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Predictability of Wind Gusts during Winter Storms in Central Europe using convection-permitting ensemble forecasts

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Windstorms associated with low-pressure systems from the North Atlantic are the most important natural hazards for central Europe. Although their forecast has generally improved over the last decades, a detailed prediction of the associated wind gusts is still challenging due to the multiple scales involved. Here, the predictability of wind gusts during winter storms is investigated in the operational convection-permitting ensemble forecast system of the German Weather Service (DWD; COSMO-DE-EPS) for the 2011–2016 period.

Ten storms are selected based on the Storm Severity Index using surface observations of wind gusts over Germany. The most severe storm of the selection is “Niklas”, which hit most of the country on 31 March 2015. In this case, strong wind gusts are relatively well predicted but other storms exhibit large errors, mainly due to large biases in the ensemble mean. Extreme wind gusts related to a rare sting jet were largely underestimated when storm “Christian” hit northern Germany on 28 October 2013. These gusts are also underestimated in the COSMO-DE analysis, which suggests that the model does not fully capture the mesoscale and boundary-layer dynamics of the storm. In contrast, strong wind gusts related to frontal convection are largely overestimated during the passage of storms “Andrea” on 5 January 2012 and “Gonzalo” on 21 October 2014.

In addition to these biases, the ensemble spread is much smaller than the mean error, thus the ensemble is under-dispersive. Statistical post-processing is applied to calibrate the ensemble using Ensemble Model Output Statistics. This generally improves the forecast of wind gusts as measured by the Continuous Ranked Probability Score. However, the improvement differs from case to case for the 10 selected storms. The results allow to distinguish between errors that are systematic in the model and those that are specific to particular processes. Simple assumptions are further tested to perform regime-dependent post-processing. This shows how the combination of physical and statistical approaches can help to better understand dynamical processes and their predictability.