Development of a data assimilation system for BSHcmod operational model of the North and Baltic Seas

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Abstract

A data assimilation (DA) system is developed for BSH operational circulation model in order to improve forecast of current velocities, sea surface height, temperature and salinity in the North and Baltic Seas. Assimilated data are NOAA sea surface temperature (SST) data for the following period: 01.10 – 30.10.07. All data assimilation experiments are based on implementation of one of the so-called statistical DA methods – Singular Evolutive Interpolated Kalman (SEIK) filter, - with different ways of prescribing assumed model and data errors statistics.

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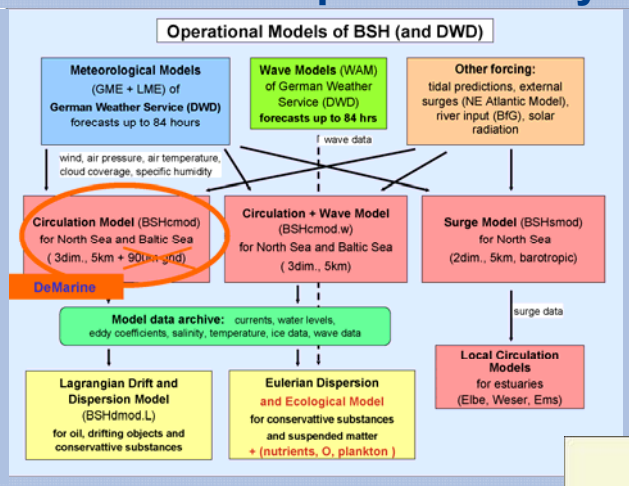
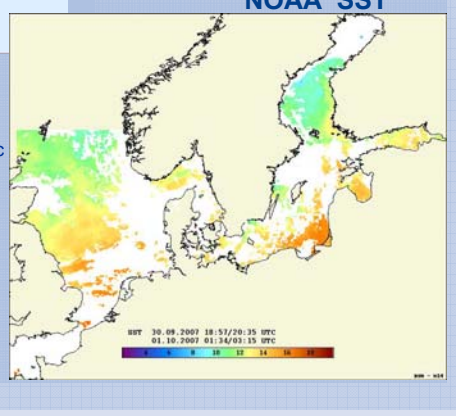
Operational System



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

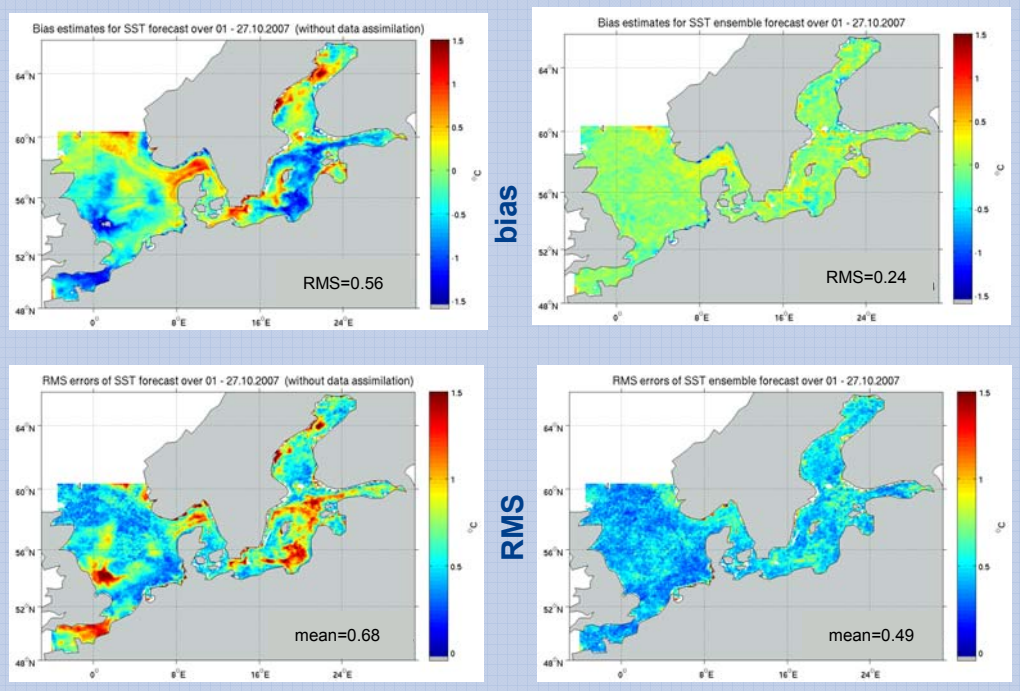


The Circulation Model (BSHcmod V.4)

- 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}=1.8°C, equal data weights (EQU);

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

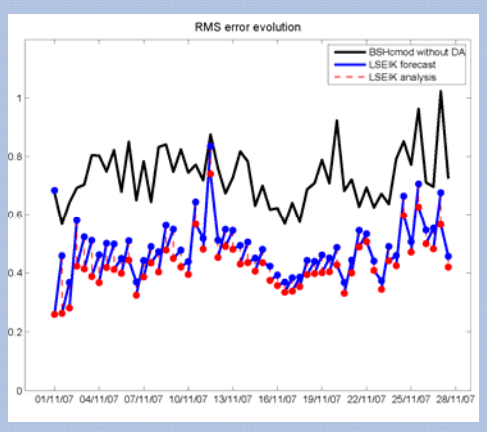
• Initial model variance/covariance matrix is computed using three months (10-12.2007) output from the BSH model run (12 hours snapshot).

• 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)

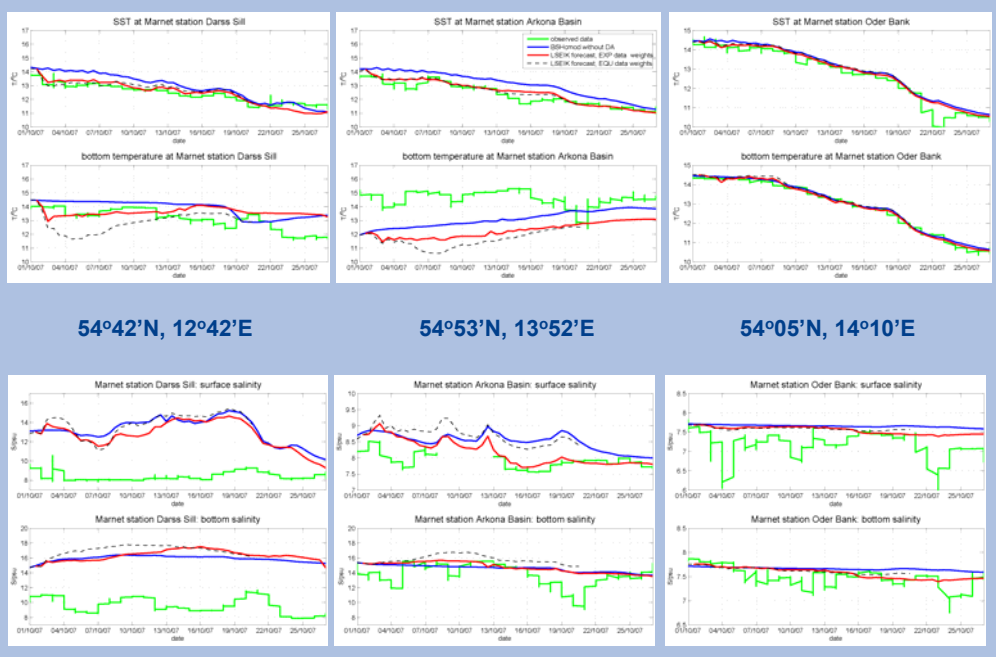
The best ensemble forecast



Temporal evolution of SST RMS error for BSHcmod forecast without DA (black); LSEIK analysis (red) and forecast (blue) with given r_l=20 gp and EXP data weghing.

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

Validation at MARNET stations



Time series of Temperature and Salinity at three of MARNET stations located along ~54.5°N between 6° and 15°E.