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On a flexible wind retrieval algorithm from measurements with a new generation of Doppler lidar systems for high resolution vertical wind profile observations

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Abstract

The wind field is one of the most important atmospheric parameters. Its accurate measurement with a high spatial and temporal resolution is crucial for operational Numerical Weather prediction (NWP) models and it is also vital for numerous other applications. The operational remote sensing of the vertical wind profile is currently dominated by radar wind profilers with frequencies ranging from L-band to VHF.

At the Lindenberg Meteorological Observatory - Richard Aßmann Observatory (MOL-RAO) one year long test measurements with a new generation of Doppler lidar systems for high resolution vertical wind profile observations have been carried out. The emphasis of the tests was on the systems capabilities with respect to technical stability, data availability and data quality for possible future operational boundary layer wind profiling. Analysing the data quality also included an evaluation of the manufacturer given wind retrieval algorithm using the DBS mode. It turned out that this retrieval algorithm has disadvantages for high resolution wind profile observations especially within a turbulent atmospheric boundary layer where the assumption of a horizontally homogenous wind field used for the wind retrieval is not fullfilled. For such cases it is easy to understand that the wind retrievals may be afflicted with errors which must be indicated. Unfortunately, using the DBS mode there is no possibility to get information about the strength of the turbulence from the measurements. This in turn makes it not possible to detect and flag such kind of erroneous wind retrievals. For this reason a more flexible wind retrieval algorithm has been developed that tries to solve such problems. The algorithm uses measurements from a VAD scan with 24 beam directions and calculates the 3D wind vector based on the assumption of a horizontally homogeneous wind field through a Moore-Penrose pseudoinverse of the overdetermined linear system. The increased number of measurements enables the employment of the goodness of fit parameter R^2 and the condition number CN as useful quality check parameters for the wind retrievals within a turbulent atmospheric boundary layer.

The presentation will describe the retrieval algorithm with focus on the main steps towards a numerically stable algorithm. In this context also the explicit Pseudoinverse for different beam directions will be discussed to give deeper insights into the sensitivity of the wind retrievals from the instruments set-up, e.g. the elevation angle and the number of beam directions. Furthermore examples documenting the outcome of the quality strategy based on R^2 and CN will be given.