18–22 September 2017, Pula, Croatia
ECSS2017-65

Lightning forecast for North Caucasus Region

Inna Gubenko (1,2)
(1) Hydrometeorological Research Center of Russia, Russian Federation (img0504@yandex.ru), (2) Nuclear Safety Institute of the Russian Academy of Sciences

Introduction

The North Caucasus region in the spring-autumn period is characterized by intensive convective storms accompanied by a number of dangerous weather events – intensive lightning activity, rain, hail, wind squalls. Thus a study of the physical conditions of occurrence and prediction of the electrical activity in convective clouds is particularly important for this district. Besides it is significant to study the parameters of the atmospheric electric field (AEDs) for the territory distinguished by the variety of orography.
This work presents simulation results of lightning activity and parameters of AEDs over the North Caucasus region of Russia during the summer, 2013. Simulation of electric charges is made using Cumulonimbus cloud (Cb) electrification model coupled with numerical weather prediction model WRF-ARW. The second part of this study is about a comparison of the prognostic values of electrical breakdown with observed thunderstorms.

Methodology

Cb electrification model is a set of equations describing the processes of the generation and separation of electric charges in convective clouds, constants and meteorological data (air temperature, wind speed, fractions of liquid and solid cloud particles). It includes two charging schemes- non-inductive and inductive. Non-inductive charge generation: implies the interaction of solid hydrometeors (ice crystals+graupels, particles of snow+graupels) in a presence of super-cooled water [2]. Pair wise interaction between other hydrometeors is neglected because of the small charge generated as a result of the collision/merger between particles [2]. The equation of the inductive charging implies the interaction of graupels and cloud droplets [3].
Full physical and mathematical discription as well as used WRF-ARW configuration are demonstared in the current work. To verify the model simulations WWLLN and local lightning detectors data are used [1].

Conclusions

According to the preliminary results proposed approach of explicit electric field modeling is applicable to short-term forecasting of intense convection.
The predicted profiles of the electric field intensity and volume charge density obtained by the electrification model have a dipole structure. Non-inductive positive charges prevail in the lower part of the cloud. Inductive positive charges are also found in a layer of 450-500 hPa. Negative inductive and non-inductive charges are concentrated in the upper part of the cloud (350-450 hPa). The density of non-inductive charges is larger compared to inductive ones.
Spatio-temporal localization of lightning activity does not contradict the observations.

References

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