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The WASTEX Field Campaign: Observing the Formation of Wind Gusts with a Doppler Lidar

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Windstorms associated with low-pressure systems from the North Atlantic are one of the most important natural hazards for central Europe. During storms, most destructions arise from short-lived (typically a few seconds) but intense wind peaks (wind gusts), which can devastate forest areas and substantially damage infrastructure. Due to their local and intermittent nature, wind gusts are not explicitly represented by weather and climate models, even at convection-permitting resolution. These models thus rely on parameterizations based on physical or statistical assumptions to predict gusts. In addition, wind gusts are not well sampled by surface observation networks, because their spatial coverage is too sparse. These issues are a challenge for both modelling and observing wind gusts.

The WASTEX (Wind and Storms Experiment) field campaign was conducted during the winter 2016/17 in Karlsruhe, southwestern Germany, to better understand the formation of wind gusts during the passage of storms. The key instrument of the field campaign was a Doppler lidar, which provides accurate wind observations along its beam with high spatial (50–100 m) and temporal (0.1-1 s) resolutions and with a range of several km. The Doppler lidar is complemented by a Doppler C-band radar and a 200-m instrumented tower located nearby. Altogether, six Intense Observations Periods were conducted and sampled multiple storms during the field campaign.

Doppler lidar observations reveal the presence of coherent structures of strong wind in the warm sector of storm “Thomas” on 23 February 2017. However, a regime change occurs and these structures disappear. This is related to a change in the boundary-layer stability, as measured by the instrumented tower. Rare observations of a convective gust are obtained a few days later with the Doppler lidar. The gust is formed in a convection line embedded in the cold front of storm “Udo” on 27 February 2017, which was simultaneously sampled by the Doppler radar. The observations are compared with convection-permitting COSMO forecasts, which rely on a gust parameterization, as well as with ICON Large-Eddy simulations, which are able to explicitly resolve at least the largest wind structures. Results from the WASTEX field campaign should help improving the representation of wind gusts in weather and climate models.