The Brazil Current Variability at the NOAA AX97 high density XBT line: a comparison between in situ data and Ocean Forecasting and Analysis Systems

M. O. Lima[1,2,3]; M. Cirano[1,2,3]; M. M. Mata[4]; I. I. C. Pita[2]; L. R. Oliveira[4]; G. Goñi[5] and M. Baringer[5]

1 – Postgraduate Program in Geophysics, Federal University of Bahia (UFBA), Brazil
2 – Tropical Oceanography Group (GOAT), Institute of Physics, Federal University of Bahia (UFBA), Brazil
3 – Numerical Modelling and Observation Network (REMO), Brazil
4 - Institute of Oceanography, Federal University of Rio Grande (FURG), Brazil
5 - Physical Oceanography Division, NOAA/AOML, USA

Introduction

The AX97 is a NOAA long-term high-density XBT (eXpendable-BathyThermograph) transect in the southwestern Atlantic Ocean. It was implemented as a partnership between Brazilian institutions and NOAA in order to increase the number of observations along the Brazil Current (BC) in this area (Mata *et al*., 2012). This project has been named MOVAR (Monitoring the upper ocean transport variability in the western South Atlantic) and the XBT transect runs between Rio de Janeiro and Trindade Island (30°W, 20°S). The AX97 samples were first collected in 2004 and it has been taken regularly, with an average periodicity of 2-3 months (n = 46). The aim of this work is to study the BC variability in the region of the AX97 line using both XBT data and numerical models outputs provided by the Ocean Forecasting and Analysis Systems in the framework of the GODAE OceanView (GOV).

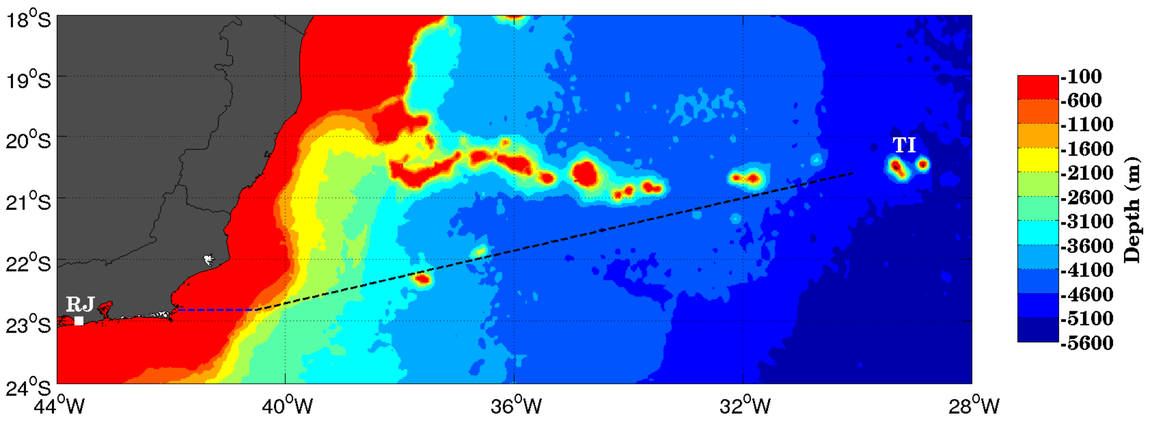

Figure 1: The AX97 reference transect (black dashed line) and the coastal transect (blue dashed line). The regional bathymetry is shown in the background (units in meters). The location of Rio de Janeiro (RJ) city and Trindade Island (TI) is indicated.

Methodology

In order to compare the XBT data, daily outputs of the HYbrid Coordinate Ocean Model (HYCOM) coupled on Navy Coupled Ocean Data Assimilation (NCODA) system analysis, with horizontal resolution of 1/12º, were used from 2004 to 2012. The outputs of the model were interpolated for the mean AX97 transect with 1/12º longitudinal resolution. To evaluate the influence of the coastal branch of the BC, a cross shore transect from Cabo Frio to the beginning of AX97 was used. The normal velocity for HYCOM and MOVAR was computed based on the AX97 angle and the dynamic method, respectively. The integrated volume transport was estimated based on the reference level at 400 dbar. To assess the role of the level of no motion, the geostrophic velocity and transport for HYCOM was also calculated.

Results

Figure 2 and Table 1 show that the BC variability was well captured from MOVAR cruises when compared with the model outputs, either during the cruise days only or the whole time length (not show). The results from the cross-transect velocity and zonally integrated transport do show that HYCOM presents a higher value than MOVAR. In addition, the -2.36 Sv mean transport associated to the coastal transect (Figure 3), shows that this region has an important contribution in the BC transport. The higher value from HYCOM/NCODA transport could be relate to the estimate of the level of no motion since the associated geostrophic transport (-3.44 Sv) presented a lower value.

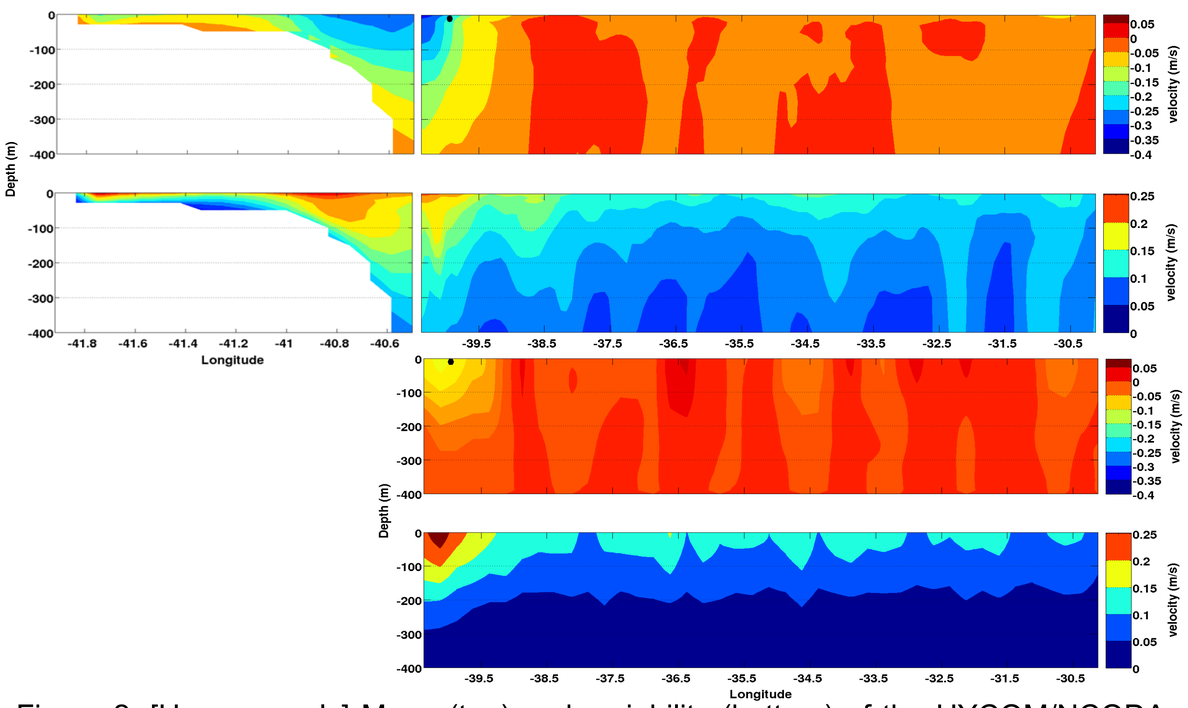

Figure 2: [Upper panels] Mean (top) and variability (bottom) of the HYCOM/NCODA cross-transect velocity for the MOVAR cruise days along the coastal transect (left) and the AX97 transect (right). [Lower panels] Mean (top) and variability (bottom) of the MOVAR baroclinic velocity along the AX97 transect. The black dot indicates the BC mean velocity core for the MOVAR data.

	HYCOM/CODA				MOVAR
	Coastal Region	AX97			
	2004-2012		Cruise days	Geostrophic	
Minimum mean velocity (Standard Deviation) (m/s)	-0.33 (0.24)	-0.39 (0.24)	-0.34 (0.21)	-0.26 (0.16)	-0.11 (0.28)
Zonally integrated transport (Standard Deviation) (Sv)	-2.36 (1.58)	-9.07 (7.47)	-7.92 (8.14)	-3.44 (1.65)	-1.80 (2.07)

Table 1: Minimum average and variability of the cross-transect velocity (m/s) from HYCOM/NCODA and MOVAR. Integrated volume transport (in Sv, referenced to 400 dbar) at the end of the transect from HYCOM/NCODA and MOVAR.

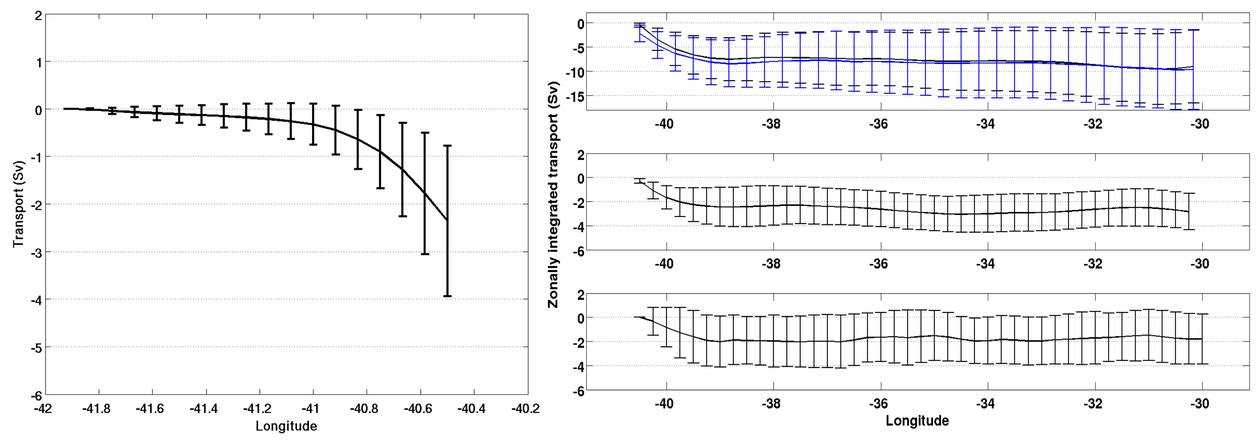

Figure 3: Mean and variability of the Integrated volume transport (in Sv, referenced to 400 dbar). HYCOM/CODA mean total transport at the coastal transect (left panel) and at the AX97 transect (right top panel) for the cruises days (blue line) and for the 2004 to 2012 period (black line). Mean geostrophic transport for HYCOM/NCODA (right middle panel) and for MOVAR XBT data (right lower panel).

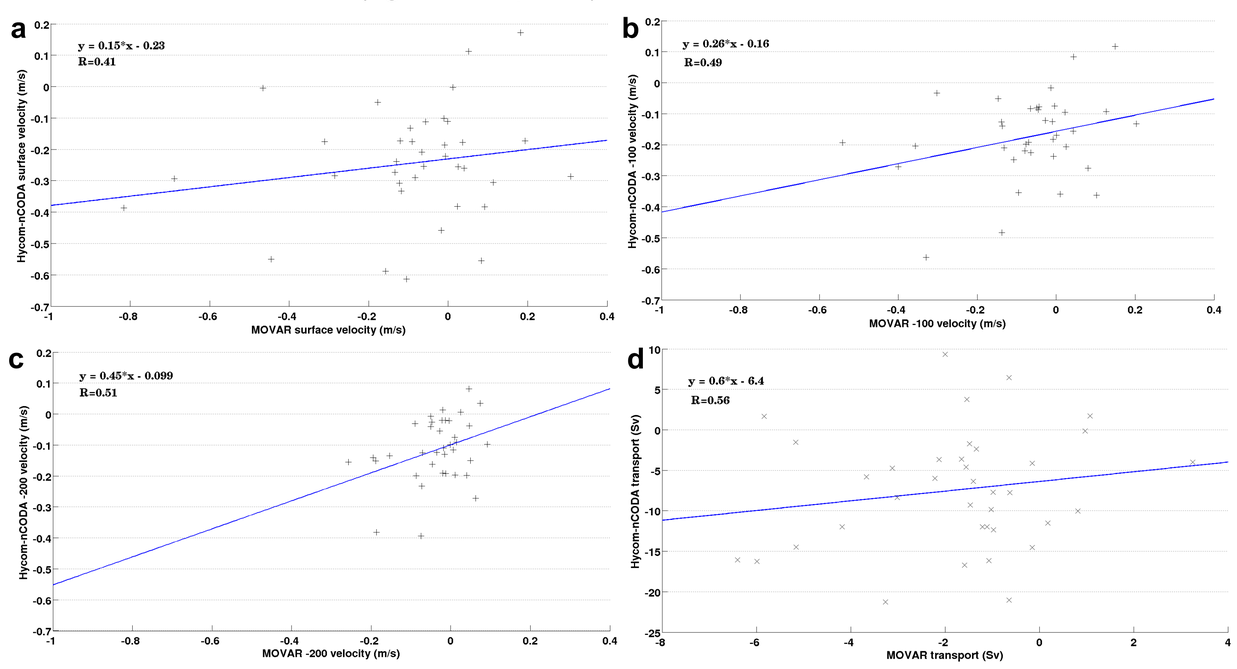

Figure 4: Scatter of the HYCOM/NCODA cross-transect velocity and MOVAR baroclinic velocity, at the BC core (see Figure 2) and HYCOM/NCODA and MOVAR integrated volume transport (in Sv, referenced to 400 dbar) at the end of the AX97 transect. The lines in blue represent the linear trend, while R is the cross-correlation coefficient at a zero lag. Panels a, b and c represent the velocity at the surface, 100 and 200 m depth, respectively, while panel d represents the volume transport.

Conclusions

The model results of the velocity maps for the study area show that the sampling strategy adopted by MOVAR (when considering only the cruise days) was able to capture most of the variability of the BC when compared to the whole period. A similar pattern is also observed for the BC volume transport, but when the model results are compared with the baroclinic volume transport derived from the XBT data, the mean volume transport from the model presents a considerably higher value. This difference in the transport could be associated to the choice of the 400 dbar reference level as the level of no motion.

Future work

While only HYCOM/NCODA has been compared for the AX97 until the present, our goal is to include all the GOV available models in order to perform a multi-model comparison. The analysis of the Met-Office daily outputs from the GloSea5 reanalysis system, which is based on the FOAM data assimilation system with ¼ degree horizontal resolution and the Mercator GLORYS2V3 daily outputs with the same horizontal resolution are already in process.

References

Mata, M. M.; Cirano, M.; Caspel, M. R. V.; Fonteles, C. S.; Goñi, G.; Baringer, M., 2012. Observations of Brazil Current baroclinic transport near 22ºS: variability from the AX97 XBT transect. **Clivar Exchanges**, No. 58, Vol. 17.