Meteor Shower Activity Derived from "Meteor Watching Public-Campaign" in Japan

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Abstract We tried to analyze activities of meteor showers from accumulated data collected by public-campaigns for meteor showers which were performed as outreach programs. The analyzed campaigns are Geminids (in 2007 and 2009), Perseids (in 2008 and 2009), Quadrantids (in 2009) and Orionids (in 2009). Thanks to the huge number of reports, the derived time variations of the activities of meteor showers is very similar to those obtained by skilled visual observers. The values of hourly rates are about one-fifth (Geminids 2007) or about one-fourth (Perseids 2008) compared with the data of skilled observers, mainly due to poor observational sites such as large cities and urban areas, together with the immature skill of participants in the campaign. It was shown to be highly possible to estimate time variation in the meteor shower activity from our campaign.

Keywords meteor showers · Geminids · Perseids · Orionids · public-campaign

1 Introduction

The public-campaign is one of the outreach programs which we perform in Japan, such as "Watch a comet", "Watch planets", "Watch a meteor shower" and "Watch an eclipse". This is widely announced to the public by the National Astronomical Observatory of Japan, and we received more than a few thousands of reports every time. The main purpose of the campaigns is to interest the general public in astronomical phenomena. However, we have noticed that we might be able to extract some scientific results from these reports because of its huge numbers, for example, over 5,000. Therefore we tried to derive the hourly rate of meteor showers from accumulated data of some campaigns, which resulted in the success described in this paper.

2 Report Form

We recommend participants in the campaigns monitor the night sky more than 10 minutes when observing meteors by naked-eye. The participants are also recommended to report their results via the internet. We use a very simple form of questionnaire for this report because the main purpose is the outreach to the general public, including children. The participants in the campaigns answer questions about observation epoch, observation time duration, number of counted meteors, distinction of meteor shower from sporadic meteors, location, and so on.

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About observation epoch, participants are asked to choose the range of observed hour, for example, before 21h, 21-22h, 22-23h, … 3-4h, after 4h on every day within the campaign period. About observation time duration, the choices are prepared as follows: less than 10 minutes, 11-20 minutes, 21-30 minutes, 31-40 minutes, 41-50 minutes, 51-60 minutes. The number of counted meteors is also divided into nine levels which are 0, 1, 2, 3-5, 6-10, 11-20, 21-30, 41-50 and more than 51. Although each report is not as precise as those coming from the skilled visual observers, the huge number of reports gives us good reason to look into the data in detail on the scientific aspect.

3 Method of Analysis

We try to analyze the collected data in order to derive activity profiles of each meteor shower. Because we set the discrete steps in our campaign, we have uncertainty in the actual observation time for each participant. We adopted the median value of each step when we analyzed data. For example, in case of the range of 11-20 minutes for the time of observation duration, we considered that it was 15.5 minutes in average. We applied the same way in the case of the meteor numbers; if the report of the number of observed meteors is the range of 6-10, we regarded this data as 8. The derived hourly rate (*HR*) is expressed as

$$HR = \Sigma\,(Nm*Nn)\,/\,\Sigma\,(Dm*Dn) * 60,$$

where *Dm* (minutes) is the median of observation duration time, *Dn* is the number of corresponding reports collected within the specified time epoch, *Nm* is the median of the number of counted meteors, and *Nn* is the number of the corresponding reports. We could remove contribution of the sporadic meteors on the basis of the judgment of each participant in the report.

4 Results

We analyzed data collected during four campaigns: Geminids in 2007 and 2009, Perseids in 2008 and Orionids in 2009. The following figures show the results plotted together with the data obtained by skilled Japanese observers (NMS; Nippon Meteor Society) for comparison. It is clear that the time profiles of the meteor showers in the campaigns are similar to those obtained by skilled observers. In order to show the similarity, the vertical axis of the NMS data in each figure is multiplied by one fourth or one fifth, of which the values are shown in the vertical axis in the right of the figure. This factor is thought to originate from the poor observational condition in the participants in the campaign. Most of the participants are in the large city or urban area where they have heavy light pollution in general.

In the case of the Geminids in 2007 (Figure 1), the derived *HR* of the campaign was about one-fifth of the data of NMS (Uchiyama 2007), while the time profile of the activity is similar to the NMS. On the other hand, the derived value of the *HR* in the campaign was one-fifth. This corresponds to the difference of a limiting magnitude of the observational condition between the campaign and NMS corresponds to 2.3 magnitude as population index (*r*) = 2.0 (IMO 2007).

In the case of the Perseids in 2008 (Figure 2), time variation of the hourly rate deduced from the campaign was also very similar to NMS (Uchiyama 2008), especially on August 12-13. The derived value of the *HR* was about one-fourth of the data of NMS. This corresponds to the difference of a limiting magnitude 1.9 magnitude as *r* = 2.1 (IMO 2008).

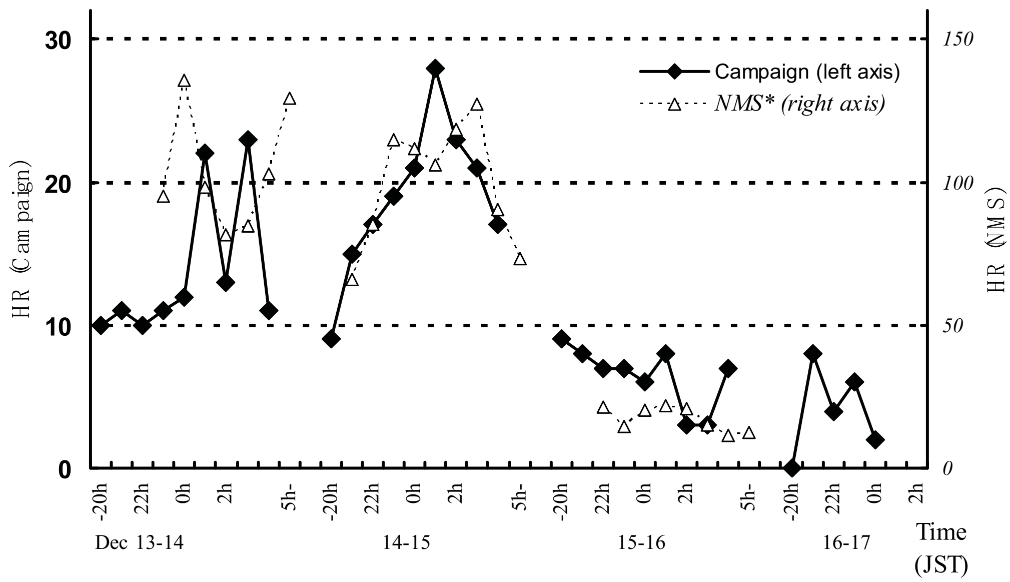

Figure 1. Hourly Rate of Geminids in 2007. The solid line with diamond marks is the results of our campaign and the dashed line with triangle marks is the results of the NMS (Nippon Meteor Society, Uchiyama 2007).

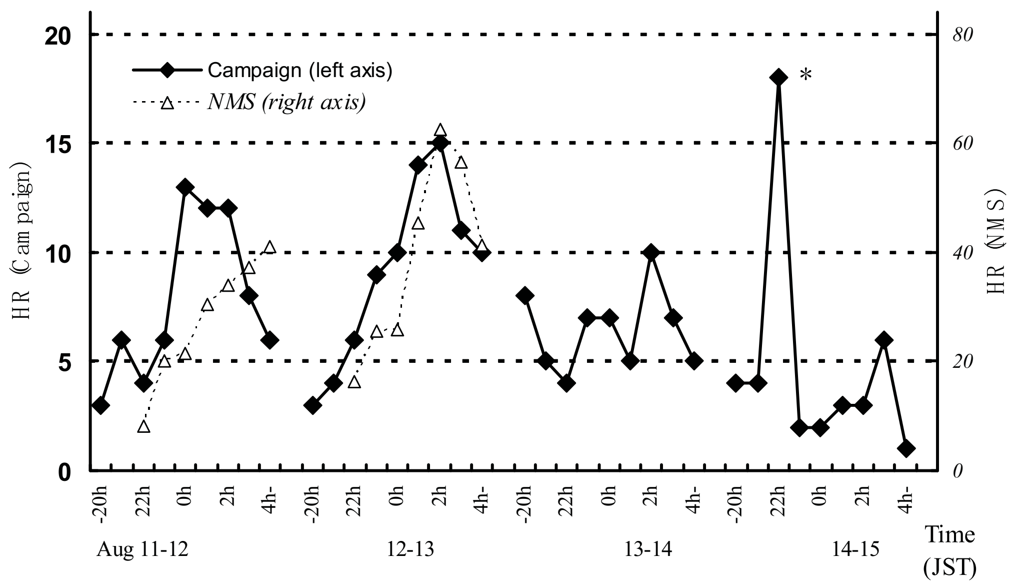

Figure 2. Hourly Rate of Perseids in 2008. The solid line with diamond marks is the results of our campaign and the dashed line with triangle marks is the results of the NMS (Uchiyama 2008). *The number of data was very few. (n = 2)

In the case of the Orionids in 2009 (Figure 3), the derived *HR* of campaign was also about one-fourth of the data of NMS (Iiyama 2009) like the case of the Perseids in 2008. The corresponding difference of a limiting magnitude is thought to be 2.0 magnitude when we apply the population index as $r = 2.0$ (IMO 2009). It should be noted that the time variation of the activity derived from our campaign seems to be smoother than the one by the NMS. Although this is mainly due to the huge number of reports, about 7,000, it may imply that the result by the huge number of observers may be better than that performed by a small number of skilled observers. We need further careful discussion on this point in the future.

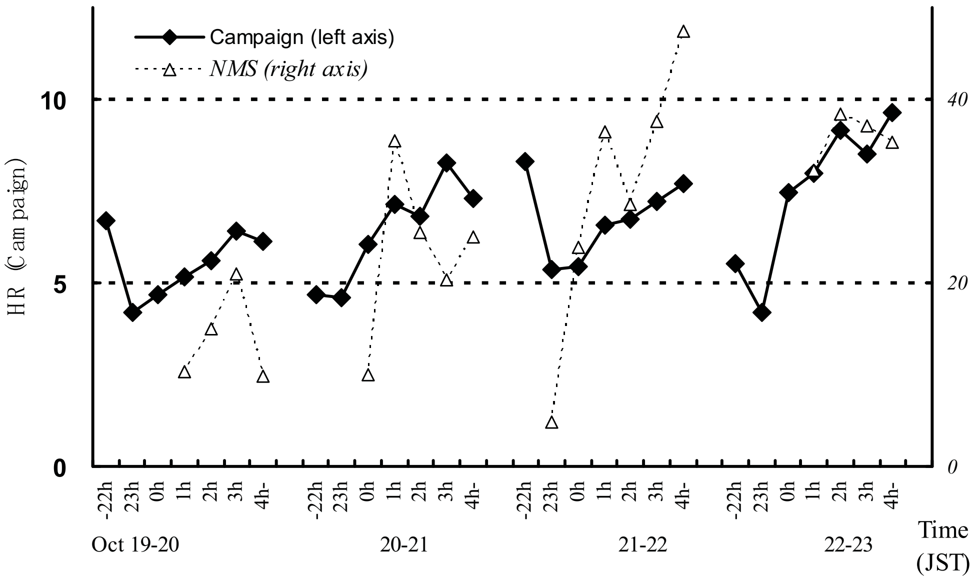

Figure 3. Hourly Rate of Orionids in 2009. The solid line with diamond marks is the results of our campaign and the dashed line with triangle marks is the results of the NMS (Iiyama 2009).

In case of the Geminids in 2009 (Figure 4), the derived *HR* of campaign was one-fifth of the data of NMS (Uchiyama 2009) from December 11 to 14. However, it changed to about one-seventh of the data of NMS from December 14 to 15. This corresponds to the variation of the limiting magnitude from 2.3 to 2.8, when we assume the population index is $r = 2.0$ (IMO 2009 No.2). The reason for this change may be due to the change of the sky condition of participating observers who reported to the campaign.

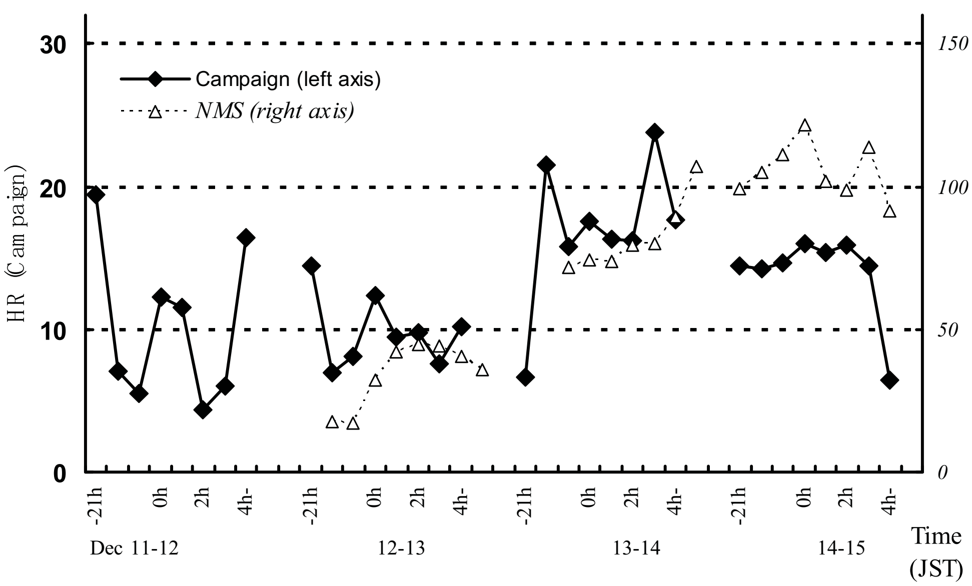

Figure 4. Hourly Rate of Geminids in 2009. The solid line with diamond marks is the results of our campaign and the dashed line with triangle marks is the results of the NMS (Uchiyama 2009).

5 Conclusion

We analyzed the data collected in public campaigns for four meteor showers, and confirmed that the derived time variation of the activities of meteor showers is very similar to those obtained by skilled visual observers.

On the other hand, the derived values of the *HR* in the campaigns are about one-fifth (Geminids in 2007 and 2009, except for from December 14 to 15) or about one-fourth (Perseids in 2008 and Orionids in 2009) compared to the data of the NMS. This is mainly due to poor observational sites for participants in the campaign, and probably partly due to immature skill of participants in the campaign. The difference of the limiting magnitude is estimated to be 1.9 ~ 2.3, as the average observational condition between the campaigns' participants and skilled observers. Even if we should have such difference, it is clear that we have a potential to extract scientific results from such outreach programs related to the meteor showers mainly due to the huge number of reports.

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