Detection of meteoric smoke particles in the D-Region using the Arecibo 430 MHz Radar: A Seasonal study

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In this work we present a seasonal study of the presence and characteristics of meteoric smoke particles (MSPs) in the D-region plasma derived from observations using the 430 MHz dual-beam Arecibo Observatory (AO) incoherent scatter radar (ISR) in Puerto Rico (18°N, 67°W). For this work, we employed the AO transmitter operating at a peak power of 2 MW and using a 13-baud Barker code, a baud length of 1 μs (a range resolution of 150 m), and an IPP of 1.04 ms to sample the D-region between 57.6 and 108 km range using the incoherent scatter technique. The power was split between the Gregorian and the line feeds to create two beams inclined 15° east and west of vertical. Received signals were sampled at 150 m resolution and Doppler spectra were obtained using 256 samples. Our results are obtained by utilizing a method similar to one developed by Strelnikova et al. [2007, Meteor smoke particle properties derived from Arecibo incoherent scatter radar observations, GRL (35)15] by fitting a summed Lorentzian function to the ISR power spectra and integrating over periods greater than 15 minutes in order to derive the MSP radii and number densities. Because of the non-vertical pointing, the spectra are Doppler shifted due to the rapidly changing neutral dynamics of the region. We first remove this effect by estimating radial velocities every 2 minutes and integrating the corrected spectra for longer periods. This method, which utilizes a mono-disperse particles assumption, allows us to determine mean particle radii and densities in the 80 – 95 km altitude range during the hours of 10 - 14 AO LT when the detected signal-to-noise (SNR) from the D-region is strongest. Our results provide insight into the presence and distribution of charged meteoric dust in the mesosphere resulting from the condensation of ablated meteoric material. In addition, our error analysis shows that spectral broadening from atmospheric sources like neutral turbulence induced by gravity wave vertical variance, and non-zero vertical winds results in < 10% change in derived MSP radii. MSPs are believed to be the condensation nuclei for the formation of ice particles, the precursor for Polar Mesospheric Clouds (PMCs). Since our dataset covers different seasons, we study the existence of possible correlations between the seasonal variations of the derived MSPs properties with that of the meteoric input function (MIF) in the MLT above Arecibo.