Range-Spread Meteor Echoes from Non-Field-Aligned Irregularities

Ana M. Tarano*(1), Diego Janches (2), and Sigrid Close(1)
(1) Stanford University, Stanford, CA, 94305, USA
(2) NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

Radars can detect a meteoroid entering the Earth's atmosphere by scattering from the plasma surrounding the extraterrestrial material and the plasma column left behind its wake. These radar returns are classified as head and trail echoes, respectively. Trail echoes are further categorized depending on the geometric conditions of the incident radar beam with the meteoroid trajectory and the geomagnetic field. Namely, "specular trails" occur when the meteoroid travels quasi-perpendicular to the radar beam while "range-spread echoes," also known as "non-specular trails," arise when the background magnetic field **B** is quasi-perpendicular to the beam **k**. According to our current understanding, the radar beam must be almost exactly perpendicular to **B** in order to reflect from sufficient field-aligned irregularities (FAI) after the onset of plasma turbulence. However, range-spread echoes were observed when the angle between **k** and **B** was between 25 to 55 degrees using the Southern Argentina Agile Meteor Radar (SAAMER), which implies that non-specular echoes can be detected from non-FAI. We examine the detected trail duration dependence on altitude, meteoroid velocity, time of day, and various geometric relationships to establish that the plasma turbulence leading to the SAAMER non-specular meteor echoes mainly arises from gradient drift and wind driven instabilities, similar to previously observed trails. We also provide insight as to whether these detected meteors are due to dusty plasma instabilities.