DIFFUSION OF METEOR TRAILS IN THE E-REGION IONOSPHERE: IMPLICATIONS FOR RADAR MEASUREMENTS

Dimant, Y. S., Oppenheim, M. M. , Dyrud, L.
Center for Space Physics, Boston University

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: dimant11962

Date Received: September 23, 2004

1. (a) Yakov Dimant
Center for Space Physics
Boston University
725 Commonwealth Ave.
Boston, MA
02215 USA
`dimant@bu.edu`
(b) 1-617-353-7411
(c) 1-617-353-6463

2. G - Ionospheric Radio and Propagation
3. (a) G/H Meteor Physics
4. C - Contributed Paper
5. No special instructions

A meteoroid penetrating the Earth's ionosphere leaves behind a trail of dense plasma observed by radars. Obtaining accurate quantitative predictions for the diffusive evolution and fields generated by these trails within the magnetized ionosphere has proven difficult. In this talk we will present a new model of the fields and evolution which fully accounts for the magnetic fields and the background plasma. This model has important implications for radar measurements of meteors. Low-power, small-aperture radars detect localized specular echoes which occur only when trail lies perpendicular to the radar line-of-sight. Upper atmospheric scientists use these radars to monitor winds between 85 and 105 km altitude and solar system scientists use them to estimate the population of small particles in the solar system. High-power, large-aperture (HPLA) VHF and UHF radars observe both head echoes, short duration signals traveling with the ablating meteoroids, and non-specular echoes, long duration signals persisting for a relatively long time in a broad altitude range within the *E*-region ionosphere. We have argued that non-specular echoes result from radar signals scattered from turbulent electron density irregularities generated by plasma instabilities (M. Oppenheim et al., *J. Geophys. Res.*, **108**, 1064, 10.1029/2002JA009549, 2003) and that head echoes result from scattering from the front edge of a meteoroid ionization path (S. Close et al., *Icarus*, **168**, 43-52, 2004) . Modeling of specular radar echoes requires knowledge of spatial/temporal distribution of the trail plasma density, while modeling of non-specular trails requires knowledge of evolution and structure of the polarization electric field which drives instabilities. Earlier papers on this topic (e.g., T. R. Kaiser et al., *Planet. Space Sci.*, **17**, 519-552, 1969); W. M. Pickering and D. W. Windle, *Planet. Space Sci.*, **18**, 1153-1161, 1970; W. Jones, *Planet. Space Sci.*, *39*, 1283-1295, 1991; A. M. Lyatskaya and M. P. Klimov, *J. Atm. Terr. Phys.*, **50**, 1007-1014, 1988; R. E. Robson, *Phys. Rev. E*, **63**, 026404, 2001) did not provide accurate predictions for the plasma trail density and the polarization electric field because they did not properly treat interaction between the trail and the background ionospheric plasma. We will present results of our recent 2-D analytical theory and numerical computations which treat such interaction for a range of trail configurations. This study provides a quantitative estimate of the plasma density and electric field spatial distribution and dynamics. We will show that during trail evolution the polarization electric field may drop below the level necessary to drive instabilities while significant plasma density perturbations of the meteor trail may still exist. Combining our theory with radar observations of specular and non-specular echoes should yield useful information about meteor trails and the surrounding atmosphere.