Analysis of Plasma Turbulence on the Formation of Specular Meteor Echoes

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As meteoroids approach the Earth at altitudes of 300 km to 100 km, collisions with air molecules cause their surface temperature to rise rapidly. This preheating lasts only seconds or a few tenths of a second. When the meteoroids reach about 2000 K, surface particles start to evaporate. During this process, which is known as ablation, meteoric and atmospheric atoms are ionized, creating ionized plasma around the meteor body and a long plasma trail in the wake of the meteoroid. Various types of radars operated at VHF and UHF frequencies can probe these plasmas. There are three primary types of meteor radar reflections: 1) traditional specular meteor trails, which are detected when the trajectory of the meteor is perpendicular to the radar **k** vector, 2) non-specular trails, which result from plasma instability and turbulence generated field-aligned irregularities (FAI) and can be detected exclusively when the radar **k** vector is oriented perpendicular to the Earth's magnetic field **B** as, and meteor head echoes, which are reflected from radar targets moving at the speed of the meteoroid.

Specular meteor echoes are currently used to derive atmospheric parameters such as temperature, pressure, and drifts; under the assumption of non-turbulent diffusion rate occurrence. We describe a numerical model of under-dense specular meteor echoes that includes the effect of plasma turbulence on the trail evolution. This numerical model simulates the progression of the trail at different stages by estimating its corresponding received power. These simulations incorporate the studies of diffusion values, which are modeled by including/excluding the effect of the Earth's geomagnetic field and plasma turbulence. We show specular meteor echoes simulations that illustrate the significant impact of turbulence on the evolution of under-dense specular meteor echoes. An important aspect of these simulations is that they can reproduce and explain how double decay in a specular meteor echo can occur. Furthermore, we report these meteor simulation results in conjunction with specular meteors collected with an *All Sky Meteor Radar* located in *La Serena, Chile* (30° 14′ 27″ S, 70° 44′ 12″ W) to produce a statistical analysis of the effect of turbulence on these type of meteor reflections.