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Nowcasting and very short range forecasting of wind gusts generated by deep convection

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The study examines several parameterizations of convective wind gusts developed for the INCA (Integrated Nowcasting and Comprehensive Analyses) and MEANDER nowcasting systems. The analysis and forecasts of INCA and MEANDER were tested in several cases of wind gusts produced by both isolated thunderstorms and widespread convective systems. Observations and experiments were provided for several countries of Central Europe, including Austria, Hungary, Slovakia and Czech Republic. The results were compared to forecasts of non-hydrostatic, high-resolution numerical models MM5 and WRF, which enabled explicit simulation of deep convection. The gust algorithms of the nowcasting systems are based on empirical methods, where the maximum possible wind gust in the neighbourhood of thunderstorm cells is related to the rate of cooling caused by pseudoadiabatic descent. The inputs are radar reflectivity measurements and temperature/moisture profiles of the thunderstorm environment derived from LAM (Limited Area Model) forecasts and adjusted by surface observations. These methods work well in situations with isolated thunderstorms and enable to assess the potential for downbursts and wind gusts generated by local thunderstorm outflows. In the parameterizations of the MM5 and WRF models, wind gusts are proportional to the wind speed in level, from which the momentum can be transported downward to the surface layer. The depth of this transport depends on the ratio of the potential and turbulent kinetic energy of the air parcels at evaluated model levels. It is shown that in contrast to empirical methods, numerical models have better performance by predicting wind gusts induced by rear-inflow-jets associated with large convective systems or with supercell thunderstorms. Gusts exceeding 30 m/s were forecasted in cases of severe thunderstorms, when such wind speed was observed or wind damage was reported. For convective systems, the enhancement of the low level wind seems to be often a consequence of large pressure gradient and mesoscale pressure perturbations, which form in the vicinity of the gust front. Forecasting of these mesoscale features requires 2D or 3D numerical models with non-hydrostatic dynamics, which are computationally expensive and their results are spatially/temporaly not enough accurate for nowcasting purposes. A combination of wind gusts forecasted by high-resolution numerical model (treated as a first guess) with simple methods based on radar and surface observations is suggested for the nowcasting period (approximately 3 hours). A smooth transition is applied to reach consistency of the nowcasting system outputs and model forecasts after the end of the nowcasting period. It is concluded that correction of model forecasts is necessary to get more realistic distribution of wind gusts, above all in situations with local thunderstorms producing intense downdrafts but relatively small-scale outflows.