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Meteoroid trajectory and ionization retrieved using BRAMS data

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The Belgian RAdio Meteor Stations (BRAMS) network is a radio forward scatter system installed in Belgium with the goal to detect and characterize meteoroids. The BRAMS network is made of a dedicated transmitter located in the South of Belgium, and a network of 35 receiving stations spread all over Belgium and neighboring countries. The transmitter emits a pure sine wave at a frequency of 49.97 MHz with no modulation. All receiving stations record data continuously and are synchronized using signals from GPS clocks.

We discuss first a general method to retrieve meteoroid trajectories based solely on time delays measured between meteor echoes recorded at multiple receiving stations. It is based on using at least 6 non-linear equations to solve for the position of one specular reflection point (3 unknowns) and the 3 components of the speed. This method has also been described recently in Mazur et al (2020) and applied to CMOR data. However, specificities of the CMOR configuration has allowed simplifications that cannot be made with the BRAMS network. In order to maximize the number of meteoroid trajectories with at least 6 stations detecting meteor echoes, a number of additional stations geographically close to each other have been installed in the Limburg province in 2020. Another method to retrieve individual meteoroid trajectories is using data from the radio interferometer located in Humain using five similar antennas in the classical Jones configuration, which can provide the direction of one specular reflection point with an accuracy of ~1°. Only data from 3 additional stations are then mandatory to retrieve the trajectory. We show preliminary results from both methods using also complementary data from the optical CAMS Benelux network. The CAMS trajectories are used to select specific meteor echoes in the BRAMS data. The results obtained with the two methods are then compared to the CAMS values (trajectory and speed) to assess their accuracy.

For each receiving station with a recorded meteor echo (depending on the geometry and the SNR ratio), the power profile is computed and the peak power values of the underdense meteor profiles are used to determine the ionization (electron line density) at the various specular reflection points along the meteor path. This is done using the McKinley (1961) formula which is strictly valid for underdense meteor echoes and an extension of the backscatter case to the forward scatter one. We discuss how we compute the gains of the antennas and how the peak power values are transformed from arbitrary units into watts using the signal recorded from a calibrating device. Finally, a discussion is provided about combining these results with a simple ablation meteor model in order to obtain an estimate of the initial mass of the meteoroid.