TITLE: Maxwell Currents Beneath Thunderstorms

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Significant Accomplishments:

We have completed analyses of single station measurements of the Maxwell current density (Jm) made under Florida thunderstorms during the summer of 1981. The results of these analyses indicate that:

(1) Jm is usually dominated by the displacement current component when the electric field is close to zero;

(2) Jm is steady with time in the intervals between lightning flashes;

(3) Jm is not altered significantly by lightning; and

(4) the average value of Jm changes slowly and over time scales that are comparable to those required for storm development.

We have also derived maps of the surface Maxwell current density for a number of the Florida TRIP (76-78) storms using field mill data to estimate Jm from the displacement current density. Our studies show that these maps provide a good indication of the location and relative intensity of the storm current generators, and area-integrations of the current contours provide estimates of the total storm currents. During a storm, the current density patterns develop and change shape slowly with time, so that current maps can be used to monitor the electrical development of a storm in space and time.

We conclude from our studies that Jm is an electrical quantity that may be coupled directly to the meteorological structure of the storm and/or the storm dynamics.

Focus of Current Research Activities:

Attempts are being made to infer the location, magnitude, and geometry of the current sources aloft from surface current density estimates by applying a least-squares minimization procedure to simple models.

Plans for FY-85:

The University of Arizona will make improved measurements of Jm this summer in Florida to investigate further the behavior of Jm under thunderstorms.

Recommendations for New Research:

Experiments to measure the Maxwell currents over the tops of thunderclouds are presently being considered for future U-2 programs. From these studies, we may be able to establish relationships between total storm current and cloud top optical emissions which later can be used to infer from optical measurements alone the electrical activity and energy output of a storm and its contribution to the atmospheric electric circuit and the charge budget of the earth. The results of these studies will be valuable in interpreting Lightning Mapper Sensor data.

Publications:

Blakeslee, R. J. and E. P. Krider, The horizontal variations of the Maxwell current density under Florida thunderstorms, EOS (Trans. Am. Geophys. Un.),64,1983 (abstract only).

Blakeslee, R. J. and E. P. Krider, The electric currents under thunderstorms at the NASA Kennedy Space Center, Preprints, VII International Conference on Atmospheric Electricity, Albany, New York, June 4-8, 1984.