# APPLICATIONS OF REMO OCEAN FORECASTS AND SIMULATIONS IN THE OIL INDUSTRY IN BRAZIL


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***Oceanographic Modeling and Observation Network (REMO)*** ***www.rederemo.org***

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## INTRODUCTION

Petrobras, the largest Brazilian oil company, as many other energy companies, works extensively exploiting oil in oceanic sedimentary basins, that cover virtually all Brazilian ocean region, as shown in Figure 1. For that reason, Petrobras is a heavy user of oceanographic information, such as in situ data, remote sensing fields, and numerical ocean model simulations and forecasts. Environmental impact assessment studies and offshore engineering projects usually make use of model simulations and hindcasts. Ocean forecasts provide key information for maritime activities (e.g. drilling) and emergency actions, such as oil contingency response and search and rescue operations.

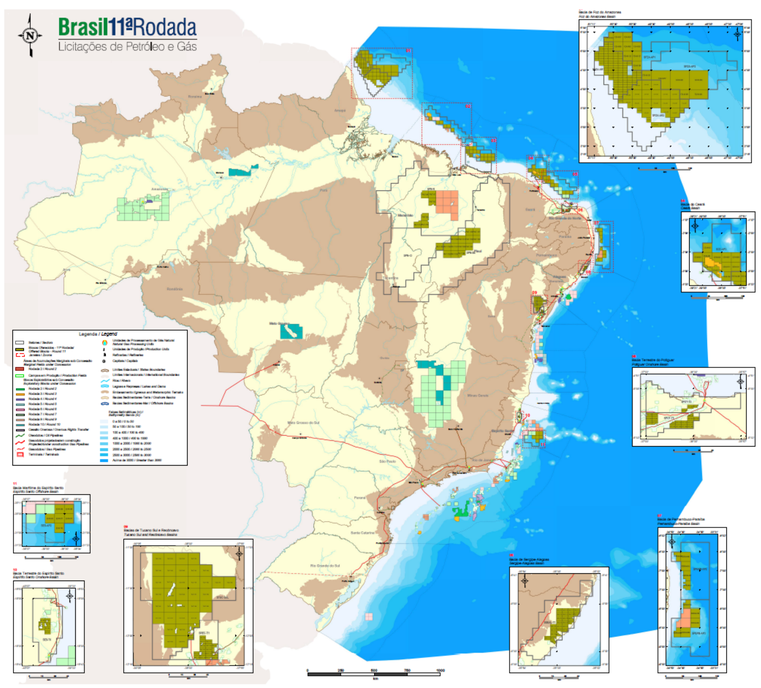


*Figure 1 - Oil and gas activities in Brazil.*

## REMO OCEAN FORECAST SYSTEM

The Oceanographic Modeling and Observation Network (REMO) is a joint research and development project of Petrobras, Brazilian universities (UFRJ, UFBA, FURG and USP) and the Brazilian Navy. It started to produce operational daily ocean forecasts in February 2010 and in February 2012 the system was updated. Today the system is based on HYCOM with 1/4°, 1/12° and 1/24° of horizontal resolution for the entire Atlantic Ocean, for the Atlantic Metarea V and for the Southwestern Atlantic west of 32°W between 12°S and 35°S, respectively (cf. Figure 2).

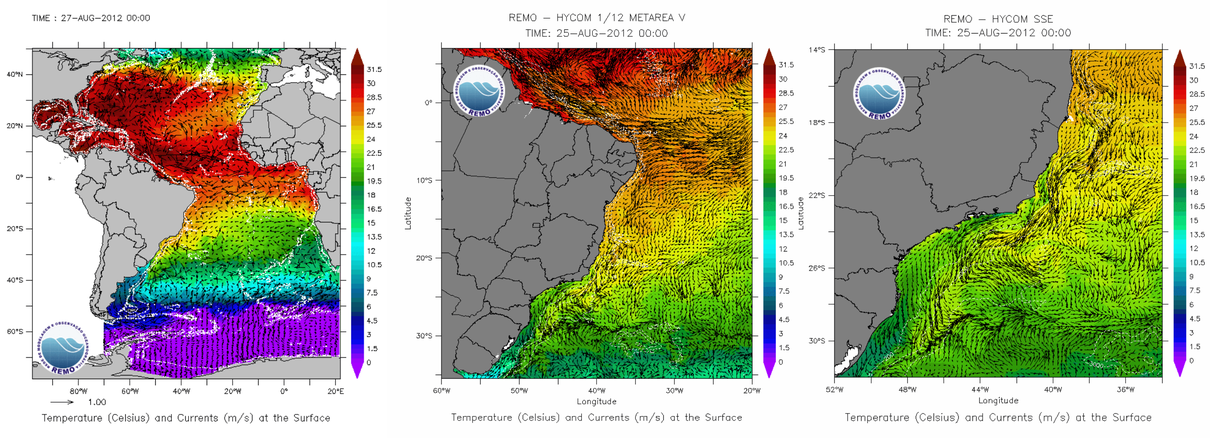


*Figure 2 - REMO forecast system based on HYCOM 1/4°, 1/12° and 1/24°.*

## APPLICATION TO MARITIME OPERATIONS

Petrobras uses these forecasts together with all ocean data available to insure safer operations. Remote sensing and in situ data are analyzed to provide ocean diagnostic and model forecast validation (cf. Figure 3). The current fields from the 3-day forecasts are used daily by the team responsible for oil contingency to plan response activities.

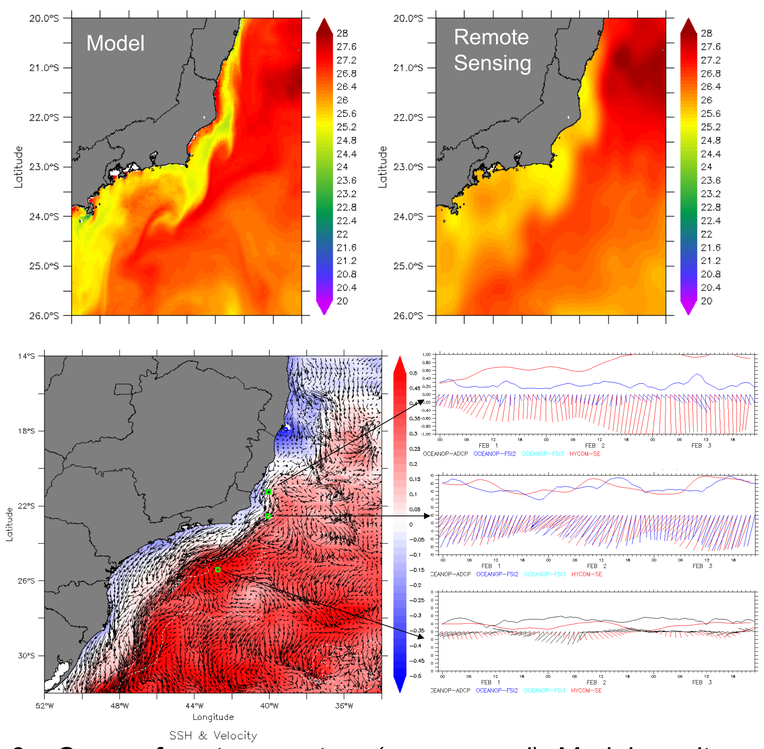


*Figure 3 – Sea surface temperature (upper panel): Model results x remote sensing data; Currents (lower panel) – Model results x in situ data*

Drilling activities are also planned with the aid of current forecasts, so that they can take into account the possibility of currents exceeding an operation threshold. This is particularly relevant in Brazilian northern continental margin, where the North Brazil Current usually reaches more than 1.5 m/s (cf. Figure 4).

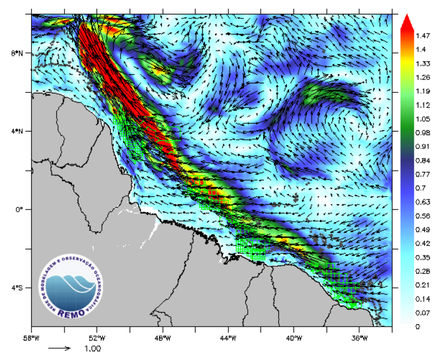

*Figure 4 - REMO current forecast for the Brazilian northern continental margin.*

## REMO OCEAN HINDCAST

The modeling system developed by REMO (figure 2) was also used to build a 10-year simulation to be applied in environmental impact assessment and off-shore structure design. The hindcast showed a very good agreement with in situ and remote sensing data, as well as with literature review. Figure 5 shows the Brazil Current transport computed with model results compared with literature data (upper panel) and the comparison between current in situ data and model results at Southeast Brazil (lower panel).

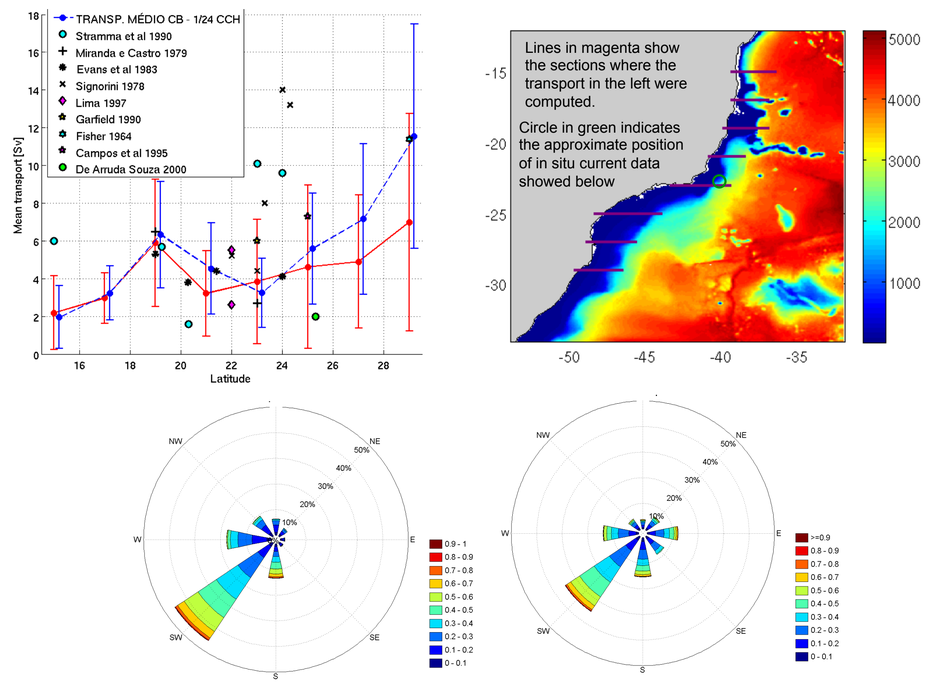


*Figure 5 – Brazil Current transport (upper panel): model hindcast x literature; Currents frequency distribution (lower panel): model hindcast (left) x in situ data (right)*

## ENVIRONMENTAL IMPACT ASSESSMENT

The time series of the hindcast current field is used as input for oil spill stochastic modeling to assess the probability of oil reaching the shore, as illustrated in Figure 6. This is a regular requirement of the Brazilian Environmental Agency to issue installation and operation licenses. Improvements on the mesoscale current forecasts and simulations will certainly lead to safer operation.

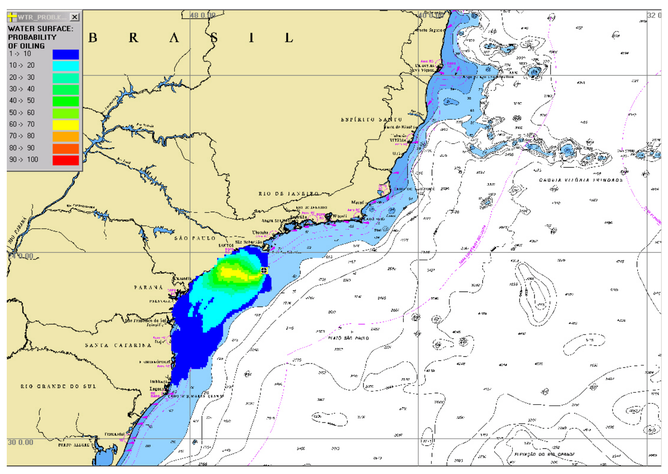


*Figure 6 - Example of probabilistic contours from stochastic oil spill modeling using REMO 1/24° model hindcast.*

## OFFSHORE ENGINEERING PROJECTS

REMO 10-year current hindcast can also be applied to ocean engineering projects, e.g., the computation of restriction diagrams for dynamic positioning plataforms (cf. Figura 7). These diagrams are required by the classification societies for the critical case in which the platform drifts caused by complete fail in the propulsion system.

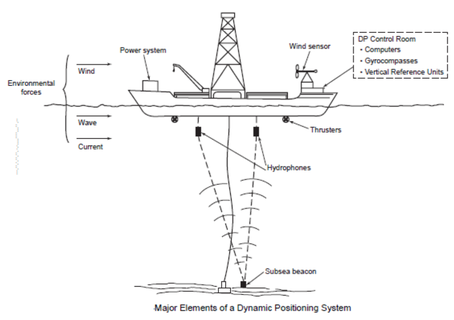


*Figure 7 – Layout of a dynamic positioning platform under the action of winds, currents and waves.*