REMO OCEAN FORECAST SYSTEM IN THE BRAZILIAN NAVY AND ITS OIL INDUSTRY APPLICATION IN BRAZIL

OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

Renato P. MARTINS[1], João B.R. ALVARENGA[2], Marcelo ANDRIONI[1], Fernando M.S. BATISTA[1], Mauro CIRANO[3], Afonso M. PAIVA[4] , Clemente A.S. TANAJURA[5], José A.M. LIMA[1]

[1]PETROBRAS Research Center, Rio de Janeiro, Brazil, [2]Brazilian Navy Hydrographic Center, Niteroi, Brazil
[3]Meteorology Department, Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil
[4]Program of Ocean Engineering, COPPE, Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil
[5]Physics Institute & Center for Research in Geophysics and Geology, Federal University of Bahia (UFBA), Salvador, Brazil

1 - INTRODUCTION

PETROBRAS, the largest Brazilian oil company works extensively exploiting oil in oceanic sedimentary basins, that cover virtually all Brazilian ocean region. Due to its constant demands for oceanographic information, PETROBRAS grouped a selected team of Brazilian universities (UFRJ, UFBA, FURG and USP) together with the Brazilian Navy to create the Oceanographic Modeling and Observation Network (REMO) aiming to develop ocean modeling with focus in short-term forecasts.

REMO started to produce operational daily ocean forecasts in February 2010, going through successive improvements until now. The first forecast system was based on a 21 sigma-theta hybrid vertical layers of HYCOM with 1/4°, 1/12° and 1/24° horizontal resolutions covering the Atlantic Ocean, the METAREA V and the Southwestern Atlantic, respectively. The latter includes tidal forcing as lateral boundary conditions.

Today, REMO forecast system assimilates vertical T/S profiles from ARGO, SST from OSTIA and along-track SLA from AVISO employing the Ensemble Optimal Interpolation method. The system runs operationally at the Brazilian Navy Hydrographic Center and PETROBRAS disseminates the 1/12° and 1/24° domain daily forecasts to all sectors of the company through an opendap server.

2 - OCEAN OBSERVATION AND FORECAST EVALUATION

In addition to its effort in ocean modeling, PETROBRAS has also been working on ocean monitoring, maintaining current meters installed in some production platforms, focusing on their main offshore production basins, Campos and Santos. Based on these current measurements and public available oceanographic data, as SST from MUR and SSH from AVISO (Figure 1), the oceanographic team produces the best possible nowcasts to support a wide variety of maritime activities. The ocean nowcasts produced based on measured data are also used to evaluate REMO and other public ocean forecasts, such as HYCOM/NCODA and MERCATOR, in order to identify the best short-term prediction for PETROBRAS specific needs, what is always a hard task, as it can be seen in Figure 2.

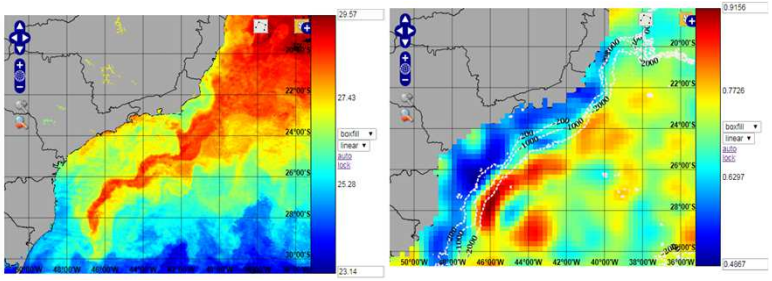

Figure 1– SST field from MUR (left) and SSH field from AVISO (right).

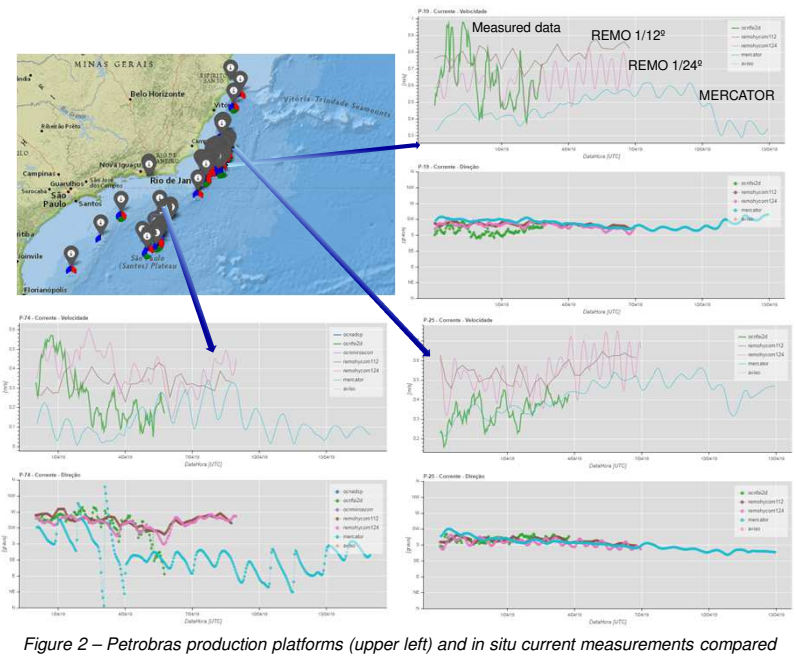

Figure 2 – Petrobras production platforms (upper left) and in situ current measurements compared with model results.

3 - REMO OCEAN MODEL DEVELOPMENT

Aiming to improve ocean forecast for PETROBRAS and Brazilian Navy applications, the REMO operational forecast system is being upgraded to a model configuration with 32 sigma-2 hybrid vertical layers of HYCOM using 1/12° and 1/24° horizontal resolutions for the Atlantic Ocean and METAREA V (Figure 3), respectively, with tidal forcing in the latter.

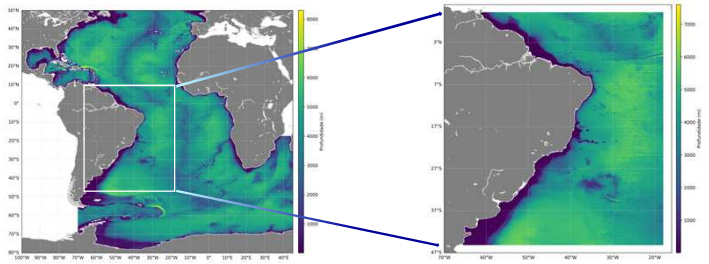

Figure 3 – Atlantic 1/12° model domain (left). METAREA V 1/24° model domain (right).

Long free-run experiments with the new system have already shown great improvements in model results, particularly at the intermediate circulation levels of the Southwestern Atlantic, a region of major interest for the oil industry in Brazil (Figure 4, right panel).

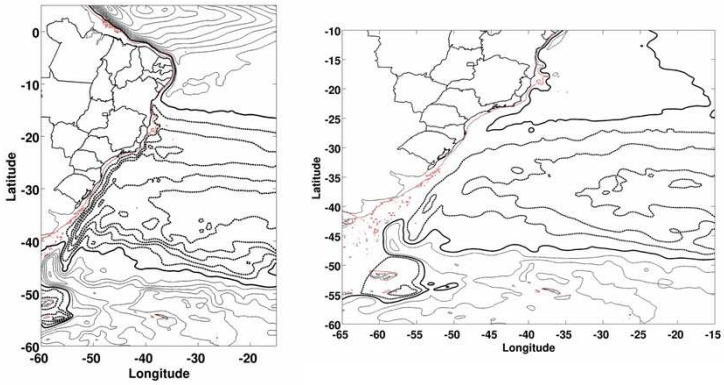

Figure 4 – Stream function of 2000-2002 mean circulation from Atlantic 1/12° model results. South Equatorial Current bifurcation at 50 m level (left) and at 800 level (right), showing good agreement with literature (Stramma and England, 1999, Rodrigues et al., 2007, Boebel et. al., 1999). Red lines indicate 200 m isobath.

Two different data assimilation schemes have been tested and implemented with good results. The REMO Ocean Data Assimilation System (RODAS), based on Ensemble Optimal Intempolation (EnOI), was developed under REMO in collaboration with Prof. Jiang Zhu, Institute of Atmospheric Physics, Chinese Academy of Sciences (Tanajura et al., 2014). The Tendral Statistical Interpolation System, T-SIS (Halliwell et al., 2014), based on Optical Statistical Interpolation, has been implemented in the REMO framework in a collaboration between COPPE/UFRJ and Dr. Ashwanth Srinivsan, from Tendral LCC. Both schemes are able to assimilate SST data, T/S profiles from Argo, CTD casts and gridded or along-track SLA data.

Results from HYCOM+T-SIS experiments (Figure 5) have shown good skills in reproducing eddy-dominated circulation in São Paulo Plateau at Santos Basin.

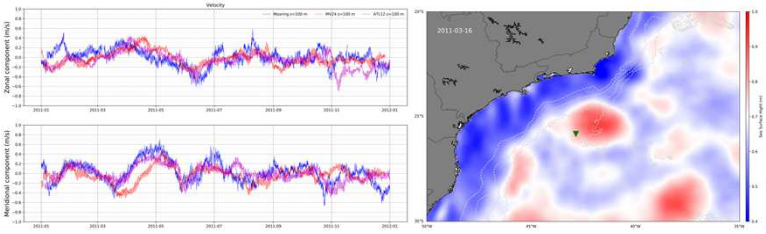

Figure 5 – Measured and model velocity time series at 100 m level (left) and SSH fields ATOBA project (right). Green triangle indicates mooring location at 2000 m water depth.

4 – FINAL REMARKS

Data assimilation strategies are still under research to improve model results. New assimilative experiments will be extensively validated with *in situ* current data and the new system is planned to start running operationally at Brazilian Navy by the end of 2019.

RELEVANT REFERENCES

HALLIWELL JR, G. R.; SRINIVASAN, A.; KOURAFALOU, V.; YANG, H.; WILLEY, D.; LE HENAFF M.; ATLAS, R., 2014. Rigorous Evaluation of a Fraternal Twin Ocean OSSE System for the Open Gulf of Mexico, American Meteorological Society, 105-130.

TANAJURA, C.A.S., SANTANA, A.N., MIGNAC, D., LIMA, L.N., BELYAEV, K. and XIE, J.,2014. The REMO Ocean Data Assimilation System into HYCOM (RODAS_H): General Description and Preliminary Results, Atmospheric and Oceanic Science Letters, 7, 464-470.