Effect of Neutral Wind Speeds on the Creation of Meteor Trail Echoes

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Everyday millions of meteoroids smaller than a grain of sand penetrate the Earth's upper atmosphere, generating columns of dense plasma between 70 and 140 km of altitude. These meteor trails represent a powerful opportunity to use modern remote sensing tools to better understand the meteoroids that produced them, and the atmosphere in which their trail reflections occur. One type of the meteor echoes that radars can routinely observe is called non-specular meteor trail, herein called meteor trail. These radar reflections are a consequence of plasma instabilities that develop in the trail and become field-aligned irregularities. In other words, these meteor trails are detected when the radar **k** vector is pointed perpendicular to the Earth's magnetic field. However, we do not fully understand the degree to which meteoroid and atmosphere properties affect the evolution of meteor trails. This paper assesses the impact that neutral winds exert on the evolution of these meteor reflections.

Neutral winds or polarization electric fields affect the electron drift that is responsible to drive the instabilities in the meteor trail. This electron drift results from a combination of external electric fields **E** (e.g. neutral winds), **E**x**B** and diamagnetic drifts. If external fields are zero, the electric field results from the self-generated ambipolar electric fields. We have applied a numerical model based on the physics of meteors to simulate meteor trails and have investigated the effect of neutral winds on the evolution of meteor echoes. Our work expands upon the research described in Hinrichs et al., (2009) and Dyrud et al., (2011) to demonstrate that neutral winds below a critical value do not sustain instabilities in the trail at all. For instance, a 0.0316μg meteoroid traveling at 35 km/s, requires neutral winds stronger than 15 m/s to in order for the trail to become unstable, while a 0.316μg meteoroid traveling at the same speed needs neutral winds stronger than 1 m/s. We also discuss how strong wind shears that occur at meteor heights could produce interesting signatures in non-specular meteor echoes, which in turn could explain a variety of features present in meteor trails reflections probed by meteor radars.