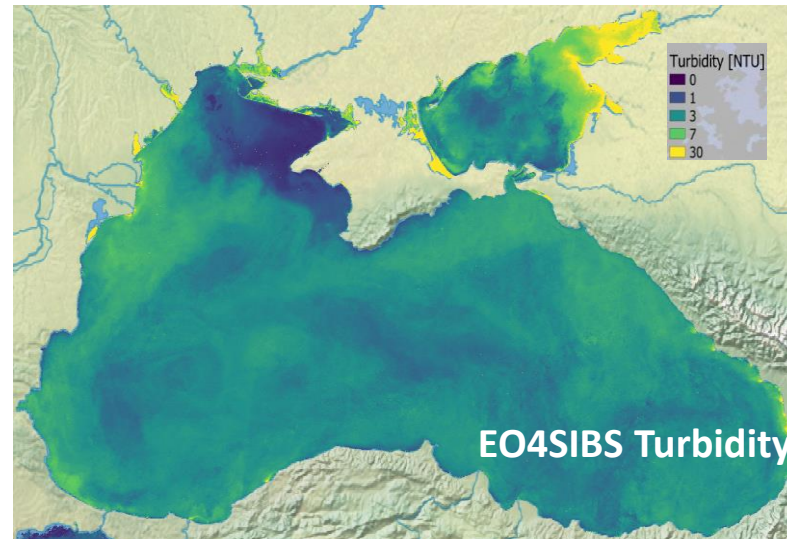


Earth Observation for Science and Innovation in the Black Sea

E04SIBS

M. Grégoire, A. Alvera-Azcarate, L. Buga, A. Capet, S. Constantin, F. D'ortenzio, D. Doxaran, Y. Faugeras, C. Gonzalez, V. Gonzalez, J.-P. Kasprzyk, M. Golumbeanu, E. Ivanov, E. Mason, R. Mateescu, C. Meulders, E. Olmedo, M. -I. Pujol, G. Sarbu, A. Turiel, L. Vandenbulcke, M. H. Rio.



Jailoo.eu

Contact: Marilaure Grégoire, mgregoire@uliege.be

Objectives

- To collect **new data** to support the development of novel algorithms
- To develop a **new generation of algorithms**
- To build novel **composite products**
- To assess how the use of EO data **can improve our understanding of physical and biogeochemical processes including plume tracking, water quality, deoxygenation and mesoscale circulation** in the Black Sea

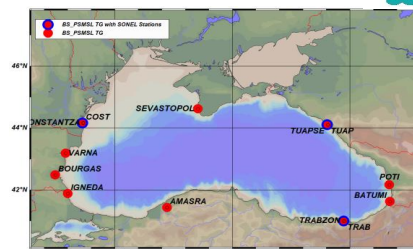
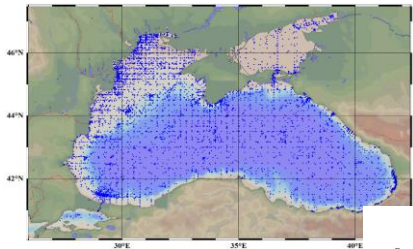


EO4SIBS at a glance

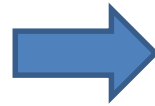
DATA

SATellite

L1 SMOS
L1 S2 & S3
L1 & L2 S-3A, Cryosat-2, 20 Hz
L4 CMEMS_DT 2018



IN-SITU

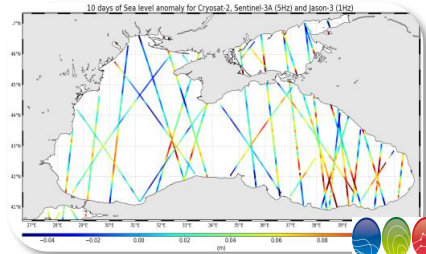


PRODUCTS (L3 & L4)

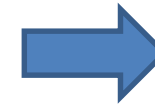
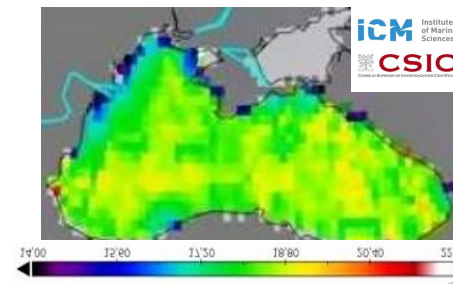
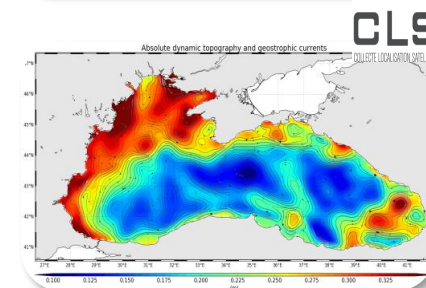
C O L O U R



A L T I M E T R Y



S A L I N I T Y

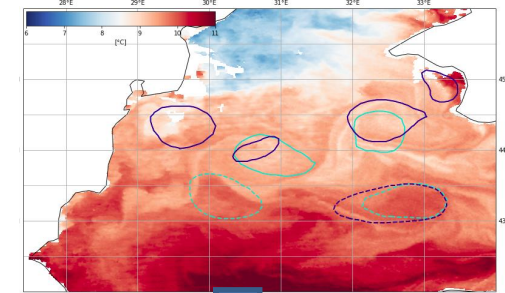


SCIENCE CASES

River plume tracking
Ocean health indicators
Coastal sea state
Mesoscale
Deoxygenation



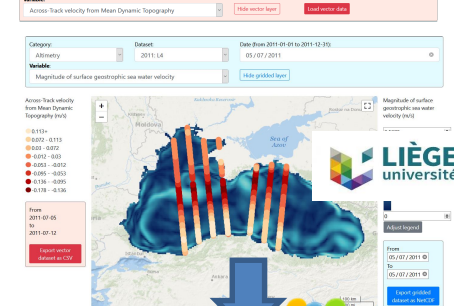
Jailoo.eu



M E S O S C A L E

WEB SERVER

<http://www.eo4sibs.uliege.be/>



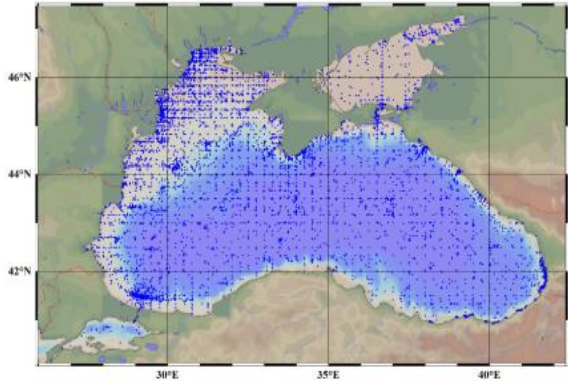
I N - S I T U



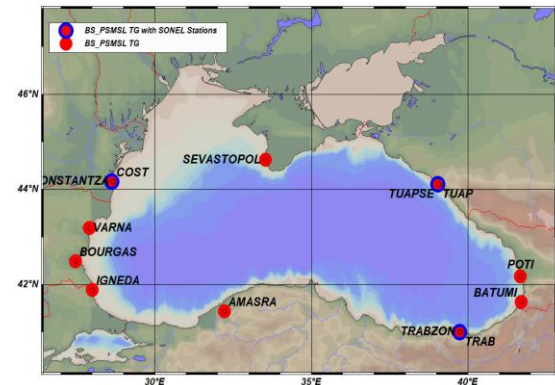
In-situ data sets collection and archiving

Various datasets are gathered in a database (EO4SIBS Data Access)..

Oxygen (EMODnet Chemistry & NIMRD Database)



Sea level – PSMSL Tide gauges



	Targeted Data (parameters)	Provider / Data Source
Ocean Colour Products	water reflectance chlorophyll-a concentrations total suspended matter concentrations turbidity attenuation particulate backscattering absorption coefficients	EMODnet Chemistry SeaDataCloud NIMRD database BGC ARGO Black Sea Bio-optical Cruise 2016 AERONET-OC L2 products (Galata Platform; Gloria Platform)
Altimetry products	tide gauges Sea Surface Heights (SSH) measurements (precise GPS positioning associated if available)	PSMSL database Turkish National Sea Level Monitoring System (TUDES) Tsunami Alert Service
Sea Surface Salinity Product	Salinity (&Temperature) CDOM	ARGO data CMEMS (INSITU_BS_TS_REP_OBSERVATIONS) MERMAID database: PANGAEA database BIO-OPT Cruises
Science cases products	oxygen nutrients primary production In-situ velocities from surface drifters	Word Ocean Data (WOD2018) Drifters dataset-Mediterranean Surface Velocity Programme NIMRD Monitoring cruises on Romanian Black Sea Shelf

Ocean Colour

DATA

Sentinel 2 and 3

APPROACH

- Operational water classification
- Blending of algorithms adapted to case 1 and case2 waters

CHALLENGES

Case 1 and Case 2 waters, highly turbid, rich in CDOM

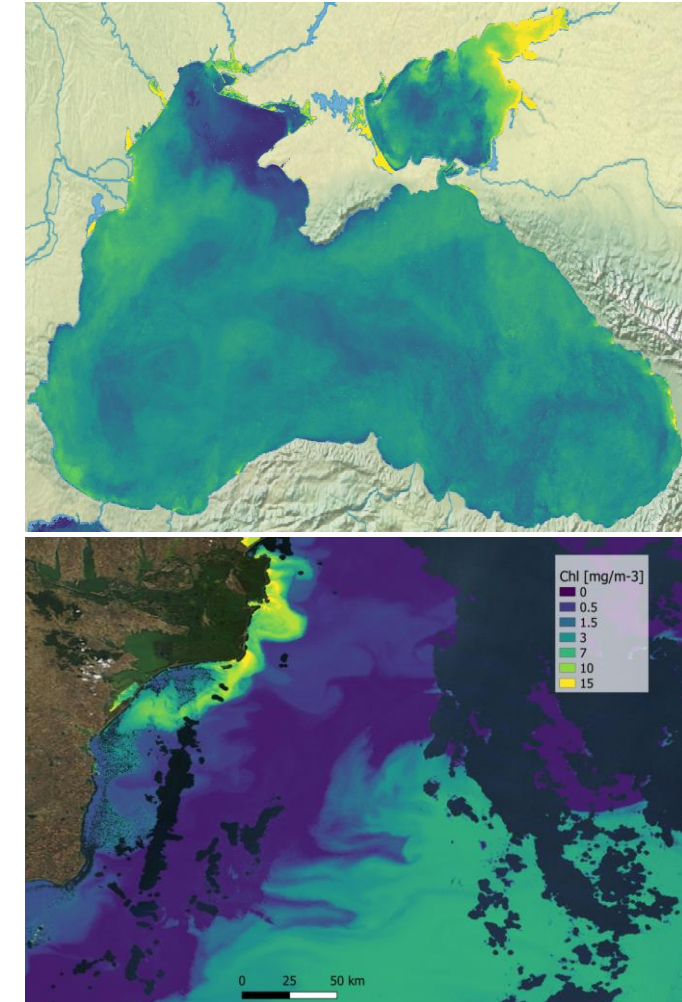
EO₄SIBS PRODUCTS

Chl_a, turbidity (TUR),TSM

INNOVATION

New products (TUR), combination of S2 and S3 for case studies

*Turbidity (top) and chlorophyll (bottom) concentration maps based on regional algorithms applied to a Sentinel3-OLCI image
June, 2019*



DATA

- L1 & L2 Cryosat-2 [2011, 2019] and Sentinel-3A [mid-2016, 2018] at 20 Hz
- L4 gridded products (CMEMS)

APPROACH

- Use improved SAR processing & up-to-date altimeter standards and corrections
- Improve Mapping methodology

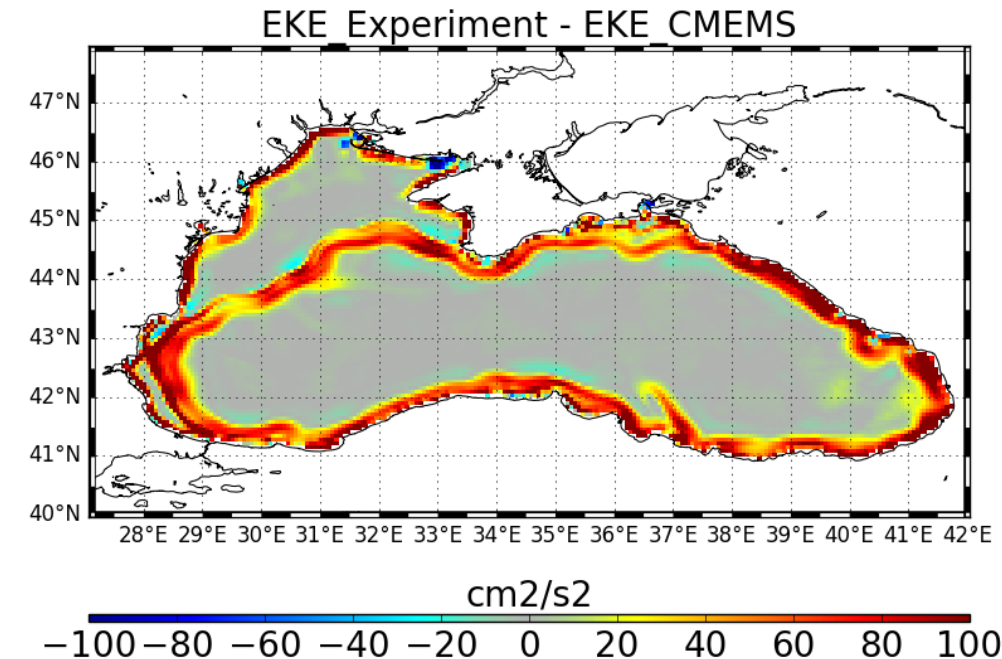
EO4SIBS PRODUCTS

- 5Hz (~1.3km) Level-3 along-track products
- L4 product that better resolve geostrophic currents

INNOVATION

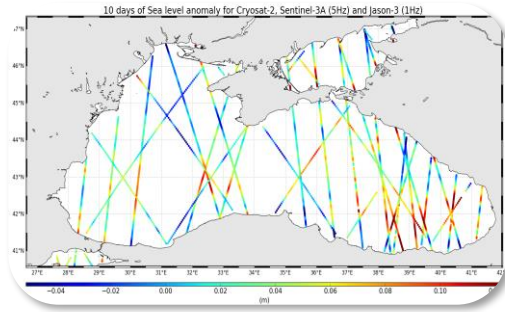
- 5Hz L3 product better adapted to coastal studies
- Improved restitution of the mesoscale signal

EKE differences between CMEMS conventional product and EO4SIBS experimental product.



- More intense currents ; Gain in EKE
- Better consistency with independent drifter measurements

Altimetry

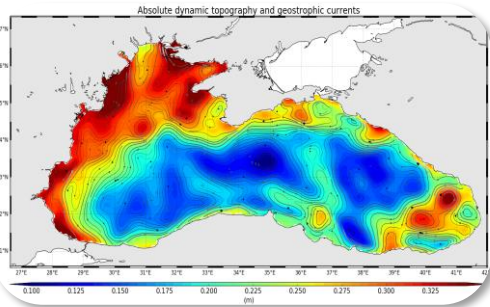


Task 1: Process full rate altimeter along-track measurement :

- Choice of the altimeter standards and corrections able to more accurately observed small mesoscales
- Definition of the processing strategy; algorithm and parameters
- Generation of 5Hz (~1.3km) Level-3 along-track products for Cryosat-2 [2011, 2019] and Sentinel-3A [mid-2016, 2018]

Results compared to conventional 1Hz product (available on CMEMS):

- **Improved data availability, especially in near-coast area** : +5 to 10%
- **Better observability of the small mesoscale signal** : observable wavelengths ~25 to 30 km i.e. reduced by more than 1/3 compared to the 1hz product capability.



Task 2 : Process multi-missions gridded products :

- Use upstream Level-3 5Hz
- Use improved mapping parameters
- Generation of Level-4 gridded Sea Surface Height product and derivatives

Results compared to conventional Level-4 product (available on CMEMS):

- **Improved restitution of mesoscale signal** :
 - Additional EKE especially along the Rim current and in coastal areas
 - eddies better resolved in coastal areas
 - Improved consistency between gridded product and independent altimeter along-track data : up to -20% reduction of the variance of the SLA differences
 - Improved consistency with independent drifters' measurements: local reduction of the variance of the geostrophic current differences by $10 \text{ cm}^2 \cdot \text{s}^{-2}$

Fig: SLA PSD and observable wavelength (SNR=1) deduced from full rate specifically processed (blue) and 1Hz (orange) Sentinel-3A measurements

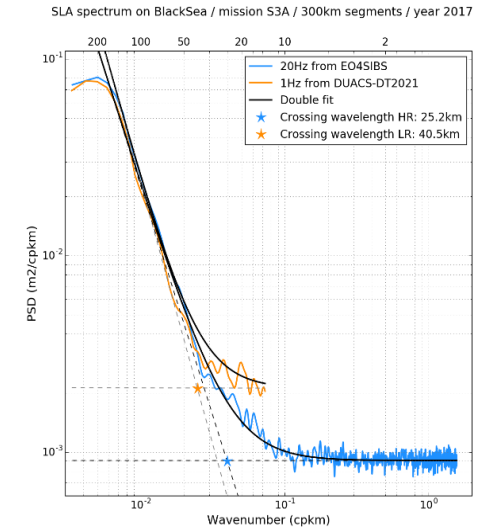
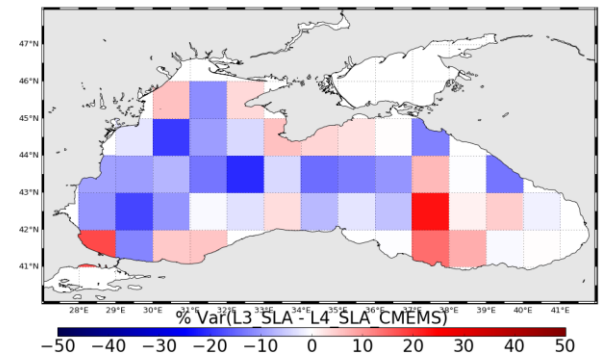


Fig: Comparison between gridded product and independent SLA along-track measurements. Comparison of the variance of the SLA differences when using EO4SIBS L4 or CMEMS L4 product. (unit : %)

**Var(L3_SLA - L4_SLA) differences:
EO4SIBS_v301-CMEMS_DT_2018**



Negative values = EO4SIBS L4 more consistent with independent measurements



Surface Salinity

DATA

L1 Soil Moisture and Ocean Salinity (SMOS) (L-band)

APPROACH

Specific treatment of radio frequency interferences, land sea contamination, fresh water discharges

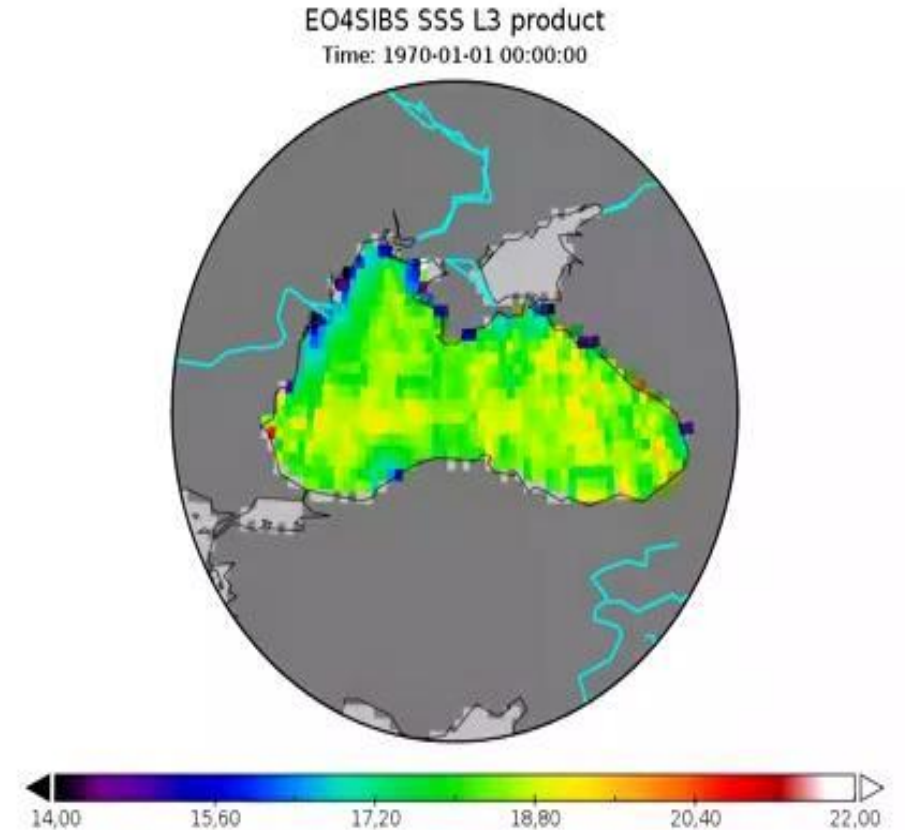
PRODUCTS

Level 2: Daily product at $0.25 \times 0.25^\circ$

Level3: 9-day maps (generated daily) at $0.25 \times 0.25^\circ$

INNOVATION

New products (TUR), combination of S2 and S3 for case studies



Eddy Tracking

DATA

CMEMS-DT-L4
EO4SIBS L4

APPROACH

Eddies detection ($L_c \sim 1-100\text{km}$) and tracking

PRODUCTS

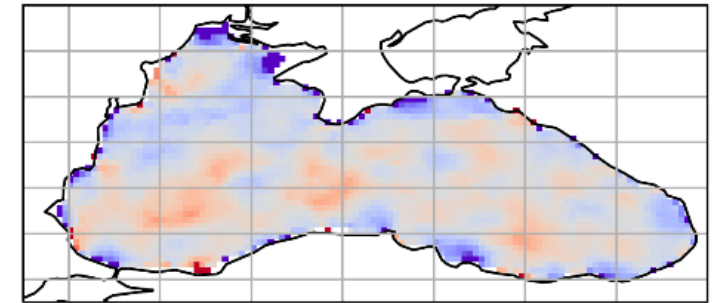
Eddies characteristics and tracks

INNOVATION

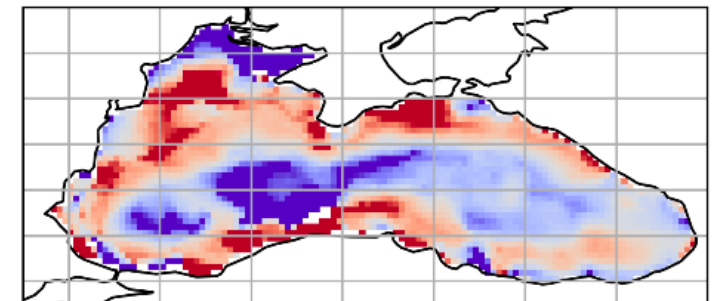
Eddies tracking performed on L4 gridded products at 5Hz using an updated MDT adapted to the Black Sea

Better distinction and distribution of Cyclonic and Anticyclonic eddies in good agreement with that obtain by CMEMS model

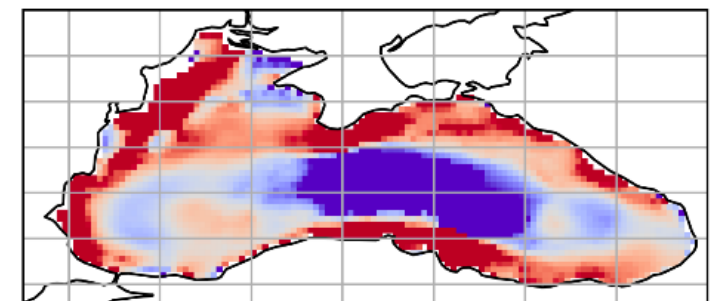
Altimetry - CMEMS - SLA



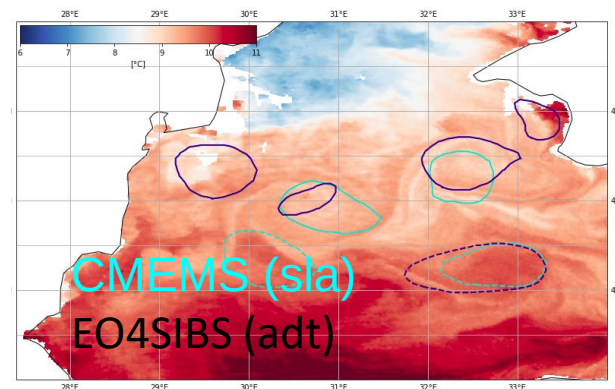
Altimetry - EO4SIBS - ADT



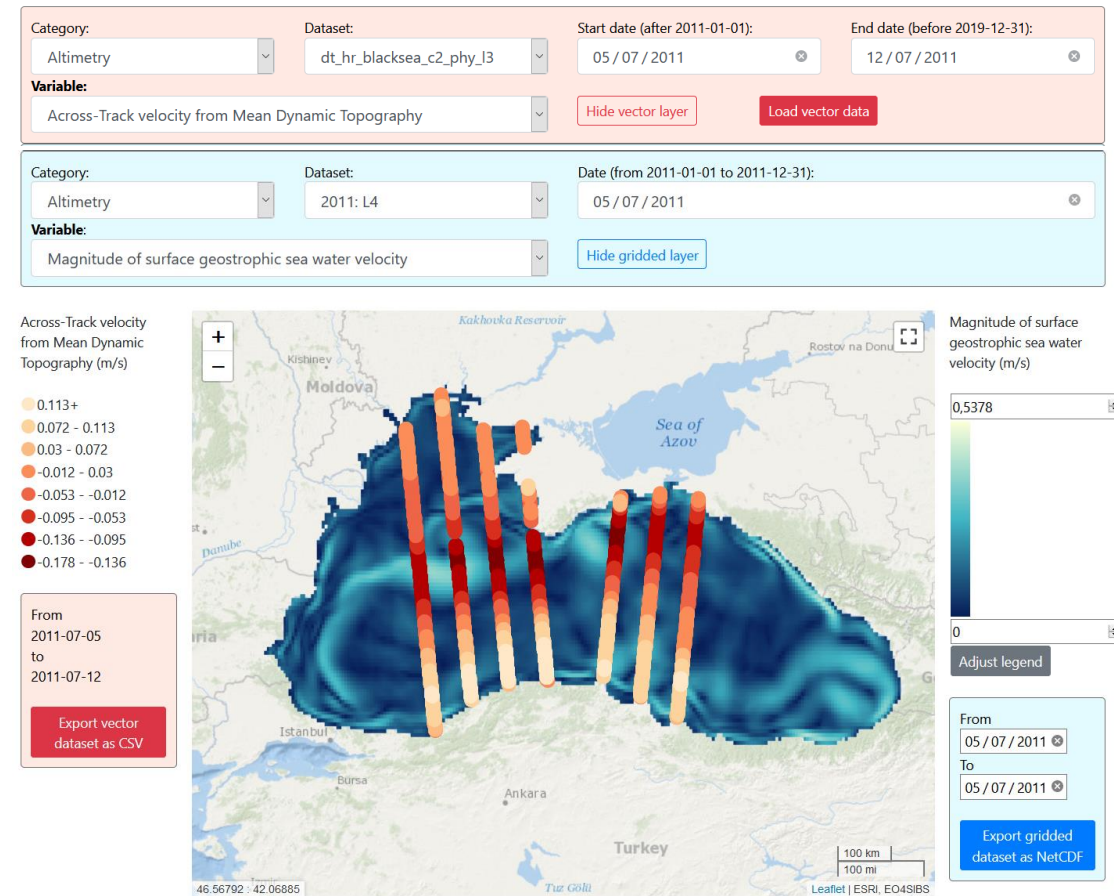
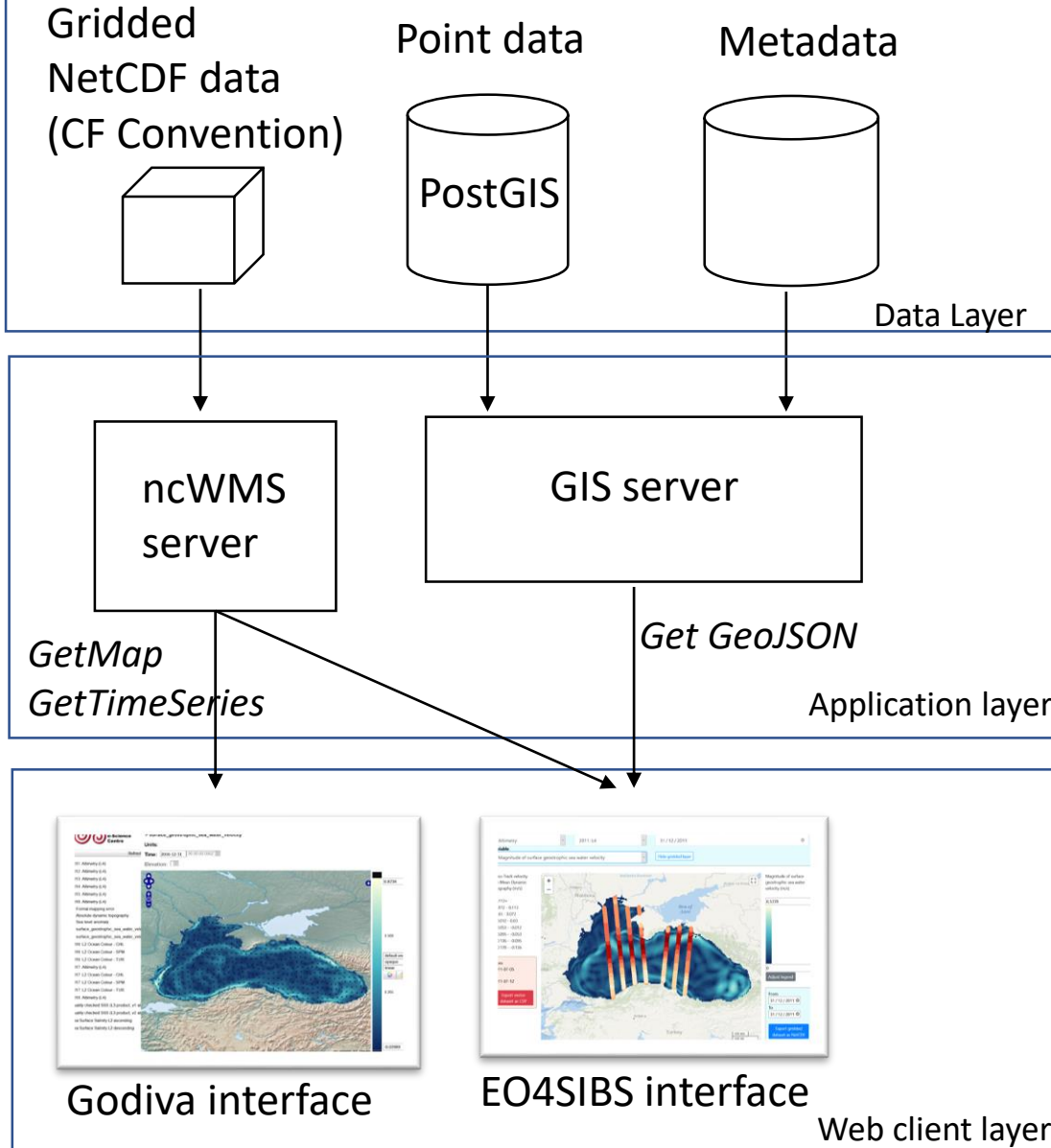
Model



Better characterization of eddies dynamics near the coast (illustrated with background SST).



EO4SIBS WEB SERVER



- Cartographic representations
 - Gridded layers: EO4SIBS products
 - Point layers: « in situ » and « along track » data
- Temporal filters
- Time series representations
- Exports
 - Gridded data: NetCDF
 - Point data: CSV (lat/lon)

<http://www.eo4sibs.uliege.be/map/map.php>