13th International Workshop on Wave Hindcasting and Forecasting & 3rd Coastal Hazard Symposium

Spatial variability of **directional misalignment** between waves and wind in the **Baltic Sea**-model study

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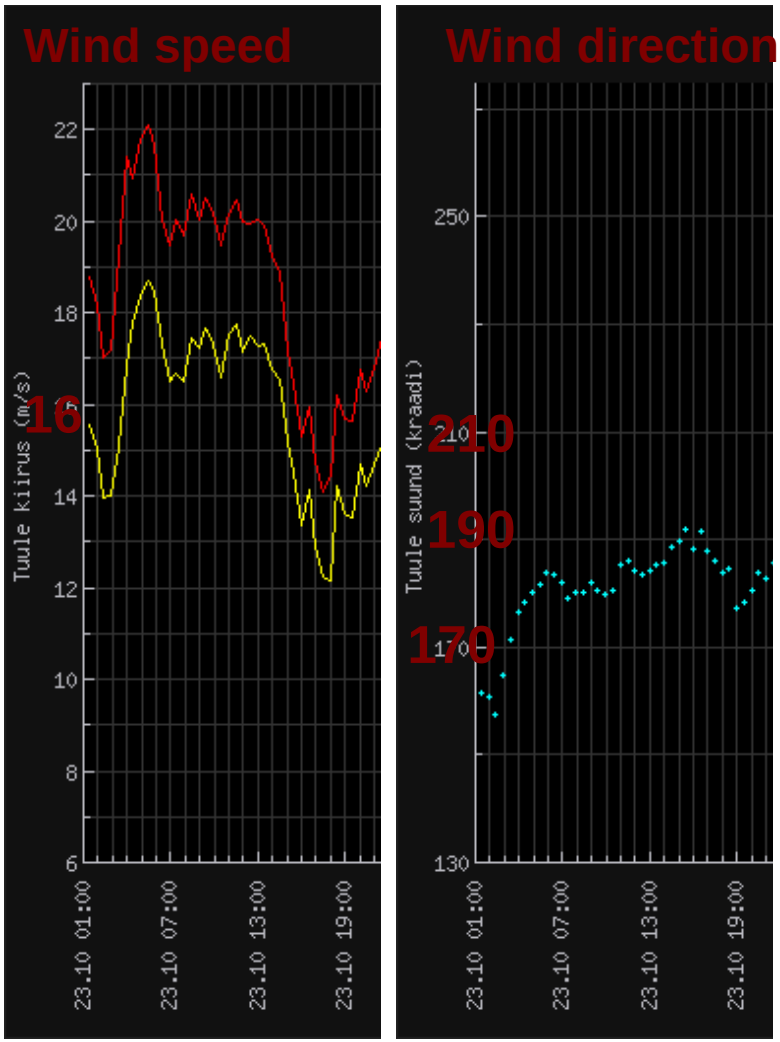
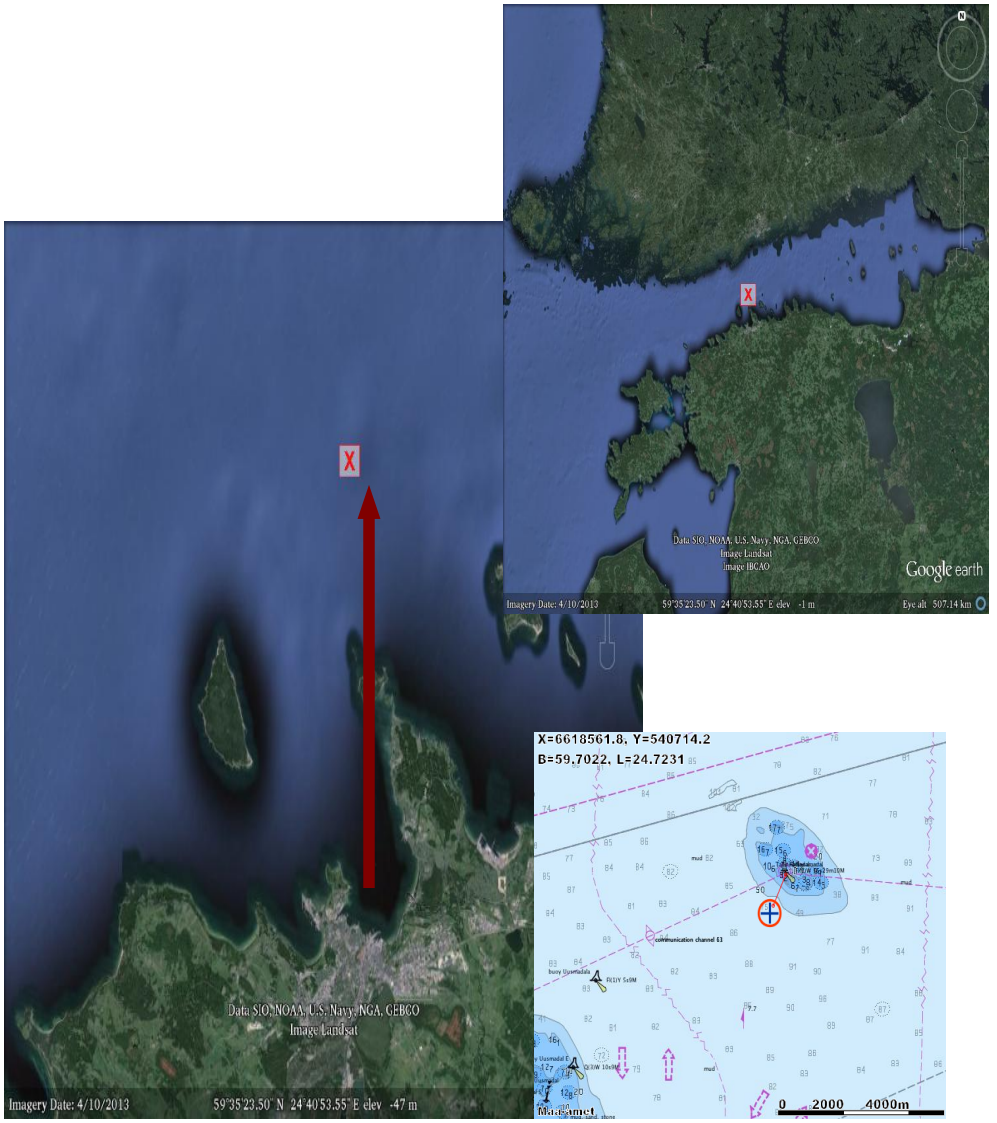
Measurements (23.10.2013)





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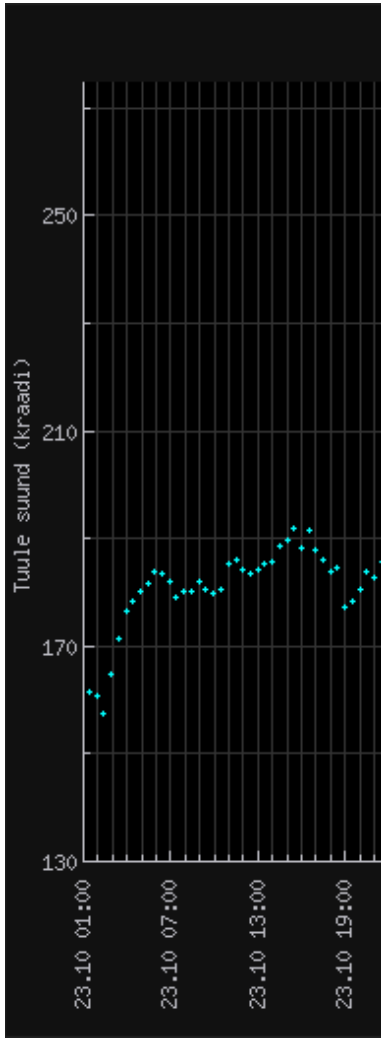

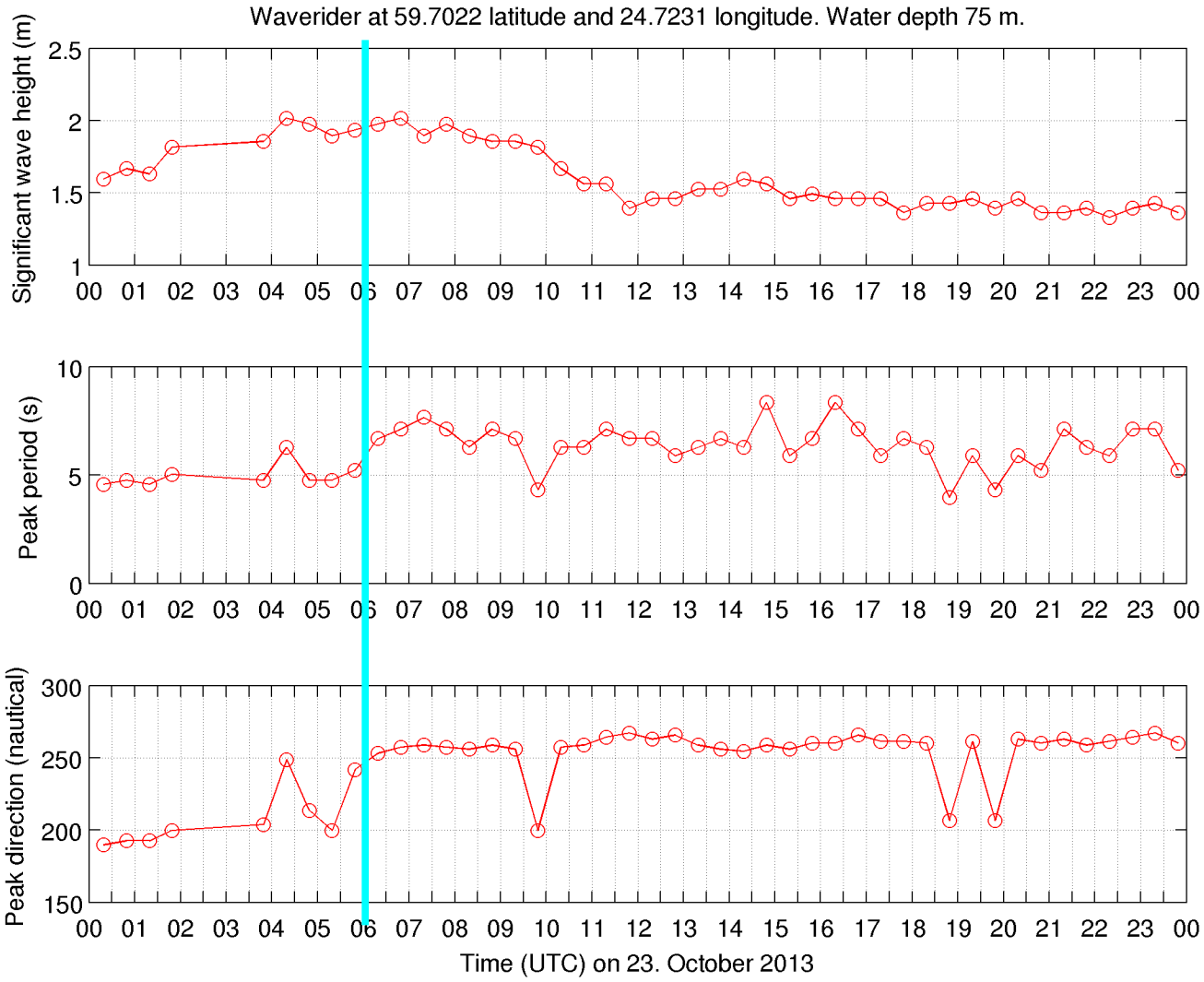

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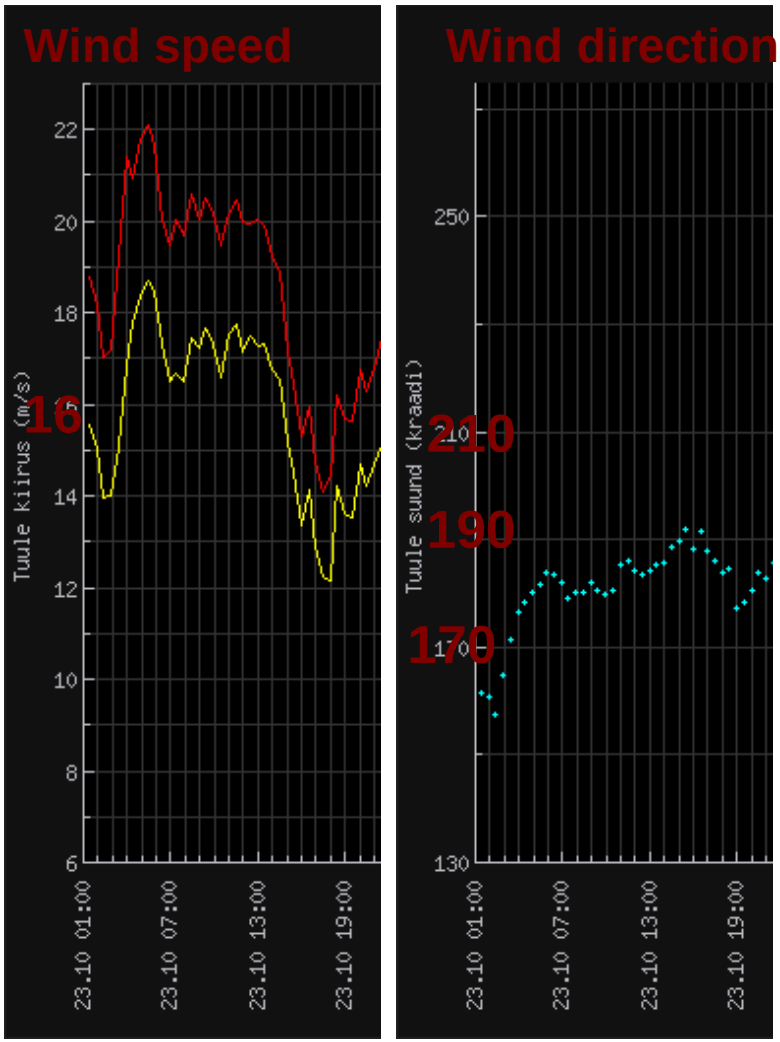
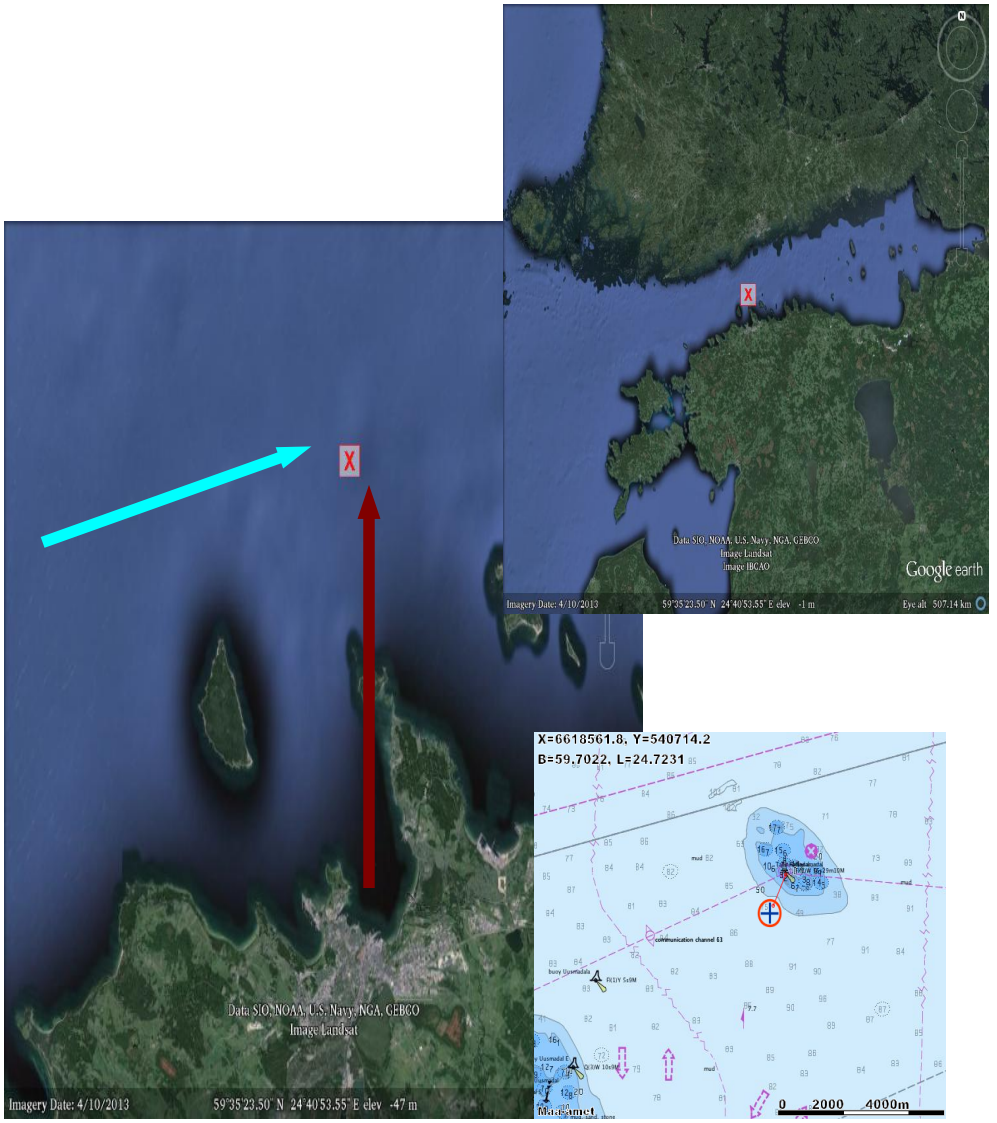
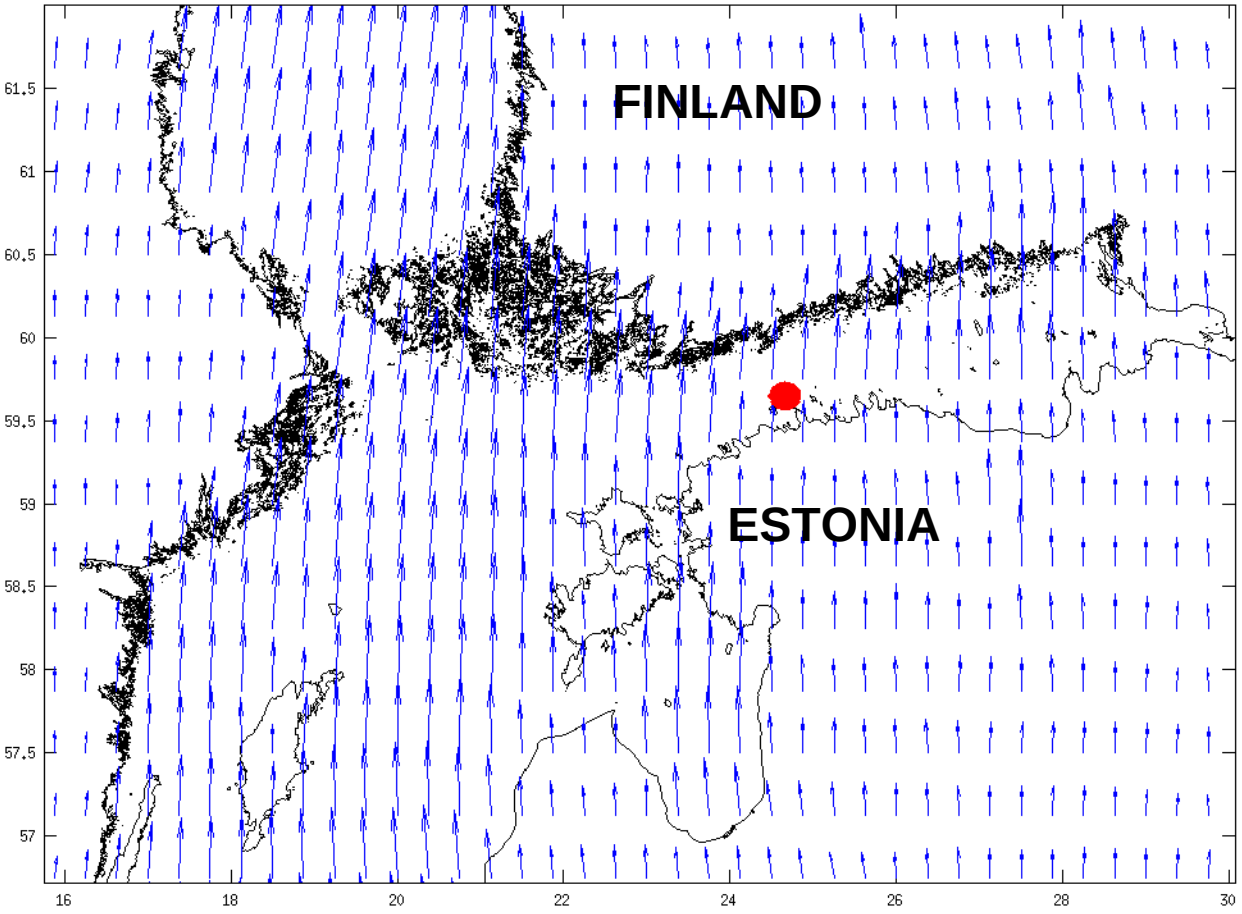




Spatial wind at max Hs and storm peak



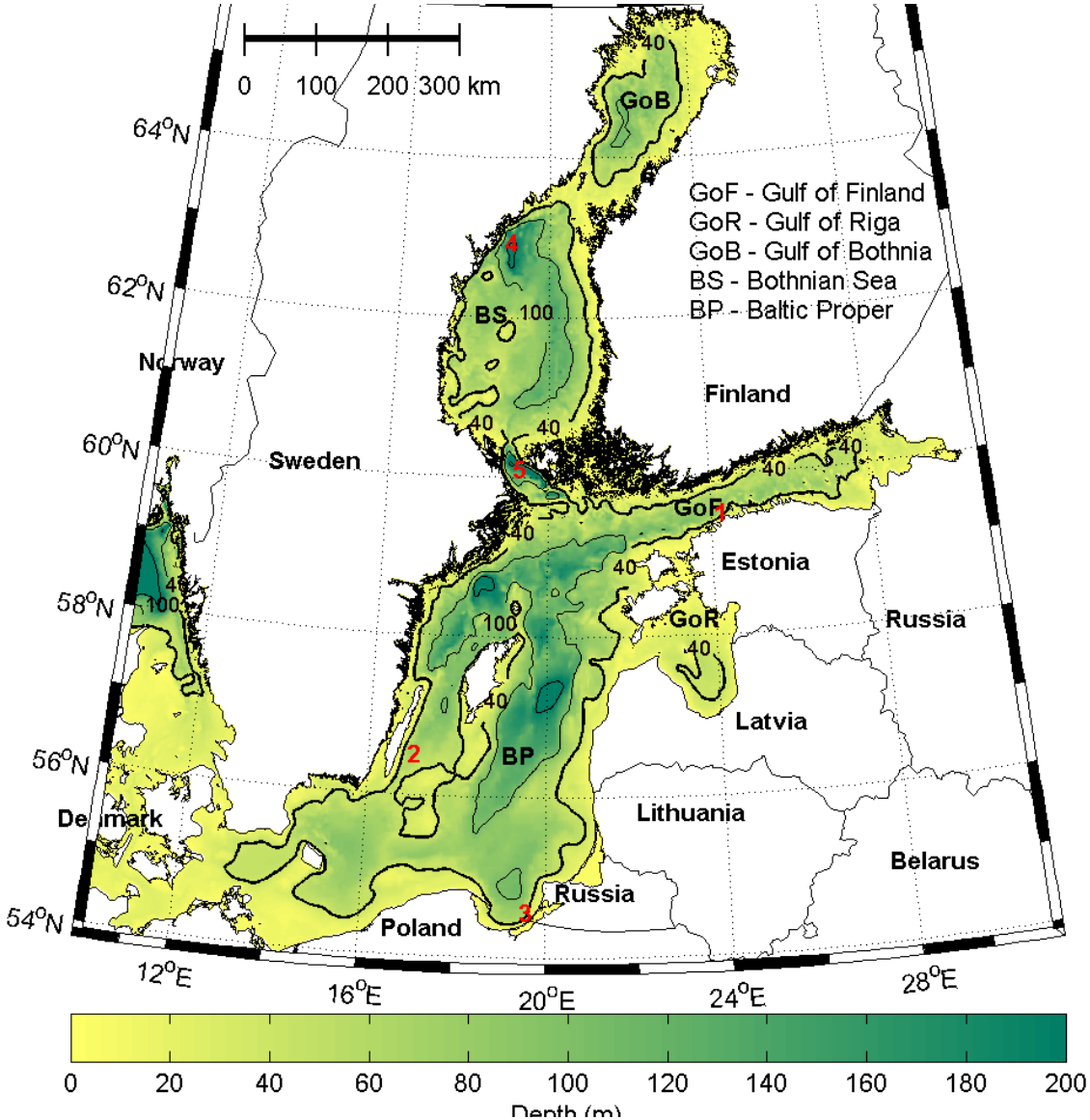
So

- Point measurements indicate **pronounced slanting fetch effects**.
- Nothing new, Pettersson et al. (2010) already showed that for the Gulf of Finland.

Background and objective

- Knowledge of wave-wind misalignment is valuable for nautical activities and design of offshore structures.
- Wind-wave misalignment is defined as as the temporal difference between mean wave direction and mean wind direction.
- **For the first time the spatial variability of wind-wave misalignment in the entire Baltic Sea was analyzed.**

Configuration of the Baltic Sea

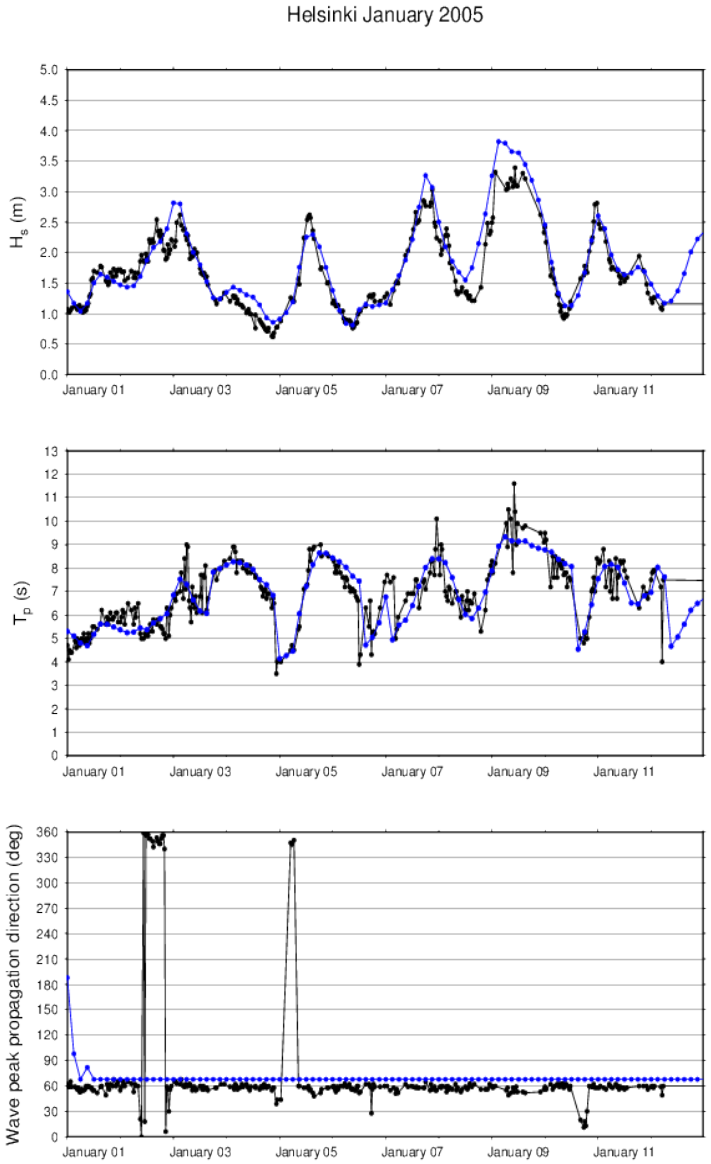


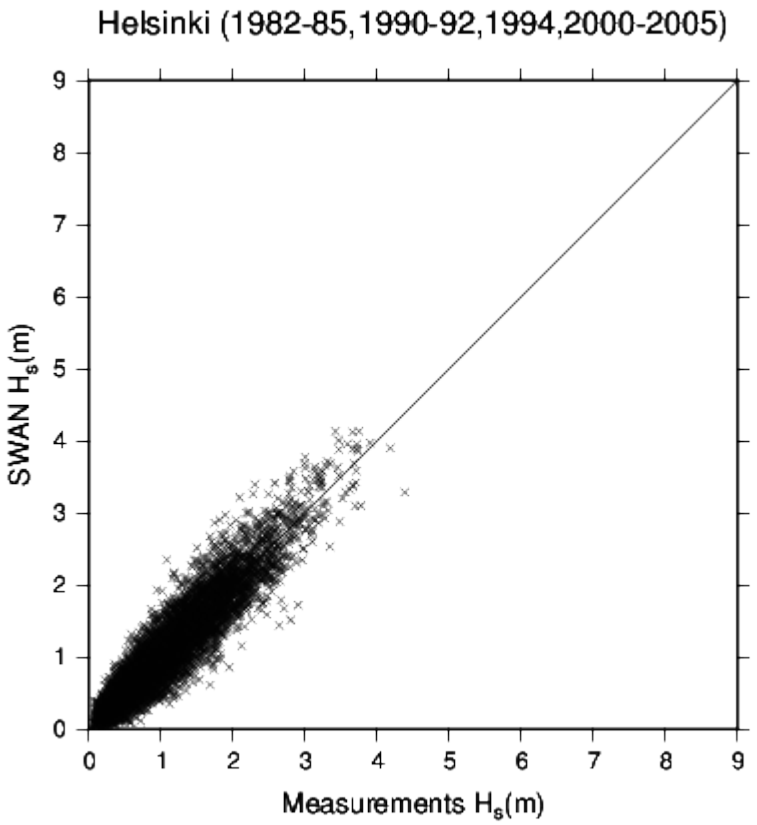
Model and its setup

- **Time-period:** 01.01.1965-31.12.2005.
- **Spatial resolution:** 1' lat, 2' lon; ~1 nautical mile.
- **Spectral resolution:** 32(f)*24(theta).
- **Integration timestep:** 15 minutes.
- **Activated:** triads and quadruplets, whitecapping, wind input, bottom friction, depth-induced breaking.

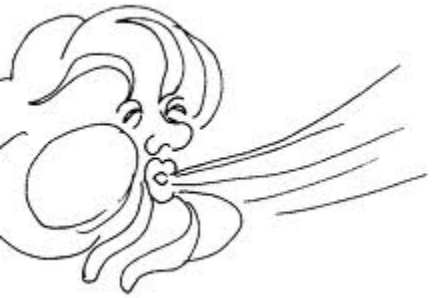
- The **wind** used was from the Baltic Sea regional reanalysis database BaltAn65+. It is a regional refinement of the ERA-40 dataset with a horizontal grid resolution of approximately 11 km.
- The **ice** concentrations used were calculated at SMHI by using a coupled ice-ocean model with a 2 nautical mile horizontal grid step.

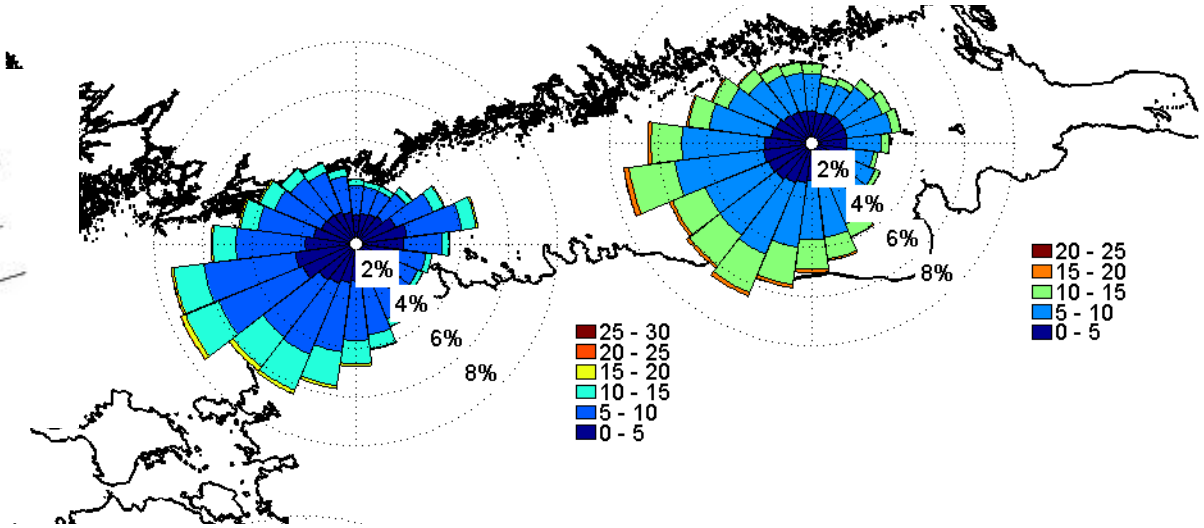
Wave validation: Gulf of Finland

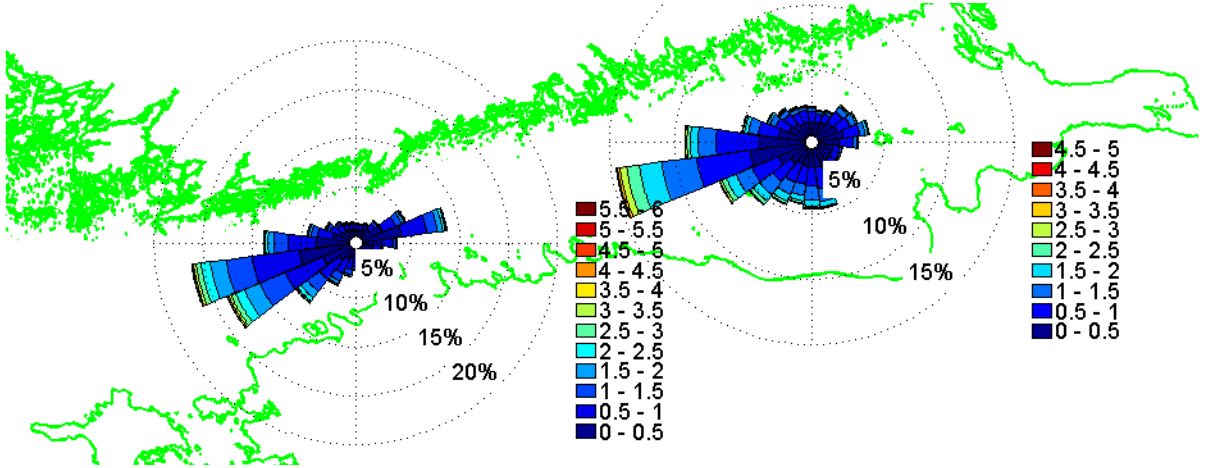




41 years of misalignment





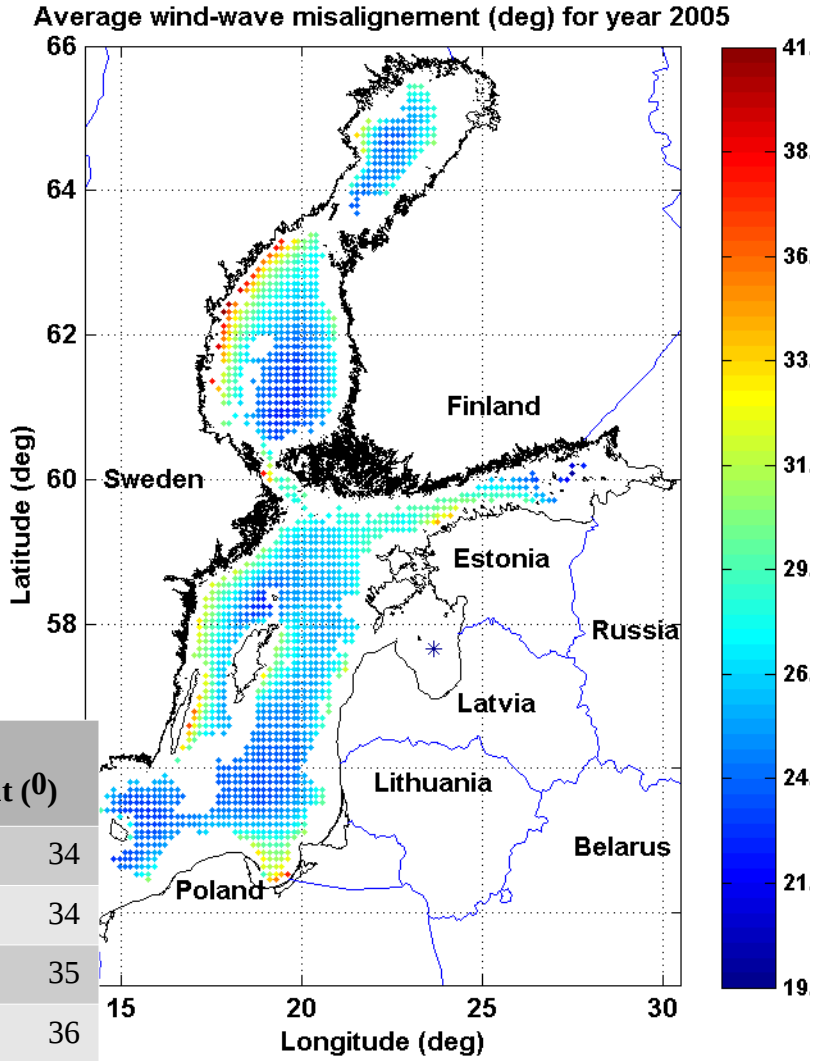


Average misalignment for 2005

1) Take wave model points which are closest to wind model points.

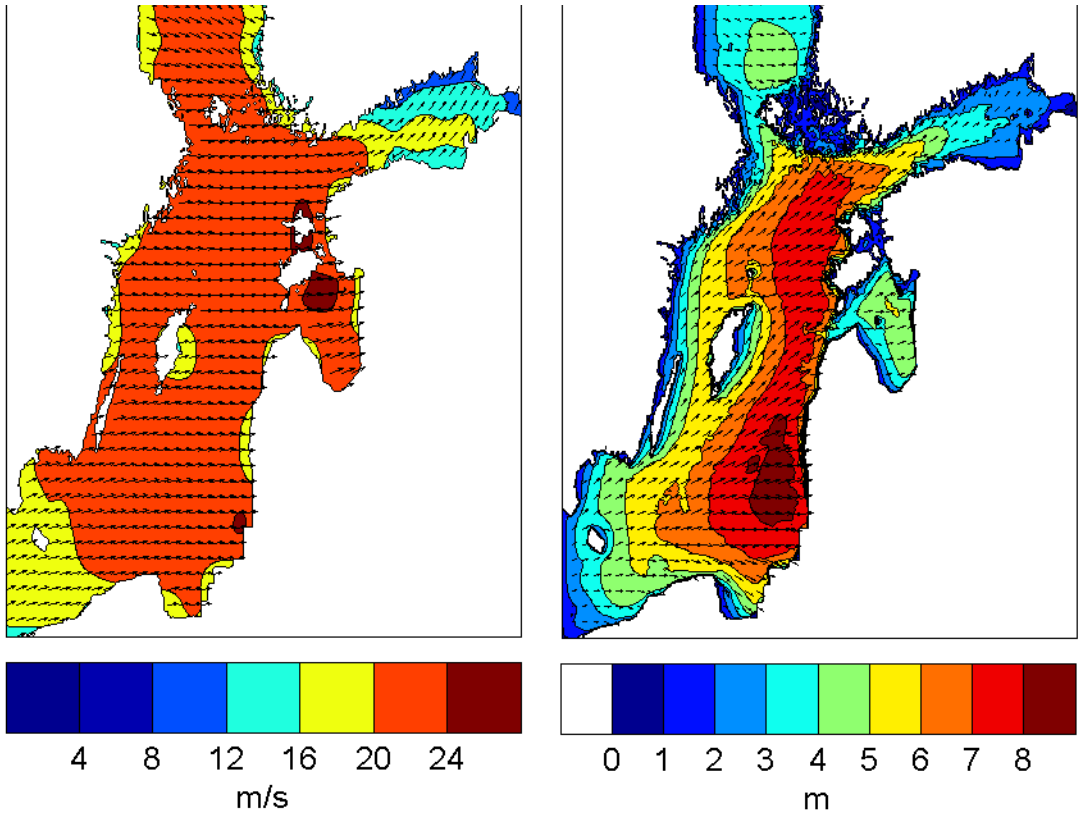
2) Make sure the points are in water deeper than 50 m.

3) Make sure the points are not closer to land than 10 km.

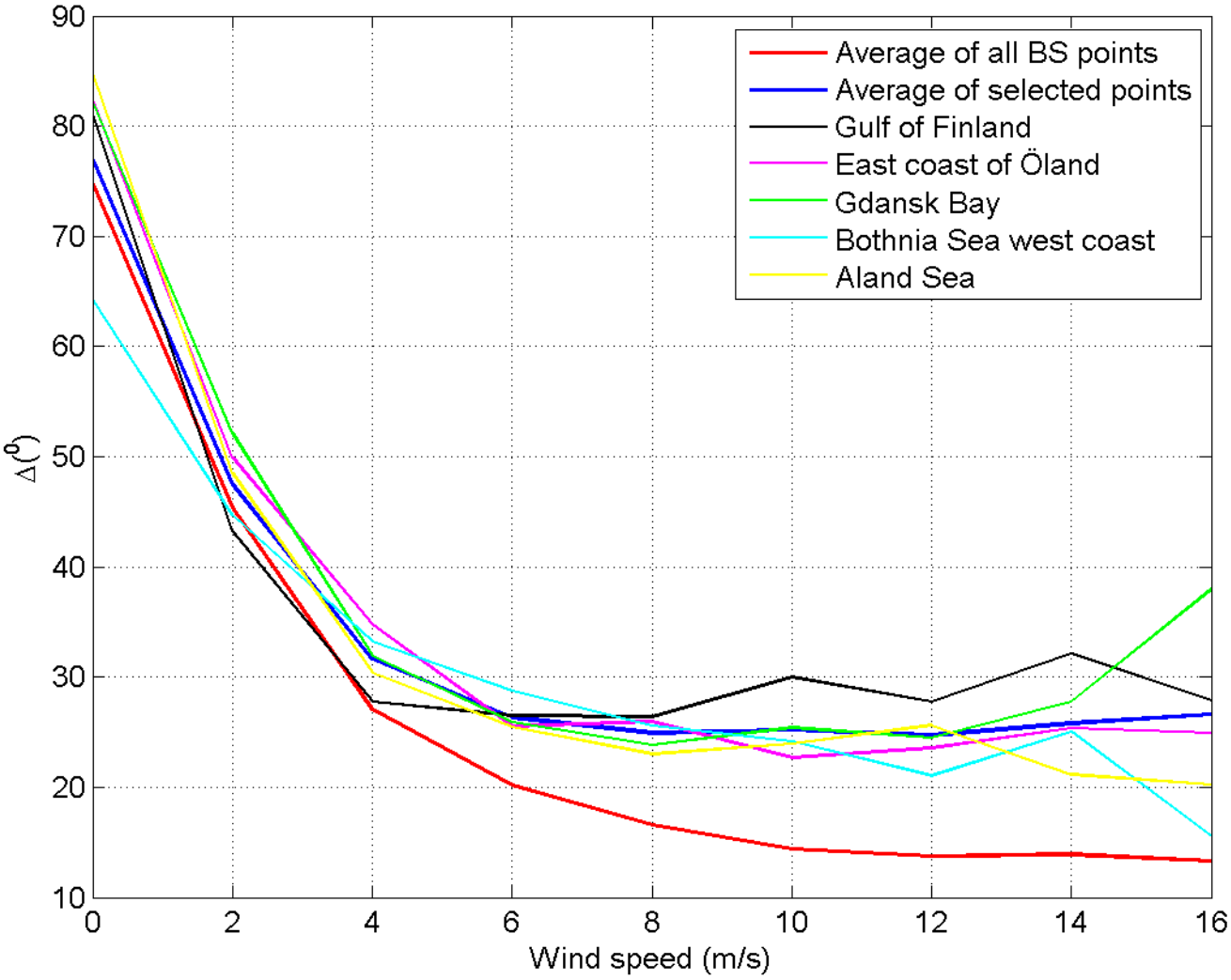


Nr	Location	Lon	Lat	Water depth (m)	Mean misalignment (^{0})
1	Gulf of Finland	24,1014	59,5083	89,2	34
2	East coast of Öland	16,8755	56,4915	71,6	34
3	Gdansk Bay	19,4396	54,5414	72,8	35
4	Bothnia Sea west coast	18,8069	62,9085	170,4	36
5	Aland Sea	19,1066	60,0917	172,9	33

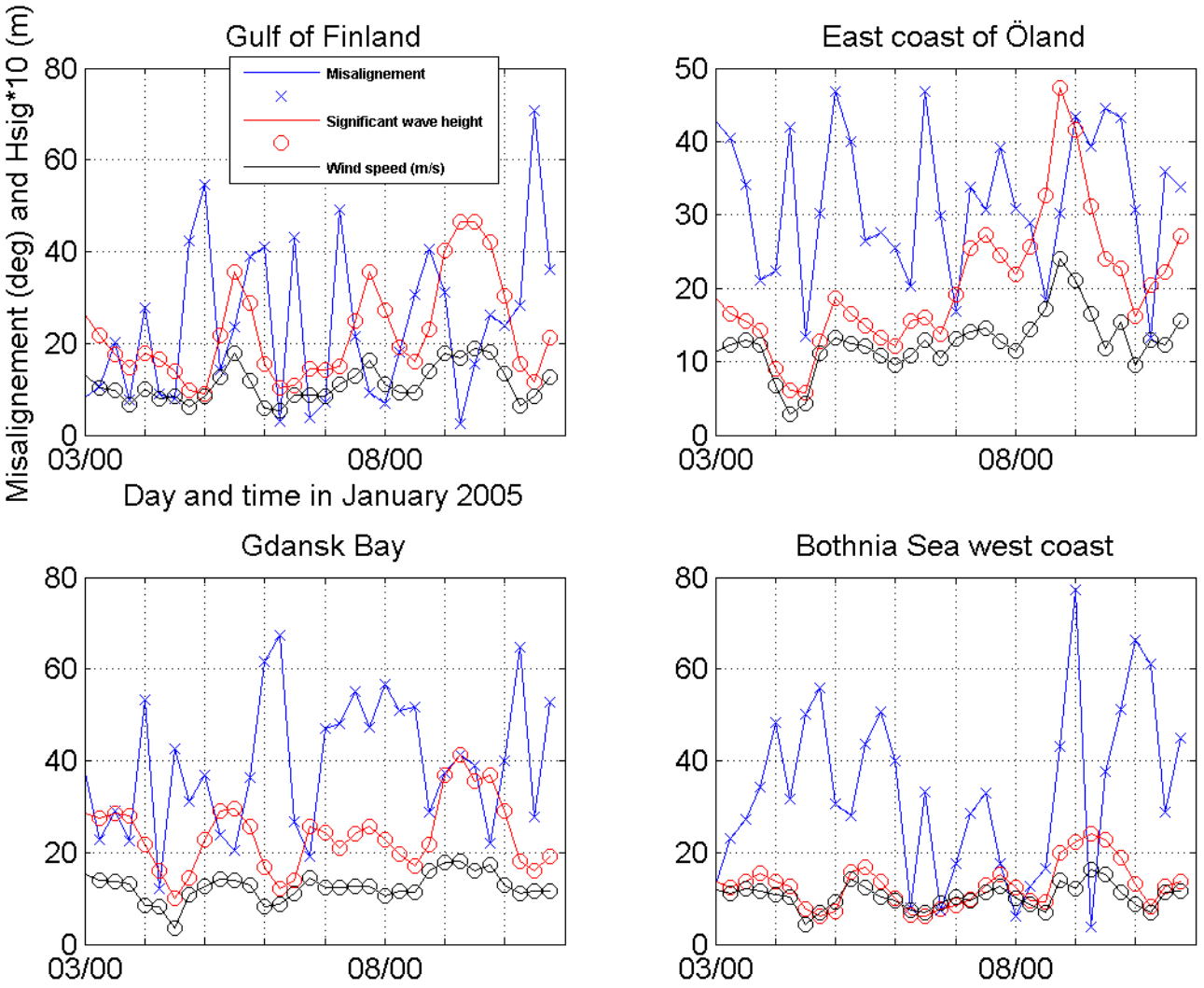
Snapshot during storm Gudrun on 06:00 UTC 09.01.2005



Misalignment vs wind speed



Temporal dynamics



Conclusions

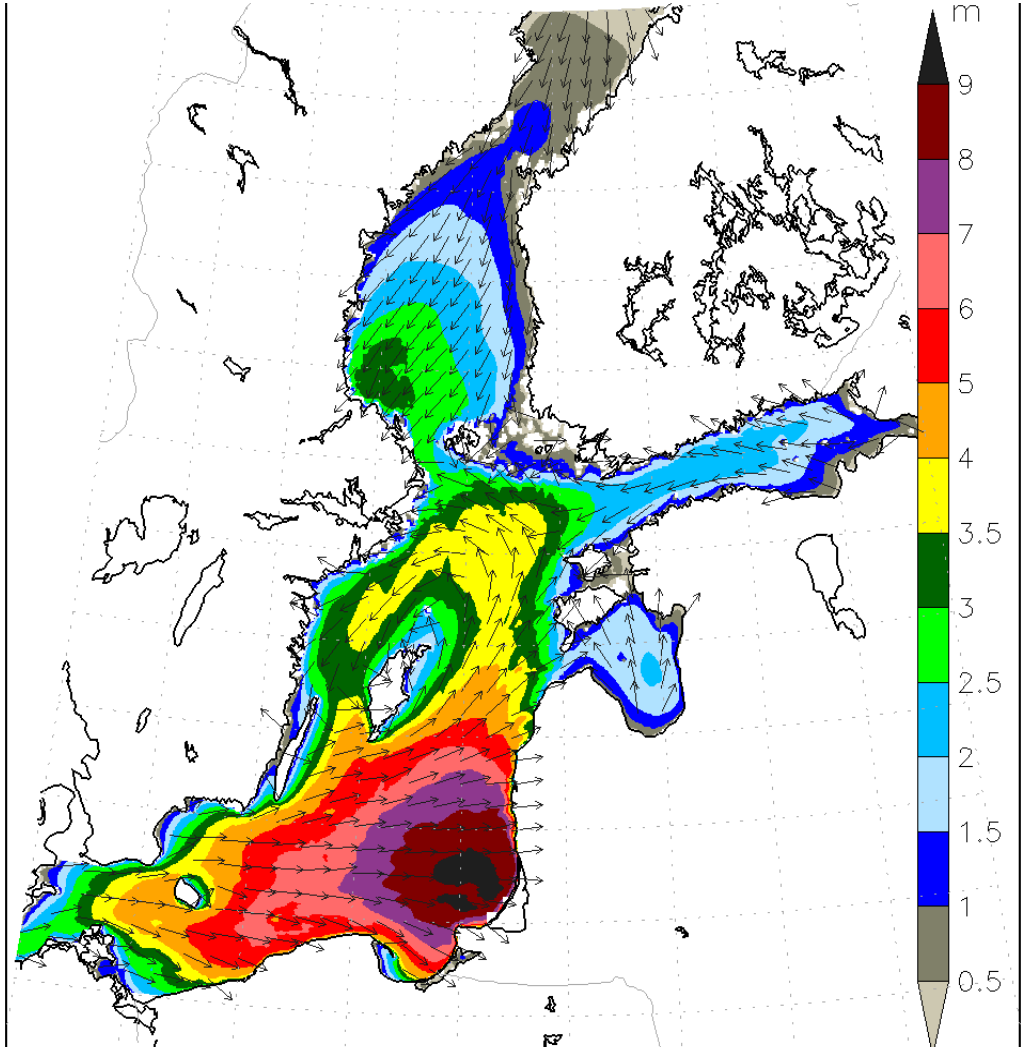
1) **Deep water** wind-wave misalignment occurs in **all sub-basins** of the Baltic Sea.

2) Average wind-wave misalignment in deep water shows large spatial variations, yielding from 20^0 to 40^0. **Instantaneous misalignment** during high sea states (significant wave height over 2 m) reaches $\mathbf{80^0}$ in deep water.

3) Misalignment dependence on wind speed shows the **decrease of misalignment with increasing wind speed.**

4) Main causes of misalignment in deep water are temporal changes in **dynamic systems** and **fetch-restriction**.

Cyclone fitting the Baltic Sea



Future plans on this topic

- Use SAR for spatial validation – 150 images with 1.5 m resolution.
- Do a sensitivity analysis with XNL.
- Upgrade to coastal regions with unstructured meshes.

Thank you for listening!