Interpolation of high-frequency radar velocities

EGU 2022 General Assembly
Oceanography at coastal scales.
Modelling, coupling, observations and applications

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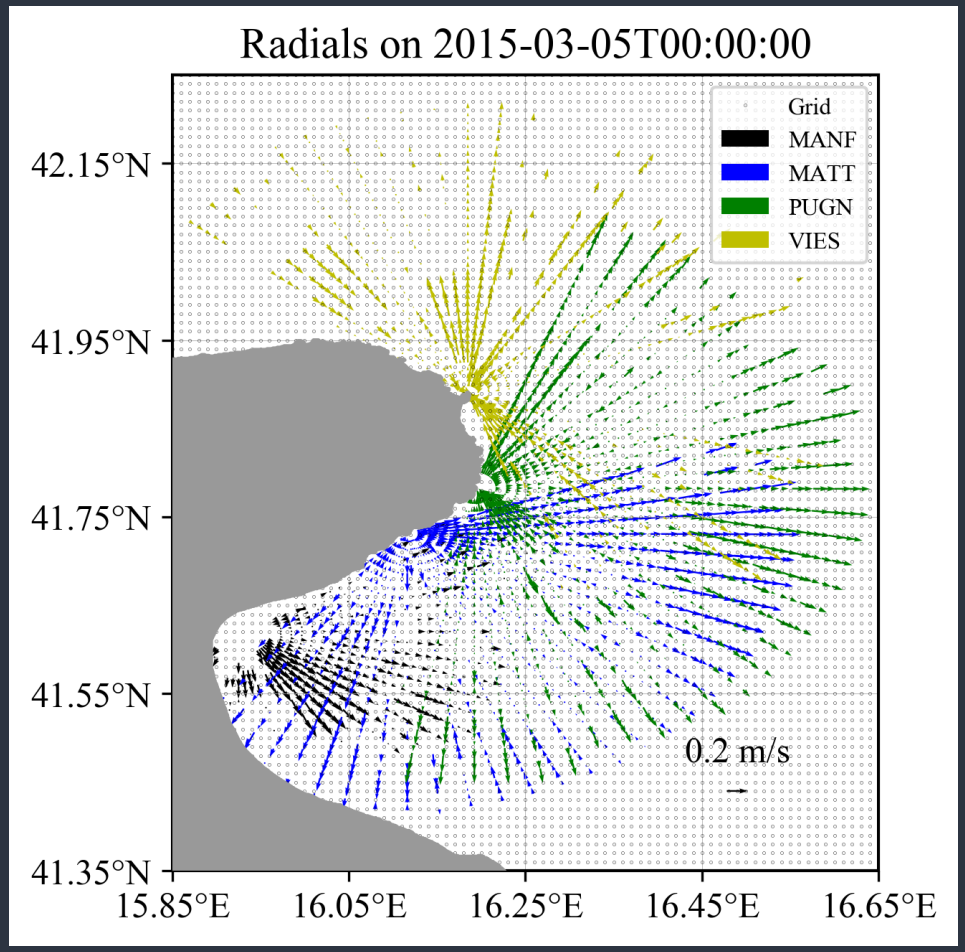
What do we do?

Generate gridded velocity fields
using radial velocities from high-frequency radar systems



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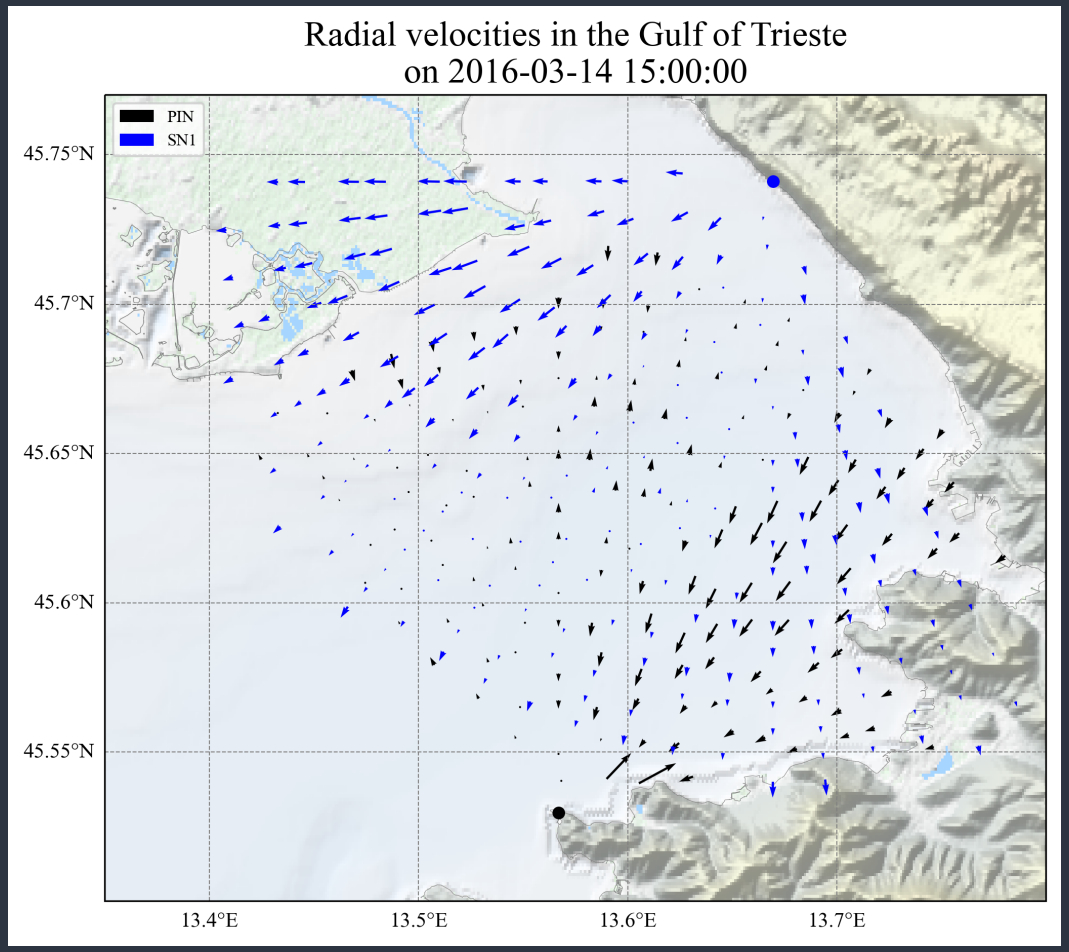


Why?

- Gaps present in original fields
- Several applications requiring filled fields
- Many methods available…

How do we do that?

DIVAnd = Data-Interpolating Variational Analysis in n dimensions

DIVAnd

repo status Active | CI passing | codecov 78% | docs stable | docs latest | DOI 10.5281/zenodo.6338121

`DIVAnd` (Data-Interpolating Variational Analysis in n dimensions) performs an n-dimensional variational analysis/gridding of arbitrarily located observations. Observations will be interpolated/analyzed on a curvilinear grid in 1, 2, 3 or more dimensions. In this sense it is a generalization of the original two-dimensional DIVA version (still available here https://github.com/gher-ulg/DIVA but not further developed anymore).

How do we do that?

Minimisation of a cost function taking into account

- Observations
- Regularity of the field

How do we do that?

Additional constraints, specific to HF radar:

divergence: weak divergence of the flow

boundary conditions: normal velocity component ≈ 0

Coriolis force: velocity at a given time is similar to the velocity before/after

DIVAnd_HFRadar.jl

CI passing | codecov 70% | docs dev

The package `DIVAnd_HFRadar` interpolates surface current data on a regular grid possibly taking dynamical contraints into account. The primary use-case is for radial current measurements for high-frequency radars (like WERA or CODAR SeaSonde). But it can also be applied to any other current data (like ADCPs or drifters).

The method is described in: Barth, A., Troupin, C., Reyes, E., Alvera-Azcárate, A., Beckers J.-M. and Tintoré J. (2021): Variational interpolation of high-frequency radar surface currents using DIVAnd. Ocean Dynamics, 71, 293–308 doi: 10.1007/s10236-020-01432-x (open access, bibtex)

Results

Fields generated in 4 regions:

1. Gulf of Manfredonia (Adriatic coast of Italy),
2. Gulf of Trieste (north of the Adriatic Sea),
3. Gulf of Naples (south-western coast of Italy) and
4. Northeast Gran Canaria island (Atlantic Ocean).

Results

Format: netCDF

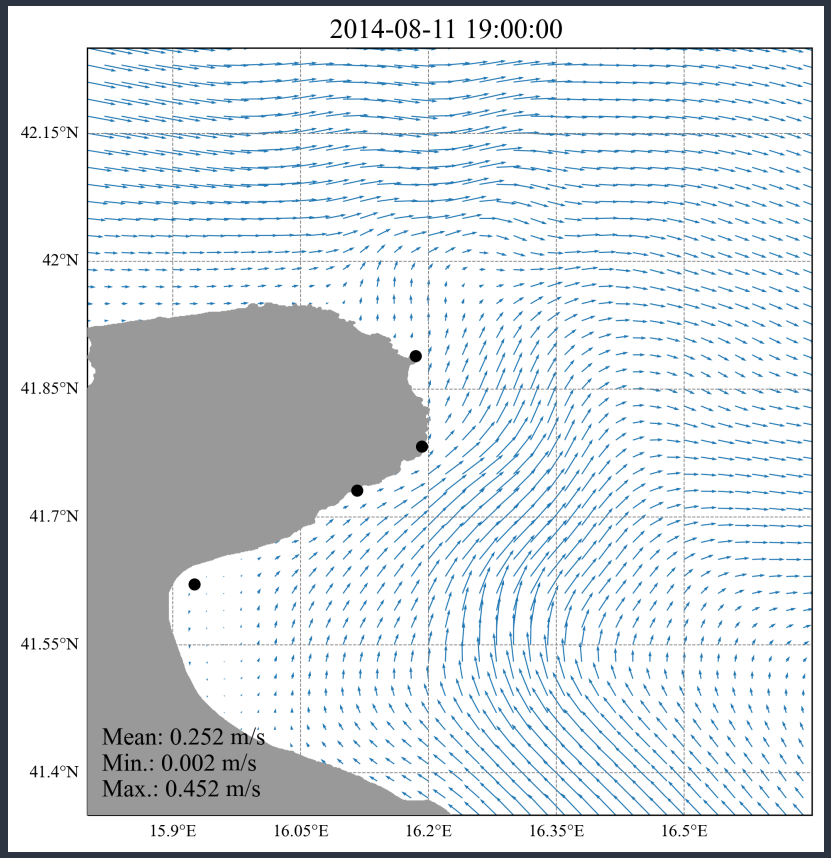
Metadata: Climate and Forecast (CF) conventions
+ recommendation of the EuroGOOS HFR Task Team

Resolution:

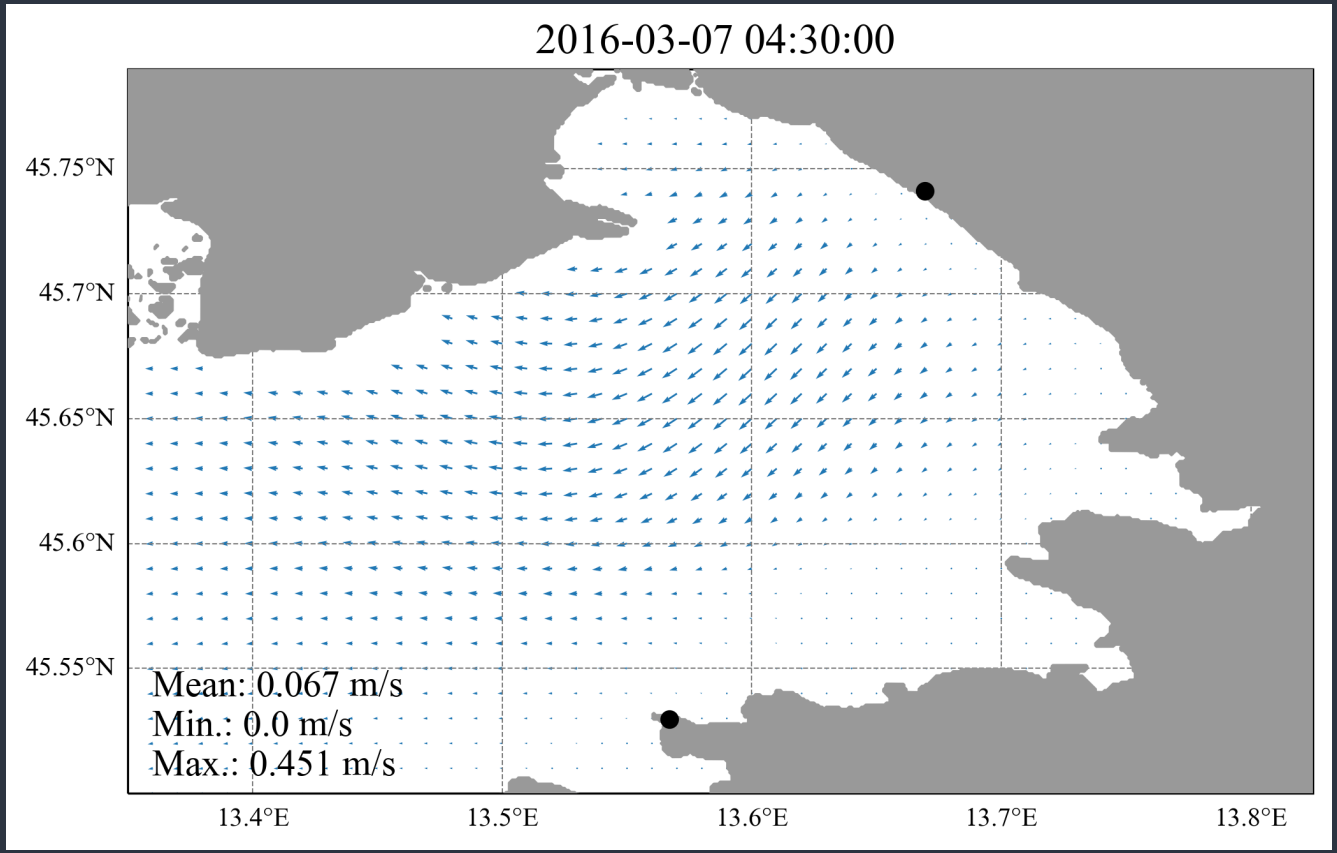
Region	Spatial resolution	Temporal resolution
Naples	$0.01° \times 0.01°$	1 hour
Canary	$0.01° \times 0.01°$	1 hour
Trieste	$0.01° \times 0.01°$	30 minutes
Manfredonia	$0.02° \times 0.02°$	1 hour

Distribution: through EMODnet Physics

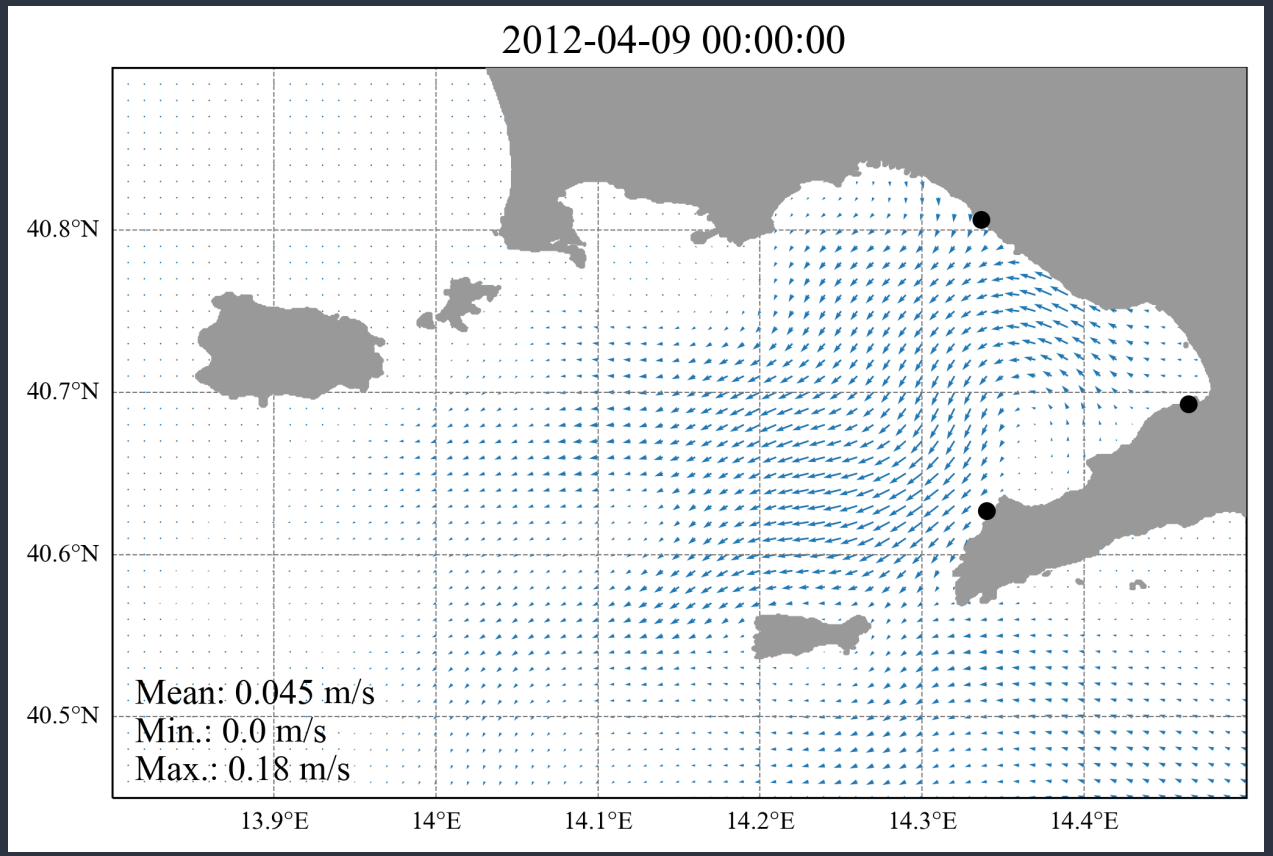
Results


2014-08-11 19:00:00
42.15°N
42°N
41.85°N
41.7°N
41.55°N
41.4°N
15.9°E
16.05°E
16.2°E
16.35°E
16.5°E
Mean: 0.252 m/s
Min.: 0.002 m/s
Max.: 0.452 m/s

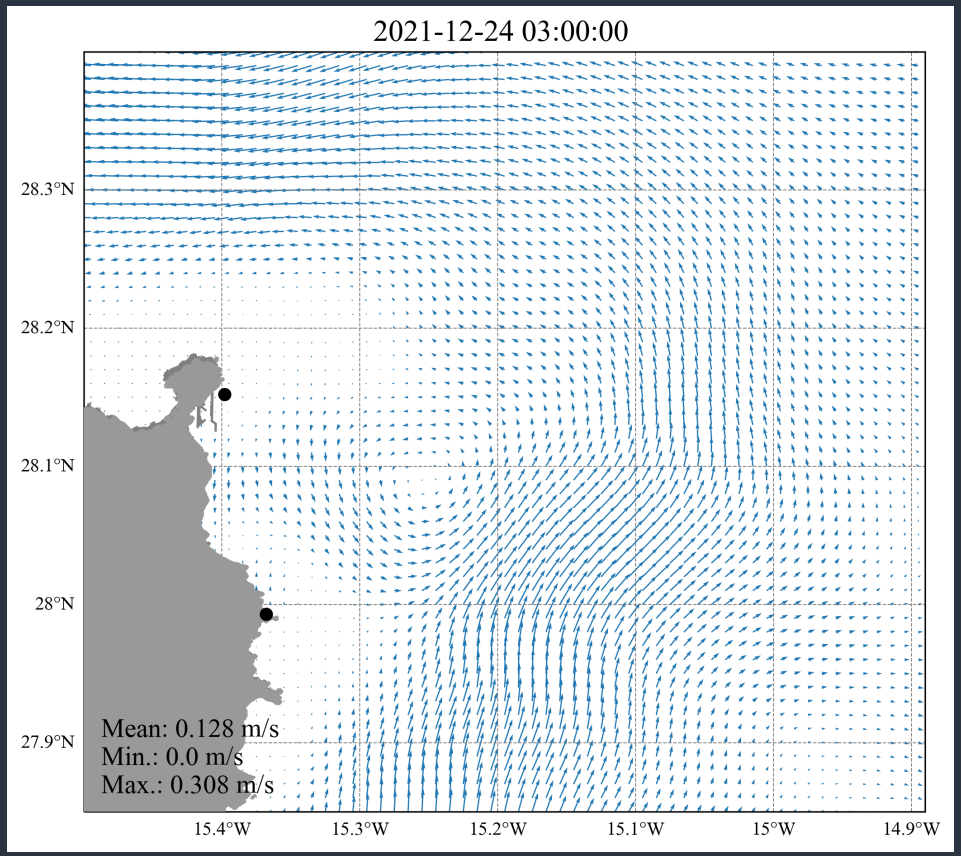
Results


2016-03-07 04:30:00
45.75°N
45.7°N
45.65°N
45.6°N
45.55°N
Mean: 0.067 m/s
Min.: 0.0 m/s
Max.: 0.451 m/s
13.4°E
13.5°E
13.6°E
13.7°E
13.8°E

Results


2012-04-09 00:00:00
40.8°N
40.7°N
40.6°N
40.5°N
13.9°E
14°E
14.1°E
14.2°E
14.3°E
14.4°E
Mean: 0.045 m/s
Min.: 0.0 m/s
Max.: 0.18 m/s

Results


2021-12-24 03:00:00
28.3°N
28.2°N
28.1°N
28°N
27.9°N
15.4°W
15.3°W
15.2°W
15.1°W
15°W
14.9°W
Mean: 0.128 m/s
Min.: 0.0 m/s
Max.: 0.308 m/s

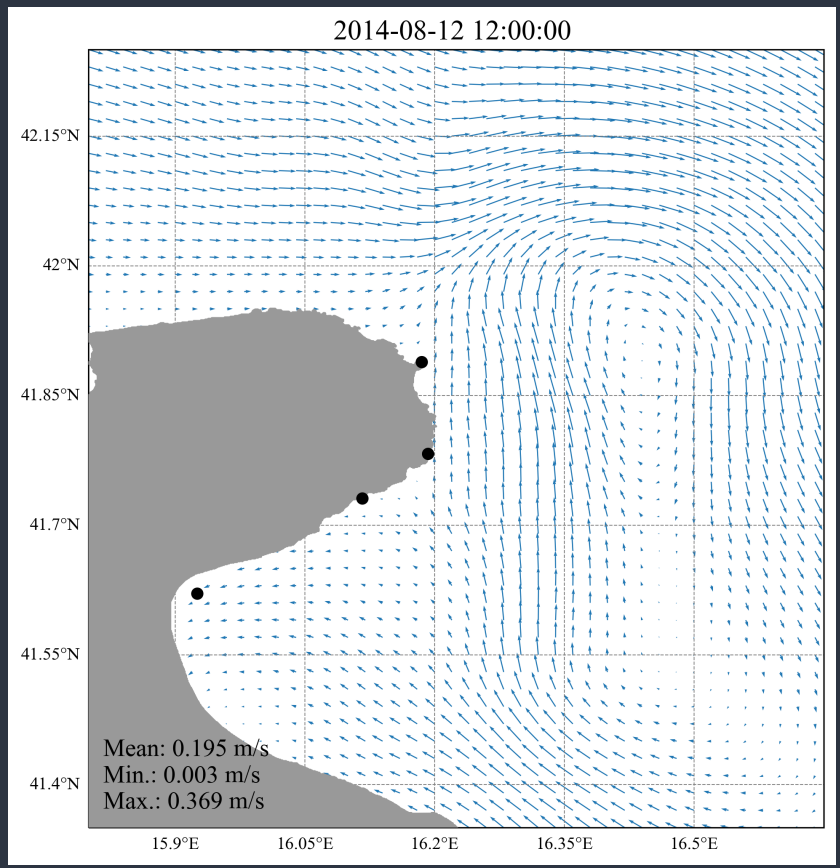
Validation

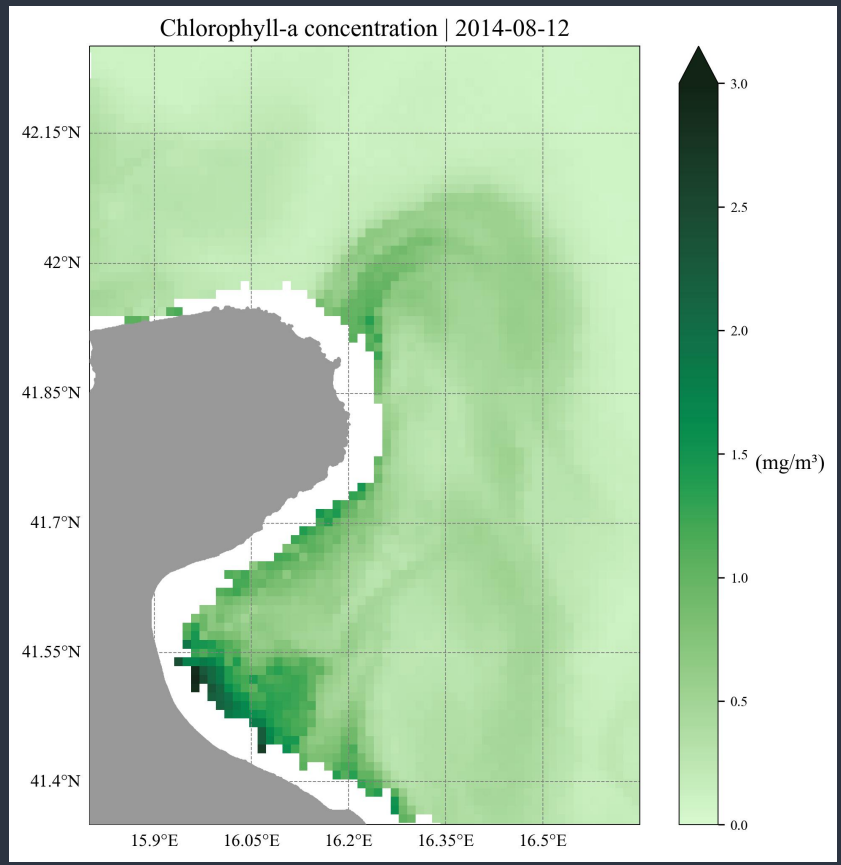
Difficult to find *in situ* measurements $\rightarrow$ external datasets

- Chlorophyll-concentration (CMEMS product no. `OCEANCOLOUR_MED_CHL_L3_NRT_OBSERVATIONS_009_04` and `OCEANCOLOUR_MED_CHL_L3_REP_OBSERVATIONS_009_073`) for the Gulf of Manfredonia.
- Velocity from model (CMEMS product no. `IBI_ANALYSISFORECAST_PHY_005_001`) for Gran Canaria.

Validation

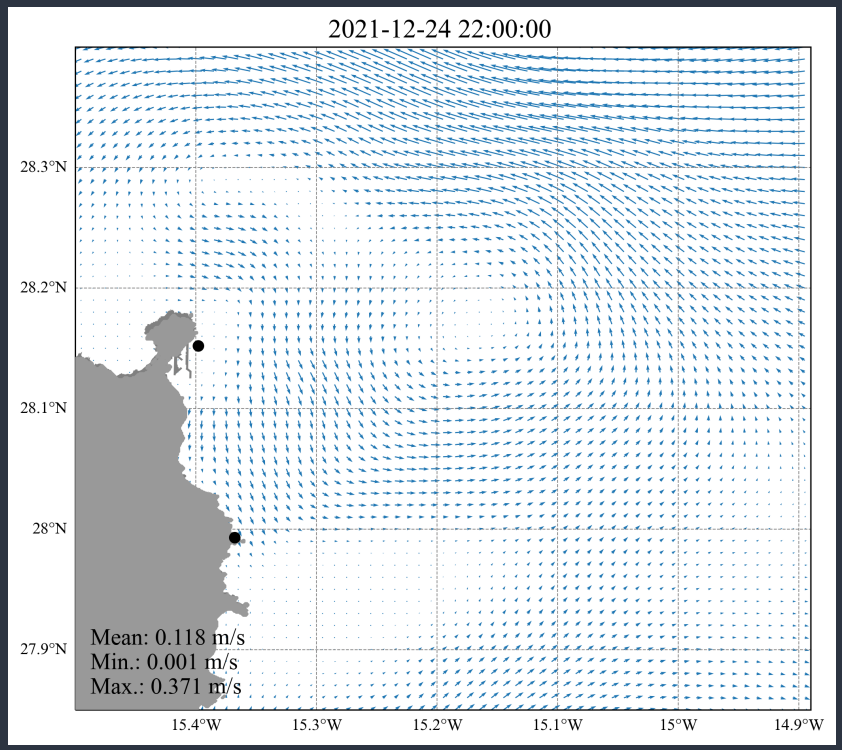
HF radar vs. chlorophyll concentration

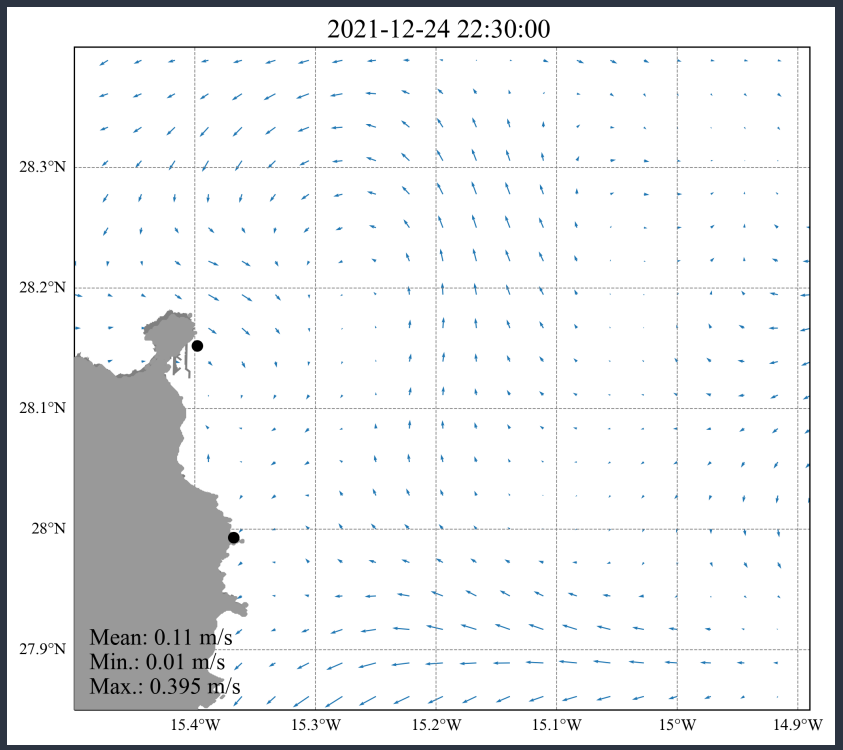




Validation

HF radar vs. CMEMS IBI model





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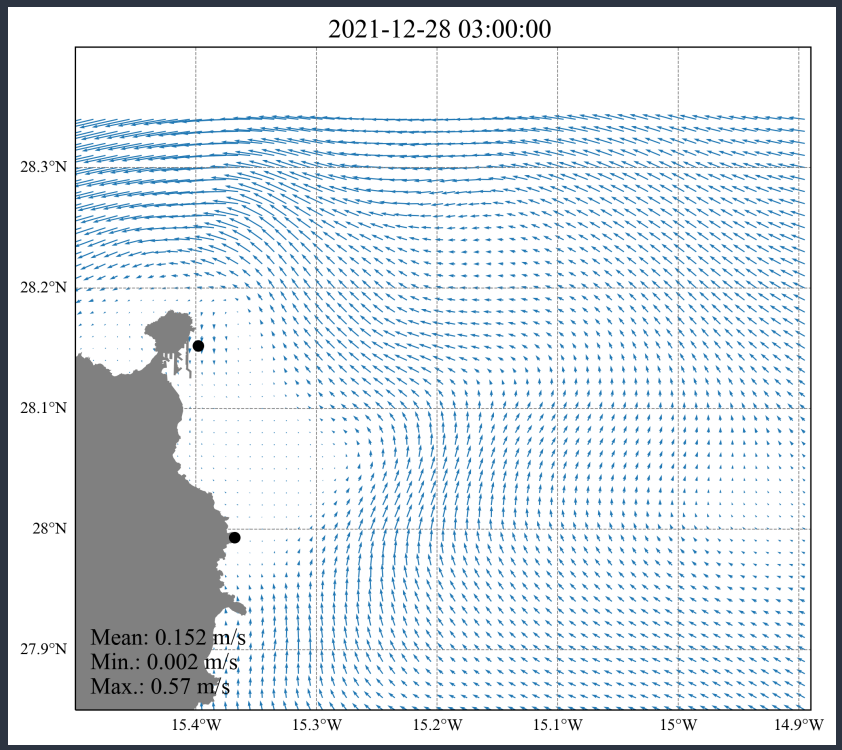

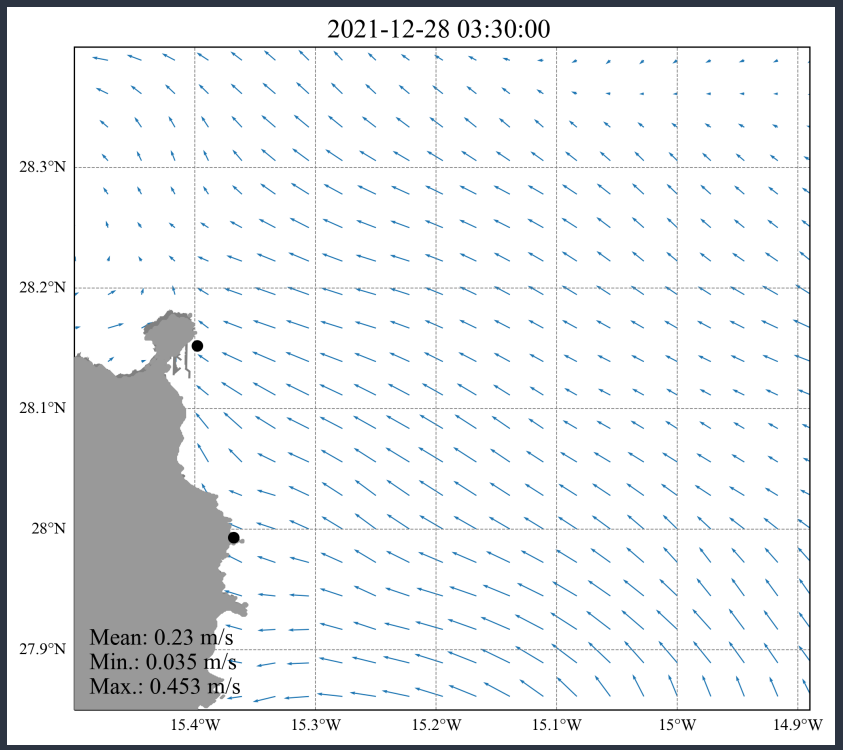

Credits

Cast	
Data access	Marco Alba, Antonio Novellino
Code developer	Alexander Barth
Application design	Charles Troupin
Validation and parameter optimisation	Basile Caterina, Quentin Renouvel and Hugo Romanelli
Code	
DIVAnd.jl	https://github.com/gher-ulg/Divand.jl
DIVAnd_HFRadar.jl	https://github.com/gher-ulg/DIVAnd_HFRadar.jl
EMODnet Physics HF Radar	https://gitlab.uliege.be/gher/diva-emodnetphysics
Publications	
Barth et al. (2021), Ocean Dynamics	doi 10.1007/s10236-020-01432-x
Report	doi 10.5281/zenodo.5811989
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