Rain and wind conditions at offshore wind farms

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Summary
The leading edge erosion of wind turbine blades is problematic at several offshore wind farms in the Northern European Seas. The study investigates the rain and wind climate. Rain and high tip speeds are expected to be the main causes of damage but also hail is potentially harmful.

1. Introduction

1.1 Motivation for study
Wind turbine blades suffer erosion at leading edges. The cost of inspection and repair is much higher at offshore wind farms than on land due to the logistics costs. Furthermore, the rate of damage to wind turbine leading edges at offshore sites appears to be faster than at land sites.

1.2 The costs related to leading edge erosion
The costs related to leading edge erosion can be grouped into three main categories: erosion, inspection and repair.

The loss of income due to erosion is related to the airfoil performance which is a function of the severity of erosion at the leading edges. The more severe the erosion is, the lower the lift coefficient is and therefore the annual energy production will be less.

The need for inspection is high at wind farms with severe leading edge erosion. The decision to act to repair damaged blades is central to limit loss of production. The decision is based on frequent inspection reports.

Finally, during repair the cost for new coating, the person-hours involved, the vessels and the downtime of the wind turbine during repair add into significant costs [1]. One option is to bring blades ashore for repair. This gives safer working conditions.

2. Rain and wind measurements

2.1 Rain (precipitation) measurements
Disdrometers measure droplet size and fall velocity at high temporal frequency, e.g. every minute. The data can be summed to rain rate (mm/hour). Rain is highly variable in time and space.

In the leading edge erosion study, the focus is on the precipitation that may cause erosion.

The hypothesis is that erosion is most severe during conditions with high tip speeds concurrent with extreme rain events (or hail).

Several disdrometers are installed in Denmark. One is shown in Fig. 1. In the UK a network of 13 disdrometer networks have been established recently [2].

Fig. 1: Disdrometer Parsivel-2 at DTU Risø Campus, Roskilde, Denmark.

2.2 Data analysis
Based on the disdrometer measurements and wind data from the sites, precipitation classes are defined. These classes are expected to become useful information in order to operate wind turbines with an erosion safe mode control to limit further leading edge erosion [1].

3. References

[1] Bech, J. I., Hasager, C.B., Bak, C. 2018 Extending the life of wind turbine blade leading edges by reducing the tip speed during extreme precipitation events. Wind Energy Science https://doi.org/10.5194/wes-2017-62.
[2] Pickering, B. 2017 The Disdrometer Verification Network (DiVeN): A low-cost installation of 13 laser precipitation sensors in the UK. Presented at an event at University of Birmingham 19th October 2017.

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