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Weather radars for offshore wind power applications

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Weather radars are routinely used in a number of meteorological applications, though not in relation with wind energy since wind farms perturb radars signals. This may soon change, however, as increased attention is put on how weather radars may actually support the integration of offshore wind energy into power systems. Research and development for better monitoring and forecasting these fluctuations is extremely timely: a number of very large offshore wind farms are to be deployed over the next few years in e.g. the North Sea, the Baltic Sea and the Irish Sea.

Offshore wind fluctuations are induced by mesoscale meteorological phenomena which cannot be anticipated using the existing network of synoptic measurements. In view of the origins of wind fluctuations at these frequencies, weather radars are foreseen as ideal instruments for developing improved monitoring and forecasting strategies, owing to their spatial coverage and high spatio-temporal resolution. The Radar@Sea experiment comprise the first worldwide installation of a X-band weather radar offshore (at Horns Rev in Denmark) in 2010. Another C-band weather radar located onshore is also used in this experiment. Wind speed and corresponding power measurements from the Horns Rev wind farm came to complete what is by now a unique data set for the research community.

Based on the collected data, precipitation systems are described with respect to their spatial structure, intensity distribution, motion and scale (based on C-Band radar images). They can also be classified in relation with the variability of wind fluctuations recorded at Horns Rev and, thus, their severity. Then, images from the onsite X-band weather radar allow spotting and tracking local fronts soon to hit the wind farm, as well as trailing cells. Evidence is given of the interest of using weather radars for the offshore wind power application. Their potential remains largely unexplored though. They indeed have other attractive capabilities e.g. *(i)* estimating wind fields at high spatio-temporal resolutions to be assimilated in mesoscale models, or *(ii)* measuring waves' height at offshore wind farms in order to optimize the scheduling of maintenance operations.