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Probabilistic storm forecasts for wind farms in the North Sea

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In the last few years there has been a significant increase in Belgian offshore wind energy production, with a 2.26 GW total installed capacity completed at the end of 2020. Storm events over the North Sea can impact many of these wind farms at roughly the same time, because they are situated relatively close together in a narrow zone in the North Sea. Each wind turbine has a characteristic cut-out speed, above which they will decrease production rapidly or shut down as a protection measure. In case of a major storm, many wind turbines can shut down simultaneously, which can lead to large imbalance risks in the electricity grid. To better understand and predict such events, the Royal Meteorological Institute of Belgium (RMI) was involved in the development of a dedicated storm forecast tool for Elia, the Belgian transmission system operator for high-voltage electricity. The aim is to forecast large storm events, several days up to seven days ahead, and associated cut-out events, a day ahead and up to two days, making use of weather models that generate wind speed forecasts at turbine height and location. Due to the uncertainty in the precise location, timing and intensity of a forecasted storm, and the fact that cut-out events are sensitive to whether or not a high wind speed threshold is exceeded, a probabilistic forecast approach was taken. Moreover, Elia also required high temporal resolution forecasts (output every 15 minutes), so that a combination of a high resolution deterministic model and lower resolution ensemble weather prediction model was used. This allows both detailed forecasts and a good estimation of the uncertainty in the forecasts, thereby helping end users in their decision making process. The storm forecast tool developed at the RMI makes use of the deterministic ALARO model (4 km resolution) combined with the ENS ensemble forecasts (18 km resolution) of the European Centre for Medium Range Weather Forecasting (ECMWF). The storm forecast tool has been operational at the RMI since November 2018. We give an overview of the current status of the storm forecast tool, together with its performance over the past years, and present some ongoing and planned future developments. These include ensemble calibration with historical wind speed measurements, the inclusion of wake effects using fast wake models and NWP wind farm parameterizations, and the prediction of ramping events.