Interpolate with DIVA and view the products in OceanBrowser: what's up?

Sylvain Watelet[1], Alexander Barth[1], Jean-Marie Beckers[1], Charles Troupin[2]

[1]Department of Astrophysics, Geophysics and Oceanography, University of Liège, Liège, BELGIUM
[2]Socib,Palma de Mallorca, SPAIN

1. Context

DIVA and OceanBrowser are both softwares tools which are continuously upgraded and distributed for free through frequent version releases. The development is funded by the EMODnet and SeaDataNet projects and include many discussions and feedback from the users community. Here, we present two recent major upgrades.

2. Analyse with DIVA...

2.1 What's the point?

The Data-Interpolating Variational Analysis (DIVA) software is a statistical tool designed to reconstruct a continuous field from discrete measurements. This method is based on the numerical implementation of the Variational Inverse Model (VIM), which consists of a minimization of a cost function, allowing the choice of the analyzed field fitting at best the data sets without presenting unrealistic strong variations. This method, equivalent to the Optimal Interpolation, is particularly suited to deal with irregularly-spaced observations and produces outputs on a regular grid (2D, 3D or 4D). The results are stored in NetCDF files.

2.2 How does it work?

We are looking for the field φ which minimizes the cost function J over our domain of interest D:

$$J[\varphi] = \sum_{j=1}^{Nd} \mu_j [d_j - \varphi(x_j, y_j)]^2 + \|\varphi\|^2 \quad (1)$$

with

$$\|\varphi\|^2 = \int_D (\alpha_2 \nabla\nabla\varphi : \nabla\nabla\varphi + \alpha_1 \nabla\varphi \cdot \nabla\varphi + \alpha_0 \varphi^2)\, dD \quad (2)$$

where the α_i and the μ_j are determined from the data d_j themselves, through their correlation length L and signal-to-noise ratio λ.

2.3 Finite-element mesh

In order to solve the problem, a triangular-element mesh is computed by DIVA. The characteristic length of each element is directly linked to the correlation length of the analyzed variable (see Fig. 1).

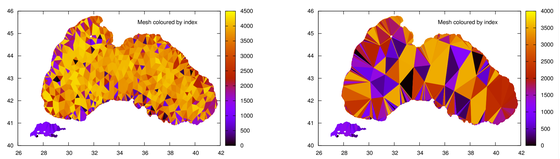


Figure 1: The mesh computed by DIVA for the Black Sea at 30 m depth, using a correlation length of 1.5° (left) and 5° (right). The resolution is higher near the coast, allowing the analyse of coastal phenomenons such as upwellings.

3. ...and view the results with Oceanbrowser!

3.1 What are we talking about?

OceanBrowser is a web-service that allows one to visualize gridded fields on-line. Within the SeaDataNet and EMODNET projects, several national ocean data centers have created gridded climatologies of different ocean properties using DIVA. In order to give a common viewing service to those interpolated products, the GHER has developed OceanBrowser which is based on open standards from the Open Geospatial Consortium (OGC), in particular:

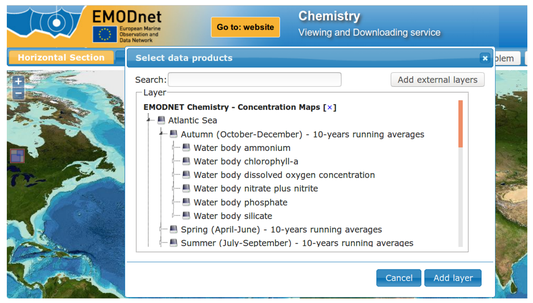
- Web Map Service (WMS);
- Web Feature Service (WFS).

These standards define a protocol for describing, requesting and querying 2D maps at a given depth and time.

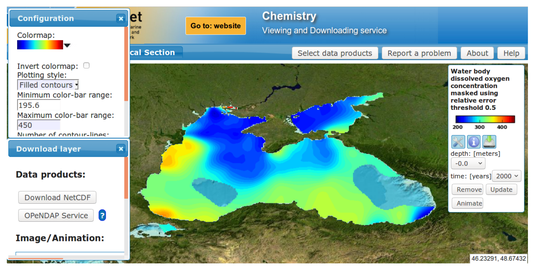
3.2 Is it user-friendly?

Short answer: yes!

1. Select domain, season, variable;



2. Choose time/depth, configure appearance... Done!



How to get the code ?

Diva is available at `http://modb.oce.ulg.ac.be/mediawiki/index.php/DIVA`, as well as documentation (user guide, tutorials,...) and binaries for various O.S.

OceanBrowser is available at `http://ec.oceanbrowser.net/emodnet/`

4. What's new in DIVA?

4.1 A bit of history...

It has been a recurrent request from the DIVA users to improve the way the analyses near the ocean bottom are produced. Up to now, the analyses were performed at several depths counted from the ocean surface, meaning that horizontal layers were used for the analyses, and then combined in a "deepest variable" field using for each grid point the deepest result available.

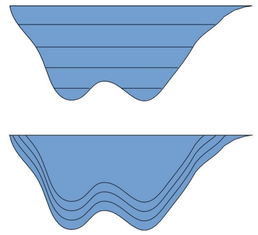


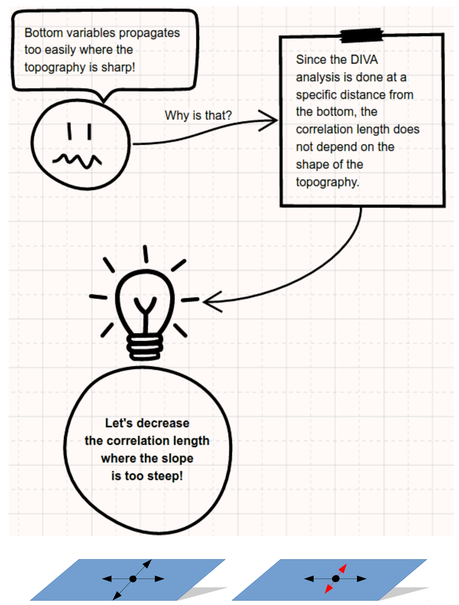
Figure 2: Illustration of both possibilities to analyze data on 2D layers: at a specific distance from the surface (top) and from the ocean bottom (bottom).

Although simple, this former method had two significant drawbacks:

- some layers close to the bottom become divided in many patches, leading to an underestimated propagation of the information;
- many applications require a fixed distance from the ocean bottom.

In the last DIVA version, a new feature allows the computation of the layers from several user-defined distances from the bottom surface (see Fig. 2).

4.2 ...leading to another improvement!



5. What's new in OceanBrowser?

From the analyses performed by EMODnet partners on the

- Atlantic;
- North Sea;
- Baltic Sea;
- Black Sea;
- Mediterranean Sea;

we created a combined European product available at all seasons and several depths for five variables : ammonium, chlorophyll-a, dissolved oxygen concentration, phosphate and silicate. At boundaries, a smooth filter was used to remove possible discrepancies between regional analyses. This is the first step towards the use of a common reference field for all European seas when running DIVA.

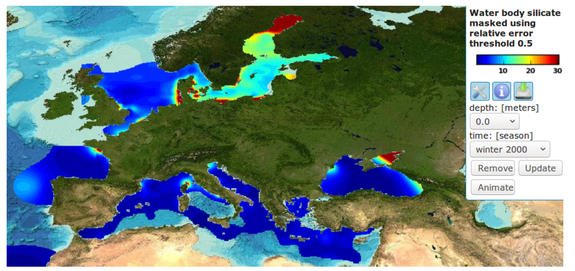


Figure 3: Example of a combined product (silicate, μmol/l).

Take-home message

- **Ocean bottom variables** can now be handled by **DIVA**
- This feature is made robust thanks to a **variable correlation length**
- **OceanBrowser** now includes **combined products**
- DIVA/OceanBrowser **users** continue to play a key role in development

Acknowledgments

The research leading to the last developments of DIVA has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement No. 283607, SeaDataNet 2, and from the project EMODNET (MARE/2012/10 - Lot 4 Chemistry - SI2.656742) from the Directorate-General for Maritime Affairs and Fisheries.

Reference

Troupin et al. (2012). *Generation of analysis and consistent error fields using the Data Interpolating Variationnal Analysis (Diva).* Ocean Modelling, 52-53, 90-101.