Improvements in the Storm Surge forecasting system PronUy_RPFM

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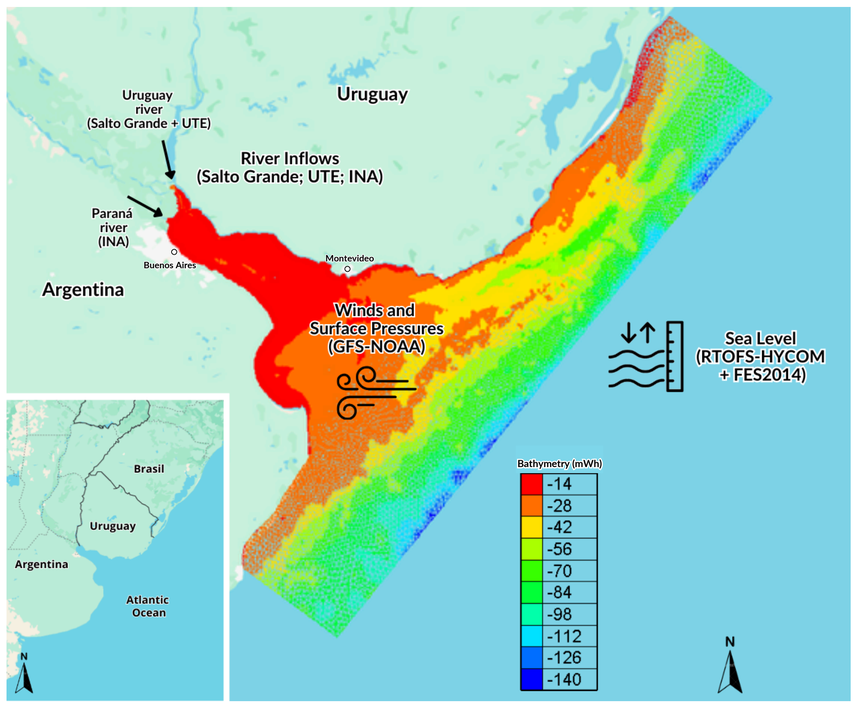
Introduction

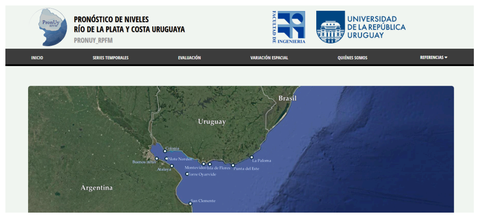
Since 2021, the global forecasting system for the Río de la Plata and Maritime Front, PronUy_RPFM, has been publishing in real time the three-day water level forecast for the region. The forecast is produced with the numerical model TELEMAC-2D, and it is forced with:

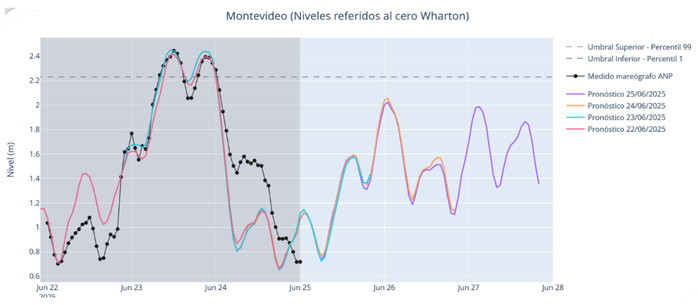
- the oceanic boundary conditions from RTOFS-HYCOM, FES2014 tides, and a fixed MeanSeaLevelValue of +0.9 m,
- the atmospheric forcing from the NCEP (NOAA) wind forecast, and
- the measured discharges of the Paraná and Uruguay rivers.



In the estuarine region, water levels result from the combined action of astronomical and meteorological tides. The Río de la Plata is a microtidal environment, where the dynamics are highly variable, and water levels at each station depend strongly on the local characteristics.

The water level forecast is evaluated in real time with data measured in-situ by 10 tide gauges located in the study area whose data are available online published by Argentina and Uruguay. The forecast is published through website and updated four times per day.



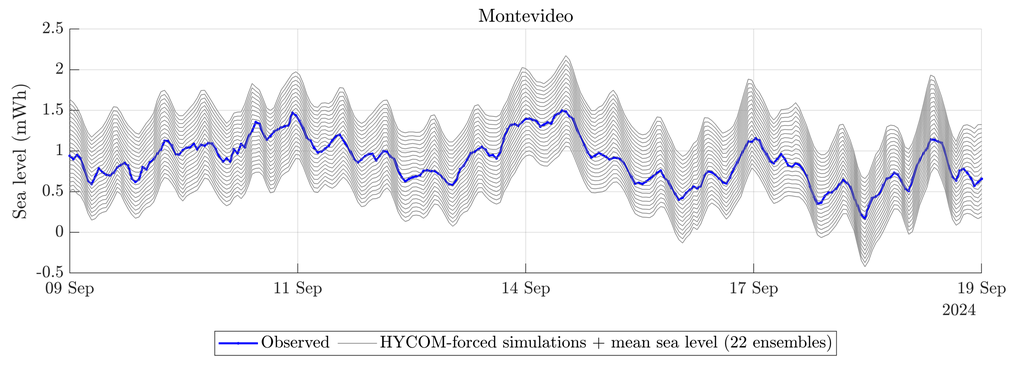


Objectives

The main objective is to reduce the current bias of the PronUY_RPFM forecast by varying the MeanSeaLevel value in the oceanic boundary conditions. This strategy aims to improve the representation of storm surge events along the Río de la Plata, the Maritime Front, and the Uruguayan coast.

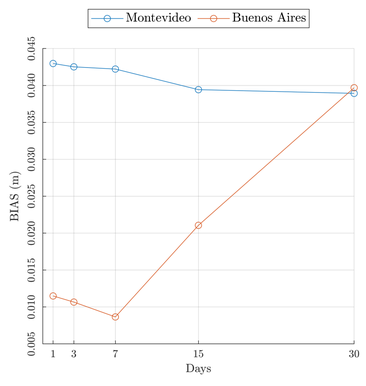
Methodology

- Generation of 22 ensembles by varying the +0.9 m MeanSeaLevel value in the HYCOM forcing; the range of ensembles was estimated from historical errors and ensured to cover past mean-level variability at the boundary conditions.
- Daily station-based selection of the best-performing ensemble, providing a global improvement compared to the current approach.
- Evaluation of improvements in the representation of extreme storm surge events, defined as those exceeding the 90th percentile of the observed data.
- The evaluation period considered spans September 2024 to August 2025.



Results

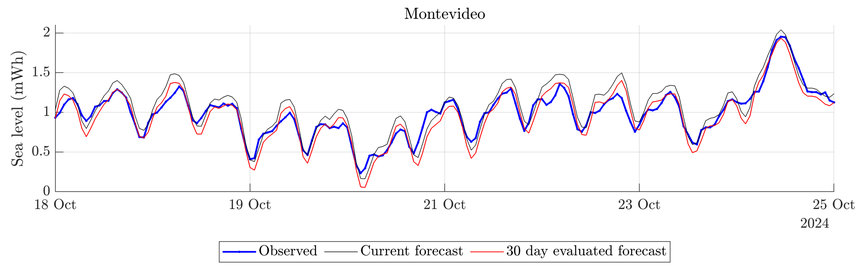
General improvements

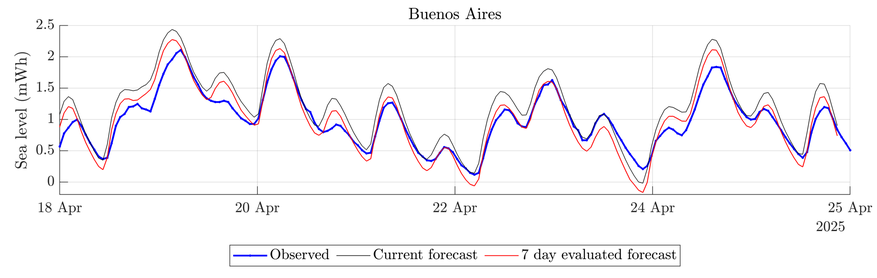


Time series were generated from the 22 ensembles using observed data at the Montevideo and Buenos Aires stations. To build these series, a daily correction procedure was applied, producing five forecast sets with different evaluation windows: 1, 3, 7, 15, and 30 days. For each day, the ensemble with the lowest bias in the selected window was used to forecast the following three days.

Results show that, on the third forecast day, longer evaluation windows generally provide better performance.

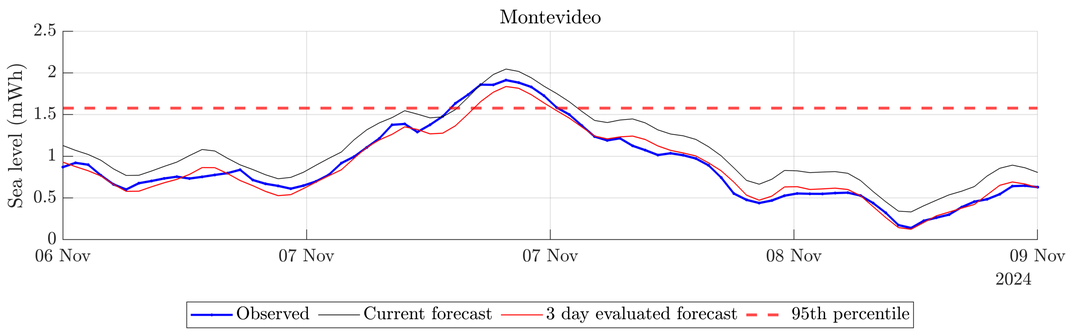
- Montevideo: the 30-day evaluation window produced the best results.
- Buenos Aires: the 7-day evaluation window produced the best results.





Storm surge events

The station Montevideo was evaluated for storm surge events. In contrast to the general bias improvements, the results show that for extreme events the best performance is obtained with the forecast series generated using the 3-day evaluation window. Extreme events were defined as those exceeding the 90th percentile threshold of the observed data during the evaluation period.



3 day evaluated forecast

Forecasted \ Observed	yes	no
yes	44	7
no	4	-

Current forecast

Forecasted \ Observed	yes	no
yes	46	16
no	2	-

The tables show:

- the number of events that were both forecasted and observed,
- the number of events forecasted but not observed, and
- the number of events observed but not forecasted.

The ensemble-based forecast with a 3-day evaluation window significantly reduced the number of false positives compared to the current forecast (7 vs. 16). This indicates a more reliable prediction of extreme events, minimizing the overestimation of storm surges while maintaining similar levels of correctly forecasted events.

Acknowledgments

ANII Project: FMV_1_2023_1_176345
Development of a specific forecast product to support navigation for users of the Martín García Channel and the Port of Nueva Palmira.