EGU22-7336
https://doi.org/10.5194/egusphere-egu22-7336
EGU General Assembly 2022

Sub-mesoscale evolution of spatial wind gust patterns measured with three Doppler lidars in a triangle configuration

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The evolution of wind gusts is difficult to observe as gusts are short-lived and small-scale phenomena. They occur with certain weather configurations (e.g. fronts, cold pools) and may already differ very locally. The question arises if individual gust observations can be taken as representative of their surroundings or if significant differences can already be apparent on the meso-gamma scale (2-20 km). Within the Field Experiment on Sub-Mesoscale Spatio-Temporal Variability in Lindenberg (FESSTVaL) different phenomena in the atmospheric boundary layer are studied with a variety of measurement instruments. This involved installing three StreamLine DWL systems from Halo Photonics at a distance of 6 km apart from each other. DWLs allow the retrieval of wind vector profiles and offer an alternative to classic meteorological tower observations, since they can be flexibly deployed at any electrified site. However, short-lived gusts are more difficult to capture than a persistent mean wind. A wind vector has to be obtained from different radial velocity measurements that are made sequentially, which limits the achievable temporal resolution. Therefore, we have developed a new retrieval method for deriving wind measurements that is suitable for different scan configurations and different time resolutions respectively different numbers of radial velocities. A fast continuous scanning mode (CSM), that completes a full observation cycle within 3.4 seconds and measures about eleven radial Doppler velocities is a suitable DWL configuration for deriving wind gusts, as shown by comparisons with measurements of a sonic anemometer at 90.3 m a.g.l. on the meteorological tower in Falkenberg. The fast CSM configuration was operated on the DWLs during the summer months 2021 at the three different sites. Their surrounding area is predominantly flat farmland, minimizing topographic impacts. This set-up allows us to observe the spatial-temporal evolution of gusts at the meso-gamma scale. Examples will be presented that illustrate the variability of wind gusts as observed during FESSTVaL.