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High-resolution observation of extreme winds at the Sub-Mesoscale with Doppler wind lidars during FESSTVaL

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Accurate monitoring of the wind field is highly relevant in many fields of meteorology. Modern, surface-based in-situ measurement devices are capable of detecting highly, temporally fluctuating wind patterns such as gusts. However, more and more applications (e.g. air traffic, wind energy, high-resolution modelling, etc.) require temporally highly resolved wind observations throughout the whole atmospheric boundary layer. Doppler wind lidars (DWLs) have the potential to provide these wind observations. Steinheuer et al. 2022 introduce a quick continuous measuring mode (CSM) in combination with a new flexible retrieval, which can be used to produce such high-resolution wind observations. In the framework of the Field Experiment on Sub-Mesoscale Spatio-Temporal Variability in Lindenberg (FESSTVaL) in summer 2021, three boundary layer profiling sites were established at a distance of about 6 km to each other in the area of the Meteorological Observatory Lindenberg, specifically at the sites Lindenberg, Falkenberg, and Birkholz. DWLs were placed at these sites and operated in the CSM from May to August 2021. With this setup, one goal was to investigate whether individual gust observations can be considered representative of their surroundings or whether significant differences are already evident on the meso-gamma scale (2-20 km). In addition, the spatial-temporal development of gusts can be observed and weather conditions leading to strong gusts can be investigated. Other measurement instruments have also been deployed at the sites and provide additional parameters to investigate specific processes. These instruments include, for example, ceilometers to determine the cloud base height or microwave radiometers that allow the determination of thermodynamic profiles. We will present different case studies demonstrating the benefits of simultaneously applying the CSM to the DWL and highlighting the differences between the sites. In particular, for small-scale weather phenomena such as cold pools, these are striking and the profiling of the wind, temperature and humidity gives insight about the vertical build up and horizontal variability of the cold pool.

Steinheuer et al. 2022: "A new scanning scheme and flexible retrieval for mean winds and gusts from Doppler lidar measurements". In: doi: 10.5194/amt-2021-426.