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Weather radars – A new pair of eyes for offshore wind farms?

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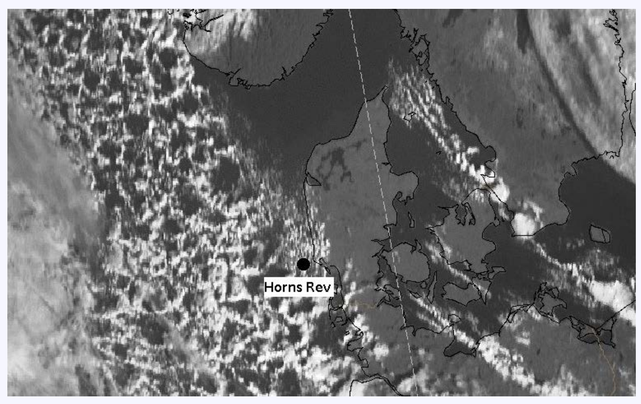
Background

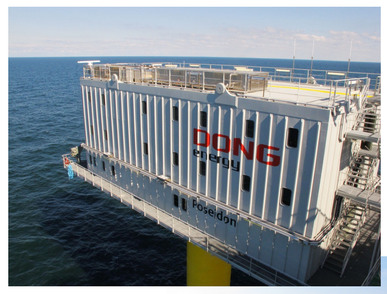
- The substantial impact of wind power fluctuations at large offshore wind farms calls for the development of dedicated monitoring and short-term (0-6 hours) prediction approaches
- Recent observations at the offshore site of Horns Rev revealed the presence of convective rain cells as a meteorological indicator for extreme wind variability and suggested the use of weather radars for detecting and tracking such phenomena (Vincent *et al.* 2011)

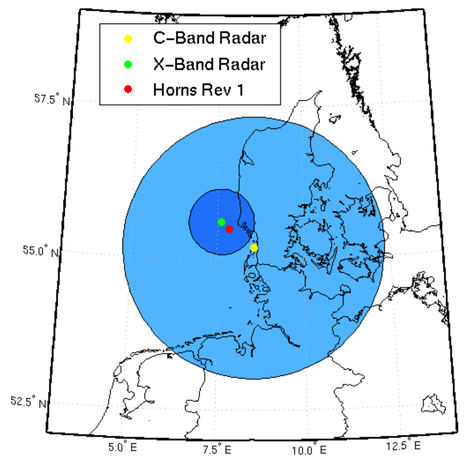


Typical situation of Open Cellular Convection over the North Sea west of Denmark

Experimental Setup

- A Local Area Weather Radar (LAWR, X-band, from DHI) was installed at Horns Rev in the frame of the Danish project Radar@Sea
- Additional Radar images are available from a Doppler radar (C-band) at Rømø on the west coast of Denmark

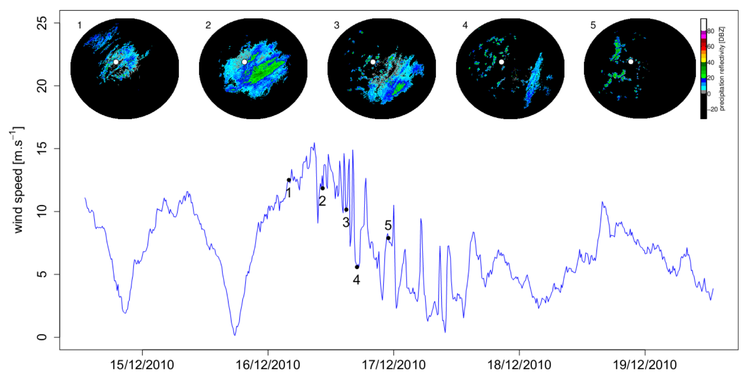


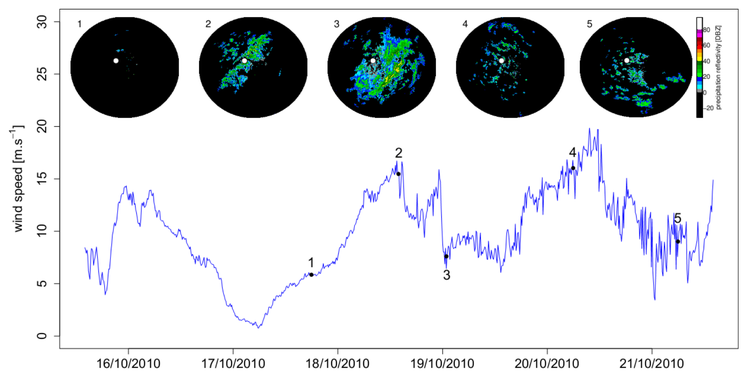


Radar type	● LAWR (X-Band)	● Doppler (C-Band)
Operator	DONG Energy & DHI	DMI
Location	Offshore	Onshore
Distance to HR1 ●	∼15km	∼70km
Opening angle	10°	1°
Range	60km	240km
Pixel resolution	500m × 500m	2km × 2km
Temporal resolution	1min	10min

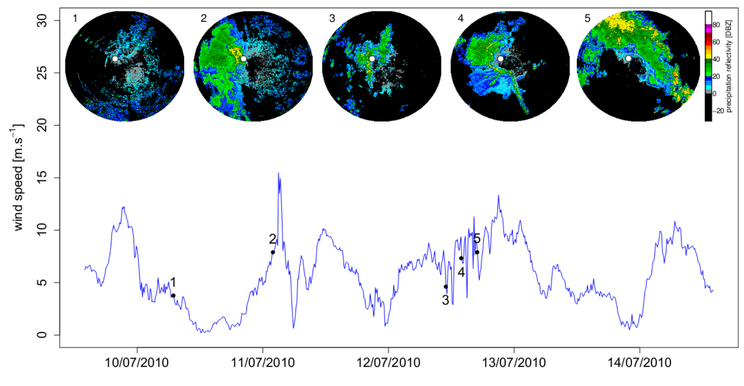
Results / Example Episodes

Typical fall and winter situations with large weather fronts and trailing precipitation cells affecting wind and power fluctuations



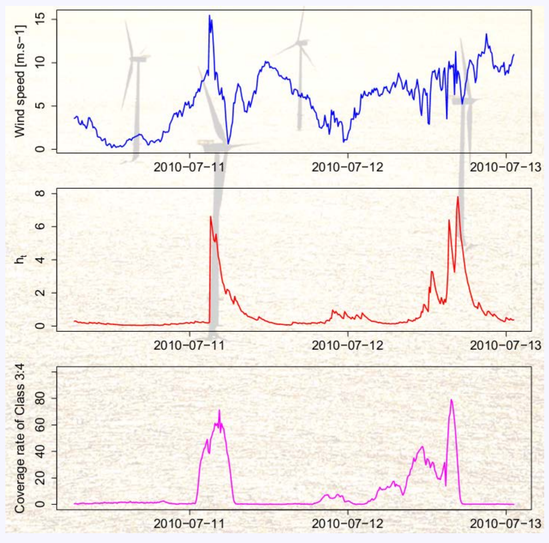


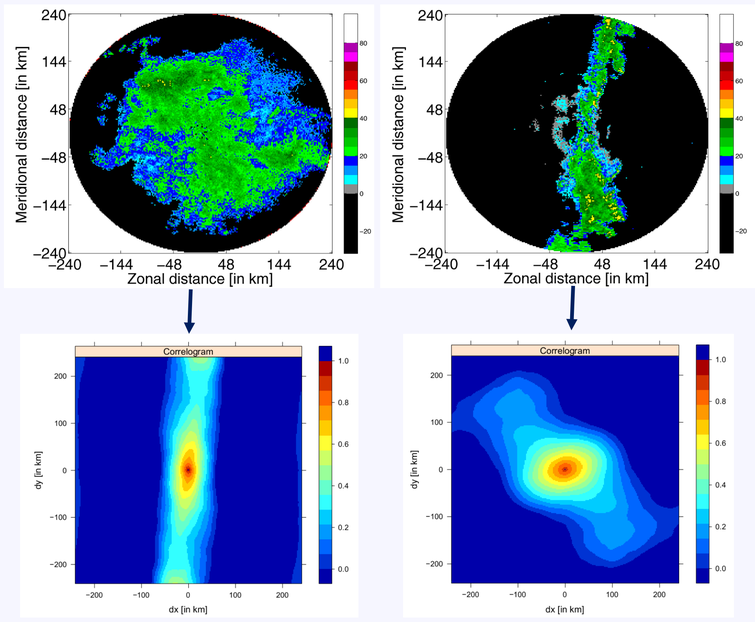
Typical summer situation with summer storms hitting the offshore wind farm



Objectives and Methodology

- Our objectives are
  - To **monitor weather conditions** in the vicinity of the offshore wind farm (for environmental studies, security of onsite personnel, etc.)
  - To **characterize the local weather phenomena** that lead to enhanced power fluctuations
  - To embed that knowledge in forecasting methodologies so **as to obtain improved predictions**
  - To account for this **regime-switching behavior in the wind farm controller**
- Time-series of wind and power observations are modeled so as to highlight their mean behavior and variability, as well as regime-switching aspects, with
  - Unobserved regime sequences (MSAR-GARCH statistical models – Trombe *et al.* (2012))
  - Observed regime sequences (based on explanatory variables eg. wind direction or based on the information given by radar images)
- Methods from image analysis are used to extract and track features in images from both radars





Conclusions

- Weather radars may become crucial onsite remote-sensing instruments for future large offshore wind farms
- Significant collaborative R&D with meteorologists, radar experts, forecasters and wind farms operators is required to fully exploit the new information provided by such remote-sensing instruments

References / Further Reading

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