Calculation of Lightning Potential Index (LPI) for different microphysics parameterizations based on WRF model and its comparative analysis with electrical parameters

Electrical Effects on Microphysics or Meteorological Applications of Lightning Data

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Forecasting of lightning activity is extremely important goal for different meteorological and physics applications. However, all modern numerical weather prediction systems do not include any electricity effects such as electrification, Coulomb's forces etc. and, therefore, cannot explicitly predict the lightning occurrence. Nevertheless, there were several attempts to predict lightning activity by indirect non-electrical parameters of weather prediction systems: CAPE, CPTP, K index, and others.

Nowadays some numerical prediction models based on different methods and schemes exist. The model we used is Weather Research and Forecasting (WRF) model [1]. This is a numerical weather prediction system designed to serve both atmospheric research and operational forecasting needs.

Recently, Lightning Potential Index (LPI) has been proposed as a new tool for predicting the lightning density, which is defined as the volume integral of the total mass flux of ice and liquid water within the charging zone in a developing thundercloud [2, 3]. However the WRF model has many different microphysics options, which makes LPI, based on the model computed mass mixing ratios for snow, cloud ice and graupel, extremely dependent on the type of used microphysics parameterizations.

In this paper, we made the comparative analysis of LPI for 4 different microphysics schemes: Purdue Lin, WSM6, WDM6, Goddard, which includes 6 classes of hydrometeors: water vapor, cloud water, rain water, cloud ice, snow and graupel. Our calculations show that absolute values and even topographical maps of LPI are highly dependent on the type of used microphysics parameterizations.

To improve this model and for theoretical «verification» of the LPI results we added the charges (generated due to the process of electrification) for hydrometeors and calculated quasistatic electrical potential φ, thus, we made a simple accounting of the electrical processes in the model based on WRF. The comparison of the LPI maps and electrical potential φ maps for different cases of charges distribution shows that the peaks of LPI and φ poorly correlated.

REFERENCES

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