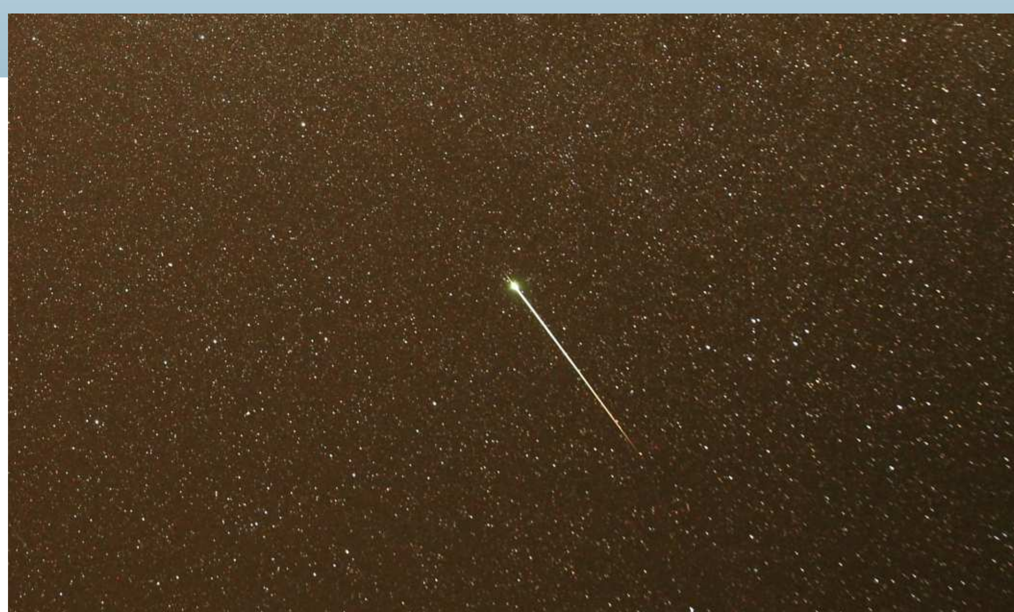
journal of the international meteor organization

# WGN

45:1
february 2017



IMC 2017 in Petnica: registration is open!
IMO Support Fund: call for proposals
August–September video meteors

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# WGN Vol. 45, No. 1, February 2017, pp. 1 – 24

## Administrative



## Conferences



## Preliminary results



## Front cover photo

Magnitude −6 fireball captured at Petrova Gora star party in Croatia on 2016 September 3 at $19^{h}48^{m}$ UT, using Canon EOS 1200D, Samyang 16 mm $F/2$ lens and 2 minute exposure at ISO 800. Photo courtesy: Željko Andreić.

**Writing for WGN** This Journal welcomes papers submitted for publication. All papers are reviewed for scientific content, and edited for English and style. Instructions for authors can be found in WGN **31:4**, 124–128, and at `http://www.imo.net/docs/writingforwgn.pdf` .



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# Writing for WGN

*Javor Kac* [1]

Advice to authors writing for WGN is presented. Comments on writing scientific papers are provided, especially on References, where mistakes are easily made. Information on the correct use of SI units is provided. The preferred LaTeX format is briefly introduced, with information for authors who use this. It is emphasized that LaTeX is not essential. Alternative information is given for those who use other formats such as Microsoft Word.

## 1 Introduction

Any journal depends on its authors, and we encourage you to write up your ideas and results for WGN. This article slightly amends instructions for authors published by Trayner (2003).

One of the strengths of the IMO is that it includes people from many professions, not just those with a scientific training. Those inexperienced in writing scientific papers may appreciate help, so guidance is given below. This article has been written in the layout of a scientific paper, for illustration.

WGN is produced in a computer format called LaTeX, and those who know this will need a little information to write their papers close to the final format. Those who do not know LaTeX need not worry, as WGN accepts papers in other forms.

## 2 Writing scientific papers

There are certain conventions in writing scientific papers, i.e. articles, to make them easy to read. One is the way a paper is divided into sections.

### 2.1 The sections of a paper

There are usually six main sections.

1. **Title and author.** There is nothing special about these, but please remember to provide both a postal and email address where interested readers can contact you.

2. **Abstract.** This should describe, very briefly, what the paper is about. It is there for readers who are not sure whether the paper is what they want. It should make it possible for them to decide without reading through the paper.

   Some people advise the following: The first one or two sentences should expand the title and say why the work was performed. The abstract should say what was done and what it contributes to science. The length should be between two or three sentences and a quarter of a page for a long paper.

   It should be possible to understand an abstract by itself, so it is bad practice to include citations (see References below).

3. **Introduction.** This should 'get the reader up to speed' on your subject. Remember that the reader may not be a specialist in your part of meteor studies, so some background may help. If your paper describes an algorithm to distinguish meteors from aircraft, for instance, your Introduction should probably say that this is a computer program which examines images from a TV camera. Many readers will be visual observers and will not understand unless you say this.

4. **Detailed sections.** These are the heart of your paper. Their number, names and contents depend on your material. Here you will have least difficulty in deciding how to organize your writing.

5. **Conclusion.** This should remind the reader of what they have learned from the paper. It should draw all the material together and point out the most important results. It may point out shortcomings and future lines of research; other than this, it should not introduce new information.

   Without a conclusion a paper stops suddenly, as if a radio's batteries had failed during a programme.

6. **References.** These are material (papers, books, etc.) which you have read and which you have referred to in your paper. As a rule, every reference should be cited at least once in the text. A later section of this article looks at them in detail.

You may sometimes need to vary this pattern. You may wish to add an acknowledgments section after the conclusion. Details which are not essential to the reader's understanding should be put in an appendix at the end and just summarized in the detailed sections. Occasionally there will be no references, for example in a social report of an International Meteor Conference.

You may want to divide some sections into subsections. These can be arranged as you wish.

### 2.2 Other aspects of style

There are many recommendations for good writing, including:

**Keep it simple.** Complicated sentences are hard to understand. A straightforward way of saying things is normally best. This is especially true for an international journal like WGN, where few readers grew up speaking English. If a sentence is too complicated, it is better to split it into two separate sentences.

**Keep it formal.** Good scientific writing is calm rather than excited, formal rather than slang. Prefer

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'it is' to 'it's', 'do not' to 'don't', and 'the results were unexpected' to 'what we'd eyeballed was, wow, kinda wild'.

Similarly, avoid exaggerations and extreme descriptions. 'The fireball was enormous, absolutely gigantic' sounds like something from a children's magazine; it does not make you sound like a careful researcher. Exclamation marks (!) are normally a mistake.

It is sometimes thought that a possessive (i.e. genitive) with an inverted comma, such as 'meteor's', is bad style. This is not true. 'The Perseid shower's maximum' is just as good as 'the maximum of the shower of the Perseids', and shorter.

**Do not use ten words when five will do.** The fewer words you use, the less time readers need to understand your ideas. Even experienced writers can improve. For instance, a first attempt at this article included

*Without a conclusion, a piece of writing seems to stop suddenly — it is a bit as if a radio's batteries have failed suddenly in the middle of a programme.*

This was changed to

*Without a conclusion a paper stops suddenly, as if a radio's batteries had failed during a programme.*

Is the meaning different? Has anything been lost? Most people would answer 'No'.

**Avoiding the first person.** Traditionally, the first person singular (I) and the first person plural (we) are avoided in scientific papers. The idea is that you are reporting on your research, not on yourself.

This convention is slowly changing, and WGN leaves the decision to the authors. However, we suggest that avoiding the first person (saying 'the results were remarkable' and not 'we thought that the results were remarkable') concentrates the reader's attention on your science.

**Keep to one tense, normally the past.** It is often hard to decide whether to write in the past or present tense. Mixing them makes it hard for the reader — they feel they are jumping between two stories, one written now and one in the past. Scientific papers are normally written in the past tense, since the work was done in the past: 'the Perseids were observed', 'analysis showed that'. However, some statements make more sense in the present tense: 'there is evidence', 'the shower is evolving'.

**Understand your readership.** Do you start by writing a basic textbook on meteors, or do you assume your readers are experts in your speciality? For WGN, you should assume that

- Your readers have a general knowledge of meteor science. You need not explain meteor showers, ZHR or $r$-value, for instance.

- They **may** know your specialized field within meteoritics, for instance telescopic meteors, history, video observations or the mathematics of meteoroid orbits. The Abstract and Introduction should say enough for them to see whether this is a speciality they understand. Sometimes it is possible for the Introduction to give a brief comment and reference(s) for people who are new to your speciality. It is impractical to do more: for the rest of your paper, you may assume your readers know your sub-field of meteor studies.

**Define mathematical symbols.** Some symbols are standard in all physical sciences (e.g. $\pi$ and $G$) or in meteor science (e.g. ZHR and $r$). All others should be defined where they first occur, e.g. 'the number of electrons $n_\mathrm{e}$ in a CCD pixel is $n_\mathrm{e} = n_\phi Q_\mathrm{E}$, where $n_\phi$ is the number of photons hitting it and $Q_\mathrm{E}$ is . . . '.

**Get a friend to read it.** By the time you have finished you research, you are so close to it that you forget how much more you know than others. Similarly, when writing your paper you are so close to it that you do not see what is too short, too long, too simple or too complicated.

A good solution is to get someone else to read your paper. There are three requirements: (1) they know meteor science; (2) they have not been involved in your research, so they see it with fresh eyes; (3) they understand that criticisms are helpful to you, not an insult.

## 3 Writing in English

Few of WGN's contributors are native English speakers. Others may worry about their ability to write good English. There is no space here to teach a language, but a few hints can be given. A good dictionary is an important tool. Spellcheckers are useful, though they miss many mistakes. If you use Linux, the ISPELL spellchecker is available; typing `man ispell` will show whether it is installed.

The Oxford University Press publishes a wide range of dictionaries and other language books, including Fowler's Modern English Usage (Burchfield, 1998), a standard work. They provide some free on-line advice at `http://community.oxforddictionaries.com/`.

Do not let worries about your English prevent you writing for WGN — your submission will be edited by someone who knows English well. This provides you with a safety-net to ensure that your ideas are presented in language that does you credit.

## 4 Tables, figures and equations

Remember to provide a caption for every figure and table. They should enable the reader to understand the illustration without reading the rest of the text. Captions like 'See text for explanation.' are unhelpful. Keep in mind that your paper will be printed in black&white, although the colours will be present in the electronic version of WGN. You should therefore avoid any reference to colour — better describe linestyle, symbols, etc.

All tables, figures and equations should be numbered. They should each have their own numbering scheme, so there will be a Table 1, a Figure 1 and an Equation 1. All tables and figures should be referred to in the text, for instance 'the apparatus (Figure 4) produced the measurements shown in Table 7'.

Equations may be numbered in brackets at the right-hand margin if you need to refer to them elsewhere in the text:

$$e = mc^2 \quad (1)$$

Tables can be typed into your document where you want them to appear. Figures should not be included in the text, however. If your submission is a computer document (which is preferred), please supply separate files. Postscript images (extension `.ps` or `.eps`) are preferred, but we can handle other forms, for instance PDF, PNG, GIF, TIFF and FITS. If you can provide Postscript images, but derived these from another format, it is a good idea to submit also the images in their original format. If the editors feel that the quality of your Postscript images is not optimal, they can try to improve the quality by starting from the originals.

It is convenient if you type the caption at the point where you want the figure to appear. If you are providing the figure as a computer file, add a note of the filename next to the caption. Remember, though, that editors often move figures and tables to make them fit on the page.

## 5 WGN conventions

What has been said is true for most scientific Journals. Like many journals, WGN has its own house style. A brief guide to these follows. For those who know LaTeX, comments on writing in this format are added. If you are uncertain about any of this, do not worry — we will format your paper correctly.

### 5.1 Units

With a few exceptions, WGN uses SI units, not mks or cgs. Thus energy is in joules not ergs, and power is in watts not ergs per second or joules per second.

The exceptions are those commonly used for good reason by astronomy and meteor science such as years, AU or earth masses.

The SI standard includes conventions as to whether letters should be upright (also called Roman) or italic (Thompson & Taylor, 2008).

- Numbers are always upright, e.g. 3.142.
- Units of measurement are upright e.g. km/s, W, $\mathrm{m/s^2}$.
- Names of variables are in italics, e.g. $T$, $t$, $v$, $\theta$. There are exceptions to this: see below.
- Names of physical constants are in italics, e.g. $c$, $G$.
- Names of mathematical constants such as $\pi$ and e are upright.

There are two exceptions where a variable name is in upright type, not italic. One is where the name (ignoring subscripts) has more than one letter, e.g. ZHR, LM. The other is where the name does not take numerical values but identifies an object; this mainly occurs in subscripts. For instance $h_\mathrm{R}$ is the angular height of the radiant, and the **R** states that it is a radiant whose height is being described. Note that the $h$ is italic since this names a numeric variable. Sometimes the subscript identifies one of a set, for instance $n_\mathrm{LEO}$, $n_\mathrm{GEM}$ or $n_\mathrm{PER}$ for the numbers of meteors from the named showers. Compare this with $v_t$, the speed at time $t$, where the subscript is a numeric variable and thus italic. The Editor will deal with difficult cases; at least one official specification document is ambiguous.

Units should follow the quantity after a space, e.g. $t = 3$ s, $v = 5$ m/s. There are exceptions to this, the main ones being degrees of angle (e.g. 90°) and temperature (e.g. 10°C or 283K). Note that absolute temperature has no degrees sign before the K.

Units in the denominator can be written with a solidus (/) or a negative exponent, e.g. m/s or m $\mathrm{s^{-1}}$. The latter is preferred for complicated forms.

Multipliers such as milli and micro are placed next to the units, e.g. 15 mm, 10 $\mu$s.

Comments follow on two particular cases.

### 5.2 Date and time

WGN prints this in scientific format, which moves monotonically from most significant 'digit' (year) to least significant 'digit' (seconds). For example: 2003 December 25, $01^\mathrm{h}23^\mathrm{m}45^\mathrm{s}$ UT, or some subset of this. Day of the week should be omitted unless there is a good reason for it.

Note (1) the month in words, to remove ambiguity; (2) the comma between days and hours, for clarity; (3) the use of superscripted **h**, **m** and **s** as units and separators; (4) the leading zero, always using two digits; and (5) the specification of the time zone, UT or local. If local time is used, make sure it is clear which time zone this is.

This format may be ignored for non-scientific purposes: 'we arrived just after mid-day on Sunday' is perfectly acceptable, for instance.

### 5.3 Astronomical magnitudes

The astronomical magnitude is not an SI unit. It is also a logarithmic measure of brightness, so it has no units. Thus a statement like 'the meteor reached 3 magnitudes' is wrong; 'the meteor reached magnitude +3' is correct. One can also write 'the meteor reached $m = +3$'.

There are two symbols for magnitude: $m$ for apparent magnitude, which is the one normally used; and $M$ for absolute magnitude, which is what the meteor's apparent magnitude would be if it were 100 km directly above the observer. Both these can be subscripted to specify the wavelengths used, for instance $m_\mathrm{V}$ or $M_\mathrm{V}$ for visible light magnitudes. Most meteor work is at visible wavelengths, however, so this is rarely necessary.

Remember that magnitude 'counts backwards'. Phrases like 'the faintest meteors (less than magnitude +5)' are unclear — did the writer mean magnitudes such as +6 or such as +4? It can be better to say 'brighter than' or 'fainter than'.

### 5.4 Writing these formats into your paper

Italics, subscripts and superscripts are easy with word-processors such as Microsoft Word; so are Greek letters. More obscure symbols, such as $\lambda_\odot$ for solar longitude, are probably best put in words, e.g. '[solar longitude]', leaving it to the Editor to typeset them properly. A covering note with the submitted paper can explain, if needed.

If you use a WYSIWYG word processor other than Microsoft Word, please export the file as PDF.

There are LaTeX commands created by WGN; for instance, `\g` gives a degrees symbol. The following list will mainly be of interest to those who write in LaTeX.

*Table 1* – Special LaTeX commands defined for WGN.

| Use | LaTeX | Result |
|---|---|---|
| Angle | `\g \mi \se` | $12^\circ 34' 56''$ |
| Decimal degrees | `\dg` | $12\overset{\circ}{.}34$ |
| Decimal arcminutes | `\dmi` | $12\overset{\prime}{.}34$ |
| Time | `\h \m \s` | $12^h 34^m 56^s$ |
| Decimal hours * | `\dhr` | $12\overset{h}{.}34$ |
| Decimal minutes | `\dm` | $12\overset{m}{.}34$ |
| V-infinity | `\vi` | $V_\infty = 72$ km/s |
| Solar longitude | `\sol` | $\lambda_\odot = 123^\circ$ |

* The command `\dh` already exists in LaTeX, so `\dhr` is used instead.

All the commands in Table 1 should be used in maths mode, for instance `$12\g34\mi56\se$` to produce the top-right entry.

These LaTeX commands are defined specially for WGN, and so are not part of any normal LaTeX distribution. They are contained in a file `imo2.sty`. If you want this, send an email to the Editor at `wgn@imo.net` and ask for a copy.

To use this file, you must place it in the same subdirectory as your paper and add a line `\usepackage{imo2}` between your `\documentclass` and `\begin{document}` statements.

## 6 References

This is the section where you refer to work you have read and which is relevant to the paper you are writing. It can help readers to

- Read background which they do not know.
- Check that they agree with your interpretation of other peoples' work.
- Read further, when your paper shows them interesting lines of research.

Just as important, references make it clear that you know when someone else discovered or invented something. There is a convention in scientific papers: if you do not mention the originator of an idea, readers assume you are claiming it as your own discovery.

### 6.1 Citations and References

There are many ways of writing references. The layout used in science and engineering involves a marker called a **citation** in the text and the full details, called the **reference**, at the end. For instance, I might say that standard reference works (Burchfield, 1998) can help in writing good English. The '(Burchfield, 1998)' is the citation. If you look at the end of this article you will find a section called references. If you look at the author and date matching the citation, you will find full details of the book described. These details are called the reference; they should be all you need to find the book or article.

Readers get to the references from the citations, so there should be no references without a citation.

### 6.2 Format of citations and references

There are several formats used in scientific writing. Citations such as (Bloggs, 1999), [Blo99], [42] and many others will be encountered.

To avoid mistakes, please do not use the numerical reference system with citations like [42].

The system used in WGN has **citations** comprising the name(s) of the author(s) and the year of publication, e.g. (Copernicus, 1543). Two authors are given as (Starsky & Hutch, 1979); three or more as (Kool et al., 2002), naming just the first author. ('Et al.' is an abbreviation of 'Et alii', which is Latin for 'and others'.) If you use more than one work by the same author(s) from the same year, use (Bloggs, 2000a), (Bloggs, 2000b) and so on. Multiple citations can be combined as (Dent, 1999; Prefect, 2002a, 2010). If what you read gave no author, use 'Anon.'; if no date, use 'No date'.

For WGN, **references** should be in alphabetical order of author(s), and within that in order of publication year.

The authors' initials should follow the surname. Where there are three or more authors, all are listed; 'et al.' is only used in the citation. Use 'and' between the last two names; '&' is only for the citation. The references at the end of this article show the format.

Different types of writing require different details for the references, as shown in Table 2. Please provide these in the order shown. Do not add any formatting such as bold face or quotation marks; we will add that in the WGN house style.

## 7 Writing for WGN in LaTeX

Here is not the place to debate the relative advantages of WYSIWYG systems such as Microsoft Word and mark-up languages such as LaTeX. It is clear, however, that LaTeX has become the accepted standard for much scientific and engineering publication.

Many WGN readers will already know LaTeX. There are several good reference works (Lamport, 1986; Goosens et al., 1994). Only a few guidelines will be given here.

- The paper size is A4 and the document style is article.

*Table 2* – Information required for References in WGN.

| | Author(s) | Year | Paper title | Journal details | Book details | Conference details | Pages | URL |
|---|---|---|---|---|---|---|---|---|
| Journal paper | √ | √ | √ | √[1] | | | √ | |
| Book | √ | √ | | | √[2] | | [3] | |
| Book chapter | √ | √ | √ | | √[2] | | √ | |
| Conference paper | √ | √ | √ | | | √[4] | √ | |
| Entire conference proceedings | √ | √ | | | | √[4] | | |
| World-wide web page [5] | √ | √ | √ | | | | | √ |

Notes

1. Journal details should include (in order): Journal name, Volume, and Issue (if known). If neither Volume nor Issue is available, month and possibly day of publication should be added.
2. Book details should include (in order): Book title, Publisher, Publisher's town and country. If the town is well known (e.g. Oxford, New York), the country may be omitted.
3. If referring to just part of a book, page numbers are helpful.
4. The Conference Details should include (in order): Conference name, Place of the conference, Conference dates and Proceedings publisher (if known). Conference dates may differ from the date of publication.
5. Web pages are impermanent, and thus are not good references.

- The start-of-document command should be `\documentclass[10pt,a4paper,twoside,dvips]{article}`. Writers in North America may prefer to omit `a4paper` for their own proof prints.
- It will be impractical for you to produce WGN's two-column layout. Use the `article` style as if you were writing for a single-column journal.

Those who use BibTeX may send a `.bib` file; contact the Editor if uncertain how to do this.

If you find it hard to produce what you want in LaTeX, don't worry — see the next section.

## 8 LaTeX is not necessary

It is easier for us if you offer your paper in LaTeX, but not essential. We would far rather receive your paper in any form than miss it. If possible, send a machine-readable form — we prefer not to have to type it in.

We will format your paper to fit WGN, and probably adjust the positions of figures and tables. It is not worth your while spending time on the exact layout.

## 9 Main things to remember

If this seem horribly complicated, remember the advice on the cover of the Hitchhikers' Guide to the Galaxy — Don't Panic! When you submit your paper you are sending it to intelligent humans, not a simple-minded machine. If we can work out what you want, we can format it. LaTeX reduces our work but is not essential.

We may want to contact you about your paper. Please give us an email address where we can contact you in the period between submission and publication.

If you are uncertain whether your work is right for WGN, submit it anyway. We will tell you honestly if it needs improvement, and give you guidance about improving it. Astronomy only advances because people conduct research and then write it up.

## 10 Conclusion

WGN welcomes submitted papers. The accepted format of a scientific paper has been outlined. With minor exceptions, all submissions should be in this format, which is designed to help readers. This article has been formatted like a scientific paper, for illustration.

Details have also been given of the correct SI format for writing quantities and units.

Papers are prepared for publication in LaTeX, and authors are encouraged to write in this form. Papers in other formats (e.g. Microsoft Word) are accepted and will be re-formatted.

Above all, readers are encouraged to share the results of their research by writing for WGN. Help to authors will be given where necessary.

## References

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Trayner C. (2003). "Writing for WGN". *WGN, Journal of the IMO*, **31:4**, 124–128.

# Janus

*Cis Verbeeck*[1]

2016 was an excellent meteor year, full of surprises.

It started with a nice treat for meteor observers as the short flux enhancement predicted for the Quadrantids a few hours before the main shower peak was confirmed by observations. An increase by about 50% of the visual ZHR and about 25% of the video meteor flux compared to neighboring values was reported by Rendtel et al. (2016), with a peak width of about 30 minutes. A similar narrow increase by about 50% was found in forward scatter data, 3.4 hours earlier than the peak of the optical meteors.

On July 27-28, a short and strong outburst of the $\gamma$-Draconids was detected by the CAMS Benelux network, the CMOR radar and video data from the IMO Network.

Visual observers will long remember the night of August 11-12, in which they could witness the strongest Perseid activity since the spectacular outburst of 1993. A combination from the 1- and 4-revolution old dust trails delivered a first high ZHR peak above 200 around the predicted time of $23^{h}20^{m}$ UT on August 11, while a second peak ZHR around 170 was observed near $07^{h}30^{m}$ UT on August 12.

Observers in Western Asia were on the outlook for potential enhanced activity of the October Camelopardalids on October 5-6, and were rewarded with an outburst well recorded on radio and video data, centered on $14^{h}45^{m}$ UT, exactly at the predicted time!

At the end of November, a call for observations on December 2-3 was sent to meteor observers to monitor the potential activity of a possible minor meteor shower linked to the asteroid 2001 XQ: the 66-Draconids. Though only very weak activity (if any) from this shower was observed, the CAMS Benelux network detected enhanced activity from *another* shower on December 2–3: the $\kappa$-Draconids.

A possibility for Ursid activity enhancement had been predicted, around $00^{h}$ UT on December 23 and $00^{h}$ UT on December 24. Instead, radio data from RMOJ and RMOB registered enhanced rates around $10^{h}30^{m}$ UT on December 22, which fits with the classical Ursid peak, but with higher rates than normal.

We live in exciting times. With the present ubiquity of smart phones, the well-developed video meteor networks, and IMO's online fireball form, large fireballs are reported all the time. Just read the news items on the IMO website, and you will see a steady stream of large events in 2016:

- February 17: bright fireball over Southern France
- March 17: bright fireball over the United Kingdom
- March 25: bright fireball over The Netherlands and Belgium
- May 17: bright fireball over the Northeastern US
- October 31: bright fireball near Perth (Western Australia) lit up the sky, shortly followed by a few sonic booms. Just over a kilogram of fresh chondrite was recovered near the town of Morawa, 300 km North of Perth, remnants of a body with estimated start weight around 100 kg.
- November 5: bright Southern Taurid fireball over Portugal
- November 22: bright fireball over Florida, Southern Georgia, Alabama
- November 28: bright fireball over The Netherlands
- December 6: very bright fireball lit up the night sky over Southwestern Siberia as if it were daylight during 3 to 4 seconds. Sonic booms followed tens of seconds later. It was estimated that the event could be caused by the entry into the atmosphere of a stone asteroid about 10–15 m diameter.
- December 11: bright fireball over Andalusia, Spain
- December 16: bright fireball over Colombia

The IMO's online fireball report form is a dedicated place where anybody can report a witnessed fireball event. Its first version was created by Mike Hankey and Vincent Perlerin for the American Meteor Society in 2006 for fireball observations in North America. Over time, they managed to build up an impressive, ever growing number of reports. Since 2015, fireball reports from over the world were added through the IMO fireball report form and its customized versions set up by local or national groups.

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IMO bibcode WGN-451-verbeeck-janus NASA-ADS bibcode 2017JIMO...45....6V

In 2016, 26 419 fireball reports were submitted. The large majority is still from North America (86.3%), which means the IMO contribution is currently 13.7% (3 610 reports; 2 152 in 2015). Out of a total of 1 069 reported events, 21.6% were submitted through IMO (231 events; 43 in 2015).

Though it is great to see so many events being reported through the IMO's fireball report form, I believe we can do much better than this, and you can help too! For instance, we received no reports whatsoever from the huge fireball over Siberia on December 6. In order to reach a lot of people around the globe, we need to boost the popularity of the fireball report form. Dear reader, please do make repeated publicity for the fireball report form in your local clubs and in any public outreach activities. Do not forget the form is available in many languages. Also, we need fast press releases for the national media when a large fireball was observed. Whenever you hear about a large fireball, please inform the IMO news editors at `newsitems@imo.net` right away.

The International Meteor Conference in Egmond was one of the highlights of 2016, bringing together meteor enthusiasts from around the globe. A broad range of interesting topics were addressed, and the Scientific Organizing Committee (SOC) introduced a few well-received new initiatives such as extended-talk sessions, an open session, best poster award and best meteor photo competition. As was evident from the results of the IMC satisfaction survey, the conference was very well-organized and the atmosphere was great, definitely one of the best IMCs ever!

In the survey, several people indicated that 10 minute talks are a bit too short to their taste. Other comments were that some feel uncomfortable with the high technical level of most talks, and more observation-oriented talks would be welcomed. The IMC 2017 SOC will take these comments into account for the next edition of the IMC.

November 2016 saw the long-awaited launch of the new IMO website. The website has been totally redesigned and developed by Mike Hankey and Vincent Perlerin, and many people contributed in many ways. Karl Antier is our new webmaster, and together with his news editors team, he does a great job keeping the website alive with regular, interesting and up-to-date news items. Apart from its good looks and vibrant news content, the website offers a lot of new features through user accounts. I would like to thank Mike, Vincent and Karl for their great efforts and achievements.

Data from visual observations can now be entered through an improved online visual form on the IMO website. A brand new Visual Meteor Database (VMDB) was set up and can be consulted through the website. It contains visual data from 1980 till present. For the first time in IMO history, a dynamic and user-friendly interface allows users to view and access all visual data. I invite you to download data too, perform your own shower analysis and submit it to *WGN*.

From 2016 November 1 to 2017 February 9, the IMO website has welcomed more than 55 000 http sessions, with an average of 4.6 pages per session. Figure 1 illustrates the distribution of website sessions per country (for the first 25 out of 200 countries). Clearly, the US is leading this list by far with about 21%, followed by Japan (6%) and Taiwan (4%). Europe and Asia rank first in the distribution of site visits over continents, followed by the Americas (Figure 2). By the sheer amount of visitors, we can see that there is a huge potential to extend the meteor community.

In December, after requests by several people, an IMO forum was launched (`http://forum.imo.net/`). All registered users from the IMO website can log in to the forum and share and discuss pictures and information on a variety of meteor-related topics. To share a video, upload it on the IMO website and link to there in your forum post. Another way to share and discuss meteor information is of course IMO's Facebook page (see inside back cover of this issue).

Over to 2017 now. One of the highlights of 2017 will be the International Meteor Conference in Petnica, Serbia on September 21–24. We hope to meet you there!

In 2017, the International Meteor Organization will organize Council elections. If you want to contribute to IMO's policy and daily management, you can present yourself as a candidate for the Council elections. The call for candidates will be announced in the brochure that comes with the April issue of *WGN*. However, there are many other ways in which you can contribute to our organization.

IMO is an organization for you, the enthusiast meteor worker! One of the main benefits of our organization is that it brings people together worldwide. So in 2017, I call upon every reader to share with the meteor community. Share visual, video or radio data, share fireball reports by yourself or someone who contacted you, share your pictures and videos on the IMO website. Share breaking news with `newsitems@imo.net` in order to be published on the IMO website, and share discussions on the IMO forum or Facebook page. If you have any questions or suggestions for IMO, share them with the relevant contact person which you find on the Contact part of the IMO website as well as on WGN's inside back cover. And last but not least, share your passion for meteors with all your meteor friends and other people around you!

Clear skies!

| | | Number of Sessions (Total: 55,081 sessions) | % of total number of sessions (Total: 55,081 sessions) |
|---|---|---|---|
| 1. | United States | 11,828 | 21.47% |
| 2. | Japan | 3,386 | 6.15% |
| 3. | Taiwan | 2,361 | 4.29% |
| 4. | United Kingdom | 2,307 | 4.19% |
| 5. | Germany | 2,212 | 4.02% |
| 6. | China | 1,962 | 3.56% |
| 7. | France | 1,796 | 3.26% |
| 8. | India | 1,433 | 2.60% |
| 9. | Canada | 1,406 | 2.55% |
| 10. | Russia | 1,373 | 2.49% |
| 11. | Belgium | 1,188 | 2.16% |
| 12. | Bangladesh | 1,153 | 2.09% |
| 13. | Brazil | 931 | 1.69% |
| 14. | Spain | 911 | 1.65% |
| 15. | Italy | 891 | 1.62% |
| 16. | Hong Kong | 874 | 1.59% |
| 17. | Australia | 871 | 1.58% |
| 18. | Iran | 853 | 1.55% |
| 19. | Poland | 823 | 1.49% |
| 20. | Netherlands | 716 | 1.30% |
| 21. | Saudi Arabia | 677 | 1.23% |
| 22. | Malaysia | 562 | 1.02% |
| 23. | Czech Republic | 549 | 1.00% |
| 24. | South Korea | 536 | 0.97% |
| 25. | Norway | 533 | 0.97% |

*Figure 1* – The geographical distribution of http sessions on the IMO website between 2016 November 1 and 2017 February 9.

| | | Number of Sessions (Total: 55,081 sessions) | % of total number of sessions (Total: 55,081 sessions) |
|---|---|---|---|
| 1. | Europe | 18,772 | 34.08% |
| 2. | Asia | 17,939 | 32.57% |
| 3. | Americas | 15,194 | 27.58% |
| 4. | Africa | 2,000 | 3.63% |
| 5. | Oceania | 1,011 | 1.84% |
| 6. | (not set) | 165 | 0.30% |

*Figure 2* – The number of http sessions on the IMO website between 2016 November 1 and 2017 February 9 in different continents.

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Janus *was a Roman god with two faces, one looking to the past and one to the future, called upon at the beginning of any enterprise. Today he is often a symbol of re-appraisal at the start of the year.*

# The IMO Support Fund

*Marc Gyssens, Treasurer*

## Introduction

The IMO has a Support Fund to help serious amateurs in realizing meteor research projects. Support will be provided based on project proposals that will be evaluated by the IMO Council. A precondition for support is that there is a return for the international meteor community.

## Eligibility conditions

To be eligible, a project submitted to the IMO Support Fund must

- be proposed by an IMO member;
- concern scientific and technological aspects of meteor observing (and hence should not be focused on outreach);
- involve a medium- to long-term commitment of 3 years or more;
- return relevant results to the international community via the IMO;
- respect the conditions defined in a contract between the successful applicant and the IMO.

## Procedure

An application for a grant from the IMO Support Fund can be submitted at any time and must be addressed to the IMO President. It should include

- proper identification of the applicants, including their past realizations in meteor astronomy;
- a scientific and technological justification of the project;
- a timing to realize the project;
- references to support the competence of the applicants, and to support the feasibility of and the timing for the project proposed;
- a motivation why a grant from the IMO Support Fund is necessary to realize the project;
- a realistic budget of the costs and revenues involved, including the grant requested from the IMO Support Fund, financing by the applicants themselves or by the local, regional or national association to which they belong, and revenues from external sources;
- an explanation how the project will be managed during at least the first 3 years;
- a statement indicating whether you want to want to maintain your proposal for consideration during the next year should the budget for the current year be exhausted.

Successful applicants will be asked to sign a contract containing both the commitments of the applicants and additional requirements of the IMO that will constitute the terms under which the grant is provided. These terms will not only refer to the content of the project and the way it is managed, but also to a proper justification of the financial means provided.

As the available budget is relatively small, the number of projects that can be financed will be limited to two or three per year. As already mentioned, there are no deadlines; applications will be evaluated on the basis of first come, first served, and each proposal will be considered carefully on its merits, in accordance with the above criteria.

## Other forms of support

In addition, the IMO Council reserves the right to support a cause at its own discretion when it feels it can further meteor astronomy in this way. This holds in particular for IMC support, which can be granted exceptionally in the form of waiving the standard registration fee, on a case-by-case basis. Requests for such support should therefore be strongly motivated from a scientific perspective (required presence at a workshop, presentation of scientific results, participation in an international project, etc.) and should reach the President no later than May 31, 2017.

IMO bibcode WGN-451-gyssens-supportfund NASA-ADS bibcode 2017JIMO...45....9G

# Conferences

## Thirty-Sixth International Meteor Conference, Petnica, Serbia, September 21–24, 2017

*Dušan Pavlović*[1], *Nikola Božić*[1], *and Marc Gyssens*

### Registration is open!

The 36th International Meteor Conference (IMC) will be hosted by the Petnica Science Center (PSC) in Petnica, a small village near the city of Valjevo (Serbia), from September 21 to 24, 2017, exactly 20 years after the IMC was first hosted at this location. Since then, the PSC underwent dramatic changes as a consequence of which it is now a modern, state-of-the-art science center, offering a wide range of facilities, including accommodation, on-campus.

More information can be found in the December 2016 issue of WGN and on the IMC 2017 web pages (`http://imc2017.imo.net`). If you want to visit these pages, and you do not have the URL at hand, do not worry: we provided a link on the home page of the IMO Website (`http://www.imo.net`). If you do not see this link right away, then just select "Next IMC" under the tab "Conference IMC" and you will see it readily.

*Figure 1* – Location of the Petnica Science Center.

Registration fees are very reasonable. The standard registration fee has been set at 130 EUR. This includes full board (accommodation in a triple bedroom, breakfast, lunch, and dinner) from Thursday evening September 21 (dinner included) till Sunday noon September 24 (lunch included), all lecture and poster sessions, conference materials, coffee breaks, and the Saturday afternoon excursion. Participants who wish to be accommodated in a double or single bedroom pay 170 EUR or 240 EUR, respectively. There are only a limited number of doubles and singles, however, which are assigned on a first-come, first-serve basis. There is also a no-accommodation option

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IMO bibcode WGN-451-pavlovic-imcthirdann NASA-ADS bibcode 2017JIMO...45...10P

for which the fee has been set at 75 EUR. This includes the same as the standard fee, except for accommodation and breakfast. For practical reasons, however, we strongly recommend full-board accommodation at PSC.

For late registrations (from July 1, 2017, onward), a fee of 20 EUR must be added to all above-mentioned prices. The final registration deadline is August 15, 2017, but mind that registration may have to be closed earlier if full capacity is reached before that date!

T-shirts and printed proceedings can both be purchased separately upon registering. Electronic proceedings will be available for free to all participants.

Accompanying persons older than 12 years sharing a room with a participant must also register as a participant.

In order to register, one has to fill out the Registration Form that is provided on the IMC 2017 web pages. The registration fee should be paid in full upon registering; failure to do so will result in the cancellation of your registration. Participants from outside Serbia pay either by International Bank Transfer or PayPal (including credit cards payments via PayPal). This does not apply to Serbian participants, who have to pay in RSD and must check this payment option on the Registration Form. Serbian participants will be contacted by the LOC for concrete payment instructions.

The cancellation policy for the IMC 2017 is as follows. Until June 30, 2017, there will be a full reimbursement, reduced with a cancellation fee of 15 EUR. Between July 1 and August 15, 2017, there will be a partial reimbursement of half of the registration fee. From August 16, 2017, onward, there will be no reimbursement.

*Figure 2* – Laboratory at the Petnica Science Center.

## Practical information

Participants are personally responsible for obtaining the necessary travel documents to enter Serbia (as well as for passing through other countries during the journey, in particular if the journey involves changing planes in a third country). On the IMC 2017 web pages (`http://imc2017.imo.net`), in "Practical Information" under the tab "Location", a link is provided to an official website of the Republic of Serbia where you can check whether or not you need a visa. Please do so!

If you need a visa, the Local Organizing Committee (LOC) can provide you with an invitation letter at your request (`imc2017@imo.net`). As the LOC will use information from your Registration Form to draft the invitation letter, make sure that your personal data on the Registration Form are consistent with those on your passport! For obvious reasons, invitation letters will only be sent to bona fide members of the meteor community.

You can also find other useful information on the "Practical Information" page, as well on the "Travel Info" page, also under the tab "Location". As some information is not yet available at this time, it pays to check these pages for updates regularly, especially when the conference draws closer.

## Conference program and proceedings

IMC 2017 participants are invited to participate actively in the conference by proposing one or more lectures or posters. The most convenient way to do so is via the Registration Form.

The actual program will be composed by the Scientific Organizing Committee (SOC). Depending on the number of proposed lectures, the SOC may have to shorten presentations or ask some authors to convert their lecture to a poster.

As usual, the IMO will publish proceedings after the conference, which are referenced in the SAO/NASA Astrophysics Data System bibliographic database. As these proceedings are essential to document the content of the IMC, a contribution is mandatory for each lecture or poster that is presented. The IMC 2017 Proceedings will be edited in LaTeX, and therefore we prefer contributions written in LaTeX, but contributions written in Word are equally welcome. (In the latter case, the editors will take care of the conversion to LaTeX.)

For a timely completion of the IMC 2017 Proceedings, it is essential that contributions are submitted as early as possible. We strongly encourage authors to submit their paper *before* the conference.

More detailed information on proposing a lecture or poster and preparing a contribution for the proceedings, including the deadlines for submitting them, can be found on the IMC 2017 web pages (`http://imc2017.imo.net`) in "Proceedings Guidelines" under the tab "Submissions".

## Contact information

For all correspondence regarding the IMC 2017, please use the generic email address `imc2017@imo.net` (or use the contact form on the IMC 2017 web pages).

We are looking forward to seeing you at the IMC 2017 in Petnica!

*Figure 3* – Petnica Science Center at night.

# Preliminary results

## Results of the IMO Video Meteor Network — August 2016

*Sirko Molau*[1], *Stefano Crivello*[2], *Rui Goncalves*[3], *Carlos Saraiva*[4], *Enrico Stomeo*[5], *and Javor Kac*[6]

Over 96 000 meteors were recorded in more than 12 000 hours of observing time in 2016 August by 77 cameras of the IMO Video Meteor Network. The flux density and population index profile of the Perseids are presented. Enhanced activity of the Perseids was noticed on 2016 August 11/12 between $22^h15^m$ and $23^h45^m$ UT, with a peak flux density of 100 meteoroids per 1 000 km$^2$ per hour near $23^h20^m$ UT.

Received 2016 December 29

## 1 Introduction

The favorable observing conditions of the preceding months continued into August. In particular in the last third of the month we experienced perfect observing conditions at almost every site. Between August 24/25 and 30/31, more than 70 out of 77 cameras were in operation with just two exceptions. Eight cameras managed to observe in August without any break (once more all of them in Italy and Portugal), and 70 cameras managed to observe in twenty or more observing nights.

With over 12 000 hours, the total effective observing was the third best outcome ever, but still it fell 3% short of August 2015 (Table 1 and Figure 1). On the other hand, we increased the maximum number of meteors ever recorded in a single month to over 96 000 (+5%).

## 2 Perseids

Highlight of the month was the Perseid meteor shower, which was particularly looked forward to in this year. The lunar phase was not optimal, since the waxing moon interfered increasingly night by night, but at least the morning hours remained moon-free. The traditional maximum, which was expected to occur in the afternoon hours UT of August 12, was predicted by M. Maslov and E. Lyytinen to be stronger than usual (Rendtel, 2015). The reason was Jupiter, which should have shifted that part of the Perseid stream, which the Earth crossed in 2016, closer to the Earth orbit. In addition, Earth was expected to pass certain dust trails. On August 11 at $22^h34^m$ UT Earth would encounter the 1-revolution dust trail, leading to slightly higher zenithal hourly rates (+10). At $23^h23^m$ UT, an increase of bright meteors was predicted, caused by the 4-revolution dust trail. Finally, according to a calculation of J. Vaubaillon, Earth was to pass the densest part of the Perseid stream already in the morning hours of August 12, caused by the 2-revolution dust trail (Rendtel, 2015).

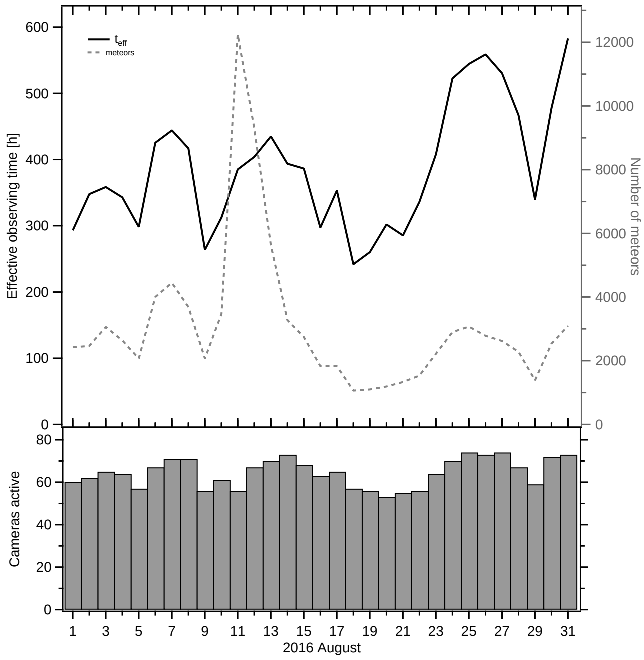


*Figure 1* – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2016 August.

The above-mentioned dust trails indeed presented a spectacular show to visual observers on August 11/12 with highest Perseid rates since the 1993 outburst (Rendtel, 1993). Also, the increase in bright meteors while passing the 4-revolution dust trail was clearly noticeable. But how would these dust trails reflect in the IMO Network video data?

Figure 2 compares the overall 2016 Perseid maximum from August 7 to 17 (red) with the average of the years 2011 till 2015 (green). On the ascending activity branch, rates were marginally lower than on average, which may be attributed to the missing moon. Between solar longitudes 139° and 140°, however, when the Earth passed the dust trails, the rates were clearly higher than average.

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NASA-ADS bibcode 2017JIMO...45...13M

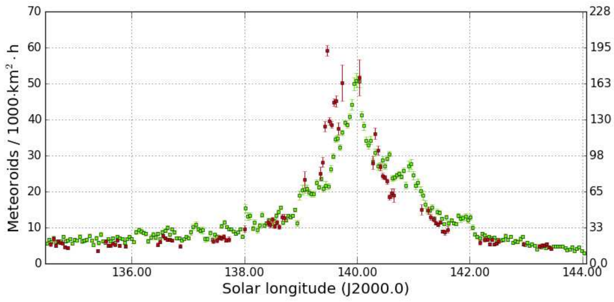


*Figure 2* – Comparison of the activity profiles of the Perseids in 2016 (darker red) with the average of 2011–2015 (brighter green), derived from video observations of the IMO Network.

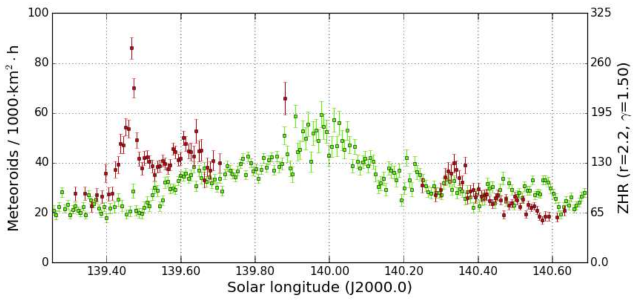


*Figure 3* – Comparison of the high-resolution activity profiles of the Perseid peak in 2016 (darker red) with the average of 2011–2015 (brighter green), derived from video observations of the IMO Network.

In Figure 3 we show only the two maximum nights. Also here we clearly see that the rates on August 11/12 were beyond the average, and we notice certain fine structures in the profile. The following night shows the typical rate decrease.

Figure 4 presents the same solar longitude interval as Figure 3, but this time in comparison with visual observation from August 2016, obtained from the live graph at the IMO homepage (International Meteor Organization, 2016) and scaled accordingly. Both graphs align quite well, but we note that the visual observations were processed with a population index of $r = 2.0$ and the video data with $r = 2.2$.

The high-resolution display (5 minutes per interval) of August 11/12 (Figure 5) shows that rates were generally enhanced between $22^h15^m$ and $23^h45^m$ UT with

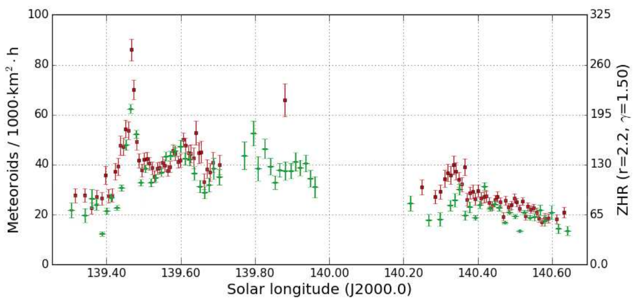


*Figure 4* – Comparison of the activity profiles of the Perseid peak in 2016 obtained by video (red squares) and visual observations collected by the IMO (green dashes) (International Meteor Organization, 2016).

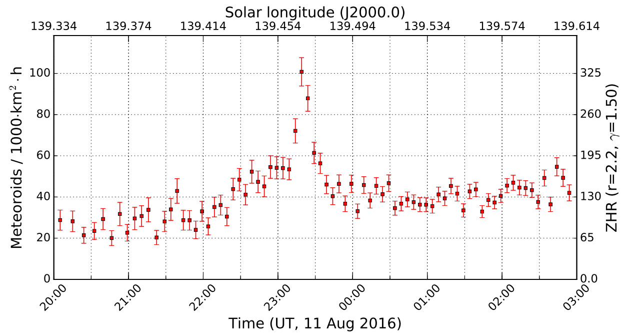


*Figure 5* – High resolution activity profile of the Perseids on 2016 August 11/12, derived from video observations of the IMO Network.

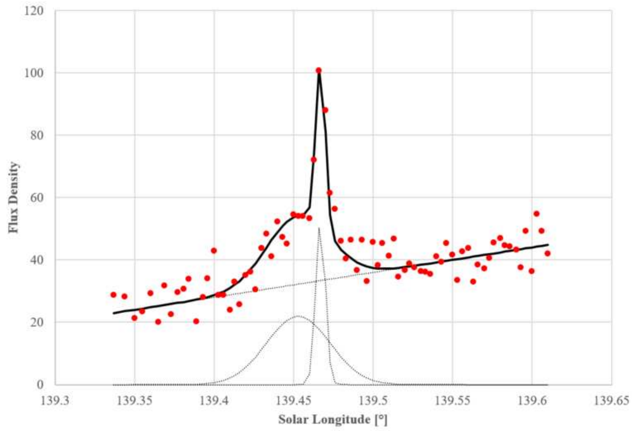


*Figure 6* – Modelling of the activity profile of the Perseids on 2016 August 11/12 (red dots) with a linear component and two Gaussians (dotted black lines). The thick black line represents the profile resulting from all three components.

a peak flux density of 100 meteoroids per 1 000 km$^2$ per hour near $23^h20^m$ UT.

We tried to model the flux density profile of Figure 5 empirically with three components (Figure 6). The background component is approximately linear in this interval with an absolute value of 32 meteoroids per 1 000 km$^2$ per hour at $23^h00^m$ UT and a slope of 80 per degree solar longitude. We add a Gaussian with peak at $\lambda_\odot = 139\overset{\circ}{.}453$ ($22^h58^m$ UT), a peak flux density of 22 meteoroids per 1 000 km$^2$ per hour and a full width at half maximum (FWHM) of 70 minutes. As third component, we add another Gaussian at $\lambda_\odot = 139\overset{\circ}{.}467$ solar longitude ($23^h19^m$ UT) with peak flux density of 50 meteoroids per 1 000 km$^2$ per hour and a FWHM of 10 minutes.

The first Gaussian should represent the 1-revolution dust trail, which occurred about half an hour later and which was stronger than predicted. It reached 2/3 of the nominal flux density at that time. The second Gaussian can be attributed to the 4-revolution dust trail. The peak time matches perfectly to the prediction given the temporal resolution of the analysis (5 minutes). The activity of this dust trail was 50% higher than the activity of the background component.

A closer look at Figure 4 hints also at the 2-revolution dust trail. After the above-mentioned dust trails, the

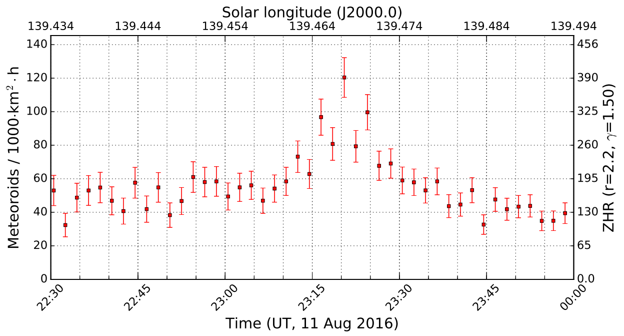


*Figure 7* – Activity profile of the Perseids on 2016 August 11/12 with maximum temporal resolution (two minutes per interval).

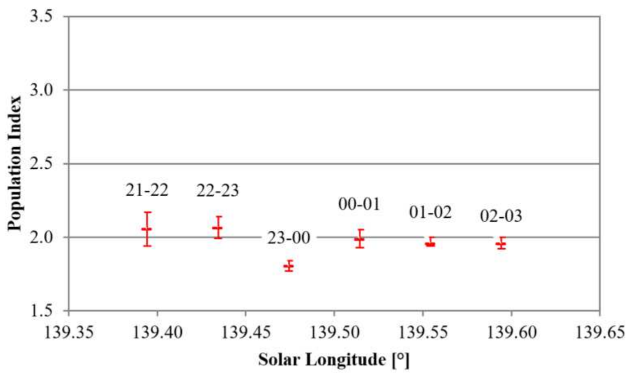


*Figure 9* – Population index profile of the Perseids on 2016 August 11/12, obtained from video observations of the IMO Network.

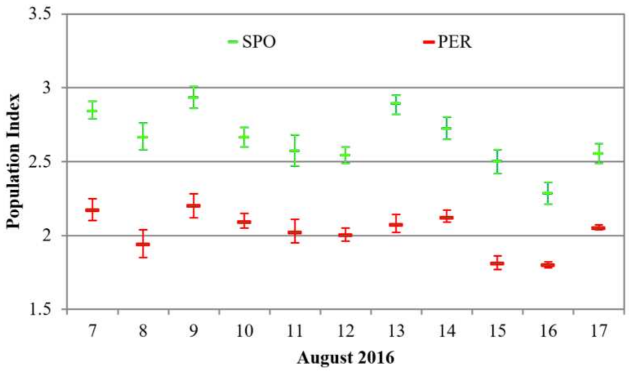


*Figure 8* – Population index profile of the Perseids and sporadic meteors in August 2016, derived from video observations of the IMO Network.

activity peaks between $139\overset{\circ}{.}60$ and $139\overset{\circ}{.}65$ solar longitude ($02^{\rm h}40^{\rm m}$–$03^{\rm h}50^{\rm m}$ UT) and declines slightly thereafter. That alone could also be caused by the fact that certain cameras already had to stop observing by then because of dawn. However, also the visual observations peak at $\lambda_\odot = 139\overset{\circ}{.}60$ solar longitude and show a significant drop thereafter. Thus, we may have passed the center of the 2-revolution dust trail at about $03^{\rm h}00^{\rm m}$ UT.

For the sake of completeness, we like to mention that at maximum resolution of 2 minutes per interval, the narrow peak of the 4-revolution dust trail shows clear oscillations (Figure 7) – an effect that has been observed e.g. during the 1999 and 2002 Leonid meteor storms (Singer et al., 2000; Rendtel, 2001; Herrara Ruiz et al., 2005).

Finally, we want to inspect the population index. Figure 8 shows the $r$-profile of the Perseids and sporadic meteors between August 7 and 17 (same interval as Figure 2). Both curves are nearly parallel with an offset of 0.6, i.e. the population index of the Perseids was on average by 0.6 smaller than the sporadic population index. Since the same fluctuations show up in both profiles, they should primarily be caused by changing observing conditions or cameras. However, we also see that the $r$-value close to the Perseid peak shows virtually no variation.

Let us inspect the Perseid population index of August 11/12 in more detail. Figure 9 shows the hourly values between $21^{\rm h}00^{\rm m}$ and $03^{\rm h}00^{\rm m}$ UT. The $r$-value deviates marginally from 2.0 in that night – only in the interval $23^{\rm h}00^{\rm m}$–$00^{\rm h}00^{\rm m}$ it is lower with $r = 1.8$. Thus, our video data confirm both the prediction and the visual impression that the 4-revolution dust trail produced brighter meteors.

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*Handling Editor:* Javor Kac

*Table 1* – Observers contributing to 2016 August data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

| Code | Name | Location | Camera | FOV [°²] | Stellar LM [mag] | Eff.CA [km²] | Nights | Time [h] | Meteors |
|---|---|---|---|---|---|---|---|---|---|
| ARLRA | Arlt | Ludwigsfelde/DE | Ludwig2 (0.8/8) | 1475 | 6.2 | 3779 | 27 | 125.6 | 1250 |
| BERER | Berkó | Ludányhalászi/HU | Hulud1 (0.8/3.8) | 5542 | 4.8 | 3847 | 25 | 149.5 | 1977 |
| BOMMA | Bombardini | Faenza/IT | Mario (1.2/4.0) | 5794 | 3.3 | 739 | 30 | 201.8 | 2408 |
| BREMA | Breukers | Hengelo/NL | Mbb3 (0.75/6) | 2399 | 4.2 | 699 | 25 | 141.7 | 709 |
| BRIBE | Klemt | Herne/DE | Hermine (0.8/6) | 2374 | 4.2 | 678 | 26 | 147.0 | 941 |
| | | Bergisch Gladbach/DE | Klemoi (0.8/6) | 2286 | 4.6 | 1080 | 24 | 139.8 | 874 |
| CARMA | Carli | Monte Baldo/IT | Bmh2 (1.5/4.5)* | 4243 | 3.0 | 371 | 29 | 169.9 | 976 |
| CASFL | Castellani | Monte Baldo/IT | Bmh1 (0.8/6) | 2350 | 5.0 | 1611 | 27 | 180.9 | 1236 |
| CRIST | Crivello | Valbrevenna/IT | Bilbo (0.8/3.8) | 5458 | 4.2 | 1772 | 31 | 200.1 | 2415 |
| | | | C3P8 (0.8/3.8) | 5455 | 4.2 | 1586 | 28 | 173.0 | 1692 |
| | | | Stg38 (0.8/3.8) | 5614 | 4.4 | 2007 | 31 | 207.8 | 3175 |
| DONJE | Donani | Faenza/IT | Jenni (1.2/4) | 5886 | 3.9 | 1222 | 30 | 213.0 | 2868 |
| ELTMA | Eltri | Venezia/IT | Met38 (0.8/3.8) | 5631 | 4.3 | 2151 | 29 | 192.7 | 1800 |
| FORKE | Förster | Carlsfeld/DE | Akm3 (0.75/6) | 2375 | 5.1 | 2154 | 20 | 121.5 | 991 |
| GONRU | Goncalves | Foz do Arelho/PT | Farelho1 (1.0/2.6) | 6328 | 2.8 | 469 | 20 | 117.9 | 504 |
| | | Tomar/PT | Templar1 (0.8/6) | 2179 | 5.3 | 1842 | 31 | 239.0 | 1589 |
| | | | Templar2 (0.8/6) | 2080 | 5.0 | 1508 | 31 | 241.6 | 1437 |
| | | | Templar3 (0.8/8) | 1438 | 4.3 | 571 | 31 | 216.8 | 578 |
| | | | Templar4 (0.8/3.8) | 4475 | 3.0 | 442 | 31 | 239.8 | 1834 |
| | | | Templar5 (0.75/6) | 2312 | 5.0 | 2259 | 31 | 216.1 | 1513 |
| GOVMI | Govedič | Središče ob Dravi/SI | Orion2 (0.8/8) | 1447 | 5.5 | 1841 | 27 | 129.5 | 841 |
| | | | Orion3 (0.95/5) | 2665 | 4.9 | 2069 | 1 | 0.2 | 2 |
| | | | Orion4 (0.95/5) | 2662 | 4.3 | 1043 | 21 | 81.0 | 342 |
| HERCA | Hergenrother | Tucson/US | Salsa3 (0.8/3.8) | 2336 | 4.1 | 544 | 23 | 175.4 | 821 |
| HINWO | Hinz | Schwarzenberg/DE | Hinwo1 (0.75/6) | 2291 | 5.1 | 1819 | 18 | 112.5 | 743 |
| IGAAN | Igaz | Budapest/HU | Hupol (1.2/4) | 3790 | 3.3 | 475 | 27 | 150.2 | 341 |
| JONKA | Jonas | Budapest/HU | Husor (0.95/4) | 2286 | 3.9 | 445 | 26 | 173.0 | 830 |
| | | | Husor2 (0.95/3.5) | 2465 | 3.9 | 715 | 27 | 180.0 | 1000 |
| KACJA | Kac | Ljubljana/SI | Orion1 (0.8/8) | 1399 | 3.8 | 268 | 22 | 138.5 | 1300 |
| | | Kamnik/SI | Cvetka (0.8/3.8)* | 4914 | 4.3 | 1842 | 17 | 117.0 | 1613 |
| | | | Rezika (0.8/6) | 2270 | 4.4 | 840 | 17 | 114.3 | 1729 |
| | | | Stefka (0.8/3.8) | 5471 | 2.8 | 379 | 13 | 82.2 | 1044 |
| | | Kostanjevec/SI | Metka (0.8/12)* | 715 | 6.4 | 640 | 15 | 93.2 | 453 |
| KOSDE | Koschny | Izana Obs./ES | Icc7 (0.85/25)* | 714 | 5.9 | 1464 | 30 | 208.3 | 1970 |
| | | | Lic1 (2.8/50)* | 2255 | 6.2 | 5670 | 28 | 212.5 | 2980 |
| | | La Palma/ES | Icc9 (0.85/25)* | 683 | 6.7 | 2951 | 30 | 209.1 | 2756 |
| | | | Lic2 (3.2/50)* | 2199 | 6.5 | 7512 | 30 | 251.7 | 3742 |
| LOPAL | Lopes | Lisbon/PT | Naso1 (0.75/6) | 2377 | 3.8 | 506 | 29 | 200.0 | 523 |

*Table 1* – Observers contributing to 2016 August data of the IMO Video Meteor Network – continued from previous page.

| Code | Name | Location | Camera | FOV [°²] | Stellar LM [mag] | Eff.CA [km²] | Nights | Time [h] | Meteors |
|---|---|---|---|---|---|---|---|---|---|
| MACMA | Maciejewski | Chełm/PL | Pav35 (0.8/3.8) | 5495 | 4.0 | 1584 | 28 | 162.2 | 1725 |
| | | | Pav36 (0.8/3.8)* | 5668 | 4.0 | 1573 | 27 | 155.8 | 1819 |
| | | | Pav43 (0.75/4.5)* | 3132 | 3.1 | 319 | 26 | 132.3 | 1021 |
| | | | Pav60 (0.75/4.5) | 2250 | 3.1 | 281 | 27 | 164.5 | 1501 |
| MARRU | Marques | Lisbon/PT | Cab1 (0.8/3.8) | 5291 | 3.1 | 467 | 31 | 251.1 | 1972 |
| | | | Ran1 (1.4/4.5) | 4405 | 4.0 | 1241 | 29 | 225.9 | 1451 |
| MASMI | Maslov | Novosibirsk/RU | Nowatec (0.8/3.8) | 5574 | 3.6 | 773 | 27 | 132.0 | 1447 |
| MOLSI | Molau | Seysdorf/DE | Avis2 (1.4/50)* | 1230 | 6.9 | 6152 | 26 | 56.3 | 548 |
| | | | Escimo2 (0.85/25) | 155 | 8.1 | 3415 | 27 | 157.9 | 423 |
| | | | Mincam1 (0.8/8) | 1477 | 4.9 | 1084 | 26 | 109.5 | 704 |
| | | Ketzür/DE | Remo1 (0.8/8) | 1467 | 6.5 | 5491 | 29 | 144.4 | 1933 |
| | | | Remo2 (0.8/8) | 1478 | 6.4 | 4778 | 29 | 144.8 | 1502 |
| | | | Remo3 (0.8/8) | 1420 | 5.6 | 1967 | 22 | 119.5 | 805 |
| | | | Remo4 (0.8/8) | 1478 | 6.5 | 5358 | 30 | 150.5 | 1601 |
| MORJO | Morvai | Fülöpszállás/HU | Huful (1.4/5) | 2522 | 3.5 | 532 | 28 | 189.1 | 741 |
| MOSFA | Moschini | Rovereto/IT | Rover (1.4/4.5) | 3896 | 4.2 | 1292 | 20 | 34.9 | 250 |
| OTTMI | Otte | Pearl City/US | Orie1 (1.4/5.7) | 3837 | 3.8 | 460 | 23 | 111.7 | 303 |
| PERZS | Perkó | Becsehely/HU | Hubec (0.8/3.8)* | 5498 | 2.9 | 460 | 26 | 145.3 | 1951 |
| ROTEC | Rothenberg | Berlin/DE | Armefa (0.8/6) | 2366 | 4.5 | 911 | 22 | 76.4 | 348 |
| SARAN | Saraiva | Carnaxide/PT | Ro1 (0.75/6) | 2362 | 3.7 | 381 | 30 | 219.2 | 768 |
| | | | Ro2 (0.75/6) | 2381 | 3.8 | 459 | 26 | 188.7 | 952 |
| | | | Ro3 (0.8/12) | 710 | 5.2 | 619 | 26 | 193.2 | 958 |
| | | | Sofia (0.8/12) | 738 | 5.3 | 907 | 29 | 181.5 | 710 |
| SCALE | Scarpa | Alberoni/IT | Leo (1.2/4.5)* | 4152 | 4.5 | 2052 | 29 | 182.1 | 873 |
| SCHHA | Schremmer | Niederkrüchten/DE | Doraemon (0.8/3.8) | 4900 | 3.0 | 409 | 27 | 150.8 | 1131 |
| SLAST | Slavec | Ljubljana/SI | Kayak1 (1.8/28) | 563 | 6.2 | 1294 | 18 | 88.1 | 433 |
| | | | Kayak2 (0.8/12) | 741 | 5.5 | 920 | 24 | 122.1 | 268 |
| STOEN | Stomeo | Scorze/IT | Min38 (0.8/3.8) | 5566 | 4.8 | 3270 | 30 | 191.3 | 2664 |
| | | | Noa38 (0.8/3.8) | 5609 | 4.2 | 1911 | 30 | 187.3 | 2377 |
| | | | Sco38 (0.8/3.8) | 5598 | 4.8 | 3306 | 30 | 191.3 | 2763 |
| STRJO | Strunk | Herford/DE | Mincam2 (0.8/6) | 2354 | 5.4 | 2751 | 28 | 135.3 | 1183 |
| | | | Mincam3 (0.8/6) | 2338 | 5.5 | 3590 | 28 | 122.8 | 772 |
| | | | Mincam4 (1.0/2.6) | 9791 | 2.7 | 552 | 27 | 131.6 | 255 |
| | | | Mincam5 (0.8/6) | 2349 | 5.0 | 1896 | 28 | 123.2 | 564 |
| | | | Mincam6 (0.8/6) | 2395 | 5.1 | 2178 | 27 | 125.6 | 810 |
| TEPIS | Tepliczky | Agostyán/HU | Huago (0.75/4.5) | 2427 | 4.4 | 1036 | 27 | 171.5 | 832 |
| | | | Humob (0.8/6) | 2388 | 4.8 | 1607 | 29 | 173.4 | 1275 |
| TRIMI | Triglav | Velenje/SI | Sraka (0.8/6)* | 2222 | 4.0 | 546 | 24 | 148.1 | 457 |
| YRJIL | Yrjölä | Kuusankoski/FI | Finexcam (0.8/6) | 2337 | 5.5 | 3574 | 21 | 58.8 | 428 |
| * active field of view smaller than video frame | | | | | | Overall | 31 | 12 013.6 | 96 296 |

# Results of the IMO Video Meteor Network — September 2016

*Sirko Molau*[1], *Stefano Crivello*[2], *Rui Goncalves*[3], *Carlos Saraiva*[4], *Enrico Stomeo*[5], *and Javor Kac*[6]

More than 62 000 meteors were recorded in over 14 000 hours of observing time by 79 cameras of the IMO Video Meteor Network in 2016 September. The flux density profile is presented for the September $\varepsilon$-Perseids, showing no deviations from the average profile of the years 2011–2015, excluding the outburst year of 2013. Further tests of the algorithms for magnitude loss in meteors are presented.

Received 2017 March 3

## 1 Introduction

During 2016 we were repeatedly able to report favourable observing conditions. September, however, topped everything, outdoing all earlier results.

Let us have a look at the plain figures. 79 video cameras contributed to the IMO Video Meteor Network in 2016 September. 70 of these managed to observe on 20 or more nights, with as many as 49 managing at least 25 nights. On a third of September nights, more than 70 cameras were active! If we forget about a short less productive spell mid-month, we see that most of the increasingly long nights delivered lengthy clear spells. As a result, we secured over 14 000 hours of effective observing time (Table 1 and Figure 1), which is an increase of about 1700 hours over the previously best month (2015 August) and even 25% more than the previously best September. The hourly meteor rate was slightly above the long-term September average, and, as a result, the overall number of meteors also reached a new all-time-high for September. More than 62 000 meteors in a single month is an output that we have never even reached in October or December. Only August 2011–2015 could compare with that yield, which is no surprise given that the Perseids contribute substantially to the meteor activity over several weeks. And September? The meteor shower lists of MDC and IMO contain only a few minor showers in the Perseus/Auriga region, which show variable activity and present no significant flux at all in many years. Activity of the September $\varepsilon$-Perseids will shortly be covered below.

Finally, we welcomed a new Polish observer who found her way to the IMO Network. Having resolved initial software problems, Wala Wegrzyk has been providing the data from her Mintron camera Pav78 to our network since September.

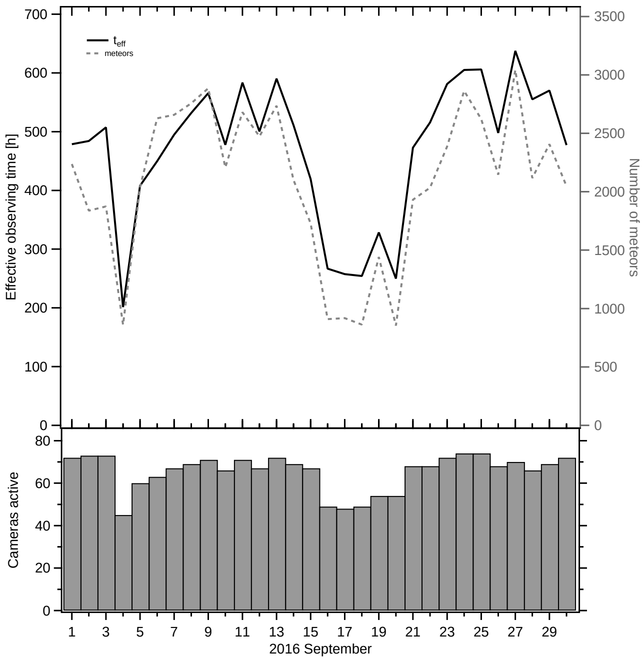


*Figure 1* – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2016 September.

## 2 September $\varepsilon$-Perseids

Notably, we received reports from American visual observers who reported increased rates from the September $\varepsilon$-Perseids (SPE) during the three nights of September 8 to 10. However, if we compare the flux density profile of this shower with the previous years (Figure 2), we see beside the 2013 outburst (which was omitted from the figure so as to not distort the graph) no significant variations.

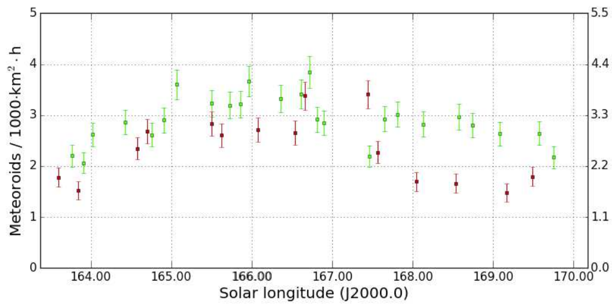


*Figure 2* – Comparison of the flux density of the 2016 September $\varepsilon$-Perseids (darker red) with the average of the years 2011–2015 (lighter green, excluding 2013), derived from video data of the IMO Video Meteor Network.

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IMO bibcode WGN-451-molau-vidsep
NASA-ADS bibcode 2017JIMO...45...18M

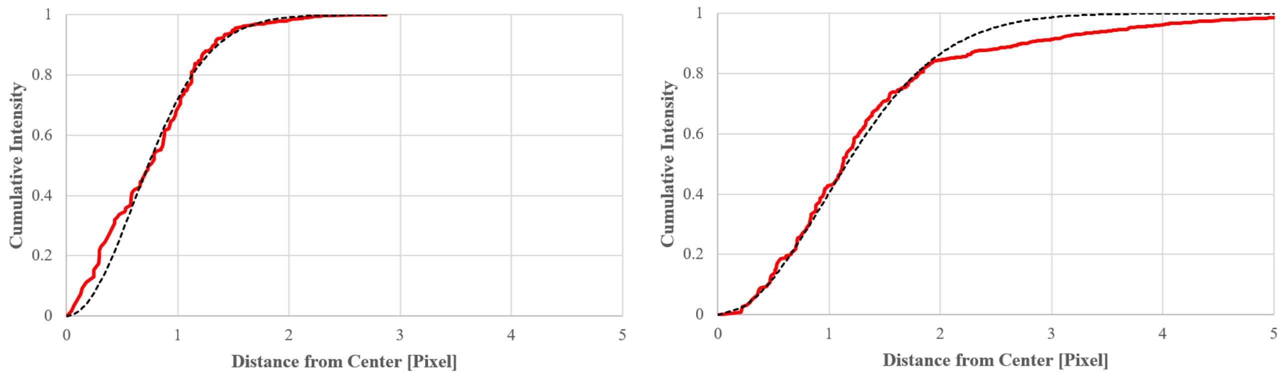


*Figure 3* – Cumulative brightness distribution of the pixels of all bright stars in the field of view depending on their distance from the center of the object. Left we see the result for Icc9, right for Avis2. The red solid line represents the measured distribution, the black dashed line the corresponding model.

## 3 Algorithms of video meteor observations

In the monthly report of 2016 March we derived a formula describing how the loss in limiting magnitude caused by the motion of meteors depends on their angular velocity and the point spread function, i.e. the focus of stars and meteors. We relied on the assumption that stars can be modelled by rotation-symmetric bi-variate Gaussians, whose only relevant parameter is the variance of the distribution (Molau et al., 2016b). In the June report we presented, how the variance of the Gaussian can be estimated from video footage by plotting the cumulative brightness of pixels against their distance from the center of the object. For better statistics, all bright stars in the field of view are combined into a single distribution (Molau et al., 2016a).

This time we want to present the first practical results using the new methods.

Having implemented the algorithm to estimate the variance in the RefStars tool, we measured all cameras which were active in September. For that, we would usually require low-noise average background images, but these were not available. As an alternative, we selected for each camera a meteor image that contains many video frames and stars. This approach has a disadvantage in that the images are more noisy than averaged images, because each pixel contains the maximum value over a number of video frames, not the mean. We shall check at a later point in time whether this is influencing the result in any systematic way.

While measuring the variance we found that the obtained cumulative distribution only sometimes matches the expected distribution (e.g. for Icc9, Figure 3, left). In many cases, the distribution has a kink in the upper part (e.g. in case of Avis2, Figure 3, right). Sometimes that kink has no impact on the variance estimate, but often the variance is getting smaller, when the distribution is fitted only up to the kink.

Taking the average over all cameras we obtain a mean variance of the bi-variate Gaussians of 0.61 without the kink correction and 0.51 with the kink correction (Figure 4). The star and meteor images are typically only a few pixels in size. In particular crisp and focussed images are provided by Templar2, Templar4 and Lic2 with variances below 0.2. Particularly large stellar images with variances above 1.0 are provided by Loomecon, Cab1 and Metka.

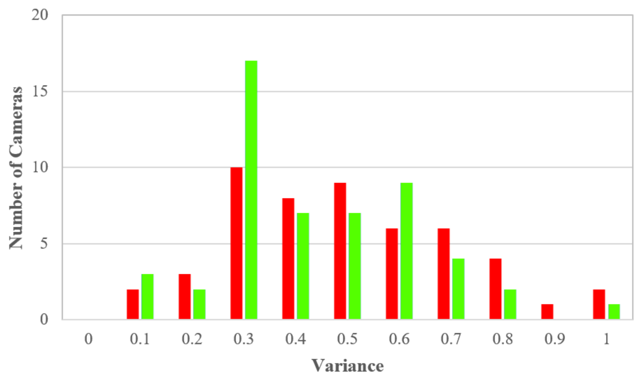


*Figure 4* – Distribution of the variance of star images with (red, darker) and without (green, lighter) considering the distribution beyond the kink.

In addition, we learned that the variance cannot yet be calculated fully autonomously with RefStars, because it reacts sensitively to a number of sources of error:

- In selected cases, we found that the segmentation of stars did not work 100% error-free. Sometimes noisy background pixels were added to the star image. That increased the calculated variance significantly. In this analysis, we removed those stars manually from the list, but maybe it is these inaccurate segmentations that are the root cause for the kink in the distributions (Figure 3).
- Particularly bright stars, for which the CCD chip is saturated and blooming, will also distort the estimate. The reason is that pixels at the object center are much brighter than the maximum possible value with 8-bit depth, so they should have a much bigger share in the lower part of the cumulative distribution.
- For about 25% of the cameras we could estimate no variance at all, because there were too few measurable stars in the field of view.

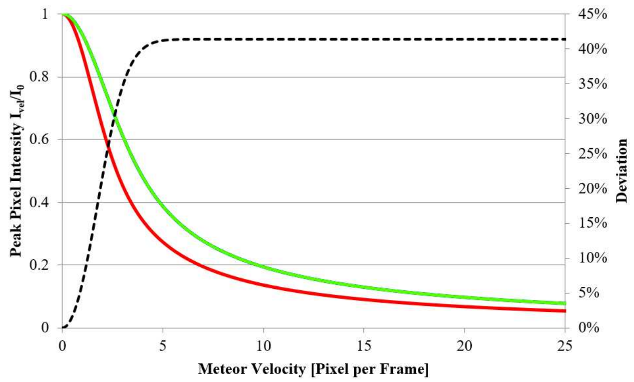


*Figure 5* – Dependency of the intensity loss from the meteor velocity for an object with a variance of 0.3 (solid darker red line) respectively 0.6 (solid brighter green line). The percental deviation between both curves is plotted against the secondary $y$-axis (dashed black line).

- In the presented analysis, we did not only look at the final estimate of the variance after measuring all bright stars in the field of view, but we also checked the interim results. Often the estimate stabilized the more stars were added, but in a few cases the variance decreased constantly the more fainter stars were added.

Maybe the estimate is getting more robust when less noisy average images are used. Perhaps the algorithm can also be improved to not use the whole cumulative distribution but only the segment up to the kink.

How much impact does the calculated variance have, however, on the meteor limiting magnitude and derived values like flux density and population index? Up to now, the loss of limiting magnitude depending on the angular velocity has been modelled identically for all cameras. With the new model, the loss depends on the camera-specific variance. Figure 5 compares exemplary the dependency for a variance of 0.3 and 0.6. The deviation between both curves rises quickly up to 40% (equivalent to 0.3 mag) and remains constant starting at a velocity of about 5 pixels per video frame.

May this difference explain the camera-specific perception coefficients that we introduced in the July 2015 report? To clarify that, we calculated the mean sporadic flux density over the whole month of September for each camera with the old and the new method. We see, that the scatter among the cameras hardly changes (Figure 6). Sraka and Icc9 are two significant upper outliers, which will need to be analysed in more detail.

The most important result is, however, that the loss in limiting magnitude due to meteor motion is more than half a magnitude less than modelled before, which increases the calculated effective collection areas by a factor of two, and reduces the flux densities by the same amount. Thus, we cannot simply merge the data obtained by both methods, but rather have to update the whole data set with the new method first.

To take the camera-specific variance into account, we re-calculated the perception coefficients for all cameras (based on Figure 6, bottom). Comparing the old and new values, we see that the perception coefficient has changed for some cameras. Otherwise all points of Figure 7 would align along the diagonal.

Finally, if we calculate the population index of sporadic meteors in all September nights and take the new perception coefficients into account, we see hardly any

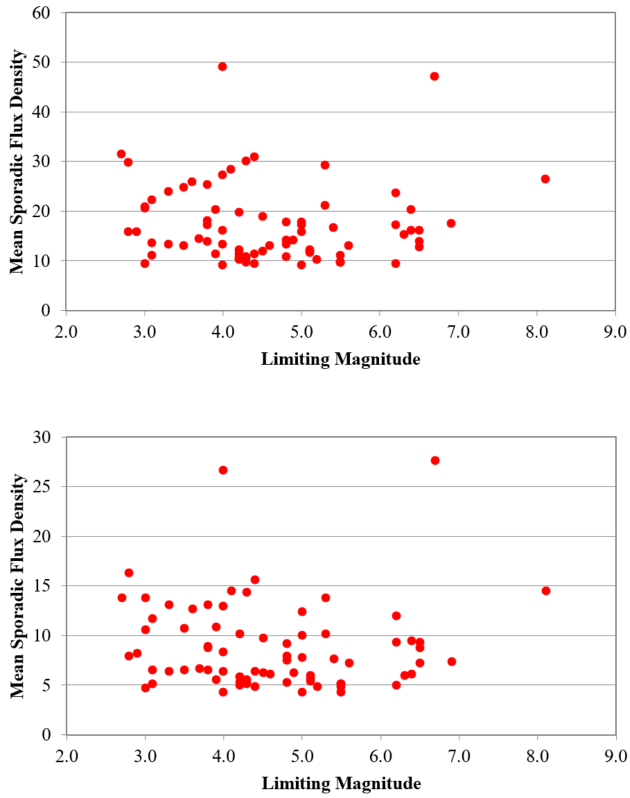


*Figure 6* – Mean sporadic flux density in 2016 September obtained by the old method, where the dependency between meteor velocity and limiting magnitude loss was identical for all cameras (top), and by the new method, where it depends from the variance of star images (bottom). The $x$-axis represents the stellar limiting magnitude of the camera.

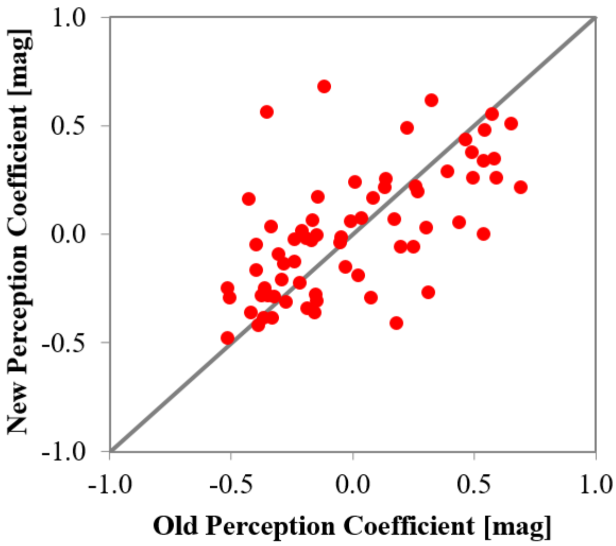


*Figure 7* – Comparison of the perception coefficients according to the old and new procedure to correct for the meteor velocity.

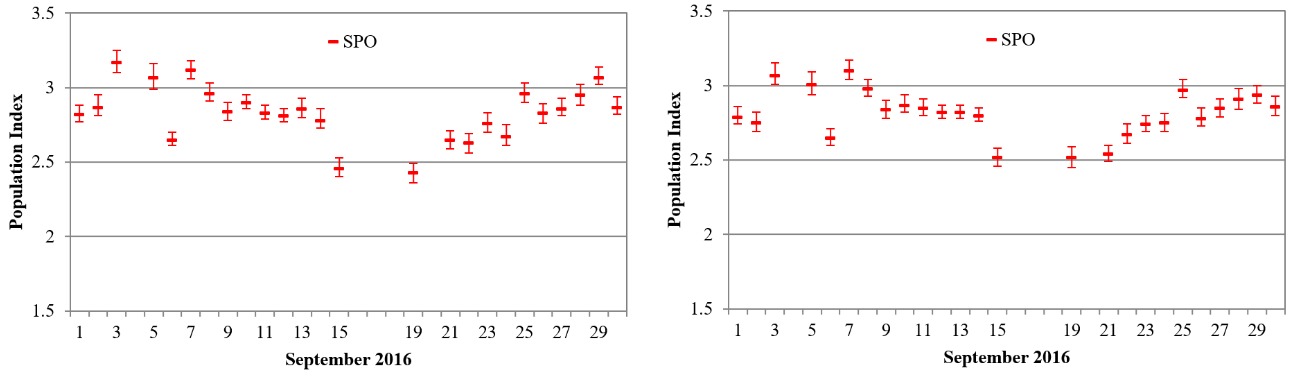


*Figure 8* – Population index of sporadic meteors in 2016 September, calculated by the old (left) and new (right) method to correct for the meteor velocity. Nights with less than 1000 sporadic meteors were skipped in this analysis.

difference compared with the old method (Figure 8). The reason is that all cameras gain more or less similarly in limiting magnitude, and deviations among the cameras are levelled out by the perception coefficient. Thus, the ratio of the meteor counts of individual cameras, which is the basis for the population index calculation, remains almost identical.

Overall the improved model helps to register the observing conditions more precisely. It has a significant impact on the calculated flux density, but no impact on the population index or known systematic errors like the dependency of the $r$-value from the lunar phase.

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Molau S., Crivello S., Goncalves R., Saraiva C., Stomeo E., and Kac J. (2016b). “Results of the IMO Video Meteor Network – March 2016, and discussion about the meteor limiting magnitude”. *WGN, Journal of the IMO*, **44:4**, 120–126.

*Handling Editor:* Javor Kac

| Code | Name | Location | Camera | FOV [°²] | Stellar LM [mag] | Eff.CA [km²] | Nights | Time [h] | Meteors |
|---|---|---|---|---|---|---|---|---|---|
| ARLRA | Arlt | Ludwigsfelde/DE | Ludwig2 (0.8/8) | 1475 | 6.2 | 3779 | 27 | 194.6 | 1315 |
| BERER | Berkó | Ludányhalászi/HU | Hulud1 (0.8/3.8) | 5542 | 4.8 | 3847 | 9 | 68.9 | 313 |
| BOMMA | Bombardini | Faenza/IT | Mario (1.2/4.0) | 5794 | 3.3 | 739 | 27 | 211.6 | 1080 |
| BREMA | Breukers | Hengelo/NL | Mbb3 (0.75/6) | 2399 | 4.2 | 699 | 27 | 166.6 | 509 |
| BRIBE | Klemt | Herne/DE | Hermine (0.8/6) | 2374 | 4.2 | 678 | 26 | 153.7 | 622 |
| | | Bergisch Gladbach/DE | Klemoi (0.8/6) | 2286 | 4.6 | 1080 | 25 | 157.4 | 586 |
| CARMA | Carli | Monte Baldo/IT | Bmh2 (1.5/4.5)* | 4243 | 3.0 | 371 | 24 | 156.5 | 423 |
| CASFL | Castellani | Monte Baldo/IT | Bmh1 (0.8/6) | 2350 | 5.0 | 1611 | 25 | 186.5 | 645 |
| CRIST | Crivello | Valbrevenna/IT | Bilbo (0.8/3.8) | 5458 | 4.2 | 1772 | 30 | 218.3 | 914 |
| | | | C3P8 (0.8/3.8) | 5455 | 4.2 | 1586 | 29 | 194.1 | 649 |
| | | | Stg38 (0.8/3.8) | 5614 | 4.4 | 2007 | 30 | 228.1 | 1530 |
| DONJE | Donani | Faenza/IT | Jenni (1.2/4) | 5886 | 3.9 | 1222 | 26 | 216.9 | 1314 |
| ELTMA | Eltri | Venezia/IT | Met38 (0.8/3.8) | 5631 | 4.3 | 2151 | 24 | 176.3 | 609 |
| FORKE | Förster | Carlsfeld/DE | Akm3 (0.75/6) | 2375 | 5.1 | 2154 | 24 | 186.6 | 793 |
| GONRU | Goncalves | Foz do Arelho/PT | Farelho1 (1.0/2.6) | 6328 | 2.8 | 469 | 14 | 102.8 | 109 |
| | | Tomar/PT | Templar1 (0.8/6) | 2179 | 5.3 | 1842 | 30 | 259.1 | 1284 |
| | | | Templar2 (0.8/6) | 2080 | 5.0 | 1508 | 30 | 263.4 | 975 |
| | | | Templar3 (0.8/8) | 1438 | 4.3 | 571 | 29 | 241.4 | 416 |
| | | | Templar4 (0.8/3.8) | 4475 | 3.0 | 442 | 30 | 256.6 | 909 |
| | | | Templar5 (0.75/6) | 2312 | 5.0 | 2259 | 30 | 233.3 | 976 |
| GOVMI | Govedič | Središče ob Dravi/SI | Orion2 (0.8/8) | 1447 | 5.5 | 1841 | 28 | 210.0 | 709 |
| | | | Orion4 (0.95/5) | 2662 | 4.3 | 1043 | 28 | 98.0 | 356 |
| HERCA | Hergenrother | Tucson/US | Salsa3 (0.8/3.8) | 2336 | 4.1 | 544 | 22 | 179.4 | 472 |
| HINWO | Hinz | Schwarzenberg/DE | Hinwo1 (0.75/6) | 2291 | 5.1 | 1819 | 22 | 158.7 | 693 |
| IGAAN | Igaz | Budapest/HU | Hupol (1.2/4) | 3790 | 3.3 | 475 | 19 | 149.1 | 118 |
| JONKA | Jonas | Budapest/HU | Husor (0.95/4) | 2286 | 3.9 | 445 | 29 | 200.6 | 358 |
| | | | Husor2 (0.95/3.5) | 2465 | 3.9 | 715 | 29 | 213.4 | 399 |
| KACJA | Kac | Ljubljana/SI | Orion1 (0.8/8) | 1399 | 3.8 | 268 | 24 | 170.7 | 646 |
| | | Kamnik/SI | Cvetka (0.8/3.8)* | 4914 | 4.3 | 1842 | 20 | 132.0 | 670 |
| | | | Rezika (0.8/6) | 2270 | 4.4 | 840 | 21 | 152.0 | 1074 |
| | | | Stefka (0.8/3.8) | 5471 | 2.8 | 379 | 20 | 136.8 | 432 |
| | | Kostanjevec/SI | Metka (0.8/12)* | 715 | 6.4 | 640 | 12 | 93.0 | 213 |
| KOSDE | Koschny | Izana Obs./ES | Icc7 (0.85/25)* | 714 | 5.9 | 1464 | 20 | 170.0 | 1485 |
| | | | Lic1 (2.8/50)* | 2255 | 6.2 | 5670 | 29 | 261.3 | 2944 |
| | | La Palma/ES | Icc9 (0.85/25)* | 683 | 6.7 | 2951 | 29 | 225.0 | 2405 |
| | | | Lic2 (3.2/50)* | 2199 | 6.5 | 7512 | 28 | 261.3 | 3082 |
| LOJTO | Łojek | Grabniak/PL | Pav57 (1.0/5) | 1631 | 3.5 | 269 | 19 | 133.6 | 632 |
| LOPAL | Lopes | Lisbon/PT | Naso1 (0.75/6) | 2377 | 3.8 | 506 | 19 | 117.3 | 214 |

*Table 1* – Observers contributing to 2016 September data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

*Table 1* – Observers contributing to 2016 September data of the IMO Video Meteor Network – continued from previous page.

| Code | Name | Location | Camera | FOV [°²] | Stellar LM [mag] | Eff.CA [km²] | Nights | Time [h] | Meteors |
|---|---|---|---|---|---|---|---|---|---|
| MACMA | Maciejewski | Chełm/PL | Pav35 (0.8/3.8) | 5495 | 4.0 | 1584 | 25 | 172.3 | 1022 |
| | | | Pav36 (0.8/3.8)* | 5668 | 4.0 | 1573 | 28 | 192.9 | 997 |
| | | | Pav43 (0.75/4.5)* | 3132 | 3.1 | 319 | 26 | 165.2 | 501 |
| | | | Pav60 (0.75/4.5) | 2250 | 3.1 | 281 | 28 | 195.3 | 1055 |
| MARGR | Maravelias | Lofoupoli-Crete/GR | Loomecon (0.8/12) | 738 | 6.3 | 2698 | 22 | 164.0 | 345 |
| MARRU | Marques | Lisbon/PT | Cab1 (0.8/3.8) | 5291 | 3.1 | 467 | 30 | 261.9 | 987 |
| | | | Ran1 (1.4/4.5) | 4405 | 4.0 | 1241 | 29 | 237.4 | 675 |
| MASMI | Maslov | Novosibirsk/RU | Nowatec (0.8/3.8) | 5574 | 3.6 | 773 | 26 | 178.2 | 926 |
| MOLSI | Molau | Seysdorf/DE | Avis2 (1.4/50)* | 1230 | 6.9 | 6152 | 25 | 207.1 | 2391 |
| | | | Escimo2 (0.85/25) | 155 | 8.1 | 3415 | 25 | 213.2 | 616 |
| | | | Mincam1 (0.8/8) | 1477 | 4.9 | 1084 | 24 | 177.9 | 701 |
| | | Ketzür/DE | Remo1 (0.8/8) | 1467 | 6.5 | 5491 | 29 | 208.2 | 1814 |
| | | | Remo2 (0.8/8) | 1478 | 6.4 | 4778 | 29 | 213.6 | 1455 |
| | | | Remo3 (0.8/8) | 1420 | 5.6 | 1967 | 28 | 206.1 | 880 |
| | | | Remo4 (0.8/8) | 1478 | 6.5 | 5358 | 28 | 219.0 | 1446 |
| MORJO | Morvai | Fülöpszállás/HU | Huful (1.4/5) | 2522 | 3.5 | 532 | 27 | 213.1 | 395 |
| MOSFA | Moschini | Rovereto/IT | Rover (1.4/4.5) | 3896 | 4.2 | 1292 | 22 | 23.7 | 142 |
| OTTMI | Otte | Pearl City/US | Orie1 (1.4/5.7) | 3837 | 3.8 | 460 | 23 | 124.4 | 208 |
| PERZS | Perkó | Becsehely/HU | Hubec (0.8/3.8)* | 5498 | 2.9 | 460 | 20 | 160.9 | 853 |
| ROTEC | Rothenberg | Berlin/DE | Armefa (0.8/6) | 2366 | 4.5 | 911 | 13 | 51.0 | 165 |
| SARAN | Saraiva | Carnaxide/PT | Ro1 (0.75/6) | 2362 | 3.7 | 381 | 27 | 217.1 | 404 |
| | | | Ro2 (0.75/6) | 2381 | 3.8 | 459 | 18 | 169.0 | 420 |
| | | | Ro3 (0.8/12) | 710 | 5.2 | 619 | 22 | 194.3 | 650 |
| | | | Sofia (0.8/12) | 738 | 5.3 | 907 | 29 | 228.4 | 404 |
| SCALE | Scarpa | Alberoni/IT | Leo (1.2/4.5)* | 4152 | 4.5 | 2052 | 13 | 86.7 | 128 |
| SCHHA | Schremmer | Niederkrüchten/DE | Doraemon (0.8/3.8) | 4900 | 3.0 | 409 | 27 | 154.0 | 644 |
| SLAST | Slavec | Ljubljana/SI | Kayak1 (1.8/28) | 563 | 6.2 | 1294 | 25 | 168.8 | 487 |
| | | | Kayak2 (0.8/12) | 741 | 5.5 | 920 | 25 | 158.8 | 154 |
| STOEN | Stomeo | Scorze/IT | Min38 (0.8/3.8) | 5566 | 4.8 | 3270 | 28 | 187.4 | 1117 |
| | | | Noa38 (0.8/3.8) | 5609 | 4.2 | 1911 | 29 | 191.4 | 817 |
| | | | Sco38 (0.8/3.8) | 5598 | 4.8 | 3306 | 29 | 202.1 | 1283 |
| STRJO | Strunk | Herford/DE | Mincam2 (0.8/6) | 2354 | 5.4 | 2751 | 24 | 155.3 | 922 |
| | | | Mincam3 (0.8/6) | 2338 | 5.5 | 3590 | 28 | 169.6 | 669 |
| | | | Mincam4 (1.0/2.6) | 9791 | 2.7 | 552 | 21 | 147.0 | 138 |
| | | | Mincam5 (0.8/6) | 2349 | 5.0 | 1896 | 26 | 170.4 | 614 |
| | | | Mincam6 (0.8/6) | 2395 | 5.1 | 2178 | 28 | 171.0 | 565 |
| TEPIS | Tepliczky | Agostyán/HU | Huago (0.75/4.5) | 2427 | 4.4 | 1036 | 28 | 222.0 | 388 |
| | | | Humob (0.8/6) | 2388 | 4.8 | 1607 | 28 | 212.1 | 722 |
| TRIMI | Triglav | Velenje/SI | Sraka (0.8/6)* | 2222 | 4.0 | 546 | 23 | 100.3 | 280 |
| WEGWA | Wegrzyk | Nieznaszyn/PL | Pav78 (0.8/6) | 2286 | 4.0 | 778 | 21 | 144.9 | 599 |
| YRJIL | Yrjölä | Kuusankoski/FI | Finexcam (0.8/6) | 2337 | 5.5 | 3574 | 20 | 106.6 | 433 |
| | | | | | | Overall | 30 | 14 077.5 | 62 285 |

* active field of view smaller than video frame

# Erratum: Results of the IMO Video Meteor Network — June 2016

*The WGN Editorial Team*

In the June 2016 Video Meteor Network report (Molau et al., 2016) an error occurred during typesetting of Equation (10). The correct Equation (10) is as follows:

$$V_d = \mathrm{erf}\left(\frac{2d}{\pi\sqrt{\sigma^2 + 0.09}}\right)^2 \tag{10}$$

We sincerely apologize to the authors and our readers for this error.

## References

Molau S., Crivello S., Goncalves R., Saraiva C., Stomeo E., and Kac J. (2016). "Results of the IMO Video Meteor Network — June 2016". *WGN, Journal of the IMO*, **44:6**, 198–204.

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# Fireball on 2017 January 20 from Austria

A bright fireball occurred on 2017 January 20 at $03^{\mathrm{h}}23^{\mathrm{m}}$ UT and was captured from Fornach, Austria. The top image shows the fireball, while the bottom image displays a persistent train 1 minute after the fireball image. Image credit: Hermann Koberger.