



Connecting the world around ocean forecasting



Applications of operational oceanography in protecting
human lives and the marine environment.

Capt(Ret) Luiz Claudio





SUMMARY

- **Overview**
- **Oil Spill Model – CMOP**
 - **Real Cases**
- **SAR Model – SPAD-SAR**
 - **Real Case**
- **Final Considerations**





OVERVIEW

- The Oceanographic Observation and Modeling Network (REMO) Project began in 2008.
- A partnership between the Brazilian Navy, the Brazilian Oil Company Petrobras and Universities (UFBA e UFRJ).
- First operational oceanographic model in Brazil.
- Support to the Marine Meteorological Service.

Navy	PETROBRAS
Safety of the navigation and support to the Naval Power	Support to the offshore activities
Operational Infrastructure and Human Resources	Funds

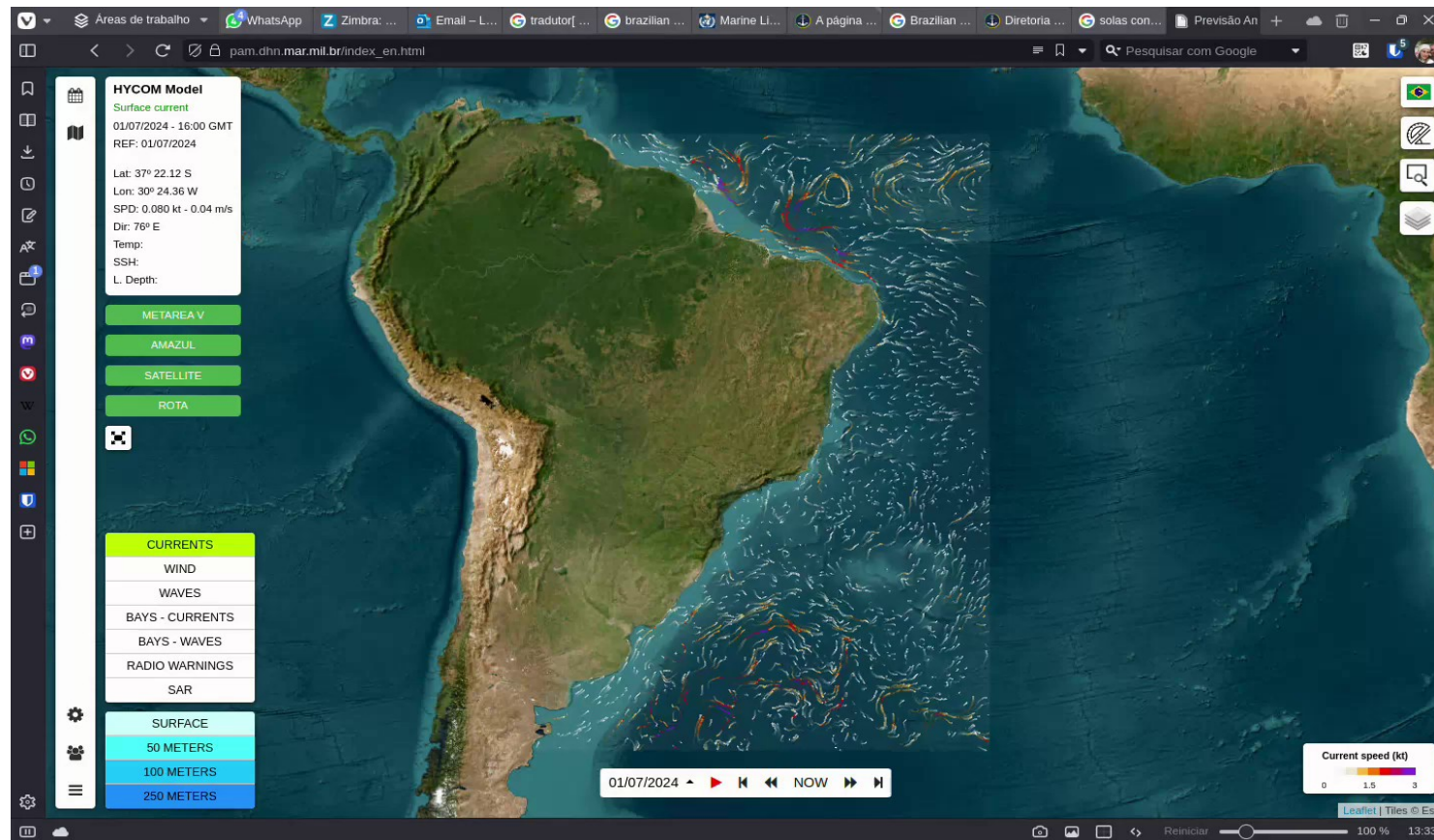




OVERVIEW

MARINE ENVIRONMENTAL FORECAST (PAM)

https://pam.dhn.mar.mil.br/index_en.html





OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP

- The CMOP (Tessarolo et al., 2023; Tessarolo et al., 2022, Barreto et al., 2021) has three individual components to model different stages of an oil spill. the **plume dynamic**, the **advection-diffusion** and the **surface** modules;
- It's implemented with the following physicochemical processes: oil dissolution, gas dissolution, formation, dissolution and decomposition of hydrates, gas separation from the main plume, water entrainment in the plume, evaporation, emulsification, and vertical dispersion;
- It's possible to use the CMOP along with different models as an input. Such as: Mercator, Delft3D, ADCIRC, HYCOM, GFS, ICON;
- The main code is in Fortran with several post processing scripts in Python.





OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP

The screenshot displays the CMOP 0.1.8 software interface, titled "DEFINE SIMULATION PARAMETERS". The interface is organized into several sections:

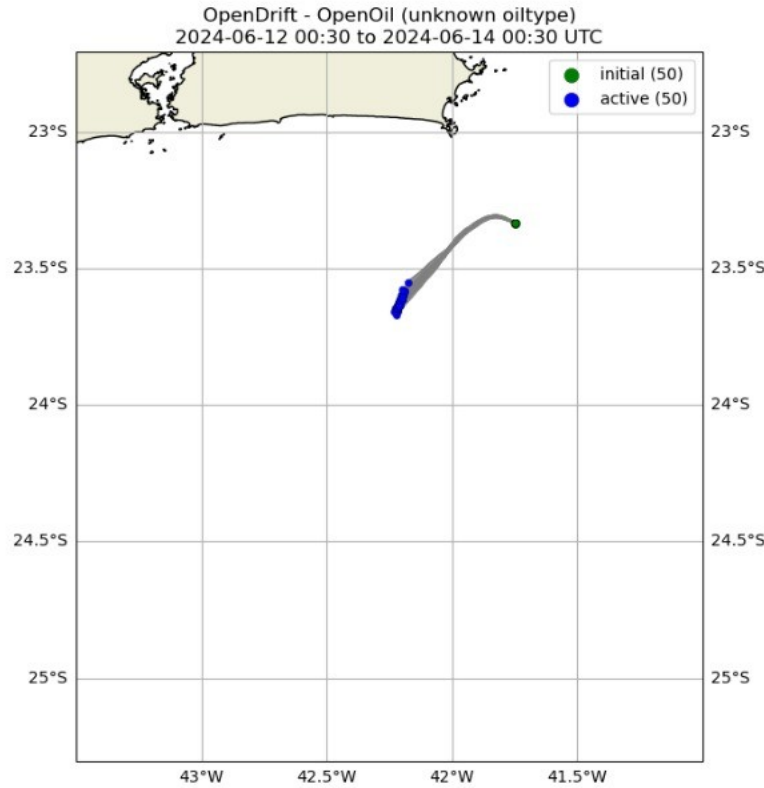
- Left Panel:** Features the logos of the Brazilian Navy (MARINHA DO BRASIL) and the REMO network. Below them is a large yellow circle with a black oil drop icon and the text "CMOP" and "Coupled Model for Oil spill Prediction". At the bottom, it reads "Rede de Modelagem e Observação Oceanográfica".
- Simulation Period:** Includes fields for Start Date (27/05/2024), Hour (0), Minute (0), and Second (0). It also has input fields for Time step, Running time in hours, and Output frequency in hours.
- Release Information:** Contains fields for LAT and LON, Volume (m³), and Number of particles. There is a radio button for "Reverse in time" and a red warning message: "Please, turn on physical chemical processes".
- Processes:** A list of checkboxes for simulation processes: Dissolution, Emulsification, Evaporation, Entrain, Theoretical, and Dissolved phase. The first four are checked.
- Spill and Dispersion:** Includes a dropdown for "Type of oil" (with "Oil specs" button), a field for "Horizontal dispersion coefficient", and input fields for "Depth of spill (negative)", "Wind coefficient", "Duct width", and "% of water in spill (0-10)".
- Wind Theoretical and Other Options:** Features checkboxes for "Wind theoretical" (with "Off. Read U and V from files" text) and "Avel" (with "Additional velocity of object" text). It includes input fields for UWD, VWD, Object velocity (ovel), and Object direction (odir), and a "Time finish" field (0 is instantaneous).
- Coupling:** Includes a checkbox for "Coupling" (with "Turn on/off coupling" text) and buttons for "Load from input.dat", "Save to input.dat", "Inputs", "View results", and "Start Simulation".
- Bottom:** A "Clear" button is located at the bottom left of the main configuration area.



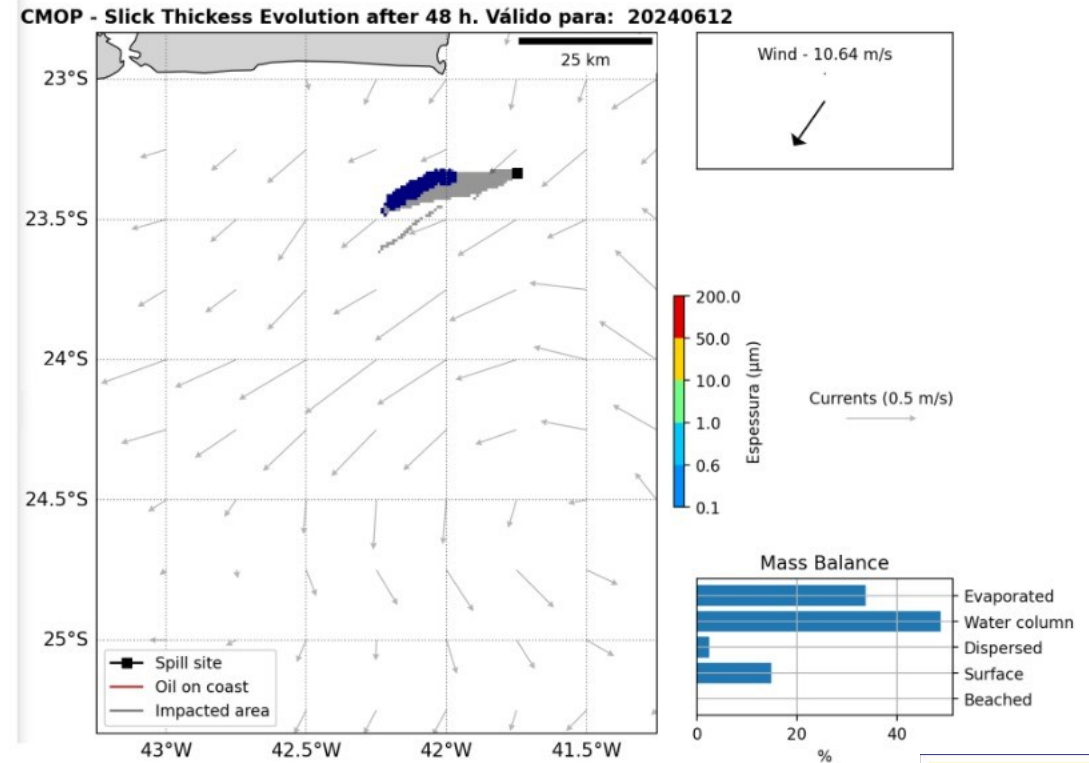


OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 01 - Comparison



OpenDrif



CMOP



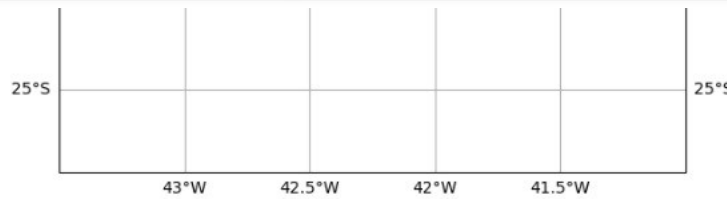
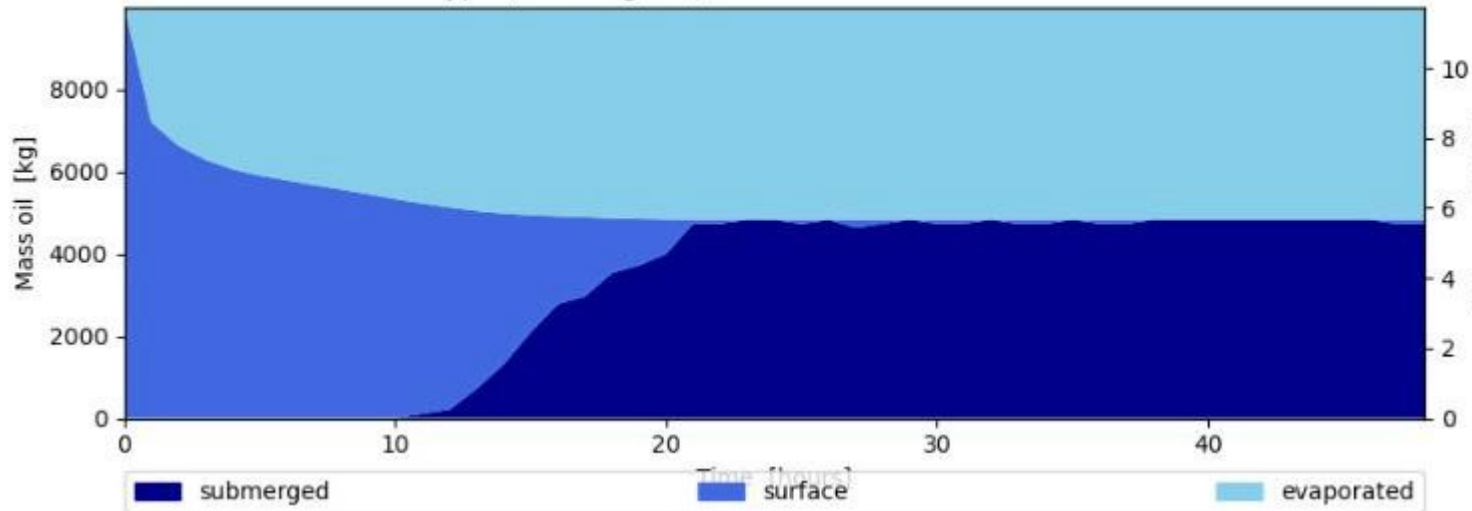


OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 01 - Comparison

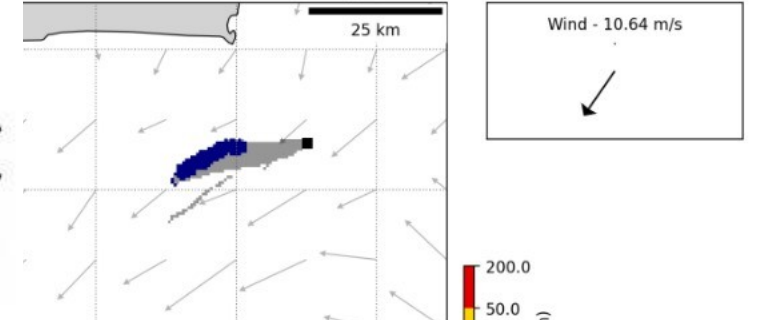
OpenDrift - OpenOil (unknown oiltype)
2024.06.12 00:30 to 2024.06.14 00:30 UTC

unknown oiltype (852.1 kg/m3) - 2024-06-12 00:30 to 2024-06-14 00:30

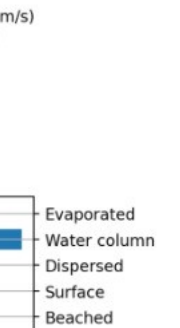
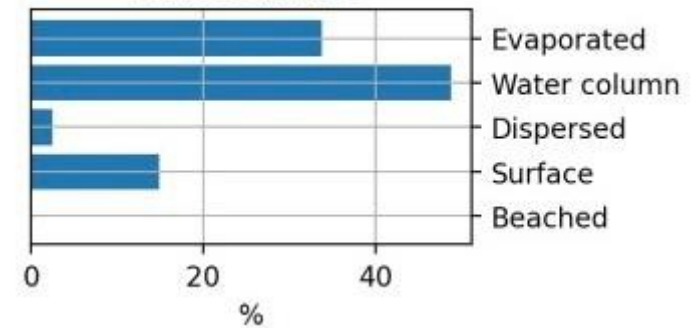


OpenDrift

Oil spill Evolution after 48 h. Válido para: 20240612



Mass Balance



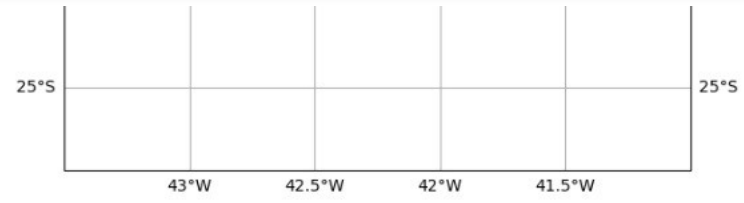
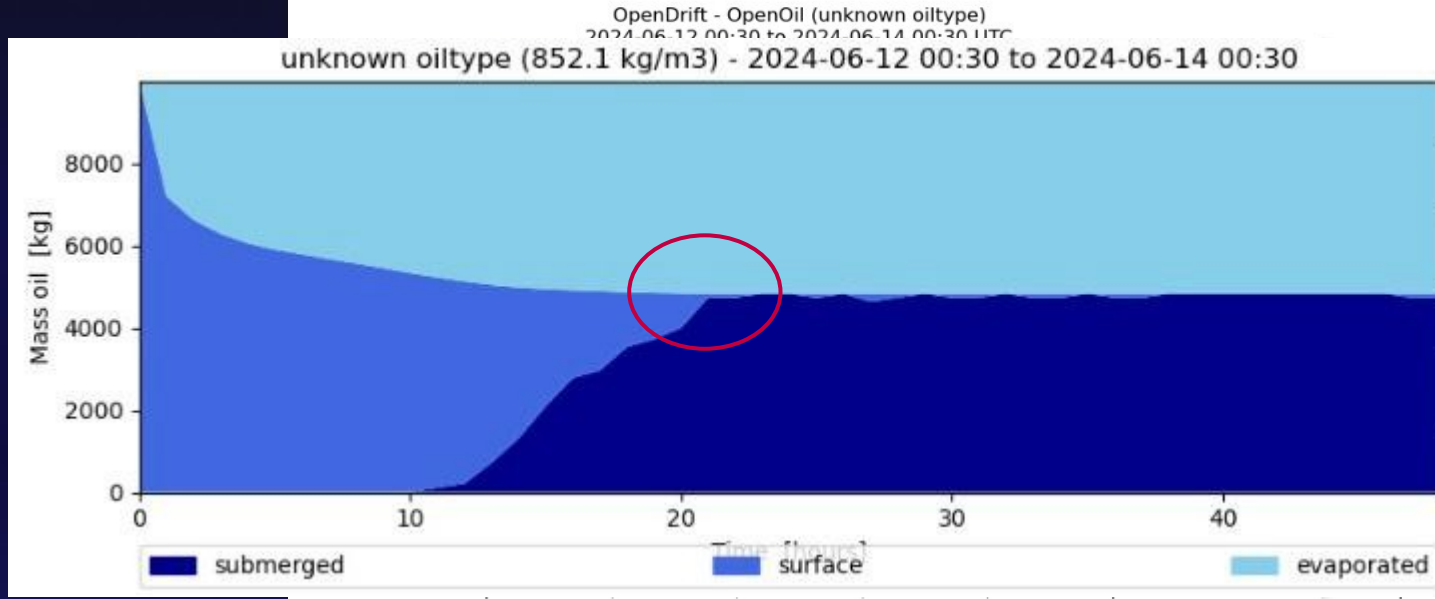
CMOP



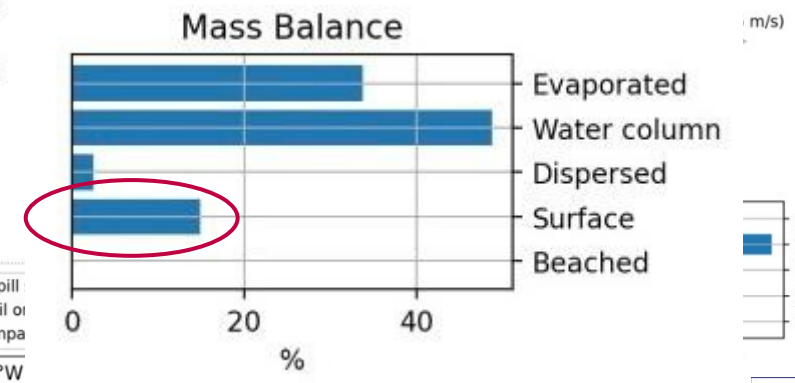
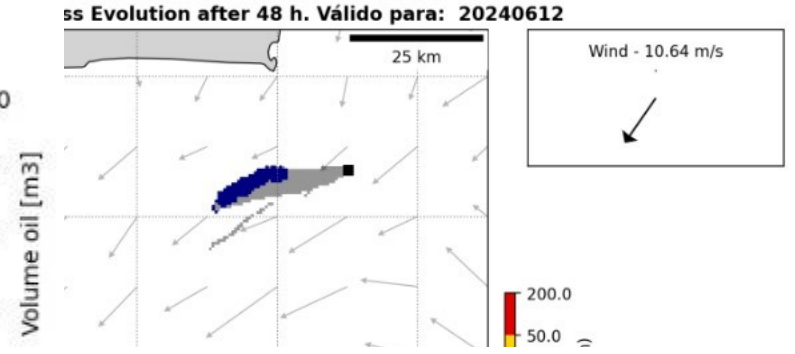


OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 01 - Comparison



OpenDrift



CMOP





OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 02 - Reverse Modeling

- Investigation of the origin of an oil slick identified in a certain position with an estimated initial area of 70,732 km² and volume between 7,073 and 21,220 m³;
- The reverse modeling was carried out with all physical-chemical processes deactivated. In this simulation, only the transport module was used;
- Current and wind data from HYCOM-CHM and GFS were used to force the model;
- As the stain shape file was available, it was inserted directly into the model. This is a crucial feature in reverse modeling studies;

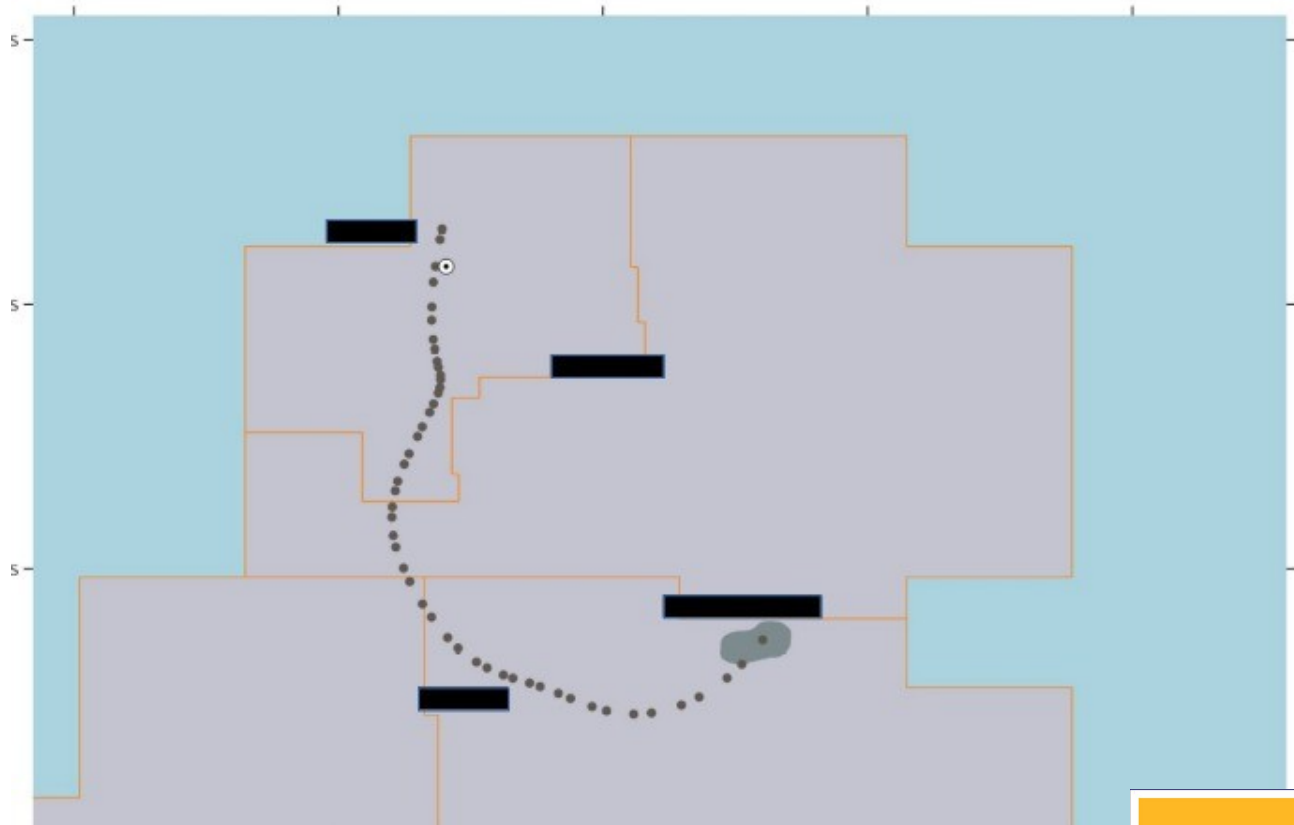




OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 02 - Reverse Modeling

- The result of the reverse modeling for 2 days, where the model accurately guessed the origin of the spill is presented.
- Measures to contain and mitigate environmental impacts could be planned and taken.

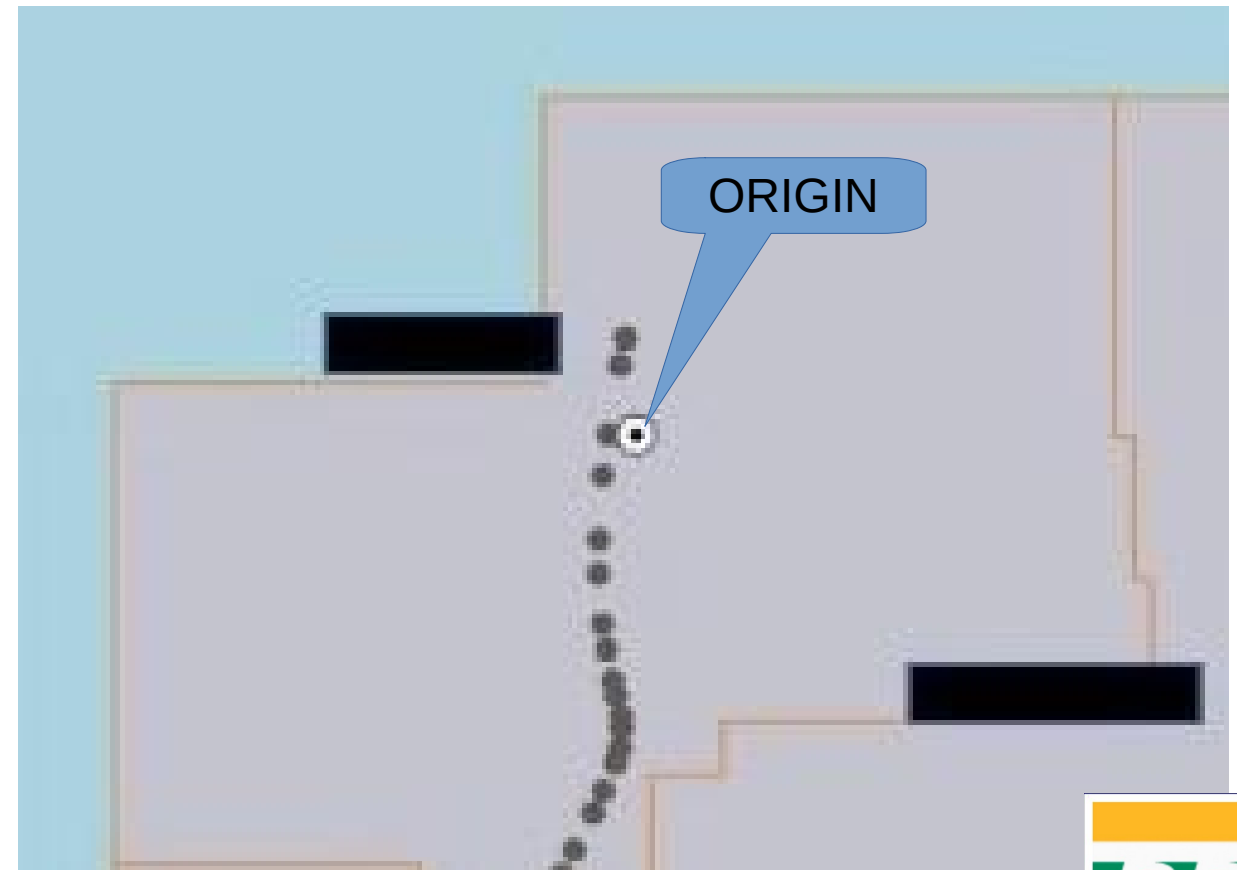




OIL SPILL MODEL - CMOP

Coupled Model for Oil spill Prediction – CMOP Case 02 - Reverse Modeling

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SAR MODEL – SPAD-SAR

Planning and Decision Support System in SAR Operations - SPAD-SAR

- SPAD-SAR is a system developed to predict the trajectories of objects drifting at sea, in progressive and regressive mode over time, using environmental modeling information to improve the quality of the forecast and automatically querying databases.
- The system was developed based on the need to speed up the planning and monitoring of SAR operations, in addition to improving the accuracy of calculations on the actions resulting from the activation of the SAR Operational Team.
- The SPAD-SAR system involves a network of Rescue Coordination Centers (RCCs) and utilizes various resources such as patrol vessels, aircraft, and trained personnel to execute search and rescue missions efficiently.;
- One of the main success factors for SAR missions is the **accuracy of the environmental conditions** at the search location entered into the system.



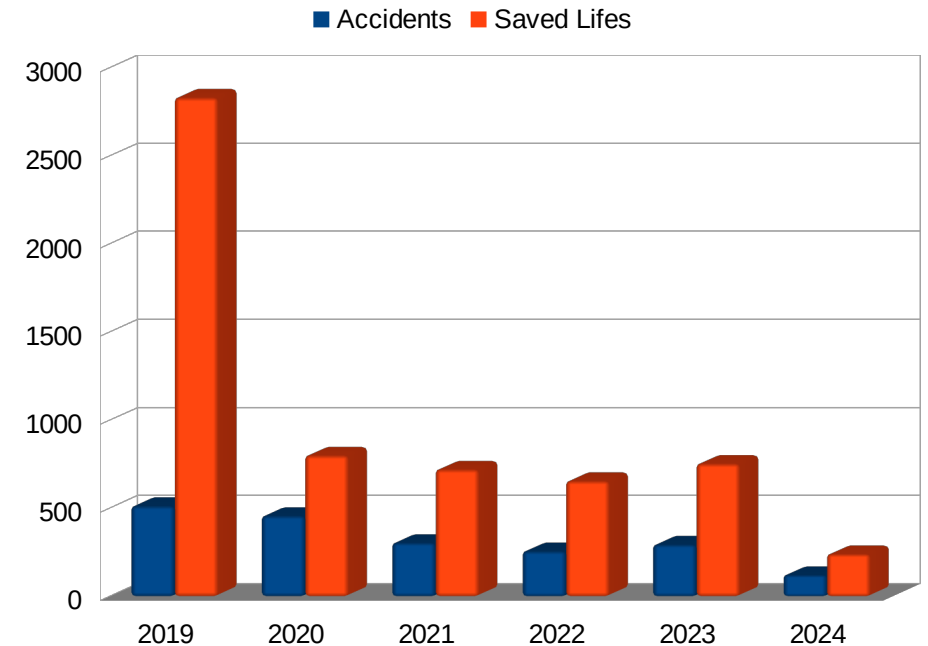
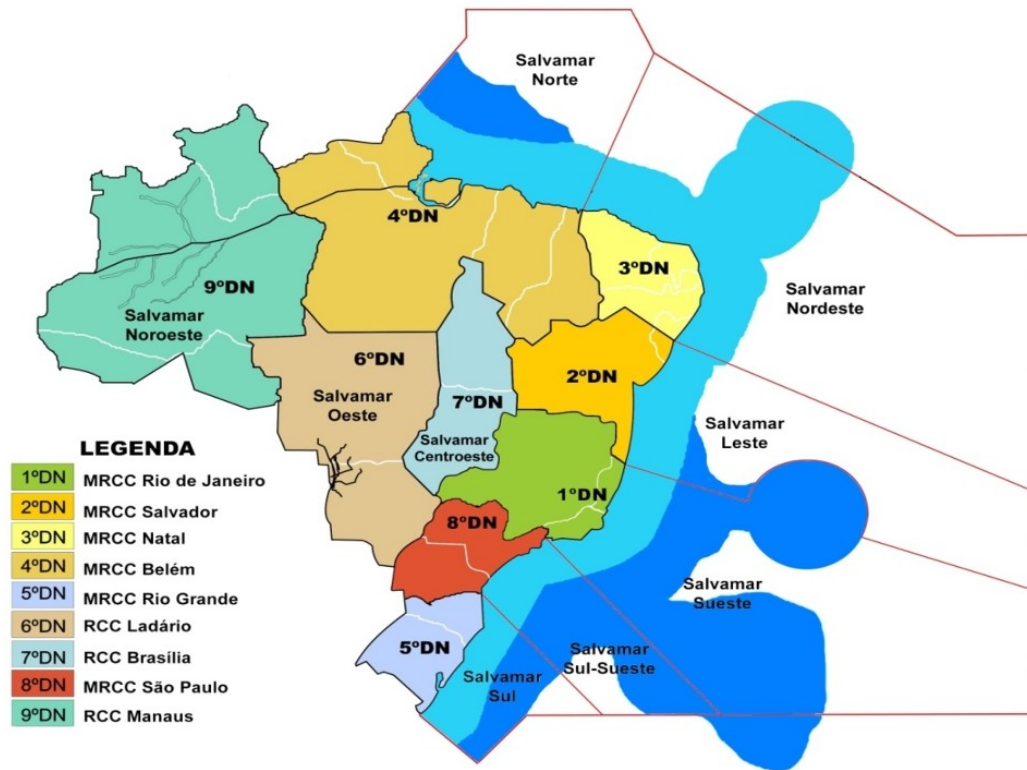
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SAR MODEL – SPADSAR

Planning and Decision Support System in SAR Operations - SPADSAR



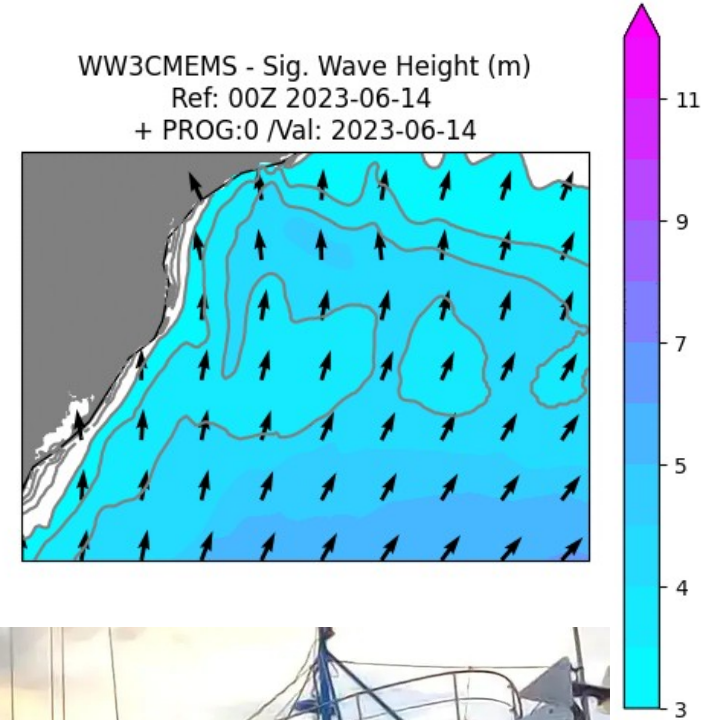
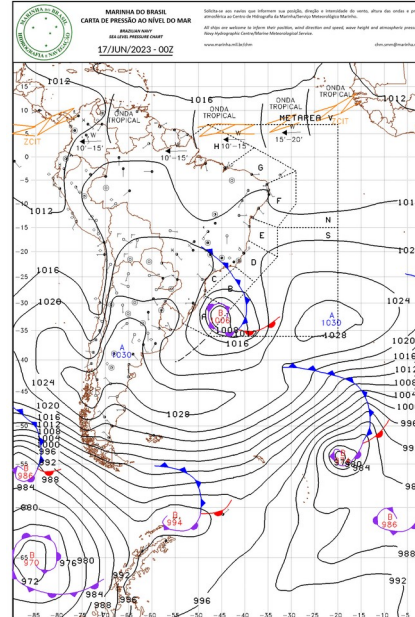


SAR MODEL – SPADSAR

Planning and Decision Support System in SAR Operations - SPA-DSAR

Case 01 – Fishing Boat

➤ Despite the the bad weather forecast and high seas warnings issued by the Brazilian Navy, the fishing vessel *Safadi Seif* left with 8 people on board to 200 km off Santa Catarina's coast in southern Brazil.



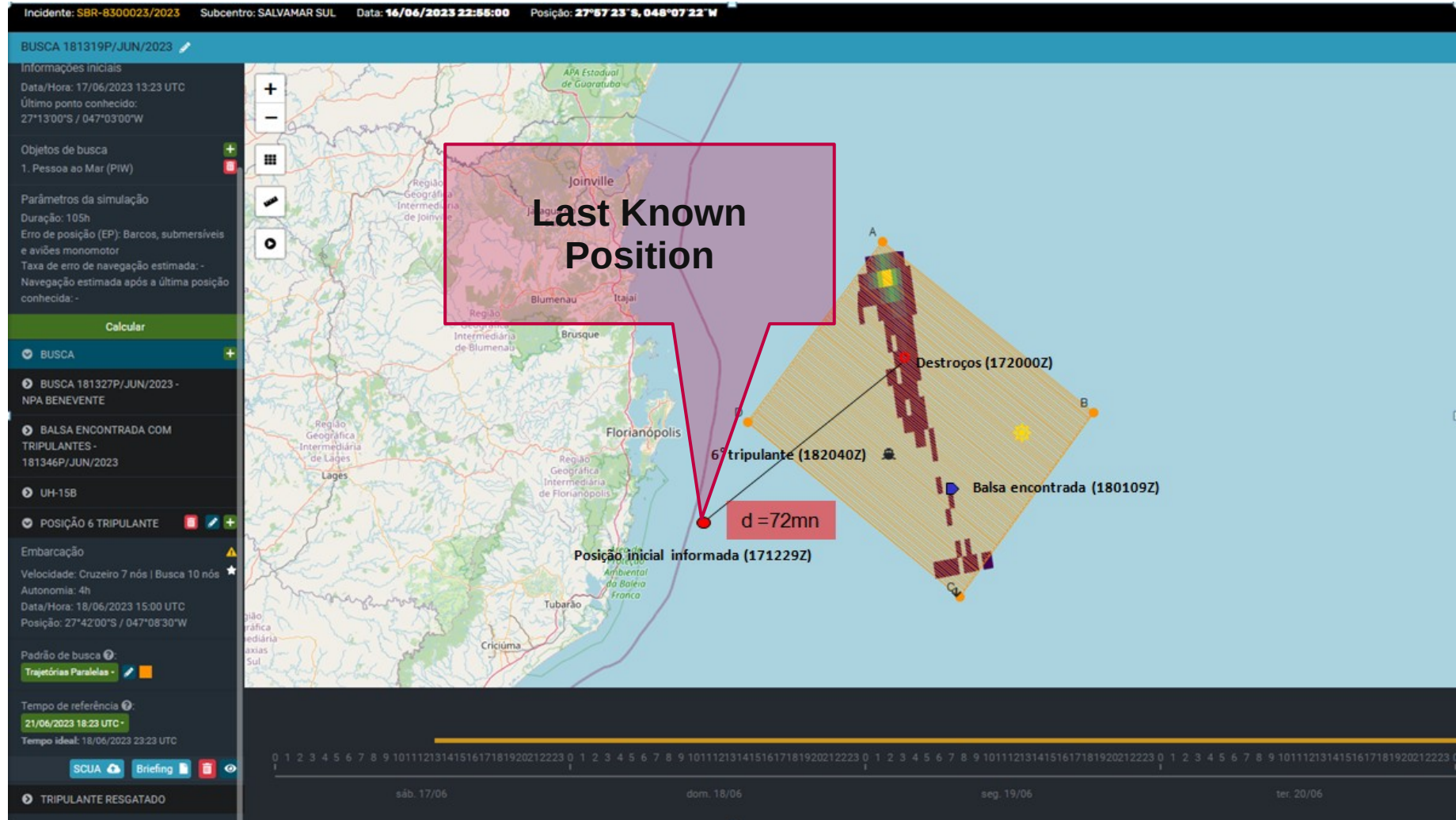
➤ On the night of June 16, 2023, the boat sank and the following day the search for survivors began.





SAR MODEL – SPADSAR

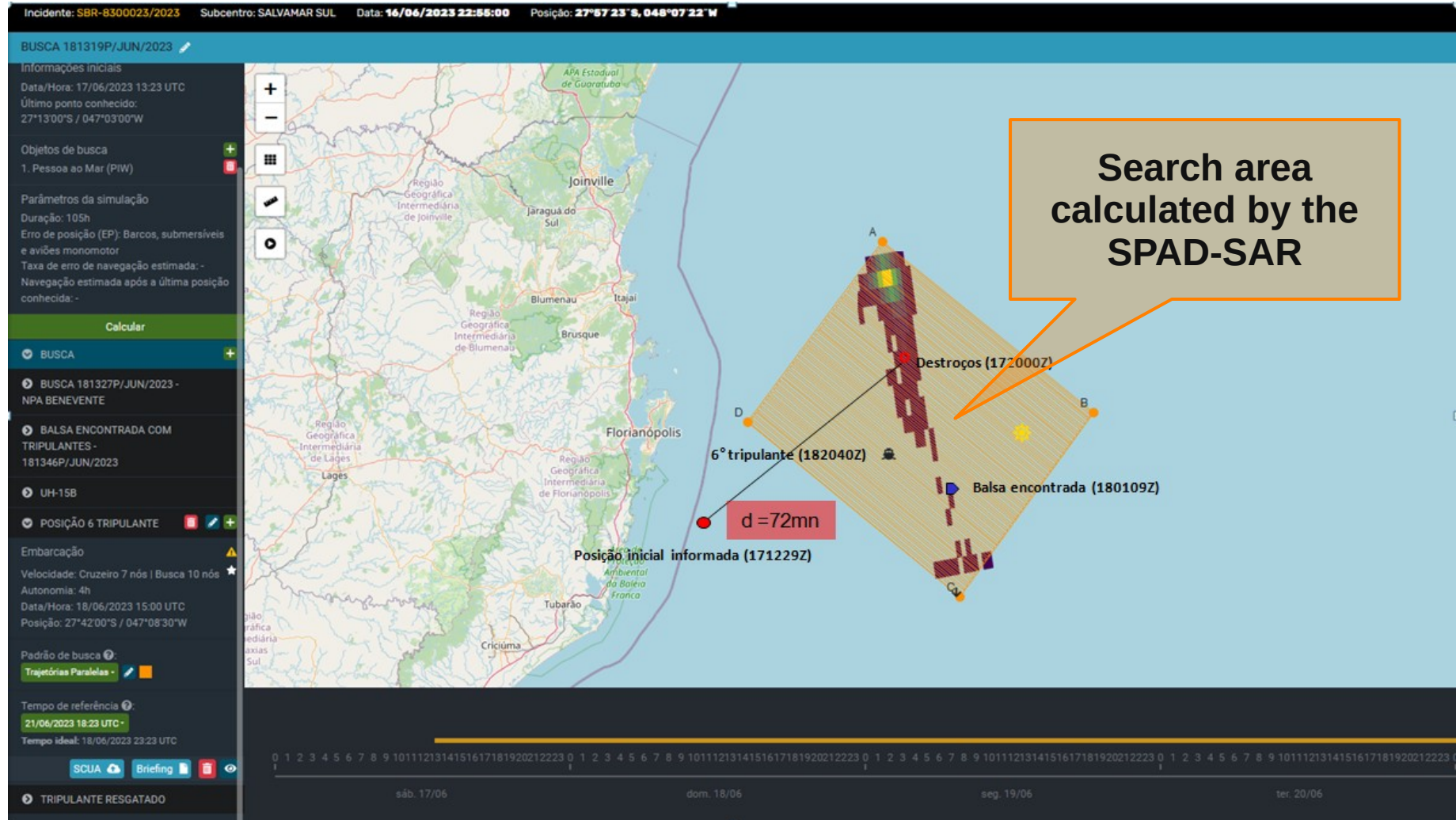
Planning and Decision Support System in SAR Operations - SPADSAR





SAR MODEL – SPADSAR

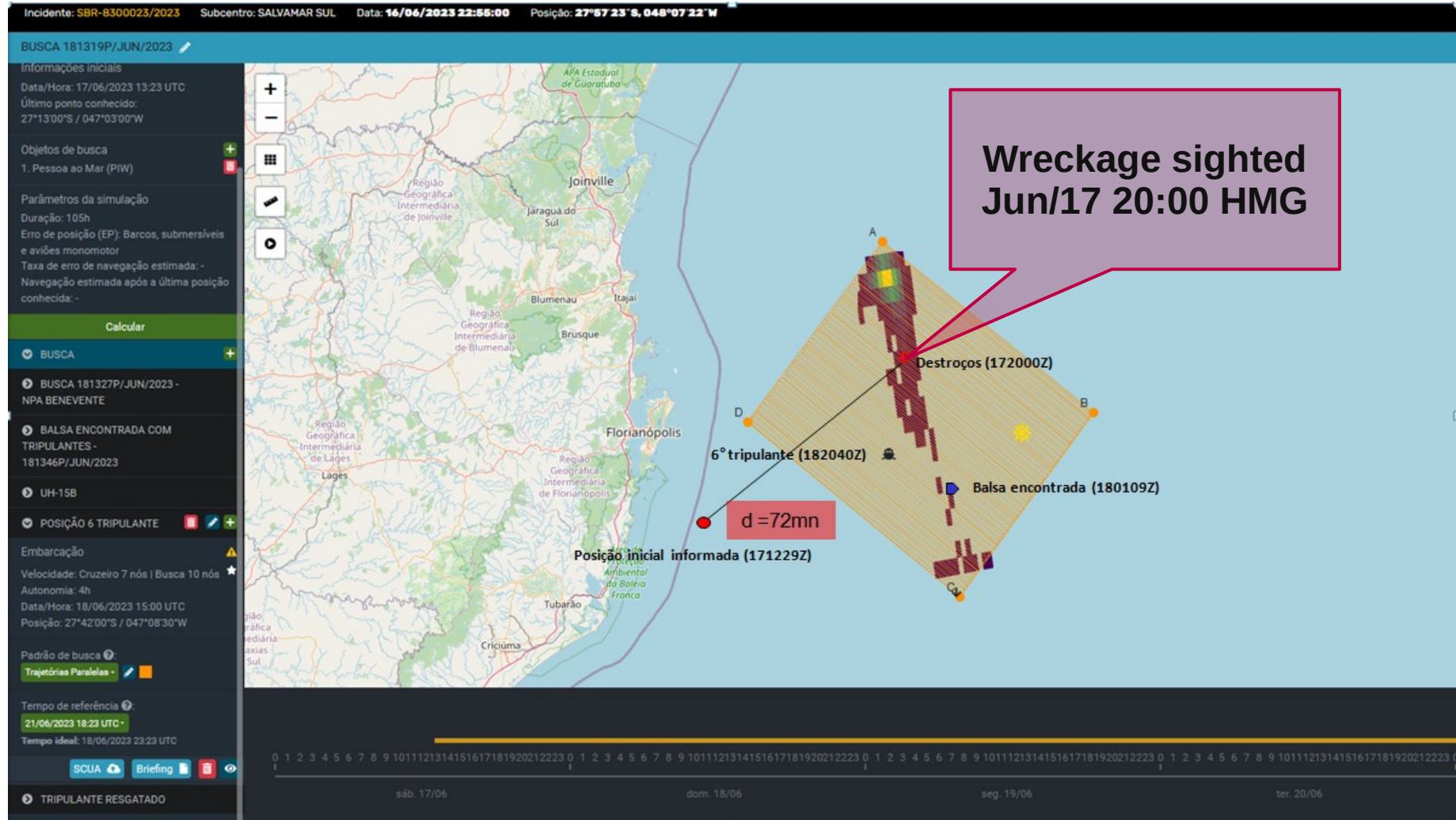
Planning and Decision Support System in SAR Operations - SPADSAR





SAR MODEL – SPADSAR

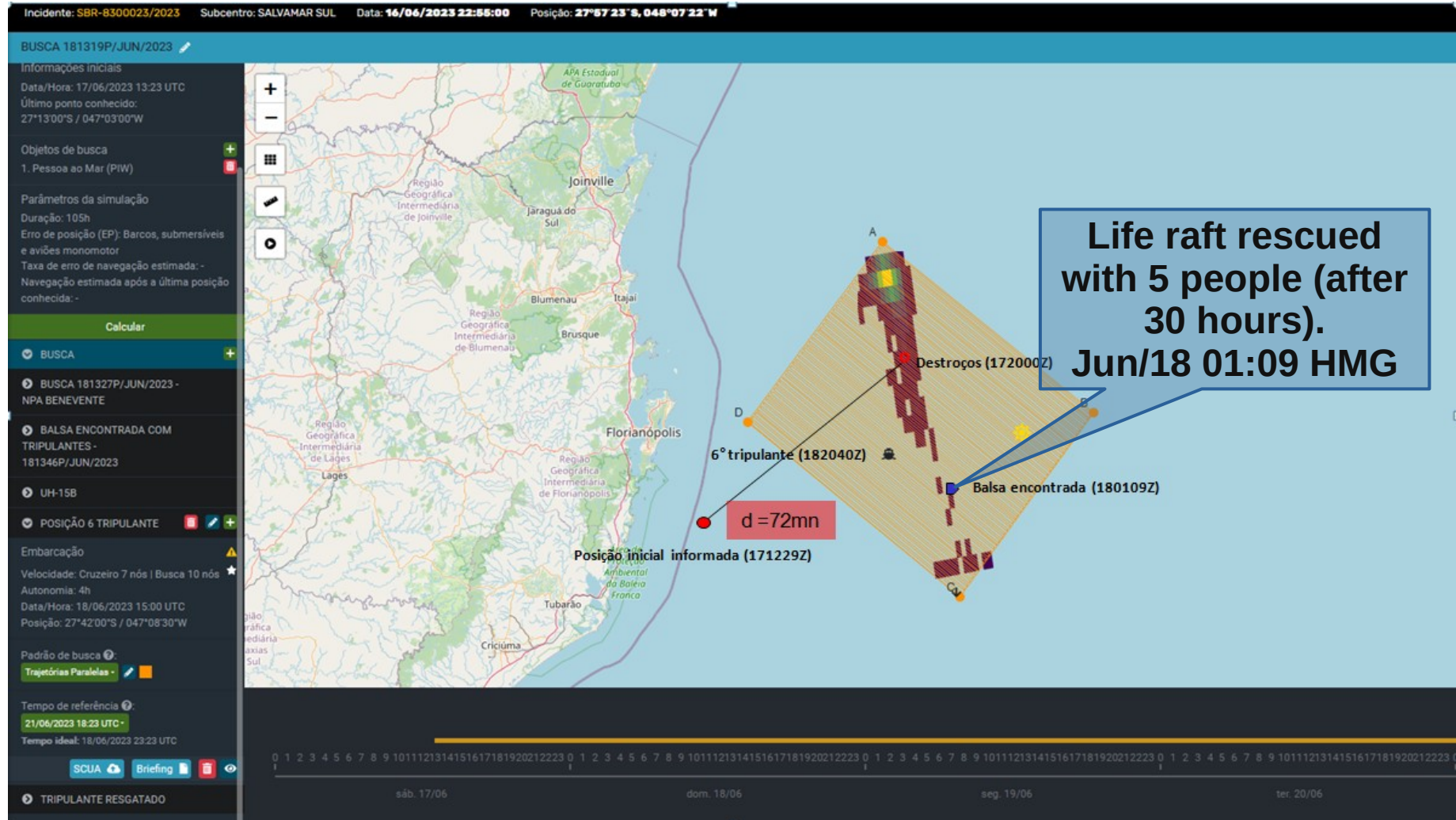
Planning and Decision Support System in SAR Operations - SPADSAR





SAR MODEL – SPADSAR

Planning and Decision Support System in SAR Operations - SPADSAR





SAR MODEL – SPADSAR

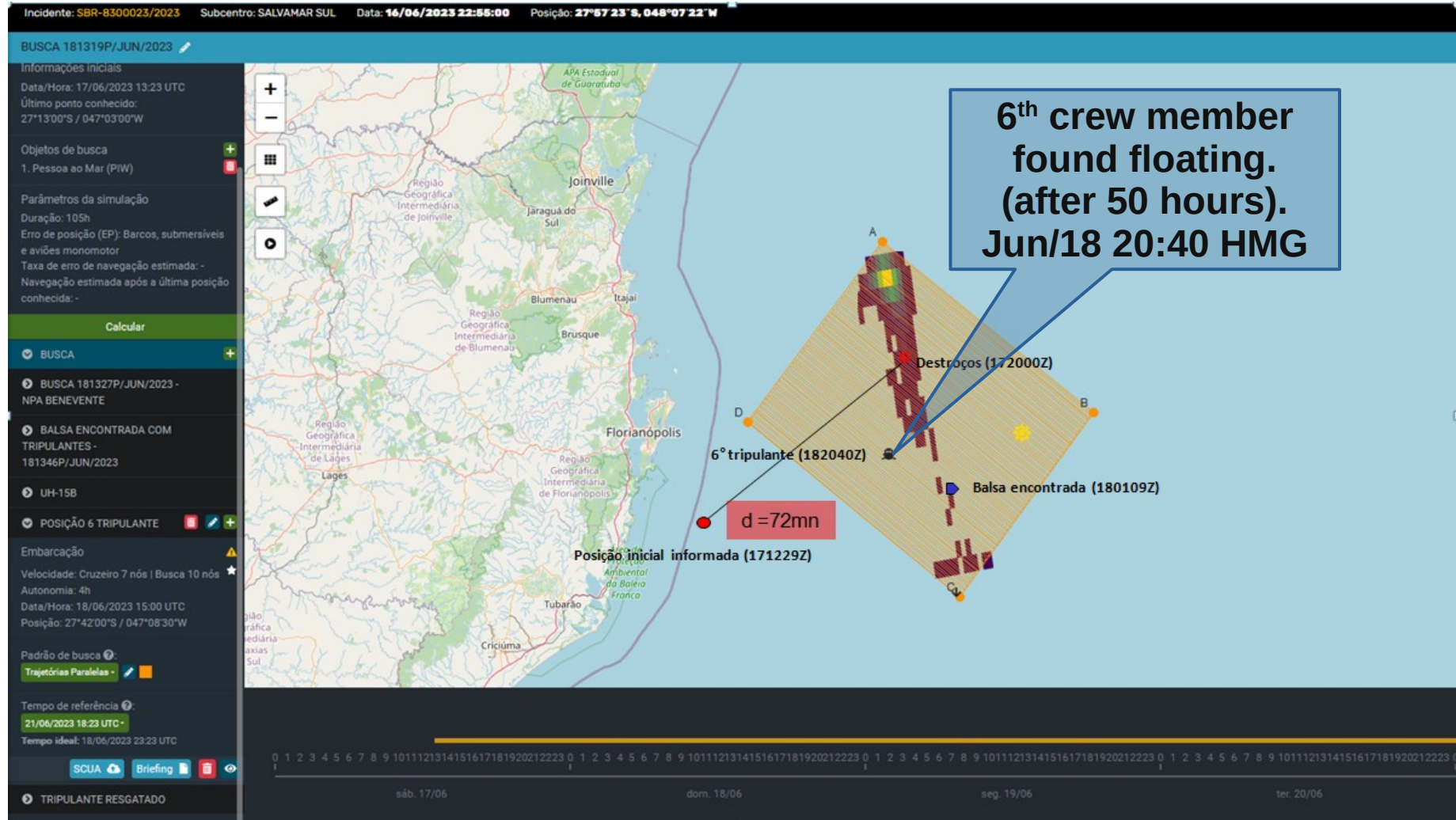
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SAR MODEL – SPADSAR

Planning and Decision Support System in SAR Operations - SPADSAR





SAR MODEL – SPADSAR

Planning and Decision Support System in SAR Operations - SPADSAR





FINAL CONSIDERATIONS



- There are no doubts within the maritime community regarding the importance of protecting human life at sea and the marine environment.
- This directly impacts the freight costs and therefore the countries' income.
- In this context, the accuracy of environmental information, whether measured or modeled, is extremely relevant for correct mitigating actions.
- Therefore, it is imperative that any coastal state that seeks to adapt to the demands of the International Maritime Organization has a **reliable operational oceanographic forecast service**.





THANK YOU !!!



“There will always be a lot left to do...”

Capt(Ret) Luiz Claudio
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