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Current gust forecasting techniques, developments and challenges

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Gusts represent the component of wind most likely to be associated with serious hazards and structural damage, representing short-lived extremes within the spectrum of wind variation. Of interest both for short range forecasting and for climatological and risk studies, this is also reflected in the variety of methods used to predict gusts based on various static and dynamical factors of the landscape and atmosphere. The evolution of Numerical Weather Prediction (NWP) models has delivered huge benefits from increasingly accurate forecasts of mean near-surface wind, with which gusts broadly scale. Techniques for forecasting gusts rely on parametrizations based on a physical understanding of boundary layer turbulence, applied to NWP model fields, or statistical models and machine learning approaches trained using observations, each of which brings advantages and disadvantages.

Major shifts in the nature of the information available from NWP models are underway with the advent of ever-finer resolution and ensembles increasingly employed at the regional scale. Increases in the resolution of operational NWP models mean that phenomena traditionally posing a challenge for gust forecasting, such as convective cells, stingjets and mountain lee waves may now be at least partially represented in the model fields. This advance brings with it significant new questions and challenges: will traditional gust prediction formulations still work as phenomena associated with gusty conditions become increasingly resolved? Do differences in the behaviour of turbulence associated with each phenomenon need to be accommodated in future gust prediction methods? A similar challenge emerges from the increasing, but still partial resolution of terrain detail in NWP models; the speed-up of the mean wind over resolved hill tops may be realistic, but may have negative impacts on the performance of gust forecasting using current methods. The transition to probabilistic prediction using ensembles at the regional level means that considerations such as these must also be carried through to the aggregation and post-processing of ensemble members to produce the final forecast.