LAgrangian transport of MARIne litter from modeling, analysis, and observations in CoAstal waters of the Bay of Biscay

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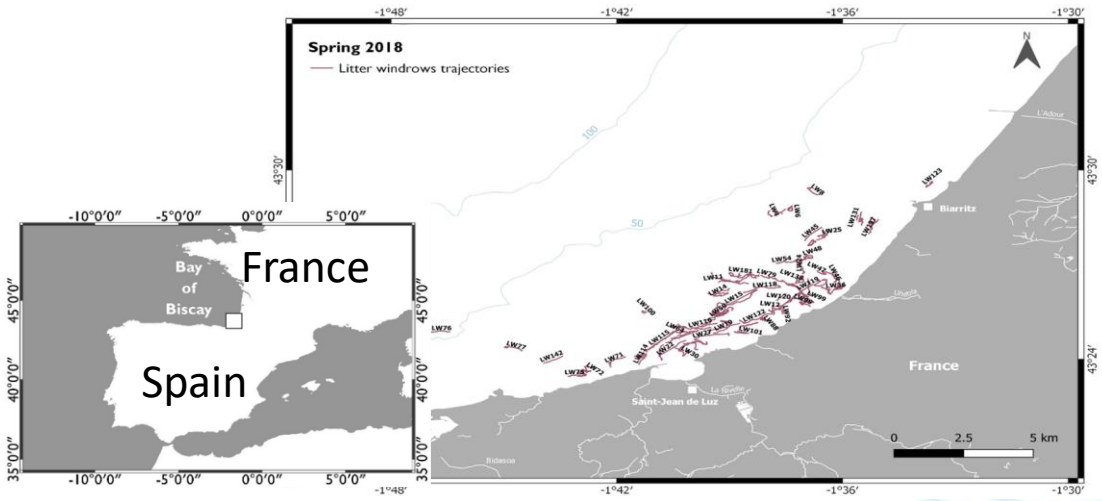
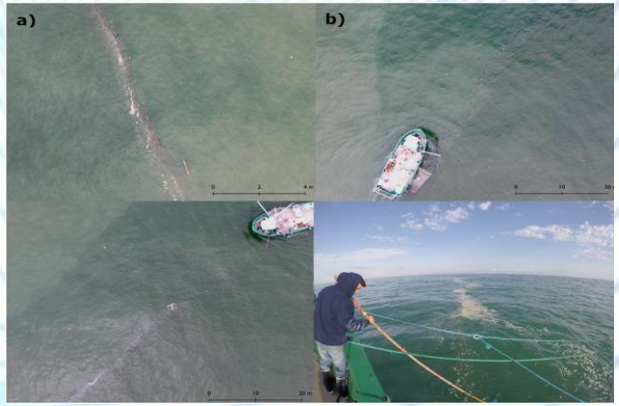
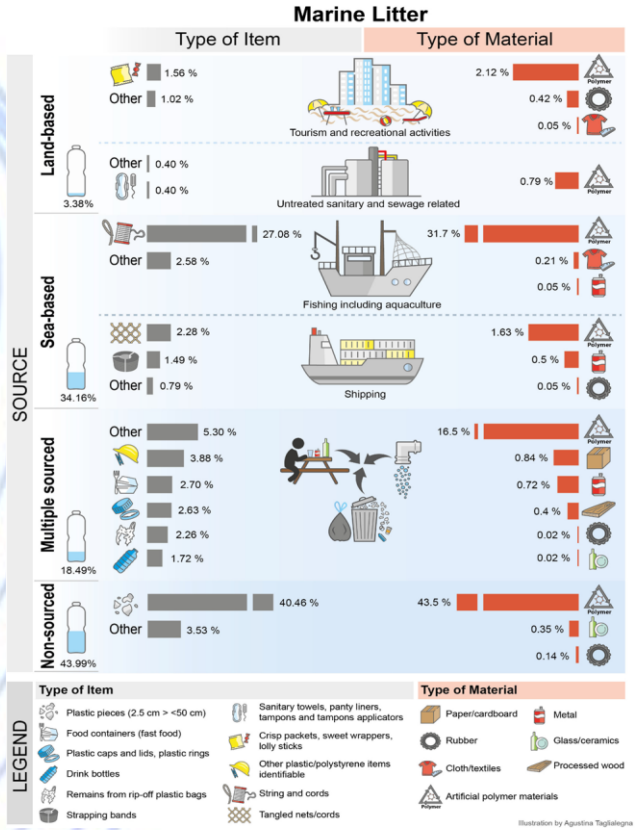
Context – Frontal accumulation of marine litter

- **Opportunity surveys** (LIFE LEMA project, Active fishing for litter off Saint Jean de Luz in France)
- In 2018, we observed a big difference (x10^4) in marine litter items number **within and out of frontal areas (Ruiz et al. 2020)**
- Most of the **litter was from Sea-based sources**

→ These fronts not only aggregate marine litter but also plankton and prey-size plastics (Gove et al., 2019)







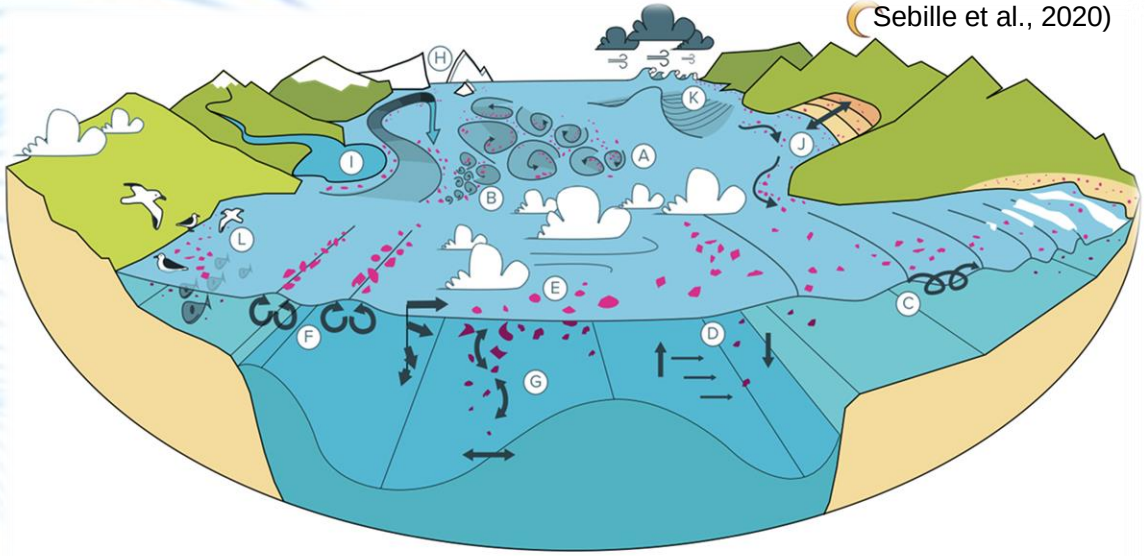
Context – LAMARCA project

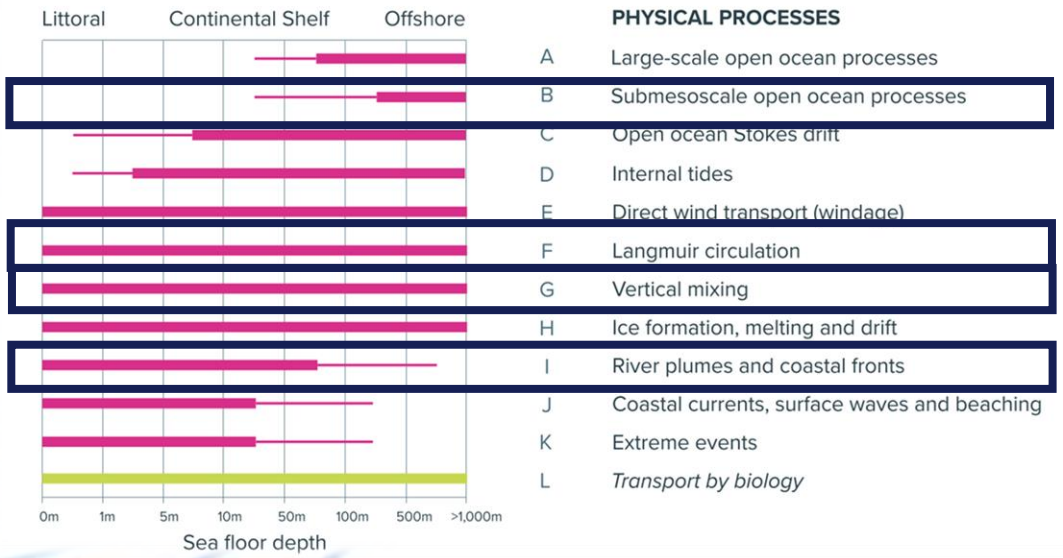
AIM: Role of oceanic transport processes in marine litter dispersion?

Special emphasis on coastal zones and in the range of scales from 1 m to 10 km, where the vertical motions by marine currents play a relevant role.

- ✓ microplastics (< 5mm) + marine litter (> 5mm)
- ✓ ad-hoc observational surveys + very fine numerical simulations → connectivity patterns and structures of transport
- ✓ surface, the water column and the seafloor

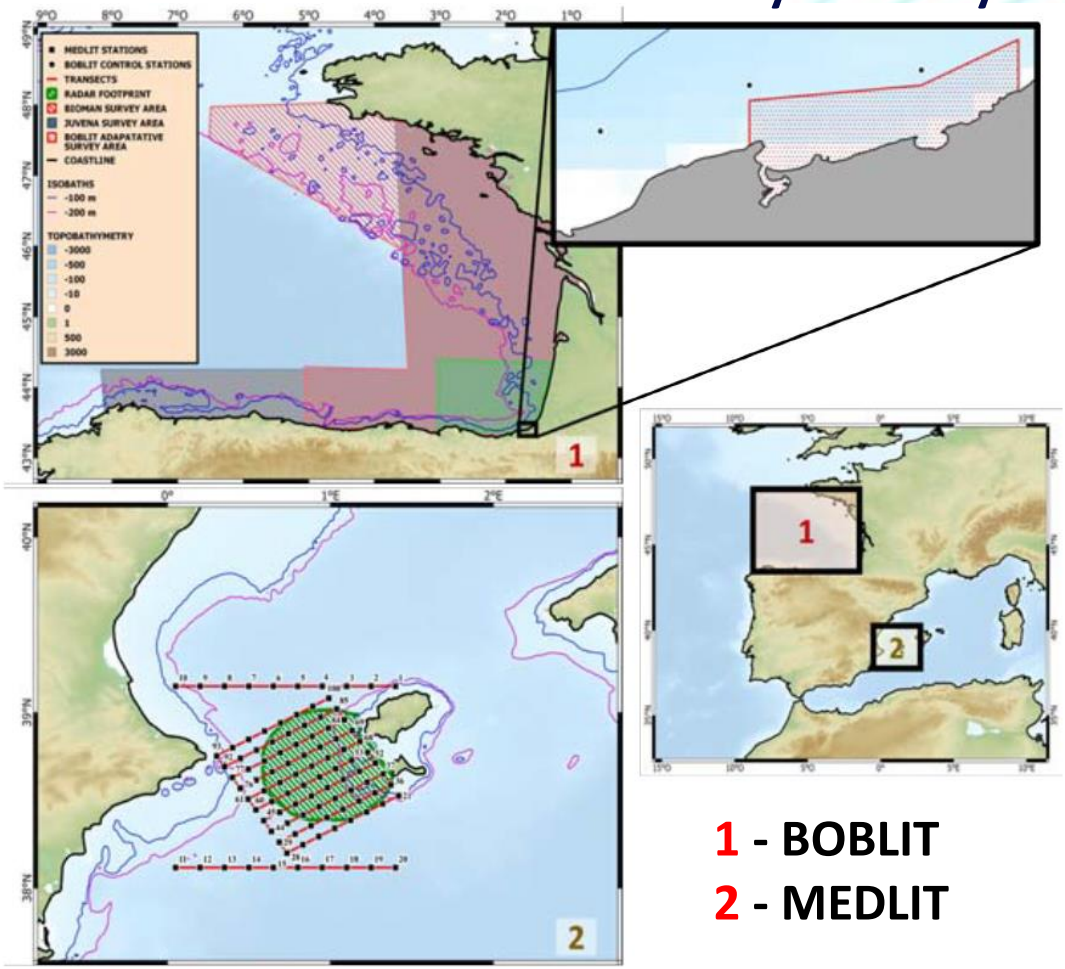
Schematic of the physical processes that affect the transport of plastic items (Van Sebille et al., 2020)





Context – LAMARCA project

SE Bay of Biscay



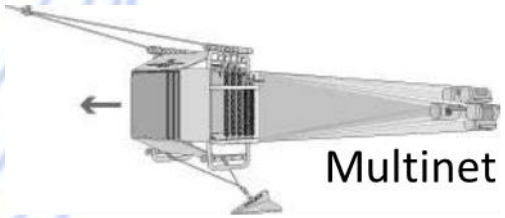
1 - BOBLIT

2 - MEDLIT

West Mediterranean Sea

✓Two study areas

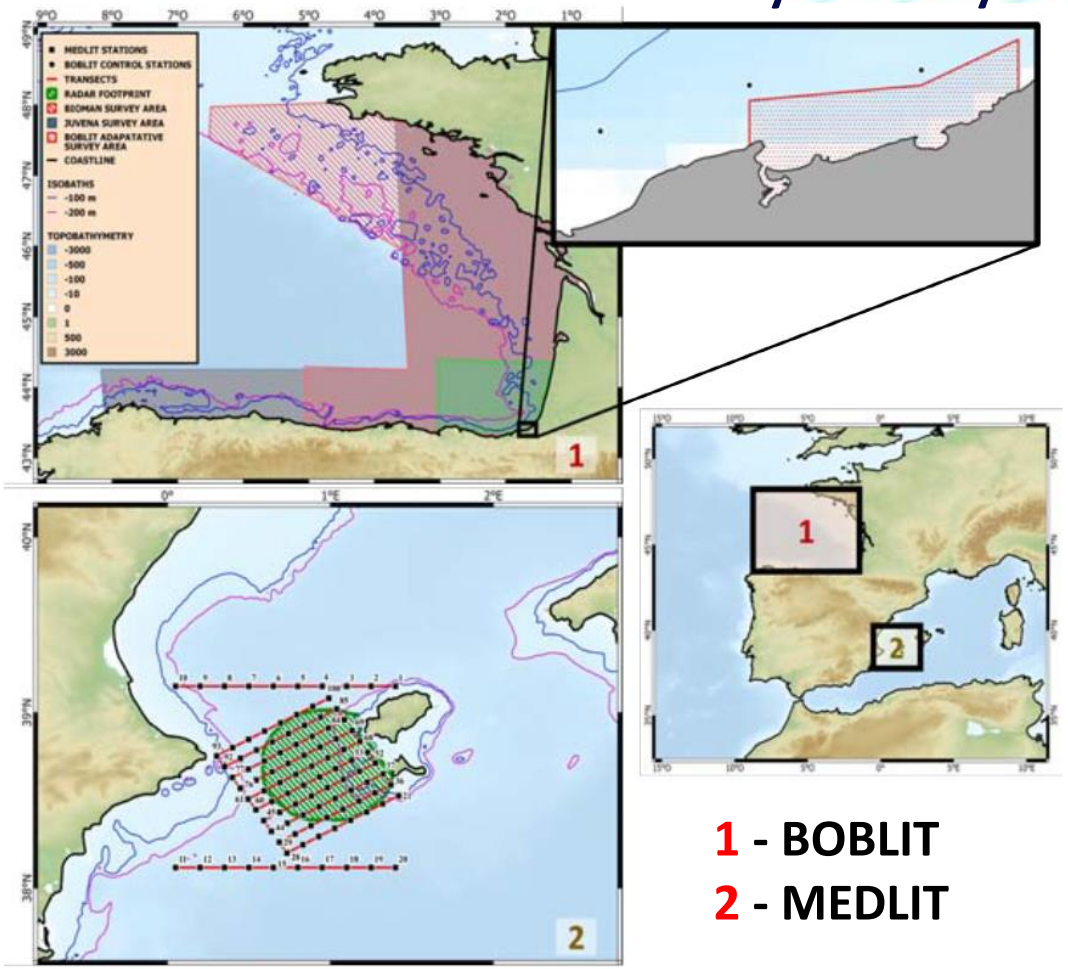
- ✓ Upcoming **MEDLIT** survey (Sept. 2023 , Ibiza Channel)
  - Hydrography & hydrodynamic samplig
  - Surface and subsurface plastic sampling
  - Surface drifters in aggregation structures



- ✓ **BOBLIT0.1 and 0.2 surveys in 2022 (SE Bay Biscay)** ←
  BOBLIT 1.X in 2024 + opportunity surveys BIOMAN & JUVENA

Context – LAMARCA project

SE Bay of Biscay



1 - BOBLIT

2 - MEDLIT

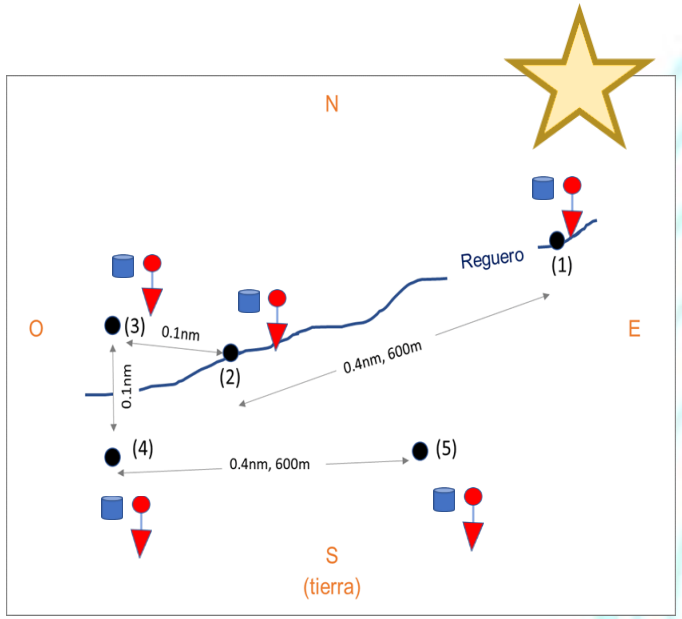
West Mediterranean Sea

BOBLIT 0.1 (APRIL 2022)
BOBLIT 0.2 (OCTOBER 2022)

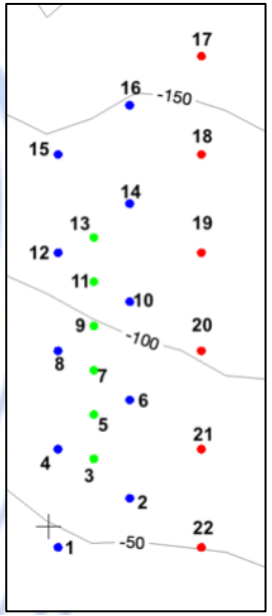
- ✓ Test different options for **frontal line Lagrangian sampling** : drifter clusters vs. drifters along transects, drifters without and with (50cm) drogue
- ✓ Insight on the main **circulation and aggregation** patterns in the area
- ✓ **Multiplatform approach**, combining drifters, in-situ current measurements (ADCP and radar) & satellite observations (and models)

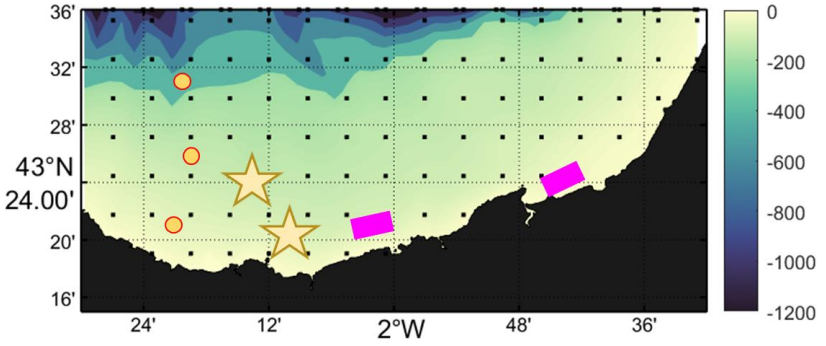
Lagrangian experiments - Design

BOBLIT 0.1 Apr 22

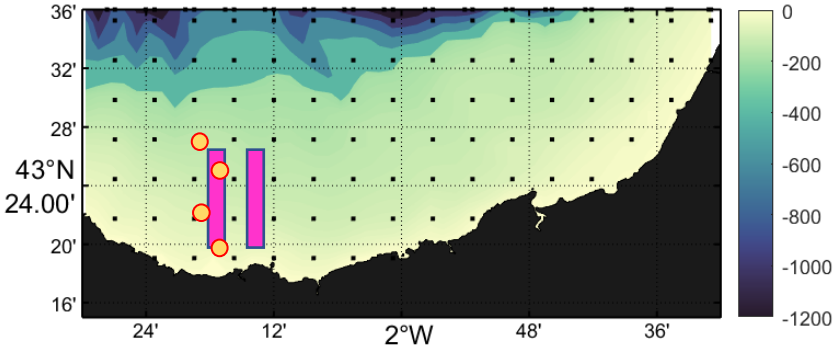


BOBLIT 0.2 Oct 22



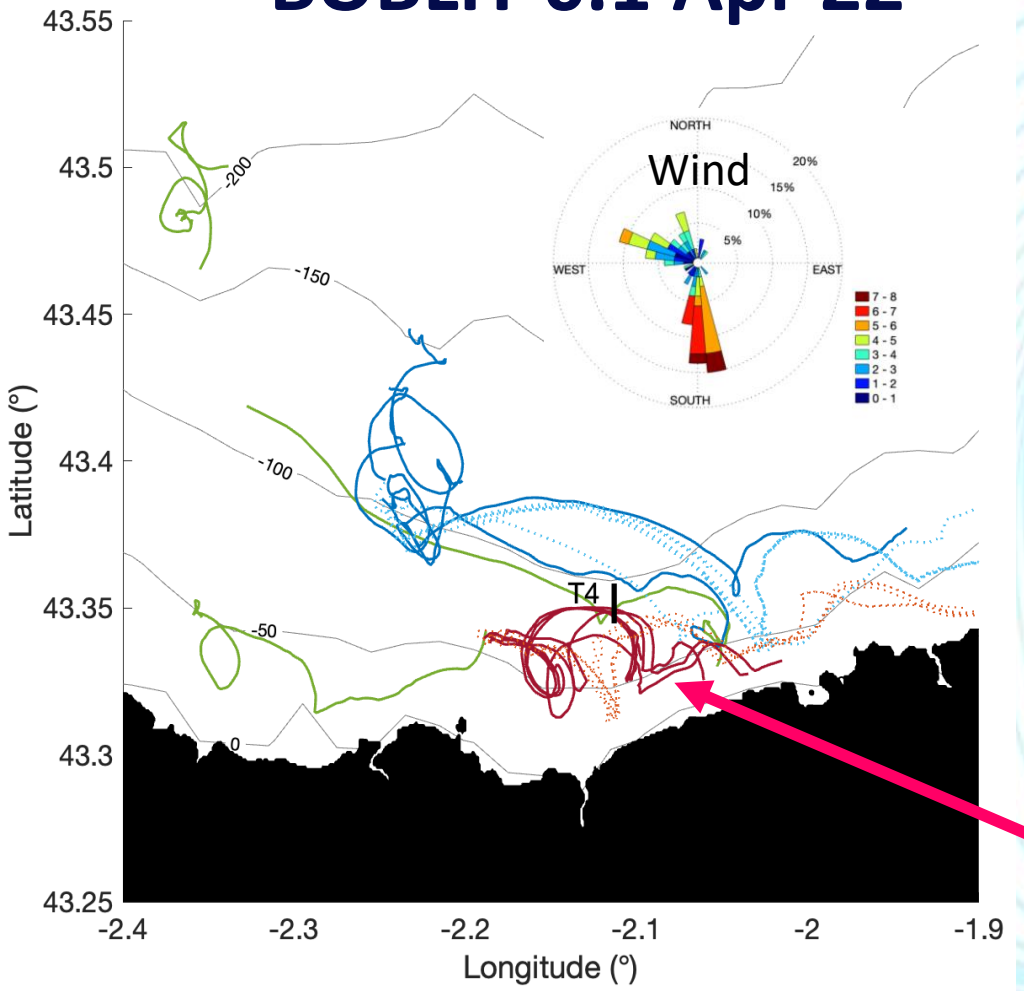


- Surface drifters(n=13, 48h)
- ADCP (RDI 600 kHz)
- HF RADAR (4.6 MHz)
- HR Satellite images



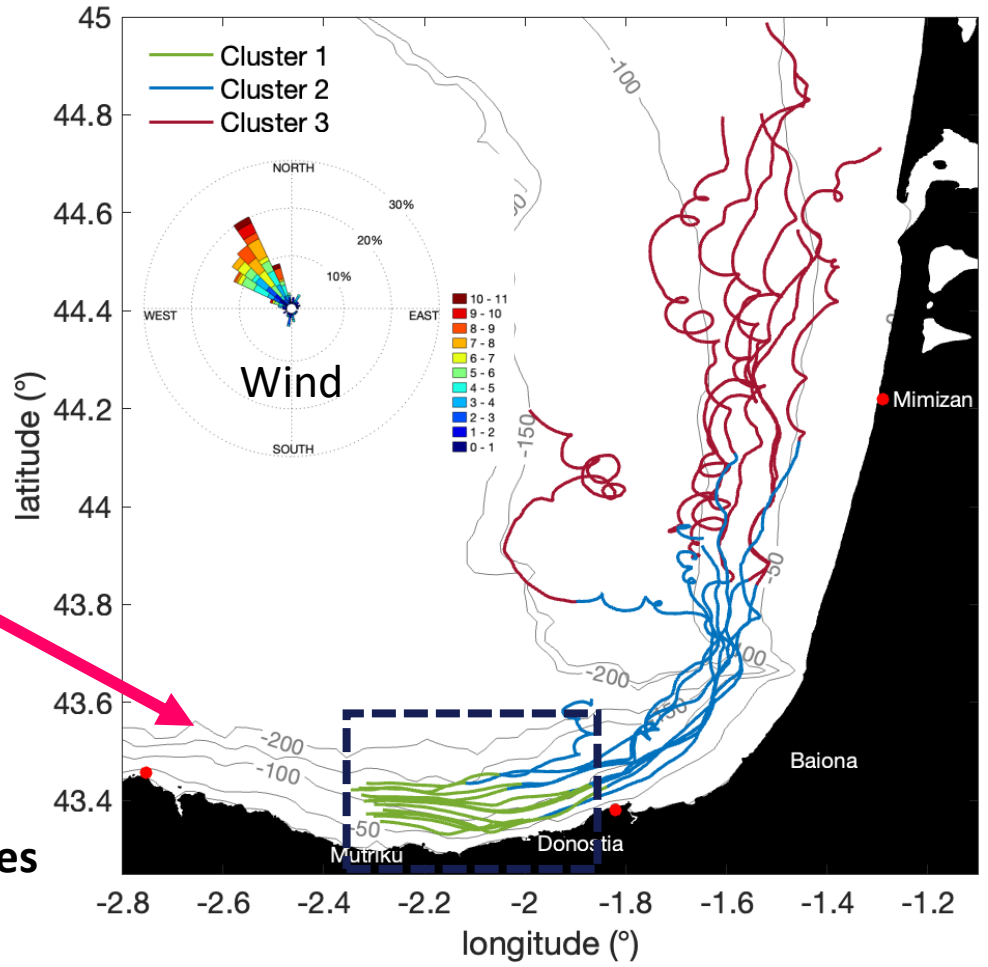
Lagrangian experiments - Trajectories

BOBLIT 0.1 Apr 22



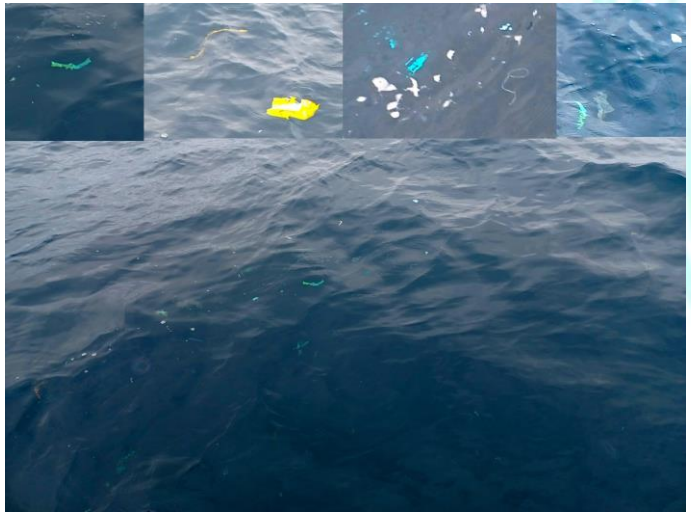
Visible litter aggregations along frontal lines

BOBLIT 0.2 Oct 22

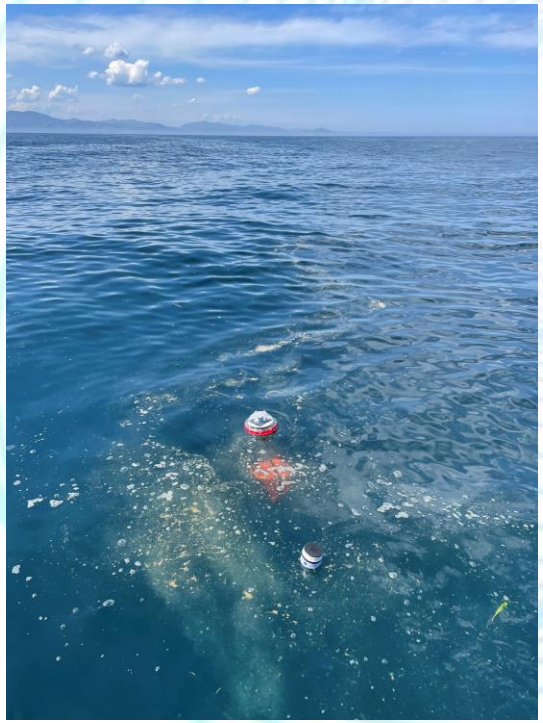


Lagrangian experiments – Litter

BOBLIT 0.1 Apr 22



Visible litter aggregations along frontal lines



BOBLIT 0.2 Oct 22

No aggregations or frontal lines

Lagrangian experiments – Litter

Lagrangian experiments - ADCP

BOBLIT 0.1 Apr 22

BOBLIT 0.2 Oct 22

Current velocities along cross-shore transects

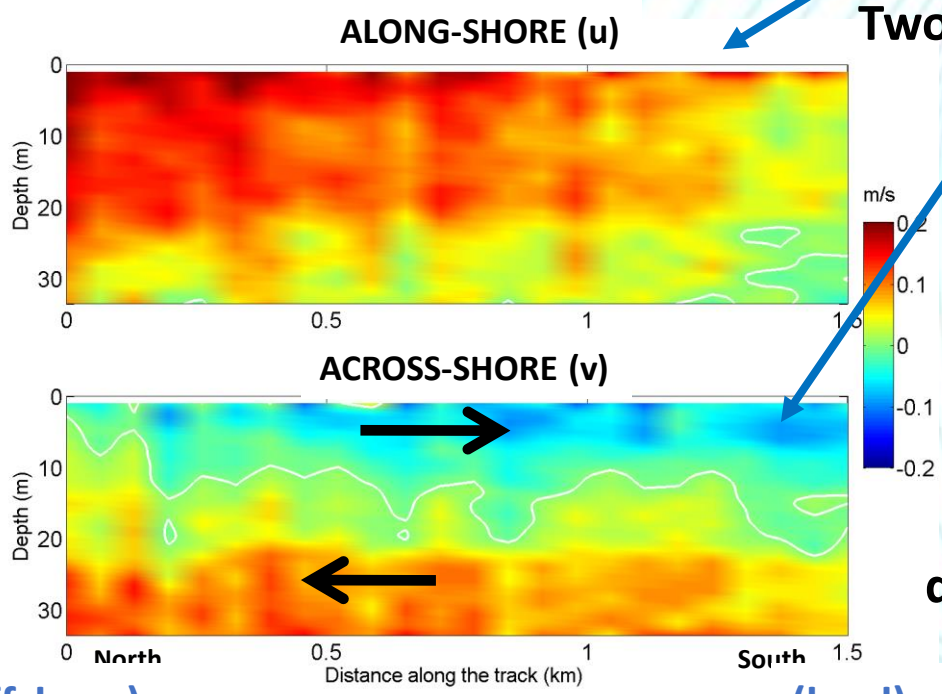
Backscatter showing fish aggregations

Eastward mean flow

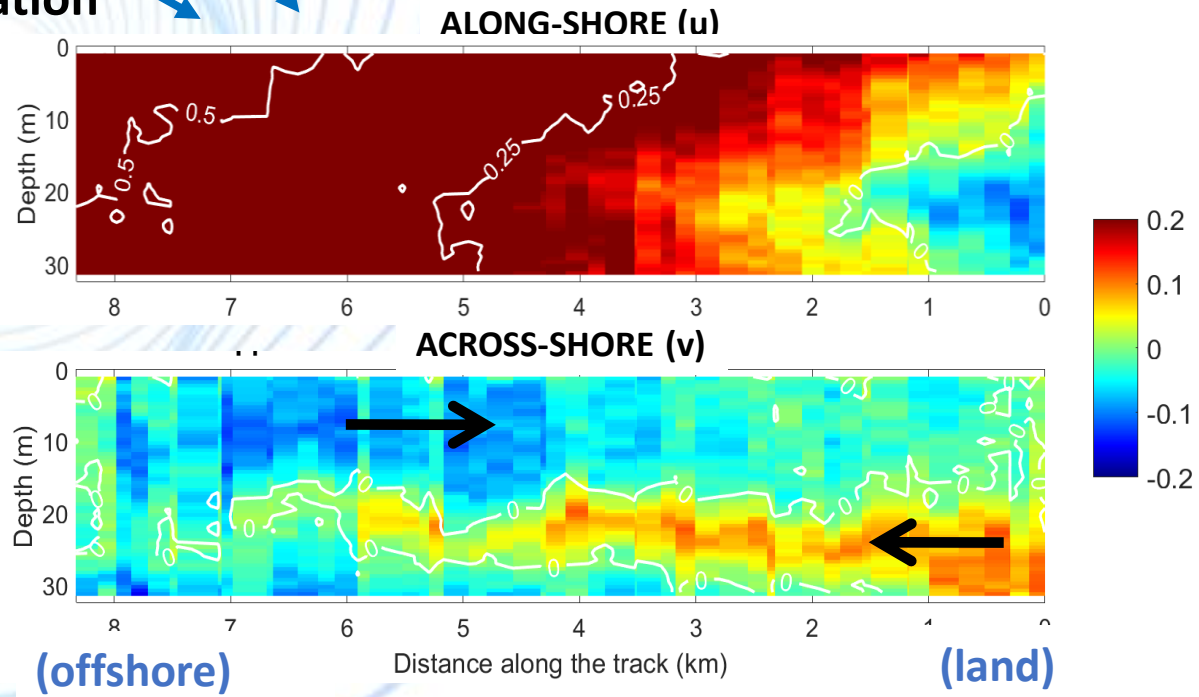
Three times more intense

Two-layer circulation

Coastal downwelling



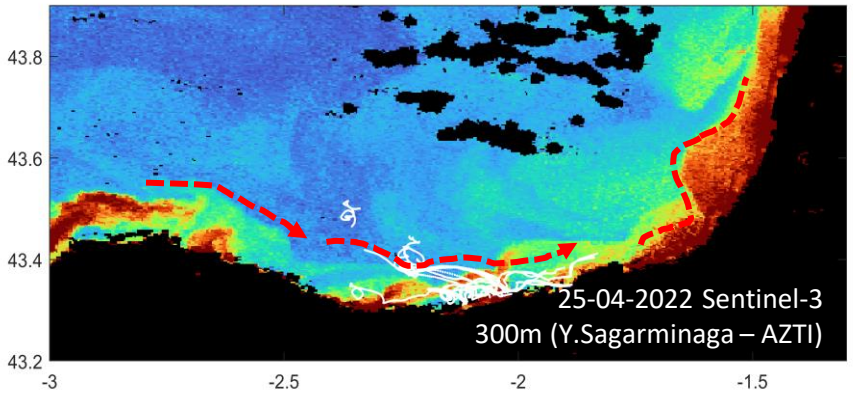
(offshore) (land)



(offshore) (land)

Lagrangian experiments - FSLE

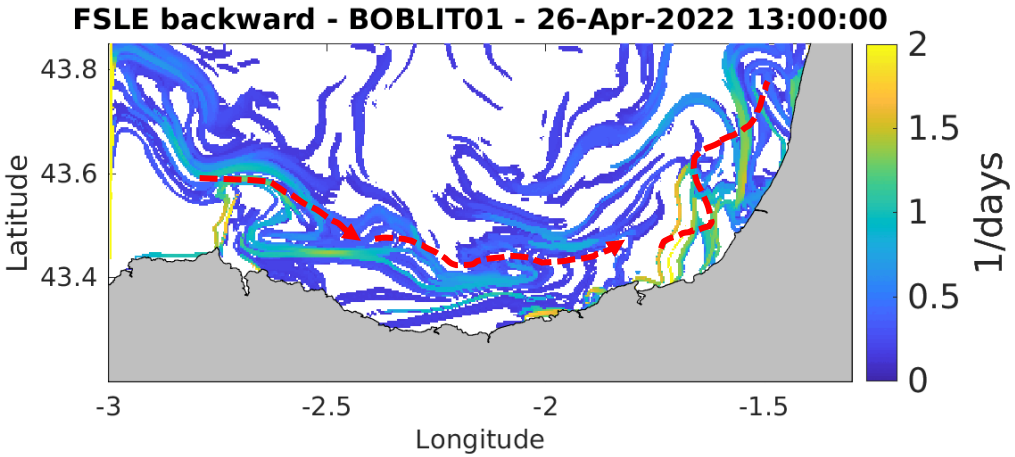
BOBLIT 0.1 Apr 22



Satellite

&

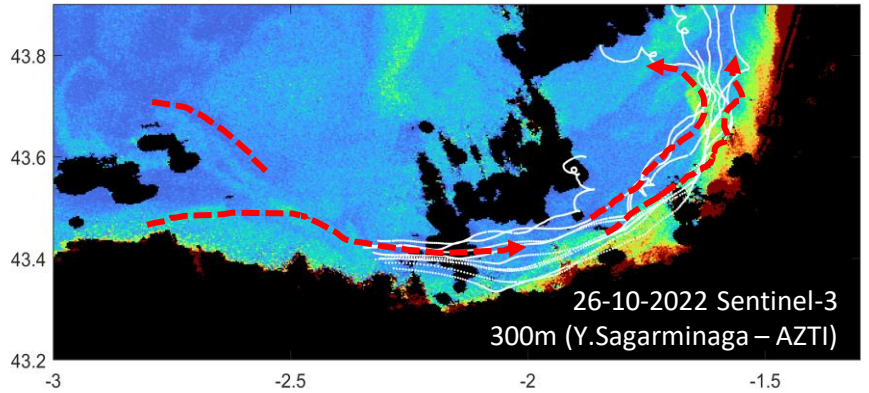
drifters

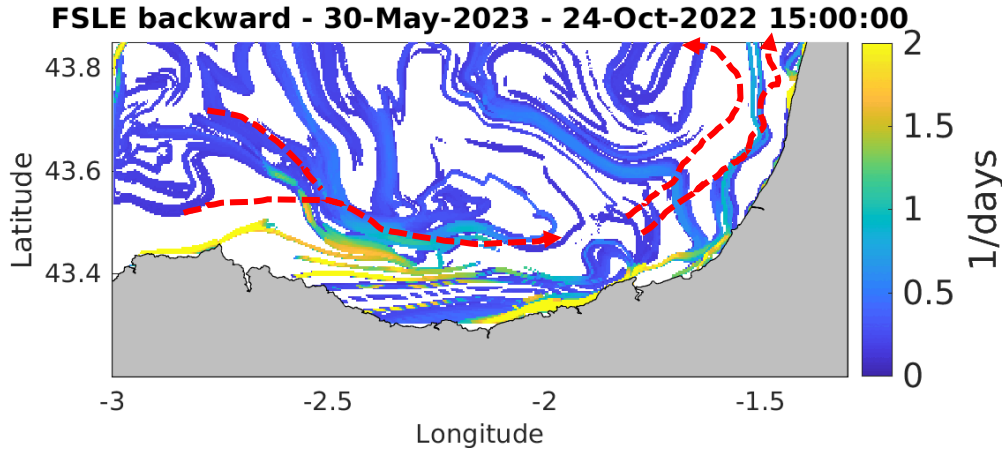


FSLE

(HF radar – 2DVar)

BOBLIT 0.2 Oct 22



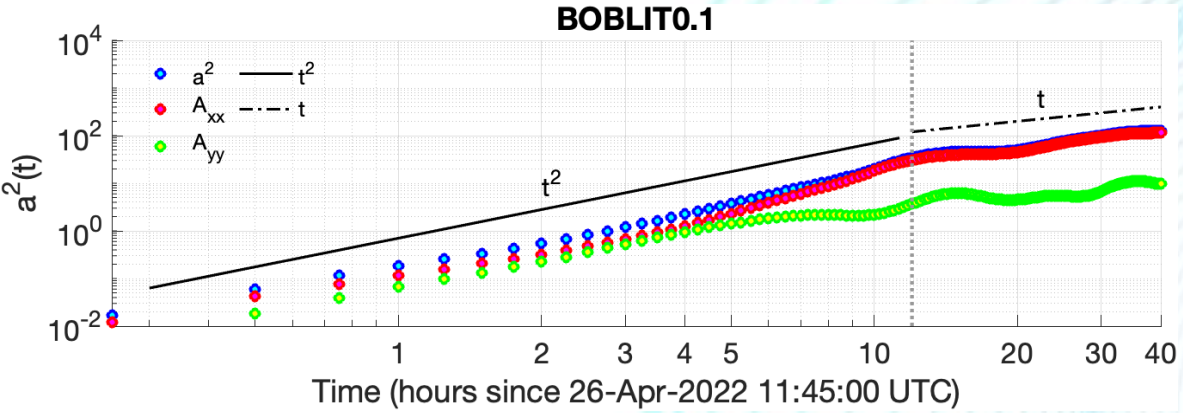


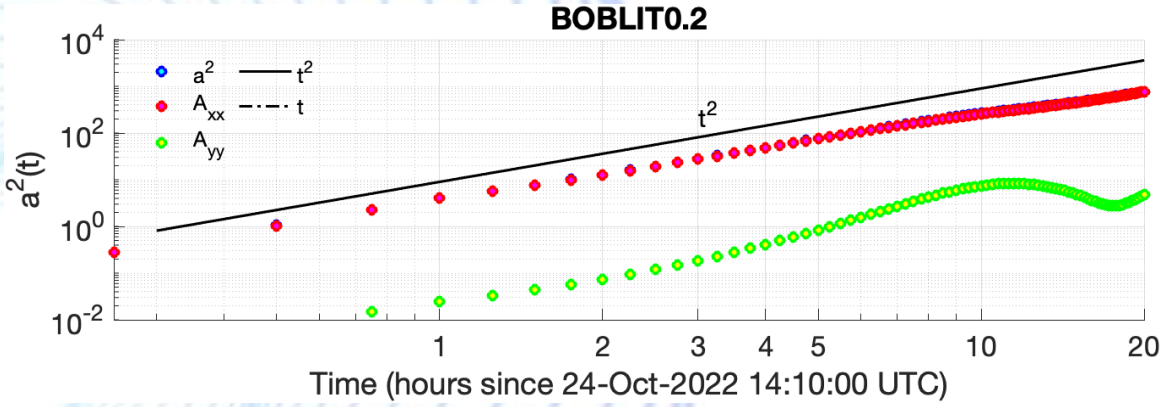
Lagrangian experiments - Dispersion

BOBLIT 0.1 Apr 22

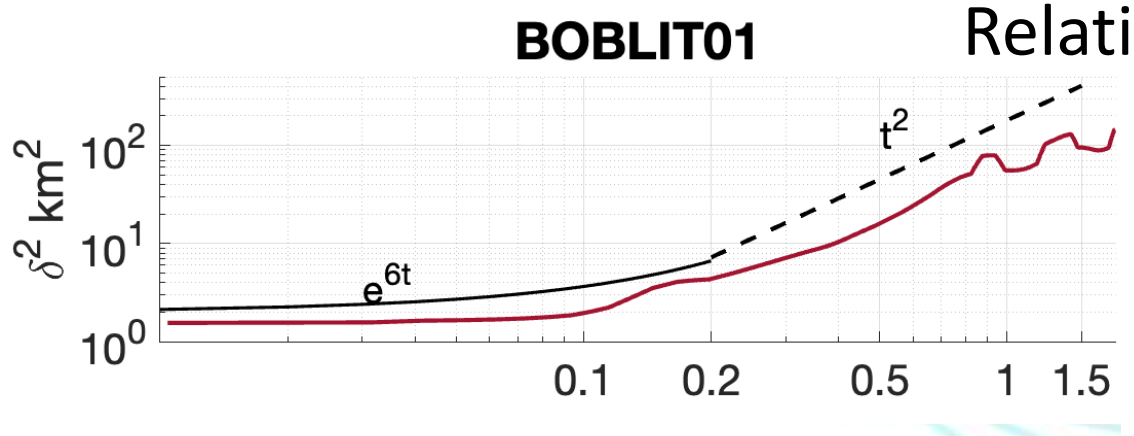
BOBLIT 0.2 Oct 22

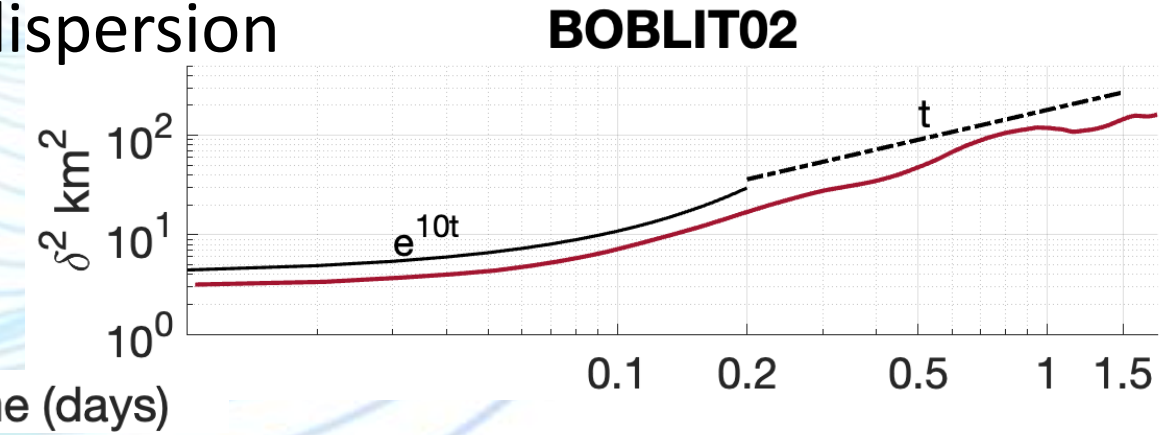
Absolute dispersion





Relative dispersion



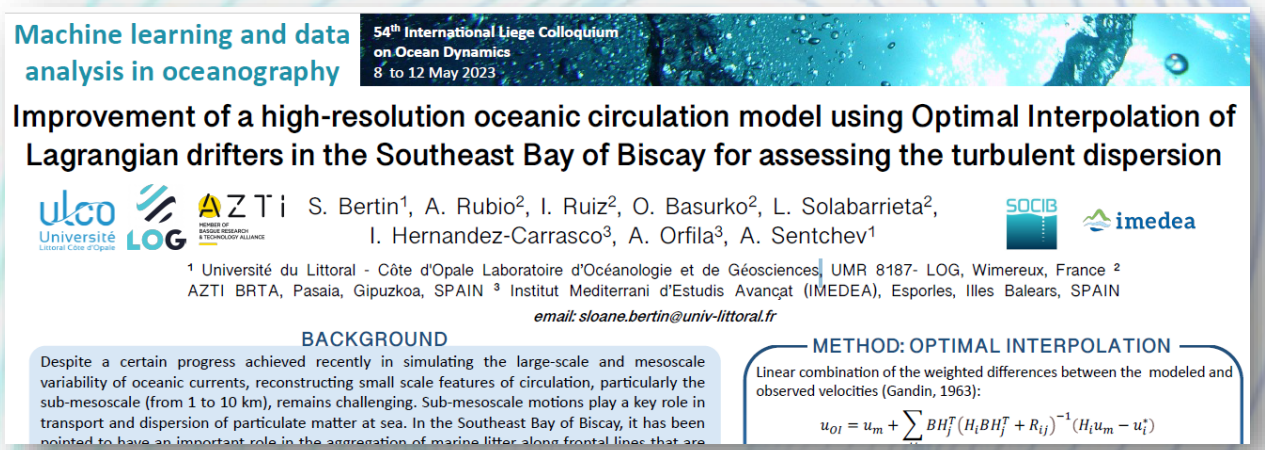


Main conclusions

- ✓ Eastward transport is prevailing but with variability at different scales – importance of **submesoscale frontal zones** – Which is the nature of these frontal zones?
- ✓ **High frequency processes effect in Lagrangian (relative) statistics** - complicated the interpretation of figures - What is the effect of the high frequency on the dispersion?
- ✓ **Visible fronts, aggregation of litter (and biological) activity observed in BOBLIT0.1 in** a downwelling situation with weaker eastward flow.
- ✓ **Dispersion regimes are coherent with the presence of alongshore fronts** as the ones observed here – What are the lifetimes and implications of these fronts? What determines their charge in marine litter or biological material?

Future /ongoing work

- Upcoming MEDLIT and BOBLIT campaings
- Sloane Bertin's Phd



Machine learning and data analysis in oceanography

54th International Liege Colloquium on Ocean Dynamics
8 to 12 May 2023

Improvement of a high-resolution oceanic circulation model using Optimal Interpolation of Lagrangian drifters in the Southeast Bay of Biscay for assessing the turbulent dispersion

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BACKGROUND

Despite a certain progress achieved recently in simulating the large-scale and mesoscale variability of oceanic currents, reconstructing small scale features of circulation, particularly the sub-mesoscale (from 1 to 10 km), remains challenging. Sub-mesoscale motions play a key role in transport and dispersion of particulate matter at sea. In the Southeast Bay of Biscay, it has been pointed to have an important role in the aggregation of marine litter along frontal lines that are

METHOD: OPTIMAL INTERPOLATION

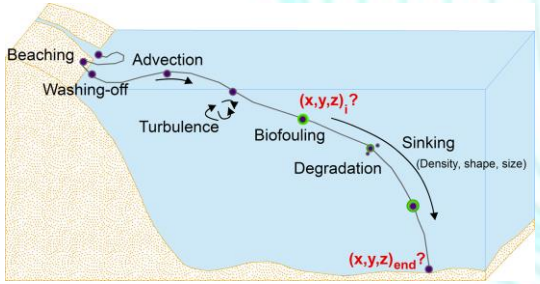
Linear combination of the weighted differences between the modeled and observed velocities (Gandin, 1963):

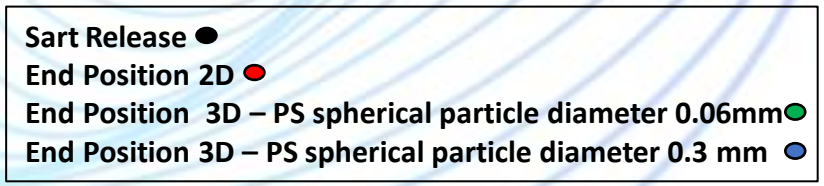
$$u_{OI} = u_m + \sum BH_j^T \left(H_i B H_j^T + R_{ij}\right)^{-1} \left(H_i u_m - u_i^*\right)$$

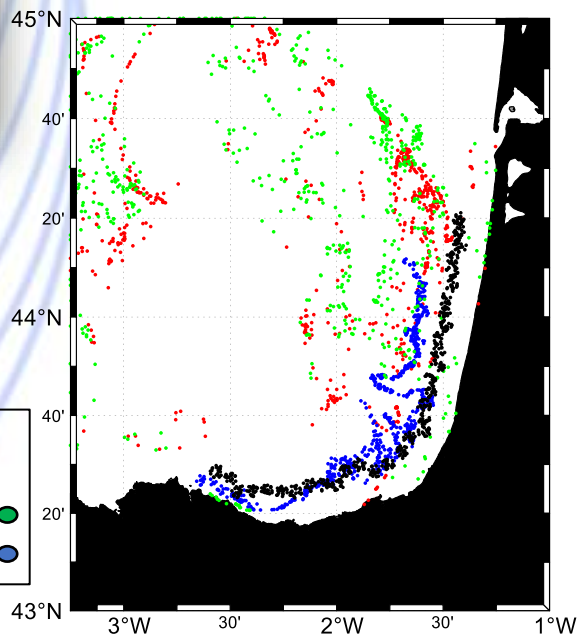
- Luigi Gifuni's PhD (Univ. Parthenope, Napoli. E. Zambianchi)

3D Lagrangian simulations in the SE Bay of Biscay

TrackMPD







Acknowledgments

https://lamarca-project.eu/

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- BOBLIT 0.X surveys were funded by the #ebegi project (Basque Government). #hfrada data is part of the euskoos.eus observatory by @azti_brta & @euskalmet. Thanks to the ECOCEAN crew!
- French LEFE program DYCOLAG -DYnamique CÔtière à sous-mésoéchelle caractérisée par des mesures LAGrangiennes
- The work of **Sloane Bertin**, is done under a co-funded Phd between AZTI and ULCO