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13. ABSTRACT *(Maximum 200 words)*

Our purpose is to identify those atmospheric conditions that lead to thunderstorm electrification. We have collected aircraft and radar measurements of atmospheric parameters made during several recent intensive field studies, and we are modifying our thunderstorm model to make it more realistic. The radar measurements will be used as inputs to the model and we will attempt to simulate in-cloud microphysical, dynamical and electrical behavior in a range of atmospheric environments. The results of the first simulations will be presented at the Atmospheric Electricity Conference in June. As our simulations evolve, we will examine the relationships between atmospheric sounding parameters and subsequent electric field development and we will classify soundings in terms of parameters relevant for lightning production.

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Abstract

Our purpose is to identify those atmospheric conditions that lead to thunderstorm electrification. We have collected aircraft and radar measurements of atmospheric parameters made during several recent intensive field studies, and we are modifying our thunderstorm model to make it more realistic. The radar measurements will be used as inputs to the model and we will attempt to simulate in-cloud microphysical, dynamical and electrical behavior in a range of atmospheric environments. The results of the first simulations will be presented at the Atmospheric Electricity Conference in June. As our simulations evolve, we will examine the relationships between atmospheric sounding parameters and subsequent electric field development and we will classify soundings in terms of parameters relevant for lightning production.

November 8, 1991

Progress Report: First Year

Initial Electrification and Thunderstorm Climatology

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1. Reiteration of Purpose:

The goal of this research is to define those environmental conditions that produce strong thunderstorm electrification. The practical value of this project is clear; the ability to determine thunderstorm conditions in advance would make it pos-ible to better protect public safety and maintain reliable telecommunications, while its scientific value is that it relates thunderstorm electrification to the thermodynamic and dynamic properties of the thunderstorm atmosphere, and thus creates a self consistent picture of this interesting and important phenomenon.

The specific questions we are addressing are the following:

(1) Which parameters of environmental soundings, wind fields and synoptic weather maps as well as the cloud groups in a given sounding are the best predictors of lightning?

(2) Which features of the environmental conditions of a thunderstorm are most crucial in determining its electrical evolution?

(3) Which low-level measurements are the most accurate predictors of lightning?

(4) To what extent do variations in glaciation mechanism and variations in warm cloud microphysics cause variations in electrical evolution?

2. Work Accomplished to Date:

a. Data Collection and Analysis

RS participated in the CaPE project (1991) where numerous aircraft and radars were used to study the initial electrification of developing storms on the eastern side of the Florida. The locations of lightning strikes (cloud to ground) and their polarity will also be available, via the lightning detection systems provided by SUNY-Albany and a local network run by the Kennedy Space Center. The NCAR sailplane was equipped with a 2D particle probe with an additional charge ring setup to determine the charge carried on particles while simultaneously giving the image and a measure of the particle size. This is a very uncommon field

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measurement and will be a great help in maintaining consistency between our model (see below) and the observed cloud characteristics.

Recently, RS installed the CANDIS data analysis utility (Raymond, 1988) on the computers of our group at the UW, to be used in examination of these data. The CANDIS system is designed to handle numerically gridded data of various types and as such maintains a consistent frame from which to simultaneously analyse the various data sets and model output.

We are collecting data sets (aircraft, balloon and radar measurements) from several projects: CCOPE (Montana, 1981), SOCORRO (New Mexico, 1984), CaPE (Florida, 1991) and COHMEX (Southeast US, 1986). We have completed the first phase of data collection for the SOCORRO and COHMEX soundings, SOCORRO radar and aircraft data and CaPE aircraft (NCAR King Air and NCAR sailplane), and we are preparing them for analysis using CANDIS.

b. Model Development

In order to determine which environmental parameters are important in thunderstorm electrification, we will make use of the model of Norville et al (1989) (N), with its explicit microphysical equations. We have modified the model so that it can take as inputs either derived wind fields, as in N, or winds that have been measured from radar. We calculate the derived winds via the model of Taylor (1989) with a change from bulk microphysics to a simplified version of the explicit microphysics of N.

The changes in the model are partially completed and testing will start in 2 months. Data sets from most of the field projects will be ready for testing at that time. We plan to report the results of the first tests at the Atmospheric Electricity Conference in St. Petersburg in June.

3. Future Plans:

We will group together observed atmospheric soundings that do and don't produce lightning to find those parameters that are important for generating large in-cloud electric fields, and we will construct "manufactured" soundings to be used with our model in order to test our hypotheses on sounding requirements for lightning production. The model output will be compared against information from aircraft measurements of cloud microphysics, electric fields, particle size-to-charge values and, as mentioned above, radar derived winds.

Previously, little has been done to characterize the conditions for storm electrification. E. Williams et al (1990) have suggested that the potential wet-bulb temperature is sufficient to determine potential electrification. Others have suggested that the measure of convectively available potential energy (cape) is the main variable to be considered. These quantities will be tested and our intent, ultimately, is to develop a classification scheme based on regional atmospheric properties. Also, we are expanding the model to be fully 2 dimensional and we hope to use it on a few case studies to determine dependence of the results on model dimension.

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