

SWOT

Science Team Meeting

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ARCACHON • France

14-17 OCT. 2025

Assessing SWOT performance to measure SSH variability over Rangiroa atoll, French Polynesia

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- **Atolls** are low-lying islands **extremely vulnerable to marine submersion** (cyclone, tsunami, swells)
- Most atolls are projected to become **uninhabitable by 2050**, due to combined effect of SLR, wave-driven flooding and their impact on freshwater resources (Storlazzi et al., 2018)
- Incident swell energy is significantly dissipated over the rough and shallow reef barrier. Yet, **99% of corals are expected to be lost** under warming of 2° (Hoegh-Gulberg et al. 2018, IPCC Special report)
- **Lack of hydrodynamic data** in the remote and harsh barrier reef atoll environments restrains understanding atoll circulation response to extreme oceanic forcings



Submersion on Hikueru atoll (L'illustration, 1903)



Rangiroa emergency shelter, inaugurated on July 2025



Challenge # 1: Anticipating the impacts of extreme weather events linked to climate change in French overseas territories



Past-to-FUTURE coastal RISKS in Tropical French Overseas Island Territories (Leads: Vi. Duvat & X. Bertin, LIENSS)

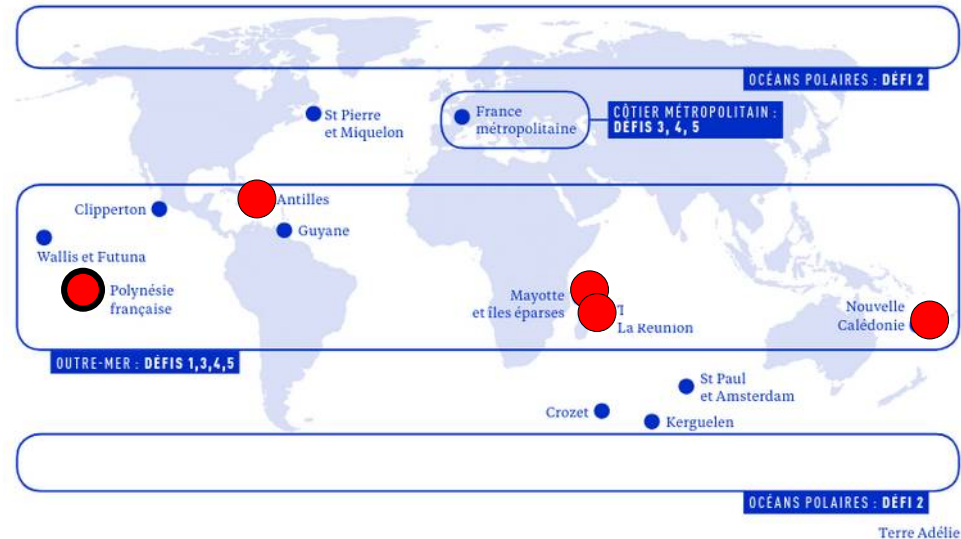
WP1. Assessing the impacts of past-to-present climate-related events on coastal systems

WP2. High resolution analysis of the processes driving coastal flooding in coral reef environments

WP3. From Coastal Risk Reduction Responses to Climate Change Adaptation Solutions

WP4. Managing coastal risks under deep uncertainties

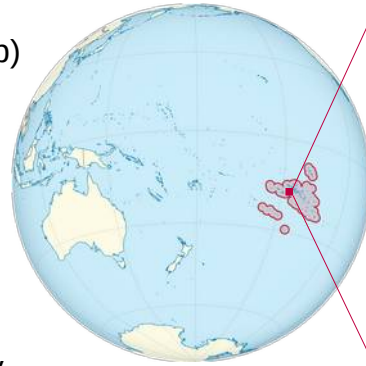
WP5. Development of a Coastal Observatory to increase the resilience against devastating climate events



Rangiroa 2025 field campaign

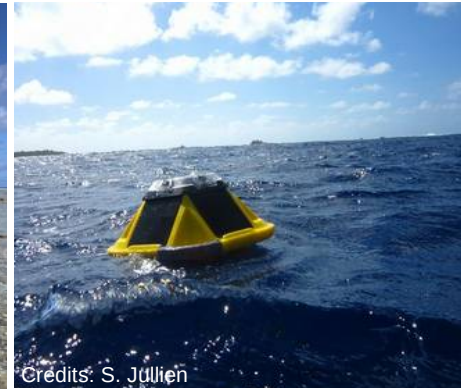
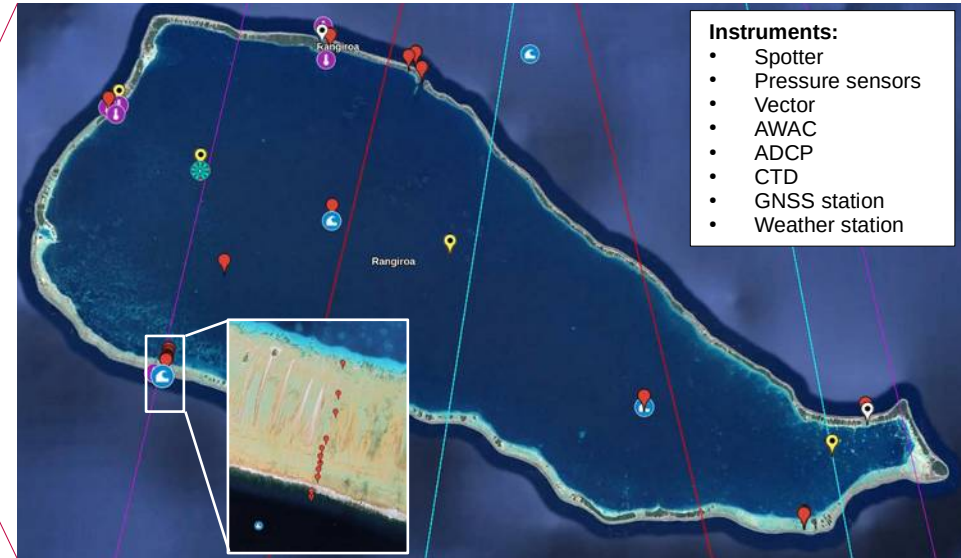
Rangiroa atoll

- ~80x30km, ~30m deep
- Semi-open atoll: 2 main passes, hundreds of hoas (shallow reef top)
- Semi-diurnal, micro-tidal regime
- Exposed to NP and SO swells
- Trade winds + occasional TCs

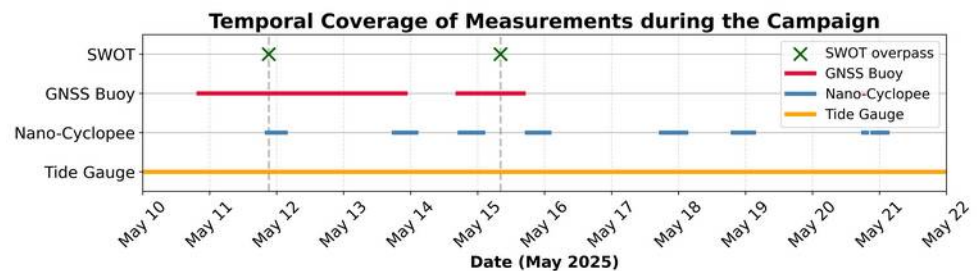
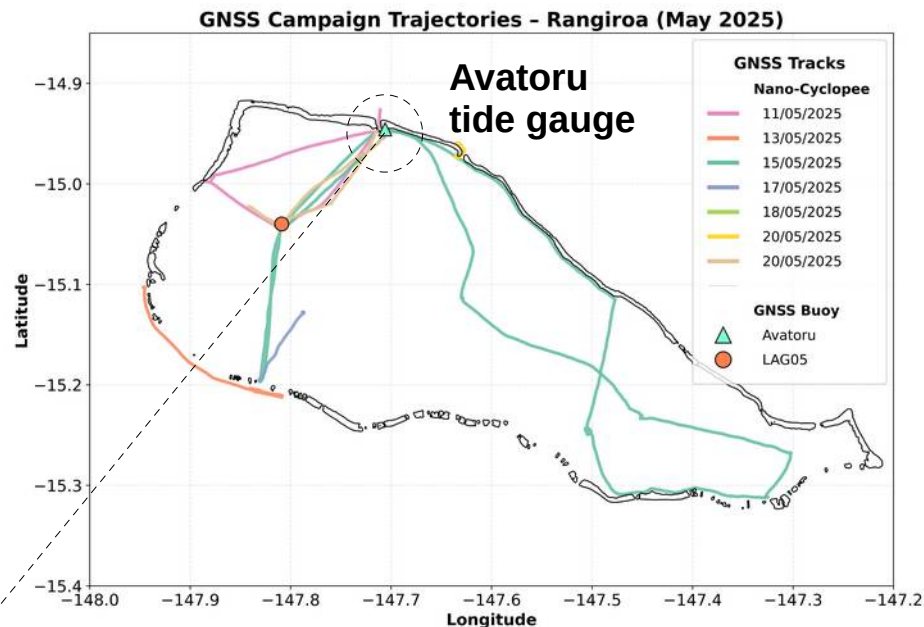
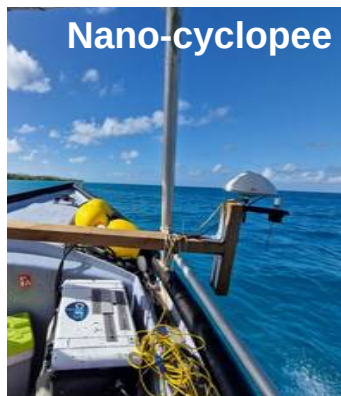


Field campaign

- May 2025 (3 weeks)
- 50 instruments deployed (lagoon, pass, reef front and reef top)
- GNSS RTK profiles + Lidar survey
- 8 participants: F. Bouchette (lead), X. Bertin, G. Dodet, E. Doerflinger, S. Jullien, L. Maillard, H. Michaud, L. Ormière



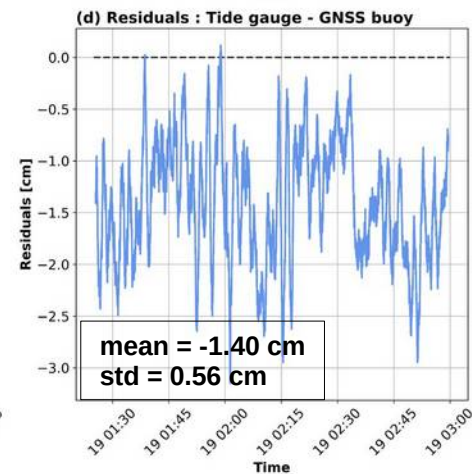
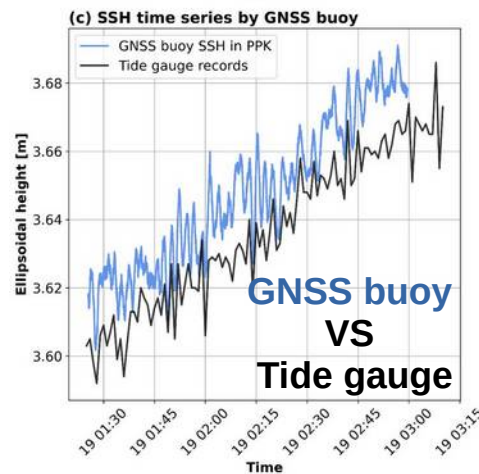
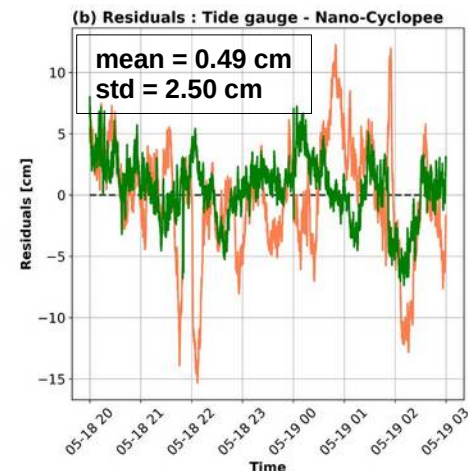
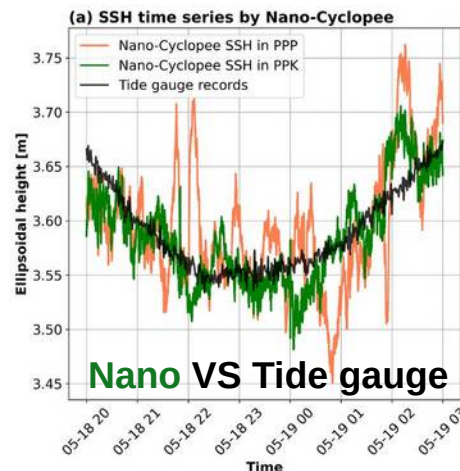
GNSS-based SSH measurements



Cross-validation of in-situ SSH measurements

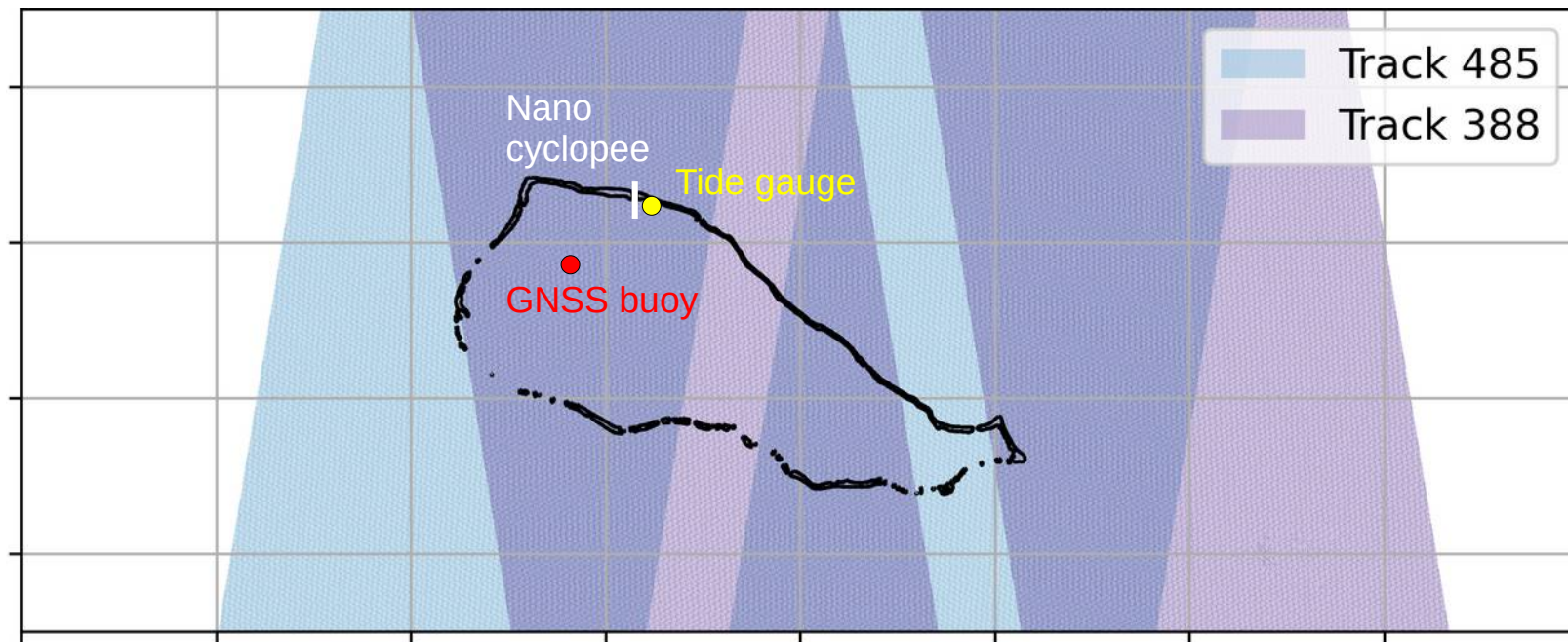
Validation against tide gauge measurements:

- Nano: low bias (0.5 cm) / moderate noise (2.5 cm)
- Buoy: moderate bias (1.4 cm) / low noise (0.5 cm)
- Improved results with PPK vs. PPP solution
- Higher noise level expected with rougher sea state and boat movements



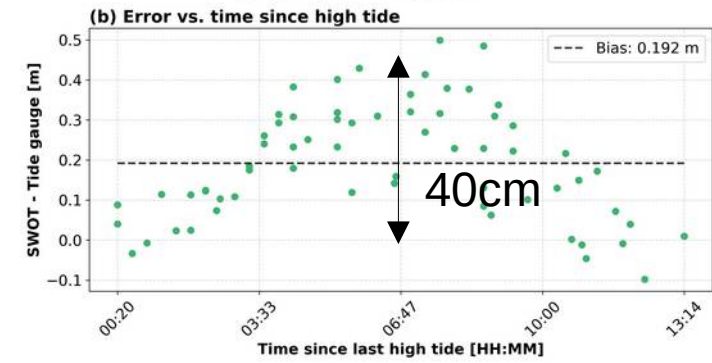
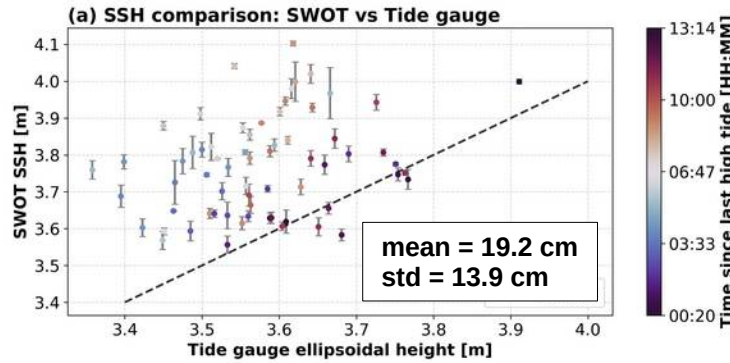
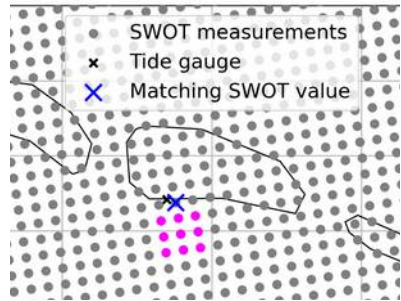
Comparison of SWOT SSH against in situ SSH

- Level2 Unsmoothed SSH
- ssh_karin_2 (modelled atmospheric and ssb corrections)
- Two tracks overpassing Rangiroa
- 36 cycles (from August 4 2023 to August 6 2025)
- 3 validation sites: Avatoru marina (tide gauge), Avatoru pass (nano-cyclopee), lagoon (GNSS buoy)

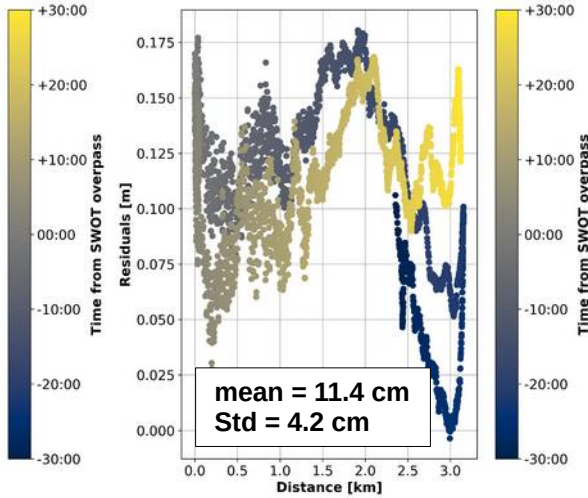
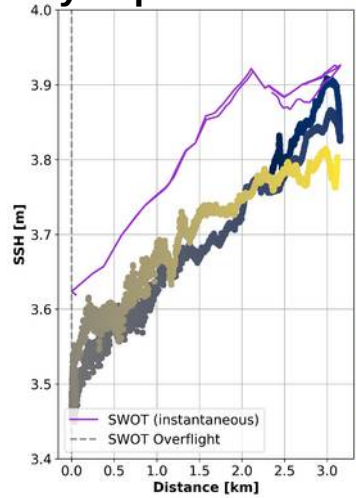
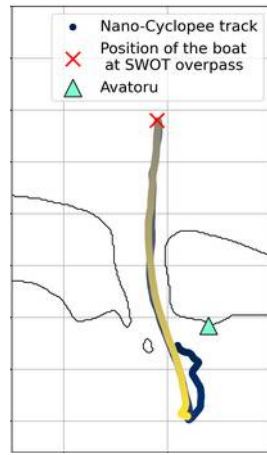


Comparison of SWOT SSH against in situ SSH

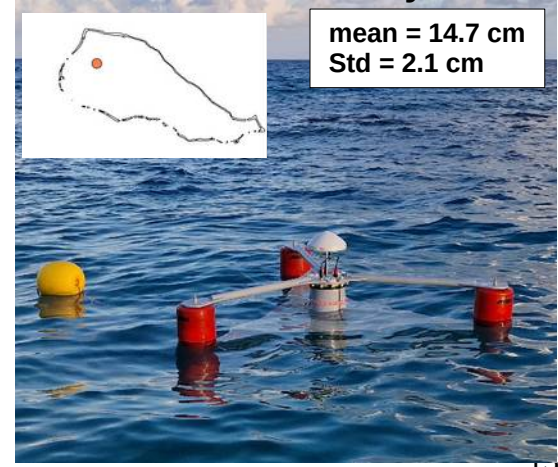
SWOT VS. Tide gauge



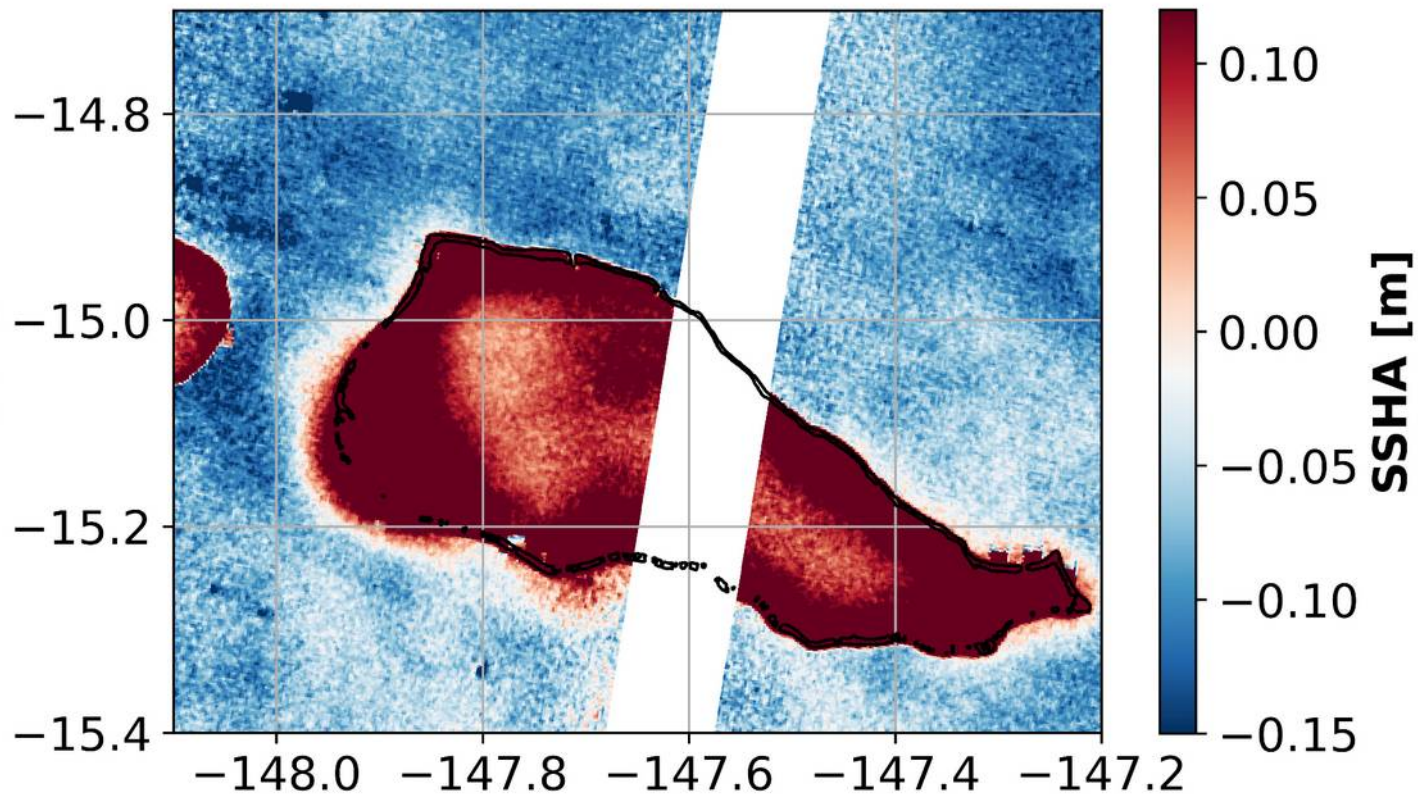
SWOT VS. Nano-cyclopee



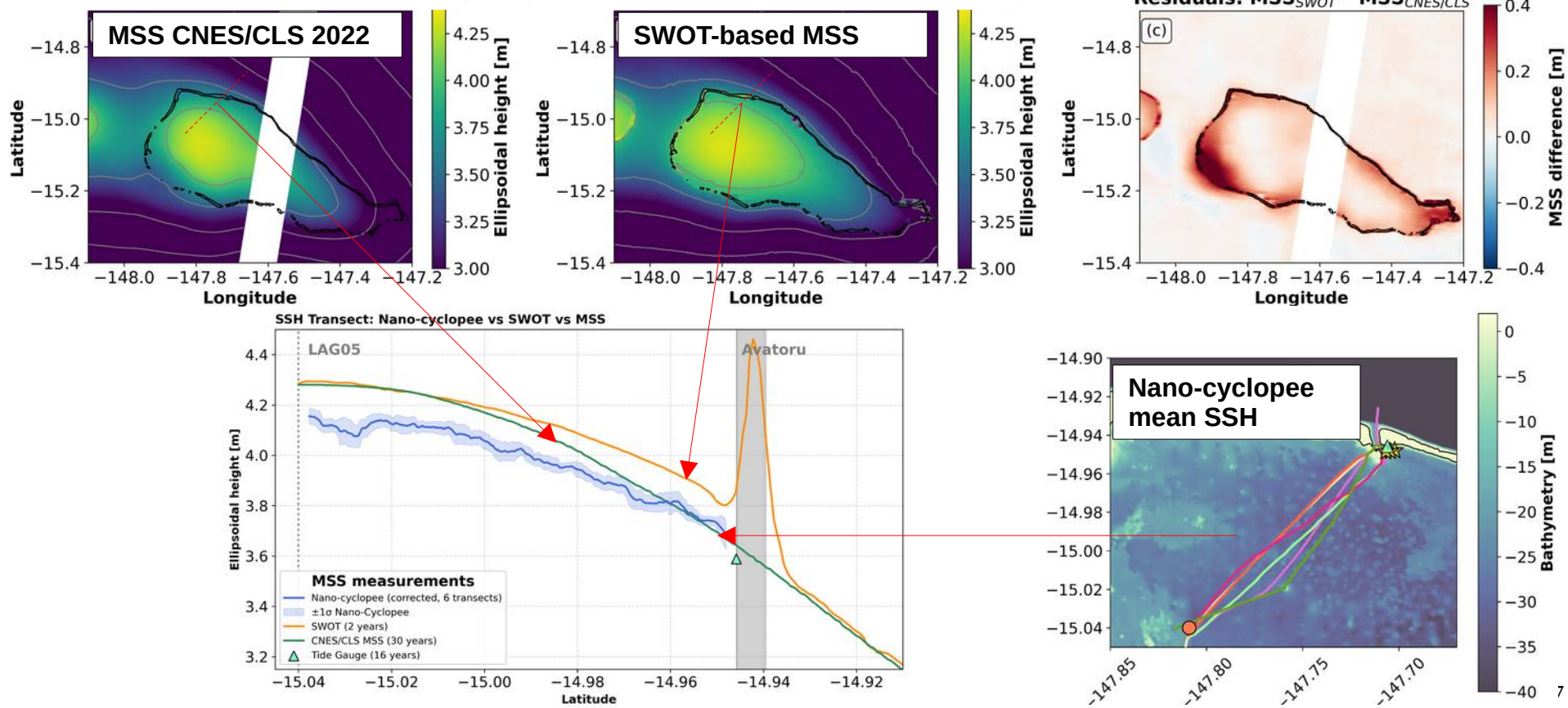
SWOT VS. GNSS buoy



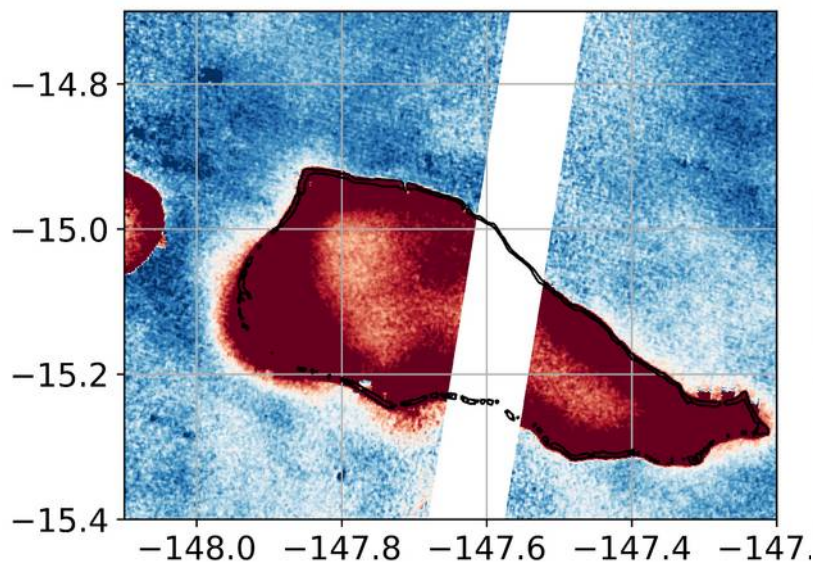
SSHA from KaRIn Level 3 Unsmoothed product



Computation of a new MSS from KaRIn L2 Unsmoothed data

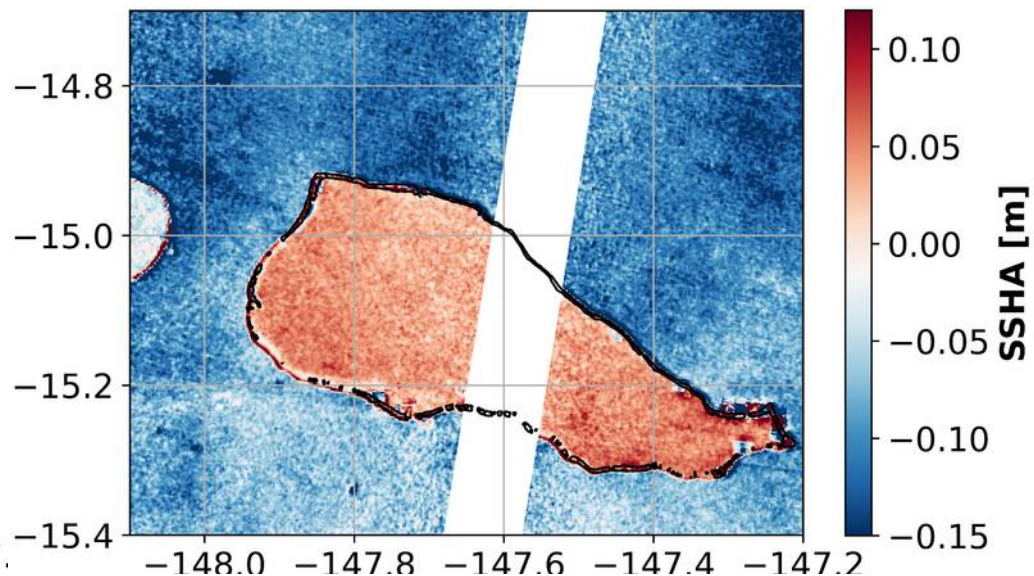


SSHA from KaRIn Level 3



using CNES/CLS2022 MSS

Corrected SSHA



using SWOT-based MSS

- An **extensive hydrodynamic field campaign** was carried out on Rangiroa atoll in May 2025
- **GNSS-based measurements provide ground truth SSH** for SWOT validation
- **Systematic deviation (~10cm) is observed in the lagoon** between KaRIn SSH and in situ SSH
- **Model-based SSB corrections certainly induced SSH biases (+) in MOST atoll lagoons** (coarse wave models overestimate SWH in atolls → **check out Taina Postec's poster**)
- **MSS from conventional altimetry is not appropriate** to reveal atoll sharp topography
- KaRIn Level 2 **Unsmoothed data can be used to improve MSS mapping over atolls**
- SSHA maps using SWOT-based MSS reveals **small-scale atoll dynamics**

THANK YOU ! / QUESTIONS ?