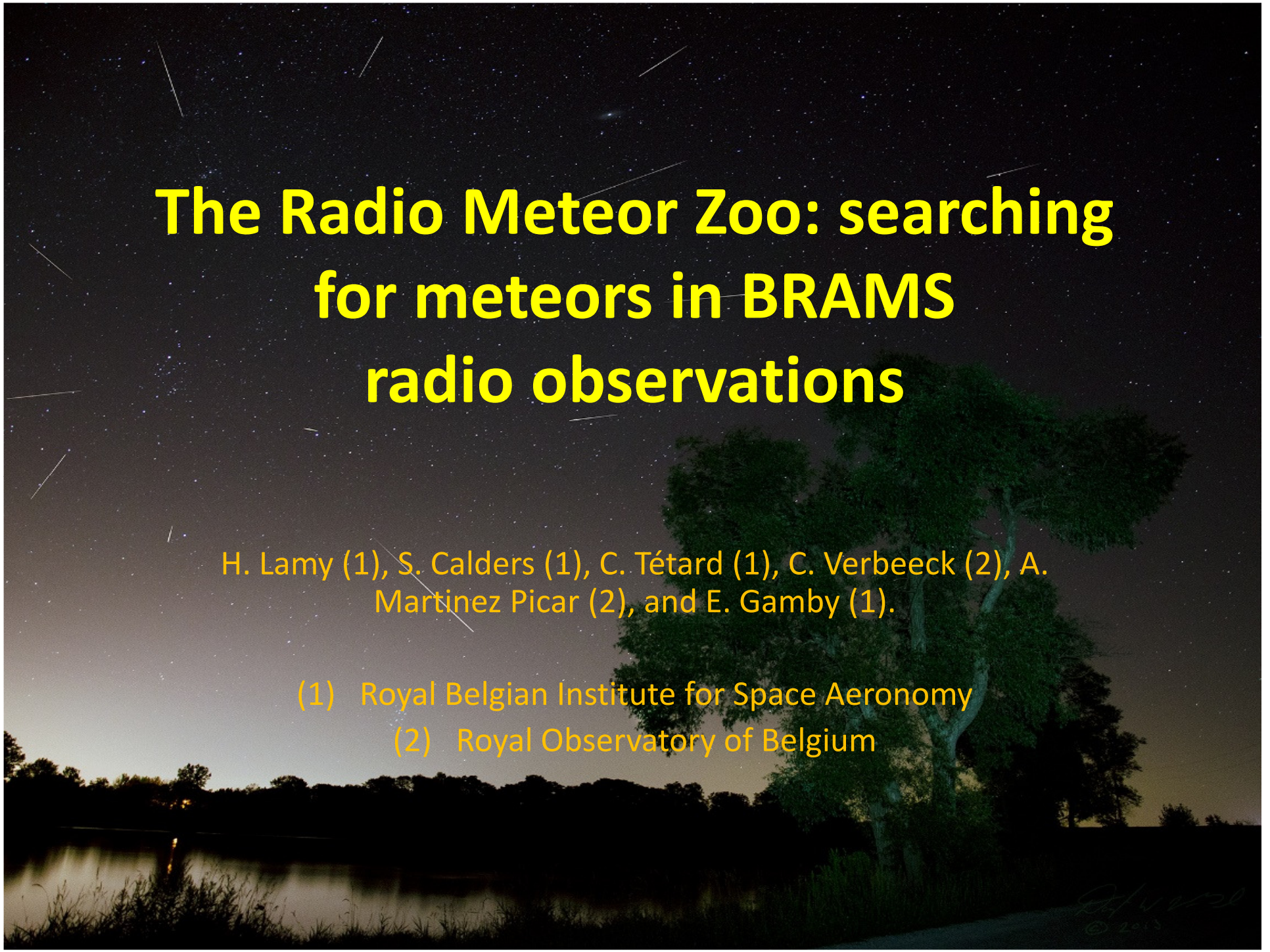

The Radio Meteor Zoo: searching for meteors in BRAMS radio observations

H. Lamy (1), S. Calders (1), C. Tétard (1), C. Verbeeck (2), A. Martinez Picar (2), and E. Gamby (1).

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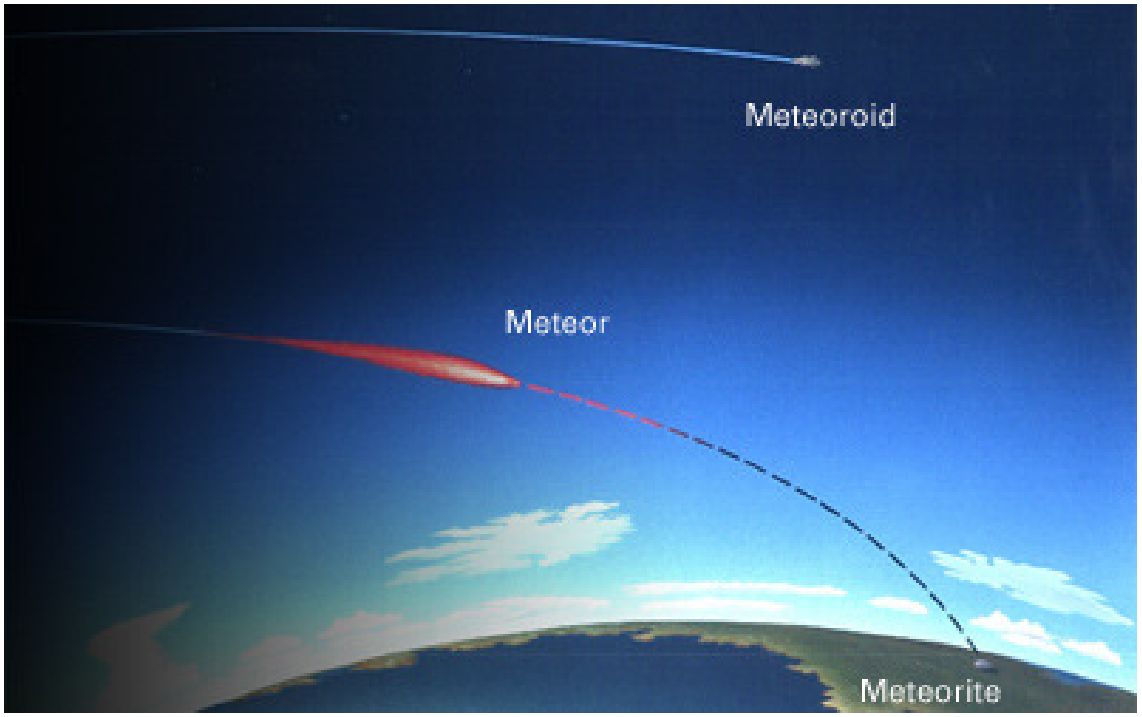
(2) Royal Observatory of Belgium

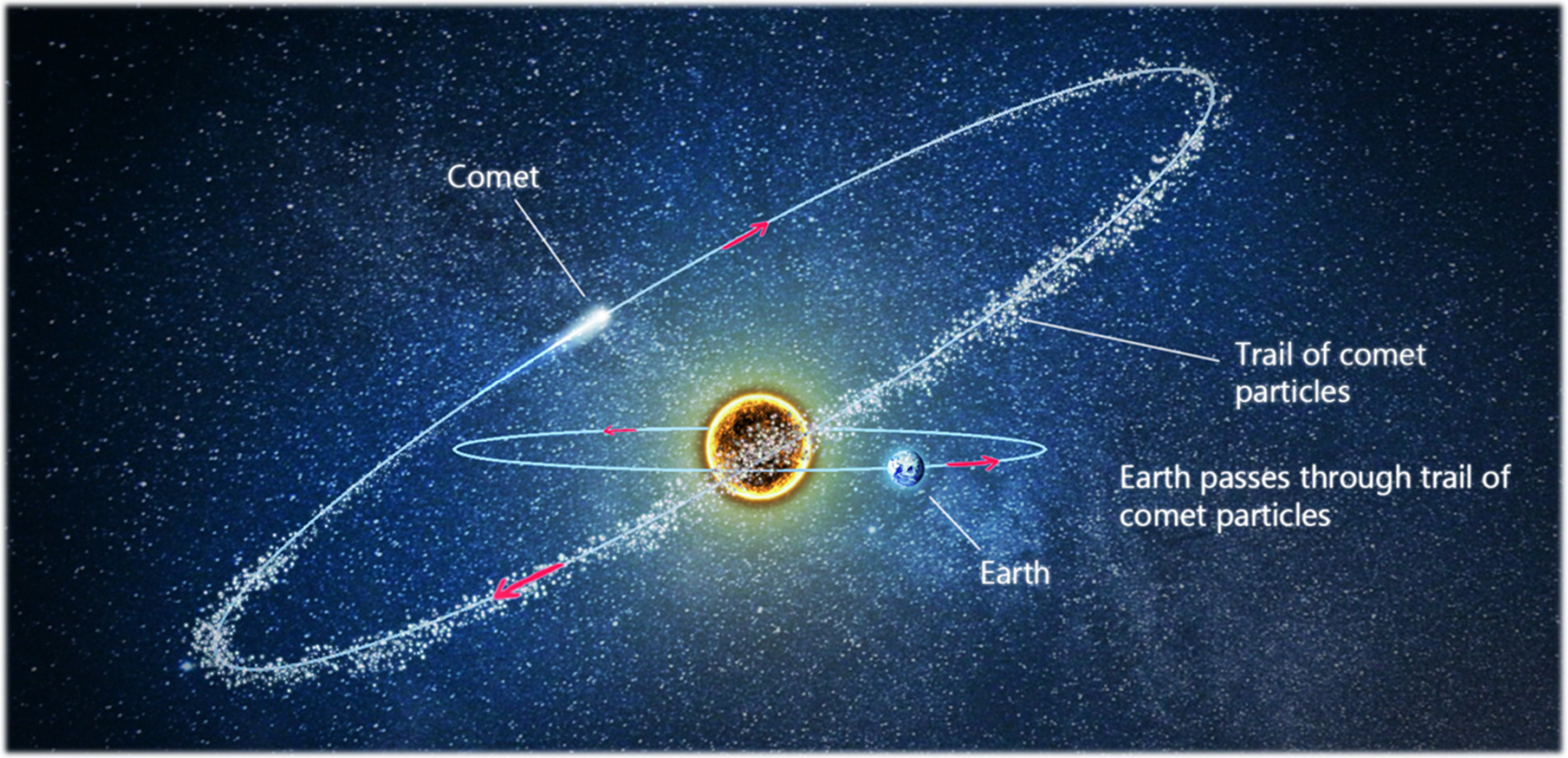
Meteors



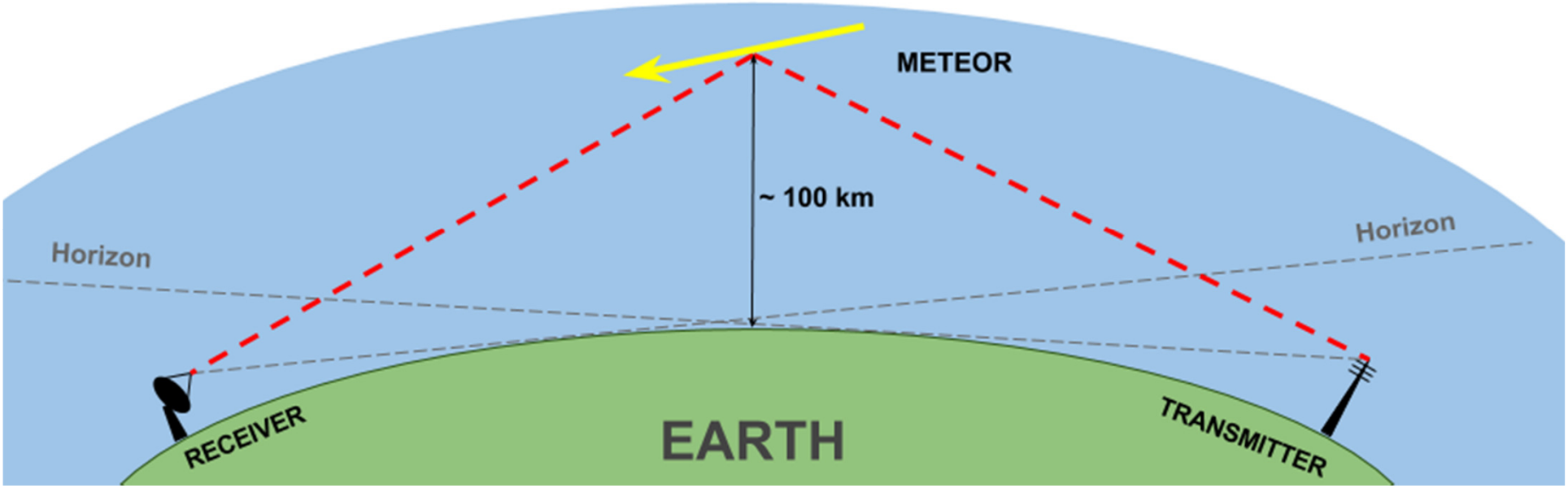
Two populations :

- Sporadics (background)
- Meteor showers

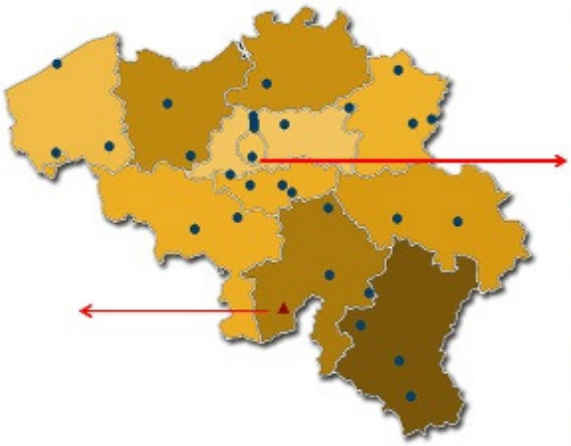
Meteor shower



Forward scatter radio obs of meteors

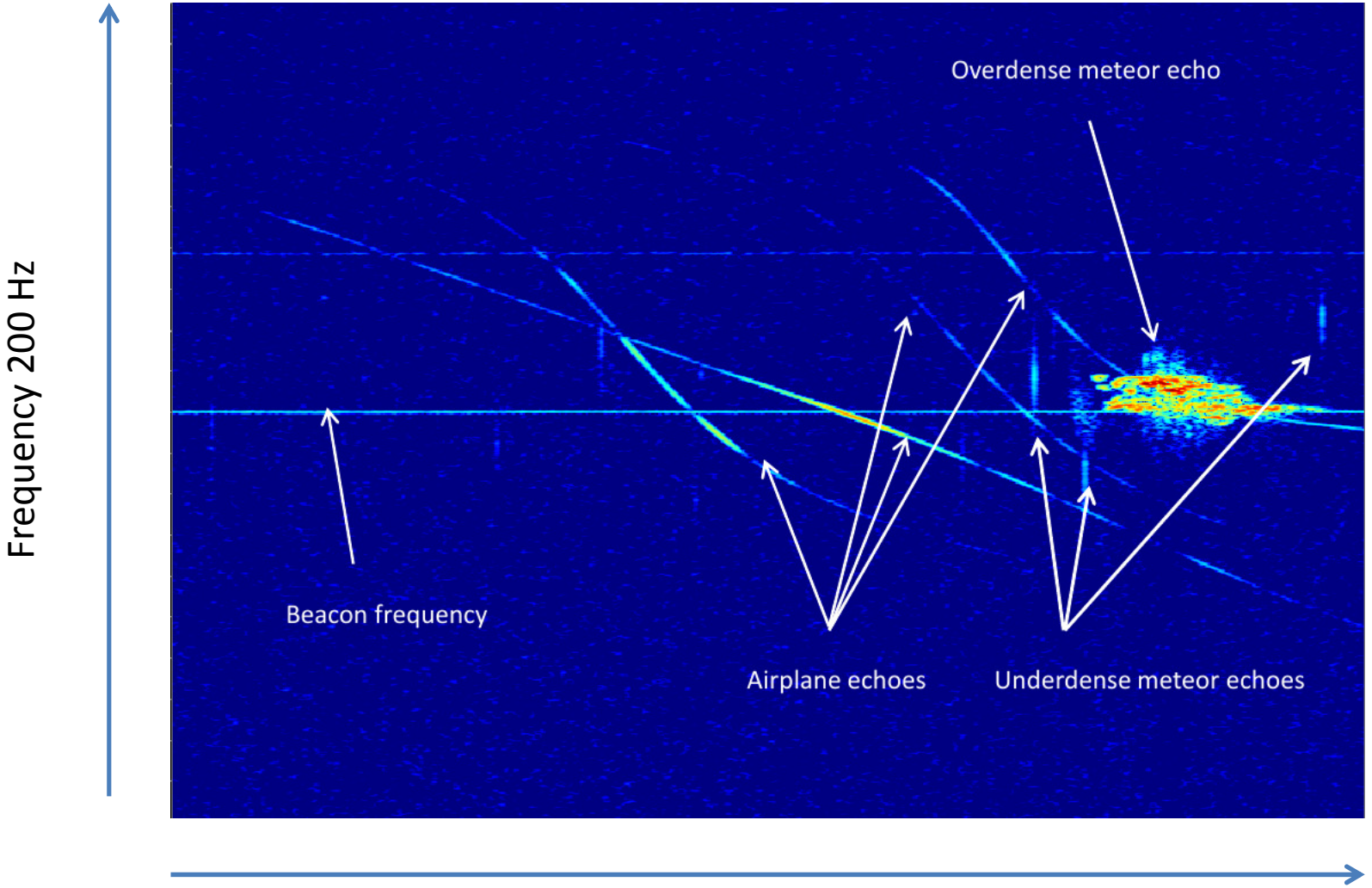


The BRAMS network



f = 49.97 MHz
P = 150 W

The BRAMS data



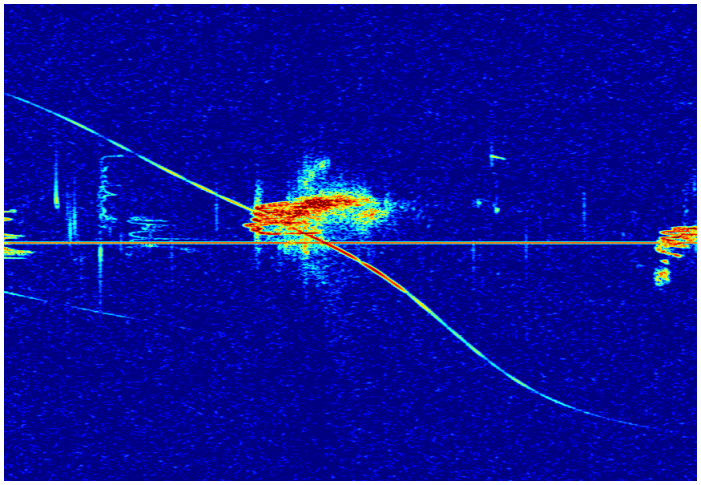
The BRAMS data

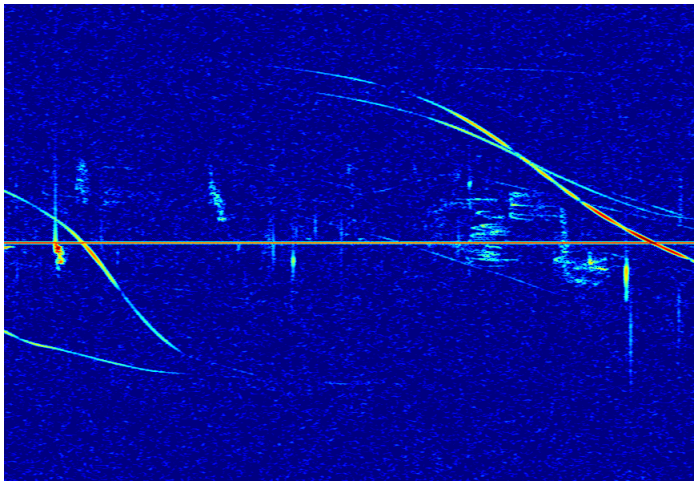
- 288 files every day per station
- 25 stations
- > 7000 images generated per day
- ~ 50000-70000 meteor echoes detected per day

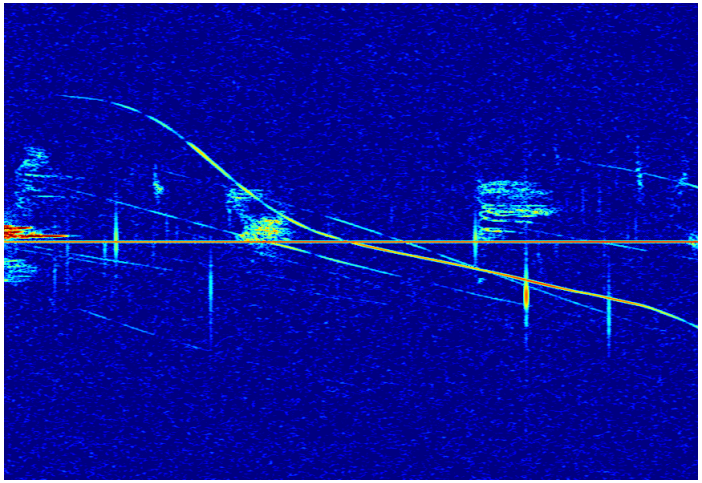
Automatic detection algorithms

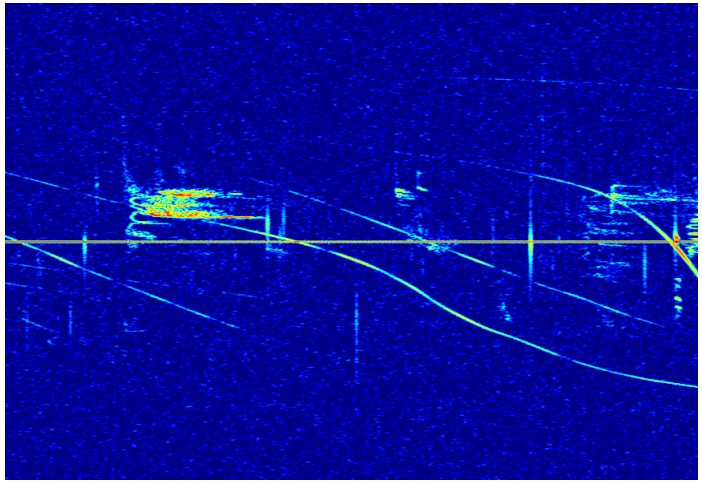
- Work well for underdense meteor echoes
- Not so well for overdense meteor echoes

BRAMS data during meteor showers

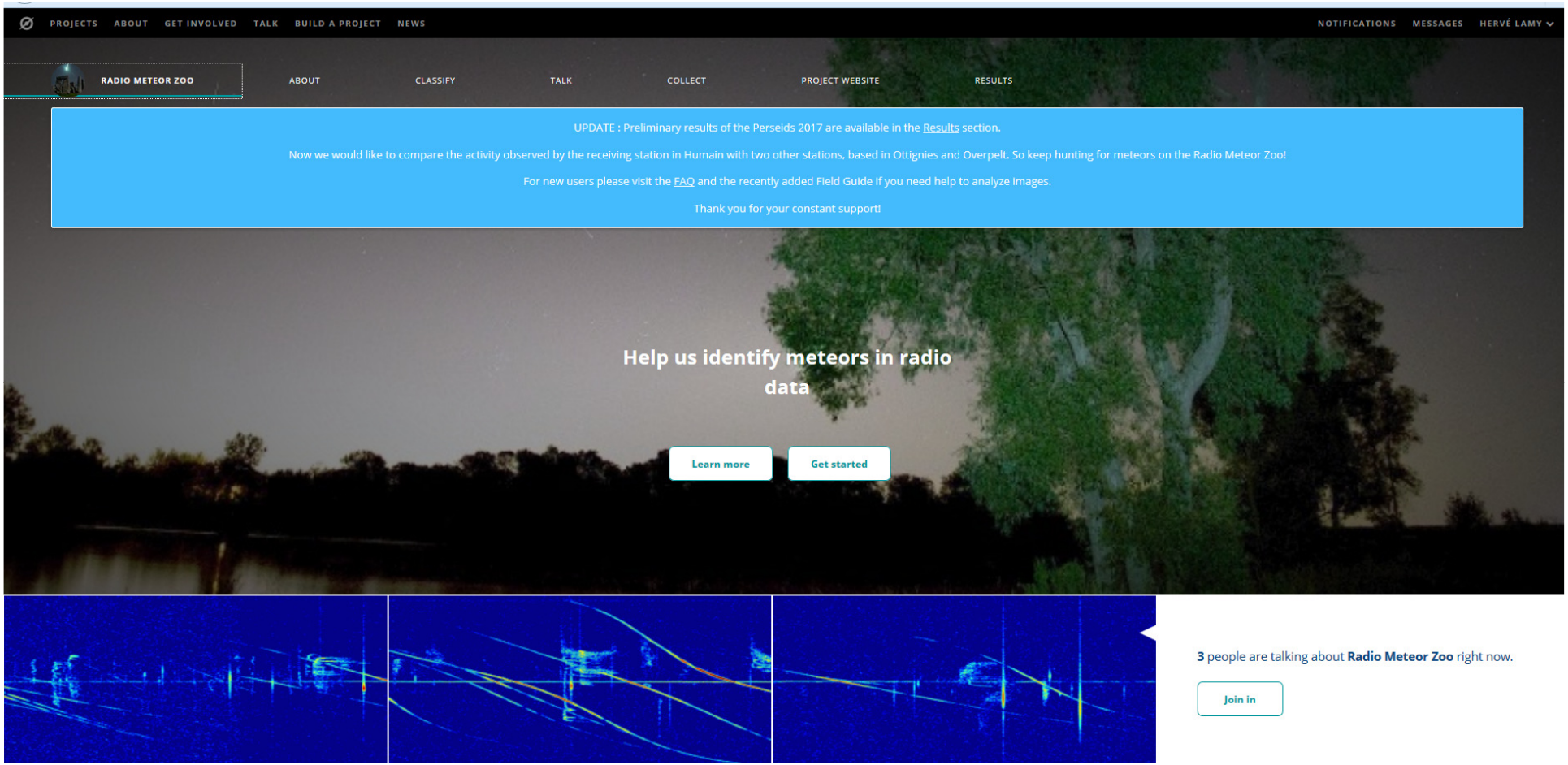




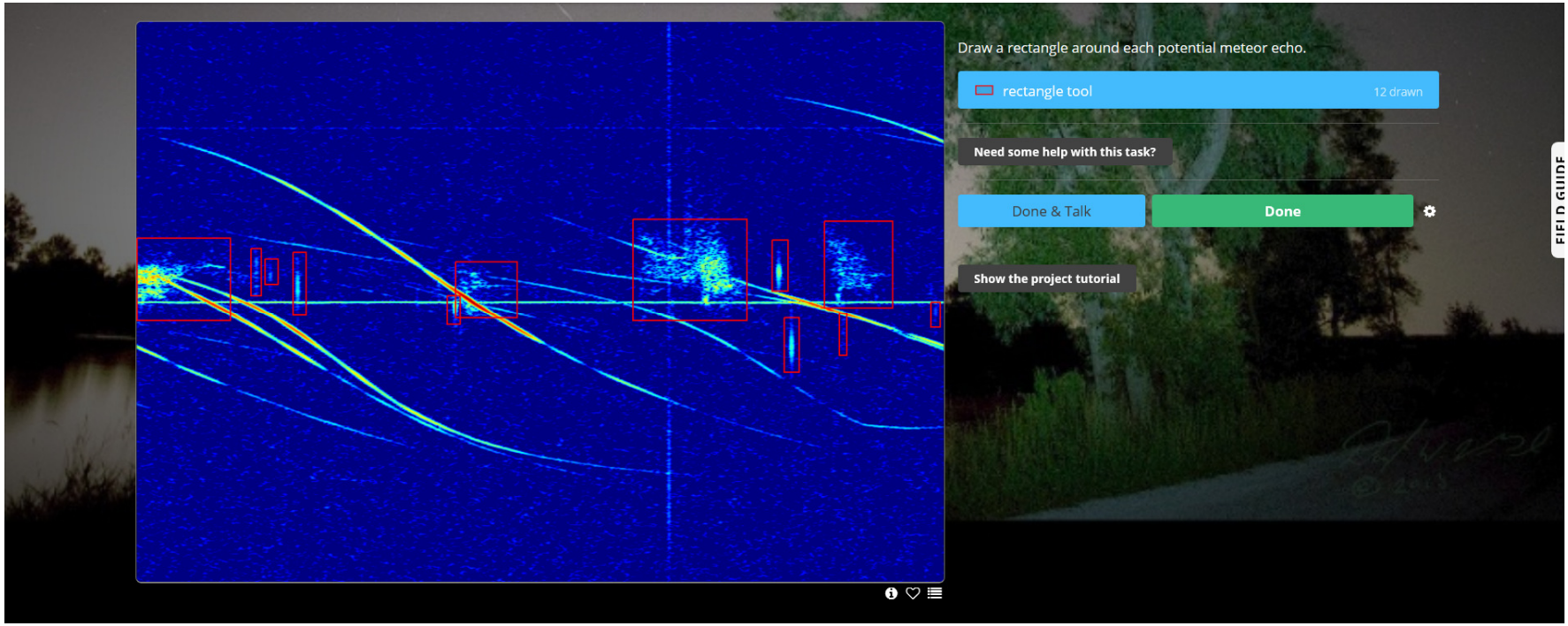




The Radio Meteor Zoo



Task for the citizen scientists



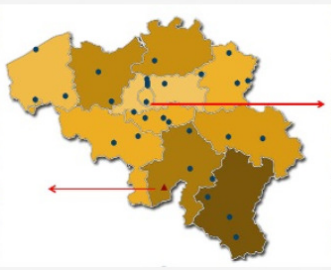
How to teach the citizen scientists?

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.

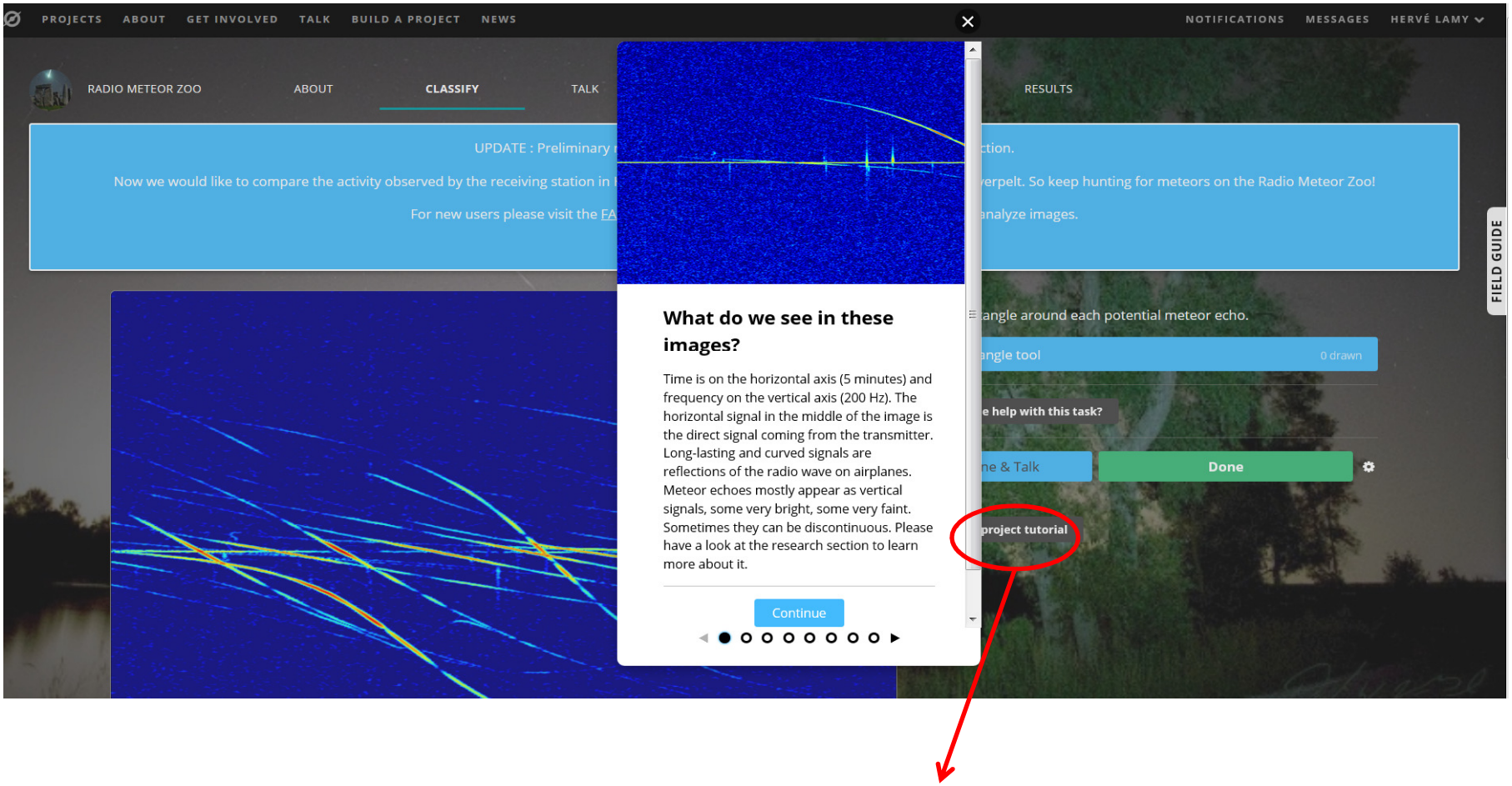
Radio observations have two main advantages over optical ones : 1) data can be recorded 24h a day and do not depend on weather conditions, 2) they are sensitive to meteoroids with lower masses that do not produce any visible light but are much more numerous.

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.

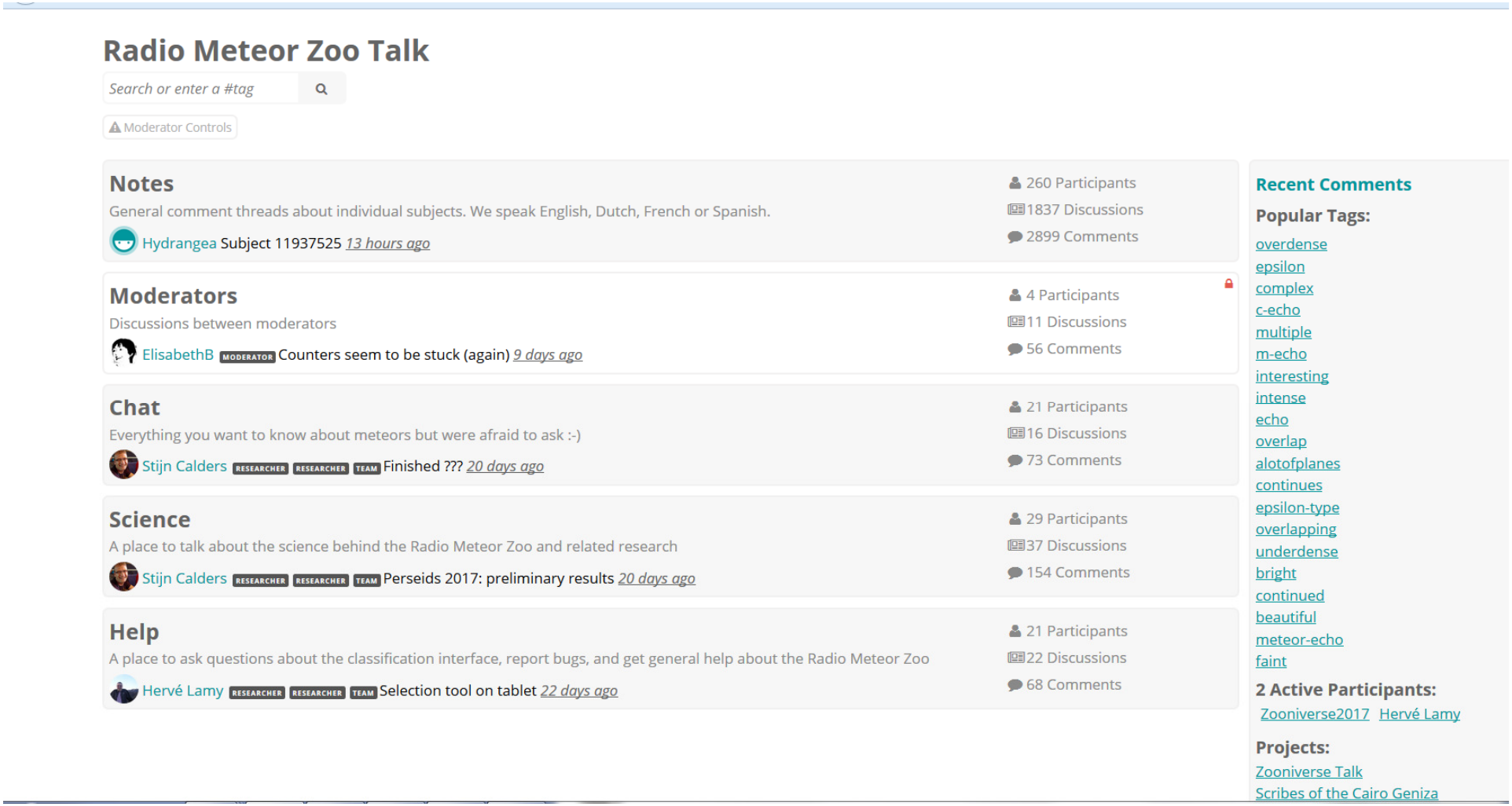
Long & detailed explanation → for hard-core fans

Quick tutorial

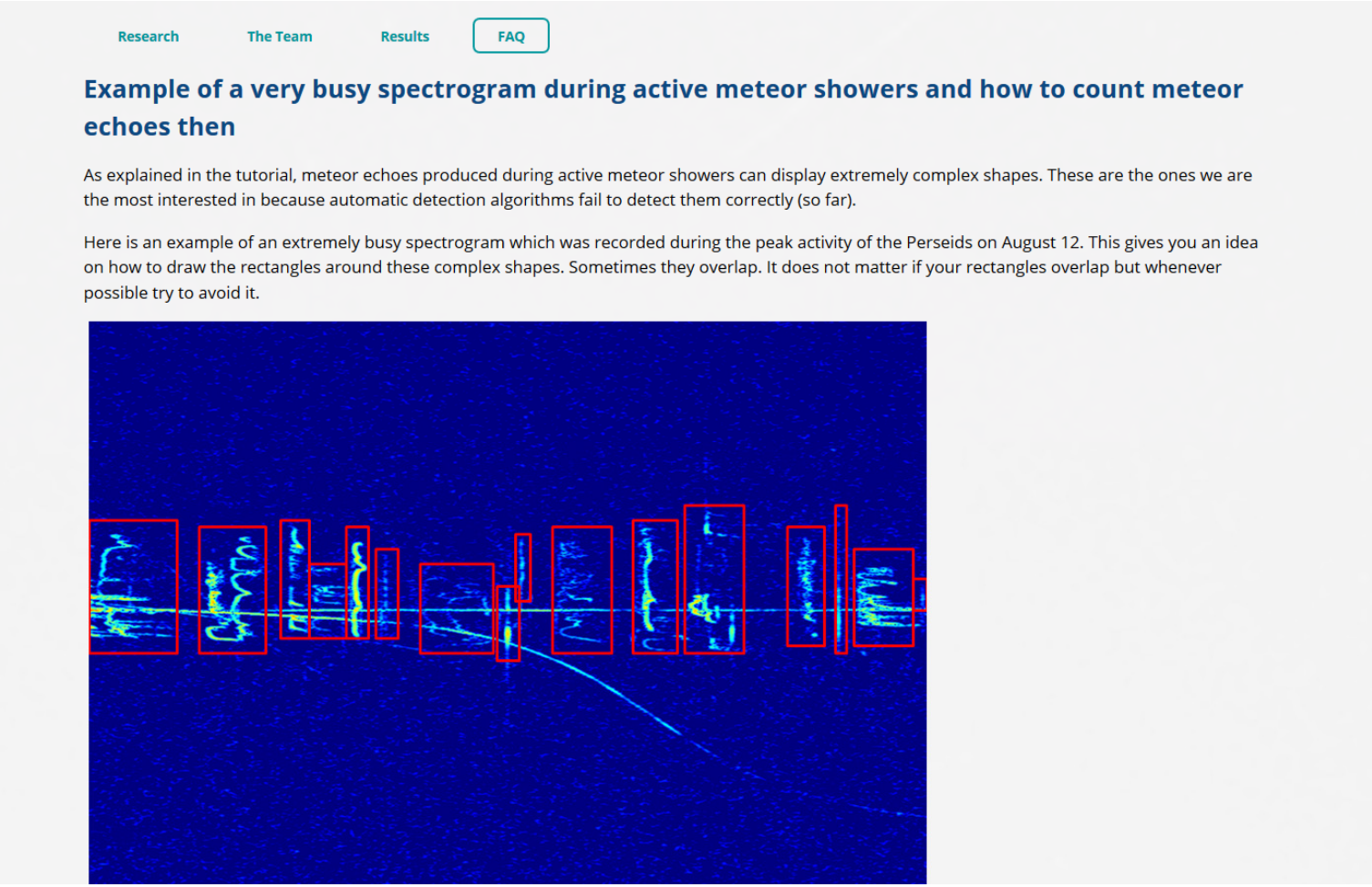


Limited information about what you see in these images, the task requested and the most obvious mistakes.

Forum

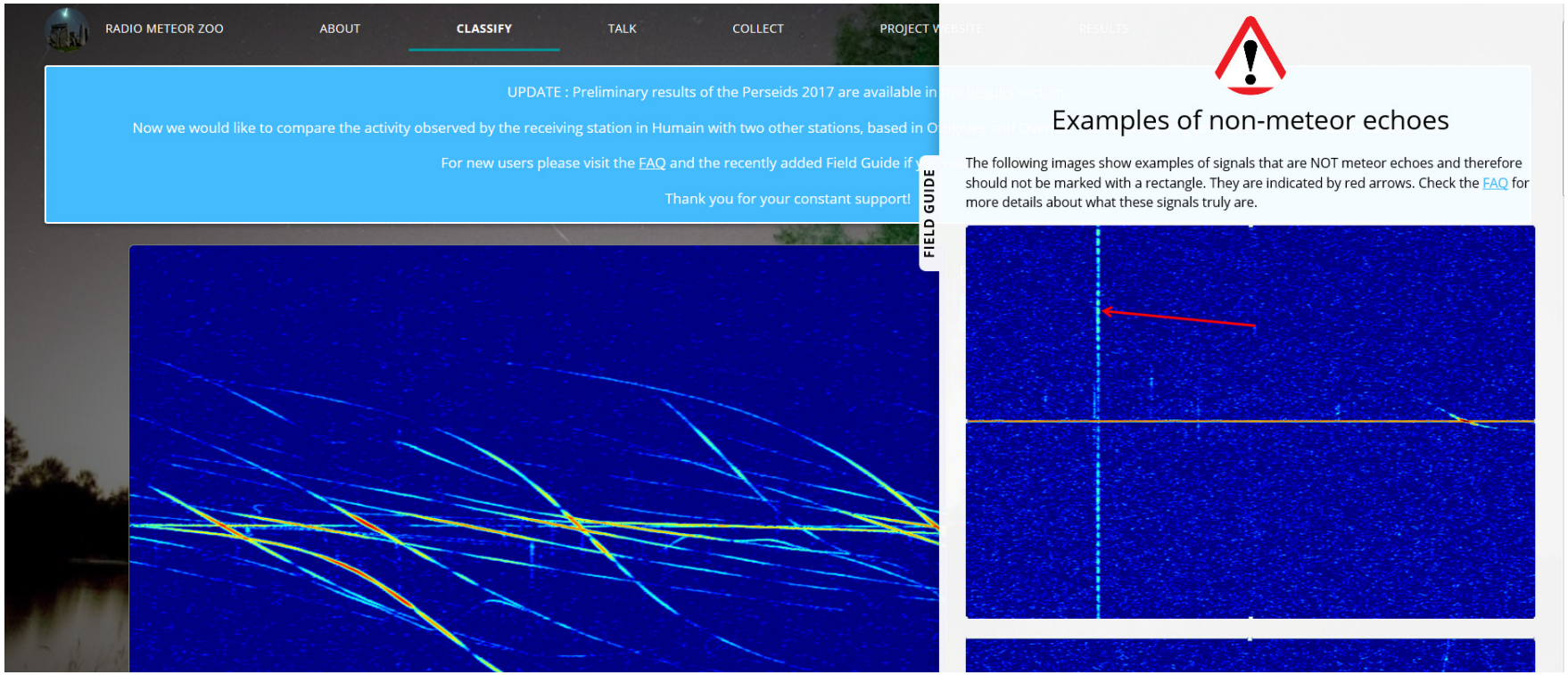

Radio Meteor Zoo Talk
Search or enter a #tag
Moderator Controls
Notes
General comment threads about individual subjects. We speak English, Dutch, French or Spanish.
Hydrangea Subject 11937525 13 hours ago
260 Participants
1837 Discussions
2899 Comments
Moderators
Discussions between moderators
ElisabethB 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



FAQ based on recurrent questions in the forum

Field Guide

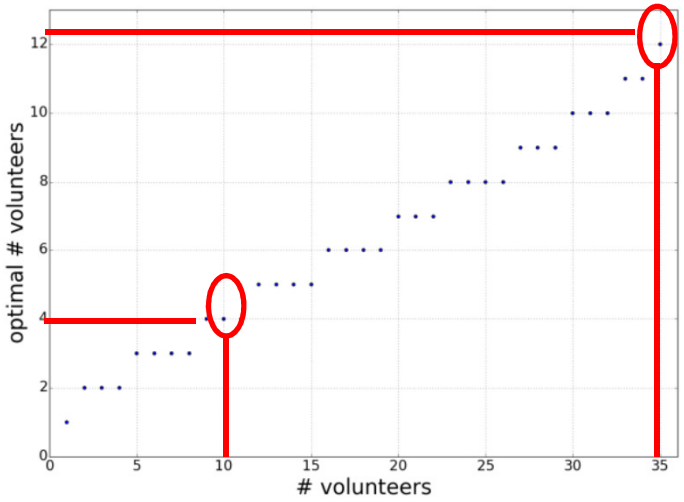


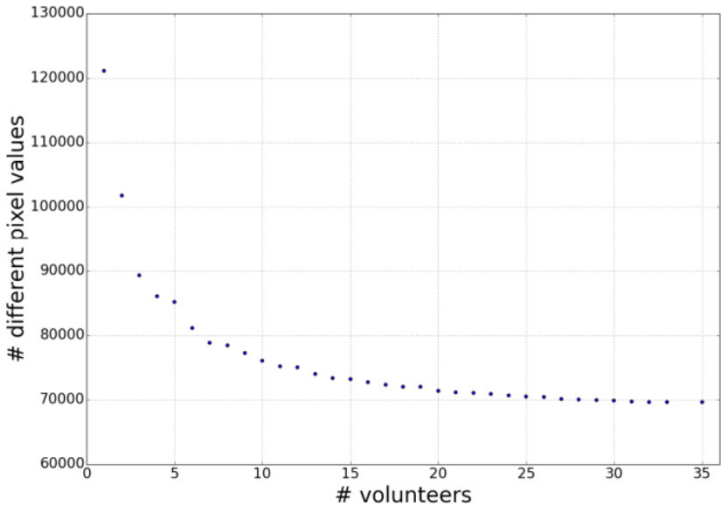
Contains examples of non-meteor echoes & meteor echoes with complex shapes

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 → D(k) for k=1…35
- D(k) is minimum for k_{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

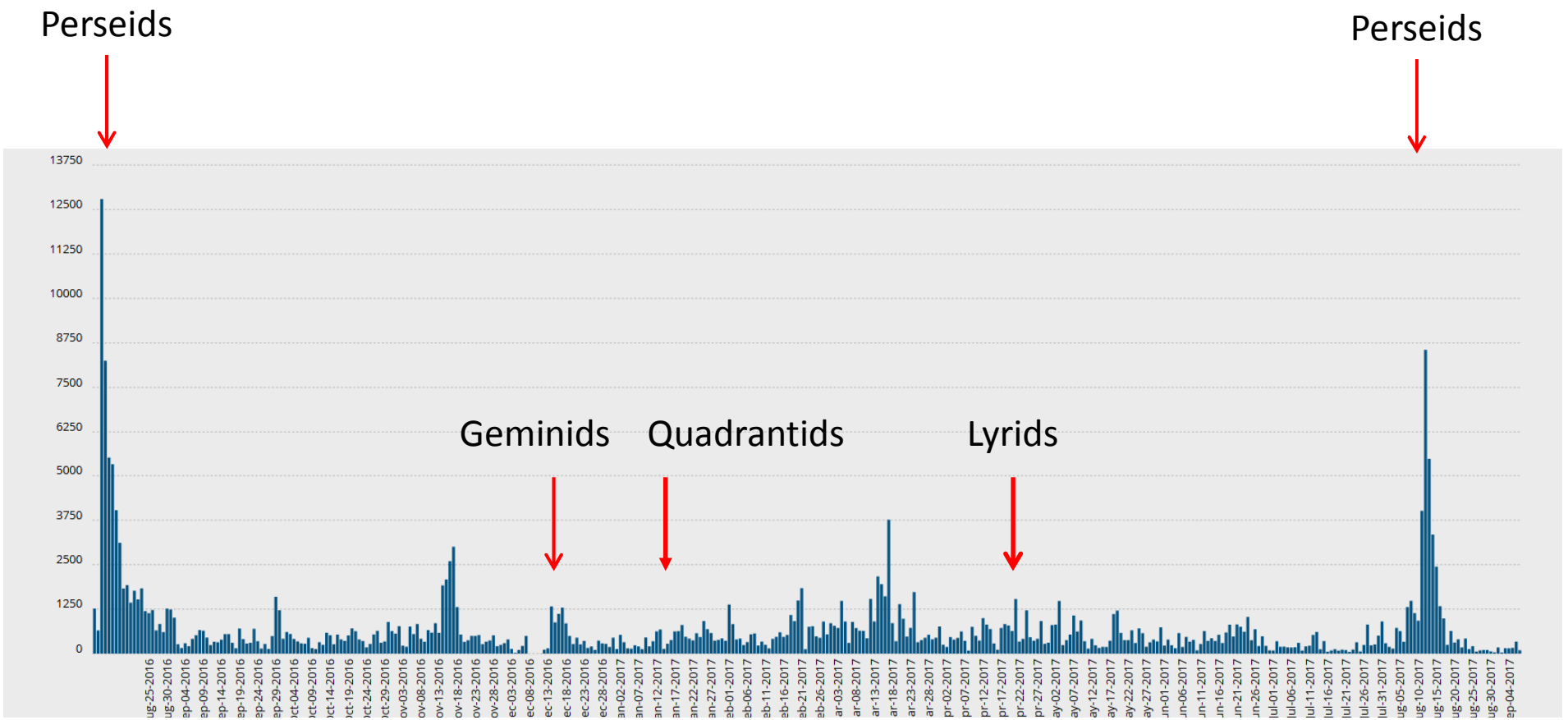




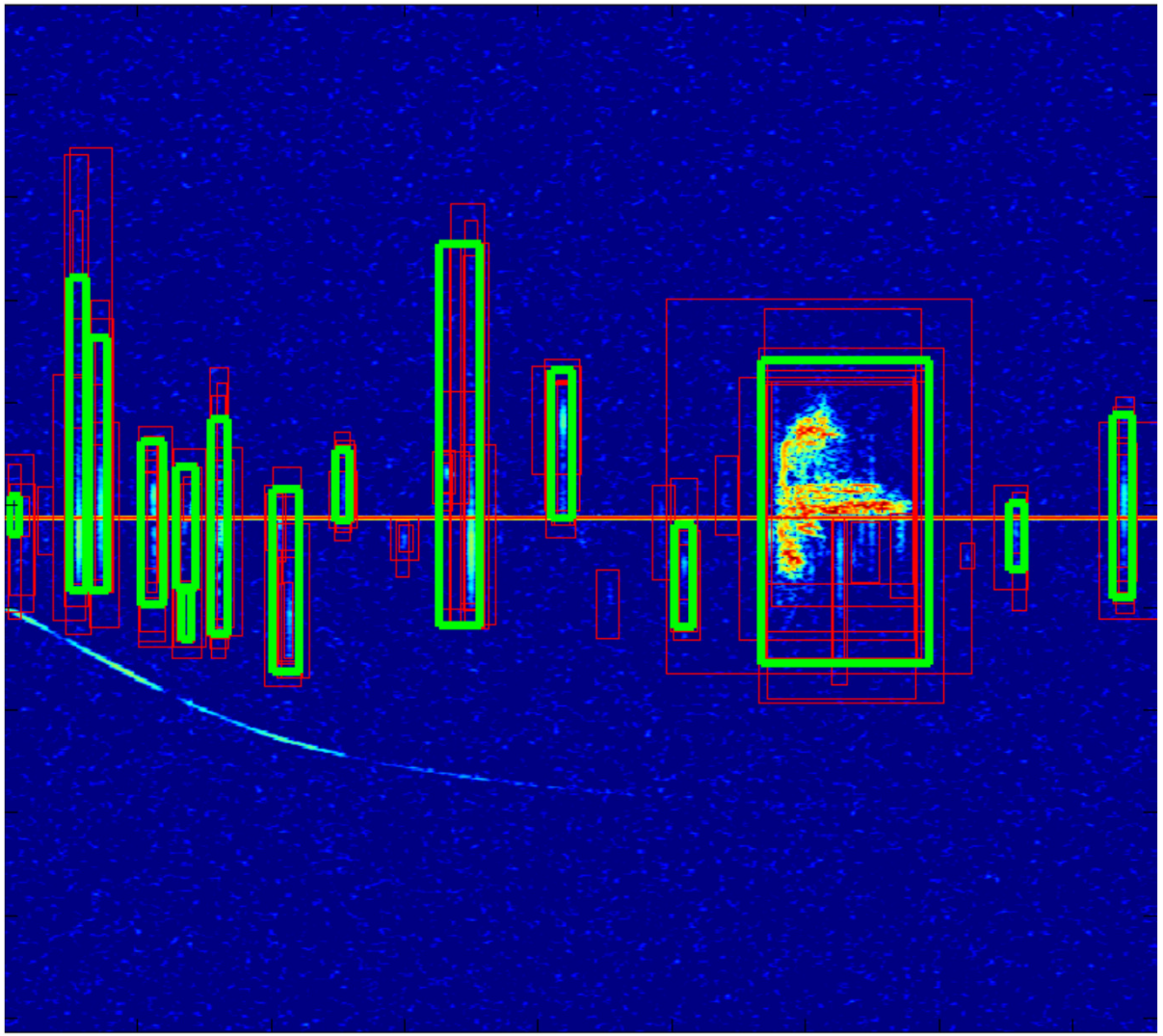
Statistics on 07/09/2017

- 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)

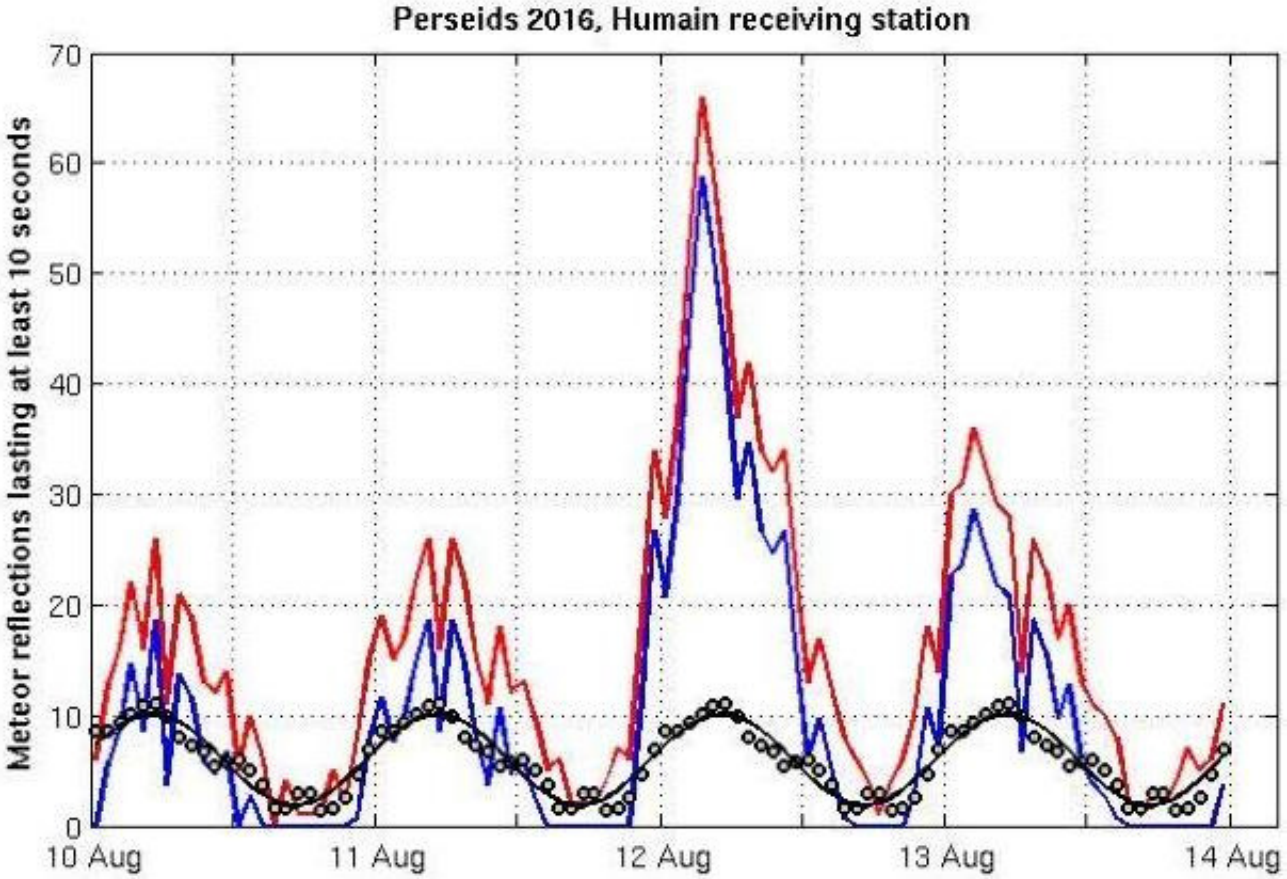
Statistics of one year



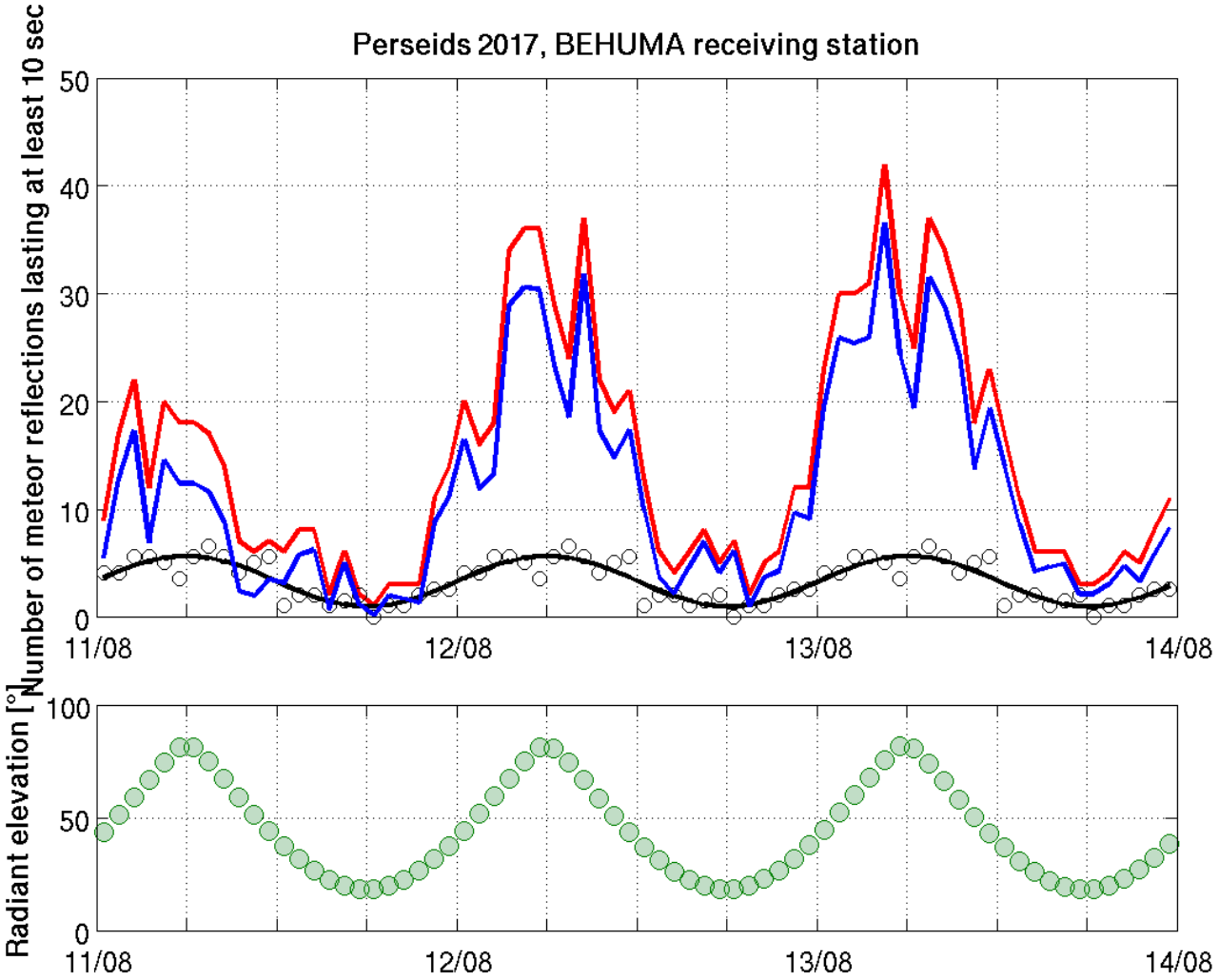
Results : aggregation method



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