Hydrostatic and advection constraints in the software DIVA: theory and applications

Troupin Charles, *University of Liège, ctroupin@ulg.ac.be, (Belgium)*
Ouberdous Mohamed, *GHER (University of Liège),*
Rixen Michel, *NURC - NATO Undersea Research Centre, Rixen@nurc.nato.int*
Sirjacobs Damien, *GHER (University of Liège), D.Sirjacobs@ulg.ac.be*
Beckers Jean-Marie, *GHER (University of Liège), JM.Beckers@ulg.ac.be*

Griding data is a frequently demanded process in geophysics: it consists in determining the value of a given field on a regular grid from the knowledge of this field at sparse locations within the domain of sake.

The most used methods are based on interpolation techniques with an assumption of isotropic behavior of the field. However, such techniques are not well adapted to the intrinsic nature of geophysical data:

1. in situ measurements are always sullied with an uncertainty on the field value, thus a strict interpolation is not suitable;
2. the effects of currents and coastlines make obsolete the assumption of isotropy.

Diva (Data-Interpolating Variational Analysis) aims at bridging over the mentioned deficiencies

by implementing the Variational Inverse Method (VIM, Brasseur et al., 1996). The principle of the method consists in minimizing a variational principle which accounts for:

- the differences between the observations and the reconstructed field;
- the relative weights of the data;
- the influence of the gradients and
- the variability of the reconstructed field.

Its major assets over classical methods are: 1. the resolution by the finite-element method, which allows a great numerical efficiency and the consideration of problems with arbitrarily complicated contours; 2. the additional tools designed in order to facilitate the the analysis and make it as objective as possible; 3. the error field (Brankart and Brasseur, 1998; Rixen et al., 2000) based on the data coverage and noise, provided along with the analysis; 4. the readiness of utilisation, with only three input file required for a typical analysis (analysis parameters, specification of the domain contours and data themselves).

Among the available tools, let us mention:

- the advection constraint during the field reconstruction through the specification of a velocity field on a regular grid, forcing the analysis to align with the velocity vectors;
- the Generalized Cross Validation for the determination of analysis parameters (signal-to-noise ratio);
- creation of contours at the selected depths;
- the detection of possible outliers.

The latest developments of Diva in the frame of the SeaDataNet project include:

1. the hydrostatic constraint for eliminating the potential hydrostatic instabilities arisen from the combined analysis of temperature and salinity data in several horizontal planes independently.
2. the specification of a variable correlation length over the domain, allowing one to consider different scales of interest according to the location;
3. the computation of the error field based on the real correlation function of the considered data.

Data sets of temperature and salinity in the Eastern North Atlantic are analyzed for illustrating the new features of the software: after gathering data from several sources (World Ocean DataBase, Coriolis, HydroBase2, Canigo) in the selected region (0-50°N, 0-50°W), we perform analysis at standard levels on annual, seasonal and monthly bases.

The complexity of the analysis is progressively increased by the consideration of realistic coast-lines, bottom topography and advection constraint.

Results are then compared with widespread climatologies from the World Ocean Atlas, giving rise to meso-scale features not properly represented in the latter, due to its lack of resolution.

References

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