Analysis of different wind gust forecast approaches

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Wind gusts are extreme event which can cause severe damage. They can reach significant values even at medium winds. However numerical atmospheric models are designed to represent average winds, not gusts. There are several approaches to estimate wind gusts. One is statistical approach which is mainly based on estimation of wind speed distribution at the location. Second is physical parameterization of wind gusts. This group of methods range from surface dependent gust factor methods to complex methods using different variables that can be resolved by numeric weather models. Gusts can be considered as reflection from upper layers of the atmosphere or as fluctuations of wind speed connected with turbulence.

To evaluate different approaches data from high frequency wind speed measurements using ultra sonic anemometers deployed in several points in Moscow region were analyzed. For more complex analysis they were connected to wind and temperature profile measurement in the same points. To enlarge the statistics data from synoptic station network over European part of Russia were also included in the analysis.

Most frequently used methods were realized using WRF-ARW model forecasts. They are compared with each other and their performance in different cases was analyzed. Most methods underestimate wind gusts except one which overestimates in many cases.

A new combined method is suggested according to the results. According to stability type of atmospheric boundary layer different methods for estimation were chosen. These lead to obtain predictability of wind gust over 22 m/s over 80% (comparing with 10-27% of other methods) in autumn and winter season. There are still some underestimate in summer season.

Also dependence of model resolution on severe wind forecasts is investigated. One of the possible wind gust formation mechanisms is convective squall line, which can be resolved only by model with convective resolving resolution. So performance of model runs with different horizontal resolution is examined.

Another possible approach is a connection between wind gusts and thunderstorms. So possibility of application of methods used for thunderstorm prediction for wind gusts forecast is discussed.