Augmenting an operational forecasting system for the North and Baltic Seas by in situ T and S data assimilation

Svetlana N. Losa1, Sergey Danilov1, Jens Schröter1, Lars Nerger1, Silvia Maßmann2, Frank Janssen2

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

Abstract

In order to improve the hydrography forecast of the North and Baltic Seas, the operational circulation model of the German Federal Maritime and Hydrographic Agency (BSH) has been augmented by a data assimilation (DA) system. The DA system has been developed based on the Singular Evolution Interpolated Kalman (SEIK) filter algorithm (Pham, 1998) coded within the Parallel Data Assimilation Framework (Nerger et al., 2004, Nerger and Hiller, 2012). Previously the only data assimilated were sea surface temperature (SST) measurements obtained with the Advanced Very High Resolution Radiometer (AVHRR) aboard NOAA’s polar orbiting satellites. While the quality of the forecast has been significantly improved by assimilating the satellite data (Losa et al., 2012, Losa et al., 2014), assimilation of in situ observational temperature (T) and salinity (S) profiles has allowed for further improvement. Assimilating MARNET time series and CTD and Scanfish measurements, however, required a careful calibration of the DA system with respect to local analysis. The study addresses the problem of the local SEIK analysis accounting for the data within a certain radius. The localisation radius is considered spatially variable and dependent on the system local dynamics. As such, we define the radius of the data influence based on the energy ratio of the baroclinic and barotropic flows.

Operational System

Toward spatially variable localisation (SVL)

To the left: Summer energy superposition of the baroclinic and barotropic flows (E_{BR}/E_{TR}) calculated for the North and Baltic Seas based on U, V velocity components averaged over June-July-August 2008. E_{BR}/E_{TR} represents water column mean estimates.

There is an advantage for vertical and temporal varying localisation.

Bottom: Spatial variability of lr the localisation radius, parametrized with summer E_{BR}/E_{TR} and used for the local SEIK analysis.

Forecast improvement with in situ T, S DA

To the left: Temperature profiles ordered and plotted along the longitudinal direction on 26 July 2008 at 12:00.

Despite of good agreement between LSEIK analysis and observations both for T and S, the forecast quality is crucially dependent upon the plausibility of the localisation conditions.

SVL validation with Scanfish T, S profiles

To the left: Temperature profiles ordered and plotted along the longitudinal direction on 29 and 31 July 2008 at 00:00.

The Figure (to the right) depicts the forecast based on local SEIK analysis under spatially variable localisation conditions against observations, forecast without DA and the best forecast based on local SEIK filtering with a constant lr.

Variable radius improves DA at certain locations and generally compares well with DA exploiting fixed localisation.

Temporal evolution of salinity at the “Arkona Basin” MARNET station (54.57 N, 13.52 E).

The figure (to the right) depicts the forecast based on local SEIK analysis under spatially variable localisation conditions against observations, forecast without DA and the best forecast based on local SEIK filtering with a constant lr.

Variable radius improves DA at certain locations and generally compares well with DA exploiting fixed localisation.