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Observability Function of the BRAMS forward scatter network

Hervé Lamy[1], Cis Verbeeck[2], Joachim Balis[1], Michel Anciaux[1], Stijn Calders[1], Antoine Calegaro[1], and Antonio Martinez Picar[2]

[1]Royal Belgian Institute for Space Aeronomy, Space Physics, BRUSSELS, Belgium (herve.lamy@aeronomie.be)
[2]Royal Observatory of Belgium, Brussels, Belgium

BRAMS (Belgian RAdio Meteor Stations) is a network using forward scatter of radio waves on ionized meteor trails to study meteoroids. It is made of a dedicated transmitter and of 42 receiving stations located in or near Belgium. The network started in 2010 but has recently been extended and upgraded.

The transmitter emits a circularly polarized CW radio wave with no modulation at a frequency of 49.97 MHz and with a power of 130 W. Each receiving station uses a 3-element zenith pointing Yagi antenna. The first stations used analog ICOM-R75 receivers and a PC. Since 2018, new improved stations have been installed using digital RSP2 receivers, a GPSDO and a Raspberry Pi, providing better dynamic, sensitivity and stability.

A vast majority of the meteor echoes detected by BRAMS are specular, which means that most of the power of the meteor echoes comes from a small region along the meteoroid path centered on the specular reflection point, a point which is tangential to a prolate ellipsoid having the transmitter and the receiver as the two foci. This puts important geometrical constraints on whether a specific meteoroid trajectory can be detected or not by a given receiving station since the position of the reflection point must fall within the so-called meteor zone.

As a consequence, for meteor showers, the observed activity based on the raw counts of meteor echoes recorded by a BRAMS station is modulated by the position of the radiant throughout the day and does not truly reflect the real activity of the shower. A possibility to correct these raw counts is to compute the so-called Observability Function (OF) introduced by Hines (1958) and further developed by Verbeeck (1997). This OF contains a geometrical part which provides the location of potentially observable meteor trails at a given moment and for a given station, and another part which takes into account which fraction of these trails will actually be detected by the receiving station. Indeed, whether a meteor echo will be detected at the station also depends on the sensitivity of the receiving chain, on the power transmitted and on the ionization at the reflection point, the latter depending on the initial mass of the meteoroid.

We will describe how the geometrical part of the OF is calculated and will provide results for several receiving stations of the BRAMS network to emphasize the importance of the geometry. We will also describe how we take into account important characteristics of the system to determine the sensitivity of the receiving chain such as the gains of the antenna in the direction of the meteor echoes. Finally, we will apply the OF to the raw counts of a few main meteor showers (e.g. Perseids, Geminids, Quadrantids) obtained from the Citizen Science project, the Radio Meteor Zoo,

that we have developed since 2016 in cooperation with Zooniverse (https://www.radiometeorzoo.be).

Hines, C., Can. J. Phys., 36, 117-126, 1958

Verbeeck, C., Proceedings of the International Meteor Conference, Apeldoorn, the Netherlands, 122-132, 1996