A new filtering approach for multiple Doppler Lidar setups

Kevin Wolz[1], Christopher Holst[1], Frank Beyrich[2], and Matthias Mauder[1,3]

[1]Karlsruhe Institute of Technology, IMK-IFU, Garmisch-Partenkirchen, Germany;
[2]Lindenberg Meteorological Observatory, German Meteorological Service (DWD), Tauche, Germany;
[3]Institute of Hydrology and Meteorology, Technical University of Dresden, Dresden, Germany

Background

- Measurements during the FESST@MOL (Field Experiment on submesoscale spatio-temporal variability in Lindenberg) campaign.
- The overall objective was to measure sub-mesoscale variability and corresponding structures in the atmospheric boundary layer.
- 19 June to 12 August 2020 in Lindenberg (Tauche), Germany.
- Instruments in use: eight Doppler lidar systems, five Eddy covariance systems, a meteorological mast (99 m) on the Falkenberg boundary layer measuring field (see Fig.1).

Methods

- Comparison of horizontal wind speed and wind direction with ultrasonic anemometer measurements at 90 m height.
- Comparison of Velocity Azimuth Display (VAD) measurements with Virtual Tower (VT) measurements.
- Looking at the different averaging times of 10 and 30 minutes in a Step/Stare and a Stare mode (Fig. 2).
- A selection of the results is presented here.

Filtering (step by step)

- SNR + 1 threshold = 1.000
- $\langle\chi\rangle - \frac{q*MAD}{0.6745} \leq \chi_i \leq \langle\chi\rangle + \frac{q*MAD}{0.6745}$, where $\langle\chi\rangle$ is the median of x, $MAD = \langle|x_i - \langle x\rangle|\rangle$ and q is a threshold value that we set to 1 since it filtered out a sufficient amount of data that way. Filter applied to 30-sec intervals (Fig. 3).
- Consistency test, where we checked if the difference in the radial velocity measurements of two consecutive range gates was higher than 1 m s^{-1} and discarded the higher range gate in that case.
- Test for unimodality, which filters out periods where there are multiple peaks in the data. Filter applied to 30-min intervals (Fig. 4).

Conclusions

- The MAD filter increases the data availability while maintaining the data quality.
- Only small data quality increases possible since quality was already good before applying any filters.
- But influence of data filters is clearly visible.
- Also filters out erroneous data points with high SNR + 1 values.
- Only usable for step/stare and stare measurements.

Acknowledgements

The authors gratefully acknowledge the funding of this work by the BMDV project within the framework of DWD's Extramural Research.

Figure 1: Overview of the experimental setup during the FESST@MOL campaign at the Falkenberg boundary layer field site of the DWD's Meteorological Observatory Lindenberg of the DWD (processed in Google Earth).

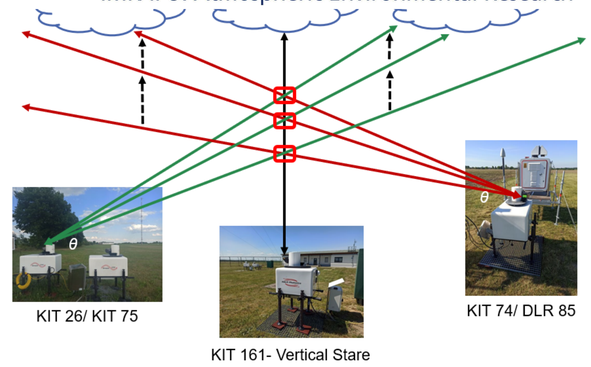

Figure 2: Representation of the VT Step/Stare mode used in the campaign.

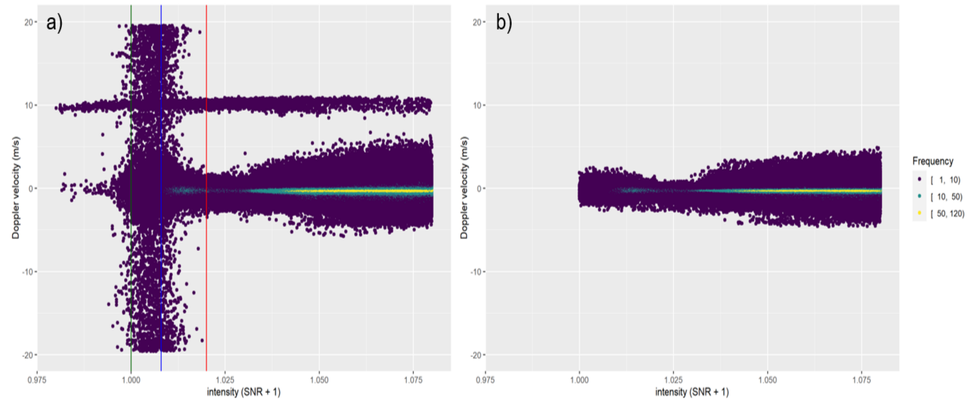

Figure 3: Comparison between unfiltered (a) and filtered (b) data of VS DL on 06 July 2020 on heights of 60 m – 500 m above ground. The colored lines in a) mark the different SNR + 1 thresholds of 1.000 (dark green), 1.008 (blue), and 1.020 (red).

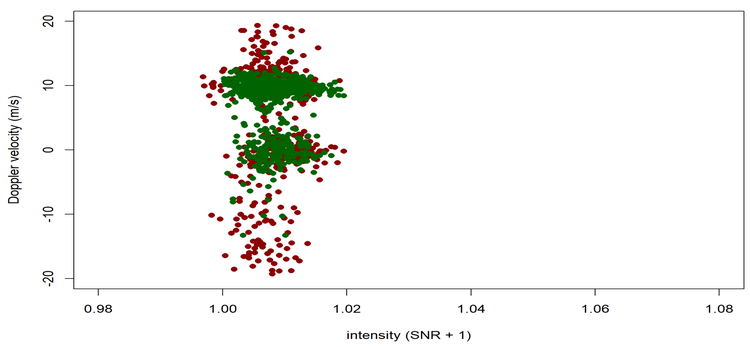

Figure 4: Example plot to show the problem of noise around zero, the figure shows the unfiltered data (red) and the data after applying the SNR + 1 and MAD filters (green) for DL 2 for the period of 10:30 – 11.00 p.m. on 06 July 2020 for a single range gate at a height of 1220 m above ground.