

Apport de la mission SWOT au suivi spatio- temporel des niveaux d'eau côtiers

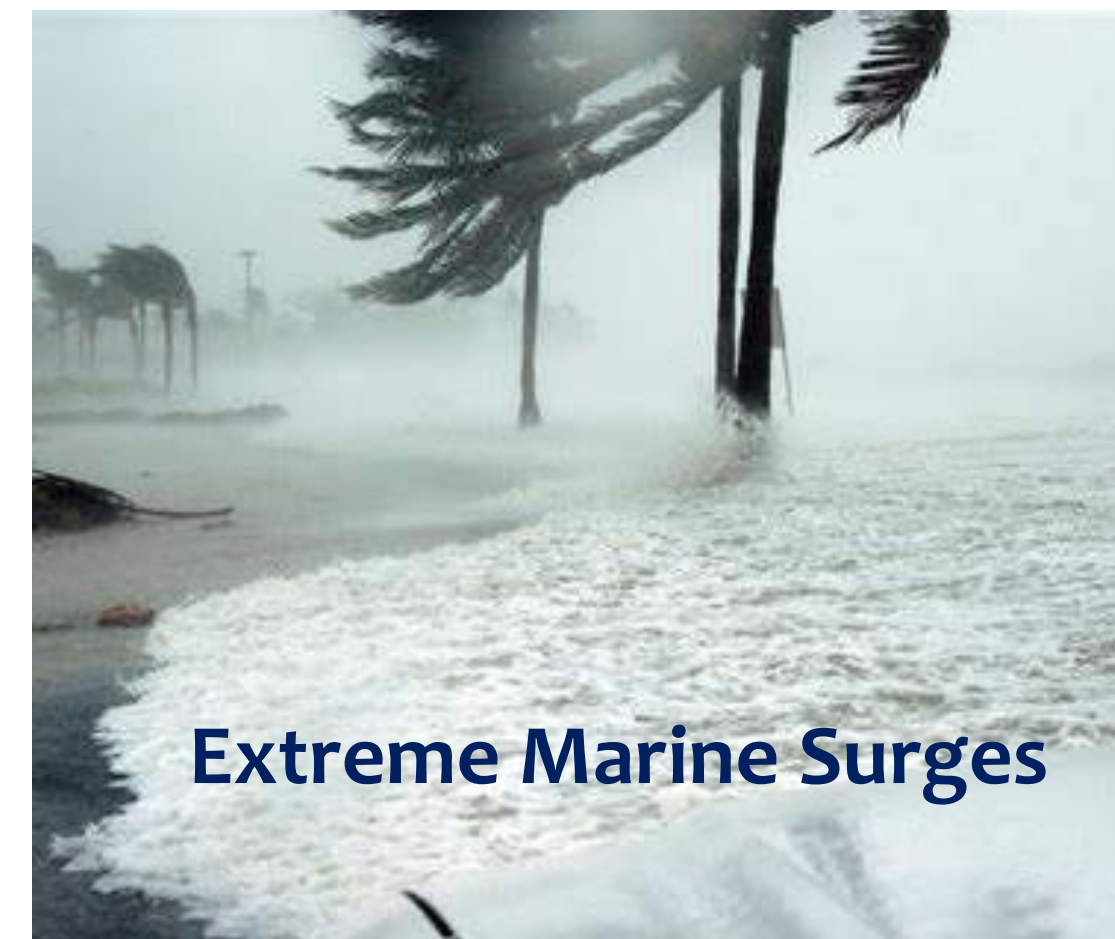
Imen TURKI, Carlos LOPEZ SOLANO, Saiful ISLAM, Pascal MATTE, Komlan, KPOGO-NUWOKLO



Advancing Spatiotemporal Monitoring of Coastal Water Levels with the SWOT Mission

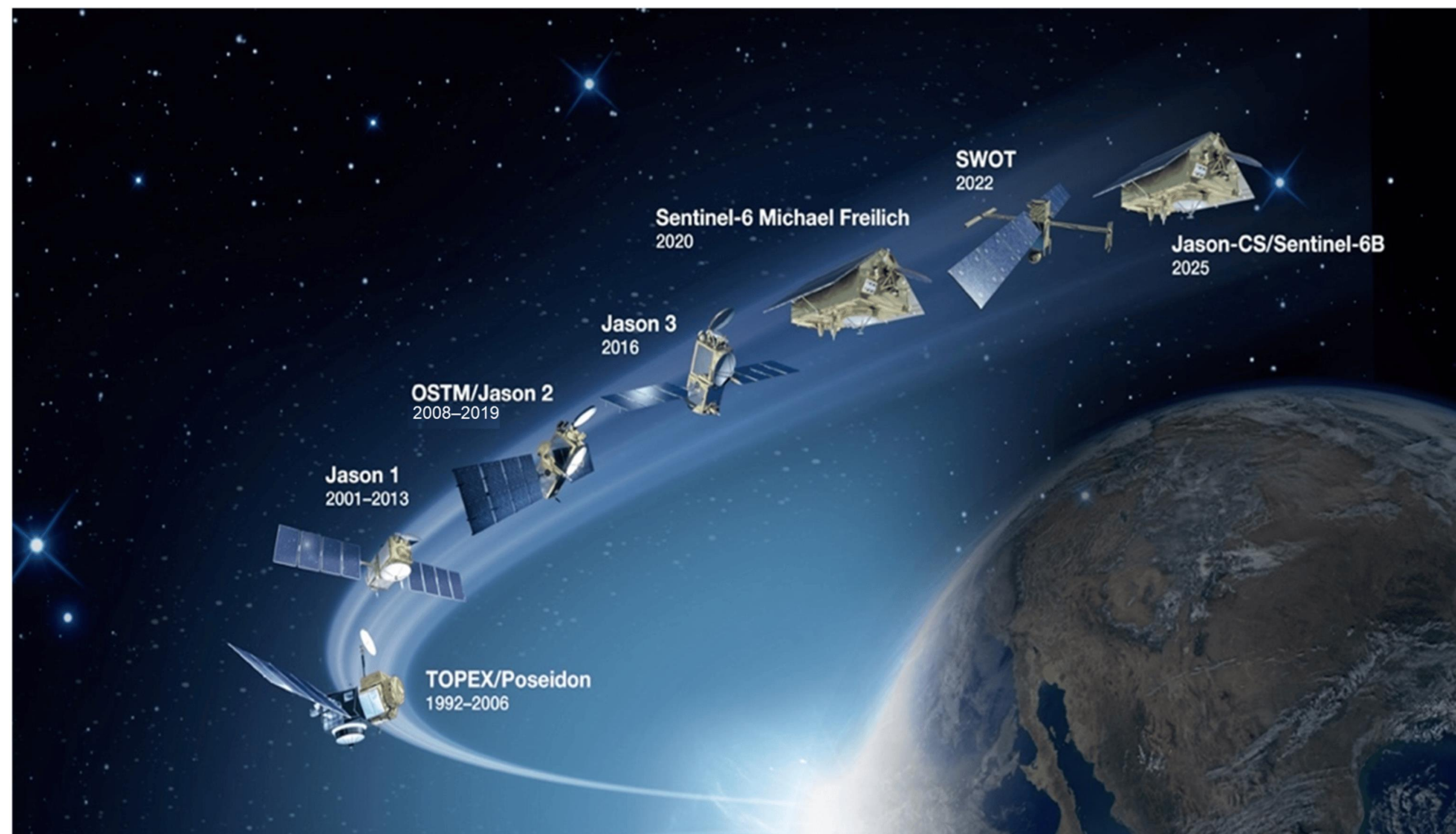
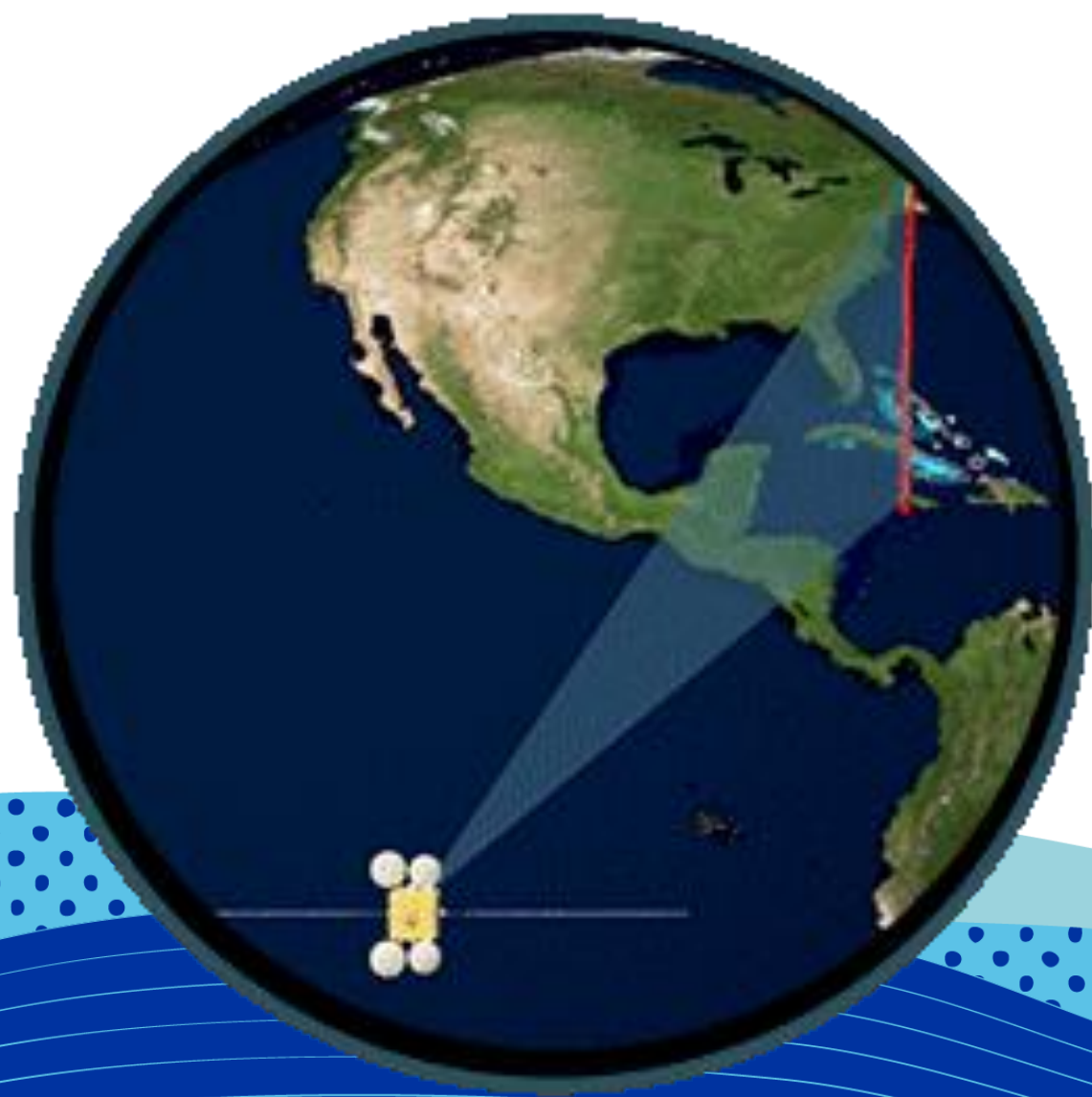
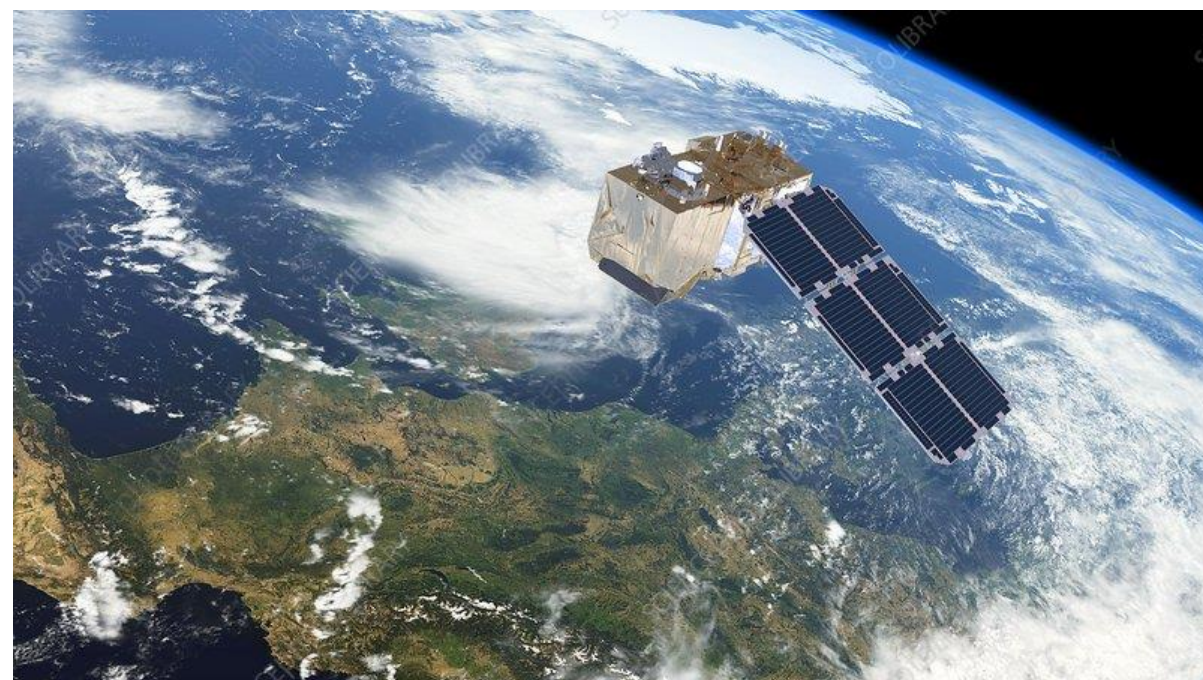


Wave Overwash



Extreme Marine Surges

Monitoring from Space



SWOT : Surface Water and Ocean Topography

SWOT_L2_LR_SSH (netCDF)

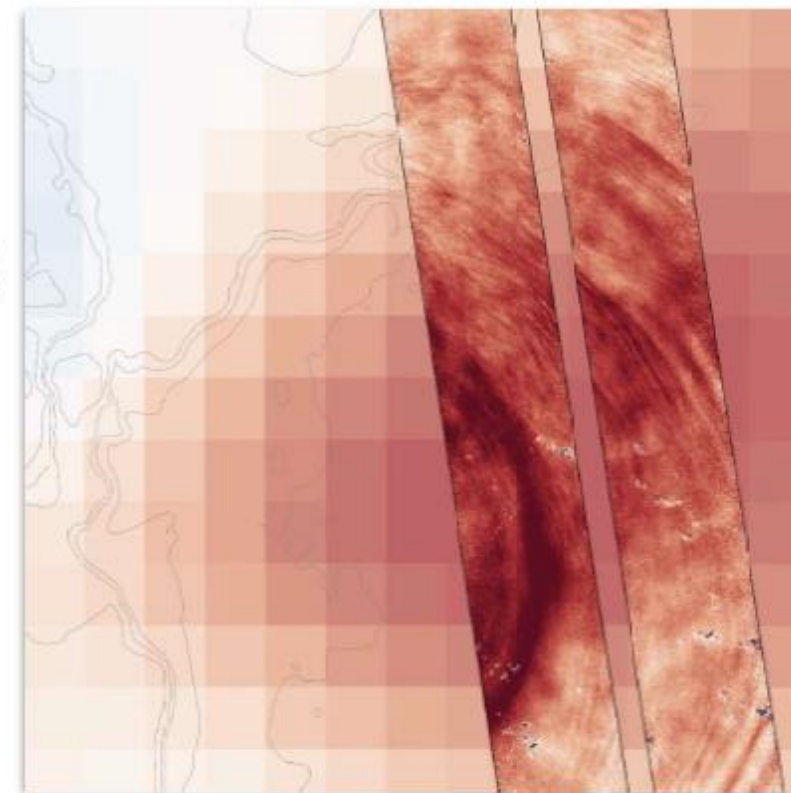
Description: Sea surface height (SSH) and significant wave height (SWH) over oceans

Spatial Extent Format: 2 km fixed-grid swath (and unsmoothed; 250 m native grid)

Select Variables: SSH, SWH

Subcollections:

- SWOT_L2_LR_SSH_Basic
- SWOT_L2_LR_SSH_WindWave
- SWOT_L2_LR_SSH_Expert
- SWOT_L2_LR_SSH_Unsmoothed



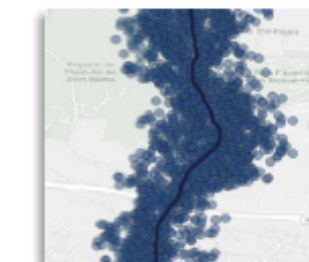
SWOT_L2_HR_PIXC (netCDF)

Description: Point cloud of water mask pixels ("pixel cloud")

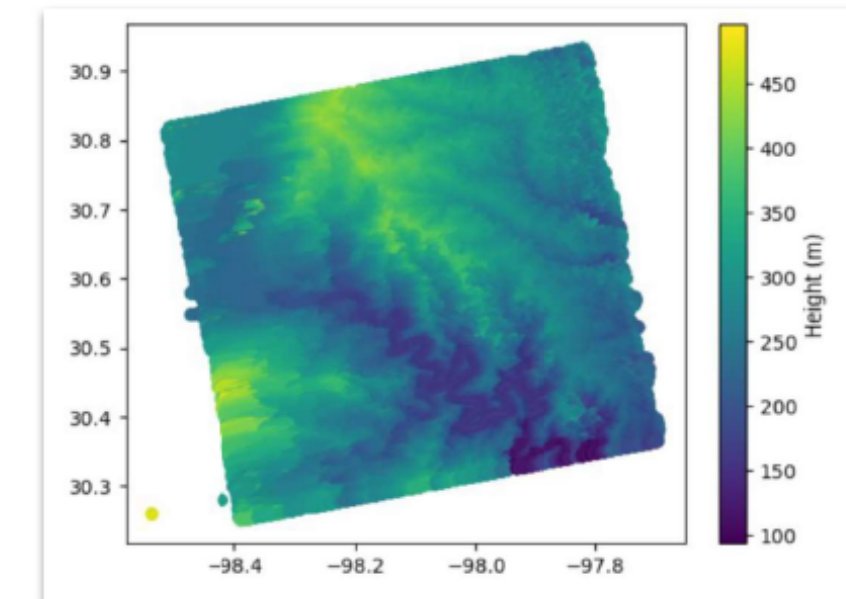
Spatial Extent Format: Tile (64x64 km²)

Select Variables: geolocated heights, backscatter, geophysical fields, and flags

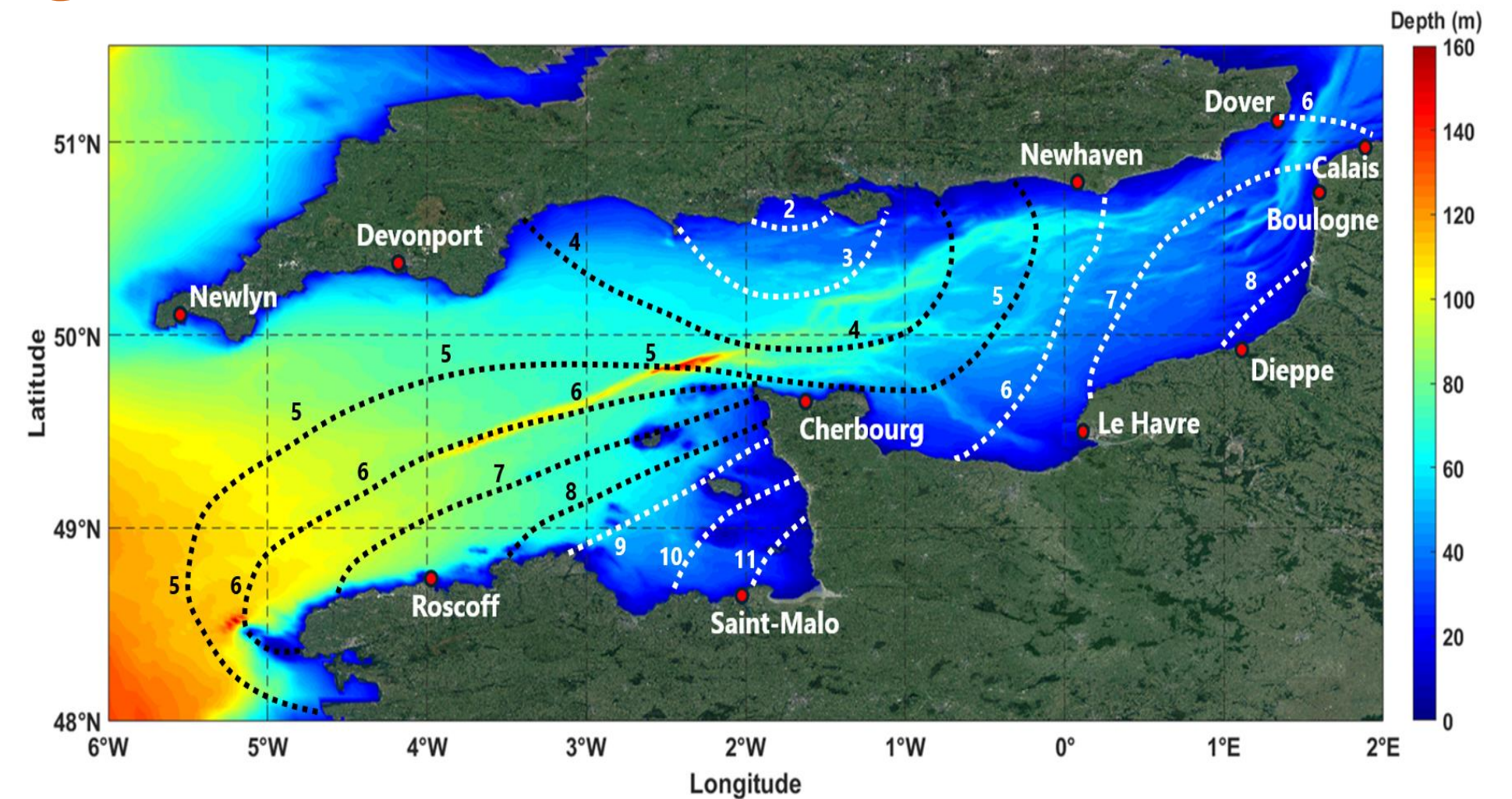
Subcollections: N/A



Example
river
pixels



Colorado River near Austin, TX



PARTENAIRE
SCIENCE COMESTO
UNION TOWN 
Financé par

Apport de la mission SWOT au suivi spatio-temporel des niveaux d'eau côtiers

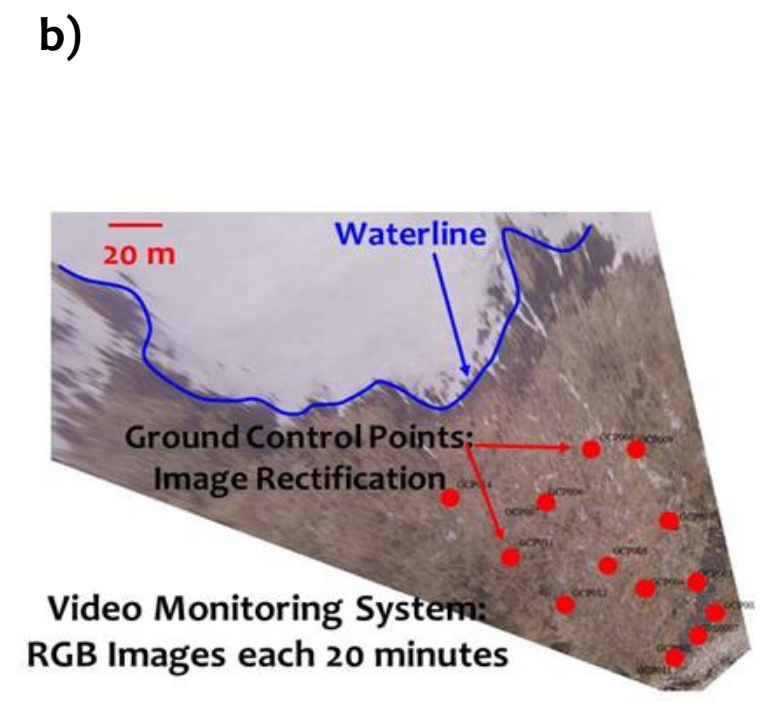
Contribution de SWOT LR

~ 1 day Orbit

-

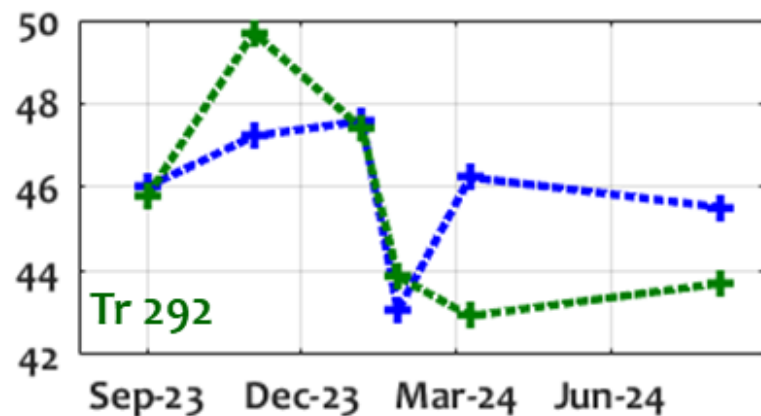


- ✓ Bonne reproduction des niveaux d'eau lors des tempêtes

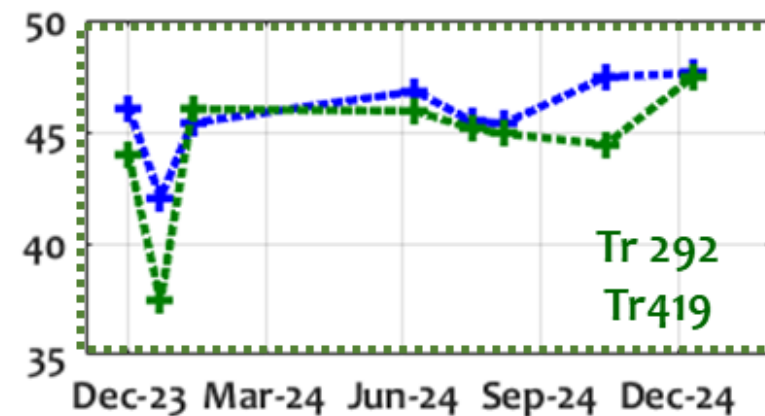


Observations of Water Levels - SWOT

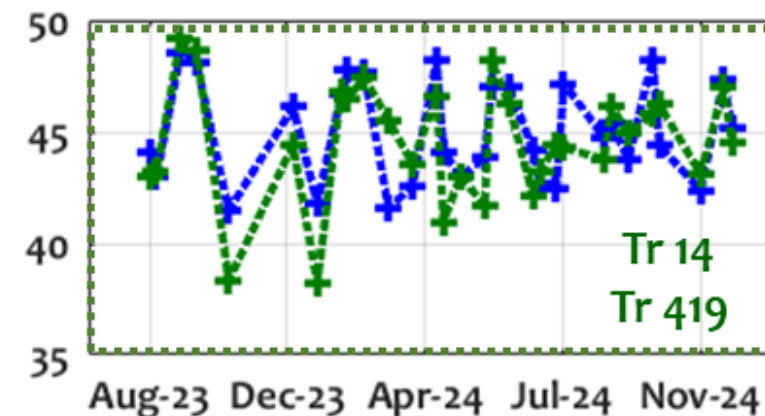
P. Calais



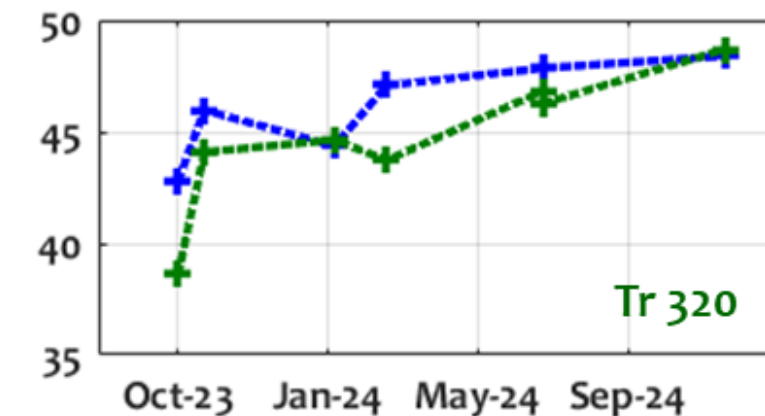
Boulogne-sur-Mer



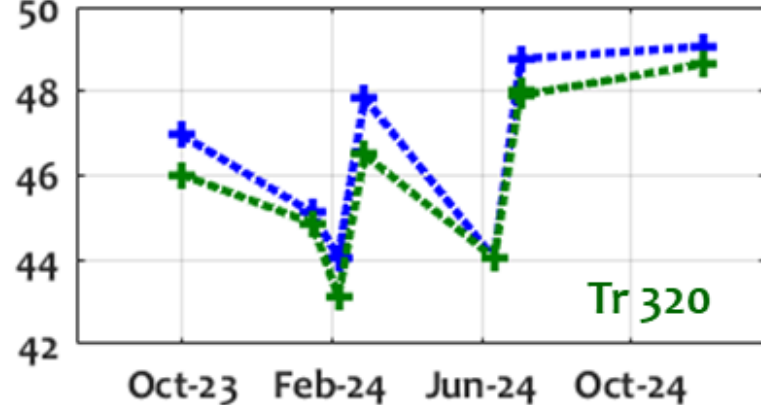
Dieppe



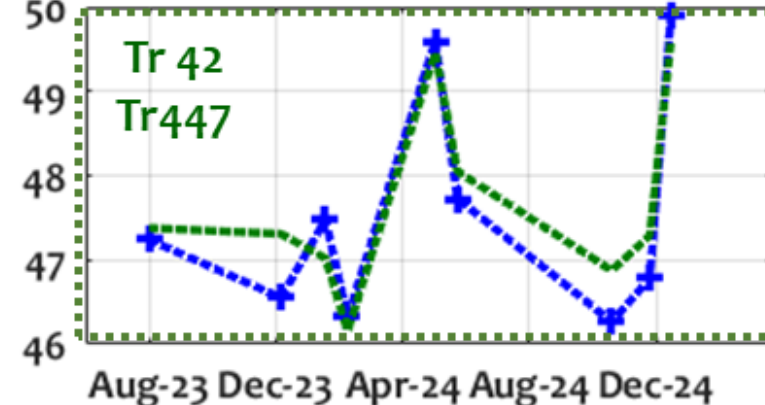
Le Havre



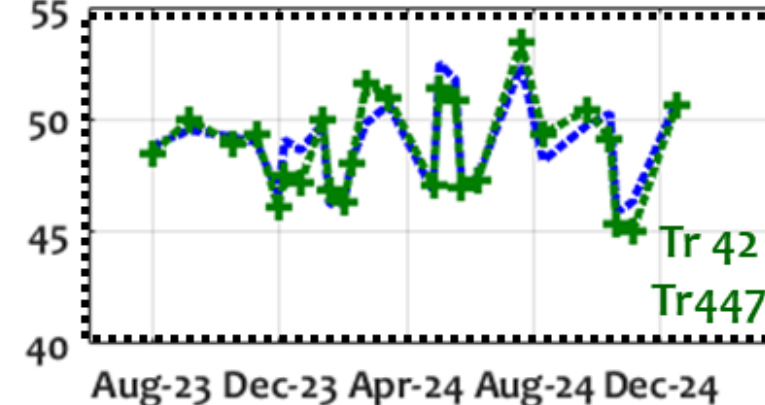
Ouistreham



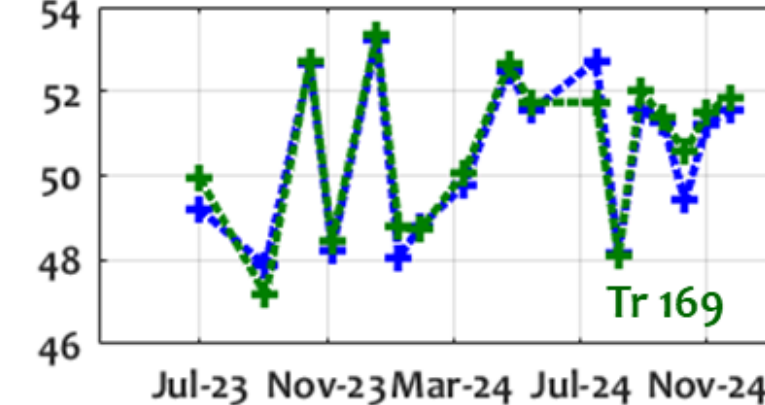
Cherbourg



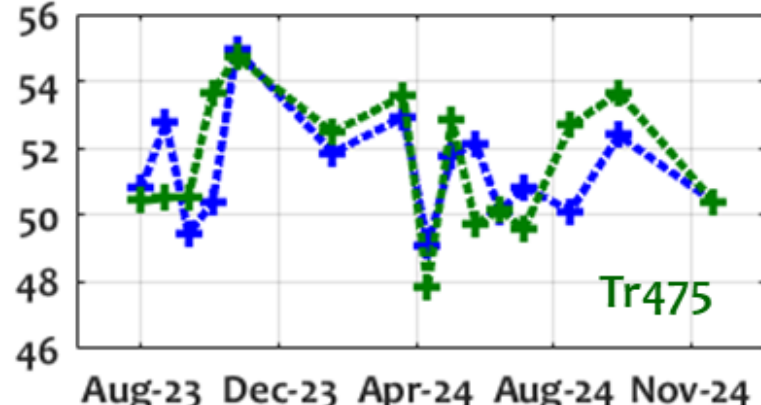
Dielette



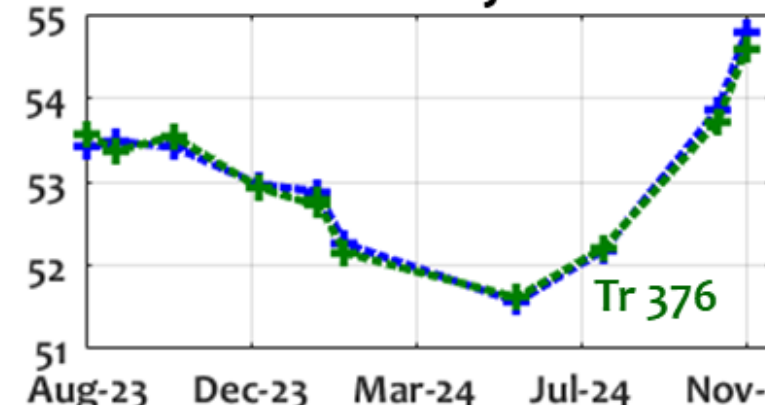
Roscoff



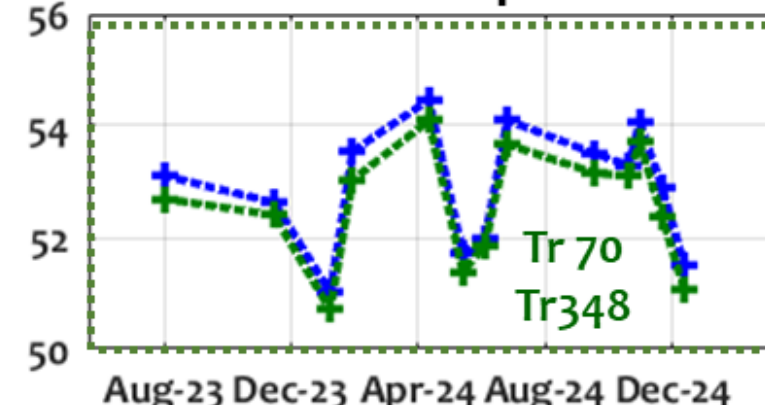
Brest



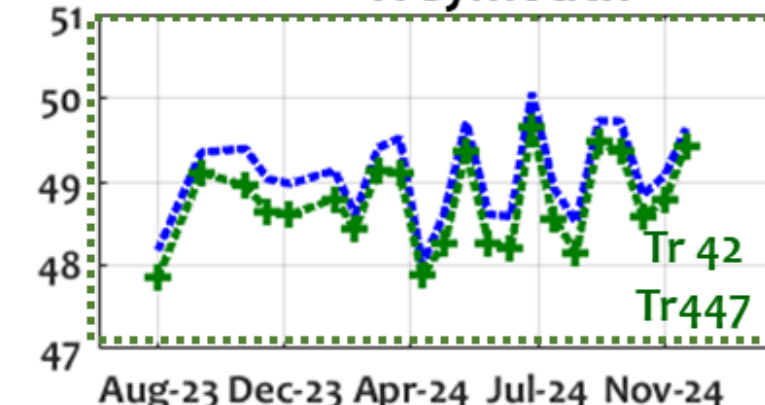
Newlyn



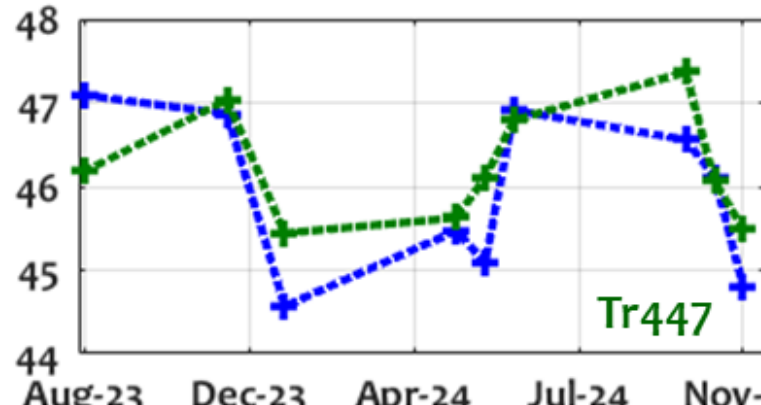
Devonport



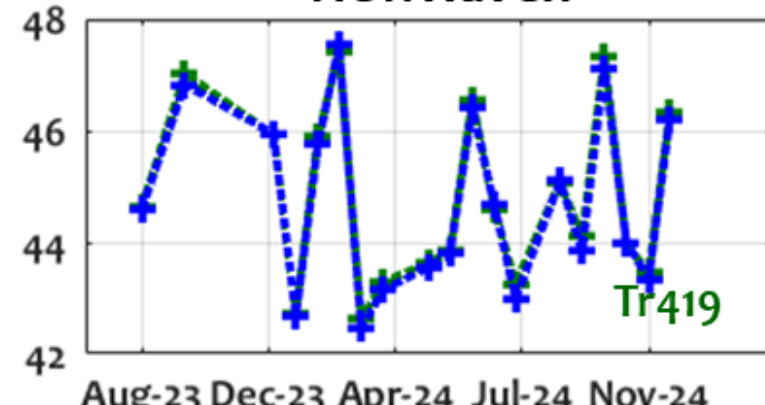
Weymouth



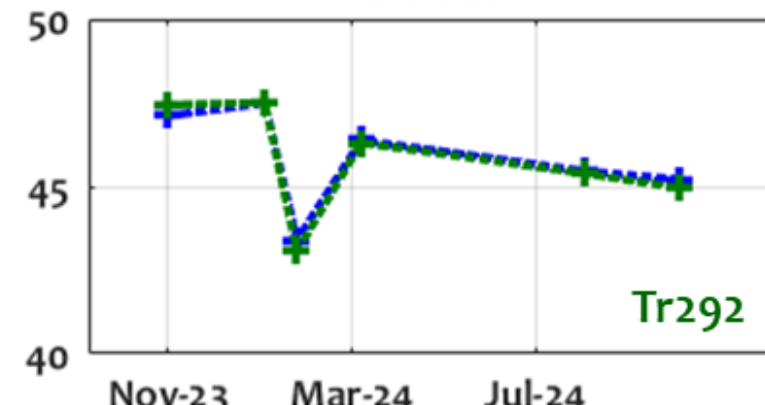
Portsmouth



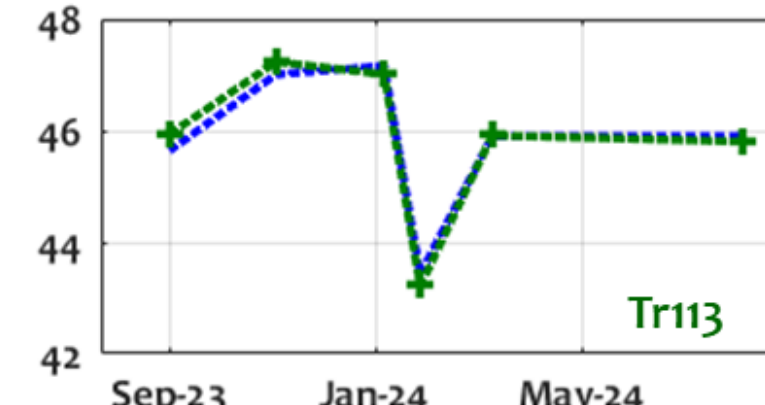
NewHaven



Dover

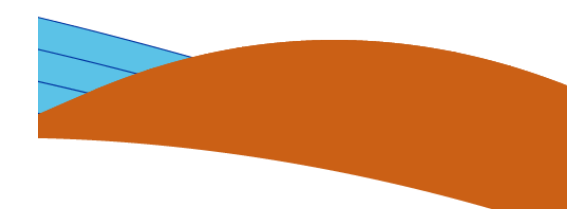


Dunkirk

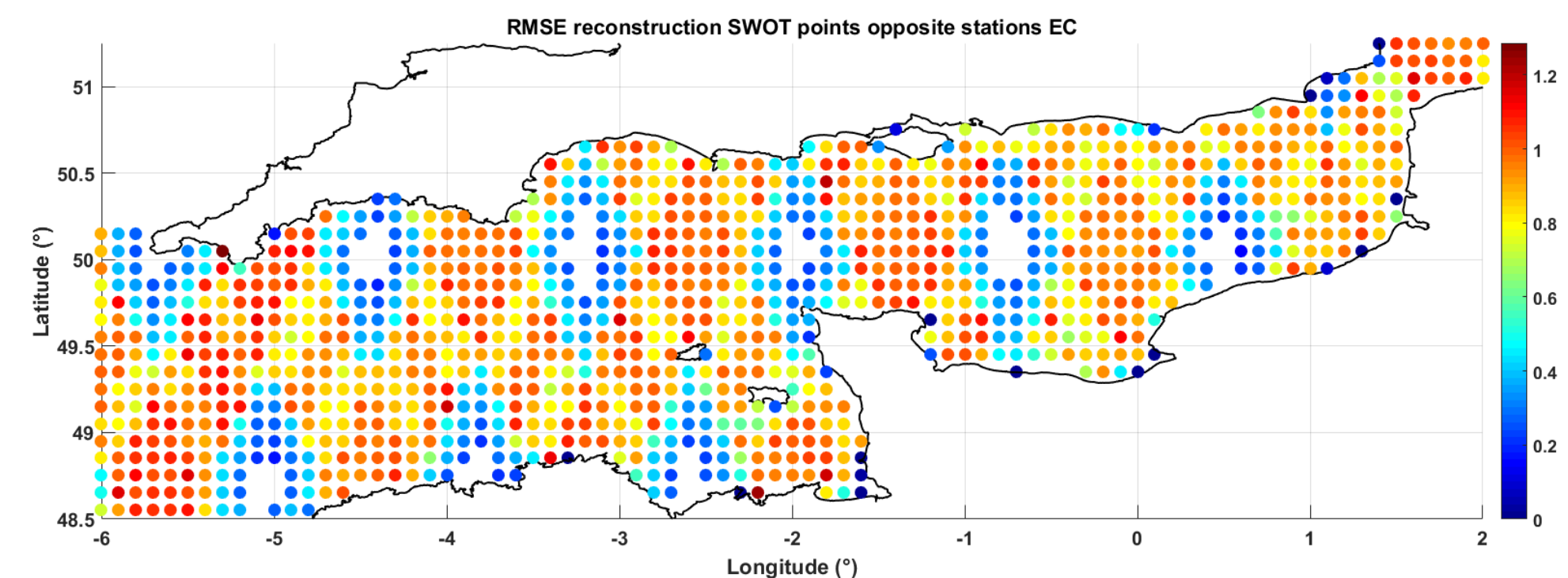
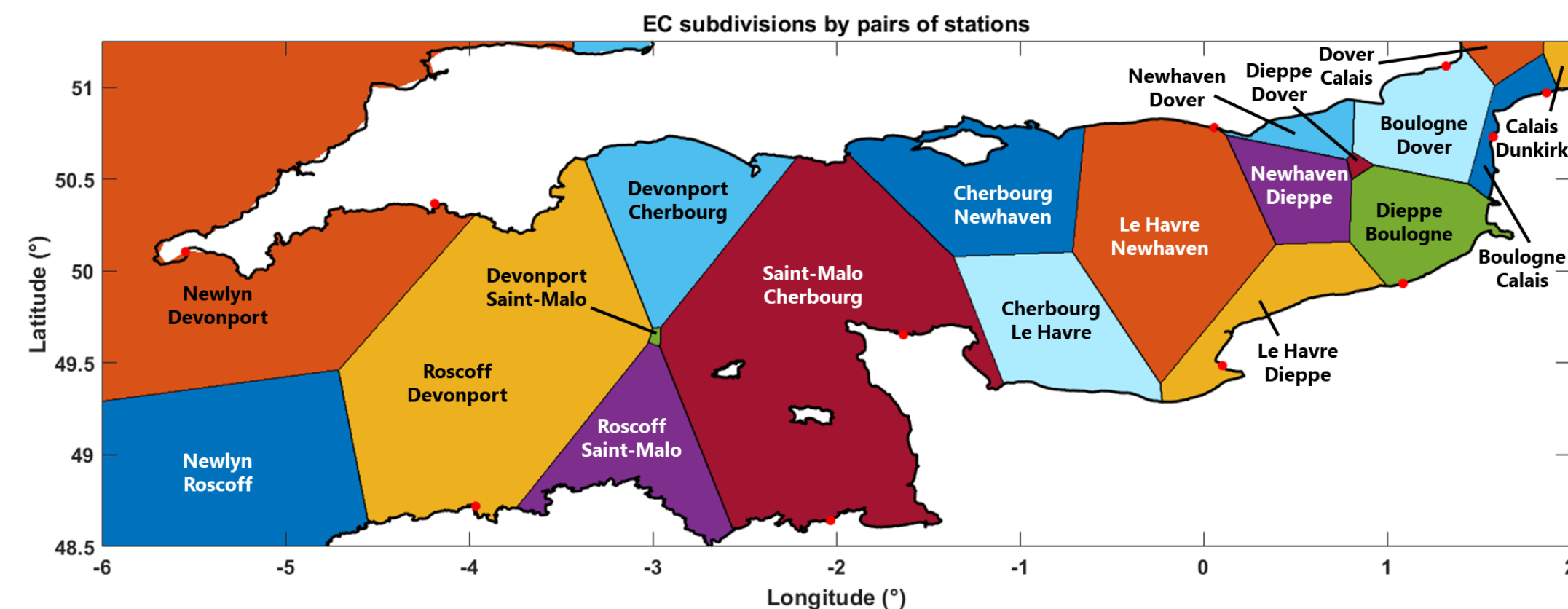


✓ Erreur
Moyenne < 90
cm

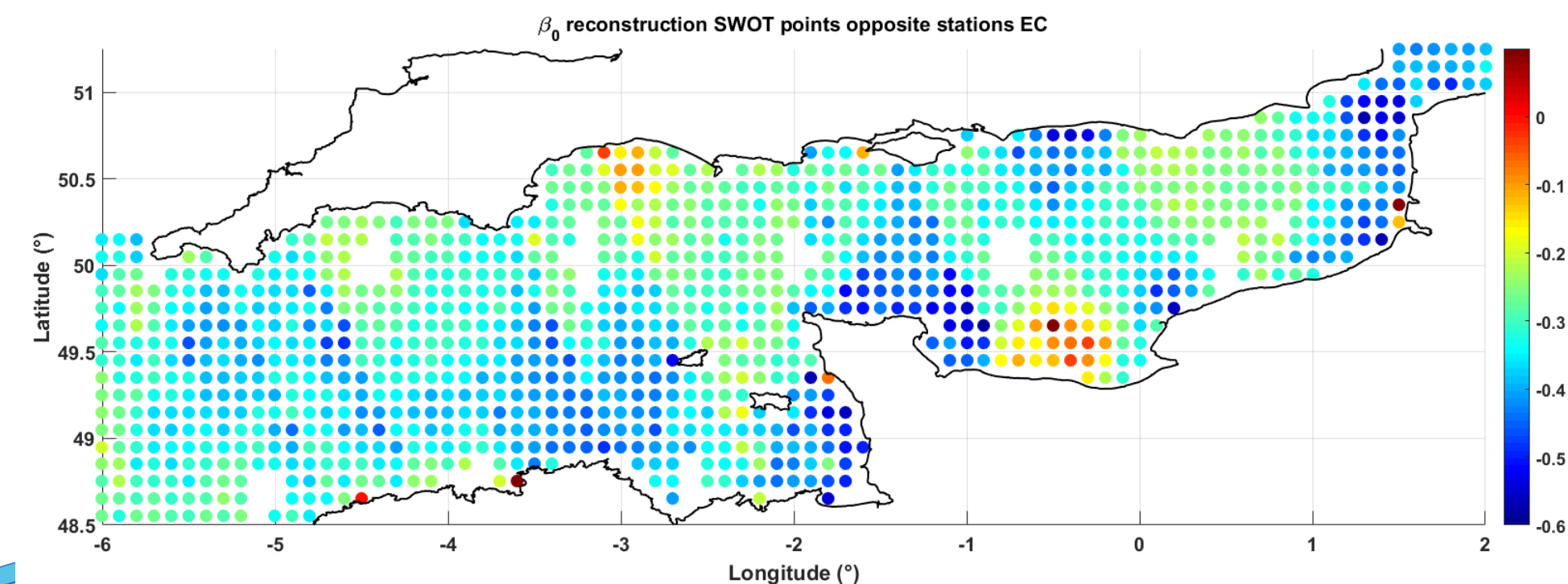
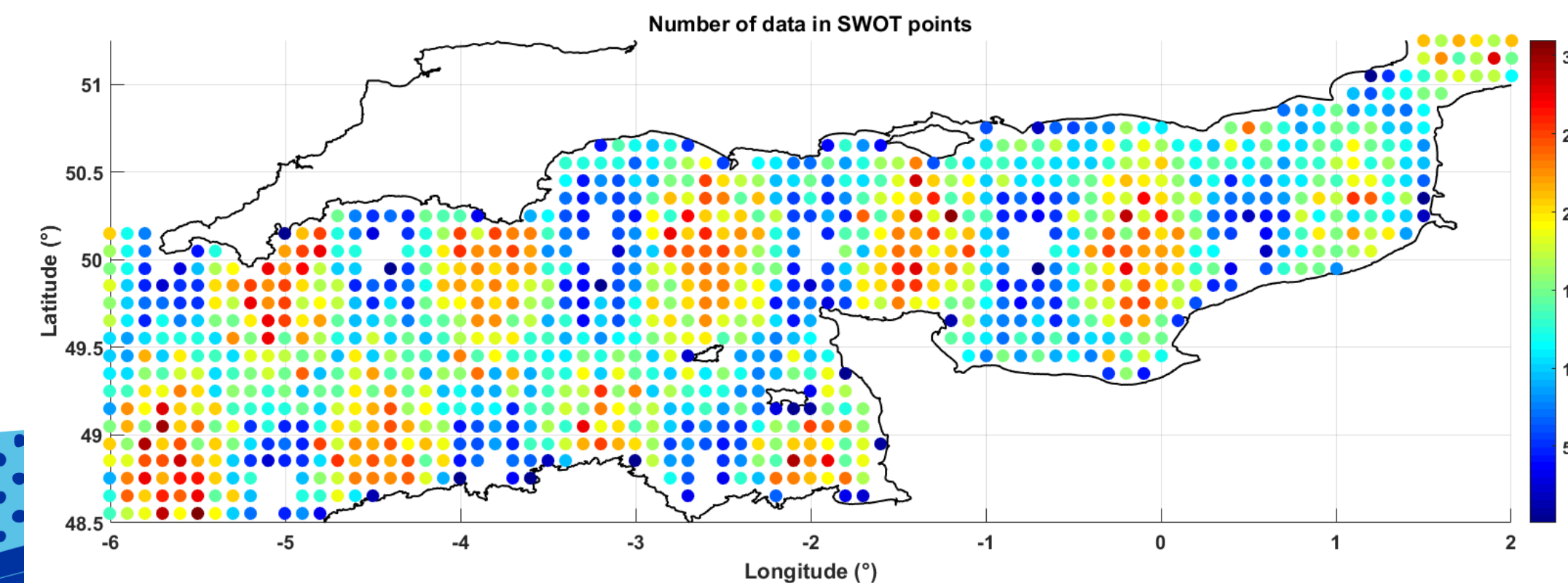
✓ Amélioration
de
l'échantillonna
ge temporel
par
combinaison
des différentes
traces



Spatio-temporal Reconstruction of Water Levels – English Channel

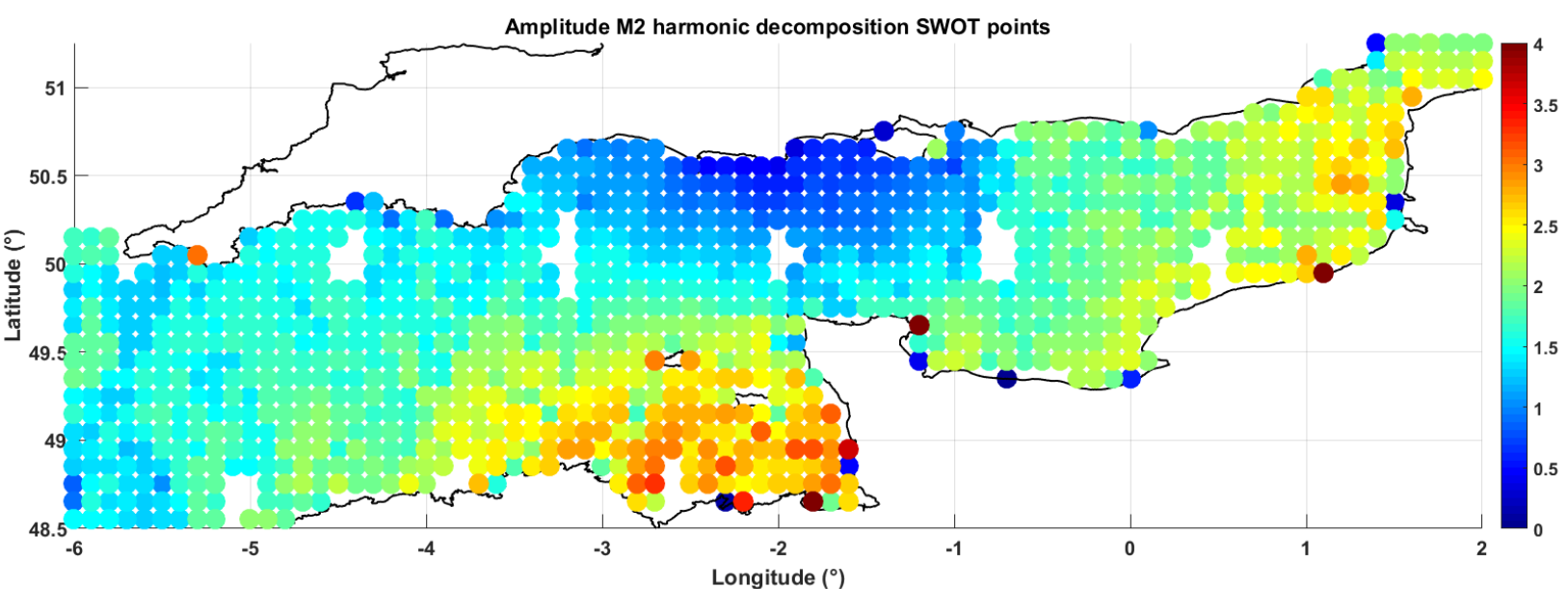
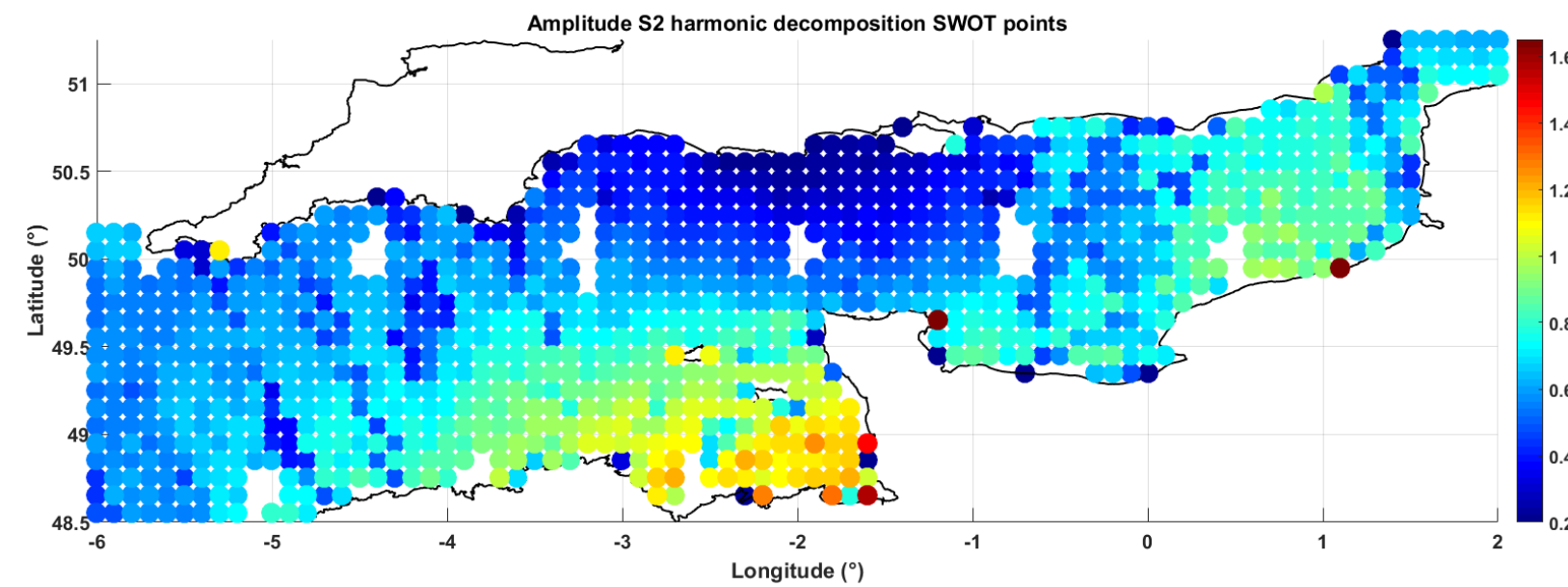
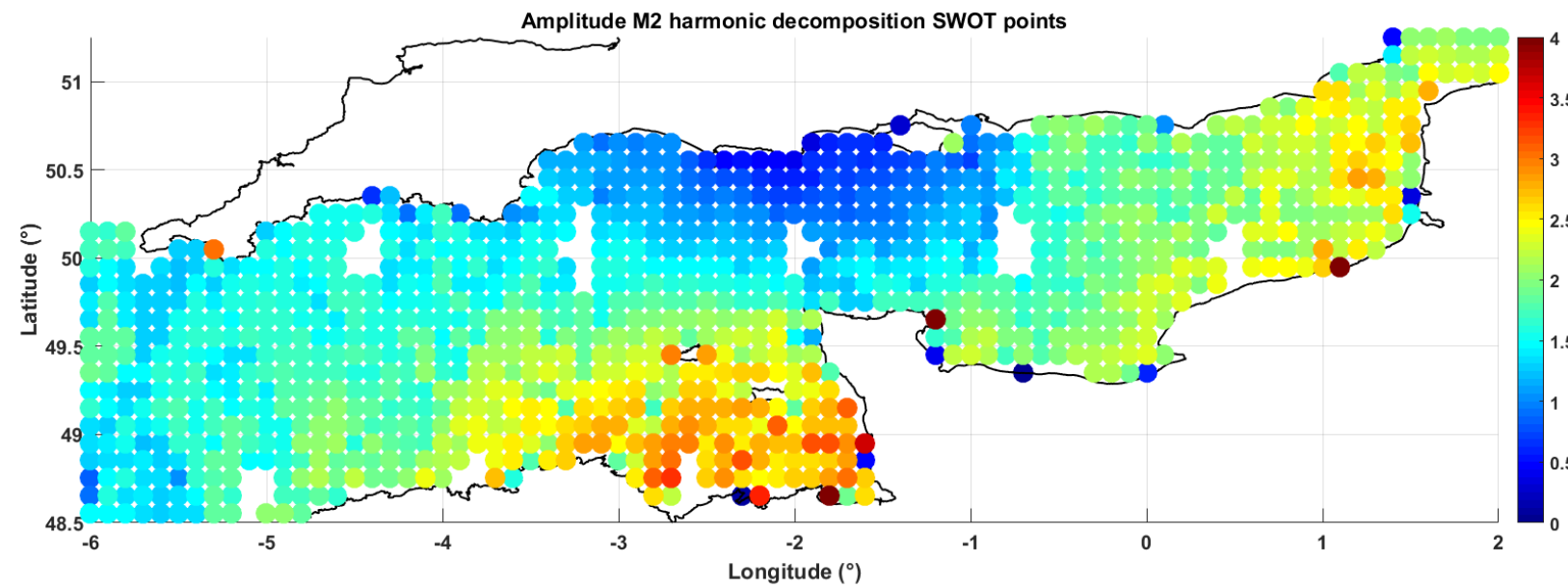


β_0 varies between -0.5 and -0.3

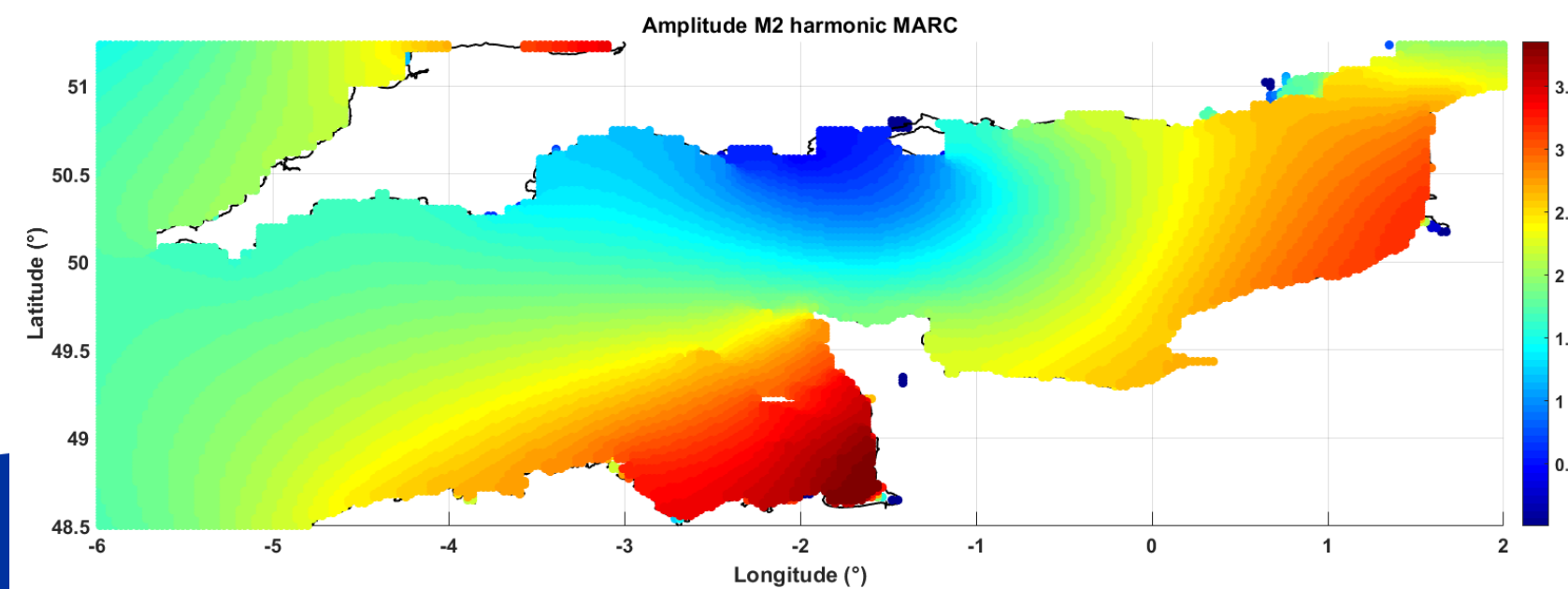
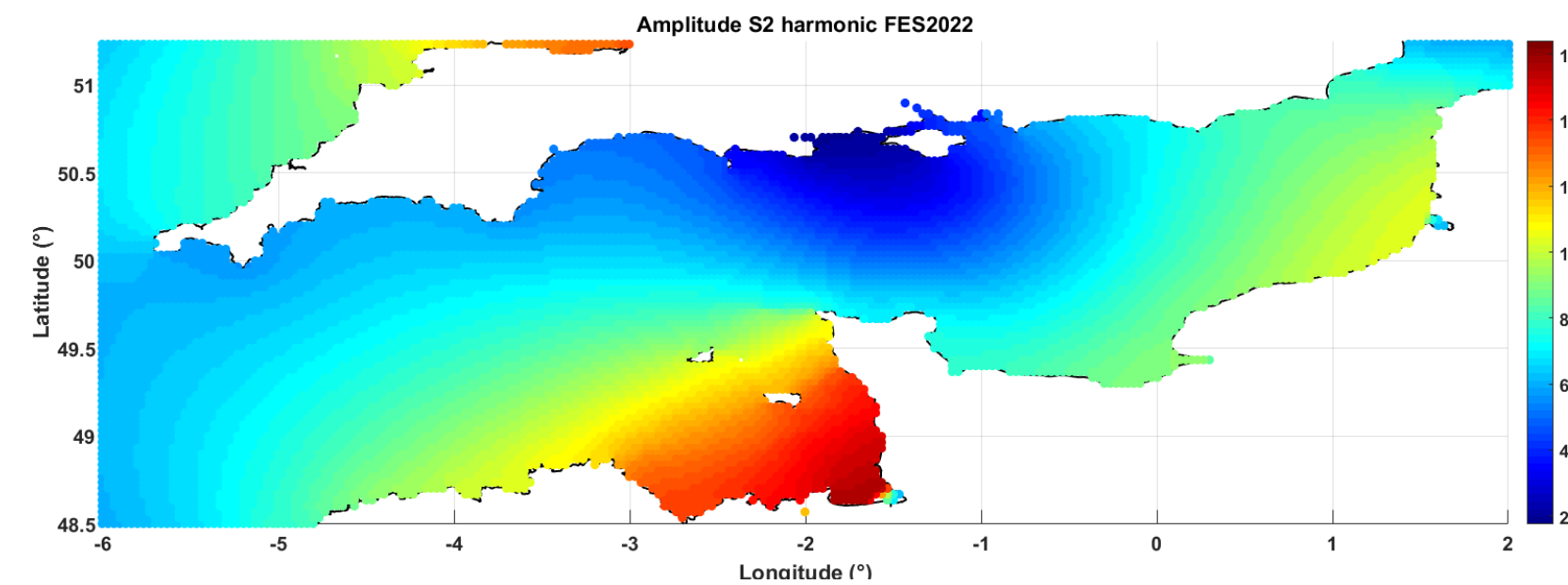
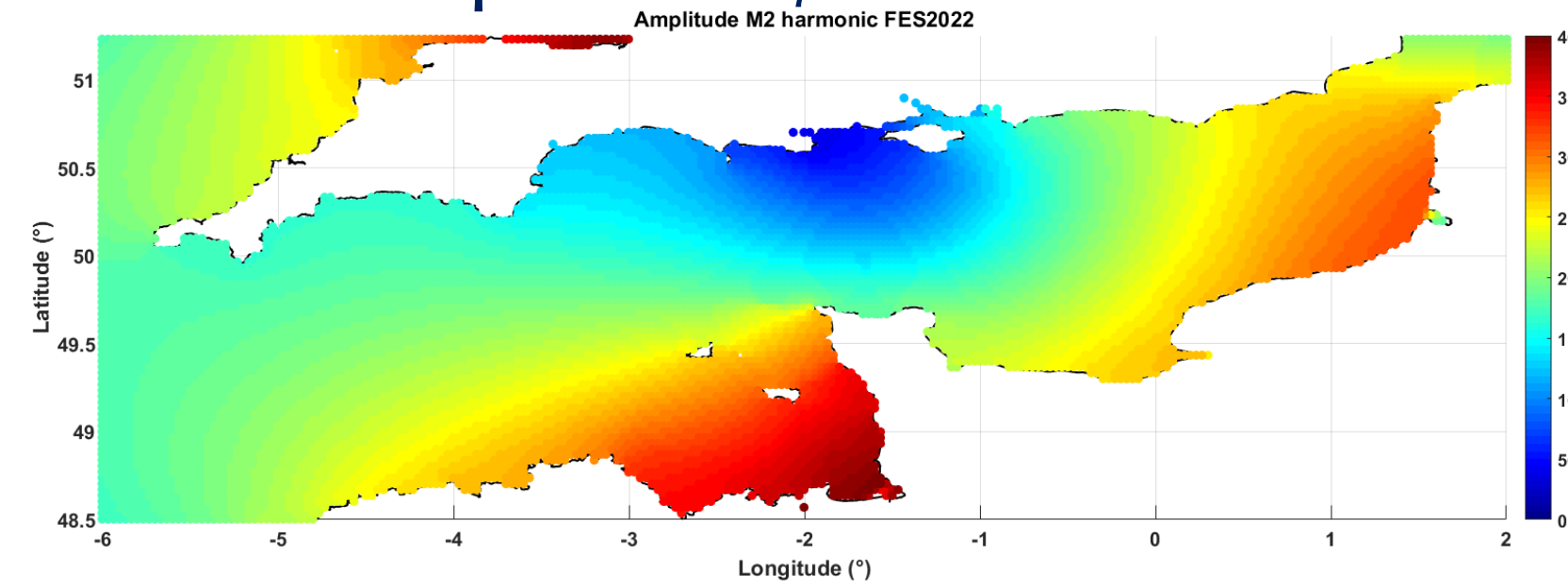


Simulations of Reconstructed Harmonic Components– SWOT-VMD

Simulation des Composantes Harmoniques par VMD-SWOT

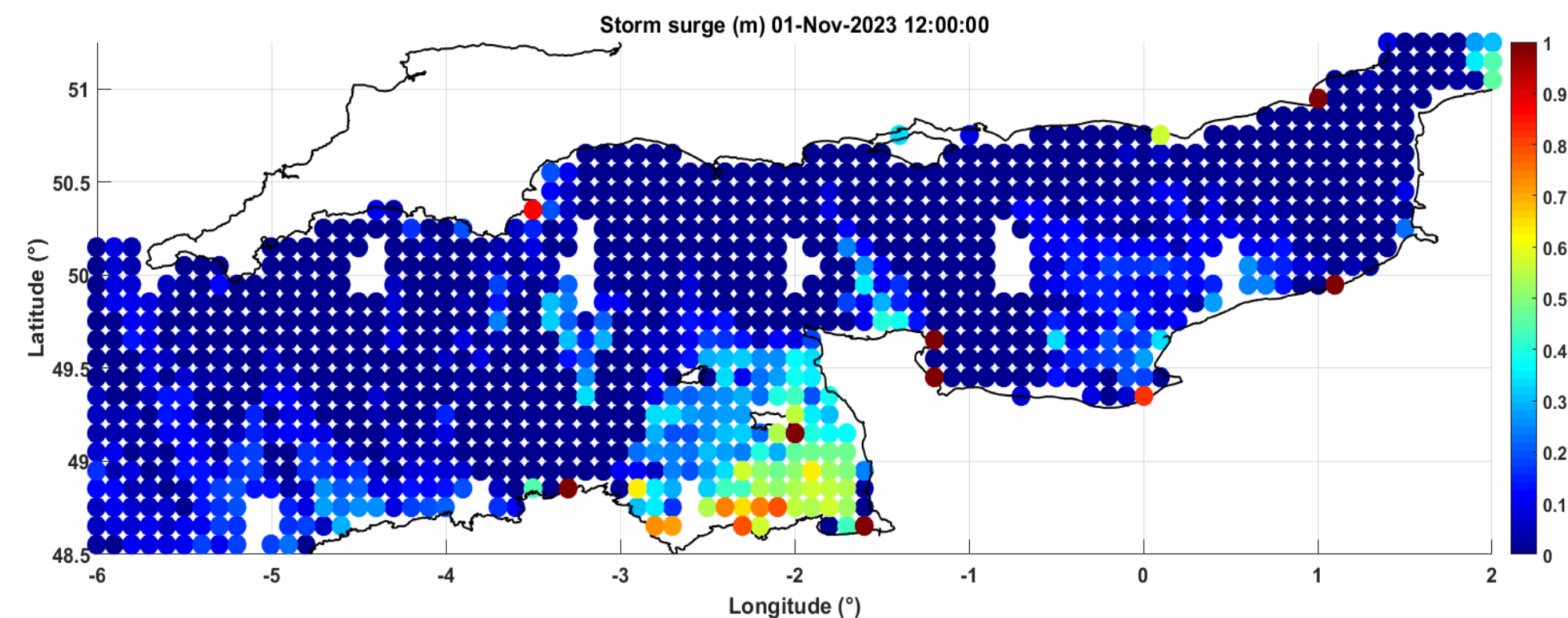


Simulation des Composantes Harmoniques par FES 2022/MARC

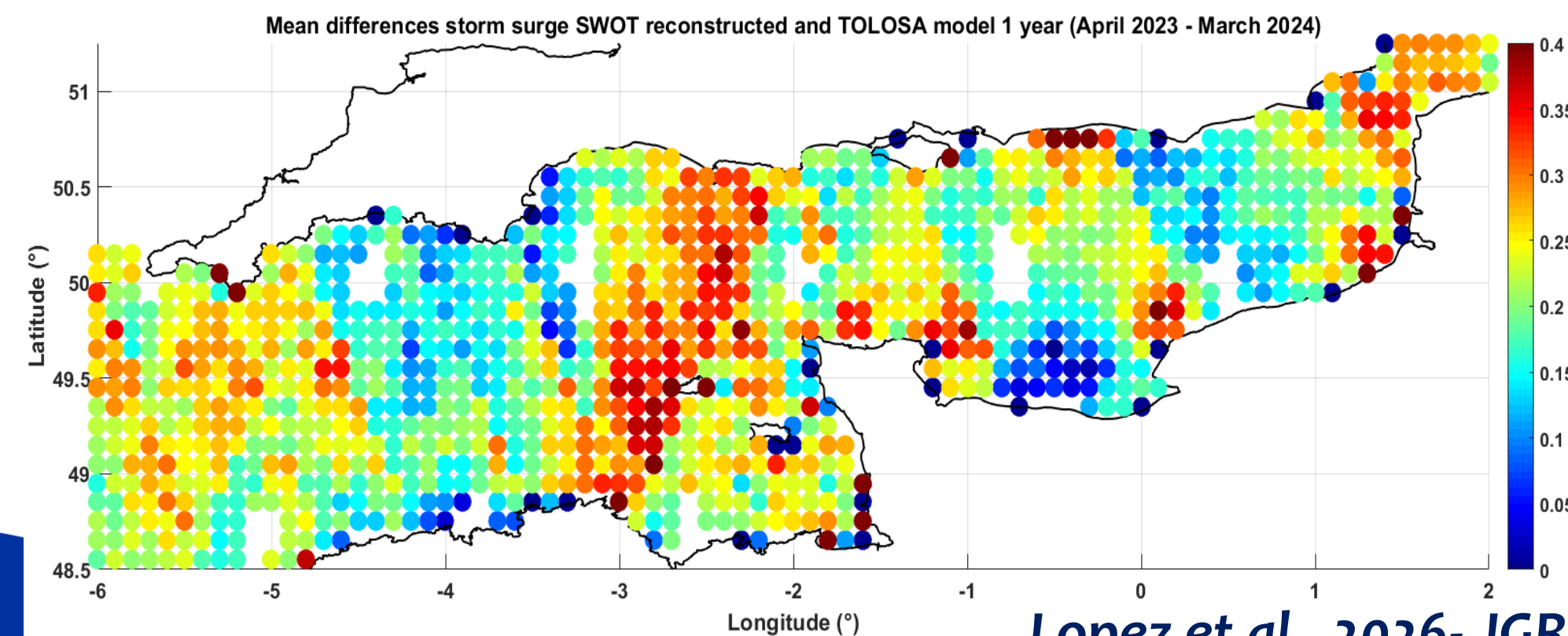


**Lopez et al., 2026-
JGR**

Storm Surges SWOT



Surges SWOT – TELOSA(Meteo-France)



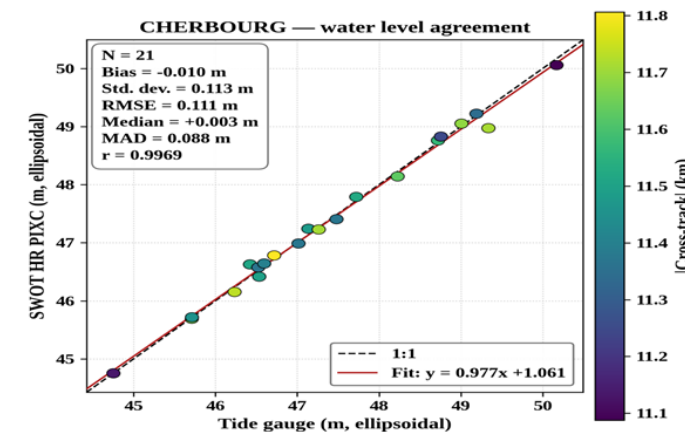
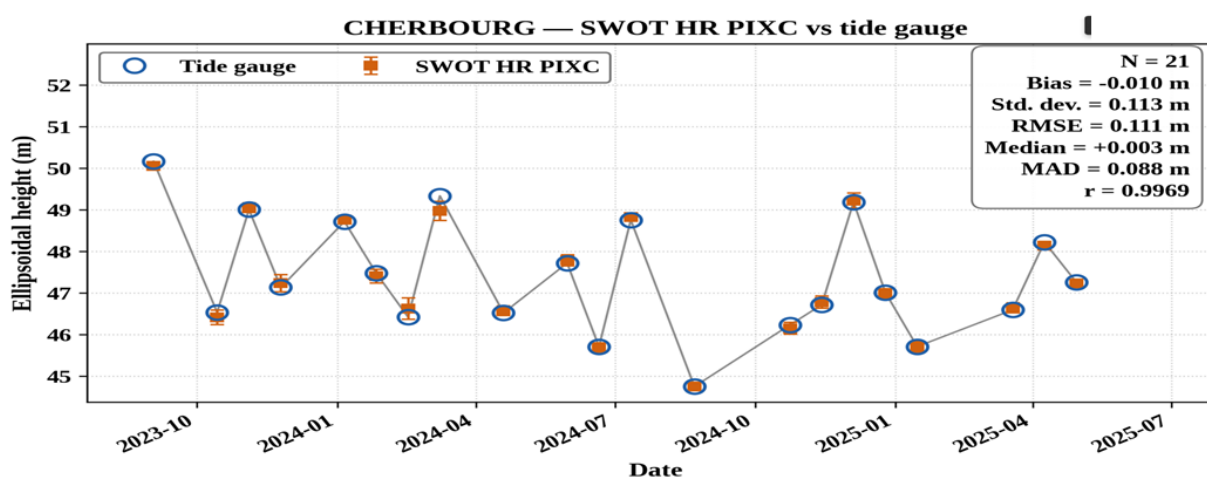
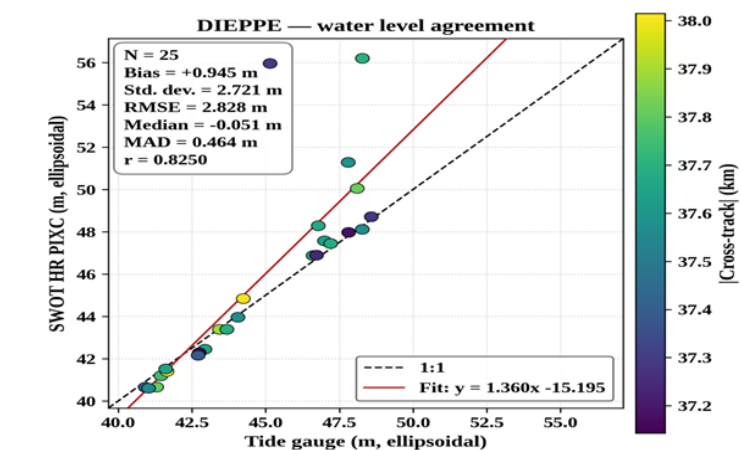
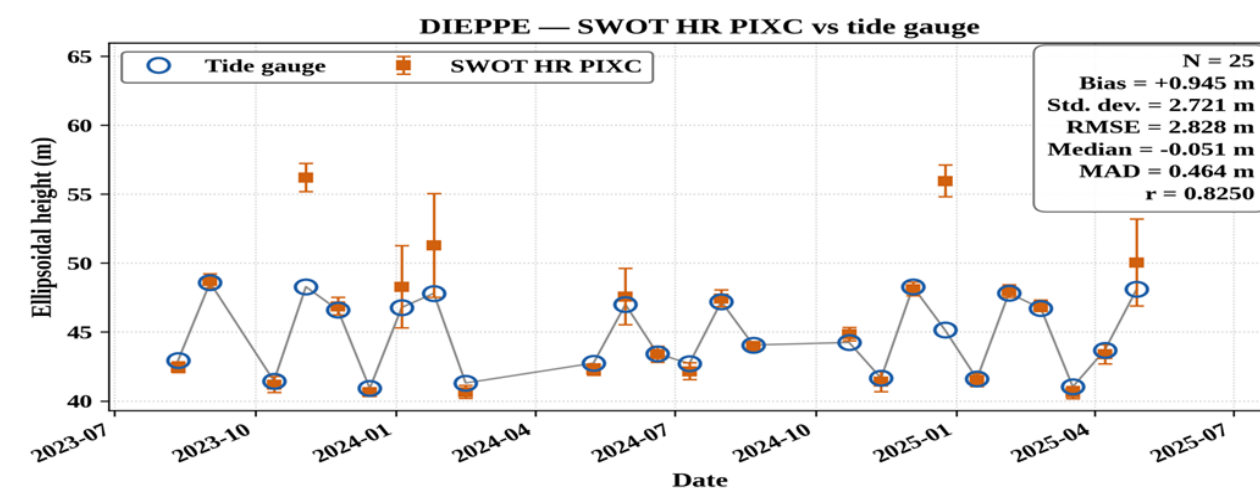
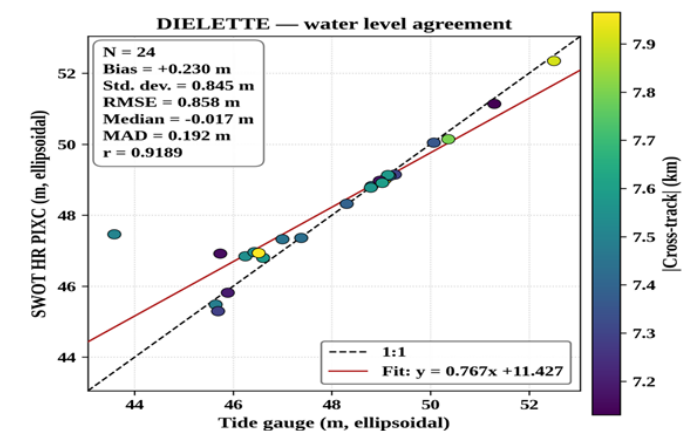
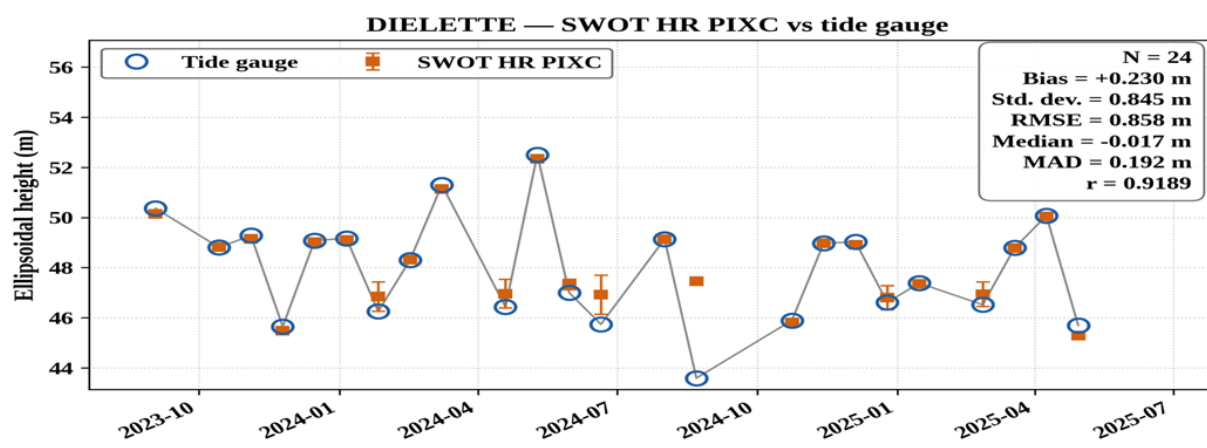
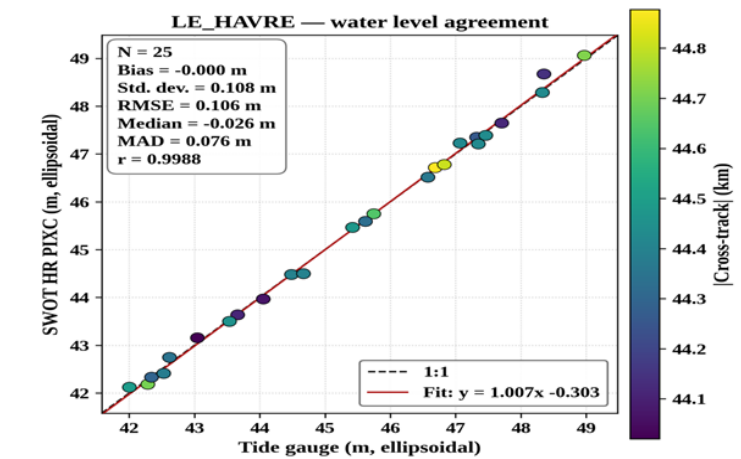
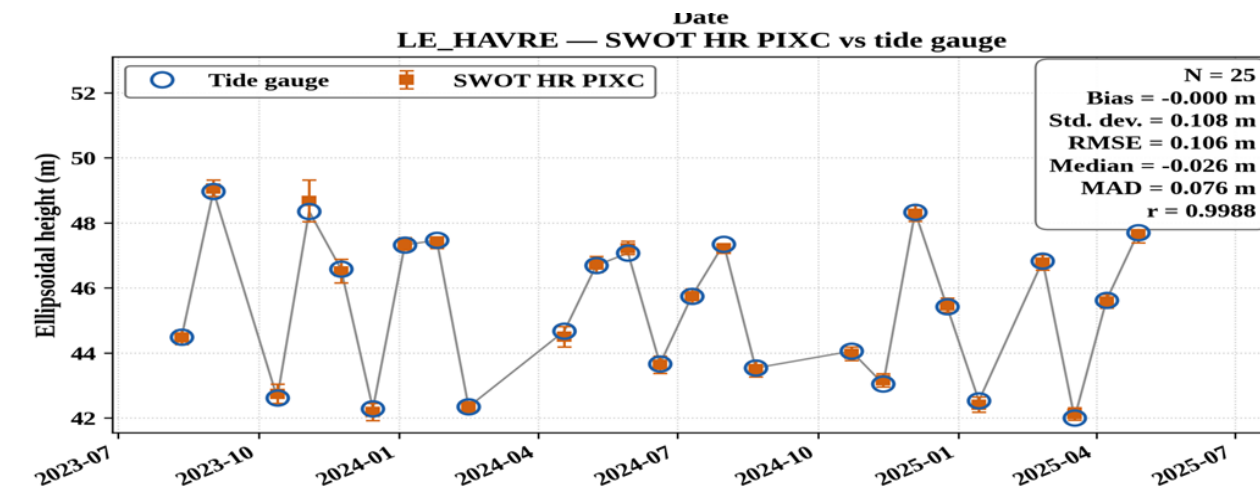
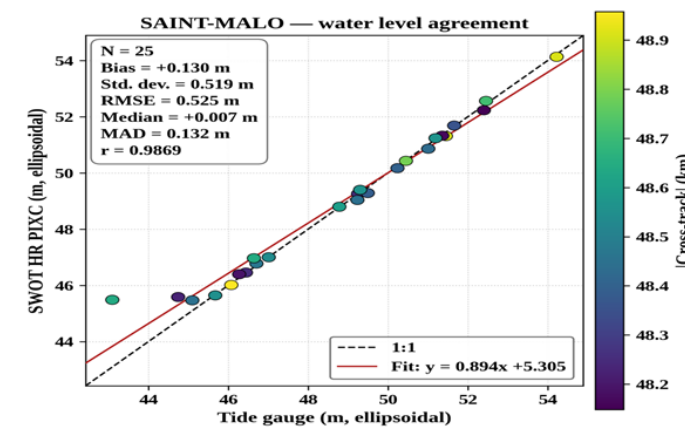
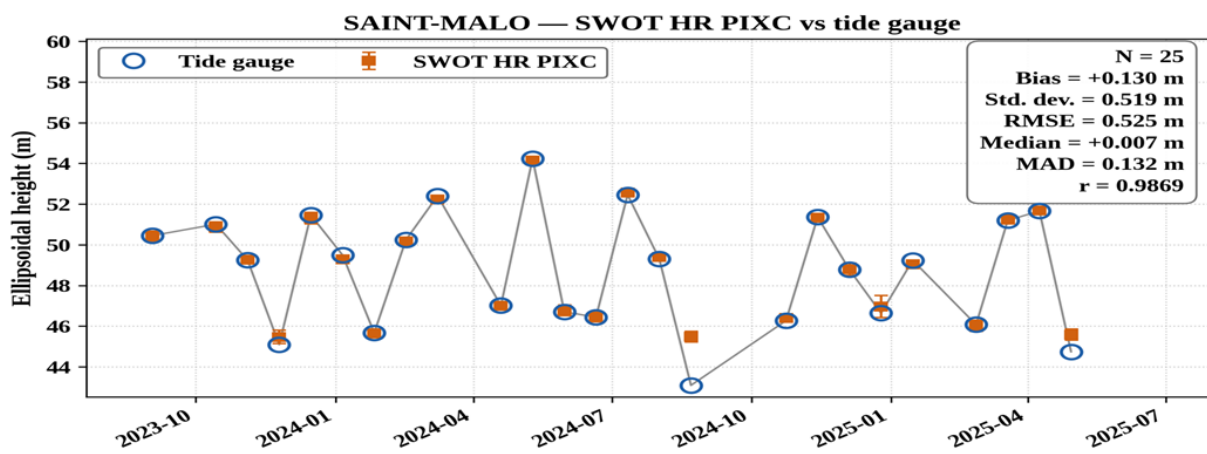
Lopez et al., 2026- JGR

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Contribution de SWOT HR

SWOT HR - Observations - PIXC

Validation de SSH –(L2 HR PIXC) - Marégraphe



Cherbourg : $RMSE \approx 0,11 \text{ m}$, $r \approx 0,997$

Le Havre : $RMSE \approx 0,11 \text{ m}$, $r \approx 0,999$

Saint-Malo : $RMSE \approx 0,53$ m, $r \approx 0,987$

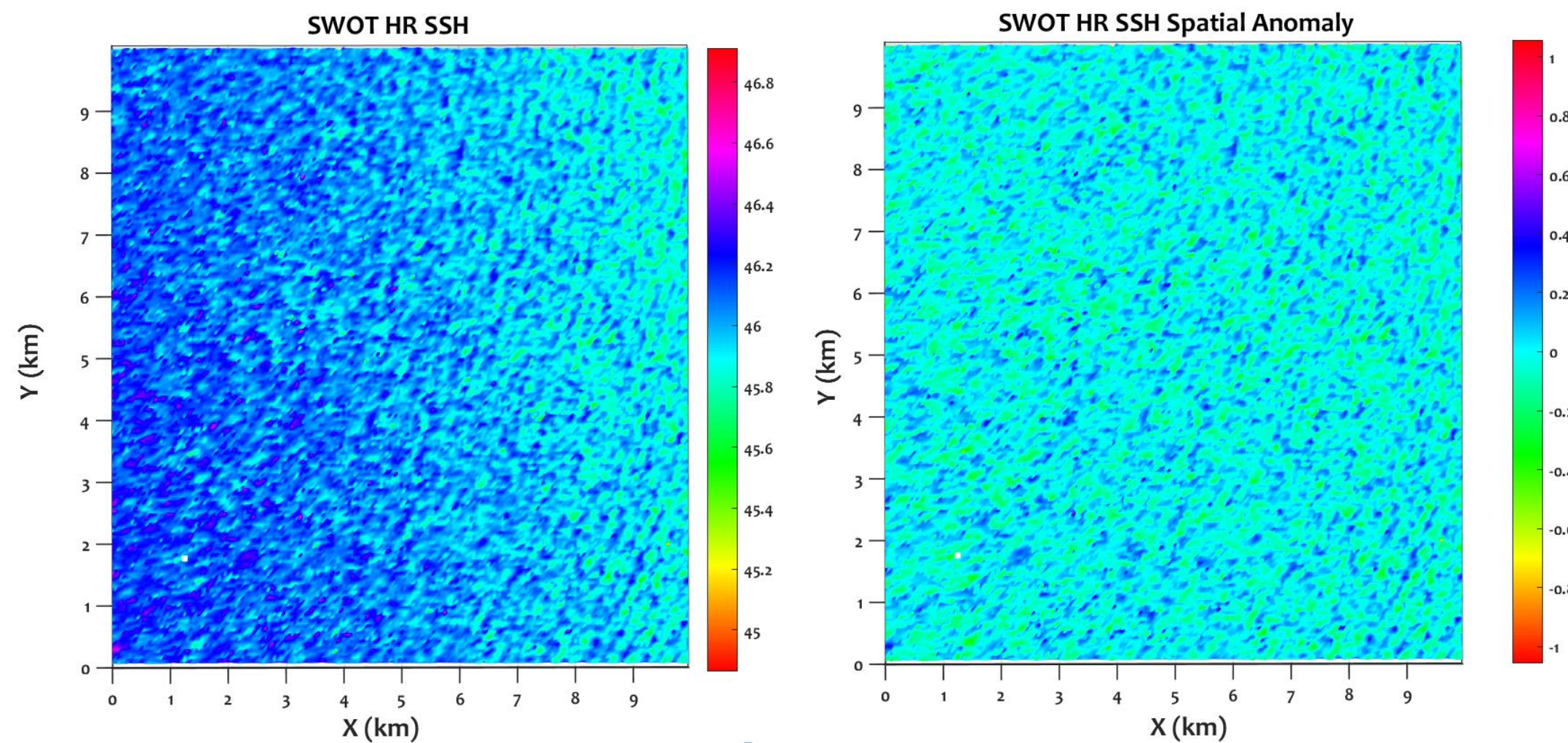
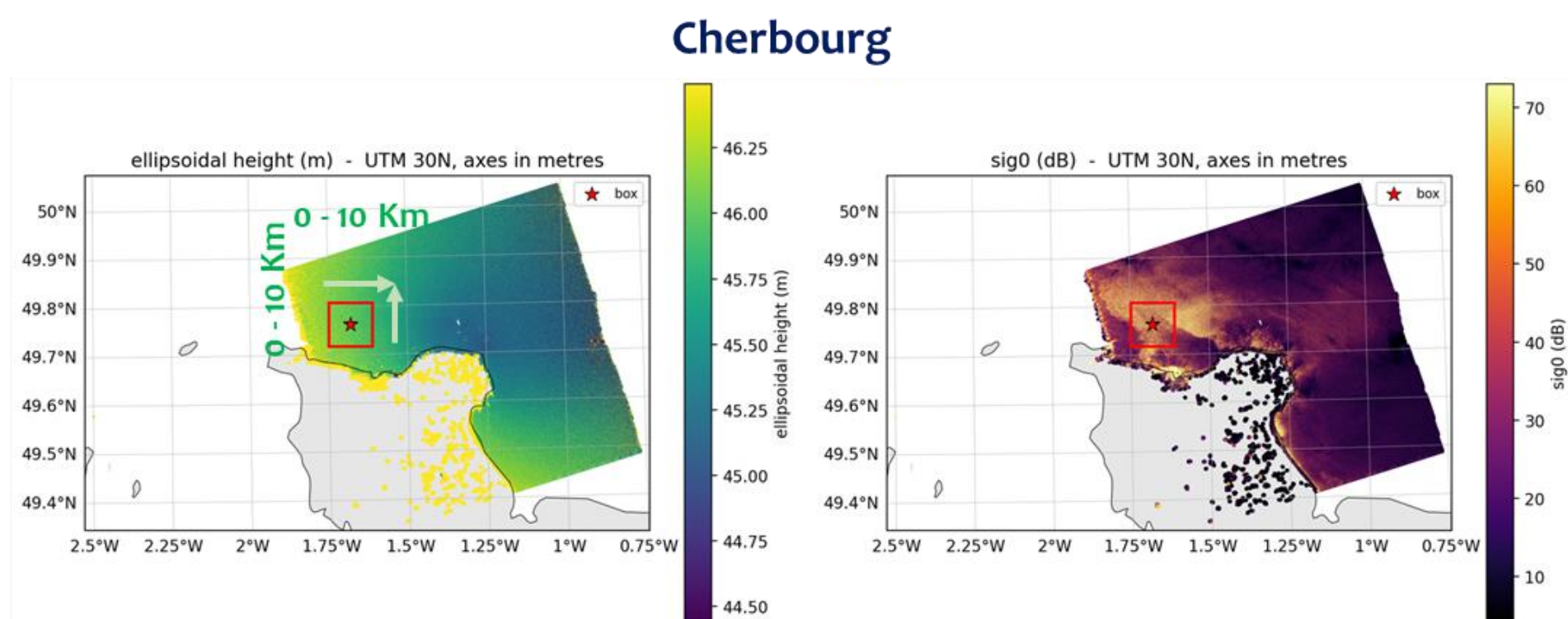
Diélette : $RMSE \approx 0,86$ m, $r \approx 0,919$

Dieppe : $RMSE \approx 2,83$ m, $r \approx 0,83$, e

Turki et al., 2026-JRS

2D Observations of Water Levels - Cherbourg

Cartes 2D des Niveaux d'eau SSH –(L2 HR PIXC)

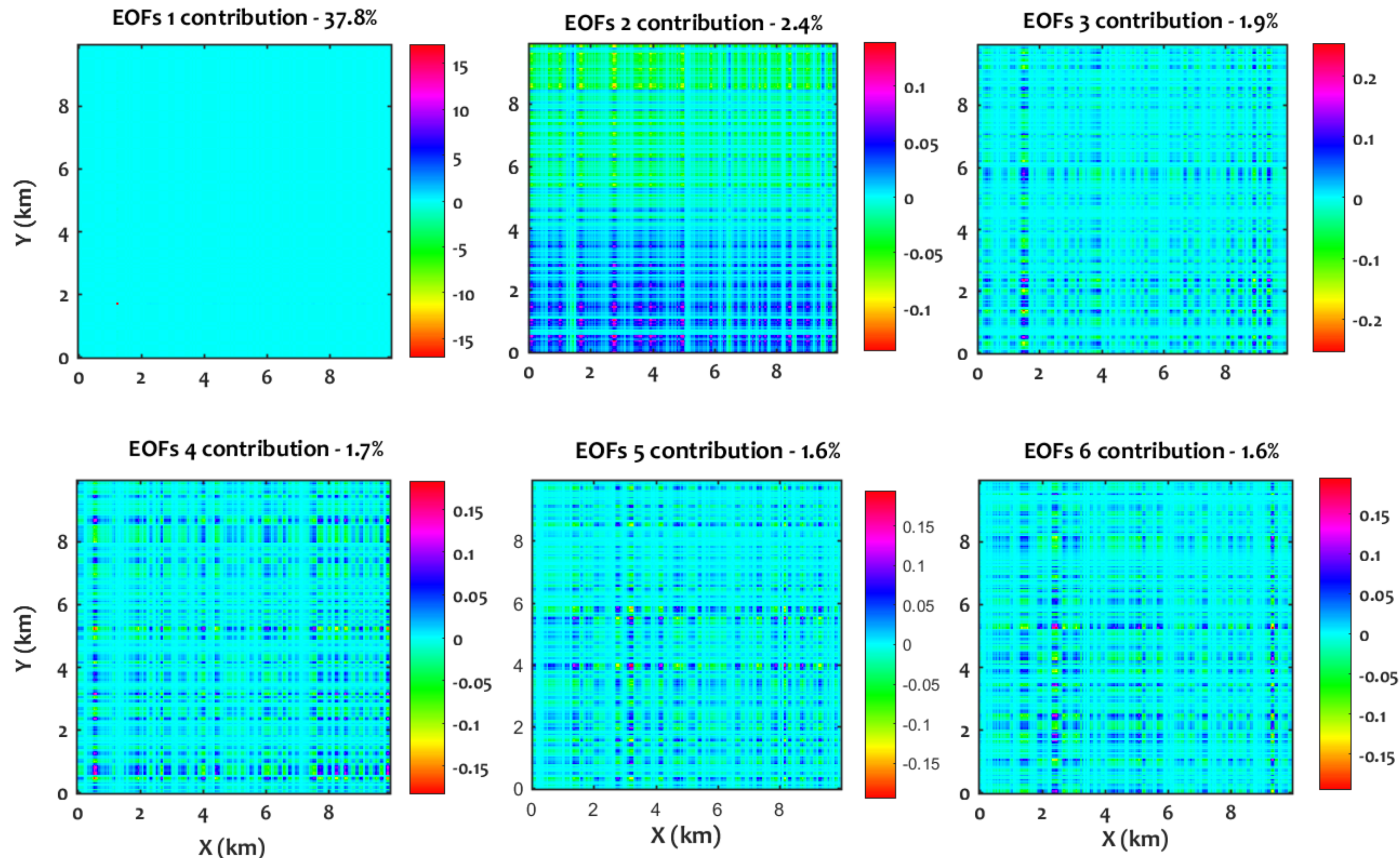


Fine-scale SSH variability

Turki et al., 2026-JRS

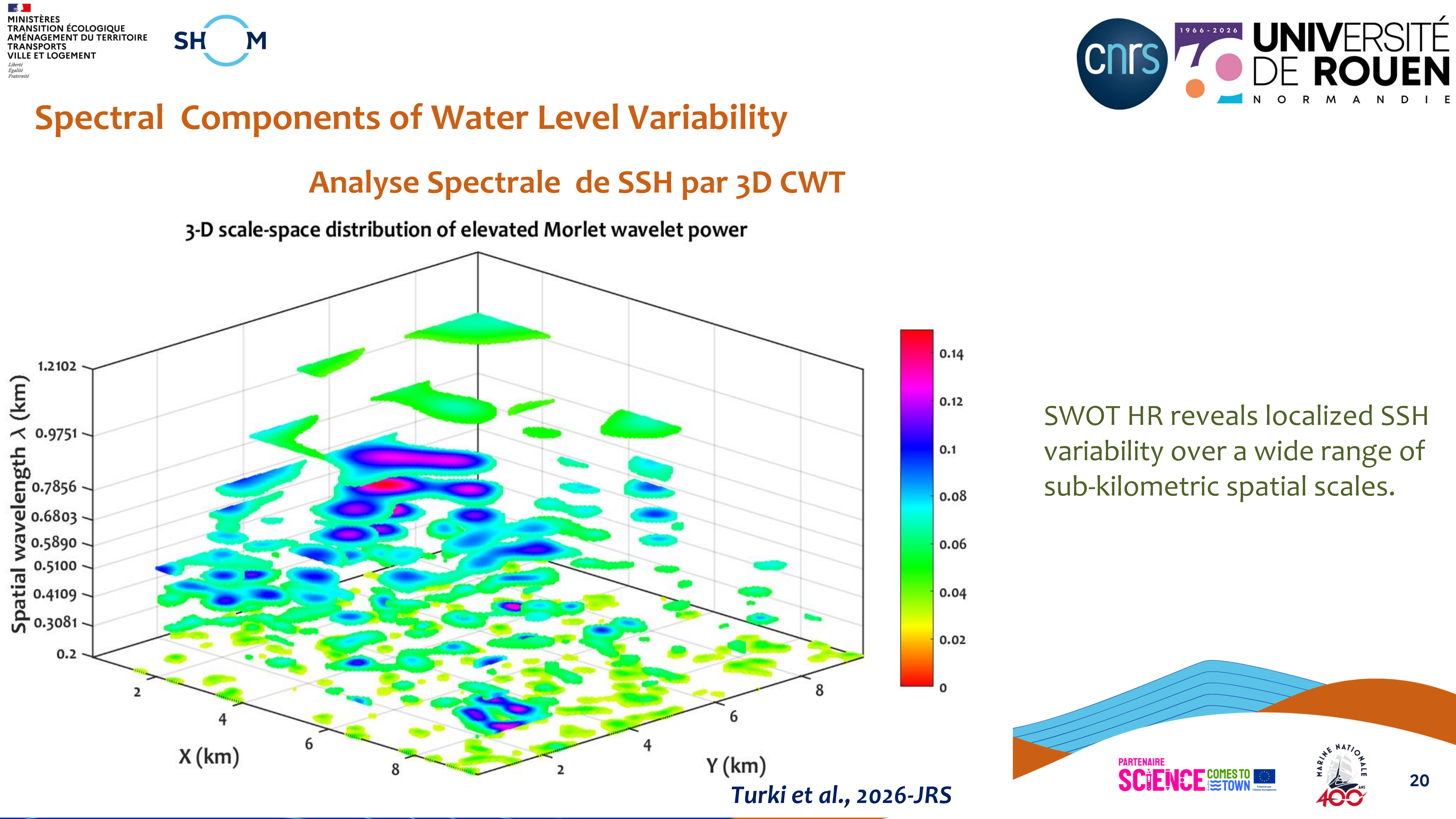
Principal Components of Water Level Variability

Decomposition de SSH par EOFs

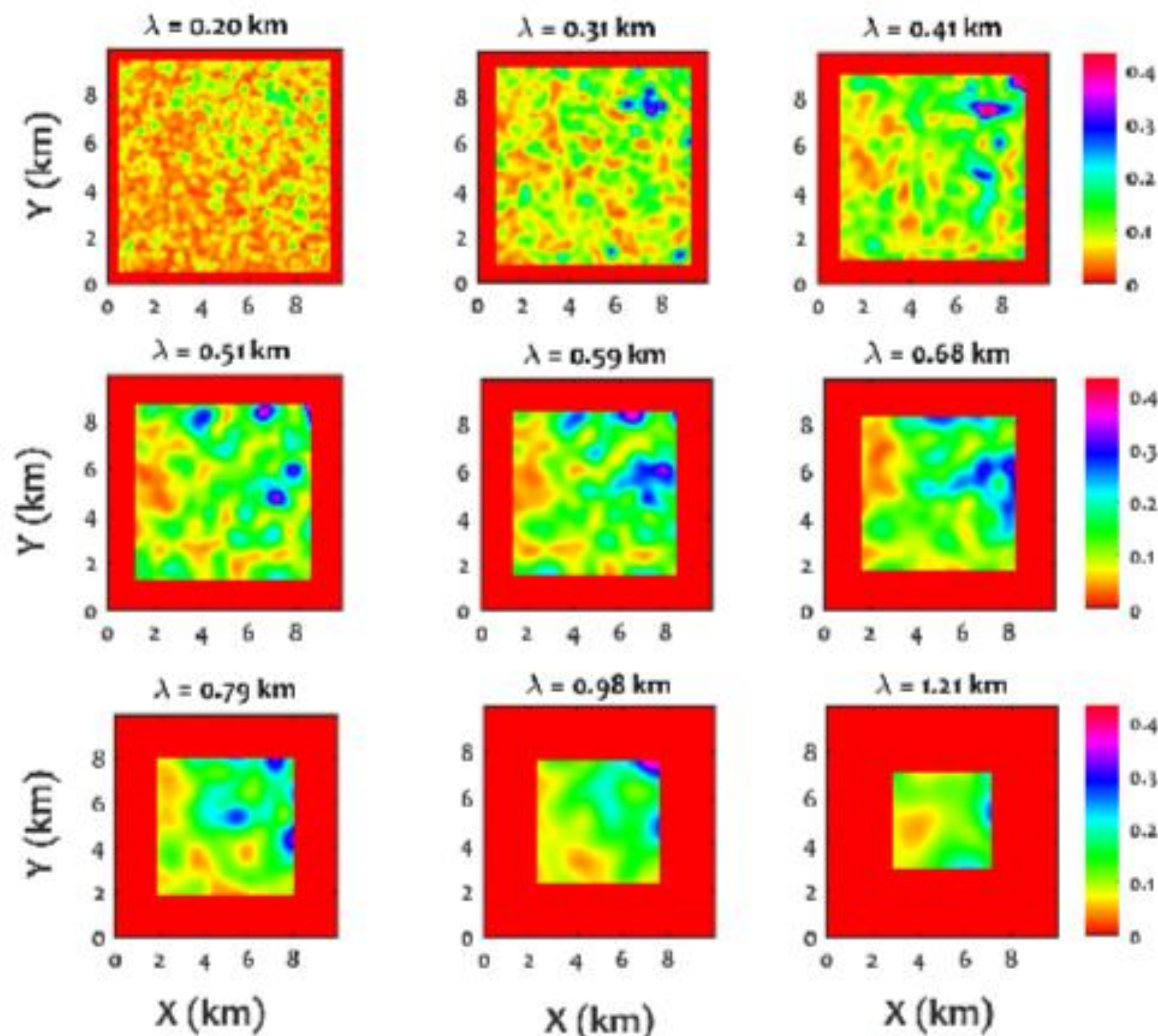


The dominant EOF captures the large-scale coherent SSH variability, while the remaining variance is distributed among numerous fine-scale spatial modes.

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2D Spatial Distribution of CWT power – SSH Anomaly



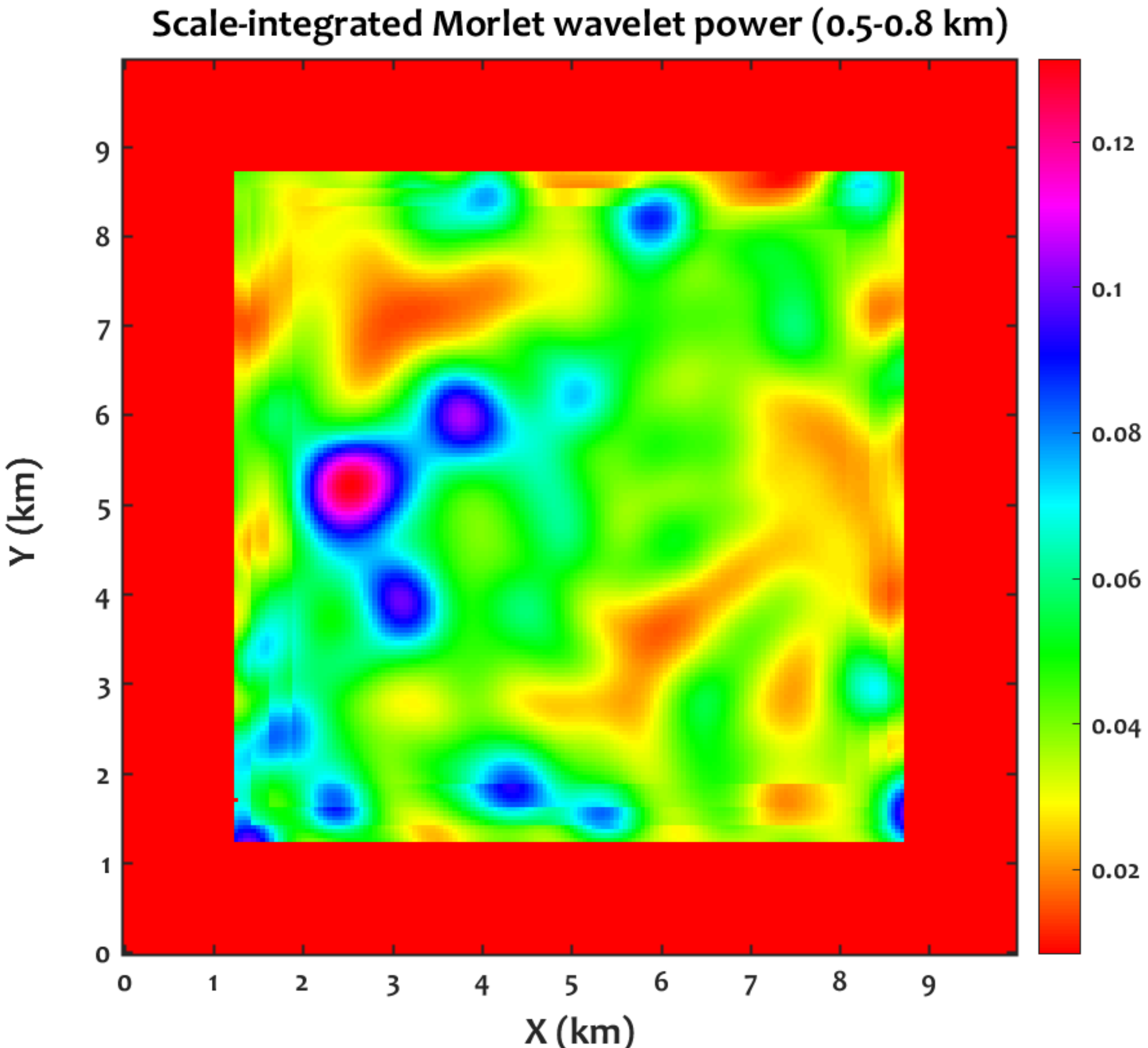
Spatial distribution of Morlet wavelet power across selected wavelengths derived from the detrended SWOT HR SSH anomaly.

Wavelet-power maps from 0.20 to 1.21 km reveal a transition from fine-scale distributed variability to larger, spatially coherent structures.

Red areas indicate regions affected by edge effects and excluded from the interpretation.

Turki et al., 2026-JRS

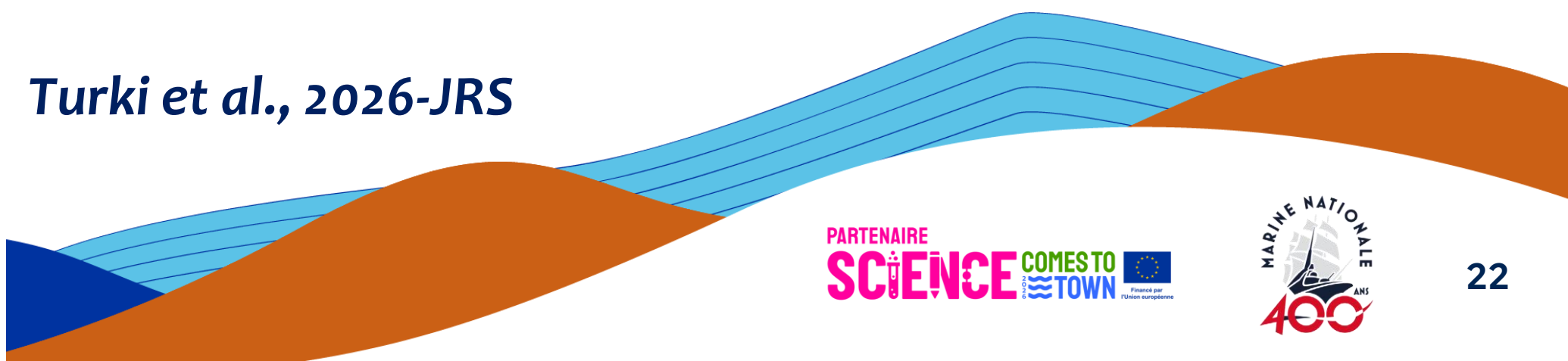
2D Spatial Distribution of scale-integrated CWT power – SSH Anomaly



Spatial distribution of scale-integrated Morlet wavelet power within the 0.5–0.8 km wavelength band.

Scale-integrated wavelet power (0.5–0.8 km) Integration of Morlet wavelet power over the dominant 0.5–0.8 km wavelength band highlights localized sub-kilometric SSH variability observed by SWOT HR. Red areas indicate regions excluded because of edge effects.

Turki et al., 2026-JRS



Concluding Remarks

1. Multi-scale SWOT observations

- **LR:** regional monitoring of water levels across the English Channel
- **HR:** access to fine-scale coastal variability, down to sub-kilometre scales

2. Strong complementarity

- **tide gauges:** improving the temporal continuity
- **Models:** hydrodynamic simulations
- **SWOT HR:** spatial structures that are difficult to capture using point-based observations alone

3. New perspectives for extreme events

- Spatiotemporal reconstruction of water levels
- Monitoring of tides, storm surges and storms
- Potential for monitoring coastal Hazards
- Reconstruction of digital Twins Framework

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