Global Variation of Meteor Trail Plasma Turbulence

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The daily occurrence of billions of meteor trails in the Earth's upper atmosphere present a powerful opportunity to use remote sensing tools to better understand the meteoroids that produced them and the atmosphere and ionosphere in which their trails occur. One of the most promising tools employed in this endeavor are high-power-large-aperture (HPLA) radars. Such radars routinely observe two distinct types of meteor echoes, head echoes and non-specular meteor trails. We now understand that non-specular trails result from field aligned irregularities produced by plasma turbulence.

We present the first images showing results from global simulations of various aspects of meteor trail plasma irregularities. By simulating plasma stability and radar observations of the same meteor at every location on Earth, we are able demonstrate the variation in meteor trail plasma turbulence. The results we present answer the question: when a meteoroid disintegrates in the atmosphere at a particular location, will the resulting trail become plasma turbulent, and if so for how long will the trial remain turbulent as a function of altitude? Understanding meteor trail plasma turbulence is important because turbulent meteor trails are easily visible as non-specular trails to coherent radars that are pointed perpendicular to the magnetic field, and turbulence influences the observations of specular meteor trails, particularly regarding the inference of mesospheric temperatures from trail diffusion rates. These images also provide visual evidence of the significant effect that neutral atmospheric wind, density, and ionospheric density have on the evolution of meteor trails and the observation of non-specular meteor trails. Including a dominant day-night difference in turbulence occurrence across the globe, where trails are far less likely to become and remain turbulent in daylight.