A wind-wave coupled mesoscale modelling system for coastal extreme wind and wave conditions

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A wind-wave coupled mesoscale modelling system for coastal extreme wind and wave conditions

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We are

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DHI (Rodolfo Bolaños, Henrik Kofoed-Hansen, Ole Petersen, Jacob T. Sørensen, Nikhil Garg)

Bergen University (Alastair Jenkins, Angus Graham)

With supports from **DONG** and **Vattenfall**

Funded by PSO ForksEL

Project name: XWIWA

We aim at

- Exploring the full potential of the different model components (atmospheric, wave and ocean model)

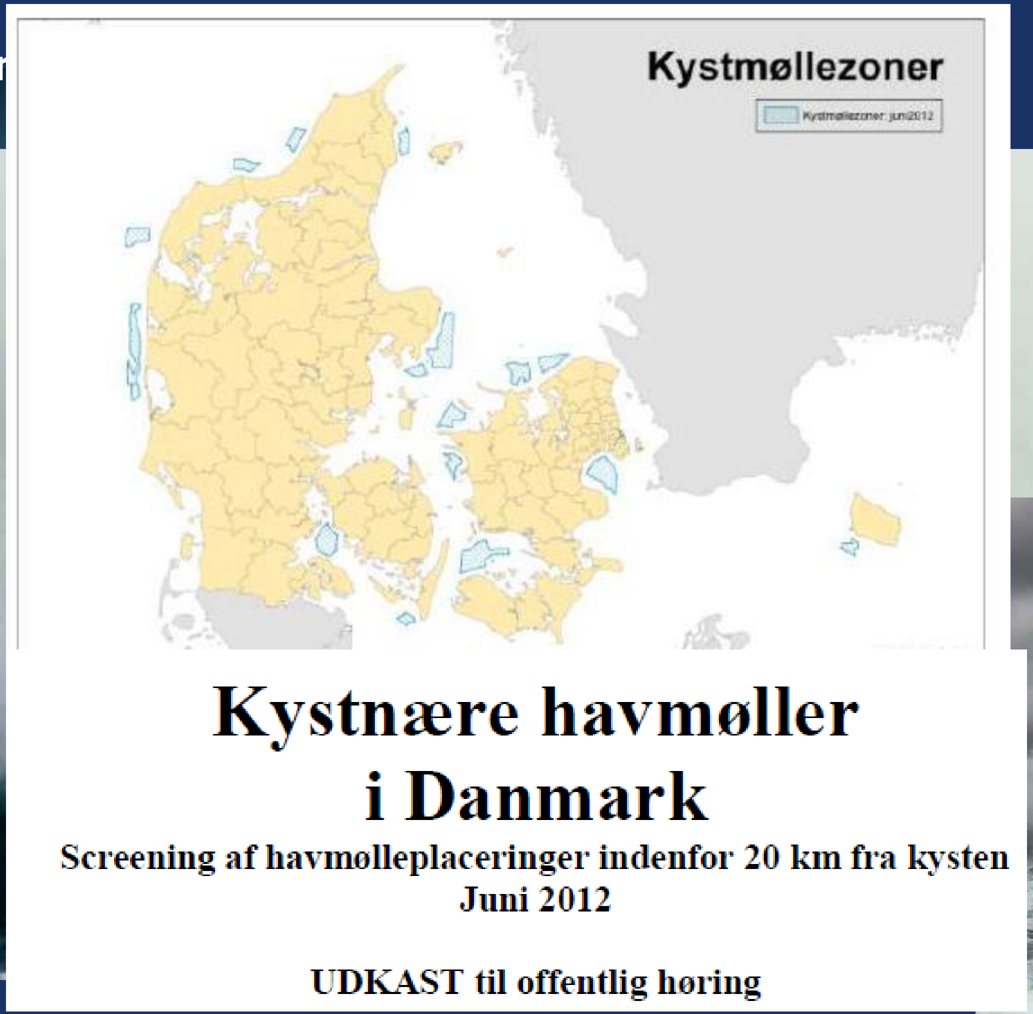
- Improving the physics and numerical descriptions for fast developing weather conditions

- Providing a coupled system that uses the strength of each model component for the challenging storm and coastal conditions

- Reducing uncertainties and therefore risk and cost for offshore, port or coastal development

Offshore challenges

--Toward lower risk ar



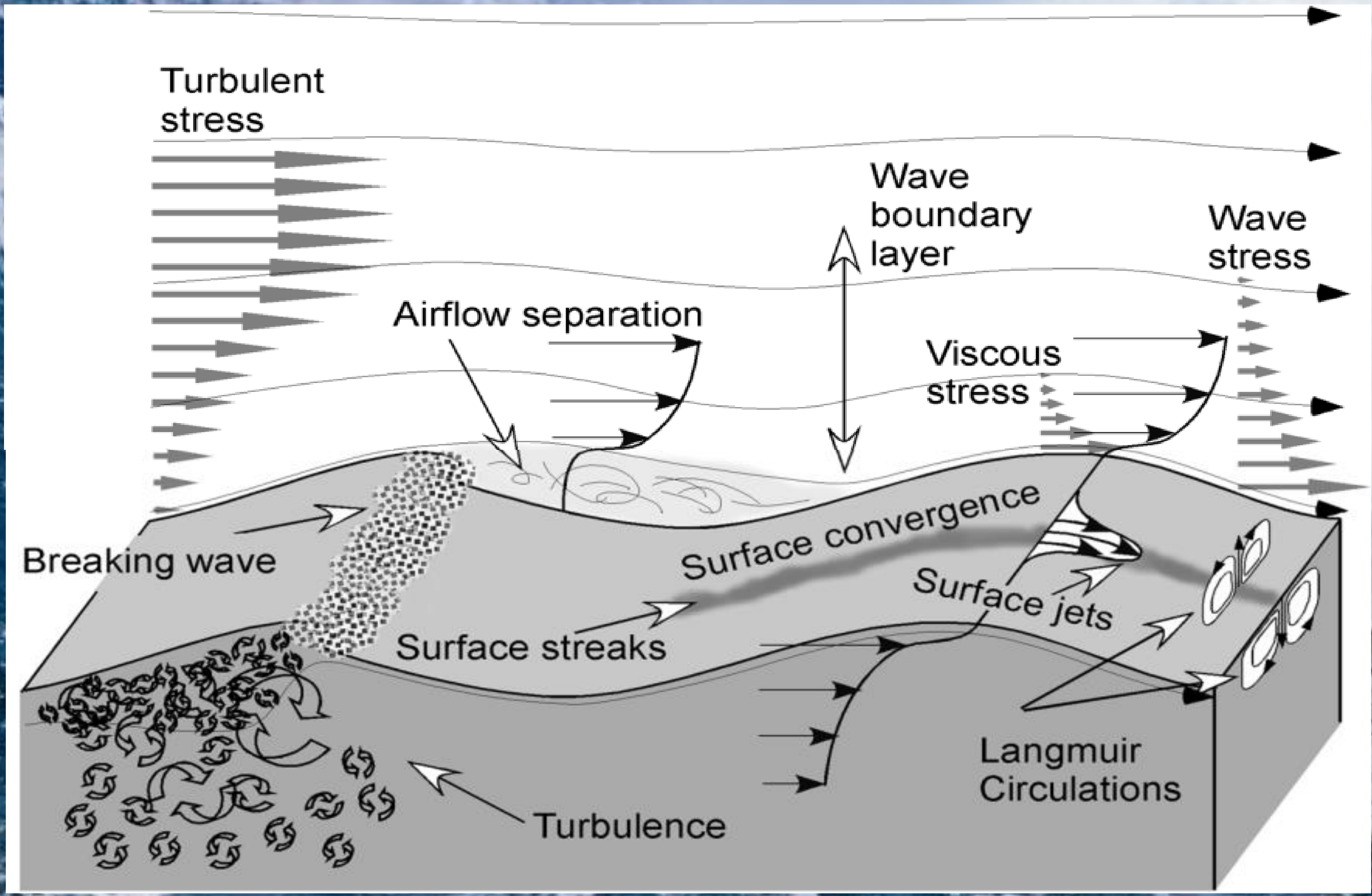
Kystnære havmøller i Danmark

Screening af havmølleplaceringer indenfor 20 km fra kysten

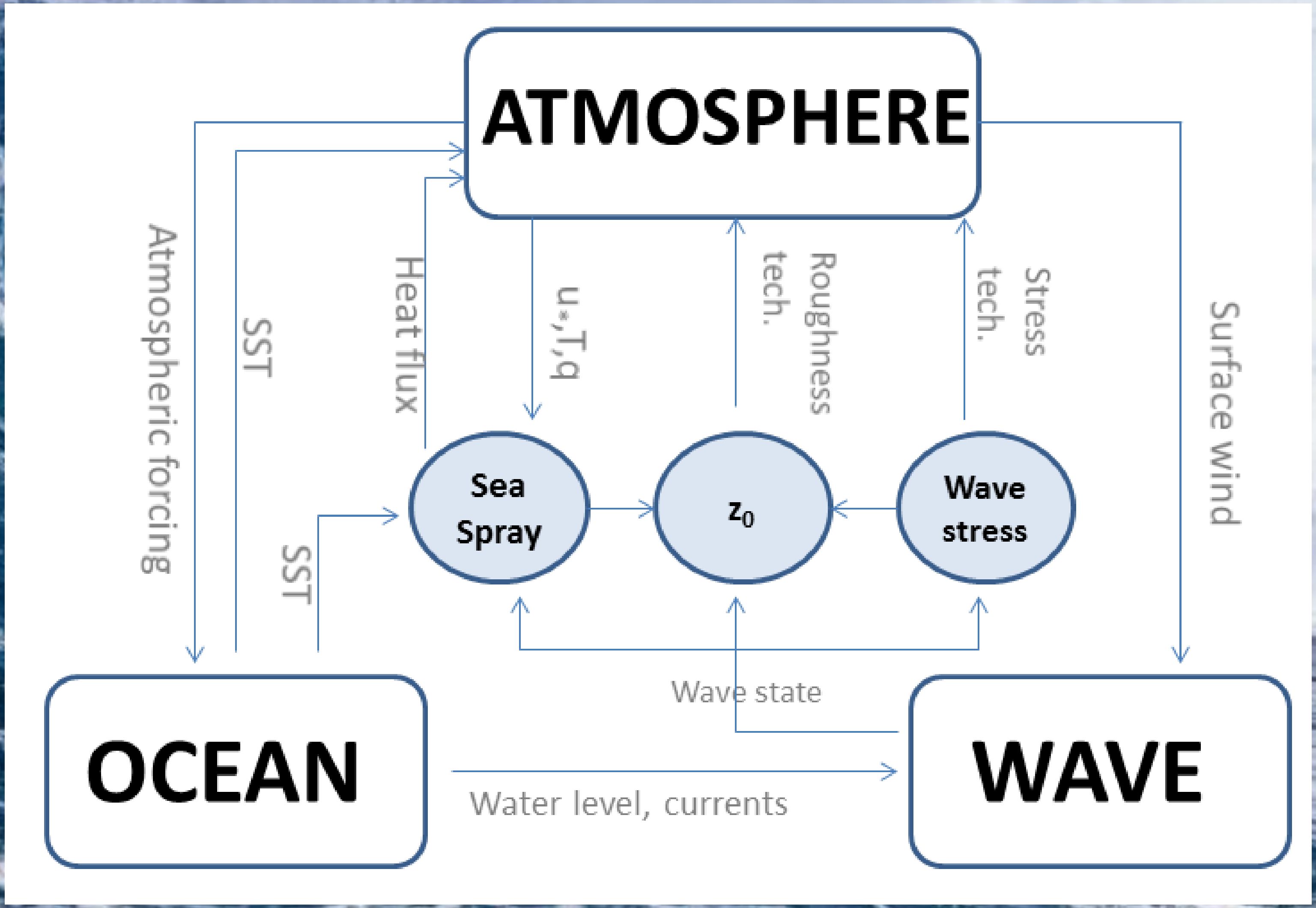
Juni 2012

UDKAST til offentlig høring

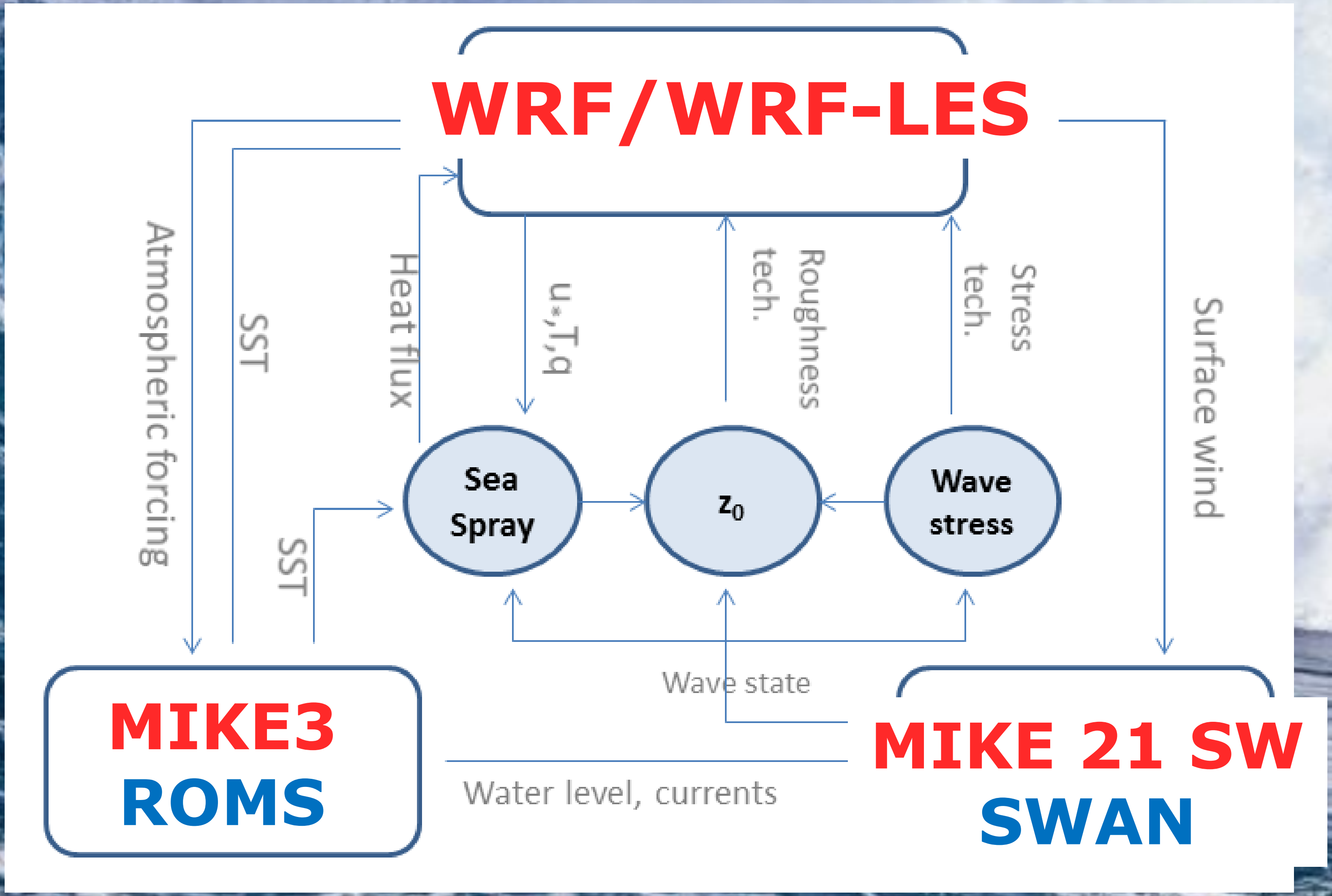
Air-sea interaction - Actions



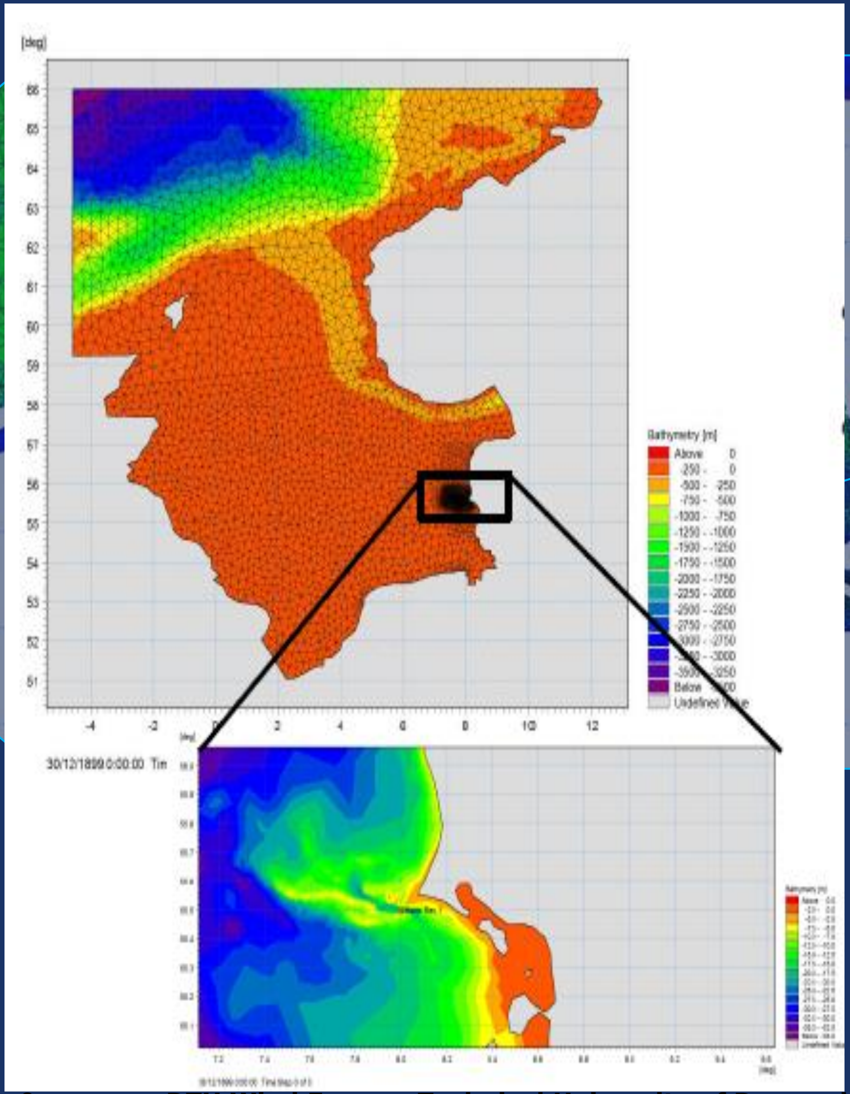
Air-sea interaction - Actions

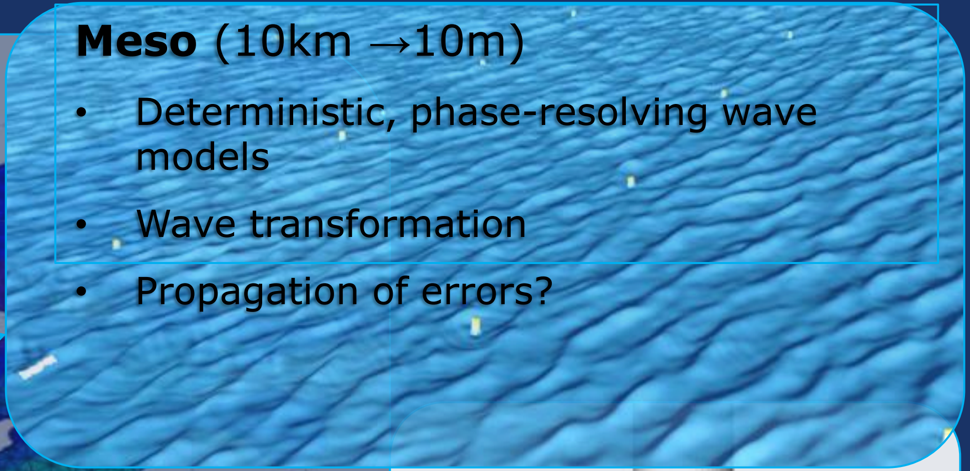


Air-sea interaction - Actions



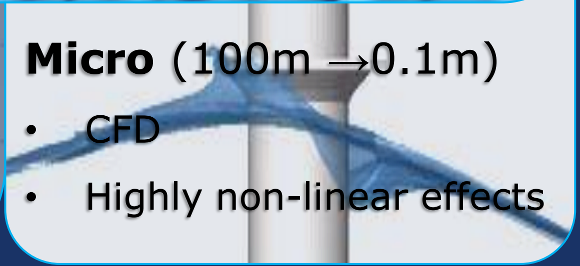
MIKE functions and strength





Meso (10km →10m)

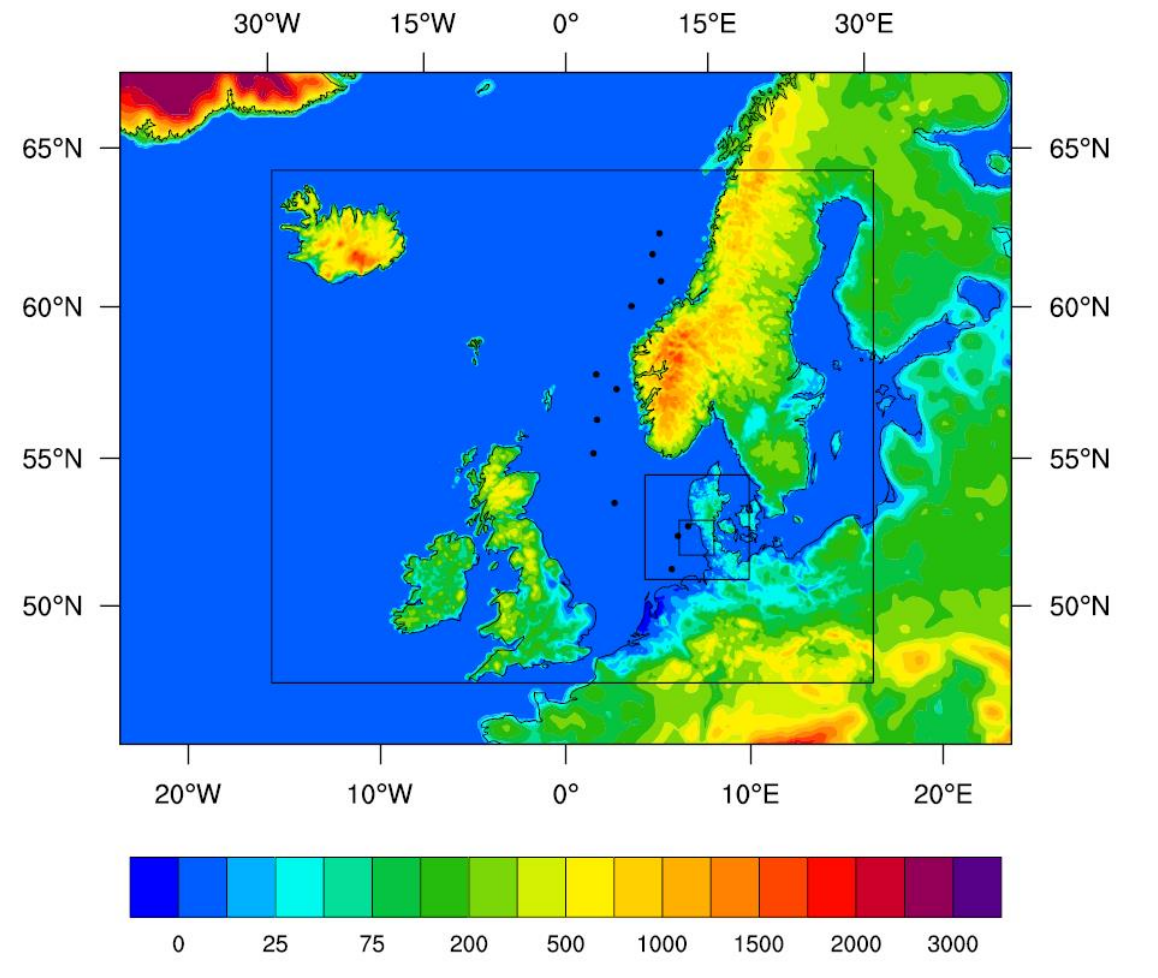
- Deterministic, phase-resolving wave models
- Wave transformation
- Propagation of errors?



Micro (100m →0.1m)

- CFD
- Highly non-linear effects

WRF functions and strength



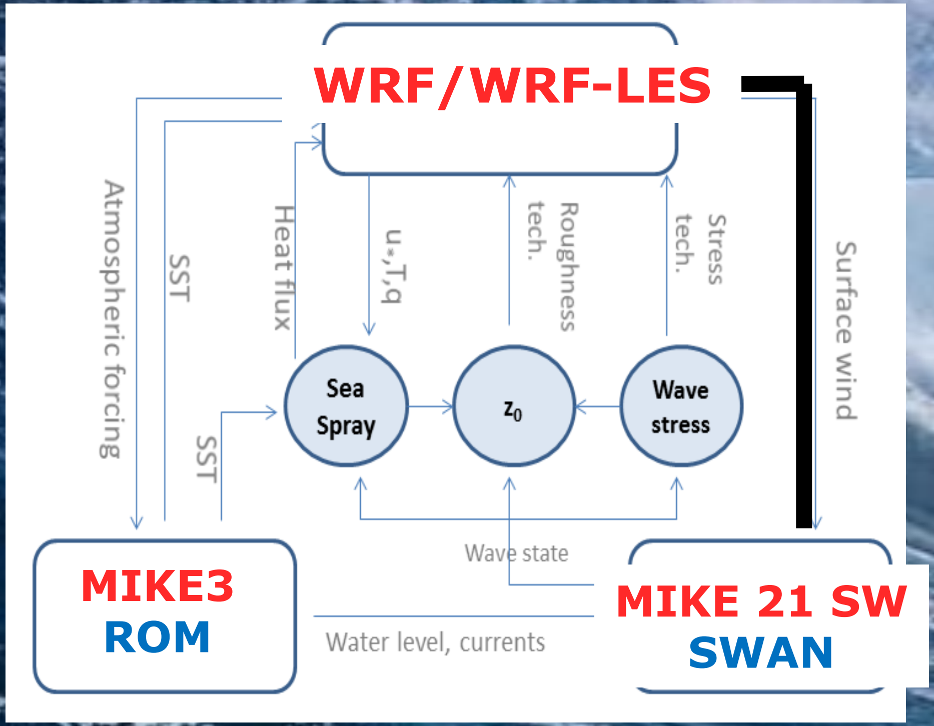
WRF model domain

18 km – 6 km – 2 km

– 666.7 m – 222.3 m ~ 100 m

(WRF-LES)

Actions



We have been examining coupling techniques:

One-way offline, two-way offline,

two-way online

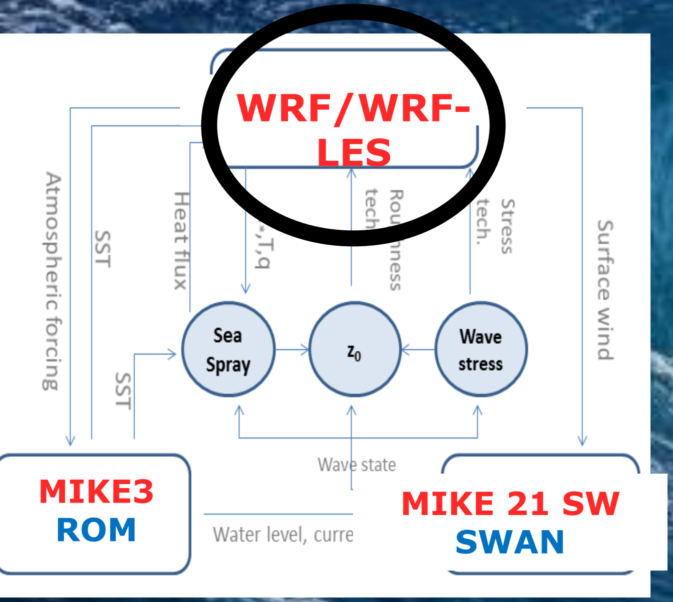
The results on the wind outputs could be very different!

Actions

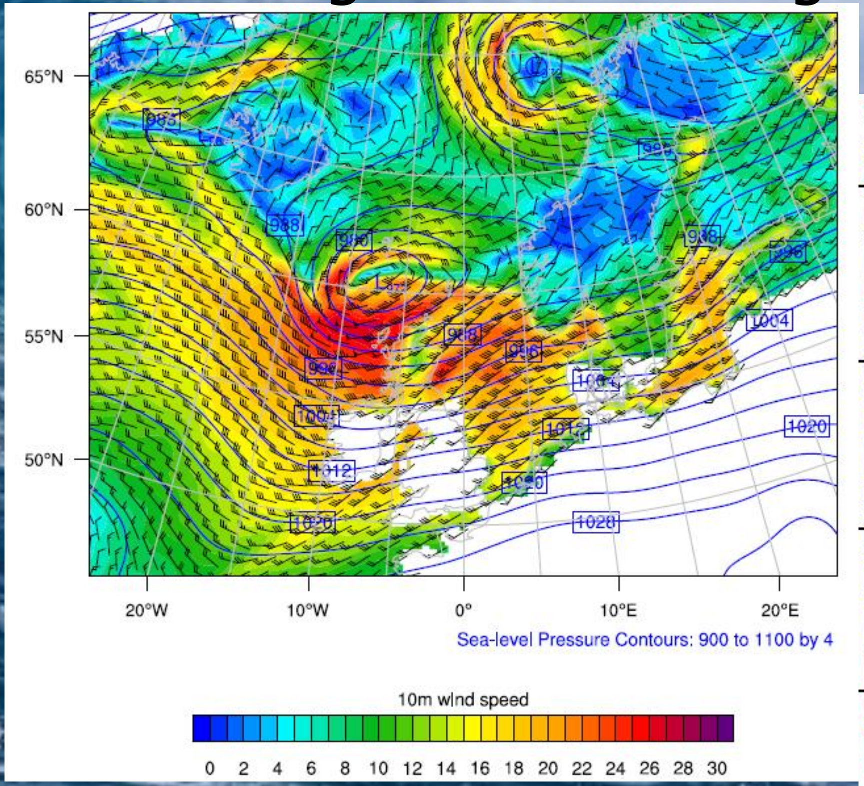
When modeling a storm, we examine

Domain, initial time

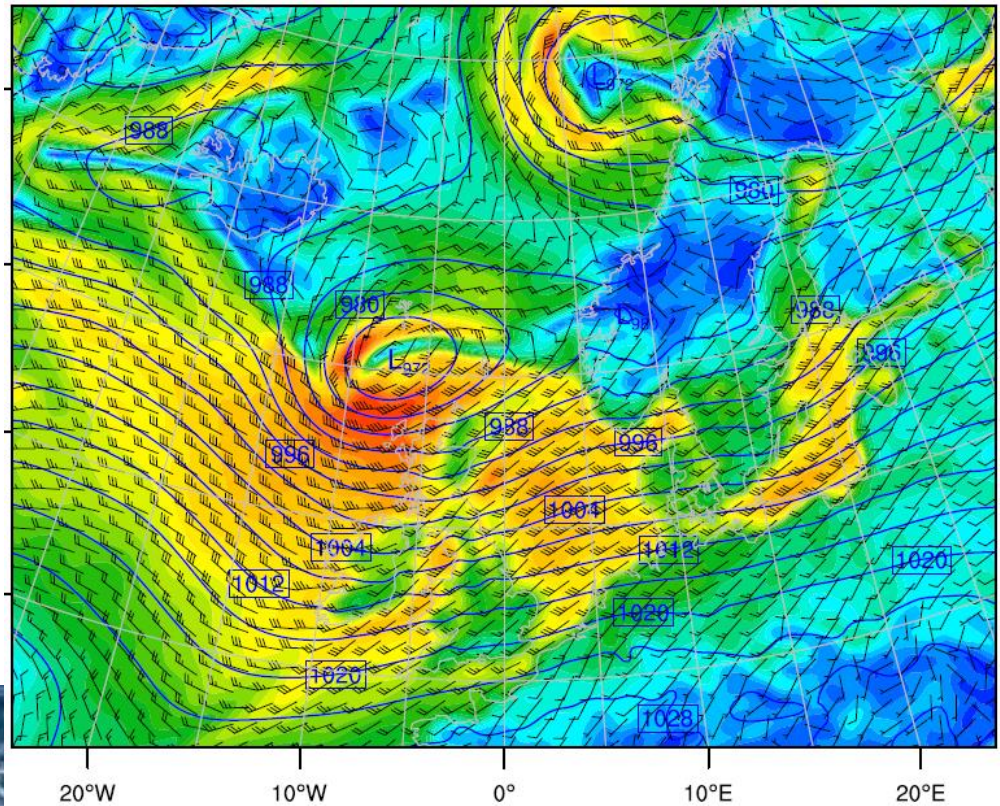
to best reserve the large scale storm structure



CFSR large scale forcing



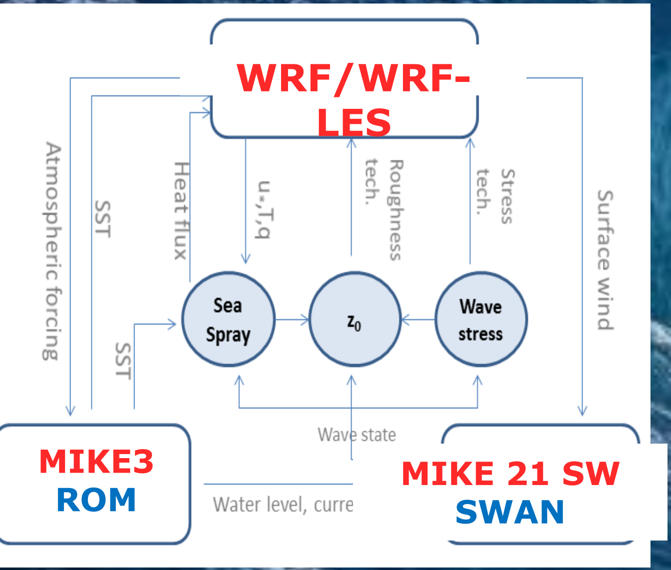
WRF outer domain

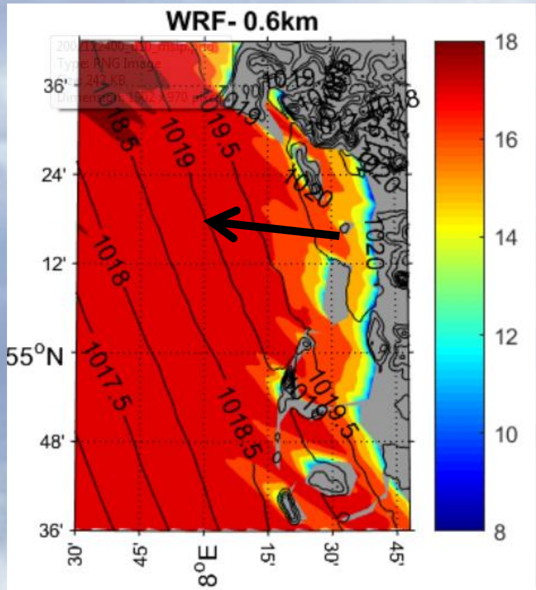


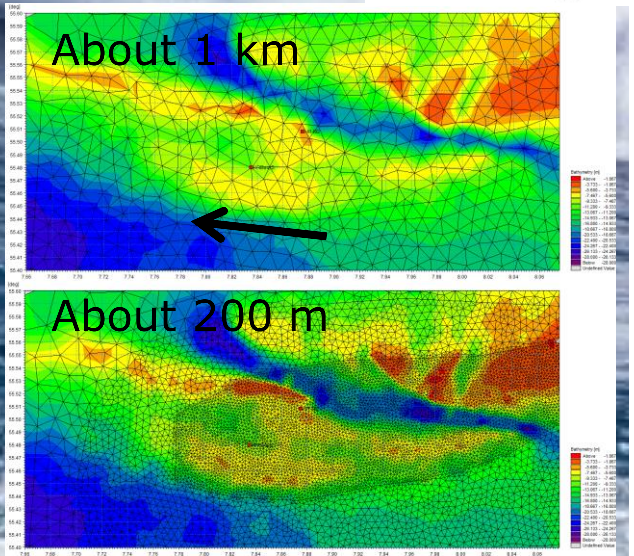
Actions

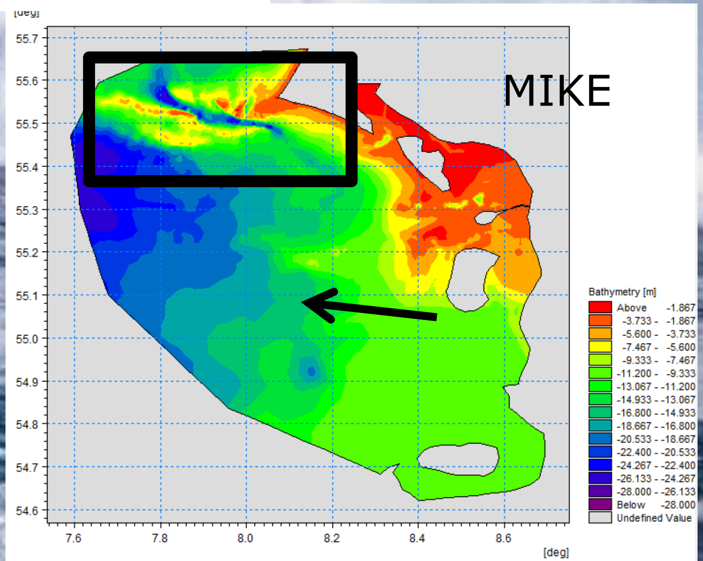
We have been examining the coastal, storm, issues, including

model resolution, input data, fetch effect



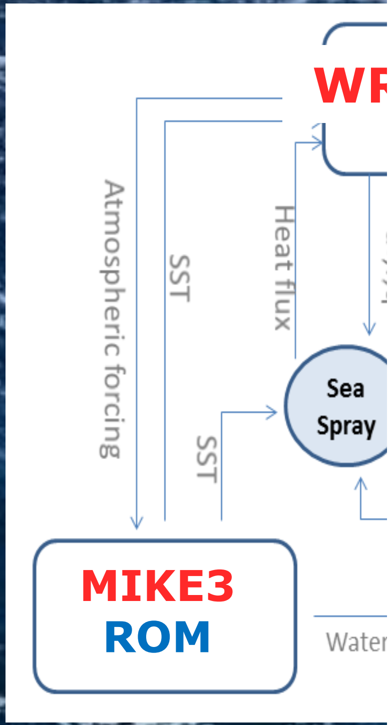


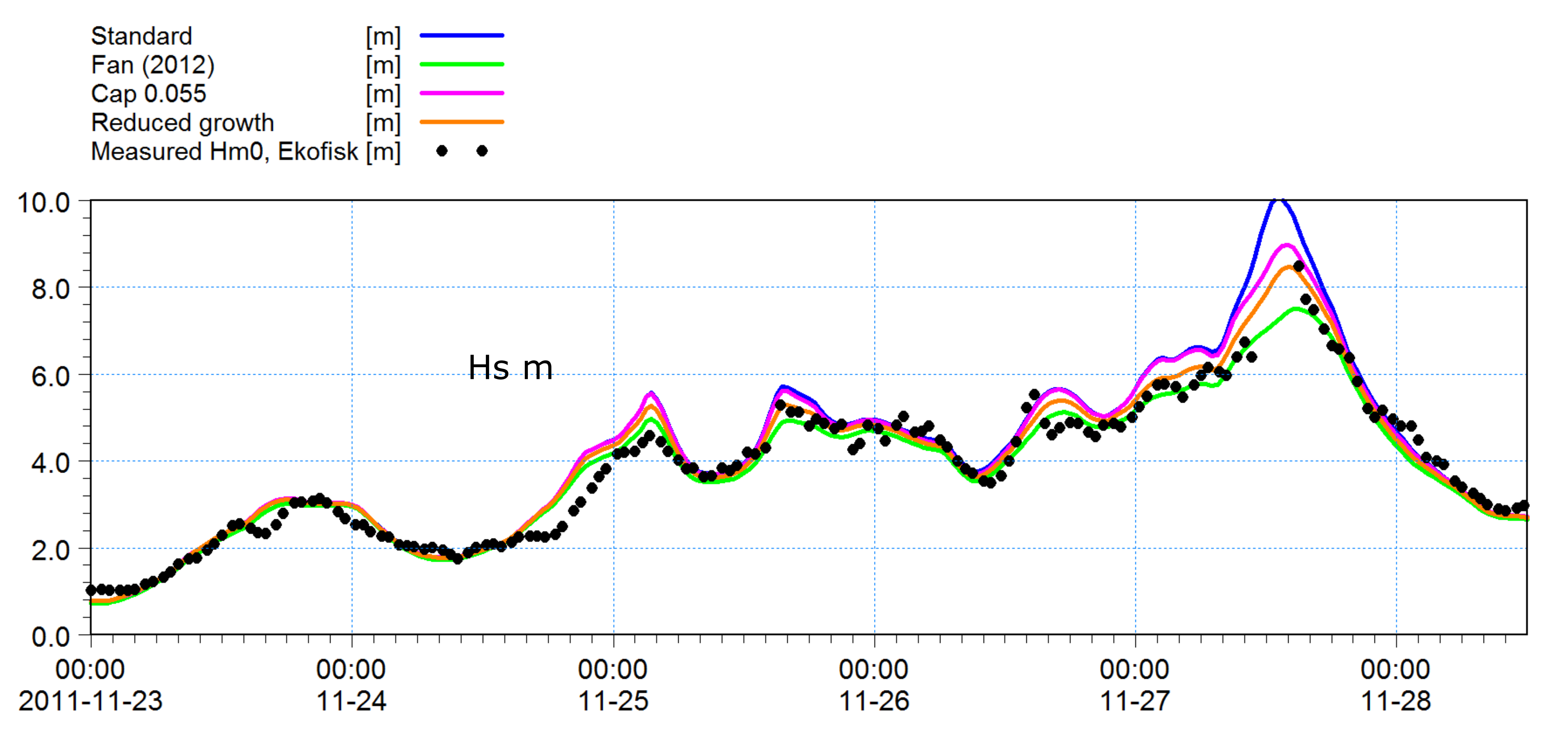




We have been examining the air-sea interaction physics

Actions …ss)





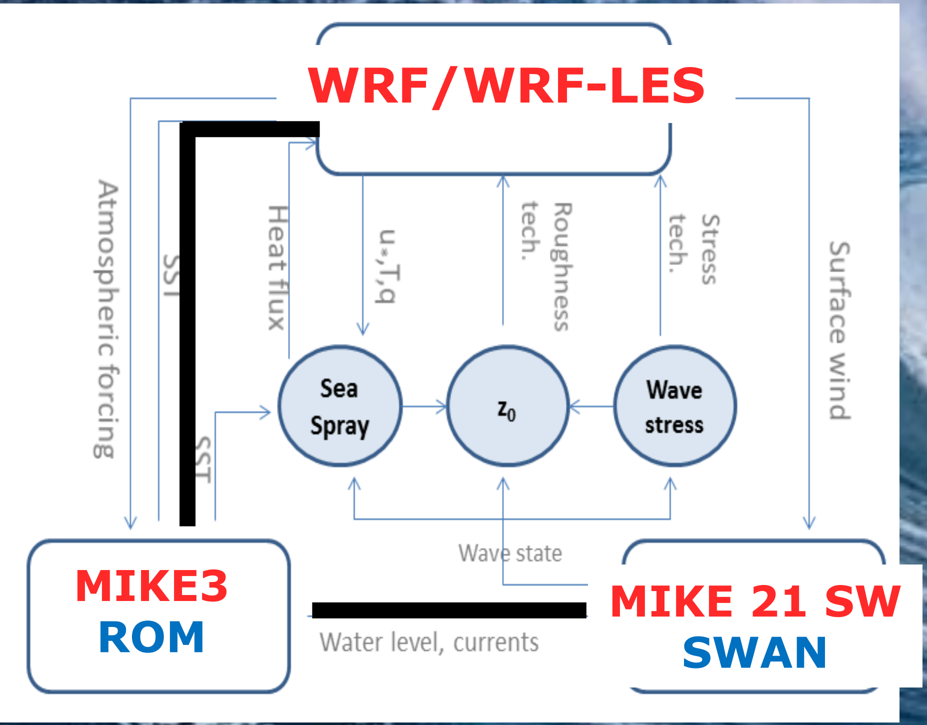
$\sqrt{1 - \frac{\tau_w}{\tau}}$

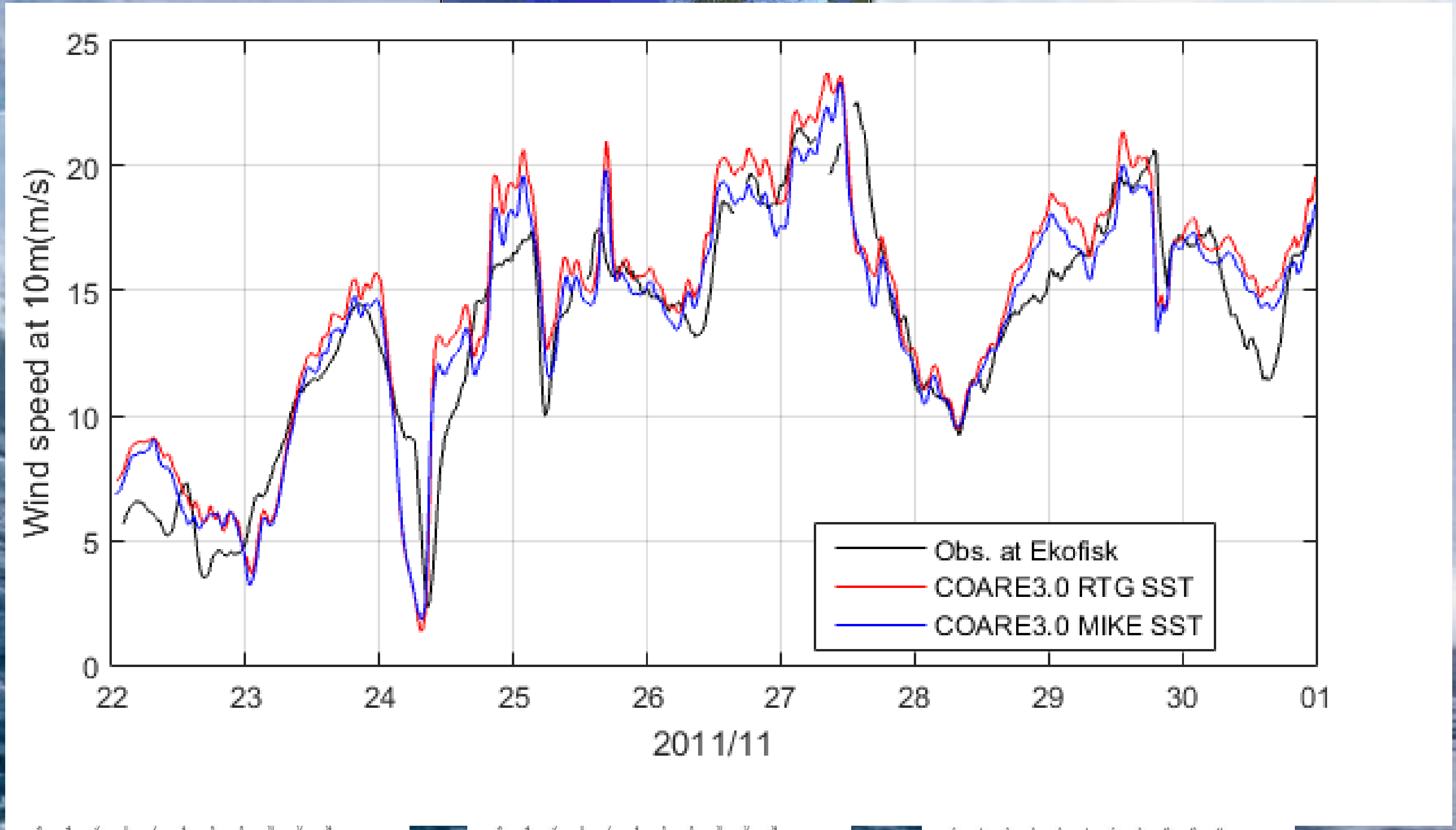
- Oost et al(2002) $z_0 = \frac{50}{2\pi} L_p \left(\frac{u_*}{c_p}\right)^{4.5} + \frac{0.11\nu}{u_*}$
- Taylor and Yelland(2001) $z_0 = 1200 h_{m0} \left(\frac{h_{m0}}{L_p}\right)^{4.5} + \frac{0.11\nu}{u_*}$

Actions

We have been examining the oceanic impact

Including **SST**, **current** and water level



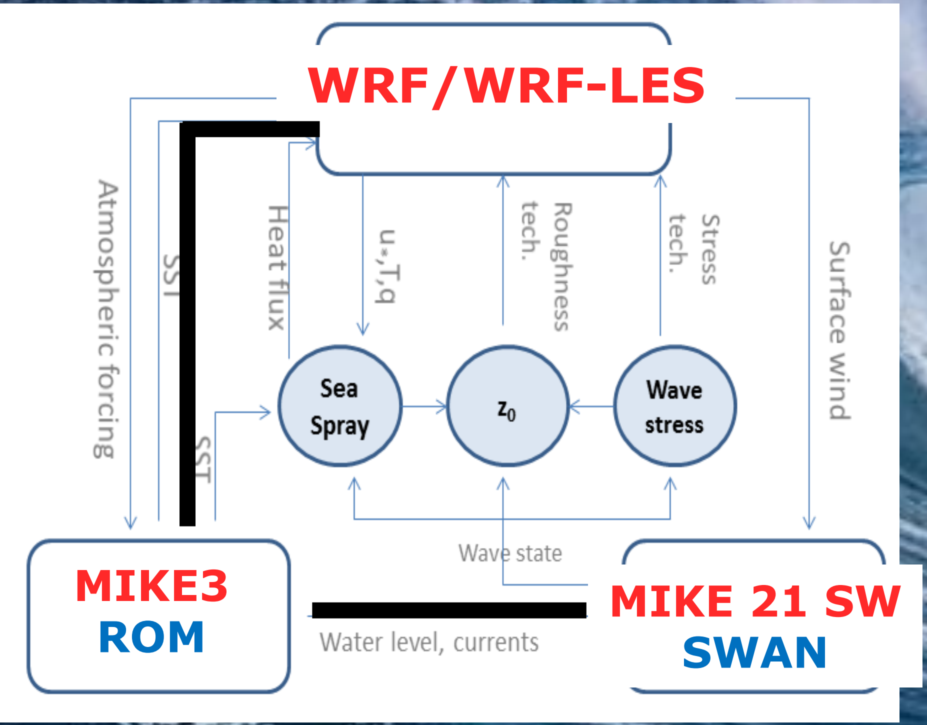


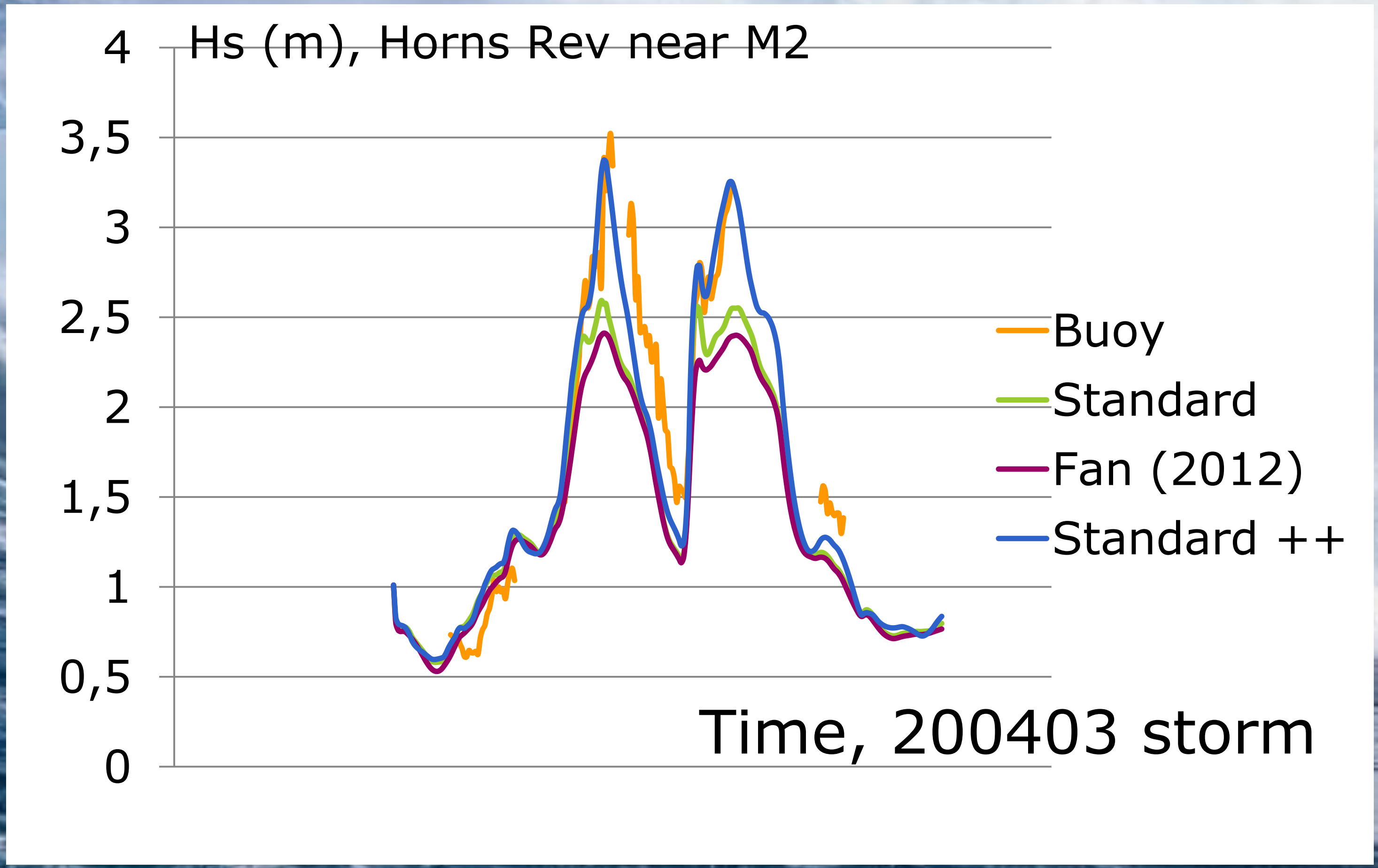
Surface current Sanility SST

Actions

We have been examining the oceanic impact

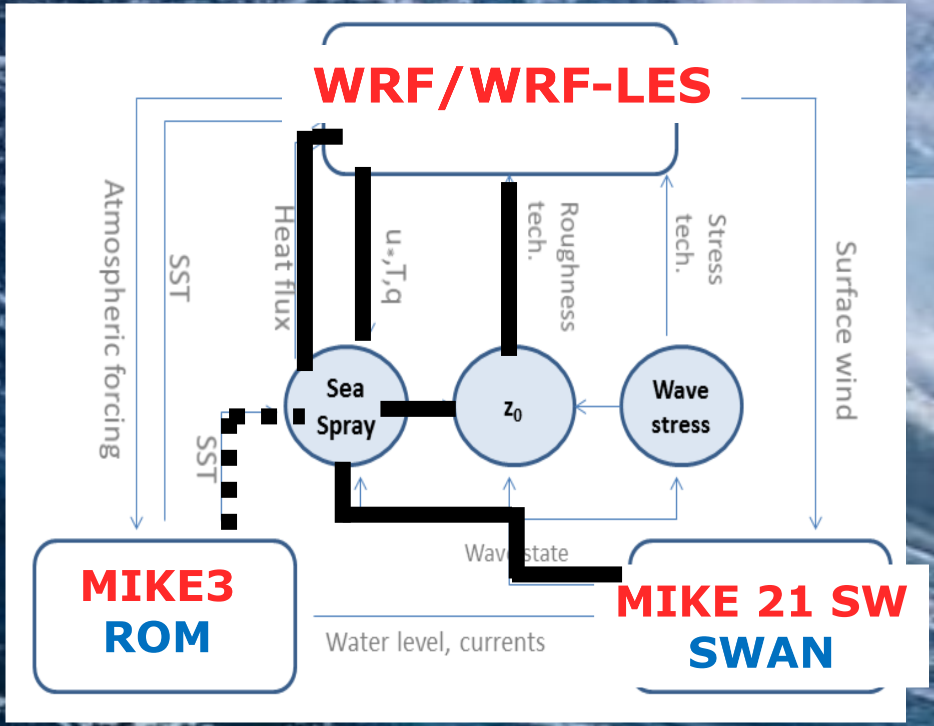
Including SST, current and **water level**





We are examining the Spray effect…

Actions



We have been validating the model results through

various kinds of measurements

Actions - Validation

Mean meteorological measurements

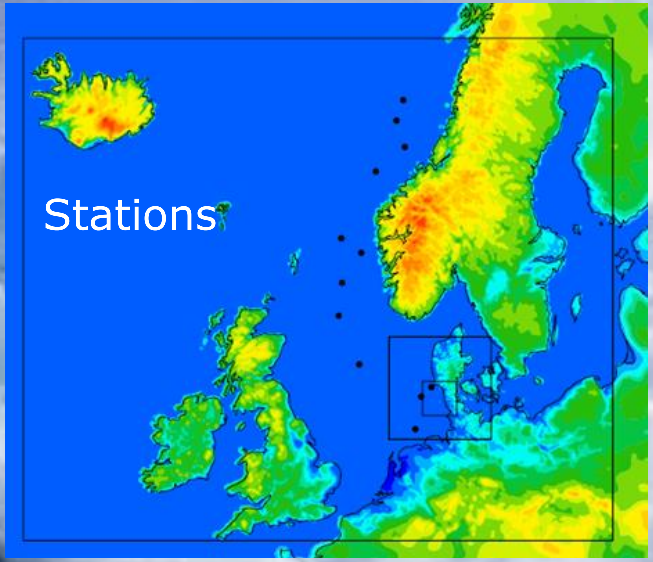
Turbulence

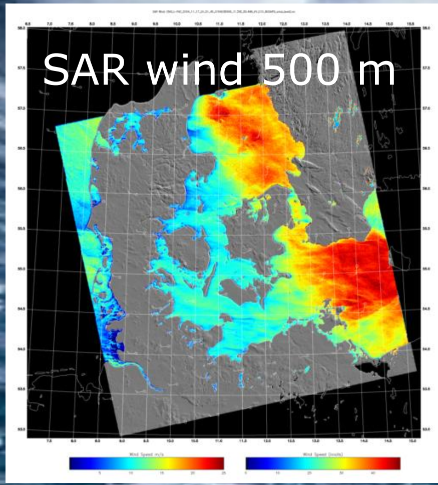
Mean wave data

Cloud pictures

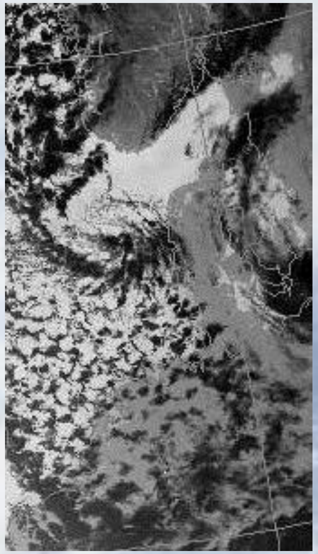
QuikSkat (wind, temperature, Hs)

SAR wind

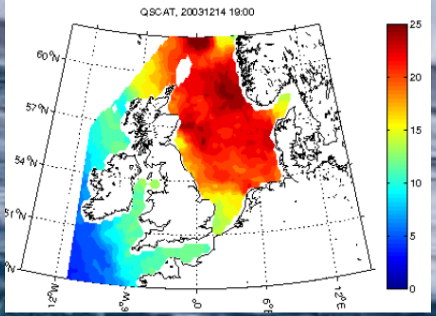




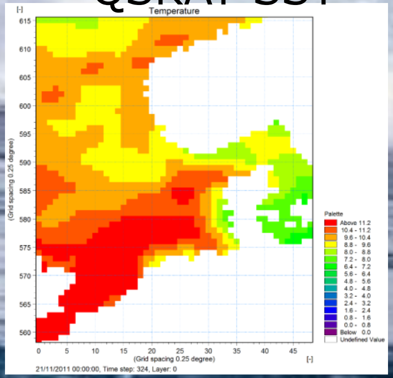
Cloud Picture



QSKAT wind, 25 km



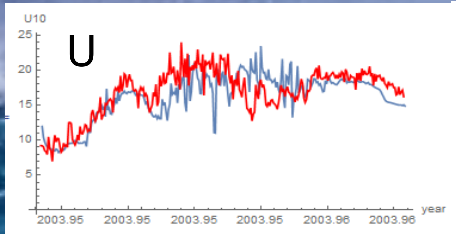
QSKAT SST

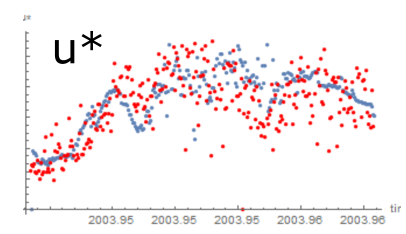


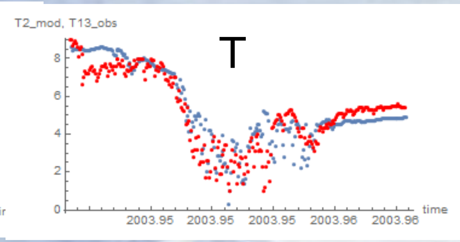
Action - Validation

We have been **validating** the model results through various kinds of measurements in many ways

- **Time series**
- **Distribution**
- **Spatial distribution**
- **Spectral analysis**
- **Compared to literatures**

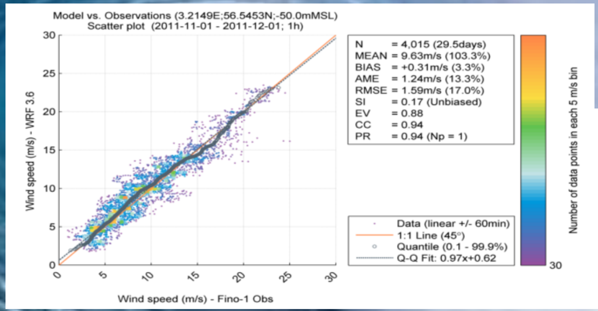


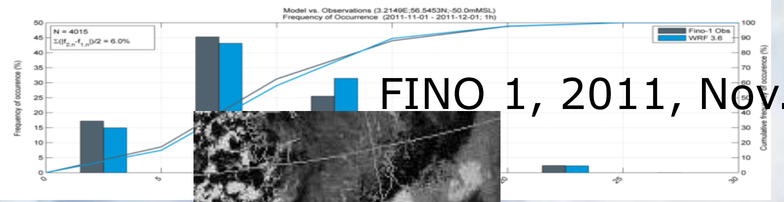




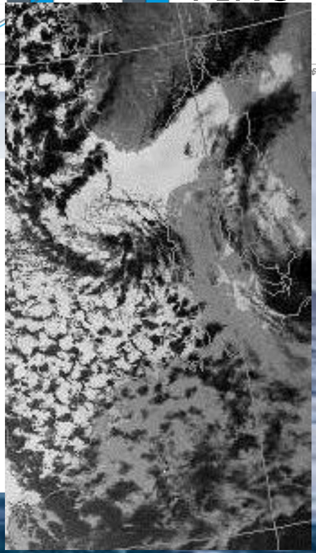
Obs

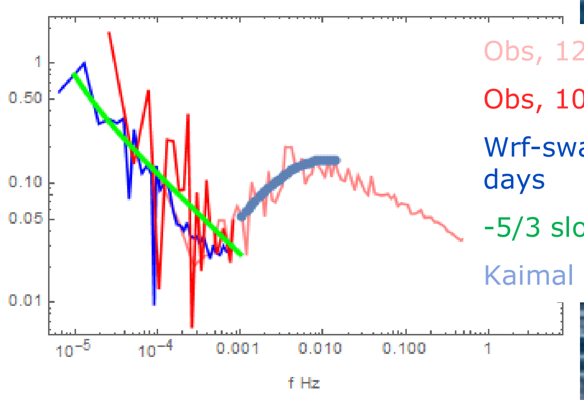
Model

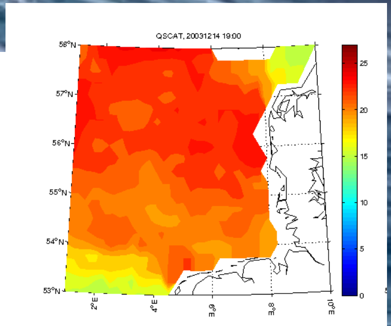




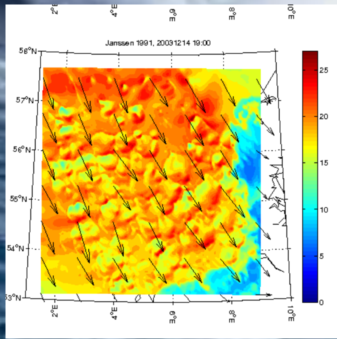
FINO 1, 2011, Nov.



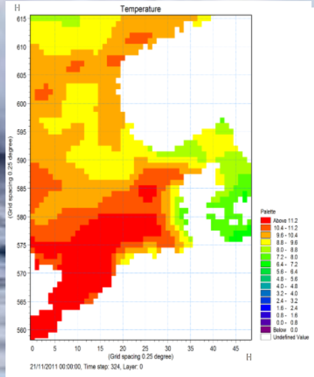


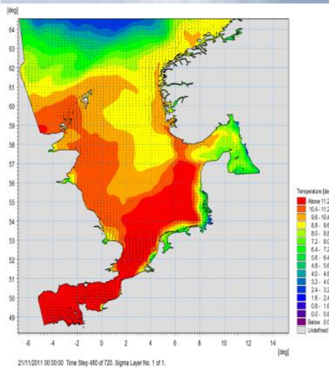


Wind QSKAT 25 km



WRF-SWAN 2km





Satellite SST, MIKE 3 SST

NOAA radiometers

What we can offer

- Wind and wave data in the coastal zones
  - high resolution
  - from advanced modeling
  - Long term statistics vs time series
  - For siting, design, O&M

- Tools
  - A modeling system, particularly for storm conditions, suitable for coastal zones
  - Post-processing program for assessing, evaluating and applying the data for particular use

- Improved knowledge, in technology, science and application

Final remarks

- Better understanding and modelling of the challenging conditions: Storms, coastal zone

- Targeted at issues relevant for offshore (open sea and coastal) applications

- Useful input for existing systems