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This grant supported the initial development of a deployable system for determining the structure of lightning discharges in three spatial dimensions and time. The purpose of this was to utilize the system to characterize lightning discharges that initiate sprites in the upper atmosphere. The grant also supported observations of sprites themselves using low-light-level video cameras and studies which identified charge transfer occurring within the sprite itself. This work resulted in the first high-speed video observations of sprites and the first recognition that significant charge transfer was occurring in sprites. Finally, it provided paratial support for improving dual-polarization radar techniques for observing storms.

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FINAL REPORT
AFOSR GRANT F49620-96-1-0304

DEVELOPMENT OF A FIELD-DEPLOYABLE OBSERVATIONAL SYSTEM FOR CHARACTERIZING LIGHTNING IN SPRITE-PRODUCING STORMS

June 15, 1996 to December 31, 1997

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This grant supported the initial development of a deployable system for determining the structure of lightning discharges in 3 spatial dimensions and time. The purpose of this was to utilize the system to characterize lightning discharges that initiate sprites in the upper atmosphere. The grant also supported observations of sprites themselves using low-light level video cameras and studies which identified charge transfer occurring within the sprite itself. Finally, it provided partial support for improving dual-polarization radar techniques for observing storms.

The grant commenced on June 15, 1996 and continued through December 31, 1997. Detailed reports of the work under this grant were provided in the first annual report of September 22, 1996 and as part of a continuation proposal of December 27, 1996. This brief report summarizes the overall activity of the grant and the 1997 results.

1. 3-Dimensional Lightning Mapping System

With initial support provided by this grant, we were successful in obtaining NSF support through the Academic Research Infrastructure program (ARI) to develop the complete lightning mapping system. The system was completed in May, 1998 and operated in a field program studying Great Plains thunderstorms during the month of June, 1998. It has provided spectacular pictures of lightning in the storms which are the subject of several papers at the upcoming Fall Annual Meeting of the American Geophysical Union in December, 1998. This was a major development project that was hard work but has been and will continue to be extremely successful scientifically.

2. Sprite Observations at Kennedy Space Center

With partial support from the AFOSR grant and also from NASA/KSC we were successful in obtaining the first observations of sprites over Florida. The sprites were at sufficiently close range that the parent lightning discharges which initiated the sprites were located by the Lightning Detection and Ranging (LDAR) system at KSC. These results, which were also very nice, were presented at last year's fall meeting of the AGU, an abstract of which is attached.

3. Sprite Observations at Langmuir Laboratory, New Mexico

During the first few months of the grant in 1996 we obtained spectacular pictures of sprites at close range to Langmuir Laboratory. In addition we obtained numerous correlations of sprites with positive cloud-to-ground lightning discharges from the National Lightning Detection Network (NLDN). In conjunction with these measurements we were able to identify the sources of satellite-detected Trans-Ionospheric Pulse Pairs, known as TIPPs. These phenomena, which have

been of substantial interest to the Air Force for several years, were found to be caused by energetic, short duration lightning discharges known as positive bipolar pulses. This work has been reported on in detail in the previous grant reports and at the 1997 AGU fall meeting. The positive bipolar pulse measurements are the subject of a joint LANL/New Mexico Tech publication to appear in the Journal of Geophysical Research.

During 1997 at Langmuir Laboratory we obtained the first observations of sprites using a high speed video camera. These showed how sprites develop with time and have been of substantial interest to sprite researchers. In addition we obtained detailed observations which showed that sprites have significant amounts of charge transfer along their extent. Our 1996 observations were the first to identify that such charge transfer was occurring in sprites; it had previously been presumed not to occur.

4. Dual-Polarization Radar Studies.

With partial support from this grant we have been able to make great strides in how to characterize and interpret dual polarization radar observations of meteorological phenomena. A publication describing these results is nearly completed.

Attachment No.: PUBLICATIONS

A. Rison, W., P. Krehbiel, R. Thomas, M. Davis, T. Hamlin, J. Harlin, T. Barber, M. Jones, A Deployable 3-Dimensional Lightning Mapping System, Fall Ann. Mtg. Amer. Geophys. Union, 1998.

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J. M. Stanley, P. Krehbiel, W. Rison, C. Moore, M. Brook, O.H. Vaughan, Observations of sprites and jets from Langmuir Laboratory, New Mexico Abstract A11A-07, Fall Annual Mtg. AGU, EOS, 77, 1996.

K. M. Stanley, P. Krehbiel, M. Brook, C. B. Moore, W. Rison, High speed video of initial sprite development, in preparation, Geophys. Res. Lett, 1999.