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3DA: Data-Driven Data Assimilation

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The 3DA (Data-Driven Data Assimilation) project aims at demonstrating the benefits of using a large ensemble of numerical ocean simulations for the interpolation of sparse and noisy ocean satellite observations. It uses analog forecasting and filtering/smoothing methods for reanalysis purposes. It is based on the Analog Data Assimilation (AnDA, Lguensat et al. 2017) method and the NEMO-based ensemble simulation (OCCIPUT, Bessières et al. 2017).

AnDA is a fully data-driven method based on a representative catalog of historical data. It combines machine learning with the analog method (or nearest neighbor search) and stochastic assimilation techniques, to learn the local relationships between state variables and to provide realistic forecasts from the analog method, without the need for an online integration of a physical model. The method can be seen as an optimal interpolation with a physically-constrained covariance structure.

The AnDA approach is first applied on the Lorenz-63 idealized model when only one variable of the system is observed. Using a set of historical simulations from this toy-model, we show that the analog strategy adaptively captures the error covariance structure and outperforms the optimal interpolation which uses constant statistical parameters.

Then, AnDA is applied to the historical database of Sea Surface Height (SSH) fields simulated by OCCIPUT, a NEMO-based 50-member ensemble of global 1/4° ocean simulations. We show that the analogs are able to learn from this large ensemble data the spatiotemporal dynamics of the SSH and, as for the Lorenz-63, the error covariance structure adaptively. AnDA is used to interpolate altimeter satellite observations.