Leading edge erosion: precipitation measurements offshore

Anna-Maria Tilg[1], Flemming Vejen[2], Charlotte Bay Hasager[1]
[1]DTU Wind Energy, Denmark. [2]DMI, Denmark

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Resource Assessment

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Keywords

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1. General summary

In the last few years, the interest on leading edge erosion of wind turbine blades (LEE) increased, especially offshore, due to high maintenance and repair costs. For developing suitable solutions to prevent or decelerate the degradation of the material at the leading edges, knowing the meteorological conditions over sea is essential. Precipitation and the kinetic energy of precipitation particles, respectively, influence the LEE to a high degree. To determine correctly the kinetic energy from precipitation events and the type of precipitation, the drop-size distribution (DSD) needs to be known. However, in-situ precipitation measurements that include the DSD are rare over ocean and therefore only limited information about rainfall kinetic energy is available. To measure such important data for LEE, in connection to the project "*EROSION – Wind Turbine Blade Erosion: Reducing the largest uncertainties*" a few disdrometers, which can measure the DSD, where installed in 2018 at the west coast of Denmark and at wind parks close to it. DSD measurements improve our understanding of following questions relevant to LEE: (1) What are typical drop sizes? (2) Which drop size dominates the total kinetic energy of a precipitation event? (3) Can drop-size measurements from the coast be extrapolated to offshore wind parks?

2. Method

Datasets from four Parsivel[2] disdrometers are available. Two sensors were installed in spring 2018 at the west coast of Denmark and two were installed in spring 2019 at wind parks offshore in the North Sea and Baltic Sea in Danish waters. The data has been recorded with a time resolution of one minute and includes the number, size and velocity of all measured precipitation particles. We exclude all non-rain data (like snow) and calculate then the rainfall kinetic energy. By summarizing over all measured events typical drop sizes and the dependence of the rainfall kinetic energy on the drop size is determined. By comparing the statistics of the locations, similarities and differences in the conditions at the coast and offshore are analyzed.

3. Results

Preliminary results show that the majority of all registered raindrops had a diameter below 1 mm independent from the geographic location. However, these drops do not

provide that much kinetic energy to the total rainfall kinetic energy. Raindrops with a diameter between 1 and 2 mm dominate the total rainfall kinetic energy. To what extent the season influences these results has not yet been analyzed because only a few months of data are available from offshore. The DSD of the four locations have not yet been compared in detail, but considering all data from spring 2019 they show a similar DSD.

4. Conclusions

Although drops with a diameter smaller than 1 mm are more abundant, slightly larger drops with a diameter between 1 and 2 mm provide more rainfall kinetic energy. This information is useful to have specific values for modelling drop impact and testing material in a rain erosion tester. However, these measurements are only valid for this geographical area. We know from literature that the DSD in other areas of the world are different and the number of larger drops is higher. Furthermore, the influence of the wind turbine and wind field around it on the fall speed of the particles and therefore on the kinetic energy of it was not considered in this analysis. For the comparison between offshore and coast more data is needed.

5. Learning Objectives

To summarize, in-situ measurements of precipitation over sea are sparse. Based on a new unique dataset received from disdrometers installed at the coast and offshore we see that most of the measured raindrops have a diameter of below 1 mm. In contrast, raindrops with a diameter between 1 and 2 mm provide most rainfall kinetic energy considering precipitation events in spring 2019 only. A first comparison of the four locations showed no major differences but there might be some when comparing single events. In general, industrial delegates interested in leading edge erosion will get further insight to the environmental impacts on turbine blades for offshore.

Preferred presentation format

Poster

I am interested in publishing my work in a scientific journal.

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