Validating an Ensemble based Forecasting System of the North and Baltic Seas

S. N. Losa¹, S. Danilov¹, J. Schröter¹, L. Nerger¹, S. Maßmann², F. Janssen²

¹Alfred Wegener Institute for Polar and Marine Research (AWI, Bremerhaven, Germany), ²Federal Maritime and Hydrographic Agency (BSH, Hamburg, Germany)

Svetlana.Losa@awi.de

Abstract
The quality of the forecast provided by the German Maritime and Hydrographic Agency (BSH) for the North and Baltic Seas had been previously improved by assimilating satellite sea surface temperature SST (project DeMarine, Losa et al., 2012). We investigate possible further improvements using in situ observational temperature and salinity data: MARNET time series and CTD and ScanFish measurements. To assimilate the data, we implement the Singular Evolutive Interpolated Kalman (SEIK) filter (Pham et al., 1998). The SEIK analysis is performed locally (Nerger et al. 2006) accounting for assimilating the data within a certain radius. In order to determine suitable localisation conditions for MARNET data assimilation, the BSHmod error statistics have been analysed based on LSEIK filtering every 12 hours over one year period (September 2007 – October 2008) given a 12-hourly composites of NOAA's SST and with the prior error statistics assessed with an entropy approach (Kivman et al., 2001). The principle of Maximum Entropy is used as an additional criterion of plausibility of the augmented system performance.

Principle of Maximum Entropy

The maximum probable forward operator in the data assimilation process is estimated, i.e. the probability density function (PDF) of model trajectories realizations is given the data. This conditional (analytical) PDF should maximize the entropy: \( S = -\int \rho(x) \log \rho(x) \, dx \), where \( \rho(x) \) is the lowest information about \( x \). The maximum probable \( x \) or mean with respect to \( \rho(x) \) is \( \int x \rho(x) \, dx \), and \( x \) is any system states satisfying the model equations \( \dot{x} = f(x) + \nu \) and data \( h(x) \), respectively. Here, \( f(x) \) is the model operator, \( \nu \) is external forcing, and \( h(x) \) is an observational operator. Kivman et al. (2001) show that the operators \( f(x) \) and \( h(x) \) depend only on \( x \) and \( h(x) \) and on our assumptions on the prior error statistics. \( h(x) \) are nonnegative, self-adjoint and \( M_n + M_n = f \)

Assessing the assumptions on the model and data errors, we search for the prior which generates the operator-valued measure \( \nu \) with the highest entropy: \( S = \int \rho(x) \log \rho(x) \, dx \), where \( \rho(x) \) is the lowest information about \( x \), is any system states satisfying the model equations \( \dot{x} = f(x) + \nu \) and data \( h(x) \), respectively. Here, \( f(x) \) is the model operator, \( \nu \) is external forcing, and \( h(x) \) is an observational operator. Kivman et al. (2001) show that the operators \( f(x) \) and \( h(x) \) depend only on \( x \) and \( h(x) \) and on our assumptions on the prior error statistics. \( h(x) \) are nonnegative, self-adjoint and \( M_n + M_n = f \)

Assimilating Scanfish T, S profiles

Temporal evolution the bottom temperature forecast at the MARNET station Darss Sill: Bottom salinity

Assimilating MARNET data

Temporal evolution the bottom salinity forecast at the MARNET station Darss Sill: Bottom temperature

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References


