FINAL REPORT

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"Aerosol and Plasma Measurements in Noctilucent Clouds"

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The purpose of this project was to develop rocket-borne probes to detect charged aerosol layers in the mesosphere. These include sporadic E layers, which have their origin in meteoric dust, and noctilucent clouds, which form in the arctic summer and are composed of ice crystals. The probe being developed consists of a charge collecting patch connected to a sensitive electrometer which measures the charge deposited on the patch by impacting aerosols. The ambient electrons and light ions in the mesosphere are prevented from being collected by a magnetic field. The magnetic force causes these lighter particles to turn so that they miss the collecting patch.

Papers published: Geophysical Research Letters (2), conference proceedings (1).
Talks given: URSI (1999, 2000), AGU (Fall 2000).

Completed experiments:

The first probe was launched November 1998 from White Sands on a rocket carrying a solar telescope. Data were taken in the mesosphere on descent. The probe detected a charge layer at 86 km altitude approximately 500 m in vertical extent and having a charge density of about 2000 cm^{-3}. This layer was interpreted as a sporadic E layer composed of heavy ions (>20 amu.) ablated from meteoric particles. The analysis was published in Geophysical Research Letters, December 2000. This payload is to be launched again in Fall 2001 and a probe array has been prepared to allow the determination of the masses of the ions. Each probe has a different cutoff mass below which ions are not detected. The probe array will allow positive and negative ions to be distinguished and will allow iron ions to be distinguished from heavier cluster ions.

Two additional "no cost" launches:

The results from the first launch were reported at AGU and URSI meetings at which contacts were made with other groups interested in mesospheric ions. Two collaborations have been started. The first is with Markus Rapp, a student with Franz-Josef Lubken's group at Kuhlungsborn, who is integrating our probe into a rocket of the

MIDAS campaign which is scheduled for launch in June 2001. The second collaboration is with Jorg Gumbel, formerly with Stockholm University (now at the Naval Research Laboratory), who will launch a rocket from Esrange in the winter of 2001 carrying a water vapor detector. These two launches greatly expand the scope of our research and will give us data from both summer and winter conditions in the arctic mesosphere.

Collaborative computational work:

A second thrust of the research is numerical simulation carried out in collaboration with Jorg Gumbel. These simulations model the supersonic flow of air around the rocket to find the trajectories of aerosol particles and their heating by the shock compressed air. This allows us to quantify the effects of the aerodynamics on the collection efficiency of our probes. A description of the code, its capabilities, and its application to our probes appeared in Geophysical Research Letters in 1999. The code is now being applied to other probes and is likely to become a standard tool for evaluation of rocket instruments.

This research is the thesis project of Byron Smiley, a Ph. D. candidate in the Physics Department at the University of Colorado.

References:

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"Dusty Plasma Experiments Related to Mesospheric Aerosols," B. Smiley, S. Robertson, M. Horányi, and Z. Sternovsky, National Radio Science Meeting (URSI), Boulder, CO, January 2000.

"Low cost rocket measurements of mesospheric aerosols," Byron Smiley, Scott Robertson, Mihaly Horanyi and Jorg Gumbel, presented at the December 2000 meeting of the American Geophysical Union.