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Fireballs
Video meteors
Meteor Beliefs Project

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Front cover photo

This magnitude −9 fireball was recorded by Hans Salm from La Paz, Bolivia on 2008 May 5, on a 42-second exposure starting at $06^h00^m40^s$ UT. The bright 'star' that the lower part of the train crosses is Jupiter. For more details, see Hans' article inside this issue.

Cover design

Rainer Arlt

Legal address

International Meteor Organization, Mattheessensstraat 60, 2540 Hove, Belgium.

Editorial

Javor Kac

This is the third issue of WGN that I am producing as Editor-in-chief, and with it a new volume of WGN is started. You will notice it is a hefty one with 50 pages. The Editorial team provided a lot of help with editing, typesetting and proofreading the articles. A Handling Editor, responsible for each individual paper, is now mentioned at the end of the paper. With this, we are pointing out their crucial contribution to the Journal. Of course, many more people are involved in producing WGN—of high importance also are other members of the Editorial team who contributed by proofreading papers for science, style and language. Special thanks goes to former WGN editor Chris Trayner who provided excellent support, particularly concerning LaTeX.

This year's International Meteor Conference will be held from September 24 to 27 in Poreč, Croatia. As in previous years, financial support is available; the deadline to apply for support is June 12. Details can be found on the following pages. I am looking forward to seeing you in Poreč in September!

The results of the questionnaire that was included in WGN **36:4**, asking readers their opinion of our Journal, are presented in this issue. We are pleased that a majority of readers are happy with the contents and appearance of WGN. From the readers' responses, we see there is a strong demand for practical how-to articles, theoretical articles, shower analyses, and articles on telescopic observations. Articles about meteor-related comet and asteroid news, meteor-related professional institute reports and reviews of meteor-related books would also be appreciated by readers.

Writing for WGN

Readers are therefore kindly invited to submit papers on any meteor-related topic for publication in WGN. All papers will be reviewed for scientific content, and edited for English and journal style. Instructions for authors can be found in WGN **31:4**, 124–128, and at `http://www.imo.net/articles/writingforwgn.pdf` .

WGN in electronic PDF format

Beginning with Volume 37, WGN subscribers are now able to access the Journal in electronic PDF format. Issue **37:1** is provided as a sample copy (free download for everybody).
Please point your browsers to `http://www.imo.net/imo/wgn` and try it out.
Tell your colleagues about this novelty!

IMO bibcode WGN-371-editorial NASA-ADS bibcode 2009JIMO...37....1K

Janus

Chris Trayner [1]

When I took over the Editorship of WGN in December 2002, I had certain ideas of how I thought I could improve it. Naturally I wanted to keep what was good with it, and WGN already had the essentials right. It published high-quality articles about observations and theory of meteors, plus non-scientific material such as administrative and historical pieces. I also thought it important that it served both professional and amateur authors, and that the latter should not get pushed out.

In December 2002, after I had agreed to be Editor, we held what I called a "conspirators' meeting" in Potsdam with the WGN "old guard". At that meeting we decided much of the new style of WGN. I had produced a proposed new-look front cover, but few people liked it. Then Rainer Arlt produced a far better one, and that is the cover you see today. We also chose a style that would minimise the Editor's workload — wisely, given my time problems towards the end of my Editorship.

If you compare WGN with a glossy magazine, you will see that its page design is very straightforward: there are no pictures across two columns or tilted at an angle. This is not because we think these are inappropriate for a scientific journal, just that they take far more time. This is also why WGN papers often end near the top

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of a page, without another article starting straight after. To do that takes a surprising amount of extra time. Articles often grow or shrink at the last minute, and if that happens to one near the start of an issue it affects everything after it. Such changes often move figures to a different page, requiring much re-adjustment.

It is interesting to look back at what I intended to do when I took over, and ask how much I have achieved.

I wanted to improve the visual appearance to make use of the improved printing that had become affordable. I think this was achieved, though that was a simple change and was done for my first issue.

I wanted to keep the delay between receiving an article and publishing it as small as possible, ideally publishing in the next issue. Initially I succeeded, but it slipped badly in the last years as time pressures got worse.

I wanted to encourage more professional astronomers to write for WGN, and in some cases approached them and asked. I have only had occasional success at this, but we have plenty of professional astronomers writing for us anyway so this was achieved without my efforts.

I was concerned to keep the amateur authors still writing for us. I am not sure this has succeeded fully. Several people have expressed worries that we have fewer amateur observational papers than before, and I agree. One worry is that amateurs with good observations might feel their work would not compare with the professional papers. Alastair McBeath suggested that I should invite such papers explicitly, making it clear that good but straightforward observations were welcome. I did this, and we have seen a small number of such papers. Let us hope more will follow. There has been much discussion in Council about whether this lack is something WGN is doing wrong, or whether such articles have shifted to email, the web and newsgroups.

It is clear that many WGN authors, with articles just as important as professional astronomers, have little training in writing scientific papers or English. I therefore always saw it as part of my job to help with advice about these things. This often produced many lengthy emails between myself and authors, to find out what they wanted to say and help them say it in good scientific English. I estimate this averaged about one third of the editing work. In some cases, with authors struggling with English, this could take over ten hours for a long paper. I have an immense regard for people writing in a language which is not their mother tongue, and I don't regret a minute of it. These efforts can have unexpected benefits — I remember several Polish authors at IMC 2005 who presented me with a bottle of Polish vodka to thank me for my help with their writing. It was beautiful vodka, and even when it was empty it took me a long time to make myself throw away the empty bottle.

In the end the time pressures on me got stronger and stronger, something that was unfortunately obvious to readers as issue after issue was late. One comment heard nowadays is that people don't have as much spare time as they did ten or twenty years ago. You hear this in Britain, and from emails within Council it seems clear that it applies to much of the rest of Europe. This is one reason for Council's decision to spread the Editorship of WGN over more people. To my mind it is clearly the right decision. What was worrying us was whether we would get enough volunteers to make it work. It was with an enormous sense of relief that at IMC 2008 we realised we did have enough. It was also there that Javor Kac told me he was willing to stand for the post of Editor. There are few people I could imagine who would be as good a choice. I hope he doesn't regret his offer — I don't think he will. Despite all the effort, I never regretted my decision to edit WGN.

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.*

Meteor Beliefs Project returns to WGN

Alastair McBeath[1] and Andrei Dorian Gheorghe (Project Coordinators)

We are delighted to be able to return to WGN this year, with some new Meteor Beliefs Project (MBP) articles to help celebrate the cultural aspects of International Year of Astronomy 2009. We have three articles planned, beginning in this issue with some further meteoric folklore from Belarus compiled by long-standing MBP contributor Tsimafei Avilin.

Many thanks to all those who contacted us to express concern at the absence of the MBP from WGN in 2008. Having been unexpectedly prevented from publishing any Project articles here, our themed set of meteorite and impact-related papers prepared to commemorate the Tunguska Event's centenary in 2008, were presented as posters at the 2008 IMC in Sachticka, Slovakia, instead. The full article texts should be published in the 2008 IMC Proceedings in due course. Preprint PDF versions of all six papers are already available on the Project's CD-ROM, along with PDFs of all the earlier MBP articles published in WGN. See the Project's webpage at

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http://www.imo.net/projects/beliefs for notes on all of these. The CD-ROM can be purchased from IMO's online shop for 4 Euros or 6 US Dollars.

We would hope to continue publishing articles in this journal in future years too, and would welcome contributions from anyone with suitable material to share, in-line with the Project's open-ended nature as described in the very first MBP article back in WGN 31:2 (2003 April). For information on what we are particularly interested in, see that article, or the Project's webpage, or contact us directly. We are always happy to have fresh, positive input for the Project!

IMO bibcode WGN-371-mcbeath-MBPreturns NASA-ADS bibcode 2009JIMO...37....2M

Vladimír Znojil (1941–2008)

Petr Pravec

Vladimír Znojil was born in Prostějov in Moravia (the eastern part of the Czech Republic) in 1941. He attended the Prostějov Public Observatory from the age of 12. His mentor there was the observatory's director Adolf Neckář. Vladimír became interested in planetary astronomy, but his main focus soon turned to meteor astronomy. He studied mathematics and physics at Charles University Prague and obtained a Master's degree in astronomy in 1963. He took up a position at the Brno Public Observatory from 1963, where the job included teaching astronomy and research in meteor astronomy.

He participated in Czech meteor expeditions from 1956 and contributed to organizing them with the preparation of observing programs. He was an exceptional observer with his unique eyesight enabling him to see the faintest objects.

In one of his first scientific papers, published in Bulletin of the Astronomical Institutes of Czechoslovakia, he analyzed the method of independent counting applied to meteor observations, which was based on the works of E. Öpik, further elaborated by Z. Kvíz. Vladimír showed that assumptions of the method cannot be fulfilled in its practical application.

Considering the inapplicability of the method of independent counting, he promoted and advanced the method of telescopic observations of meteors, involving the plotting of meteor trajectories on to charts of the sky, most successfully with superior 10×80 binoculars.

Vladimír's enthusiasm, diligence, accuracy and standards of rigor became legendary. His mathematical skills were outstanding. He influenced many fellow researchers. His speeches always commanded attention, giving to an audience a lot of food for thought as well as amusement.

Around 1968, he took a job as computer programmer for Czechoslovak Air Traffic Control. There he made the best of his great skill in writing complex computer codes. His mathematical and computer skills resulted in the success of simultaneous meteor observations with telescopic, visual, and radar techniques in 1972 and 1973.

After completing the work on analyses of the simultaneous observations and publishing scientific papers with the results, he turned his focus to biophysics. He worked together with J. Vácha from the Biophysical Institute of the Czechoslovak Academy of Sciences and with D. Povolný of the Mendel University of Agriculture and Forestry in Brno. He continued studies of low-activity meteor showers.

Vladimír's first PhD thesis was so special that there was no reviewer able to evaluate it. He then wrote a second thesis in the field of human physiology, specializing in the modeling of haemopoiesis and ferrum transfer. In the early 1990s he got a job at the Faculty of Medicine of Masaryk University in Brno, in the Department of Pathologic Physiology. He worked on mathematical modeling of physiological processes and obtained the position of associate professor. He co-authored more than 100 papers there.

Vladimír Znojil became the head of the Interplanetary Matter Division of the Czech Astronomical Society in the late 1980s. In 1995 the Division was transformed into the Czech Society for Interplanetary Matter, with Vladimír being its first president. He produced more than 200 issues of the Bulletin of the Society for Interplanetary Matter, to which he contributed heavily. In collaboration with Petr Hájek and Jan Hollan, he produced the Gnomonic Sky Atlas Brno 2000. The Atlas became the recommended set of charts for meteor plotting in the International Meteor Organization and has greatly improved the accuracy of visual meteor plotting. Vladimír continuously compiled the data sets of visual observations from the Czech Republic for the Visual Meteor Database of the IMO over a period of about 15 years. These were always among the best prepared data sets contributed to the database.

For his contribution to astronomy, Vladimír Znojil became a honorary member of the Czech Astronomical Society in 1998. The minor planet (15390) discovered by Petr Pravec from Ondřejov was named in Vladimír's honor.

Vladimír Znojil died on 2008 December 29 from a serious illness. With his passing, Czech amateur meteor astronomy has lost a most outstanding person.

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From the Treasurer — Electronic Shop and Recent Publications

Marc Gyssens

Electronic shop

The IMO's electronic shop has been operational for over a year, now. To access it, just surf to `http://www.imo.net` and click on 'Publications' under 'Organization'. There, you get an overview of all publications that are available (it has now become impossible to order publications that are sold out). A green marker indicates there is still ample stock. An orange marker, however, indicates that there are only a few copies left and that you should hurry if you want to secure one for yourself. After having placed your order, you will then be directed to another page where you can indicate your shipping information and method of payment. Just follow the instructions; in case you did not try it yet, it is very easy!

The available payment options are the same as for membership renewal. That is why we suggest to take a look at the available publications now, because it may be interesting to combine a publications order and your membership renewal in one payment.

Recent publications

We want to point out the attention of our readers to our most recent publications:

- *Handbook for Meteor Observers.* This long overdue publication has now become available. For a more detailed description, we refer to the October 2008 issue (WGN 36:5). Price: 20 EUR or 28 USD.
- *WGN Volume 36 (2008).* Price: 15 EUR or 21 USD.
- *WGN Volume 35 (2007).* Price: 15 EUR or 21 USD.
- *WGN Volume 34 (2006).* Price: 15 EUR or 21 USD.
- *Proceedings of the 1st EuroPlaNet Workshop on Meteor Orbit Determination.* This workshop took place in conjunction with the 2006 IMC in Roden. As of the time of this writing, only 2 copies remain! Price: 15 EUR or 21 USD.
- *IMC 2006 Proceedings.* These proceedings contain the articles of the presentations at the 2006 International Meteor Conference at Roden, the Netherlands. Price: 15 EUR or 21 USD.
- *Radio Meteor School 2005 Proceedings.* These proceedings resulted from bringing together for the very first time professional and amateur radio meteor observers, and is therefore a basic contribution to this field of meteor observing. Price: 15 EUR or 21 USD.
- *IMC 2005 Proceedings.* These proceedings contain the articles of the presentations at the 2005 International Meteor Conference at Oostmalle, Belgium. Price: 15 EUR or 21 USD.
- *DVD archive of WGN and IMC proceedings.* Several WGN volumes and IMC proceedings, many of which no longer available in printed form, are now available on DVD. Price: 45 EUR or 63 USD.

For other back volumes of WGN or IMC proceedings that are still available, please refer to the inside back cover or visit our electronic shop!

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Conferences

International Meteor Conference 2009
September 24–27, Poreč, Croatia

Korado Korlević and Željko Andreić

Location and period

The 2009 International Meteor Conference (IMC) will take place from September 24 to 27 in the town of Poreč. Poreč borders the the Adriatic Sea and is situated on the Istrian Peninsula, about 70 km south of the Italian city of Trieste. It is a historic town almost 2000 years old, that still preserves some Roman remains. Several of the streets on which you will be walking actually date back to these times! The town is set around a harbor of protected from the sea by the small island of Sveti Nikola. The town's major landmark is the 6th century Euphrasian Basilica, which, in 1997, was designated as a UNESCO World Heritage Site.

In more recent years, the city developed as a seaside resort, benefiting from the mild Mediterranean climate. During the period of the IMC, you may expect maximum temperatures in the order of 20–24° C and minimum temperatures in the order of 10–15° C. Currently, the population of Poreč is approximately 12 000 people. For the City of Poreč, which also includes the suburbian area, this number rises to 17 000.

Quite nearby is also the village Višnjan which is the location of the Višnjan Observatory.

For more information on Poreč, you may visit `http://www.istra.hr/porec/en`.

Venue

The conference will take place in the *Pical Hotel*. For more information in English, please visit the web page `http://www.valamar.com/objekt.aspx?j=ENG&o=hpical&s=o_objektu&d=NA`. There are double rooms and double rooms with an extra bed. Each room has toilet, shower, and TV. Single rooms will require a supplement of 40 EUR. The hotel has also a lot of recreational facilities and the beach is at only 150 m!

As customary, the IMO will provide limited support to dedicated meteor workers who need it in order to be able to attend. We are fortunate that the local organizers have also dormitory facilities available near the Višnjan Observatory, which considerably increases our possibilities to provide support. More details can be found in a separate article following this one.

How to get there

Fromt the conference location, the nearest major cities are Venice and Trieste (Italy), Pula, Riejeka and Zagreb (Croatia), and Ljubljana (Slovenia), all of which have airports. For those intending to fly, Trieste is perhaps the most convenient destination. There are regular bus services from Trieste to Poreč. Train travelers can choose Trieste, Rijeka, Zagreb, or Ljubljana, and take a bus from there. Poreč itself has no railroad connections. There are also ferries from Venice. Finally, Poreč can also be reached by car very easily.

Please contact the Local Organizers if you need transportation from the town to the hotel.

To give you a better idea of the conference location, we calculated the distances to the cities mentioned above:

Venice (I)–Poreč	200 km
Trieste (I)–Poreč	70 km
Pula (HR)–Poreč	70 km
Rijeka (HR)–Poreč	90 km
Zagreb (HR)–Poreč	260 km
Ljubljana (SLO)–Poreč	150 km

Local Organization

This year, the Local Organization is in the hands of the Višnjan Observatory. The main organizers are Korado Korlević and Željko Andreić.

IMO bibcode WGN-371-korlevic-imcann NASA-ADS bibcode 2009JIMO...37....5K

Registration fee

The registration fee amounts to 160 EUR. If you book no later than 2009 June 30, however, you get a 10 EUR deduction, and you pay only 150 EUR. In this amount is included:

- a parking place for those coming by car;
- general conference materials and a 2009 IMC T-shirt;
- accommodation for 3 nights;
- all meals (from dinner of Thursday, September 24, up to lunch on Sunday, September 27);
- refreshments during coffee breaks;
- the conference excursion and dinner;
- the proceedings.

We also encourage you to give a presentation of your results or the results of your group. Make sure your registration as well as the abstract of the talk(s) you intend to give reaches us before 2009 August 31. However, we strongly advise you not to wait that long and register at your earliest convenience.

Practical information

To register, please visit `http://www.imo.net/imc2009` and fill out the registration form that you will find there by following the appropriate link. Alternatively, you can fill out the paper registration form you find here and send it to *Marc Gyssens, IMO Treasurer, Heerbaan 74, B-2530 Boechout, Belgium.* **However, please use the webform if you can!** The paper form is intended only for those having no easy access to the internet.

For your registration to remain valid, the IMO excepts to receive either the full sum of 150 EUR (early)/160 EUR (late) or a prepayment of at least 75 EUR **within two weeks after registration**. If you have registered electronically, you will be automatically directed to the page with payment information. For those who cannot register electronically, the paper form contains this info as well. Electronic registrants get automatic confirmation emails for both receipt of their registration and receipt of (each) payment. If you only make a prepayment, you can pay the balance at a later data or at the conference itself.

Contact information

For more information, check the IMC 2009 website at `http://www.imo.net/imc2009`.

For further questions regarding registration and payment, please contact the IMO Treasurer, Marc Gyssens, via email at `treasurer@imo.net` or write to him—Marc Gyssens, Heerbaan 74, B-2530 Boechout, Belgium.

For all other questions, contact the Local Organization via e-mail at `imc2009@imo.net` or write to them—Višnjan Observatory, Istarska 5, HR-52463 Višnjan, Croatia. This is in particular the case for those needing a formal invitation to obtain a visa. Notice that such invitations will be supplied only to serious applicants known to the international meteor community.[1] Also mind that Croatia is not yet part of the European Union or the Schengen Agreement, as a consequence of which there is formal border control upon entering the country.

[1]It is the participant's responsibility to obtain all documents required to enter Croatia. Failure to do so does not constitute a valid reason for full or partial reimbursement of the registration fee or prepayments thereof.

International Meteor Conference
Poreč, Croatia, 2009 September 24–27
Registration form

Do not use if you have internet access! Please register electronically on `http://www.imo.net/imc2009` if you can. Only if you have **no** internet access, fill out one form for each individual participant and return it to Marc Gyssens, IMO Treasurer, Heerbaan 74, B-2530 Boechout, Belgium, as soon as possible. Registration will be guaranteed only after Marc Gyssens has received either the full registration fee of 150 EUR (up to June 30)/160 EUR (from July 1 onward) or a pre-payment of at least 75 EUR. We expect this payment to arrive within two weeks after the form.

Name: ____________________ Address: ____________________

____

____

Phone: ____________ Fax: ____________ E-mail: ____________

- I wish to register for the IMC 2009 from September 24 to 27.
- I intend to travel by ________, together with ____________________
- I want to share a room with ____________________
- T-shirt: Size (S-M-L-XL): ________ Gender: ________ (included in fee)
- I am vegetarian.

For participants wishing to contribute to the program:

Lecture: ____________________

Requirements: ____________________

Duration: ________ minutes

Workshop: ____________________

Poster(s): ____________________ Space: ________ m^2

Comments:

- I am paying the entire registration fee of 150 EUR (early)/160 EUR (late)
- I am paying the advance (75 EUR) now, the remainder later
- I want a single room (a supplement of 40 EUR will be charged).

The indicated amount should be sent to IMO Treasurer, Marc Gyssens. The following payment options are available:

- **International bank transfer** to the International Meteor Organization, Mattheessensstraat 60, B-2540, Hove, Belgium, IBAN account number: BE30 0014 7327 5911, BIC bank code: GEBABEBB (Fortis Bank, Belgium). This is recommended for people living in the European Union, as it is no more costly than a domestic bank transfer when done correctly.
- **PayPal payment** to `payment@imo.net`. In that case, we must ask you to add the costs involved in the transaction (3.4% of the total sum including costs, plus 0.35 EUR).
- **Other arrangements**. Please contact the IMO Treasurer for information.

Financial support for IMC 2009 participants

Jürgen Rendtel and Marc Gyssens

As during previous years, *IMO* is making limited funds available to support participation in the *IMC* 2009. In addition, we are very fortunate this year that Local Organizers have dormitory facilities near Višnjan Observatory (about 12 km from Poreč, which will significantly increase our capabilities to provide support. The Local Organizers will provide a shuttle service between the dormitory and the actual conference location.

To apply for support, please do the following:

1. E-mail your application to *IMO* President Jürgen Rendtel, at `president@imo.net`. Include the word 'Meteor' in the subject line to get round the anti-spam filters. *IMO* cannot be held responsible for applications which are lost or arrive late. The application must be submitted by an *IMO* member, but may also request support for other meteor workers. The proposal must state that all the candidates are committed to attend the *IMC* (except for unforeseen circumstances) if the requested support is granted in full.
2. Complete an *IMC* Registration Form (preferably electronically) for everyone seeking support (unless already done before).
3. Include a brief curriculum vitae of everyone seeking support, focusing on aspects relevant to meteor work. Supported participants are expected to present either a talk or a poster at the *IMC*. (Indicate and detail this on the Registration Form.)
4. The application must explain the motivation for participating in the *IMC* and the importance of this participation it to the person or group of persons requesting support.
5. Include a budget for travel costs and registration, and the amount of support requested. Other sources of external support, or their absence, must be mentioned. The proposal must indicate to what extent *IMO* support is essential to attend the *IMC*.
6. The applications should reach the President no later than Friday, 2009 June 12. The decision of the *IMO* Council will be made as soon as possible, probably within two weeks after this deadline. If the support is granted in full, the registration form becomes final. If the requested support is not granted, or only partially granted, the candidates should inform the President within three weeks after notification of the *IMO* Council's decision if they want to sustain or withdraw their registration. Most likely, the support will consist of waving registration fees, which will be settled directly between the IMO and the Local Organizers. Additional support is unlikely, but, it granted, will be paid in cash at the *IMC*.

Should the application be turned down, the standard conference fee (i.e., €150, without the surcharge for a late application) will still apply. We strongly encourage all meteor workers who want to attend the *IMC* 2009, but who are prevented from doing so by financial considerations, to apply for support.

IMO bibcode WGN-371-rendtel-imcsupport NASA-ADS bibcode 2009JIMO...37Q...8R

Call for Future IMCs

Jürgen Rendtel and Marc Gyssens

In the past, the locations for IMCs were chosen on an ad-hoc basis depending on what was offered. To offer every interested party an equal chance and to avoid situations in which no proposals are offered, to avoid not having an IMC, we are making a formal call for organizing the 2010 IMC, which is supposed to take place around the third week of September, from Thursday evening (arrival of the participants) to Sunday lunchtime (departure of the participants). Similar calls for future IMCs will be made regularly in the February issue of WGN.

Proposals are due 2009 June 1, and should be sent to the President, Jürgen Rendtel, Eschenweg 16, D-14476 Marquardt, Germany, `jrendtel@aip.de`, preferably in PDF-format.

The IMO Council will decide on the proposal to be accepted in 2009 September, at the IMC in Poreč, Croatia. The Council may take advantage of the intermediate time to ask for clarifications or additional information from the candidates.

From past experience, we know it is often difficult to choose between several proposals. If multiple proposals merit the opportunity to host an IMC, the Council will contact such candidates to ask them to retain their candidacy for the next year. If in the next round the Council must decide between equally worthy proposals, priority will be given to the older one.

There are no forms to solicit for the 2010 IMC, but your proposal should at least contain the following elements:

1. **Who are you?** Who is going to be the local organizers? Which local, regional, or national astronomical organization(s) is/are backing you up? What is your experience with meteor work? Have you been involved in past IMCs, as passive/active participant or as co-organizer? Do you or the organization(s) to which you belong have experience in organizing events that can be compared to an IMC?

2. **Why do you want to do it?** What is your motivation for wanting to organize an IMC?

3. **Where do you want to do it?** At what location do you want to organize an IMC? Why is this a good location? Can it easily be reached by plane, public transportation, and/or car? How many hours is it by public transport from the nearest major international airport? Provide a few pictures of the location, or, a weblink to such pictures.

4. **At what venue are you going to hold the IMC?** Preferably, lectures and accommodation should be under the same roof, but there is no real objection to the lecture room being at a separate location within easy walking distance from the accommodation. Describe the accommodation at your disposal. Preferably, add an offer from the hotel and/or the institution providing additional accommodation to prove that the venue you propose is indeed available and that the price is within the limits of your budget (see below). Provide also a few pictures of the accommodation, or, a weblink to such pictures.

5. **What will it cost?** Draft a preliminary budget for the IMC proposed. Mention all sources of income, in particularly sponsors or subsidies. Take into account that the price per participant should not exceed 150 EUR by much. Of this amount, 10 EUR must be reserved for producing and mailing the (post-)proceedings to the participants. With respect to the expenditures, take into account that the participants must be offered full board from Thursday evening, dinner, up to Sunday, lunch, inclusive. Of course, lecture room facilities should be accounted for, as well as a coffee break in the morning and in the afternoon. Finally, it is also customary to have a half-day excursion, usually on Saturday afternoon.

   Note that, although the IMC provides the service of collecting the registration fees for you, the IMC will in principle *not* cover any negative balance that you might incur, so, please, draft your budget responsibly!

6. **Can it also be done in a later year?** We can only have one IMC every year. It is therefore important for us to know if you can also make this offer in a subsequent year. If there are reasons why the application cannot be postponed, please describe these reasons clearly! It is imperative that you answer the questions honestly. Of course, we understand that you are keen to organize next year's IMC, otherwise you would not have applied, but having a clear picture of the real time constraints of all the candidates is a serious help for the Council to make the best decision possible!

Of course, you may add to your application any information or considerations which you think may influence your candidacy favorably. In general, however, help the Council in seeing the wood for the trees! While it is important that your application is complete and addresses all the issues mentioned above, please do so *concisely*! Avoid beating about the bush with meaningless phrases and be as factual as possible!

If you are interested in applying for the local organization of the 2010 IMC, please email the President as soon as possible that you intend to apply by the due date of 2009 June 1. Even though such a declaration of intent is not a formal commitment, it is an indication for the Council as to how many applications may be expected: based on this information, the Council may actively solicit additional candidacies.

We hope to receive many candidacies!

IMO bibcode WGN-371-rendtel-futureimcs NASA-ADS bibcode 2009JIMO...37R...8R

Bolides and Meteorite Falls International Conference May 10–15, 2009, Prague, Czech Republic

communicated by Jiři Borovička and Pavel Spurny

Bolides and Meteorite Falls, the International conference on the occasion of the 50th anniversary of the Pribram meteorite fall, and the 80th birthday of Zdenek Ceplecha will be organized on 2009 May 10–15 in Hotel Michael, Prague, Czech Republic.

This announcement contains information about the conference program, registration, accommodation, abstract submission, travel requirements, and post-conference excursion. Full information can be found at the conference webpage `http://www.bolides09.com`.

Scientific topics

After the historical discovery of the small asteroid (or large meteoroid) 2008 TC3, which produced the first predicted bolide, we have added a new topic – observations of meteoroids in space. The full list of scientific topics is:

- observation of bolides and superbolides (optical, acoustic, space-borne, radar)
- interaction of large meteoroids with the atmosphere (ablation, fragmentation, deceleration, radiation etc. - observations and models); satellite re-entries
- derivation of meteoroid properties from bolide observations, classification of meteoroids
- observation of meteoroids in space (e.g. 2008 TC3)
- meteorite dark flight, impact, strewn fields, craters
- physical properties of meteorites (density, porosity, strength, fusion crust)
- meteorite and meteoroid flux, impact hazard
- meteorite delivery to the Earth, sources of meteorites (comets as well?)
- existence of meteorite streams
- legal aspects of meteorite recovery and collection
- meteorites on other planets

Social program

The welcome reception will be held in the main building of the Academy of Sciences of the Czech Republic on Sunday, May 10. The building is located in the center of Prague, near National Theater. The reception will be connected with the opening of an exhibition '50 years from the recovery of the Pribram meteorites'.

An excursion to the Ondrejov Observatory will be organized for conference participants and accompanying persons in the afternoon of Wednesday, May 13. Ondrejov Observatory, located 40 km from Prague, was founded in 1898 and is currently the headquarters of the Astronomical Institute of the Academy of Sciences of the Czech Republic. Zdenek Ceplecha has been working here since 1951. Ondrejov Observatory was one of the two sites where the photographs of the Pribram bolide were taken in 1959. Today, the observatory is a working place for about 100 people and contains, apart from historical buildings and a small museum, living astronomical instruments, including a two-meter stellar telescope, a 65-cm telescope for asteroidal observations, solar telescopes and radio telescopes and, of course, bolide cameras.

A post-conference excursion will be organized on Saturday, May 16.

Registration

On-line registration has been opened at the address: `https://secure.cbttravel.cz/bolides09/registration-online` Please, follow the instructions on the web page. The registration will be completed only after the payment of the registration fee is received. The registration fees are as follows:

Participant

Before 2009 March 1: 5800 CZK (about 210 EUR as of 2009 February)

After 2009 March 1: 6400 CZK (about 230 EUR)

The fee covers the participation in scientific sessions, conference bag, program and abstracts, coffee breaks, welcome reception, excursion to Ondrejov Observatory, and dinner at the observatory. We currently do not plan to issue conference proceedings.

Accompanying person

Before 2009 March 1: 1200 CZK (about 45 EUR)

After 2009 March 1: 1450 CZK (about 55 EUR)

The fee for accompanying persons covers the conference bag, welcome reception, excursion to Ondrejov Observatory, and dinner at the observatory.

We are looking forward to seeing you in Prague!

IMO bibcode WGN-371-borovicka-conference NASA-ADS bibcode 2009JIMO...37...10B

WGN Questionnaire: The Results

Cis Verbeeck [1]

In the August issue of WGN, the IMO Council introduced the WGN questionnaire. The results of this questionnaire are presented below. Respondents to the questionnaire would particularly like to see more articles on practical aspects of meteor work — how to observe, how to analyze data, and giving advice on equipment. We therefore encourage readers that can write such articles to submit them to WGN. There is also demand for other types of articles as described in the 'General conclusions' below.

Received 2009 January 31

1 Introduction

First, let me express the IMO Council's gratitude towards the 26 readers who entered their answers through the IMO website and those 13 who sent in their filled out paper copy. 39 readers out of 233 is only 17%, however, which tells us that we need to draw all conclusions with some caution.

2 Questions and answers

1. **How many years have you been a WGN reader?** 0-2/2-5/5-10/> 10

0– 2	10	25.64%
2– 5	3	7.69%
5–10	5	12.82%
> 10	21	53.85%

More than half of the respondents are long-time readers. Yet 25% have just recently started reading WGN.

2. **In terms of meteor astronomy, do you consider yourself:**

(a) an amateur/a professional;

an amateur	35	89.74%
a professional	4	10.26%

Apart from 35 amateurs, also 4 professionals took the effort to fill in the questionnaire.

(b) **your level of expertise to be:** beginner/intermediate/advanced?

beginner	4	10.26%
intermediate	19	48.72%
advanced	16	41.03%

Most respondents consider their expertise as intermediate or advanced.

3. **How do you judge the contents of WGN overall?** Very good/Good/Quite good/OK/Quite poor/Poor/Very poor/No opinion

Very good	7	17.95%
Good	14	35.90%
Quite good	5	12.82%
OK	6	15.38%
Quite poor	5	12.82%
Poor	0	0.00%
Very poor	0	0.00%
No opinion	2	5.13%

67% thinks WGN contents are quite good up to very good. The biggest single bin is 'good' (36%). However, 15% chooses 'OK', while 13% say 'quite poor'. Let us listen to their advice or complaints in the next questions.

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IMO bibcode WGN-371-verbeeck-questionnaire NASA-ADS bibcode 2009JIMO...37...11V

4. **Would you like to see more, less or the same of any of the following?**

It is only natural that readers will typically prefer more articles rather than less articles in any category. To get the full picture we should also compare the results of the individual categories relative to each other. To this end, we calculated the weighted average of the opinion for each category (1 = much more → 5 = much less). The lower the value of the weighted average, the more positive the average response for that category.

(a) **Theoretical articles** (e.g., stream modeling, shower & outburst predictions, ZHR computation methods) — Much more/More/The same/Less/Much less/No opinion

Much more	4	10.26%
More	19	48.72%
The same	14	35.90%
Less	0	0.00%
Much less	0	0.00%
No opinion	2	5.13%

59% wants more; nobody wants less; 36% is happy to leave things as they are.
Weighted average = 2.27.

(b) **Practical articles** (e.g., how to observe, how to analyze data, advice on equipment) — Much more/More/The same/Less/Much less/No opinion

Much more	10	25.64%
More	22	56.41%
The same	7	17.95%
Less	0	0.00%
Much less	0	0.00%
No opinion	0	0.00%

82% wants more; nobody wants less; 18% is happy to leave things as they are.
Weighted average = 1.92.

(c) **Detailed shower analyses from recent observations** — Much more/More/The same/Less/Much less/No opinion

Much more	6	15.38%
More	10	25.64%
The same	20	51.28%
Less	3	7.69%
Much less	0	0.00%
No opinion	0	0.00%

41% wants more; 8% wants less; 51% is happy to leave things as they are. Weighted average = 2.51.

(d) **Historical articles** (e.g., biographies of notable past meteor astronomers, earlier meteor showers, Meteor Beliefs Project) — Much more/More/The same/Less/Much less/No opinion

Much more	2	5.13%
More	10	25.64%
The same	15	38.46%
Less	10	25.64%
Much less	1	2.56%
No opinion	1	2.56%

31% wants more; 28% wants less; 38% is happy to leave things as they are. Weighted average = 2.95.

(e) **Reports from local observing campaigns, expeditions and projects** — Much more/More/The same/Less/Much less/No opinion

Much more	3	7.69%
More	11	28.21%
The same	21	53.85%
Less	1	2.56%
Much less	2	5.13%
No opinion	1	2.56%

36% wants more; 8% wants less; 54% is happy to leave things as they are. Weighted average = 2.68.

(f) **Conference announcements & reports** — Much more/More/The same/Less/Much less/No opinion

Much more	1	2.56%
More	5	12.82%
The same	30	76.92%
Less	2	5.13%
Much less	1	2.56%
No opinion	0	0.00%

15% wants more; 8% wants less; 77% is happy to leave things as they are. Weighted average = 2.92.

(g) **Letters & opinion articles** (e.g., Janus, editorials) — Much more/More/The same/Less/Much less/No opinion

Much more	0	0.00%
More	9	23.08%
The same	26	66.67%
Less	2	5.13%
Much less	0	0.00%
No opinion	2	5.13%

23% wants more; 5% wants less; 67% is happy to leave things as they are. Weighted average = 2.81.

(h) **Articles aimed at beginners or youngsters** — Much more/More/The same/Less/Much less/No opinion

Much more	2	5.13%
More	17	43.59%
The same	10	25.64%
Less	5	12.82%
Much less	1	2.56%
No opinion	4	10.26%

49% wants more; 15% wants less; 26% is happy to leave things as they are. Weighted average = 2.60.

(i) **Information notices from the IMO** (e.g., new publications, subscription information, news of Council discussions & decisions) — Much more/More/The same/Less/Much less/No opinion

Much more	0	0.00%
More	5	12.82%
The same	31	79.49%
Less	1	2.56%
Much less	1	2.56%
No opinion	1	2.56%

13% wants more; 5% wants less; 79% is happy to leave things as they are. Weighted average = 2.95.

(j) **Photographs & illustrations** — Much more/More/The same/Less/Much less/No opinion

Much more	0	0.00%
More	9	23.08%
The same	29	74.36%
Less	0	0.00%
Much less	0	0.00%
No opinion	1	2.56%

23% wants more; nobody wants less; 74% is happy to leave things as they are.
Weighted average = 2.69.

(k) **Fireball reports** — Much more/More/The same/Less/Much less/No opinion

Much more	2	5.13%
More	9	23.08%
The same	22	56.41%
Less	6	15.38%
Much less	0	0.00%
No opinion	0	0.00%

28% wants more; 15% wants less; 56% is happy to leave things as they are. Weighted average = 2.82.

(l) **Imaging meteor work** (e.g., photography, spectroscopy, video) — Much more/More/The same/Less/Much less/No opinion

Much more	1	2.56%
More	17	43.59%
The same	19	48.72%
Less	2	5.13%
Much less	0	0.00%
No opinion	0	0.00%

46% wants more; 5% wants less; 49% is happy to leave things as they are. Weighted average = 2.56.

(m) **Radio meteor work** — Much more/More/The same/Less/Much less/No opinion

Much more	3	7.69%
More	12	30.77%
The same	20	51.28%
Less	1	2.56%
Much less	1	2.56%
No opinion	2	5.13%

38% wants more; 5% wants less; 51% is happy to leave things as they are. Weighted average = 2.59.

(n) **Telescopic meteor work** — Much more/More/The same/Less/Much less/No opinion

Much more	3	7.69%
More	12	30.77%
The same	22	56.41%
Less	0	0.00%
Much less	0	0.00%
No opinion	2	5.13%

38% wants more; nobody wants less; 56% is happy to leave things as they are.
Weighted average = 2.51.

(o) **Visual meteor work** — Much more/More/The same/Less/Much less/No opinion

Much more	3	7.69%
More	11	28.21%
The same	25	64.10%
Less	0	0.00%
Much less	0	0.00%
No opinion	0	0.00%

36% wants more; nobody wants less; 64% is happy to leave things as they are.
Weighted average = 2.56.

General conclusion of question 4:

Summarizing the weighted averages, we get (in increasing order):

b	a	c+n	l+o	m	h	e	j	g	k	f	d+i
1.92	2.27	2.51	2.56	2.59	2.60	2.68	2.69	2.81	2.82	2.92	2.95

Upon comparing the weighted averages, it is clear that there is a strong demand especially (in declining order) for practical how-to articles, theoretical articles, shower analyses, and articles on telescopic observations. On the other hand, the readers are of the opinion there are already enough articles on historical topics, conference announcements and information notices from IMO.

We kindly invite our readers to submit papers on any meteor-related topic for publication in WGN. Theoretical, practical, shower analyses and telescopic observation papers are especially encouraged.

5. **Are there topics which currently feature rarely or not at all in WGN that you would like to see included in future?** Yes/No

   If 'Yes', please indicate your preferences from this list *(mark all those you prefer):*

   (a) **Biographies of prominent living amateur and professional meteor workers.**

Yes	15	38.46%
No	4	10.26%
No opinion	20	51.28%

   (b) **Book reviews.**

Yes	24	61.54%
No	7	17.95%
No opinion	8	20.51%

   (c) **Impact events and craters.**

Yes	16	41.03%
No	9	23.08%
No opinion	14	35.90%

   (d) **Meteorites.**

Yes	12	30.77%
No	12	30.77%
No opinion	15	38.46%

   (e) **Meteor-related comet and asteroid news.**

Yes	29	74.36%
No	4	10.26%
No opinion	6	15.38%

   (f) **Meteor-related professional institute reports and news.**

Yes	27	69.23%
No	5	12.82%
No opinion	7	17.95%

   (g) **Other (please specify):**
   Three readers would like to see more shower analyses, explaining in more detail how they are performed, and which interesting questions are useful next to determining when the peak of a meteor shower occurs. Remember how well these how-to topics scored in question 4.

   Other readers would like to read more about light curves; meteorite strikes, where to see, read and surf about meteorites; NEO news; and latest meteor news in general, respectively.

   General conclusion of question 5:

   There is a very pronounced demand (in declining order) for articles about meteor-related comet and asteroid news; meteor-related professional institute reports and news; and book reviews. Also sporadic publication of articles of the other 3 categories (biographies, impact events, craters) should be considered, as at least 30% of the respondents would like this. WGN welcomes papers about all of these categories, and when you read a newly published meteor-related book, do not be shy and send in your book review! Even a short review would be very welcome.

6. Do you find **the level of discussion and articles in WGN** is currently: Much too complicated/Too complicated/A little too complicated/About right/A little too simple/Too simple/ Much too simple/No opinion?

Much too complicated	0	0.00%
Too complicated	0	0.00%
A little too complicated	7	17.95%
About right	30	76.92%
A little too simple	2	5.13%
Too simple	0	0.00%
Much too simple	0	0.00%
No opinion	0	0.00%

77% opine that the level is about right, meaning it should not be altered too much. The other 23% mainly feel the level is a little too high. We invite submissions of varied levels, as in such a mix, everyone will find enough papers of his or her like.

7. Do you think **the physical appearance of WGN** (e.g., page layout and size, typeface, font size, photographs and illustrations) is currently: Very good/Good/Quite good/OK/Quite poor/Poor/Very poor/No opinion?

Very good	9	23.08%
Good	14	35.90%
Quite good	6	15.38%
OK	9	23.08%
Quite poor	1	2.56%
Poor	0	0.00%
Very poor	0	0.00%
No opinion	0	0.00%

Clearly the physical appearance of WGN is appreciated by its readers.

8. As WGN is edited by committed volunteers having busy jobs, **the journal often arrives late in your mailbox.** Does this: Bother you a lot/Bother you/Bother you a bit/Not bother you at all/No opinion?

Bother you a lot	1	2.56%
Bother you	4	10.26%
Bother you a bit	12	30.77%
Not bother you at all	20	51.28%
No opinion	2	5.13%

Even though it would be better to have the journal arrive on schedule, less than 15% of our readers are seriously bothered by this situation. Meanwhile, in only a few months' time, Javor Kac and his editors managed to eliminate the backlog, and they will do their best to keep up the pace.

9. **Does WGN represent good value for money for you presently?** Yes/No

Yes	34	87.18%
No	4	10.26%
No opinion	1	2.56%

About 10% of our readers does not think WGN represents good value for its money presently.

If 'No', is there a **particular reason** (please state)?

One person states 'Declining page count in recent years; the April and June 2008 issues have been very poor, more like newsletters. WGN often seems lifeless — too few authors, too few articles, too many weak articles — meteors in a LUNAR atmosphere!'

A second one says there are too few good articles.

Once more a reason to invite our readers to send in papers about varied meteor-related topics.

10. If an **electronic version of WGN** were to be available as part of your usual IMO membership, as well as the paper version, but without costing you any more than the current fee, **would you prefer to read:** Only the printed version/Only the electronic version/Both (though I'd find the printed version more useful)/Both (though I'd find the electronic version more useful)/Both (and I'd find both equally useful)/No opinion?

Only the printed version	6	15.38%
Only the electronic version	3	7.69%
Both (though I'd find the printed version more useful)	23	58.97%
Both (though I'd find the electronic version more useful)	2	5.13%
Both (and I'd find both equally useful)	5	12.82%
No opinion	0	0.00%

Only 15% would prefer just the printed version, and even only 8% would prefer just the electronic version. So it is clear IMO should provide both versions to WGN readers. Which is what we will do starting with the present issue!

11. **Do you regularly read any other meteor-related publications apart from WGN?** Yes/No
If 'Yes', please indicate which from the following list *(mark all those you read):*

(a) **e-Radiant.**

Yes	8	20.51%
No	31	79.49%

(b) **IMO-News e-mail list.**

Yes	23	58.97%
No	16	41.03%

(c) **Meteorobs e-mail list.**

Yes	19	48.72%
No	20	51.28%

(d) **Meteoor.**

Yes	6	15.38%
No	33	84.62%

(e) **Meteoros.**

Yes	6	15.38%
No	33	84.62%

(f) **Meteor Trails.**

Yes	6	15.38%
No	33	84.62%

(g) **Radiometeoren e-mail list.**

Yes	2	5.13%
No	37	94.87%

(h) **Radio Meteor Observation Bulletin.**

Yes	8	20.51%
No	31	79.49%

(i) **Other (please state):**

Yes	13	33.33%
No	26	66.67%

WGN readers read a whole gamut of meteor-related journals. As only half of the respondents are currently subscribed to the IMO News mailing list, we encourage the other readers to do so too.

33% also consults meteor-related information sources not listed above, which include Earth, Moon and Planets; Meteoritics and Planetary Science; Meteorite Quarterly; Sky & Telescope; Scientific American; NAMN Notes; Czech Circular of the Interplanetary Mass Society; SPA Bulletins; Nippon Meteor Society mailing list; Dutch language mailing lists dms-mail and meteoren-nv; Spanish language meteoros_obs and LIADA-meteoros mailing lists and SOMYCE journal 'Meteors'; conference reports and proceedings; journal articles in Folklore.

12. **If you have any other comments about WGN, please give them here:**

5 readers, among which 3 professionals, congratulate the editor for producing an interesting and nice journal.

One reader says he has seen a couple of 'attacks' on submissions in WGN lately, and would like to see more constructive criticism in such cases. The Council takes this to heart, but is not aware of such cases.

Another reader finds the quality of material and mix was better before 2006 or so, and complains about the last 2 issues (June and August 2008) having been very poor and thin. Still another one would like more variety in the topics and level of WGN articles. According to another reader, there are enough articles beginners can understand in WGN, and the level of the journal should not be lowered.

One respondent suggests to invite professionals to write for WGN, as they have a lot of interesting things to tell. This should not keep amateurs from writing the main bulk of the journal. We think this is a great idea, and explicitly invite professional astronomers to submit papers for WGN.

Different readers opine that the cover picture is too small; illustrations are sometimes too small; pages that only contain a few lines should be filled up with articles or nice illustrations; only one WGN issue per year should contain the extensive IMC announcement.

One reader loves the Meteor Beliefs Project while another one finds it of least interest. Still another one really enjoys the Meteor Shower Calendar.

One reader asks for articles about electrophonic meteors; another one for articles about small solar system bodies.

Three respondents ask for articles providing practical hints for visual observers, as well as shower analyses explaining in more detail the how and why of the analysis (like the Orionid 2007 analysis in the June 2008 issue). One of them would also like to see more technical articles about how photographic, video, and radio systems are implemented. He/she would like to see WGN as a place where people present results and discuss data.

3 General conclusions

Two-thirds of the respondents are happy with the contents of WGN, whereas 13% thinks these are quite poor. For almost every kind of articles we asked about, there is a significant number of readers who would like to see more of them. This suggests that our readers want a larger variety of topics, as is also explicitly pointed out by some of them. As the journal is made by your contributions, we kindly invite you to write about any meteor-related topic, of course including the meteor work you are doing yourself.

Throughout several questions, many readers stressed that they especially need practical articles showing how to observe, how to analyze data, and giving advice on equipment. Also articles on stream modeling, shower and outburst predictions, ZHR computations, detailed shower analyses and telescopic meteor work are badly wanted. Though committed articles in WGN are certainly in order, we also hope that part of this need will be alleviated by IMO's new *Handbook for Meteor Observers*.

Our suggestion to include some new kinds of topics in WGN was met with a lot of enthusiasm. Especially meteor-related comet and asteroid news, professional institute reports and news, and book reviews appeal to many readers. Impact events, craters, and biographies of living meteor astronomers should not be dismissed either.

18% of the respondents find the level of WGN a little too high. This again points to the need for explanatory articles, allowing people to increase their knowledge of meteor science and its techniques. These should not replace higher level articles; there is enough place for both. After all, 5% finds the level of the articles somewhat too low. We welcome articles of all levels.

According to a large majority of the respondents, the physical appearance of WGN is fine. Though less than 15% of our readers are seriously bothered by WGN arriving late in the mailbox, the new editors of WGN have already eliminated the backlog.

About 10% of our readers does not think WGN represents good value for its money presently. They point out WGN needs more (quality) articles, about more topics, from more authors. We kindly invite all meteor workers to contribute to the journal, be it by writing a letter or an article, or sending a picture. Note that we intend to include a broader range of topics than appeared in the journal before, as pointed out above.

As only 15% of the respondents would prefer just the printed version of WGN, and a mere 8% would prefer just the electronic version, we will provide both versions to our readers, starting with this issue. Enjoy!

4 Prize draw

We kindly thank all our readers who participated in the WGN questionnaire. The lucky winner of the WGN and IMC DVD is **Robert Pomohaci** from Romania. Congratulations, Robert!

On how to report new meteor showers

Peter Jenniskens [1]*, Tadeusz J. Jopek, Jürgen Rendtel, Vladimir Porubčan, Pavel Spurný, Jack Baggaley, Shinsuke Abe, and Robert Hawkes*

New meteor showers should first be reported to the International Astronomical Union before they are discussed in the scientific literature (which includes WGN). The IAU keeps a tally of reported showers, and will officially name those showers that are established. The first batch of showers is up for official naming at the upcoming IAU General Assembly in Rio de Janeiro, Brazil, on 2009 August 3–14.

Received 2009 January 22

1 Introduction

The literature on meteor showers is enormous and hard to comprehend due to a general lack of effort made to compare results with those of previous workers in the field. Numerous showers are known under several names. It is not always clear which showers are established, and which are not (Jenniskens 2006).

To solve this problem, a Task Group on Meteor Shower Nomenclature was established at the 2006 IAU General Assembly in Prague, with the objective to formulate a descriptive list of established meteor showers that can receive official names during the next IAU General Assembly in Rio de Janeiro, on 2009 August 3–14. Its task aims to uniquely identify all existing meteor showers and establish unique names for each shower.

The 27th Assembly in Rio is now only months away. Before the meeting, the Task Group will convene at Prague, during the International Conference on Bolides and Meteorite Falls (May 10–15) in an effort to finalise the List of Established Showers to be presented for a vote at the IAU General Assembly. This paper describes how you can help the Task Group work throughout this process.

2 Reporting new showers

The Task Group works from a Working List of meteor showers, which is posted at the IAU Meteor Data Center website: `http://www.astro.amu.edu.pl/~jopek/MDC2007`. The total number of showers in the list is 276. To help compare your newly discovered shower with those already in the list, the MDC has developed recently a tool to interactively search this database.

The Working List can be extended to include newly discovered showers. Since the foundation of the Group, 13 new showers were added, twelve from the work of the Canadian Meteor Orbit Radar by Peter Brown and coworkers of the University of Western Ontario, and one new shower first reported in WGN (Uehara et al., 2006) that was discussed in a paper for the Meteoroids 2007 conference. Once (a batch of) new showers are reported, the astronomical community is alerted by means of a CBET telegram from the IAU Central Bureau for Astronomical Telegrams.

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IMO bibcode WGN-371-jenniskens-nomenclature
NASA-ADS bibcode 2009JIMO...37...19J

To arrive at a unique name for each shower, a system of nomenclature rules was adopted based on traditional ways of naming meteor showers:
`http://www.astro.amu.edu.pl/~jopek/MDC2007/Dokumenty/shower_nomenclature.php`

The point of contact for reporting the discovery of new meteor showers is Dr. Tadeusz J. Jopek of Poznan University, Poland (`jopek@amu.edu.pl`). The Working List of meteor showers should include all showers that are discussed in the literature from now on. Tentative detections should not be given a name. Whenever a shower detection is deemed certain enough to give it a name, it should first be registered by the Meteor Data Center, before publication. The IAU number can then be mentioned in the publication.

In order to bring transparency to the literature, a new meteor shower should not be discussed in WGN, or any other journal, without first having been reported to the Meteor Data Center. Upon contacting Dr. Jopek, the shower will receive a tentative name (which you may propose based on the nomenclature rules), an IAU number, and a 3-letter code. That number (or code) should be mentioned in your paper, e.g. the 'October Ursae Majorids (IAU#333)' (Uehara et al., 2006). This will then provide a unique identification for later discussions of the stream.

Before reporting to the MDC, amateur astronomers that recognize new meteor showers from visual and single-station video observations should contact the International Meteor Organization and present their claim for referral. Point of contact is Task Group member Jürgen Rendtel (`jrendtel@aip.de`). Observations should strongly suggest a shower. For example, an outbursts of a significant number of meteors from a compact radiant in a brief period of time (e.g., beta Hydrusids) should be observed; or a persistent radiant detected over several nights whose coordinates change at a rate consistent with the Earth's motion.

3 Towards establishing showers

New studies of meteor showers may help establish (or disprove) meteor showers in the Working List. You can help the Task Group in deciding whether or not to move streams to the List of Established Showers by sending a copy of your report to the Meteor Data Center (Jopek).

From the Working List, showers are transfered to the List of Established Showers. The current list contains 56 of the total 276 of all showers and is posted at:

http://www.astro.amu.edu.pl/~jopek/MDC2007/Roje/roje_lista.php?corobic_roje=1&sort_roje=0.

These are the showers that will be put to a vote of confidence the IAU Commission 22 business meeting in Rio, after which they will receive their official name.

If you are a professional astronomer and member of the IAU and are interested in serving on the Task Group in the next three years, please contact the current chair (P. Jenniskens: pjenniskens@mail.arc.nasa.gov).

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Ongoing meteor work

Report from the ISSI team meeting "A Virtual Observatory for meteoroids"

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The content and format of the Virtual Meteor Observatory (VMO) was discussed in a one-week team meeting at the International Space Science Institute (ISSI) in Bern, Switzerland, in 2008 November. The current status of the VMO (in 'beta' version) was presented and discussed. The visual and camera sections are ready to be populated with data; a fireball section will be created. The radio/radar section is still open. In the discussion, several points were addressed: The relation to the Planetary Science Archive, treatment of shower catalogues, how to best perform astrometry, how to compute and store orbital data. The meeting ended by producing a list of future work, which is given at the end of the paper.

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1 History

Over the last 20 years, both intensified and un-intensified video cameras started to be used in the meteor community. Lately, more and more groups started setting up networks of cameras, which make it possible to determine meteoroid orbits from simultaneous meteor observations. Triggered by the question on how different orbit codes would compare, ESA/RSSD organized a EuroPlanet workshop called "Meteor Orbit Determination (MOD) Workshop" in collaboration with the IMO, just before the International Meteor Conference in Roden, the Netherlands, in 2006[a]. One of the conclusions of that workshop was that a common data format for storing orbit information would be very beneficial – and that it would be very important to also store the underlying single-station data in an easily accessible format.

As a result of the MOD workshop, the Yahoo discussion group 'modwg' for MOD working group was formed at `http://groups.yahoo.com/groups/modwg`. Of course, within the International Meteor Organisation, data is already stored centrally. S. Molau maintains a database for video observations[b], Rainer Arlt one for visual observations[c]. G. Barentsen has supported R. Arlt in producing a web-based interface for the visual meteor observations[d]. In Roden, we decided that it would be good to merge all these efforts and offer a central repository to those who would be willing to contribute to one – and to produce an interface format definition to allow the 'interoperability' with those groups that would want to keep their local archives.

From this, the concept of a 'Virtual Meteor Observatory (VMO)' was born. It was initially called the 'Unified Meteor Database' (Barentsen, 2006). A prototype implementation was started by G. Barentsen during his time at ESA/RSSD's Meteor Research Group (Barentsen et al., 2007; Koschny et al., 2008). During an interface meeting between the authors in 2008 January the idea was born to propose a so-called ISSI Team in Bern, Switzerland (ISSI = International Space Science Institute). ISSI offers funding to host workshops for small scientific groups to discuss different scientific topics (see `http://www.issibern.ch`). They cover hotel costs and provide the meeting facilities. The travel costs have to be paid by the participants themselves. One has to write a proposal, a selection committee then decides on whether the workshop should be funded.

Rainer took the lead in writing a proposal and a few months later we received a positive reply. We finally met in Bern in the week 2008 November 23–28.

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NASA-ADS bibcode 2009JIMO...37...21K

[a]`http://europlanet.oeaw.ac.at/index.php?option=com_content&task=view&id=52&Itemid=41`
[b]`http://www.imo.net/video/data`
[c]`http://www.imo.net/data/visual`
[d]`http://www.imo.net/zhr`

Table 1 – Participants in the working group.

Name	Affiliation
Rainer Arlt	International Meteor Organization
Prakash Atreya	Armagh Observatory, UK
Geert Barentsen	Armagh Observatory, UK
Joachim Flohrer	DLR, Germany
Tadeusz Jopek	Adam Mickiewicz University, Poznan, Poland
André Knöfel	International Meteor Organization
Detlef Koschny	ESA/ESTEC, The Netherlands
Pavel Koten	Astronomical Institute of the Academy of Sciences, Czech Republic
Hartwig Lüthen (*)	University of Hamburg, Germany
Jonathan Mc Auliffe (*)	ESA/ESAC, Villafranca, Spain
Jürgen Oberst	DLR, Germany
Juraj Tóth	Comenius University, Slovak Republic
Jeremie Vaubaillon (*)	IMCCE, Paris, France
Robert Weryk	University of Western Ontario, Canada
Mariusz Wisniewski	Polish Fireball Network PKIM, Poland

2 Proposal and participants

This is the summary of the proposal as it was sent to ISSI:

"The investigation of the distribution and dynamics of dust in the Solar System is of statistical nature and depends critically on the amount and availability of observational data. The advent of virtual observatories in astrophysics is ideally timed with the observational advances in data recording in meteor science. We are seeking the installation of a virtual observatory for meteoroids and meteors. The team will deal with all types of requirements for such a project. Outcomes of the team meeting comprise data exchange interfaces, database models, data qualification procedures, and preview analysis tools. The team meeting consists of presentations of meteoroid data types at present and possible future types, discussions on the structure of the virtual observatory, and actual programming. The output will be considerable progress in creating a database of meteoroid information including interfaces for accessibility."

Table 1 gives a list of the team members which proposed and their affiliation. Not the complete proposal group managed to be there, the people absent are marked with an asterisk (*).

3 Workshop overview

The workshop was scheduled for one week, from Monday through Friday. Most of us arrived on Sunday evening in the hotel Arabelle, organized by ISSI. We started on Monday, $09^{\rm h}30^{\rm m}$, with introductions by the team members to their observational setups. Some of us are directly involved in double-station video meteor work and we saw presentations of the Polish Fireball Network, the intensified all-sky video camera of the Czech observing group, the meteor observing activities of the DLR Berlin, and the camera and radar systems of the University of Western Ontario. D. Koschny gave a flash-back to the Meteor Orbit Determination (MOD) workshop in Roden 2006. There, the participants produced some recommendations for data storage which we realized are mainly fulfilled—the recommendation was to start the development of the Virtual Meteor Observatory, in particular to start the definition of a data structure, and to ensure proper archiving and backing up of the data. During the MOD workshop, we identified a number of points which should be tested to better understand the quality of the data. There, the progress was very small—out of a long list (see Koschny & Mc Auliffe, 2008, p. 85) only one point had been addressed, namely that the timing accuracy of video cameras is good to about 1 ms (see e.g. `http://www.dangl.at` or `http://tko.koschny.de/Time_measurements/index.html`). The statistical power of visual flux measurements and format issues of the Visual Meteor Database (VMDB) which need to be addressed in a VMO were presented by R. Arlt on Tuesday afternoon. The next day was dedicated to existing databases and data formats. We learned about the database fields of the Fireball Data Center (FIDAC), the output format of the meteor detection software MetRec, and the output format of the Sposh (Smart Panoramic Optical Sensor Head) camera of ESA and DLR. On Wednesday G. Barentsen introduced the existing prototype for the Virtual Meteor Observatory, located at `http://vmo.imo.net`. The interface format of the VMO will be based on the XML (Extended Markup Language) standard, which we were introduced to. We discussed the top-level architecture of the VMO, see the next Section for more details. Wednesday afternoon and Thursday was dedicated to going through all fields of the VMO and ensuring that we all agree and have a common understanding of the data which will be supported. On Friday we agreed on the future activities—the main agreement was that we need to involve more people outside this group, and that we want to meet again in June 2009, hopefully again at ISSI.

4 Overview of the current VMO

A detailed description of the current architectural design of the VMO is given in Koschny et al. (2008). The main idea is to define a standard for storing all kind of meteor data, and to offer a central repository for all meteor data—it is not required to store the data centrally; but we'll provide an interface definition which will allow groups that want to store their data locally that data

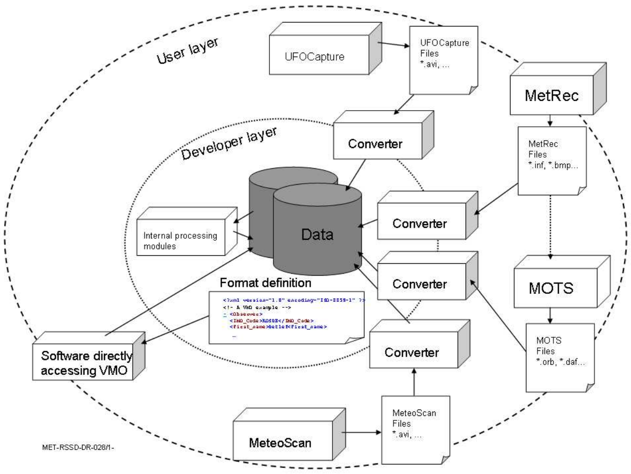

Figure 1 – Architectural design of the VMO. For an explanation, see the text.

```
<?xml version="1.0" encoding="utf-8"?>
<vmo xmlns="http://www.imo.net">
    <fireball>
        <time>2008-11-23T15:24:13</time>
        <brightness>as the full moon</brightness>
        <observer>Heidi Klum</observer>
        <location_latitude>
          35.24351
        </location latitude>
        <location_longitude>
          -89.62907
        </location longitude>
        <country code>US</country code>
        ...
    </fireball>
</vmo>
```

Figure 2 – Example XML fragment.

can easily be exchanged. The following considerations are written as if there were only a single repository, but the plan is to allow for a distributed database in the future. Figure 1 shows a sketch of the architecture, based on a first discussion at the Meteor Orbit Determination workshop in Roden in 2006 (see Koschny et al., 2007 for a summary of that workshop). The VMO is a relational database implemented in PostgreSQL. The actual data formats are defined via files in the XML (Extended Markup Language) format. It is physically hosted on a dedicated computer at ESA/RSSD's computing department and can be reached via the url `http://vmo.imo.net`. Figure 1 shows the different layers of the system. The central layer is called the 'developer layer'. In it, the VMO gives direct access to the database elements. This requires that user software base their data files on the XML definitions of the VMO. An example XML fragment is given in Figure 2.

Alternatively, in the 'user layer', the software outputs their own data formats (as is the case for some of the existing meteor detection software such as MetRec (Molau, 1999), MeteorScan (Gural, 1997), or UFOCapture). A converter will then convert the output data to the VMO format. Currently, a converter is available only for the MetRec data files, but more will be produced in the upcoming months. The data in the VMO is organised into different sections:

- VIS – Visual meteor observations;
- CAM – Video and still camera data;
- RAD – Forward or backward scatter radio observations;
- FIR – Fireball observations;
- ORB – Orbit data

The data of each section is stored in a separate database. Certain metadata is stored separately and linked to from the actual data sections. These are:

- Observers
- Locations
- Shower codes
- Radiant catalogs

In addition, the database allows keeping a plain file repository. Meteor data ingestion is done by using ftp to transfer data files to an incoming directory. Via a web interface, one can 'validate' the data files—different consistency checks will be executed and error messages or warnings will be displayed in case of problems. After fixing all issues, the data will be converted to the VMO-internal format and ingested into the database. Different search and browse tools are available; also, a SQL-interface is available which allows to user to write his/her own queries. The data is grouped in so-called 'sessions' which contain a logical block of observations, typically one observing night. Each session can be broken down in 'periods'. While the observer, observing equipment, and location would be constant for on session, items like the limiting magnitude or the cloud factor change, thus requiring the periods. We discuss the usefulness of this concept. Would an observer who observes with the same equipment in exactly the same setup for one year only have one session? The answer is no, the session could be seen as the dataset which is delivered at one delivery, and a daily (nightly) delivery would be acceptable. In the end we agree that the concept of sessions and periods is good, the session is a logical duration of an observation and does not necessarily imply anything scientific. The periods shall be useful entities for the determination of meteoroid flux for a given source. Thus, significant changes in limiting magnitude or cloud cover should result in a new period to be started. Note that the combined availability of visual and video data will allow for very detailed analyses of the particle flux of meteoroid streams. The VMO also provides routines to search and identify potential simultaneously observed meteors, and allows the computation of orbits using an updated version of the Meteor orbit and trajectory software called MOTS (Koschny & Diaz del Rio, 2002). Alternatively, complete orbit data sets can be ingested (e.g., the IAU orbit database (Kornos & Toth, 2006)).

5 Discussion points

Organisational aspects

One of our discussion points was addressing 'political' aspects. While we try to involve as many data providers as possible in our discussions, some of us may not want to store all their data centrally, or they may not able to do it for proprietary reasons. We agree that the idea of the VMO is not to *require* central data storage; rather, the VMO will *offer* the possibility to centrally store the data. However, all meteor data providers shall be encouraged to follow the recommendations laid down by the VMO working group to ensure easy data exchange. Besides storing data, the VMO also aims at providing data mining possibilities and provide 'services' to do data analysis, e.g., the already implemented possibility of computing orbits of ingested data.

Relation to the Planetary Science Archive (PSA)

At the MOD workshop in 2006, the two external reviewers of the recommendations which were decided recommended to get the support of official entities like ESA and NASA, and look into the possibility of using support of official planetary archives like the European Planetary Science Archive (PSA), which stores all the data of the European planetary space missions and some related ground-based data. The first part has been successful—the prototype implementation of the VMO has been done with support from ESA. We confirm that we want to draw on the expertise available in the PSA. We see the VMO as an 'active archive' which can be used for daily data ingestion, quick-look, and data mining. We recommend to consider the PSA as a long-term archive. This would require a conversion of the data in the VMO to the PSA format (which is following the Planetary Data System (PDS) standard). The PSA-responsible at ESA is supporting this idea and suggested to request funding from the European Union for getting support to prepare the data. The team believes that this is a good idea, however, no immediate action will be taken. This will be kept in mind for possible future implementation.

Treatment of shower catalogues

The VMO adopts the shower codes and names as designated by the IAU (Jenniskens, 2007) but allows multiple shower catalogues to be archived and used. In particular it is important to keep the designation of old showers, as showers may be disappearing or newly forming over the years. Even if a shower turns out to be spurious, the designation should be reserved for all times for database consistency. For every meteor shower determination, the VMO stores a link to the used shower catalogue.

Astrometry

While not directly related to the data base structure, we spent some time discussing the positional accuracy of meteor data. ESA/RSSD's intensified and non-intensified video cameras yield a mean stellar deviation of typically 0.5 pixel, corresponding to 1′, when using about 30–40 reference stars for the astrometric solution. The Polish Fireball Network uses an advanced technique of stacking many images to obtain a reference star image for performing the astrometric solution, which effectively results in many hundred stars used for performing an astrometric fit. M. Wisniewski states that their cameras yield about 1/4 pixel accuracy, about 3–5′ at their typical field of view of 60–80°. On the other hand, the SPOSH camera used at ESA yields about 1/8 to 1/10 pixel accuracy (40–50″ at 120° field of view). P. Koten presents a comparison between an astrometric solution as obtained automatically by MetRec and manual measurements of the same images. He shows the resulting orbit data for four different meteors and in some cases the orbit obtained via the automatic measurement deviates very much from the manual measurements. He concludes that it may not be possible at all to obtain good orbits using automatic measurements. His presentation is much disputed though—D. Koschny mentions that comparisons done at ESA/RSSD between MetRec measurements and manual measurements do not differ significantly (Piberne, 2004). In conclusion we realize that the astrometric quality of the existing systems should be better tested and compared—confirming a conclusion from the MOD workshop in 2006.

A separate section for fireball data?

On Tuesday, A. Knöfel presented the current content fields of the IMO Fireball Data Center (FIDAC). On the IMO web site, there is a fireball report form available; however, searching for fireballs is only possible for the years 1993 to 1997, as this form has not been given high priority recently. We compare different fireball report forms, e.g. from the Czech group[e] and the American Meteor Society[f]. The general usefulness of an additional report form for fireballs in addition to 'normal' meteor data was discussed. The group concluded that it is important to collect information for bright fireball events from the general public to support e.g. the identification of potential meteorite-dropping fireballs, and also as an outreach activity. A. Knöfel prepares an updated proposal for data to be stored in the fireball database during the meeting which is agreed by the group on Friday as an excellent starting point. In particular, we want to add references to possible 'accidental' photographic or video observations. We also discuss some aspects of the user interface, where e.g. the direction of begin and end positions of the fireball could be determined via a link to the Google Maps application. We recognise that fireball data from the general public is best collected by local astronomy groups; also a number of report forms are already available on different web pages and we should not try to 'take something away' from them. However, not for all local pages a search capability is available—this would be a useful add-on service of the VMO. We thus agree on the following:

[e] http://www.asu.cas.cz/~meteor/report.htm

[f] http://www.amsmeteors.org/fireball/report.html

a. We will have a separate fireball section in the VMO;

b. We will produce source code for a sample form which can be regenerated in different languages by local astronomy groups. The data from the form sheet can be ingested into a local database, directly into the central database, or in both. In the central database it shall be possible to search for fireballs provided by one particular local group only.

c. An interface definition will be made available so that external groups can ingest fireball data into the VMO.

d. A. Knöfel will take the lead in implementing the fireball section.

Items concerning the orbit data

One of the important points discussed at the MOD workshop in 2006 was that we need to have traceability — i.e. for any given orbit it should be possible to find out how many observations were used to compute the orbit and which method was used. It should also be possible to go back to the underlying single station data and check its quality. In the current implementation of the VMO this is possible via links (none of the data is stored in more than one place). We discuss different possibilities of computing the orbits. One could use heliocentric orbits or solar system barycentric orbits. We recommend using the same method as used in the Minor Planet Center, which is using heliocentric orbits (Spahr, pers. comm.) to make comparison of orbits easier. It was suggested that for each orbit it should be made quite clear how the orbit was computed, i.e. which method was used. In the optimum case, the orbit computation code would be available via the VMO; in the minimum case a reference should be given. If no detailed description is available on how an orbit was computed, it should be written, thus requiring some work on the side of the programmers. To assess the quality of an astrometric measurement, a 'distortion plot' can be helpful. This is a plot of the coordinate grid of celestial coordinates in the field of view. The software MetRec, for example, will display this grid when using the program RefStars, but it does not allow to store this image. It is recommended to the data producers that it will be made possible to store such images. We discuss the best way of presenting the distortion, e.g. in terms of how many pixels the grid is distorted. In the end we agree that we should not require any specific representation, as long as it is clear how to interpret the distortion map. The main discussion concerning orbit data addresses the question of which orbit we really want to store. After the double-station analysis of a meteor one can derive a state vector relative to the Earth which describes the x/y/z position in geocentric coordinates and the velocity components in an Earth-centered coordinate system for a given time. From this one can backward-propagate the orbit of the meteor to the edge of the sphere of influence of the Earth, or one can determine the radiant as use the formula for the zenithal attraction to correct for the influence of the Earth. Note that we found that different values are in use for the sphere of influence – this needs to be further discussed and a value needs to be agreed to achieve consistent datasets. Both methods should result in very similar heliocentric radiants for the meteor (i.e. the direction where the meteor comes from when outside the sphere of influence). Also, it was not clear in the beginning whether the orbit outside the sphere of influence (or after applying the Zenithal attraction) should be given at all, as it is not the directly observed direction where the meteor comes from, but a derived value. In the end, we agree after some discussion that we should give the orbit of the meteor which it would have without the influence of the Earth's gravitation, at a given time (also called Epoch). Thus, if a meteor is seen at 17:30:00, one could give the orbit at the time when it entered the sphere of influence of the Earth, say at 15:30:00, in solar system barycentric coordinates. Or, one could give the orbit at the epoch (i.e. the time) of observation, but without the influence of the Earths mass. Thus ones orbital code would need to integrate the orbit backwards to the edge of the sphere of influence, then integrate forward to the time of the meteors occurrence but without the Earths mass, and give the orbital elements at that time. The group agrees to allow the orbital elements to be given at any epoch, as long as the epoch is specified. We should clarify here that the orbit given in the VMO is only one representation of the motion of the observed meteoroid, chosen by the contributor of the data. It should come along with a reference to the orbit determination method used. The team found it unsuitable to enforce a certain orbital representation which may easily become outdated once better methods are developed in the future.

6 Conclusions and future work

The major decisions were:

a. The concept of sessions and periods within the VMO is approved.

b. The VMO shall offer a central repository for data, but not require it.

c. The VMO shall specify its interface standard, so that all data producers can provide their data in a similar way, allowing 'interoperability' of possible decentralized databases and tools.

d. The general structure of the VMO data definition as presented by Barentsen was approved.

e. D. Koschny, R. Arlt, and J. Tóth will take the lead in producing a set of documentation which describes the implementation of the VMO in detail, with technical input coming from G. Barentsen. This documentation shall be made available via the IMO.

f. We will have a dedicated section for fireballs, with the detailed statements as given in Section 3, 'A separate section for fireball data?' A. Knöfel will lead this effort.

g. Concerning orbit data, the group recommends to use the heliocentric coordinates rather than solar system barycentric coordinates.

h. A reference shall be given for which orbit code was used to produce any given orbit.

i. It is recommended that the software which is used to determine the astrometric solution (e.g. MetRec, UFOCapture) allows to store 'distortion maps' which will allow to assess the quality of an astrometric fit.

j. It is not clear whether the accuracy of automated orbit computations based on data from cheap video cameras is sufficient for scientific analysis. More work has to be done to verify this.

k. A broader audience shall be involved in the process of defining the VMO, both by addressing relevant people directly and by involving the MOD working group via the Yahoo discussion group.

l. We will request a follow-up ISSI Team meeting to focus on teaching data providers how to interface with the VMO. The target date for this workshop is 2009 June 08–12.

m. An ESTEC workshop will be requested in addition by D. Koschny.

Acknowledgements

We would like to thank ISSI for their generous financial support. Thanks to G. Thörner for making it possible that the VMO is hosted by the Research and Scientific Support Department of ESA/ESTEC. Travel expenses for T. Jopek were covered by the Polish Ministry of Science and High Education, grant no. N N203 30233; for J. Tóth VEGA – No. 1/0636/09.

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Figure 3 – The ISSI Team "Virtual Observatory for meteoroids".

A new meteor detection processing approach for observations collected by the Croatian Meteor Network (CMN)

Peter Gural [1] *and Damir Šegon* [2]

The CMN operates a very unique system for meteor monitoring and is in the process of completing a nation-wide deployment of cameras. The meteor detection and analysis processing has now been automated through both a customized software interface for data ingest and the usage of the existing meteor scanning package MeteorScan. A new maximum temporal pixel detection algorithm is described that works seamlessly with the reduced bandwidth video stream archived by the CMN via the SkyPatrol software.

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1 Introduction

The Croatian Meteor Network (CMN) has been in existence since 2006, collecting and archiving video from low cost cameras in a special compressed format (Andreić & Šegon, 2009). From the outset the goals have been to provide astrometric and photometric meteor data for both scientific and educational purposes. To achieve those goals, a very unique video camera and data archiving system was created that required the development of customized meteor detection capability. The reason for the latter is that the imagery and metadata recorded is quite unusual for the meteor community, involving the compression of a video sequence into its maximum pixel values in time and their associated frame number. This paper will describe the collection system and current deployment sites, the camera characteristics and data recording, the meteor detection interface and processing algorithm, as well as the post-detection analysis capability that is currently under development.

2 Collection system

The CMN is a meteor network based on inexpensive CCIR video surveillance cameras connected to second-hand PCs, with a total cost per system of about 200 EUR. The 1004X camera employed is a low-light sensitive black-and-white video unit based on the EXview HAD Sony CCD. It comes with an automatic gain control, which adjusts the limiting magnitude of the system for variations in moonlight levels and light polluted skies in urban settings. This can make calibration more challenging and is therefore an undesirable feature. Thus the cameras have been modified by the CMN to maintain a fixed gain that is set to a level about 90% of maximum. Using a standard CCTV lens of 4 mm focal length and $f/1.2$ speed, the field of view is $64^\circ\times48^\circ$ providing a resolution of $10'$/pixel. The limiting stellar magnitude from dark sky sites is approximately 4.0, while for urban locations it is no fainter than 3.5. When accounting for worst case trailing losses for the meteor motion across the focal plane, the meteor limiting magnitudes are at most 1.5 brighter. Since its inception in 2006, the CMN has grown to 15 cameras, with almost complete sky coverage over the Croatian territory (Figure 1). The network is continuing to expand with the expected number of stations to reach approximately 25 by the end of 2009.

The existing data collection and archiving approach uses the SkyPatrol software package (Vornhusen, 2003). This software processes a real-time PAL formatted video feed and retains the maximum intensity value and associated frame number of each pixel across a multi-second time period, storing the resultant images in a color RGB bitmap file. See Figure 2 for an example of the file contents. Since the SkyPatrol software processing is not computationally heavy, the computer system requirements are quite modest requiring only a PC with 700 MHz or faster processor and 128 MB RAM. However, the software interfaces to a vintage Video-for-Windows (VfW) driver using a newer capture card with the Microsoft VfW-WDM wrapper under the Windows XP operating system, provides only a one-half resolution 384×288 pixel image at this time.

The concept of operations for the CMN is to collect every clear night from multiple stations to yield a minimum of two stations for radiant association and orbit estimation. The typical time duration of the short video sequences that are compressed is 60 seconds, which results in several hundred files saved for one night's observation per site. These files are stored in a bit-mapped graphics format (BMP) within a single folder using a naming scheme with sequential numbering. The total disk space occupied for one night is no more than 300 Mbytes, resulting in an effective compression ratio of a factor of 2000 relative to raw uncompressed video. Effectively each file contains 1500 frames of compacted video (60 seconds of PAL video at 25 fps) compressed to just the maximum and frame number images. The collection system saves each night in a different folder to avoid overwriting the same filename. The time stamp of any given image sequence is determined from the `logfile.txt` output file provided by the SkyPatrol software, which in turn is based on the computer system clock.

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NASA-ADS bibcode 2009JIMO...37...28G

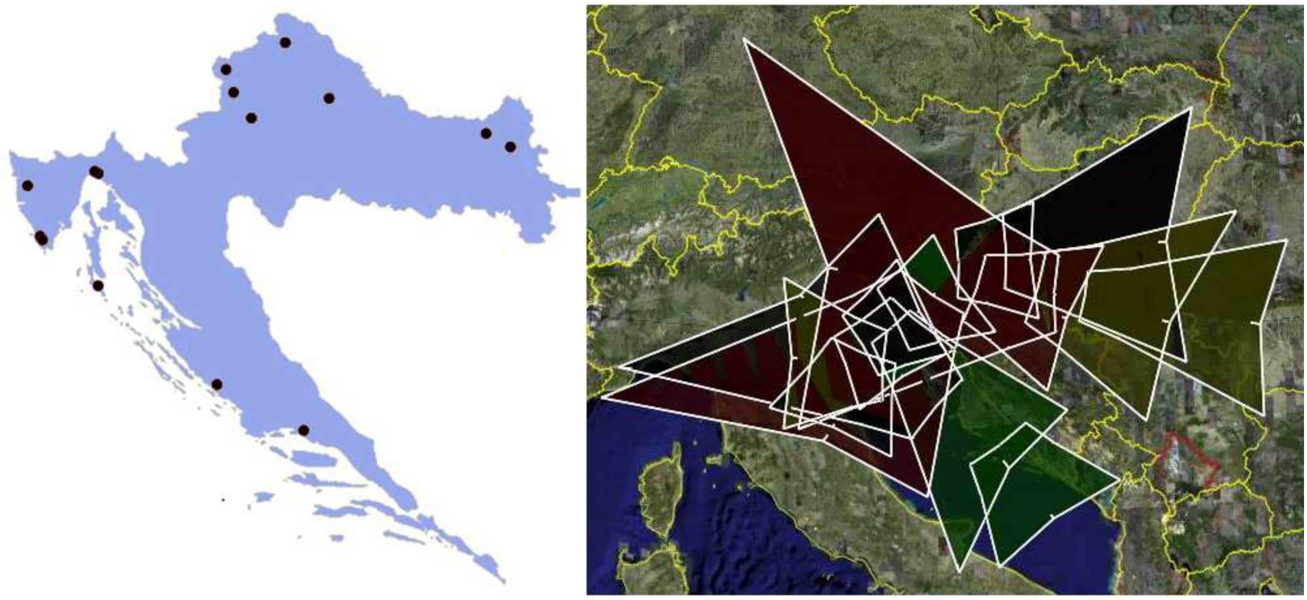

Figure 1 – CMN observing sites (left) and sky coverage (right). It is expected that the network will have 18 operational stations by the spring of 2009.

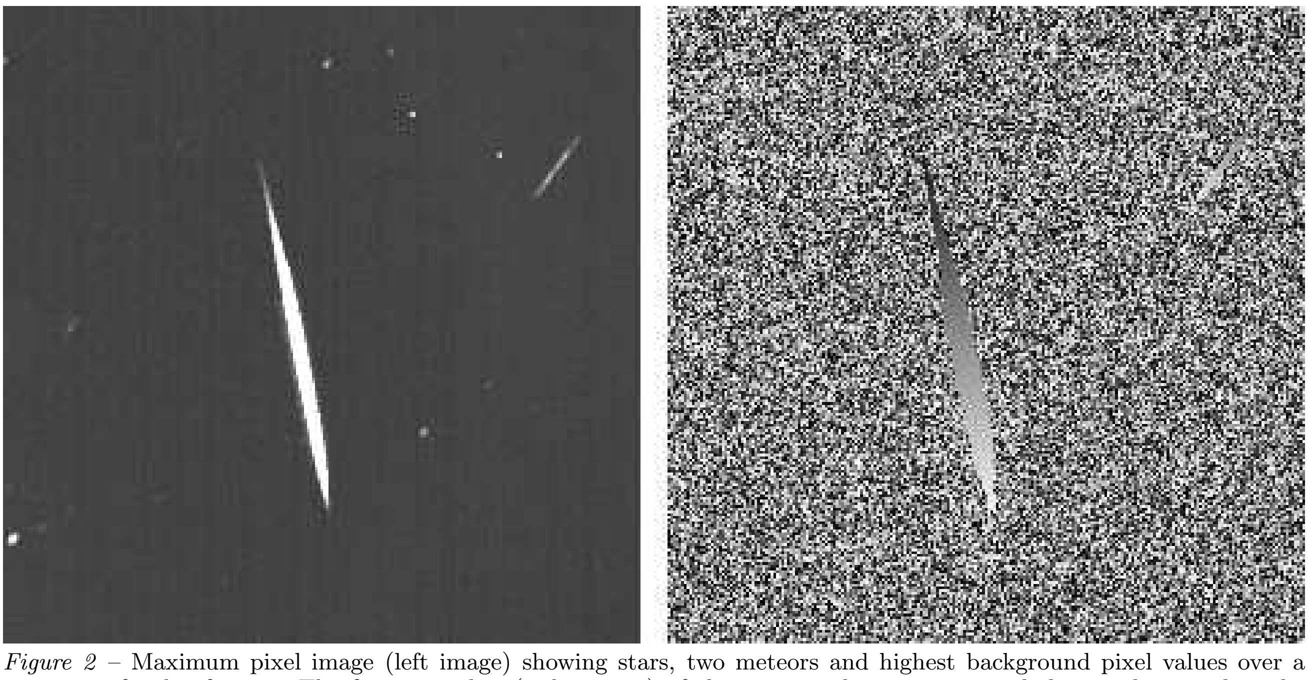

Figure 2 – Maximum pixel image (left image) showing stars, two meteors and highest background pixel values over a sequence of video frames. The frame number (right image) of the associated maximum pixel that is also saved in the color bit-mapped file. Note that the changing frame number (gray level in right image) of the meteor track provides the temporal information that makes space-time meteor detection possible in these compressed video segments. (For the purpose of this Figure, the gray level is plotted as the frame number modulo 64, to enhance the changing gray level in the meteor track.)

3 Meteor detection processing

A software package was developed by one of the authors (PG) to automatically scan through the collected series of files from a given night's SkyPatrol output. The challenge was to detect meteors in sixty seconds worth of digital video that had been compacted into a single bit-mapped color file. Note that the BMP file represents a single maximum intensity image combined with its associated temporal information. Although the imagery was originally obtained at video frame rates, only the maximum value in time and its associated frame number are stored for each pixel. The bit-mapped files are encoded such that the red and green channels contain the frame number ($\mathrm{red} + 100 * \mathrm{green}$) and the blue channel contains the maximum value across time for the entire exposure duration on a per pixel basis. Initially, the Long Frame Integration (LFI) Meteor Detector software, developed for the Spanish Fireball Network (Trigo-Rodriguez et al., 2008), was used to process only the maximum pixel snapshot since the LFI software was designed for dual-frame meteor processing with large time delay spacing. Since each file represented a 60 second lag between frames, this seemed a logical first approach. However, to take advantage of the temporal information contained within the BMP files, the Maximum Temporal Pixel (MTP) Meteor Detector algorithm and software package was developed for the CMN.

The MTP software interfaces to the MeteorScan 'detection' modules (version 2.95) to take advantage of combined space-time processing for the detection of meteors (Gural, 1999; Molau & Gural, 2005). This approach was made possible because of a recently completed upgrade to MeteorScan that was designed to handle meteor detection at remote sites run by the University of Western Ontario's Meteor Physics Group. The upgrade permitted the embedded detection modules of MeteorScan to be called independently of the user interactive GUI, pre/post processing calibration, analysis, and archiving functions. Thus a separate driver program and file input/output interface module was built around MeteorScan to handle the unique format of the CMN data sets yet still utilize the spatial-temporal processing advantages of MeteorScan's Hough transform and matched filter detector.

Several requirements were laid out for the MTP driver program that included:

- Scan through an entire night's collected files in a single sweep automatically.
- Provide frame-by-frame focal plane positions of each meteor's track.
- Automatically estimate positions of stars in each BMP for astrometric calibration.
- Operate under partly cloudy conditions.
- Flag bad pixels in the BMP file by identifying invalid frame numbers.

A breakdown of the image processing steps of the MTP meteor detector follows. This processing is applied to each bit-mapped file that is collected and archived by the CMN cameras along with the generation of several output files. For each BMP file:

1. Extract the maximum pixel image and associated frame number image from the RGB bit-mapped graphics file. Save off the maximum pixel image to a separate gray level BMP file for future reference. Note that the frame number image can also be optionally saved modulo 256 to another output gray level BMP file. Lastly, check for and clear any frame number counts that exceed the maximum collection frame count and record that information to an error log file. These are typically associated with short static-like noise traces that appear very infrequently in the recorded BMPs and can have the appearance of horizontal meteor traces.

2. Compute the median of the maximum pixel image using a 19×19 pixel sliding window (second snapshot in Figure 3). The median image will be used to represent the background and can be optionally saved to a gray level BMP file. Estimation of the background variance (standard deviation) of the noise residuals is obtained by differencing the maximum pixel image and the median, and then iteratively removing outliers that are greater than 2σ away from the mean. A user input factor (typically six) times the final standard deviation sets the threshold for locating stars and meteor track endpoints.

3. Make an initialization call to the MeteorScan detection modules followed by the spinning-up of the MeteorScan noise tracking and Hough space filters via the processing of several hundred pairs of zero filled images. Also initialize the pixel exclusion mask to all zeros for later use in star location and centroiding. Finally in preparation for report generation, open the detection output file list.

4. Loop over sequential temporal frame numbers starting at the first frame and stepping by two frames until all frame numbers present in the BMP file are processed:

   (a) Build a pair of images for frame number N and $N+1$ by initializing a zero filled image and then setting pixels to the maximum pixel image value *only* for those pixels where the frame number image matches the current frame number being generated (right sequence of snapshots in Figure 3).

   (b) Remove the median from each generated image, forcing pixels less than zero to exactly zero. This processing step has been added to mitigate the effects of fast moving clouds across the field of view. In normal video operations, MeteorScan differences the

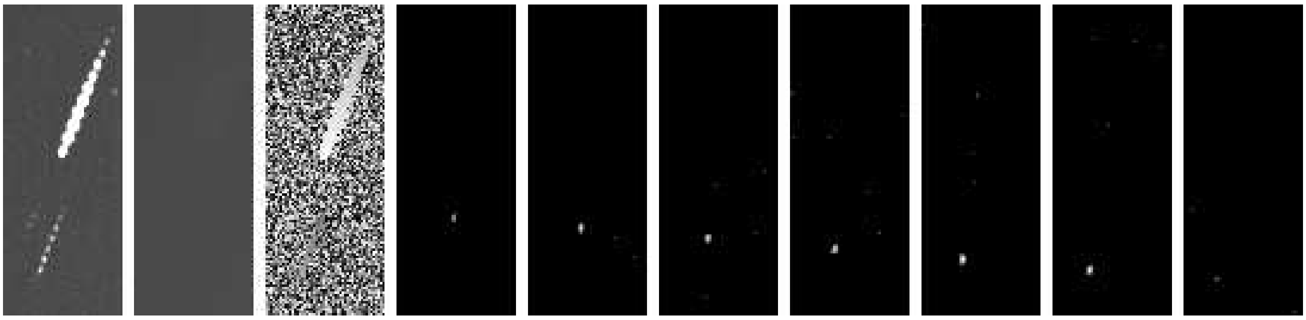

Figure 3 – An example subimage block of 130 × 50 pixels in size showing the components that go into the step-by-step image processing procedure. From left to right: the extracted maximum pixel image, computed median, frame number modulo 32, and reconstructed frames numbered 1296 to 1302.

frames and nearly stationary objects would normally be eliminated. However, in a maximum temporal pixel storage format only one frame during the entire video sequence will have the cloud value in a given pixel. Thus simple differencing fails to remove the clouds so the subtraction of a spatially spread median aids in partially mitigating slowly moving extended objects.

(c) Call the MeteorScan detection module feeding it the pair of images associated with frame index N and $N+1$. The MeteorScan image processing function differences the images, finds those pixel exceedances greater than the tracked noise background (which is essentially zero for this type of imagery), transforms the locally paired exceedances to Hough parameter space, integrates Hough space over eight image pairs and searches for peaks above the Hough space threshold. For any significant peaks found, the line orientation and estimated angle rate define the motion hypothesis for the matched filter detector. If both a maximum likelihood estimate and binary integrator of exceedances (i.e. number of pixel exceedances along the suspected line) are found to cross the associated detection thresholds, then detection is declared. The user can control the false alarm rates to a suitable level through adjustment of the detection thresholds.

(d) For all detections found on this MeteorScan call, the software computes the positions of the meteor track for each temporal segment backwards and forwards of the peak intensity, writing the results to a detection log file. It also flags a swath of pixels in the pixel exclusion mask to identify regions of avoidance for star estimation later. Curiously, due to the nature of the compression format, the trains of meteors do not appear in the rebuilt temporal record and thus do not bias the centroids of the meteor's track: an algorithmic sleight-of-hand that may be useful in automated angular velocity measurements of other researchers.

(e) Return to the top of this loop to process the next pair of frames until the entire frame set is exhausted.

5. Locate stars in the maximum pixel image avoiding regions flagged as meteors in the pixel exclusion mask. Save the stars and their centroids to a file and close the output detection list file.

For output, a single `MTPdetections.txt` file is generated for the contents of the processed folder which is the complete set of BMP files collected on a given night. The information recorded includes the detection number for a given file, file name of the BMP file processed, speed of the meteor in pixels per frame, and the Hough ρ and ϕ line orientation parameters. For each meteor detected, there are several rows of information that include frame number, column centroid, row centroid, and integrated intensity less the median along the meteor track. Each meteor can have a different number of output lines since they each have different durations of their illumination intensity above the meteor track endpoint threshold.

In addition, for each BMP file processed, a list of stars that were found and centroided from the maximum pixel image is listed in a single `CalibrationStars.txt` file for all the files in the folder. The information recorded includes the star number, BMP file name processed, integrated intensity counts minus the median, column centroid, and row centroid.

Additional output files are the maximum pixel image file in gray-scale BMP format, an error log text file, and optionally the frame number and median images. The non-real-time nature of the whole process allows the user to fine tune the runtime parameters (i.e. MeteorScan settings) and find the optimal set of parameters for faint meteor detection. The processing time to scan an entire night's BMP files on a 2.5 GHz Celeron PC is slightly more than one hour during the extended collection periods of the long winter nights. This is approximately 6 seconds per BMP file (60 second collection) so the software runs faster than ten times the collection rate.

4 Post-detection processing

False alarms can be an issue with any detection methodology and to reduce them, the CMN has developed a post-detection screening capability. A case in point is separating meteors from bats flying through the field of view and other non-meteor events. This is achieved through a separate application program that allows an operator to mitigate those false alarms and prepare data for astrometric/photometric analysis in less than ten minutes. The filtered data is then ready to be processed through additional CMN software which is currently under development. An example is the use of the star calibration output file which will be used for FOV calibration and photometry estimation, and should be ready by the spring of 2009.

5 Discussion

This new approach of merging the SkyPatrol, MTP, MeteorScan, and CMN suite of software for collection, detection, and post-processing allows one to automatically review a night's collections for meteors, mitigate false alarms, gather more precise astrometry positions, obtain photometric data, and retain a scientifically useful compressed data archive. This is a more complete end-to-end capability that was not previously available to the CMN using the SkyPatrol software alone. Further improvements could be made to the capture process by retaining the full resolution (768×576 pixels per frame of both PAL fields) so additional enhancement in data precision can be achieved. At the present time work within the CMN community is focused on the post-detecting processing and analysis.

Given that there is a dramatic compression achieved by taking a video snippet and converting it into a single color bit-mapped file and yet retaining both the temporal and photometric information, opens the door for archiving options of previously collected video and future collections. For example, using the four-byte BMP file format of red/green/blue/transparency and limiting the video length to 256 frames, one could save the maximum pixel value in time, frame number of maximum, temporal mean excluding the maximum, and temporal standard deviation with a resultant 64× compression ratio. One night's worth of video from a single camera could easily fit on a single DVD at full resolution, and still retain a good representation of the light curve and astrometry of the meteors. Having a temporal mean and standard deviation would do away with the imprecise nature of the spatial median currently calculated and permit full flat fielding (whitening) of the maximum pixel image prior to detection processing.

6 Software availability

The MTP Meteor Detector software has been developed for the standard PC series of computers using Windows XP and Metrowerks CodeWarrior release 6. It should be compatible with most PCs available today; however, with Windows there are never any guarantees. Although the basic detection algorithms are not wedded to a particular computer system, the software does operate by reading from a single color image file of BMP format. The non-real-time nature of the existing version does not put any processing constraints on the size and speed of the processor. The MTP Meteor Detector software is available for free from the authors and includes a user's guide, executable, input parameter file as well as the source code for the MTP driver, interface, and the C callable library of MeteorScan. The latter three components are for those ambitious enough to modify and improve upon the existing processing stream. For Linux, a version does not yet exist but could be easily built if there is a need in the community.

Acknowledgements

The authors would like to thank Mark Vornhusen for initially developing the SkyPatrol software and with his later assistance in decoding/verifying the RGB channel compression scheme that was employed therein.

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Handling Editor: David Asher

A telescopic meteor observed during the Metis campaign

Scott Degenhardt [1] *and Peter Gural* [2]

A recent occultation observing campaign inadvertently captured a meteor in multiple narrow field-of-view video cameras. A quick analysis of the tracks classified it as a sporadic with implications for the possibility of doing short baseline meteor triangulation. The primary goal of the collection was also met in that the size and shape of asteroid Metis was successfully measured.

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1 Introduction

The following report is about a serendipitous recording of a meteor on multiple video cameras that occurred during the asteroid Metis occultation timing experiment. The principle interest of one of the authors (SD) is in designing inexpensive narrow field of view camera systems and deploying them for asteroid occultations of stars to support the measurement of asteroid size and shape. The chance meteor appearance during a recent collection campaign, however, suggests an alternative way of doing meteor triangulation with short baseline observations. Thus this paper describes the event, the observing method and equipment, and data reduction results which could prove to be inspirational to others in the meteor community.

2 Event Background

On the morning of 2008 September 12 the asteroid (9) Metis was predicted to pass in front of the 6th magnitude star HIP 14764 and would be visible from a 271 km wide path on the ground across the United States. The International Occultation Timing Association (IOTA) scheduled its annual meeting to occur on the same date in Apple Valley, California to get as many people together in one general location and thus provide as many chords of occultation measurements as possible across the asteroidal body. The California location was chosen for its stable and generally clear weather during that time of year. For the Metis event, the plan was to deploy for the first time, fifteen 'Mighty Mini' observing systems that will be described in detail below. These fifteen unattended systems were to be spaced approximately 3 km from each other along a line roughly perpendicular to the ground path of the shadow. They were all pre-pointed to the same exact altitude and azimuth in the sky so that at precisely $06^h21^m59^s$ UT, the star HIP 14764 would drift through the center of the field of view of each camera, and the miniDV recorders would record the video and hopefully capture the shadow of Metis whizzing past at 4 km/s. This would appear as the star winking out for a short period of time that would be dependent on Metis' physical size and shape.

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NASA-ADS bibcode 2009JIMO...37...33D

3 Initial Occultation Results

The actual occultation occurred with very little time between the end of twilight and the passing of Metis's shadow. Due to the low elevation ($+16\overset{\circ}{.}8$ altitude), the severe haze up to about 20° of elevation from the Exxon/Mobile oil field gas plumes burning in the distance, and one encounter with Security, only eleven stations were successfully pre-pointed with their recorders running. Each camera's recording was time stamped in UT with a GPS KIWI OSD system (accuracy ±1 ms). The KIWI-OSD[1] is a video time inserter that displays a highly accurate time stamp superimposed on recorded video imagery. It works in conjunction with a GPS unit to provide a time reference for each frame of the video sequence as well as station latitude, longitude, and height above sea level. All eleven of the recordings showed a miss on the asteroid Metis, but there did appear about a minute before the predicted occultation time, a meteor about half as bright as the 6th magnitude target star, which had streaked through the field of view of Station #08. Out of curiosity the other station's recordings were reviewed and the same meteor streak was discovered for stations #09, #10, #11, and #12. Thus five of the eleven stations had recorded the same meteor, and all of them displayed an easily visible parallax of the meteor's position relative to the star HIP 14764. Given the greatest camera separation of 12.5 km and timing accuracies to 1 ms ±8 ms (the duration of one NTSC video field) an initial attempt was made to reduce these video observations and glean as much information about the meteor as possible. What initially came to mind was the possibility of determining the altitude of the meteor and the light curve from the ablation. With the GPS position known for each observation site, and the ability to determine the exact RA and Dec of the meteor at a given UT time, it was feasible that one could determine a rough orbit, or at a minimum, the radiant association with any active showers. In addition, the telescopic nature of the recording is rare in the field of meteor research and could prove interesting with the 18 arc second resolution available in the 'Mini' camera systems.

4 Meteor Reduction Results

It took several weeks by the principle author (SD) of manipulating the raw data before a satisfactory reduction method was found, having had no past experience in the meteoric area of data analysis. Once an approach

[1] http://www.pfdsystems.com/kiwiosd.html

was finalized however, the actual processing per station was completed in less than an hour. The first result concerns the light curve of the meteor. The correlation between intensity versus time for all five different views/recordings was simply amazing! This should not be so surprising on reflection, because if all the cameras are synchronized correctly and properly calibrated, then the results should be consistent since there is very little change in look aspect or recording position between the stations. It just wasn't expected that all five intensity profiles would lay right over each other as seen in Figure 1. Converting the meteor track to RA and Dec was also more difficult than it should have been, but was accomplished for four of the five stations. Station #09 refused to scale properly so a bit of an average scaling was used to get the track to fall correctly on the plot in Figure 2. This did not significantly impact the end result, as Station #08 and Station #12 are the two most spatially separated stations that one would use to triangulate for altitude. The following is a list of the initial measured parameters associated with the observation sites and meteor:

- Approximate peak meteor red magnitude: $+6^{\rm m}\!.87$

- Time of peak intensity: 2008 September 12 $06^{\rm h}20^{\rm m}44^{\rm s}\!.455$ UT ±8 ms

- Station #08 RA and Dec of peak intensity: $3^{\rm h}11^{\rm m}13^{\rm s}\!.59$, $+11^\circ 19' 28''\!.25$
- Station longitude: $-119^\circ 37'\!.4429$
- Station latitude: $+35^\circ 18'\!.0885$
- Height above MSL: +331.3 m MSL

- Station #12 RA and Dec of peak intensity: $3^{\rm h}09^{\rm m}54^{\rm s}\!.16$, $+11^\circ 20' 54''\!.84$
- Station longitude: $-119^\circ 40'\!.2197$
- Station latitude: $+35^\circ 24'\!.3913$
- Height above MSL: +158.7 m MSL

- Duration: 50 NTSC fields so nearly 1 second long

- Angular line-of-sight separation between Station #08 peak and Station #12 peak: $19'\!.541$

- Straight line distance between Station #08 and Station #12: 12.5 km

A back of the envelope calculation placed the line-of-sight range to the observed track at 2200 km or over 800 km above the Earth's surface (locally under the object), making this initially appear more likely a satellite than a meteor! At this point, contact was made with US amateurs and professionals in the meteor community and the co-author (PG) offered to reduce the data further to get a more accurate estimate of the altitude and potential radiant association. Calibrating each camera's field of view from available star positions and using the intersecting planes solution given the meteor track points from stations numbered 8 and 12, yielded the following result:

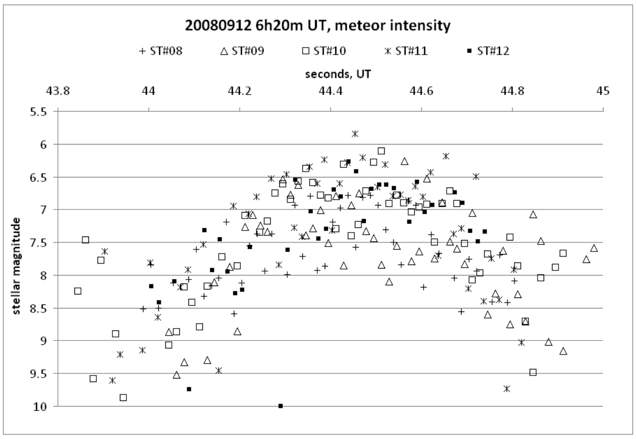

Figure 1 – Calibrated light curves of the Metis meteor from the five stations with a video track.

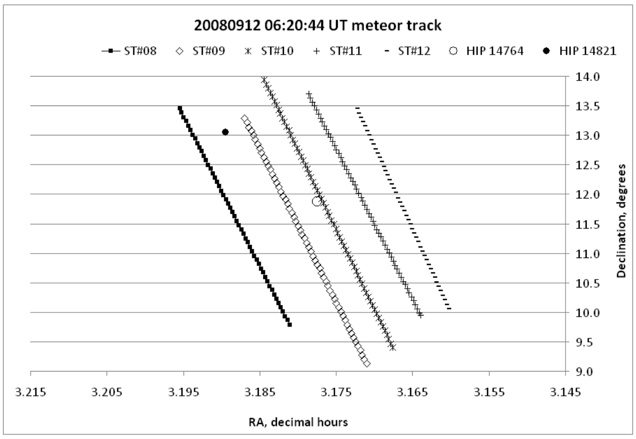

Figure 2 – Meteor positions as observed from the five stations in stellar coordinates for each video frame.

- Apparent angular velocity = $2.33^\circ/s$

- Range of the visible track went from 321 to 345 km – moving away from the observing sites

- Height of the visible track within the narrow FOV went from 92 km down to 90.5 km (Figure 3)

- Entry velocity = 32 km/s

- Radiant position: RA = $15^{\rm h}\!.7$ Dec = $+11^\circ$

- Radiant association = Sporadic

- The focal plane trailing loss due to the meteor smear across the CCD during one frame integration period (1/60 second) amounted to 2.2 magnitudes.

- The distance fading loss relative to 100 km was 2.6 magnitudes

These results were consistent when pairing other stations together. Clearly this met the criteria of a meteor. The back propagation and entry velocity classify this particular meteoroid as a sporadic.

5 Observing Equipment

As mentioned earlier, the Metis asteroidal occultation was the 'first light' deployment for the Mighty Mini

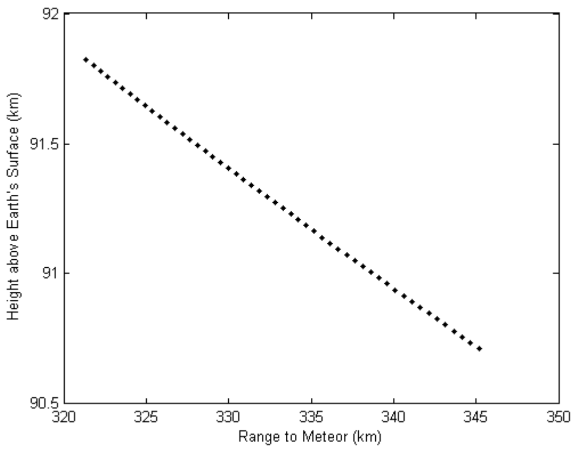

Figure 3 – Meteor height as a function of the line-of-sight range.

observing platform. This system consists of one optical objective from a Tasco Essentials 10 × 50 binocular mounted to two pieces of PVC plumbing hardware. The latter provides the optimal spacing given the objective's focal length to allow it to focus on a standard high sensitivity security camera (Supercircuits PC164CEX-2). The camera is placed at the back end of the optical train that includes an Owl focal reducer screwed onto a 12.7 mm spacing video camera adapter to increase the effective field of view. The system provides a $2.4^\circ \times 3.2^\circ$ FOV with a +10.2 limiting stellar magnitude under dark sky conditions at 30 fps video frame rates. The total length of the Mighty Mini with the camera installed is only 20 cm (8 inches as shown in Figure 4) and thus very portable and easy to setup at multiple remote sites. A cautionary note is that the system is optimized for occultation work and despite the extreme magnitude sensitivity for stationary objects like stars, there can be up to a 4 magnitude loss for meteors. This is due to the extensive smearing of the meteor across the high resolution pixels during a single video field integration period (1/60 second).

A complete observing platform consists of a Mighty Mini mounted on a MX350 tripod, a Canon ZR (Models ZR10-ZR300) miniDV camcorder acting as a VCR only, and a 9 cell battery pack of Duracell AA NiMH 2650 mAh batteries as seen in Figure 5. Also shown is a KIWI OSD which grabs the high accuracy clock signal from the GPS constellation of satellites for the time stamping/insertion into the video recording. The complete system can also be operated at prime focus to yield a smaller FOV that provides higher magnification for lunar occultations of stars. The complete telescopic portion of the system costs under $100 to build (excluding the cost of the PC164CEX-2, Owl focal reducer and KIWI OSD, and the complete system cost is about $400) and weighs less than 10 lbs.

6 Meteor Analysis Conclusions

- For an occultation observer, it was amazing that well over 200 meteor magnitude data points fit so nicely together in both time and intensity. This provided a reverse verification that the methods of time stamp placement and determination, as well as the software reduction tools in use for occultation work, are very efficient and accurate and transferable to meteor reduction and analysis.
- The wider field of view of the Mighty Mini relative to other occultation camera systems (reducing the apparent angular velocity of meteors over each pixel) coupled with the sensitivity of the PC164 CEX-2 and the low price per system, would seem to make a very handy meteor observing tool that could be arranged to do triangulation analysis. Due to the high angular resolution of the narrow field of view cameras, a closer spacing between observing sites should be tolerable. The loss in spatial coverage can be partially compensated for by observing at low altitudes above the horizon as in the Metis collection geometry. This will cover a larger volume of the air cap at meteor ablation altitudes.
- In future asteroidal occultation deployments of multiple imagers, the video records will be scanned for other meteoric events. In addition, a test is planned during a future meteor shower to lay out several stations at varying distances to help determine the optimal separation distance between camera sites given the high angular resolution of the Mighty Minis. A large separation baseline of 40 km will provide the high accuracy results, while the closer stations can be tested to find the minimal distance acceptable for triangulation processing. If successful, this could lead to a short baseline and narrow FOV meteor orbit estimation concept of operations.

7 IOTA Further Information

- IOTA Main Page[2] (International Occultation Timing Association)
- OccultWatcher[3] (OW is a software package that will track all asteroid and TNO occultations, and satellite mutual events visible from your local observing site)
- Occult 4.0[4] (Lunar and asteroidal occultation prediction and reduction software)
- 'Chasing the Shadow: The IOTA Occultation Observer's Manual' by Richard Nugent[5]
- IOTA discussion group[6] (you will want to join this to get involved in continuing ongoing discussions in the field of occultations, the latest equipment, and software updates, etc. It is an extremely valuable knowledge base.)

[2] http://www.lunar-occultations.com/iota/iotandx.htm
[3] http://www.hristopavlov.net/OccultWatcher/OccultWatcher.html
[4] http://www.lunar-occultations.com/iota/occult4.htm
[5] http://www.poyntsource.com/IOTAmanual/Preview.htm
[6] IOTAoccultations@yahoogroups.com

Figure 4 – Mighty Mini video camera and objective lens system. The measuring tape shown is in units of inches.

Figure 5 – Complete Mighty Mini system with imager, recorder, power and GPS.

A 2008 September 12, (9) Metis Occultation Results

For those who are interested to know the results of the asteroid shape measurement of that evening, the results were excellent! Over 30 nearly evenly spaced stations were set up by 20 individuals, and while the 11 deployed by SD as described in this paper were clean misses, David Dunham set up 3 stations using the Mighty Mini, and all 3 got positive measurements! This makes his three observations the first positive event for the Mighty Mini since its inception. Figure 6 shows the measurement chords obtained revealing the size and shape of Metis.

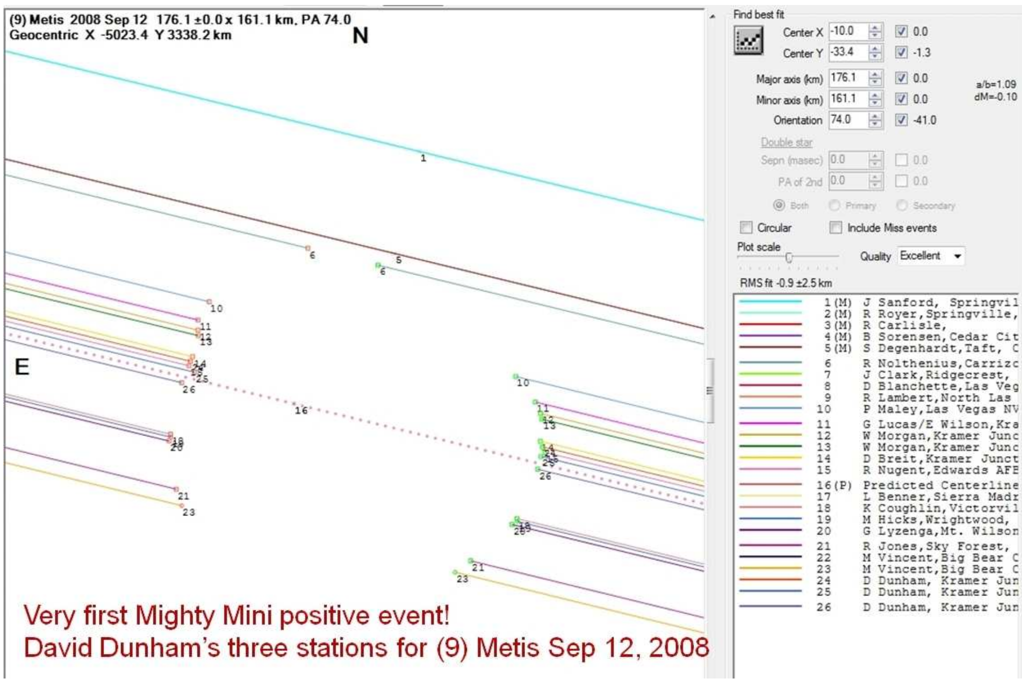

Figure 6 – This is a graphical representation of the combined observations of the Metis occultation. The lines represent when the target star was visible and breaks in the line represent when Metis occulted the light from the target star. By combining the different observations we can measure the shadow an asteroid casts on the ground, thus we can measure its size, shape, and position in space.

Handling Editor: Željko Andreić

Photographic fireball observations from La Paz

Hans Salm [1]

A photographic fireball observing setup is presented. After the first two weeks of observations, two fireballs were recorded by the setup and are presented in this report.

Received 2008 September 22

1 Introduction

The development of video and digital SLR cameras during the last years, accompanied by a reduction of their prices, favored the implementation of fireball patrol systems, especially in Europe and USA. However, near the Equator and in the Southern Hemisphere, there still are very few meteor observing stations. In order to contribute to fireball studies, in a suburb of La Paz, Bolivia, I established the following setup:

- Camera: Canon EOS 400D DIGITAL
- Lens: Super Wide-angle lens MS PELENG 3.5/8A (Belarusian)
- Computer: Sony Vaio
- Exposures: 32 s, 1600 ASA, $f/3.5$; one picture every 40 s (8 s to discharge an image)
- Observation site: La Paz, Bolivia (68°03′46″ W, 16°32′34″ S, 3400 m a.s.l.)

2 Test successful: first fireball!

I started photographic fireball observations on 2008 April 20. Because of moonlight, the projected observation time on 2008 April 20 (local time) was only 1.5 hours. Just when I was about to stop the observation, I had to attend to a phone call and I left the camera taking pictures for another five minutes, with the Moon already entering the camera field. That was when the camera recorded a long −7 magnitude fireball (Figure 1).

Figure 1 – Fireball of 2008 April 21, exposure from $00^h43^m46^s$ to $00^h44^m18^s$ UT.

Figure 2 – Fireball of 2008 May 5, exposure from $06^h00^m40^s$ and $06^h01^m12^s$ UT. The bright 'star' that the lower part of the train crosses is Jupiter. A colour reproduction of the fireball is shown in the front cover.

3 Two weeks later: a second fireball with a long-lasting train

In the night of 2008 May 4–5, the camera was operating from 23^h15^m to 05^h45^m local time (03^h15^m to 09^h45^m UT). Between $02^h00^m40^s$ and $02^h01^m12^s$ local time ($06^h00^m40^s$ and $06^h01^m12^s$ UT) a −9 magnitude fireball appeared (Figure 2). Subsequently, a long lasting persistent train was recorded on more than 20 images. The train disappeared at 6^h18^m UT behind the roof of a neighbours house. Figure 3 shows the evolution of the train during the first 272 seconds.

4 Discussion and conclusions

The appearance of a fireball at a certain site is not a very common event. About one in 1 200 observed meteors becomes brighter than magnitude −5, while only one in 12 000 reaches magnitudes −8 or brighter (Rendtel & Knöfel, 1989). In our case, fortune allowed us to record two bright fireballs in less than 30 hours of observation. Ongoing routine observations will provide data to improve our knowledge of fireball flux density and its seasonal variation.

In reference to the persistent train of May 4–5, it was probably one of the longest lasting ever captured by a camera. Trains frequently are produced by bright meteors and can last some seconds or, rarely, a few minutes (Benítez Sánchez, 2005; Borovička, 2006). Despite light pollution from La Paz city, the train still was recorded by the camera 15 minutes after the fireball event.

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NASA-ADS bibcode 2009JIMO...37...37S

Figure 3 – Evolution of train between $06^h01^m20^s$ and $06^h05^m52^s$ UT.

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Handling Editor: Javor Kac

Preliminary results

Results of the IMO Video Meteor Network — November 2008

Sirko Molau [1] *and Javor Kac* [2]

The cameras of the IMO Video Meteor Network operated on all 30 nights in 2008 November. We collected more than 2 200 hours of effective observing time and recorded more than 9 000 meteors. Preliminary analysis of the 2008 Leonids is presented. Possible double-radiant nature of the Monocerotids was found similar to the Taurids.

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1 Introduction

For most European observers, November was a typical cloudy fall month presenting only a few clear nights. Our two American observers, on the other hand, enjoyed once more perfect conditions and collected more than 25 observing nights. Also in Portugal and parts of Italy, the weather was fine. Our new observers Paolo Ochner and Fabio Moschini, for example, who jointly operate a meteor camera in Albiano near the city of Trento, managed to collected more than 100 hours of effective observing time right at the start. As also Stefano Crivello is now operating a second camera, we have seven cameras in operation in Italy. The number of observers is identical to Germany (5). In Slovenia, Javor Kac is operating a fourth camera. Overall, we collected more than 2 200 hours of effective observing time despite the weather, which is the third best result in the IMO network. With more than 9 000 meteors, 2008 November can of course not keep up with August or October, but it still was the best November result to date (Figure 1 and Table 1).

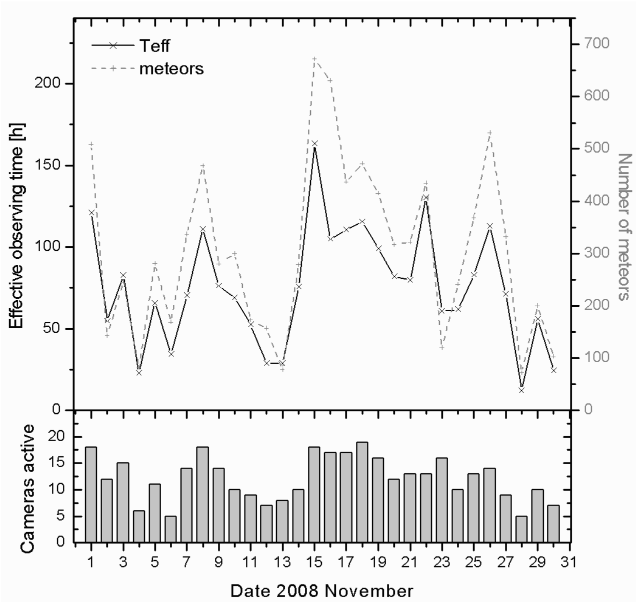

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2008 November.

2 Leonids

No other meteor shower has spurred on meteor science in the last decade as much as the Leonids. Meanwhile, the dust trail model has been successfully applied to predict outbursts of different meteor showers. This year, however, it was once more the Leonids that proved the strength of the model, which celebrated its first major success during the Leonid storm of 1999. On 2008 November 17, at 01^h30^m UT (i.e., more than a decade after the last return of the parent comet) the Earth was supposed to cross the 1466 dust trail. Therefore, Jeremie Vaubaillon predicted enhanced activity with a ZHR between 25 and 100 (Vaubaillon, 2008). Visual observations were rare, because weather permitted meteor observations almost nowhere in Europe, and the waning moon did the rest. Still, the live activity profile of IMO confirmed a peak ZHR of nearly 100 between 01^h45^m and 02^h30^m UT.

Unfortunately, video observers were hampered similarly by the poor sky. Just a single camera in Portugal (Templar1) enjoyed clear skies all night long, but the moon crossed the field of view just at the maximum, so that only 39 Leonids were recorded in total. Other observers caught at least a part of the outburst. In Berlin, Armefa recorded 8 Leonids between 01^h30^m and 02^h00^m UT. BMH2 observed a total of 16 Leonids in northern Italy between 01^h40^m and 03^h00^m UT (but clouds drifted through the field of view all night long). North of Munich, skies cleared after a shower front at 02^h10^m UT. Until the end of night at 05^h30^m UT, Mincam1 could record 67 Leonids under good conditions. In Genova the clouds disappeared completely at 04^h00^m UT only. Until 05^h30^m UT, C3P8 still recorded 37 Leonids, and STG38 11 Leonids.

Figure 2 shows the hourly Leonid rate of Mincam1 and Templar1, corrected for the radiant altitude. In addition, an empirical correction factor was applied for Templar1 to account for the percentage of the field of view glared by the Moon. These data sets can only give a rough hint on the Leonid activity, but they suggest that the outburst might have lasted longer than derived from the sparse visual data. Between 01^h30^m and 05^h30^m UT, the Leonid rate was enhanced, with a maximum between 02^h00^m and 03^h30^m UT.

What else did we learn about the Leonids from the

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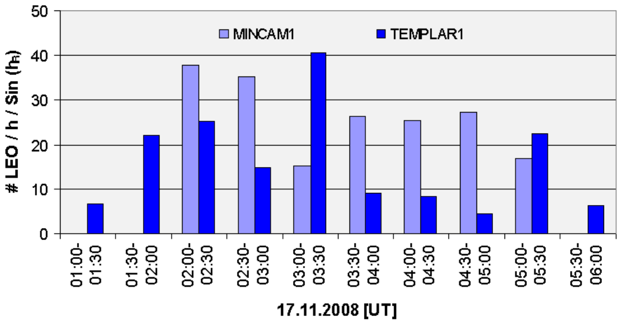

Figure 2 – Corrected hourly Leonid rates of the cameras MINCAM1 and TEMPLAR1 on the morning of 2008 November 17.

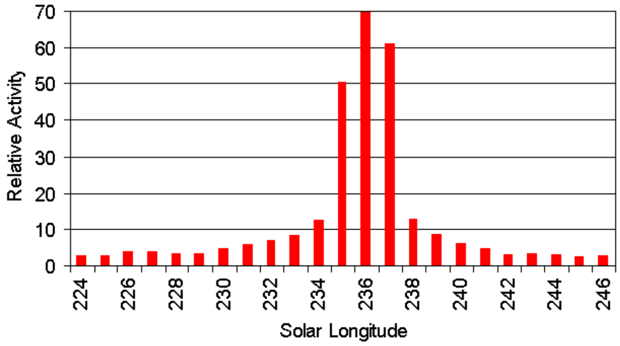

Figure 4 – Activity profile of the Leonids.

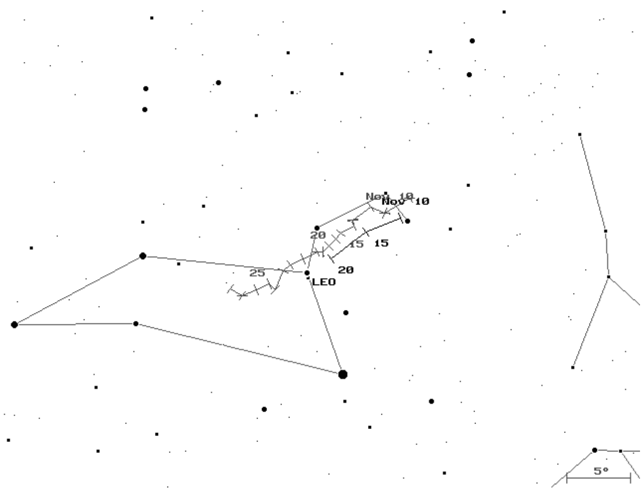

Figure 3 – Radiant position of the Leonids from data of the IMO Video Meteor Database (gray). Black line denotes the Leonids radiant drift as given in the IMO Handbook.

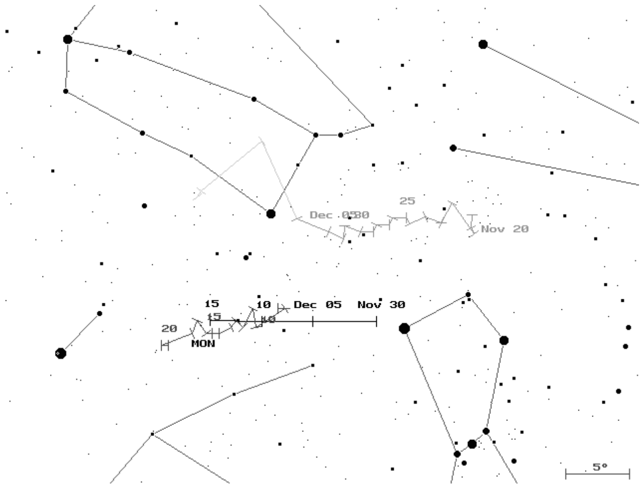

Figure 5 – Radiant position of the 'classical' Monocerotids (gray) and the unknown meteor shower (light gray) from data of the IMO Video Meteor Database. Black line denotes the radiant drift of the Monocerotids as given in the IMO Handbook.

data of the IMO network? Accoring to the last edition of the IMO handbook for meteor observers (Rendtel & Arlt, 2008), this shower is active between November 10 and 23. In the recent analysis of the video data, almost 25 000 Leonids could be identified between November 7 and 28. Thus, this shower even outperforms the Perseids thanks to numerous video observations during the major storms of 1999 to 2002. The radiant is well defined all the time (Figure 3), from which we can conclude that the extended activity interval is real. The radiant is found about a degree north of the position given in the IMO handbook.

Between solar longitude 235° and 237°, the long-term activity profile of the Leonids (Figure 4) is shaped by the different meteor storms of the last decade. More reliable are the values away from the maximum, which confirm a roughly symmetric activity profile.

3 α Monocerotids

Right after the Leonids, the α Monocerotids become active, whereby 'active' is a relative term. If we do not witness one of the rare outbursts as in 1995, the shower is hardly noticeable. In the latest meteor shower analysis, the α Monocerotids were not detected at all, and also the list of individual radiants per solar longitude interval shows no sign of this shower.

4 Monocerotids

Instead of that, the 'other' Monocerotids are present twice in the list! According to the IMO handbook, the Monocerotids are active between November 27 and December 17. Indeed, a shower with 630 meteors was found in the video data, whose radiant position and drift matched perfectly to the values given in the Handbook (Figure 5, gray). Also the velocity (41 km/s) is in agreement with the literature (42 km/s).

The second shower was detected in the video data analysis with 850 meteors between November 18 and December 9 (resp. December 7, when only reliable radiant positions are taken into consideration). The activity interval overlaps slightly with the 'classical' Monocerotids. The radiant of the second shower (Figure 5, light gray) is located about 7° north of the Monocerotids, but the value and direction of radiant drift are identical. With respect to the velocity, the second shower is slightly faster than the Monocerotids (46 km/s).

The 'classical' Monocerotids reach their peak activity right at the beginning on December 7/8 (IMO handbook: December 8), and the second shower peaks at the end of November. The peak activity level of both showers is identical. Interestingly, also the activity profile given in the IMO handbook (dots) shows not just

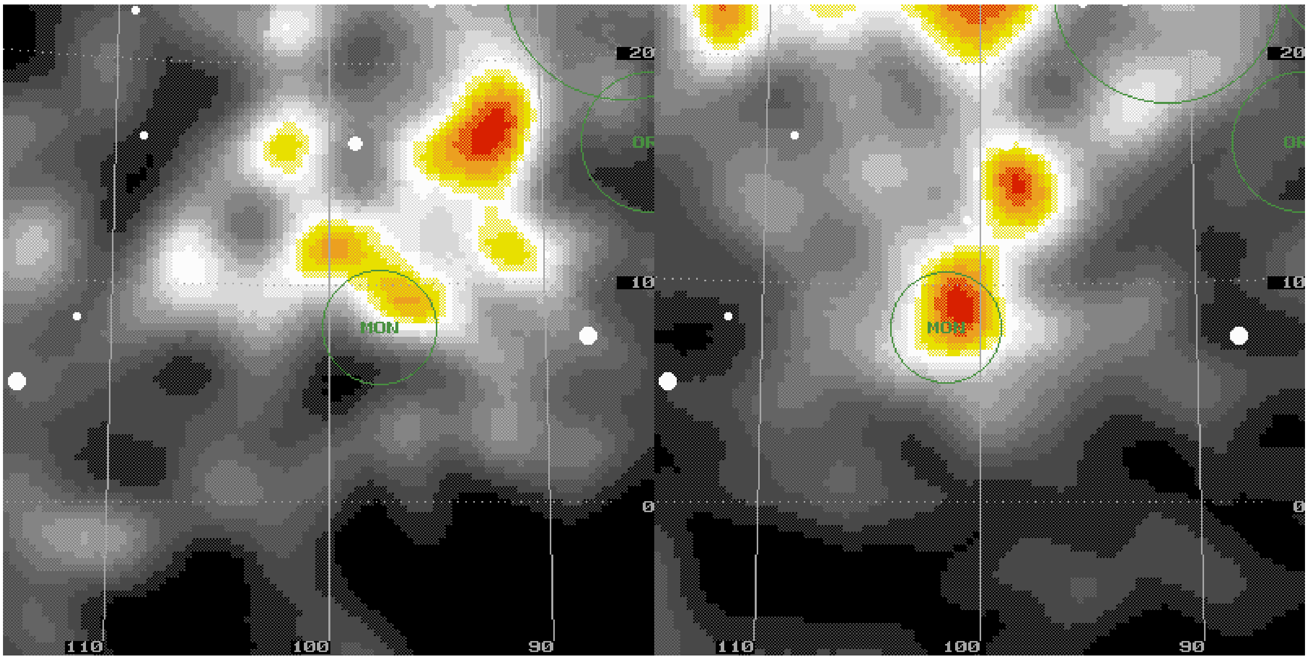

Figure 6 – Radiant plot for solar longitude interval 253°–255° (left) and 258°–260° (right) given a $v_{\mathrm{inf}} = 42$ km/s.

a single maximum, but enhanced rates in early December (Figure 7). It suggests, that the visual profile covers the activity of both showers, which is no surprise given a peak ZHR of 2 and a radiant distance of seven degrees only. That would also explain, why according to the IMO handbook the activity of the Monocerotids starts earlier than was found in the video data.

To verify the result, a few radiant plots were computed with the RADIANT software. The two examples in Figure 6 (solar longitude 253°–255° and 258°–260°, $v_{\mathrm{inf}} = 42$ km/s) prove, that there are indeed two distinct radiants. Whereas in the first plot the northern component dominates, it is the southern component in the second plot. We see, that the second shower is active beyond the activity interval found by the automated shower analysis. It confirms, that the statistical meteor shower search is limited when it comes to such close radiants with similar velocity.

It leads us to the last question: Are these two branches of the same shower (similar to the Northern and Southern Taurids) or do we observe two independent showers? The similarity of both is an argument for a single shower; the small, but significant difference in velocity is a counter argument. For this reason, we tend to believe in two independent meteor showers.

5 Taurids 2008 revisited

In the end, let's have a retrospect at the Taurids: their brightness distribution at the end of October seemed to suggest that the Taurids of 2008 were brighter than in the years before. If the plot is extended until November 20 with the newly available data (Figure 8), this result is not confirmed. There are indeed times where the shower meteors are somewhat brighter than usual, but at other times they are equally fainter. Overall there is no clear trend towards brighter Taurids in 2008.

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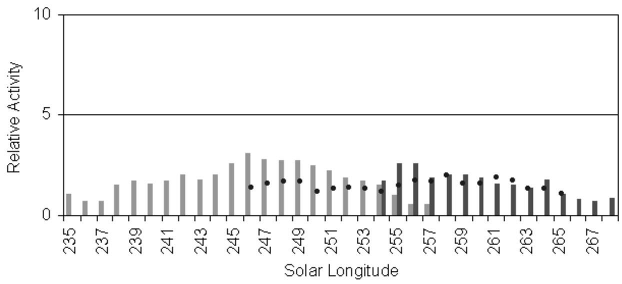

Figure 7 – Long term activity profile of the 'classical' Monocerotids (gray) and the new meteor shower (light gray). Dots represent the ZHR profile of the Monocerotids from the current Handbook of IMO.

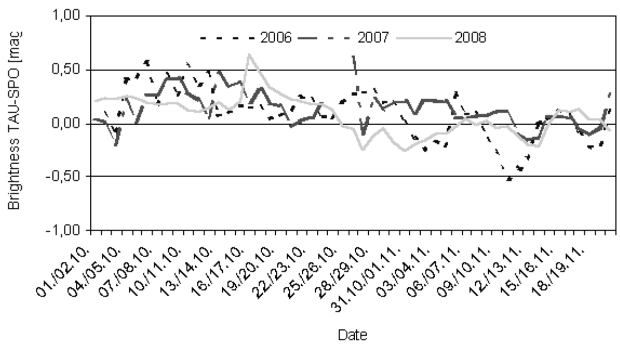

Figure 8 – Mean brightness difference between the Taurids and sporadic meteors in the years 2006 till 2008.

Table 1 – Observers contributing to November 2008 data of the IMO Video Meteor Network.

Code	Name	Place	Camera	FOV	LM	Nights	Time (h)	Meteors
BENOR	Benitez-S.	Las Palmas	TIMES5 (0.95/50)	⊘ 10°	3 mag	14	43.4	89
BRIBE	Brinkmann	Herne	HERMINE (0.8/6)	⊘ 55°	3 mag	5	17.9	94
CASFL	Castellani	Monte Baldo	BMH1 (0.8/6)	⊘ 55°	3 mag	15	118.3	354
			BMH2 (0.8/6)	⊘ 55°	3 mag	22	147.4	478
CRIST	Crivello	Valbrevenna	STG38 (0.8/3.8)	⊘ 80°	3 mag	2	20.8	111
		Genova	C3P8 (0.8/3.8)	⊘ 80°	3 mag	14	101.3	581
ELTMA	Eltri	Venezia	MET38 (0.8/3.8)	⊘ 80°	3 mag	6	52.6	207
GONRU	Goncalves	Tomar	TEMPLAR1 (0.8/6)	⊘ 55°	3 mag	22	183.1	1036
HERCA	Hergenrother	Tucson	SALSA (1.2/4)	⊘ 80°	3 mag	28	258.5	596
HINWO	Hinz	Brannenburg	AKM2 (0.85/25)	⊘ 32°	6 mag	17	108.0	489
KACJA	Kac	Kostanjevec	METKA (0.8/8)	⊘ 42°	4 mag	14	110.6	303
		Kamnik	REZIKA (0.8/6)	⊘ 55°	3 mag	13	79.4	404
			STEFKA (0.8/3.8)	⊘ 80°	3 mag	6	31.8	82
		Ljubljana	ORION1 (0.8/8)	⊘ 42°	4 mag	13	65.6	180
KOSDE	Koschny	Noord-wijkerhout	TEC1 (1.4/12)	⊘ 30°	4 mag	3	7.4	21
LUNRO	Lunsford	Chula Vista	BOCAM (1.4/50)	⊘ 60°	6 mag	26	212.2	1368
MOLSI	Molau	Seysdorf	AVIS2 (1.4/50)	⊘ 60°	6 mag	15	71.3	661
			MINCAM1 (0.8/6)	⊘ 60°	3 mag	22	79.7	221
		Ketzür	REMO1 (0.8/3.8)	⊘ 80°	3 mag	4	13.5	35
			REMO2 (0.8/3.8)	⊘ 80°	3 mag	4	12.7	35
OCHPA	Ochner	Albiano	ALBIANO (1.2/4.5)	⊘ 68°	3 mag	15	112.3	418
PRZDA	Przewozny	Berlin	ARMEFA (0.8/6)	⊘ 55°	3 mag	12	67.9	219
SLAST	Slavec	Ljubljana	KAYAK1 (1.8/28)	⊘ 50°	4 mag	11	58.0	134
STOEN	Stomeo	Scorze	MIN38 (0.8/3.8)	⊘ 80°	3 mag	15	92.8	320
STRJO	Strunk	Herford	MINCAM2 (0.8/6)	⊘ 55°	3 mag	16	44.9	153
			MINCAM3 (0.8/8)	⊘ 42°	4 mag	8	28.7	88
			MINCAM5 (0.8/6)	⊘ 55°	3 mag	9	40.3	223
YRJIL	Yrjölä	Kuusankoski	FINEXCAM (0.8/6)	⊘ 55°	3 mag	15	73.7	270
					Overall	30	2263.1	9170

Results of the IMO Video Meteor Network — December 2008

Sirko Molau [1] *and Javor Kac* [2]

IMO Video Meteor Network cameras covered all 31 nights in 2008 December. More than 10 000 meteors were collected in 2 285 hours of effective observing time. Preliminary analyses of the 2008 Geminids and Ursids are presented. Coma Berenicids radiant position was further confirmed to be offset by about 15° when compared to the IMO Working List positions. An annual overview of the IMO Video Meteor Network is also presented.

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1 Introduction

A very successful 2008 petered out with a meager December. In the first half of the month, there was reasonable weather at hardly any sites, such that the Geminids did not only become victims of the Moon, but also of the clouds. Only western Germany enjoyed clear skies for the Geminid maximum nights. In the second half of December, the weather slowly improved and there were already a few more observers who caught the Ursids maximum. From Christmas on, the weather became close to perfect at many sites, so that the statistics improved a bit towards the end. Finally, there were at least three cameras which managed to log more than 20 observing nights. The monthly total for December was nearly 2 300 hours effective observing time and more than 10 000 meteors observed (Figure 1 and Table 1).

In December we were also able to welcome a new observer in the camera network, whom we were especially happy about. Klaas Jobse, a real 'veteran' of video meteor observation, found his way to us. Five year before this article's first author constructed his first meteor camera, Klaas was already recording meteors by video in the Netherlands with Betsy1. His current system Betsy2 utilizes the same powerful image intensifier as Avis2 and Ond1. So it comes as no surprise that Klaas managed to record nearly a thousand video meteors from scratch using the perfect weather in his location at the end of 2008.

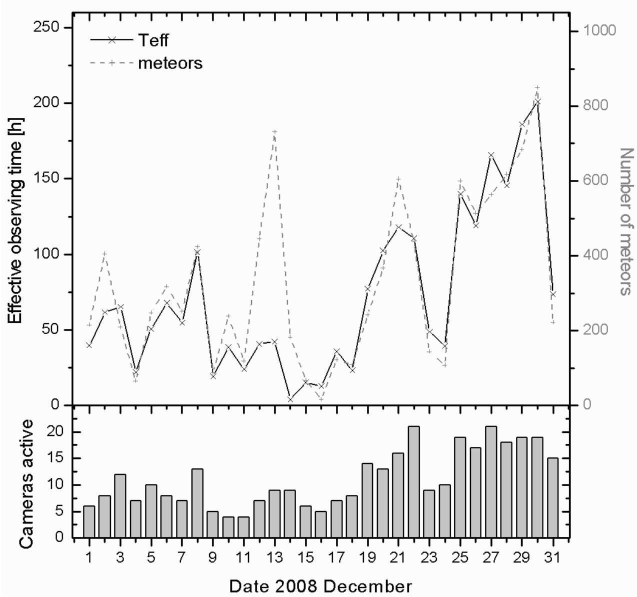

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2008 December.

2 Geminids

As mentioned before, the Geminids could hardly be observed in 2008. In the IMO Video Meteor Database, however, they remain the third strongest annual shower with more than 12 000 members. According to the latest edition of the IMO Handbook for meteor observers (Rendtel & Arlt, 2008), they are active between December 7 and 17, reaching their maximum on December 13. In the current video data analysis, the shower was clearly detected between December 5 and 18. The position of the Geminid radiant agrees well with the value from literature (Figure 2); only the drift direction differs slightly. The calculated velocity of 35 km/s is identical to the value given in the Handbook.

The long-term activity profile of the Geminids (Figure 3) has an asymmetric shape with a moderate ascent until the maximum on December 13/14, followed by a steep descent. Three days after the maximum, the shower is hardly detectable anymore.

3 Ursids

When the Ursids peaked on December 21/22, we at least had clear skies in Italy and Portugal, so the maximum was covered by seven cameras. The activity profile resulting from 164 Ursids and 200 sporadics is given in Figure 4. The Ursid counts were determined in one hour intervals, corrected by the radiant altitude, and averaged over all cameras. For comparison, the hourly sporadic rate is given. The activity of the Ursids rose to maximum between 2 and 3 UT on December 22 and declined thereafter. As expected, the sporadic activity increased steadily towards the morning.

Figure 5 compares thee 2008 Ursids with the previous two years, with the activity plotted against solar longitude. It is obvious that the activity level in 2008 was lower than in the two previous years.

What do we learn about the Ursids from the video meteor database? According to the IMO Handbook, they are active between December 17 and 26. This agrees well with the activity interval December 16 to 25 derived from 750 video observations of the Ursids.

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NASA-ADS bibcode 2009JIMO...37...43M

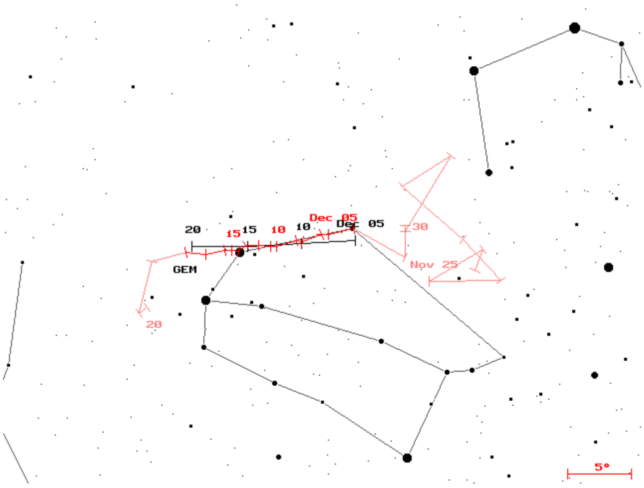

Figure 2 – Radiant position of the Geminids from data of the IMO Video Meteor Database. Black line denotes the Geminids radiant drift as given in the IMO Handbook.

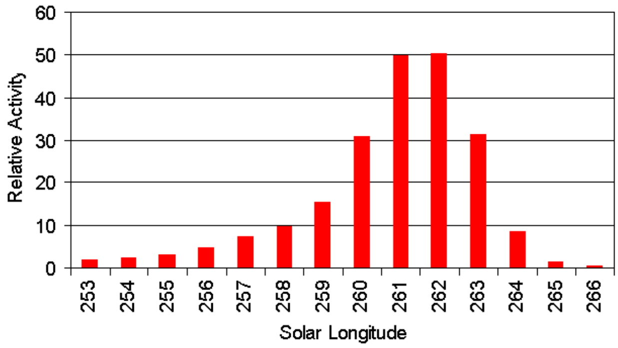

Figure 3 – Long-term activity profile of the Geminids from the IMO Video Meteor Network video data.

Due to the lower meteor number, the radiant drift (Figure 6) is not as well defined as for major showers. Still, the radiant is on average close to the expected position, and also the determined velocity of 32 km/s agrees well with the value from the IMO Handbook (33 km/s).

The long-term activity profile (Figure 7) reveals that the Ursids are reasonably active in only a very short interval, which confirms the observation from the last two years. Two degrees of solar longitude is an upper limit, because the maximum is smeared out when sliding intervals of two degrees' length are used.

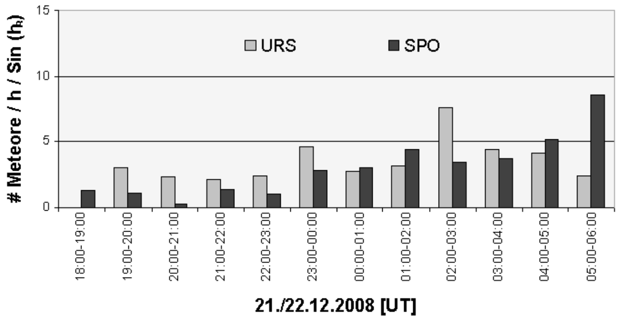

Figure 4 – Corrected hourly Ursid rates and sporadic counts on 2008 December 21/22.

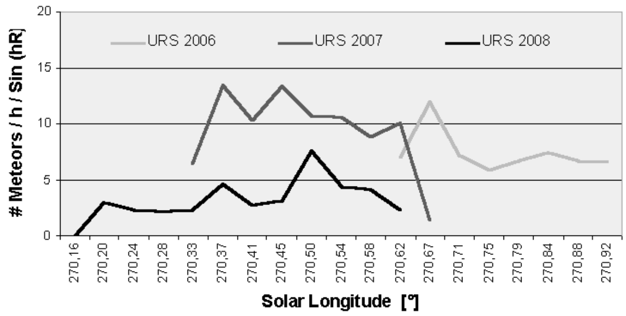

Figure 5 – Ursid activity in 2006–2008 plotted against the solar longitude.

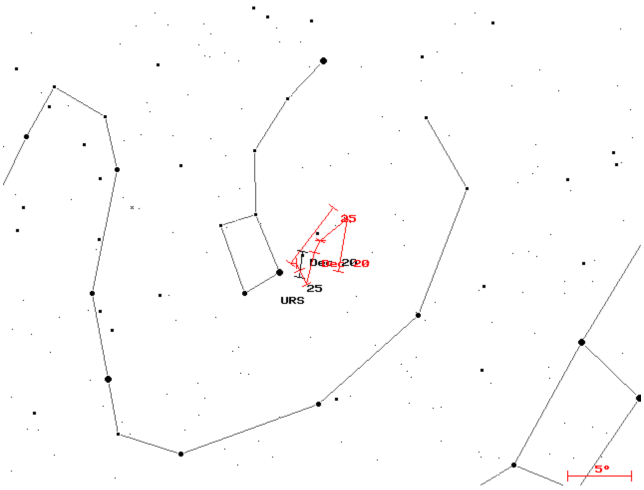

Figure 6 – Radiant position of the Ursids from data of the IMO Video Meteor Database. Black line denotes the Ursids radiant drift as given in the IMO Handbook.

4 Coma Berenicids

The Coma Berenicids are active in December, too. The current edition of the IMO Handbook points to a significant discrepancy between the radiant position published earlier (Rendtel et al., 1995) and the results from a first video data analysis in 2006 (Molau, 2007). Could that result be confirmed by the current analysis based on 2 300 shower meteors?

At first glimpse, the observed radiant position seems to match well the values from the old Handbook (Figure 8). A closer inspection, however, reveals an offset of about 17 days. On January 6, for example, the radiant is observed at a position given for December 20 according to the old ephemeris. In other words, the radiant

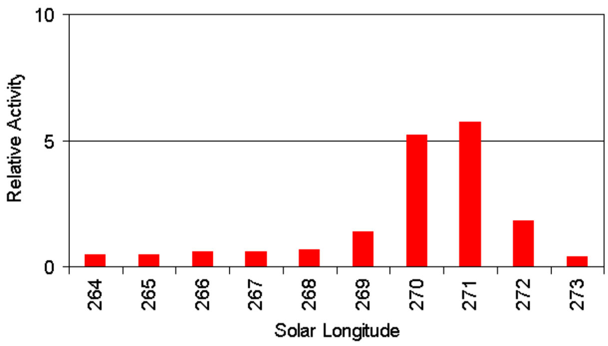

Figure 7 – Long-term activity profile of the Ursids from the video data.

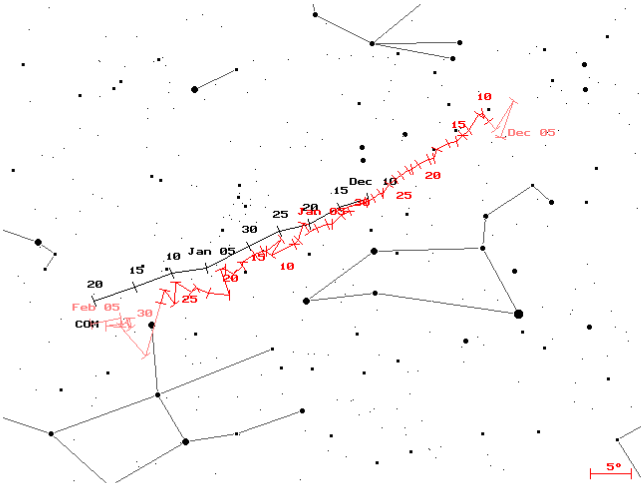

Figure 8 – Radiant position of the Coma Berenicids from data of the IMO Video Meteor Database. Black line denotes the Coma Berenicids radiant drift as given in the IMO Handbook.

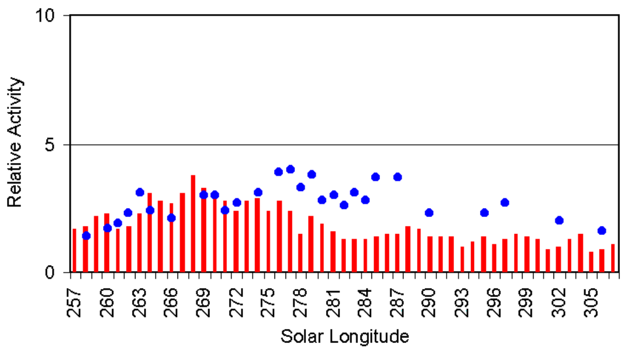

Figure 9 – Long-term activity profile of the Coma Berenicids. The dots represent the profile derived from visual data.

is off by 15° in the north-western direction. The activity interval, on the other hand, agrees well with the value from literature. The Handbook lists an interval of December 12 to January 23 (with a maximum near December 20), whereas the radiant was well observed between December 9 and January 27 in the video data. Also the calculated velocity (64 km/s) is in good agreement with the Handbook (65 km/s).

Figure 9 shows the activity profile derived from the video data, which confirms the maximum occurs on December 20. The profile is less pronouned than that of other showers, and the peak ZHR of five, given in the IMO Handbook, does not seem to be reached. For comparison, the profile derived from visual data (based on the old radiant position) is given with dots. Up to a solar longitude of 275°, both profiles agree well. Thereafter there are larger discrepancies.

5 2008 summary

In 2008, 24 observers (2007: 22) from 10 countries (2007: 9) contributed to the camera network with 37 camera systems overall (2007:30). Most of the stations of the IMO network are still located along a north-south axis in Central Europe (Germany, Slovenia, Italy), but the situation is improving in other regions.

Due to the extension of the camera network, we can collect more data than ever. Thanks to the leap year, we achieved an unbeaten 366 (2007: 364) observing nights, in which almost 23 000 observing hours (2007: 17 000) were amassed. The average number of meteors per hour (4.0) decreased once more (2007: 4.4). One reason for this is that most cameras joining the network are unintensified. In addition, most major showers of 2008 were victims of the weather or the Moon. Still, we recorded more than 92 000 meteors (2007: 75 000).

For the first time, we managed to amass more than a thousand observing hours each month. In February and from August to December, more than two thousand hours were amassed monthly. The best result of all was achieved in October 2008 with 2 750 hours of effective observing time and more than 17 000 meteors observed. Table 2 gives the details for each month.

Eight observers (2007: 6) managed to get more than 200 observing nights in 2008. With 336 nights, Sirko Molau was again on top of the list, improving his own record from 2007 by 12 nights. Javor Kac, Jörg Strunk, Carl Hergenrother and Bernd Brinkmann all got about 250 nights. Note that Carl joined the network only in March. Furthermore, all peak performers beside Carl and Bernd operated more than one camera. The results for each observer are given in Table 3, whereby the number of cameras and stations refers to those cameras and stations principally responsible for the majority of data collection during the course of the year.

Let's have a look at the ten most successful video systems (Table 4). REMO1 in Ketzür and MINCAM1 in Seysdorf were again on top. They are followed by SALSA in Tucson, which will probably take the lead in 2009. The camera with the highest output (AVIS2: 9790 meteors) and 'only' 153 nights did not make it to the Top-10.

All observations of 2008 are checked for consistency and stored in the video meteor database. The data will be made available is PosDat format at `http://www.imonet.org` for free download.

At this point, we would like to thank all participants in the IMO network for the fine cooperation in 2008. We wish all of us much success in the new year.

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Table 1 – Observers contributing to December 2008 data of the IMO Video Meteor Network.

Code	Name	Place	Camera	FOV	LM	Nights	Time (h)	Meteors
BENOR	Benitez-S.	Las Palmas	TIMES5 (0.95/50)	⊘ 10°	3 mag	9	31.2	50
BRIBE	Brinkmann	Herne	HERMINE (0.8/6)	⊘ 55°	3 mag	12	106.7	543
CASFL	Castellani	Monte Baldo	BMH1 (0.8/6)	⊘ 55°	3 mag	15	140.8	403
			BMH2 (0.8/6)	⊘ 55°	3 mag	17	141.5	397
CRIST	Crivello	Valbrevenna	STG38 (0.8/3.8)	⊘ 80°	3 mag	1	11.0	33
		Genova	C3P8 (0.8/3.8)	⊘ 80°	3 mag	19	135.9	871
ELTMA	Eltri	Venezia	MET38 (0.8/3.8)	⊘ 80°	3 mag	6	45.1	164
GONRU	Goncalves	Tomar	TEMPLAR1 (0.8/6)	⊘ 55°	3 mag	18	145.3	742
			TEMPLAR2 (0.8/6)	⊘ 55°	3 mag	5	26.2	80
HERCA	Hergenrother	Tucson	SALSA (1.2/4)	⊘ 80°	3 mag	25	174.1	444
HINWO	Hinz	Brannenburg	AKM2 (0.85/25)	⊘ 32°	6 mag	13	76.6	373
JOBKL	Jobse	Oostkapelle	BETSY2 (1.2/85)	⊘ 25°	7 mag	7	86.4	978
KACJA	Kac	Kostanjevec	METKA (0.8/8)	⊘ 42°	4 mag	9	56.6	194
		Kamnik	REZIKA (0.8/6)	⊘ 55°	3 mag	5	21.1	112
			STEFKA (0.8/3.8)	⊘ 80°	3 mag	4	13.4	24
		Ljubljana	ORION1 (0.8/8)	⊘ 42°	4 mag	8	10.2	22
KOSDE	Koschny	Noord-wijkerhout	TEC1 (1.4/12)	⊘ 30°	4 mag	11	91.1	150
LUNRO	Lunsford	Chula Vista	BOCAM (1.4/50)	⊘ 60°	6 mag	12	100.8	631
MOLSI	Molau	Seysdorf	AVIS2 (1.4/50)	⊘ 60°	6 mag	8	74.4	886
			MINCAM1 (0.8/6)	⊘ 60°	3 mag	19	90.3	220
		Ketzür	REMO1 (0.8/3.8)	⊘ 80°	3 mag	20	93.1	275
			REMO2 (0.8/3.8)	⊘ 80°	3 mag	19	68.5	243
OCHPA	Ochner	Albiano	ALBIANO (1.2/4.5)	⊘ 68°	3 mag	21	134.6	305
SLAST	Slavec	Ljubljana	KAYAK1 (1.8/28)	⊘ 50°	4 mag	3	9.1	23
STOEN	Stomeo	Scorze	MIN38 (0.8/3.8)	⊘ 80°	3 mag	12	85.9	316
STORO	Stork	Ondrejov	OND1 (1.4/50)	⊘ 55°	6 mag	1	2.8	11
STRJO	Strunk	Herford	MINCAM2 (0.8/6)	⊘ 55°	3 mag	19	105.7	463
			MINCAM3 (0.8/8)	⊘ 42°	4 mag	12	69.2	372
			MINCAM5 (0.8/6)	⊘ 55°	3 mag	13	98.8	782
YRJIL	Yrjölä	Kuusankoski	FINEXCAM (0.8/6)	⊘ 55°	3 mag	4	39.0	101
					Overall	31	2 285.4	10 208

Table 2 – Monthly observing statistics for the IMO Video Meteor Network in 2008.

Month	Observing nights	Eff. observing time [h]	Meteors	Meteors / Hour
January	31	1 293.9	4 544	3.5
February	29	2 419.7	6 200	2.6
March	31	1 573.0	3 155	2.0
April	30	1 470.6	3 060	2.1
May	31	1 607.1	3 645	2.3
June	30	1 228.2	2 821	2.3
July	31	1 605.0	8 375	5.2
August	31	2 262.5	14 406	6.4
September	30	2 061.2	9 029	4.4
October	31	2 761.1	17 036	6.2
November	30	2 401.8	9 832	4.1
December	31	2 285.4	10 208	4.0
Overall	366	22 969.5	92 311	4.0

Table 3 – Individual observers' statistics for the IMO Video Meteor Network in 2008.

Observer	Country	Observing nights	Eff. observing time [h]	Meteors	Meteors / hour	Cameras (stations)
Sirko Molau	Germany	336	4 108.5	20 884	5.1	4 (2)
Javor Kac	Slovenia	262	2 863.1	10 092	3.5	3 (3)
Jörg Strunk	Germany	248	1 840.6	7 133	3.9	4 (2)
Carl Hergenrother	USA	247	1 905.1	4 143	2.2	1 (1)
Bernd Brinkmann	Germany	242	1 003.9	3 623	3.6	1 (1)
Flavio Castellani	Italy	229	1 868.1	4 713	2.5	2 (1)
Rui Goncalves	Portugal	204	1 462.8	6 659	4.6	1 (1)
Robert Lunsford	USA	204	1 391.8	8 899	6.4	1 (1)
Wolfgang Hinz	Germany	172	1 043.8	3 951	3.8	1 (1)
Stane Slavec	Slovenia	145	639.9	1 284	2.0	1 (1)
Enrico Stomeo	Italy	142	922.0	3 038	3.3	1 (1)
Ilkka Yrjölä	Finland	131	690.5	2 005	2.9	1 (1)
David Przewozny	Germany	125	728.1	2 879	4.0	1 (1)
Stefano Crivello	Italy	87	594.4	3 220	5.4	1 (1)
Detlef Koschny	Netherlands	71	399.6	699	1.7	1 (1)
Mihaela Triglav	Slovenia	55	216.4	495	2.3	1 (1)
Biondani Roberto	Italy	54	244.2	497	2.0	1 (1)
Orlando Benitez-Sanchez	Spain	51	199.5	443	2.2	1 (1)
Maurizio Eltri	Italy	41	297.7	1 604	5.4	1 (1)
Paolo Ochner	Italy	37	254.0	768	3.0	1 (1)
Milos Weber	Czech Rep.	23	43.6	950	21.8	1 (1)
Rosta Stork	Czech Rep.	17	124.2	3 221	25.9	2 (2)
Klaas Jobse	Netherlands	7	86.4	978	11.3	1 (1)
Stephen Evans	UK	7	41.3	133	3.2	1 (1)

Table 4 – Top-10 video systems in the IMO Video Meteor Network in 2008.

Camera	Observing Site	Observer	Observing nights	Eff. observing time [h]	Meteors	Meteors / hour
REMO1	Ketzür (D)	Sirko Molau	271	1 251.2	4 327	3.5
MINCAM1	Seysdorf (D)	Sirko Molau	253	1 119.1	3 279	2.9
SALSA	Tucson (US)	Carl Hergenrother	247	1 905.1	4 143	2.2
HERMINE	Herne (D)	Bernd Brinkmann	242	1 003.9	3 623	3.6
MINCAM2	Herford (D)	Jörg Strunk	231	679.8	2 170	3.2
ORION1	Ljubljana (SL)	Javor Kac	220	983.0	2 539	2.6
REMO2	Ketzür (D)	Sirko Molau	209	875.4	3 488	4.0
BOCAM	Chula Vista (US)	Bob Lunsford	204	1 391.8	8 899	6.4
TEMPLAR1	Tomar (PT)	Rui Goncalves	204	1 462.8	6 659	4.6
METKA	Kostanjevec (SL)	Javor Kac	171	1 138.1	3 094	2.7

History

Meteor Beliefs Project: More Belarussian meteor folklore

Tsimafei Avilin[1]

Some additional material collected since the author's first article on Belarussian meteor beliefs in 2006 is presented.

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1 Introduction

As mentioned in the author's first Meteor Beliefs Project article on Belarussian meteor and meteorite folklore (Avilin, 2006), it was hoped that future work and field researches would bring to light more such material. This present article provides some of the findings made since, including through the author's own fieldwork in 2006 (where no other reference source or researcher is indicated). All translations into English are by the author, and all material is from Belarus where not stated. As noted previously, but to avoid repetition below, the creatures called *zmey* or *tsmok* are fiery, often serpentine, draconic creatures in Belarussian folk-belief. They are commonly linked with meteors, and often the being itself is thought to be the meteor, frequently a fireball-class one.

2 Meteors

A falling star might be related to either good or bad events, as was noted previously. "The fall of a star was related to something good, something divine," according to the people of Sjanno town (Orsha ditrict, Vitebsk region), "When a star fell, it was said that a man died, or evil forces came to the ground, therefore one should cross oneself" (L. N. Hamich in Navasady village, Barysau district, Minsk region, collected by G. V. Vasileuskaja), or "If a star falls behind the house then it will bring something bad on the homestead" (G. P. Krauchanka in Studzenaja Guta village, Gomel district, Gomel region collected by G. P. Sharenda). Also, a falling star might denote the fact that a *bajstruk* (bastard child) had been born (EPA, 2007).

As in the case of other Slavonic and Baltic peoples (for example, see Avilin, 2007), in Belarus too you should make a wish at the sight of a falling star. "A star falls; it is necessary to make your wish" (A. I. Radkevich in Brodauka village, Barysau district, Minsk region, collected by T. I. Hatskevich), or "A star falls – make your wish. Because when a star falls the soul of observer 'opens'. This gives the cause for making a wish" (collected by N. E. Belevich from Kossovo town, Ivatsevichy district, Brest region). The speed of the meteor was a very important element/indicator too. "A star falls; make your wish. It was said that it will undoubtedly come true. If the star falls fast, the wish will come true more quickly" (an Azjaryshcha villager, Vitebsk district, Vitebsk region, collected by M. Zhukava). It is possible the wish-making related to the belief about a descending angel (comparable also to the Russian belief – on both, see Avilin, 2006), or to a wish made of one's own house-spirit. For example, "Formerly my mother told me: 'To whoever associates [i.e. makes friends] with the *zmey*, it will bring grain'. It looked like a piece of oblong fire." (V. E. Galubovich in Dukorshchyna village, Cherven district, Minsk region); or, "Somebody found gold where the star had fallen. This is gold brought by the *tsmok*" (A. F. Seljava in Jalga village, Cherven district, Minsk region).

The random nature of meteor phenomena and their unpredictable appearances provided the peasants with an apparently similarly random comparison for the occurrence of good or bad fortune, including 'predicting' uncertain future events like births and deaths. This is regardless of any more mythological beliefs they may have been aware of (e.g. as passed on from Classical European literary sources). A similar psychology can be invoked to explain the interest shown in other 'omens', like a black cat crossing one's path, the appearance of a whirlwind, etc.

Some additional notes about such meteoric folk-predictions:

- "If the star flies and scatters [i.e. if it fragments] – it is for a big murder, but if [it flies] simply – the man just died" (M. M. Nikalaenka in Zalesse sovkhoz, Bragin district, Gomel region);
- "If three stars fall [at once] – there is somewhere a murder, but it is a rare event" (ibid.);
- "[If it is a] suicide – the star flies here and there" (ibid.) [perhaps meaning the meteor's fall was in some way unusual];
- "If the star falls calm and quiet – the good-souled man died, but if it flies and twinkles – a sorcerer or a wizard [died]" (ibid.);
- "If many stars fall – it is a murder or some kind of accident" (ibid.);
- "If the star falls – it'll be death" (a Dzjamjanauka villager in Puhavichy district, Minsk region);
- "Where the star flew, there the man was born" (A. F. Seljava in Jalga village, Cherven district, Minsk region);

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NASA-ADS bibcode 2009JIMO...37...48A

- "If the bright star flies, a man of good soul died" (ibid.).

Some meteor beliefs are related to sorcery or its cure. "If a man has a wart or some kind of sore on his hand, then when a star falls he should shake his hand, as though to shake off the wart. Then the wart will disappear after a while." (a Lisicy villager, Cherven district, Minsk region), or, "One baba [an old woman] lived in our village, who might turn into a fire-zmey. The fire-zmey flies in the air in the form of fire, like a long arc" (F. M. Nikalaenka in Zalesse sovkhoz, Bragin district, Gomel region). It is also well-known that people sometimes identify the *zmey* as a house-spirit and they tell that a falling star is a flying *zmey* which passes down the chimney into the house (EPA, 2007): "A house-spirit brings riches down the chimney to its owner: if red then it brings gold, if white (literally 'light') it brings silver; sorcerers fly and make harm" (N. S. Kutseka in Studzenaja Guta village, Gomel district, Gomel region collected by G. P. Sharenda).

A star's fall is also related to a man's death by Belarussian popular belief. "The star fell – a man died. His soul flies to Paradise or to Hell" (a Dzjamjanauka villager, Puhavichy district, Minsk region); "If the star flies – somebody died" (related by villagers at Chornaruchcha, Vilejka district and Gaponava, Lagojsk district, both in Minsk region); "The soul flew to the sky when the star falls" (a Talka villager, Puhavichy district, Minsk region); "The falling star is a sinner's soul, who went to Hell from the gate of Paradise" (from Verhnedvinsk city, Verhnedvinsk district, Vitebsk region, collected by A. Kisyalevich); "A star's fall is a bad sign. Somebody can die" (from Kossovo town, Ivatsevichy district, Brest region, collected by N. E. Belevich).

Moreover, relations between meteors, plants and cloth-patterns can be found in Belarussian folklore. One example is the *bezvershnik* (literally "without tops") plant, *Veronica chamaedrys*. It is so-called because it is believed a flying *zmey* ate away the tops of the plant. This plant is used as a medicine for shock, and young women may wash their faces with a decoction of *bezvershnik* to prevent evil spirits visiting them (EPA, 2007). It is said too that a star falling down on a fern on Midsummer's Night makes the fern begin to shine (ibid.). Another belief is that if a star falls down onto some embroidery, it turns into a flower (as part of the pattern in the embroidery). This floral symbol is also called *Paraskeva-Pjatnitsa* (St. Parasceva). If a young woman embroiders it, she will marry in the near future (L. I. Saljanka in Stolbtsy town, Stolbtsy district, Minsk region collected by L. Adamovich).

3 Meteor showers

"People thought that the Lord threw arrows at them for their sins, when they saw many stars fall. Therefore they prayed and didn't go out of their houses" (G. S. Lifanava in Zembin village, Barysau district, Minsk region, collected by N. Ja. Ermakova). The maxima of some stronger meteor showers may foretell a war: "Like [somebody] sows [or shakes] a sieve [so the stars fall] at the time of war" (M. M. Nikalaenka in Zalesse sovkhoz, Bragin district, Gomel region). Using the image of a sieve here is very interesting. Both the sowing process and falling flour are used as similes to describe a strong meteor shower, and moreover, the image of the sieve played a very important role in archaic Slavonic and Baltic beliefs, where it was closely tied to the image of the sky, and it widely represents the sky in oral and literary astral code. When there is a starry sky Belarussians say, "the sieve covered all the sky" (either meaning the stars in the sky are compared to holes in the sieve, or perhaps it reflects the scatter of flour onto a surface, likened to the scattered stars). It was believed too that the starry sieve (most likely the Pleiades, which were known by a number of names, including Sito, the Sieve, as also the Coma Berenices star cluster was known sometimes) was at the topmost crown of the World Tree.

4 Meteorites

A meteorite fall was neither a unique nor an inexplicable event for the Belarussians. Quite the contrary, it had a certain mythological basis, particularly concerning its connection with the *zmey*, and it was just a part of Belarussian life. "When the stone fell, people thought this place [where the stone had fallen] to be fruitful, and connected it with evil" (L. N. Hamich in Navasady village, Barysau district, Minsk region, collected by G. V. Vasileuskaja), or, "If the star fall on a house, it will burn. And old people told that it actually was so" (F. D. Klimchuk in Simanavichy village, Dragichyn district, Brest region).

As noted previously (Avilin, 2006), supposedly sky-fallen arrows, mostly made of stone, may include prehistoric stone weapons (not just arrow-heads), fulgurites or even meteorites in Belarus, as elsewhere. "Formerly my grandfather showed me a stone arrow, and said that it had fallen from the sky" (V. I. Burak in Dukorshchyna village, Cherven district, Minsk region). However, most such stone arrows were more commonly related to lightning or pjarun (thunder) instead. "[If lightning flashes] – it flies as an arrow like a bar, and it flies with such strong force that it even may kill a man. Old people said: 'Pjarun shoots stone arrows, these are weapons.' Pjarun killed many people – making a hole [in the man]. It is obligatory for there to be a hole somewhere in the head [in such a case]" (V. E. Galubovich in Dukorshchyna village, Cherven district, Minsk region). An analogous belief about hail (or possibly a shower of small meteorites?) seems to be found in another variant: "If it rained small stones – [it was because] the Lord became angry. And if the Lord was kind, he threw sweets" (T. Ja. Guretskaya in Smilavichy town, Cherven district, Minsk region).

5 Conclusion

It has been interesting to find that so much information about meteor folklore has survived through the 20th and 19th centuries at least (and most likely from long before) by oral traditions alone in Belarus, to be collected now in the early 21st century. It is hoped more such material may yet come to light for preservation for the future, and shows the importance of trying to do so even today.

6 Acknowledgements

The author would like to express gratitude to A. P. Samohina (a local historian in Novy Sverzhan village, Stolbtsy district, Minsk region), P. Sharenda (Gomel Regional U. I. Lenin Library, local history department), M. N. Tolstaja and A. A. Plotnikava (Institute for Slavic Studies RAS) for providing material (Plotnikova, 2006), and the Electronic Polessia Archive (EPA).

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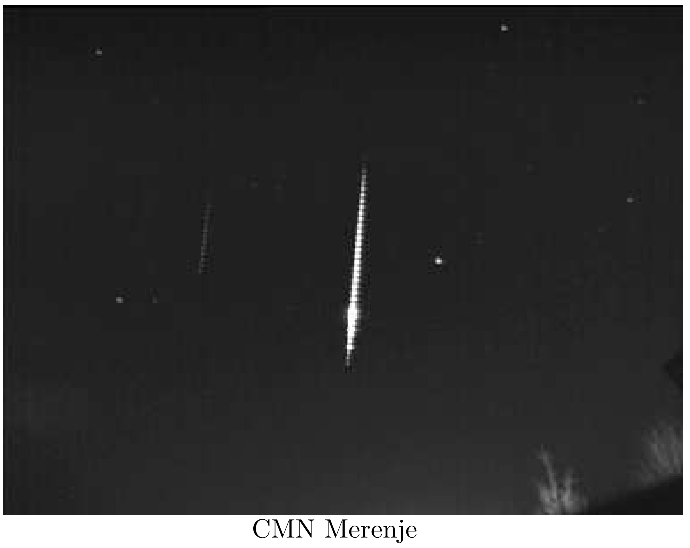
Video Ursids

CMN Rijeka_B

CMN Rijeka_A

CMN Šibenik



CMN Merenje

This Ursid fireball with a burst was recorded by many stations of Croatian Meteor Network (CMN) on 2008 December 22 at $03^{\rm h}10^{\rm m}17^{\rm s}$ UT.

Rezika (Kamnik, Slovenia)

Metka (Kostanjevec, Slovenia)

A magnitude −4 Ursid fireball was captured by two cameras operated by Javor Kac on 2008 December 22 at $01^{\rm h}06^{\rm m}34^{\rm s}$ UT.