Polarization Properties of Head Echoes Collected at ALTAIR

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In this paper we present the results of an in-depth investigation into the polarization properties of meteor head echoes collected with ALTAIR (ARPA Long-Range Tracking And Instrumentation Radar) in 2007 and 2008. ALTAIR is a dual-frequency, high power radar that is extremely well-calibrated. It is located on the island of Roi-Namur in the Kwajalein Atoll. We can achieve a range resolution of 15 m at the transmission at 160 MHz (VHF), and from measurements of azimuth and elevation channels use monopulse calculations to create an accurate 3D position track of targets in the radar beam. ALTAIR transmits circularly polarized light and is capable of receiving in both the principle polarization (PP) and opposite polarization (OP) orientations. The ratio of the two returns (PP/OP) is a parameter known as the polarization ratio (PR). We examine the polarization properties of meteor head echoes, the radar scatter off of the plasma that immediately surrounds the meteoroid and travels at the meteoroid velocity, and analyze these results for a dependence on altitude and angle with the magnetic field. Head echo returns resemble reflection from spheres, returning primarily PP orientation scatter, but variations exist most notably for those meteors that propagate near-vertical to the magnetic field and with head plasma radii larger than the transmitting wavelength. There is a radar cross section (RCS) dependence on magnetic field which may contribute to the types of shape discrepancies that would allow for the changing PR ratio not explained by a perfect spherical scatterer.