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New flexible retrieval for gusts and mean winds from Doppler wind lidars

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Phenomena in the atmospheric boundary layer are investigated in the Field Experiment on Sub-Mesoscale Spatio-Temporal Variability in Lindenberg (FESSTVaL, www.fesstval.de). Our aim is the retrieval of wind gusts from measurements of a Doppler wind lidar (DWL). DWLs allow the determination of wind vector profiles with high vertical resolution (≈ 30 m) and represent an alternative to classical meteorological tower observations. They can receive signals from altitudes higher than towers and are flexible in positioning. However, the retrieval of wind gusts from DWL measurements is not trivial because a monostatic lidar provides only one radial velocity, i.e., only one component of a three-dimensional vector, and measurements in three linearly independent directions are necessary to derive the wind vector. These have to be performed sequentially which limits the achievable time resolution, while wind gusts are short-lived phenomena. Therefore, we have developed a new wind retrieval that is applicable to different scanning configurations and various requested time resolutions. We tested several DWL configurations in autumn 2019 using DWL systems 'StreamLine' from Halo Photonics and evaluated gust peaks and the 10min mean wind at 90 m height against data from a sonic anemometer at the meteorological tower. The most useful configuration for retrieving wind gusts is a fast continuous scan mode (CSM) that completes a full circulation cone within 3.4s. During this time interval, about eleven radial velocity measurements are completed. This fast CSM configuration was again successfully operated over a three-months period in summer 2020. We found that CSM paired with our new retrieval technique provides gusts which compare well to classical anemometer measurements from a meteorological tower. Future work includes the application of the new retrieval to DWL data during the FESSTVaL campaign in 2021 when DWL measurements are planned at different sites in order to study the sub-mesoscale variability of wind gusts.