

# FROM IN SITU OBSERVATIONS TO GRIDDED FIELDS



# The A-team



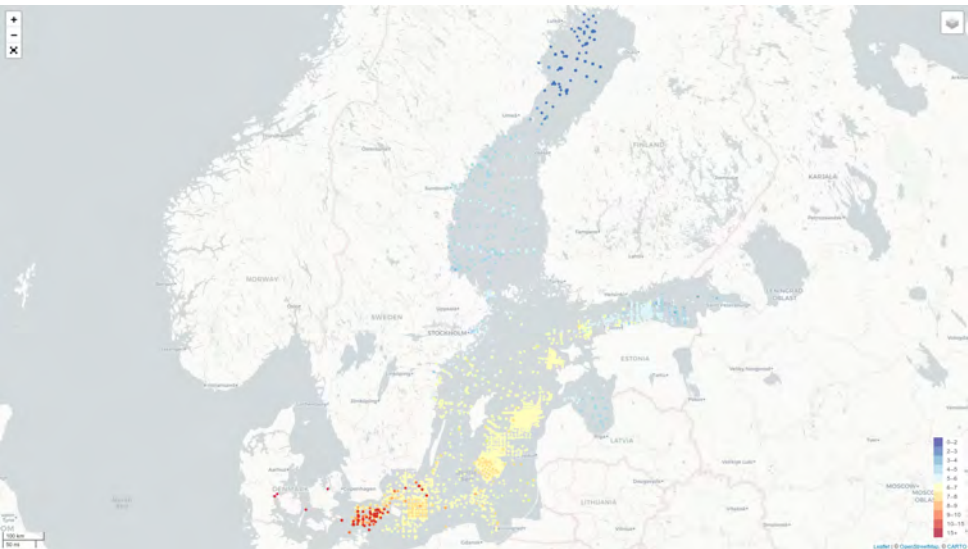
# The A-team



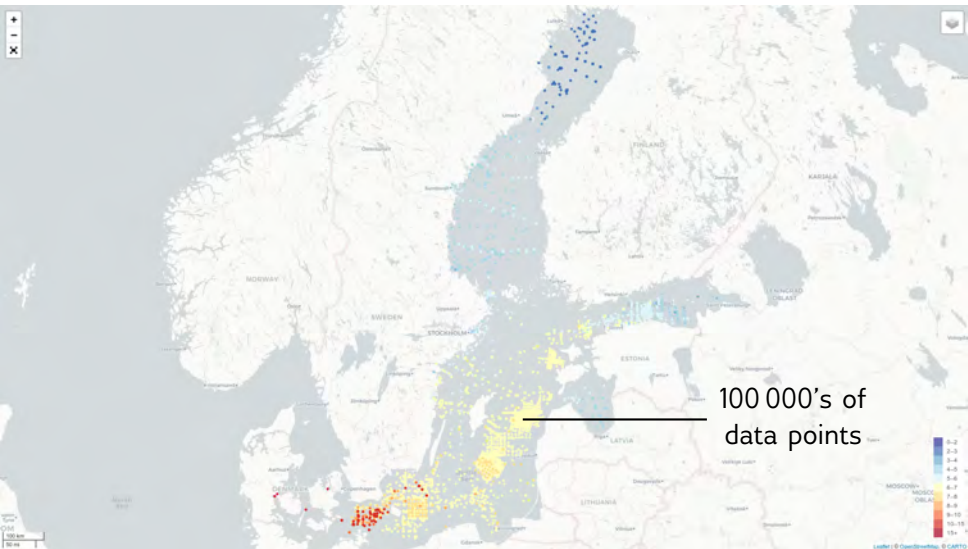
# The A-team



# Interpolation in oceanography

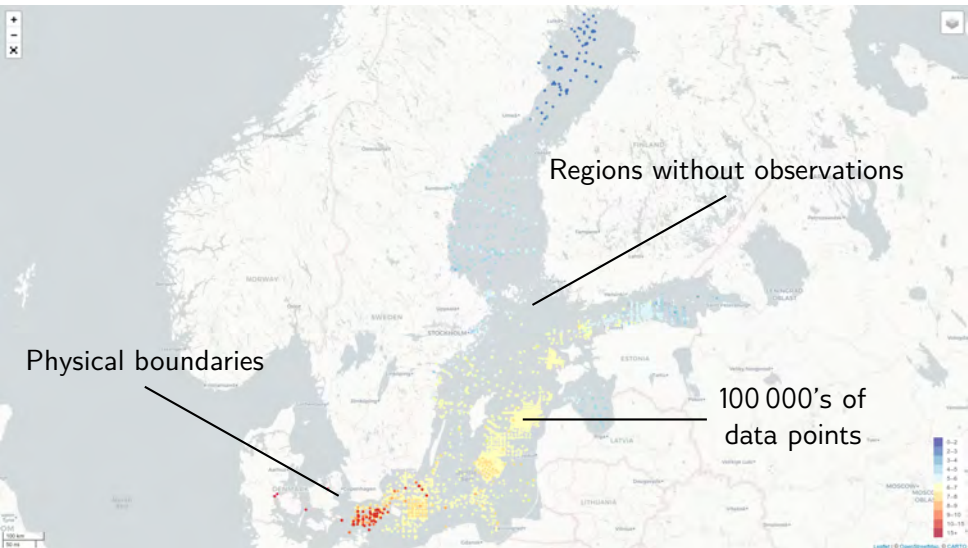


# Interpolation in oceanography



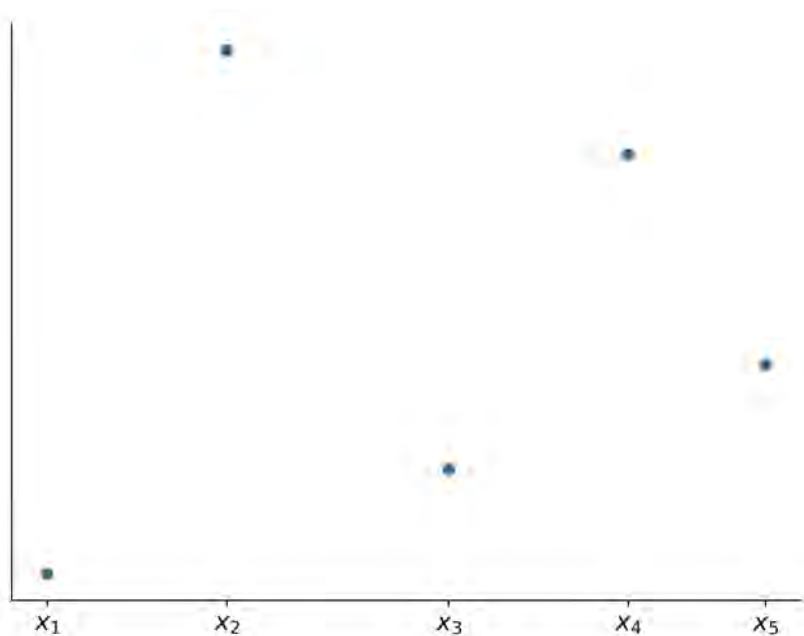


# Interpolation in oceanography





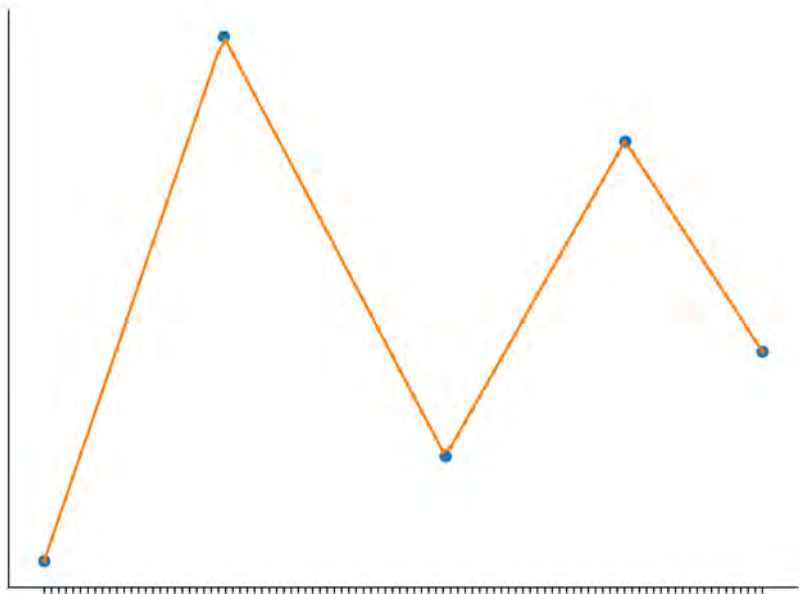
# Interpolation vs. approximation



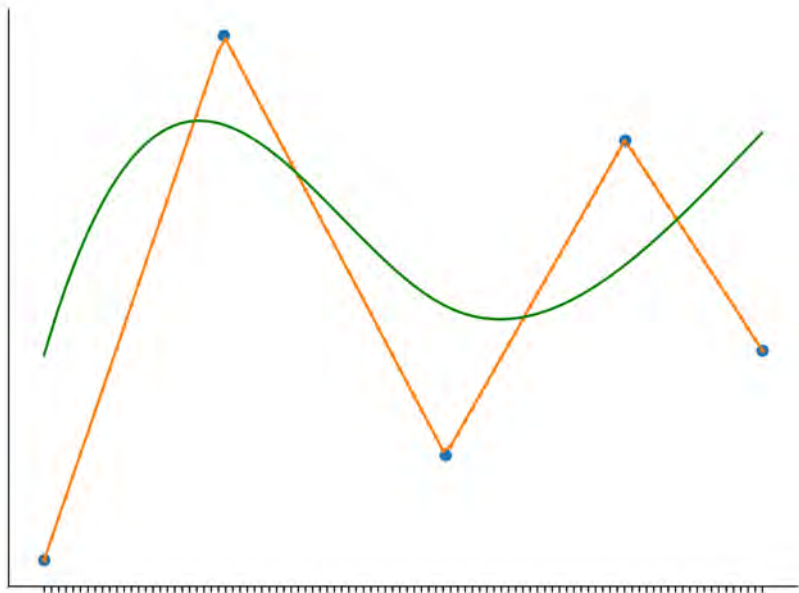
# Interpolation vs. approximation



# Interpolation vs. approximation



# Interpolation vs. approximation



# Data-Interpolating Variational Analysis



# Data-Interpolating Variational Analysis



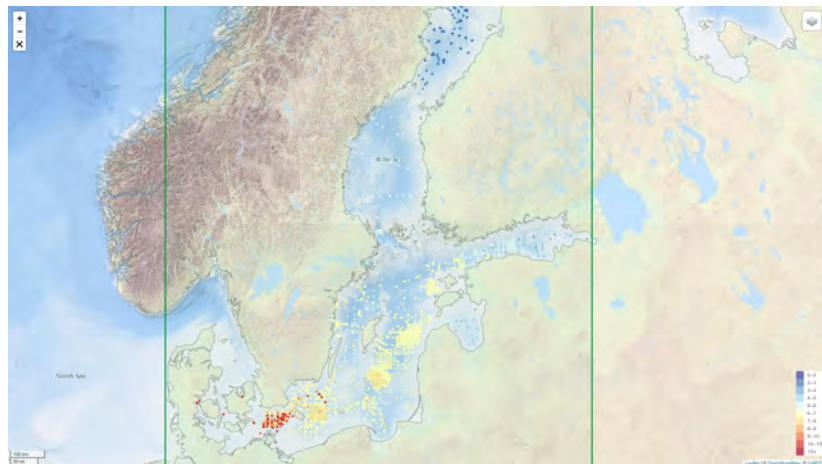
# Data-Interpolating Variational Analysis



Baltic Sea - Temperature and salinity observation collection V2

<https://www.seadatanet.org/Products#/metadata/1610aa44-0436-4b53-b220-98e10f17a2d4>

# Data-Interpolating Variational Analysis



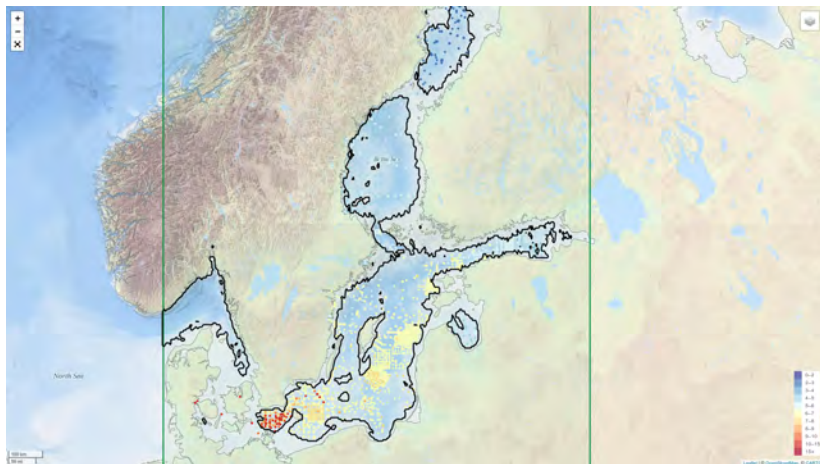


# Data-Interpolating Variational Analysis



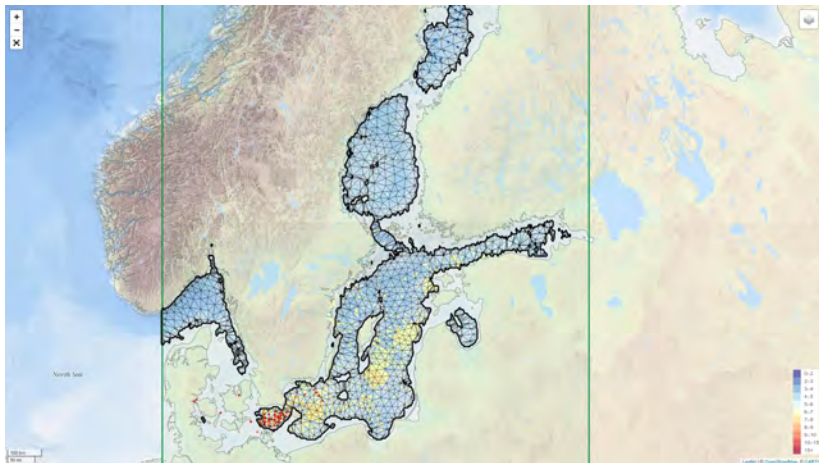
Contour at 0 meter depth

# Data-Interpolating Variational Analysis



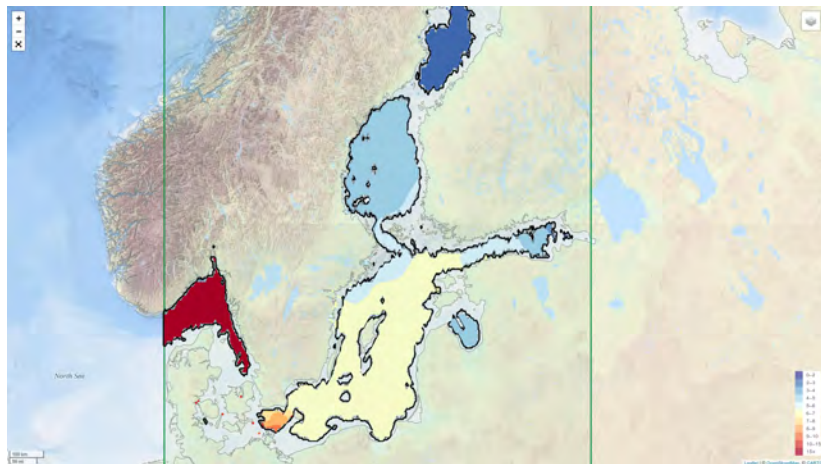
Contour at 30 meters

# Data-Interpolating Variational Analysis



Triangular, finite-element mesh

# Data-Interpolating Variational Analysis

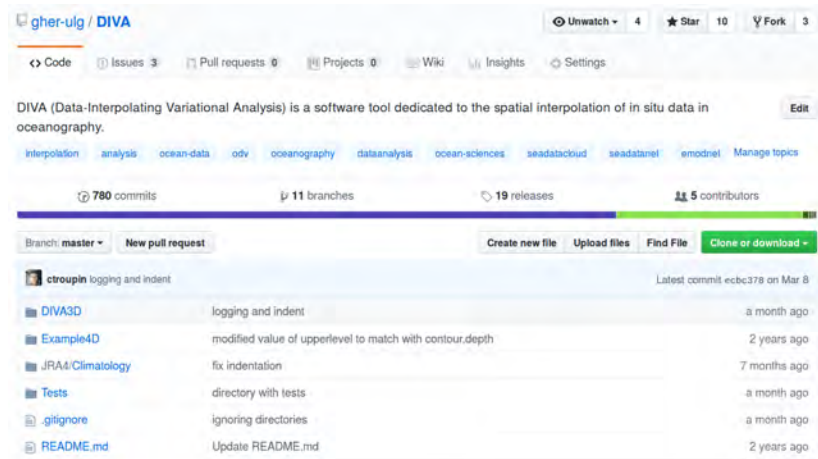


Interpolated salinity field

# Data-Interpolating Variational Analysis

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

 [10.5281/zenodo.592476](https://doi.org/10.5281/zenodo.592476)



gher-ulg / DIVA

Unwatch 4 Star 10 Fork 3


Code Issues 3 Pull requests 0 Projects 0 Wiki Insights Settings







DIVA (Data-Interpolating Variational Analysis) is a software tool dedicated to the spatial interpolation of in situ data in oceanography. Edit

interpolation analysis ocean-data odv oceanography dataanalysis ocean-sciences seadatacloud seadatanel emodnet Manage topics

780 commits 11 branches 19 releases 5 contributors

Branch: master New pull request Create new file Upload files Find File Clone or download

 **ctroupin** logging and indent Latest commit ecbc378 on Mar 8

 DIVA3D	logging and indent	a month ago
 Example4D	modified value of upperlevel to match with contour.depth	2 years ago
 JRA4/Climatology	fix indentation	7 months ago
 Tests	directory with tests	a month ago
 .gitignore	ignoring directories	a month ago
 README.md	Update README.md	2 years ago

# What should we improve?



# What should we improve?



What should we improve?





# Where should we improve?

- 1 Code compilation (different O.S., compilers, ...)
- 2 (Too) many options & input files
- 3 No graphical interface

# INNOVATION

GOING TO N DIMENSIONS

# $n$ -dimensional generalization: DIVAnd

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

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

Geosci. Model Dev., 7, 225–241, 2014  
www.geosci-model-dev.net/7/225/2014/  
doi:10.5194/gmd-7-225-2014  
© Author(s) 2014. CC Attribution 3.0 License.



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

**A. Barth<sup>1,\*</sup>, J.-M. Beckers<sup>1</sup>, C. Troupin<sup>2</sup>, A. Alvera-Azcárate<sup>1</sup>, and L. Vandenbulcke<sup>3,4</sup>**

<sup>1</sup>GHER, University of Liège, Liège, Belgium

<sup>2</sup>IMEDEA, Esporles, Illes Balears, Spain

<sup>3</sup>seamod.ro/Jailoo srl, Sat Valeni, Com. Salatrucu, Jud. Arges, Romania

<sup>4</sup>CIIMAR, University of Porto, Porto, Portugal

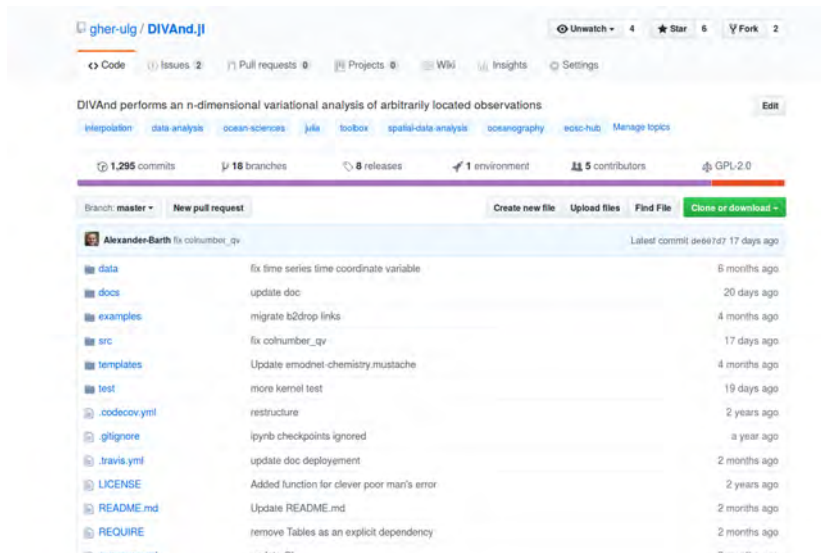
*\* Invited contribution by A. Barth, recipient of the EGU Arne Richter Award for Outstanding Young Scientists 2010.*

Correspondence to: A. Barth (a.barth@ulg.ac.be)

# $n$ -dimensional generalization: DIVAnd

 <https://github.com/gher-ulg/DIVAnd.jl>

 [doi:10.5281/zenodo.592476](https://doi.org/10.5281/zenodo.592476)



The screenshot shows the GitHub repository page for `gher-ulg / DIVAnd.jl`. At the top, there are navigation links for Code, Issues (2), Pull requests (0), Projects (0), Wiki, Insights, and Settings. The repository description states: "DIVAnd performs an  $n$ -dimensional variational analysis of arbitrarily located observations". Below this, there are tags for interpolation, data-analysis, ocean-sciences, julia, toolbox, spatial-data-analysis, oceanography, and eosc-hub. The repository statistics show 1,295 commits, 16 branches, 8 releases, 1 environment, 5 contributors, and a GPL-2.0 license. The main content area shows a list of files and their commit history:

File	Commit Message	Time
<code>data</code>	fix time series time coordinate variable	6 months ago
<code>docs</code>	update doc	20 days ago
<code>examples</code>	migrate b2drop links	4 months ago
<code>src</code>	fix colnumber_qv	17 days ago
<code>templates</code>	Update emodnet-chemistry.mustache	4 months ago
<code>test</code>	more kernel test	19 days ago
<code>.codecov.yml</code>	restructure	2 years ago
<code>.gitignore</code>	ipyrb checkpoints ignored	a year ago
<code>.travis.yml</code>	update doc deployment	2 months ago
<code>LICENSE</code>	Added function for clever poor man's error	2 years ago
<code>README.md</code>	Update README.md	2 months ago
<code>REQUIRE</code>	remove Tables as an explicit dependency	2 months ago

# What have we improved?

- 1 New mathematical formulation
- 2 Julia language
- 3 Only 2 input files
- 4 Applications as Jupyter notebooks

Barth et al. 2014  
instead of Fortran  
data & bathymetry  
all in one

# What have we improved?



Founder Collective

@fcollective

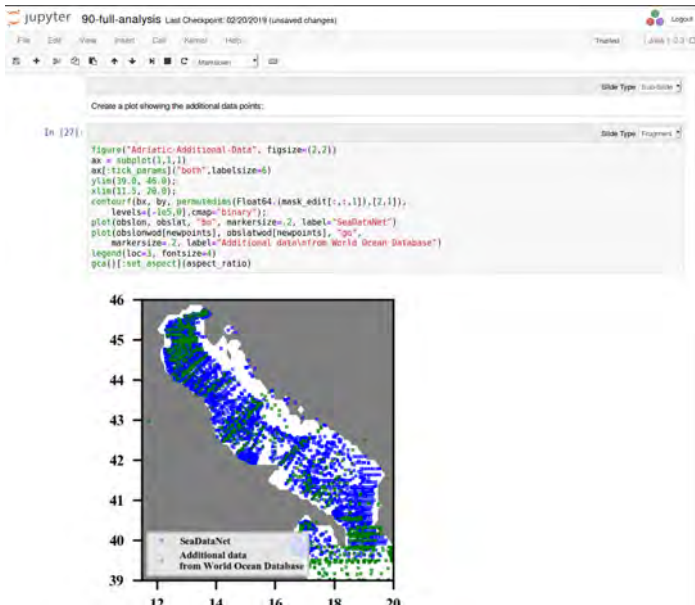
Follow

Congrats to the [@JuliaLanguage](#) team on their 1.0 release! We look forward to watching the [@JuliaComputing](#) team use it to smash the competition like so much bœuf à la Bourguignonne! [github.com/JuliaLang/jull ...](https://github.com/JuliaLang/julia)  
[#ProudInvestor](#)



11:59 PM - 8 Aug 2018

# Jupyter notebooks as guidelines



# Jupyter notebooks as guidelines

jupyter 90-full-analysis Last Checkpoint: 02/20/2019 (unsaved changes)

File Edit View Insert Cell Help Trusted Jupyter 0.3.0

Slide Type: Sub-Slide

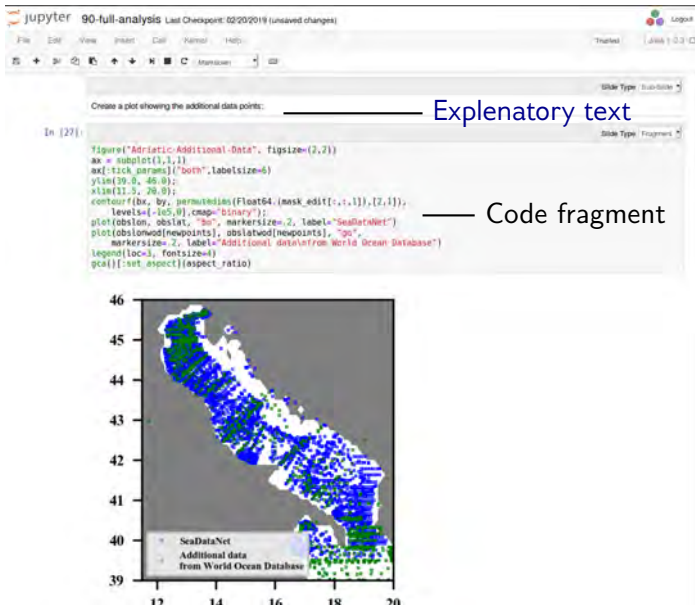
Create a plot showing the additional data points: \_\_\_\_\_ Explanatory text

```
In [27]:  
Figure("Adriatic-Additional-Data", figsize=(2,2))  
ax = subplot(1,1,1)  
ax.set_tick_params("both",labelsize=6)  
ylim(39.0, 46.0);  
xlim(13.0, 20.0);  
contour(fbx, by, normed=True, cmap="magma", levels=[0.5, 1.0], [2,1]);  
plot(obslon, obslat, "bo", markersize=2, label="SeaDataNet")  
plot(obslonwd[newpoints], obslatwd[newpoints], "go",  
      markersize=2, label="Additional data from World Ocean Database")  
legend(loc=3, fontsize=4)  
gca().set_aspect('square')
```

Legend:  
• SeaDataNet  
• Additional data from World Ocean Database



# Jupyter notebooks as guidelines



The image shows a Jupyter Notebook interface. At the top, the title bar reads "jupyter 90-full-analysis Last Checkpoint: 02/20/2019 (unsaved changes)". Below the title bar is a menu bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", and "Help". To the right of the menu bar are "Trust" and "Jupyter 0.3" buttons. Below the menu bar is a toolbar with various icons for navigation and editing. The main content area is divided into two sections: a text cell and a code cell.

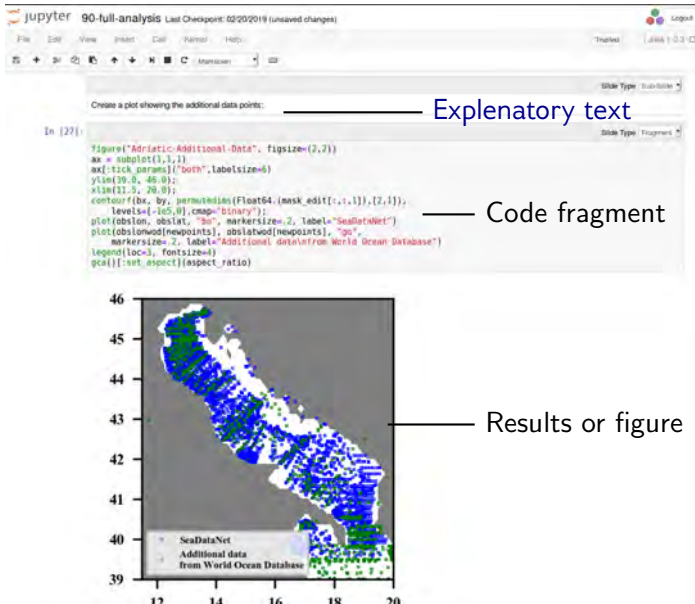
The text cell contains the instruction: "Create a plot showing the additional data points: \_\_\_\_\_ Explanatory text".

The code cell contains the following Python code:

```
In [27]:  
Figure("Adriatic-Additional-Data", figsize=(2,2))  
ax = subplot(1,1,1)  
ax.tick_params("both",labelsize=6)  
ylim(39.0, 45.0);  
xlim(13.0, 20.0);  
contour(fbx, by, permutedjcs(Float64(mask_edit[:,1]),[2,1]),  
        levels=[0.5,0],cmap="binary");  
plot(obslon, obslat, "bo", markersize=2, label="SeaDataNet");  
plot(obslonwod[newpoints], obslatwod[newpoints], "go",  
      markersize=2, label="Additional data\nfrom World Ocean Database");  
legend(loc=3, fontsize=4)  
gca().set_aspect(aspect_ratio)
```

The code cell is followed by a plot. The plot is a scatter plot showing data points in the Adriatic region. The x-axis ranges from 13 to 20, and the y-axis ranges from 39 to 46. The plot shows two data series: "SeaDataNet" (blue circles) and "Additional data from World Ocean Database" (green circles). The plot is titled "Adriatic-Additional-Data".

# Jupyter notebooks as guidelines



The image shows a Jupyter notebook interface. At the top, the title bar reads "jupyter 90-full-analysis Last Checkpoint: 02/20/2019 (unsaved changes)". Below the title bar is a menu bar with "File", "Edit", "View", "Insert", "Cell", "Format", and "Help". A toolbar with various icons is visible below the menu bar. The main content area contains a text cell with the instruction "Create a plot showing the additional data points:" followed by a line pointing to the right. Below this is a code cell labeled "In [27]:" containing a Python code snippet. The code creates a plot titled "Adriatic-Additional-Data" with a figure size of (2,2). It uses a subplot to show a map of the Adriatic region, plotting data from "SeaDataNet" (blue dots) and "Additional data from World Ocean Database" (green dots). The plot includes axes, tick marks, and a legend. The output of the code cell is a scatter plot showing the distribution of data points in the Adriatic region. The x-axis represents longitude (ranging from 17 to 20) and the y-axis represents latitude (ranging from 39 to 46). The plot shows a dense cluster of blue dots (SeaDataNet) and a sparser cluster of green dots (Additional data from World Ocean Database) along the coast. A legend in the bottom-left corner identifies the two data sources.

Create a plot showing the additional data points: ————— Explanatory text

```
In [27]:  
Figure("Adriatic-Additional-Data", figsize=(2,2))  
ax = subplot(1,1,1)  
ax[:tick_params]("both",labelsize=6)  
ylim(39.0, 46.0);  
xlim(17.0, 20.0);  
contour(fbx, by, permutedjcs(Float64.(mask_edit[:,1]),[2,1]),  
        levels=[-105.0],cmap="binary");  
plot(obslon, obslat, "bo", markersize=2, label="SeaDataNet")  
plot(obslonwod[newpoints], obslatwod[newpoints], "go",  
      markersize=2, label="Additional data\nfrom World Ocean Database")  
legend(loc=3, fontsize=4)  
gca()[:set_aspect](aspect_ratio)
```

————— Code fragment

Results or figure

# Jupyter notebooks as guidelines

jupyter 90-full-analysis Last Checkpoint: 02/20/2019 (unsaved changes) Logout

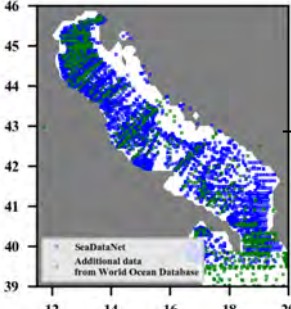
File Edit View Insert Cell Help Kernel (language) — Trusted — 0.0.0

Slide Type: Sub-Slide

Create a plot showing the additional data points: Explanatory text

```
In [27]:  
Figure("Adriatic-Additional-Data", figsize=(2,2))  
ax = subplot(1,1,1)  
ax.set_tick_params("both", labelsize=6)  
ylim(39.0, 46.0);  
xlim(13.0, 20.0);  
contour(fbx, by, permutedjcs(Float64.(mask_edit[:,1]),[2,1]),  
        levels=[-105,0], cmap="binary");  
plot(obslon, obslat, "bo", markersize=2, label="SeaDataNet");  
plot(obslonwod[newpoints], obslatwod[newpoints], "go",  
      markersize=2, label="Additional data from World Ocean Database");  
legend(loc=3, fontsize=4)  
gca().set_aspect(aspect_ratio)
```

Slide Type: Fragment



Results or figure

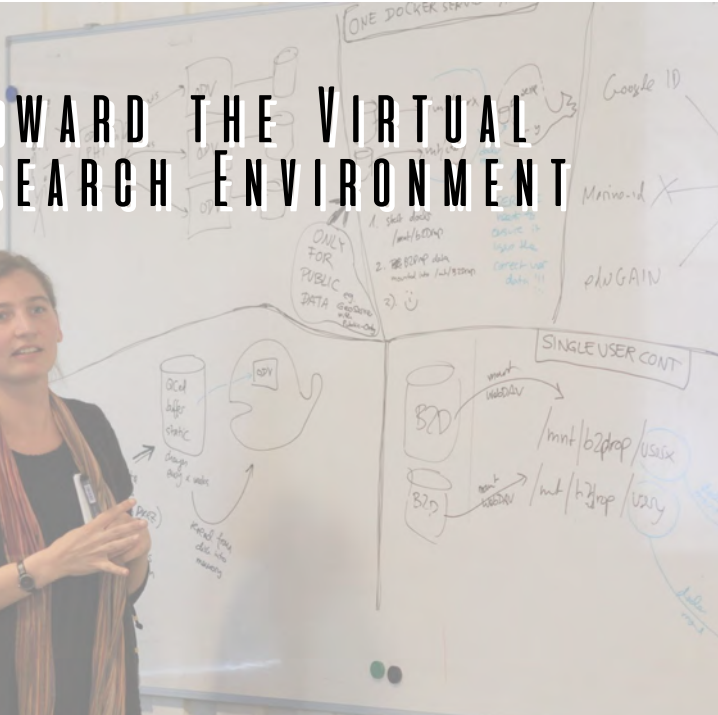
# What should we improve?



# What should we improve?

- 1 Access to computing power
- 2 Data availability
- 3 Documentation

# TOWARD THE VIRTUAL RESEARCH ENVIRONMENT



# Principles (simplified)

- 1 User login using Marine-ID
- 2 Upload of personal data (optional)
- 3 Pre-process and quality control using Ocean Data View
- 4 Interpolate using DIVAnd configuring the notebook
- 5 Dynamic visualization using Deltares tools
- 6 Publish results and notebooks

# How do we do it?



<https://www.docker.com/>  
applications deployed as Docker containers



<https://kubernetes.io/>  
management and scaling of containers



**WANT TO KNOW MORE?**

📅 Thursday, 11 April 2019, 08:30–10:15 📍 Hall X1 – Poster X1.46

Geophysical Research Abstracts  
Vol. 21, EGU2019-14104, 2019  
EGU General Assembly 2019  
© Author(s) 2019. CC Attribution 4.0 license.



## **Combining variational interpolation (DIVAnd) and neural networks to generate ocean climatologies from in situ observations**

Alexander Barth (1), Peter Herman (2), Charles Troupin (1), Aida Alvera-Azcárate (1), Jean-Marie Beckers, and (1)

(1) University of Liege, AGO/GHER, Liege, Belgium (a.barth@uliege.be), (2) Delft University of Technology, Department of Hydraulic Engineering, Delft, The Netherlands

📅 Thursday, 11 April 2019, 08:30–10:15 📍 Hall X1 – Poster X1.48

Geophysical Research Abstracts  
Vol. 21, EGU2019-6596, 2019  
EGU General Assembly 2019  
© Author(s) 2019. CC Attribution 4.0 license.



## **Bringing the *Ocean Data View* Software to the Web**

Reiner Schlitzer and Sebastian Mieruch-Schnülle

Alfred Wegener Institute, Bremerhaven, Germany (reiner.schlitzer@awi.de)

# SeaDataCloud user workshop

Splinter meeting SMP28

📅 Thu 11 April 2019 - 10:45–12:30 📍 Room 0.16



# More data = better products

## EMODnet Data Ingestion:

<https://www.emodnet-ingestion.eu/>

<p><b>WAKE UP YOUR DATA</b></p> <p><i>Set them free for Blue Society</i></p>  <p>EMODNET-INGESTION.EU</p>	<p><b>WAKE UP YOUR DATA</b></p> <p><i>Set them free for Blue Society</i></p>  <p>EMODNET-INGESTION.EU</p>	<p><b>WAKE UP YOUR DATA</b></p> <p><i>Set them free for Blue Society</i></p>  <p>EMODNET-INGESTION.EU</p>	<p><b>WAKE UP YOUR DATA</b></p> <p><i>Set them free for Blue Society</i></p>  <p>EMODNET-INGESTION.EU</p>	<p><b>EMODnet</b>, the European Marine Observation and Data Network, has over 160 organisations that work together to assemble and harmonise marine data, metadata and products, making them more accessible to Blue Society.</p> <p>The <b>Data Ingestion Portal</b> facilitates submitting marine datasets for further processing, Open Data publishing and contributing to applications for society.</p>  <p><b>EMODnet</b> European Marine Observation and Data Network</p>
--	--	--	---	--

## General conclusion

- 1 Interpolation of oceanographic data requires specifically designed techniques
- 2 DIVA & DIVAnd are open software made available to the scientific community
- 3 A Virtual Research Environment is being set-up to remove hurdles

# THE DEVIL IS IN THE DETAIL



THANKS FOR YOUR ATTENTION