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Convective wind gusts in Germany

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Convectively-driven straight-line winds often cause significant damage to vulnerable structures such as buildings, critical infrastructures or forests. These gusts are induced by the cold pool of organized convective systems that occur most frequently during the summer months in Central Europe. Several observations have shown that straight-line convective gusts reach higher speeds (up to 50 m/s) compared to that associated with large-scale winter storms.

In Germany, the state of knowledge about the characteristics, climatology and frequency of convective gusts as well as their local enhancement by constructions is still very poor. In a first step, most important gust characteristics are analyzed from available observations with a very high temporal resolution (e.g., 20 Hz). Gust parameters such as amplitude, shape, time labels, acceleration, and gust factor are identified for individual cases. Our analyses suggest that straight-line winds are usually asymmetric with respect to the temporal evolution. Furthermore, the convective gust factor is substantially higher than the turbulent gust factor, but is strongly controlled by the averaging period and the duration of the convective event.

From SYNOP stations in Germany, where data are available over more than 20 years, we quantified the spatial distribution of the convective gust and estimated return values for different probabilities. According to the analyses, convective gusts above 20 m/s are well observed throughout Germany each year, whereas the probability for a 25 m/s gust is reduced by 75%. The results also mirror the stochastic nature of convection, even if convective gusts from high-resolved reanalysis run show a large-scale trend with increasing gust probability from north-to-south.

In the next step, the connection between strong convective wind gusts, precipitation induced downdrafts and horizontal wind speeds in the free atmosphere (jet maximum) will be examined in detail.