The new method of estimating the ZHR using radio meteor observations

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It has been very difficult to estimate the Zenithal Hourly Rate in the case of radio meteor observations, although radio observing is a very useful method to capture all meteor activities even if the weather is bad or during daytime. This research tries to estimate the Zenithal Hourly Rate using radio meteor observations.

1 Introduction

As a known method for combining all radio meteor observations, H. Ogawa et al. (2001) published a new index that was introduced as the "Activity Level" Index. Although this index is very useful for compiling meteor activity profiles (period, level, etc.), it is impossible to compare it with visual observations.

This research tried to estimate the Zenithal Hourly Rate using radio meteor observations. By using this estimated *ZHR*, it becomes possible to compare and to discuss based the same reference table as the visual observations.

2 Method

The estimated *ZHR* is obtained by the following steps:

(1) Correcting the hardware features such as antenna, receiver, receiving level, etc. and removing sporadic meteors;
(2) Correcting the limiting magnitude;
(3) Correcting radiant elevation;
(4) Combining all calculated data.

2.1. Correction for hardware features

This step adopts the previous method by H. Ogawa et al. (2001). The first step is the same as to obtain the Activity Level index. The Activity level is derived from the following formula.

$$A(t) = \frac{N_{obs}(t) - N_{ave}(t)}{D_{ave}}$$

Where, N_{obs} is the hourly rate of the observed meteor echoes. N_{ave} is the background level valid for the past two weeks. N_{ave}, therefore, stands for the sporadic meteor activity. D_{ave} is the average number of meteor echoes for a day after two weeks. $A(t)$ means the activity level at time t.

2.2. Correcting limiting magnitude

The Corrected Hourly Rate is derived from the following formula:

$$CHR = A(t) * S_{bas}$$

Where, $A(t)$ is the Activity Level as described in previous subsection. S_{bas} is the daily number of sporadic meteors obtained with a Limiting Magnitude = +6.5. The number of sporadic meteors shows a variation during the year. Shigeo Uchiyama provides a result of visual observations. S_{bas} is obtained by comparing the observed radio data to the observed visual data (*Figure 1*). Radio meteor observing data were provided for about 800 months. This formula translates the radio results from the activity level into the visual results as a *CHR* (*Figure 2 and 3*).

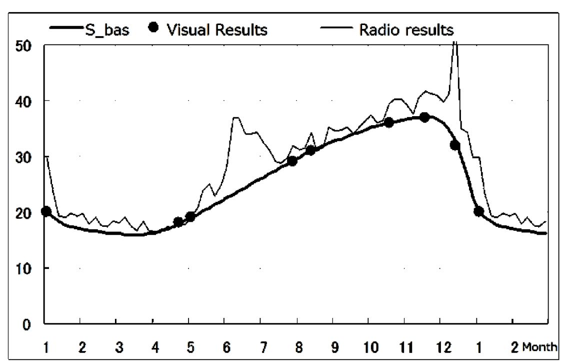

Figure 1 – The relationship between S_{bas}, visual results and radio results.

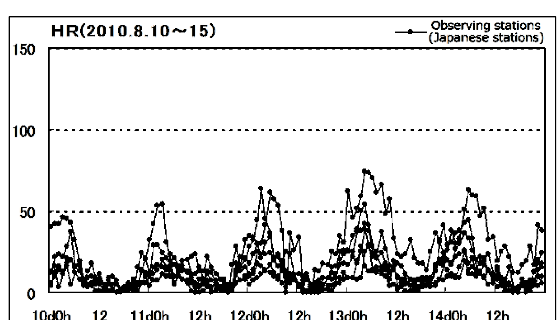

Figure 2 – Results for the Hourly Rate.

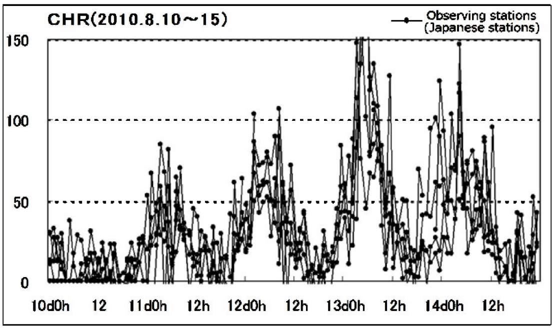

Figure 3 – Results for the *CHR*.

2.3 Correcting radiant elevations

This research basically uses only radiant elevations higher than 20 degree. The *ZHR* is obtained with the following formula:

$$ZHR = CHR * sin(h)$$

where, *CHR* as described in the previous subsection and *h* is a radiant elevation (*Figure 4*).

2.4 Combining all calculated data

The calculations of the previous sections are done for each observing station. Next we need to combine the data from all observing stations. As a final step we calculate the average for all observing stations at time *t* (*Figure 4*: bold line as the worldwide average).

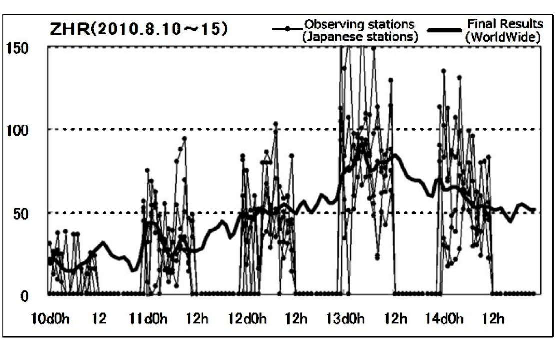

Figure 4 – Results of the estimated *ZHR* using worldwide data.

3 More corrections

3.1. Removing unusual data

Radio meteor observations sometimes have unusual observed data other than meteor activity. This is caused by noise, sporadic-E, receiving conditions etc. These obvious erroneous data are removed in this research.

3.2. Removing meteor shower activity in D_{ave}

D_{ave} sometimes includes some meteor shower activity. This is because D_{ave} is derived from observed data during previous two weeks. If one meteor shower has a long period activity, D_{ave} is influenced by this meteor shower. This method tries to remove this affected data when the radiant elevation is being corrected.

4 Results

This method succeeds to estimate the Zenithal Hourly Rate using radio meteor observations and the results are similar as the visual observing results.

This way it becomes possible to capture the Zenithal Hourly Rate even if the weather is bad or when a Full Moon interferes. Of course, it also becomes possible to monitor daytime meteor showers.

This methodology has already been used for many meteor shower results (see my website). It was sometimes successful to detect the activity of predicted outbursts.

Acknowledgment

We wish to thank all radio meteor observers in the world[9,10], Mr. Shigeo Uchiyama for providing visual data, Mr. Masayoshi Ueda for his advice to this research and transmitting stations.

References

Ogawa H., Toyomasu S., Ohnishi K. and Maegawa K. (2001). “The Global Monitor of Meteor Streams by Radio Meteor Observation all over the world”. *Proceeding of the Meteoroids 2001 Conference*, 6–10 August 2001, Kiruna, Sweden. Ed.: Barbara Warmbein. ESA SP-495, Noordwijk: ESA Publications Division, ISBN 92-9092-805-0. Pages 189–191.

[9] http://www.amro-net.jp
[10] http://www.rmob.org/