Influence of temperature data assimilation on a biogeochemical ocean model for the North and Baltic Seas

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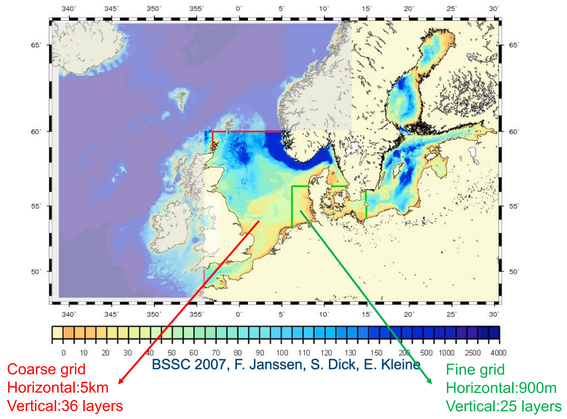
INTRODUCTION

The forecasting of physical and biogeochemical variables has always proven to be a challenge in marginal and coastal seas. Over the years, data assimilation has played a significant role in improving model accuracy for operational forecasting. In this study, we assess the impact of assimilating satellite temperature data in an operational forecast model with the aim to improve the forecast of ocean variables in the North and Baltic Seas. For this purpose, we use the data assimilation software PDAF coupled to the biogeochemical ocean model HBM-ERGOM, which is used operationally at the BSH, and perform data assimilation using an ensemble Kalman filter. The study will discuss and quantify the effects of the data assimilation on the oceanographic and biogeochemical variables in the model and on the coupled interaction of ocean physics and biogeochemistry.

MODEL AND OBSERVATION DATA

Model

- Operational models :
  HIROMB-BOOS-MODEL (HBM)
  coupled to
  Ecological ReGional Ocean Model (ERGOM)
- Nested domains :Coarse grid and Fine grid

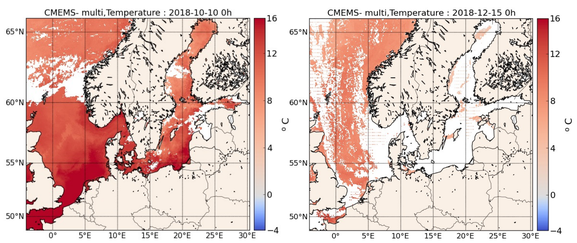


Coarse grid
Horizontal:5km
Vertical:36 layers

Fine grid
Horizontal:900m
Vertical:25 layers

CMEMS Satellite SST data

- Vertical coverage – sea surface subskin temperature
- Temporal resolution - daily (Midnight)

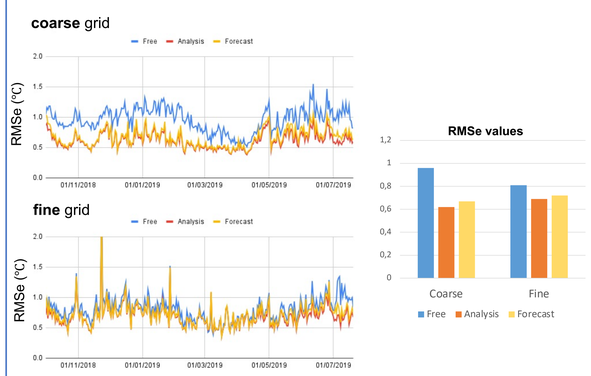


DATA ASSIMILATION SETUP

- Experiment time period: October 2018-July 2019
- Assimilation performed every day at: Mid-night
- Filter type used - LESTKF
- 40 ensemble members.
- Localization radius :
  - Coarse grid - 30 km
  - Fine grid - 5 km
- Experiments:
  - Free run
  - DA run

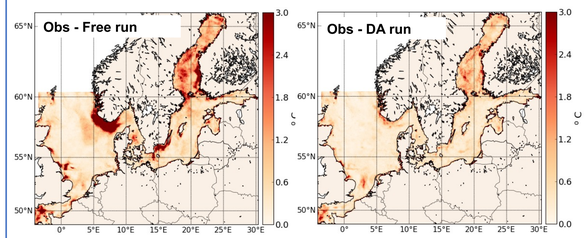
RESULTS

SST RMS error with regard to assimilated satellite data
October 2018 to July 2019



- SST assimilation pulls the model SST towards the observation.
- The overall reduction in error is smaller in fine grid.

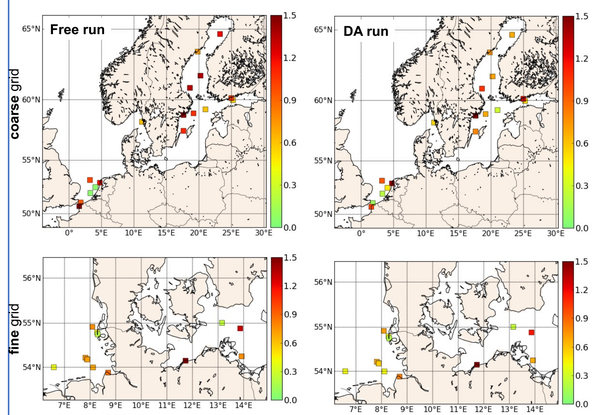
SST RMS error with regard to assimilated satellite data
July 2019 – Coarse grid



- Satellite SST assimilation reduces errors in North Sea and Baltic Sea.
- No significant improvement in the German coastal regions of North Sea.

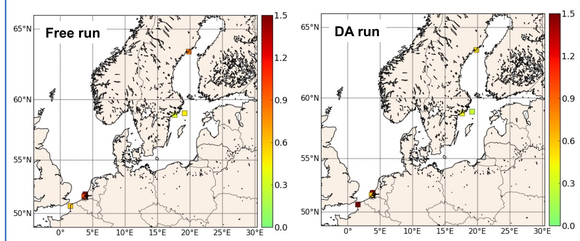
RESULTS: Validation with insitu data

Mean Sea surface temperature RMSe - July 2019



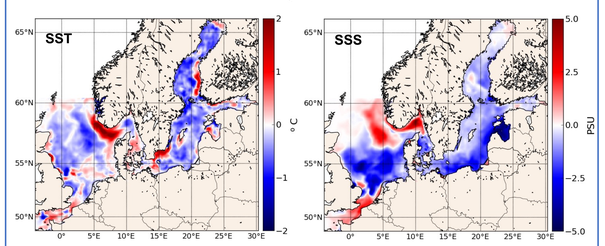
- Improvement is better in regions away from coast

Mean Sea surface salinity RMSe - July 2019



- Sparse data
- No significant salinity improvement with regard to insitu salinity data

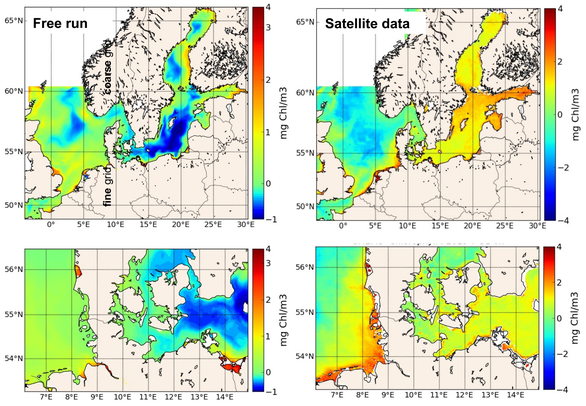
Mean difference between DA and free run
July 2019



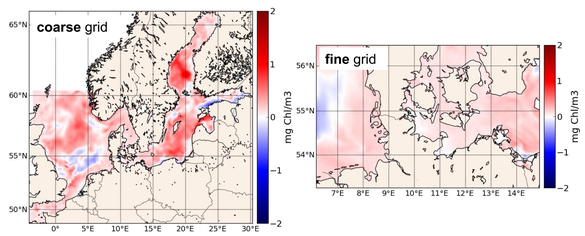
- Assimilation results in SST changes of around 2 ℃ compared to no assimilation.
- SST assimilation induced strong salinity changes in the model.

Changes in Surface Chlorophyll

Log Mean surface chlorophyll - July 2019



Mean difference between DA run and free run
July 2019



- Baltic Sea - Improvement in surface chlorophyll.
- North Sea – Overestimation of surface chlorophyll in the central and northern parts.

SUMMARY

- Satellite SST data assimilation improves the model SST.
- Reduces the error in both Baltic and North Seas.
- Coarse grid error reduction (0.3 ℃) is better than fine grid (0.1 ℃).
- The DA improvements are significant in the open sea compared to regions closer to coast.
- SST assimilation drives dynamical changes in chlorophyll through changed physical conditions.

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