Multi-Model-Ensemble of Forecast Products

BOOS Annual Meeting, Brussels, May 2018

Inga Golbeck, Thorger Brüning
Federal Maritime and Hydrographic Agency

MME: Overview

- „Poor-man‘s ensemble“: MME based on several independent ocean forecasting models for North Sea (8 members) and Baltic Sea (10 members)

- Aims and benefits of MME:
  - Temporal / spatial distribution of forecast uncertainties
  - Supplement to single-model validation
  - Best estimates of forecasts (e.g. water level)
  - Detection of forecast products drifting away from MME

- Financing & Partners of BOOS MME:
  - MME developed in Copernicus Marine Service
  - MME lead: BSH

- Data and parameters:
  - Hourly 48h-forecasts
  - Sea surface temperature, - salinity, - currents (5m mean)
  - Sea bottom temperature, - salinity
  - Water level
  - Mass and salt transports (daily data)

- Dokumentation:
  - Golbeck et al (2015): Spatio-temporal statistics

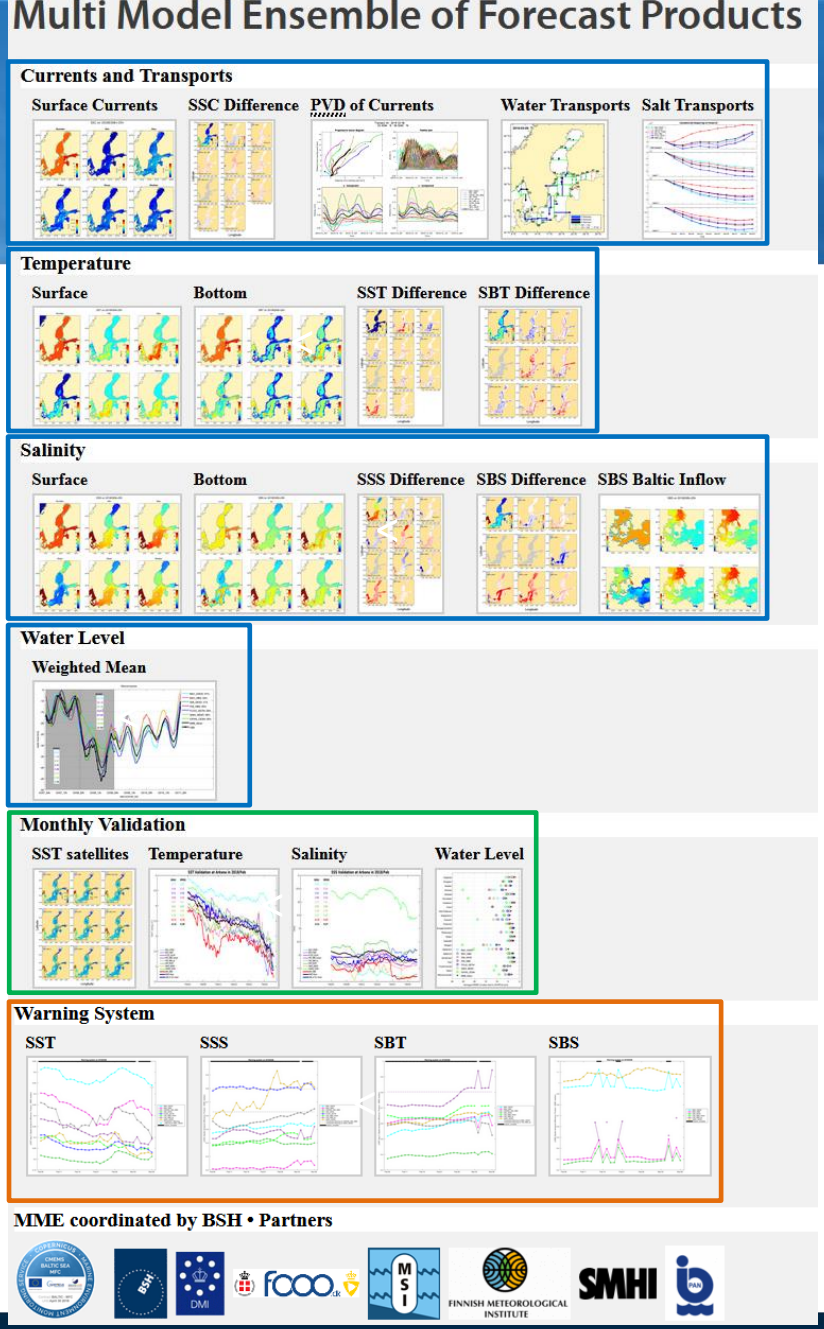
- Website:
  - *http://www.boos.org/multi-model-ensemble-of-forecast-products/*

Funded by the European Union

Inga.Golbeck@bsh.de

MME: Metrics

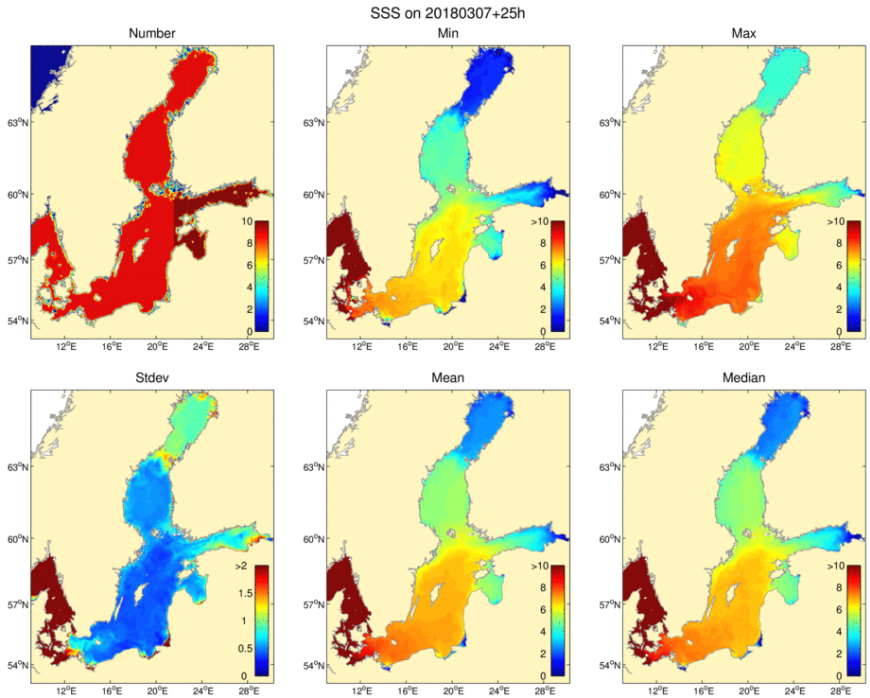
- Uncertainty estimates / forecast ensemble statistics – daily update
  - MME mean, median, min, max, standard deviation
  - Bias between MME median & each ensemble member
  - Individual metrics for transports and currents
- Validation – monthly update
  - Temperature, salinity (bottom, surface) with in-situ data
  - SST with CMEMS L3 satellite data
  - Water level with in-situ data
- NEW: "Warning System" – daily update
  - Based on spatio-temporal difference between MME median and each ensemble member



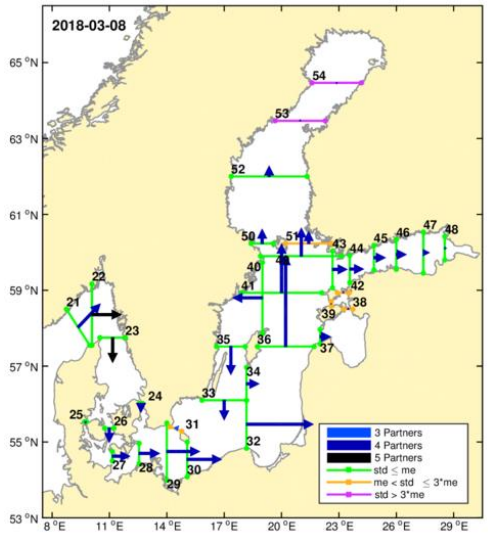
Funded by the European Union

Inga.Golbeck@bsh.de

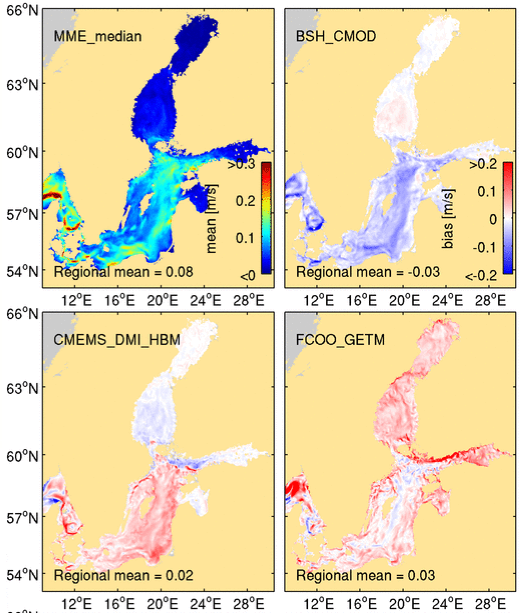
Examples Uncertainty estimates (daily)



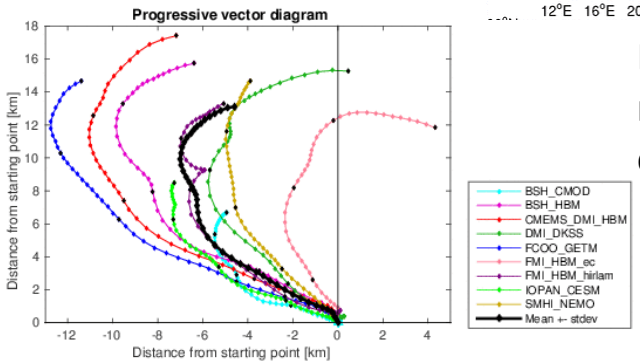
Ensemble mean, median, min, max, standard deviation



Coefficient of variation for water transports

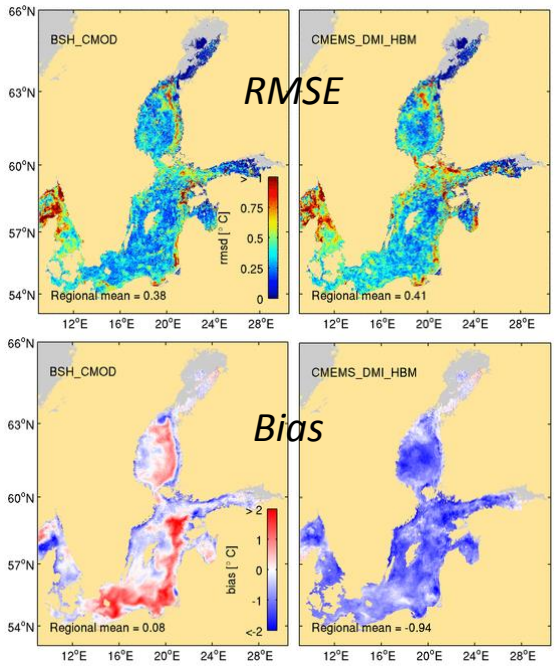


Bias between MME median and each ensemble member

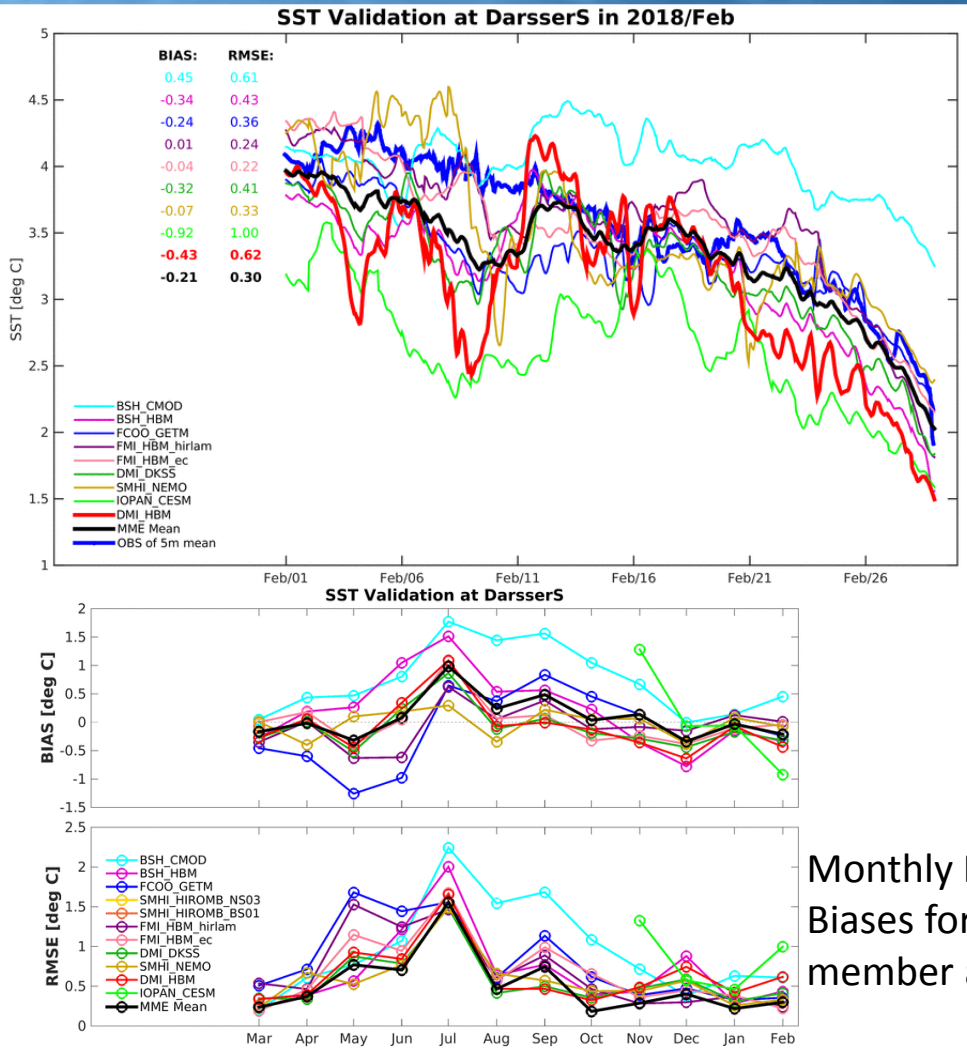


Surface currents: Progressive Vector diagrams at centers of BOOS transects

Examples Validation (monthly)

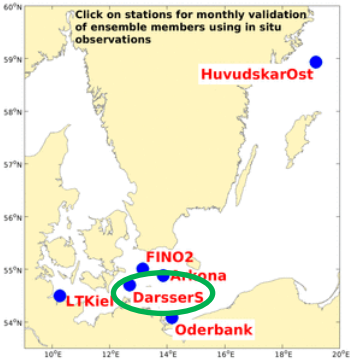


For each ensemble member and MME:
Validation of SST with CMEMS L3-satellite data: RMSE, Bias



Validation of T, S with CMEMS in-situ data: RMSE, Bias

Map with stations

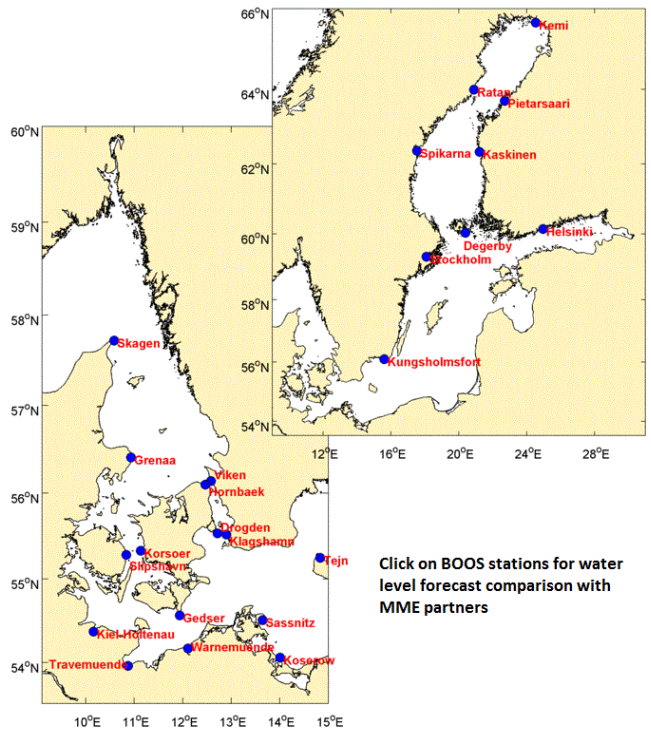


Monthly RMSEs and Biases for each ensemble member and MME mean

Funded by the European Union
Copernicus Europe's eyes on Earth

Inga.Golbeck@bsh.de

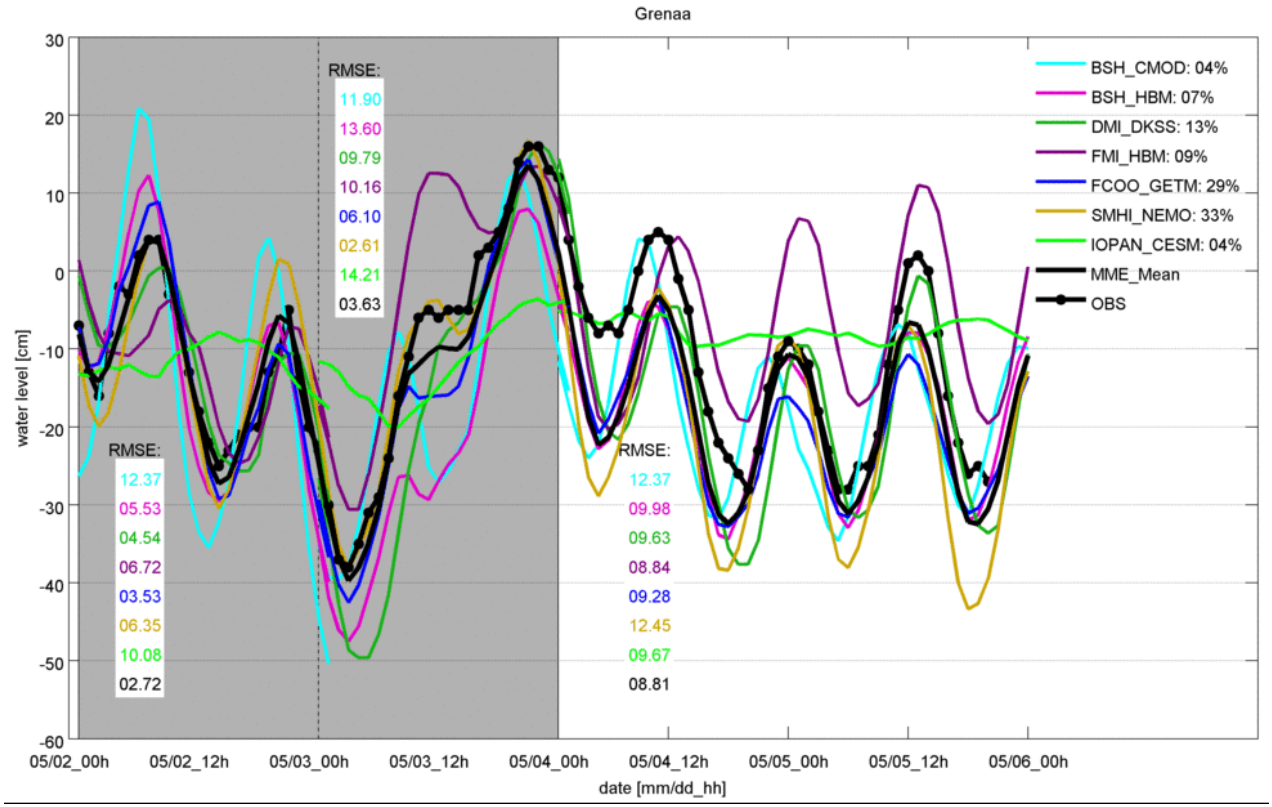
Sea level validation (1/2)



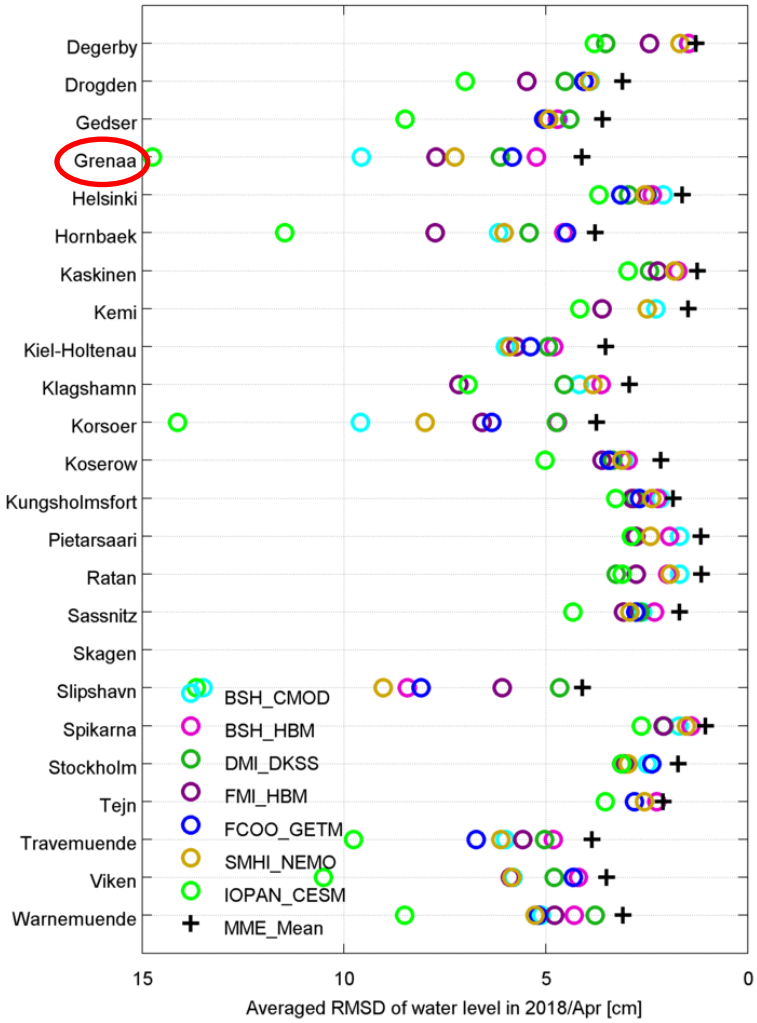
Click on BOOS stations for water level forecast comparison with MME partners

- 24 BOOS stations
- BIAS removed
- RMSE of MME weighted mean

- Comparison of forecasts with MME weighted mean
- Calculation of weights using RMSEs of the forecasts 2 days before present

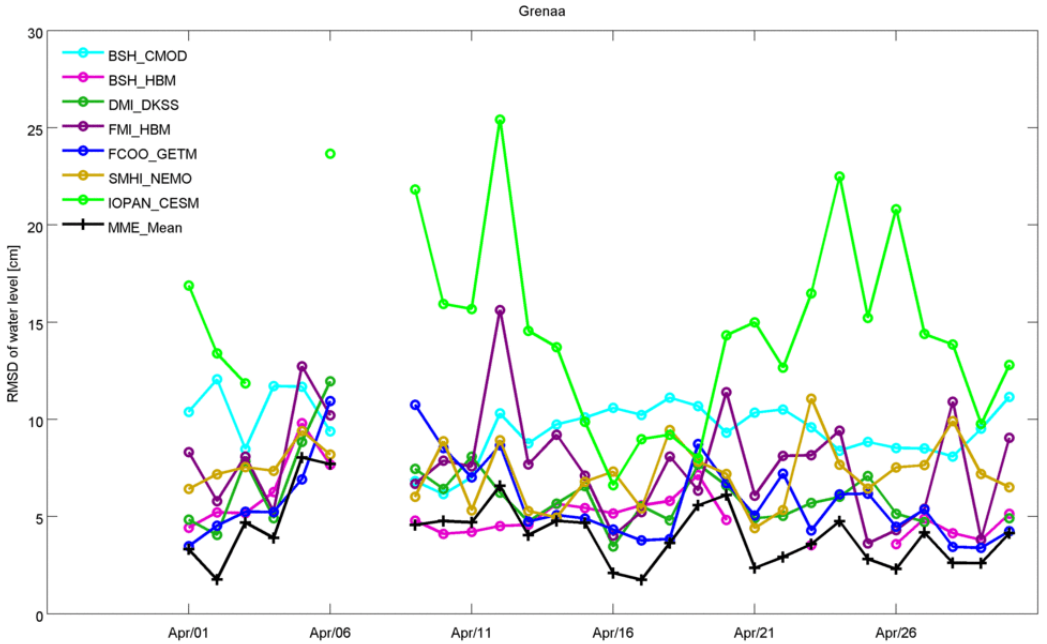


Sea level validation (2/2)



Monthly values and daily time series of RMSEs

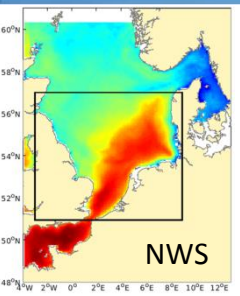
- MME provides best estimate at most stations



Funded by the European Union

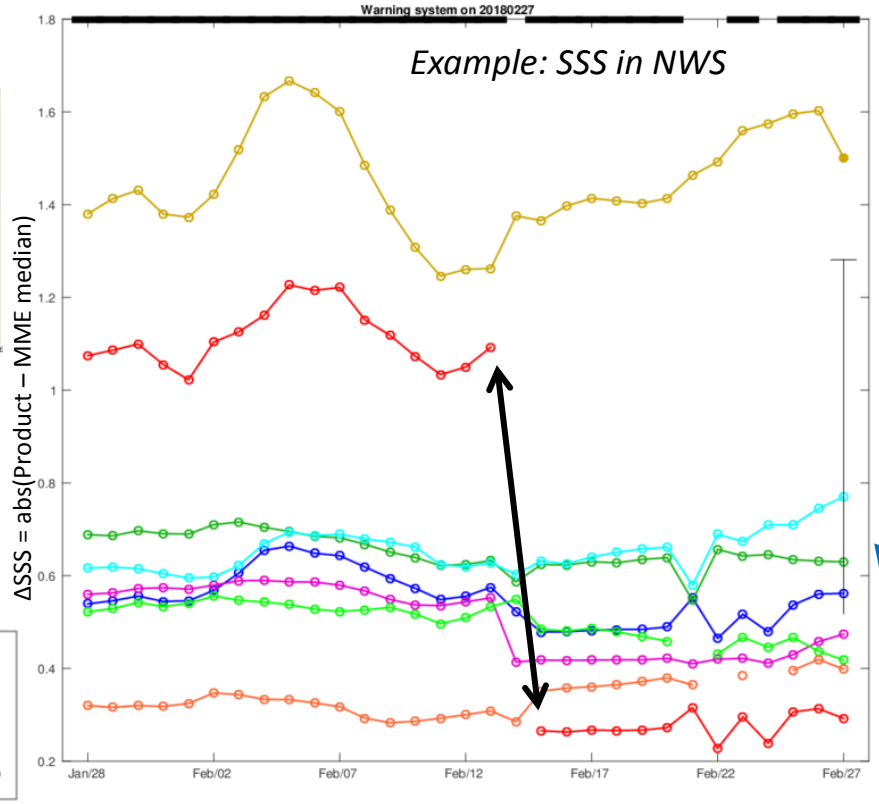
Inga.Golbeck@bsh.de

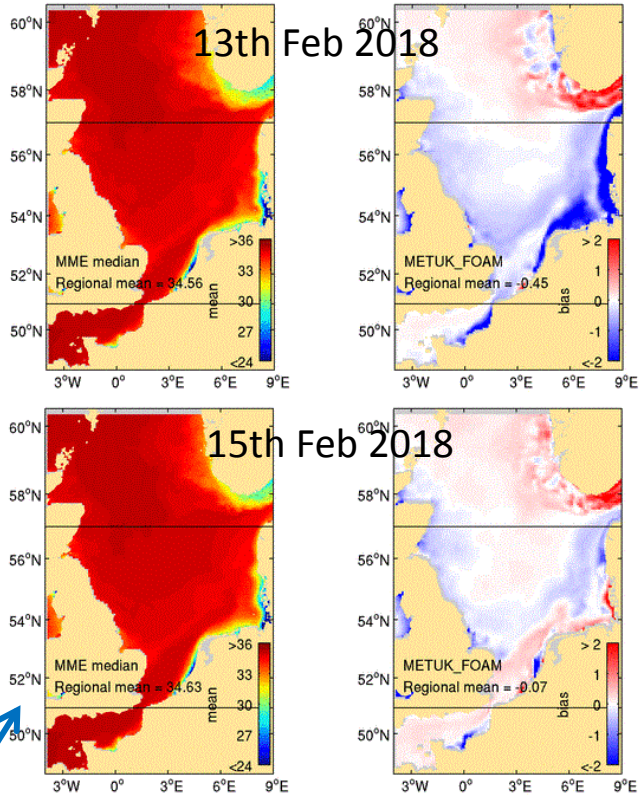
Example „Warning-system“



“Warning system” based on absolute temporally & spatially averaged difference between forecast product & MME median

Available for: SST, SSS, SBT, SBS





Significant drop of SSS caused by change (14th Feb):

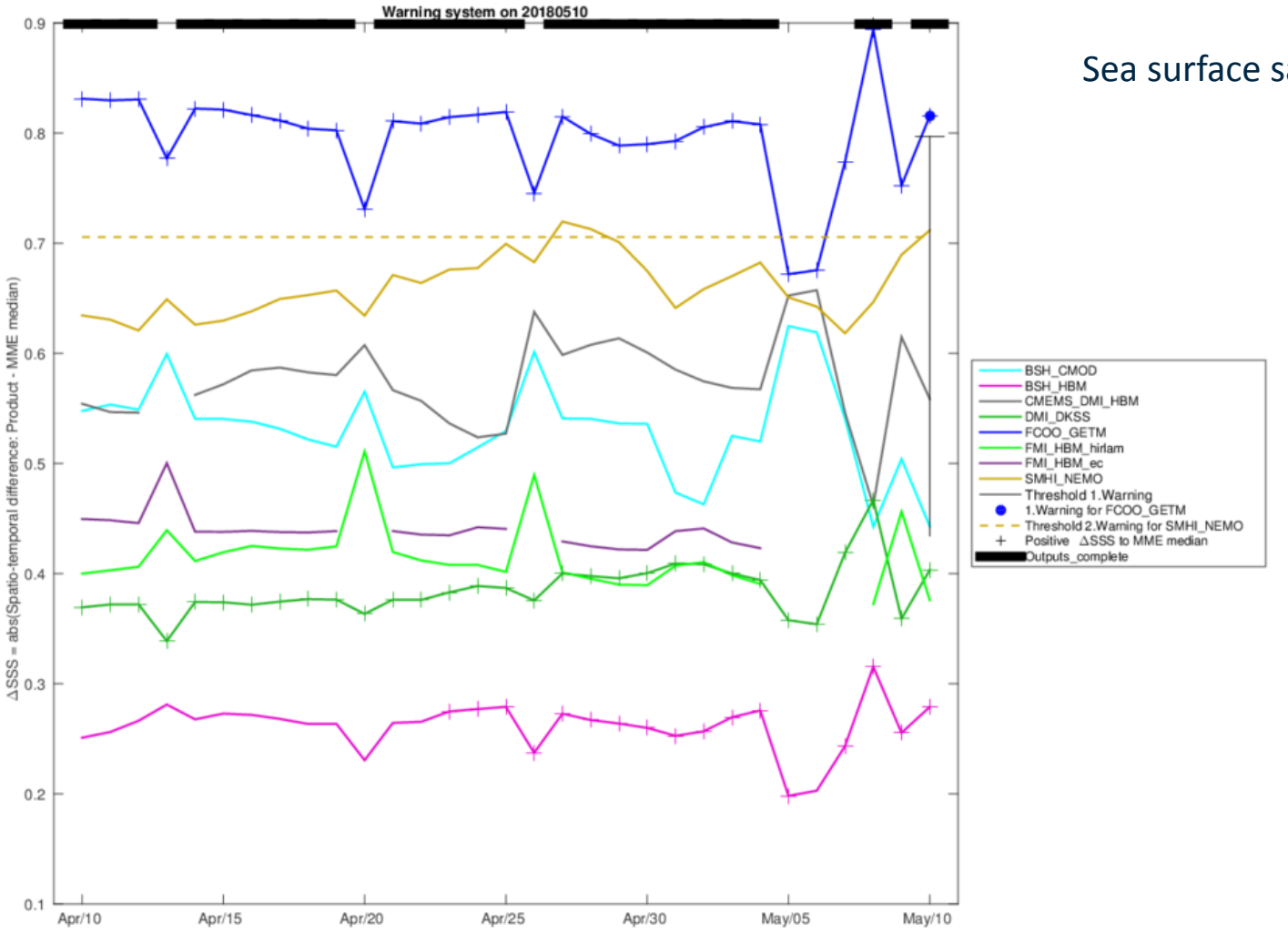
SSS 5m-mean from FOAM_AMM7v8

SSS 3m-depth from CMEMS (FOAM_AMM7v9)

Funded by the European Union

Inga.Golbeck@bsh.de

Example „Warning-system“



Sea surface salinity

Funded by the European Union

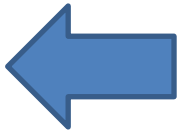
Inga.Golbeck@bsh.de

Tasks for CMEMS phase 2

- Validation of SSC
- Validation in general: include more stations from CMEMS In-Situ TAC
- MME of ice parameters → *planned for 2019*
- MME of wave parameters → *wave height?*
- MME of biogeochemical parameters → *not enough forecast products*
- New metrics: e.g. power spectral density for currents

- Add new stations (e.g. sea level)

- Option 1: To identify a list of stations, exchange the model and observation data at the stations, BSH make centrally the MME; then all BOOS members retrieve the data



- Option 2: Each BOOS member submit a job to BSH server to extract sea level forecast at a given list of stations, then does the MME in house by himself (the BSH MME software will be installed in each member).