SABWAS – Semi-Arid Brazil Water Analysis with SWOT: Advancing Multi-Scale Reservoir Monitoring with Machine Learning and SWOT Products

Rafael OLIVEIRA (Funceme/GET, Brazil)

Marielle Gosset (IRD, France); **Eduardo Martins** (Funceme, Brazil)

Event: 2025 SWOT Science Team Meeting
Session: Hydrology: HR SWOT Data (Data Validation & Enhancement)
Presentation type: No preference

The semiarid region of Ceará, in Northeastern Brazil, is characterized by a dense network of over 20,000 reservoirs, ranging from large state-monitored systems to numerous small farm dams under 0.01 km². These water bodies are crucial for water security, particularly in the context of recurrent droughts and climate variability. However, their monitoring remains a major challenge due to the dispersed and fragmented nature of the storage infrastructure.
The Surface Water and Ocean Topography (SWOT) mission offers a transformative opportunity for inland water monitoring with its KaRIn instrument providing high-resolution altimetry data. This study parts of the SWOT-ST project SABWAS (Semi-Arid Brasil Water Analysis with Swot) evaluates the performance of SWOT products for hydrological monitoring of reservoirs in the Crateús watershed, one of the designated cal/val regions in Brazil. The analysis included six state-monitored reservoirs from the Ceará water resources agency and eight additional small reservoirs not-monitored. The methodology involved assessing the L2_HR_LakeSP and L2_HR_PIXC (PixelCloud) products, covering observations from both the calibration/validation and the nominal mission phase. Initially, geolocation matching between datasets was performed, followed by time-series comparison and altimetric bias correction for the monitored reservoirs. In addition, for the smaller not-monitored, a Machine Learning analysis using Random Forest was conducted to improve understanding of the altimetry data and to enhance the pixcloud filtering process by evaluating the relative importance of each variable in predicting an acceptable water surface elevation (WSE) outcome. Performance metrics were calculated using RMSE and 1? standard deviation after outlier removal.
Results indicate excellent agreement for large reservoirs (area > 5 km²), with errors ranging from 0.06 m to 0.25 m. These large monitored reservoirs exhibited strong temporal coherence with SWOT-derived water level time series for the LakeSP product. However, this coherence tends to diminish with decreasing reservoir size, and in smaller water bodies, errors often exceeded the mission's 10 cm altimetric precision target. The assessment of eight small reservoirs (with surface areas typically under 1 km²), monitored in the field, also revealed significant variability in product performance. However, the comparison between products revealed a better performance of the PixelCloud data relative to LakeSP, especially when more robust filtering processes were applied. RMSE improvements were substantial in many cases (6 to 90%). These results highlight the difficulty of small lake detection, but also demonstrate the potential of machine learning–based filtering approaches to improve WSE retrievals. The potential superior performance of the filtered PIXC product highlights the need to continue investigations focused on more region-specific processing strategies for semi-arid environments. These efforts should also consider the incorporation of more recent product versions, which are currently being processed and released by the satellite operating agencies, in order to refine and expand the applicability of SWOT data for small reservoir monitoring.
In conclusion, SWOT demonstrates robust capabilities for operational water level tracking in major reservoirs and sets a foundation for future integration of smaller systems into regional water management networks. Calibration and assimilation of SWOT altimetry with local geodetic benchmarks remain key to unlocking the full potential of the mission in semi-arid regions.

Corresponding author:
Rafael OLIVEIRA
Funceme/GET
Brazil
reis.rafaeu@Gmail.com