Detection of Meteoric Dust in the Mesosphere by the CHAMPS Rockets

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In October 2011, two CHAMPS (charge and mass of meteoric smoke particles) sounding rockets were launched into the polar mesosphere, each carrying an electrostatic multichannel mass analyzer for charged aerosol particles. The payloads also carried Faraday rotation antennas and an array of plasma probes for determining electron and ion densities and the payload charging potential. The launches were from the Andøya Rocket Range, Norway, following the end of the noctilucent cloud season. One day launch (11 October 21:50 UT) and one night launch (13 October 13:50 UT) helped to elucidate the role of photo-detachment and photoelectric charging. Charge layers in two distinct altitude ranges were observed on both flights: a high altitude negative charge layer between 77 - 93 km, and low altitude positive and negative charge layers that coexist from 63 - 73 km. In a layer spanning approximately 77 - 93 km, the nighttime data show negatively charged particles with masses in the range 500 - 2,000 amu , 2,000 - 8,000 amu and 8,000 - 20,000 amu. These mass ranges occur together each with a particle density of ~400 cm^{-3}. In this altitude range, the Faraday rotation data show that the electron density rises from about 10^3 cm^{-3} to about 10^5 cm^{-3} indicating that there are sufficient electrons for the fraction of dust that is charged to be near 100%. This negative layer from 77 - 93km was also present during the day with approximately the same number density. From about 73 km to about 63 km where data acquisition ended, the nighttime data show both positive and negative particles in the 500 - 8,000 amu mass ranges with densities of 2,500 cm^{-3} and 500 cm^{-3} respectively. The heavier particles have peak densities at lower altitudes. In this altitude range, the dust densities exceed the electron density. These layers are again present in the daytime data with approximately the same altitude distribution; however, the number densities for the positive particles are reduced by a factor of ~3 and the negative particle densities are reduced by more than an order of magnitude. The smaller daytime density of positive particles suggests that photoelectric charging is not the dominant charging mechanism for positive particles. The smaller daytime density of negative particles may be a consequence of photodetachment of electrons.