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Meteor shower activity derived from meteor watching public campaign in Japan

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ABSTRACT

We have carried out a meteor watching public campaigns from 2004 for major meteor showers in the case of appropriate observing condition as one of the outreach programs conducted by National Astronomical Observatory of Japan. We received a huge number of the reports on meteor counts from the general public participants. The results sometimes show similar time variation of the hourly rates derived from the data collected by skilled observers. In this paper, some of the results are presented showing that such campaigns have a potential to extract scientific result related to the meteor showers mainly due to the large number of the data collected by unskilled observers.

1. Introduction

The public-campaign is one of the outreach programs conducted by the Public Relations Center, National Astronomical Observatory of Japan(hereafter, NAOJ) when the appropriate astronomical phenomena are expected to occur. The campaigns performed until now are gWatch a cometh, gWatch planetsh, gWatch a meteor showerh and gWatch an eclipseh. They are widely announced to the general public on the web site of the NAOJ through the internet in advance accompanied the method of observations of the target phenomena. The participants of the campaigns are allowed to report their observational results to the NAOJ. The analyzed results of the reports along with some statistics are also presented in the web site after the target events. The number of the reports we received depends on the weather condition at the time of the phenomena. Sometimes we received more than a few thousands of reports especially in meteor shower campaigns.

Although the main purpose of these campaigns is to generate interest in the general public in astronomical phenomena, we have noticed that we might be able to extract some scientific results from these reports because of the huge samples. Therefore we tried to derive the hourly rate of meteor showers from the accumulated data of some campaigns, which resulted in the success described in the previous report (Sato et al., 2010). In this paper, we introduce the results obtained by the latest campaigns together with the appropriate previous campaigns.

2. Selected data and reduction

The meteor watching public campaigns performed until 2016 and their results are listed in Table 1. We did not carry out such campaigns in the case of poor observational conditions expected by the Moon phase. Total 20 campaigns have been performed until the summer in 2016. Unfortunately we cannot use the data until the Perseids campaign in 2007 because we did not ask the participants to discriminate between targeted shower meteor and sporadic ones. Among the remaining 14 campaigns, we selected six for the analysis due to the large number of received reports. One is the Orionid meteor shower in 2009, which was expected to show a strong display in advance (Sato and Watanabe, 2007), which was announced by the NAOJ so that many people participated in this observing campaign. Two concern the Geminid meteor showers in 2009 and 2010, for which we received 3994 and 3402 effective reports, respectively. These two are the largest numbers of reports in the Geminids campaigns. The other three are the Perseid meteor showers in 2009, 2015 and 2016. The numbers of the effective reports are 2079, 2103 and 2731, respectively. These three are the largest numbers of reports provided for the Perseids campaigns except that in 2007.

All the received reports include observation time with the duration, and the number of shower meteors seen by the reporters. Most of the participants of these campaigns are unskilled observers living in large cities or the urban areas. Therefore, the number of meteors seen in a certain period show large differences depending on the reporters. However, thanks to the large number of reports, the averaged value is expected to be useful.

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Table 1
Meteor Shower Public Campaigns until 2016.

Target Meteor Shower	Date	Average Moon Phase	Number of Received Reports	Note
2004 Geminids	Dec. 13	1.6	2164	
2006 Quadrantids	Jan. 4	4.5	1564	
2006 Geminids	Dec. 13–14	23.2	272	Bad Weather
2007 Perseids	Aug. 11–14	0.1	11,014	
2007 Geminids	Dec. 13–15	4.9	2701	
2008 Perseids	Aug. 11–14	11.7	1553	
2009 Quadrantids	Jan. 2–4	7.1	1517	
2009 Perseids	Aug. 11–14	22.7	2079	
2009 Orionids	Oct. 19–22	2.9	14,339	
2009 Geminids	Dec. 11–14	26.3	3994	
2010 Perseids	Aug. 11–14	3.0	1580	
2010 Geminids	Dec. 13–15	8.9	3402	
2011 Perseids	Aug. 12–14	13.8	1327	
2012 Perseids	Aug. 10–13	23.9	1089	
2012 Geminids	Dec. 12–15	0.3	2655	
2013 Perseids	Aug. 9–13	4.7	1312	
2014 Perseids	Aug. 11–13	16.7	346	Bad Weather
2015 Perseids	Aug. 12–14	28.6	2731	
2015 Geminids	Dec. 12–15	2.7	1420	
2016 Perseids	Aug. 10–15	10.3	2103	

The method of the reduction is simple. We converted each number of meteors reported in a certain time period into the hourly rate. The obtained hourly rates within a certain period are simply averaged. The averaged hourly rate is plotted in order to see the time variation of the activity of the target meteor shower. The hourly rates obtained here is lower than those derived by skilled observers mainly because most participants are observing meteors in urban region under the severe light pollution. Then we corrected the hourly rate of the campaign data not only for the zenith distance of the radiant point, but also by the sky condition, assuming that the faintest star is 4.6 magnitude in average. There is one exception in the case of the twilight time zone for the last time slot in the Perseid campaign. We calculated the average sky brightness and applied the 3.5 for the assumed faintest star in average. This correction is just to adjust the obtained Zenithal Hourly Rate (hereafter, ZHR) to that of the data collected by the International Meteor Organization(hereafter, IMO). The ZHR is the number of meteors a single observer would see in an hour under ideal observing condition of the radiant located at zenith. This correction causes the raw hourly rate to increase by a factor of about five. This parameter is determined by the eye-inspection while we applied the given limiting magnitude for all the reduction in this study. Then, we compared the derived time variation of the rate with that derived from the data obtained by skilled observers in of the IMO. In the next section, we will show the result for selected campaigns.

3. Results

3.1. Perseids

The Perseid meteor shower is one of the most active showers which can be witnessed by many amateur astronomers annually (Jenniskens, 2008). It occurs during the summer vacation in Japan so that it is an appropriate target for many students to perform visual observation. We carried out 10 campaigns for the Perseids among the total 20 meteor shower campaigns as shown in Table 1. Here we selected three results of the years 2009, 2015 and 2016. The results are shown in Figs. 1–3, respectively.

It is obvious that the obtained ZHR by the campaign is higher in the earlier time slot of the night in Fig. 1. Note that all the IMO data shown in this paper is slighty different with those shown in the URLs because our data was retrived at the time of our paper submission. After our retrival, the data are updated by the new addition to the IMO. The reason of this tendency is interpreted such that some unskilled participants, including young students, try to witness Perseid meteors before mid-night local time, when the radiant point is not so high that they seem to have counted sporadic meteors as shower meteors. However, the general trend of the time variation such as the maximum on August 12 is marginally recognized from the campaign result. The average value on August 12 is higher than for the other night, which is consistent with the trend derived by skilled IMO observers. The scattered result is mainly due to relatively poor statistics because the number of effective reports is 2079, which spread over 4 nights. In 2015 we succeeded to collect 2731 effective reports just over three nights. However it is strange that even the IMO observers could not find any strong time variation over the period (Fig. 2). Although the average value of the ZHR is higher on August 13, the ZHR obtained by campaign is lower than that on August 14.

On the other hand, in 2016 there is excellent similarity of time variation between the campaign and IMO results as shown in Fig. 3. The maximum activity is seen on August 12, and the increasing and decreasing tendency of the ZHR can be recognized on the previous and next night, respectively. We do not have any tendency of earlier high rate, and some higher rate can be seen just before the morning mainly due to the small numbers of reports in this year.

3.2. Geminids

The Geminid meteor shower is another one of the active annual meteor showers (Jenniskens, 2008) which is appropriate for an outreach campaign. We performed 7 Geminid campaigns until 2015, and

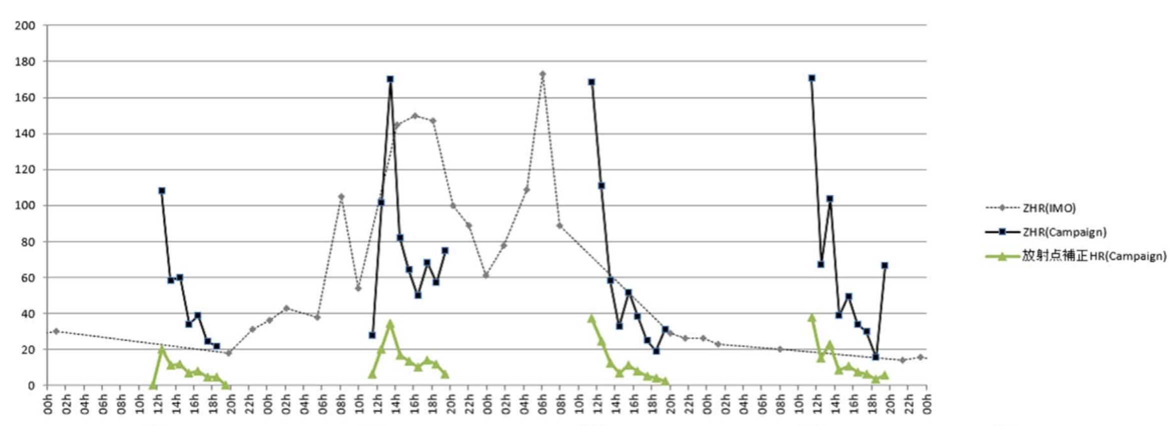

Fig. 1. Time Variation of the ZHR of Perseids in 2009. The solid line is the corrected ZHR for a limiting magnitude of 4.6, while the lower solid line is ZHR corrected only for the zenith angle of the radiant point of our campaign. The dashed line is the result of the IMO (http://www.imo.net/live/perseids2009/).