covariance matrix instead of model covariances to correct mean sea level

References :

- Fukumori, I., R. Raghunath, L. Fu, and Y. Chao, 1999. Assimilation of TOPEX/POSEIDON data into a global ocean circulation model: How good are the results?, J. Geophys. Res., 104, 25,647-25,665.
- C. Eden, R.J. Greatbatch and C. W. Böning, 2004, Adiabatically correcting an eddy-permitting model using large-scale hydrographic data: Application to the Gulf Stream and the North Atlantic Current, Journal of Physical Oceanography, 34, 701-719.
- Pham, D. T., Verron, J., and Gourdeau, L. 1998b. Singular evolutive Kalman filters for data assimilation in oceanography. C. R. Acad. Sci., Ser. II 326(4), 255-260.