Physical properties of meteoroids based on middle and upper atmosphere radar measurements

M. Gritsevich[1,2], J. Kero[3], J. Virtanen[1], C. Szasz[4], T. Nakamura[5], J. Peltoniemi[1,2], and D. Koschny[6]

[1]Finnish Geodetic Institute, Geodeetinrinne 2, P.O. Box 15, FI-02431 Masala, Finland
[2]University of Helsinki, Department of Physics, P.O. Box 64, 00014 Helsinki University, Finland
[3]Umea University, Kiruna, Sweden
[4]Swedish Institute of Space Physics, Sweden
[5]National Institute of Polar Research, Tachikawa, Tokyo, Japan
[6]European Space Agency, Noordwjik, Netherlands

We present a novel approach to reliably interpret the meteor head-echo scattering measurements detected by the 46.5 MHz MU radar system near Shigaraki, Japan. A meteor head echo is caused by radio waves scattered from the dense region of plasma surrounding and co-moving with a meteoroid during atmospheric flight. The signal Doppler shift and/or range rate of the target can therefore be used to determine meteoroid velocity. The data reduction steps include determining the exact trajectory of the meteoroids entering the observation volume of the antenna beam and calculating meteoroid mass and velocity as a function of time. The model is built using physically-based parametrization. The considered observation volume is narrow, elongated in the vertical direction, and its area of greatest sensitivity covers a circular area of about 10 km diameter at an altitude of 100 km above the radar. Over 100,000 meteor head echoes have been detected over past years of observations. Most of the events are faint with no alternative to be detected visually or with intensified video (ICCD) cameras. In this study we are focusing on objects which have entered the atmosphere with almost vertical trajectories, to ensure the observed segment of the trajectory to be as complete as possible, without loss of its beginning or end part due to beam-pattern-related loss of signal power. The analysis output parameters are range, altitude, radial velocity, meteoroid velocity, instantaneous target position, Radar Cross Section (RCS), meteor radiant, meteoroid ballistic and ablation coefficients, mass loss parameter and meteoroid mass, with possibility to derive other parameters.