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Probabilistic forecasting of wind power production losses in cold climates

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Next-day forecasts of icing on wind turbines are needed for the estimations of wind power production and safe operations in cold climates. These forecasts are uncertain owing to uncertainties in the meteorological initial conditions and model formulations, in the employed ice growth models, and in the production loss models. Therefore, in order to forecast the risk for icing conditions it is necessary to develop a probabilistic forecasting system.

In this study the contribution of the meteorological uncertainties to the icing and production loss forecasts is examined using the mesoscale ensemble prediction system HarmonEPS, based on the numerical weather prediction model Harmonie/AROME. The ensemble prediction system consists of 11 members and has been run for up to +42 hours for a two week period in the winter 2011/2012 with a horizontal resolution of 2.5 km over a Swedish domain of 1100x1600 km2. In addition to the ensemble method, a method accounting for the uncertainties in the horizontal placement of weather phenomena, such as showers, is examined. This method utilizes the neighbouring grid points to produce several forecasts from one single forecast.

The forecasted meteorological parameters are used as input to the icing model, generating an ensemble of the icing intensity and ice load. The production losses due to the icing are estimated from the icing intensity and ice load with an empirical model.

For the verification meteorological observations from ten stations where three stations provide also production data of the wind turbines, is used. The skill and spread of the ensemble prediction system concerning meteorological parameters at the height of wind turbine nacelles is studied. It is found that the ensemble mean provides generally more skillful forecasts than a single forecast member. The reliability of the ensemble spread as a measure of the meteorological forecast uncertainty is assessed. The study demonstrates the benefit of using an ensemble forecasting system for predicting icing and production losses of wind turbines.

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