eosc | Blue-Cloud2026

Coastal Currents from observations, an integrated multi-source approach to analyze surface currents

VLAB #2

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OBJECTIVES

Integrate measurements of drifters, altimetry and HF radar into a common data stream to increase the quality of the sea surface currents maps and other related products.

INTRODUCTION

- Ocean circulation is a key variable to understand dynamics that affect several areas. From biology, chemistry and also impacting commercial routes.
- Ocean currents are listed as essential ocean variables according to the ocean observing system [1].
- Details of the surface are critical for effective management of the coastal zones [2]. And are mainly retrieved by using three sources of data.

DRIFTERS
Highly accurate
Direct measurement
Tracking and deployment might be costly.
Constrained to the region of deployment.
Available data
2015 – 2024.

SATELLITES
Synoptic view.
Limited resolution for small-scale features.
Temporal gaps.
Limited to an along-track retrieval.
Available data
1992 – 2024.

HF RADAR
High resolution for coastal set-ups.
Data requires specific treatment. Presents limited observation of open ocean.
Available data
2015 – 2024 [3].

- Several platforms provide the three types of datasets but the methodologies for extracting the currents information are different and not standardized.
- A hub that allows the extraction, interpolation and merge of all the datasets will facilitate the process increase the resolution of the outputs.
- Main circulation patterns and other features as gyres will be easily observed and assessed in terms of variability, seasonality and strength.
- The proposed workflow will provide gridded datasets for the Mediterranean sea, ready to input into different models.

METHODOLOGY

DIVAnd – Data Interpolating Variational analysis in n-dimensions is a method that interpolates observations in a curvilinear grid **[3]**. Using the following cost function:

$$J(\phi) = \sum_{j=1}^{N_d} \mu_j \left[d_j - \phi(\boldsymbol{X}_j)\right]^2 + \|\phi - \phi_b\|^2$$

Where, ϕ is the velocity field defined and d_j are the N_d measurements of ϕ at locations $\boldsymbol{X}_j$ for a speficic time instance and with respective weights μ_j. The background estimate (ϕ_b) is the first guess of the velocity to interpolate.

Spatial and temporal coherence of the field are defined by penalizing spatial anomalies over a domain Ω as it folllows:

$$||\phi||^2 = \int_\Omega (\alpha_2 \nabla\nabla_\phi : \nabla\nabla_\phi + \alpha_1 \nabla_\phi \nabla_\phi + \alpha_0 \phi^2)\, d\Omega$$

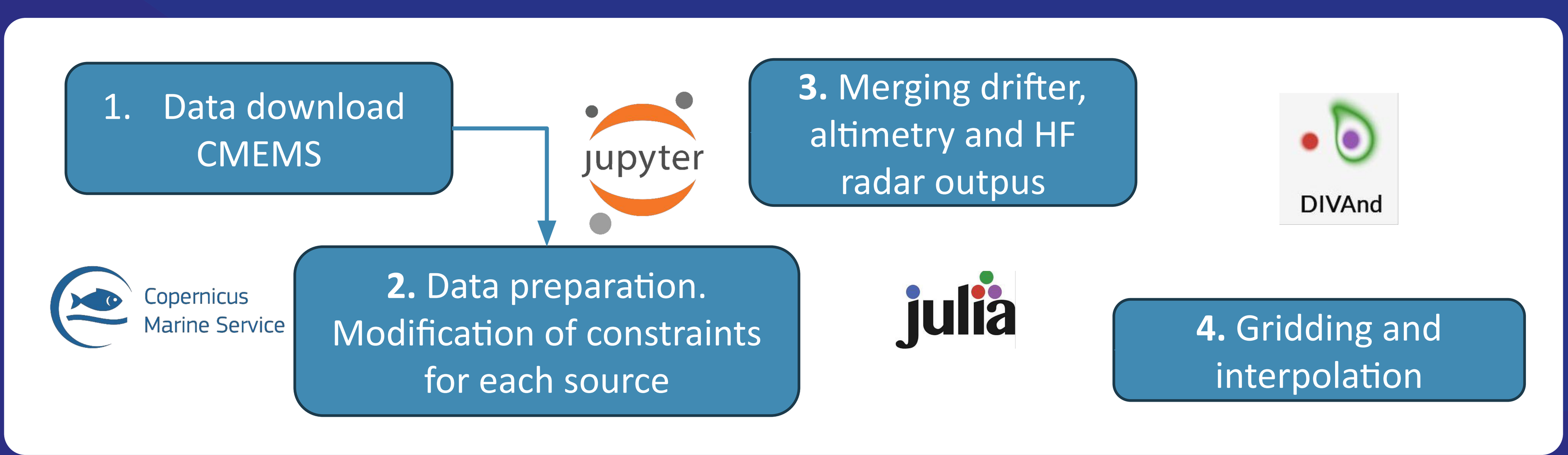
Where coefficients α define the relative importance of each of the contributions**[5]**.

DIVAnd hyperparameters

Correlation length (Len) – Controls the spread of the information (Km). Error variance of the observation (ϵ^2) – Sets the accuracy of the dataset type.

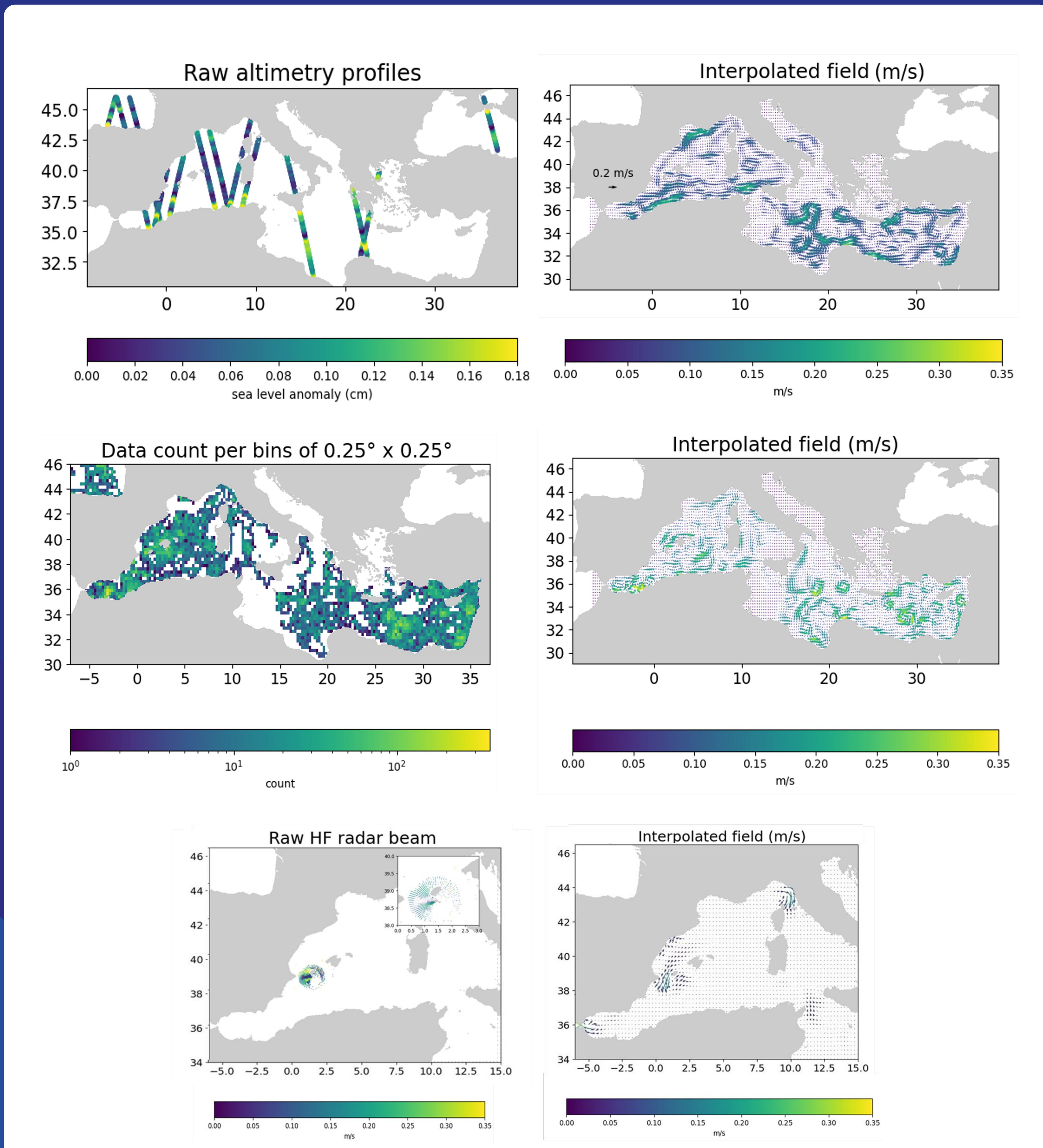
Hyperparameter	Value
Len	137.8km
ϵ^2 altimetry	0.02562
ϵ^2 drifters	0.00618
ϵ^2 HFRadar	0.09856

WORKFLOW



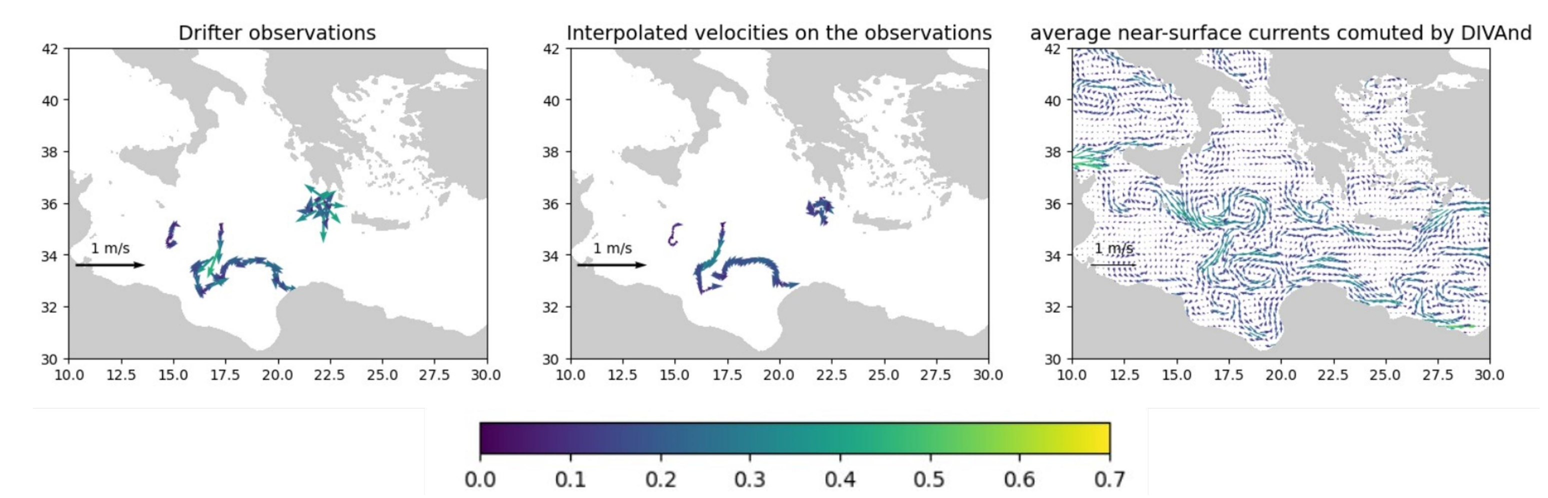
PARTIAL RESULTS AND DISCUSSION

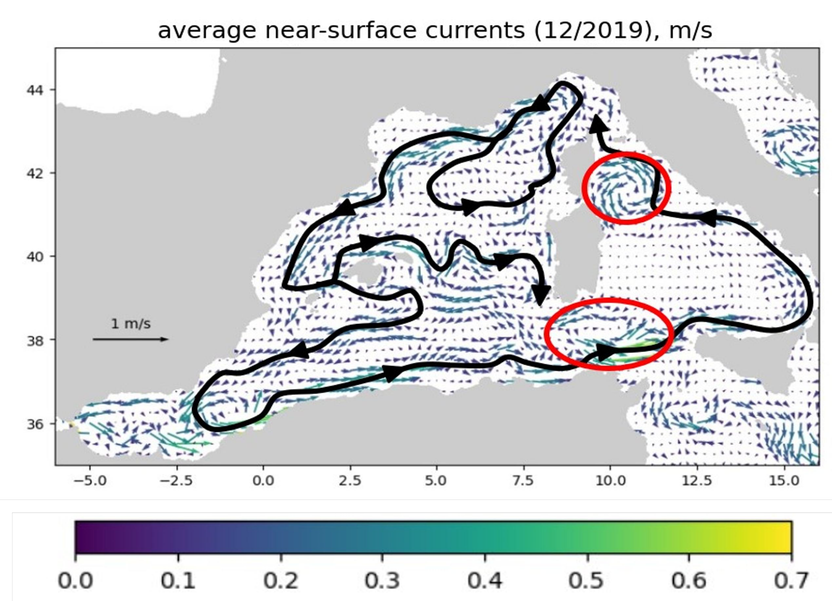
In the first stage of this work single outputs averaging the currents per year from 1993 to 2023 have been obtained.
For each of the three initial sources dataset an initial raw input is showed and the subsequent interpolated output.



Cross – validation

Drifters are direct measurements and thus used as the source of accurate data for cross-validation. In situ data for the Ionian sea can be observed in the figure, the observations are withheld from the interpolation and then compared to it. The correlation length.





Results
General currents patterns during winter 2019 in the wester mediterranean. The latter match the expected circulation at this period.

CONCLUSIONS AND FURTHER REMARKS

- Following cross-validation, Initial outputs provide reliable estimates that match the general circulation patterns of the Mediterranean sea.
- Jupyter Hub work environment provided by BlueCloud2026 represents a fluent platform to develop the workflow easy to use for non-expert users.
- Further downstream applications will use the outputs of this work as inputs for an oil spill model called Medslik II and the resulting datasets will be part of the EMODnet physics hub.

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