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A New High-Resolution Ocean Reanalysis for the Baltic Sea: Insights into Ocean Dynamics

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EGU General Assembly 2023, Vienna

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Services Opportunities Access Data Use Cases User Corner About

Baltic Sea Physics Analysis and Forecast

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- Description
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DOCUMENTATION

- Quality Information Document
- User Manual
- Licence
- How to cite

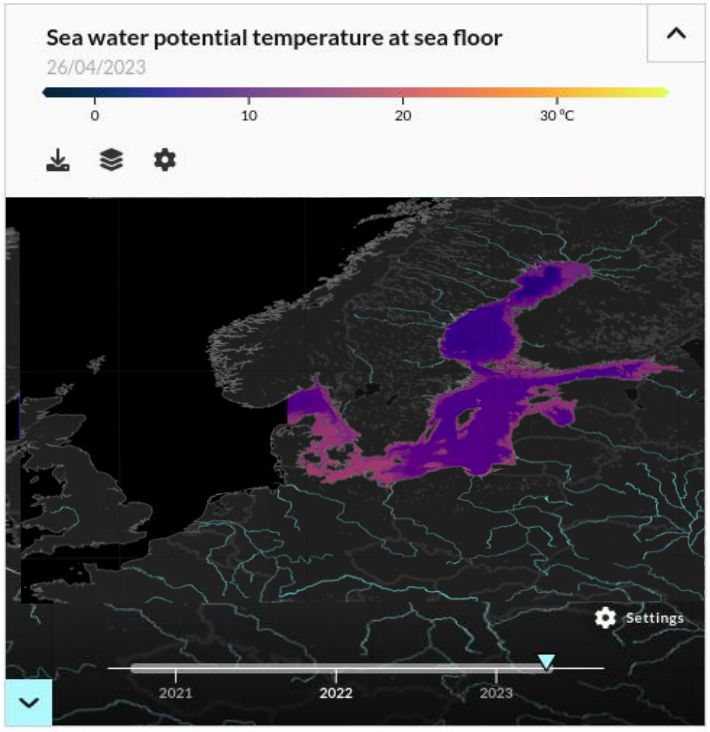
DOI

10.48670/moi-00010

Overview

This Baltic Sea physical model product provides forecasts for the physical conditions in the Baltic Sea. The Baltic forecast is updated twice daily providing a new six days forecast. Four datasets are provided: One with hourly instantaneous values, one with daily mean values and one with monthly mean values, all containing these parameters: sea level variations, ice concentration and thickness at the surface, and temperature, salinity and horizontal and vertical velocities for the 3D field. Additionally a dataset with 15 minutes (instantaneous) surface values are provided for the sea level variation and the surface horizontal currents. The product is produced by a Baltic Sea set up of the NEMOv4.0 ocean model. This product is provided at the models native grid with a resolution of 1 nautical mile in the horizontal, and up to 56 vertical depth levels. The area covers the Baltic Sea including the transition area towards the North Sea (i.e. the Danish Belts, the Kattegat and Skagerrak). The ocean model is forced with Stokes drift data from the Baltic Wave forecast product (BALTICSEA_ANALYSISFORECAST_WAV_003_010). Satellite SST and in-situ T and S profiles are assimilated into the model's analysis field.

DOI (product):
https://doi.org/10.48670/moi-00010



Explore in MyOcean Pro

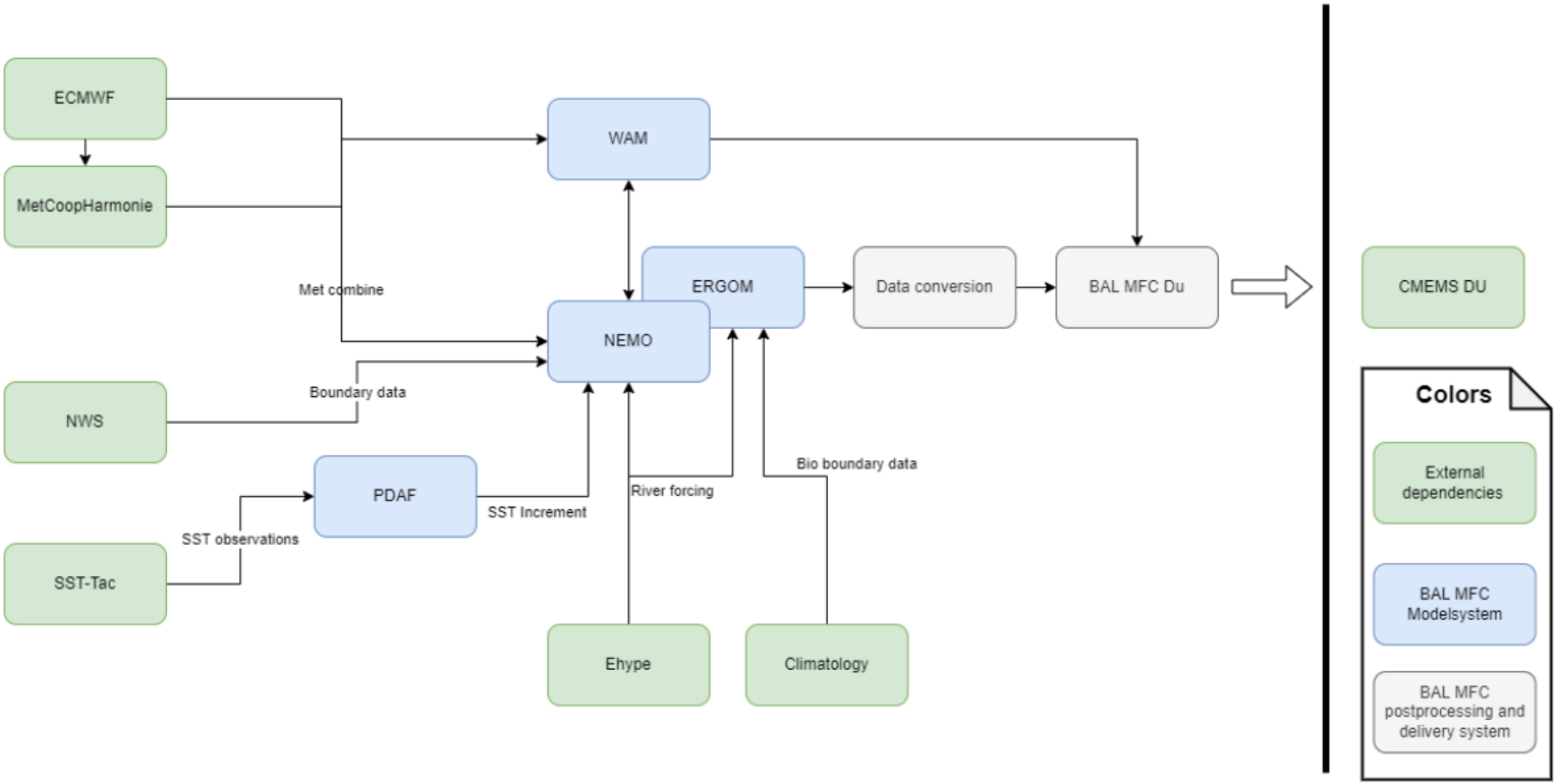


Figure 3.1 process chart of the BAL MFC model system

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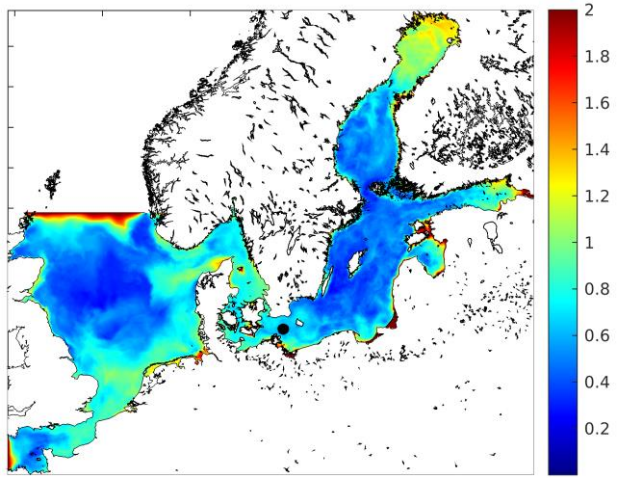
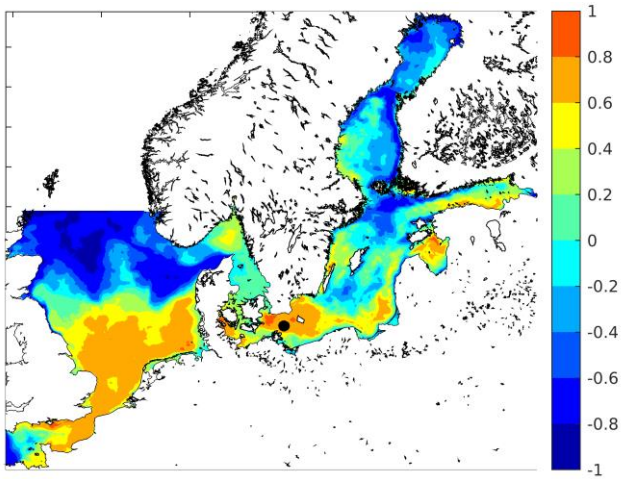
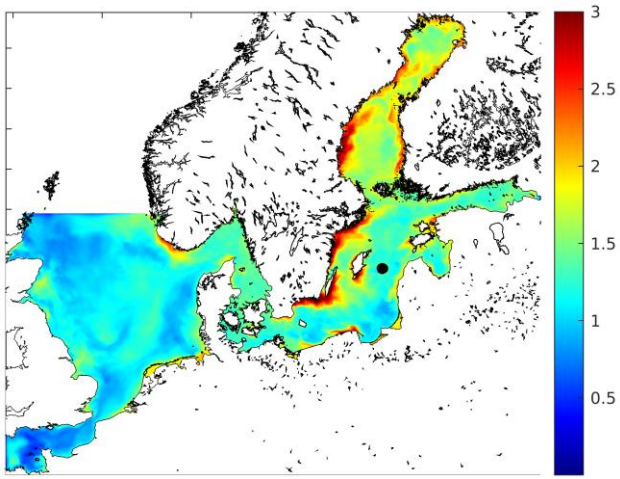
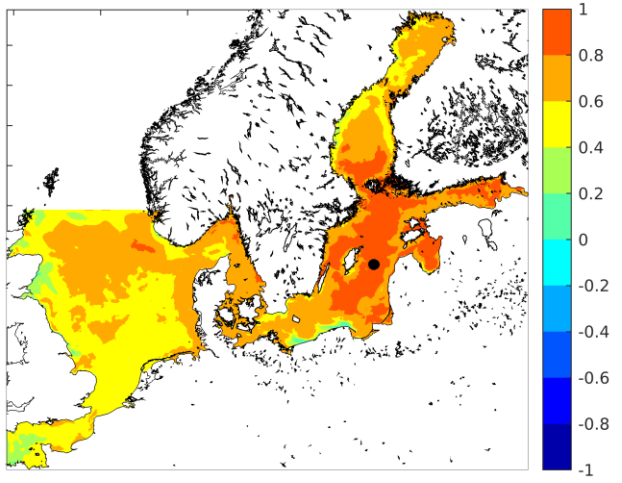
Assimilation system LESTKF

- Climatological ensemble std (for SST) and (SST-T) error covariances sampled from the 5-year hindcast run with 15-day window, N = 150









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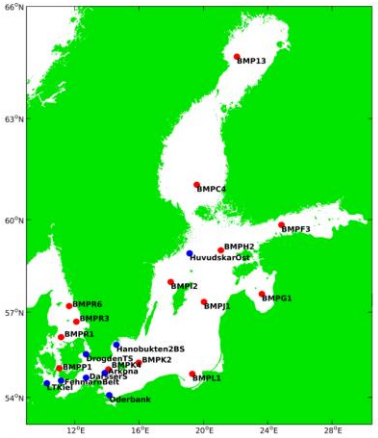
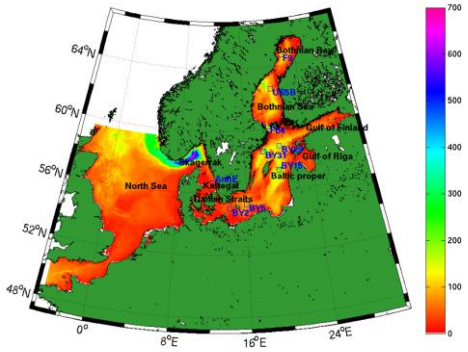
Reanalysis validation metrics



Ocean parameter	Metrics	Supporting reference dataset	resolution	Statistics performed incl. figure
Sea level	Class 2&4	INSITU_BAL_TS_REP_OBSERVATIONS_013_038	Spatial: surface level (vertical) & nearest grid point (horizontal) Temporal: hourly	Time series of data Statistics: standard deviation, correlation and cRMSD displayed in Taylor diagram
Sea surface temperature	Class 4	SST_BAL_SST_L3S_REP_OBSERVATIONS_010_016 (1993-2021)	Spatial: surface level (vertical) & 1 nautical mile (horizontal) (0.02° × 0.02°) Temporal: daily	Statistics: mean, bias, standard deviation and root mean square deviation (monthly) Maps of mean, bias and root mean square deviation (monthly)
	Class 4	SST_BAL_SST_L4_REP_OBSERVATIONS_010_016	Spatial: surface level (vertical) & 1 nautical mile (horizontal) (0.02° × 0.02°) Temporal: daily	Statistics: daily mean, bias, standard deviation and root mean square calculated for sub domains as well as the full Baltic domain of the product Timeseries of these metrics for each domain
	Class 2 & 4	INSITU_BAL_TS_REP_OBSERVATIONS_013_038 (Tide gauges)	Spatial: surface level (vertical) & nearest grid point (horizontal) Temporal: hourly	Time series of data Statistics: Bias, RMSD and linear correlation displayed in a Target diagram; cRMSD is also displayed as EAN over all stations
Temperature profiles	Class 2 & 4	ICES station data and INSITU_BAL_TS_REP_OBSERVATIONS_013_038 (monitoring stations, buoys,...)	Spatial: surface & bottom level as well as all levels (vertical) & nearest grid point (horizontal) Temporal: daily	Time-series of daily data Statistics: Bias, RMSD, linear correlation & cRMSD displayed in Target diagram; RMSD is also displayed as EAN over all stations
Salinity profiles	Class 2 & 4	ICES station data and INSITU_BAL_TS_REP_OBSERVATIONS_013_038 (monitoring stations, buoys,...)	Spatial: surface & bottom level as well as all levels (vertical) & nearest grid point (horizontal) Temporal: daily	Time-series of daily data Statistics: Bias, RMSD, linear correlation & cRMSD displayed in Target diagram; RMSD is also displayed as EAN over all stations
Sea ice concentration	Class 1, 3 & 4	Monthly sea ice concentration climatology SMHI ice charts &	Spatial: surface (vertical) & 1 nautical mile (horizontal)	Maps showing the sea ice concentration climatology of the product. Daily values of ice extent data

History of Reanalysis Products for Baltic Sea



BALTICSEA_REANALYSIS_PHYS_003_008
(2017)

Model: Hyromb-BOOS (HBM)

Resolution: **3nm** (5,5 km)

Atm Forcing: < 2014 Euro4M
(22 km HIRLAM)
> 2014 SMHI oper
(11 km HIRLAM)

Assimilation: 3d-EnVAR
SST, SIC, SIT
T/S ICES

Open Boundaries: NOAMOD
T/S Climatology

BALTICSEA_REANALYSIS_PHYS_003_011
(2019)

Model: Nemo 3.6

Resolution: **2nm**

Atm Forcing: < 2012 Euro4M
(22 km HIRLAM)
> 2012 UERRA
(11 km)

Assimilation: LSEIK
SST, SIC, SIT
T/S ICES

Open Boundaries:NOAMOD
T/S Climatology

BALTICSEA_REANALYSIS_PHYS_003_011-V4
(2023)

Model: Nemo 4.0

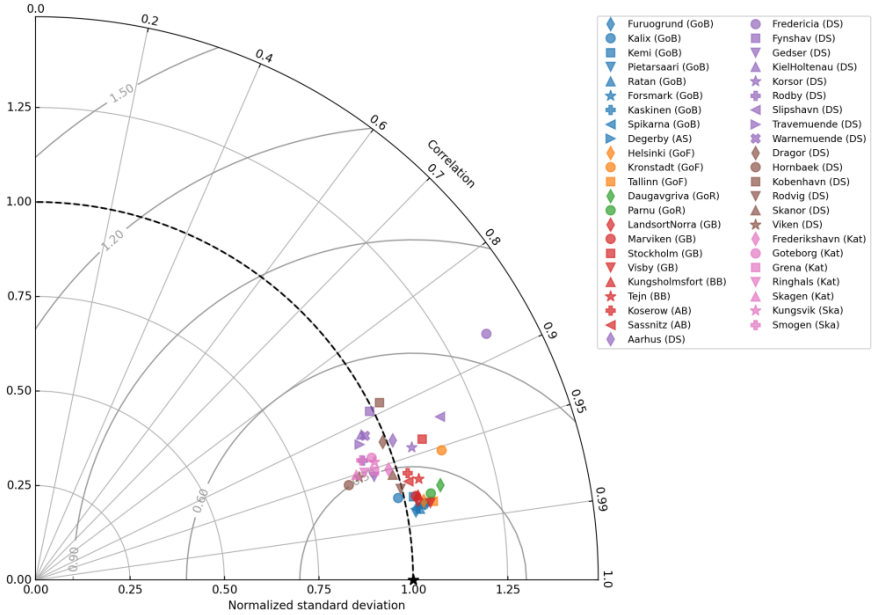
Resolution: **1nm**

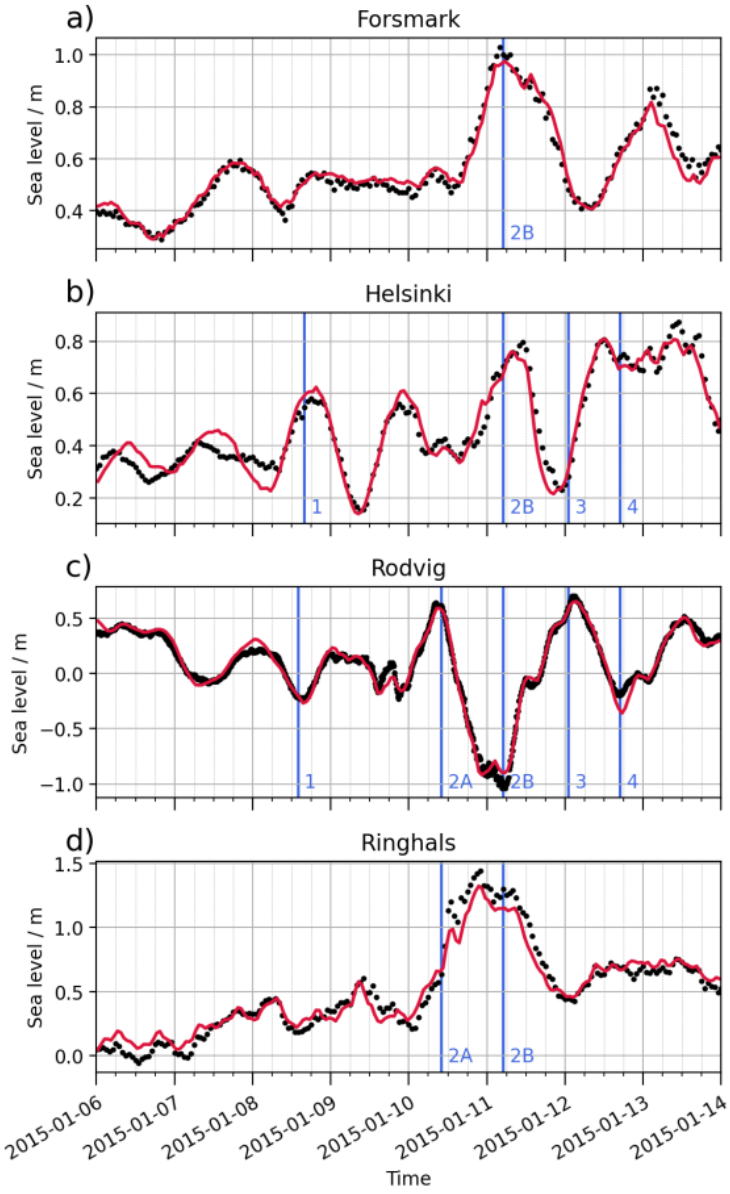
Atm Forcing: ERA5
(31 km)

Assimilation: LESTKF
SST
T/S ICES

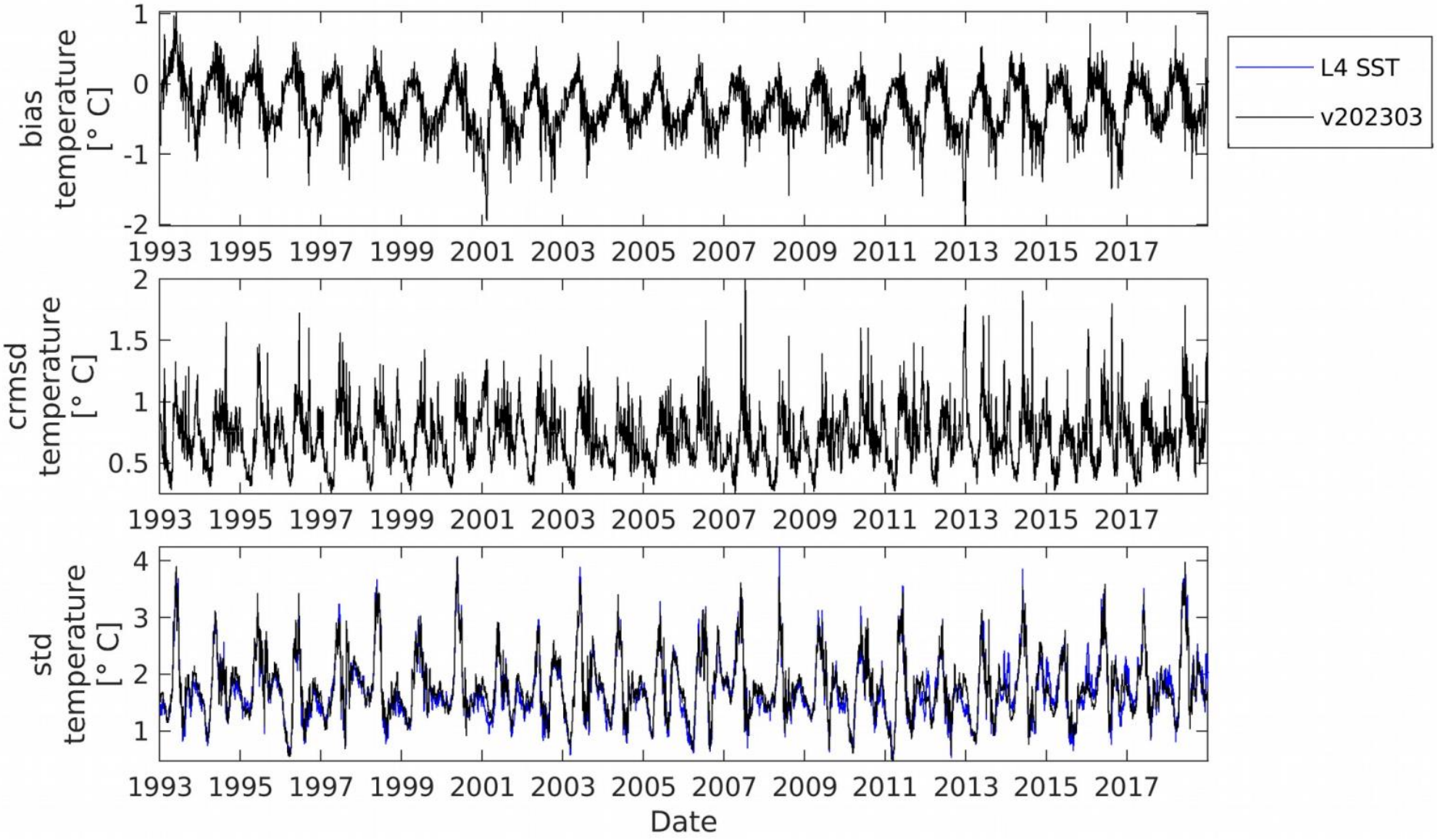
Open Boundaries:
NWSHELF_MULTIYEAR_PHY_004_009

Sea level validation

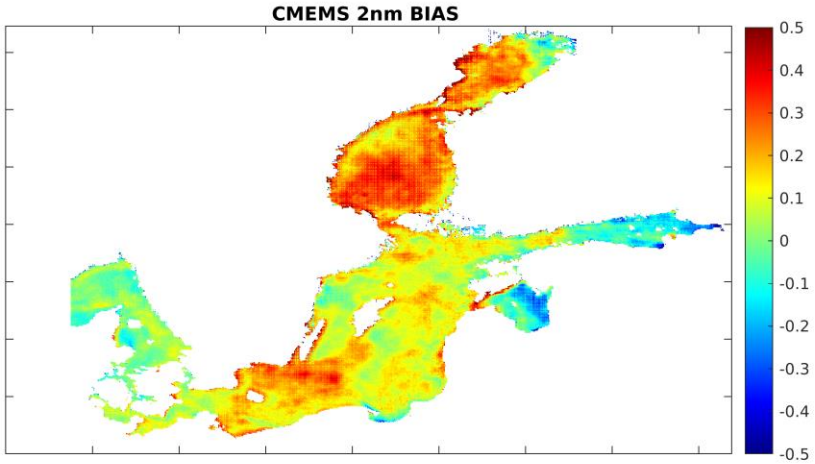


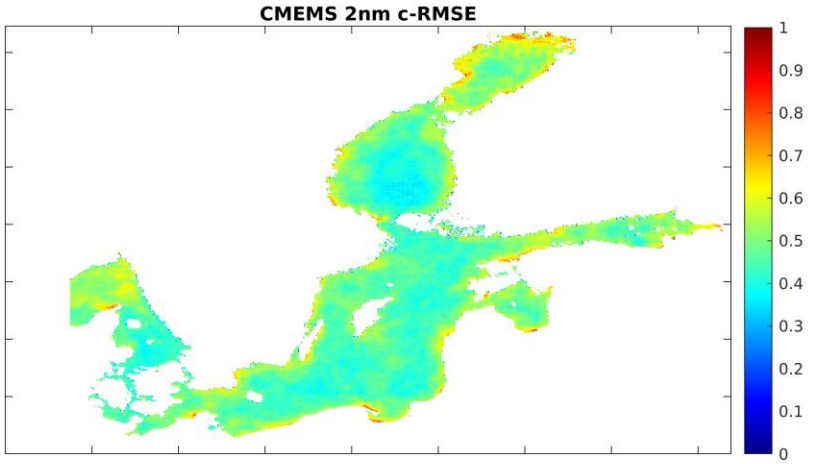


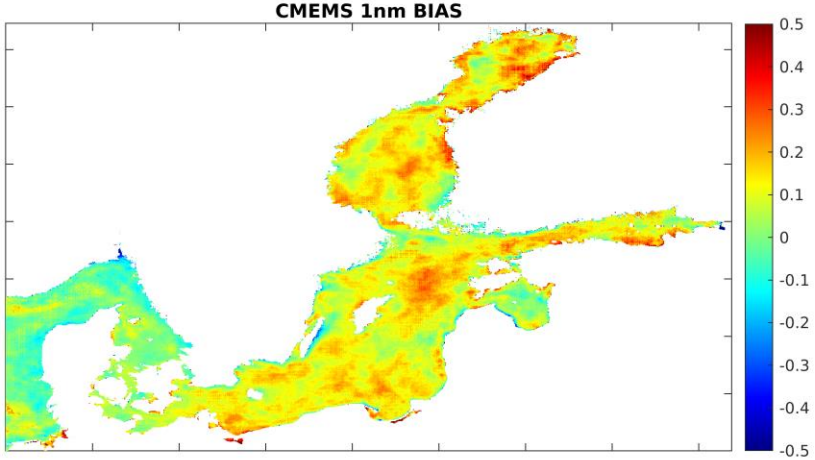
SST Validation against L4

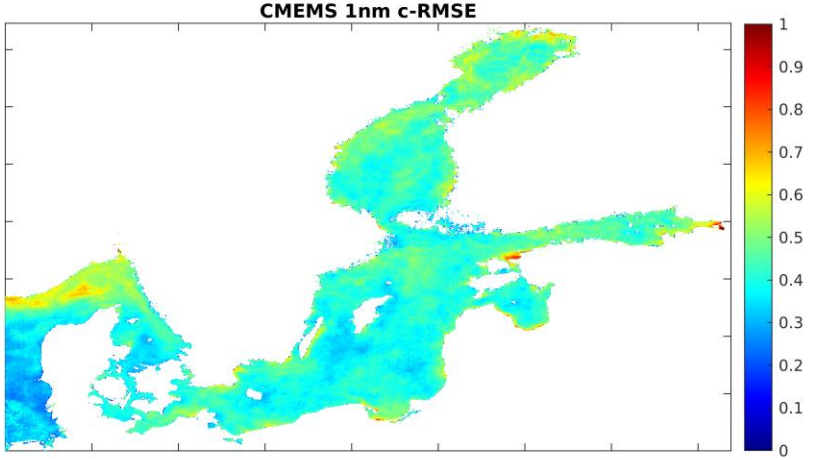


Improvements in SST: 2nm RAN and 1nm RAN

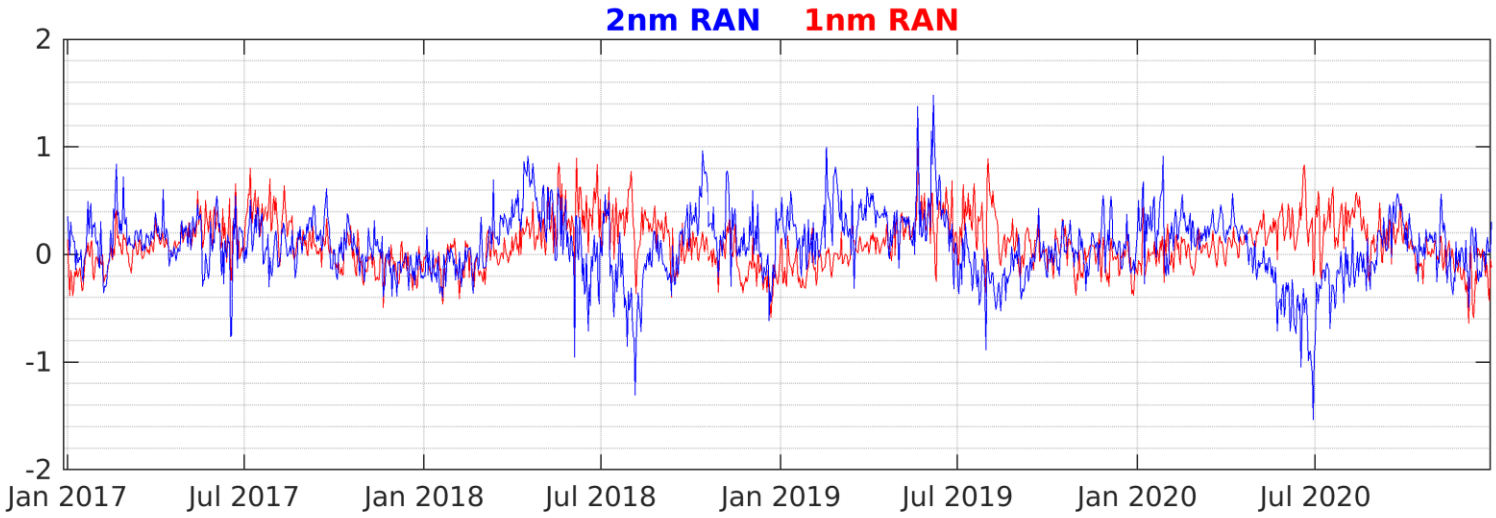


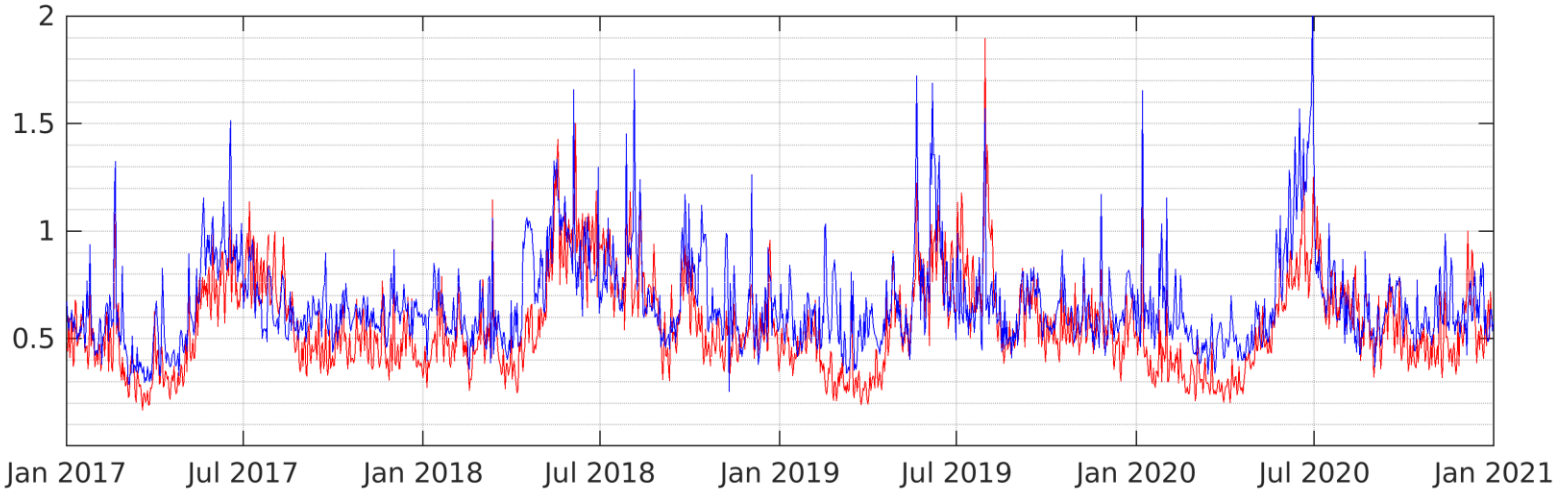




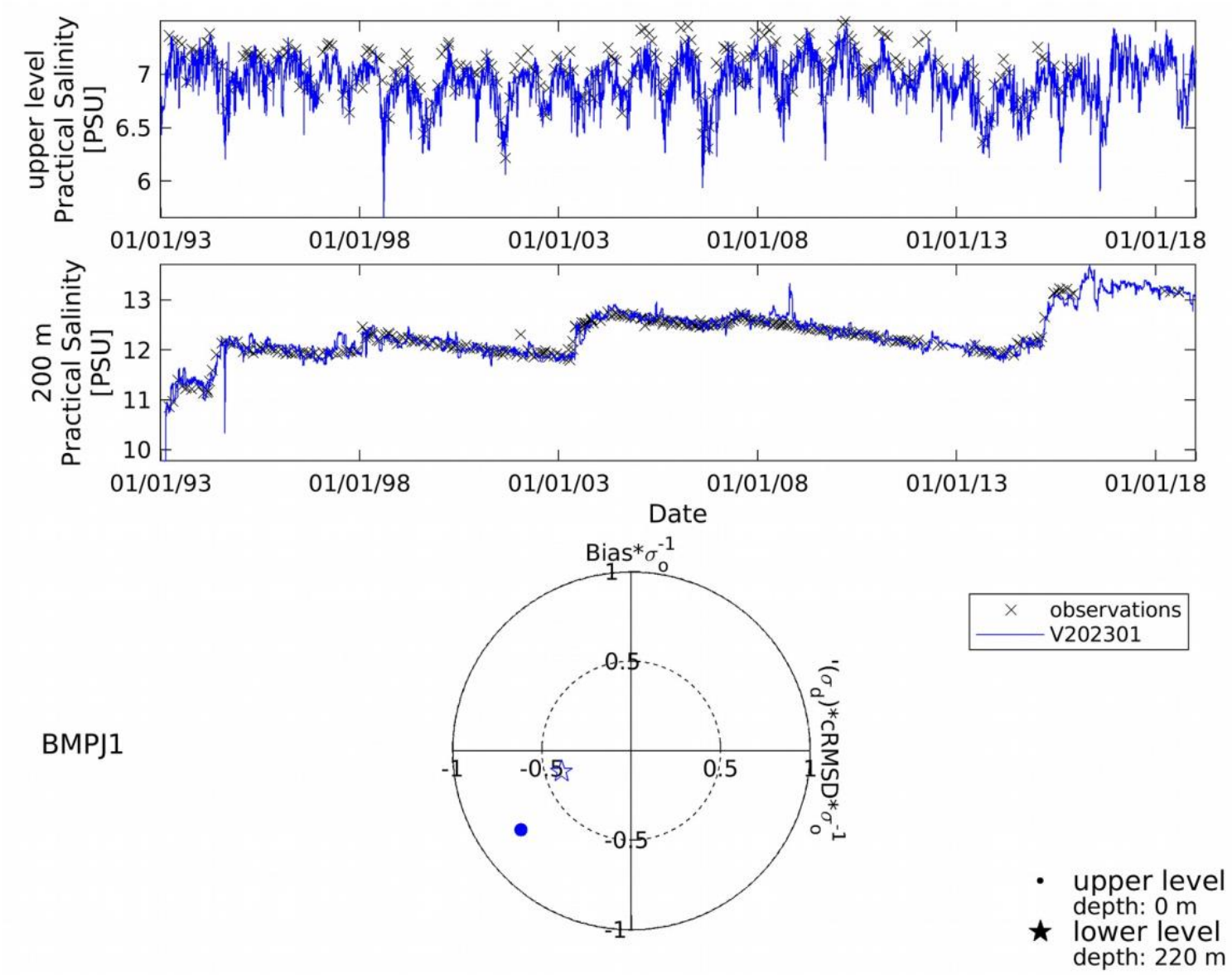


Improvements in SST: 2nm and 1nm

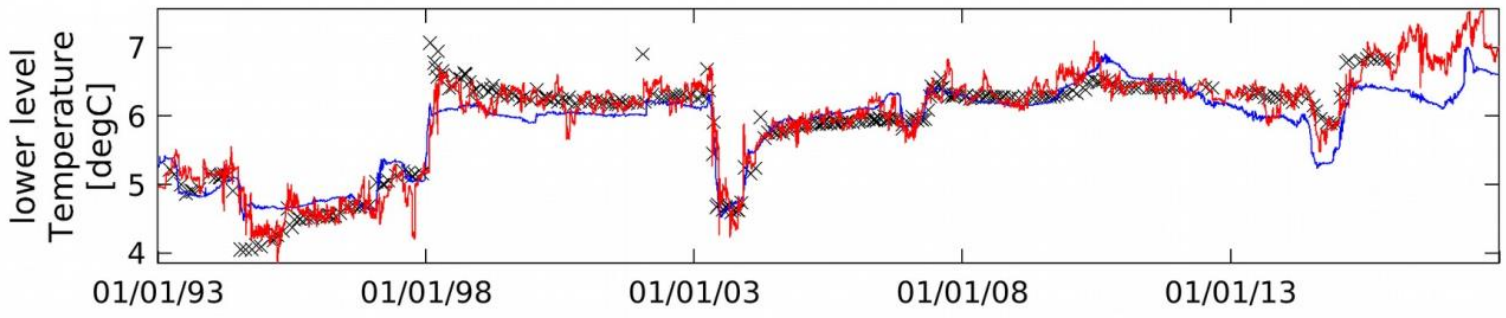


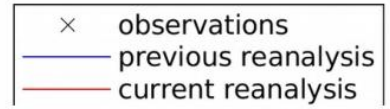


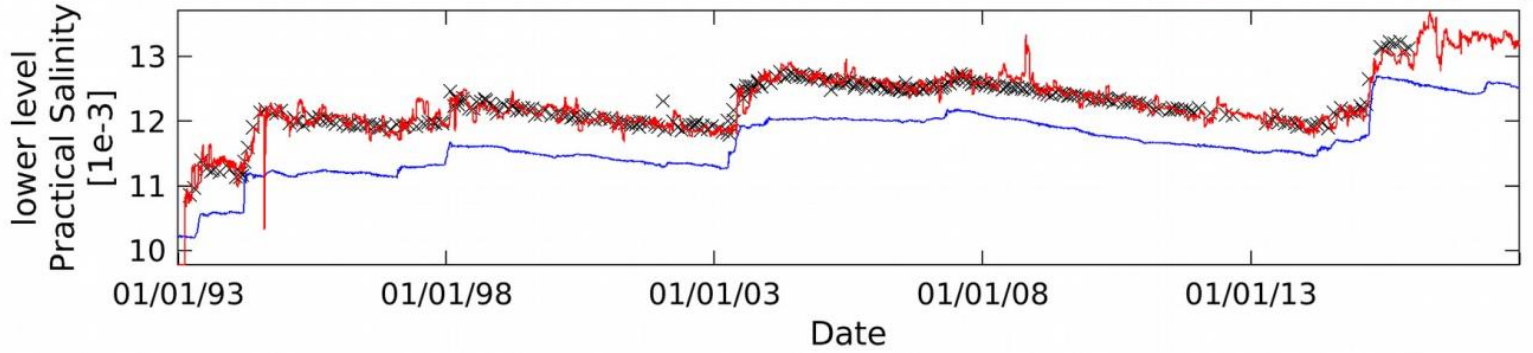
Salinity time series during Major Baltic Inflow events: BMPJ1 (Bornholm Basin)

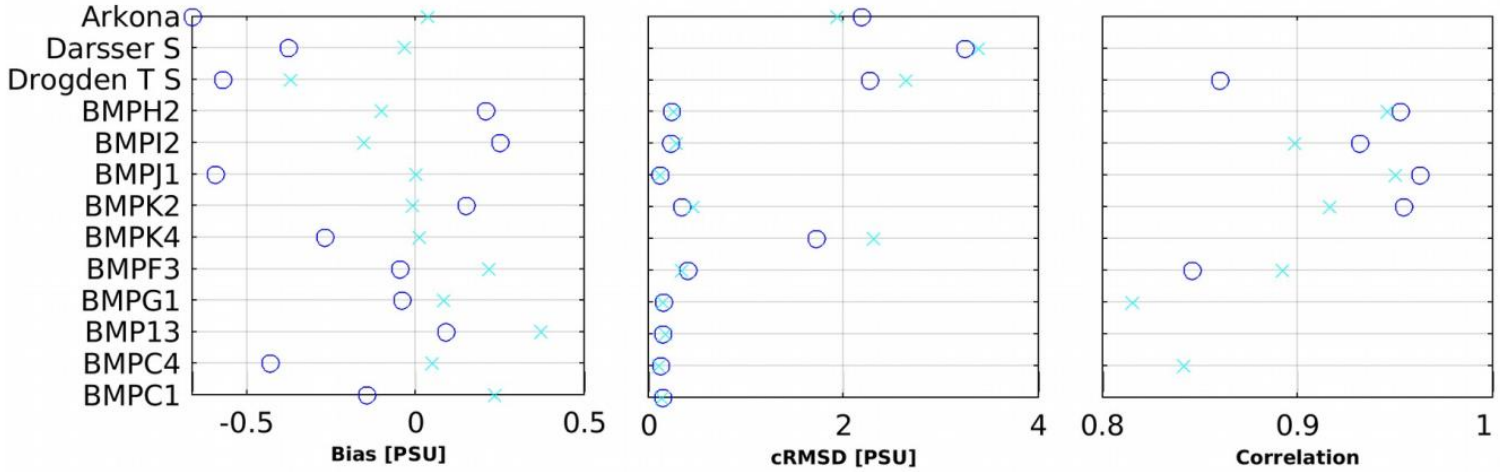


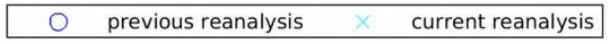
Bottom Temperature and Salinity at BMPJ1



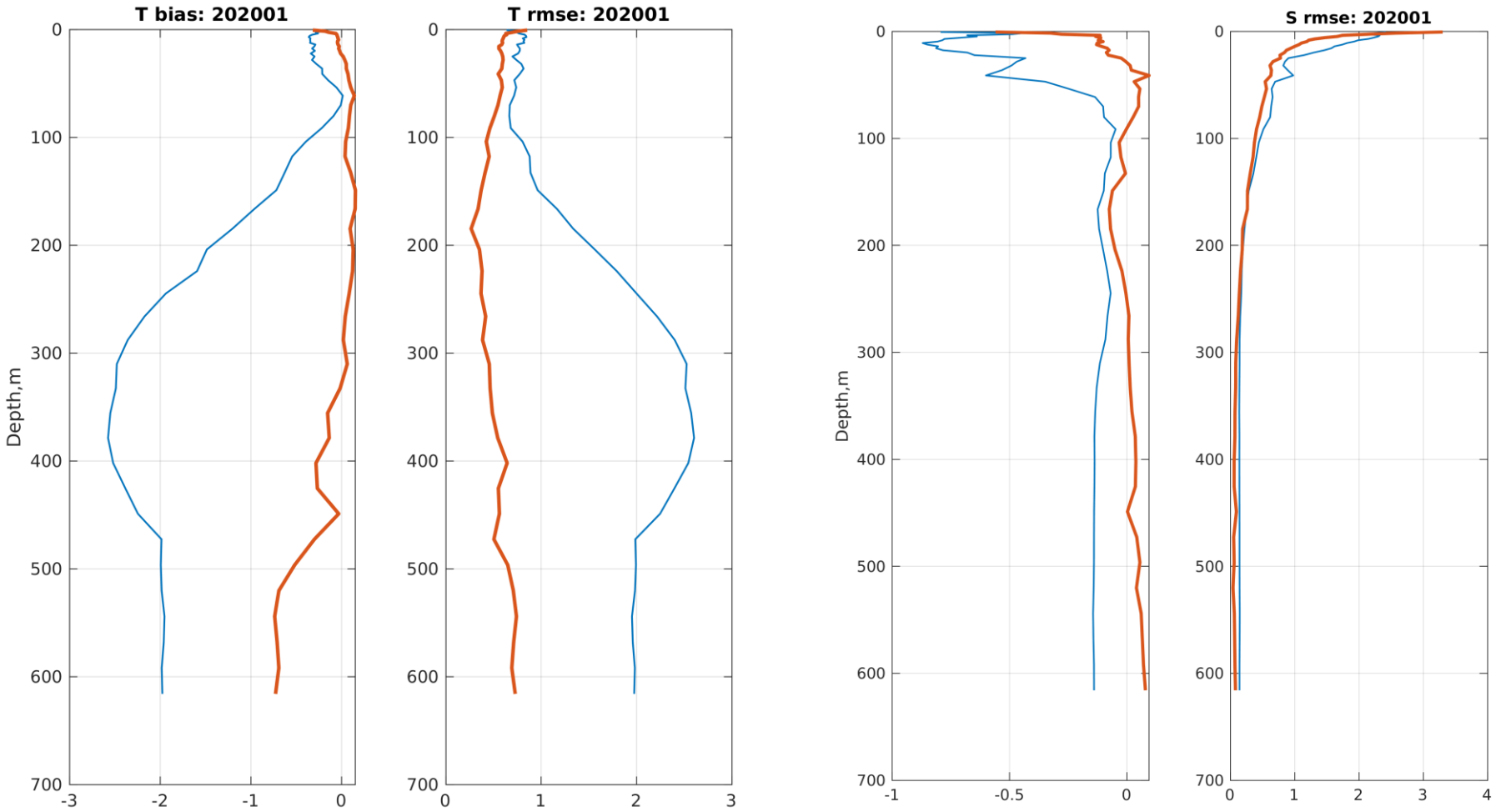




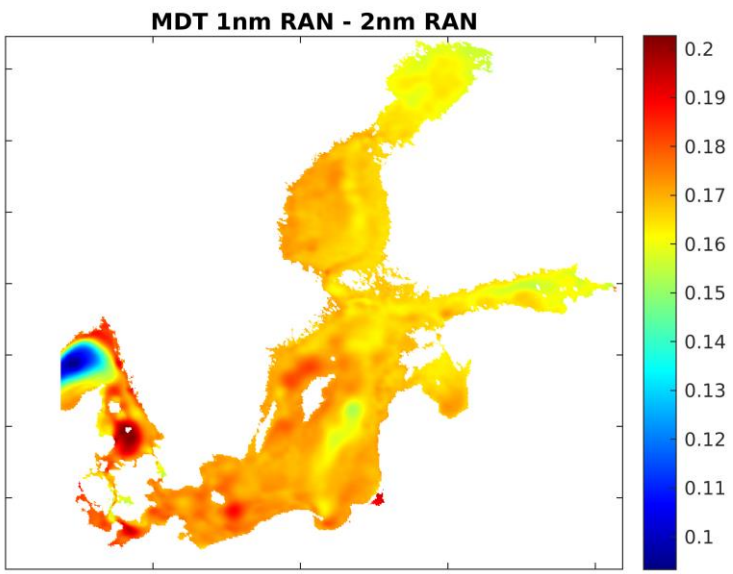


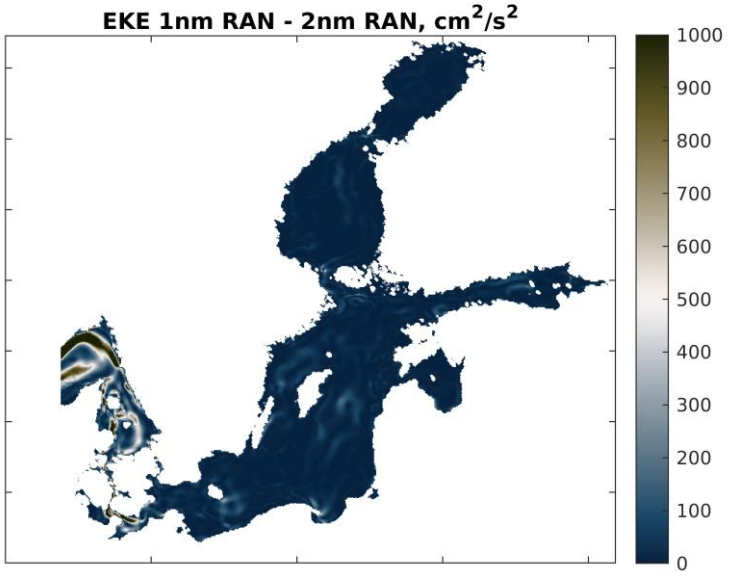


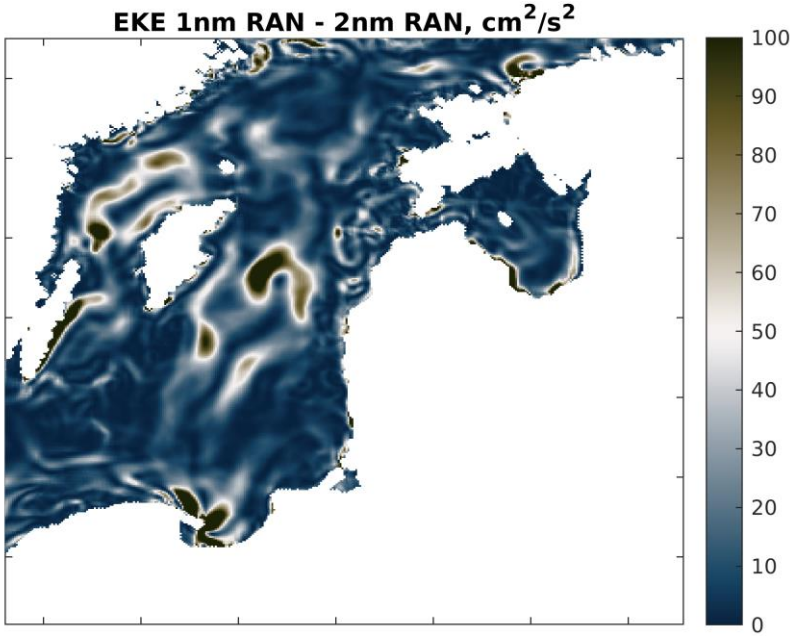
Improvements in T/S between 2nm RAN and 1nm RAN



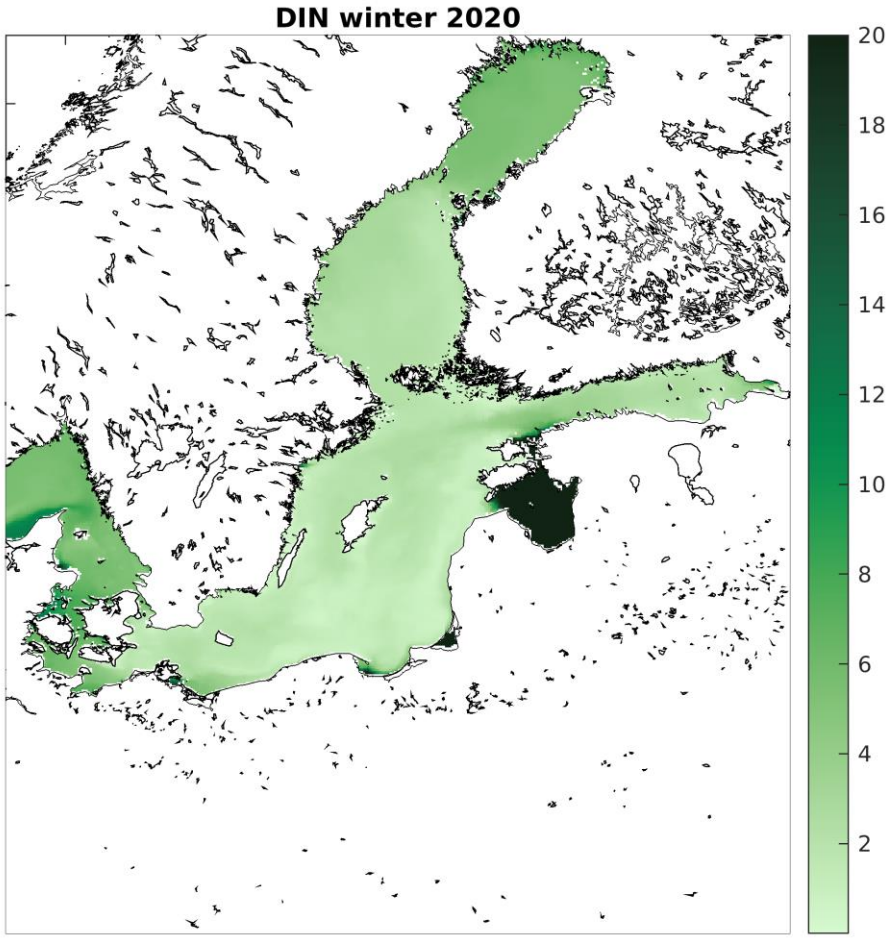
Improvements in MDT and EKE



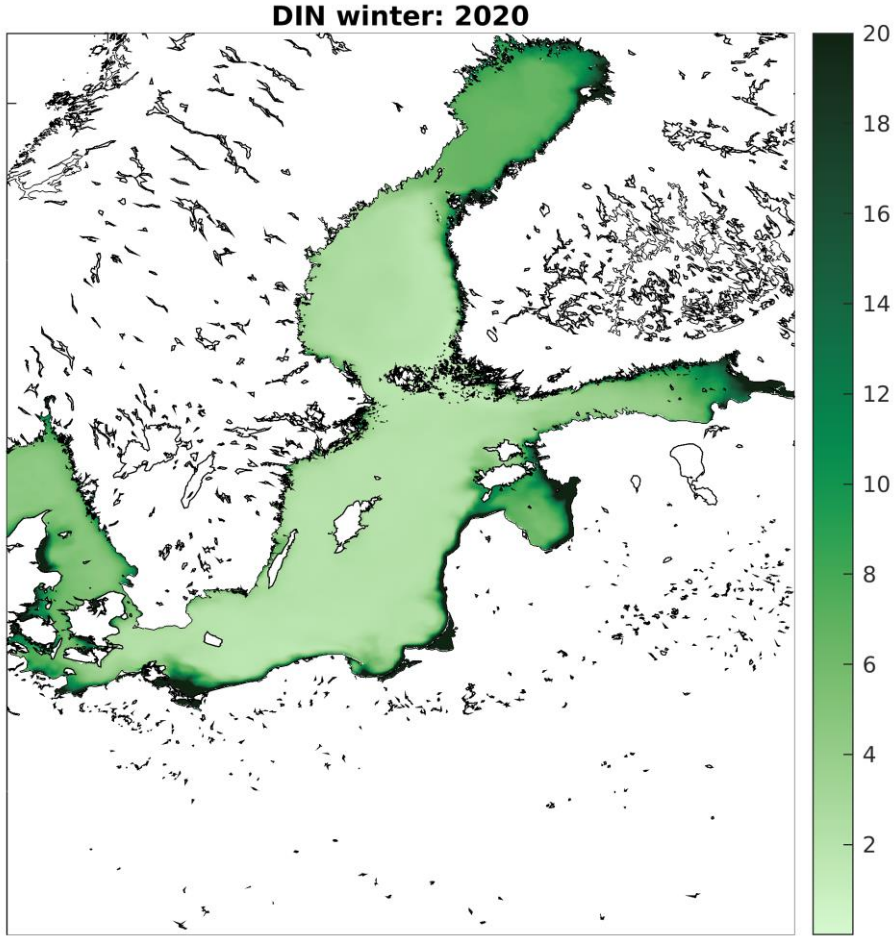




Improvements in Dissolved Inorganic Nitrogen (eutrophication and algae blooms)

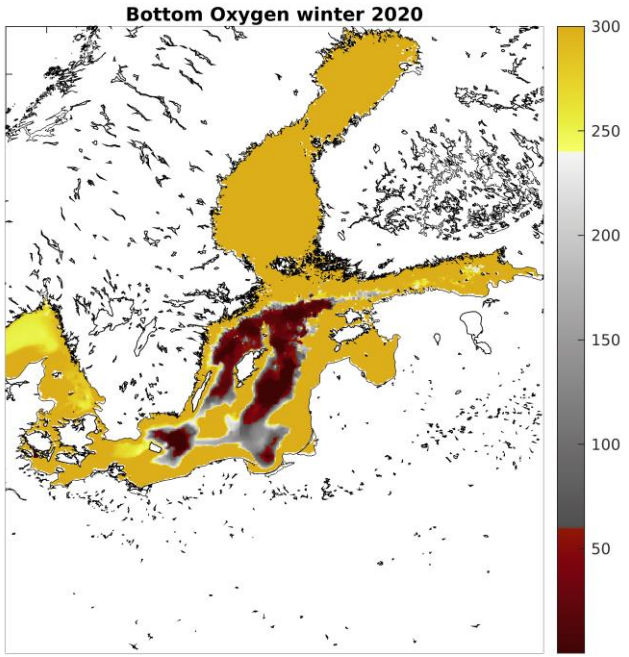


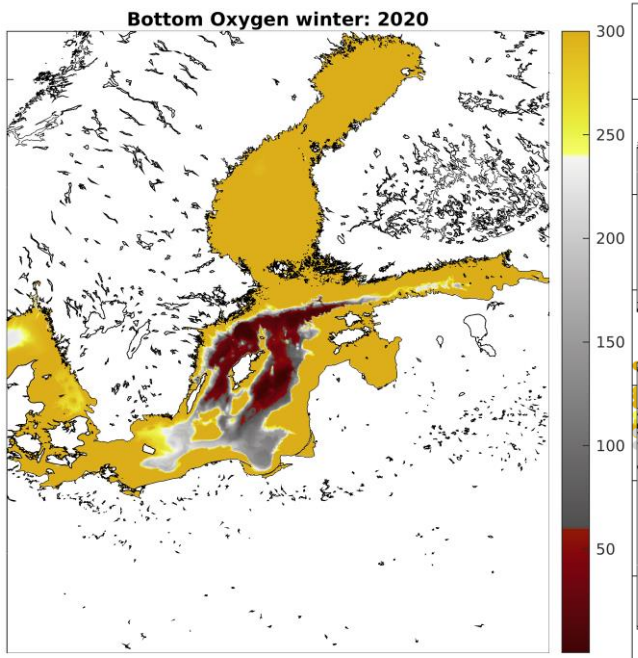
CMEMS 2-nm RAN

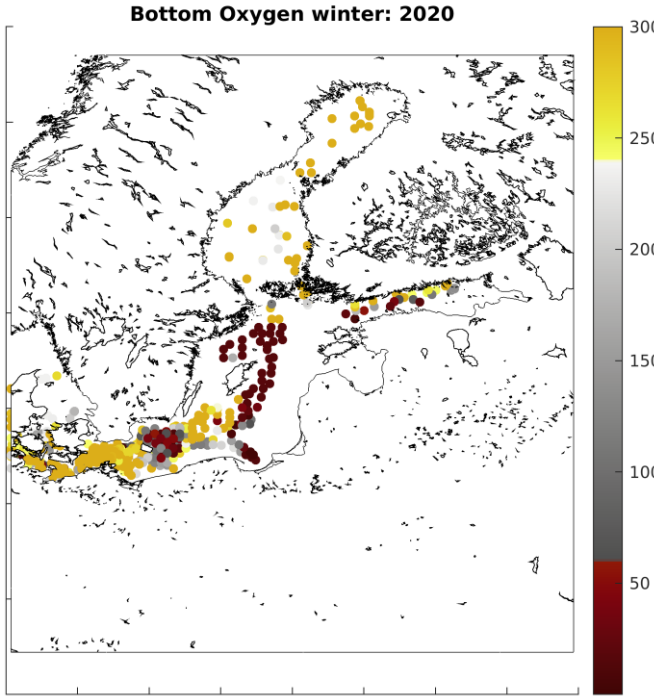


DMI Interim 1-nm RAN

Improvements in Dissolved Bottom Oxygen (mmol/m3)







CMEMS 2-nm RAN

DMI Interim 1-nm RAN

ICES Observations

Summary and future directions

- Summary of the results:

- Both temperature and salinity are well mapped by the reanalysis especially during the inflow events
- Reduced biases both for surface and bottom T and S
- Increased resolution results in more realistic currents

- Next update will include:
- ice assimilation (SIC, SIT)
- Biogeochemical profiles assimilation (OXY, NO3, PO4)
- Possible extension to 1980 -2022

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Thank you