The International Project for Radio Meteor Observation 2001-2003

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1. Mechanism of Radio Meteor Observation

Meteor ionizes the atmosphere

Increase of the electron density

Making of ionized trail

Height = 80km – 120km

Increase of electron density
1. Mechanism of Radio Meteor Observation

- Electron scattering very high frequency (VHF) (30MHz ~ 300MHz)

VHF wave is scattered due to the appearance of meteor!

Radio Meteor Observation !! (RMO)
2. A kind of Radio Meteor Observation

Back-Scattering

Ex. Radar Observation
(Transmitting Station is also Receiving Station)

Measurements of meteor and wind velocity, etc.

Forward-Scattering

incident angle = reflection angle
(A receiving station is different from the transmitting station.)

This is inexpensive and easy observation
Japanese observing stations are more than 150!!
Radio Meteor Observation is possible to observe continuously.

- Bad weather, daytime and twilight: No problem!!
- Continuous observation
- Forward Scattering is easy to start

But

We cannot discuss or estimate meteor shower activity at only one observing station.

This is because...

1. Radiant elevation
2. Reflection area of Radio Meteor Observation

Therefore

We cannot observe meteor echoes when radiant rises around zenith…
**Motivation**

We would like to monitor meteor shower activity at all times.

--- It is possible to observe at all time even if it is bad weather or daytime.

--- By unifying worldwide data, it becomes possible to observe without radiant problem.

Therefore

We have organized Worldwide Radio Network since 2001!!

**Purpose of this project**

1. To observe all activities of a meteor stream without effect of radiant elevation

2. To catch outburst meteor streams and research its characteristics
This project’s keywords are...

1. Instantaneity (ex. FLASH and LIVE)
   - **LIVE system** --- installed by Mr. M. Kobayashi and H. Ogawa
     - observed image --- updated every 10 minutes
   - **FLASH system** --- collected and calculated by H. Ogawa
     - calculated manually --- updated every 6 – 12 hours

2. Many observing stations
   - We must cover the whole world.

3. building Mailing-List for participants
   - International and Japanese Mailing-List
- Project Organization -

Flow Chart

Observer’s Field

Observation (HROFFT)

count

analyze

Ogawa’s Field

WWW

Open Web

Automatic update (every 10 minutes)
Project Organization

Participants Map

91 sites in 15 countries

2001

126 sites in 23 countries

2002
- Project Organization -

Participants Map

2001

74 sites

2002

84 sites
Using Frequency Type

- **Japan** ・・・ Ham-band
- **Europe** ・・・ TV and FM Broadcast Station
- **America** ・・・ FM Broadcast Station

- Unknown
- VOR
- Radar
- **Ham**
- FM broadcast Station
- TV broadcast Station
In this time…. We analyze world observed data….

difference of receiver, location, frequency, etc.

but...

We adopt “Relative Value” named “Activity Level”.

\[
A(t) = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{H(t)_i - \overline{H}(t)_i}{D_i} \cdot \frac{1}{\sin(h)} \right)
\]

- \( H_i \): the number of echoes at Observing Station, \( i \)
- \( \overline{H}_i \): the background number of echoes at site \( i \),
- \( \overline{D}_i \): average number of echoes during a day at site \( i \)
- \( h \): Radiant Elevation,
- \( t \): time,
- \( N \): the number of observing stations
1. The factor of radiant elevation (h)
   20deg < h < 80deg data is only used.
   1/sin (h) is corrected

2. Elimination of observational error data
   - $1.5 \sigma (H) < \text{results} < +1.5 \sigma (H)$ is only used (91% of total).

And I am thinking about the factor of using frequency.
This is because we have to consider “Height Ceiling”
This effect is “reflection time of echoes in low frequency
is longer than high.”
In Leonids, it became impossible to count the number of echo.

The activity level was estimated from “reflection time” of echo

reflection time (sec.) of echo more than 10dB, 20dB, 30dB and 40dB
2001
Leonids

2002
Quadrantids, Perseids, Leonids, Geminids, Ursids

2003
Quadrantids, Lyrids, eta-Aquarids, Perseids, (Leonids), (Geminids)
Results in 2001 & 02 Leonids

First peak: 10h(UT) 18th
Second peak: 18h(UT) 18th

Leonids 2001 by Radio Meteor Observation
Leonids 2001 project all over the world
20deg < R.P. < 100deg

Activity Level

Radiant elevation (deg)

Time[UT, 2001]
Results in 2001 & 02 Leonids -

The Structure of Second peak

Main peak (expected)
Time: 18:20-30 (UT)
FWHM:
- 90min / +100min

Sub peak (Unexpected)
Time: 21:20-30 (UT)
FWHM:
- 45min / +40min

(Reflection Time analysis)
First Peak (Europe) • • • 4h 19th (UT) \( A(t)=4.0 \)  FWHM: ±120min
Second Peak (America) • • • 10h 19th (UT) \( A(t)=6.2 \)  FWHM: ±60min
Leonids 2002 (Reflection Time Analysis)

First Peak: 19th 04:10-20
Second peak: 19th 10:40-11:00

30dB for Japan, 20dB for Europe, 10dB for America
Since it is too difficult to define the background level because of some other meteor streams, Perseid project is difficult …
In Japan, Geminids observation is too difficult…

Because...

Geminid radiant rises around zenith…

Therefore, Radio Observation cannot detect meteor echoes
In Japan, Geminids observation is too difficult…

**Because…**

Geminid radiant rises around zenith…
Therefore, Radio Observation cannot detect meteor echoes
1. This project is very useful to monitor whole activity

   “Activity Level” shows meteor activity
   Some problems are solved by using relative value
   This network is possible to monitor whole meteor activity

2. LIVE and FLASH is very useful for monitoring

   It is very important to monitoring meteor activity at all times.
   This network is possible to monitor and open on the web.

3. Local area networks are very important

   Observing conditions depend on each country (or area)
   In Japan, the original network “AMRO” is organized
   This network is useful for Japanese observers
1. There are a few observing stations in Southern Hemisphere
   This project is too difficult to catch if outburst occurs in Southern Hemisphere

2. We have to consider reflection area
   Radio Meteor Observation mechanism is too complex.
   Forward scattering observation cannot know “Where did meteors appear ?”.
   Therefore we have to obtain this information to discuss the meteor flux, etc.

3. The amount of observed data is too large !!
   We would like to open these observed data on the web.
   But we do not have enough web space.
I have already edited the proceeding of this project in JAPANESE !!

but !! Don’t worry !

I am editing and making ENGLISH version now !!!

If you want to see proceeding in Japanese version, please tell me !!
In the future, I do not decide whether we continue this project or not.

But, in Japan, many observers have already researched many research program (such as reflection area, long echo, multi frequency, decision of meteor echo position, etc.)

Therefore, we will continue this project (probably...)

And I would like to do interesting research program “worldwide scale” !!

So, if you have a idea, please contact me !!
(mailto: ogawa@nms.gr.jp)

PS. Please talk questions and opinions slowly (if possible, easy English)