

# Variational data analysis for generating ocean climatologies (DIVA) and web-based distribution of data products (OceanBrowser)

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## Variational interpolation in an $n$ -dimensional space

DIVA-nd (Data-Interpolating Variational Analysis -  $n$ -dimensional) is a tool that allows to generate gridded data products from *in situ* observations. DIVA-nd extends the 2d capabilities of the DIVA tool and allows the interpolation of observations on curvilinear orthogonal grids in an arbitrary high dimensional space by minimizing a cost function. This cost function penalizes the deviation from the observations, the deviation from a first guess and abruptly varying fields based on a given correlation length (potentially varying in space and time). Physical constraints can be added to this cost function such as an advection constraint, diffusion or source terms. One major advantage of the method is that it naturally decouples basins that are not connected and where water masses often have very different properties. Individual elements of the *a priori* and *a posteriori* error covariance matrix can also be computed, in particular expected error variances of the analysis. The benefit of this multidimensional approach over the traditional 2d analysis (stacking of horizontal layers) is that the analysis is smooth in all dimensions. However the computational cost is increased compared to the stacking of horizontal layers.

Primal (problem solved in the grid space) and dual formulations (problem solved in observation space) are implemented using either direct solvers (based on Cholesky factorization) or iterative solvers (conjugate gradient method). In most applications the primal formulation with the direct solver is the most efficient method, especially if an *a posteriori* error estimate is needed. However, for correlated observation errors the dual formulation with an iterative solver is more efficient.

## Validation of the method and improvement relative to 2d analysis

The method is tested by using pseudo observations from a global model. The distribution of the observations is based on the ARGO float positions. The benefit of the 3-dimensional analysis (longitude, latitude and time) compared to 2-dimensional analysis (longitude and latitude) and the role of the advection constraint are highlighted.

The tool DIVA-nd is developed in the frame of the SeaDataNet 2 project and distributed under the terms of the GPL license (<http://modb.oce.ulg.ac.be/mediawiki/index.php/DIVAnd>).

## Distribution of data products

Data products generated by DIVA and DIVA-nd are distributed by the OceanBrowser portal

(<http://gher-diva.phys.ulg.ac.be/web-vis/>). This web interface is developed to visualize gridded oceanographic data sets. Those data sets are typically four-dimensional (longitude, latitude, depth and time).

OceanBrowser allows one to visualize horizontal sections at a given depth and time to examine the horizontal distribution of a given variable. It also offers the possibility to display the results on an arbitrary vertical section. To study the evolution of the variable in time, the horizontal and vertical sections can also be animated. The user can customize the plot by changing the color-map, the range of the color-bar, the type of the plot (linearly interpolated color, simple contours, filled contours) and download the current view as a simple image or as Keyhole Markup Language (KML) file for visualization in applications such as Google Earth. The data products can also be accessed as NetCDF files and through OPeNDAP.

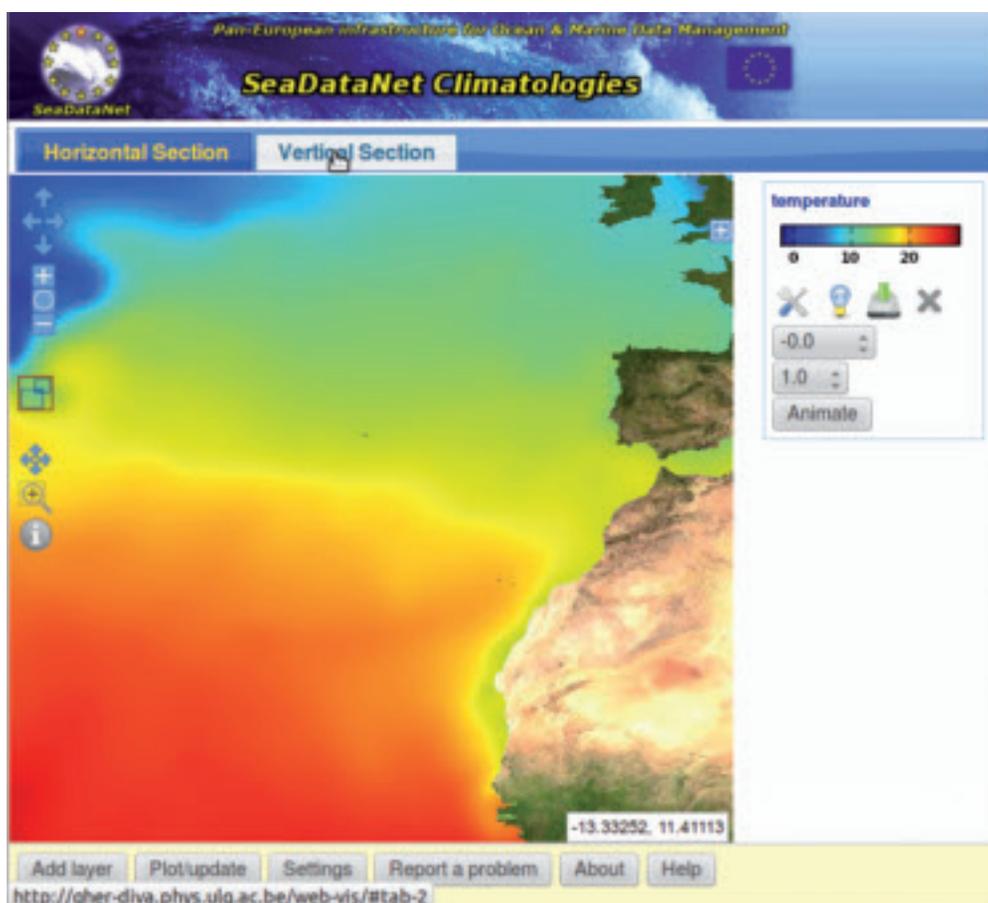


Fig. 1 - A temperature climatology visualized in OceanBrowser.