Assimilating NOAA SST data into BSH operational circulation model for North and Baltic Seas

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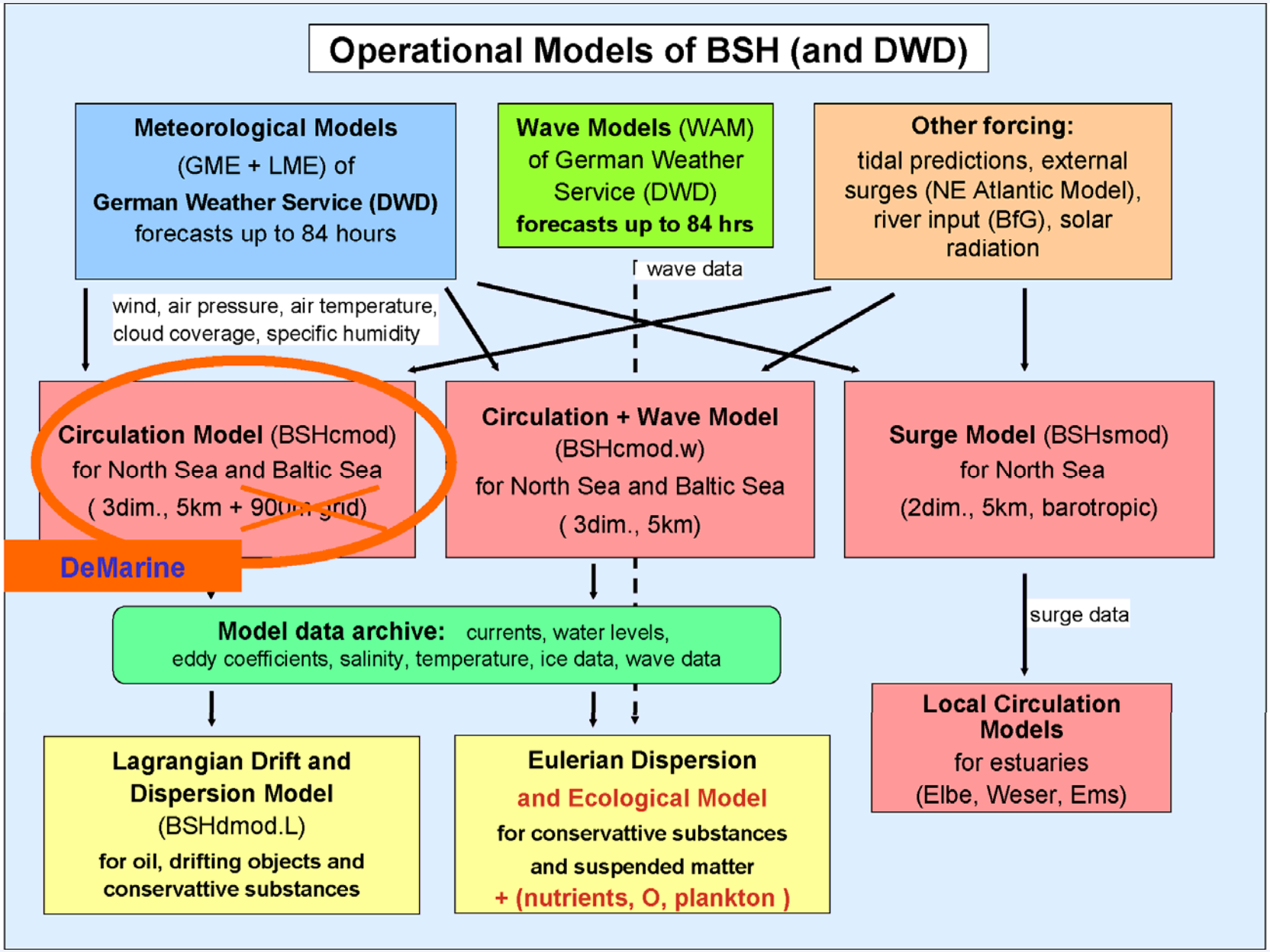

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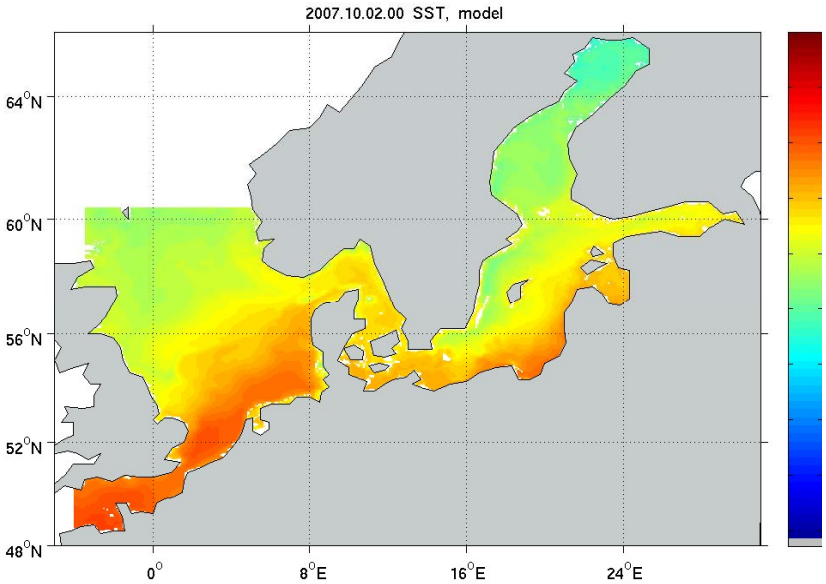
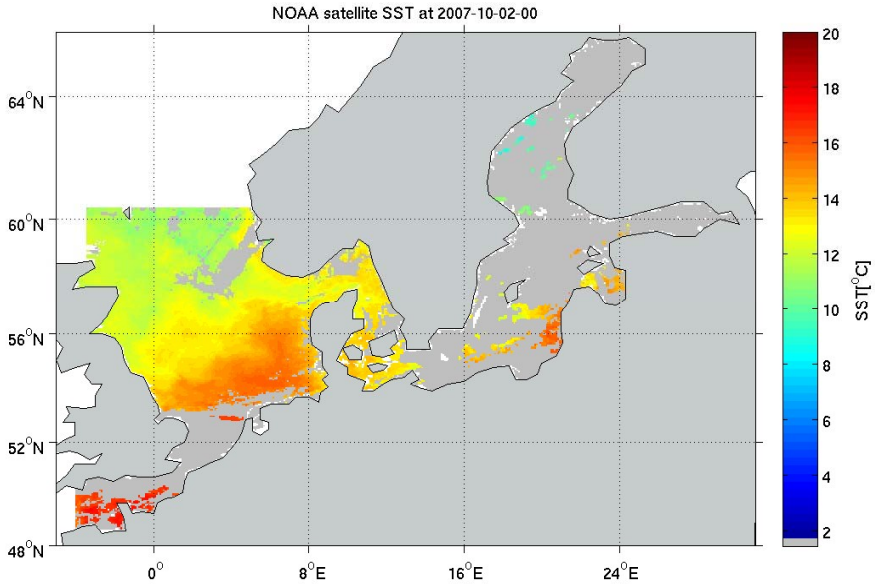
Assimilating SST data

Operational BSHcmod (Version 4)

NOAA data





Extraction and combination of the information from two different sources - the model and the data - in order to improve our understanding of both sources and, therefore, of reality itself

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Assimilation algorithm

$$\mathbf{w}_k^a = \mathbf{w}_k^f + \mathbf{K}_k(\mathbf{w}_k^o - \mathbf{H}_k\mathbf{w}_k^f),$$

$\mathbf{w}_k^f$, $\mathbf{w}_k^a$ denote forecast and analysis of ocean state vector consisting of temperature, salinity, SSH and velocity fields at time t_k at all grid points;

$\mathbf{w}_k^o$ - temperature satellite observation available at t_k

$\mathbf{P}_k^f$ - forecast error covariance matrix is time evolving error covariance matrix derived from ensemble of model states, multivariate, nonstationary, nonisotropic.

$\mathbf{R}_k$ - observational error covariance matrix

$$\mathbf{K}_k = \mathbf{P}_k^f\mathbf{H}_k^T(\mathbf{H}_k\mathbf{P}_k^f\mathbf{H}_k^T + \mathbf{R}_k)^{-1}$$

Implementation

- DA Method: Local SEIK (LSEIK) filter algorithm (Nerger et al., 2006) with different localization techniques

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

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

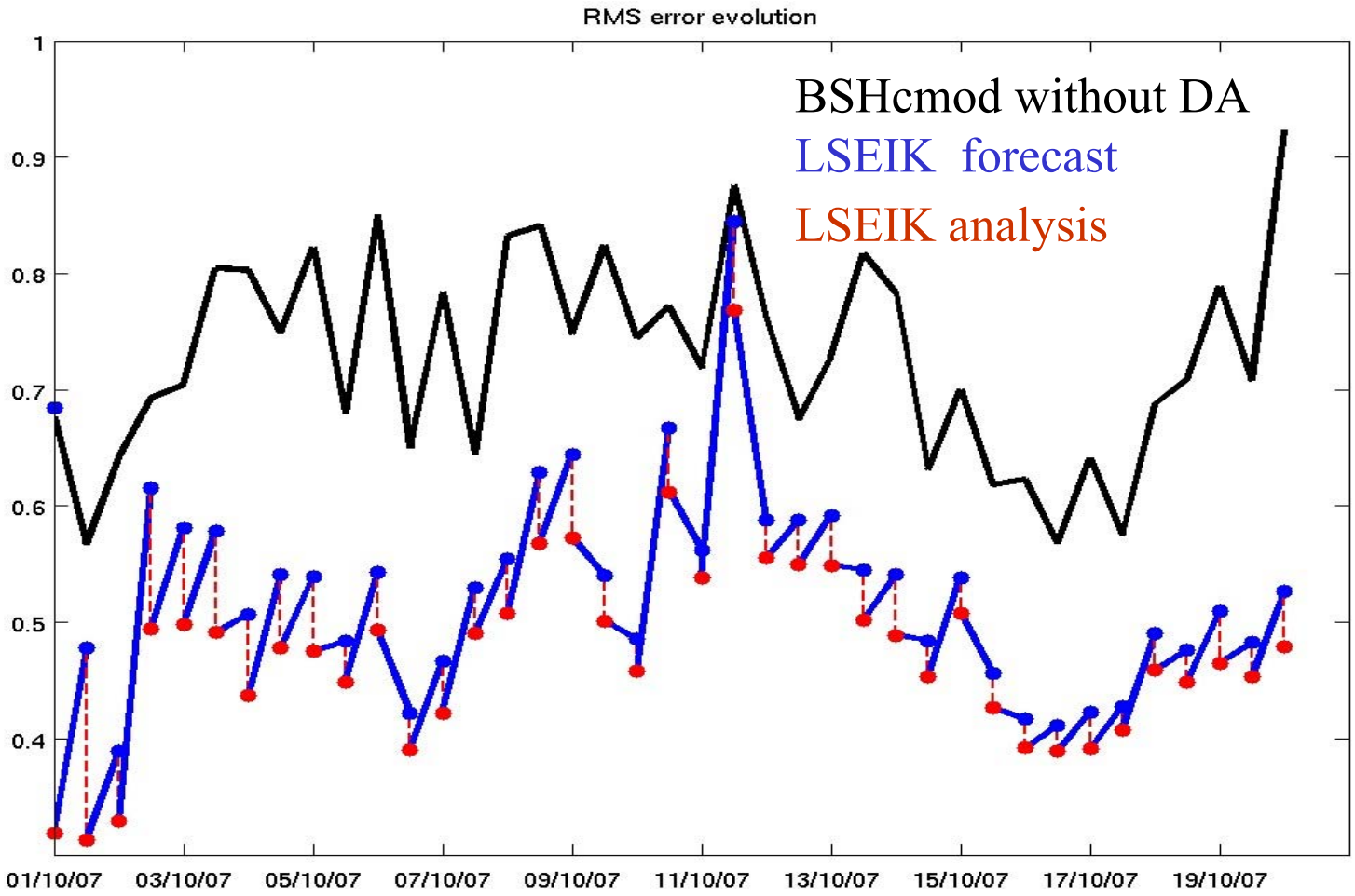
- Initial model variance/covariance matrix is computed using three months (10-12.2007) output [T, S, SSH, u, v] from the BSH model run (12 hours snapshot).
- First 8 EOFs are used to generate an ensemble (8 members) of model states (temperature, salinity, current velocities, sea surface elevation).
- NOAA SST data are assimilated every 12 hours.

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

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

Assessing SST forecast

Temporal evolution of SST RMS error for BSHcmod forecast



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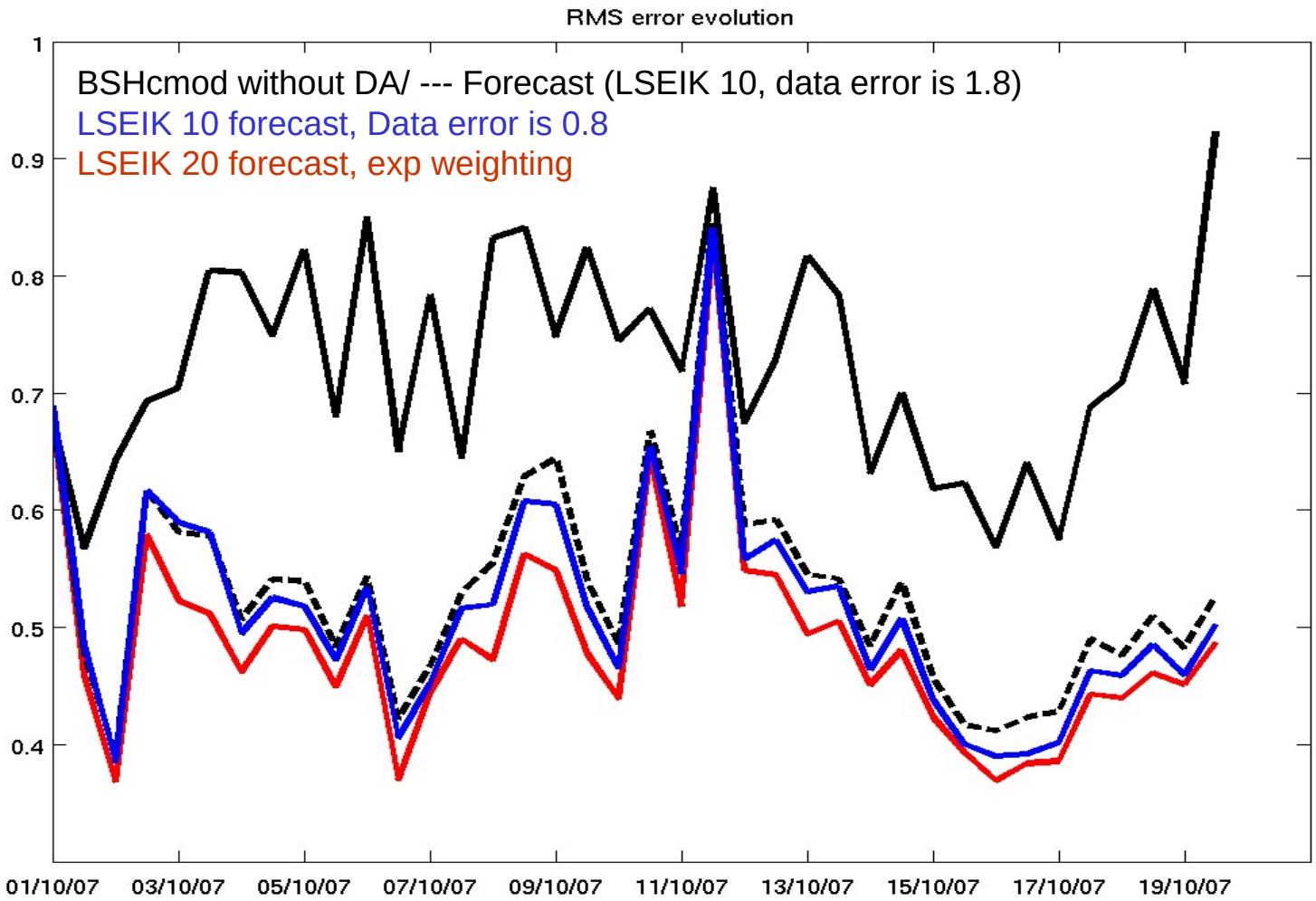
Assessing SST forecast

Temporal evolution of SST RMS error for BSHcmod forecast



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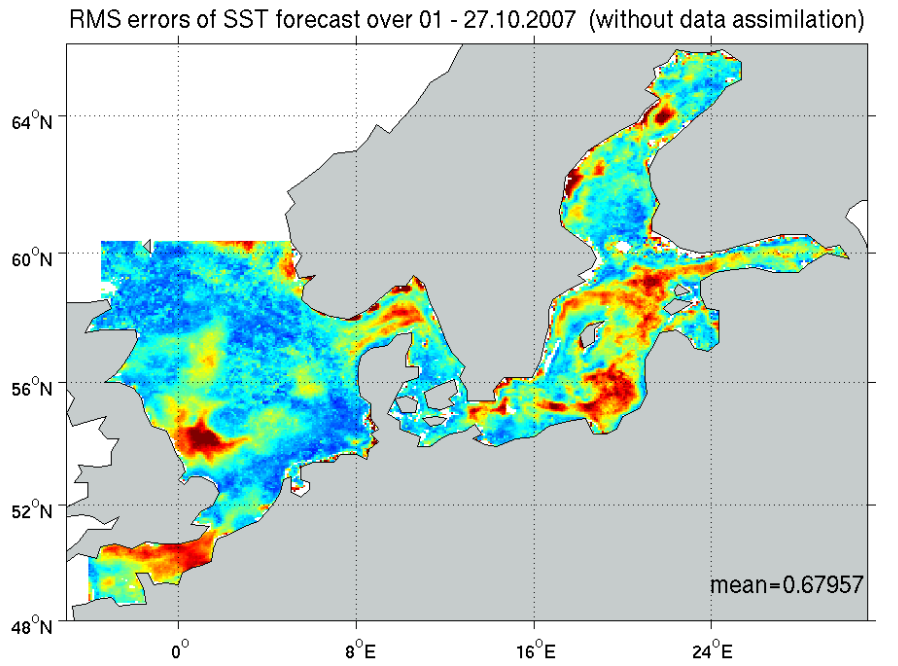
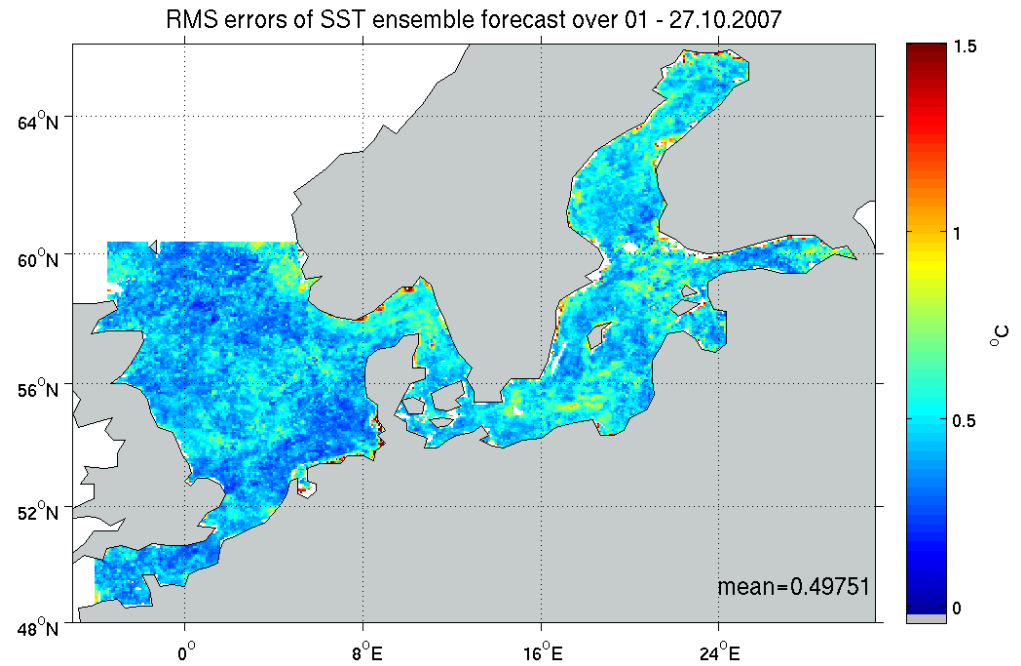
Improvement of SST forecast in the North and the Baltic Seas when sequentially assimilating satellite data

➢ RMS without DA with LSEIK filter





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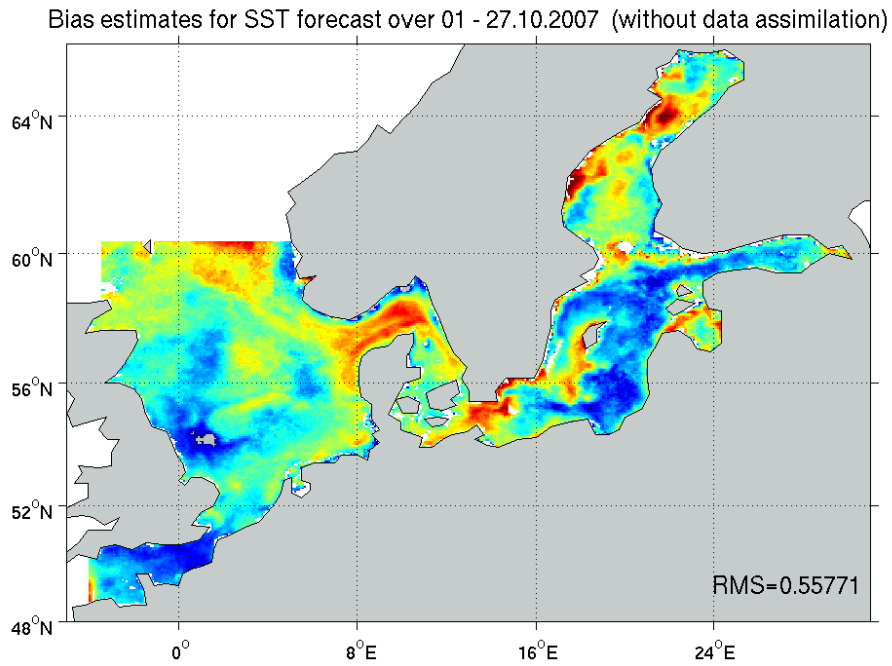
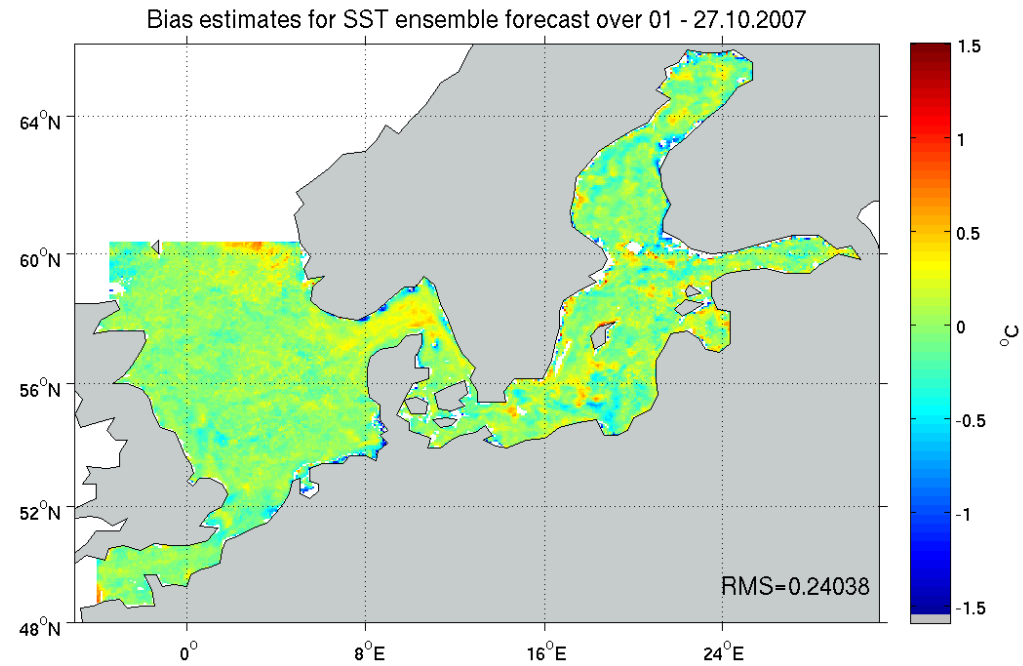
Improvement of SST forecast in the North and the Baltic Seas when sequentially assimilating satellite data

➢ Bias without DA with LSEIK filter





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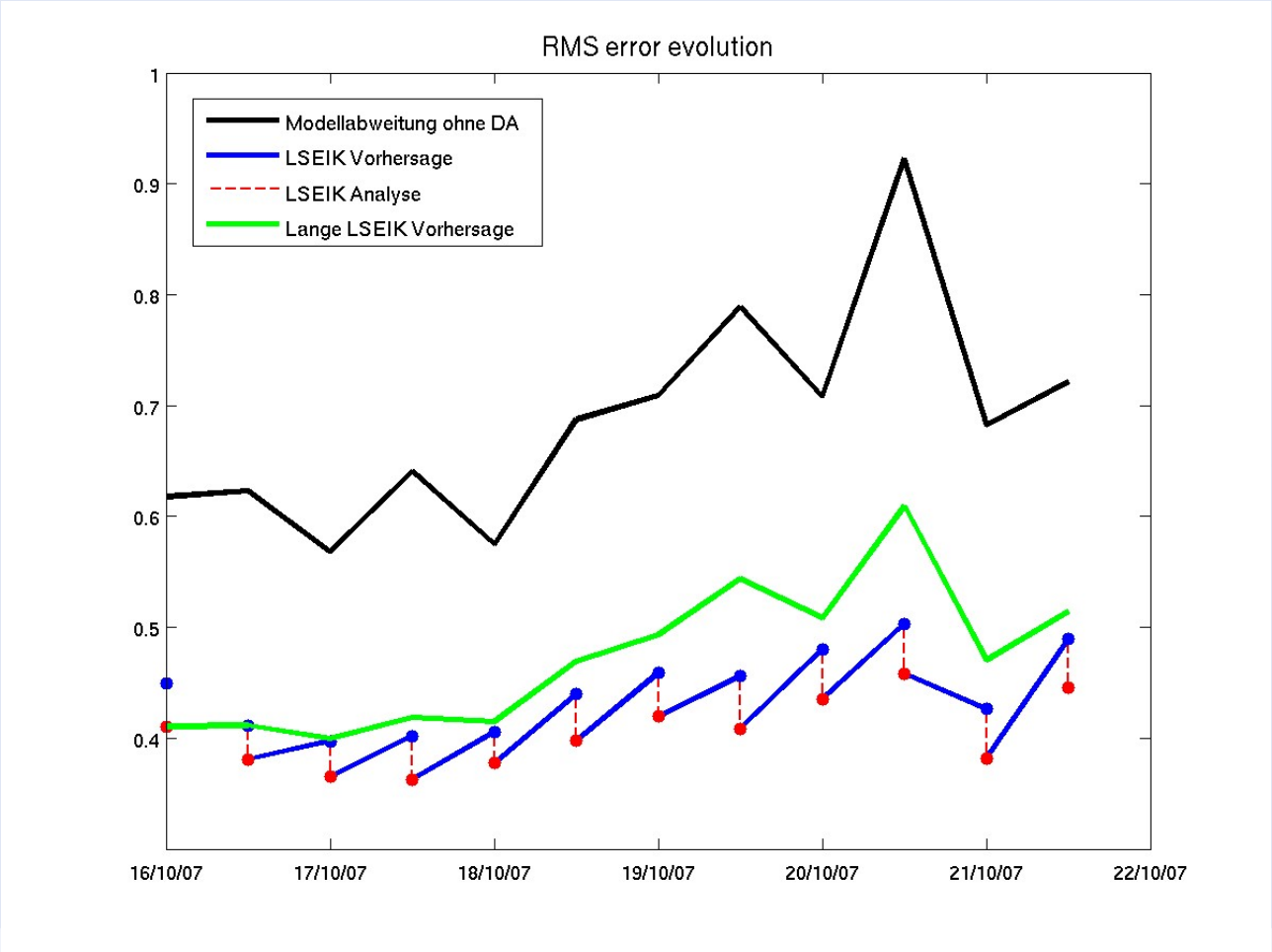
Long forecast (~ 120 hours)

Temporal evolution of SST RMS error for BSHcmod forecast



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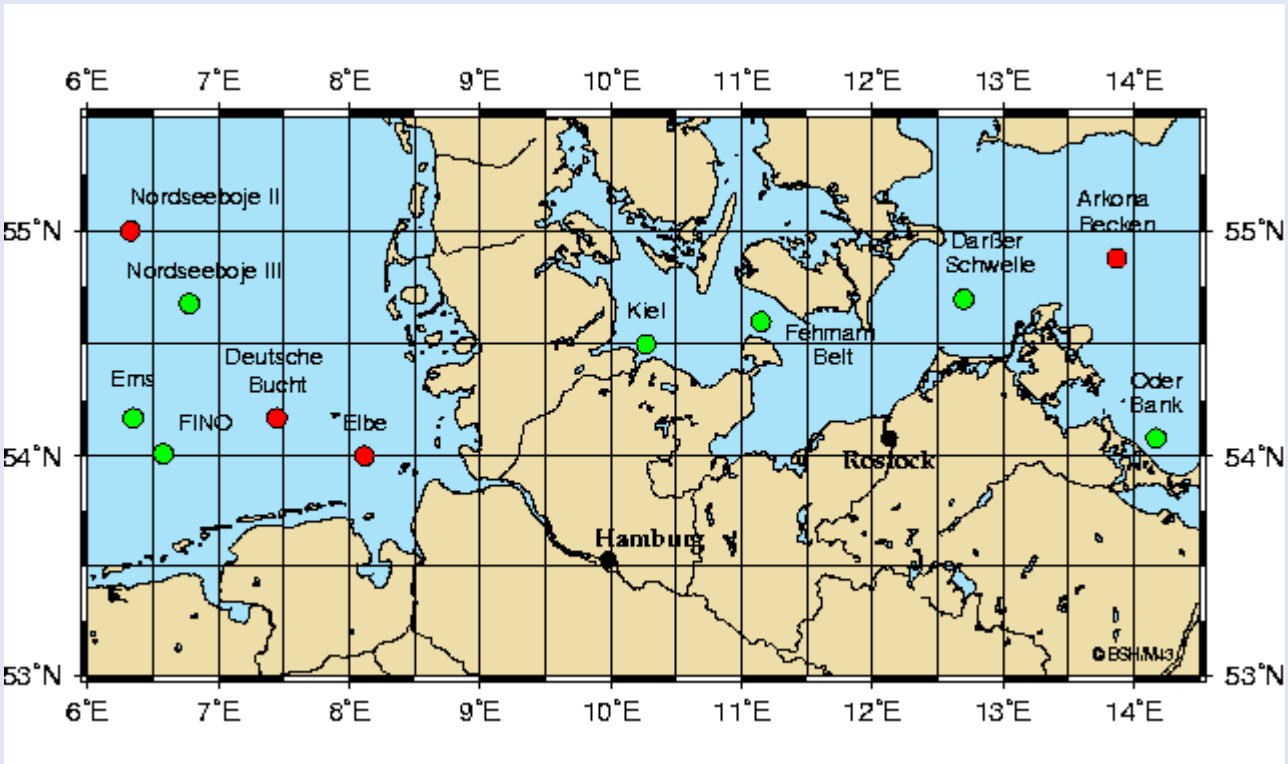
MARNET stations



Arkona See

Oder Bucht

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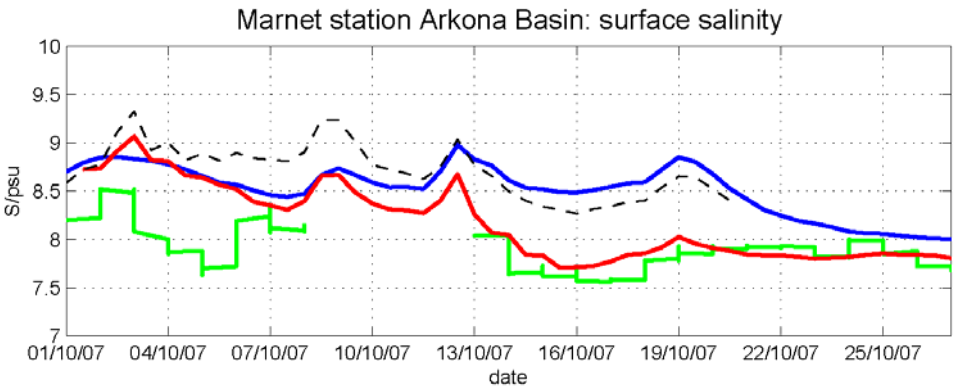
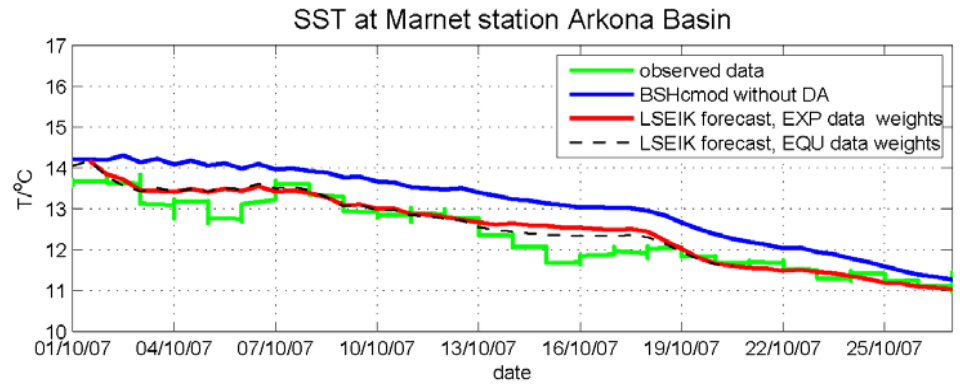
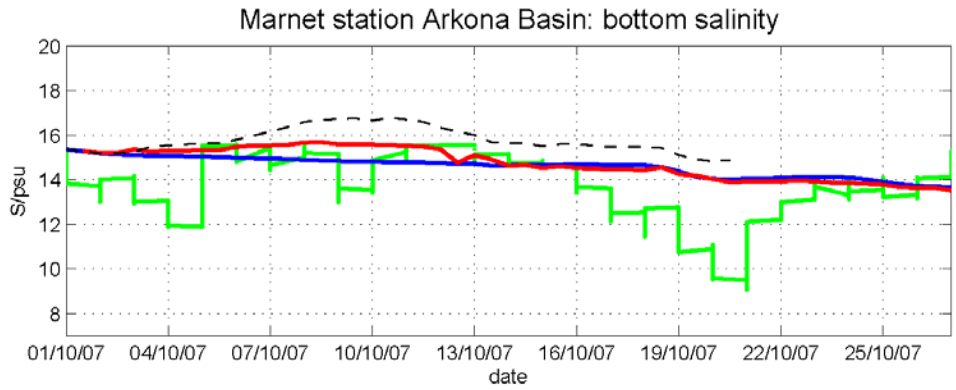
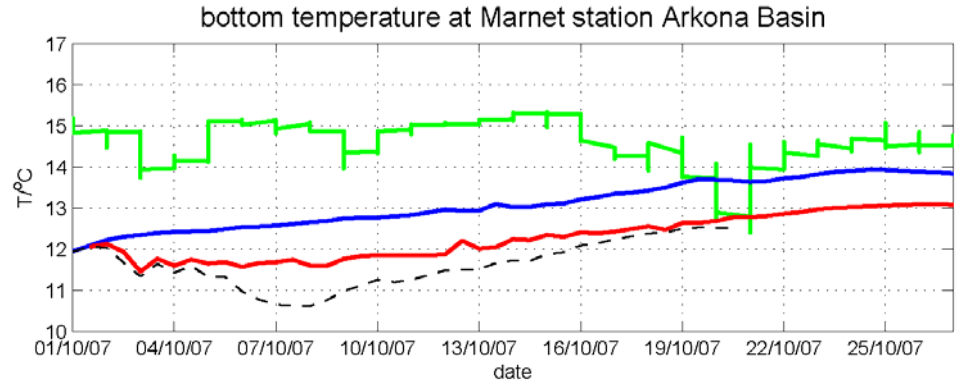
Validation at MARNET stations

- MARNET Station Salinity and Temperature (Arkona Basin)









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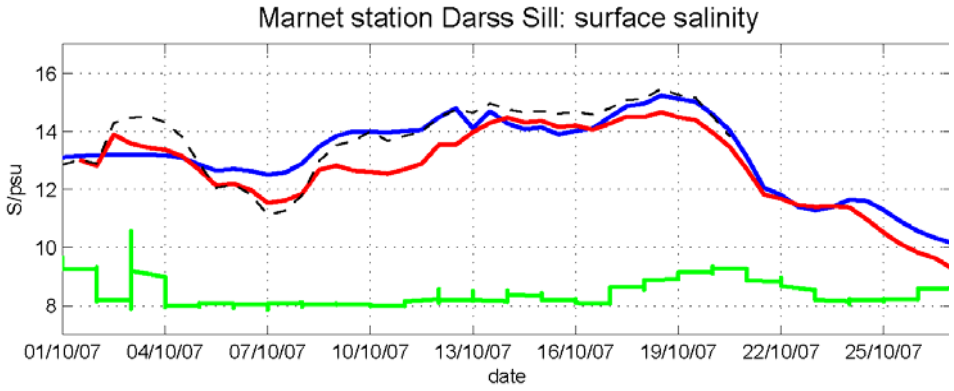
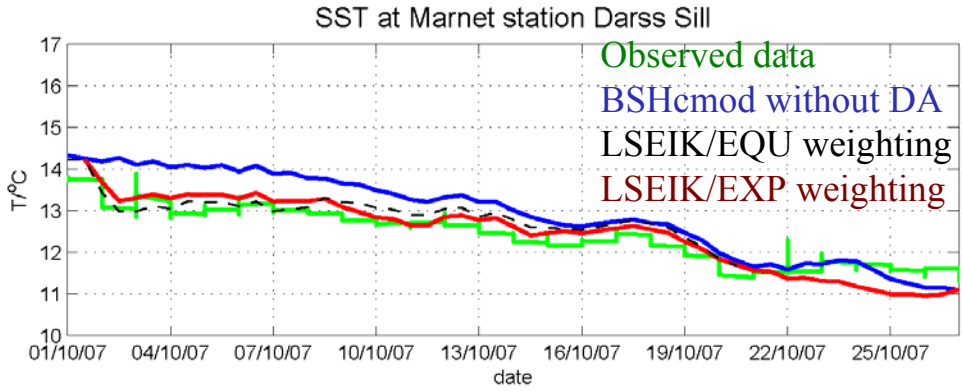
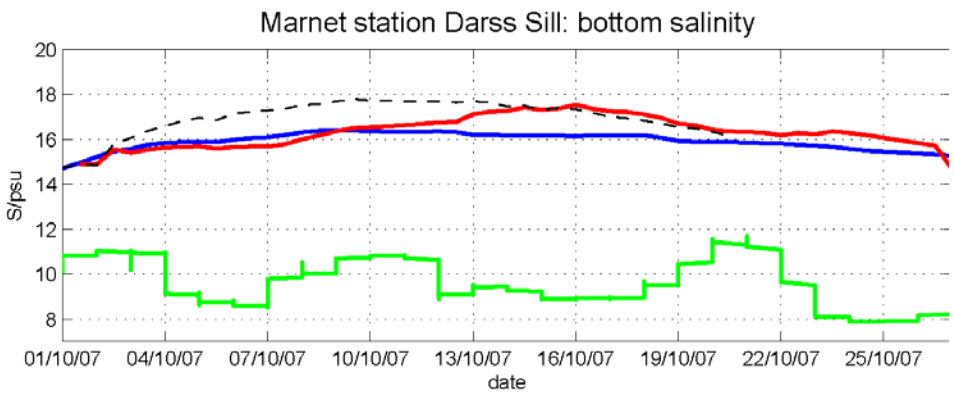
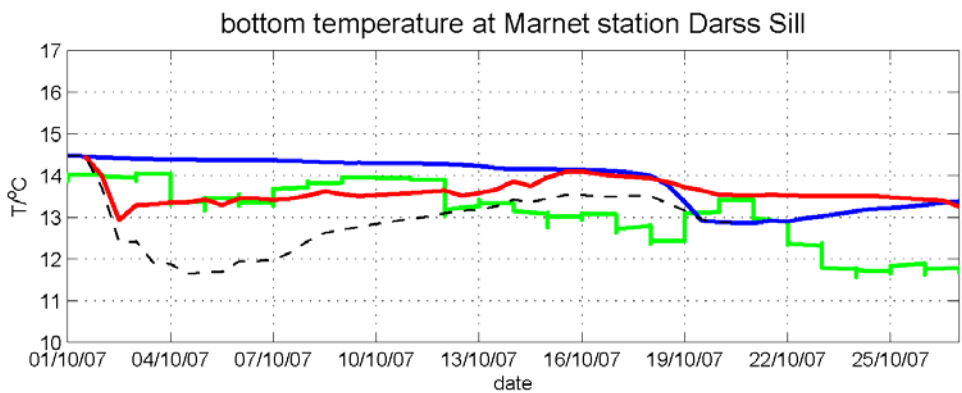
Validation against independent data

- MARNET Station Salinity and Temperature (Darß Sill)









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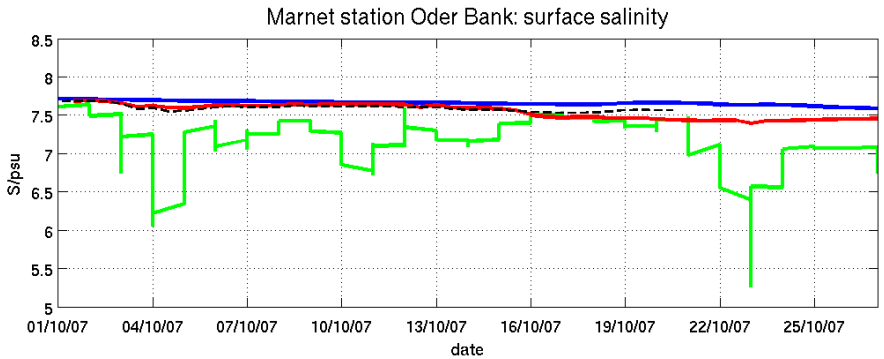
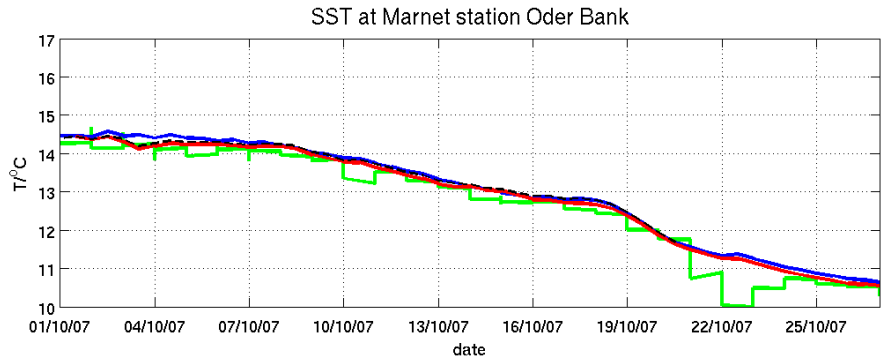
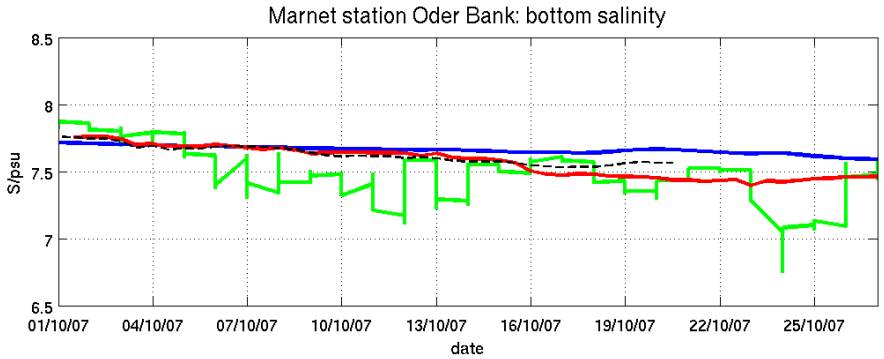
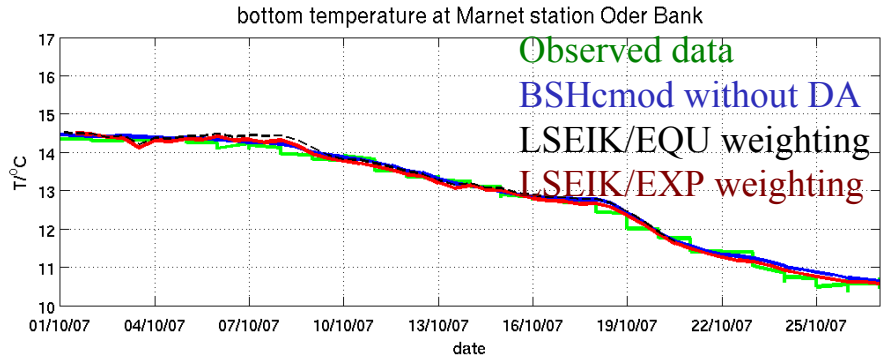
Validation against independent data

- MARNET Station Salinity and Temperature (Oder)









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Conclusions

- LSEIK Filter has been implemented for NOAA SST data assimilation into operational BSHcmod and validated for October 2007 (the period 1.10.2007 – 8.03.2008).
- The SST forecast has been improved (the best results have been achieved with the assumption of data error to be 0.8oC and exp weighting and radius of data influence equal to 20 gp)
- The major improvement is the bias reduction.
- Possibility of long SST forecast (120 hours).
- Comparison with independent MARNET temperature and salinity time series also indicates the improvement in SST forecast, but for bottom temperature and salinity at few stations some problems remain.
- Future work will include assimilation of the Darβ Sill MARNET station temperature and salinity data.