WEATHER RADARS FOR WIND ENERGY APPLICATIONS

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INTRODUCTION

From 2009 to 2012, two weather radars were used to monitor weather conditions at the offshore site of Horns Rev, Denmark.
The goal of this experiment, called Radar@Sea, was to characterize meteorological phenomena associated with large wind fluctuations in order to improve the predictability and controllability of offshore wind power fluctuations in the very short-term, up to 2 hours ahead.

PARTNERS

DTU, VATTENFALL, Dmi, DONG energy, DHI

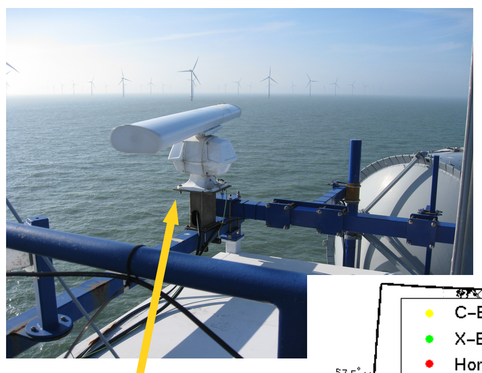
MOTIVATIONS

Both empirical observations and meteorological analysis reveal that large wind fluctuations tend to occur simultaneously with precipitation at Horns Rev [1-2].

IDEA & OBJECTIVE

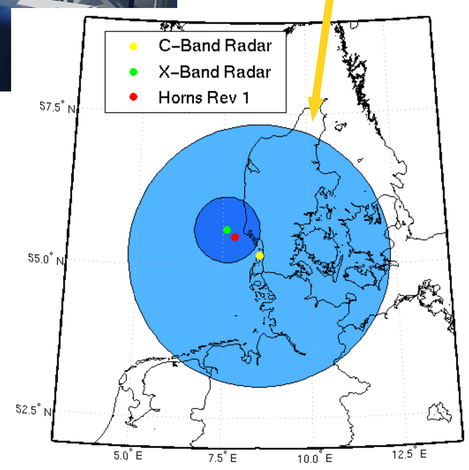
Weather radars are the ideal tools for detecting and tracking precipitation at high spatio-temporal resolutions.
Our objective is to extract the relevant information from weather radar observations and integrate that information into a wind power prediction system [3].

EXPERIMENT

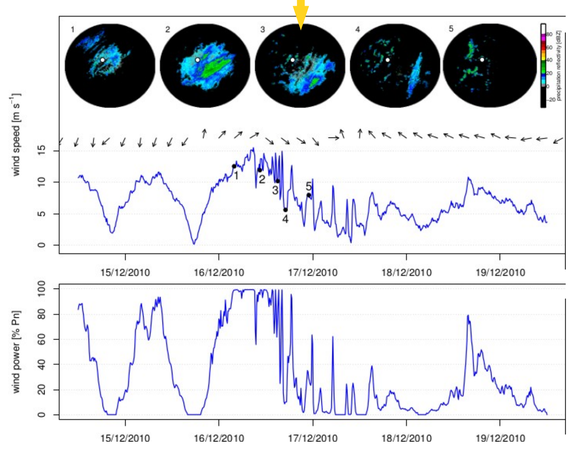


One of the two weather radars was installed offshore.

Respective coverage area of the two weather radars.

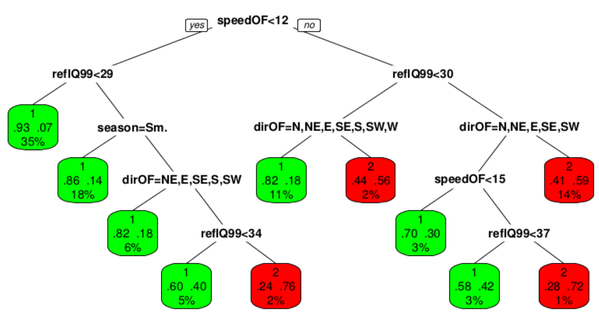


Example of weather radar observations in relation with wind speed and wind power time series from Horns Rev 1. This episode illustrates the passage of a cold front followed by open cellular convection producing precipitation.



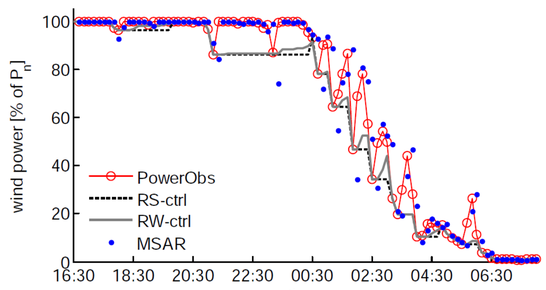
APPLICATIONS

Classification of offshore wind regimes



The speed and direction of advection of precipitation, as well as its maximum reflectivity are important for characterizing wind variability (see [4]).

Design of regime-switching controls for offshore wind farms

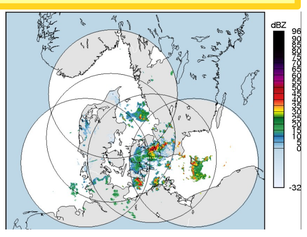


Integrating regime-switching forecasts into controls can help reducing wind power fluctuations when needed (see [5]).

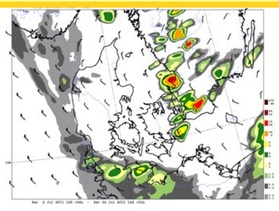
Weather radar data assimilation into meteorological models

DMI is developing a NWP nowcasting system based on the DMI-HIRLAM model running with a 3 km horizontal resolution. Radar data and satellite cloud cover will be included in the data assimilation. The forecast will be done hourly, and the output fields will have a time resolution of 10 minutes.

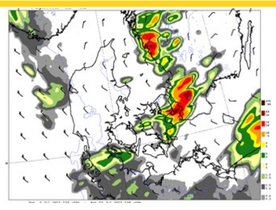
Example of weather radar obs.



Corresponding (operational) NWP forecasts (+5hrs)



Updated forecasts with weather radar data assimilation



DID YOU KNOW? Weather radars can also be used for detecting migrating birds and monitoring wave height at offshore wind farms.

CONCLUSIONS

Even though further research is still needed for integrating weather radar observations into forecasting systems through data assimilation or tracking convective precipitation cells for instance, weather radars are called to play an important role for wind energy applications in the future.

ACKNOWLEDGEMENTS

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TO READ ON THE TOPIC

[1] Kristoffersen J. (2005) The Horns Rev wind farm and the operational experience with the wind farm main controller. In *Proceedings of the Offshore Wind International Conference and Exhibition*, Copenhagen, Denmark, 2005.
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[3] Trombe P-J *et al.* Weather radars — The new eyes for offshore wind farms? (Under revision).
[4] Trombe P-J *et al.* (2013) Automatic classification of offshore wind regimes with weather radar observations. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, available online.
[5] Barahona B. *et al.* (2013) Regime-based supervisory control to reduce power fluctuations from offshore wind power plants. In *Proceedings of the IEEE PowerTech*, Grenoble, France, June 2013.

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