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Wind lidars within Dutch offshore wind farms

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The growing number of wind farms in the Dutch part of the North Sea [1] offers the necessity, as well as the opportunity, to measure the meteorological conditions at these locations. Wind lidars are deployed on the TenneT substations within those wind farms, to continuously measure the wind conditions. These measurements can be used to determine possible compensations if the offshore electricity net should be unavailable, but also for nowcasting and improvement of weather forecasts, to increase efficiency of the wind turbines, or wind climatological purposes. The Royal Netherlands Meteorological Institute (KNMI) acquires the wind lidar data and makes it available near-real time to specific users, such as the wind farm owners and KNMI operational weather forecasters, and publicly on a daily basis [2].

The first wind lidar within this network became operational in the summer of 2019 and since then four more wind lidars became active within wind farms *Borssele*, *Hollandse Kust Zuid* and *Hollandse Kust Noord* (all about 20 km from the Dutch west coast). Five more wind farms, 50km to 100km from the coast, are planned in the next four years [1], within which wind lidars will be deployed as well. The current instrument is the ZX300M vertical profiling wind lidar (ZX lidars), measuring wind speed and wind direction in a range of 10m to 200m above the instrument. Theses wind lidars are installed on the roof deck of the offshore substations, 40m to 45m above mean sea level. In 2018-2020 KNMI carried out an intercomparison of a ZX300M wind lidar and wind measurements in the 213m tall meteorological mast at our Cabauw site [3], and a ZX300M firmware intercomparison was conducted in 2020 [4].

In this presentation we give an overview of the current and upcoming wind lidar network, and the data retrieved so far. We present a study on the flow distortion caused by the substation, which affects the wind lidar measurements in the first 50m above the substation. Most importantly, the wind lidars are deployed the middle of wind farms, such that the wind profiles are disturbed, in particular around the wind turbine hub heights. To assess this effect we have compared wind lidar data before and after Borssele wind farm became operational, together with the HARMONIE-AROME weather model with and without wind farm parameterization [5].

[1] https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/

[2] https://dataplatform.knmi.nl/dataset/windlidar-nz-wp-platform-10min-1 and https://dataplatform.knmi.nl/dataset/windlidar-nz-wp-platform-1s-1

[3] Knoop, S., Bosveld, F. C., de Haij, M. J., and Apituley, A.: A 2-year intercomparison of continuous-wave focusing wind lidar and tall mast wind measurements at Cabauw, Atmos. Meas. Tech., 14, 2219–2235, 2021, https://doi.org/10.5194/amt-14-2219-2021

[4] Knoop, S.: ZephIR 300M wind lidar firmware intercomparison, KNMI Internal report IR-2021-01, https://cdn.knmi.nl/knmi/pdf/bibliotheek/knmipubIR/IR2021-01.pdf

[5] https://wins50.nl/