RÉPUBLIQUE FRANÇAISE
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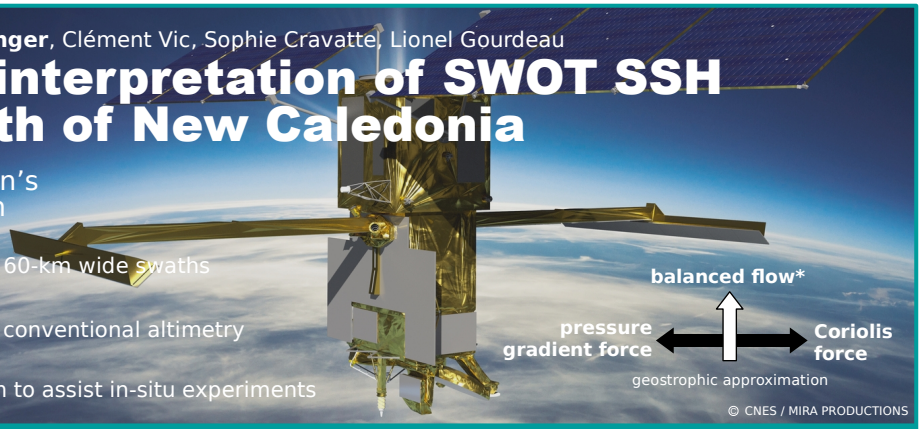
Dynamical interpretation of SWOT SSH south of New Caledonia

SWOT | Unraveling the ocean's fine-scale circulation

SSH Sea Surface Height along two 60-km wide swaths

10x higher spatial resolution than conventional altimetry

AdAC Adopt-A-Crossover consortium to assist in-situ experiments



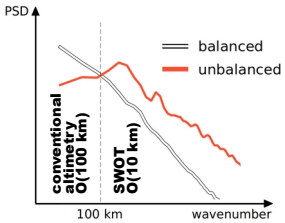
Objective Infer ocean dynamics beneath SWOT swaths

SWOT SSH requires accurate disentanglement since it resolves wavelengths at which ocean dynamics are not purely associated with balanced motions, i.e. large-scale, slowly evolving dynamics, as it the case for conventional altimetry.

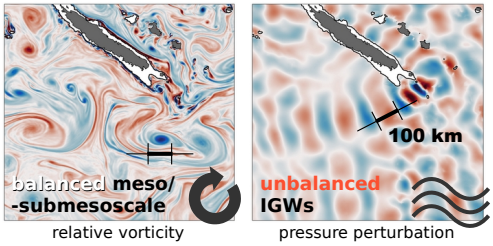
balanced*		unbalanced
mesoscale	submesoscale	internal gravity waves (IGWs)
O(10-100 km) O(1 week - 1 month)	O(1-10 km) O(1 day – 1 week)	O(10-100 km) O(1 hour – 1 day)

! Geostrophic approximation partially not valid as the submesoscale can be strongly ageostrophic

! Balanced motions and IGWs with overlapping spatial scales and equal contribution to SSH variance



NEMO CALEDO60 - regional numerical model output with tides (1/60°)

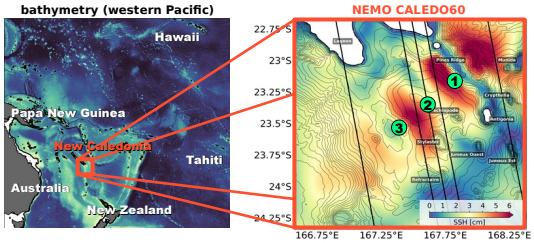


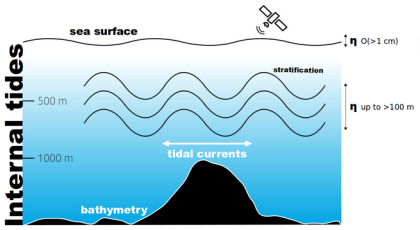
New Caledonia Unique study site to address SWOT SSH observability

Elevated mesoscale and submesoscale activity (i.e. eddies and fronts)

Internal-tide generation hot spot due to complex bathymetry (i.e. ridges and seamounts)

Located beneath the swaths of SWOT's fast-sampling phase (1-day repeat orbit)





Internal tides IGWs at tidal frequency which form when barotropic tide interacts with bathymetry causing the vertical displacement of density surfaces

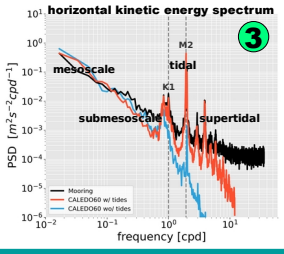
Methodology Full-depth moorings

SWOTALIS (involvement in SWOT-AdAC)

An extensive in-situ experiment was carried out in March 2023 subject to the deployment of three oceanographic moorings providing at fixed locations ① ② ③ for 9 months high-frequency measurements of temperature, salinity, pressure, and ocean currents.

Time-filtering technique

Knowing at what time scales and frequency bands the dynamics of interest dominate, we can decompose the time series into the different dynamical flow regimes.



Allowing for...

the derivation of steric SSH (***sSSH***), i.e. SSH induced by density (***ρ***) changes in the water column such as the downward and upward displacement of density surfaces, for both balanced and unbalanced motions: $sSSH(t) = \int g\rho(t,z)dz$

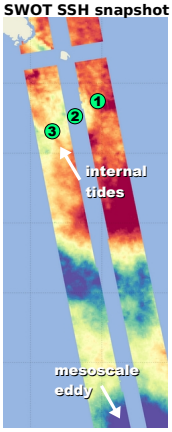
$$\rho_{full} = \underbrace{\rho_{mesoscale}}_{>5\ days} + \overbrace{\rho_{submesoscale}}^{1\text{-}5\ days} + \rho_{inertial} + \rho_{diurnal} + \underbrace{\rho_{semidiurnal}}_{\sim 12\ hours} + \ldots$$

Preliminary results & outlook

2024 Mooring data processing and quality control

Derivation of SSH signature based on steric height depth integral **2025**

Comparison of mooring-derived and SWOT SSH **2026**



Decomposing the time series

Full-depth velocity time series reveals balanced **mesoscale** component alongside high-frequency variability dominated by the unbalanced **semidiurnal tide**.

Coherent semidiurnal tide

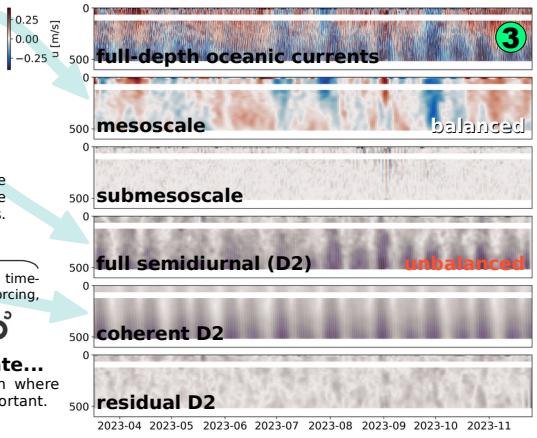
The fraction of tidal variability which is in phase with astronomical tidal forcing, i.e. spring-neap tide cycle (M2, S2, N2), estimated by harmonic analysis.

$$u_{full,D2} = u_{coherent,D2} + \underbrace{u_{residual,D2}}_{\text{incoherent tide}}$$

The residual (also referred to as incoherent tide) is the time-varying component which is out of phase with tidal forcing, highly unpredictable and challenging for SWOT.

Full-depth moorings will help allocate...

SWOT SSH to the different dynamics in a region where balanced and unbalanced motions are equally important.



Take home

Unique dataset of **full-depth mooring observations** in the internal-tide generation hot spot south of **New Caledonia** beneath the SWOT swaths during its fast-sampling phase with valuable insight into the governing dynamics at play. The associated surface signature will help **interpret and understand SWOT SSH** in a region of complex circulation.

SWOT AdAC