Simulating the Effects of Latitude, Longitude, Neutral Wind, and Plasma Density on Non-Specular Meteor Trails

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We present VHF radar observations of non-specular meteor trails from two different mid-latitude locations: 1) Camp Santiago, Salinas, Puerto Rico (17.998°N, 66.285°W)[1] and 2) Fort Macon, Atlantic Beach, North Carolina (76° W, 24° N)[1]. These observations were conducted during the winter equinox and during the summer periods and therefore provide a wide range of mid-latitude meteor data with different geophysical parameters. We present a case study of a numerical model developed[2] to determine the effects of latitude and longitude, neutral wind, meteor mass velocity and entry angle, and plasma density as the major variable parameters in the duration of non-specular meteor trails. The model takes into account the data-suggested theory that many more meteors are observed before dawn than after dawn, and attempts to predict the diurnal variation that is observed in non-specular meteor trails.

The simulation models the entire lifetime of the meteor in the atmosphere; from initial ablation and ionization until final formation of field aligned irregularities. Simulations are homogeneously conducted throughout the day to help understand meteor trail duration as a function of when in the day it entered the atmosphere. The meteor trails simulated in this program show radically different behavior depending on when and where they enter the atmosphere, which is indicative of the difference of wind speeds at different places on the earth, and the difference in plasma density at different times of day. For example, we show that mid-latitude trail durations are often shorter lasting than equatorial trail observations because of the difference in mid-latitude wind speed and equatorial drift speed. Initial findings suggest that meteor duration is mostly sensitive to lower thermospheric wind intensity and background ionospheric electron density.

[1] Urbina et al. Analysis of VHF coherent scatter observations of E-region irregularities in Puerto Rico and North Carolina Geophys. Res. Lett 27, 2853-2856, 2000

[2] Dyrud, Kudeki, and Oppenheim, Long Durration meteor trails, Journal of Geophysical Research, 2007