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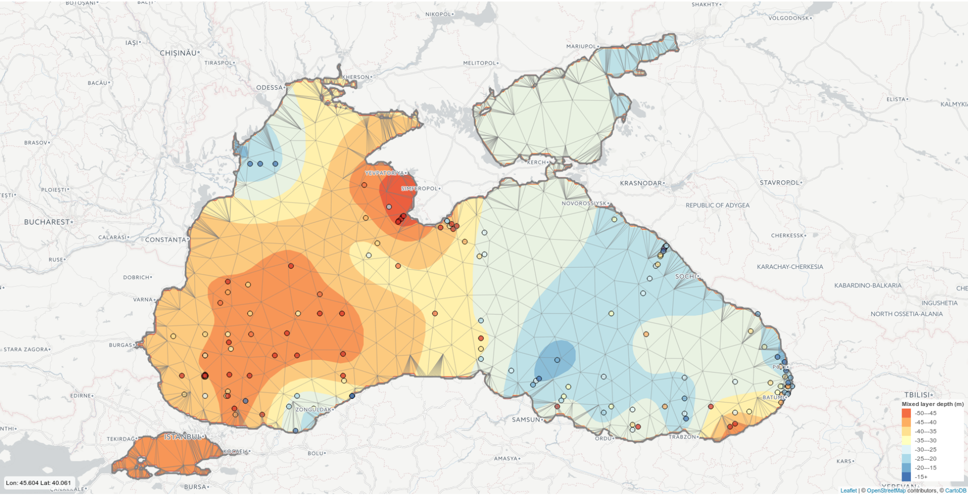
GHER - ~~ULg~~ ULiège

Status of Diva online as VRE application

SeaDataCloud 1st Plenary meeting

WP10.2.3	development of DIVA online (VRE)
WP11.2	Produce standard climatological data products for the global ocean and European Seas basins
WP11.3	Development of new products
WP11.5	Training on data products generation

Diva: from in situ data to gridded fields



https://github.com/gher-ulg/DIVA

DOI 10.5281/zenodo.836727

divand: generalised, n-dimensional interpolation

https://www.geosci-model-dev.net/7/225/2014/gmd-7-225-2014.pdf

https://github.com/gher-ulg/divand.jl

divand-1.0: *n*-dimensional variational data analysis for ocean observations

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[*] *Invited contribution by A. Barth, recipient of the EGU Arne Richter Award for Outstanding Young Scientists 2010.*

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2013: Octave/MATLAB

2016: Julia

faster, better, stronger

User interfaces:

Jupyter notebooks and WPS

Notebooks: interactive computational environments

Notebooks combine:

1. code fragments that can be executed,
2. text for the description of the application and
3. figures illustrating the data or the results.

In [2]:
```python
import numpy as np
import matplotlib.pyplot as plt
```

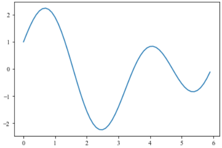
Data

Let's create a simple function.

In [6]:
```python
x = np.arange(0, 6, .1)
y = np.cos(x) + 1.5 * np.sin(2 * x)
```

Make a simple plot

In [7]:
```python
plt.plot(x, y)
plt.show()
```



Notebooks: interactive computational environments

Notebooks combine:

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"Digital Playground"

"Data Story Telling"

"Computational Narratives"

Notebooks: interactive computational environments

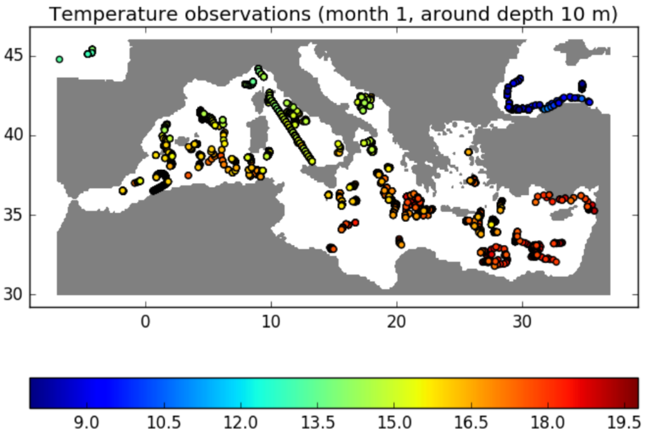
Notebooks combine:

1. code fragments that can be executed,
2. text for the description of the application and
3. figures illustrating the data or the results.

"Interactive notebooks: Sharing the code", Nature (2014)
http://www.nature.com/news/interactive-notebooks-sharing-the-code-1.16261

divand in a notebook

In [36]:
```
# sets the correct aspect ratio
gca()[:set_aspect](1/cos(mean(latr) * pi/180))
```

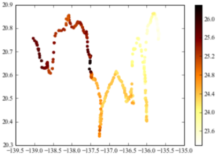


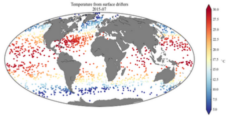
Setup the domain using the bathymetry from the file `bathname`.

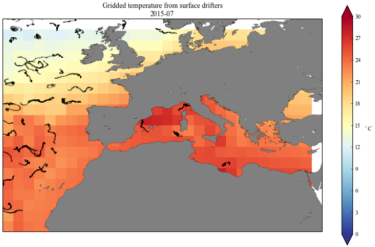
Example online

Notebooks in other initiatives...

- trajectories:
  - Read_drifter_data_1.ipynb: read a netCDF file containing a surface drifter trajectory.
  - Read_drifter_data_2.ipynb: scatter plot using the data from the previous example.
  - Read_drifter_data_3.ipynb: creation of a gridded field using the same data.







https://github.com/CopernicusMarineInsitu/INSTACTraining

divand in the VRE with jupyterhub

WP10.2.3

Management of multiple instances
of the single-user Jupyter notebook server

https://github.com/jupyterhub/jupyterhub

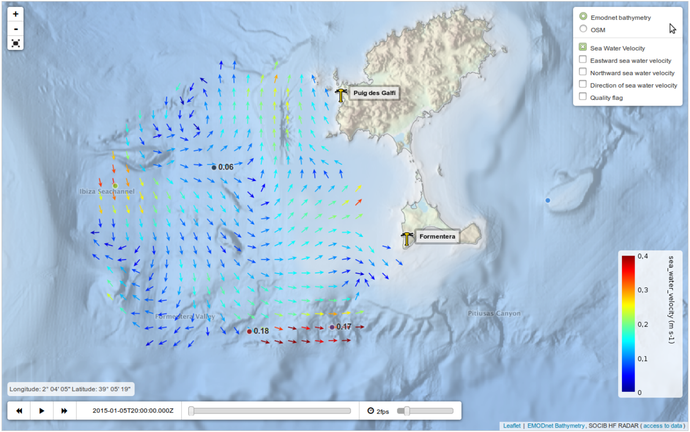
Demo: https://hub-test.oceanbrowser.net/ (deployed at CINECA)

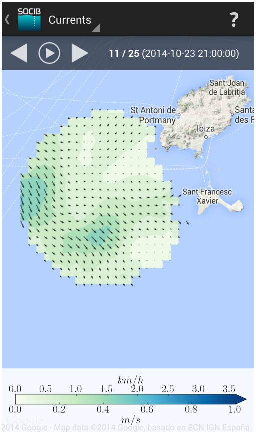
(Brand) New product

Velocity field from HF radar

H2020 SeaDataCloud call: emphasis on coastal data

WP11.3

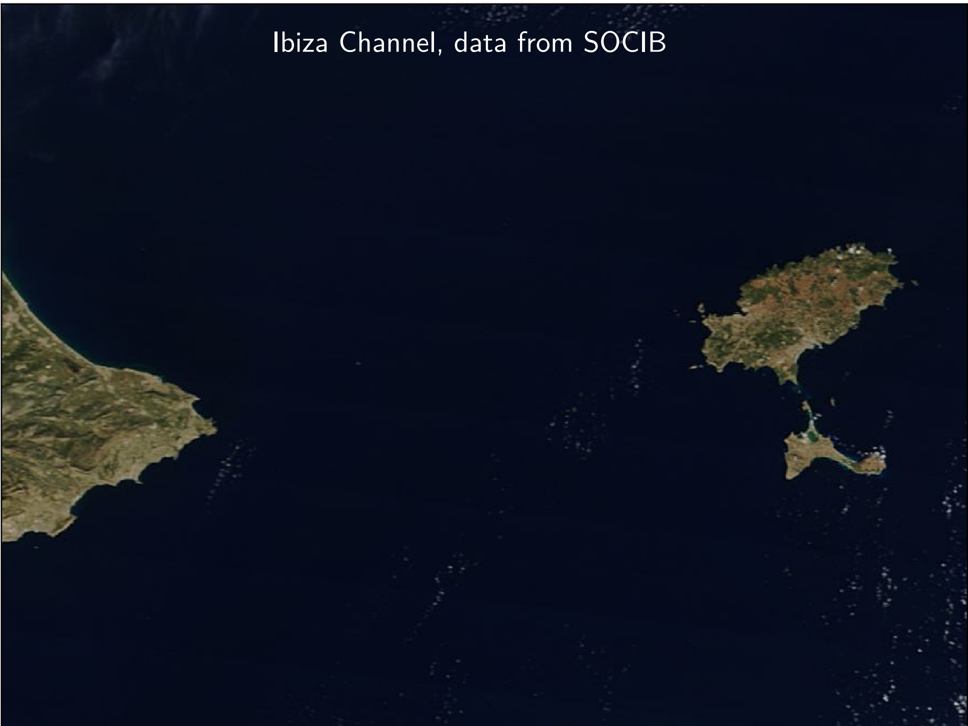




Data: SOCIB HF radar in the Ibiza Channel

http://www.socib.es/

Ibiza Channel, data from SOCIB



2 antennas located in Ibiza and Formentera

Each antenna provide **radial** currents

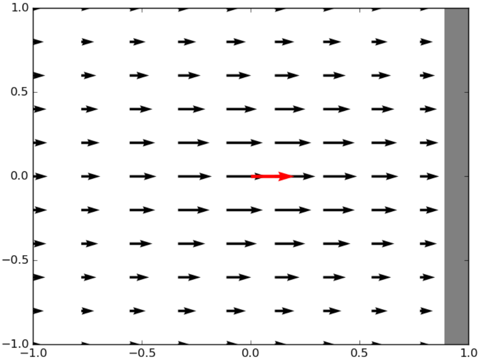
Each antenna provide **radial** currents

Total velocities are derived on a regular grid

New product: currents

→ hypothetical measurement

→ analyzed field



- Analysis of radial currents to derive total currents
- Observation operator links the radial currents of the different radar sites

Formulation: couple velocity components

Norm : $|\varphi|^2 = \int_\Omega (\alpha_2 \nabla\nabla\varphi : \nabla\nabla\varphi + \alpha_1 \nabla\varphi \cdot \nabla\varphi + \alpha_0 \varphi^2)\ d\Omega$

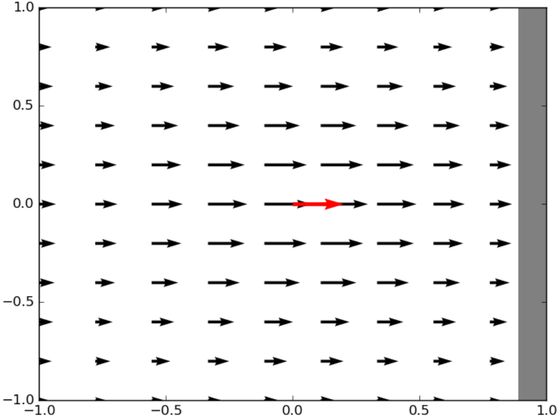
Cost function: $J(\vec{u}) = |u|^2 + |v|^2 + \sum_{\imath=1}^{N} \frac{(\vec{u}_\imath \cdot \vec{p}_\imath - u_{r\imath})^2}{\epsilon_\imath^2}$

$\vec{u} = (u, v)$
$\vec{p}_\imath$ = normalized vector pointing toward the correspond HF radar site of the $\imath$-th radial observation $u_{r\imath}$

Coastline as a boundary condition ($\vec{u} \cdot \vec{n} = 0$)

Cost function (OFF)

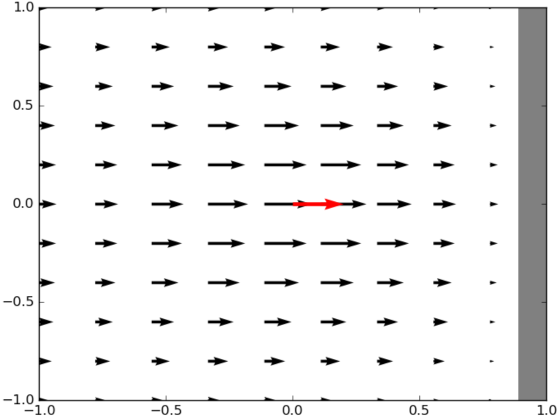
$$J_{\mathrm{bc}}(\vec{u}) = \frac{1}{\epsilon_{\mathrm{bc}}^2} \int_{\partial\Omega} (\vec{u} \cdot \vec{n})^2 ds$$



Coastline as a boundary condition ($\vec{u} \cdot \vec{n} = 0$)

Cost function (ON)

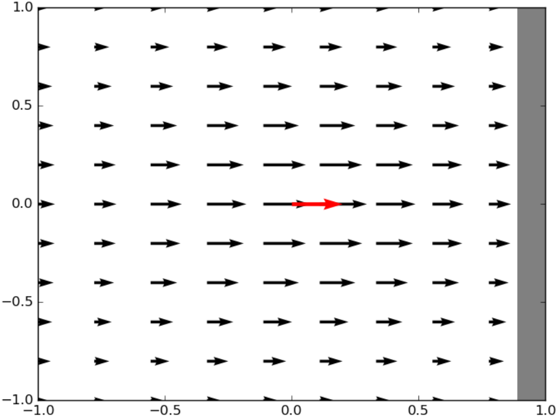
$$J_{bc}(\vec{u}) = \frac{1}{\epsilon_{bc}^2} \int_{\partial\Omega} (\vec{u} \cdot \vec{n})^2 ds$$



Low horizontal divergence of currents ($\nabla \cdot \vec{n} = 0$)

Cost function (OFF)

$$J_{\mathrm{div}}(\vec{u}) = \frac{1}{\epsilon_{\mathrm{div}}^2} \int_\Omega (\vec{\nabla} \cdot \vec{u})^2 dx$$



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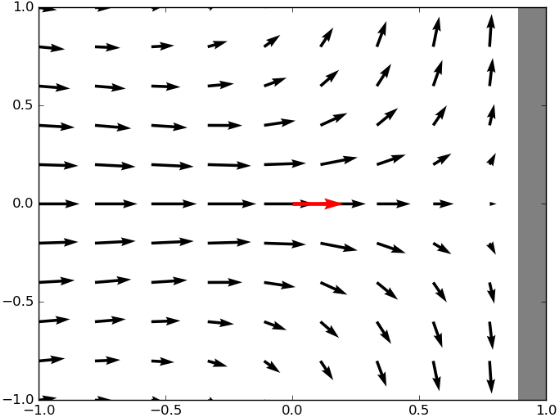
$$J_{div}(\vec{u}) = \frac{1}{\epsilon_{div}^2} \int_\Omega (\vec{\nabla} \cdot \vec{u})^2 dx$$



3D analysis: longitude, latitude and time

- Include the data the hour before and after
- Temporal correlation length
- Coriolis force

Coriolis force and geostrophically balanced mean flow

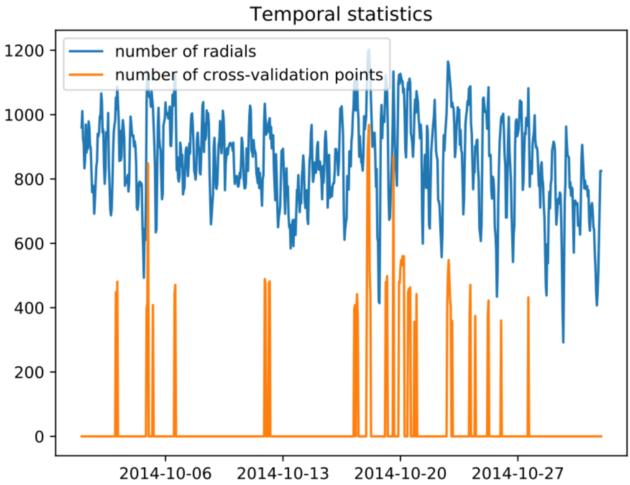
$$
\begin{aligned}
\frac{\partial u}{\partial t} &= fv - g\frac{\partial \eta}{\partial x} \\
\frac{\partial v}{\partial t} &= -fu - g\frac{\partial \eta}{\partial y}
\end{aligned}
$$

f = Coriolis frequency

η = sea surface elevation

Cross validation

In 30 current maps with the best coverage,
some data points are marked as missing (for both sites)



Test cases: more constrains (physics) included

Case	Description
2D	classical 2D-analysis (longitude, latitude)
2D_bc	as 2D, but with boundary conditions
2D_iv	as 2D, but imposing small horizontal divergence
3D	3D-analysis (longitude, latitude, time)
3D_Coriolis	3D-analysis with the Coriolis force
3D_Coriolis_geo	3D-analysis with the Coriolis force and the surface pressure gradient

Skill score

$$\mathsf{S}(\mathsf{Case}) = 1 - \frac{\mathsf{MSE}(\mathsf{Case})}{\mathsf{MSE}(2D)}$$

- The 2D case is the base-line
  for computing the relative improvement
- $\mathsf{MSE}(C)$ is the mean square error
  (relative to the cross-validation dataset)
- If $\mathsf{S} = 0$: reconstruction as "good/bad" as the base-line
- If $\mathsf{S} = 1$: reconstruction matches perfectly the validation dataset.

Comparison: increased skill with more constrains

Case	RMS	Skill score	Optimal parameter(s)
2D	0.0652	0.000	ϵ^2=0.0001161
2D_bc	0.0652	0.000	ϵ^2=0.0001, ϵ^2_{bc}=10
2D_div	0.0650	0.005	ϵ^2=9.799e-05, ϵ^2_{div}=2.778e+08
3D	0.0606	0.134	ϵ^2=0.1219, lent=6904
3D_Coriolis	0.0547	0.295	ϵ^2=5.673e-05, ϵ^2_{Cor}=9.207e-05
3D_Coriolis_geo	0.0485	0.447	ϵ^2=5.37e-05, ϵ^2_{Cor}=5.65e-05, ratio=26.46

Proposed training activities

WP11.5

Diva workshop: 2–6 April 2018, Liège, Belgium

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Diva pre-workshop: 18 October 2017, Athens, Greece (4PM?)

Proposed training activities

WP11.5

Diva workshop: 2–6 April 2018, Liège, Belgium
Diva pre-workshop: 18 October 2017, Athens, Greece (4PM?)
Extra session: 18 October 2017, Athens, Greece (5PM?)

Questions?

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$$
\begin{aligned}
& K^{n,m}(r) \\
= \; & c^{n,m} \frac{(2\pi)^{-\frac{n}{2}}}{2(1-m)} r^{\frac{2-n}{2}} \int_0^\infty \mathrm{J}_{\frac{n-2}{2}}(kr) k^{\frac{n-2}{2}} \frac{d}{dk}\left(\frac{1}{(1+k^2)^{m-1}} \right) dk \\
= \; & c^{n,m} \frac{(2\pi)^{-\frac{n}{2}}}{2(m-1)} r^{\frac{4-n}{2}} \int_0^\infty \mathrm{J}_{\frac{n-4}{2}}(kr) k^{\frac{n-4}{2}} \frac{k}{(1+k^2)^{m-1}} dk \\
= \; & \frac{1}{4\pi(m-1)} \frac{c^{n,m}}{c^{n-2,m-1}} K^{n-2,m-1}(r)
\end{aligned}
$$

where

n is the dimension

m is the highest derivative

$K^{n,m}$ is the Kernel

$J_\nu(r)$ is the Bessel function of first kind or order ν

Questions?