The BRAMS Viewer: an on-line tool to access the BRAMS data

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This short paper focuses on the status of the BRAMS network in 2012, and describes a recently developed on-line tool, called the BRAMS Viewer, which provides access to the BRAMS data.

1 The BRAMS network

The Belgian RAdio Meteor Stations (BRAMS) is a network of 22 radio receiving stations located in Belgium and aimed at detecting and characterizing meteors with forward scatter techniques (see, e.g., McKinley (1961) or Wislez (2006) for a review on meteor forward scatter). The beacon is a crossed dipole antenna with an 8 m × 8 m metallic grid as reflecting plane. It is located in Dourbes, in the South-East of Belgium, near the French border. It emits a circularly polarized purely sinusoidal wave towards the zenith at a frequency of 49.97 MHz with a power of 150 W. All receiving stations use a 3-element Yagi antenna and a commercial ICOM-R75 receiver. An accurate time reference at each station is ensured by a GPS receiver. The stations are hosted mainly by radio amateurs or groups of amateur astronomers working closely with the Belgian Institute for Space Aeronomy (BISA), which coordinates the project. The status of the BRAMS network at the end of 2012 is illustrated in the map shown in Figure 1.
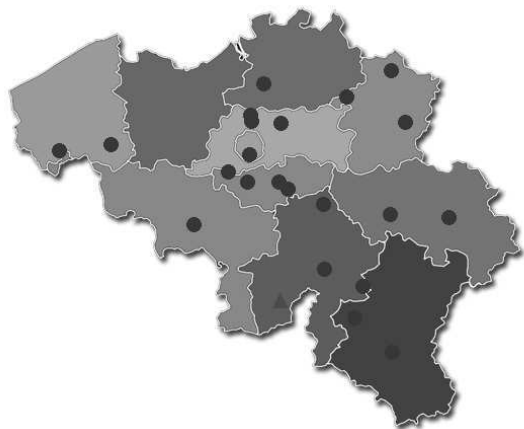

Figure 1 – BRAMS network at the end of 2012. The triangle in the South-East of Belgium, near the French border, is the beacon located in Dourbes. The 22 black dots indicate the locations of the receiving stations.

In each receiving station, the signal is mixed with that from a local oscillator (LO) to translate it to a frequency around 1 kHz. Due to a slight inaccuracy of the LO frequency in the receiver, the beacon frequency does never exactly appear at a frequency of 1 kHz, but can be shifted by up to ±100 Hz. Due to thermal effects, this frequency can also slightly change with time. The signal from the receiver and a PPS (pulse per second) signal coming from the GPS receiver are sampled simultaneously by an external sound card at a frequency of 5512 Hz, then stored on a local PC as a sound (WAV) file every 5 minutes. Except for the PC, the material is identical at each station and provided by BISA. Data are stored locally, then sent every month to BISA where they are added on-line, and, later on, archived.

2 The BRAMS Viewer

Recently, an on-line tool called the BRAMS Viewer was developed for external registered users to access and download the online BRAMS data.

First, a code was developed at BISA to generate spectrograms using an FFT of the raw BRAMS audio files. The user only needs to provide the name of a specific receiving station, a date, and an hour as input.

An example of such a spectrogram is shown in Figure 2 for the Humain Station on 9 October 2011 at 3^h10^m UT. By default, the frequency axis is centered on the beacon frequency (in the present case, the constant horizontal line at around 1105 Hz) with a total range of 200 Hz. The FFT is run with 16 384 samples and a 90% overlap giving a time resolution in the spectrogram of approximately 3 seconds. The amplitude of the signal is color-coded.
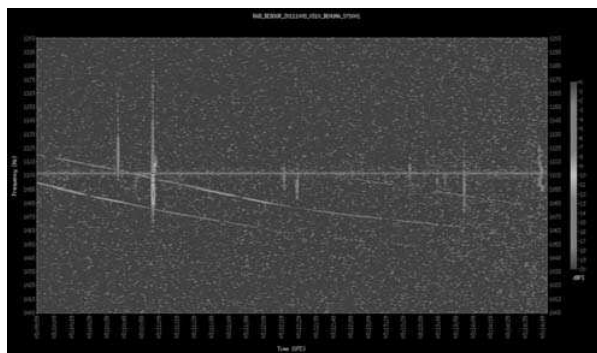

Figure 2 – Example of a spectrogram for the data recorded at Humain on 9 October 2011 at 3^h10^m UT.
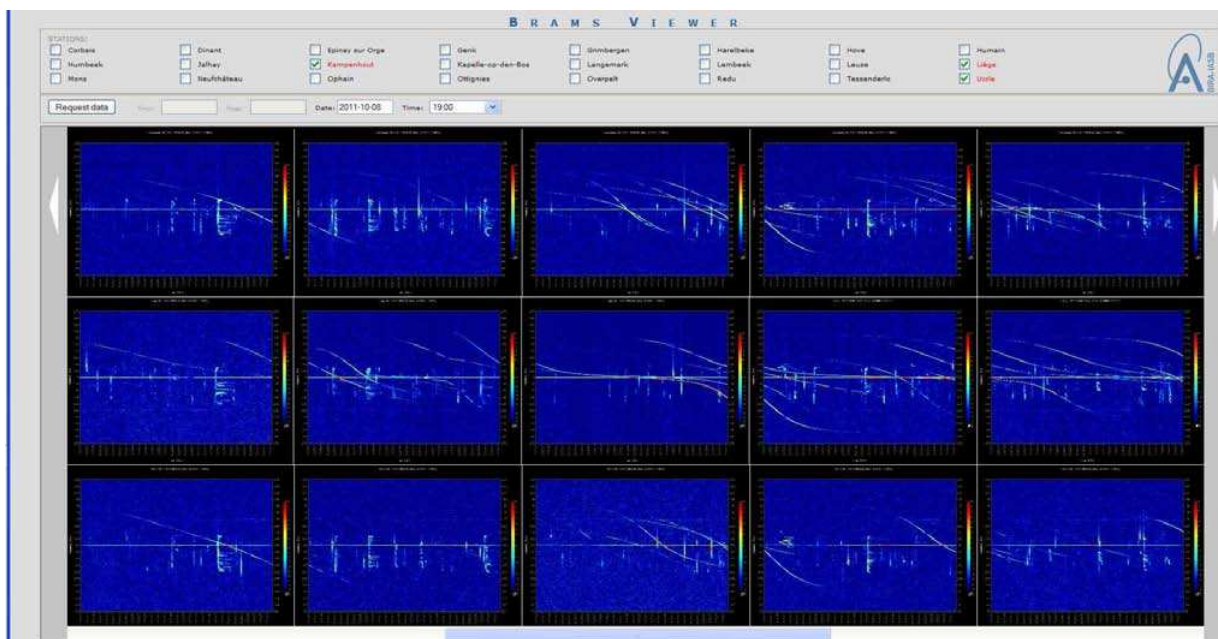
Figure 3 – Visualisation window in the BRAMS Viewer. The output of three stations, from top to bottom, Kampenhout, Liège and Uccle, is shown on 8 October 2011 at 19^h00^m UT. The Draconids outburst is clearly visible with a lot of overdense echoes.

The long-lasting S-shaped echoes are reflections on airplanes of radio waves coming from the beacon. The vertical lines are meteor trail echoes. Most of them are probably underdense meteor echoes, but, due to the limited-time resolution of these spectrograms, this can only be confirmed when looking at the power profiles in the raw data. (Underdense meteors are characterized by a sharp increase of the received power followed by a quick exponential decay due to ambipolar diffusion of electrons in the surrounding neutral atmosphere. Typical durations are a few tenths of a second; see McKinley, 1961).

On the other hand, the echo at around $3^h10^m05^s$ UT is definitely an overdense echo as its duration is in the order of a few seconds.

Spectrograms are very useful tools to analyze BRAMS data.

First, they allow to discriminate meteor echoes from spurious echoes, such as reflections on airplanes or local interferences. This is easily done by eye, but is much more complicated to do automatically. Since the BRAMS network produces approximately 7000 similar spectrograms per day, an automatic method for counting meteor echoes is mandatory and is currently in development at BISA.

Second, the spectrograms also carry information about line-of-sight (LOS) speeds which can be obtained by measuring the Doppler shifts. Speeds of trail echoes may reflect thermal speeds of diffusing electrons or shear winds at high altitudes (or possibly a combination of both). Speeds from head echoes (not shown in Figure 2) are directly related to the speed of meteoroids themselves.

These data and tools are now available for external users through an on-line facility called the BRAMS Viewer[1].

The user has the possibility to select several BRAMS stations, a particular date and time, and request the data. The BRAMS Viewer then accesses the online raw data and computes the spectrograms if data are available. By default, spectrograms are generated by slots of one hour, yielding a total of maximum 12 per station if all data are available. An example is shown in Figure 3 for three stations (Kampenhout, Liège, and Uccle) on 8 October 2011 at 19^h00^m UT, during the Draconids outburst.

The visualisation window allows an easy comparison of the spectrograms, e.g., to see if a given meteor has produced several echoes at specific stations, and, hence, if these multi-stations echoes can be used to retrieve the trajectory of the corresponding meteoroid. If the user wants to look in more detail at the spectrograms, a click on one of the thumbnails opens a new window and loads a larger version of the spectrogram. In this window, a number of buttons also gives the possibility for the user to (1) browse through (previously selected) stations at the same time and to compare the spectrograms; (2) see all the spectrograms generated for the hour selected at the specific station; and (3) save the spectrogram in PNG format or the corresponding raw data in WAV format.

Due to storage constraints, currently only data from the last 6 months are kept online and are accessible via the BRAMS viewer. Registered users will soon be able to also access previously archived data via requests sent through the website.

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[1]See http://brams.aeronomie.be/pages/brams_viewer.

3 Conclusions

The BRAMS network is nearly fully operational and provides approximately 22 GB of data every day. These data are collected every month and saved on-line at BISA. The BRAMS Viewer is a very useful on-line tool that allows users to select and download the data. It is constantly being improved with new additional functionalities.

Acknowledgements

References

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IMO Treasurer Marc Gyssens sitting behind his desk in the conference room. (Credit Bernd Brinkmann.)