Methodology for obtaining wind gusts using Doppler lidar

A new methodology is proposed for scaling Doppler lidar observations of wind gusts to make them comparable with those observed at a meteorological mast. Doppler lidars can then be used to measure wind gusts in regions and heights where traditional meteorological mast measurements are not available. This novel method also provides estimates for wind gusts at arbitrary gust durations, including those shorter than the temporal resolution of the Doppler lidar measurements. The input parameters for the scaling method are the measured wind-gust speed as well as the mean and standard deviation of the horizontal wind speed. The method was tested using WindCube V2 Doppler lidar measurements taken next to a 100 m high meteorological mast. It is shown that the method can provide realistic Doppler lidar estimates of the gust factor, i.e. the ratio of the wind-gust speed to the mean wind speed. The method reduced the bias in the Doppler lidar gust factors from 0.07 to 0.03 and can be improved further to reduce the bias by using a realistic estimate of turbulence. Wind gust measurements are often prone to outliers in the time series, because they represent the maximum of a (moving-averaged) horizontal wind speed. To assure the data quality in this study, we applied a filtering technique based on spike detection to remove possible outliers in the Doppler lidar data. We found that the spike detection-removal method clearly improved the wind-gust measurements, both with and without the scaling method. Spike detection also outperformed the traditional Doppler lidar quality assurance method based on carrier-to-noise ratio, by removing additional unrealistic outliers present in the time series.

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