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Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Trombe, P.-J., Pinson, P., Vedel, H., Barahona Garzón, B., & Madsen, H. (2013). Weather radars for wind energy applications. Poster session presented at Danish Wind Power Research 2013, Fredericia, Denmark.

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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



VATTENFALL



DONG energy



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

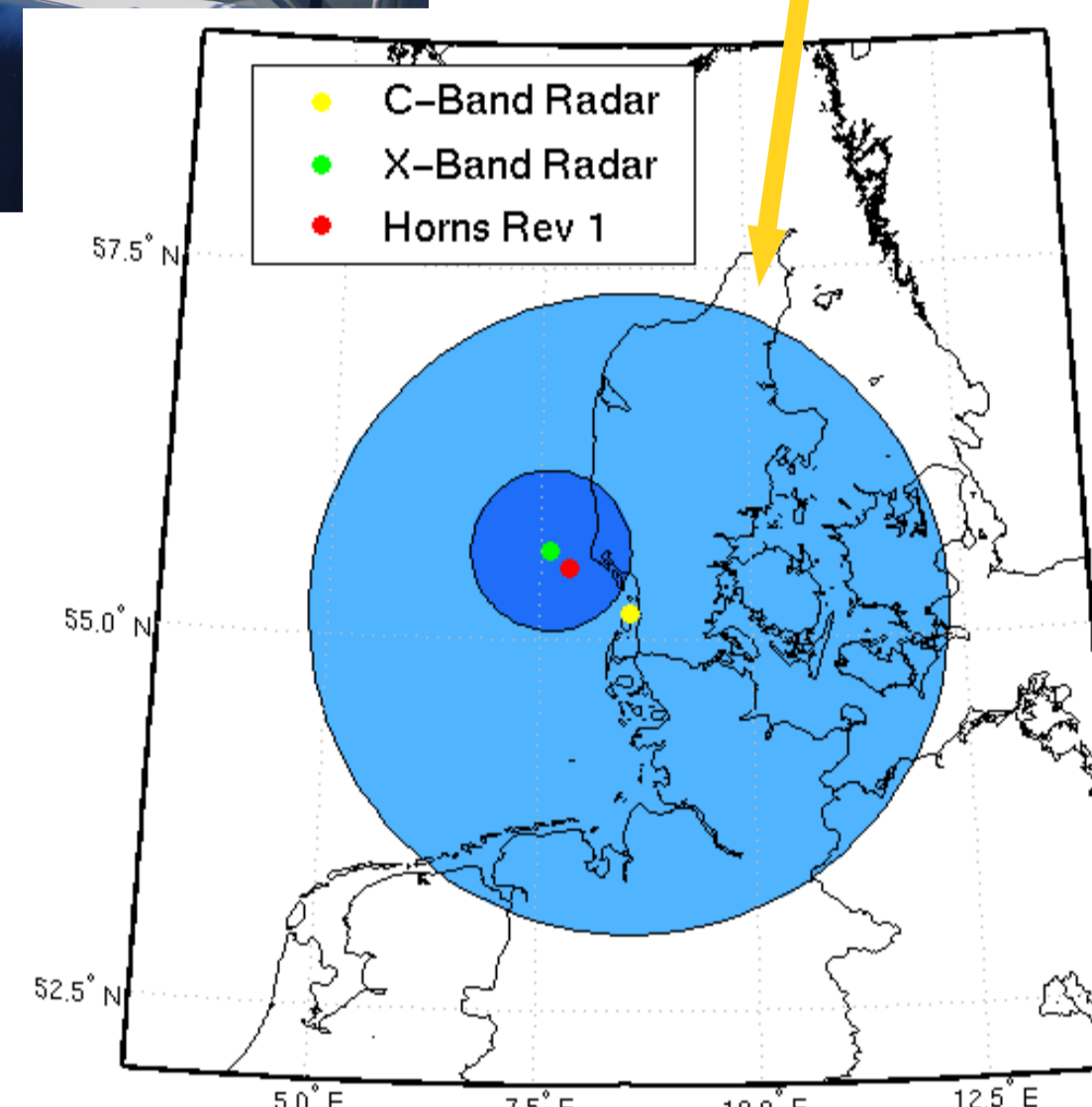
Weather radars are the ideal tools for detecting and tracking precipitation at high spatio-temporal resolutions. Our objective is to extract the relevant information from weather radar observations and integrate that information into a wind power prediction system [3].

EXPERIMENT

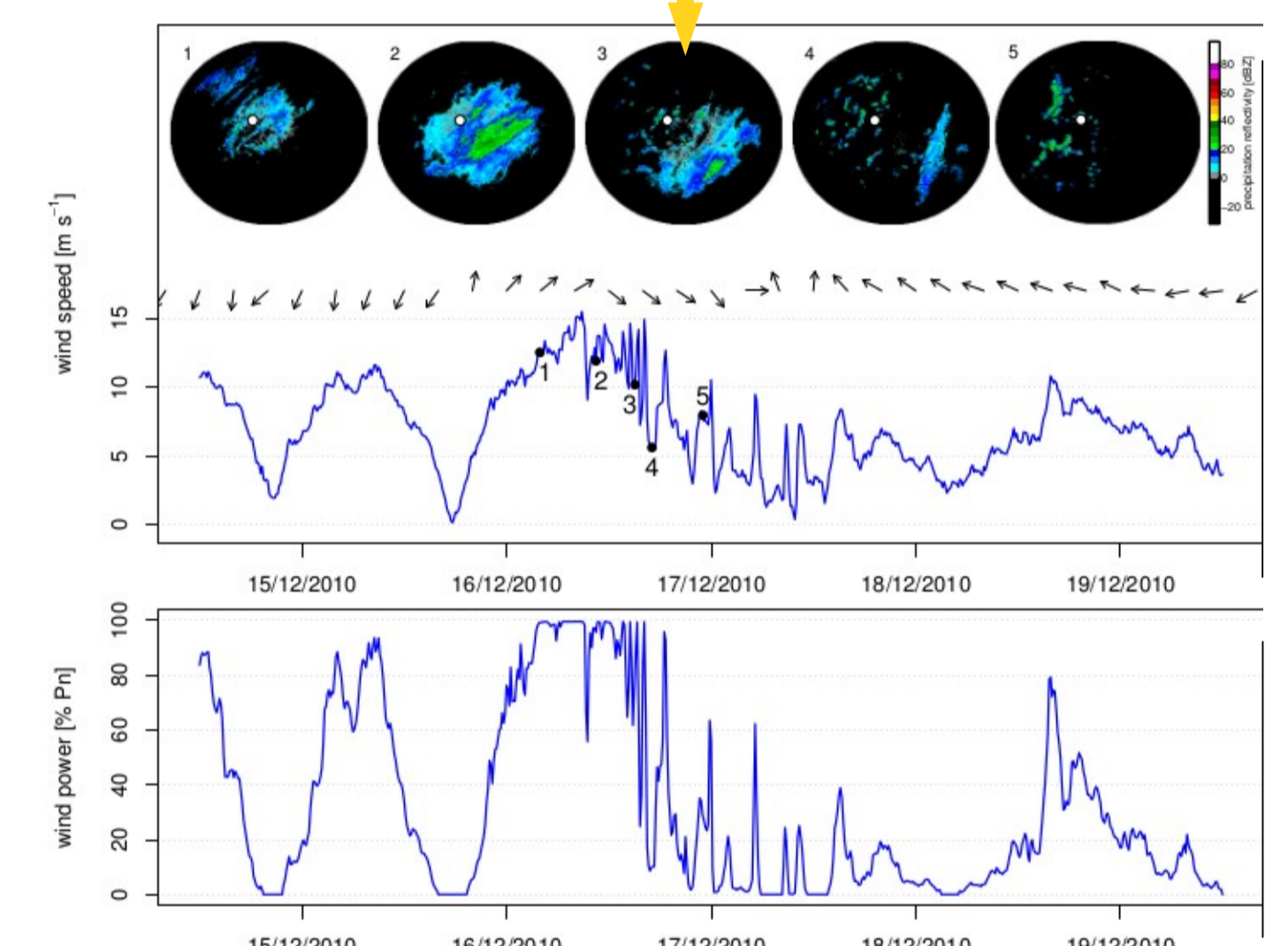


Respective coverage area of the two weather radars.

One of the two weather radars was installed offshore.



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.

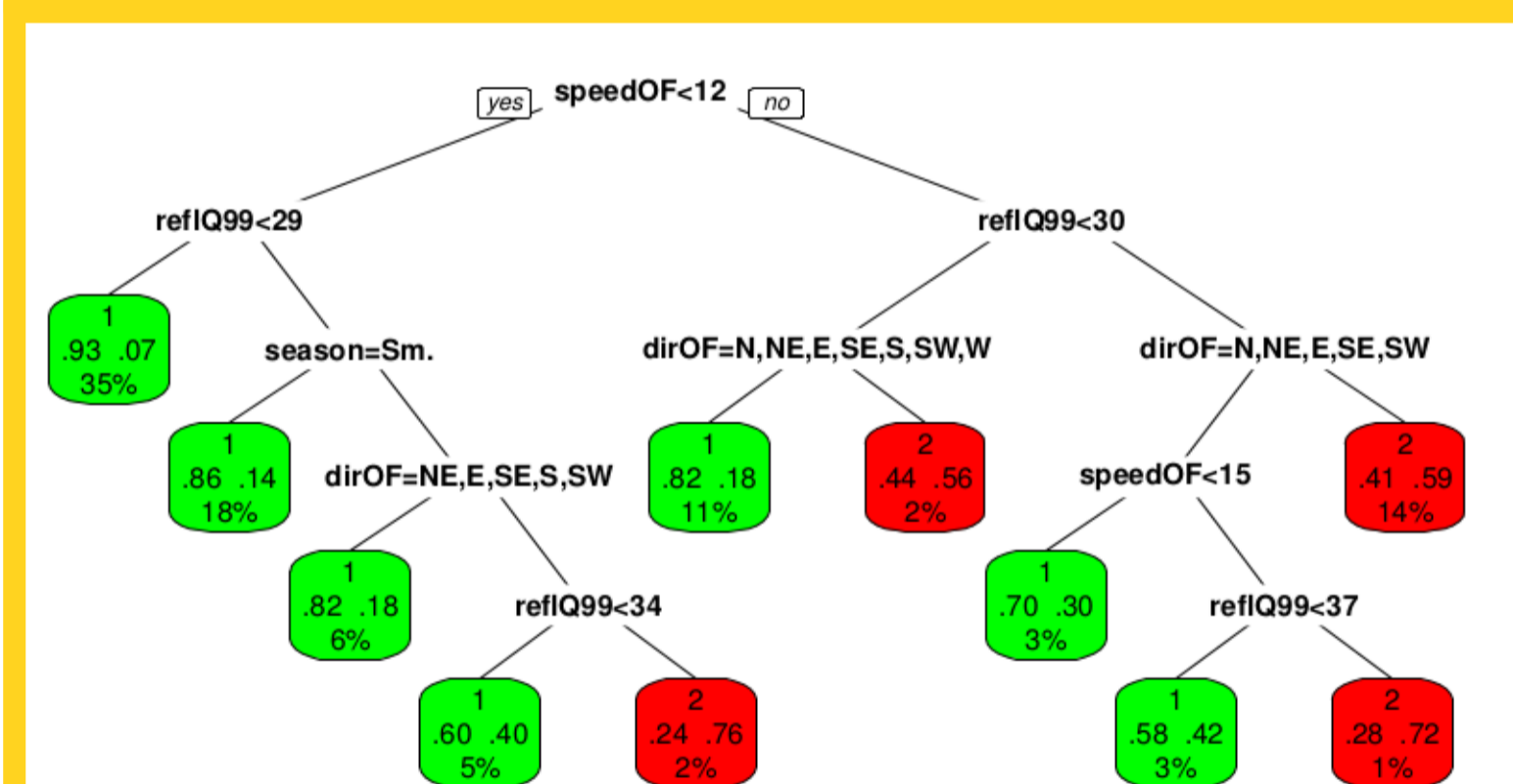


APPLICATIONS

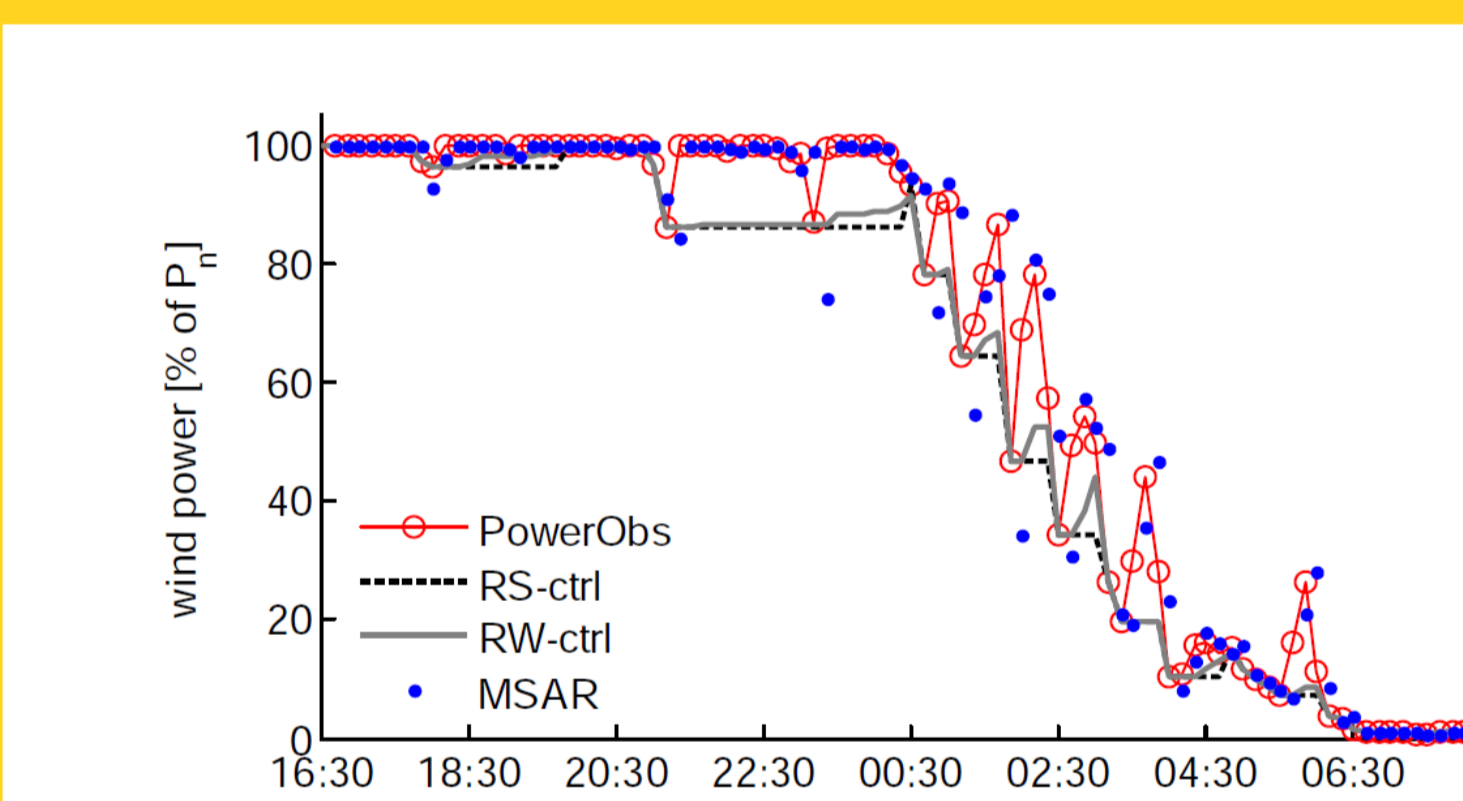
Classification of offshore wind regimes

Design of regime-switching controls for offshore wind farms

Weather radar data assimilation into meteorological models



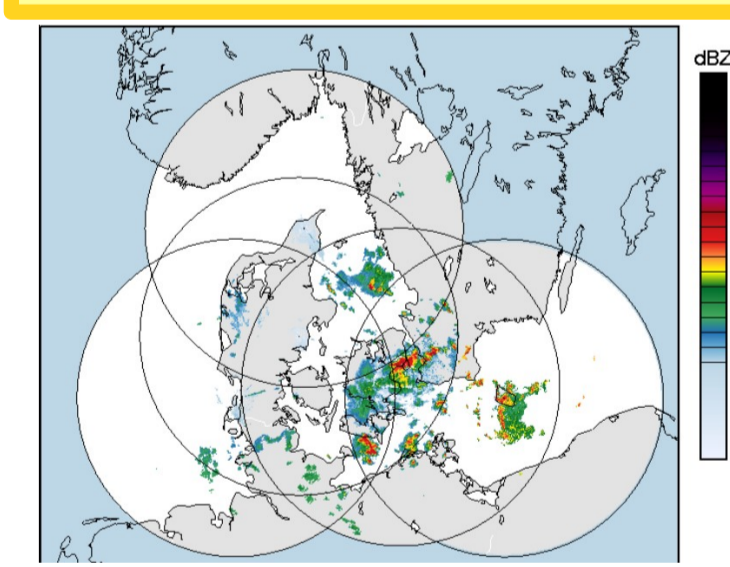
The speed and direction of advection of precipitation, as well as its maximum reflectivity are important for characterizing wind variability (see [4]).



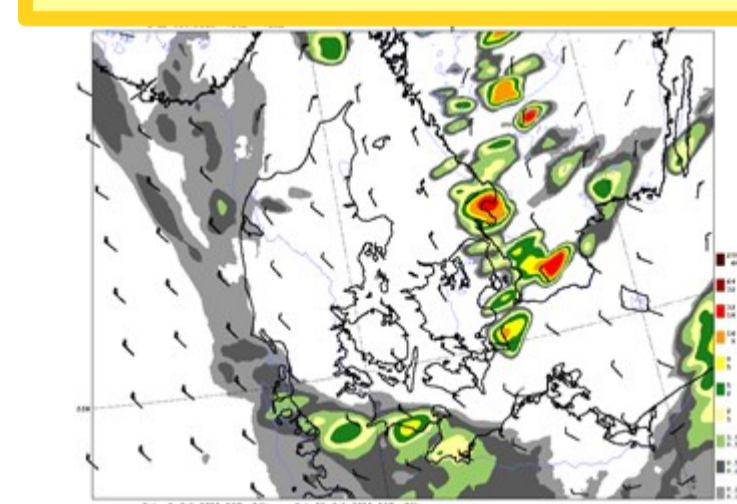
Integrating regime-switching forecasts into controls can help reducing wind power fluctuations when needed (see [5]).

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.

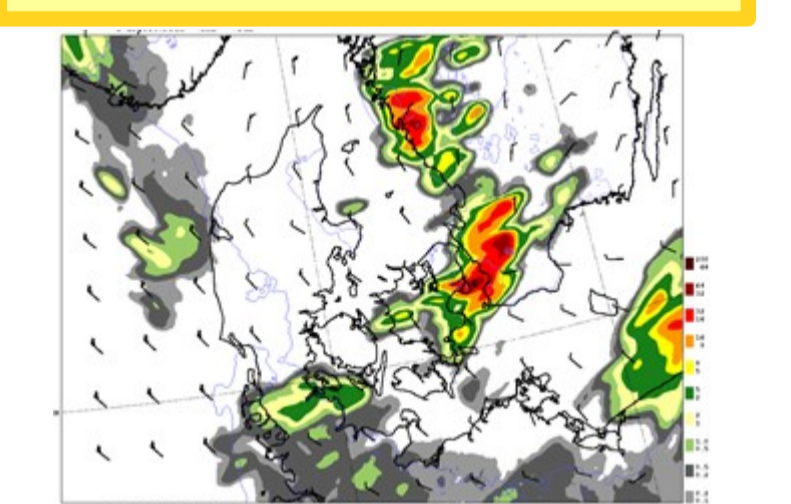
Example of weather radar obs.



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

This work was supported by the Danish Public Service Obligation (PSO) fund project 'Radar@Sea' (under contract PSO2009-1-0226) which is gratefully acknowledged. We are grateful to the Danish Meteorological Institute (DMI) for sharing the data from the Rømø radar. We also thank Vattenfall and DONG Energy respectively, for providing wind power data from the Horns Rev 1 wind farm and the images generated by the LAWR.

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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