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Analysis of simulated electrical charge structure at the atmosphere during the thunderstorms over different parts of Russia

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Introduction.

The research of the electrical structure in convective clouds is one of the fundamental problems of the atmospheric electricity. Since there is a lack of observations of the electrical parameters in thunderclouds the perspective tool for the analysis could be the electrification model. Proposed technique is based on explicit calculation of the electric charging in the convective clouds. The better understanding of electrical processes at the atmosphere could improve the forecast of thunderstorms – severe weather events of the small spatio-temporal scale. Thus, it is significant to study the parameters of the atmospheric electric field for the districts distinguished by the variety of orography.
This work presents simulation results of lightning activity and electrical charge structure of thunderclouds over Russian Central Federal District (CFD) and North Caucasus region for summer, 2013. Simulations are made using Cumulonimbus cloud (Cb) electrification model coupled with numerical weather prediction model WRF-ARW.

Methodology.

Cb electrification model is a set of equations describing the processes of the generation and separation of electric charges in Cb, constants and meteorological data. It includes two charging schemes: non-inductive and inductive. Full physical discription and WRF-ARW configuration are discussed. Simulated total volume charge density profiles are analyzed over districts of Russia with different orography.
Scores of the thunderstrom forecast given by the electrification model are demostrated. WWLLN and local lightning detectors data are used for verification.

Conclusions.

This work includes analysis of the simulated electrical structure made for 781 thunderstorms over CFD and 344 ones over Russian North Caucasus region using electrification model. For CFD it was found that the predicted profiles of the total volume charge have mainly the stucture of three layers. At the top of the cloud there is a predominance of positive non-inductive charges. Maximum value of total volume charge density is 12 nC/m3. Positive inductive charges are found at the bottom of the Cb. Maximum value of total volume charge density is 7 nC/m3. At the middle of the cloud there is a layer with the predominance of negative inductive charges where the minimum value of total volume charge density is -16 nC/m3.
The values of total volume charge density are less in thunderclouds over highlands of Russian North Caucasus region. The profiles have mainly the dipole structure. Positive charges prevail in the lower part of the cloud. The maximum values of total volume charge density are 2,8 and 2,3 nC/m3 for non-inductive and inductive charges respectively. Negative inductive and non-inductive charges are concentrated in the upper part of the cloud. Minimum values of total volume charge density are -1,4 and -2,4 nC/m3 respectively.
As for the application of Cb electrification model to the lightning forecast, it is shown that hits are 33 and 39%, correct rejections are 95 and 94% for CFD and North Caucasus region respectively.

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