

GNSS-IR monitoring of coastal and inland water levels in Cameroon

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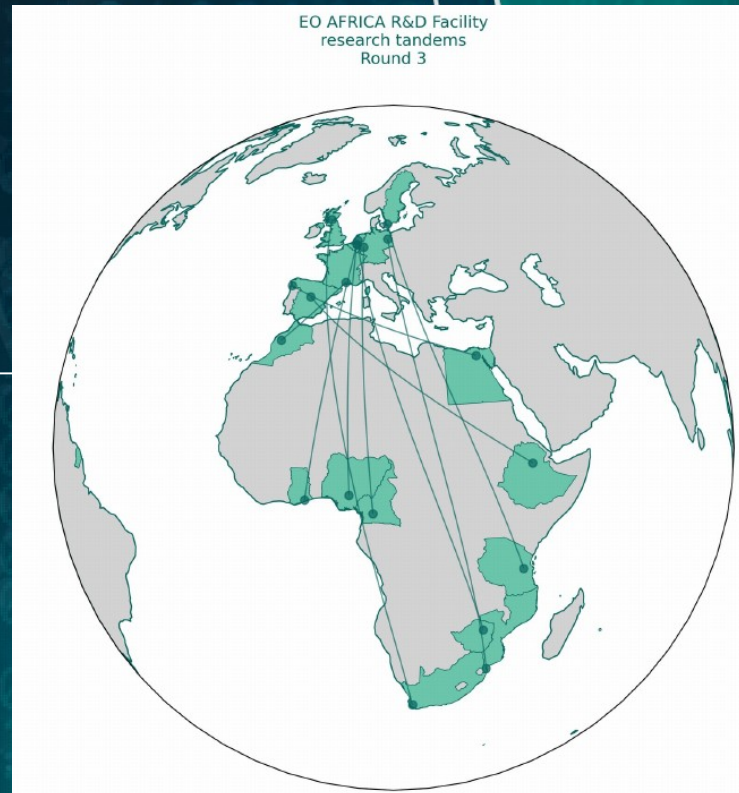
EO AFRICA



CAMEO-WAGST project

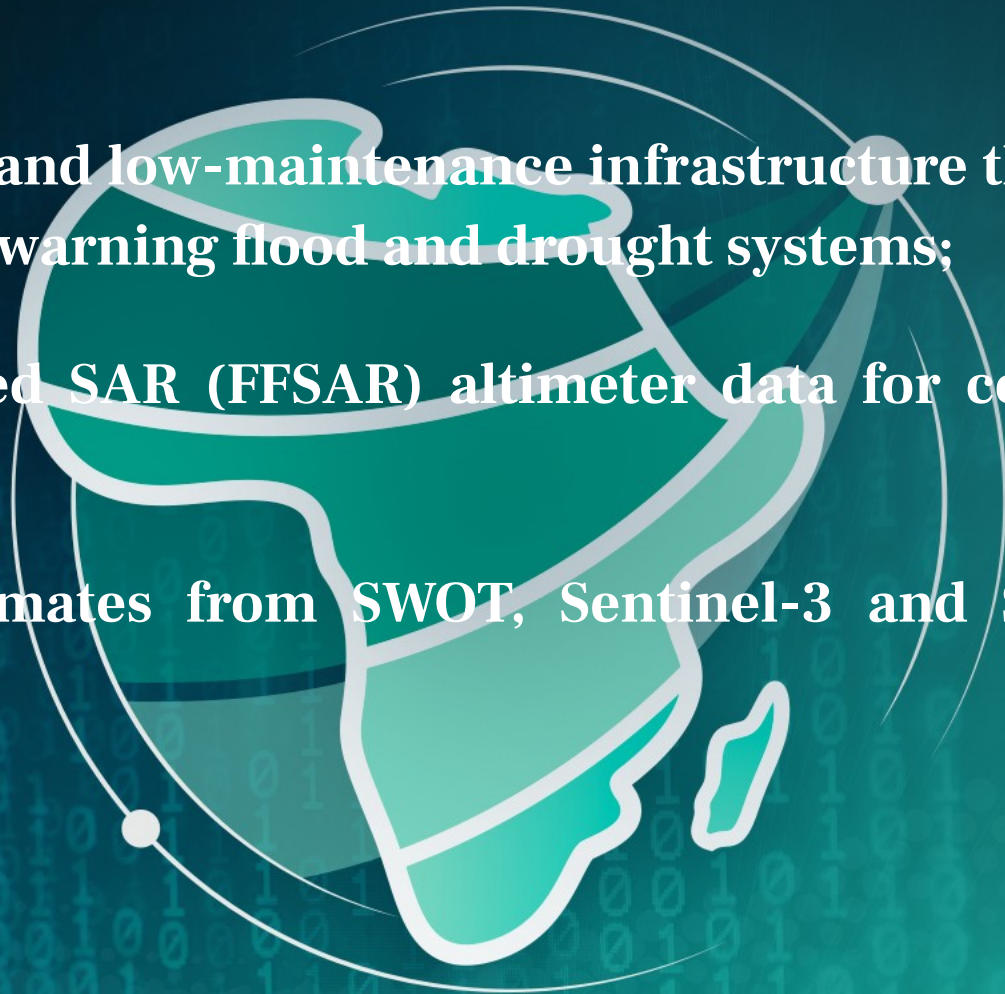
The project was funded by the Earth Observation (EO) Africa R&D Facility, supported by the European Space Agency (ESA) and the African Union Commission.

- 10 out of 63 submitted tandems with 2 reviews each proposal
- It began on December 4, 2024 and will run for 15 months with a total budget of €30,000.



1. Objectives:

- 1) Developing a prototype of cost-effective and low-maintenance infrastructure that can be adopted across Africa for operational early warning flood and drought systems;
- 2) Assessing the potential of Fully Focused SAR (FFSAR) altimeter data for coastal and estuarine monitoring ;
- 3) Validate the water and sea level estimates from SWOT, Sentinel-3 and Sentinel-6 satellites.



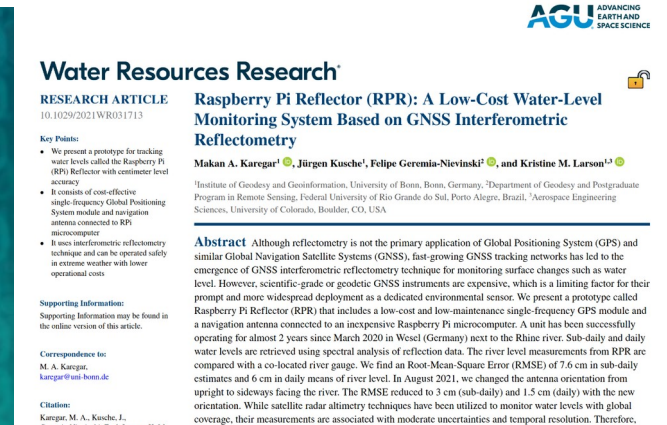
Powerful sensor for water level monitoring

SS receiver and an L1 antenna; uses low power and can be deployed on flat surfaces near the antenna.

in [GitHub](#).

extreme weather with lower operational cost. Data is transferred via GSM or LoRa, respectively.

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[https://
agupubs.onlinelibrary.wile
y.com/doi/full/
10.1029/2021WR031713](https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021WR031713)

3. RPR network in Cameroon

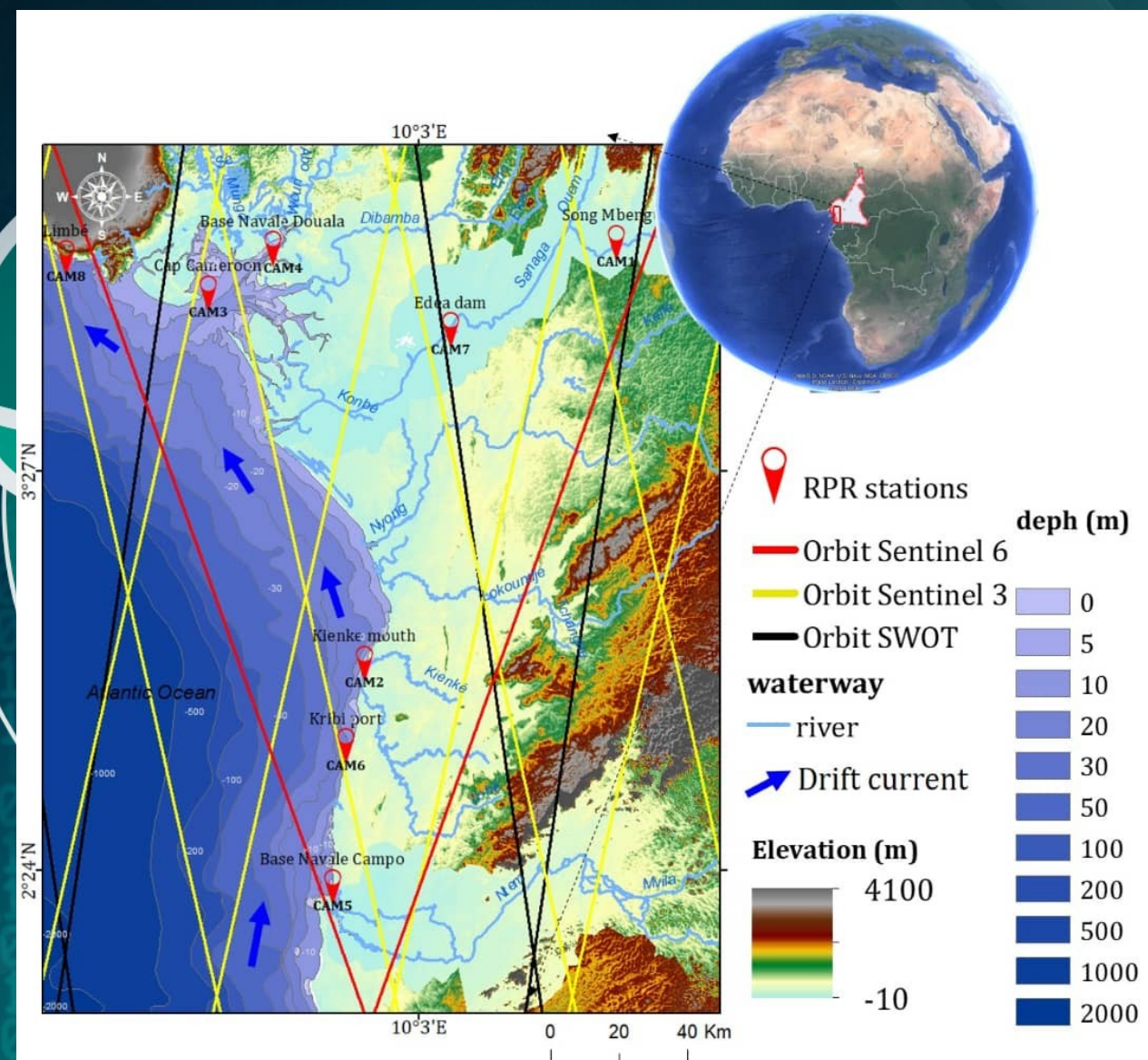


Eight RPR installations:

Sanaga River: Song Mbengué (site of a planned major hydropower dam), Edea Dam
Coastline: Wouri estuary (near Douala, a large tidal estuary with river convergence),

Limbé

Gulf of Guinea coastline: 5 RPRs

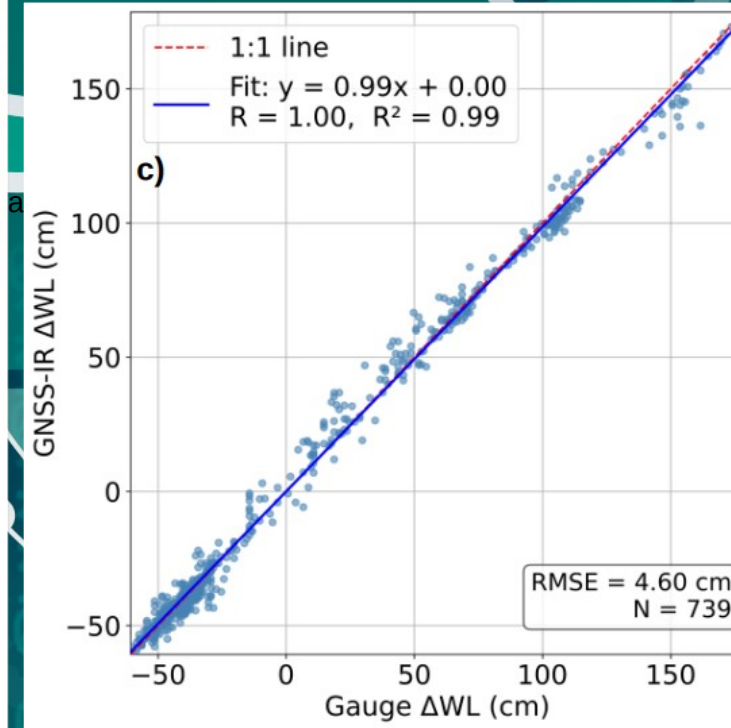
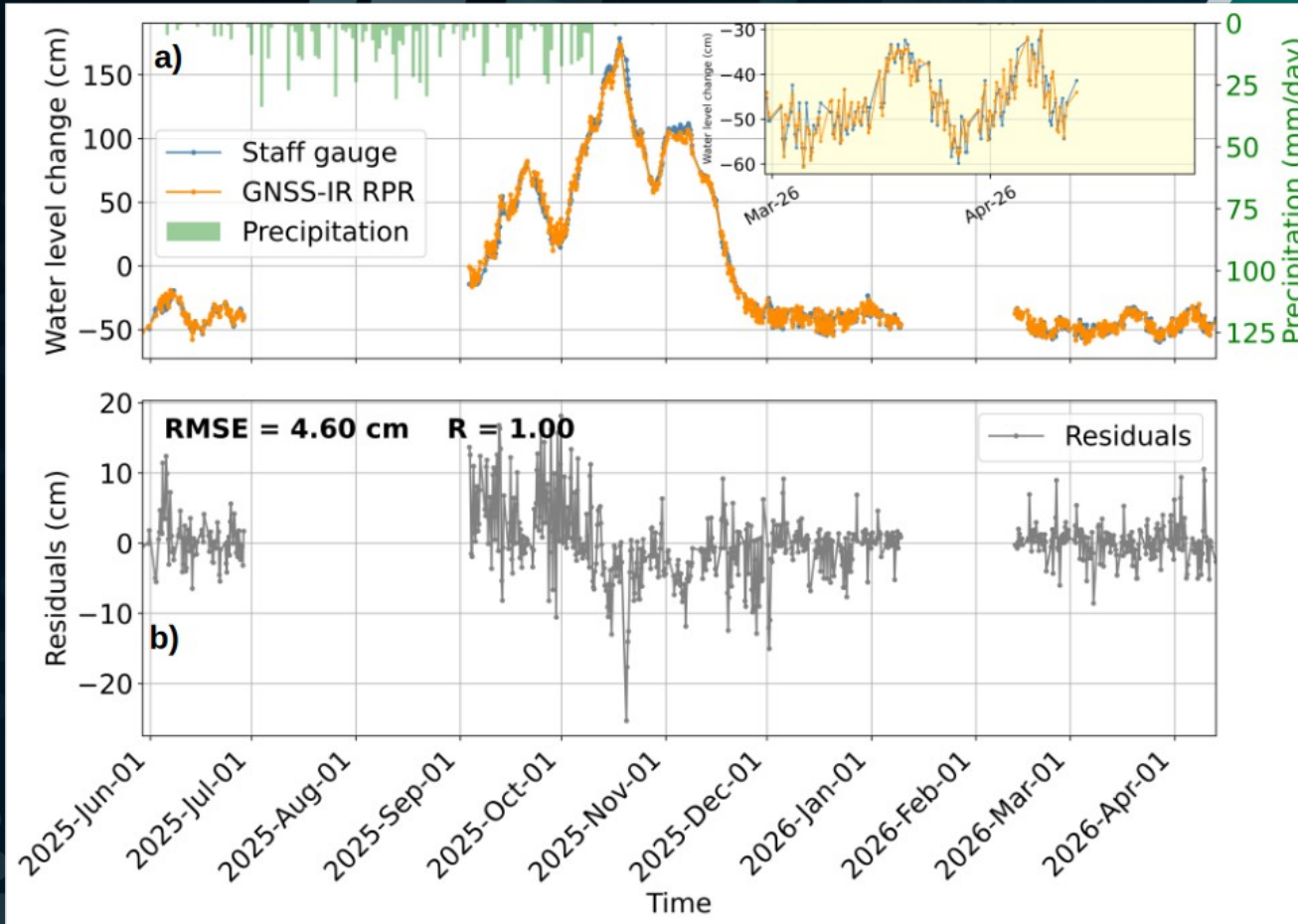


4. Three fieldwork campaigns



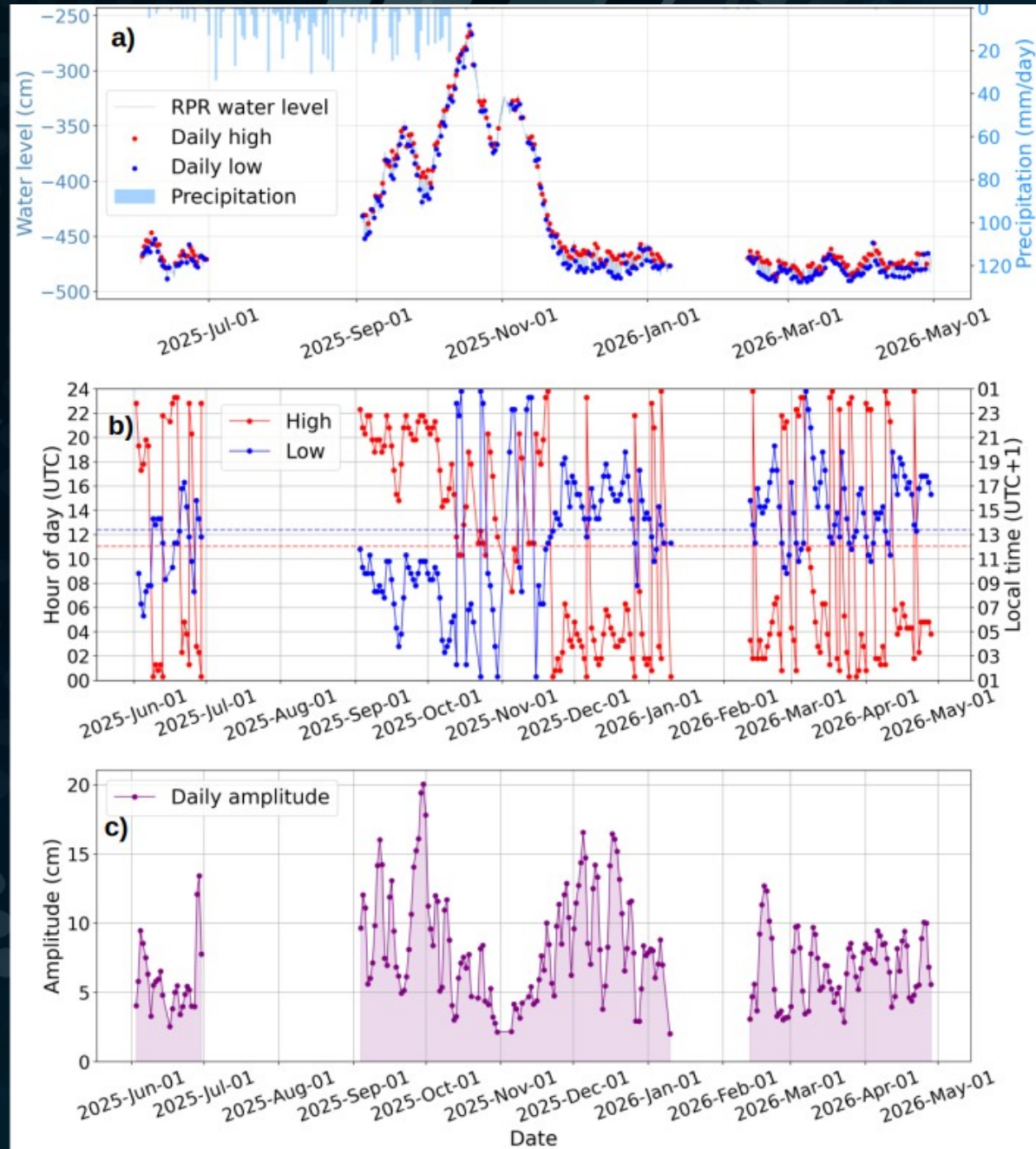
5. Results

5. 1. GNSS-IR performance at Song Mbenguè (River site)



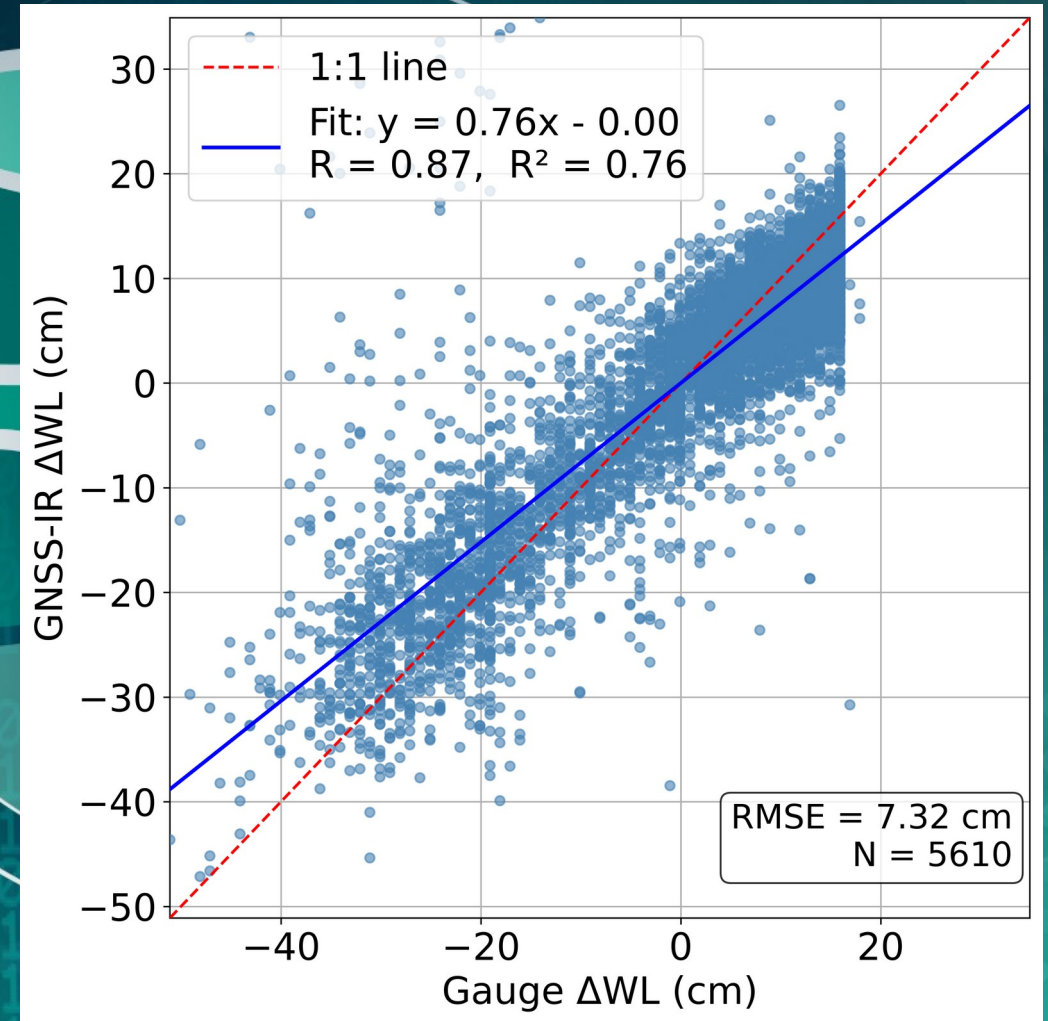
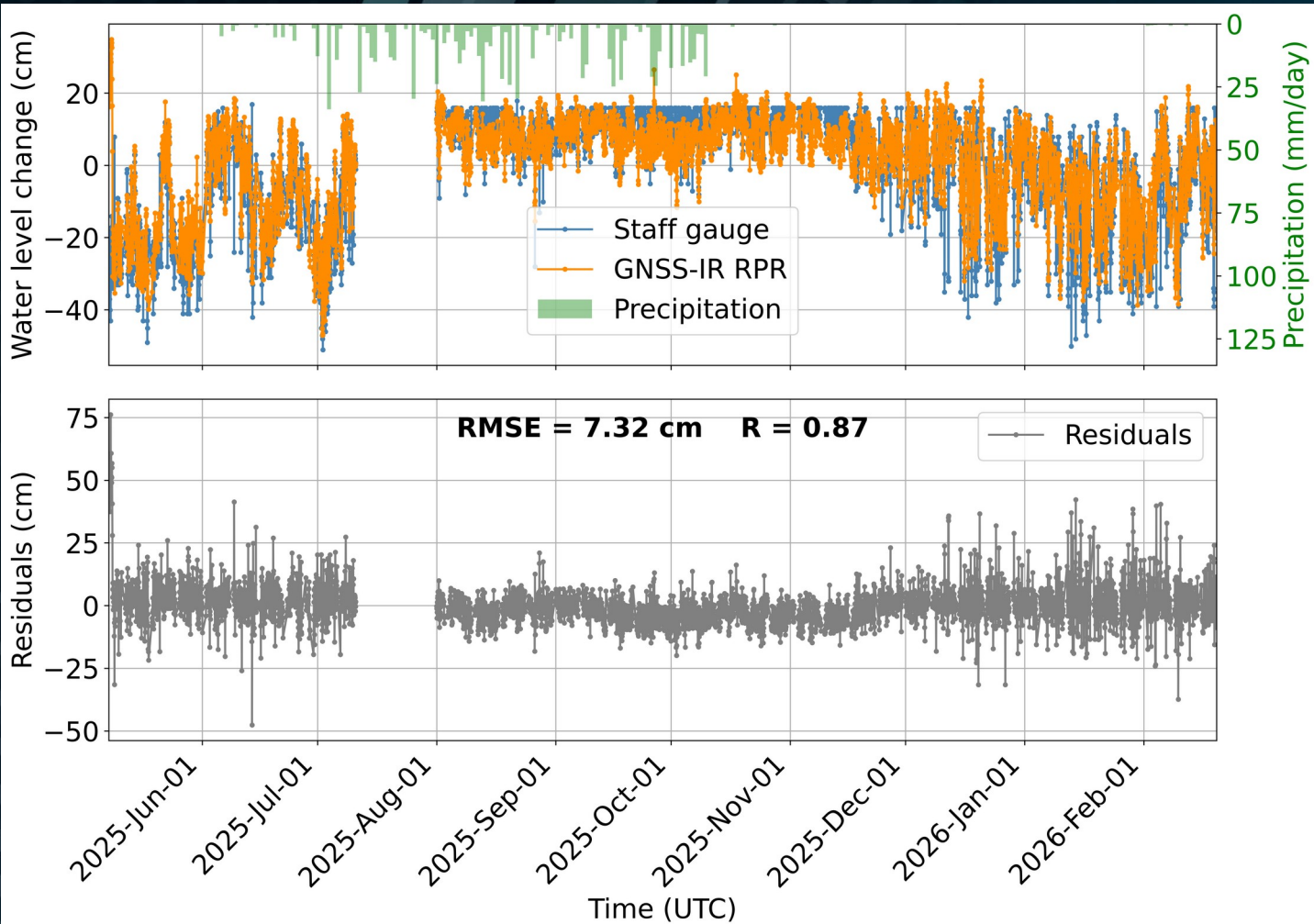
a) Water level change from the RPR (orange) and staff gauge (blue) with IMERG daily precipitation (green). The inset shows the diurnal cycle during March-April 2026. b) Residuals between RPR and staff gauge. c) Scatter plot of RPR versus staff gauge water level changes.

5. 1. GNSS-IR performance at Song Mbenguè (River site)



a) RPR water level time series with daily highs (red) and lows (blue), and IMERG daily precipitation (light blue). b) Timing of daily high and low water levels throughout the record. Dashed lines indicate the mean timing of daily highs (red) and lows (blue). c) Daily diurnal amplitude. The diurnal cycle is attributed to upstream hydropower regulation at the Nachtigal Dam.

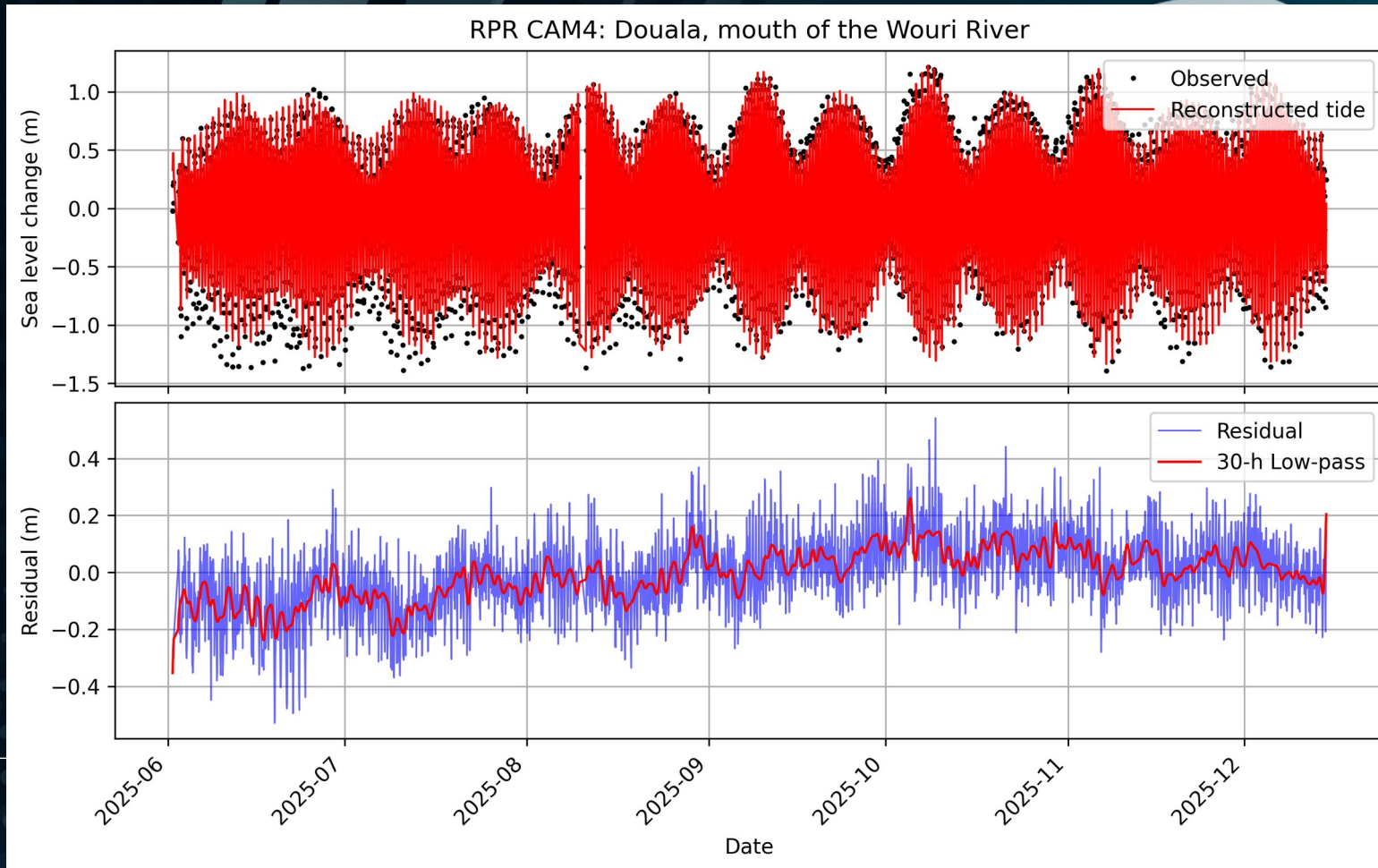
5. 2. GNSS-IR performance at Edea dam (River site)



Water level change from the RPR (orange) and pressure gauge (blue), with residuals (grey). The gauge exhibits a flat ceiling near +15 cm during high-water seasons while the RPR continues to resolve variability above this threshold.

b) Scatter plot of collocated RPR versus gauge anomalies. The diurnal cycle is attributed to upstream hydropower regulation at the Nachtigal Dam.

5.3. Resolving tidal dynamics and short-term fluctuations

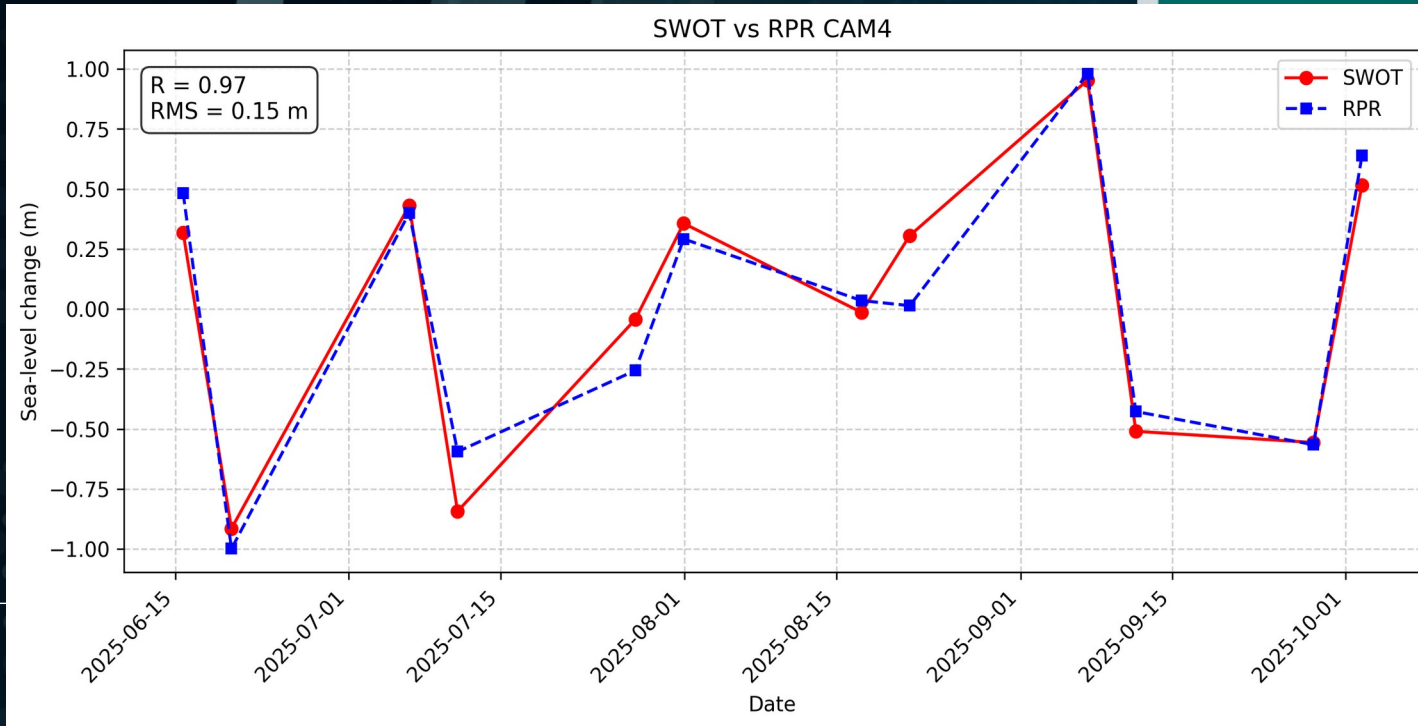


Main tidal constituents:

$M_2 = 0.780$ m, $S_2 = 0.249$ m, $N_2 = 0.139$ m, $K1 = 0.130$ m

5.4. SWOT vs. RPR

SWOT-PIXC version C



* Extraction based on the nearby 1km radius.

* Keep only points:

- Classification > 2
- Geolocation_qual > 4

* Temporal matching, ± 24 h averaging around satellite overpass times and ± 5 h averaging for coastal sites,

* IQR filtering, normalization

6. Key takeaway

- * Part of the CAMEO-WAGST EO Africa project to develop Africa's first GNSS-IR network for water level monitoring.
- * The RPR network allows geographically comprehensive tidal estimates for coastal Cameroon.
- * We will remove tidal predictions from the observed water levels to isolate the non-tidal residuals by storms, winds, waves and currents.
- * The campaign provides an opportunity to validate SWOT measurements.

