Forecasting of Real Thunderstorms based on Electric Parameters Calculations in Numerical Weather Prediction Models

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Now-casting and long-term forecasting of lightning flashes occurrence are urgent problems from different points of view. There are several approaches to predicting lightning activity using indirect non-electrical parameters based on the relationship of lightning flashes with vertical fluxes of solid-phased hydrometeors but for more explicit forecasting of the lightning flashes occurrence electric processes should be considered. In addition, a factor playing a key role for now-casting of lightning activity is the earliness.

We have proposed an algorithm, which makes the process of thunderstorms prediction automatic (due to automatic start of the electric parameters calculation) and quick (due to the use of simplified methods). Our forecasting was based on the use of Weather Research and Forecasting (WRF) model, which does not include the electrification processes, but it was supplemented with two modules. The first is an algorithm, which allows us to select thunderstorm events indirectly. It is based on such characteristics of thunderclouds and thunderstorms as radar reflectivity, duration and area and provides us with information about an approximate beginning and duration of the thunderstorm. The second module is a method for electric parameters calculations, which we have proposed before. It was suggested that the non-inductive mechanism of charge generation and separation plays a key role in the thundercloud electrification processes. Also charge densities of solid-phased hydrometeors are assumed to be proportional to their mass in elementary air volume. According to the models by Saunders and Takahashi, particles change the sign of charge while getting into the lower part of thundercloud from the upper and vice versa. Electric neutrality in the vertical air column was supposed in the course of vertical charge separation due to collisions between falling graupels and carried upward ice crystals. Electric potential (and consequently electric field) can be found as a solution of a 3D Poisson equation.

We have made an automatic modelling for several thunderstorms in Nizhny Novgorod region. The results of calculations were compared with data of observations and radar data. This comparative analysis shows quite good spatial and temporal correlation between predicted and observed parameters of the thunderstorms.