



Doppler lidar horizontal wind retrievals from a meteorological perspective

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Within the EU Cost Action TOPROF (Towards operational ground based profiling with ceilometers, Doppler lidars and microwave radiometers for improving weather forecasts), the Working Group on Doppler lidar has advanced the objective of creating a European Doppler lidar network for meteorological applications, through coordinating the Doppler lidars performing meteorological research in Europe. This group is tasked with assessing the performance of the various instruments in use, and establishing operational procedures for the provision of quality-controlled products for a wide variety of end-users, including operational evaluation and assimilation of winds and BL classification in NWP models.

Recent work by members of the Working Group have shown that the reliability of the retrieval of the vertical profile of horizontal wind (speed and direction) depends on the scanning strategy employed. All single-instrument retrieval methods require an assumption on the homogeneity of the wind flow, and that this can be rendered invalid in the presence of strong turbulence and other coherent features. Due in part to the fewer beams usually employed, the DBS method appears more susceptible to this than the VAD method. There are retrieval methods that can identify and flag situations where the necessary assumption of homogeneity is not met. However, removal of wind profiles leads to the issue of conditional sampling which may be a problem in climate and wind turbine applications.

Optimum settings for obtaining horizontal winds from a VAD scan under certain conditions, such as assuming homogeneity, are available in the literature and include a rigorous treatment of the impact of measurement uncertainties. However, the discussion and quantification of the impact of turbulence, which may render the homogeneity assumption invalid, is not so thorough and it is not clear what are the relative merits of the various scan strategies at different locations, under different atmospheric conditions.

Here, we attempt to quantify the impact of turbulence on wind retrievals to enable the design of suitable scanning strategies. Initial investigations suggest that the impact of turbulence can be mitigated by scanning at lower elevations, but that this does not prevent coherent structures from rendering the homogeneity assumption invalid. If low-level jet detection and wind gusts are of interest then this may also alter the optimal scanning strategy. We propose that a wide variety of requirements can be adequately attained by a set of sequential VAD scans at different elevations, with the lower elevation scan enabling high vertical resolution near the surface and some mitigation of the turbulent impact.