The effect of charged particles on ambipolar diffusion in the polar mesopause region

Andrew P. Ballinger[1], Phillip B. Chilson*[2], Robert D. Palmer[2], Sheila Kirkwood[3], and Nick J. Mitchell[4]

[1] Atmospheric and Oceanic Sciences Program, Princeton University, Princeton, NJ, USA

[2] School of Meteorology, University of Oklahoma, Norman, Oklahoma, USA

[3] Atmospheric Physics Programme, Swedish Institute of Space Physics, Kiruna, Sweden

[4] Department of Electronic and Electrical Engr., University of Bath, Bath, UK

At any location during any given day, many thousands of meteors enter the Earths upper atmosphere. The frequency of incoming meteors fluctuates but generally follows a well-understood diurnal and seasonal cycle. Most of the meteors ablate as they interact with the increasingly dense air molecules, leaving an ionized plasma trail in their wake. It has been recently suggested that charged or neutral particles could cause a reduction in meteor echo decay rates. It is thought that some proportion of the electrons in a meteor trail are able to be absorbed by the background dust as they diffuse outward. It is important to investigate the magnitude of this absorption effect. If not accounted for, the reduction in the meteor echo power due to this mechanism could be attributed to ambipolar diffusion, which may lead to a significant overestimation of the diffusion. This would in turn impact temperatures that are estimated using the diffusion coefficient. Since the background dust has a limited electron absorption capability, the relative effect will depend on the initial electron density. Hence, the weaker (stronger) trails should have a greater (smaller) proportion of the initial electron content absorbed by the dust. A systematically faster apparent diffusion for weaker trails compared to stronger trails may be an indication that absorbing dust is present. Through the use of a meteor radar located in northern Sweden and by comparing the strongest 50% (by maximum backscattered power) of meteor echo trails to the remaining weaker echoes we will present evidence of dust in the polar mesopause region and demonstrate its interaction with the observed meteor echo plasma trails. This effect is most pronounced at a height of approximately 85 km.