High-resolution real-time forecasting systems and services in support of fine-scale field experiments in the Western Mediterranean Sea

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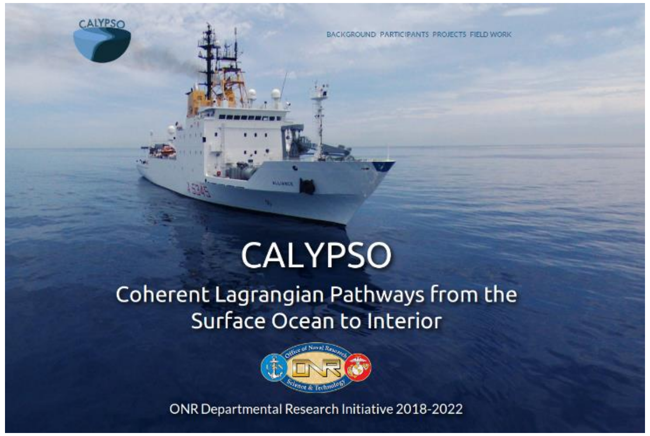
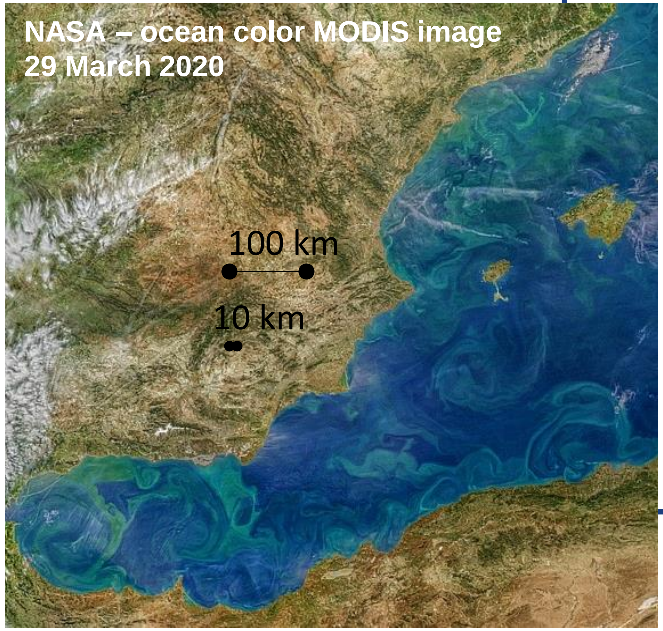
Paris, 18 November 2024

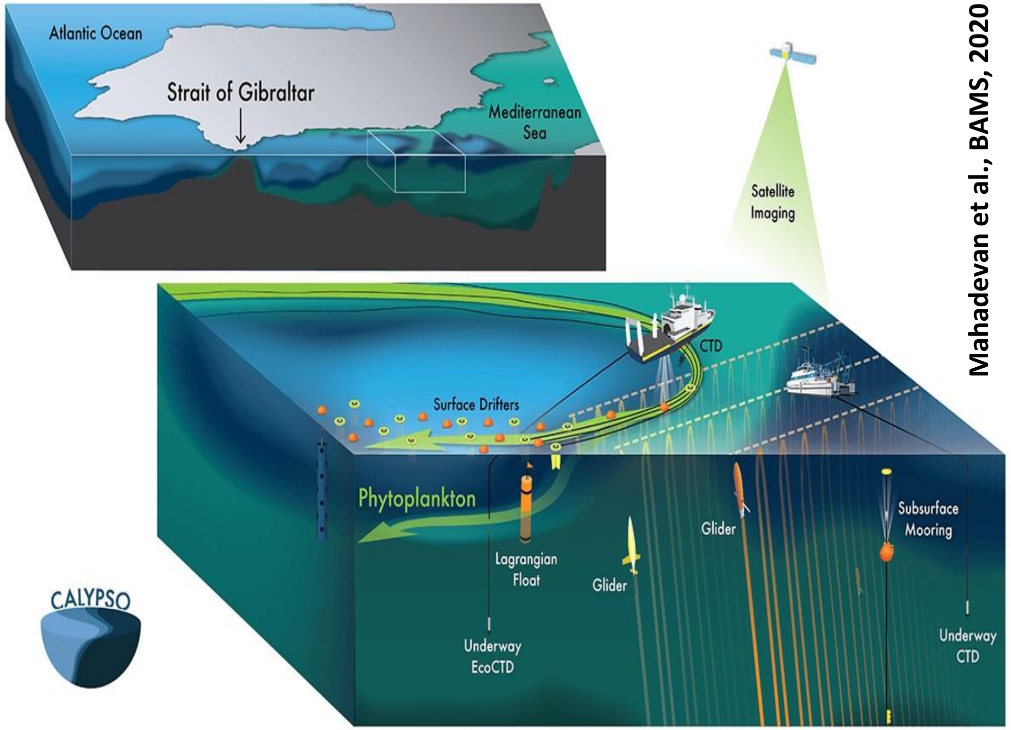
CALYPSO: Coherent Lagrangian Pathways from the Surface Ocean to Interior



https://calypsodri.whoi.edu/

Objective: improve understanding of 3-dimensional water pathways in the surface ocean

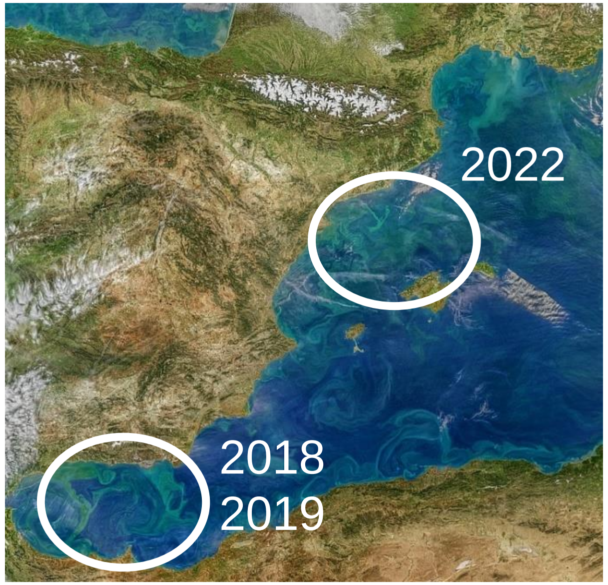




Mahadevan et al., BAMS, 2020

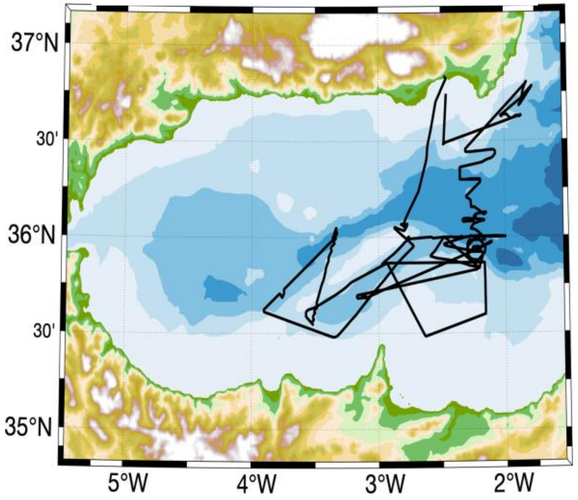
→ High-resolution observations and modelling of small-scale variability in the western Mediterranean Sea

CALYPSO: Coherent Lagrangian Pathways from the Surface Ocean to Interior



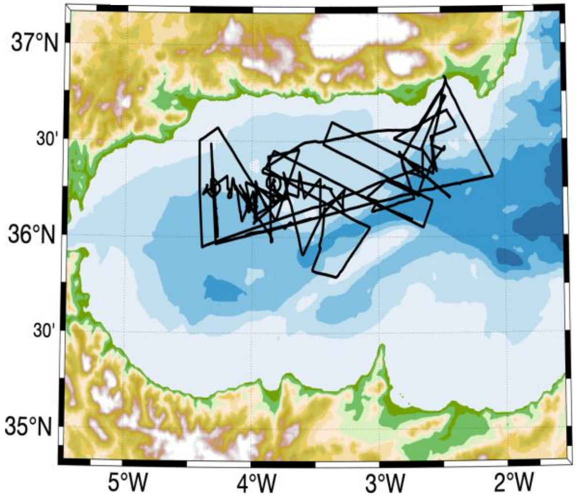
→ 3 intense observational campaigns

Alboran Sea
May-June 2018



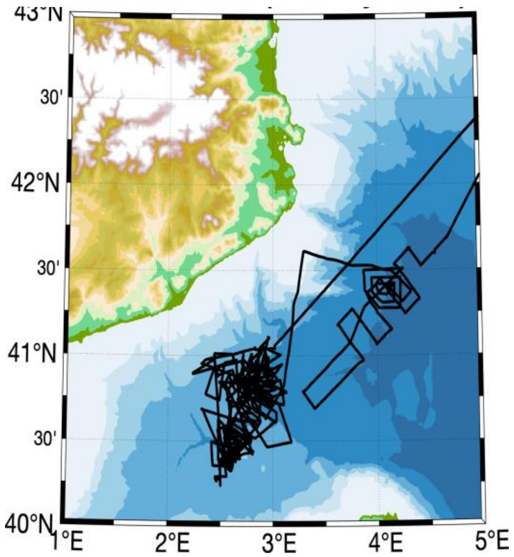
- 2 ships
- > 1600 uCTD profiles
- 3 gliders
- > 80 drifters

Alboran Sea
Mar-Apr 2019



- 2 ships
- > 3500 uCTD profiles
- 8 gliders
- > 180 drifters

Balearic Sea
Feb-Mar 2022

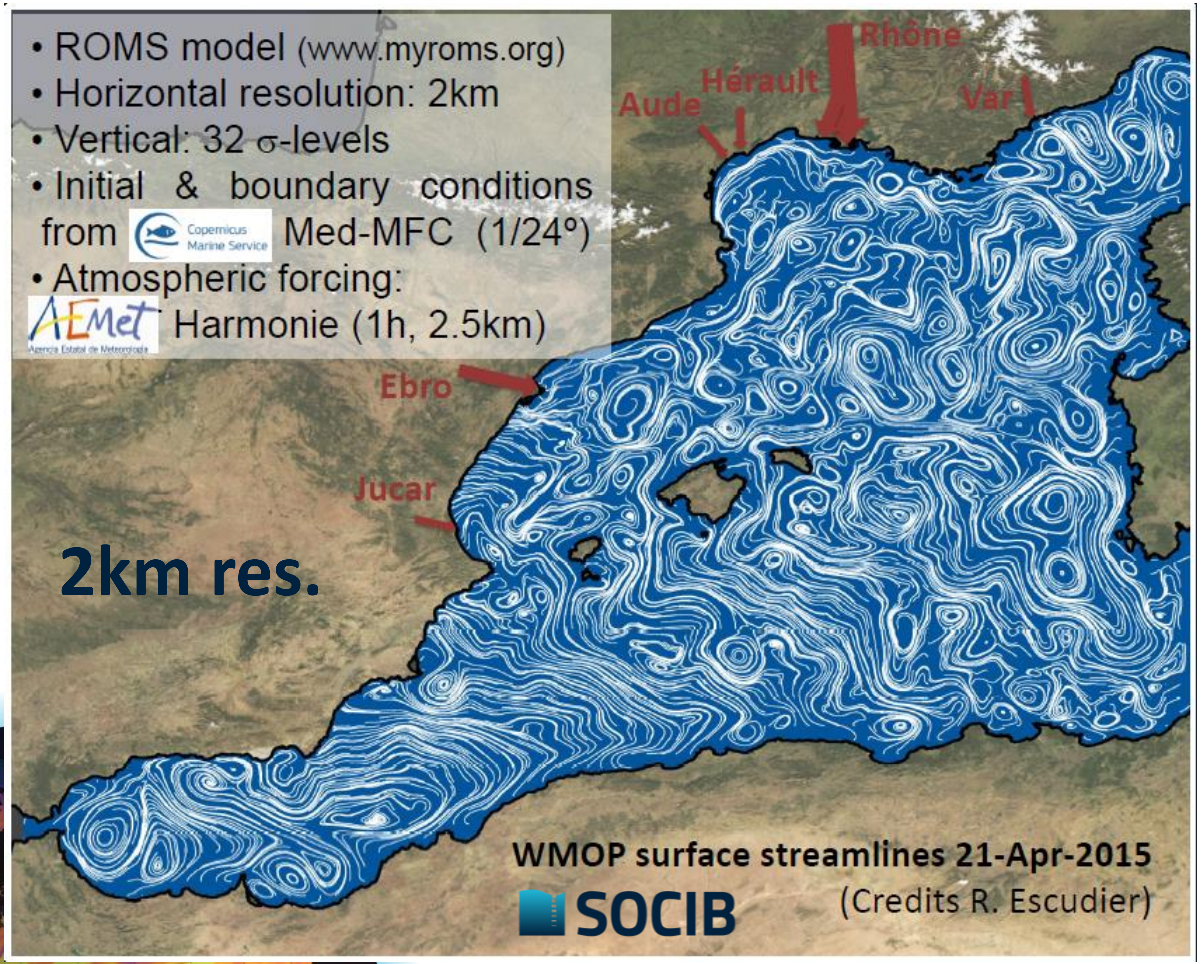


- 2 ships
- > 2400 EcoCTD profiles
- 8 gliders
- > 300 drifters

(Mathieu Dever, Amala Mahadevan)

Real-time forecasting support

WMOP Western Mediterranean OPerational modelling system



Real-time forecasting support

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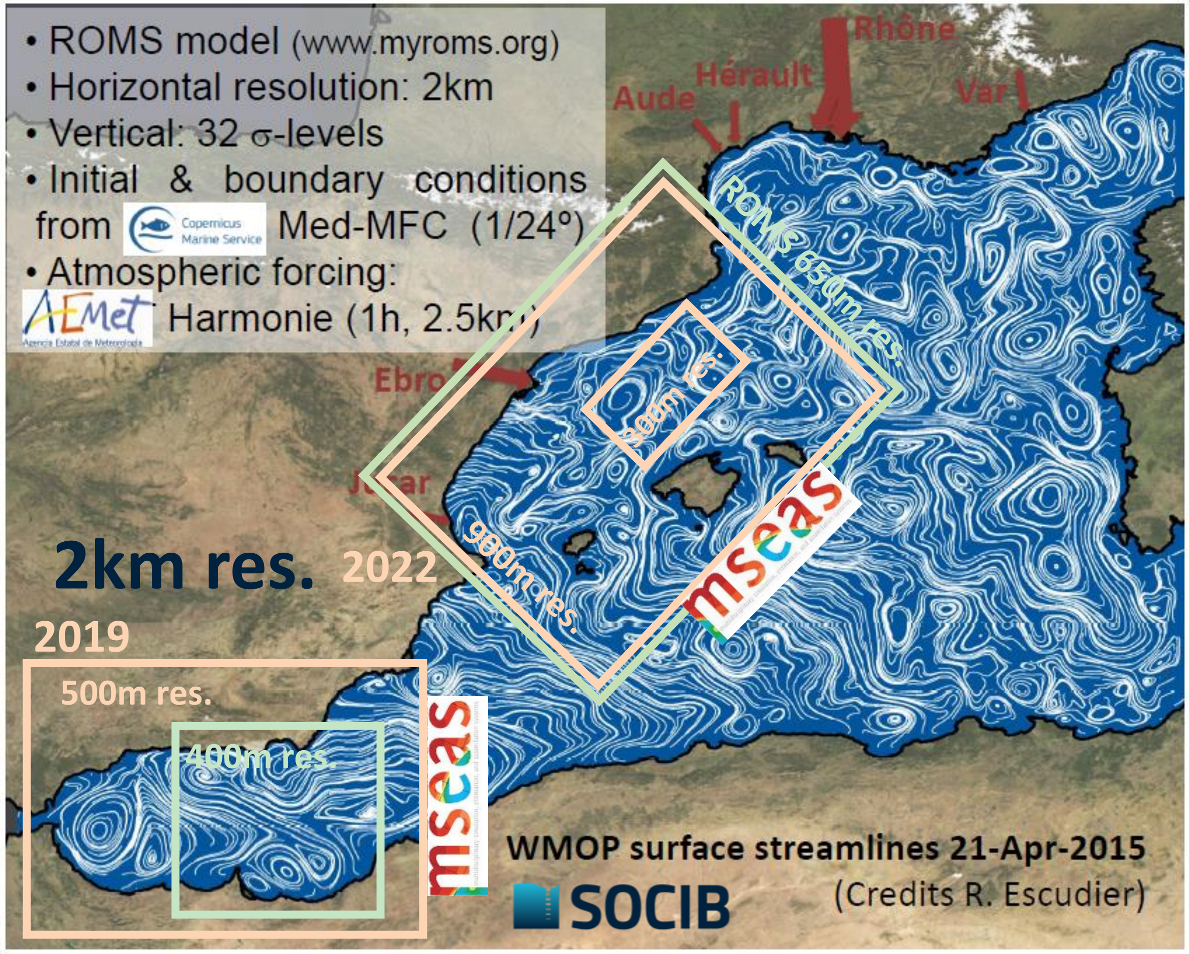
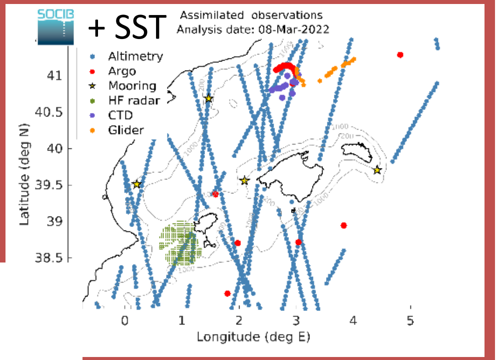


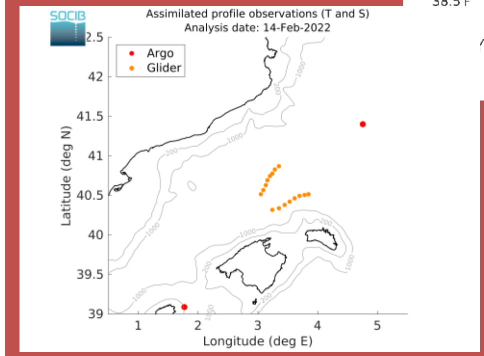
1-way nesting

Delayed time – free run

Reanalysis

Data assimilation:
Multimodel Local Ensemble
Optimal Interpolation



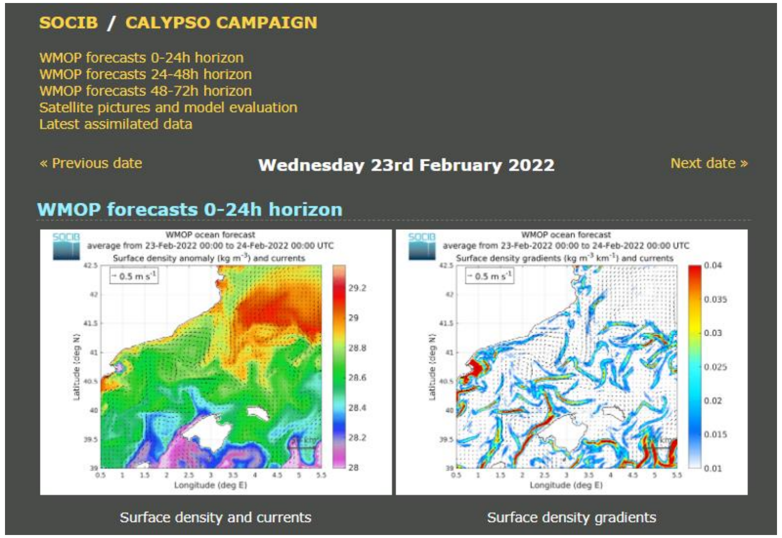


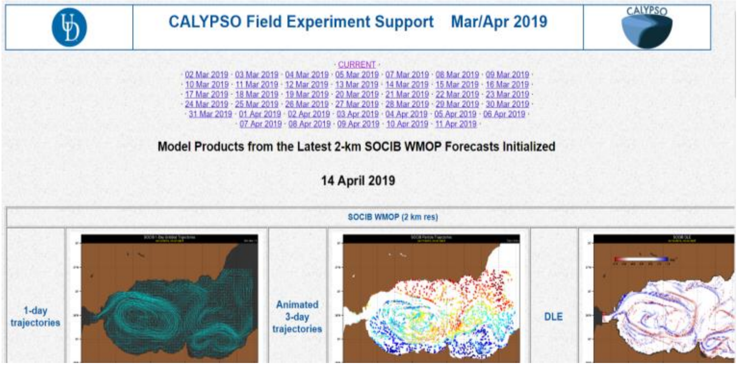
Daily analysis, including glider and underway CTD data during the 2022 campaign.

→ 72-hour forecast horizon

Real-time forecasting support

Real-time model results, validation against observations and advanced Lagrangian diagnostics were made available through several web pages with the objective to help identifying frontal and subduction areas.





Real-time

Real-time model re
diagnostics were m
identify frontal and

dvanced Lagrangian
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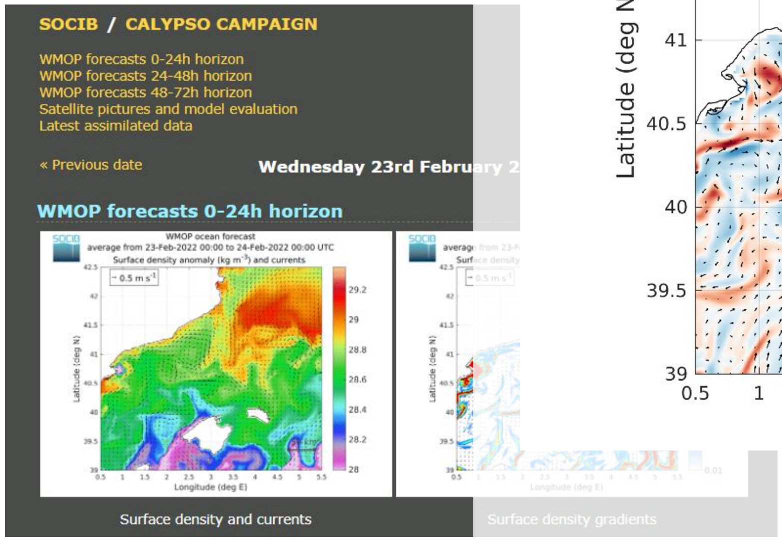
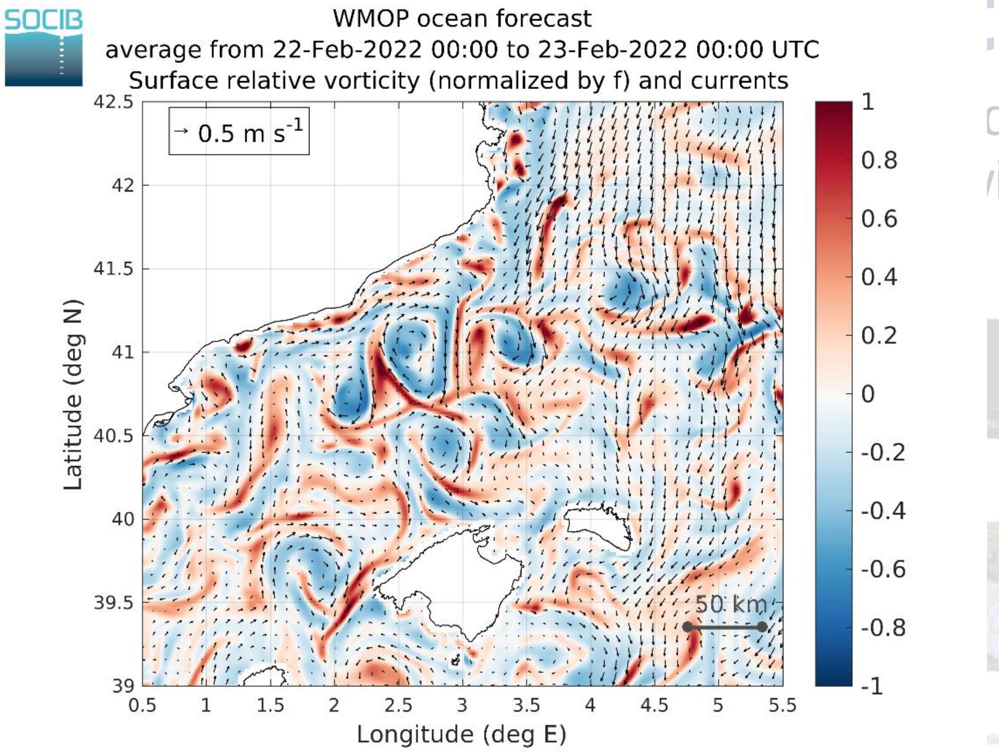
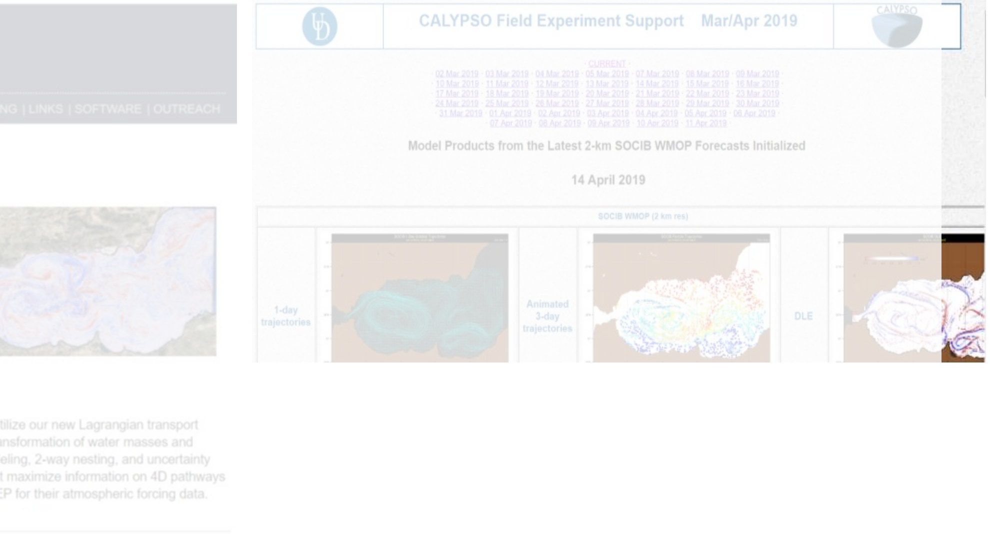
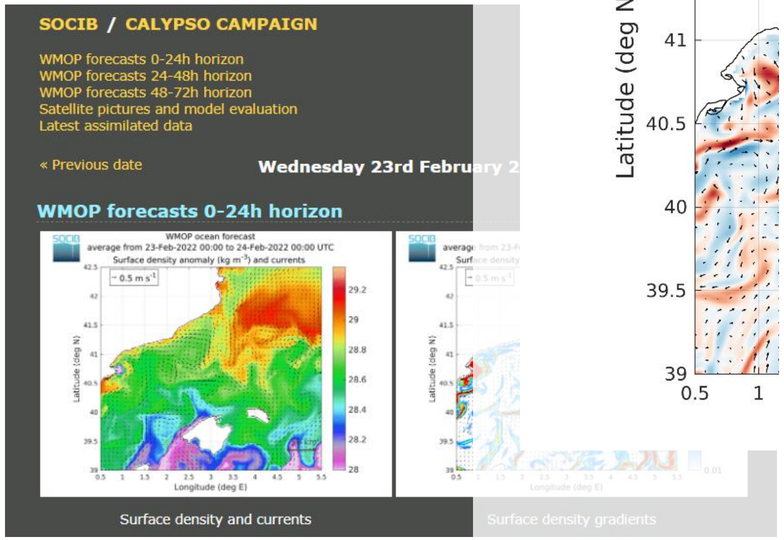


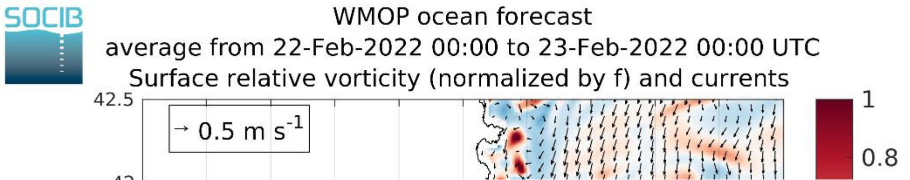


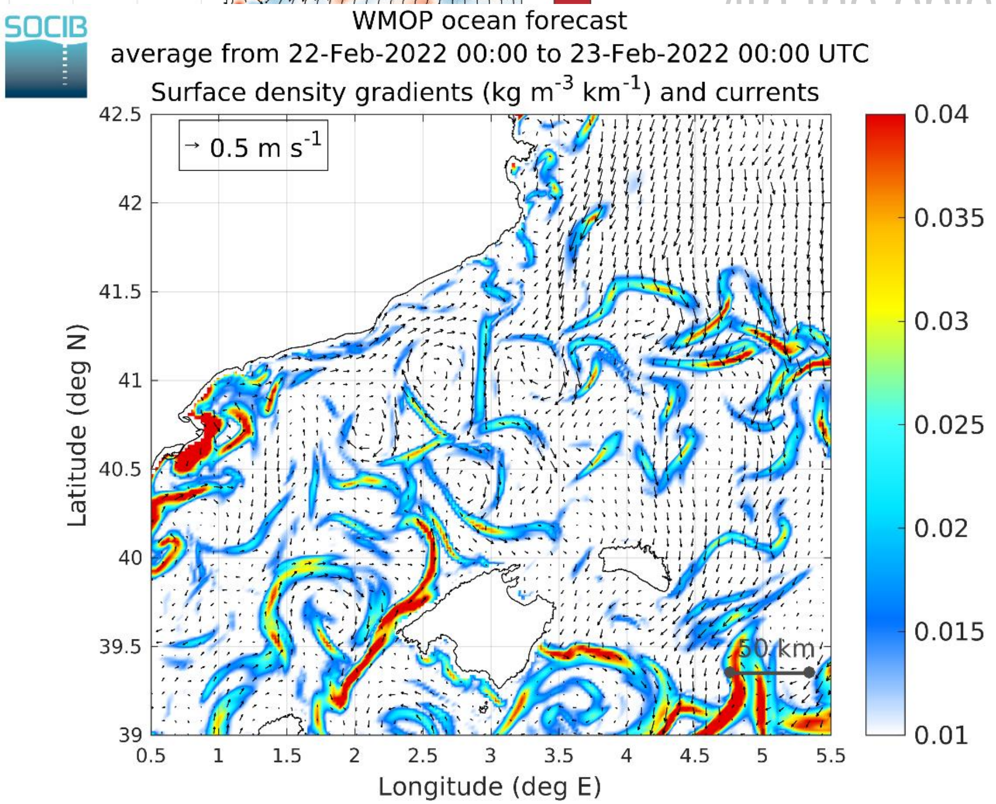


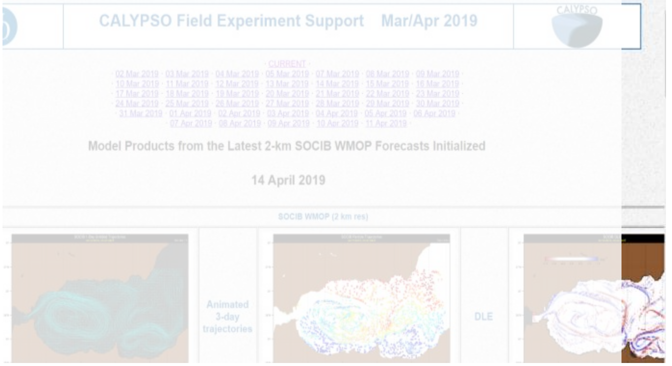
Real-time

Real-time model re… dvanced Lagrangian diagnostics were m… with the objective to help identify frontal and …









Real-time

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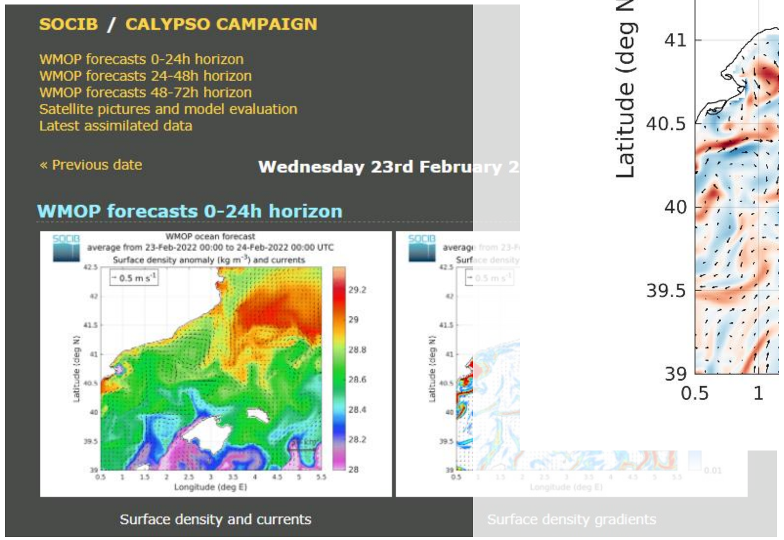

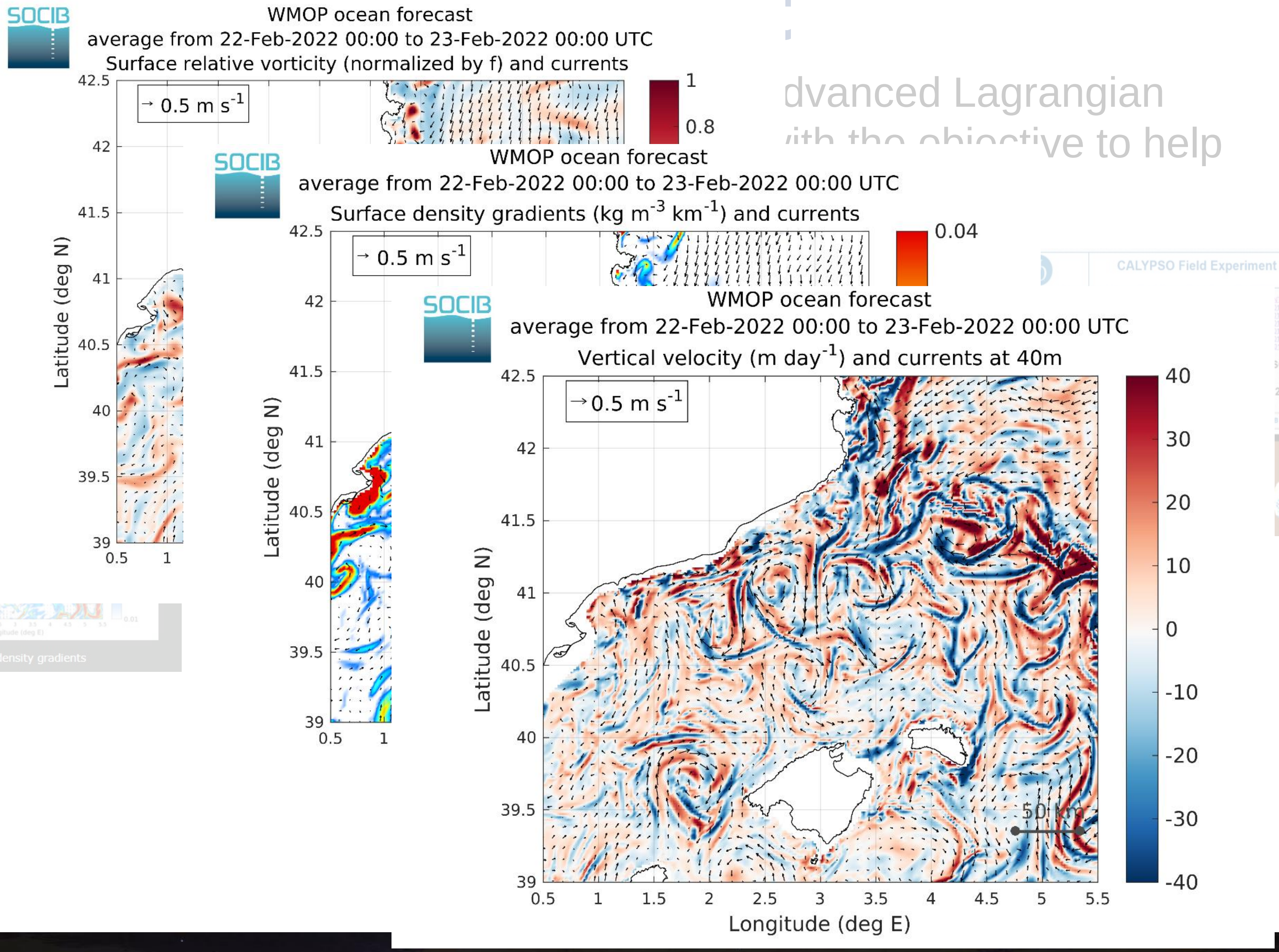

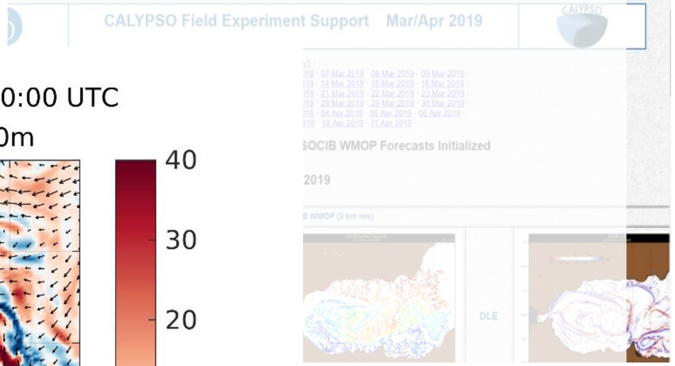

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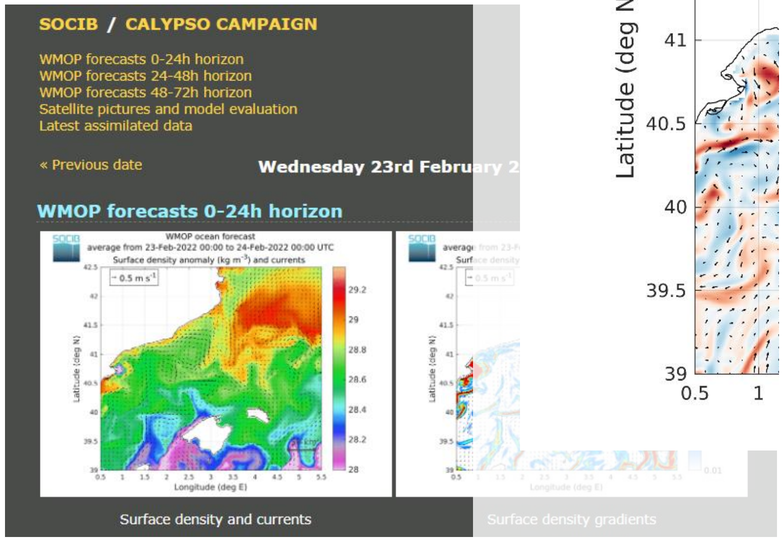

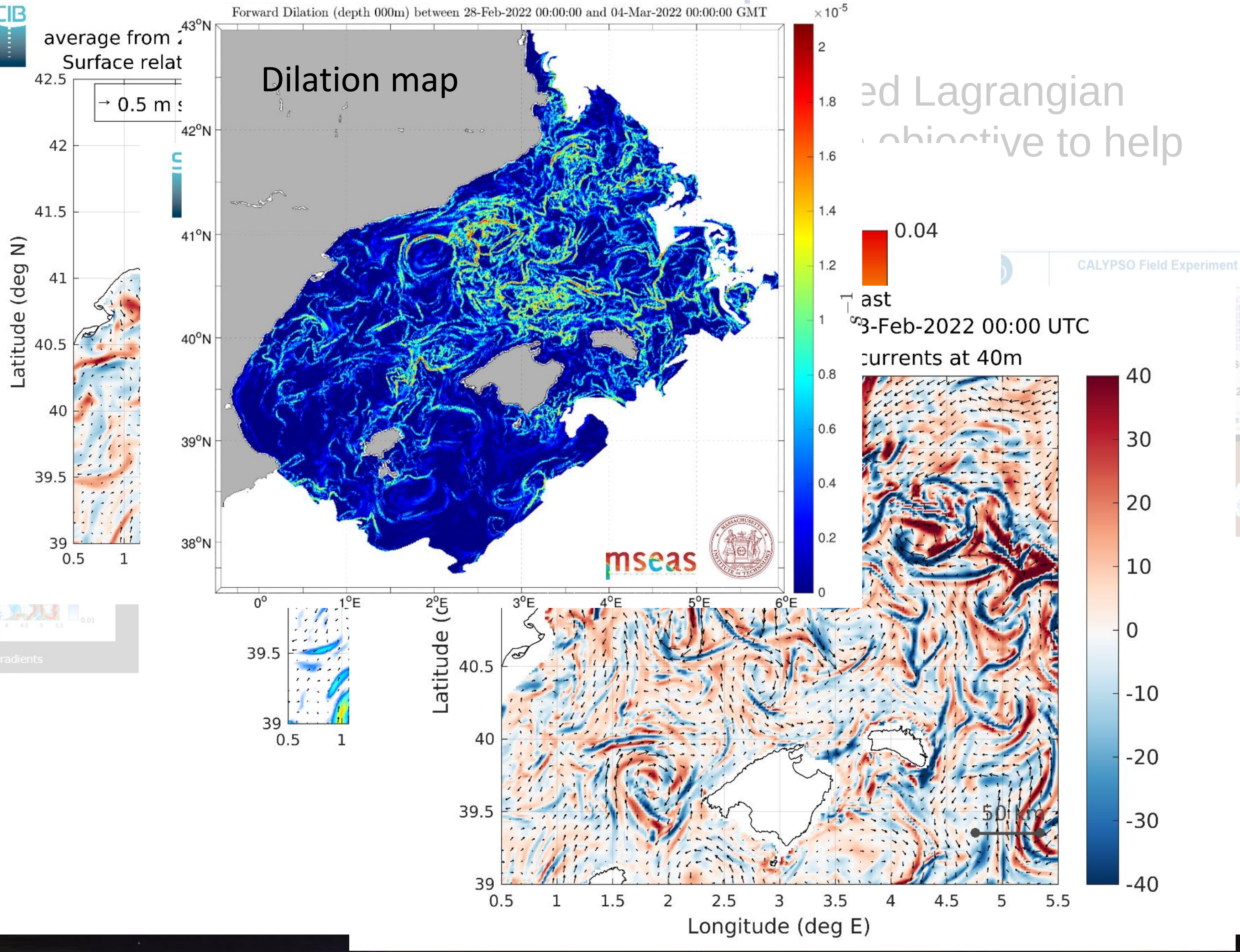

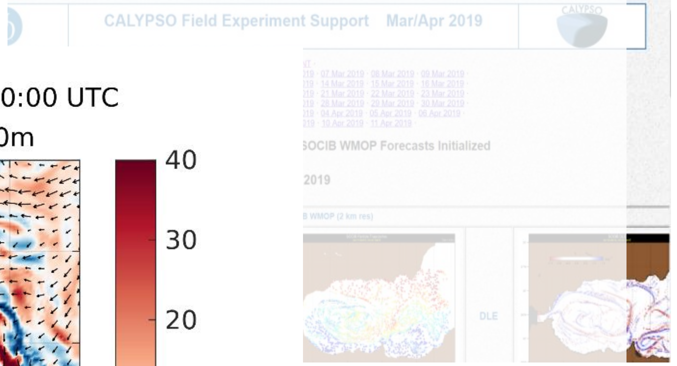

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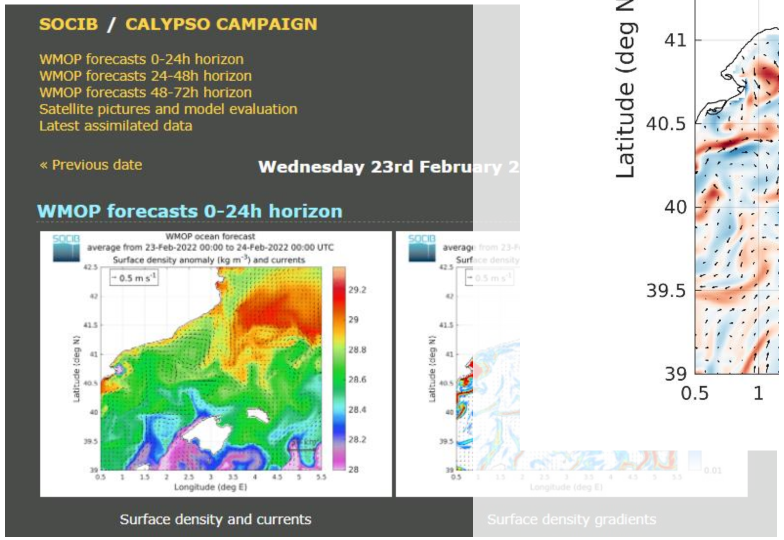
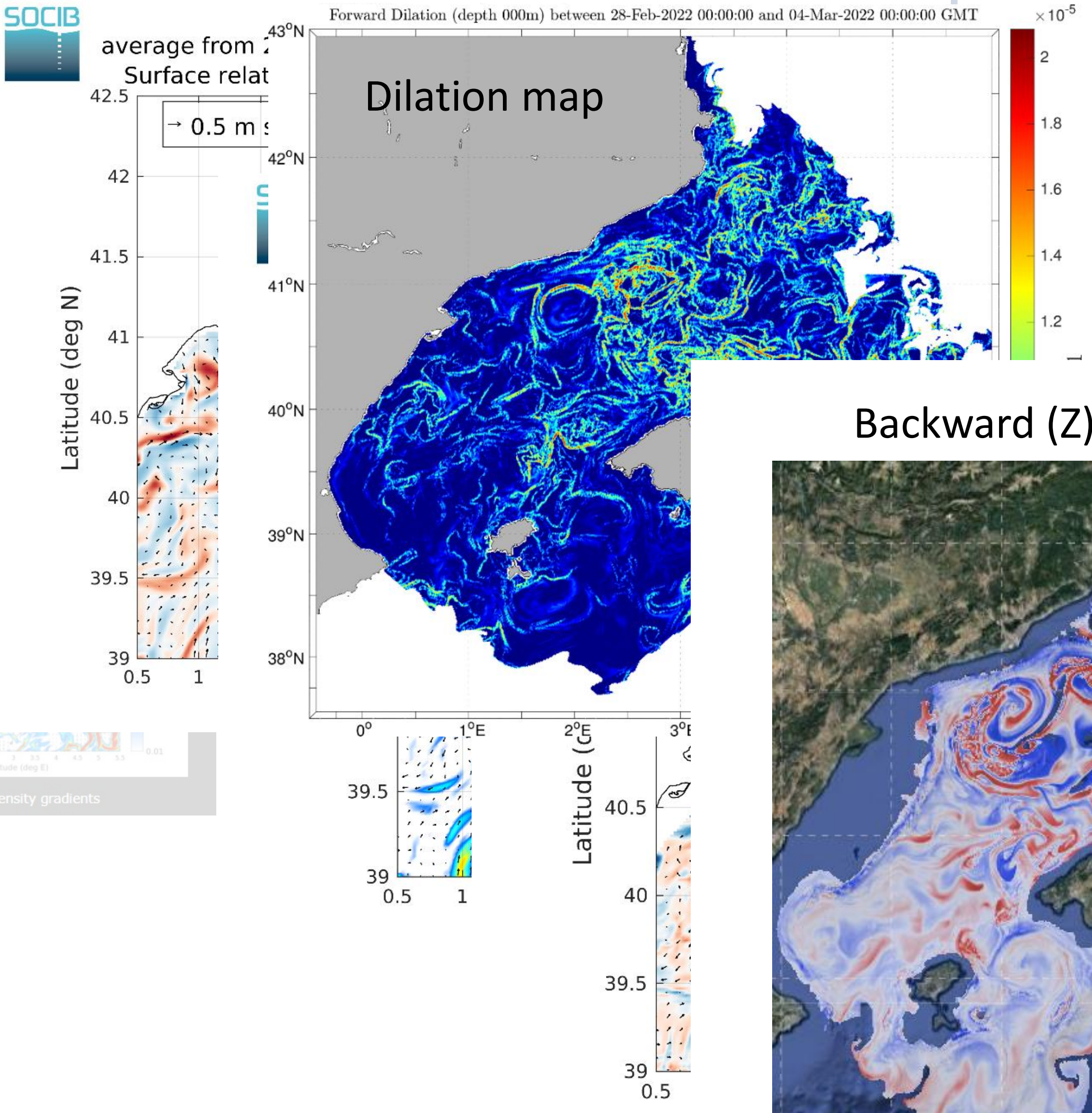
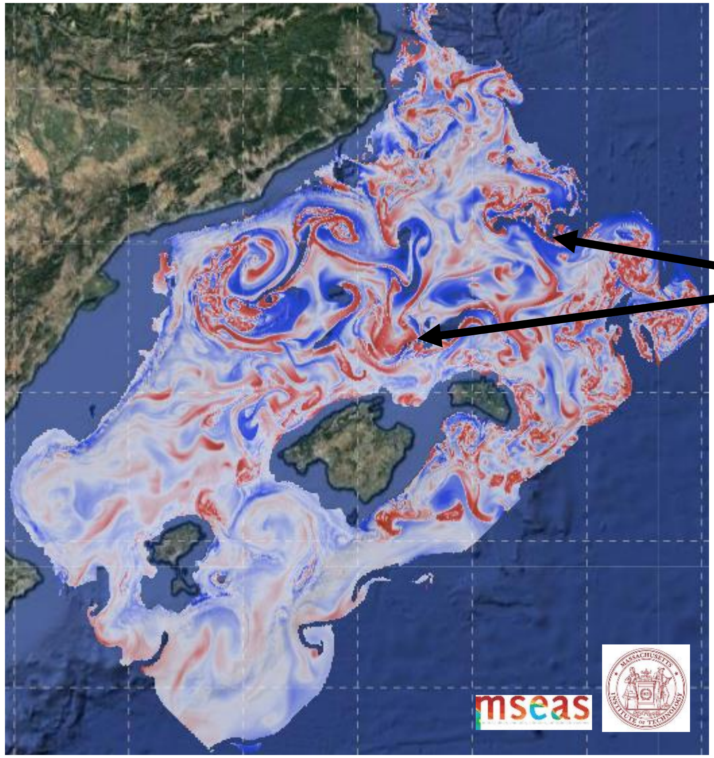




Backward (Z) Flowmaps



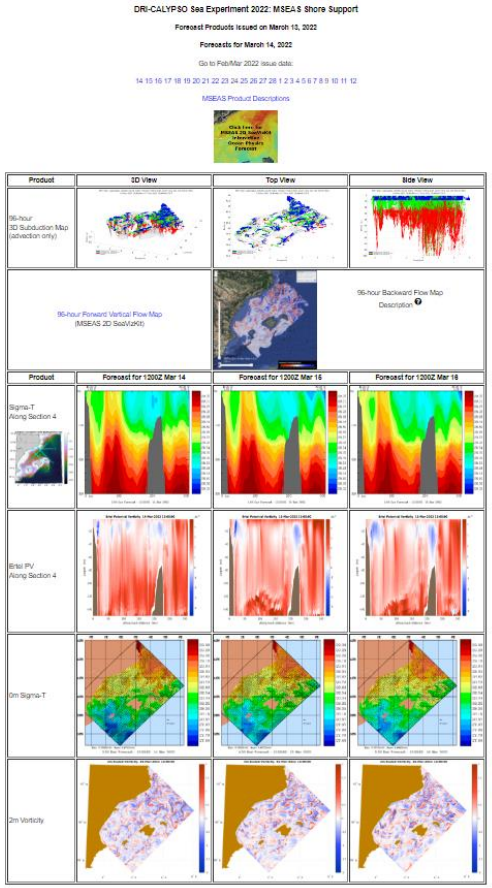
Subducting water masses (red): 28 Feb 2022 0 Z at 102m

Displays at final location of water parcel its initial position (z0) as it is advected over 4 days: helps find subduction regions

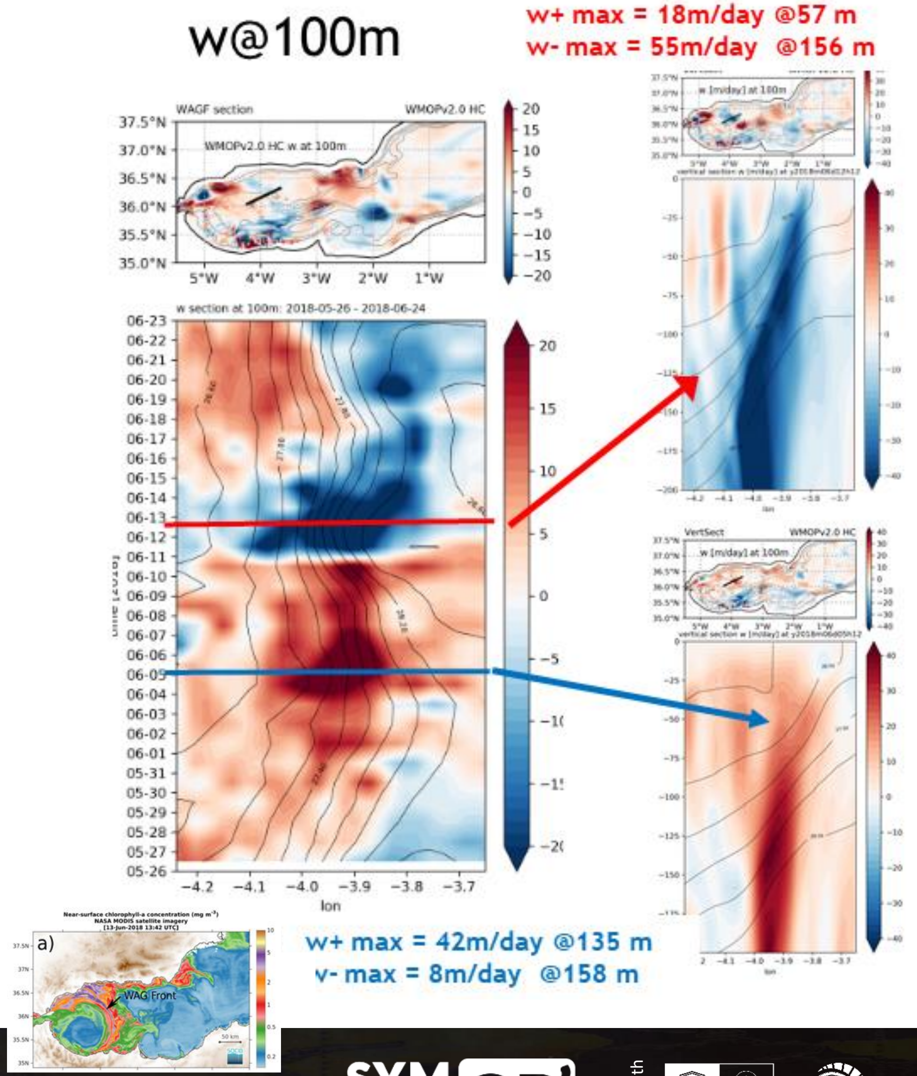
Real-time forecasting support

Help for sampling design

Support during the campaigns

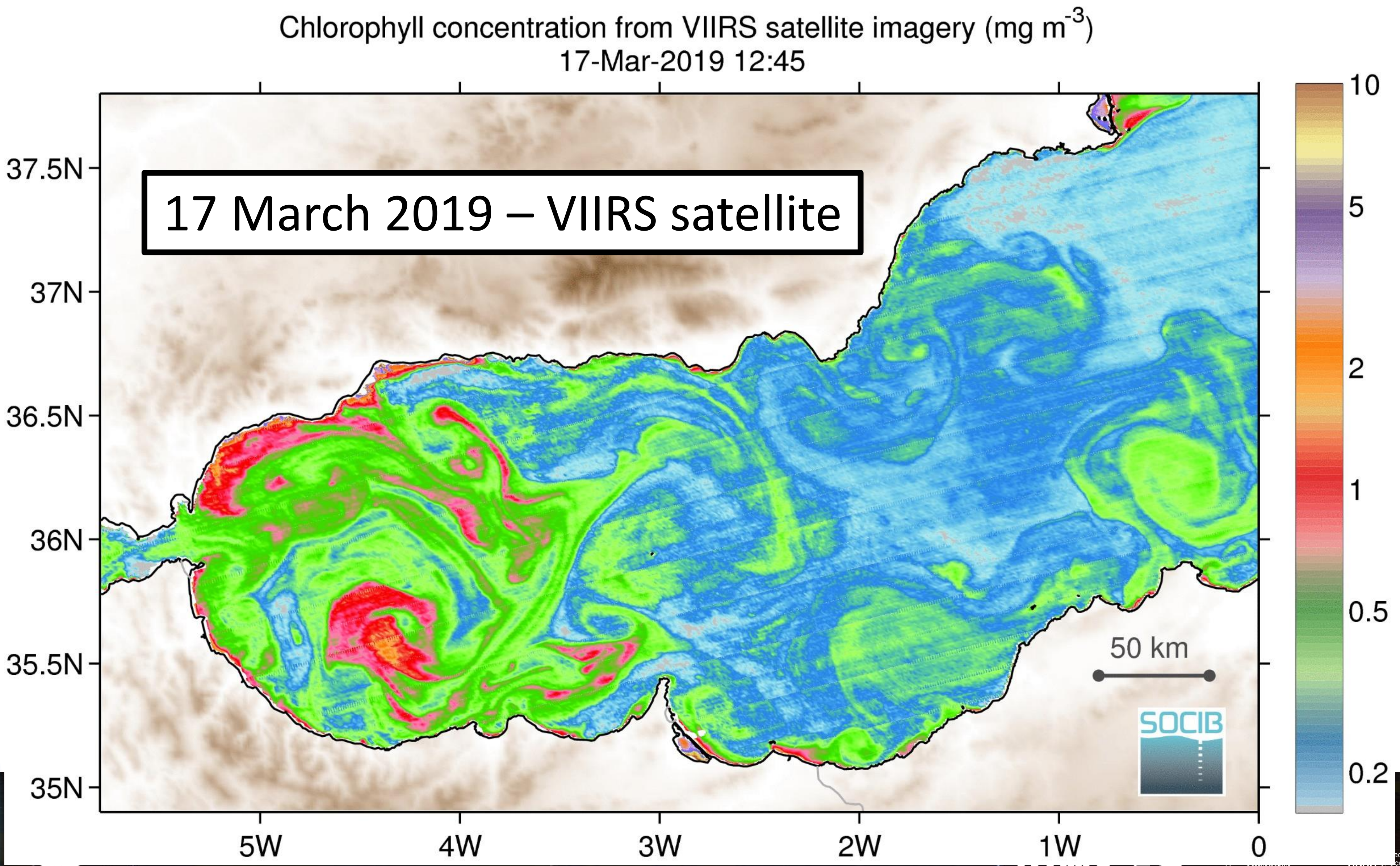


Analysis of small-scale dynamics and associated 3-dimensional pathways

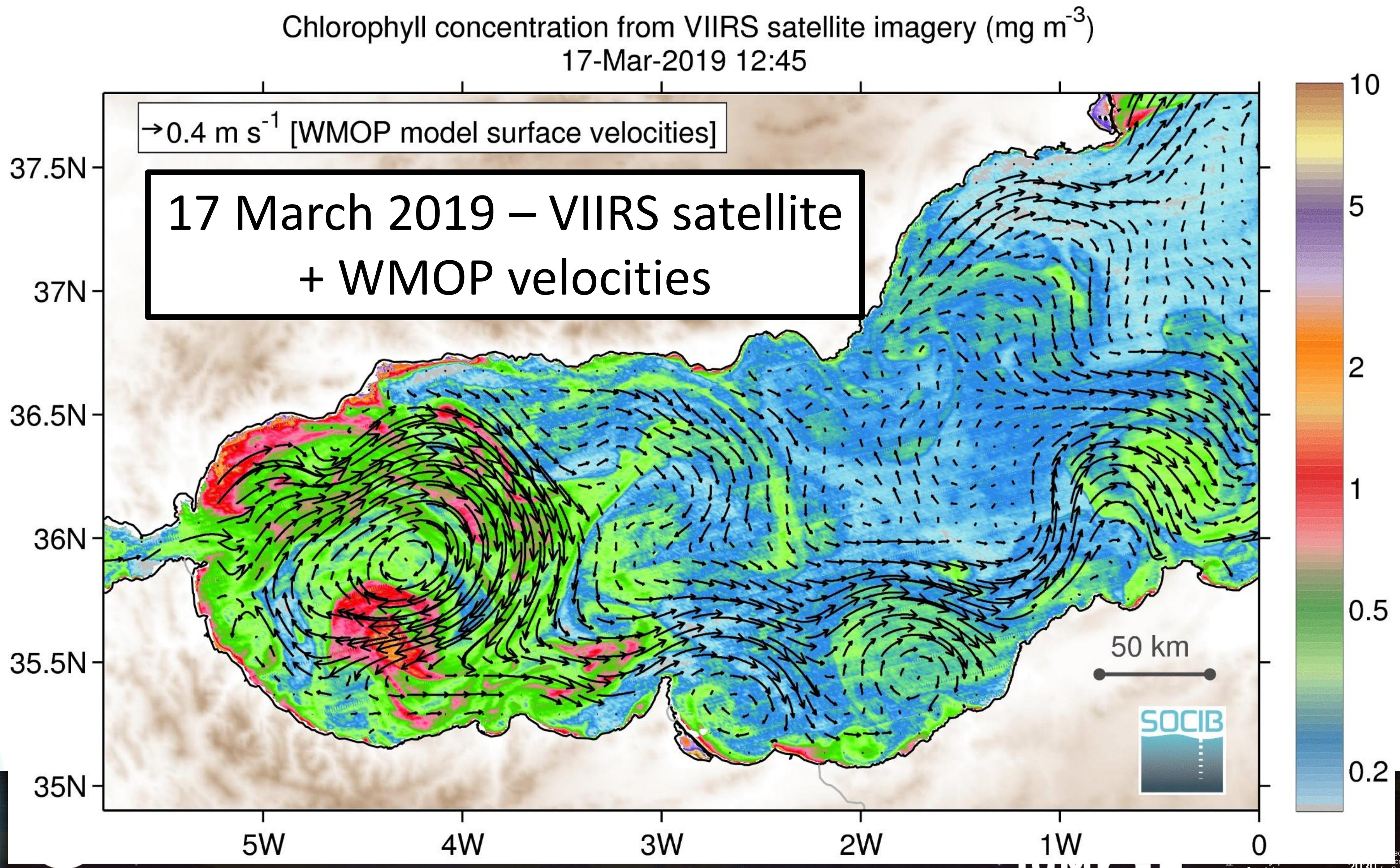


(Garcia-Jove et al., JGR-Oceans, 2022)

Real-time forecasting support

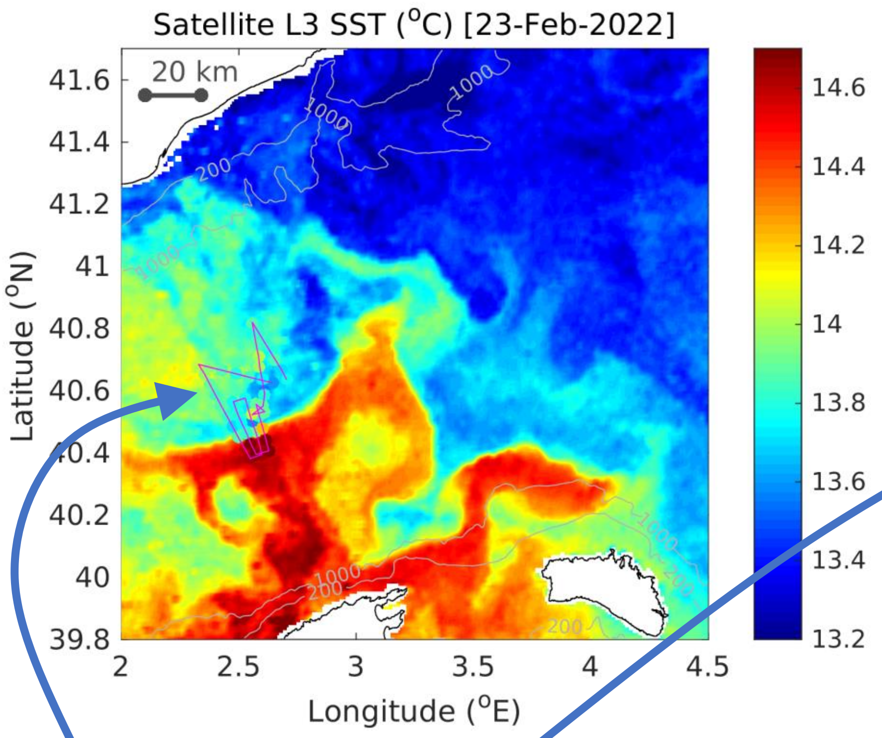


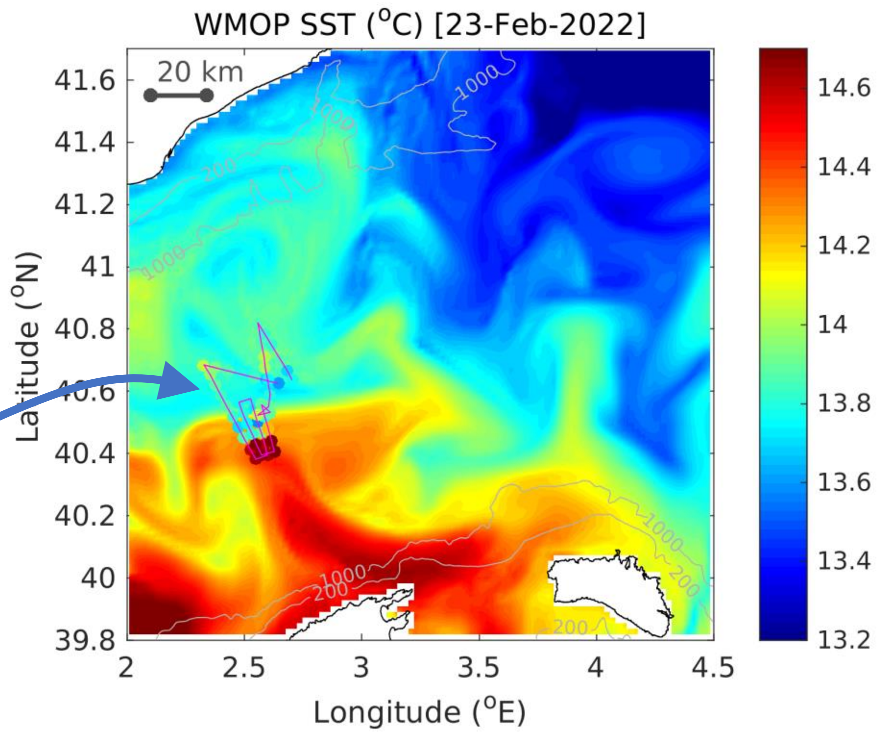
Real-time forecasting support



Real-time forecasting support

SST maps on 23-Feb-2022





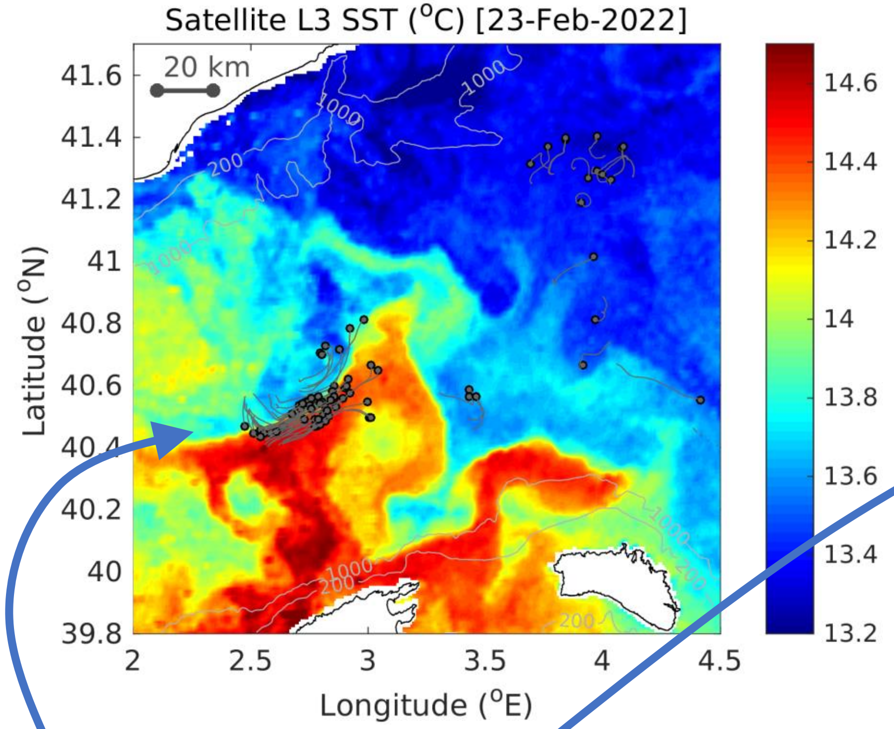
Ship thermosalinograph data

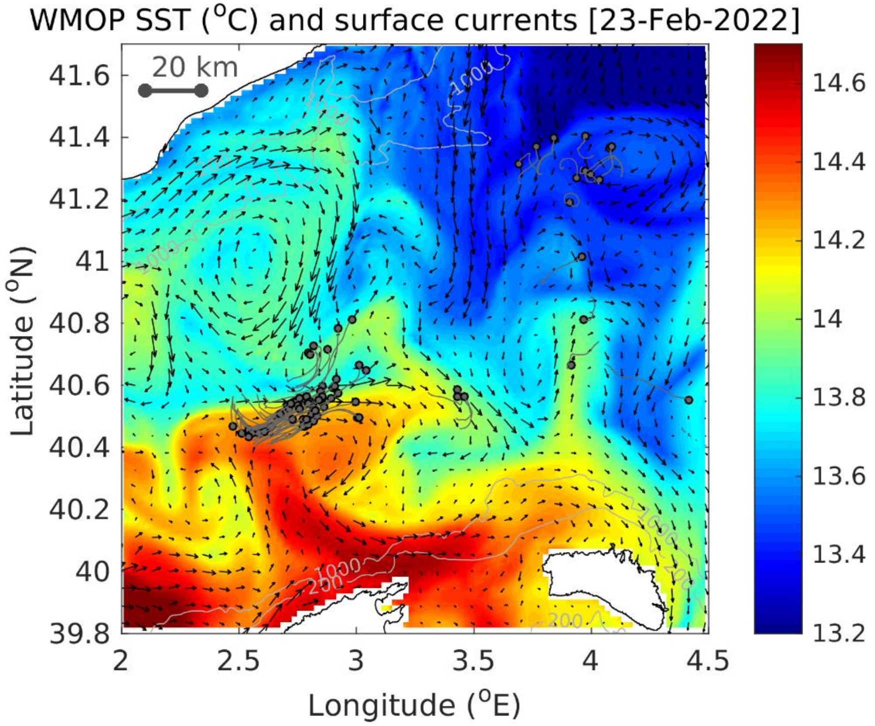
Satellite

WMOP model

Real-time forecasting support

SST maps on 23-Feb-2022



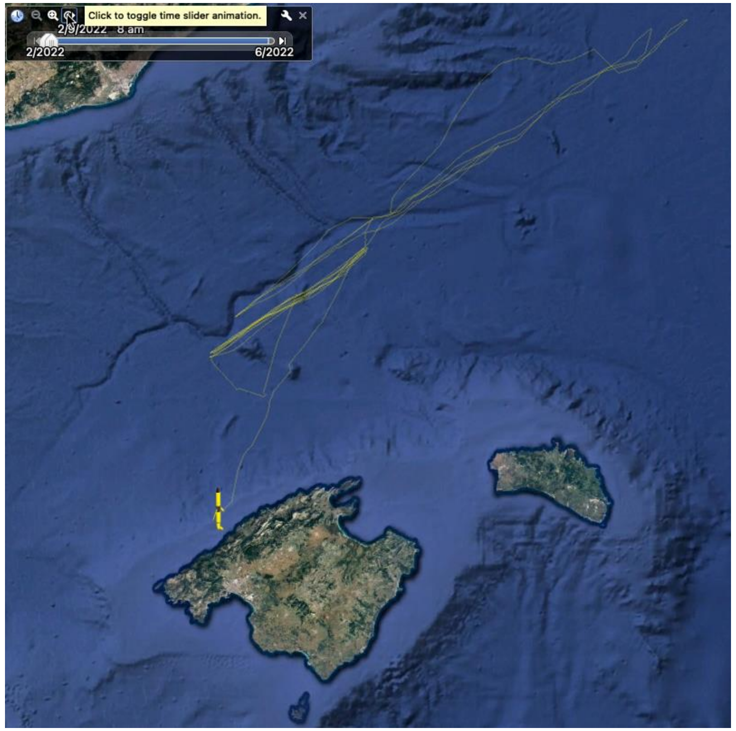


Satellite

WMOP model

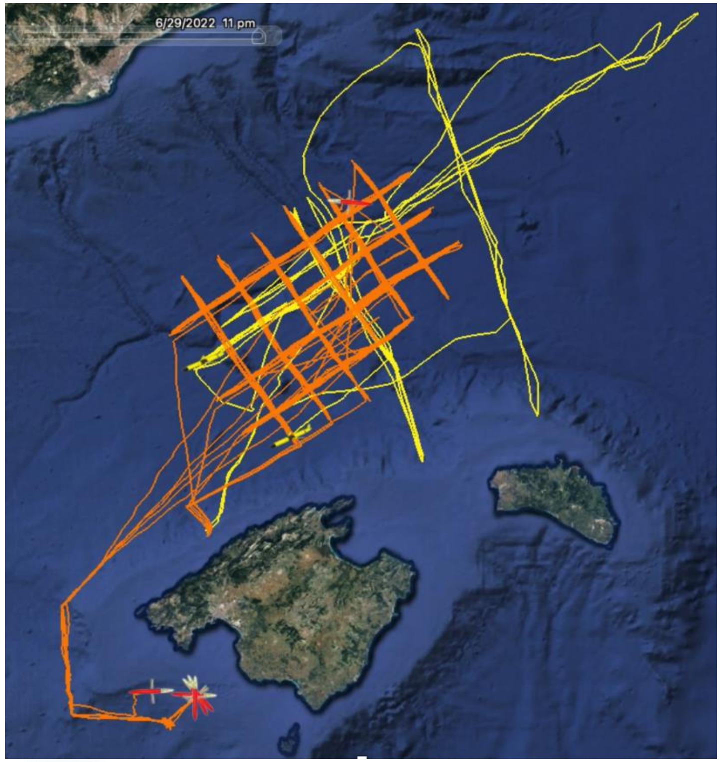
Drifters

Glider sampling design and data assimilation



8 gliders
9 Feb – 29 June 2022

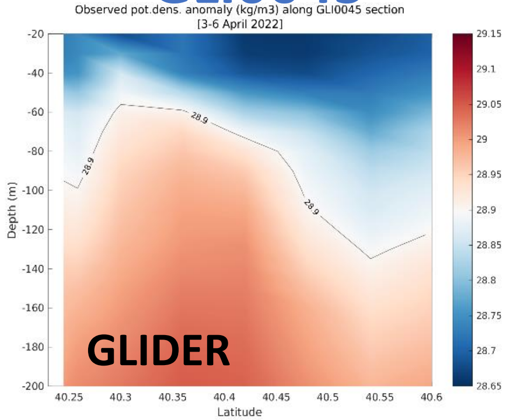
Glider sampling design and data assimilation

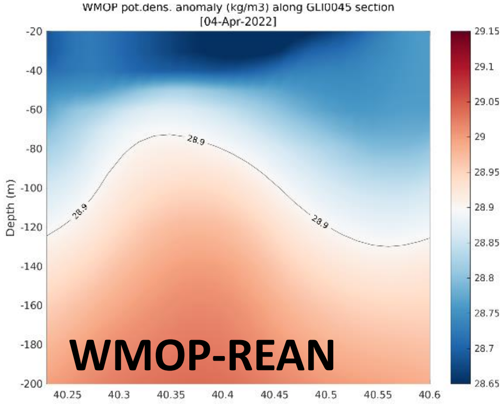


8 gliders
9 Feb – 29 June 2022

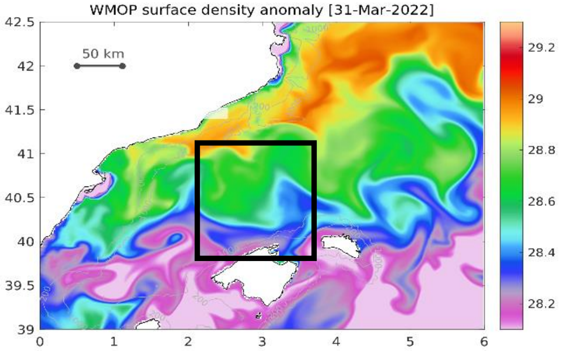
Evaluation: depth of 28.9kg/m^3 isopycnal

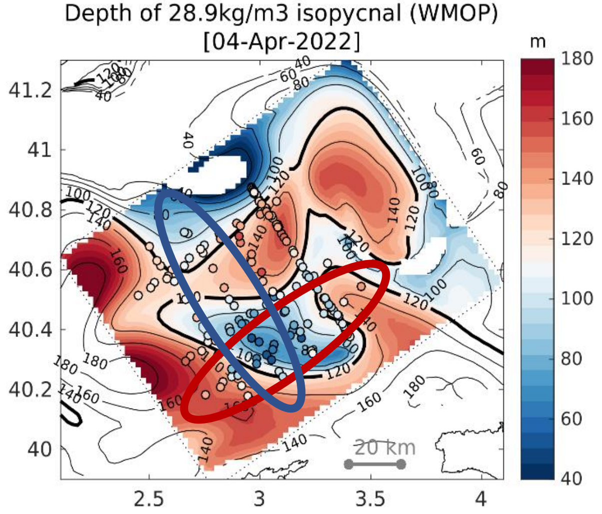
GLI0045





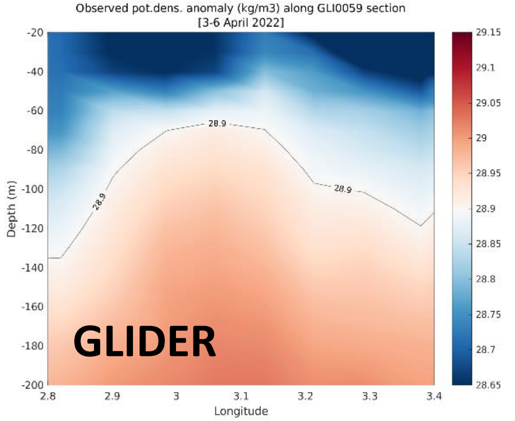
42 km

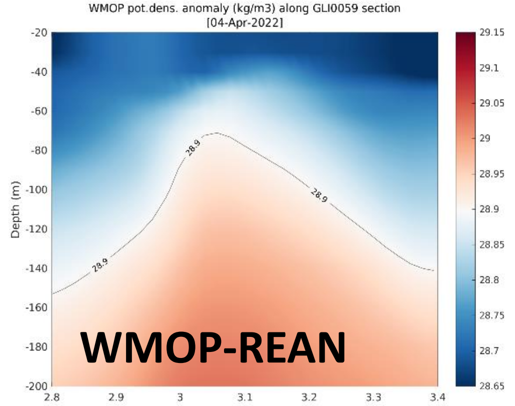




Dots: glider observations

GLI0059

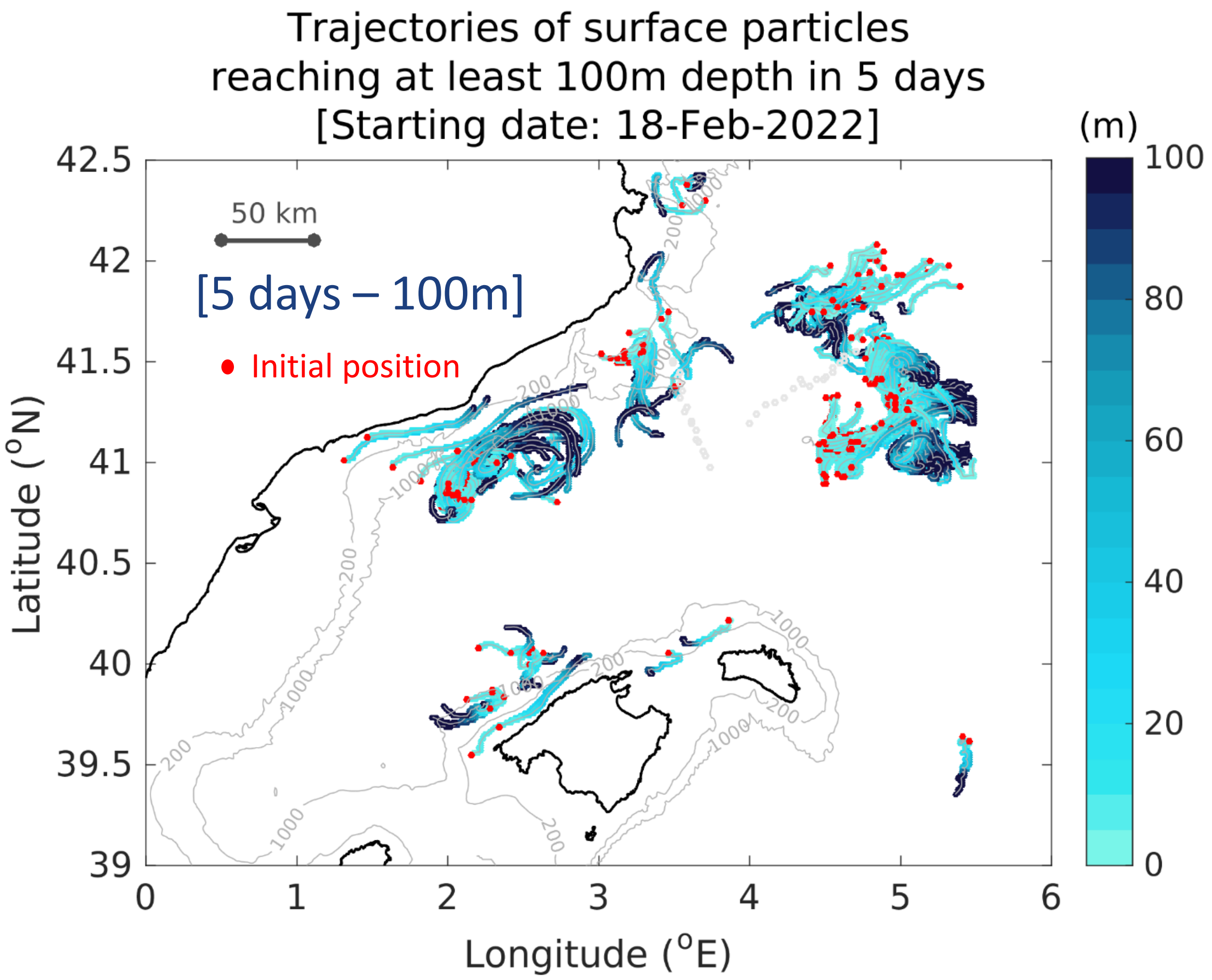




50 km

3D pathways

Parcels are seeded at every model gridpoint (2km-res) at 5m depth, and advected by model velocities (u, v, w) during 15 days.



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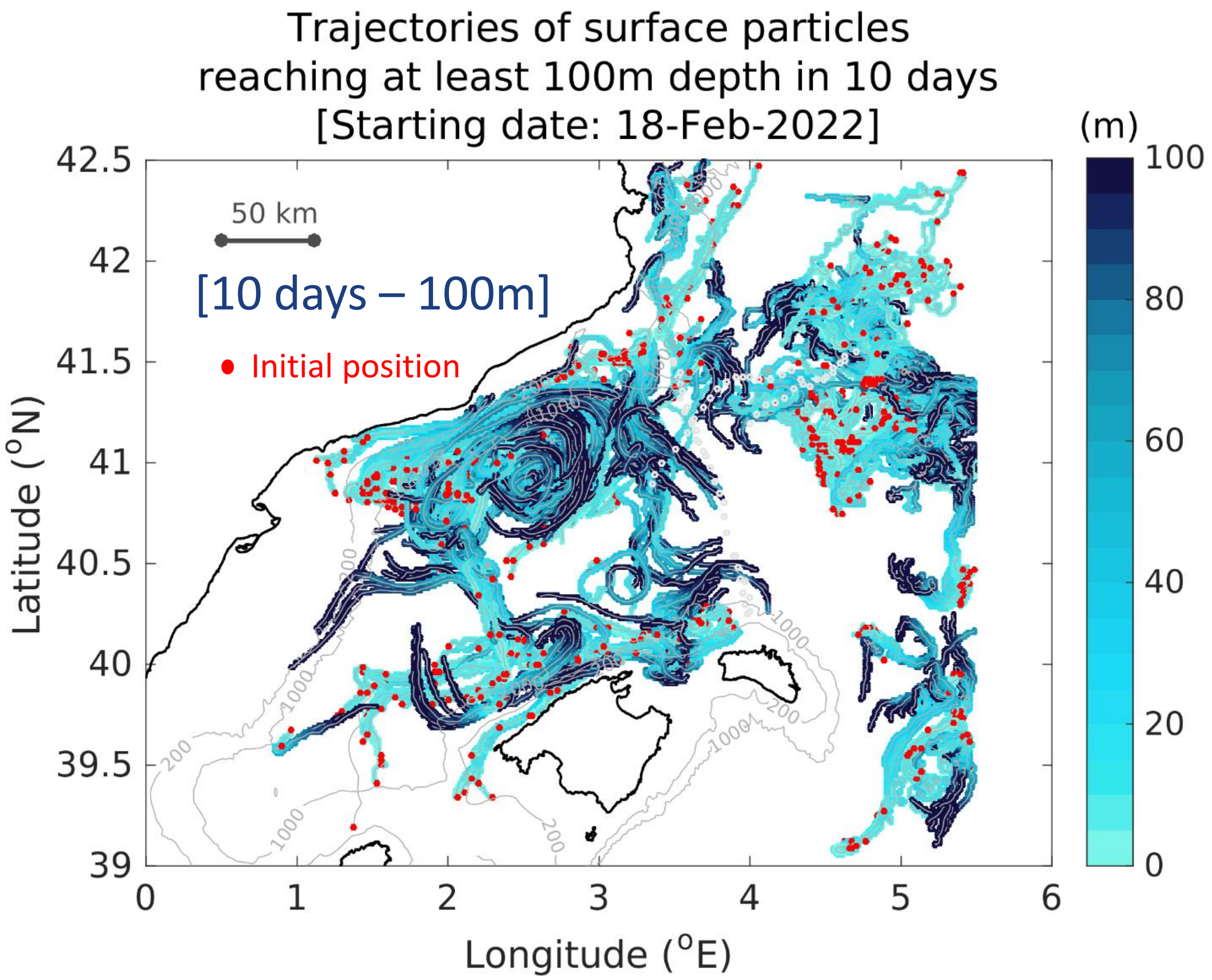

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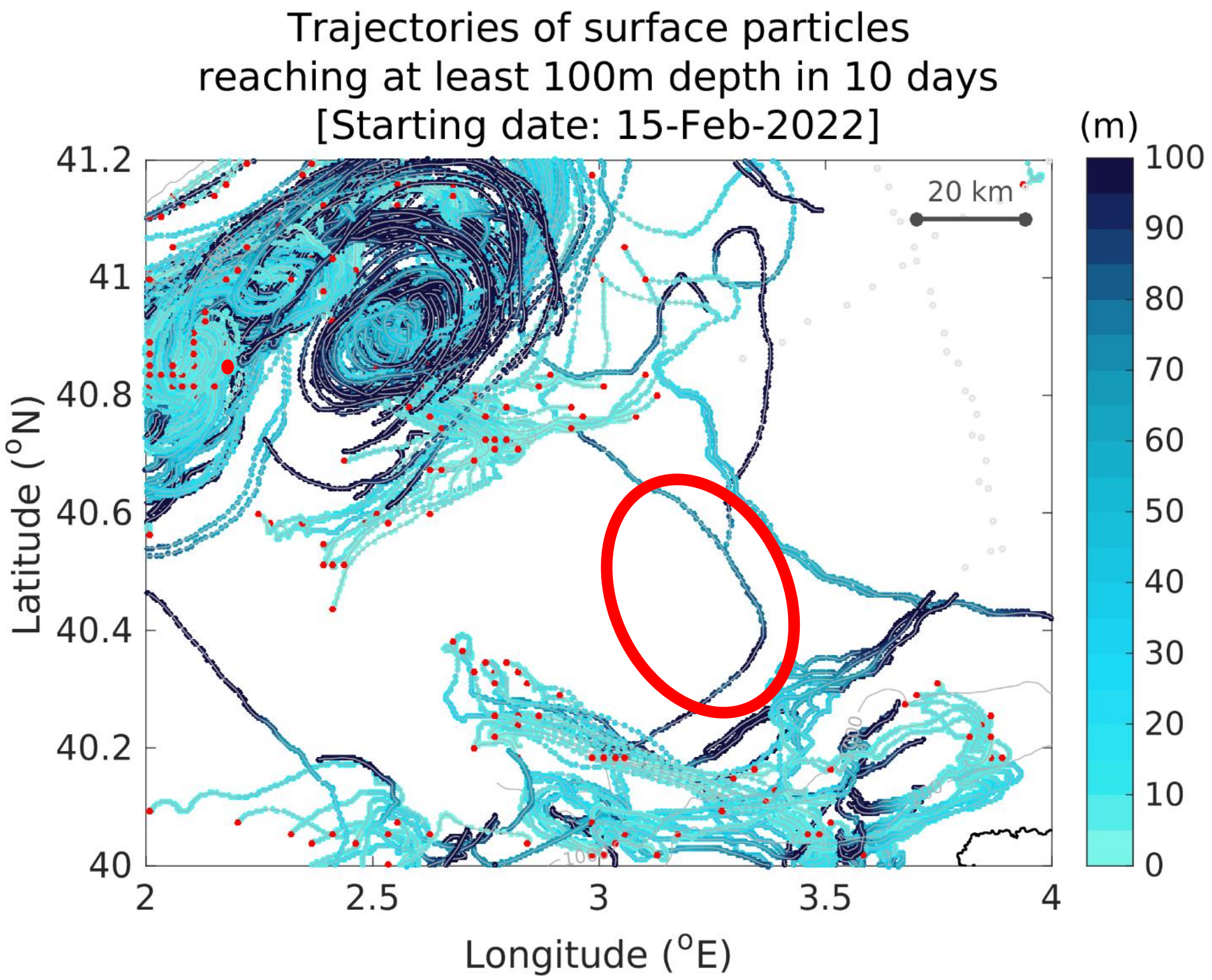
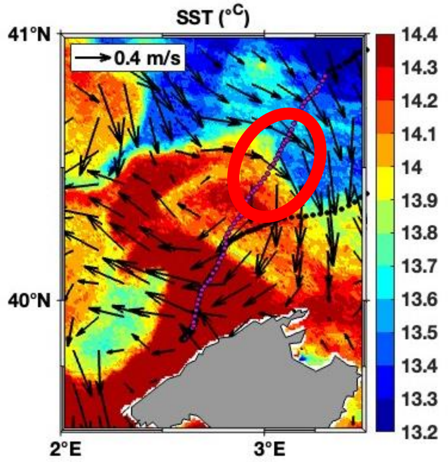
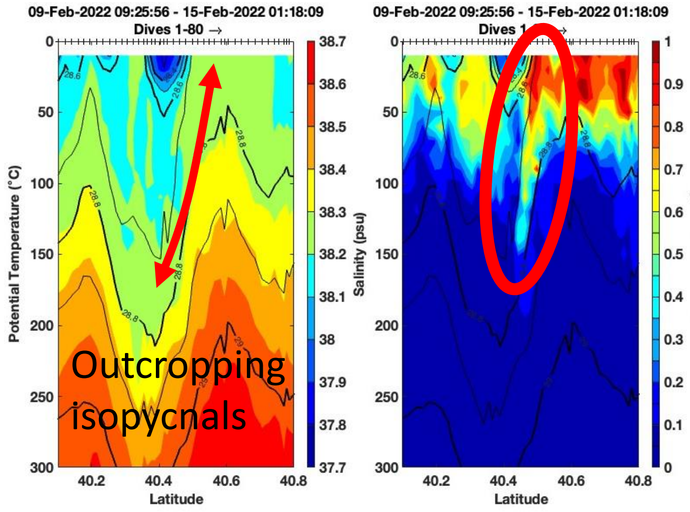






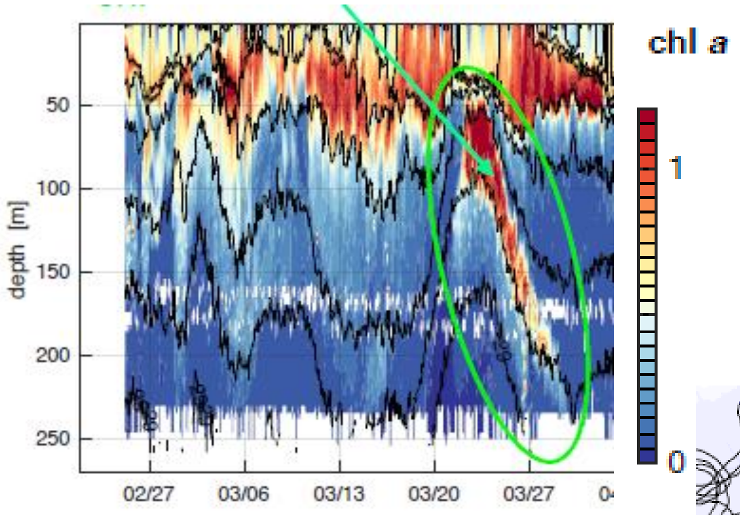
Glider data (from N. Zarokanellos)

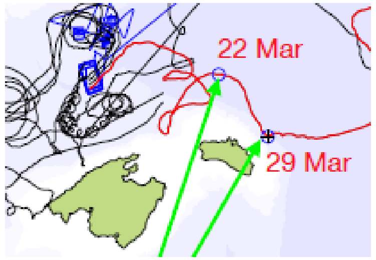
→ Subduction from the surface to below 100m identified in the frontal area

3D pathways

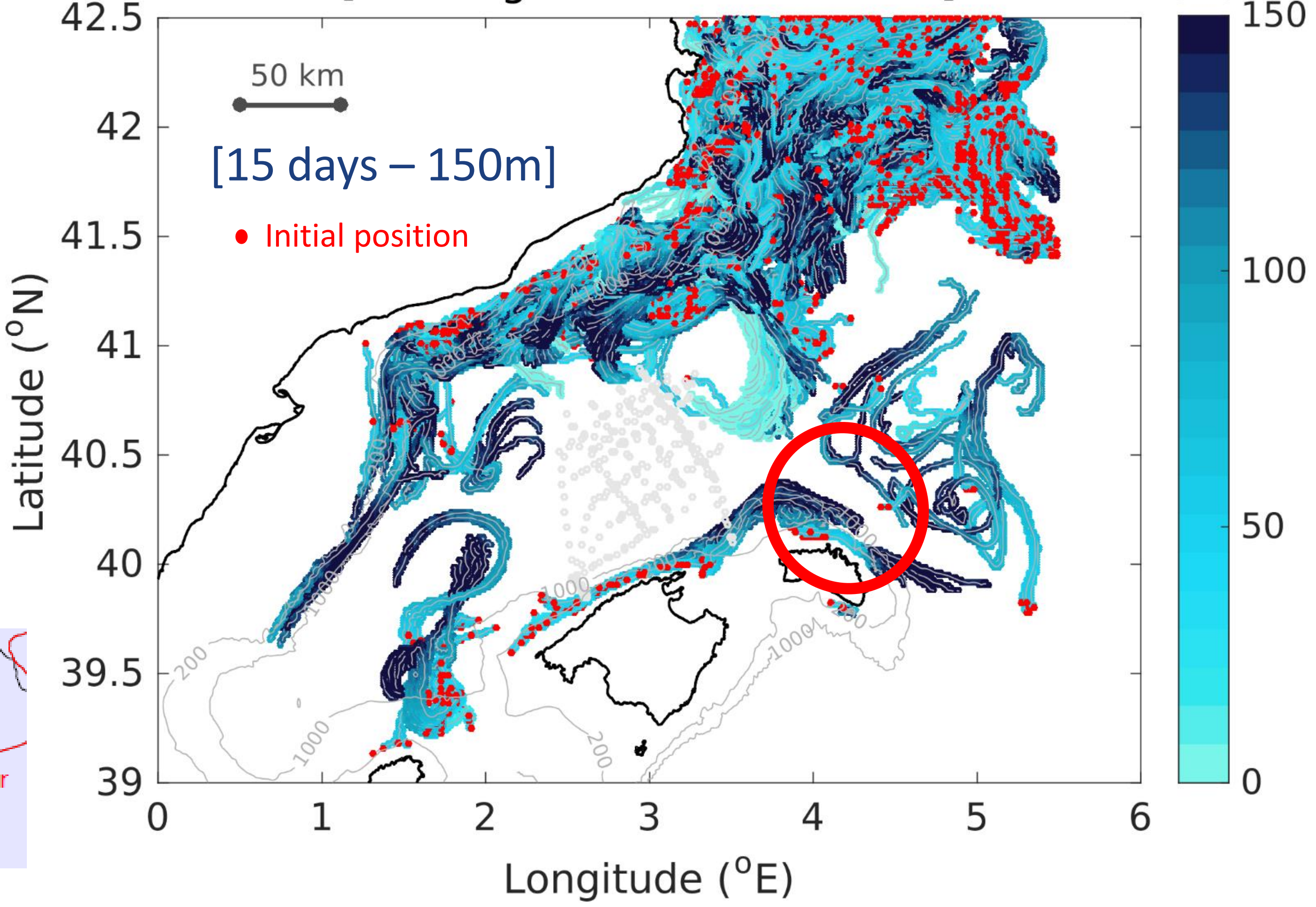
(Initial depth: 50m)

→ Subduction area north of Menorca identified in Chla observations from a profiling float.





(figure from Shaun Johnston)



Conclusions

- Collaborative high-resolution real-time forecasting effort providing support to small-scale ocean observing experiments
- Simulations and modelling products developed during three campaigns: opportunity for incremental improvements!
- Modelling tools applied for predictions, nested free runs on refined grids and reanalysis, providing a satisfactory level of realism

→ Used for sampling design, characterization of multivariate variability, understanding of dynamical processes, Lagrangian analysis and three-dimensional pathways at meso- and submesoscale

Ocean Predict

In partnership with unesco Intergovernmental Oceanographic Commission

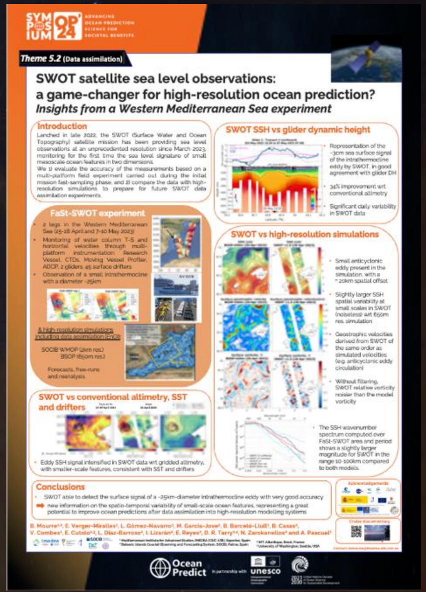
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

SYMPOSIUM OP'24

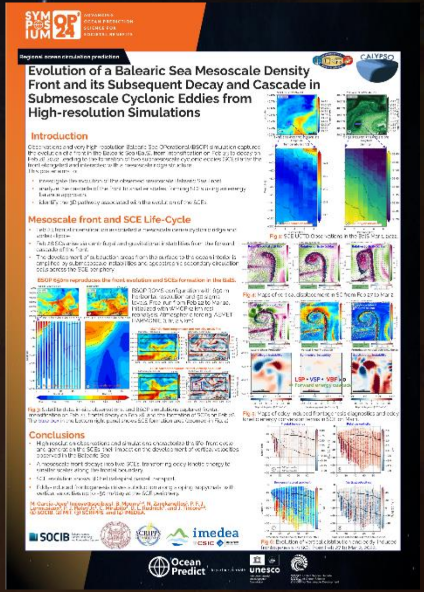
ADVANCING OCEAN PREDICTION
SCIENCE FOR SOCIETAL BENEFITS

Thank you!

Mon 18 - Data assimilation



Wed 20 – Regional prediction



European Commission

Copernicus Marine Service

EU4 Oceanobs INTERNATIONAL OCEAN GOVERNANCE EU COMPONENT TO GLOBAL OCEAN OBSERVATIONS

MERCATOR OCEAN INTERNATIONAL

esa

Australian Government Bureau of Meteorology

cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

Met Office

NERSC

Canada