32[nd] URSI GASS, Montreal, 19-26 August 2017

Multi-radar observations of meteors

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1. Extended Abstract

We present the initial results from a set of multi-instrument observations campaigns conducted 2016-2017. The radar systems in the study are the 930 MHz EISCAT UHF radar located near Tromsø, Norway (69.59°N, 19.23°E), and the 53.5 MHz Middle Atmosphere Alomar Radar System (MAARSY) located on the Norwegian island Andøya (69.30°N, 16.04°E). The 32-m steerable parabolic dish antenna of the EISCAT UHF radar was pointed to elevation 37° and azimuth 257° towards a measurement volume at 100 km altitude in zenith above MAARSY. The campaigns are concentrated during nights close to new-moon conditions in the period October-March to enable simultaneous meteor detections with a double-station optical system temporarily installed near MAARSY. The purpose of the campaigns is to collect a data set of double-frequency radar and optical meteors to confine radar cross section (RCS) frequency dependent parameters in a full-wave model of radio wave scattering from meteor plasmas. The ultimate goal of the simulation work is to enable meteoroid mass determination from well-calibrated head echo meteor plasmas in order to improve the estimation of the meteoroid mass influx to the Earth's atmosphere. Here, we give an overview of the observation campaigns, focusing on a comparison of the meteor detection sensitivity limits of the two radar systems and the frequency dependence of meteor head echo RCS.

EISCAT UHF is a monostatic radar system, which means that the location of meteor targets in the antenna beam pattern cannot be determined and that only the radial (line-of-sight) velocity component is measured. The main lobe of the antenna has a gain of 47dBi gain and a half power beam width of only 0.6°. The high gain in combination with 1.5 MW transmitter power enables detection of faint meteor targets.

MAARSY has a transmitter power of 866 kW, directive gain of 33.5 dBi, half power beam width of 3.6°, and is an interferometric radar system consisting of 433 Yagi antennas combined to 61 receiving channels. This enables in-beam interferometry, localization of meteor targets and calculation of the full meteoroid velocity vector. The position of the target is used to quantify the gain of the MAARSY beam pattern where a meteor appears to determine the time profile of its RCS.

The meteor target position information from MAARSY is used to locate simultaneous detections in the EISCAT beam, compensate for the EISCAT antenna gain, and calculate the RCS at the 930 MHz operating frequency in addition to the RCS measured by MAARSY at 53.5 MHz.