Wind gust measurements using pulsed Doppler wind-lidar: comparison of direct and indirect techniques - DTU Orbit (10/01/2019)

The measurements of wind gusts, defined as short duration wind speed maxima, have traditionally been limited by the height that can be reached by weather masts. Doppler lidars can potentially provide information from levels above this and thereby fill this gap in our knowledge. To measure the 3D wind vector, we need information from at least three different lines of sight pointing towards different directions. The instrument sensitivity depends on the amount of aerosol present and the velocity measurement uncertainty is directly related to the amount of signal. With the commercial lidars traditionally used today it takes several seconds to measure each line of sight with sufficient sensitivity and therefore the temporal resolution of the wind measurement is of the order of tens of seconds, which is not sufficient for gusts. Here we deploy a fast scanning lidar (temporal resolution for a scan is 3.9 s) which can provide high resolution turbulent measurements, both in the vertical direction, and potentially in the horizontal direction. In this study we explore different strategies of wind lidar measurements to measure the wind speed maxima. We use a novel stochastic turbulence reconstruction model, driven by the Doppler lidar measurements, which uses a non-linear particle filter to estimate the small-scale turbulent fluctuations. The first results show that the reconstruction method can reproduce the wind speed maxima measured by the sonic anemometer if a low-pass filter with a cut-off frequency similar to the lidar measurement frequency is applied to the sonic data. These results from the reconstructed wind are better than the maxima derived directly from the wind lidar measurements. However, the maxima of the raw sonic anemometer signal are still higher than the maxima of the reconstructed winds. This gap between the maxima can potentially be filled by using information about the particle velocity distributions within the turbulence model.

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