

Assimilating NOAA's SST data and in situ T, S profiles into the BSH operational circulation model for the North and Baltic Seas

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

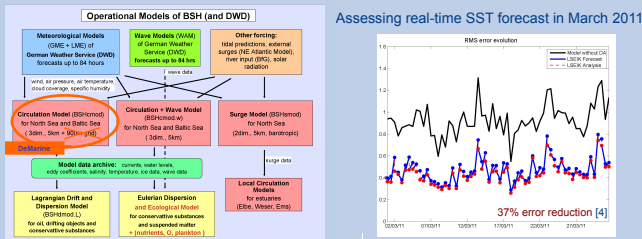
¹Alfred Wegener Institute for Polar and Marine Research (AWI, Bremerhaven, Germany),
²Federal Maritime and Hydrographic Agency (BSH, Hamburg, Germany)

Abstract

The operational circulation model of the German Federal Maritime and Hydrographic Agency (BSH) has been augmented by a data assimilation (DA) system in order to improve the hydrography forecast of the North and Baltic Seas. The DA system has been developed based on the Singular Evolution Interpolated Kalman (SEIK) filter algorithm [1] coded within the Parallel Data Assimilation Framework [2], [3].

The quality of the forecast has been previously improved by assimilating sea surface temperature (SST) measurements obtained with the Advanced Very High Resolution Radiometer (AVHRR) aboard NOAA's polar orbiting satellites [4], [5]. We investigate possible further improvements using in situ observational temperature and salinity data: MARNET time series and CTD and Scanfish measurements. 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.

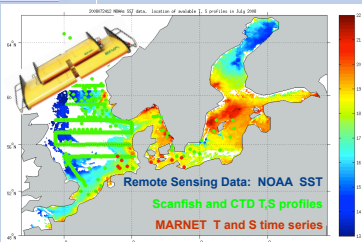
Operational System



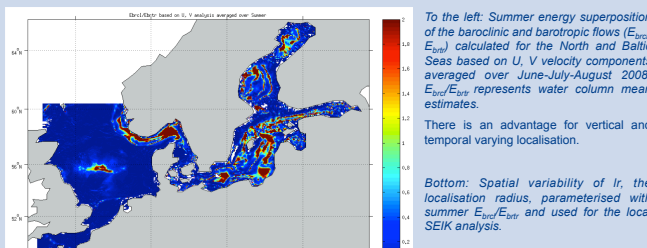
Observational Data:

12 hourly—around 00:00 and 12:00,—composites of SST measured by the Advanced Very High Resolution Radiometer (AVHRR) aboard polar orbiting satellites;
In situ T&S data based on measurements collected by BSH, Sweden's Meteorological and Hydrological Institute (SMHI) and the Institute of Marine Research (IMR, Norway).

Acknowledgement: The authors are grateful to Simon Janitz for setting up the in situ data archive; to NOAA and BSH satellite data service for providing the SST data.



Toward spatially variable localisation (SVL)

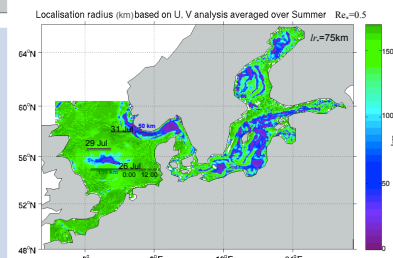


Scaling the localisation radius based on E_{brc}/E_{btr}

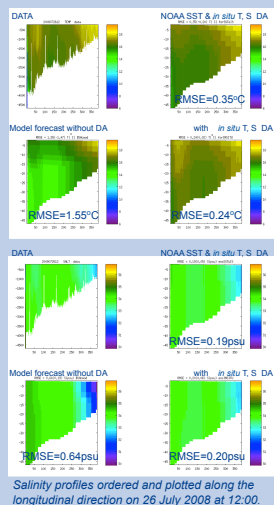
$$l_r = \max\left(\frac{l_r}{Re + Re}, .15\right)$$

$$Re = \frac{E_{brc}}{E_{btr}}$$

l_r is the localisation radius (km);
 l_{r_0} is a reference localisation radius;
 Re is a reference Re

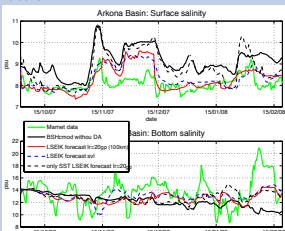


Forecast improvement with in situ T, S DA



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.

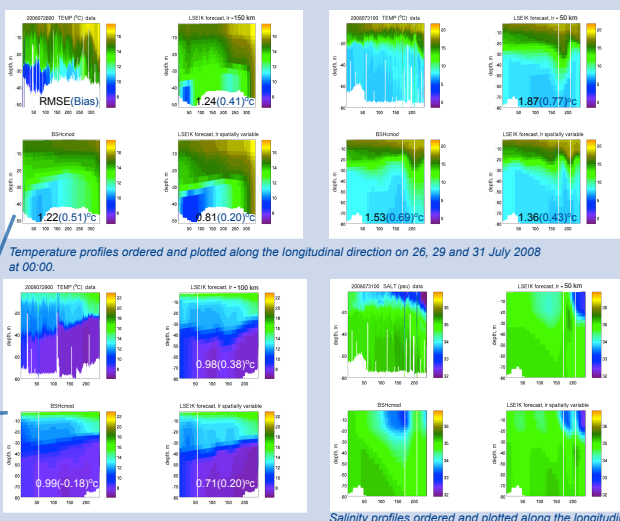


Temporal evolution of salinity at the "Arkona Basin" MARNET station (54°53' N, 13°52' E).

The figures (to the right) depict 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 l_r .

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

SVL validation with Scanfish T, S profiles



[1] Pham, D. T., J. Vernon and L. Gourdeau (1998). Singular evolutive Kalman filters for data assimilation in oceanography. C. R. Acad. Sci. Paris, Earth and Planetary Sciences, 328, 255–260.

[2] L. Nerger, W. Hiller, J. Schröter (2005). PDAF - The Parallel Data Assimilation Framework: Experiences with Kalman Filtering. In: Zweifelhofer, W., Moczyński, G. (Eds.), Use of high performance computing in meteorology, proceedings of the Eleventh ECMWF Workshop on the Use of High Performance Computing in Meteorology, Singapore: World Scientific, Reading, UK, 63–83.

[3] L. Nerger, W. Hiller (2013). Software for Ensemble-based Data Assimilation Systems — Implementation Strategies and Scalability. Computers and Geosciences, 55, 110–118.

[4] Losa, S.N., Danilov, S., Schröter, J., Nerger, L., Maßmann, S., Janssen, F. (2012). Assimilating NOAA SST data into the BSH operational circulation model for the North and Baltic Seas: Inference about the data. Journal of Marine Systems, 105–108, pp. 152–162.

[5] Losa, S.N., Danilov, S., Schröter, J., Nerger, L., Janssen, F. (2012). Assimilating NOAA SST data into the BSH operational circulation model for the North and Baltic Seas: Part 2. Sensitivity of the forecast's skill to the prior model error statistics. Journal of Marine Systems, doi:10.1016/j.jmarsys.2013.06.011