LABORATORY EXPERIMENTS RELATING TO POLAR MESOSPHERIC CLOUDS

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Laboratory experiments are in progress to create nanometer-size ice crystals in plasma to investigate the role of charging processes in noctilucent clouds (NLC) and polar mesospheric summer echoes (PMSE). Rocket-borne probes have observed localized "bite-outs" in the density of free electrons caused by small ice particles in the lower ionosphere. Charge collectors have recently found evidence for both positive and negative aerosols near NLC and PMSE layers[1]. The mass distribution of these particles and the reaction rates for electron attachment, photoionization, photodetachment, etc. which are necessary for modeling are not known. Two new experiments are underway to answer these questions[2].

First, a rocket-borne charge-collecting probe with a magnetic field for mass discrimination has been constructed and tested in the laboratory. The magnetic field prevents collection of singly-charged species with mass below a threshold determined by the rocket velocity and the magnetic field strength. Several of these probes with differing mass thresholds will be used to provide a low-resolution mass spectrum of NLC particles. Laboratory tests of a prototype probe show that the magnetic field is effective in preventing collection of low energy electrons.

Second, a large plasma chamber (0.9 m diameter x 1.2 m) is being fitted with a supersonic nozzle which generates ice clusters. Clusters which become charged will be detected by Faraday cups and their mass distribution will be determined by mass spectrographs. Electron attachment rates will be inferred from the dependence of the charged fraction on the electron density. An arc lamp source with a cutoff wavelength similar to that of the solar spectrum at 80 km will be used to determine the role of photodetachment and possibly photoionization. Sodium or other impurities may be added to the flow creating the ice particles to determine whether or not their presence results in a lower work function.

References:

1) O. Havnes, et al., JGR 101, 10839, 1996.
2) S. Robertson, et al., Advances in Dusty Plasmas, 244, 1997.

Acknowledgments:

This work is supported by NASA Sun-Earth Connection ITM Physics Program (NAG5-4526).