Modeling the Role of Atmosphere on the Duration of Non-Specular Meteor Trails

F. R. Galindo[1], J. V. Urbina[1], L. P. Dyrud[2] and J. Fentzke[3]

(1) Communications and Space, Sciences Laboratory, Pennsylvania State University, University Park, PA, USA
(2) Head Earth and Space Science, Charles Stark Draper Laboratory, Cambridge, Massachusetts
(3) Scientific Solutions, Inc and Shell, Cambridge, Massachusetts

Recent papers by Hinrichs et al., (2009) and Dyrud et al., (2011) discuss how non-specular meteor radar reflections can vary due to atmospheric parameters. This theoretical simulator models the evolution of an individual meteoroid into the atmosphere, including ablation, ionization, thermal expansion and plasma stability based upon the meteor Farley-Buneman Gradient-Drift (FBGD) instability. They demonstrate that trails are far less likely to become and remain turbulent in daylight, explaining several observational trends for non-specular meteor trails. In this paper we present a detailed analysis of the role that atmospheric and ionospheric parameters such as ionospheric plasma density, termospheric winds, etc. have on the development of meteor trail turbulence and evolution. Our work is an extension of the research described in Hinrichs et al., (2009), and Dyrud et al., (2011). Preliminary results show that the trail duration exhibits a linear dependency with changes (up to one order of magnitude) in the ionospheric plasma density. Larger variations in the ionospheric plasma density produce exponential changes in trail duration. For example, a 1 μg meteoroid moving at 35 km/s produces a trail duration of 5.7 s while the same meteoroid can last 0.85 s if the ionospheric plasma density changes by a factor of 10. These simulations are validated with meteor data collected with the University of Illinois Portable Radar that was installed in Fort Macon, North Carolina (34° N, 65° W). The antenna beam was pointed 26° West of the magnetic north, and at an elevation angle of 16°. The antenna bore-sight was aimed perpendicular to the Earth's magnetic field.