

## Maps of mesoscale wind variability over the North Sea region

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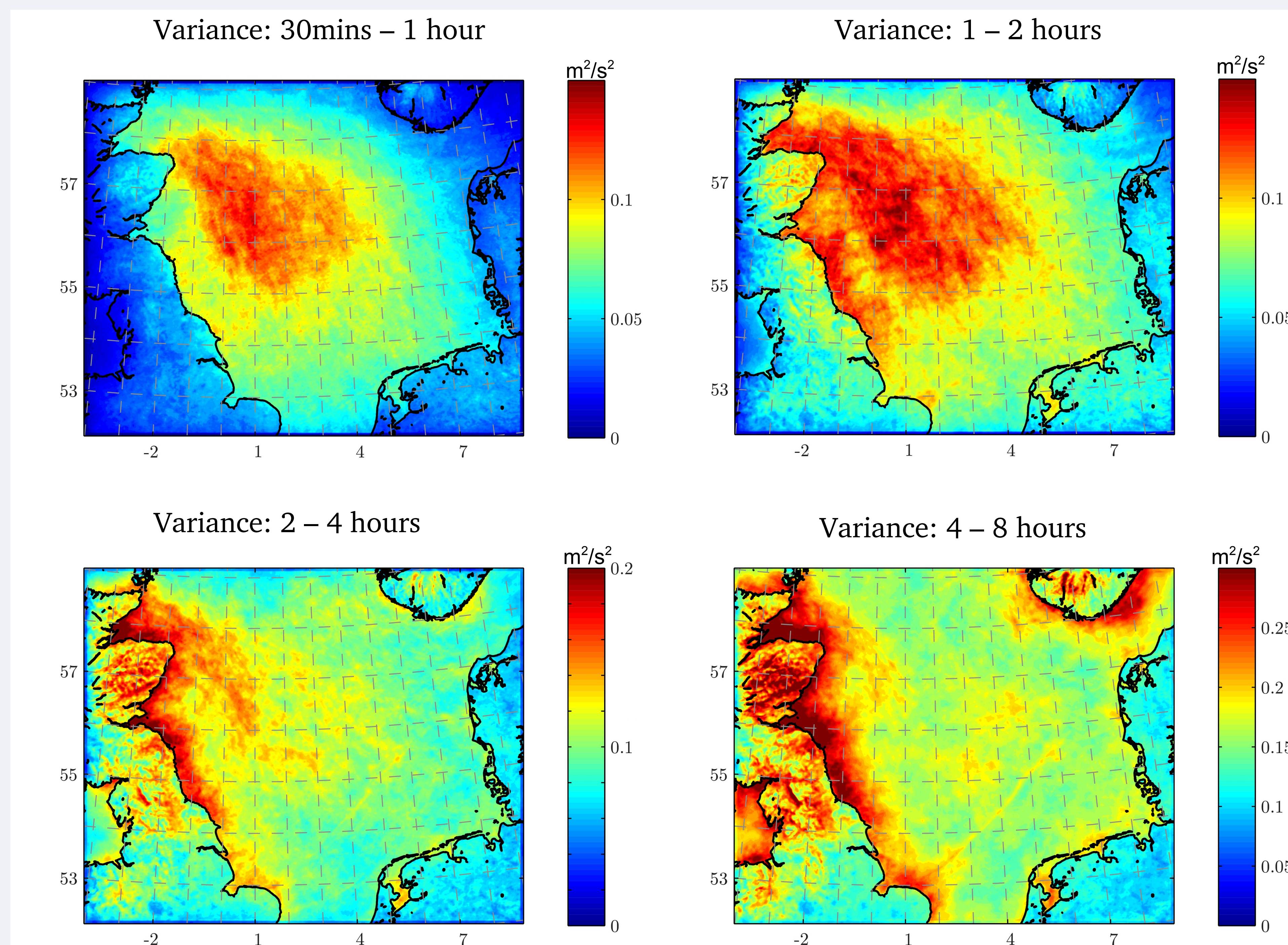
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## Introduction

Mesoscale wind fluctuations affect the operation of wind farms, particularly as the number of geographically concentrated wind farms in the North Sea increases (Akhmatov et al. 2007). The frequency and intensity of wind fluctuations could be considered as a new siting criterion, together with existing criteria such as the wind resource and proximity to grid connection points.

We used the Weather Research and Forecasting (WRF) model to calculate the average wind variability over the North Sea for wind fluctuations with periods of 30 minutes to 8 hours. Modelled winds are saved every 10 minutes for a 1 year period. The model was run with a horizontal grid spacing of 2 km. The variability maps are created by integrating the average 24 hour spectra at every grid point over different time-scales.



## Discussion

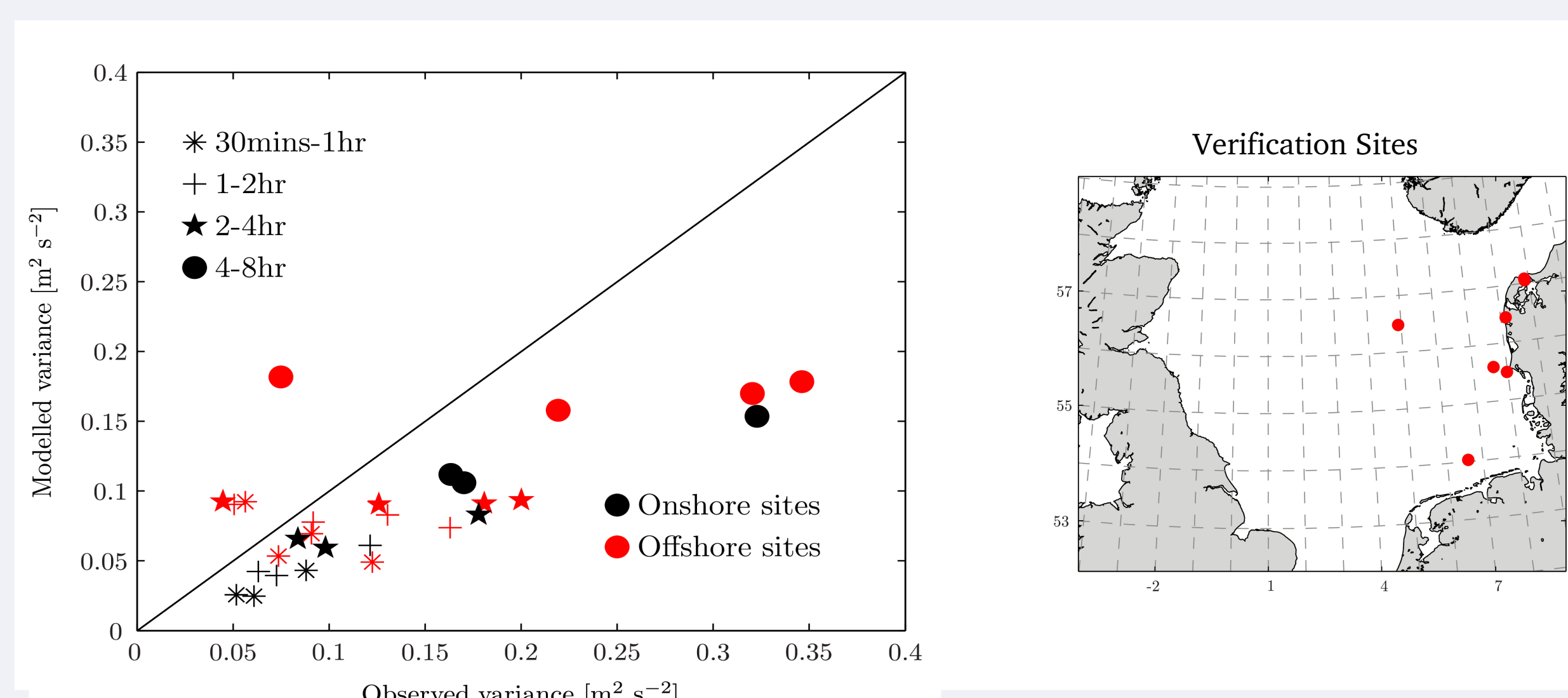
The highest variability for time scales of half an hour up to 2 hours is in the centre of the North Sea, where the flow from the North Atlantic is undisturbed. This is consistent with Vincent et al (2011) and Vincent et al. (2012), where it was shown that cellular convection is the main driver of severe wind variability over the North Sea, and Trombe et al. (2014), who showed that variability at the Horns Rev wind farm was higher in West and North Westerly flow and in the presence of precipitation.

For longer time-scales, the highest variability is near the coast – possibly related to differences in the mean wind as it crosses the coastline (associated with variability in wind direction), or to sea or land breezes.

**All time scales studied show a tendency for higher variability over the sea than the land.**

## Comparison with observations

Results were verified against observations from both onshore and offshore meteorological mast measurements from heights of around 40 m. Variability is generally higher over the sea than the land for both modelled and observed winds.



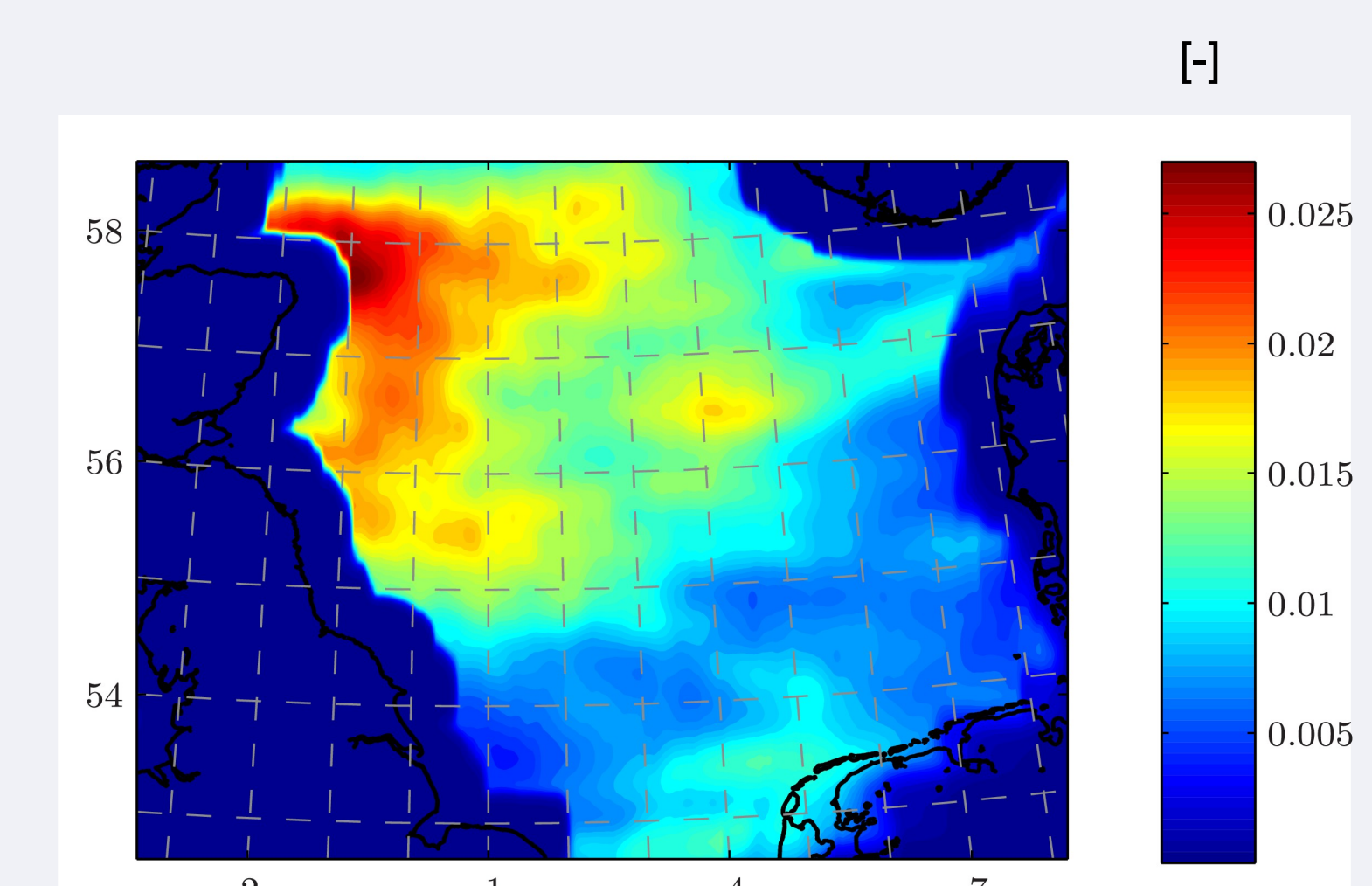
## Summary

- There is a great deal of spatial variability in the intensity of wind fluctuations on scales of 30 minutes to 8 hours.
- Wind variability on studied time-scales is generally higher over the water than over the land
- Wind variability can be considered as an additional siting criteria for large offshore wind farms
- Further verification of our work is necessary, including comparison of spatial spectra from satellite data.

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## Comparison with spatial spectra

Temporal spectra were compared with spatial spectra, calculated over a box of 50X50 grid points sliding over the whole domain. Spatial averaging means that the plot has less resolution than the temporal plots, but shows the same trends. This strategy lends itself to a similar analysis using satellite observations of winds over the sea. We show the spatial variance for wavelengths of 14-58 km, which corresponds approximately to time-scales of 30mins-2hr given a mean wind speed of 8 m/s. The spatial variance is of the wind is normalised by that of the topography to remove static topographic effects.



## References

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