Preliminary results of a regional ocean model forced with downscaled IPCC-AR4 scenarios

Pereira, Edson J.R.[1]; Tonelli, M.[1]; Vieira, D.R.[1]; Pereira, A.[1]; Campos, C.[2]; Andrioni, M.[2]; Lemos, A.[2]; Wainer, I.[1]; research group IVAM-OAS
[1]: DOF - IOUSP
[2]: CENPES/Clima - Petrobras
Contact: zedson@usp.br

Objective

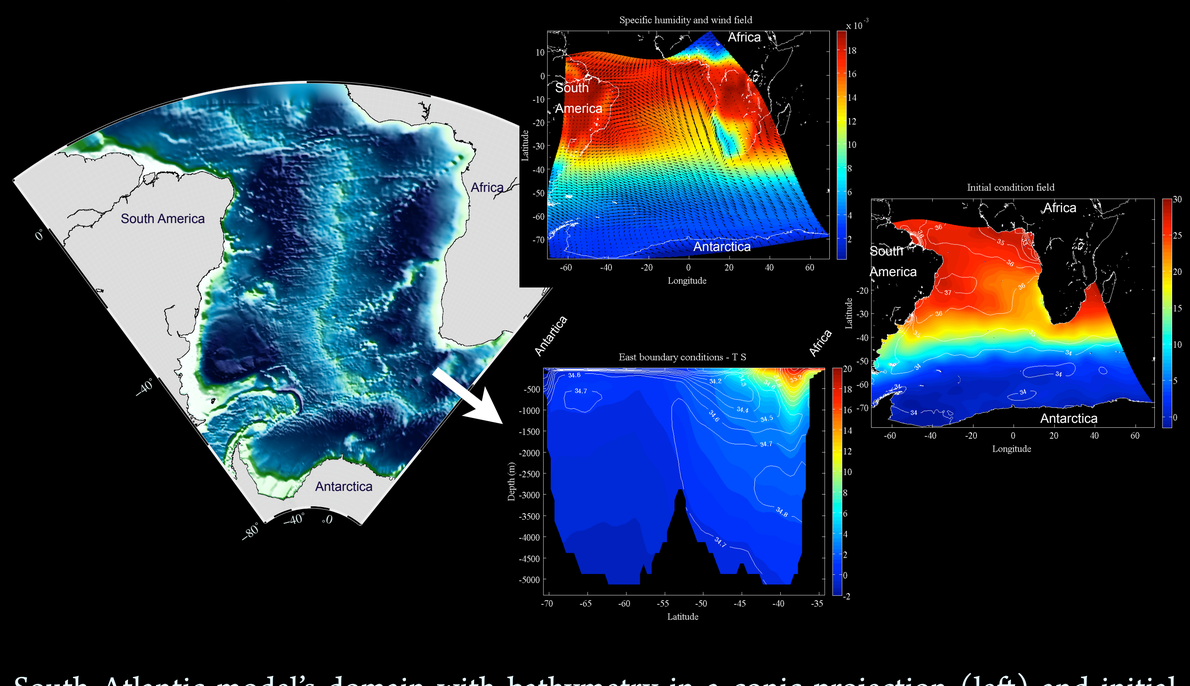
Using a regional model (ROMS), we aim to translate the global scale results from the IPCC-AR4 scenarios for the South Atlantic, testing the sensitivity of the regional-to-local response to climate change. The aim is to be able to solve time-space anthropic scales and use the resources of the regional model to understand the impact of climate change at the local scale.

Introduction

South America Atlantic's coastal zone (SAACZ) is densely populated and concentrates important economical activities. The expectations of this study is to obtain a reliable tool to examine at the local-to-regional ocean the impacts of climate change. At present, the focus is the validation of the ocean dynamics of the regional model setup in the SAACZ using 20th century climatological forcing.

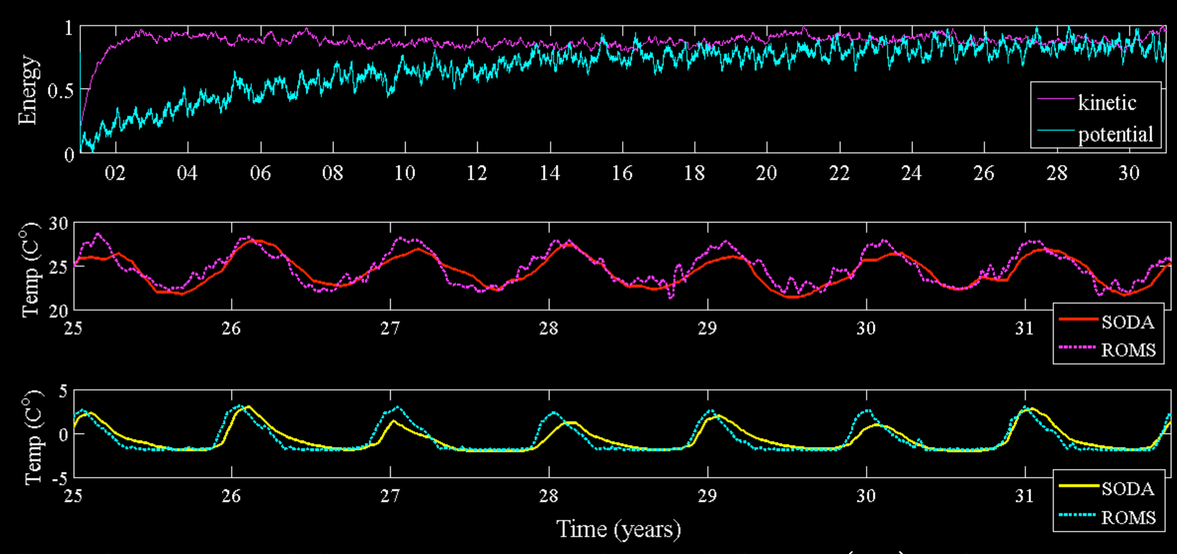
The current version of the regional ocean model has now 12km average resolution in 2 focal points (Brazilian Coast and Weddell Sea), forced with CORE fluxes (Large & Yaeger, 2009; bulk variables) and late 20th century climatology from SODA as initial and at artificial boundaries.

The model setup



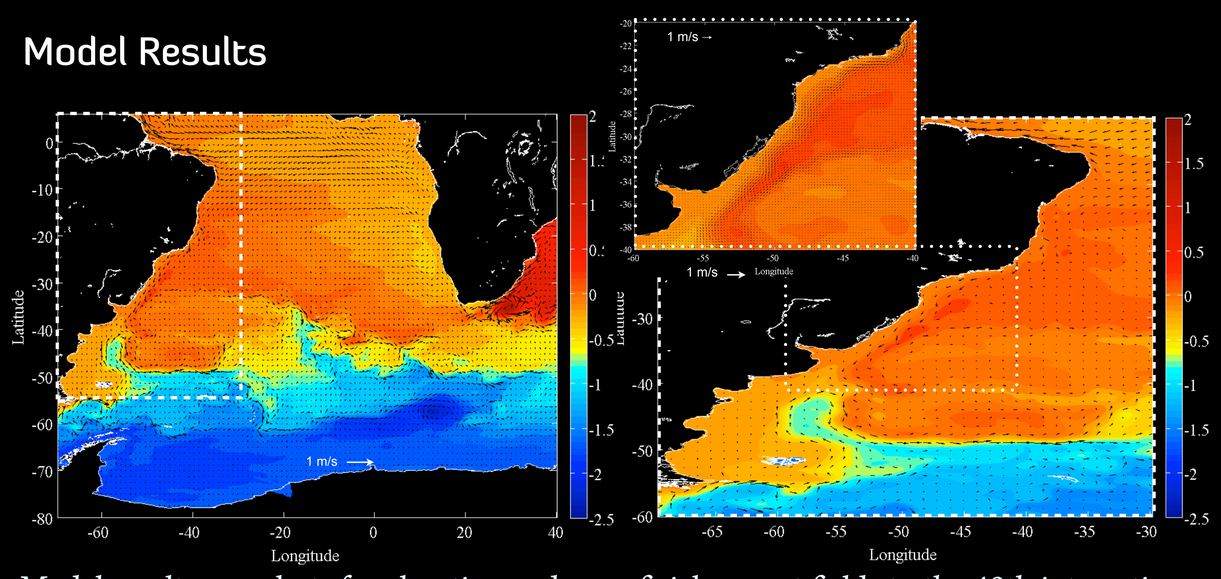
South Atlantic model's domain with bathymetry in a conic projection (left) and initial and boundary examples in mercator snapshots (right): for humidity & wind (top); Temperature & Salinity (TS middle); TS vertical structure used at east open boundary (right bottom). The actual grid resolution varies from 7km to 20 km with two main focus: east focus on Brazil current (average 10 km) and South focus on Weddell Sea (7 km).

Model time stability



Typical energetic stabilization time averaged over all domain (top) and internal model energy (Model output temperature & Soda reanalysis in the same area) at Central Atlantic (middle) and Weddell Sea areas (bottom).

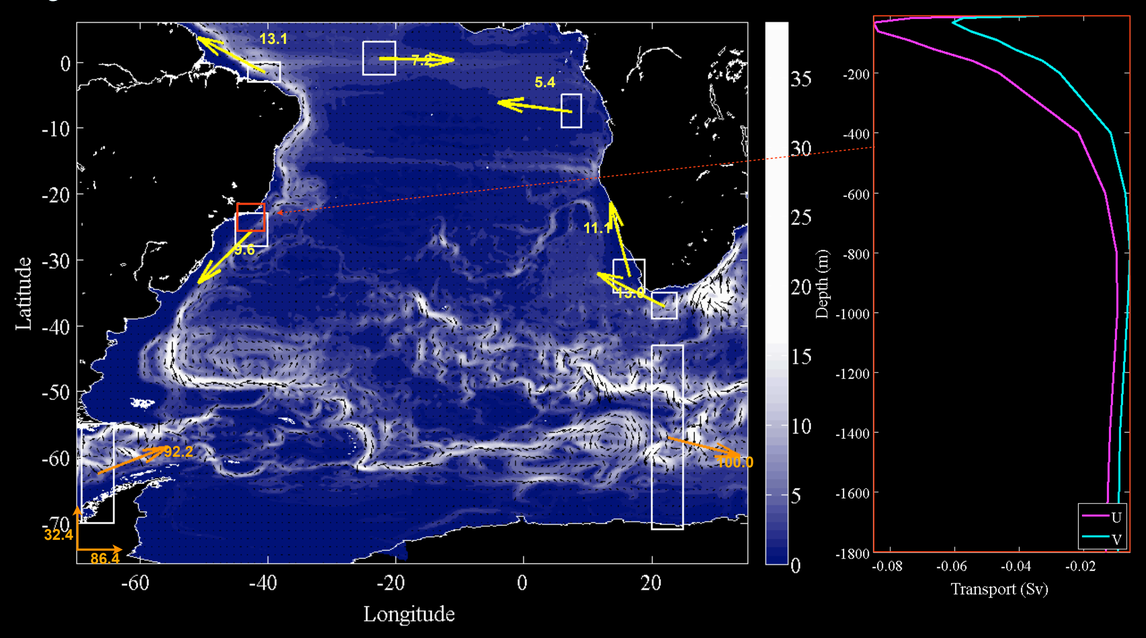
Model Results



Model results snapshots for elevation and superficial current fields to the 40th integration year (averaged to summer at South Hemisphere), zoom at Brazil Current area.

Model results - derived variables

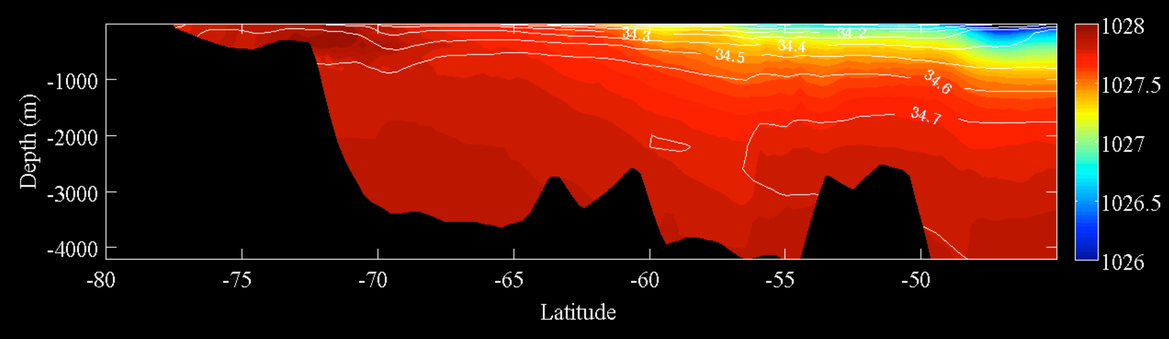
The vertically integrated transport from the 35th year (time averaged) results of a climatological run (CORE - 100 years). Local transport (for each gridded element) presented on the left (shading and vectors). Integrated total transport in yellow (up to 1000m) and red (surface-bottom) arrows. Detailed transport profile (red box below) of the Brazil Current at right.



The table shows measurement data (transport) in equivalent areas pointed out in the plot above.

Transport	Area	Main reference
92 - 145 Sv	Drake (both)	Cunningham et al, 2003 - Gent et al.,2001
2.4 - 10.9 Sv	Brazil Current	I. Silveira et al, 2000
15 averaged	North Brazil Current	Johns et al.,1998
87 to 148 Sv	ACC	0rsi et al, 1993 100 Sv < 3000m
12-20 Sv	EUC	Friedrich A. Schott et al., 2003
13 Sv	Agulhas Retroflection	Garsoli et al.,1998
8-15 Sv	Benguela Current	Rodrigues et al., 2010

An example of the TS vertical structure can be seen below. Averaged cross shelf at Weddell Sea (43w-47w) density (shading) and salinity field (contour). These results are summer averaged to the year 35th. Some density instabilities at surface layer - suggesting ADW water formation thermodynamics. This model setup uses ROMS' sea-ice module (without ice shelves specification).



Conclusion

- Fast equilibrium state and quite stable results were achieved in that simulation, even close to the open boundaries and to all variables investigated;
- Although an ongoing experiment, these results already point out to a reliable tool, absolutely required condition to simulate downscaling scenarios;
- This setup is relatively fast (to actual resources) and simultaneously eddy resolving, along South American coast.
- Transport is slightly underestimated as expected (because the climatological forcing) but the results are in general agreement with expected measured data.
- Preliminary experiments show that the use of non climatological forcing will increase the superficial (wind driven) transport.
- Baroclinic 3D structures are also stable and physically consistent with expected results.
- At Weddell sea an interesting result has been observed. The coupled model (with the sea-ice) was able to reproduce the dynamical mechanisms expected to deep water formation. However, it requires more detailed analysis to track and understand these results.

To near future

- Sensitivity analysis, using seasonal river fluxes and high frequency forcings have already been started (including Amazon, Prata and Congo rivers);
- Same run (100years) with dated forcing (reanalysis NCEP);
- Increase of vertical model resolution to reach actual computational limits;
- 20th century IPCC-AR4 scenarios based on CCSM3 results (A1 B1), analysis focused to 2090-2100 period.

Acknowledgments

WMO - World Meteorological Organization
CNPq - Conselho Nacional de Pesquisa - PNPD e Criosfera programs