12th International Workshop on Wave Hindcasting and Forecasting
and 3rd Coastal Hazards Symposium

Near coastal wave modelling in the German Bight and Wadden Sea

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COSYNA

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Motivation

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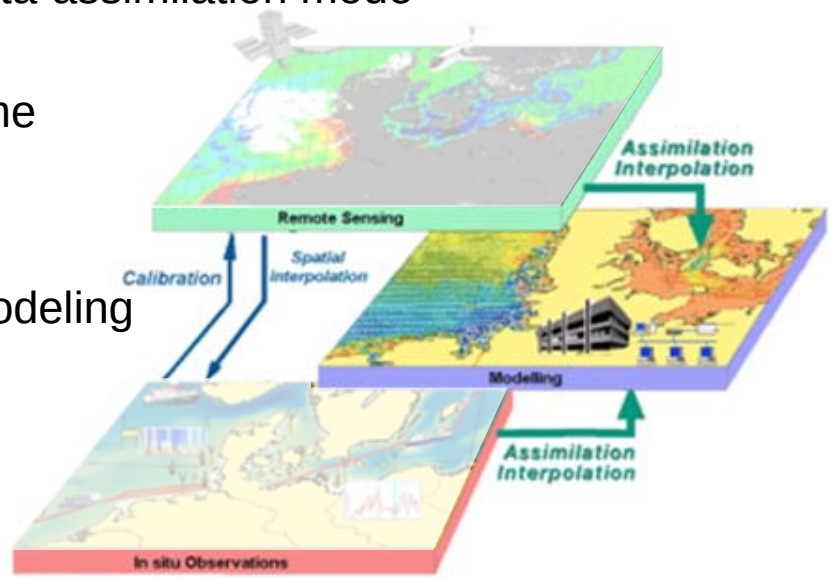
Coastal Observing System for Northern and Arctic Seas coordinated by HZG

- pre-operational system joining observations and numerical models
- observations:
  - in-situ measurements from fixed (piles and buoys) and mobile (FerryBox) platforms
  - remotely sensed data from shore by HF-radar and from space by satellite
- forecasting suite include nested
  - wave model (WAM)
  - 3-D hydrodynamic model (GETM) running in data-assimilation mode

- motivation is the continuous provision of near real-time products for pre-operational service
- main characteristic of the system is the integrated approach combining observations and numerical modeling



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COSYNA - Numerical Models

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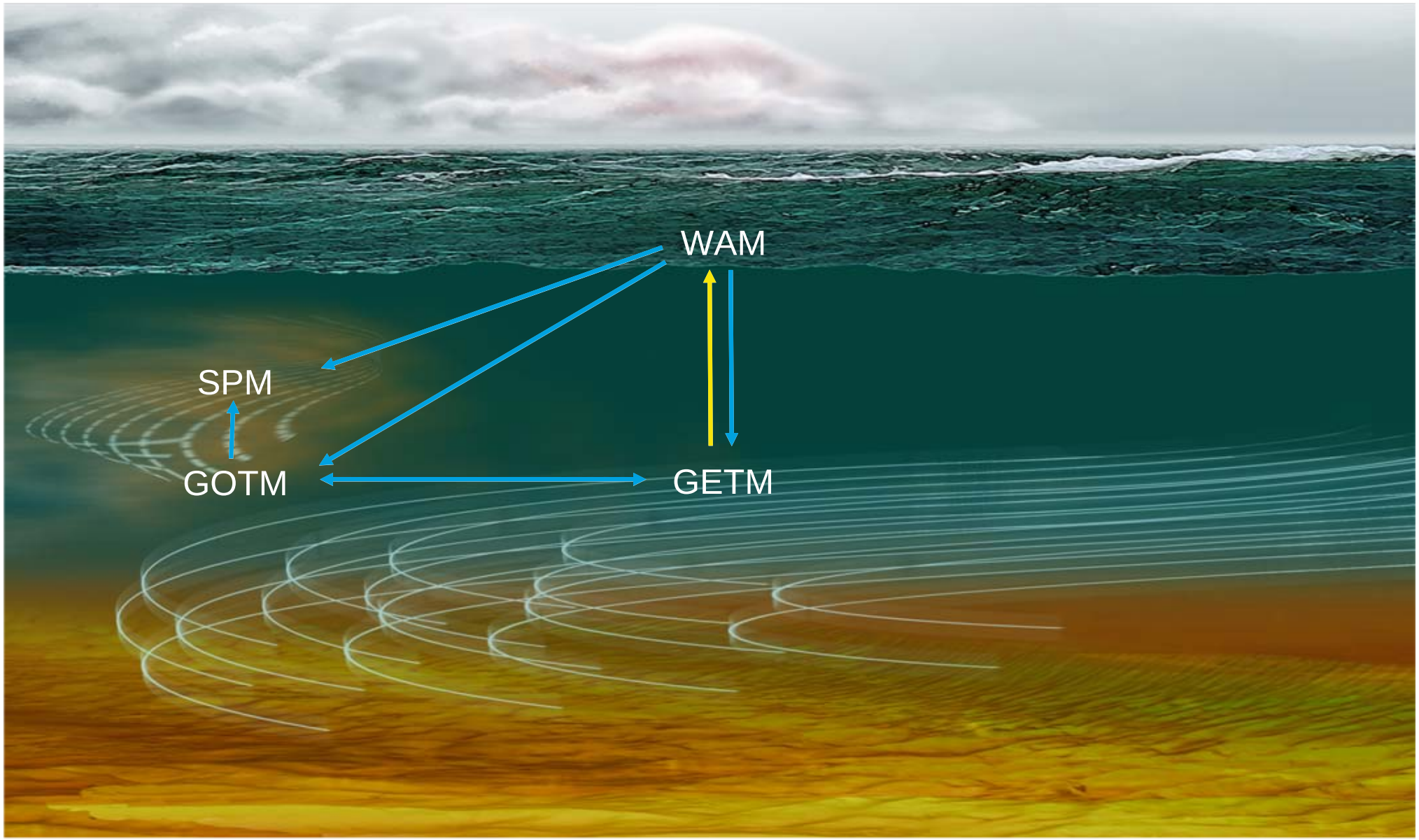

WAM Developments (Cycle 4.5.3)

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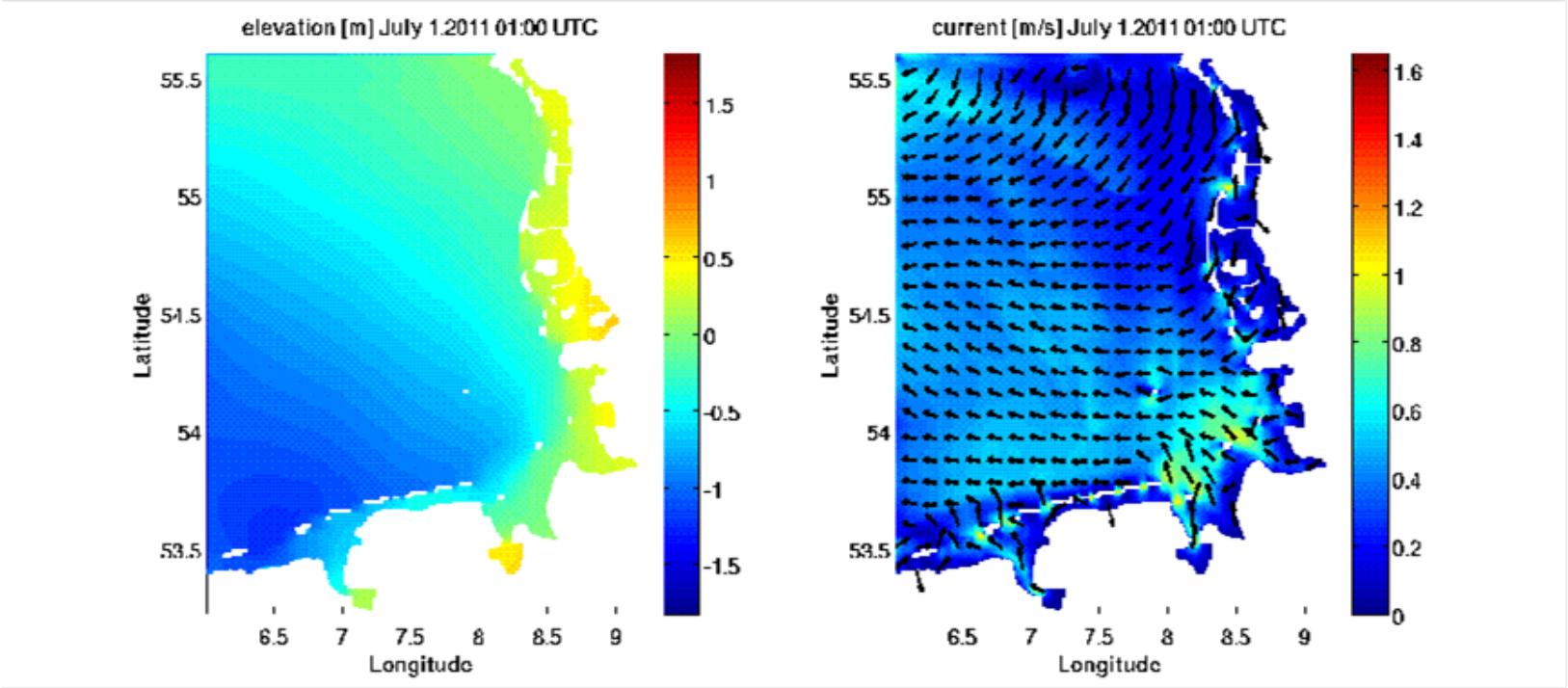
- source function integration scheme of Hersbach and Janssen (1999)
- reformulated dissipation source function of Bidlot, et al (2005, 2007) and Janssen (2008)
- depth induced wave breaking of Battjes & Janssen (1978)

- in-stationary sea ice
- in-stationary water depth
- in-stationary currents



Model Setup

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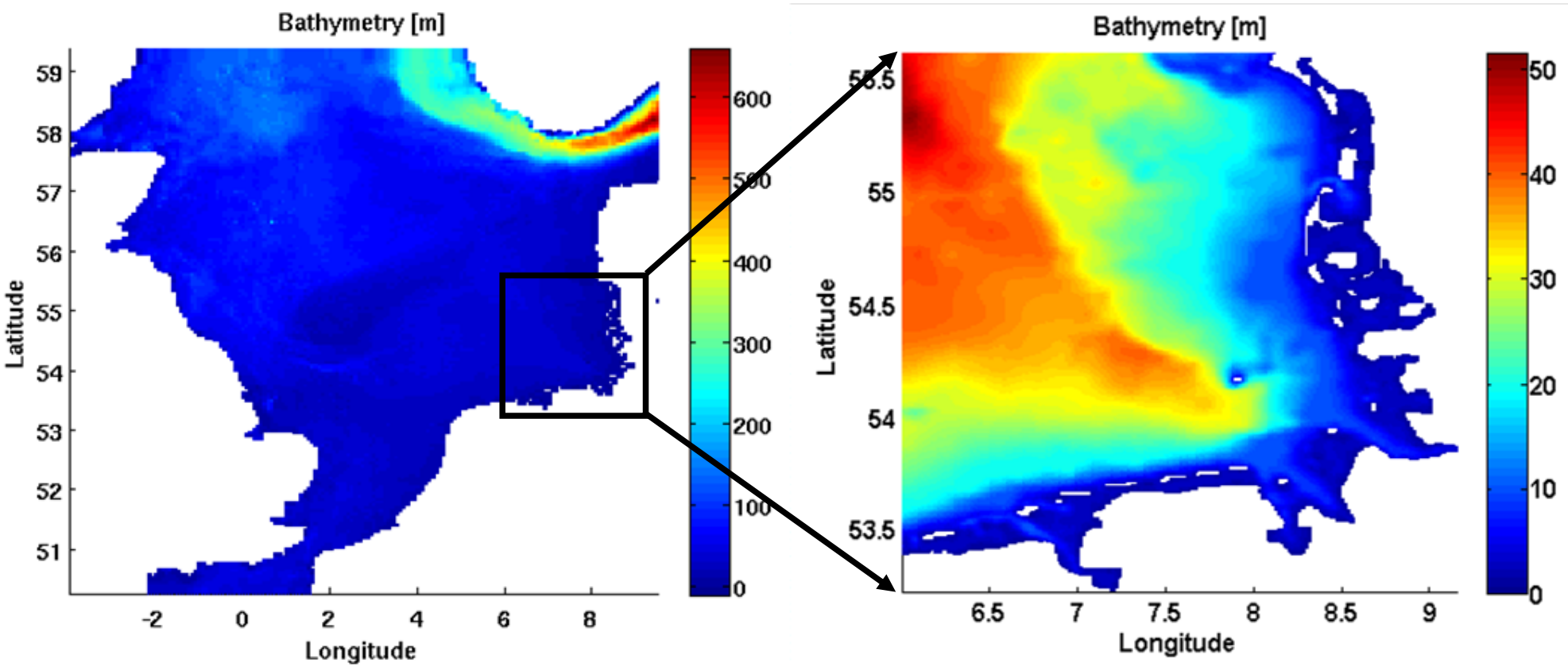
North Sea
spatial resolution: 3nm

forcing wind fields and boundary values from German Weather Service (hourly)

German Bight
spatial resolution: 1km

forcing water level and surface current fields from GETM (hourly)



Impact of Hydrodynamic Forcing

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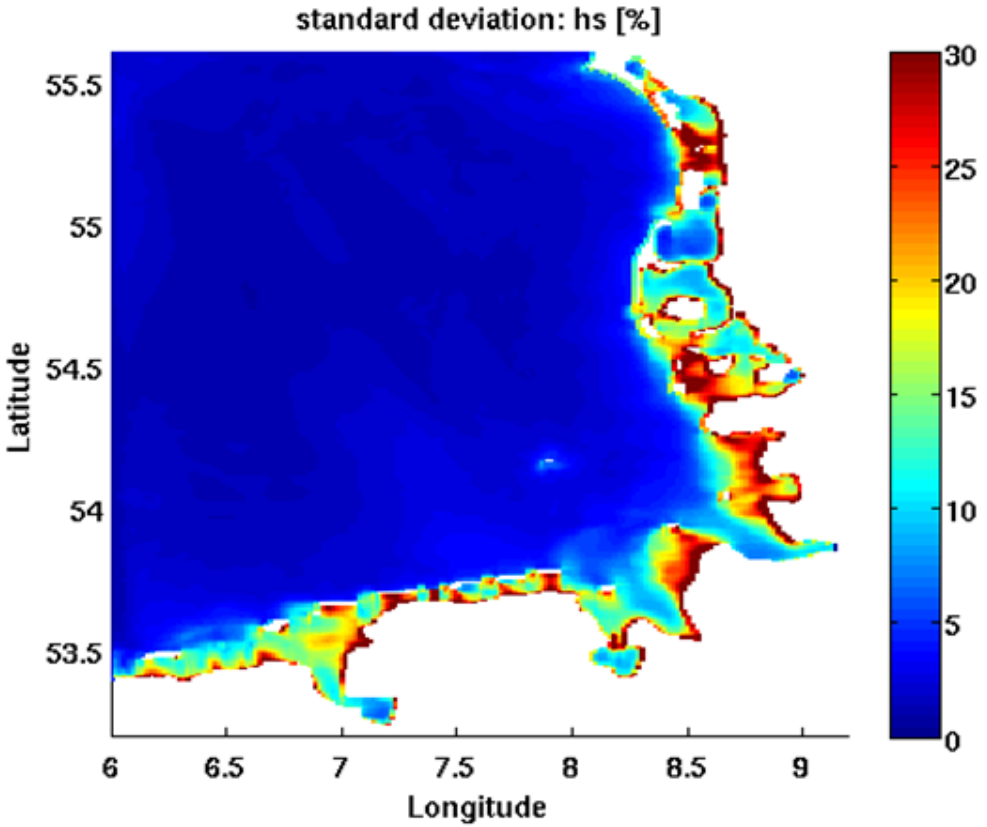
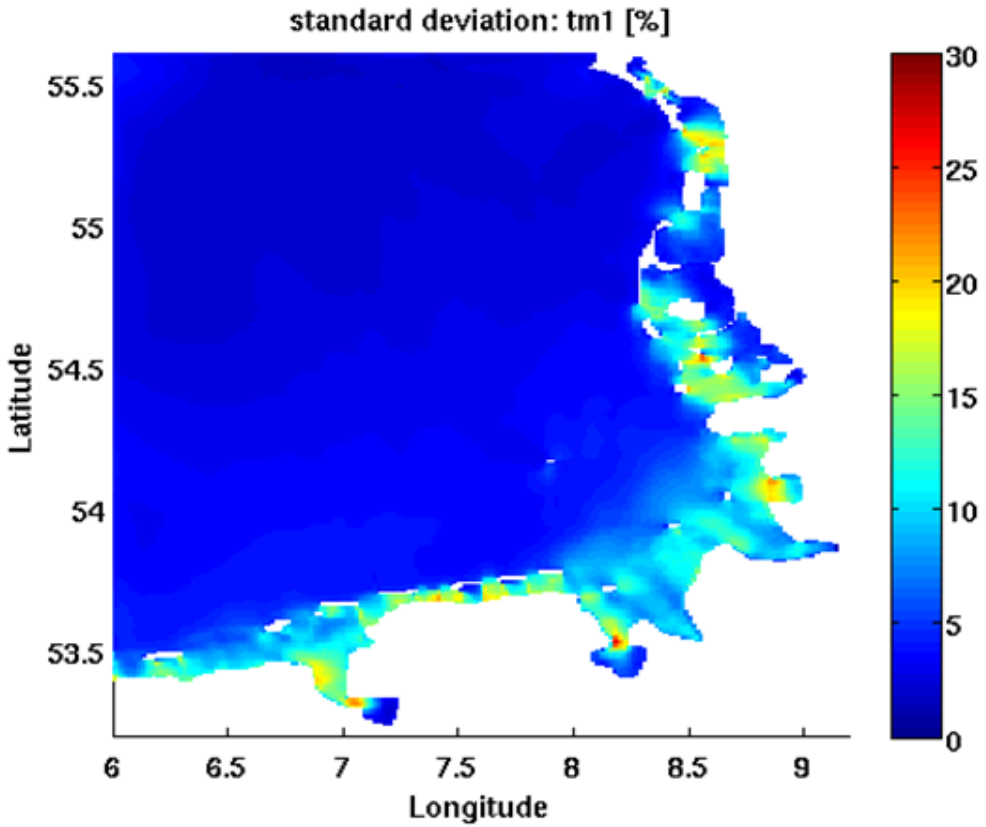
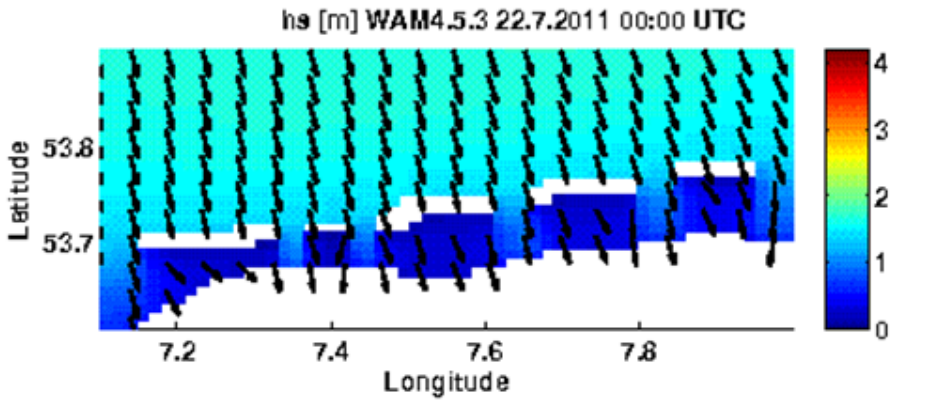
- in the open North Sea nearly no difference is found
- significant differences (30% hs, 10-15% tm1) near the coast and in the Wadden Sea (mainly due to water depth changes)
- small areas where STD of tm1 up to 30% (Doppler Shift)






hs [m] WAM4.5.3 22.7.2011 00:00 UTC
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53.8
53.7
7.2
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7.6
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Longitude
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3
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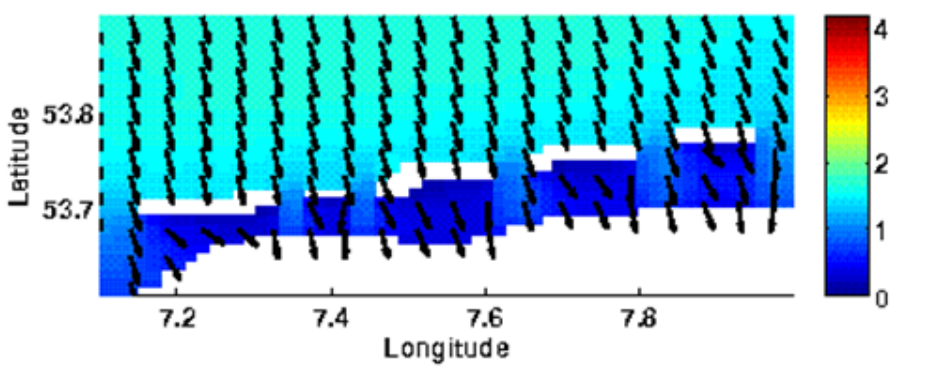
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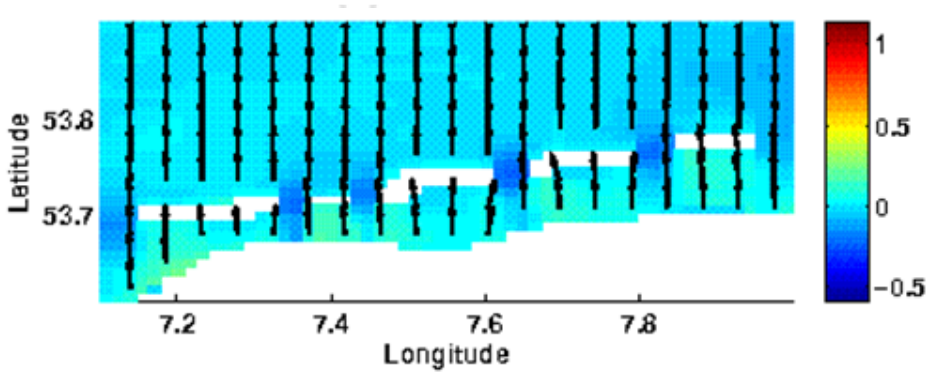
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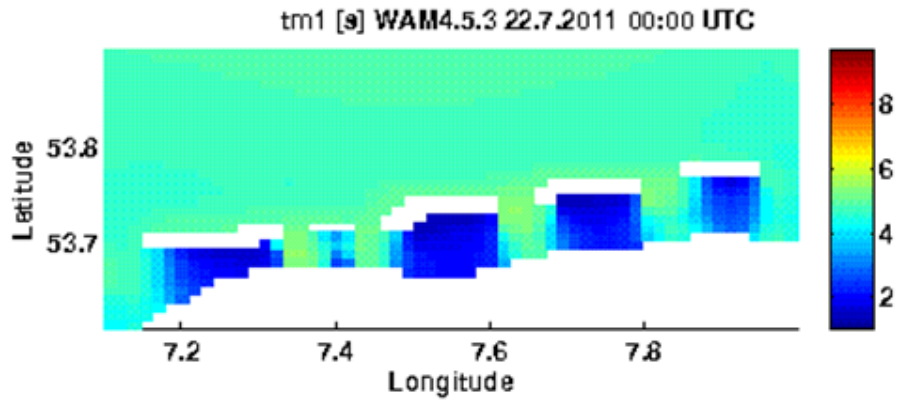
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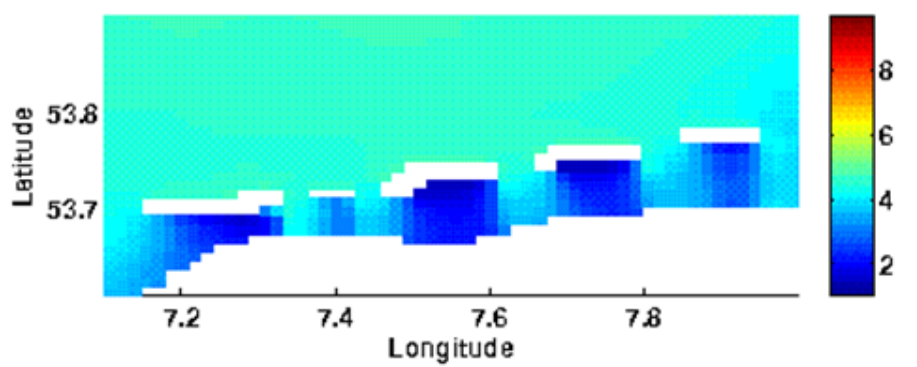
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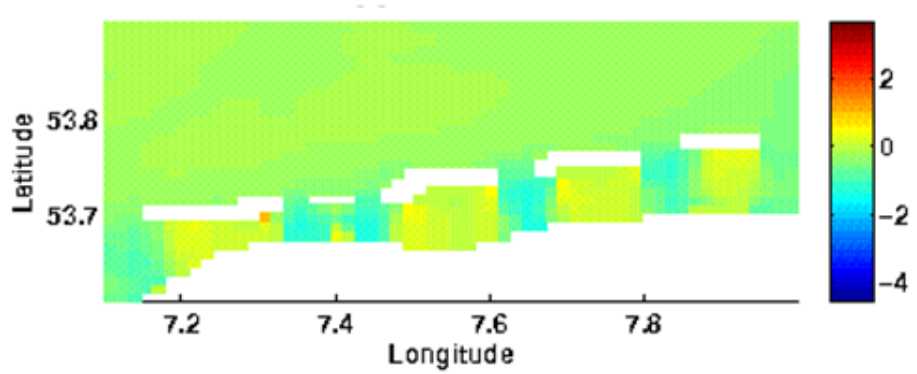
Latitude
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7.2
7.4
7.6
7.8
Longitude
2
0
−2
−4

Validation with buoys

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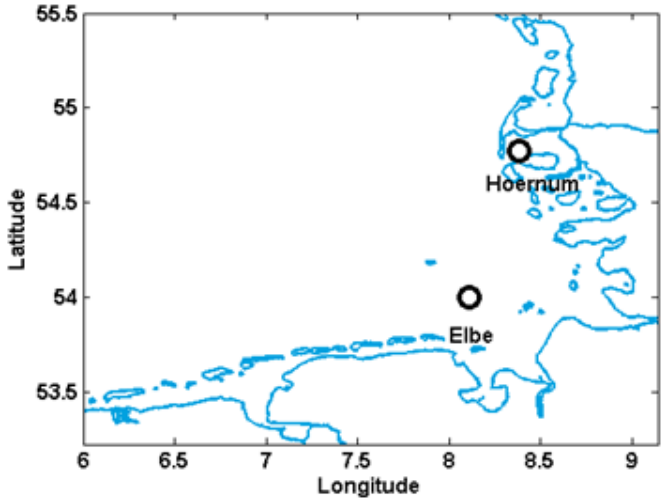
Name	Mean water depth (m)	Tide range (m)
Elbe	20.9	2.5
Hoernum Tief	3.7	1.0



	'Elbe'				'Hoernum Tief'			
	hs [m]		tm1 [s]		hs [m]		tm1 [s]	
mean meas.	1.10		4.36		0.33		2.43	
	WAM	WAM c/wl	WAM	WAM c/wl	WAM	WAM c/wl	WAM	WAM c/wl
bias	0.004	-0.025	0.245	0.174	-0.073	-0.120	0.326	0.150
std	0.164	0.171	0.439	0.397	0.117	0.136	0.350	0.293
slope	1.051	1.085	0.982	1.026	0.779	0.835	0.322	0.574
intercept	-0.061	-0.068	-0.169	-0.285	0.146	0.174	1.323	0.886

Buoy `Elbe´ - Time Series

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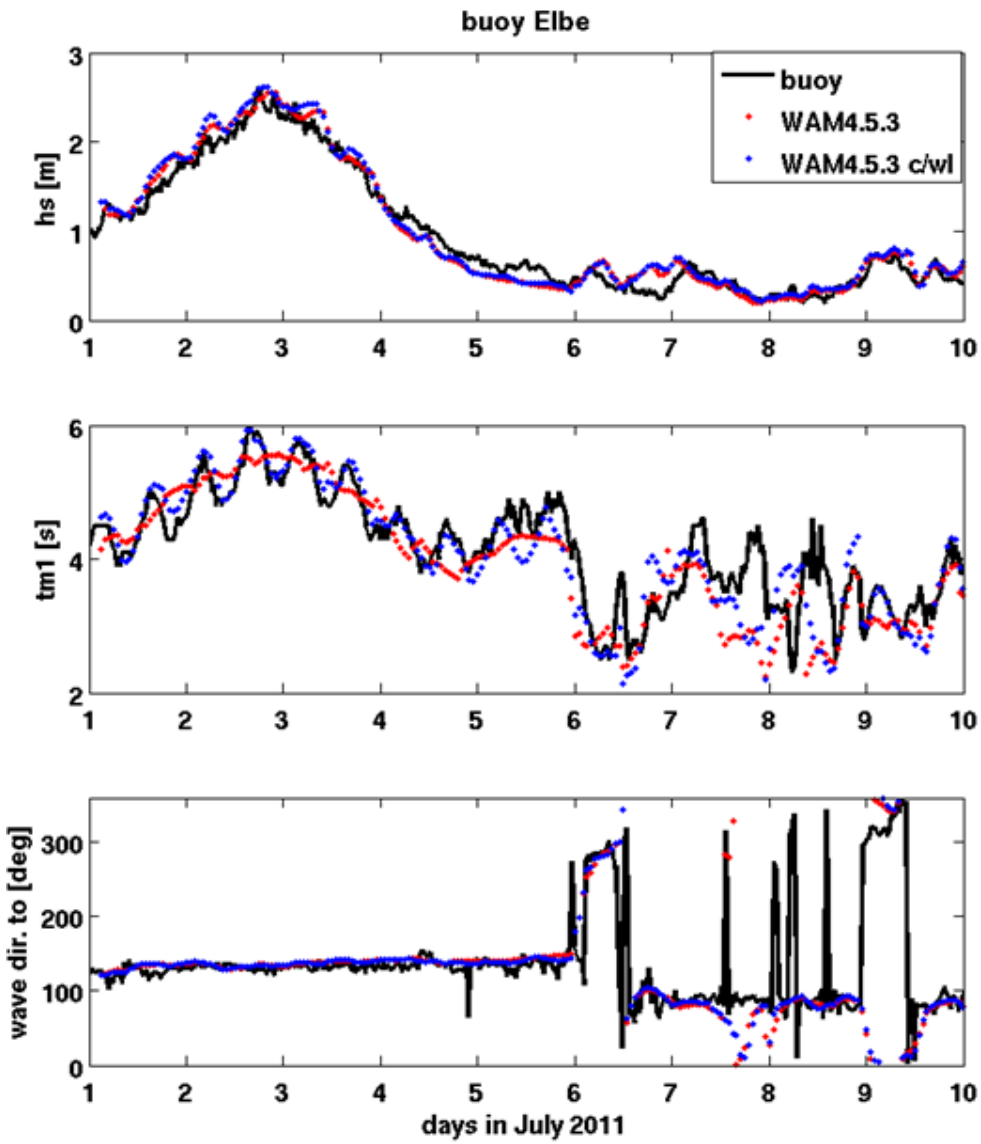

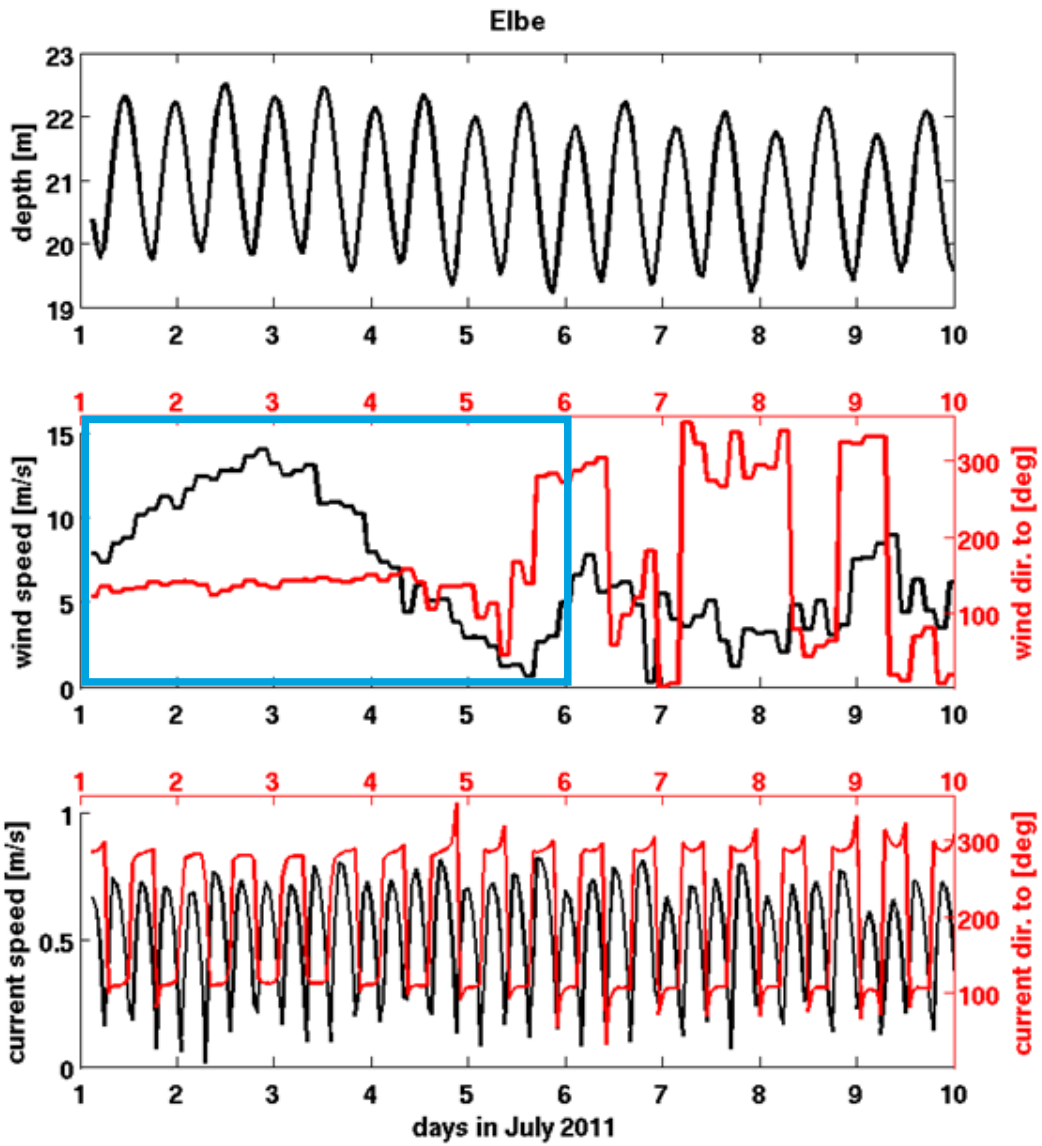

Buoy `Elbe´ - Wave Spectra

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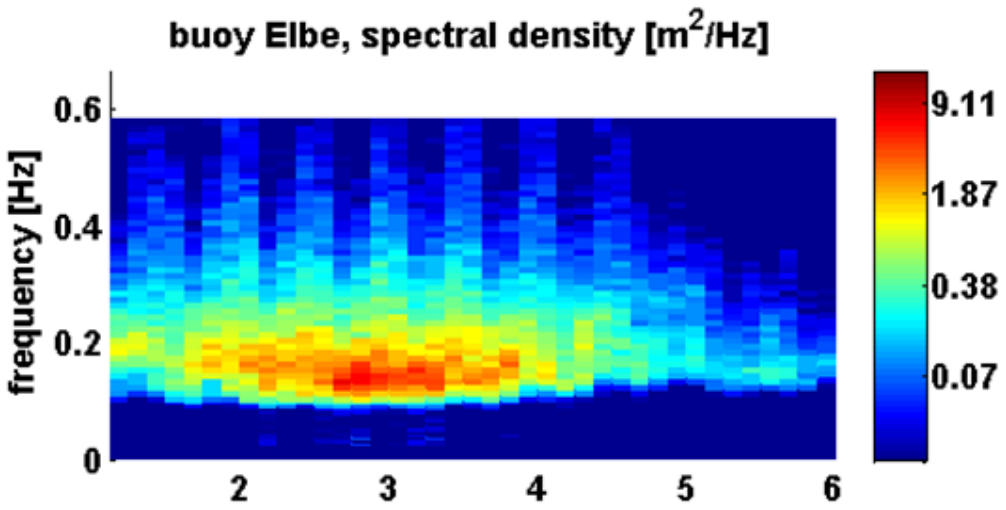

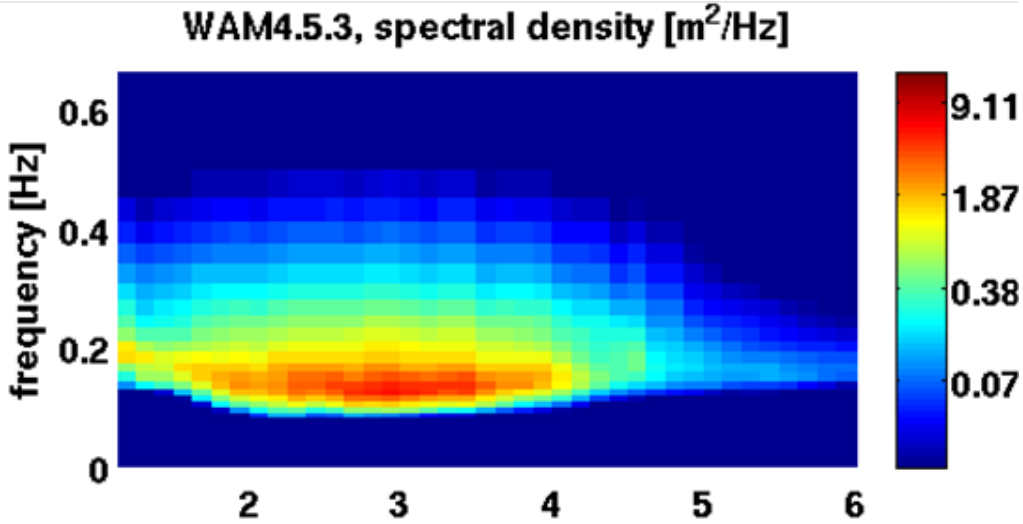

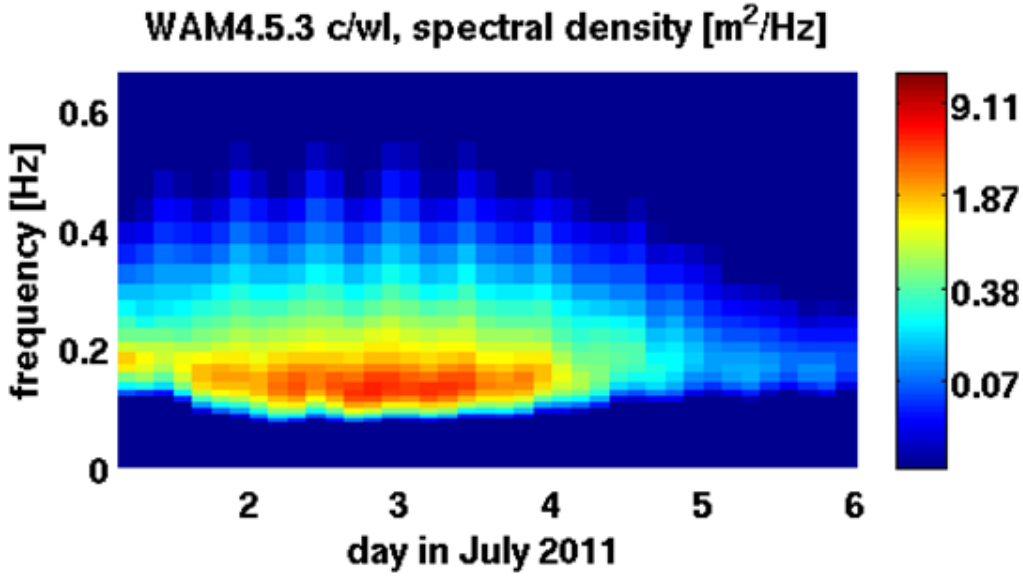

Buoy `Hoernum Tief´ - Time Series

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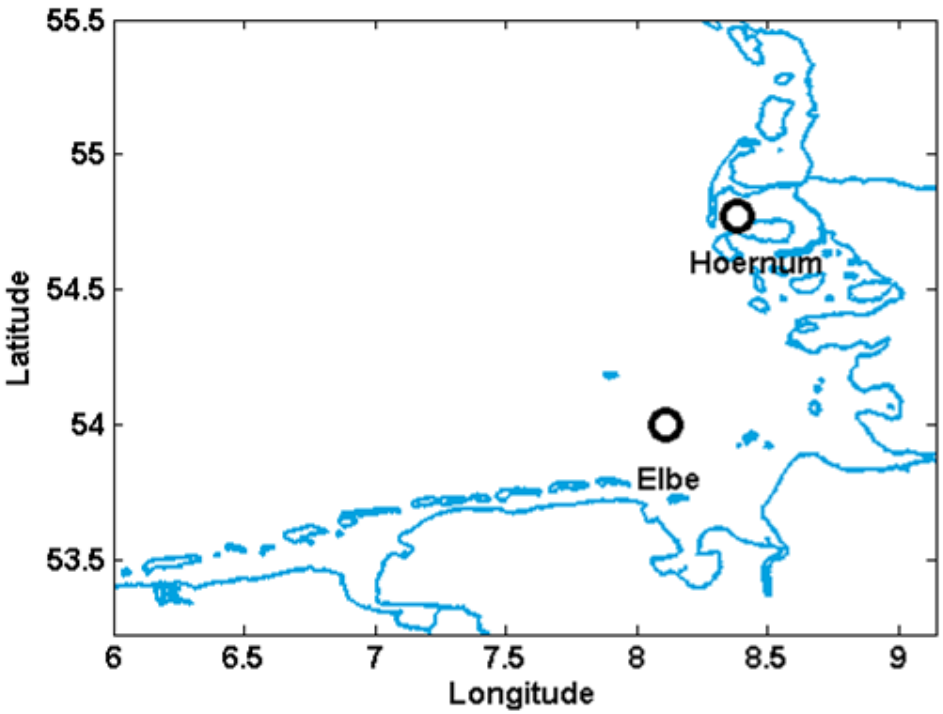

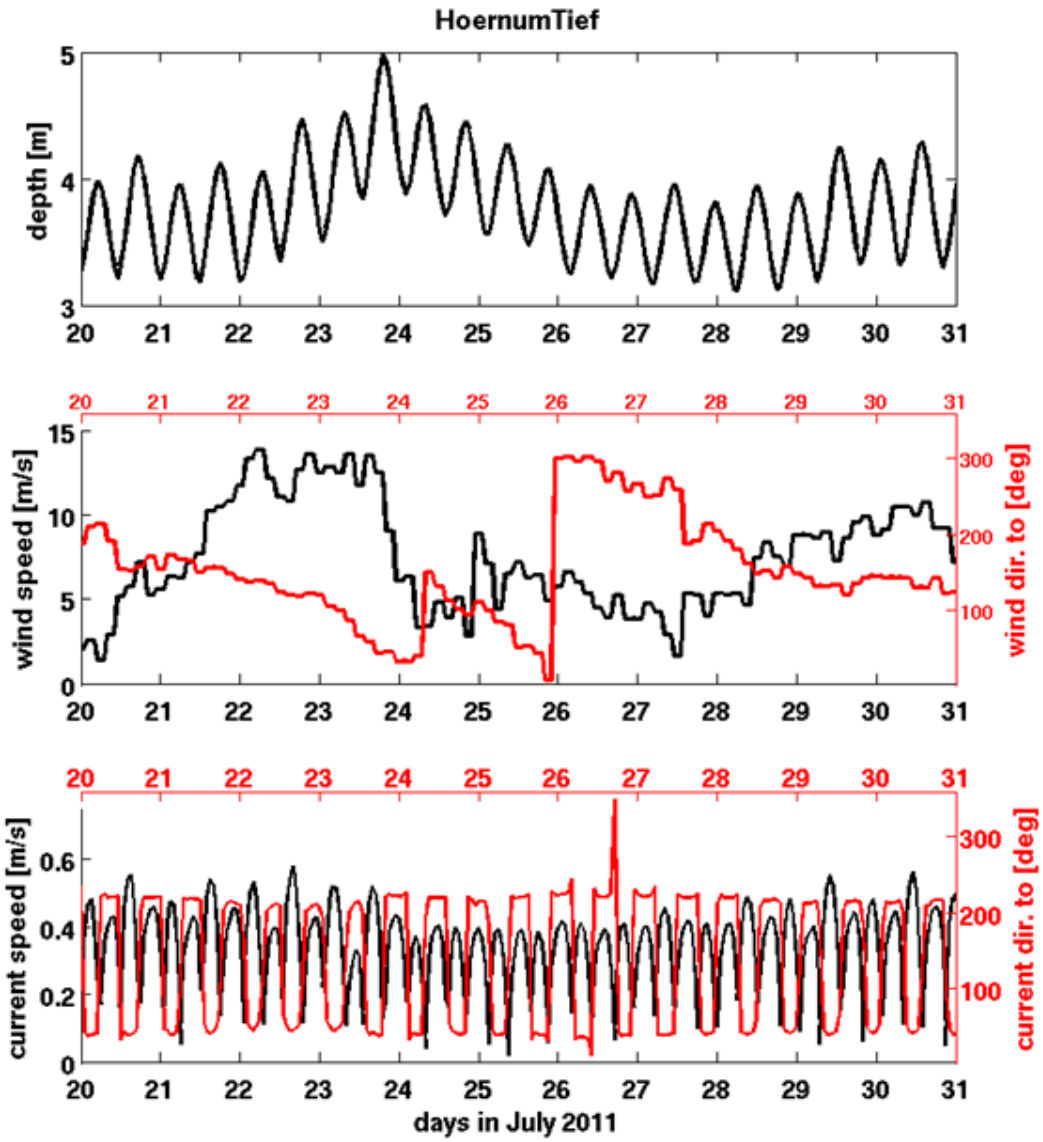

Buoy `Hoernum Tief´ - Wave Spectra

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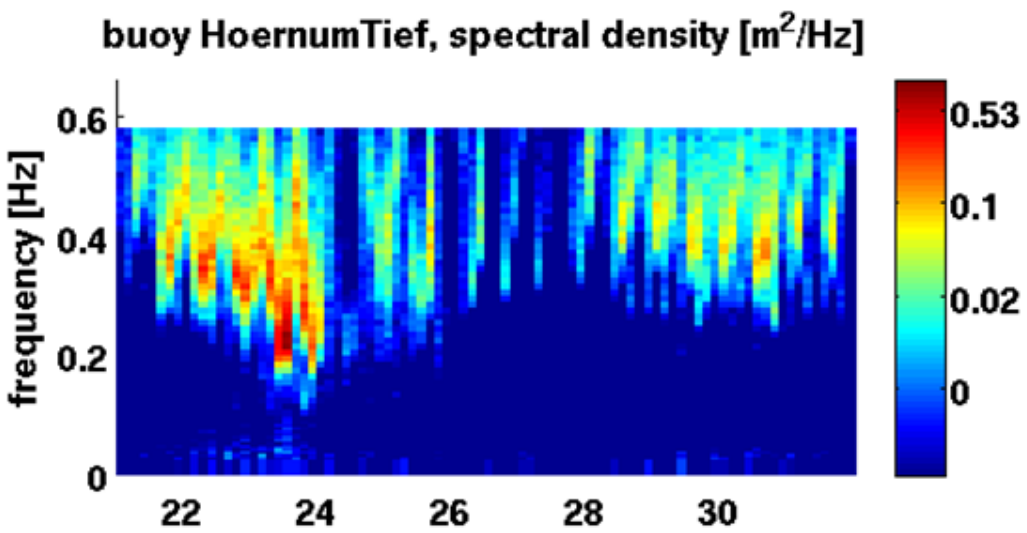

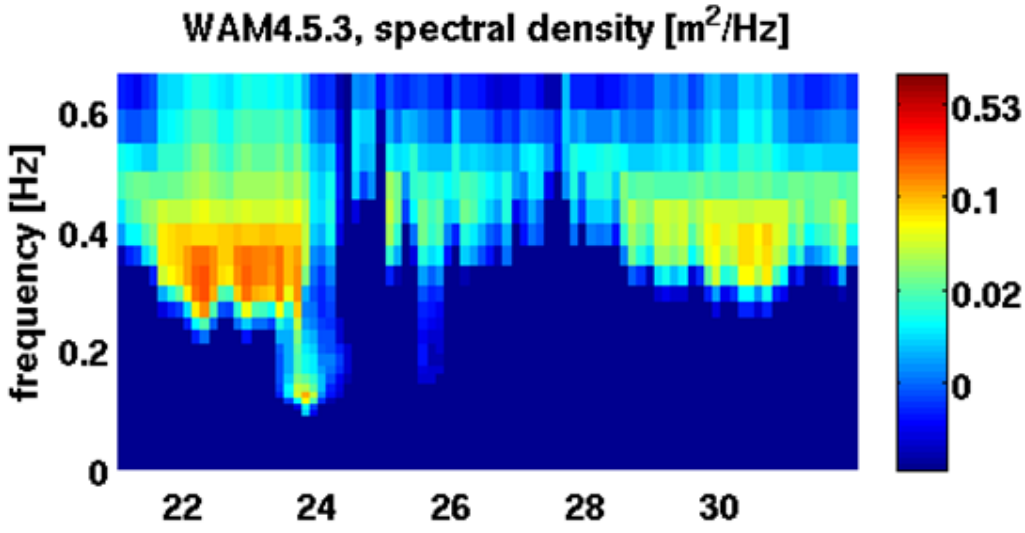

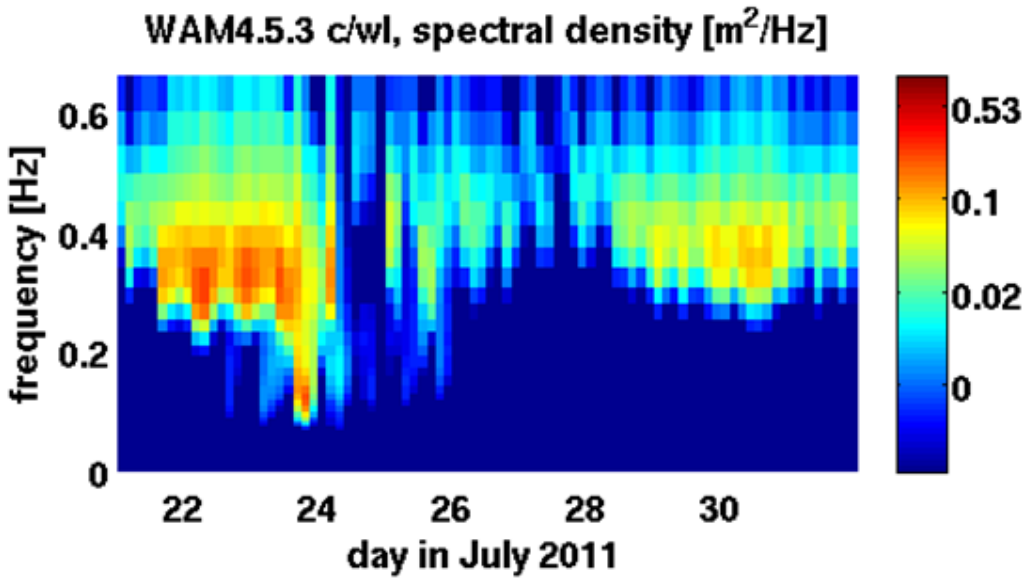

Summary

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- we have analysed the impact of changing water levels and currents on WAM
  - in the open North Sea nearly no impact
  - significant impact (std 30% hs, std 10-15% tm1) in the shallow water areas near the coast and in the Wadden Sea
  - impact on wave period reaches more off-shore than on wave height
  - in tidal inlets (strong currents opposing the waves) std of wave period close to 30%

- we have validated the model results with buoy data at two sites
  - wave period measurements were reproduced much better with hydrodynamic forcing
  - agreement in wave heights is excellent at the site in open waters for both model runs
  - at the semi-enclosed bight the model did not reproduce the amplitude of wave height variations with the tide
  - modelled wave directions agree well with the measured ones

- we conclude that the WAM model can be applied with variable currents and water levels

- in a next step the model will be incorporated in the pre-operational model system in a two-way coupled set-up

Thank you

for your attention!