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The predictability of wind gusts associated with winter storms over central Europe

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Wind storms associated with low-pressure systems from the North Atlantic are the most important natural hazard for central Europe. Although the forecast of winter storms 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 we report about new insights into the synoptic-scale predictability of 25 severe storms of the 1995–2015 period using data from the recently available homogeneous re-forecast dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF) evaluated against ERA-Interim reanalysis. In contrast to operational predictions, the re-forecast dataset is generated with an identical data assimilation and forecasting system over a time period long enough to allow a statistical analysis of historical events.

The predictability of the storms is assessed with two sets of metrics: (a) the position and intensity to investigate the storms' propagation and dynamics and (b) the Storm Severity Index (SSI) to estimate the impact of wind gusts associated with the storms. This analysis shows that the storms are captured by the ensemble re-forecasts up to 2–4 days ahead only, which restricts the use of ensemble mean and spread to relatively short lead times. However, the metrics also show that the storms are correctly predicted at least by some ensemble members up to one week ahead.

Following this result, the Extreme Forecast Index (EFI) and Shift of Tails (SOT) are computed from the individual re-forecasts and the model climate. Using these indices, we show that the model has some skill in forecasting the area covered by extreme wind gusts up to 10 days, which indicates clear potential for the early warning of storms. However, a large variability is found between the predictability of individual storms, which does not appear to be related to the storms' characteristics. This may be due to the limited sample of 25 cases, but also suggests that each severe storm has its own dynamics and sources of forecast uncertainty.

In the future, the analysis will be expanded to mesoscale dynamics and turbulent gust generation mechanisms using high-resolution limited-area ensemble predictions and observations (e.g. from an ongoing field campaign using wind lidar).