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Dependence of Weibull distribution parameters on the CNR threshold in wind lidar data

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The increase in height and area swept by the blades of wind turbines that harvest energy from the air flow in the lower atmosphere have raised a need for better understanding of the structure of the profiles of the wind, its gusts and the monthly to annual long-term, statistical distribution in the boundary layer.
Observations from tall towers in combination with observations from a lidar of wind speed up to 600 m are used to study the long-term variability of the wind profile over sub-urban, rural, coastal and marine areas. The variability is expressed in terms of the shape parameter in the Weibull distribution.
When the lidar Carrier to Noise Ratio (CNR) is lower than a threshold value the observations are often not used as the uncertainty on the wind speed of the lidar measurements increases. This analysis shows that the mean wind speed is a function of the applied CNR threshold, which indicates a higher concentration of dust and aerosols driven by changes of near-surface wind speed. The height of the maximum in the profile of the shape parameter in the Weibull distribution (so-called reversal height) was found to depend on the applied CNR threshold; it is found to be lower at small CNR threshold values.
Based on the measurements, a parametrization of the vertical profile of the shape parameter that consists of two terms is devised. Comparison with the observations reveals that the terms interplay in such a way that for heights typical for wind turbines (100 to 150 m) the first term is essential over land, both terms are about equally important in the coastal area where the height of the reversal height is low and in the marine conditions, the second term dominates.