

Prediction of Ocean State by assimilation of FerryBox temperature and salinity data. A case study for the Baltic Sea

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Stanev(1)

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Germany

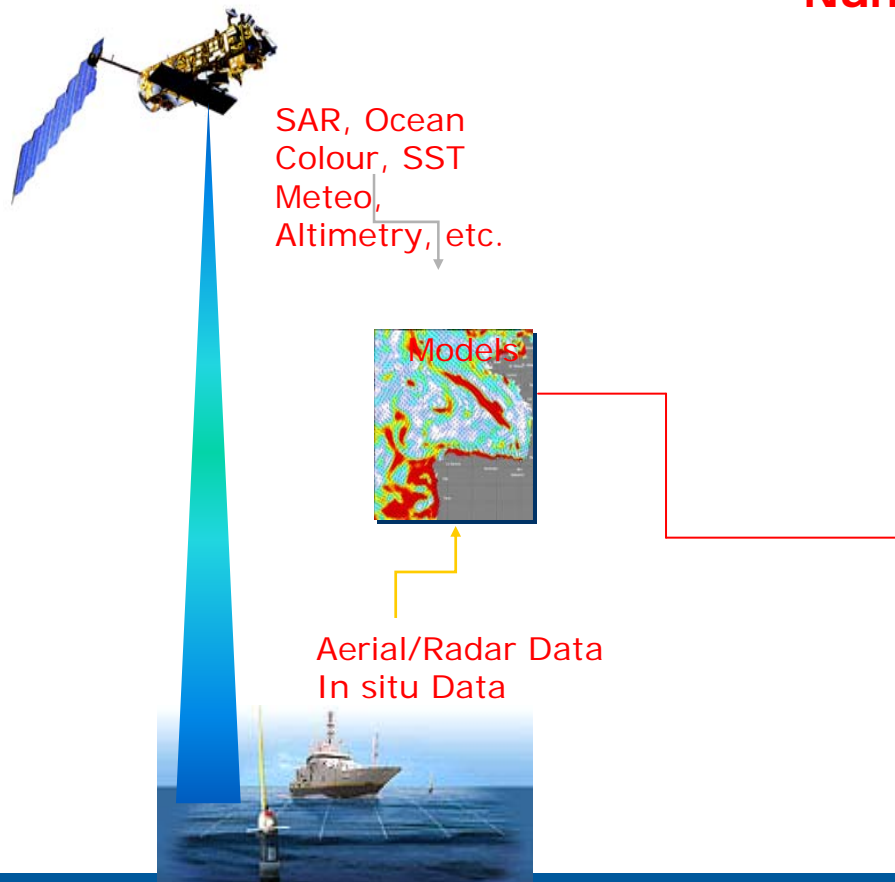
Ferrybox Workshop 2011

OUTLINE

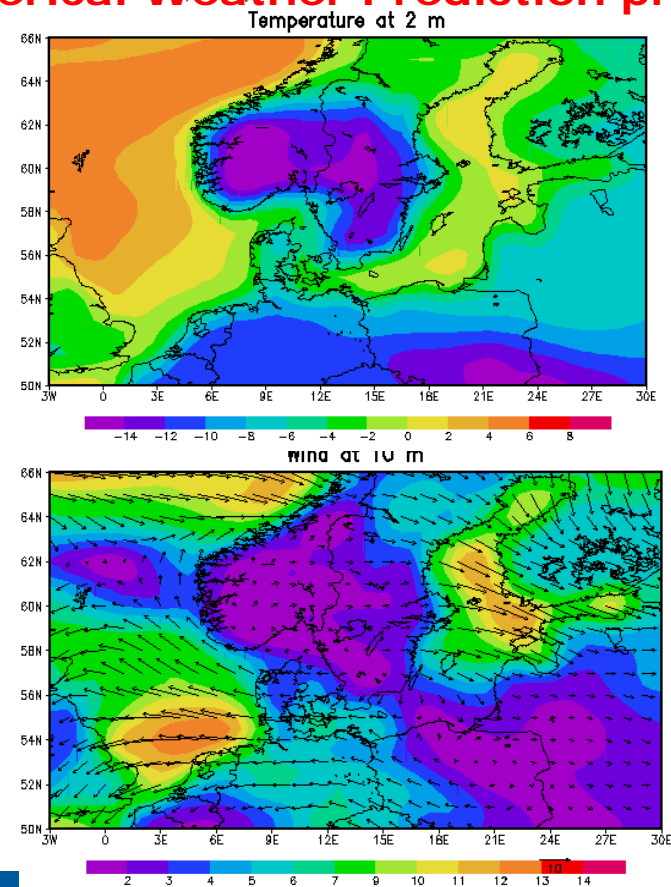
- Observational data
- Model description
- Assimilation results
- Pre-operational model
- Conclusions/Problems

Operational coastal modelling system

The focus is on the utilization of data of different types toward pre-operational and operational oceanography of the German Bight

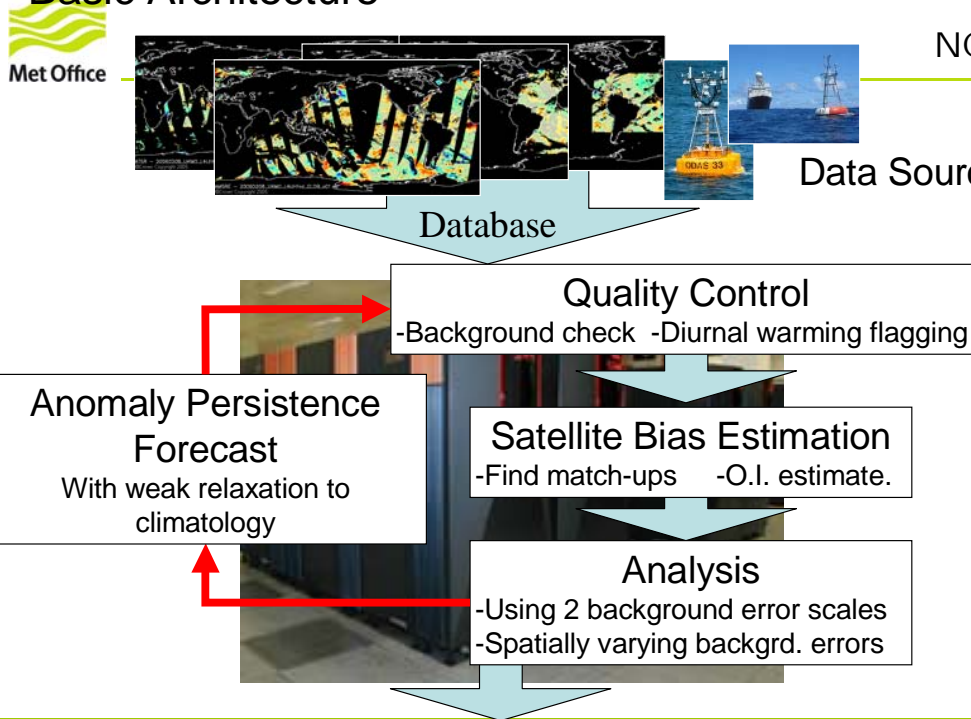


Numerical Weather Prediction products



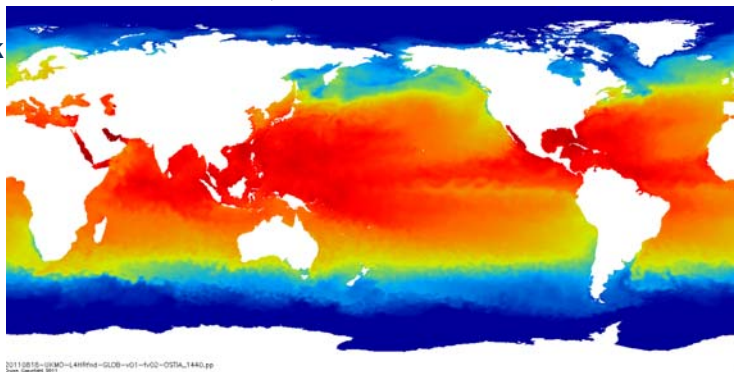
Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA)

Basic Architecture

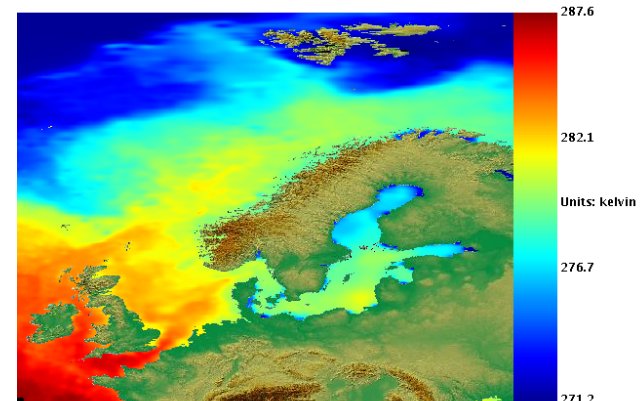


NCOF OSTIA uses satellite data provided by the [GHRSSST project](#), together with in-situ observations to determine the sea surface temperature. The analysis is performed using a variant of optimal interpolation (OI). The analysis is produced daily at a resolution of $1/20^\circ$ (approx. 5km). OSTIA data is provided in [GHRSSST netCDF](#) format every day.

www.ncof.gov.uk



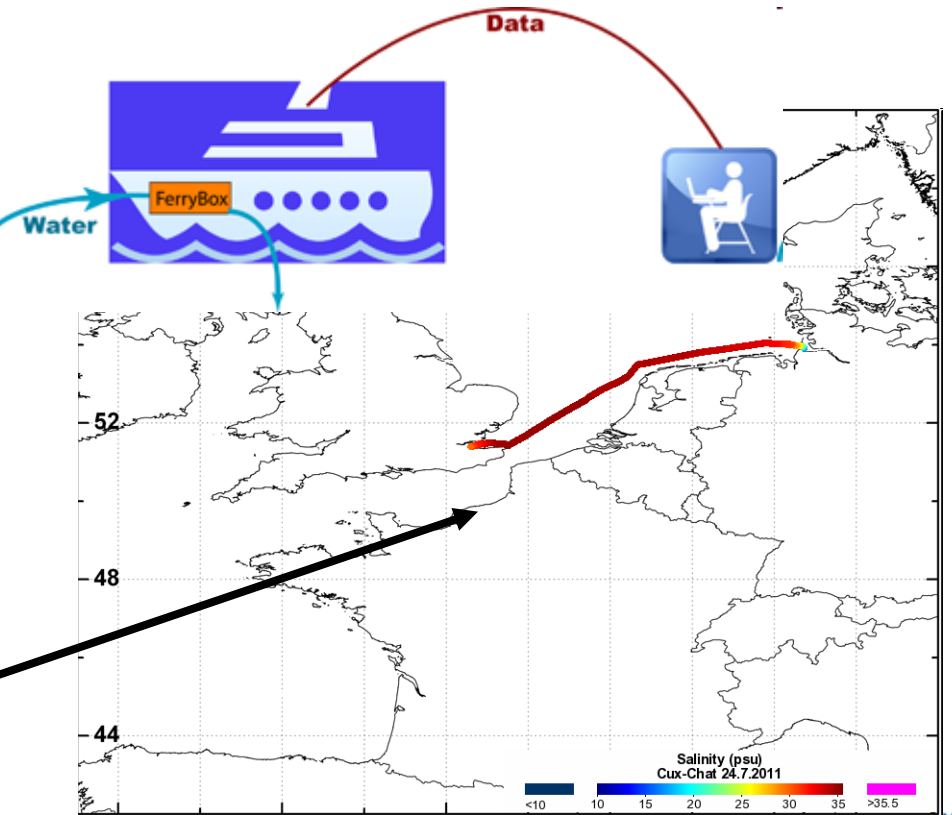
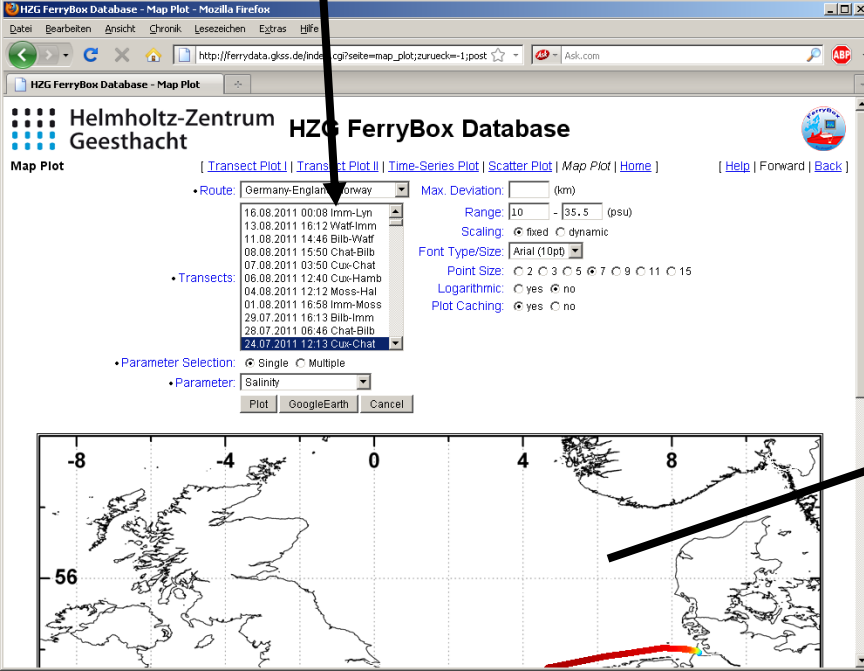
Met Office Web Map Service > OSTIA RAN SST > sea_surface_temperature
Time: 2007-12-08T12:00:00.000Z



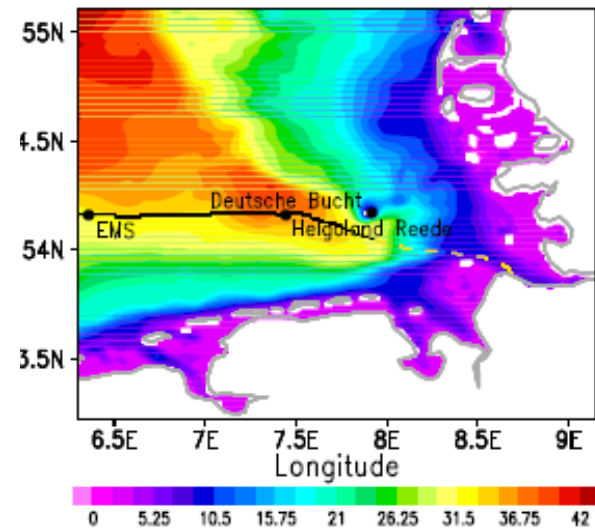
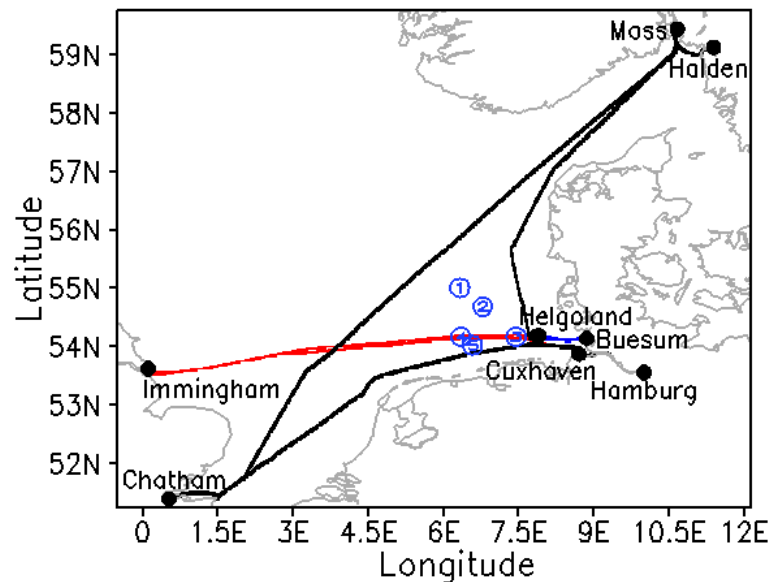
FerryBox Data

Automated instrument packages on ships of opportunities, - "FerryBox", are already in use since many years

www.ferrybox.org

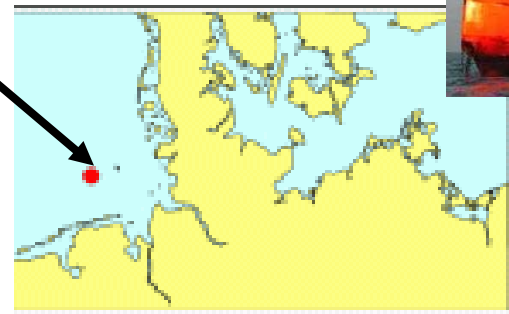
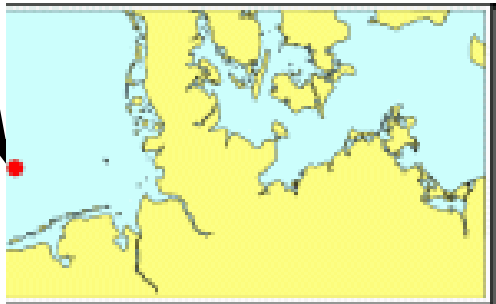
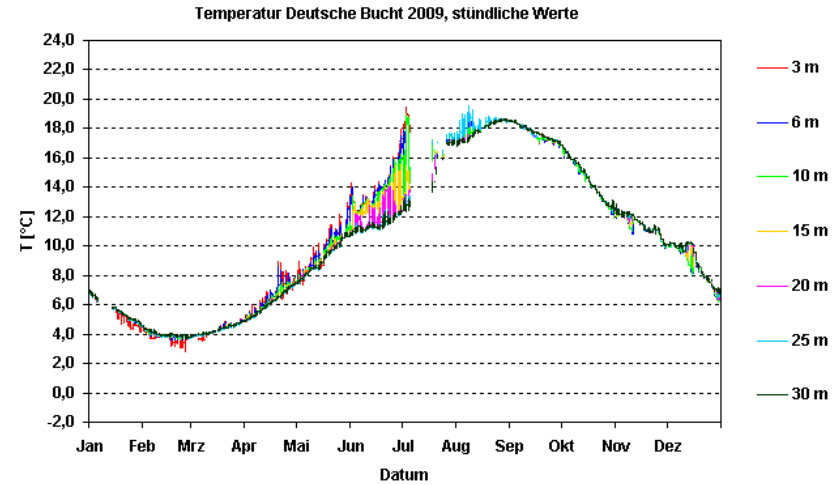
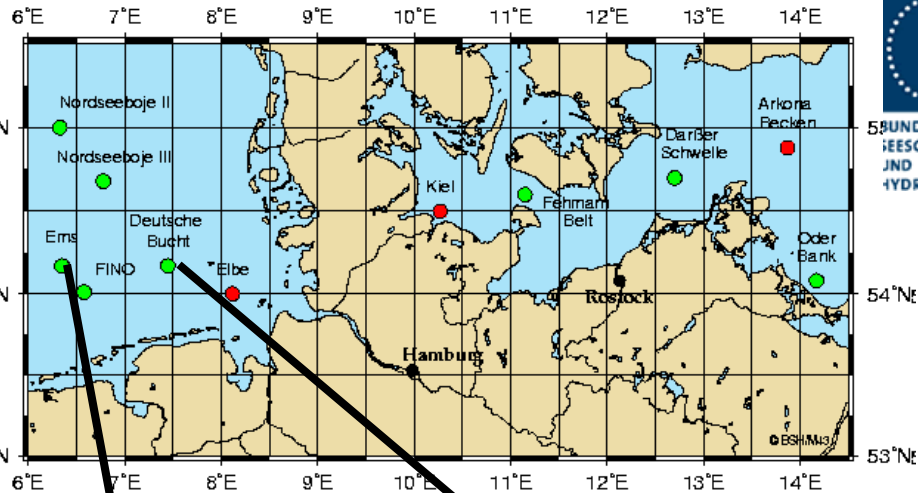


FerryBox routes in the North Sea between Cuxhaven, Immingham, Buesum and Helgoland and Hamburg Cuxhaven-Chatham-Moss-Halden



Bottom topography (m) of the German Bight and part of the FerryBox track Cuxhaven-Immingham. The black part of the track is where the bottom is deeper than 30 m. The dots show the positions of Ems, Deutsche Bucht and Helgoland Reede data stations used for estimating the quality of the analysis from the numerical model.

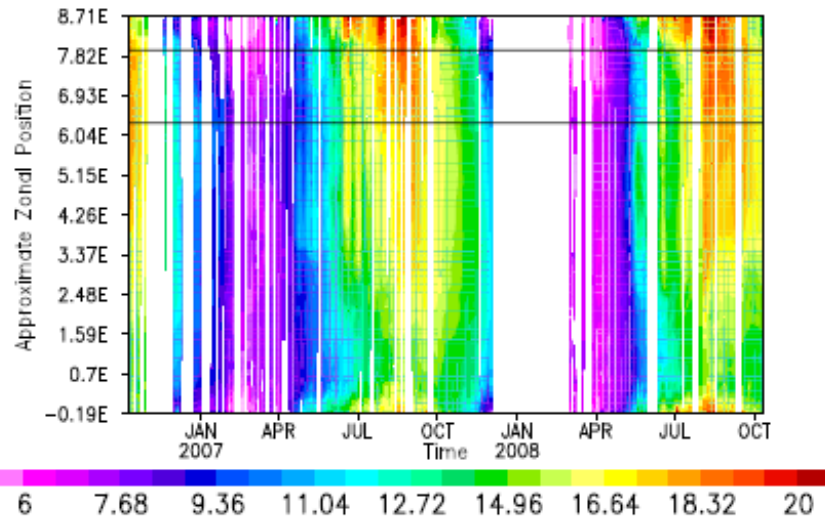
MARNET Stations - BSH



FerryBox vs. OSTIA SST

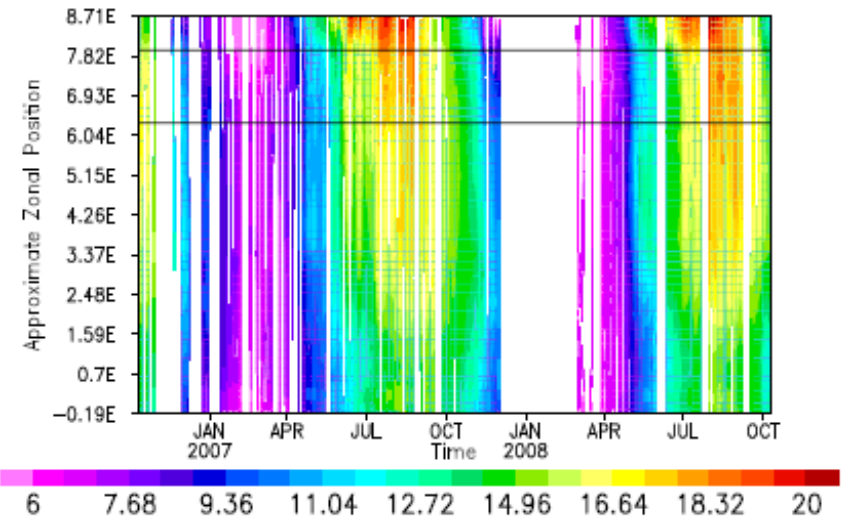
a)

SST from Ferrybox [deg C]



b)

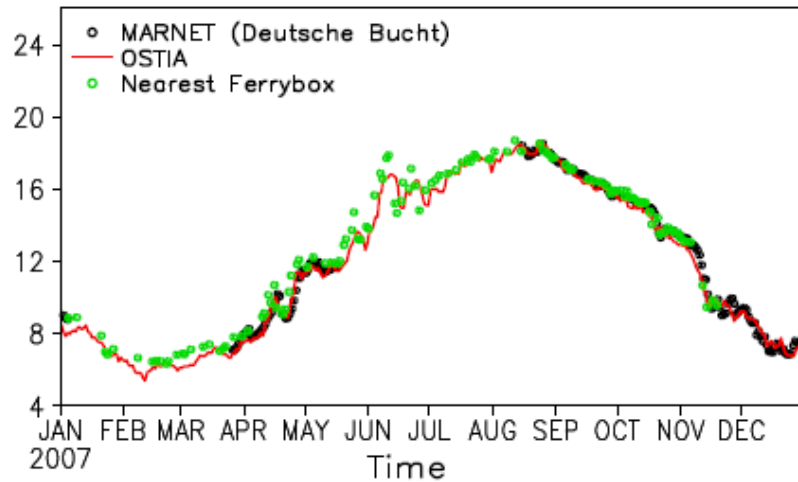
SST from OSTIA [deg C]



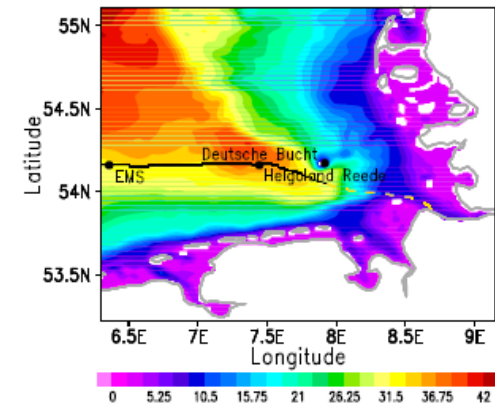
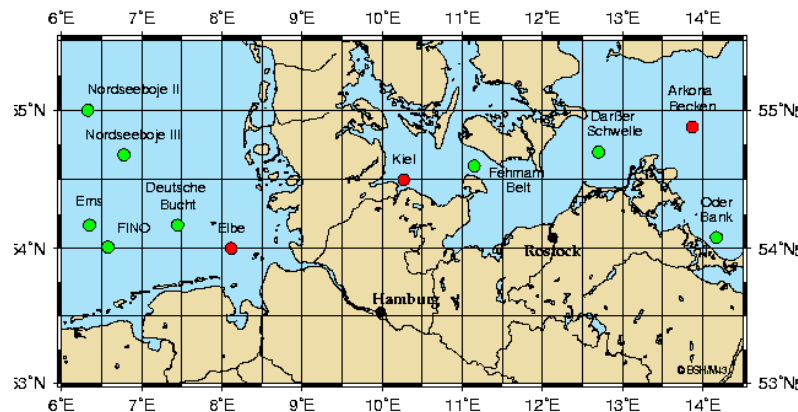
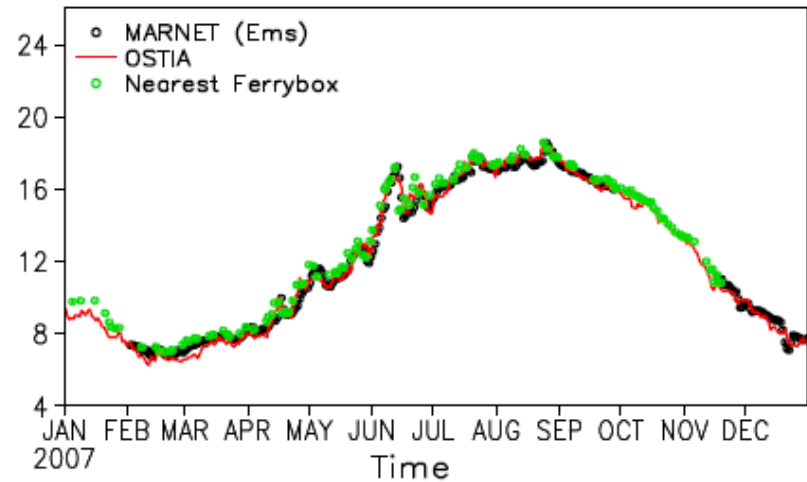
FerryBox SST along the track Cuxhaven-Immingham (a), and OSTIA data (b) sampled along the FerryBox track. The temporal resolution in the plots is 24h. The data analysed and assimilated in the model (in the German Bight) lies between the black lines.

SST (MARNET, OSTIA, Ferrybox)

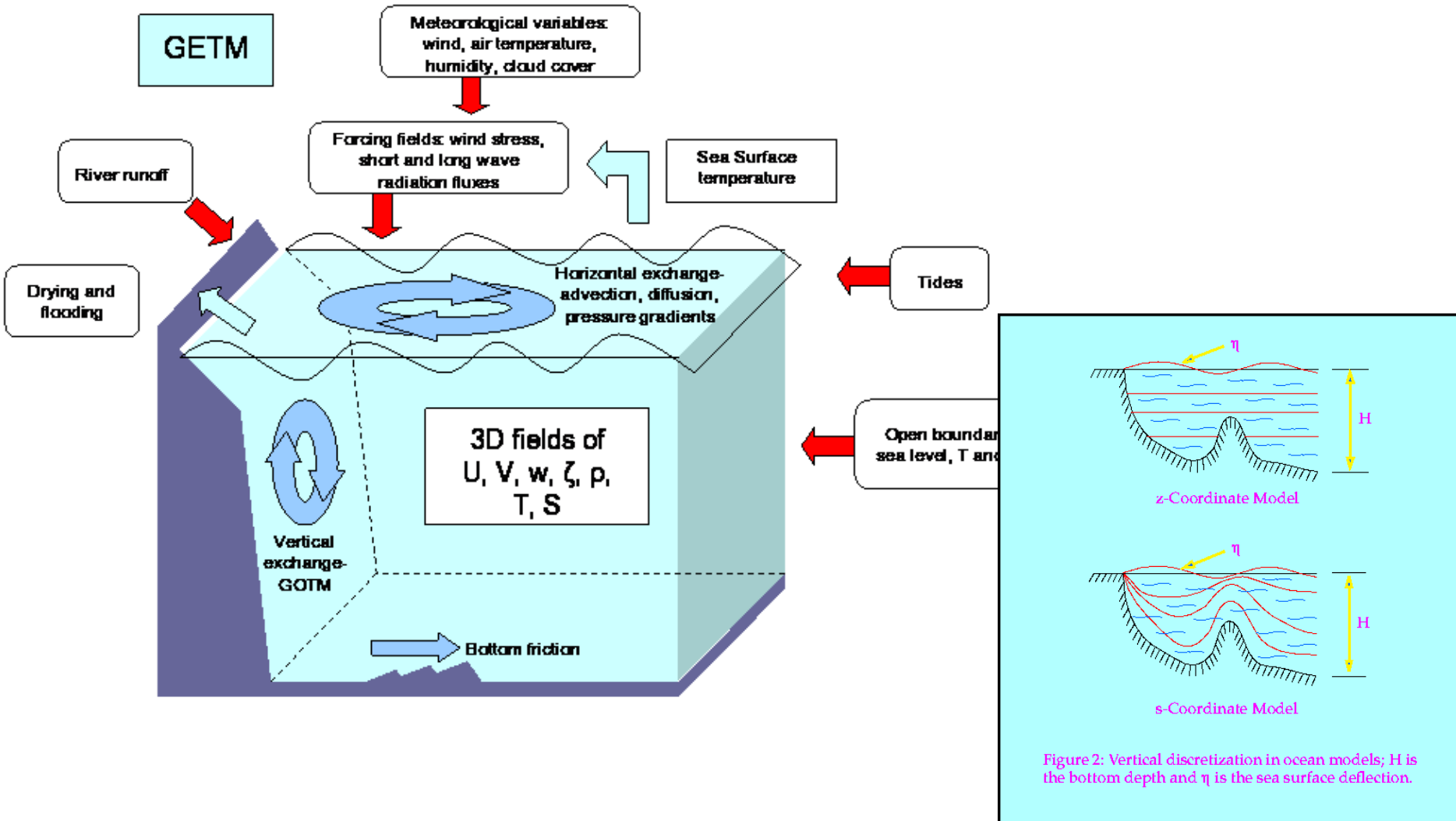
a) Deutsche Bucht Station – 54.17N 7.45E
SST [deg C]



b) Ems Station – 54.17N 6.35E
SST [deg C]



General Estuarine Transport Model (www.getm.eu)



Nested modelling system

Atmospheric forcing (6-hr ECMWF data analyses),
river run-off – hourly data

Open BC – tides, T and S

North Sea-Baltic Sea

$\Delta\lambda=\Delta\phi= 3$ nm, Time step = 30 s

2 open boundaries (S and N)

German Bight

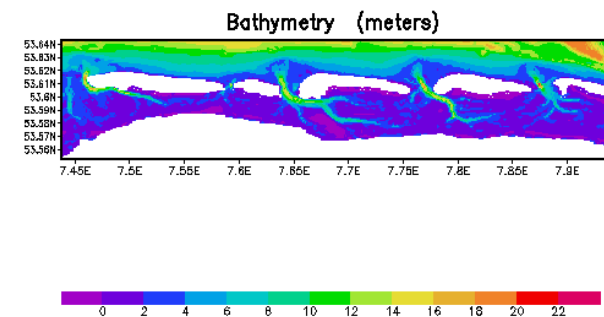
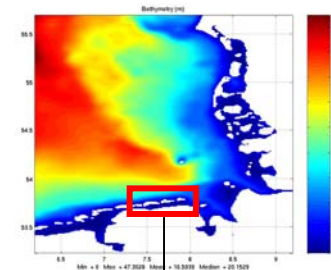
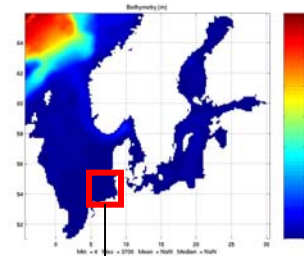
$\Delta\lambda=\Delta\phi= \sim 1$ km, Time step = 10 s

2 open boundaries (W and N)

Wadden Sea

$\Delta\lambda=\Delta\phi= 200$ m, Time step = 3 s

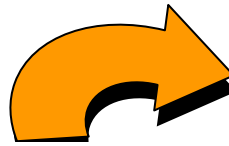
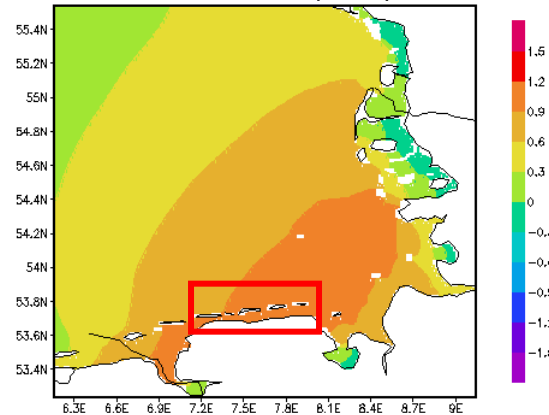
3 open boundaries (W, N and E)



Nested models – Sea level

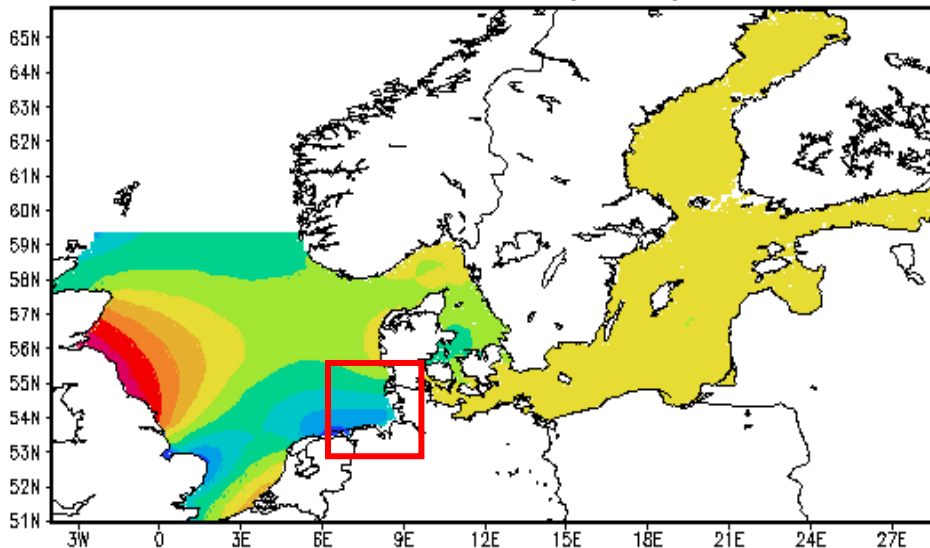
AT 1x.1 hours from 01.06.2004:0:0

Surface Elevation (meters)



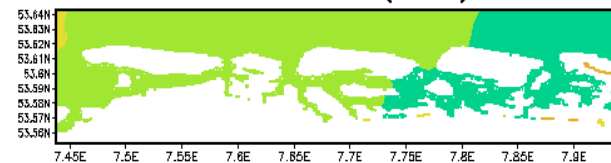
AT 1x.1 hours from 01.06.200

Surface Elevation (meters)



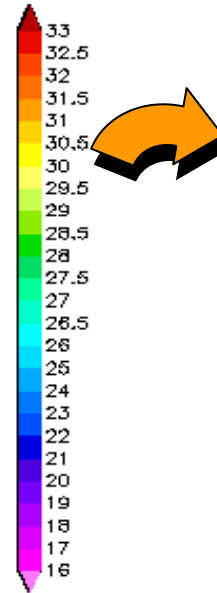
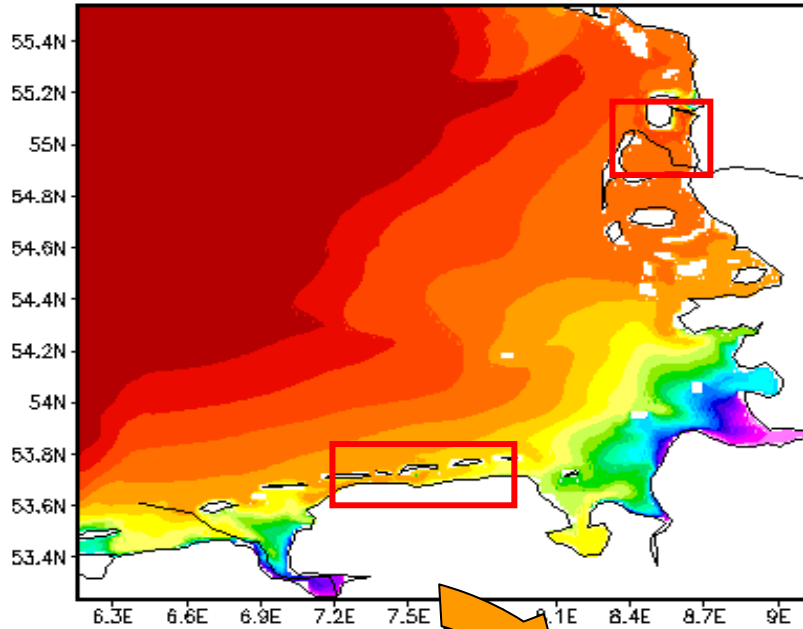
1x.1 hours from 26.06.2004:0:0

Surface Elevation (meters)

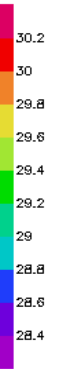
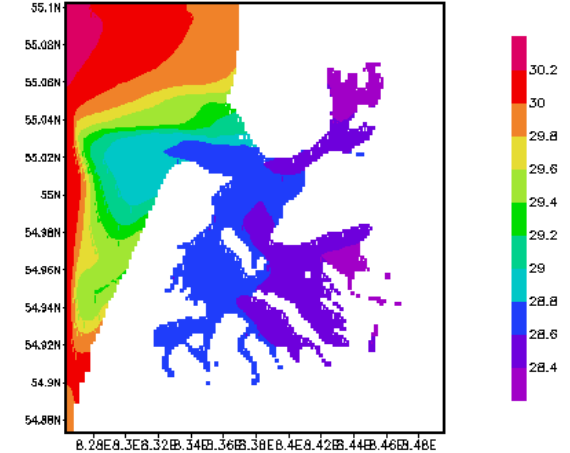


Nested models – Surface salinity

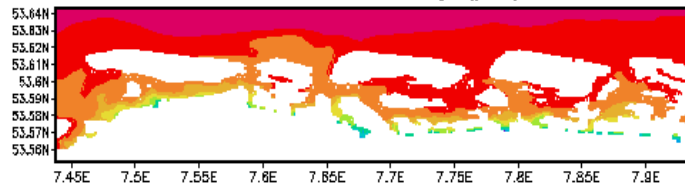
AT 140x.1 hr from 01.03.2005:0:0
Sea Surface Salinity (psu)



AT 49x.1/2 hours from 26.04.2004:0:0
Surface Salinity (psu)



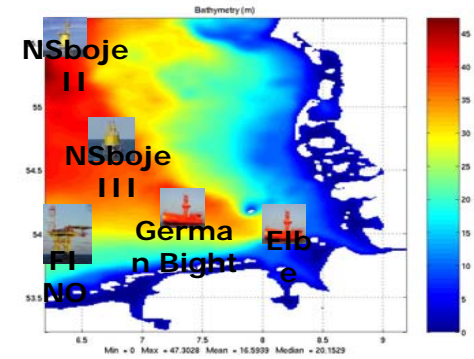
Sea Surface Salinity (psu)



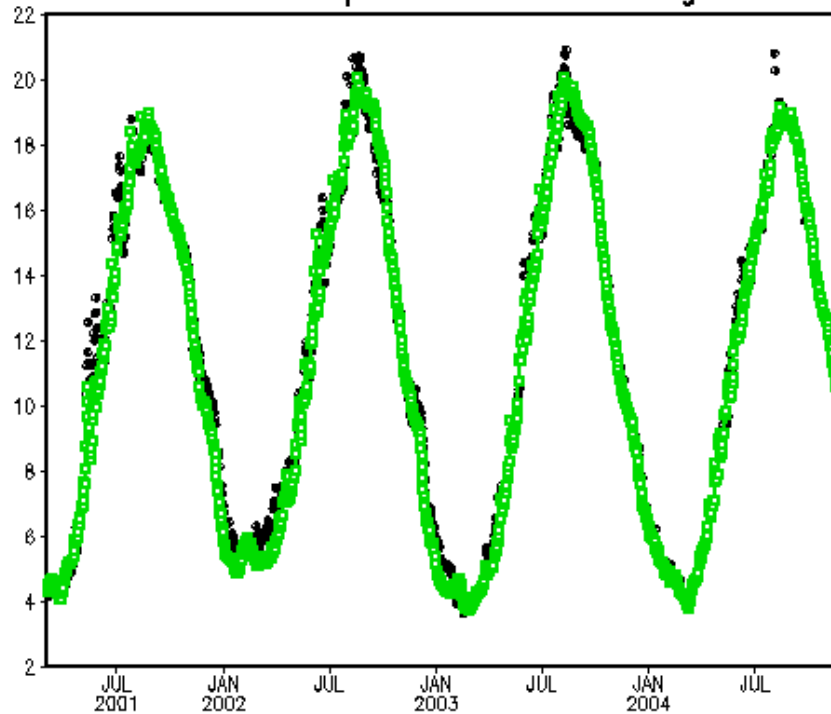
SST MARNET vs. GETM



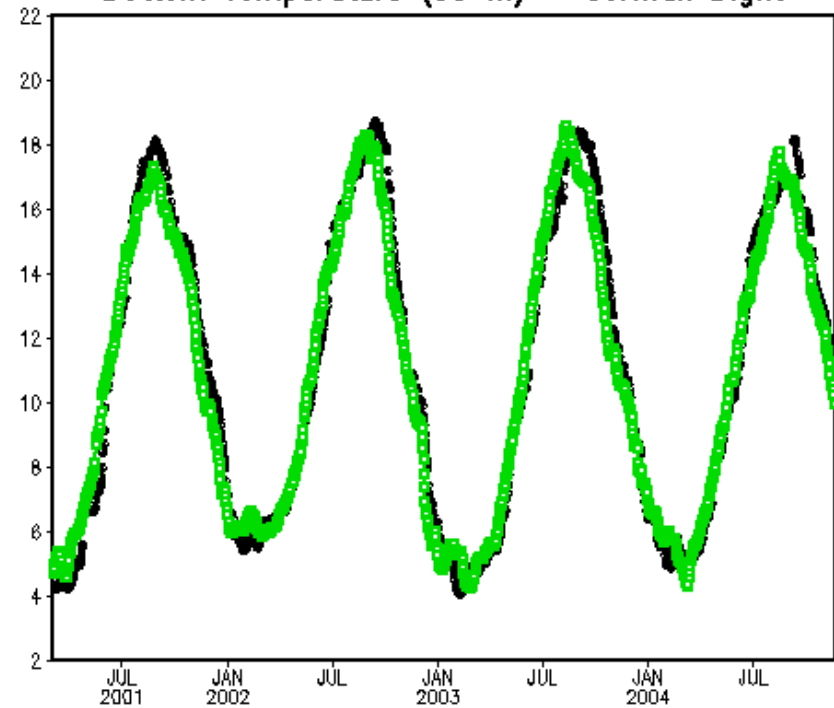
German Bight



Surface Temperature – German Bight



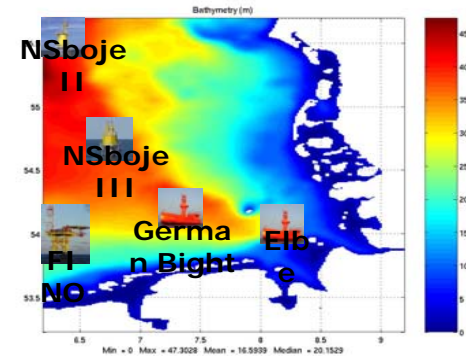
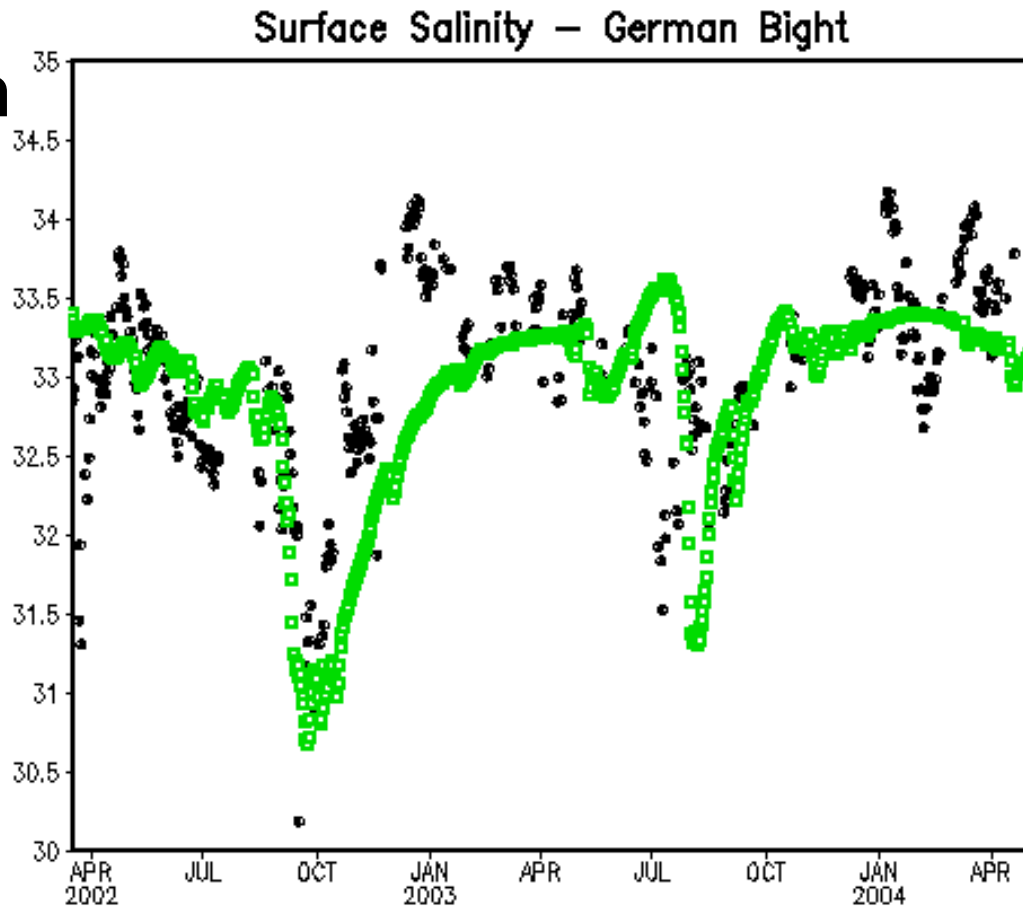
Bottom Temperature (30 m) – German Bight



MARNET vs. GETM

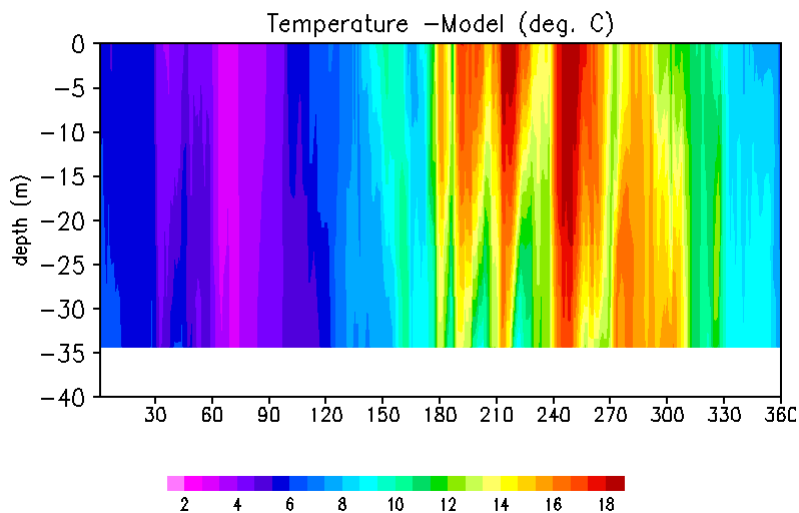
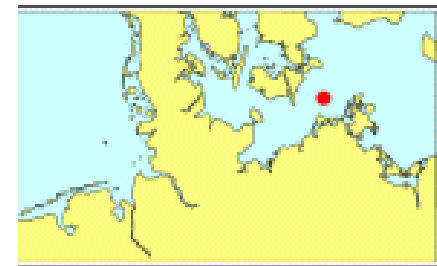
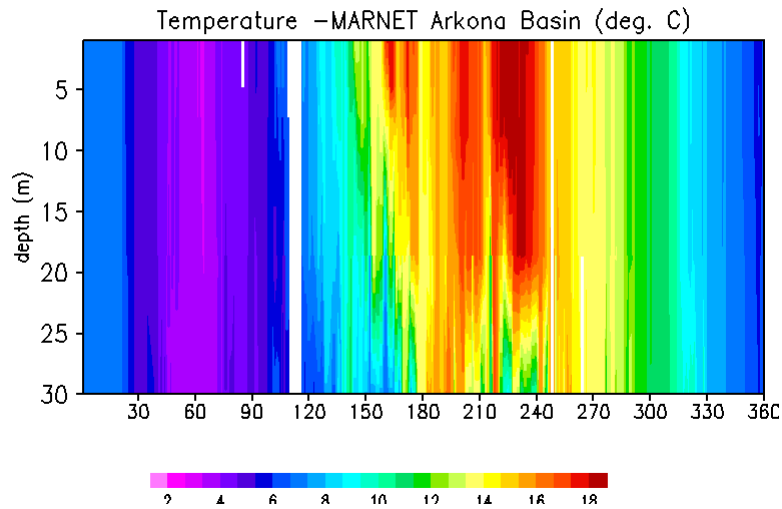


German
Bight



Staneva et al. (2008)

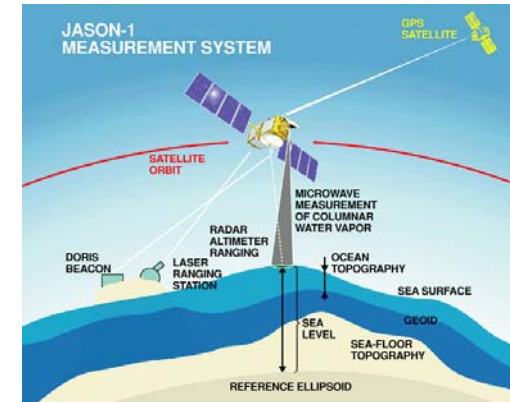
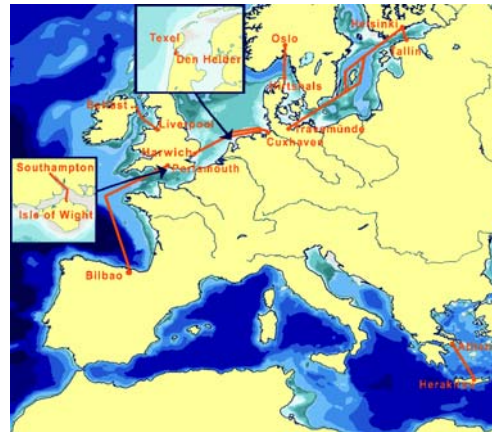
MARNET vs. Model – Arkona Basin



Increasing Operationality

**DATA
ASSIMILATION:**
*Combines model
and data for best
ocean estimate
(all source data
fusion).*

Model:
*FTP Input Data
Automatized run
Data Assimilation
Web Application*

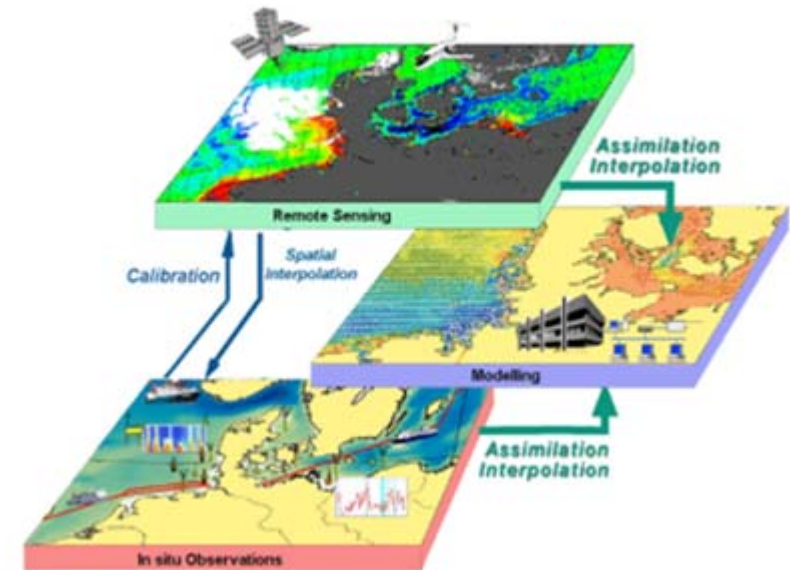
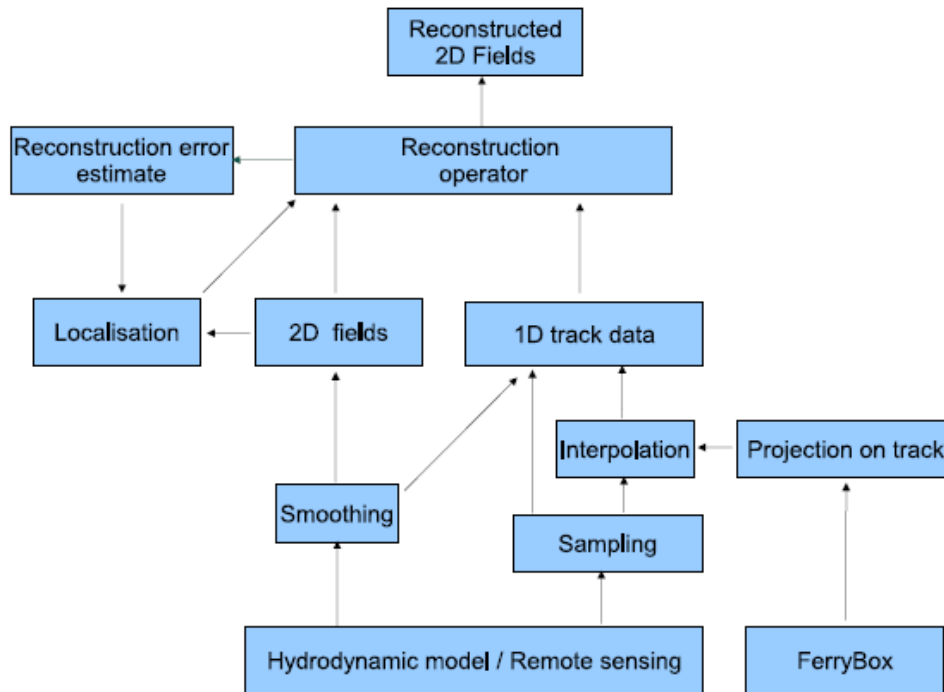


*George Veronis's
law:
"Do not assimilate
data into a model
that the model
cannot simulate"*



Assimilation

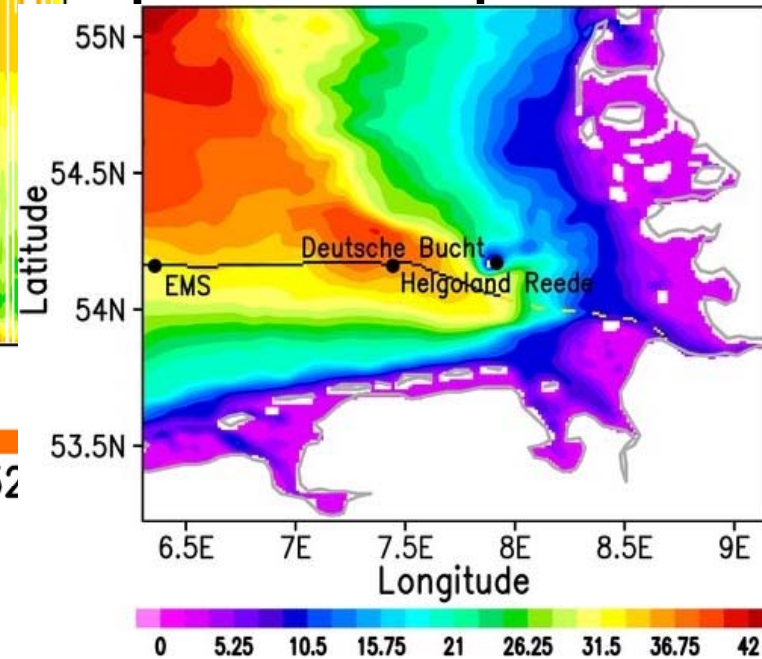
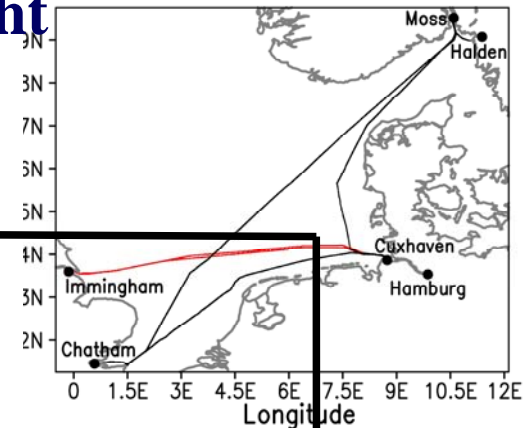
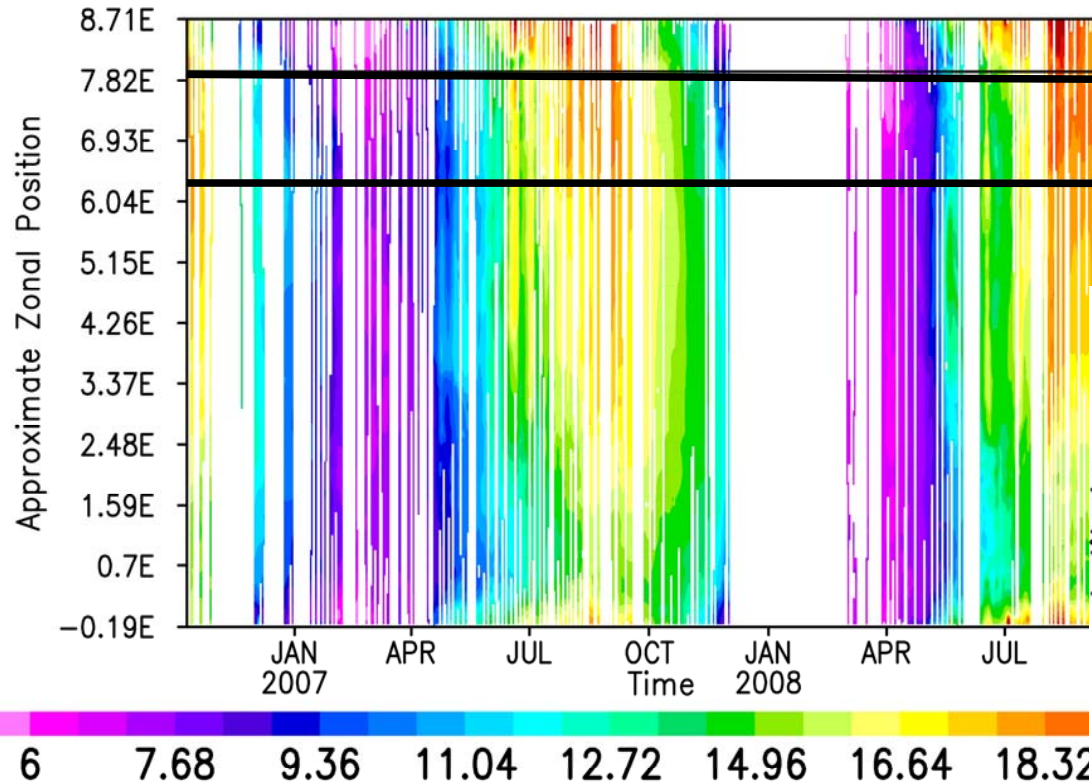
We use a singular evolutive extended *Kalman filter* (SEEK)
 The temporal resolution and OSTIA data is 24 hours and its
 reference time is 12 o'clock. Assimilation is done every 24 hours
 at 12 o'clock UTC.



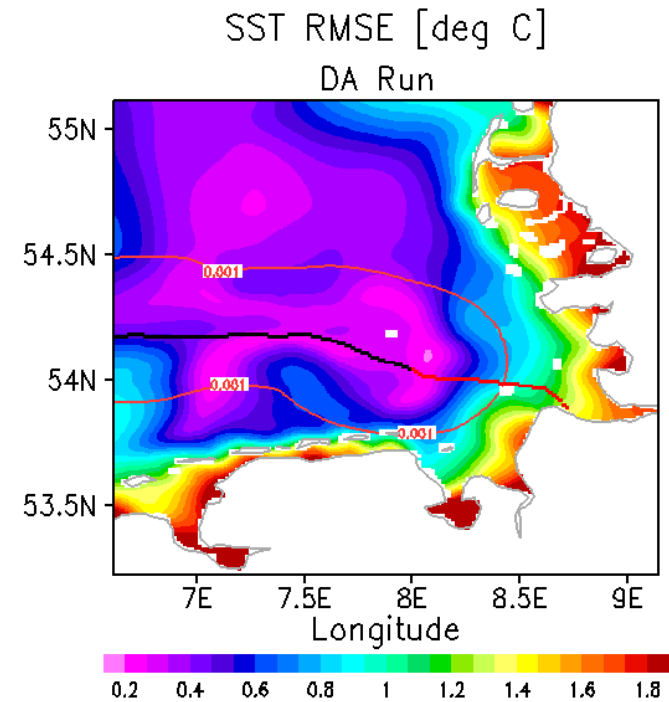
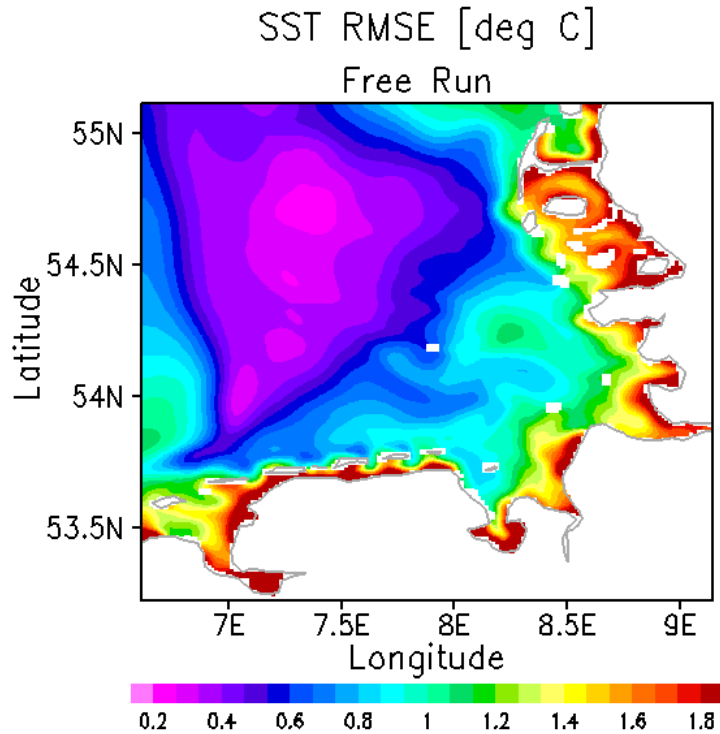
Data flow diagram for assimilation of FerryBox Data

Assimilation of FerryBox surface temperature and salinity measurements to improve model based estimates for the German Bight

SST from Ferrybox [deg C]

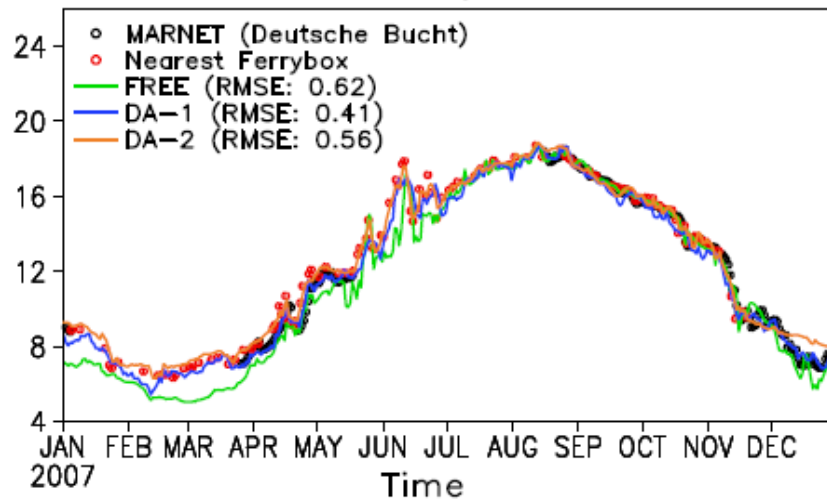


RMSE of SST

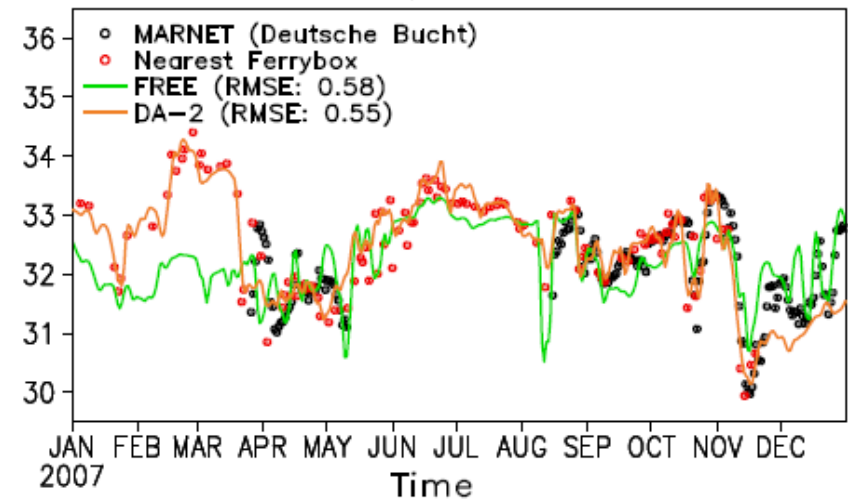


Validation of SST and SSS

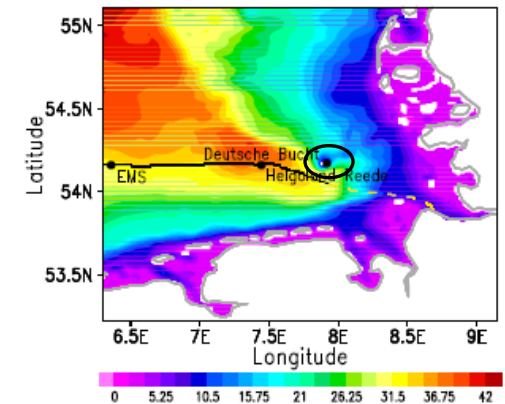
a) Deutsche Bucht Station – 54.17N 7.45E
SST [deg C]



b) Deutsche Bucht Station – 54.17N 7.45E
Salinity at 6m

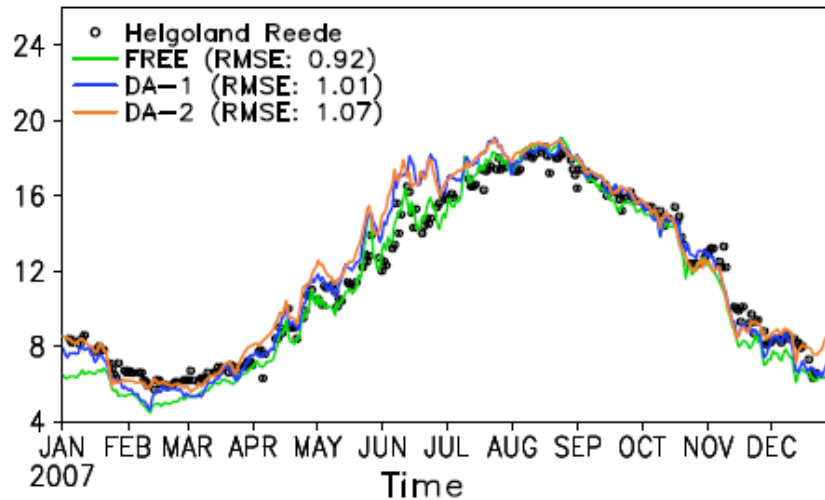


Validation of simulated SST and SSS against MARNET observations.

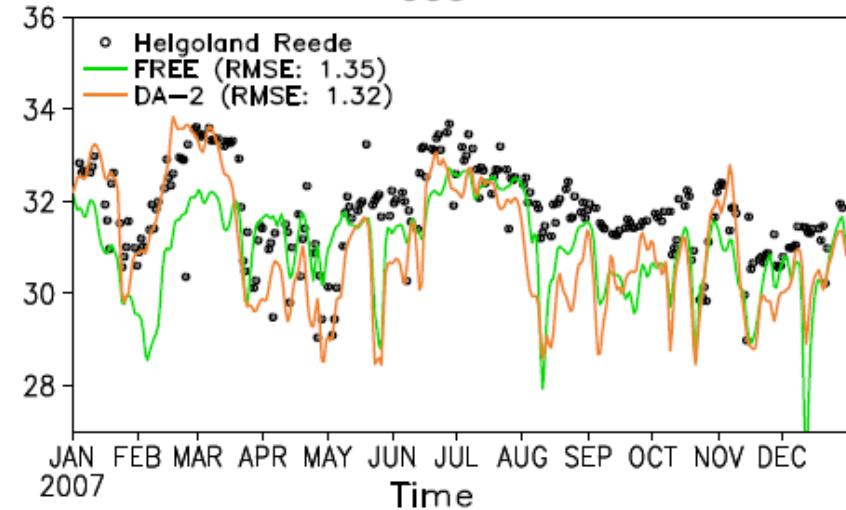


Validation of SST and SSS

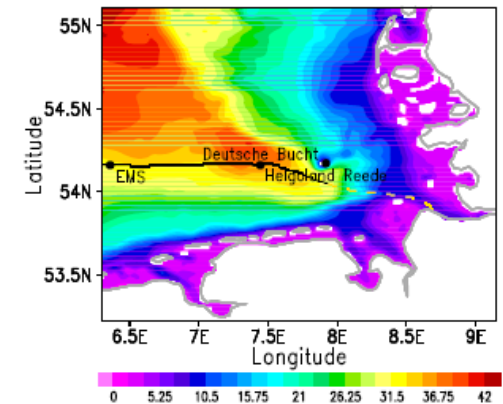
e) Helgoland Reede – 54.18N 7.88E
SST [deg C]



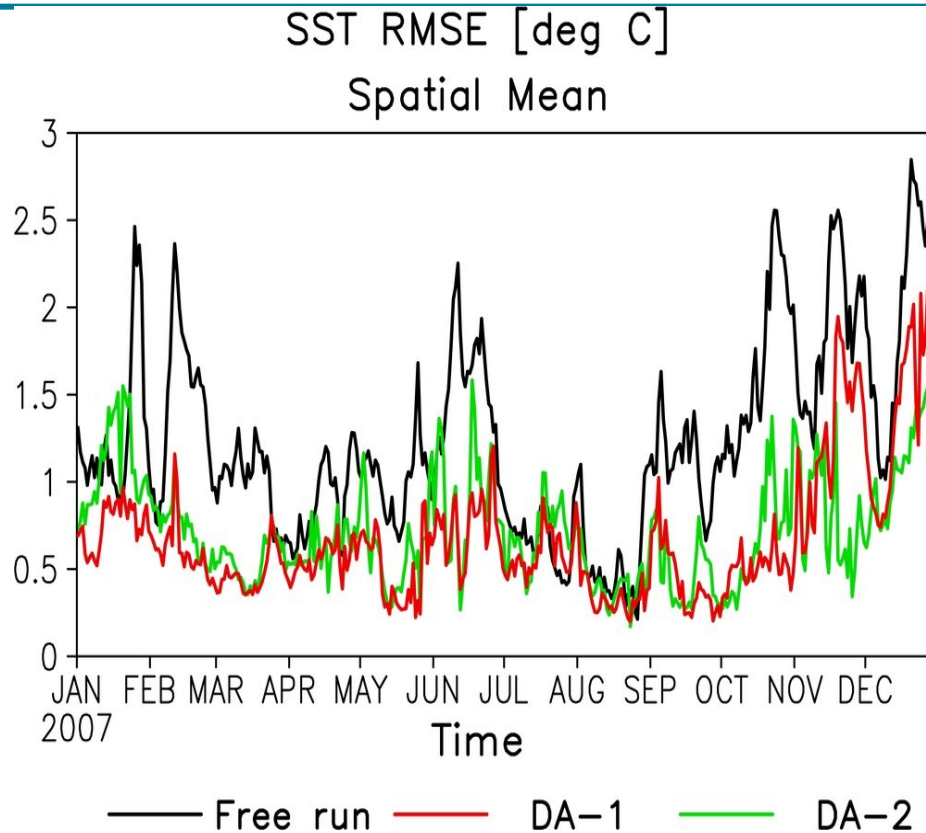
f) Helgoland Reede – 54.18N 7.88E
SSS



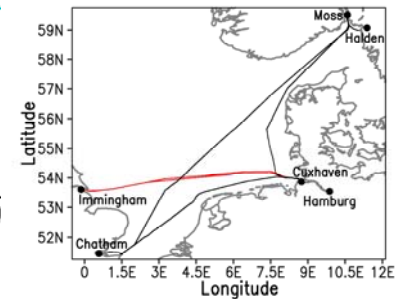
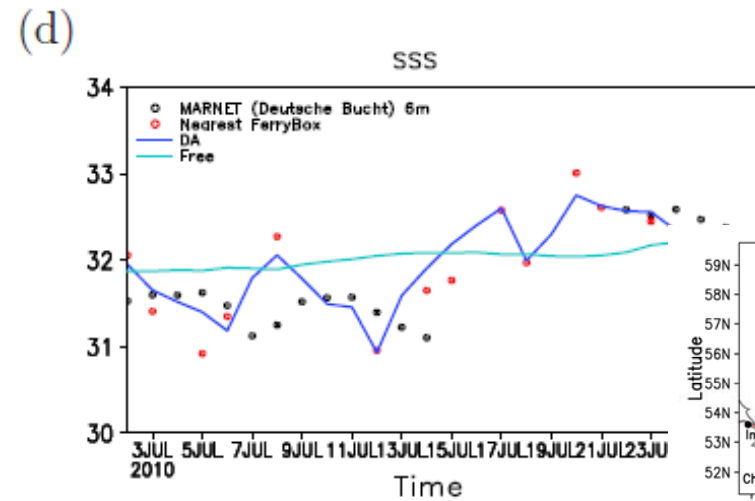
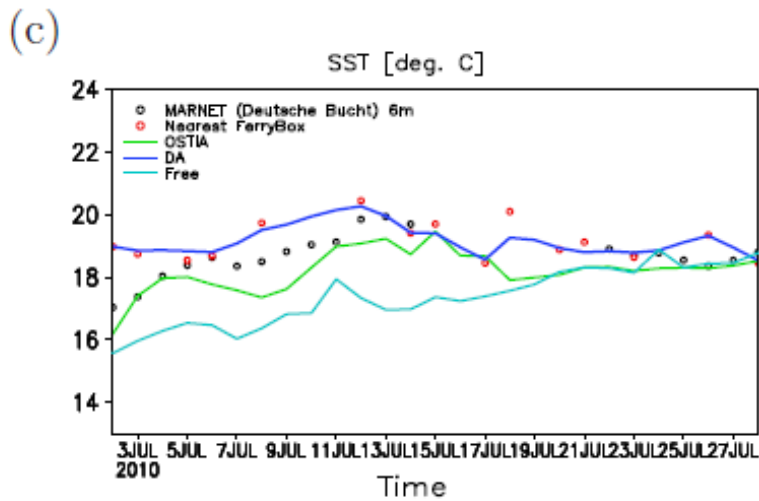
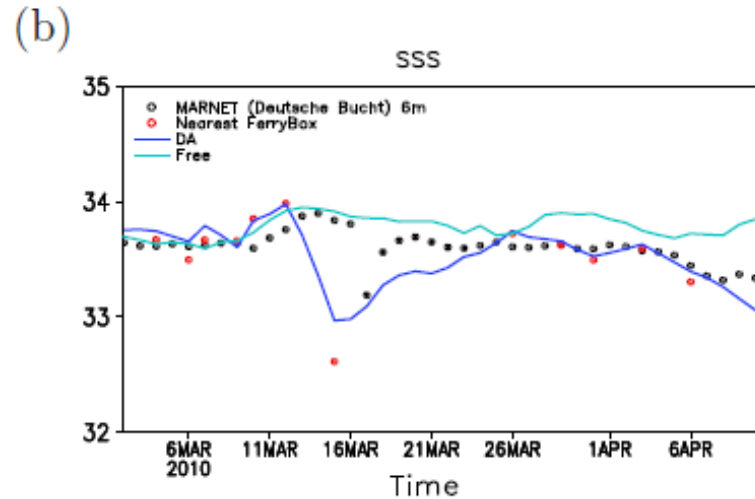
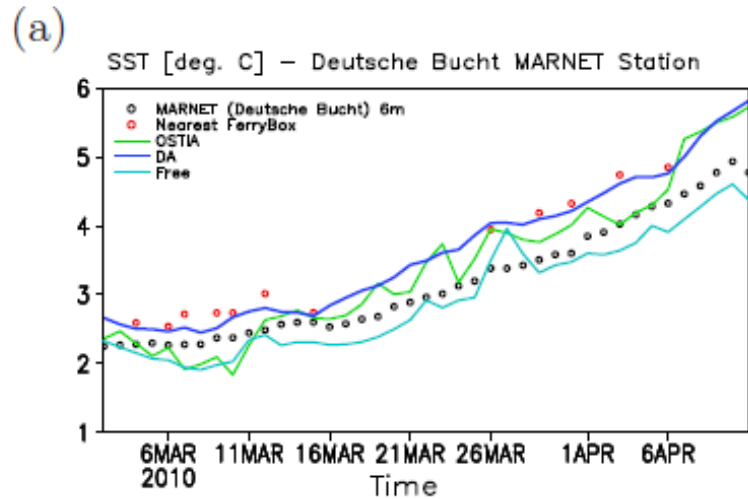
Validation of simulated SST and SSS against Helgoland Reede observations.



Assimilation Impact



Comparison of SST and SSS from the Free Run and DA at Deutsche Bucht Station.



Using data from several FerryBox Routes for DA

Challenge:

Larger area covered with observational data
assimilated will improve the ocean state

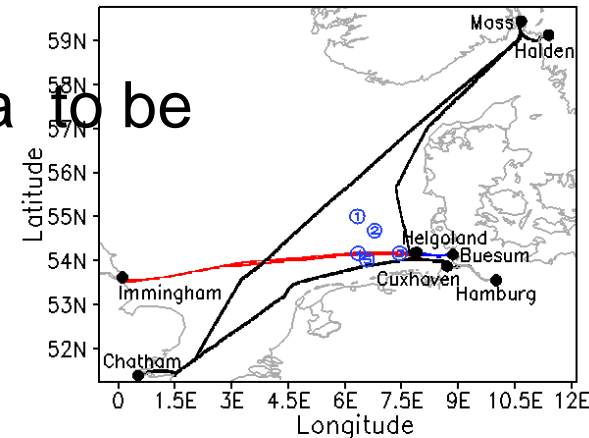
Problems:

FerryBox Data Frequency – (e.g. Germany-
England-Norway Ferry box Rote)

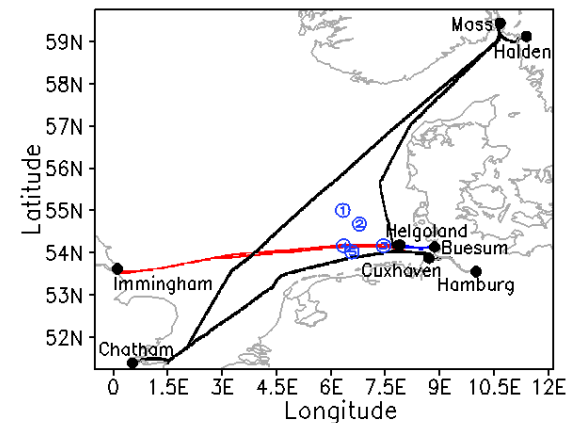
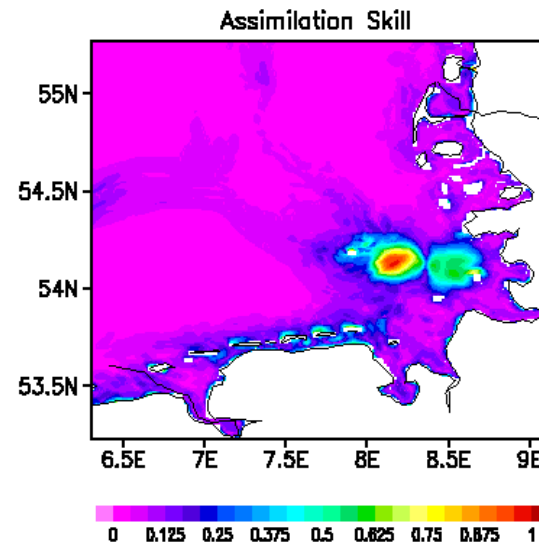
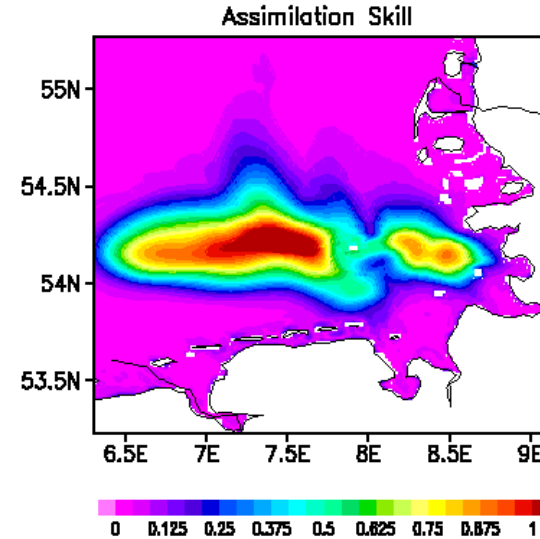
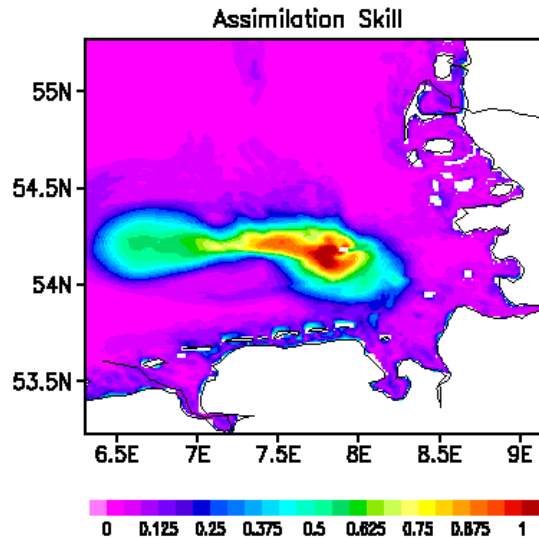
FerryBox Data gaps –(e.g. Buesum-Helgoland is
only for the summer months)

Finally:

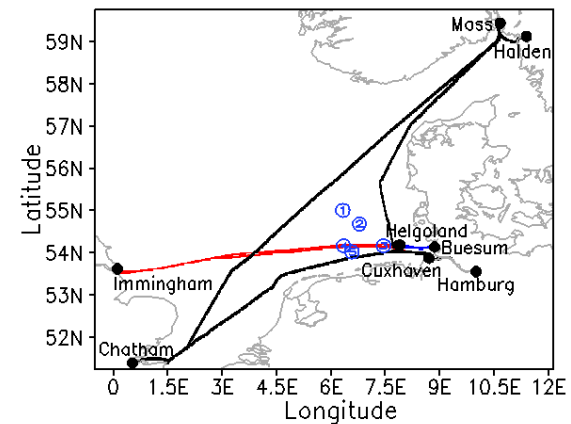
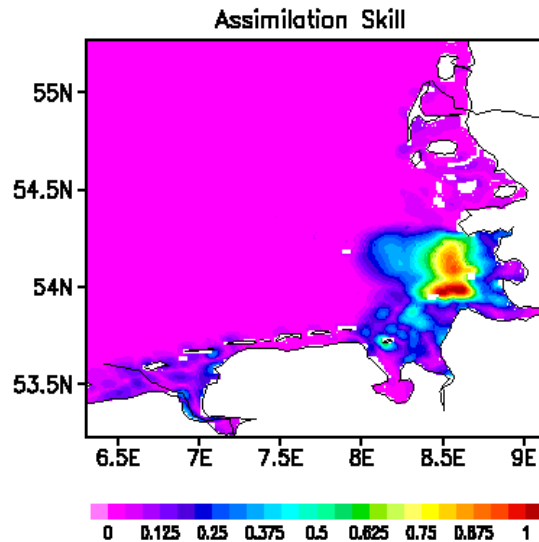
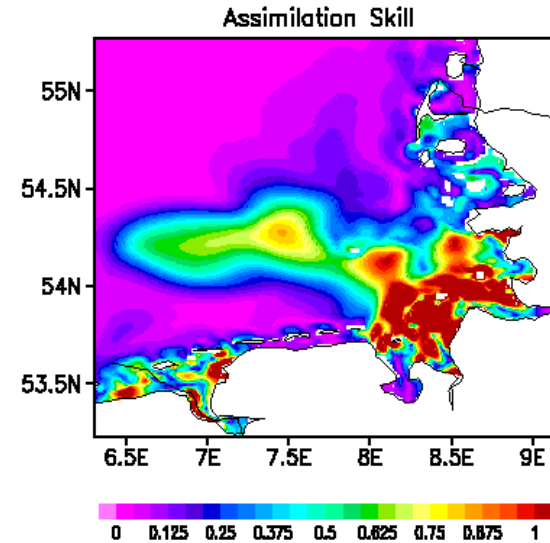
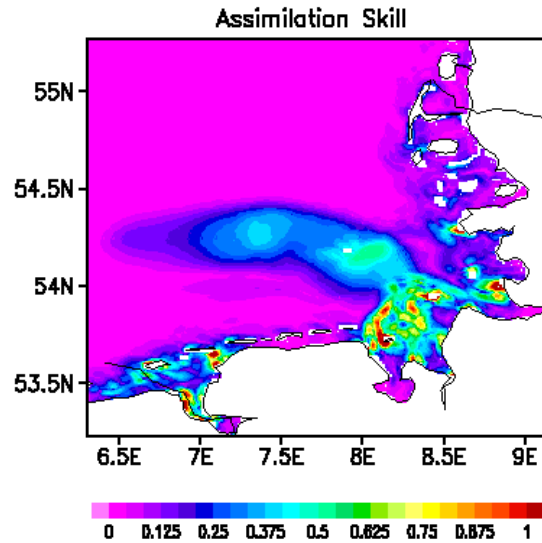
We use Cuxhaven-Irmingam and Buesum-
Helgoland for May-July 2010



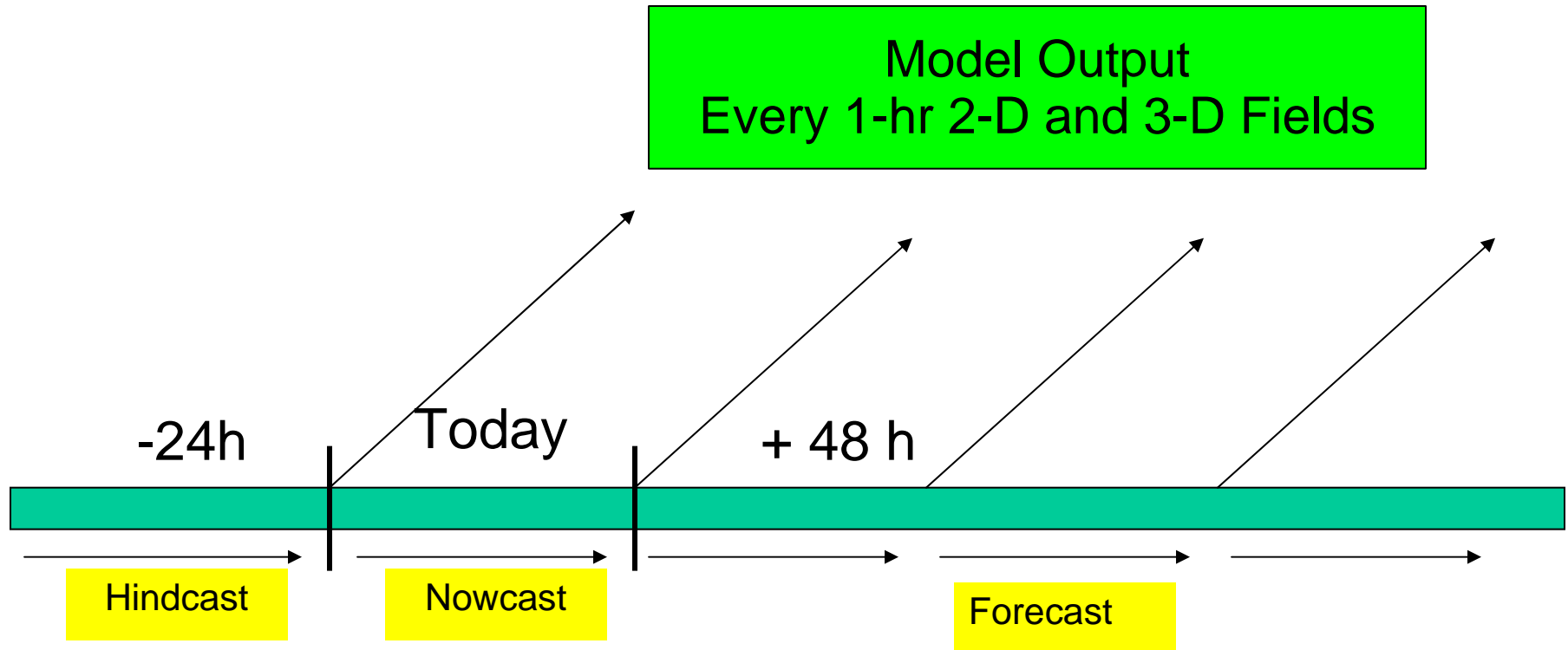
Influence of assimilation of FerryBox SST on state estimate



Influence of assimilation of FerryBox SSS on state estimate



Toward pre-operational coastal oceanography: Real time products



The System runs twice a day (via crontab) – at 05:00 and 18:00

Toward pre-operational oceanography: Real time products

www.cosyna.de

GODIVA2 Data Visualization demo page - Mozilla Firefox

Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

<http://kofserver2.gkss.de:8080/ncWMS/godiva2.html?menu=&layer=>

GODIVA2 Data Visualization demo pa...

Auto-zoom on select

COSYNA ncWMS Server
[MER_RR_Single](#)
[Meris Timeseries](#)
[Waves Forecast](#)
[Getm 2d German Bight 1 km](#)
[Getm 3d German Bight 1 km](#)
[Data from Pegelonline](#)
[Waves German Bight](#)
[North Sea-Baltic Sea 2d](#)
 [sea surface salinity](#)
 [sea surface temperature](#)
 [surface_eastward_sea_water_velocity](#)
 [surface_northward_sea_water_velocity](#)
 [elevation](#)
 [surface_sea_water_velocity](#)
[North Sea-Baltic Sea 3d](#)
[HF Radar Current](#)
[Getm 2d reanalysed](#)
[Pelets](#)
[test2](#)
[Meris KOF Proc.](#)

[User guide](#)

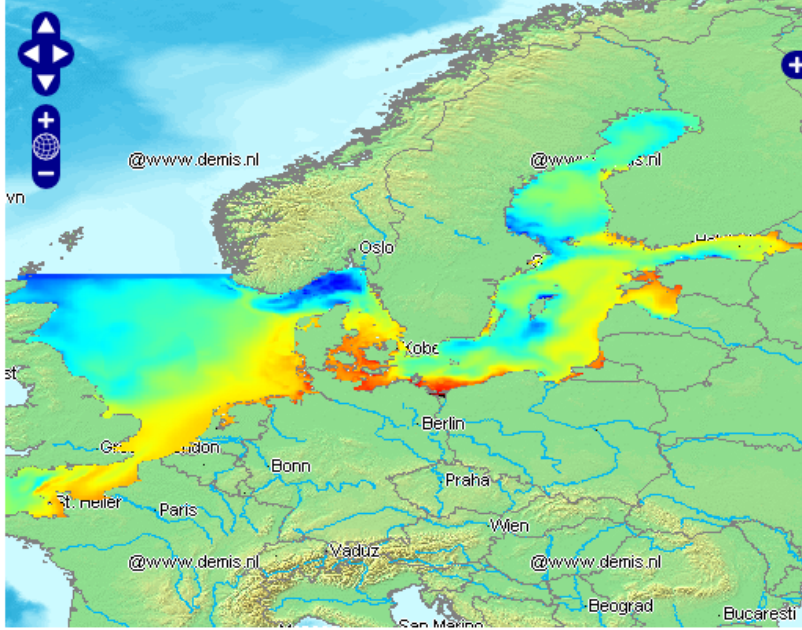
Layer: COSYNA ncWMS Server > North Sea-Baltic Sea 2d > sea surface temperature
Units: grads

Date/time: 26 Aug 2011 17:00:00 UTC [first frame](#) [last frame](#)

August, 2011						
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Sun	Mon	Tue	Wed	Thu	Fri	Sat
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Select date



[Fit layer to window](#)



22
 18.00
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 10

[test image](#) [Open in Google Earth](#) [Screenshot](#)

Overlay opacity: 100%

Conclusions

- Nested-grid model is set-up and applied to study the circulation and thermohaline evolution of the German Bight
- Synergy between data and modelling shows promising results
- Assimilation of FerryBox Data improves the state estimate of temperature and salinity, but locally
- FerryBox Data – to be used in combination with other observational data (e.g. Gliders, Fixed Station-Marnet, FINO-3, Buoys, etc.) to increase the operationality
- Model system is running pre-operationally in HZG

Problems (for the discussion)

Data access – data should be free and operationally available

- The more data – the better – e.g. combined use of North Sea - Baltic Sea FerryBox Routes
- Quality control – very important for a near real time services
- Data gaps and data frequency
- What is the minimum required Ferry Box data frequency (for which area and for what purposes)?
- Feedback from the „end-users“