

High-resolution Sea Surface Height mapping with assimilative simple models: status and plans

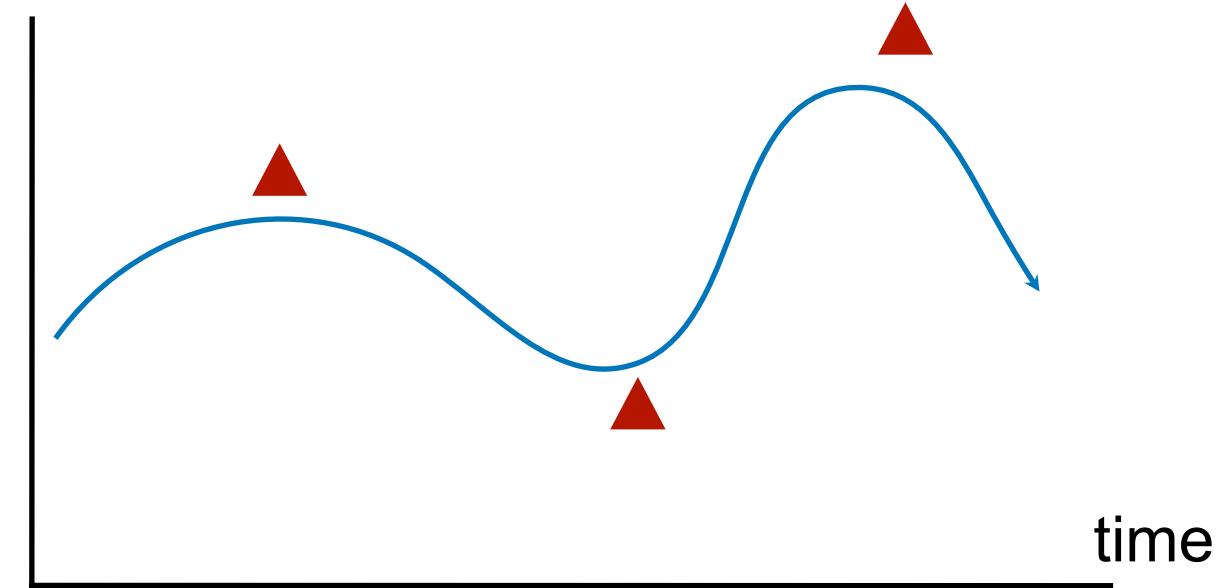
A. Stella, **V. Bellemin-Laponnaz**, F. Le Guillou, S. Metref,
C. Ubelmann, A. Barboni and E. Cosme

SWOT Science Team meeting 2023, Toulouse



Our approach: use simple and low-cost dynamical models

- Physically-based, consistent time interpolation of SWOT data
- Implement adapted, possibly high-level inversion algorithms
- Limit tuning efforts, ensure geographical flexibility
- Limit CPU and carbon costs
- Regional focuses (so far. And no tropics)



Check the posters!

Assimilation of wide swath satellite altimetry to map geostrophic and internal tide signals of the ocean dynamics

Abstract
Assimilating the IOD results from the additional altimetric signals (120 km), whereas conventional tide altimetry is currently limited to the large mesoscale range (150-200 km), we propose a new approach to estimate the geostrophic currents and the internal tides. This approach uses a 3D geostrophic balance and a 2D wave model to separate the contributions to SSH variations.

Method
 $\mathbf{y} = \mathbf{y}^{obs}$ is the vector of observations and \mathbf{y}^{pred} is the vector of predicted values.

Model & Parameters
The model is a 1-layer oceanographic model. Parameters: reference bathymetry, geostrophic balance, wave model, and tidal model.

Preliminary results
Reference field vs Reconstructed field, Total SSH, Balanced Motion (BM), Internal Tide (IT).

References

Designed for SWOT
SWOT will revolutionize our understanding of the ocean's high-resolution dynamics by using a model to bridge the temporal gap in between passes. This poster presents the first results obtained by assimilating SWOT data to a regional ocean model. The results are compared with artificial SWOT events based on model simulations. BPN-QO is used for SWOT data and depends on priori maps of high spatial resolution.

Back-and-Forth Nudging the QG model in the Mediterranean Sea

- Tested in Near-Real-Time to cover the C-SWOT/WEMSWOT companion campaigns, 21 march – 17 april 2023
- processes 7 nadir altimeters from CMEMS + SWOT nadir when available

BFN-QG geostrophic vel.
White arrows

C-SWOT Transect
ADCP Bk: surf, Rd: 200 m

Satellite SST

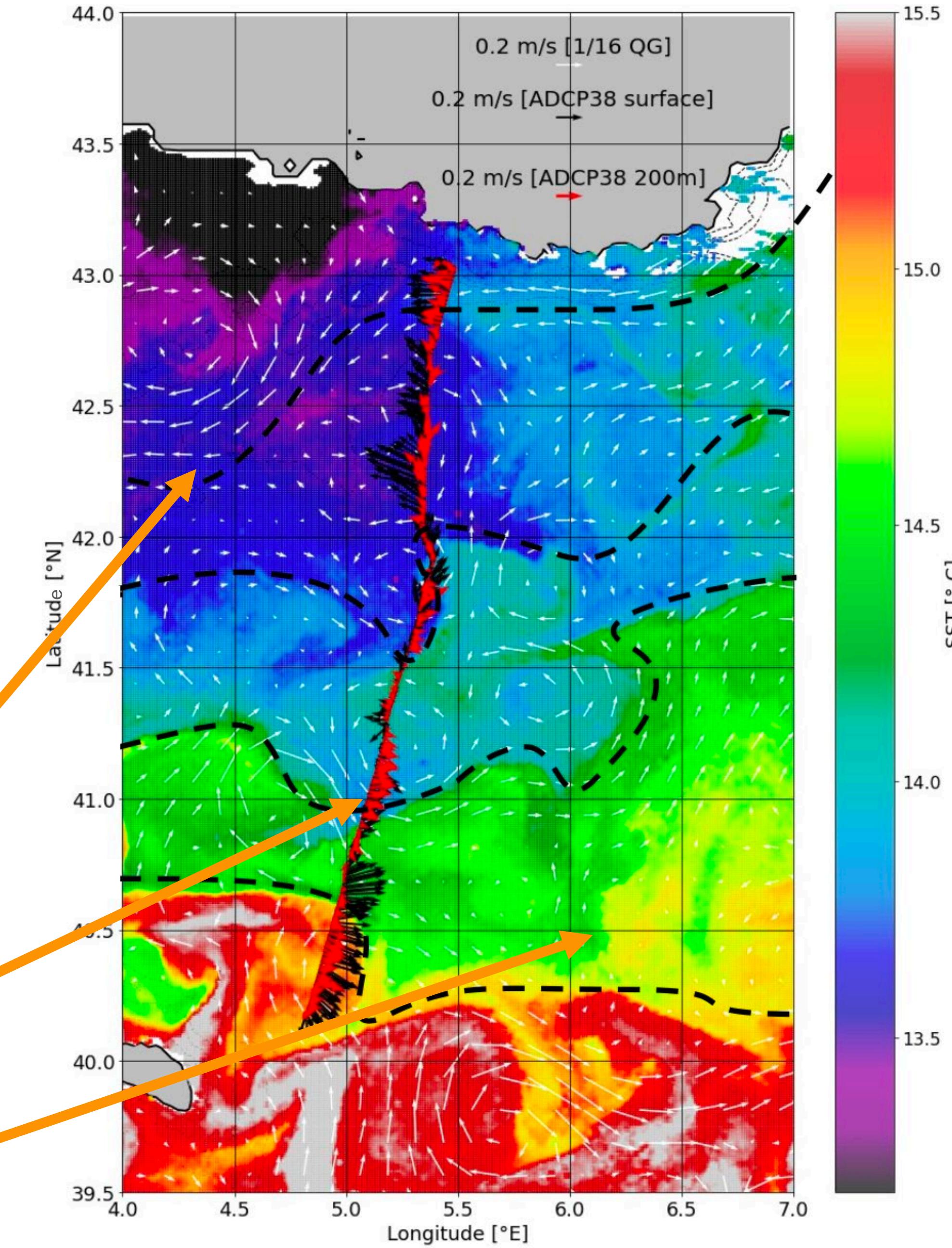
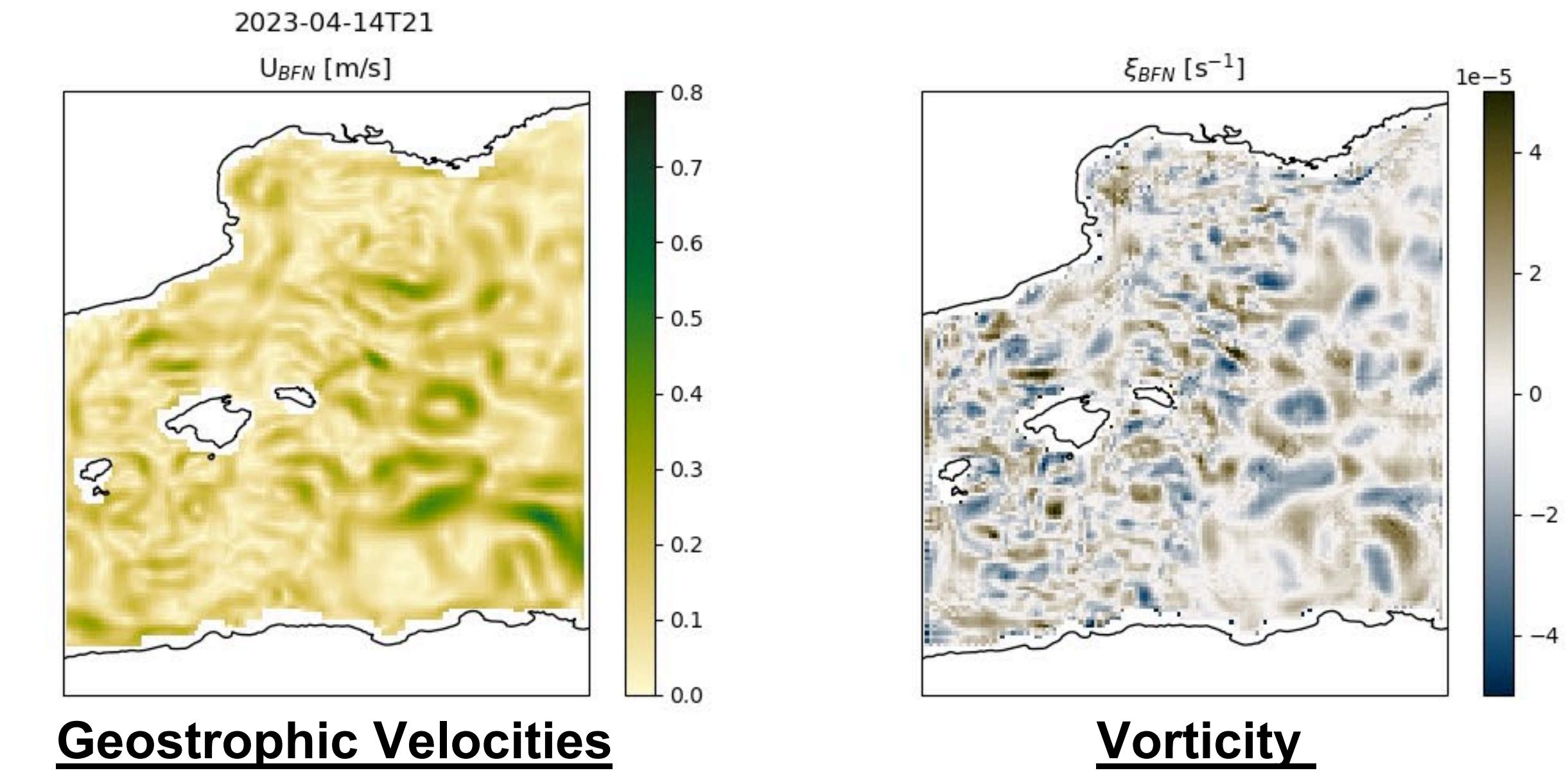
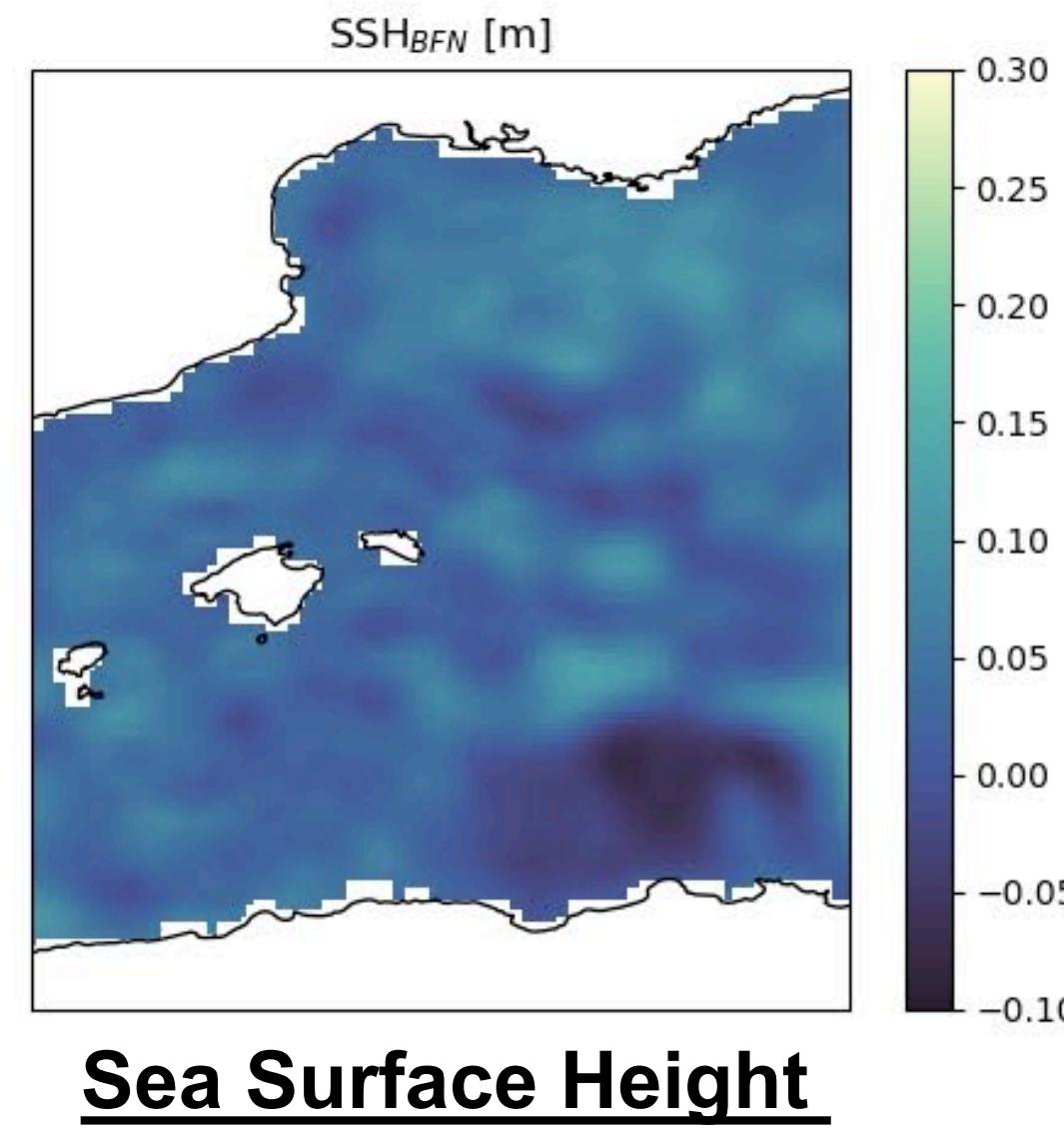
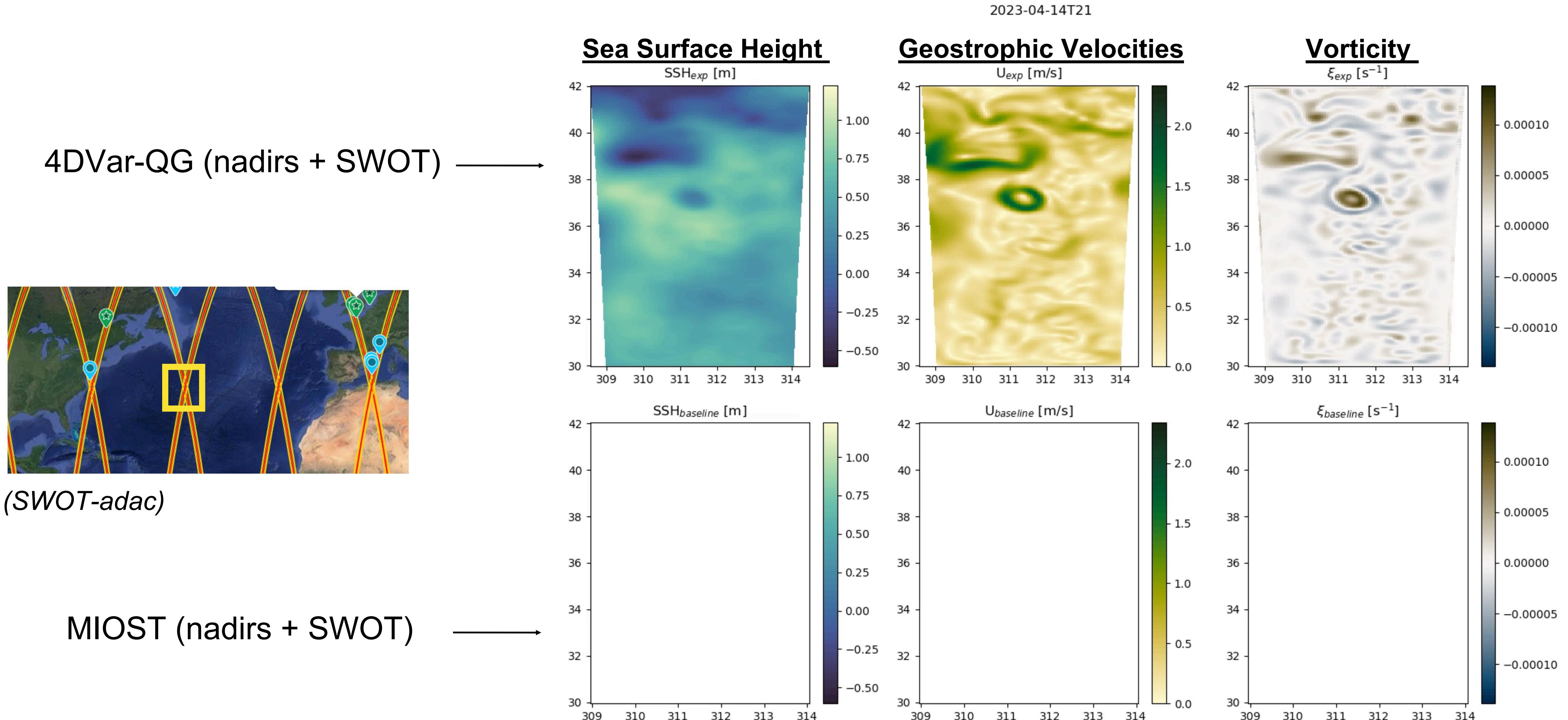


Figure from A. Barboni, F. Dumas, P. Garreau

Back-and-Forth Nudging the QG model in the Mediterranean Sea **WITH SWOT**

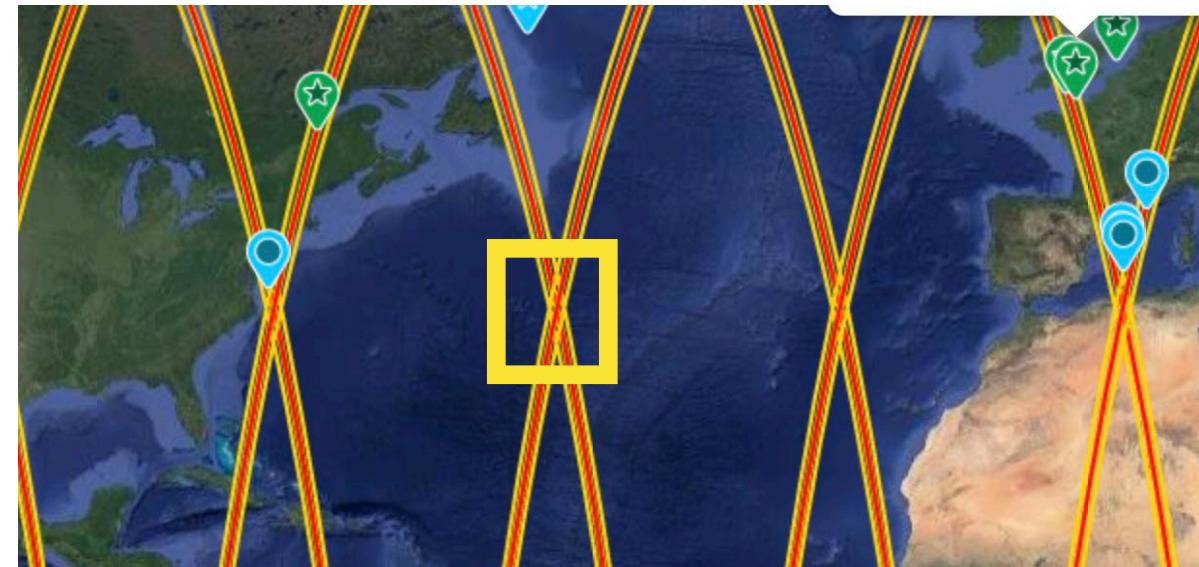


4DVar and QG model in the North Atlantic



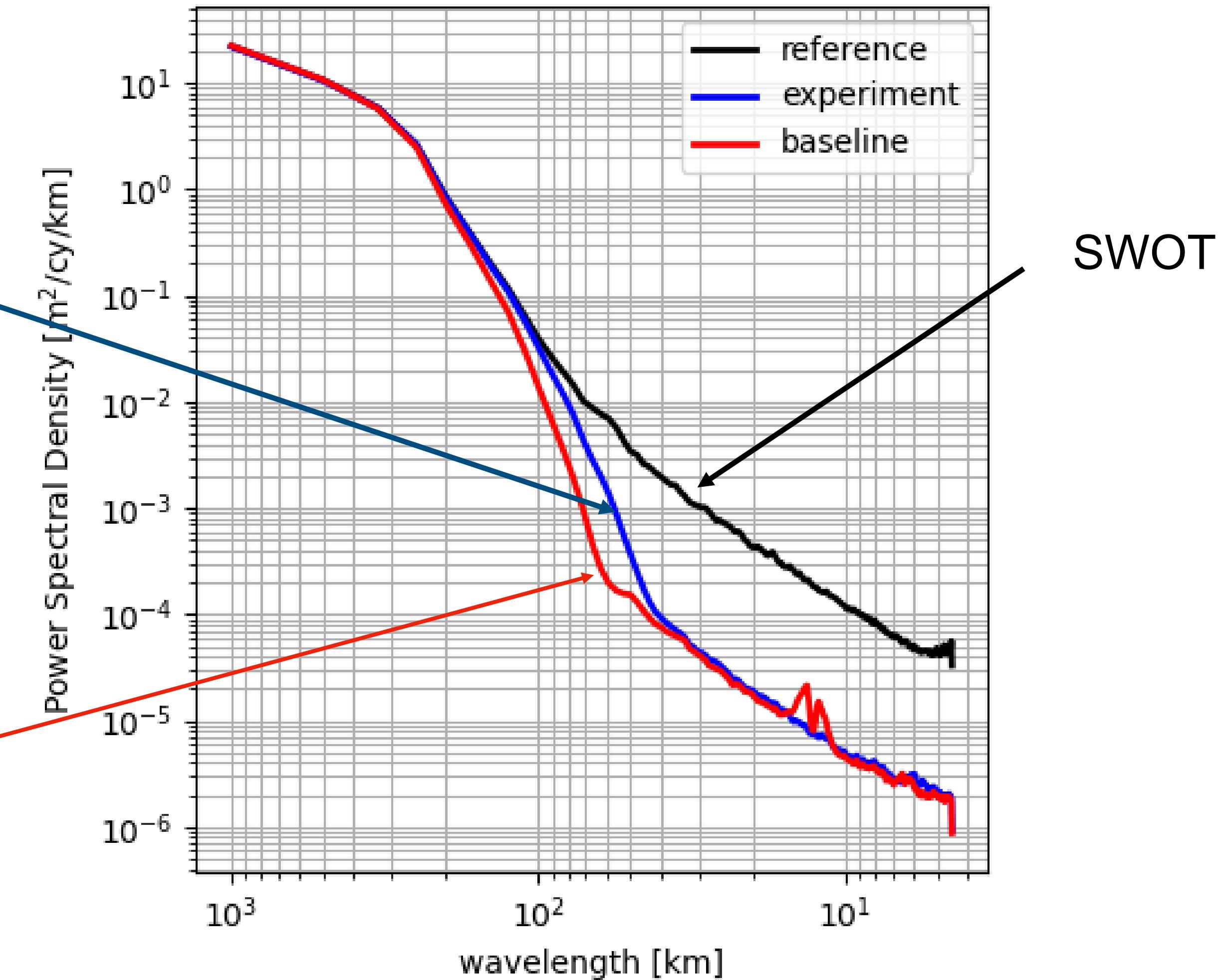
4DVar and QG model in the North Atlantic

4DVar-QG (nadirs + SWOT)
on SWOT swath



(SWOT-adac)

MIOST (nadirs + SWOT)
on SWOT swath



4DVar and QG model in the North Atlantic

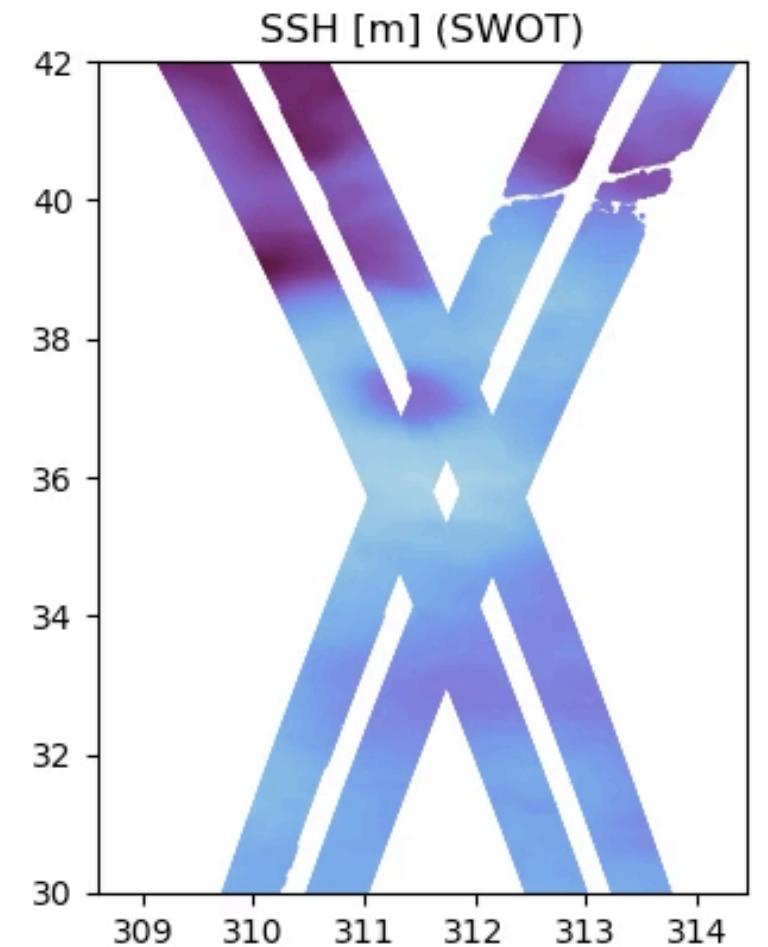
SWOT filtered with Unet
(Treboutte et al, 2023)



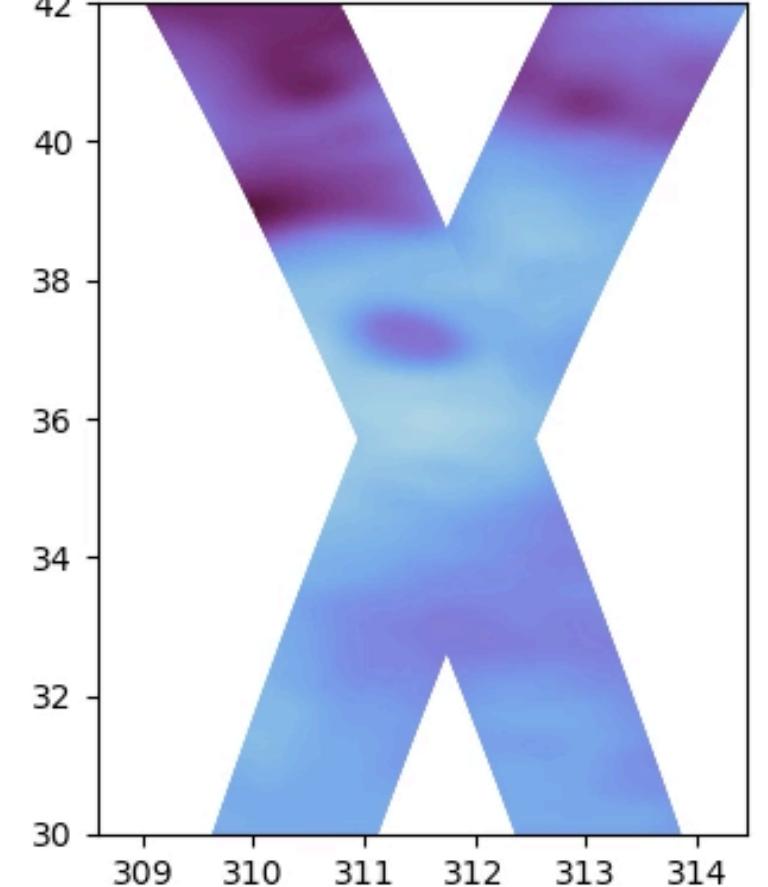
(SWOT-adac)

4DVar-QG (nadirs + SWOT) →

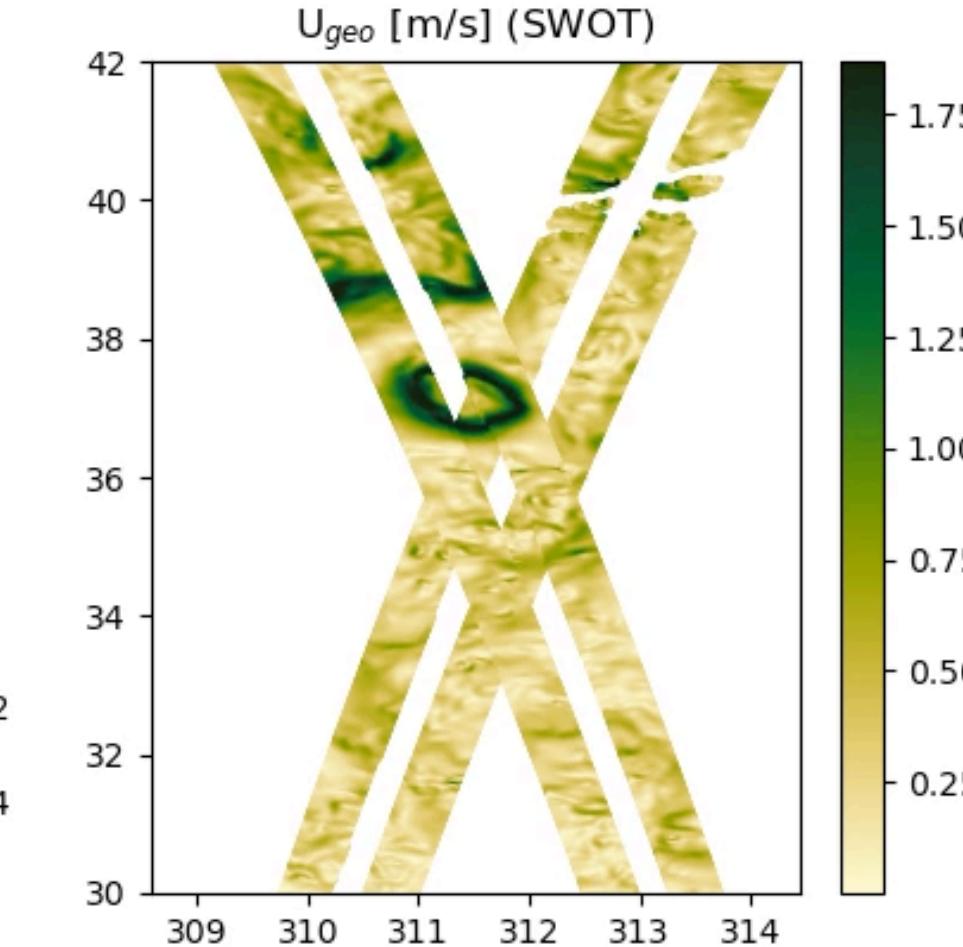
Sea Surface Height



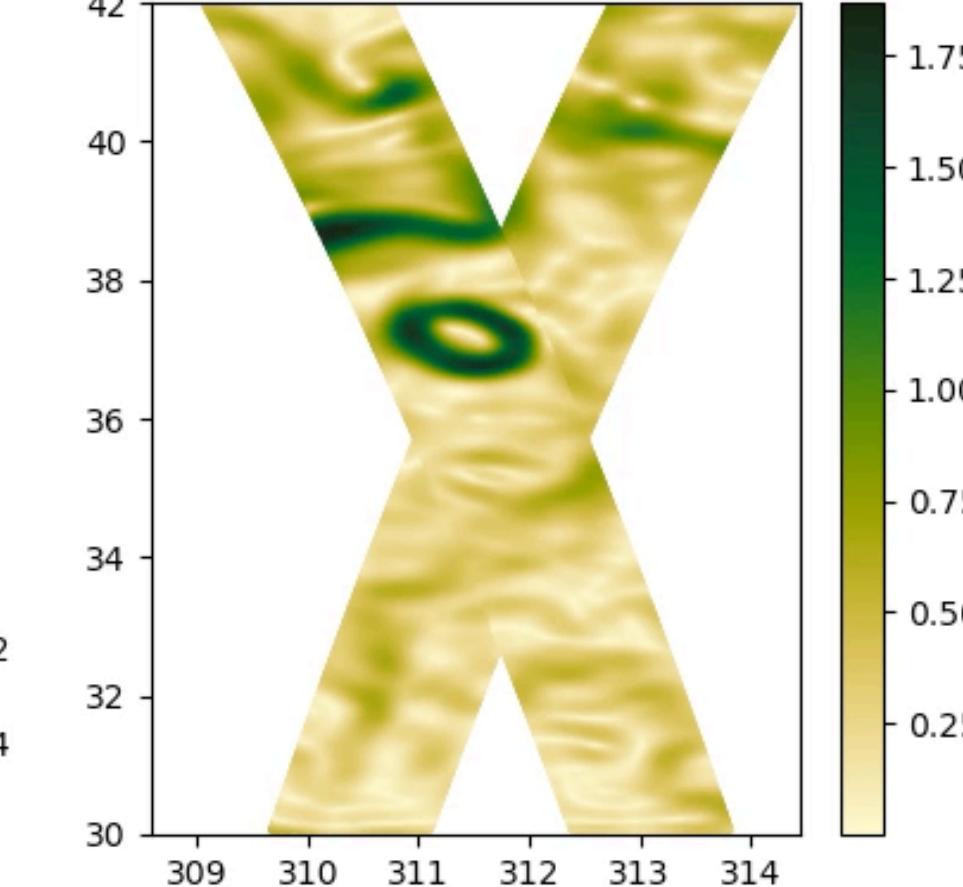
SSH [m] (4DVAR-QG)



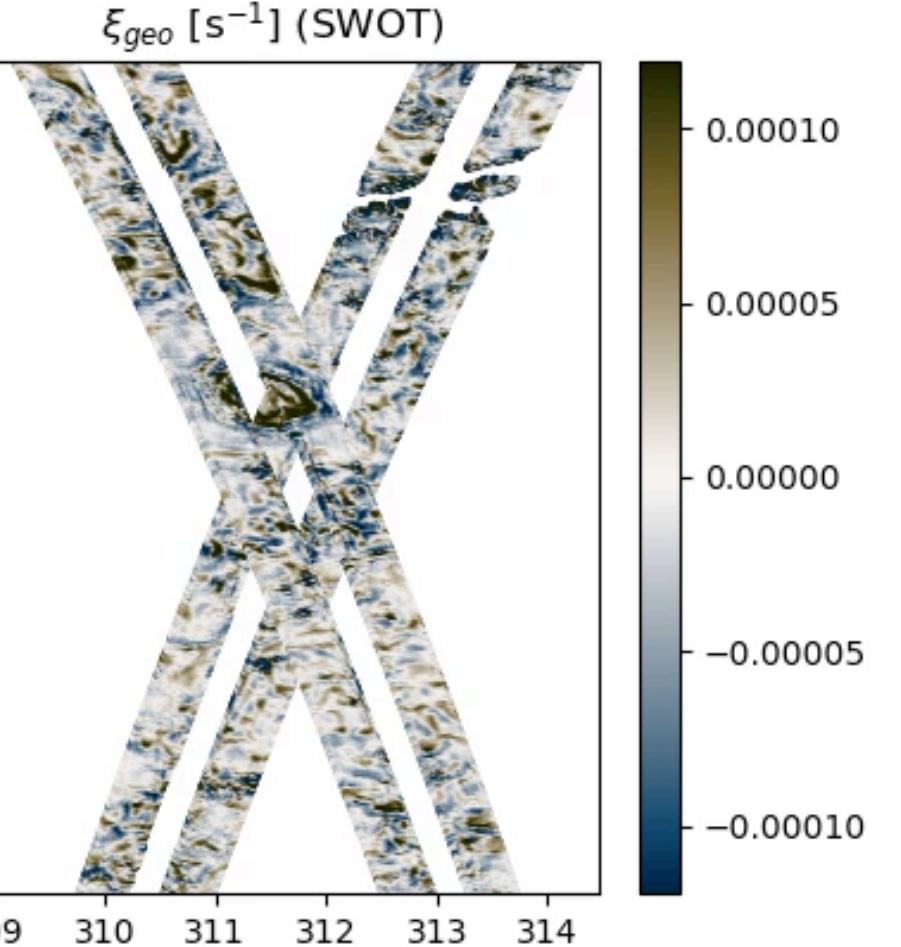
Geostrophic Velocities



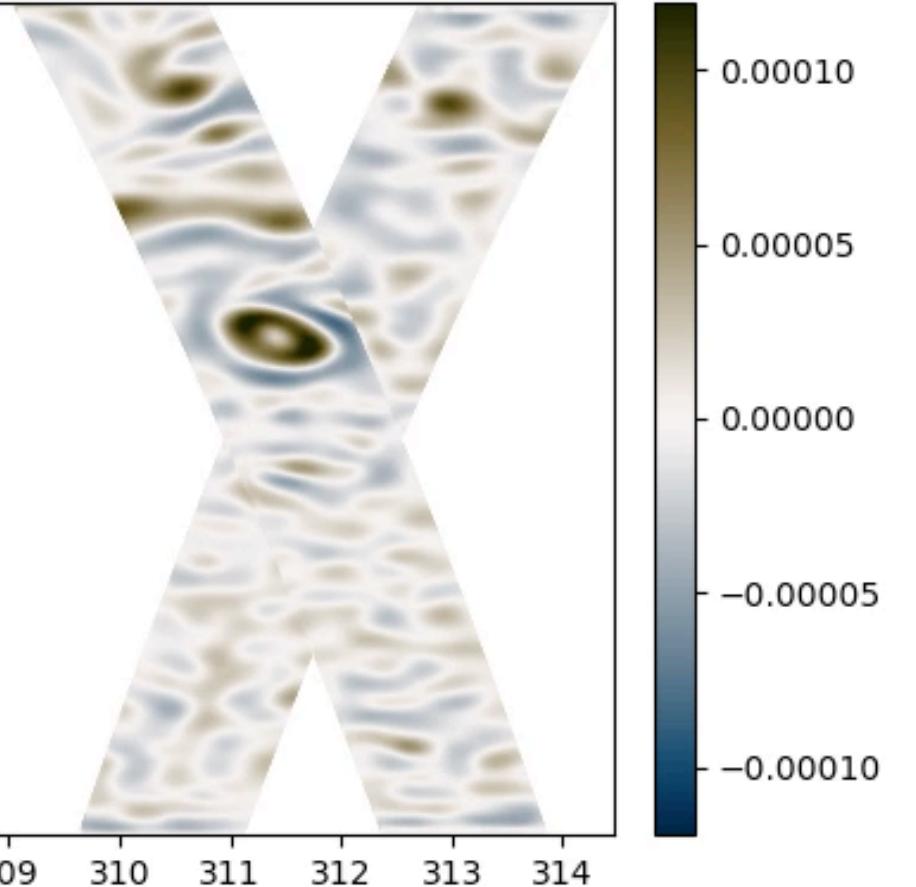
U_{geo} [m/s] (4DVAR-QG)



Vorticity



ξ_{geo} [s^{-1}] (4DVAR-QG)





Data challenges and tools for diagnostics

The screenshot shows the GitHub repository 'ocean-data-challenges'. It displays four public repositories related to ocean data challenges:

- 2022a_SWOT_karin_error_filtering** (Public): A challenge on the SWOT Karin instrumental error filtering organised by Datlas, IMT Atlantique and CLS. (Jupyter Notebook, MIT License, 2 stars, 2 forks, 0 issues, updated 5 days ago)
- 2020a_SSH_mapping_NATL60** (Public): A challenge on the mapping of satellite altimeter sea surface height data organised by MEOM@IGE, Ocean-Next and CLS. (benchmark, machine-learning, dataset, oceanography, satellite-data, Jupyter Notebook, MIT License, 10 stars, 24 forks, 1 issue, 0 pull requests, updated 5 days ago)
- 2023a_SSH_mapping_OSE** (Public): A challenge on the mapping of real satellite altimeter sea surface height data organised by Datlas and CLS. (Jupyter Notebook, MIT License, 0 stars, 0 forks, 0 issues, 0 pull requests, updated 5 days ago)
- 2021a_SSH_mapping_OSE** (Public): A challenge on the mapping of real satellite altimeter sea surface height data organised by MEOM@IGE, Ocean-Next and CLS. (Jupyter Notebook, MIT License, 4 stars, 7 forks, 2 issues, 0 pull requests, updated 5 days ago)

The screenshot shows the 'ODC - global OSE mapping' documentation page. The sidebar contains the following information:

- Global scale**: Gulf Stream region
- SPECIFIC FOCUS**: Near inertial oscillation
- NOTEBOOKS**: Notebooks evaluation, Notebooks download the data
- METRICS DETAILS**: SSH - Along track metrics, Currents - Along drifter metrics, Currents - Lagrangian metrics
- SCRIPTS**: mod_compare module, mod_filter module, mod_interp module, mod_plot module, mod_powerspec module, mod_read module, mod_spectral module, mod_stat module

The main content area includes a 'Read the Docs' button and a 'v: latest' dropdown.

The screenshot shows the 'ODC - global OSE mapping' documentation page. The top features a large blue header with the text 'Data Challenges DC global OSE'. Below the header, there is a 'Context & Motivation' section containing the following text:

The Copernicus Marine Service (CMEMS) is committed to providing high-quality, state-of-the-art ocean products through the validation and verification of physical oceanic parameters on both global and regional scales. Among the variables distributed by the service, ocean surface topography and surface currents are of great interest to the oceanographic communities for practical applications and for scientific research.

Logos for SLICING, Copernicus Marine Service, MERCATOR INTERNATIONAL, CLS, datlas, and IMT Atlantique are displayed at the bottom.



A few plans

- Consolidate results on the Med Sea
- Further develop mapping capacities, in particular for geostrophic current / internal wave separation (see poster on 4Dvar)
- Estimation of ageostrophic part of current
- Consolidate codes usability

What we can provide to colleagues



- All the codes are in open access (github.com/leguillf/MASSH)
- We are (almost) ready to run BFN-QG or 4DVar-QG in any non-tropical region upon request
- We provide free, open, documented and easy-to-use diagnostic tools.

