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Summertime Thunderstorms Prediction in Belarus

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Mesoscale modeling with the Weather Research & Forecasting (WRF) system makes it possible to predict thunderstorm formation events by direct numerical simulation. In the present study, we analyze the feasibility and quality of thunderstorm prediction on the territory of Belarus for the summer period of 2014 based on analysis of several characteristic parameters in WRF modeling results that can serve as indicators of thunderstorms formation. These parameters include vertical velocity distribution, convective available potential energy (CAPE), K-index, SWEAT-index, Thompson index, lifted condensation level (LCL), and others, all of them being indicators of favorable atmospheric conditions for thunderstorms development.

We perform mesoscale simulations of several cases of thunderstorm development in Belarus with WRF-ARW modeling system using 3 km grid spacing, WSM6 microphysics parameterization and explicit convection (no convective parameterization). Typical modeling duration makes 48 hours, which is equivalent to next-day thunderstorm prediction in operational use. We focus our attention to most prominent cases of intense thunderstorms in Minsk. For validation purposes, we use radar and satellite data in addition to surface observations.

In summertime, the territory of Belarus is quite often under the influence of atmospheric fronts and stationary anticyclones. In this study, we subdivide thunderstorm cases under consideration into 2 categories: thunderstorms related to free convection and those related to forced convection processes. Our aim is to study the differences in thunderstorm indicator parameters between these two categories of thunderstorms in order to elaborate a set of parameters that can be used for operational thunderstorm forecasting. For that purpose, we analyze characteristic features of thunderstorms development on cold atmospheric fronts as well as thunderstorms formation in stable air masses.

Modeling results demonstrate good predictive skill for thunderstorms development forecasting in summertime, which is even better in cases of atmospheric fronts passage. Integrated use of thunderstorm indicator parameters makes it possible to further improve the predictive skill.