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Evaluation of wind gusts in German wide LES weather forecast simulations

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Today's weather forecasts are mainly based on cloud resolving models with scales of O(1 km), which isn't sufficient to resolve small scale features like wind gusts. Large Eddy Simulations (LES) were often restricted to small domains or idealised setups. Increased computational power allow nowadays for realistic LES simulations. The output provides valuable information about wind gusts and related processes to improve our understanding and parameterizations of actual weather forecast models. A detailed evaluation is crucial to ensure physical consistency, which require new evaluation techniques and high frequent wind observations. On the other hand, only few operational turbulence resolving wind measurements are available.

Within the High Definition Clouds and Precipitation for Advancing Climate Prediction (HD(CP)^2) project, German wide LES weather forecast like simulations were performed with the novel ICON-LES model. Several days were simulated with resolutions down to 156 m and an output frequency of up to 9-seconds. Physical consistent COSMO simulations with 2.8 km were performed for comparison. The DWD weather station network is used for a basic and spatial evaluation of the wind and gusts. Fuzzy verification methods are applied to consider for problems of a point-to-point comparison. Furthermore, the boundary layer is investigated in detail by the long term ultrasonic wind measurements of the Wettermast Hamburg (280 m) and the Falkenberg tower (99 m). The mean diurnal cycle of the mean wind and gusts as well as the variability is analysed.

The wind and gust representation of the ICON LES model is assessed and its potential for further model based studies discussed. The added value of the LES is examined for gusts. Characteristics and differences of both boundary layer towers are presented. The mean wind is e.g. highest during night-time, whereas highest wind gusts occur mainly during noon. The deficiency of high resolved wind measurements and the consequences for LES evaluation are addressed.