

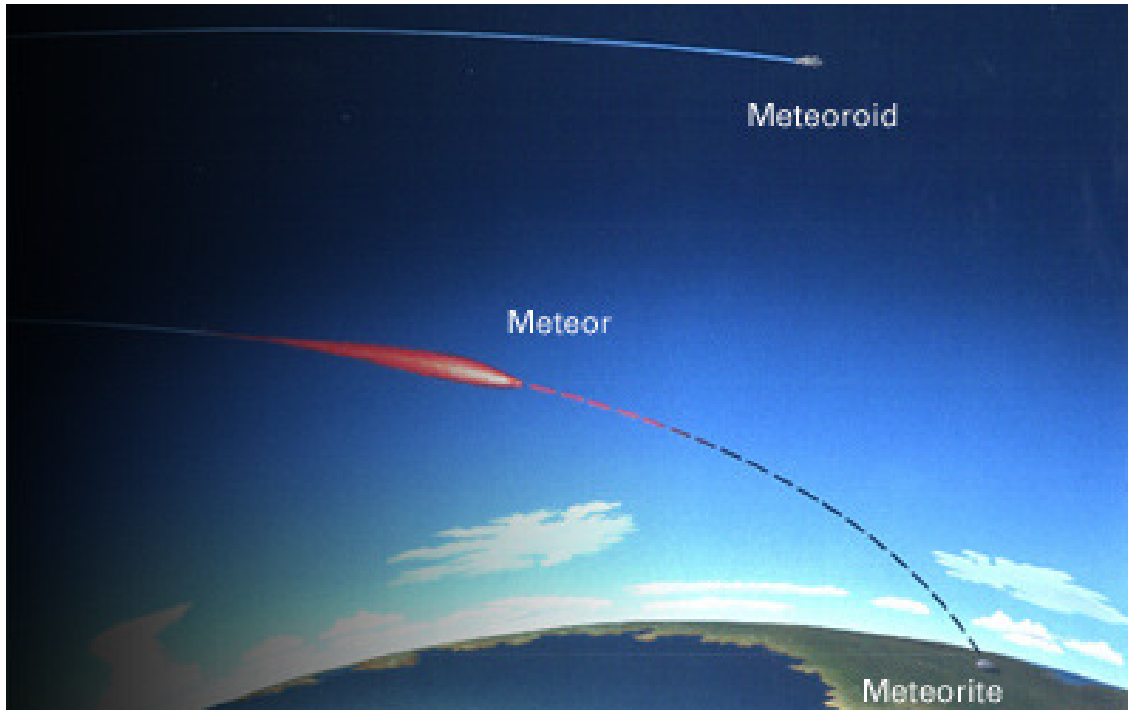
The Radio Meteor Zoo: searching for meteors in BRAMS radio observations

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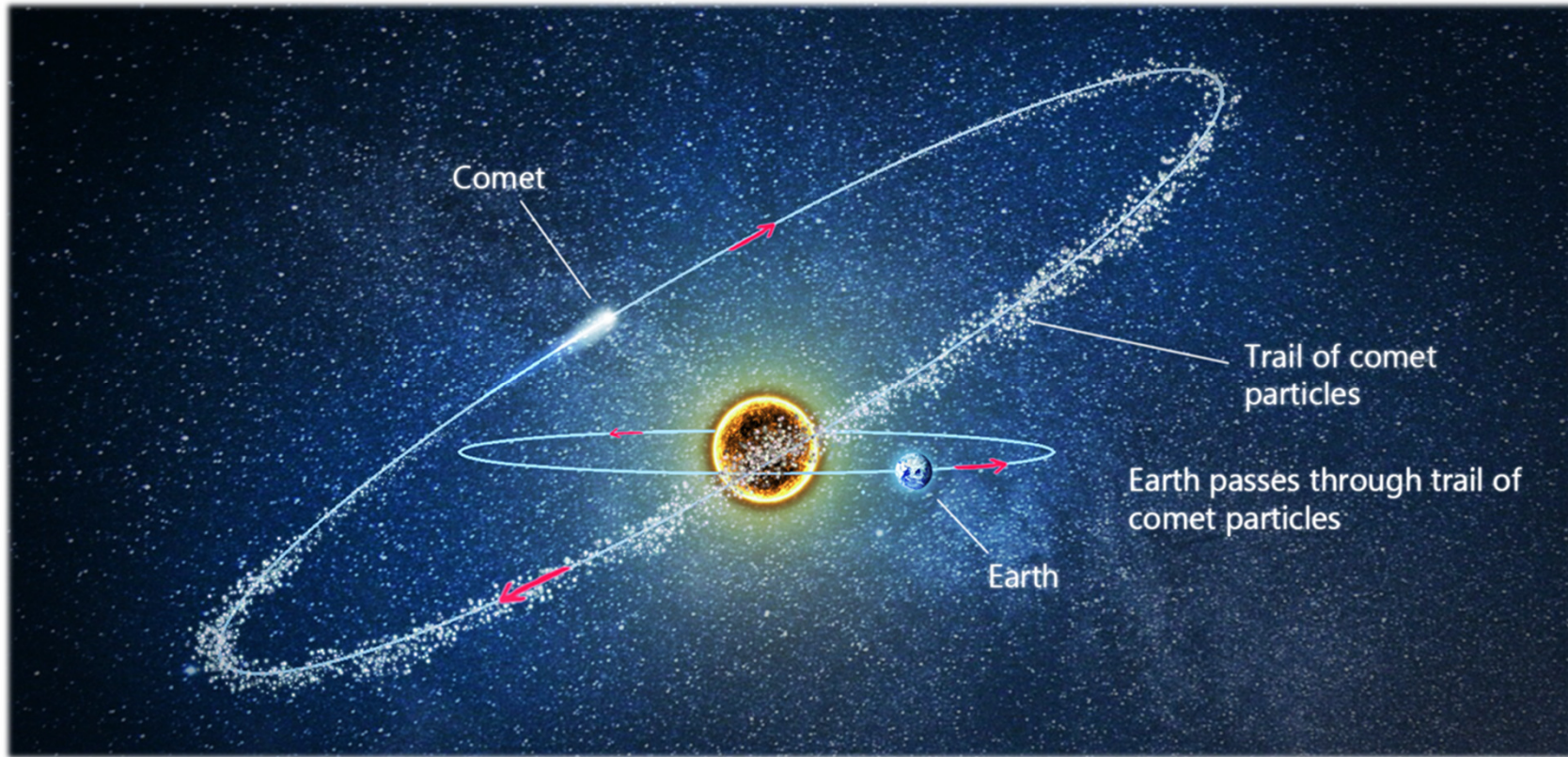
Meteors



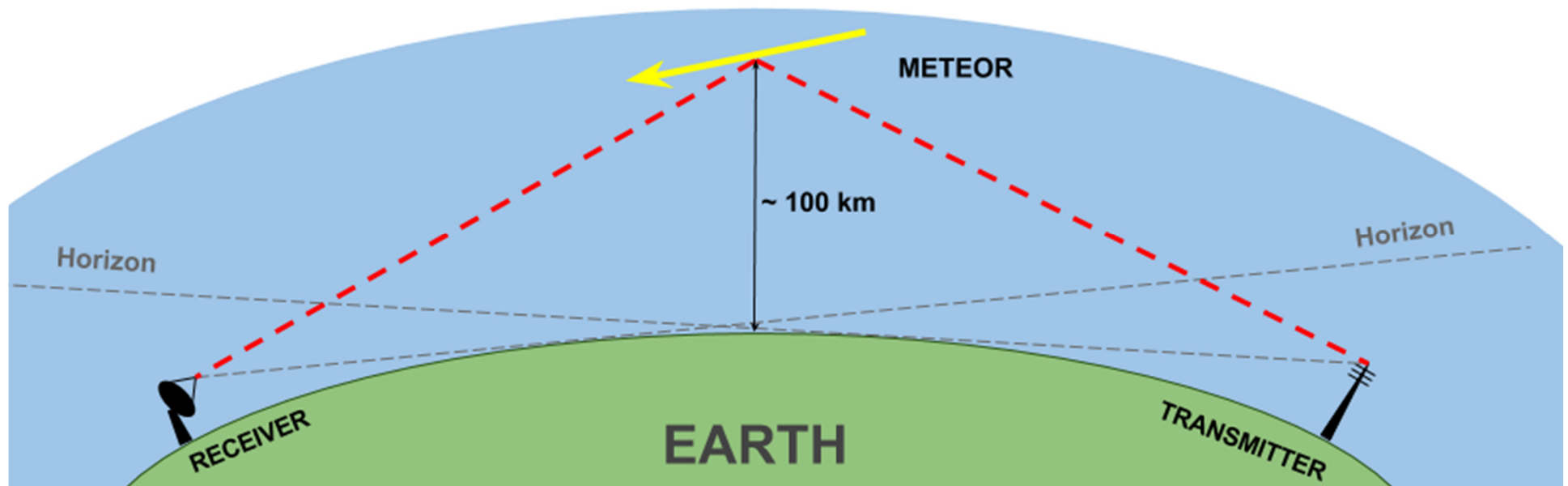
Two populations :

- Sporadics (background)
- Meteor showers

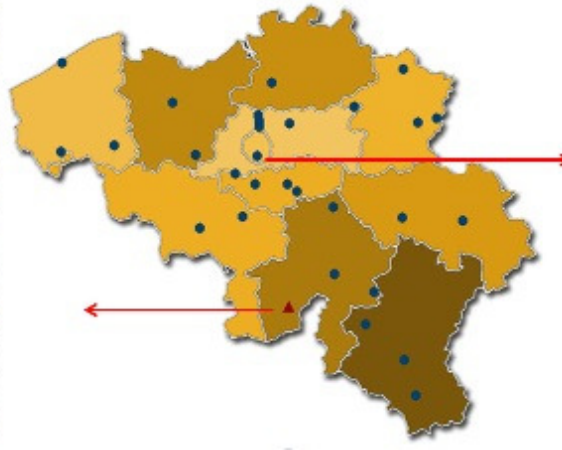
Meteor shower



Forward scatter radio obs of meteors



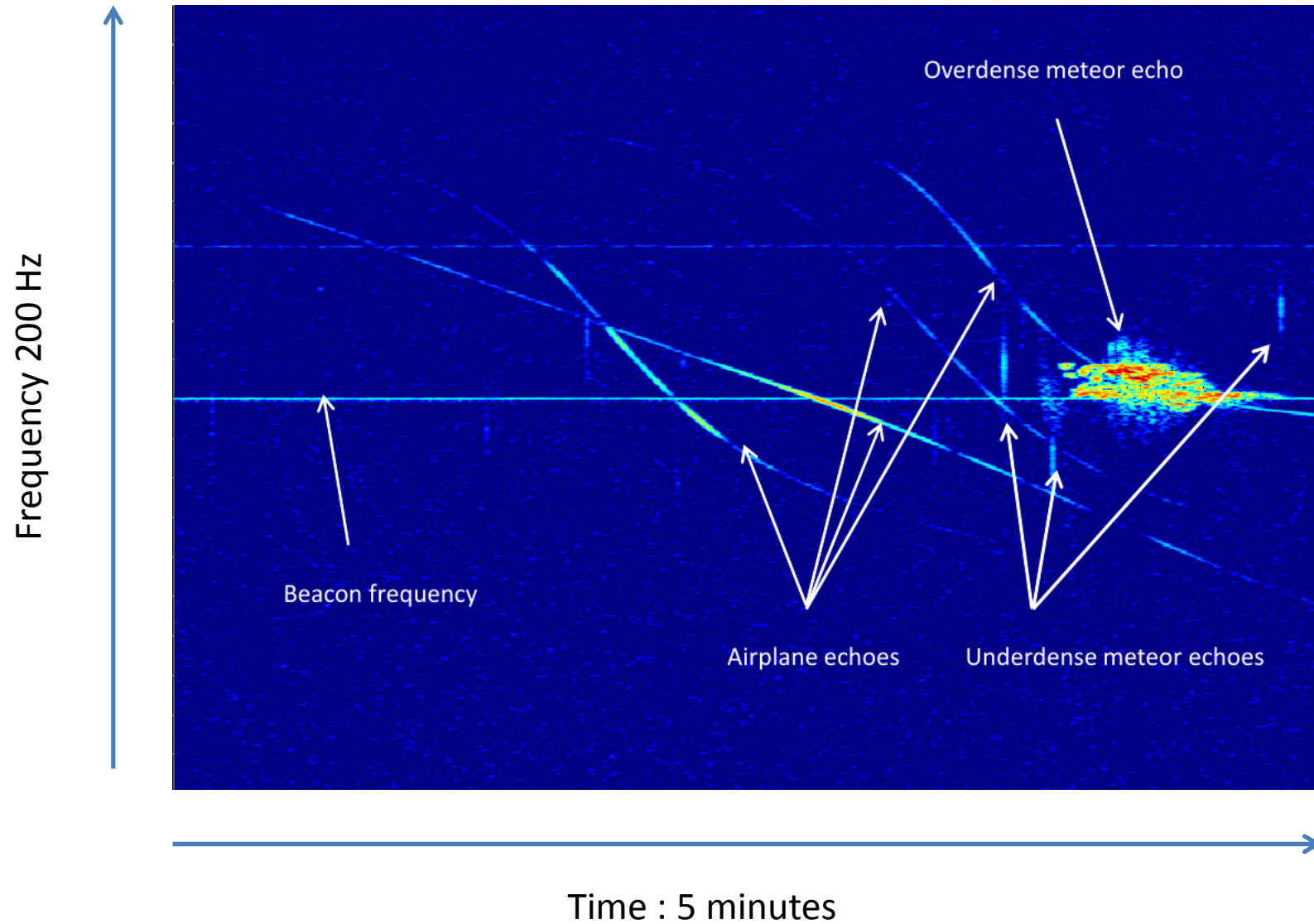
The BRAMS network



$f = 49.97 \text{ MHz}$

$P = 150 \text{ W}$

The BRAMS data



The BRAMS data

- 288 files every day per station
- 25 stations
- > 7000 images generated per day
- ~ 50000-70000 meteor echoes detected per day

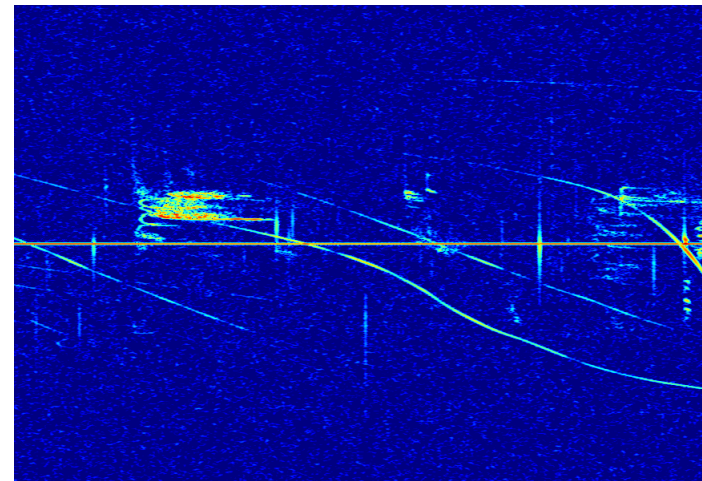
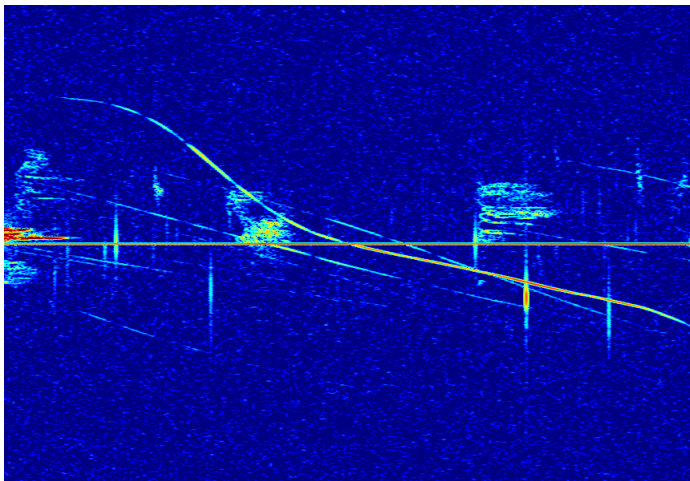
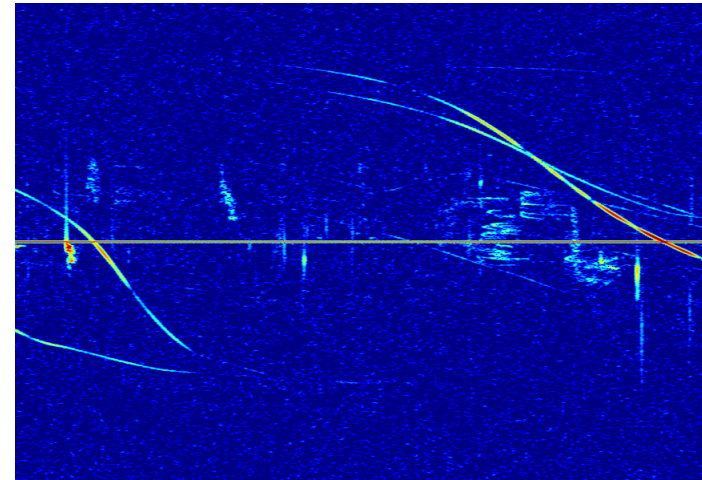
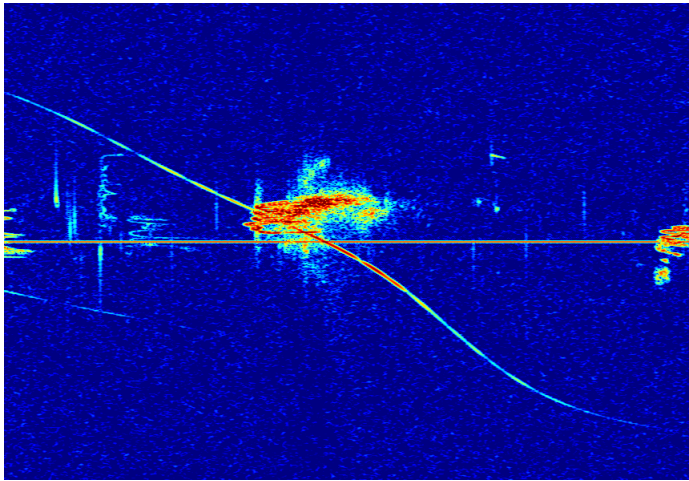


Automatic detection algorithms

- Work well for underdense meteor echoes
- Not so well for overdense meteor echoes



BRAMS data during meteor showers



The Radio Meteor Zoo

The screenshot shows the website's navigation bar with links for PROJECTS, ABOUT, GET INVOLVED, TALK, BUILD A PROJECT, NEWS, NOTIFICATIONS, MESSAGES, and HERVÉ LAMY. Below the navigation is a secondary menu with links for RADIO METEOR ZOO, ABOUT, CLASSIFY, TALK, COLLECT, PROJECT WEBSITE, and RESULTS. A blue notification box contains an update about the Perseids 2017 results and a request for help comparing data from different stations. The main content area features a background image of a tree at night and the text 'Help us identify meteors in radio data' with 'Learn more' and 'Get started' buttons. At the bottom, there are three panels of radio meteor data plots and a 'Join in' button next to a notification that 3 people are currently talking about the project.

PROJECTS ABOUT GET INVOLVED TALK BUILD A PROJECT NEWS NOTIFICATIONS MESSAGES HERVÉ LAMY

RADIO METEOR ZOO ABOUT CLASSIFY TALK COLLECT PROJECT WEBSITE RESULTS

UPDATE : Preliminary results of the Perseids 2017 are available in the [Results](#) section.
Now we would like to compare the activity observed by the receiving station in Humain with two other stations, based in Ottignies and Overpelt. So keep hunting for meteors on the Radio Meteor Zoo!
For new users please visit the [FAQ](#) and the recently added Field Guide if you need help to analyze images.
Thank you for your constant support!

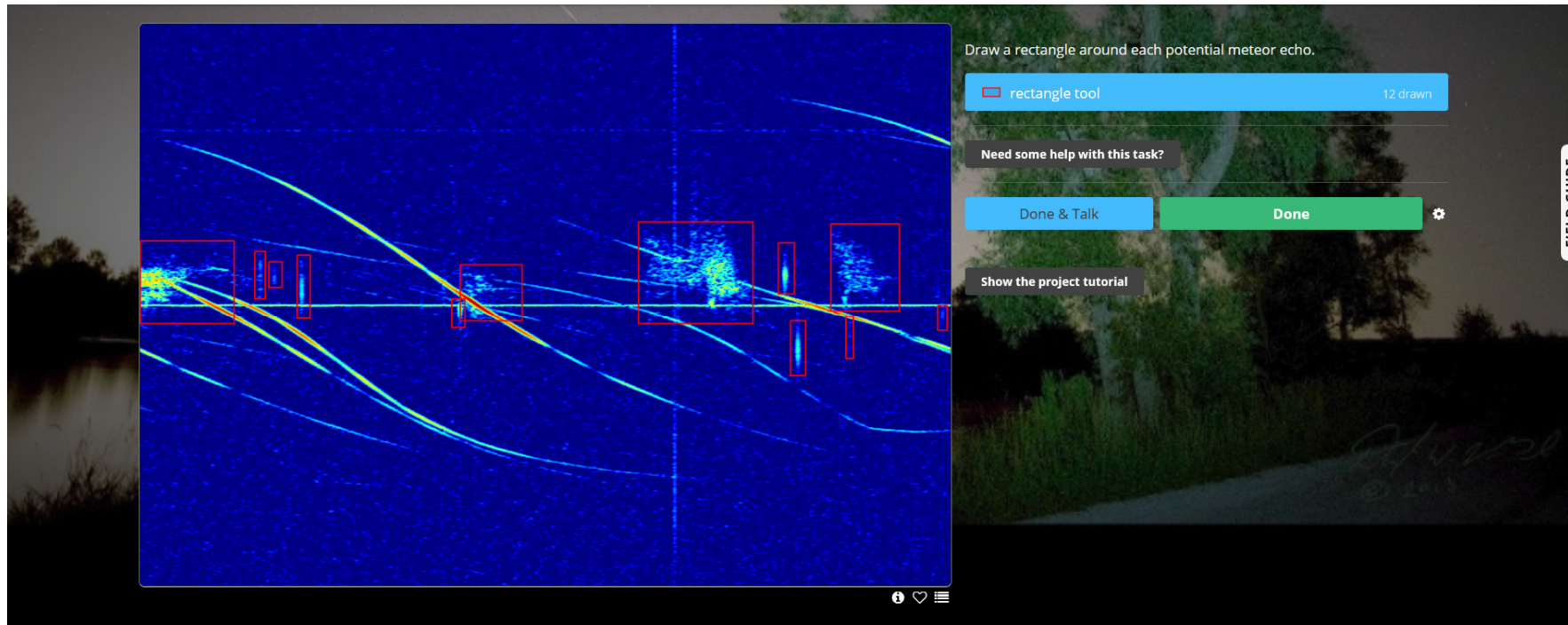
Help us identify meteors in radio data

Learn more Get started

3 people are talking about **Radio Meteor Zoo** right now.

Join in

Task for the citizen scientists



Draw a rectangle around each potential meteor echo.

rectangle tool 12 drawn

Need some help with this task?

Done & Talk Done

Show the project tutorial

FIELD GUIDE

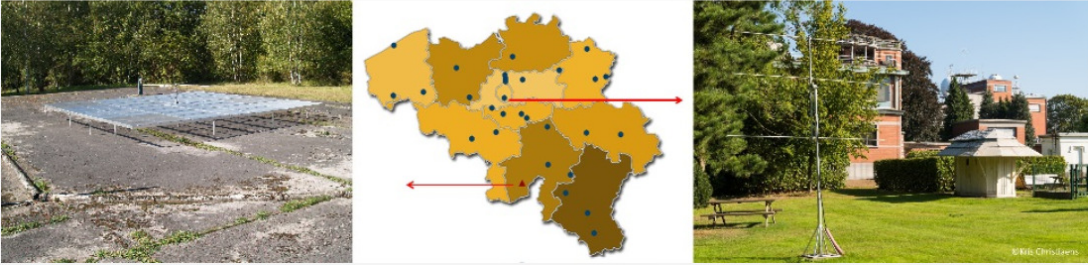
How to teach the citizen scientists?

Research description

Research The Team Results FAQ

Context

[BRAMS](#) (Belgian RAdio Meteor Stations) is a Belgian network of radio receiving stations using forward scattering to detect and characterize meteoroids falling into the Earth's atmosphere.



A dedicated transmitter/beacon (red triangle on the map above) is located in the south of Belgium and emits toward the zenith a pure sine wave at a frequency of 49.97 MHz and with a total power of 150 Watts. The incident radio wave is reflected on the ionized trail left behind the meteoroid when it falls into the atmosphere. About 30 receiving stations (blue dots in the image above) are spread all over Belgium and record radio signals reflected off meteor trails (hereafter called meteor echoes). Pictures of the transmitter and of one receiving antenna (located in Uccle) are visible respectively in the left/right parts of the image above.

Radio observations have two main advantages over optical ones : 1) data can be recorded 24h a day and do not depend on weather conditions, 2) they are sensitive to meteoroids with lower masses that do not produce any visible light but are much more numerous.

Every day a huge amount of data is produced by the BRAMS network with thousands of meteor echoes registered, which requires the use of automatic detection algorithms. BRAMS radio data are usually presented as images (called spectrograms, see definition below) and automatic detection algorithms try to detect specific shapes associated with meteor echoes. However, none of them can perfectly mimic the human eye which stays the best detector.

With this Radio Meteor Zoo project we focus on meteor showers, which are mainly due to dust particles released on its orbit by a comet when it approaches the Sun. The Perseids around August 12 are a well-known example of a meteor shower. During a meteor shower, many radio meteor echoes display complex shapes in BRAMS data and automatic detection algorithms struggle to detect them correctly. This is where the Radio Meteor Zoo volunteers come in. You can help us a lot by identifying meteor echoes during meteor showers.

Long & detailed explanation → for hard-core fans

Quick tutorial

The screenshot shows the 'Radio Meteor Zoo' website interface. At the top, there is a navigation bar with links: PROJECTS, ABOUT, GET INVOLVED, TALK, BUILD A PROJECT, NEWS, NOTIFICATIONS, MESSAGES, and HERVÉ LAMY. Below this, a secondary navigation bar includes RADIO METEOR ZOO, ABOUT, CLASSIFY, and TALK. The main content area features a blue banner with text: 'UPDATE : Preliminary...', 'Now we would like to compare the activity observed by the receiving station in...', and 'For new users please visit the EA...'. A large spectrogram is displayed, showing a dense field of blue dots with several bright, curved lines. A white tutorial overlay is positioned in the center, titled 'What do we see in these images?'. The text in the overlay explains the axes (time and frequency), the horizontal signal, and the nature of meteor echoes. At the bottom of the overlay is a 'Continue' button and a progress indicator. A red circle highlights a link labeled 'project tutorial' in the bottom right corner of the overlay, with a red arrow pointing downwards from it.

Limited information about what you see in these images, the task requested and the most obvious mistakes.

Forum

Radio Meteor Zoo Talk



Search or enter a #tag

 Moderator Controls

Notes


General comment threads about individual subjects. We speak English, Dutch, French or Spanish.




 [Hydrangea](#) Subject 11937525 *13 hours ago*

 260 Participants
 1837 Discussions
 2899 Comments

Moderators


Discussions between moderators




 [ElisabethB](#) **MODERATOR** Counters seem to be stuck (again) *9 days ago*

 4 Participants
 11 Discussions
 56 Comments

Chat

Everything you want to know about meteors but were afraid to ask :-)



 [Stijn Calders](#) **RESEARCHER** **RESEARCHER** **TEAM** Finished ??? *20 days ago*

 21 Participants
 16 Discussions
 73 Comments

Science


A place to talk about the science behind the Radio Meteor Zoo and related research


 [Stijn Calders](#) **RESEARCHER** **RESEARCHER** **TEAM** Perseids 2017: preliminary results *20 days ago*

 29 Participants
 37 Discussions
 154 Comments

Help

A place to ask questions about the classification interface, report bugs, and get general help about the Radio Meteor Zoo

 [Hervé Lamy](#) **RESEARCHER** **RESEARCHER** **TEAM** Selection tool on tablet *22 days ago*

 21 Participants
 22 Discussions
 68 Comments

Recent Comments

Popular Tags:

[overdense](#)
[epsilon](#)
[complex](#)
[c-echo](#)
[multiple](#)
[m-echo](#)
[interesting](#)
[intense](#)
[echo](#)
[overlap](#)
[alotofplanes](#)
[continues](#)
[epsilon-type](#)
[overlapping](#)
[underdense](#)
[bright](#)
[continued](#)
[beautiful](#)
[meteor-echo](#)
[faint](#)

2 Active Participants:

[Zooniverse2017](#) [Hervé Lamy](#)

Projects:

[Zooniverse Talk](#)
[Scribes of the Cairo Geniza](#)

FAQ

[Research](#)

[The Team](#)

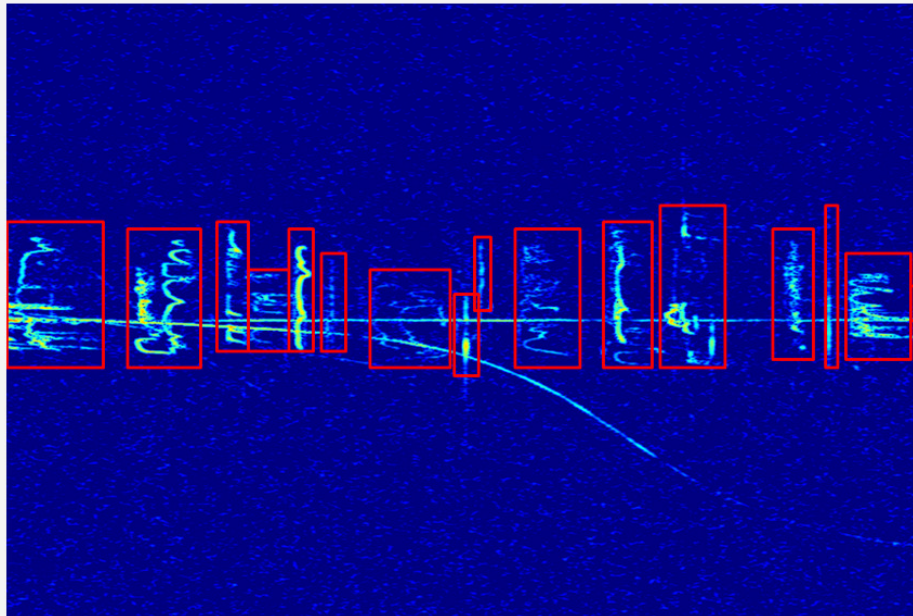
[Results](#)

[FAQ](#)

Example of a very busy spectrogram during active meteor showers and how to count meteor echoes then

As explained in the tutorial, meteor echoes produced during active meteor showers can display extremely complex shapes. These are the ones we are the most interested in because automatic detection algorithms fail to detect them correctly (so far).

Here is an example of an extremely busy spectrogram which was recorded during the peak activity of the Perseids on August 12. This gives you an idea on how to draw the rectangles around these complex shapes. Sometimes they overlap. It does not matter if your rectangles overlap but whenever possible try to avoid it.



FAQ based on recurrent questions in the forum

Field Guide

The screenshot shows the 'CLASSIFY' page of the Radio Meteor Zoo website. The navigation bar includes 'RADIO METEOR ZOO', 'ABOUT', 'CLASSIFY', 'TALK', 'COLLECT', 'PROJECT WEBSITE', and 'RESULTS'. A blue banner at the top contains an update about the Perseids 2017 and a notice for new users. The main content area is titled 'Examples of non-meteor echoes' and features a warning icon. Below the text, there are two spectrograms: the left one shows complex meteor echoes with multiple colored lines, and the right one shows non-meteor echoes with a vertical dashed line and a red arrow pointing to a specific signal.

RADIO METEOR ZOO ABOUT CLASSIFY TALK COLLECT PROJECT WEBSITE RESULTS

UPDATE : Preliminary results of the Perseids 2017 are available in the Results section.

Now we would like to compare the activity observed by the receiving station in Humain with two other stations, based in Orléans and Gisors.

For new users please visit the [FAQ](#) and the recently added Field Guide if you are new to the project.

Thank you for your constant support!

FIELD GUIDE

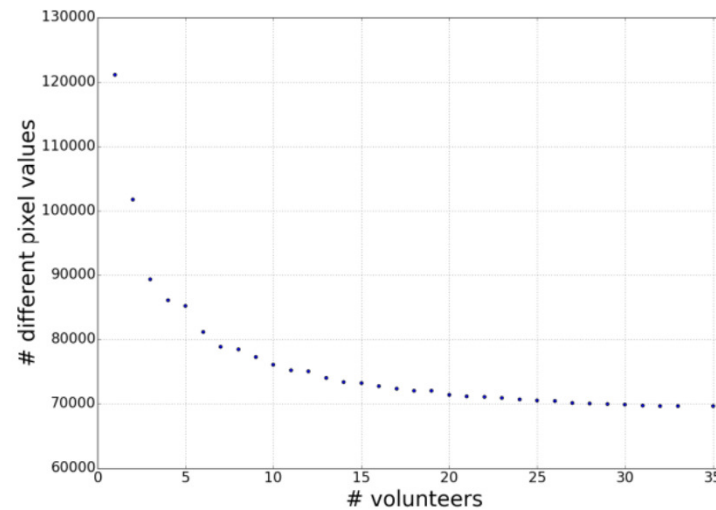
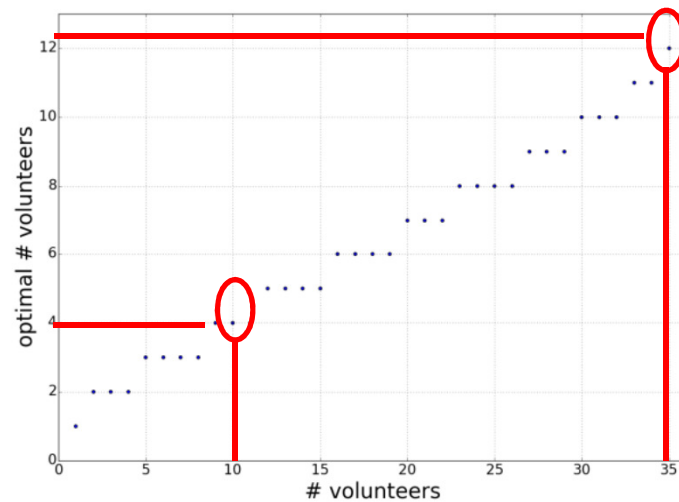
Examples of non-meteor echoes

The following images show examples of signals that are NOT meteor echoes and therefore should not be marked with a rectangle. They are indicated by red arrows. Check the [FAQ](#) for more details about what these signals truly are.

Contains examples of non-meteor echoes & meteor echoes with complex shapes

Optimal number of users

- Small scale test with 35 users and 12 spectrograms
- Comparison of « meteor pixels » in the reference spectrograms (counted by us) and counted by at least k users $\rightarrow D(k)$ for $k=1\dots 35$
- $D(k)$ is minimum for $k_{\text{opt}}=12$ when each spectrogram is counted by 35 users
- In practice we need less people counting so searching for when the number of users = 1, 2, ..., 35



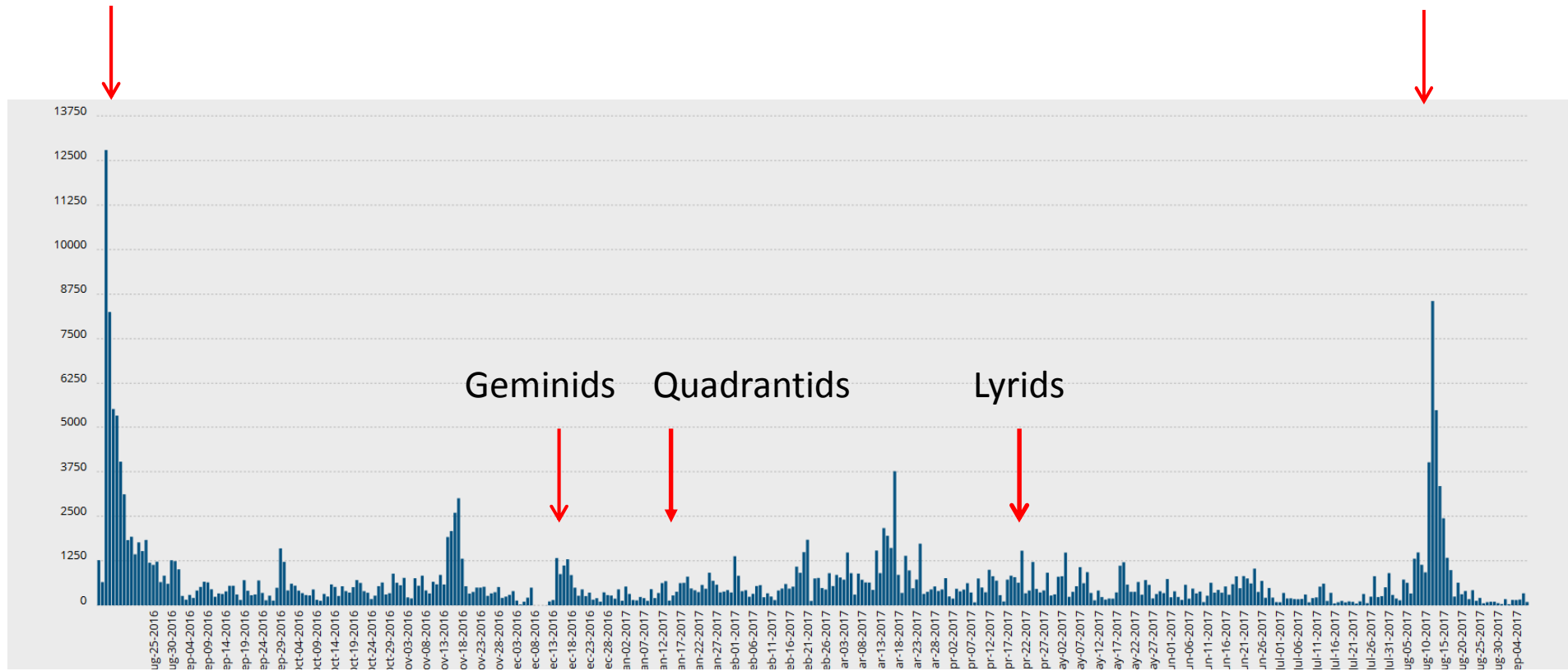
Statistics on 07/09/2017

- Number of uploaded images : 29 006 (~ 100 days of data)
- Number of retired images : 28 838
- Number of registered users : 5235
- Total number of classifications : 309 106
- Meteor showers analyzed so far :
 - Perseids 2016 : 6 stations, 7 days
 - Geminids 2016 : 5 stations, 6 days
 - Quadrantids 2017 : 2 stations, 5 days
 - Lyrids 2017 : 1 station, 5 days
 - Perseids 2017 : 3 stations, 5 days (on-going)

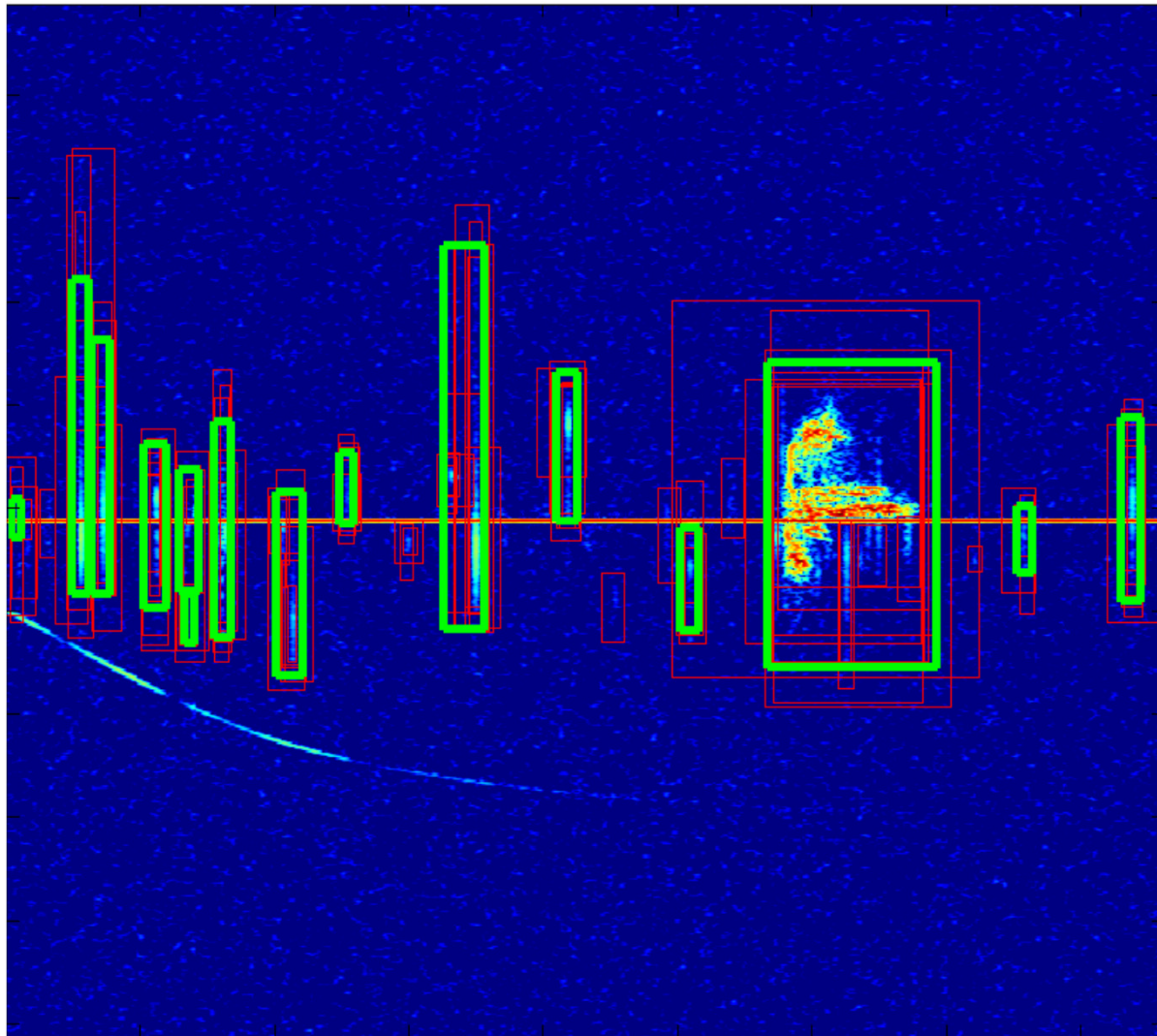
Statistics of one year

Perseids

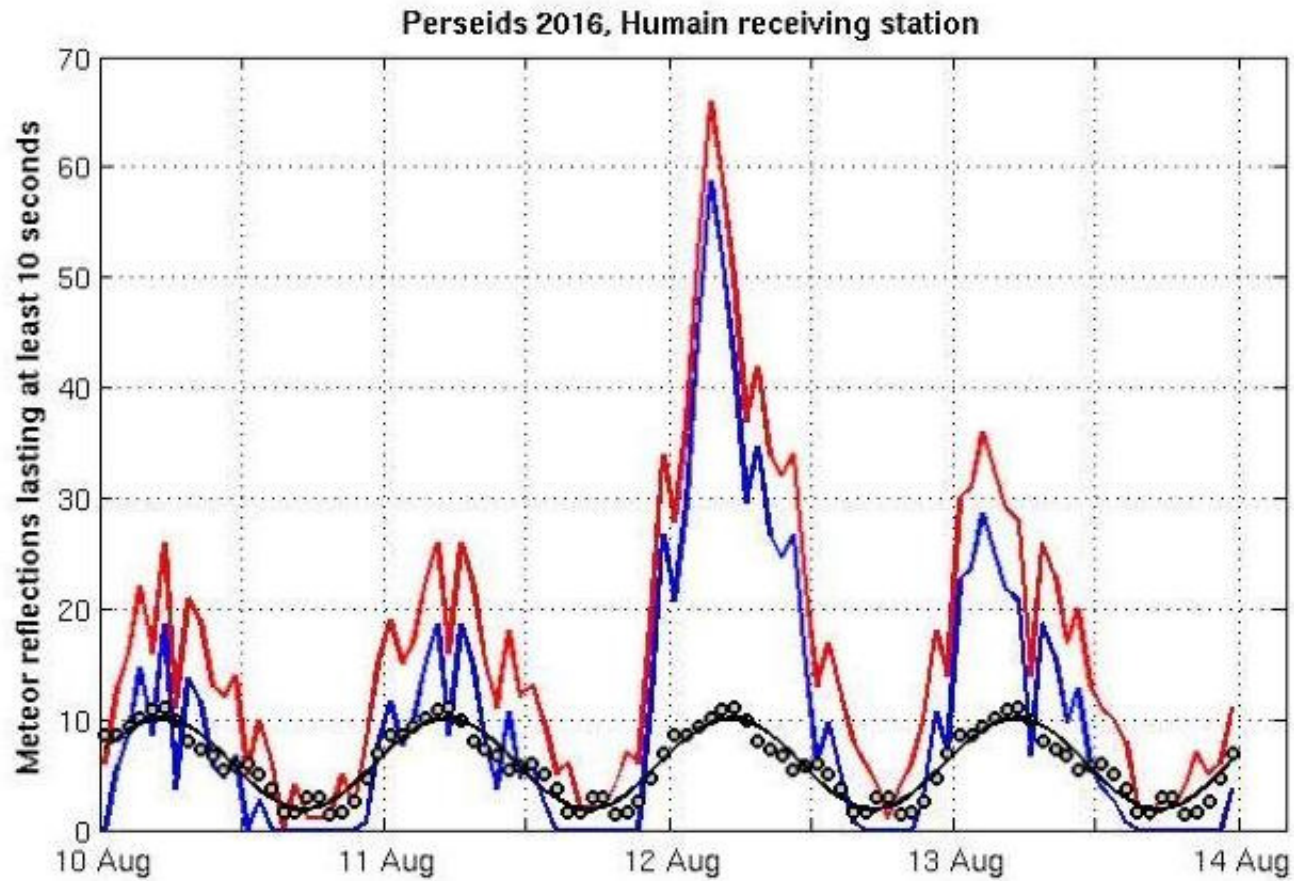
Perseids



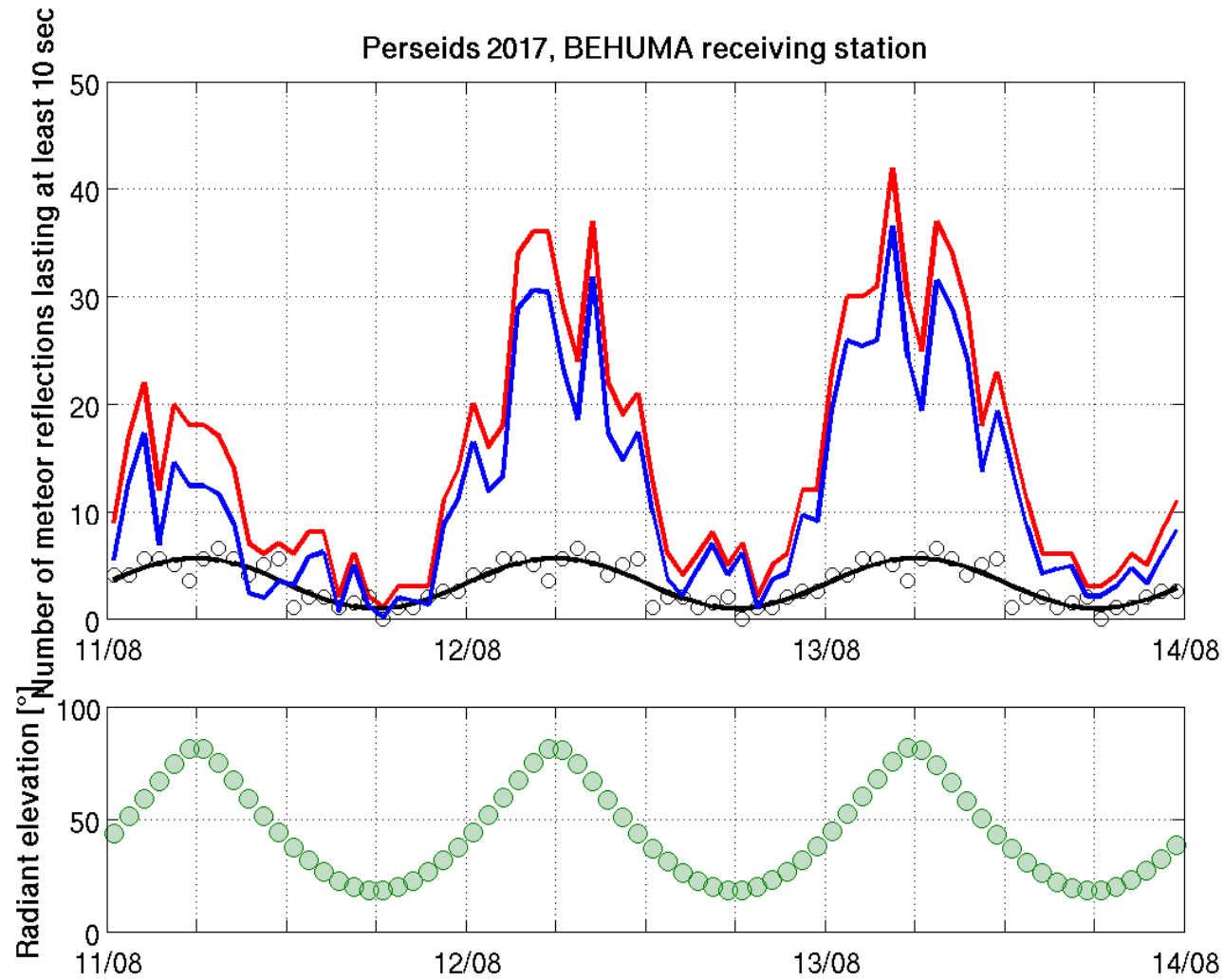
Results : aggregation method



Results : Perseids 2016



Results : Perseids 2017



Improvements

- The current aggregation method provides good results but sometimes creates big rectangles containing several meteor echoes
- So far, each user input has been given the same importance. We plan to introduce weights to favor inputs from very good users and to reject inputs from very bad users
- Teaching is currently mostly done via Tutorial, Field Guide and interaction on the forums. We would like to use « gold standards » which are spectrograms already processed by us but the user doesn't know about it. Once the user has completed his task, he/she would see the correct result and can compare → immediate teaching

Conclusions

- The RMZ has been successful so far, both in terms of science return and in terms of outreach/education
- For the future we intend to continue uploading data regularly but we will mostly focus on meteor shower campaigns with a limited number of stations and days