Direct Observations of the Connection Between Meteor Activity and Mid-latitude Sporadic-E using the Long Wavelength Array Radio Telescope

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The phenomenon of mid-latitude sporadic-E (E_S), transient and dense layers of ions within the ionospheric E-region, has been well established to be formed via a combination of zonal wind shears, ion/neutral coupling, and E×B forces at altitudes of ~100 km. The time scales on which these processes work require relatively long-lived metallic ions. Thus, it has been surmised that the likely seeds for E_S are meteors, which deposit significant amounts of metallic material as they ablate within the E-region. However, efforts to uncover observational evidence to support this presumption have had mixed results. Here, we report results from a recent VHF-regime observing campaign that appear to support this notion.

The first station of the planned long wavelength array, LWA1, was used for a yearlong program for all-sky monitoring of meteor activity via reflected analog TV transmissions at 55.25 MHz. Located in western central New Mexico, LWA1 is a 100-meter diameter array of 256 bent dipole antennas. It can be operated in an “all-sky” mode where the signals from individual antennas are recorded to be combined later, allowing for all-sky imaging. While other 55.25 MHz sources were frequently detected such as transmitter ground waves and reflections off airplanes, analysis of the temporal structure of bright sources shows that above 30° elevation, >90% of sources are meteor trail reflections.

We have made all-sky maps of 55.25-MHz peak signal-to-noise ratio (S/N) for 66 one-hour observations made pre-dawn (11-12 UT; roughly 3.8-4.8 local time) from Feb. to Oct. 2014. During these times, meteor rates are highest and contamination by airplane reflections is minimal. We then used data from the digital ionosonde in Boulder, Colorado to separate these into two groups according to E_S activity. The two average peak S/N maps are shown in the figure below. The typical peak S/N per hour is significantly higher in the region dominated by meteor trails (elevation>30°) when E_S was strongly present. In addition, we have found evidence of a correlation between E_S plasma frequency and peak meteor-trail S/N, implying a direct correlation between E_S layer density and the amount of material deposited by ablating meteors.