Evaluation of numerical models by FerryBox and fixed platform data in the southern North Sea

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Introduction

FerryBoxes installed on ships of opportunity (SoO) provide data of selected tracks on a regular basis. One reasonable scientific approach is the evaluation of model simulations applied to the North Sea with operational FerryBox data.

Aims:

- Identify gaps in model performance in simulating physical properties of the North Sea
- Communication with modelers and joint finding of solutions for model weaknesses through analyses of more than one model and their specifications, e.g. data assimilation, exchange and mixing processes.

Resulting differences between the datasets vary between parameters. To combine data from FerryBox routes with other observation types seems promising for model evaluation.

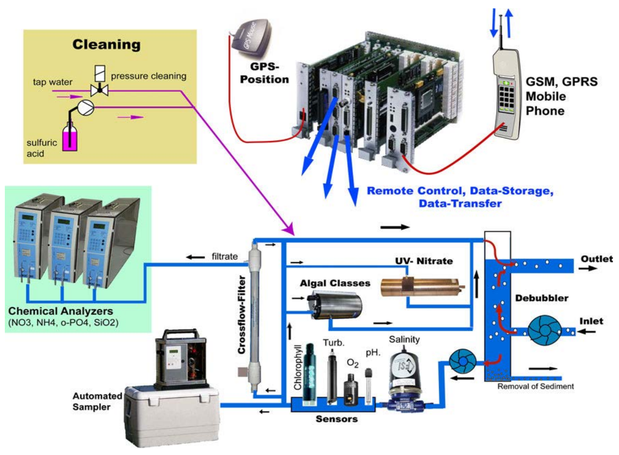

Fig. 1: Scheme of FerryBox flow-through system.

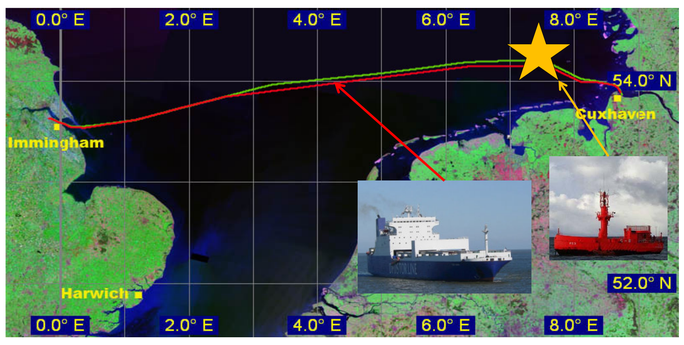

Fig. 2: FerryBox route Cuxhaven – Immingham, crossing the North Sea in longitudinal direction onboard of SoO "TorDania". The star denotes MARNET station "Deutsche Bucht".

Model descriptions

Model names	BSHcmod v4	FOAM AMM7 NEMO
Model type	Operational 3D- hydrodynamical ocean circulation model	Coupled hydrodynamic-ecosystem model, nested in Met Office global ocean model
Grid resolution, time resolution, vertical levels	5km (900 m in German Bight), 0.25 h, 36 levels	7km (1/9° x 1/15°), 1h, 32 levels (hybrid s-sigma terrain following coordinate system)
Boundary conditions	Meteorological and wave forecasts by German Weather Service (DWD)	One-way nested with FOAM 1/12° Met Office deep ocean model, meteoroloical forcing by Met Office weather model
Freshwater input	Daily averages from German rivers, climatological runoff from other rivers	Climatological inputs from 300 rivers, updated river scheme
Time period	01/2009 – 01/2012	04/2011 – 04/2012

Observation data

FerryBox	Marnet
Cargo RoRo ship „TorDania"	Light-vessel „Deutsche Bucht" 7.45°E 54.1667°N
Avg. cruising speed 12 kn, transect every 2-3 days, time resolution 10s	Time resolution 1 hour
Lat, Lon, Water temperature, Salinity in 5m depth	Water temperature, Salinity at 6m depth
Data until 04/2012	Data available 01/2010-10/2011

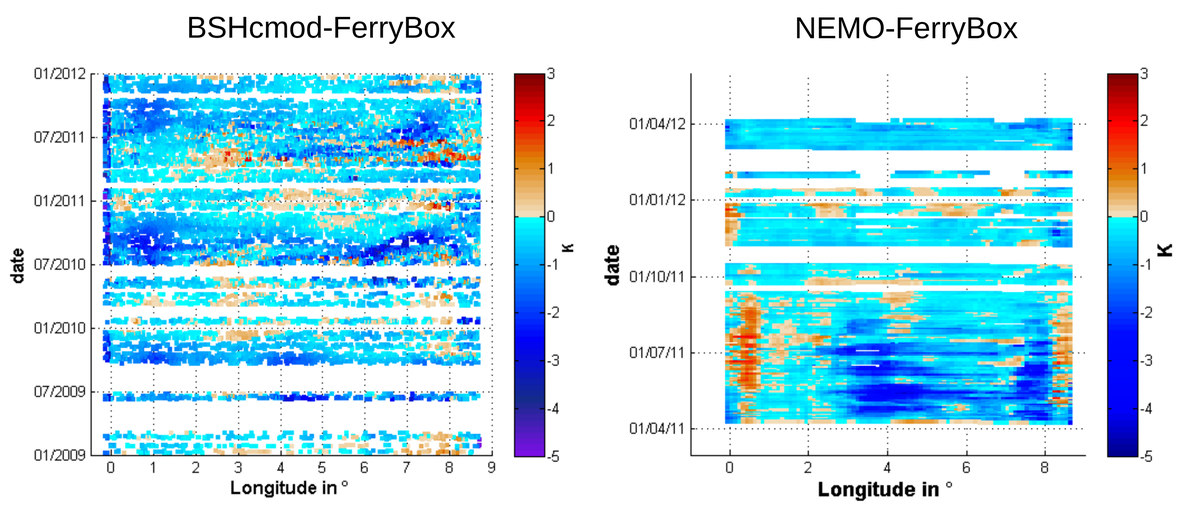

Fig. 3a/b: Differences of water temperature.

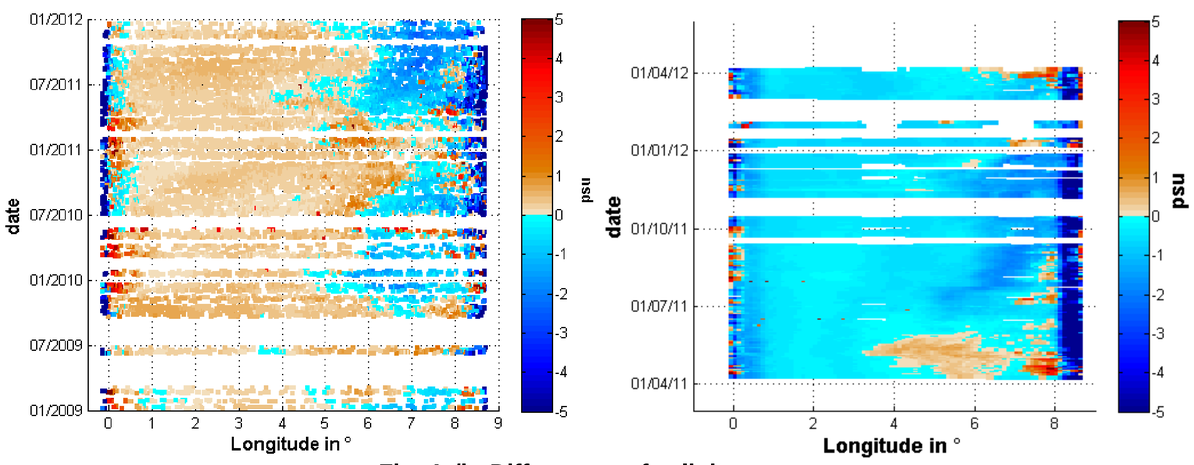

Fig. 4a/b: Differences of salinity.

Parameter	BSHcmod v4 WTemp	NEMO WTemp	BSHcmod v4 Salinity	NEMO Salinity
Bias	-0.52 K	-0.41 K	-0.16 psu	-0.95 psu
Skill variance	0.93	1.03	0.7	0.73
STDE	0.72 K	0.61 K	0.7 psu	0.63 psu
Cost function	0.13	-0.12	1.03	-1.61
Index of Agreement	0.9	0.96	0.54	0.24
Correlation	0.93	0.99	0.7	0.14

Results

Both hydrodynamical models have been compared with FerryBox measurements in the southern North Sea (Fig.2). Note the different time scales.

The main insights for water temperature analysis are:

- Both models tend to underestimate temperatures (in Fig.3a/b), Bias around -0.5 K).
- Higher differences of over -2 K appear in both model comparisons: e.g. in late summer off the English coast (BSHcmod) and in second half of 2011 in the German Bight and between 3° and 5° E (NEMO).
- The variability and annual cycles are well reproduced in both models (Fig.5).

Main results of salinity analyses:

- BSHcmod shows slight overestimation for central parts and strong underestimation for the coastal regions (Bias at -0.16 psu), hinting at river runoff overestimation. NEMO generally underestimates the salinity distribution (Bias -0.95 psu).
- Near the coasts, this underestimation is enhanced strongly. Statistical values point in the same direction: SKVAR around 0.7; the IOA only at 0.5 and 0.2, respectively.
- Annual cycle is not represented adequately (Fig.6).

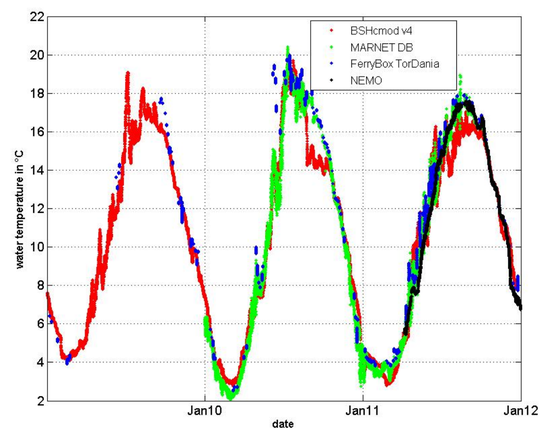

Fig. 5: Time series of water temperatures at Marnet Station (7.45° E, 54.1667° N).

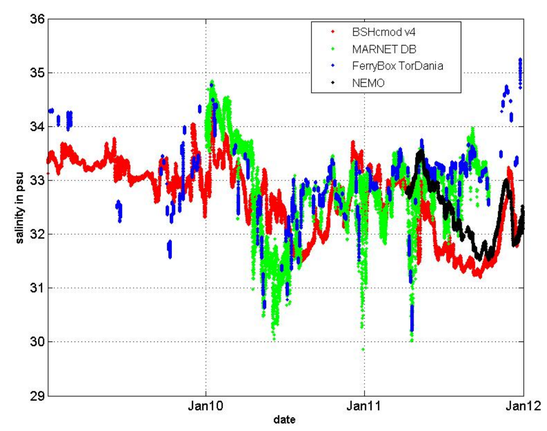

Fig. 6: Time series of salinity at Marnet Station (7.45° E, 54.1667° N).

FerryBox Community

Further information about FerryBox data via QR-Code.

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