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Characteristics of convective wind gusts in Germany

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Convectively-driven strong winds usually associated with thunderstorms frequently cause substantial damage to buildings and other structures in many parts of the world. Decisive for the high damage potential are short-term wind speed maxima with duration of a few seconds, termed as gusts. Several studies have shown that convectively-driven gusts can reach even higher wind speeds compared to turbulent gusts associated with synoptic-scale weather systems.

Due to the small-scale and non-stationary nature of convective wind gusts, there is a considerable lack of knowledge regarding their characteristics and statistics. In an effort to remedy this situation, we investigated a set of 110 climate stations of the German Weather Service (DWD) between 1992 and 2014. We analyzed the temporal and spatial distribution, intensity, and occurrence probability of convective gusts. Similar to thunderstorm activity, the frequency of convective gusts decreases gradually from South to North Germany. A relation between gust intensity/probability to orography or climate conditions cannot be identified. Rather, high wind speeds, e.g., above 30 m/s, can be expected everywhere in Germany with almost similar occurrence probabilities. A comparison of the 20-year return values of convective gusts with those of turbulent gusts demonstrates that the latter have higher frequencies, especially in northern Germany. This is mainly due to the fact that the return values of turbulent gusts show a distinct north-to-south gradient over Germany caused by the higher frequency of low pressure systems coming from the Atlantic Ocean in the north. Thunderstorm activity in that area, on the other hand, is substantially reduced due to the higher stability near the North Sea and Baltic Sea.

For a better understanding of the temporal evolution and some further properties of convective gusts events such as their three-dimensional structures or the dependence of the convective gust factor (i. e., maximum to mean wind speed) from the averaging period of the mean wind, we currently analyze thirty convective gust events with high-resolved wind measurements (in seconds) and compare the characteristic with that of turbulent gusts. Additionally, we investigate further micro-meteorological conditions in terms of the evolution of the temperature, humidity, wind direction, precipitation, and surface pressure during the events.