Developing a data assimilation system for operational BSH circulation model of North and Baltic Seas:

Local SEIK implementation for NOAA SST data assimilation

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Abstract

Within the DeMarine-Environment project- as a part of the European Global Monitoring for Environment and Security (GMES) initiative,- a data assimilation (DA) system is developed for BSH operational circulation model in order to improve forecast of hydrographyc characteristics in the North and Baltic Seas. The technical aspects of the system and the used Parallel Data Assimilation Framework (PDAF) are discussed in the companion contribution by Nerger et al.. Here we present results of NOAA sea surface temperature (SST) data assimilation for the period 01.10.07 – 30.09.08 when locally implementing Singular Evolutive Interpolated Kalman (SEIK) filter algorithm.

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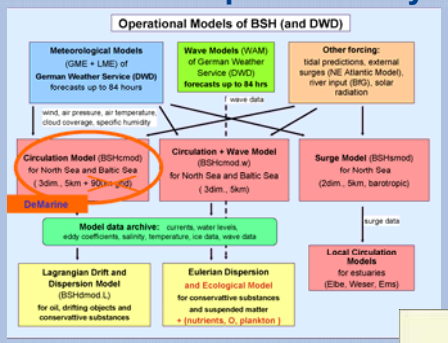
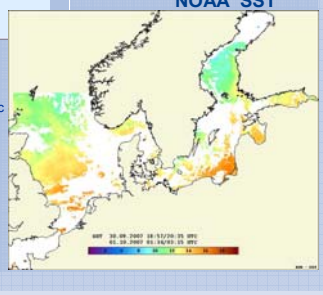
Operational System



Model setup

- horizontal grid spacing:
  ΔLon: 5' , ΔLat: 3' (~5km)
- number of vertical layers: 44
- layer thickness increases from top (~2 m) to depth
- bottom layer with approx. 3 m thickness (=> SPM)
- total no. of grid points: 2dim - 161.199, 3dim - 1.783.352
- time step 30s

Remote Sensing Data: NOAA SST

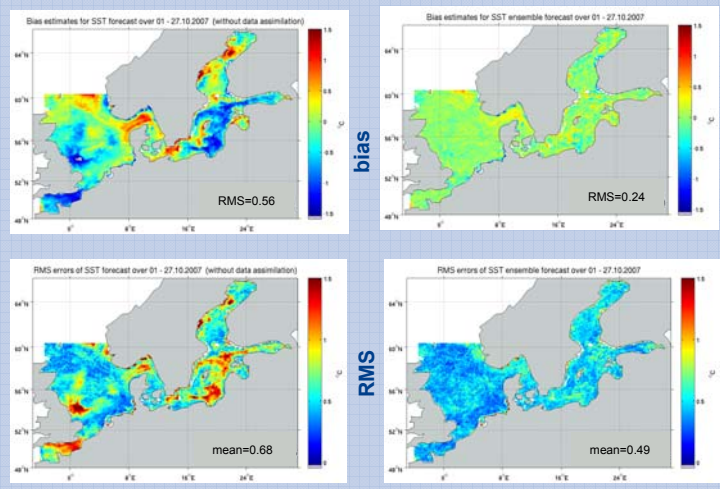


The Circulation Model (BSHcmod V.4)

- three-dimensional shallow water equations, baroclinic, prognostic
- generalised vertical co-ordinates (Kleine, 2004*)
- mixing length formulation for horizontal and vertical turbulence
- sea ice dynamics (Hibler, 1979) and thermodynamics
- tidal forcing using 14 tidal constituents
- flooding and drying of tidal flats
- climatological boundary data for T and S (+sponge layer)

Assessing SST forecast for October 2007

Without data assimilation **With Local SEIK**



Improvement of Sea Surface Temperature (SST) forecast in the North and the Baltic Seas when sequentially assimilating satellite (NOAA) SST data into the BSH operational circulation model. Major improvement is the bias correction.

Data Assimilation

Experiment Design

•DA Method: Local SEIK (LSEIK) **filter algorithm (Nerger et al., 2006) with different formulations of data error correlation**

r_l=10gp, σ_{sst}=1.8ºC, equal data weights (EQU1);

r_l=10gp, σ_{sst}=0.8ºC, equal data weights (EQU2);

r_l=20gp, σ_{sst}=0.8ºC, weights exponentially (EXP) dependent on distance from updated water column.

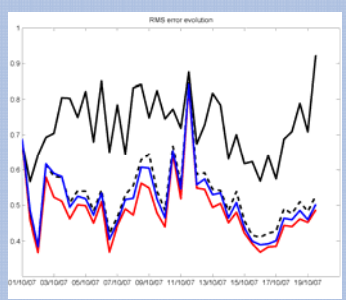
• Initial model variance/covariance matrix is computed using three months (10-12.2007) output from the BSH model run (12 hours snapshot).

• First 8 EOFs are used to generate an ensemble (8 members) of model states (temperature, salinity, current velocities, sea surface elevation).

•NOAA SST data are assimilated every 12 hours.

r_l – radius of assimilated data influence (in grid points, *gp*)

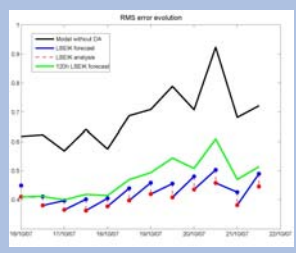
Sensitivity



Temporal evolution of SST RMS error for BSHcmod forecast without DA (black); EQU1 LSEIK forecast (black dashed); EQU2 LSEIK forecast (blue); EXP LSEIK forecast (red).

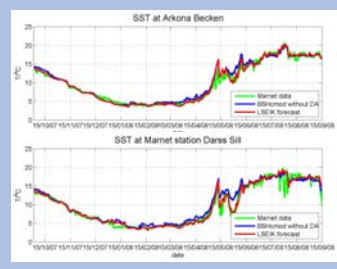
Nerger, L., S. Danilov, W. Hiller, and J. Schröter. Using sea level data to constrain a finite-element primitive-equation model with a local SEIK filter. Ocean Dynamics 56 (2006) 634.

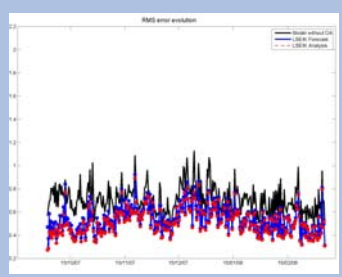
120 hours forecast

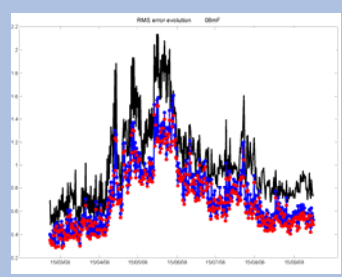


Independent data

Time series at Marnet stations







Temporal evolution of SST RMS error over the period 1.10.2007- 30.09.2008 for BSHcmod forecast without DA (black); LSEIK analysis (red) and forecast (blue).