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

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DIVAnd (Data-Interpolating Variational Analysis - n-dimensional) creates gridded data products from in situ observations. DIVAnd 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.

For some data sets (e.g. biological data and chemical data), the data coverage is relatively low (in particular compared to physical data) and therefore it is interesting to use other indirectly related parameter to derive full gridded fields. For instance, if a given biological species has a particular affinity to a range of salinity, using the salinity will help to generate gridded abundance fields. This is the general motivation to extend the approach of DIVA to use a multi-variate analysis.

Neural networks can be easily extended to use various inputs (called features) to produce a given outcome (here the gridded field). The relationship between the input data and the output is derived from the observations. Formally, there are similarities in variational interpolation and neural networks as both minimize a cost function by computing its gradient evaluated using the observations. The advantages of both techniques are combined by minimizing a joint cost function. The method is applied to data from the EMODnet Biology project and shows how different co-variables (like dissolved oxygen concentration, salinity and distance from the coastline) affect the final result.