COSS-ICW4, Lisbon, 31.8. – 4.9.2015

The HBM-PDAF assimilation system for forecasts of physics and biogeochemistry in the North and Baltic Seas

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BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

DeMarine

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Motivation

- BSH (German Federal Maritime and Hydrographic Agency)
  - produces and issues forecasts for North and Baltic Seas already for many years
  - Based on a set of numerical models (circulation, drift, surges, waves)
- At beginning of DeMarine project (2008):
  - no data assimilation yet applied (but very good forecasts anyway)
- Apply data assimilation to improve forecasts

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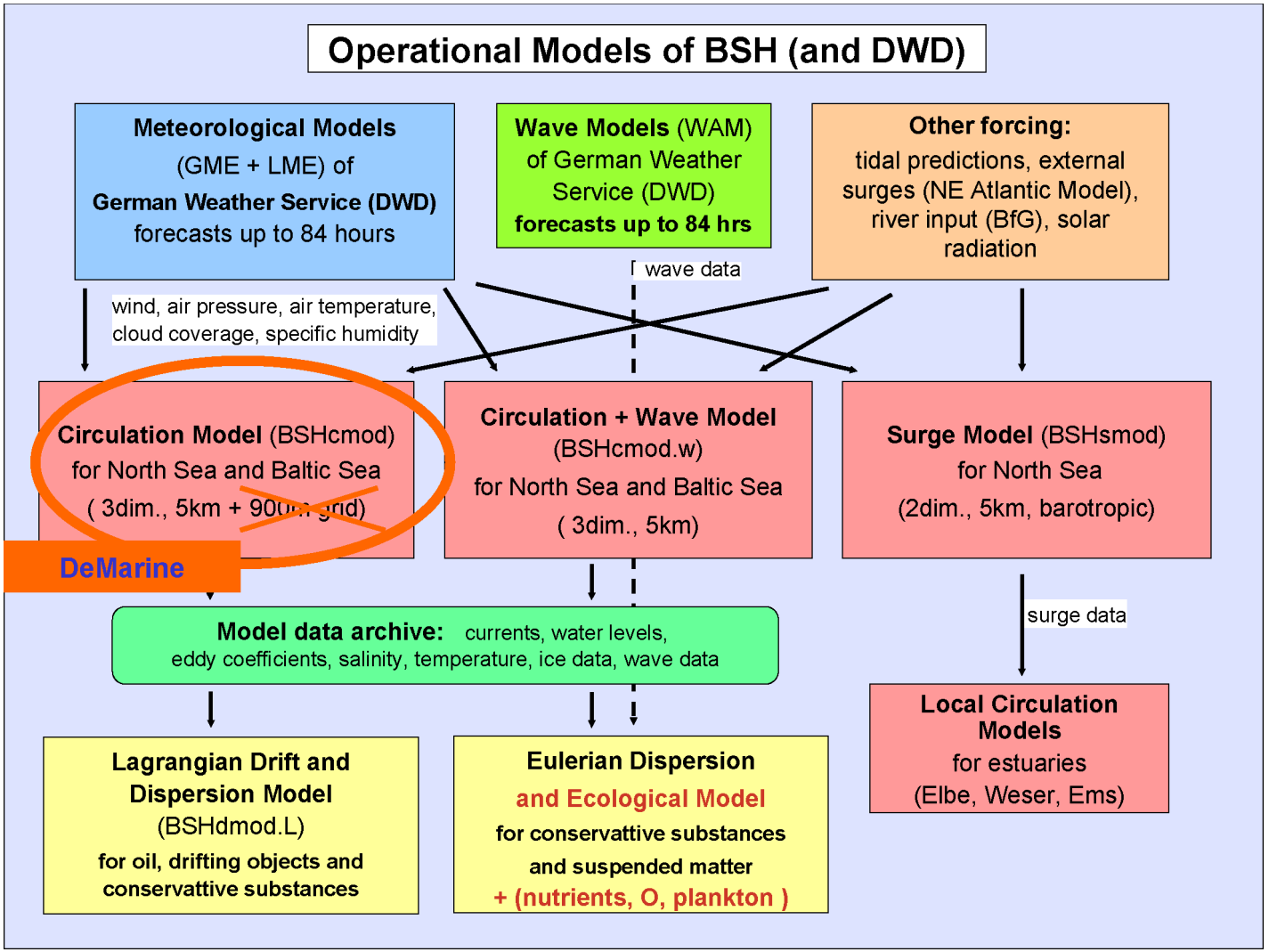
Operational models at BSH



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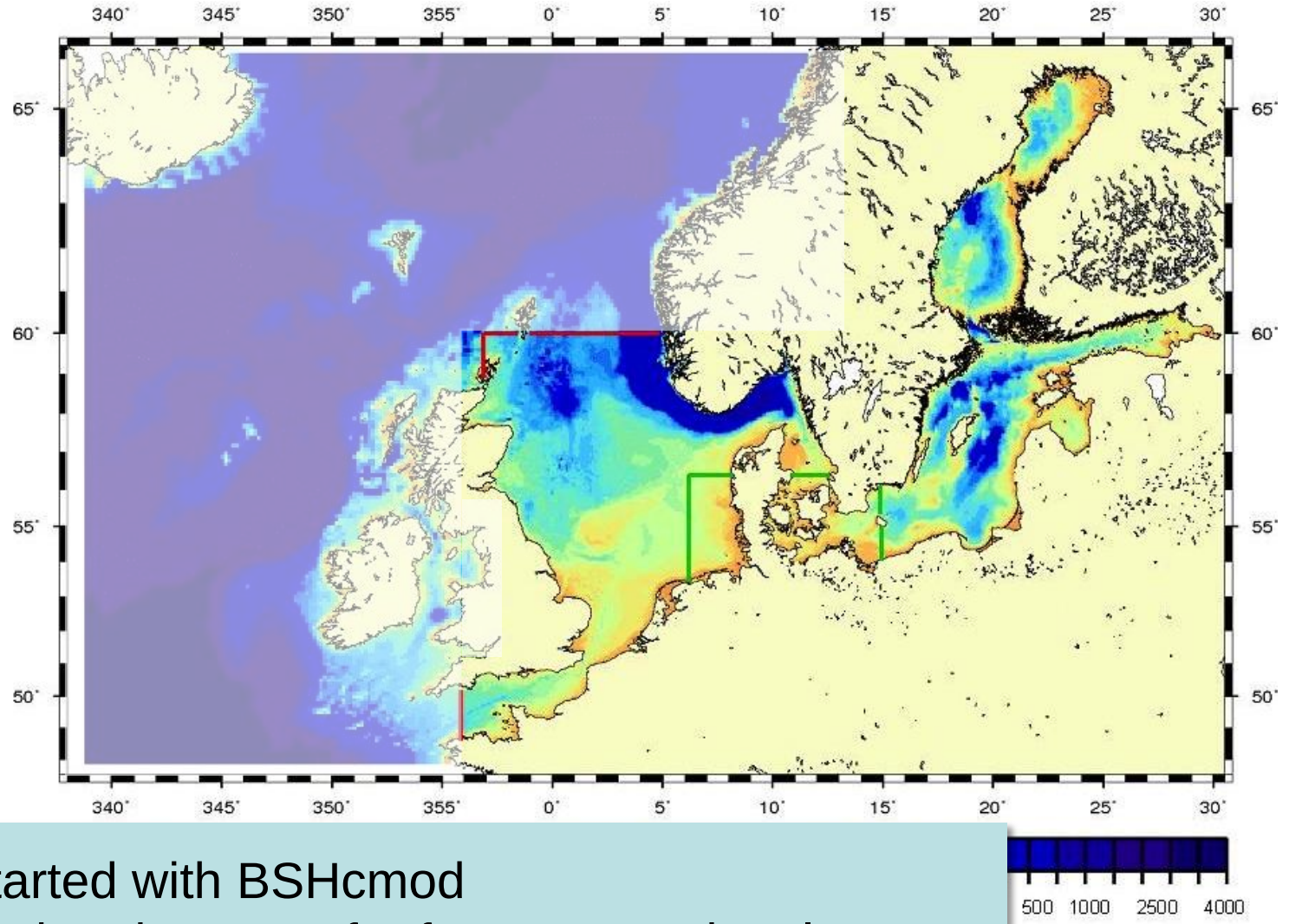
Starting point: Operational BSH Model (BSHcmod), V4

Grid nesting:

- **10 km grid**
- **5 km grid**
- **900 m grid**

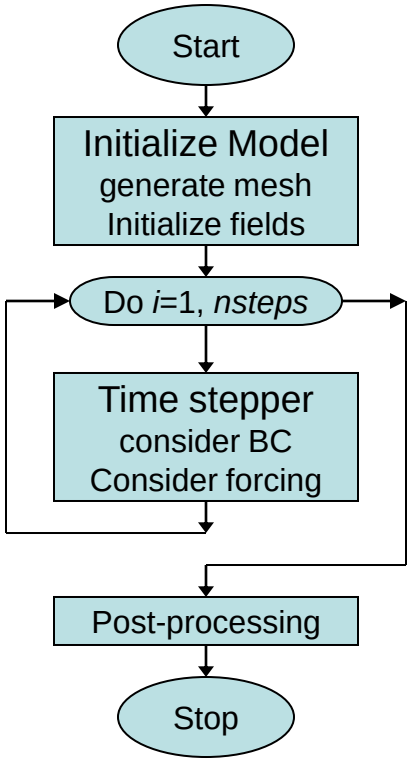


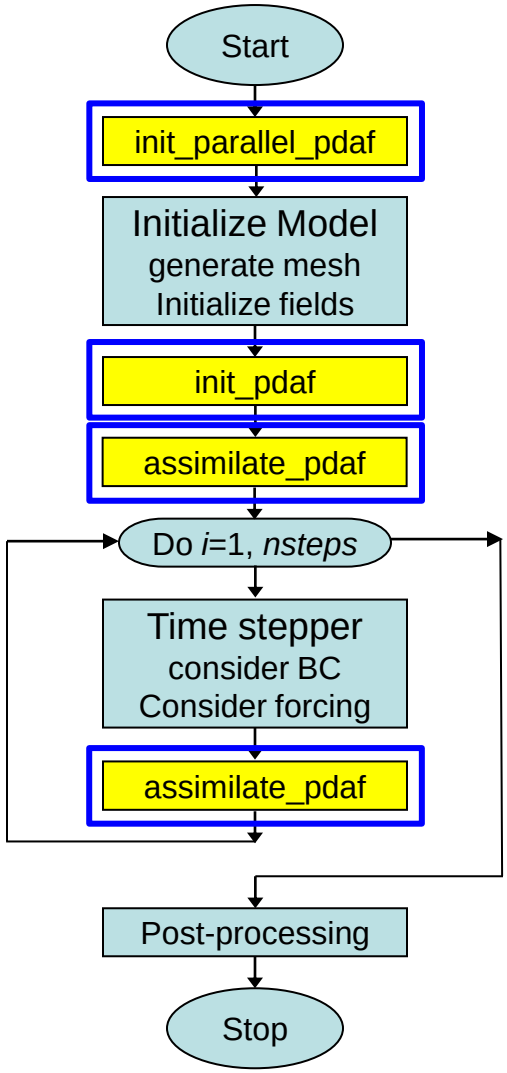
- started with BSHcmod
- updated to HBM for future operational use

Extending a Model for Data Assimilation

PDAF Parallel Data Assimilation Framework

Model





Extension for data assimilation

plus:
Adapt writing of sponge files

Enable ensemble forecasts using parallelization

PDAF: A tool for data assimilation

PDAF Parallel Data Assimilation Framework

PDAF - Parallel Data Assimilation Framework

- provide support for ensemble forecasts
- provide fully-implemented parallelized filter algorithms
- easily useable with (probably) any numerical model (coupled also to NEMO, MITgcm, FESOM, ADCIRC)
- separate development of model and assimilation algorithms
- makes good use of supercomputers

Open source:
Code and documentation available at

http://pdaf.awi.de

BSH
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L. Nerger, W. Hiller, Computers & Geosciences 55 (2013) 110-118

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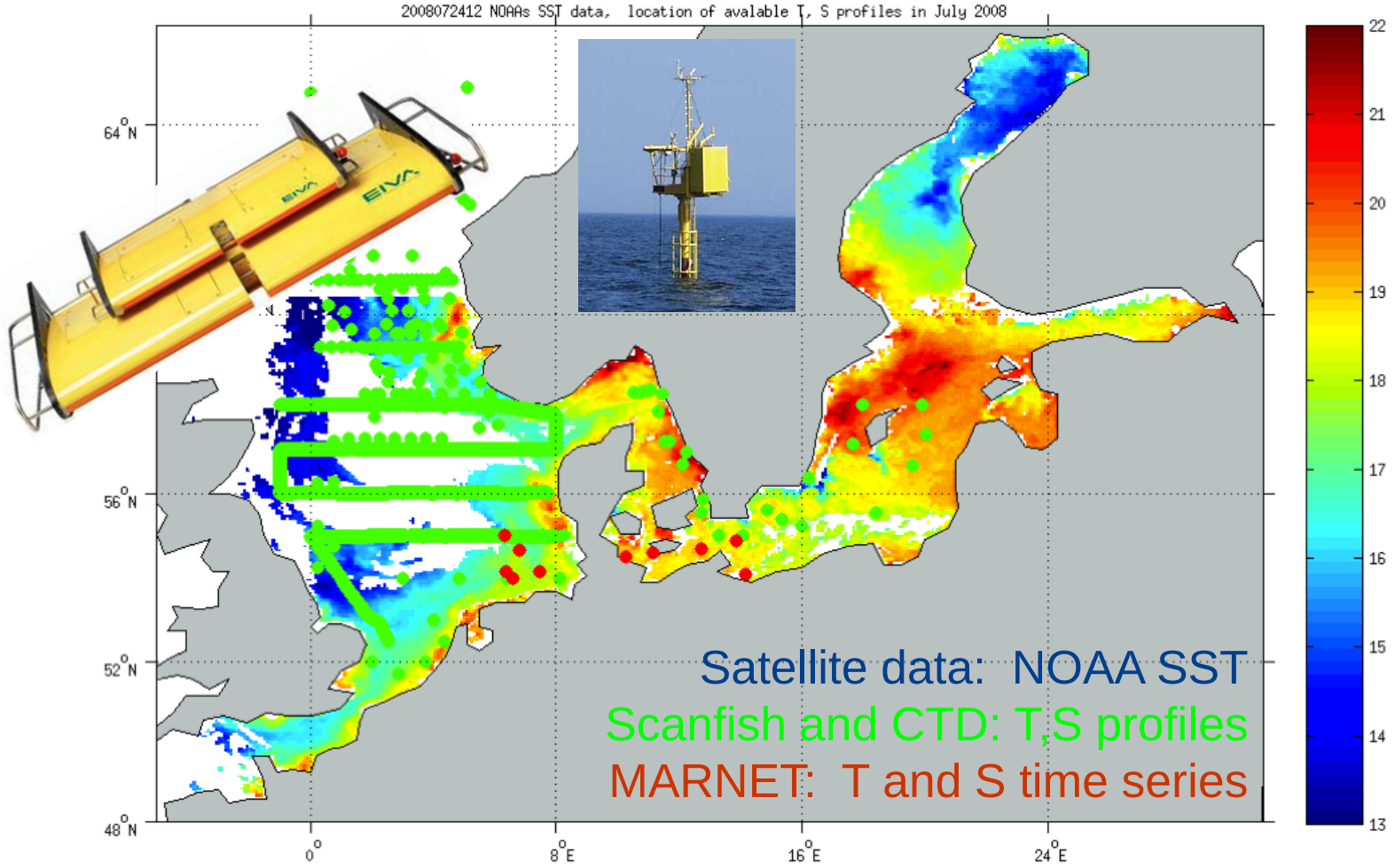
Assimilated Data – Satellite, MARNET and profiles



SST:

- AVHRR data from NOAA satellites
- 12-hour composites
- Strongly varying data coverage

Lars Nerger et al. – HBM-PDAF Assimilation System

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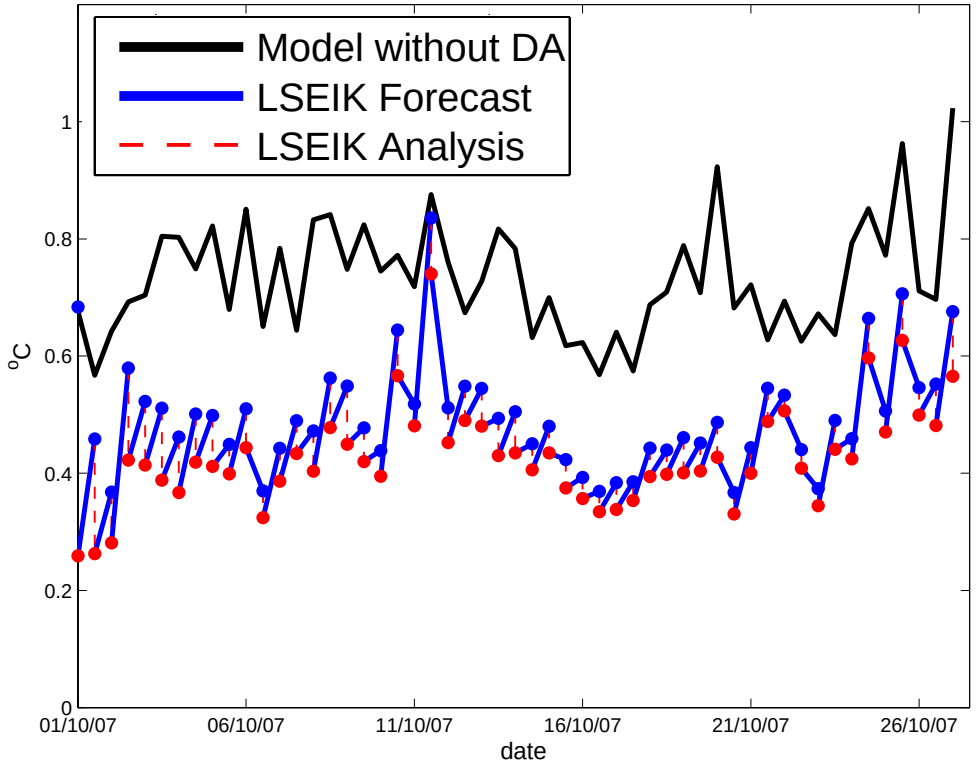
Assimilation influence on surface temperature

RMS error for SST over time



- Ensemble Kalman filter (SEIK with localization)
- Ensemble size 8
- Assimilate each 12 hours

- Reduction of SST error by 0,3ºC
- Similar in pre-operational setting on 2011

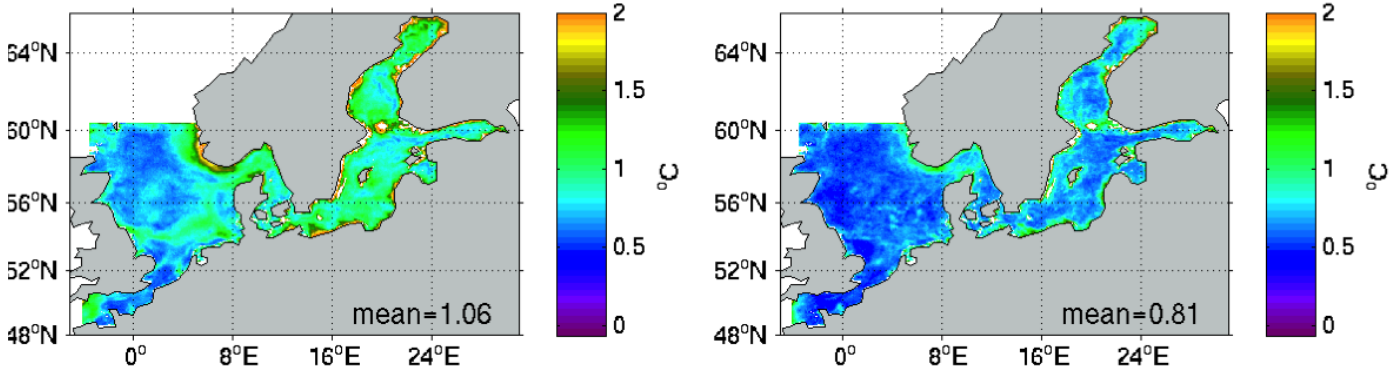
Deviation from NOAA Satellite Data

- RMS errors and bias for SST in 12-hour forecasts
- Average over 1 year (10/2007 – 9/2008)

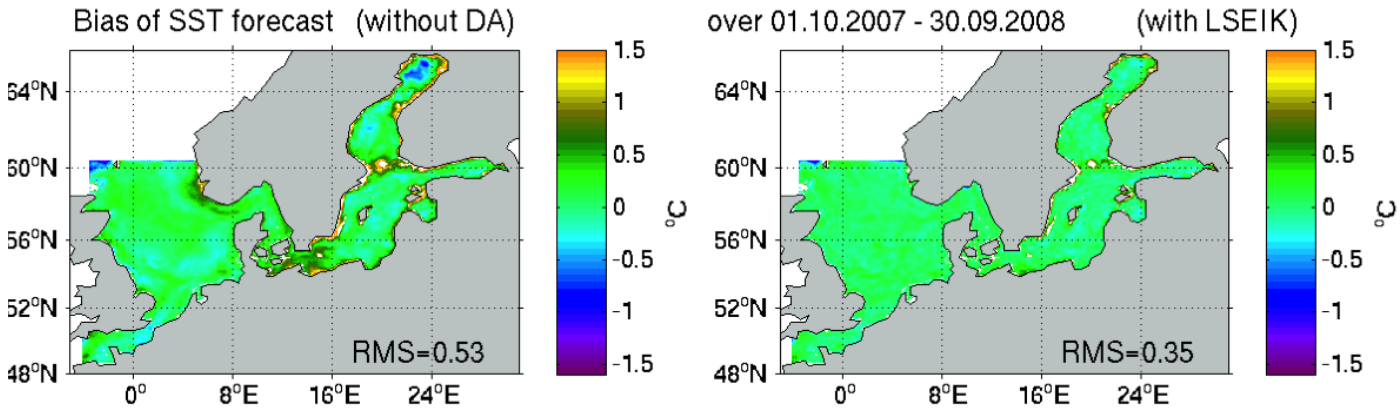
No assimilation

SST assimilation

RMS errors



bias



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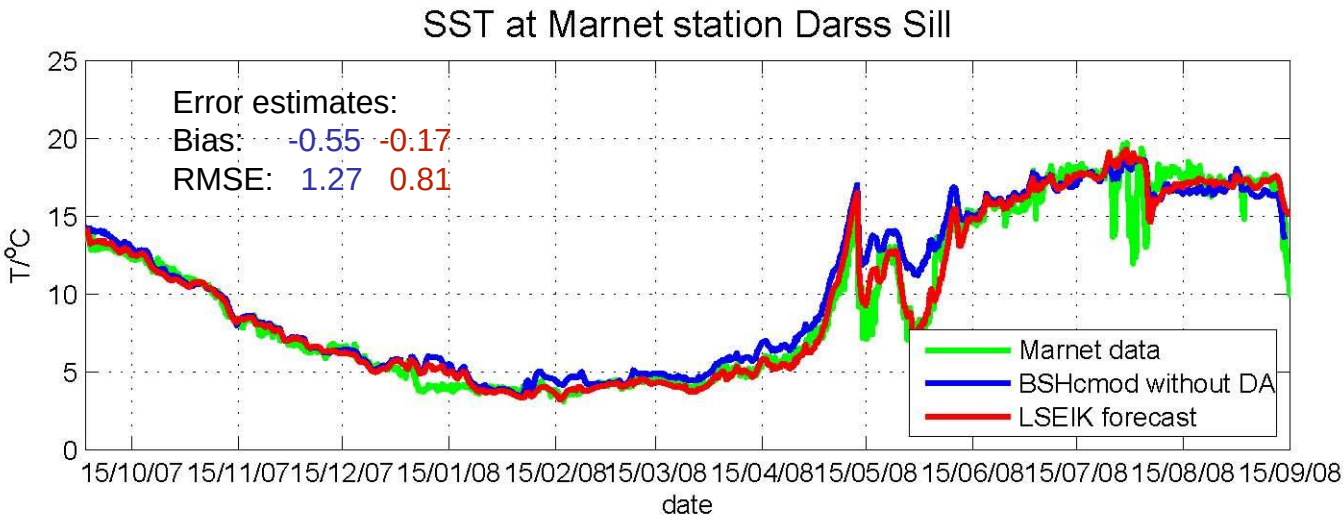
Validation with independent data

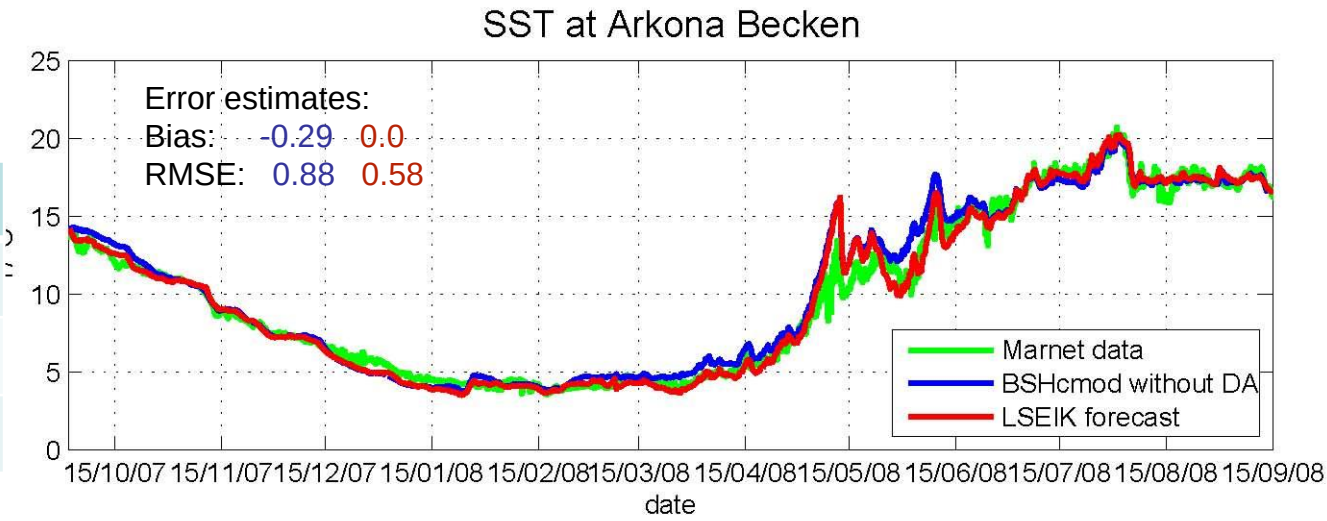
MARNET station data not assimilated here

- Reduction of
  - Bias
  - RMS error



1 year mean over 6 stations:

	RMSe	bias
free	0.87	0.3
data	0.59	0.11
assim.	0.55	0.08



Red: Assimilation 12h forecasts

Forecast improvements

black: free model run

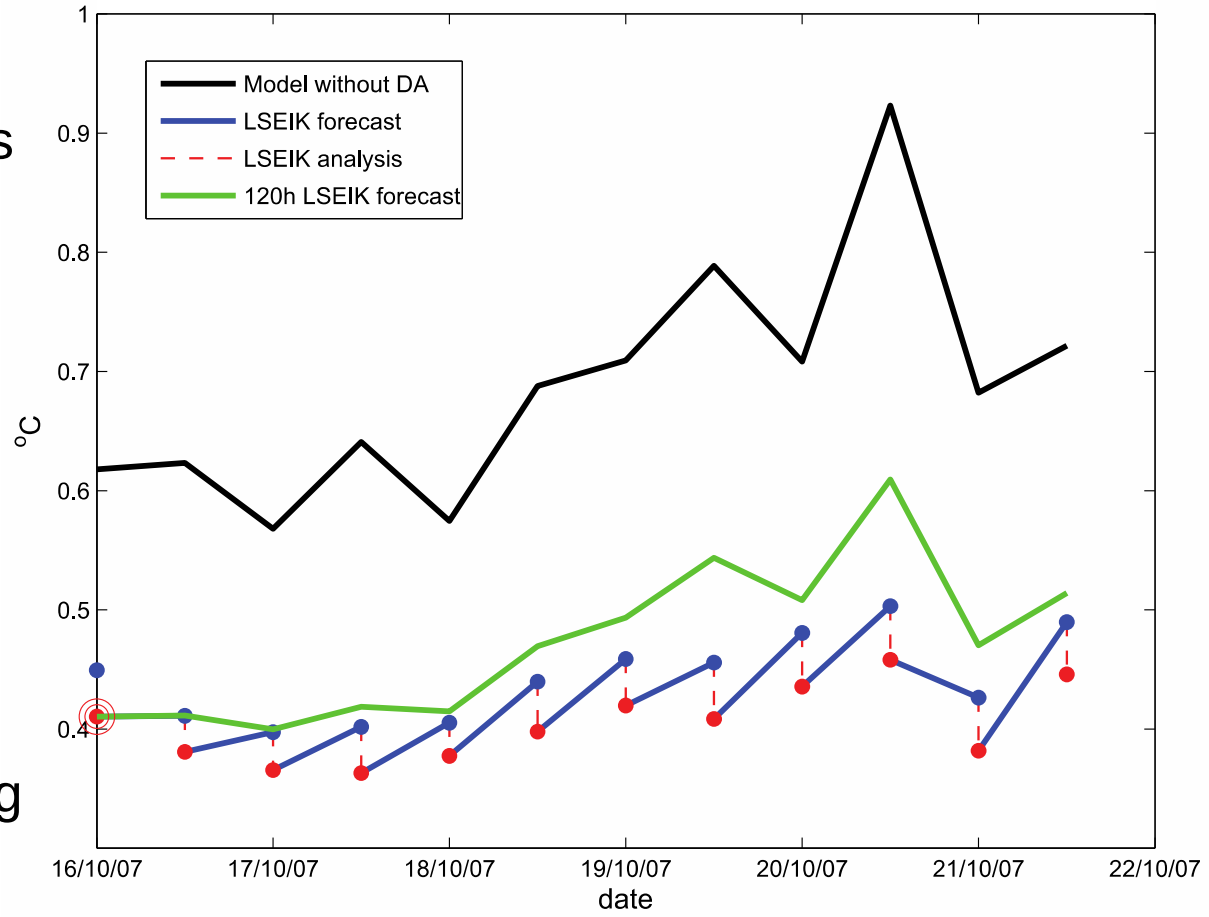
blue/*red*: 12h assimilation/analysis cycles

green: 5 day forecast from 16/10

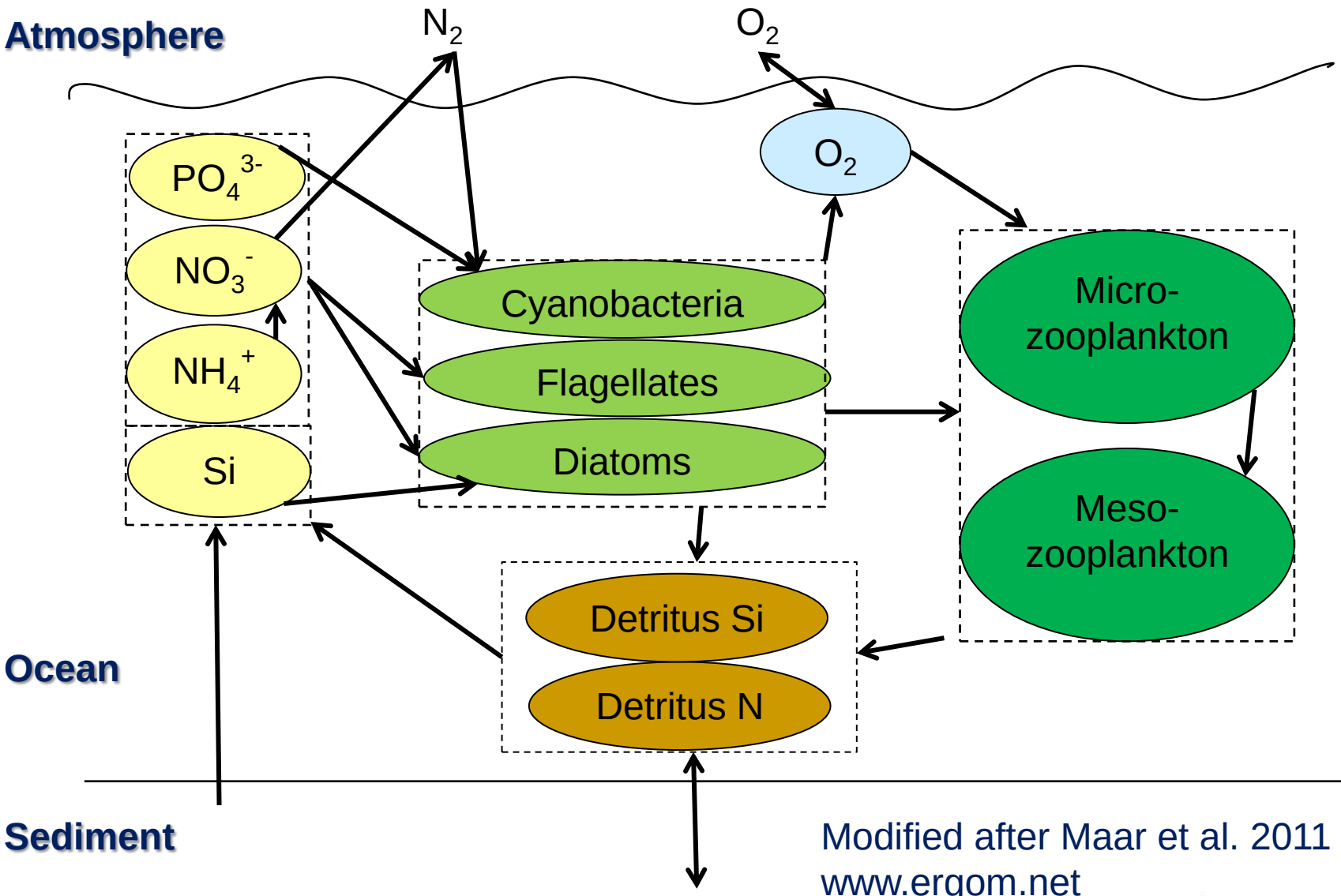
➜ Very stable 5-day forecasts

➜ Sometimes strong tendency to free running model afterwards

RMS error for SST over time



Biogeochemistry: ERGOM model

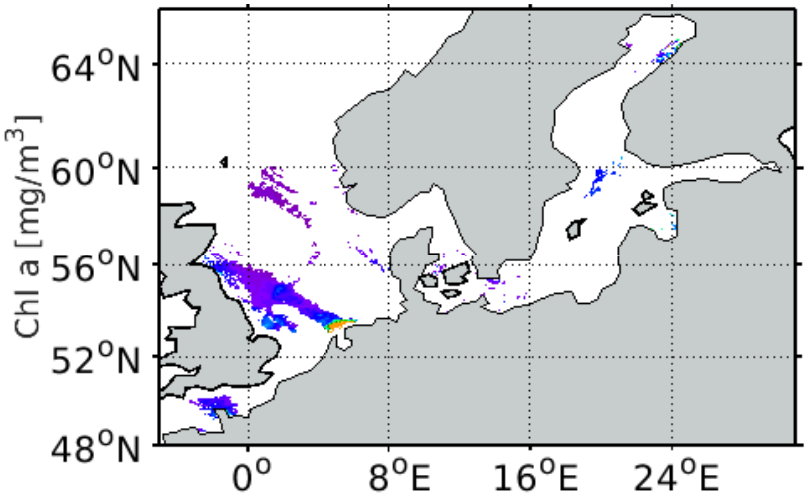


Modified after Maar et al. 2011
www.ergom.net

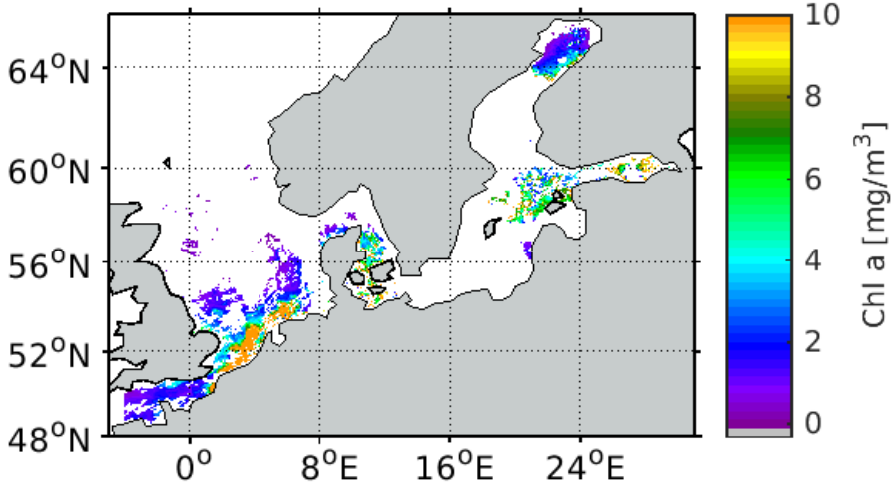
Observations: Chlorophyll from MODIS sensor

- Processing by Brockmann Consult in Germany
- Use 12-hour composites
- Data coverage even worse than SST from NOAA satellites

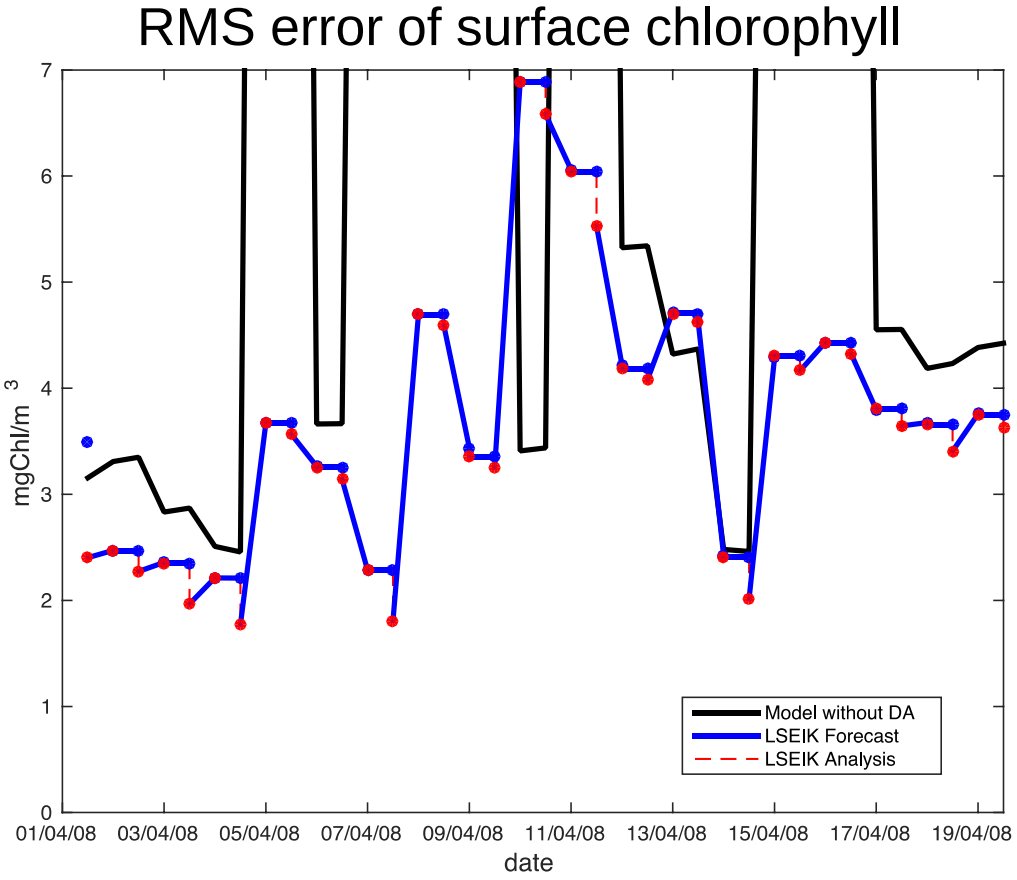
April 2, 2008



April 12, 2008



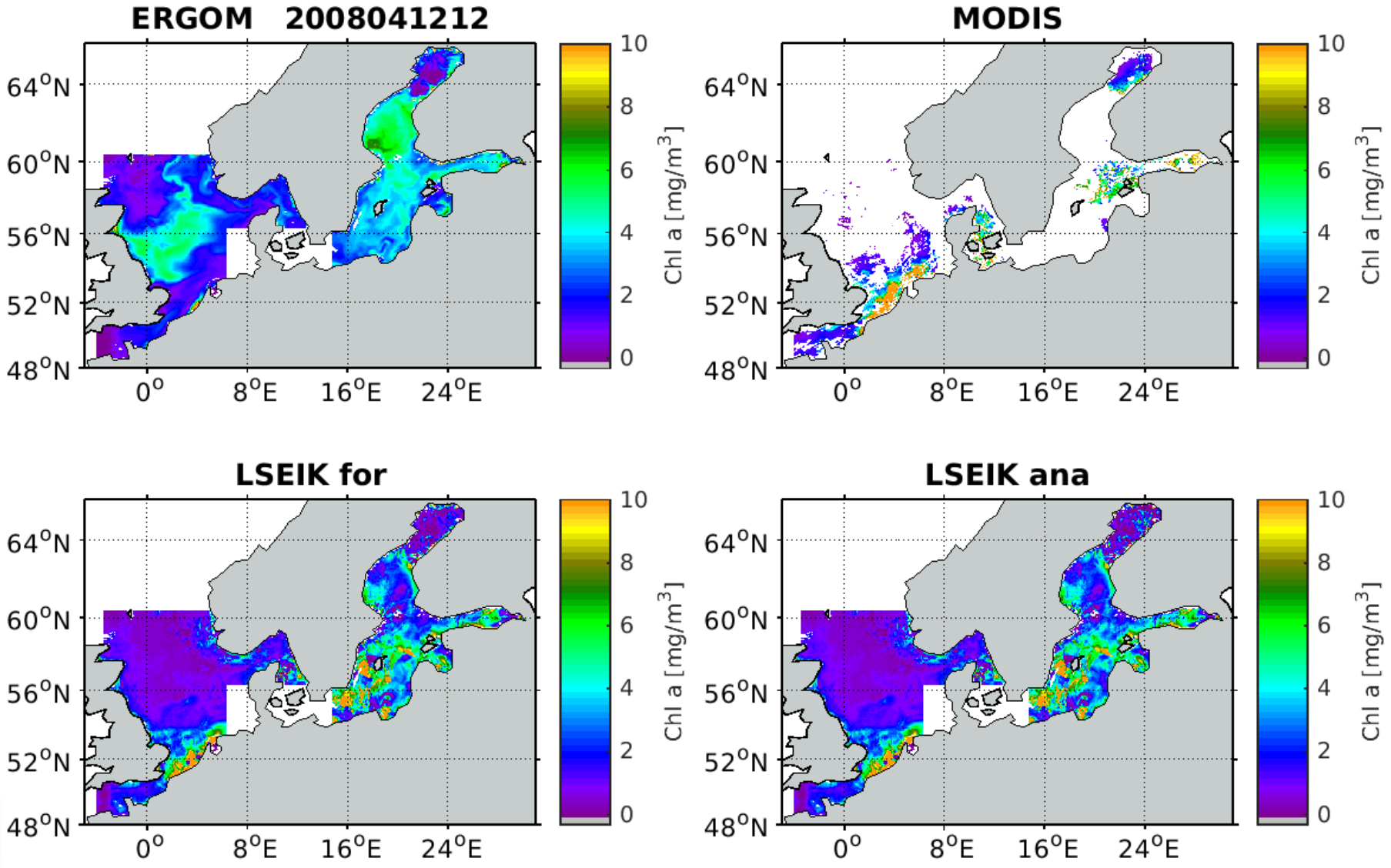
RMS errors of chlorophyll



- Ensemble Kalman filter (SEIK with localization)
- Ensemble size 48
- Assimilate each 12 hours
- Assumed data errors: 30% of concentration

- Large deviations of free model at some times
- Strong imrovement (stabilization) by assimilation of Chlorophyll data

RMS errors: Chlorophyll



Summary

HBM-PDAF system

- based on operational model and PDAF
- toward operational use
- assimilating satellite SST and profile T & S data
- extension for biogeochemistry: ERGOM model
- started assimilation of chlorophyll concentrations

Thank you!

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