Title: **Nighttime Observations of Thunderstorm Electrical Activity from a High Altitude Airplane**

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Significant Accomplishments:

Observations of nocturnal thunderstorms made from above by a NASA U-2 airplane disclose features of cloud structure and lightning that are not generally visible from the ground. Most, if not all, lightning activity seems to be associated with clouds having strongly convective cauliflower tops. When the lightning occurs deep within the cloud, it can be seen that the folds and creases of the cauliflower top are not superficial surface characteristics, but extend deep into the cloud.

In both of the storms that were studied lightning channels are visible in the clear air above the cloud in 5-10% of the lightning events. This finding shows that substances known to be produced by thunderstorm electrical discharges, such as NO_x and O_3 can be introduced directly into the stratosphere. More detailed measurements will be required to determine whether or not the quantities introduced are of importance.

The cause and nature of the discharges above the cloud are not clear. Possibly they may be produced by accumulations of space charge in the clear air above the cloud. Alternatively the discharges may arise solely because of the intense electric fields produced by charges within the cloud. In the latter case the ions introduced by these discharges will have the effect of increasing the electrical conductivity of the air above the cloud and will increase the conduction current that flows from the cloud to the electrosphere.

Lightning spectra observed from above thunderstorms do not appear to differ significantly from similar observations of lightning that have been made from the ground beneath the cloud. More quantitative data at higher resolution may eventually show significant spectral differences between cloud-to-ground and intracloud strokes.

Our findings show that electric field-change data taken with an electric field-change meter mounted in an airplane provide data on lightning discharges from above that are quite similar to those obtained from the ground in the past. The transients produced by the photocell optical system correlate well with those provided by the E field-change meter. It appears that even though E field-change measurements cannot be made from a satellite, the optical signals from dart leaders, from return-strokes, and from continuing currents are recognizable, and in some instances, can be used to provide detailed information on the fine structure of lightning. In particular, they can be used to distinguish between cloud-to-ground and intracloud flashes.

We have emphasized the "optical alone" aspect of sensing lightning discharges from above clouds because of the interest in satellite measurements, especially from geosynchronous altitude. Clearly, optical measurements from a single platform are uniquely suited to provide the space and time resolution necessary to view an earth hemisphere on which hundreds of thunderstorms may be active simultaneously. Additional scientific objectives have been discussed in Davis, et al. (1983), and an update of the presently used instrumentation package, with some preliminary statistics on optical pulse frequency, is given in Christian, et al. (1983).

Focus of Current Research Activities:

Photographs of nocturnal thunderstorms showing lightning channels and cloud structure taken in recent flights will be compared with that which has already been analyzed to determine the extent of the variability of these phenomena.

Plans for FY-85:

FY-85 will be devoted to further analysis of data that has been obtained and preparation of supplemental U-2 instrumentation for flights in 1986.