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Conference reports
η-Hydrids discovered
2008 SPA Meteor Section results
Persistent train used to determine wind speed
June–July video meteors

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Front cover photo

A Northern Taurid fireball over the Lake of Thun (Switzerland), photographed on 2012 November 17 at $20^{\mathrm{h}}51^{\mathrm{m}}$ UT using Canon 7D equipped with Canon EF 8–15 mm 1:4L Fisheye USM lens at $f = 10$ mm and $f/d = 4.0$, with a 30 s exposure at ISO 1600. Photo courtesy: Jonas Schenker.

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

Cover design Rainer Arlt

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Editorial

Javor Kac

This issue reaches you with significant delay for which I sincerely apologize. In it you will find conference reports from the International Meteor Conference and Meteoroids conference, both held in the same Polish city of Poznan, presenting personal reflections of delegates that took part in them.

Availability of the IMC 2012 Proceedings is announced and abstracts are provided for all papers contained in this two-volume publication. The Proceedings can be ordered from the IMO (see inside back cover for details).

This issue also contains a number of interesting papers. The Croatian Meteor Network present their study on a possible new meteor shower, the η-Hydrids. This shower is concurrent with the previously known σ-Hydrids but has different orbital elements. Another paper by Bill Ward deals with single-station determination of high-altitude wind speed by means of persistent train observations. This paper may stimulate others to do similar analyses using a more complete data set, such as double-station photographs. Incidentally, the same author's letter reports on the unusual spectrum of a Perseid meteor captured by a video camera. Readers may want to follow up with Bill to share ideas or present similar spectra. A somewhat delayed SPA Meteor Section results for 2008 are presented, as well the June and July results of the IMO Video Meteor Network.

I hope you will enjoy reading this issue.

IMO bibcode WGN-415-editorial NASA-ADS bibcode 2013JIMO...41..139K

From the Treasurer — IMO Membership/WGN Subscription Renewal for 2014

Marc Gyssens

We invite all our members/subscribers to renew for 2014. The fees are as tabulated below. We are happy that we can offer WGN at the same cost as last year. We also continue to offer an electronic-only subscription at a reduced rate.

IMO Membership/WGN Subscription 2014				
Electronic + paper with surface mail delivery:		€26		US$ 39
Electronic + paper with airmail delivery (outside Europe only):		€49		US$ 69
Electronic only:		€21		US$ 29
Supporting membership:	add	€26	add	US$ 39

It is possible to renew for two years by paying double the amount.

General payment instructions can be found on the IMO's website, at `http://www.imo.net/payment`. Members and subscribers who have not yet renewed will find enclosed a leaflet where these payment instructions are further detailed. Please follow these instructions! Choosing the most appropriate payment method results in low or even no additional costs for you as well as the IMO. The IMO strives to keeping these costs low in order to control the price of the journal!

When you renew, give a few minutes of thought to becoming a **supporting member**. As you may know, there is an IMO Support Fund. With this Support Fund, we support meteor-related projects. Our ability to provide this service to the meteor community depends primarily on the gifts we receive from supporting members!

Another way to help meteor workers with limited funds is to offer them a gift subscription.

We already thank all our members that will renew for their continued trust in our Organization!

One final request: every year, a lot of members renew late. As a consequence, back issues that already appeared have to be sent out to these members. Please support our volunteers in their bimonthly effort to have WGN shipped to you by renewing promptly! Thank you for your understanding and cooperation!

IMO bibcode WGN-415-gyssens-renewals NASA-ADS bibcode 2013JIMO...41..139G

Letter — Preliminary examination of an unusual spectrum from a Perseid fireball

Bill Ward [1]

1 Introduction

During the peak of the Perseid meteor shower a very bright fireball occurred at $00^{\rm h}38^{\rm m}56^{\rm s}$ UT on the morning of 2013 August 13. The fireball spectrum was captured using a Watec 902H2 Ultimate video camera with a Pentax 12 mm $f/1.2$ lens. The lens was fitted with a 300 lines per mm grating directly in front of the objective. The video composite of the fireball spectrum is shown in Figure 1. The spectrum covers the first order (from $\sim$ 400 nm to $\sim$ 850 nm) at the left of the frame whilst the remainder is filled with the second order spectrum and the start of the third order at the extreme right. Unfortunately the fireball (zero order) itself was not captured, this ran just outside the frame to the left.

Figure 1 – Video composite of Perseid fireball spectrum.

2 Inspecting the spectrum

Whilst stepping through the de-interlaced frames, ostensibly to examine the terminal flare, it was found that the spectrum had an unusual characteristic! A single full video frame of spectrum is shown in Figure 2. In the montage of spectrum frames (Figure 3) each frame represents 1/25 of a second. It can be clearly seen that in spectrum 3 and spectrum 4 the terminal flare has split into two distinct spectra.

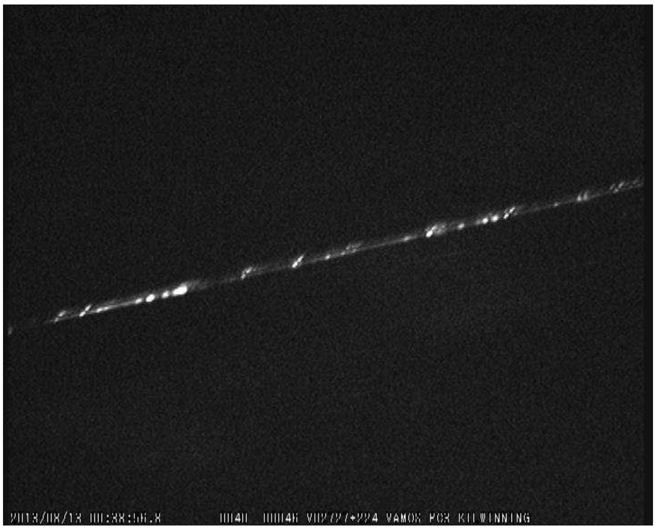

Figure 2 – Individual de-interlaced video frame showing dual spectrum.

Due to geometric distortion and low resolution precision measurement of the spectrum lines is near impossible. As the zero order image is not directly available another spectrum recorded on the night was used to provide a scale of resolution that was mapped to this spectrum. This is not ideal as the relative displacement of the zero order image with respect to the grating axis increases the error of measurement. The measurement error is also compounded by the geometric distortion present in the lens optics. However based on the mapped resolution and by fitting to assumed prominent lines the other fainter lines were "filled in".

Using a resolution scale of 1.2485 nm/pixel in the second order the lines across the centre of the central section were measured. As wavelength references, the sodium doublet and the magnesium triplet both unresolved at this scale were averaged and taken to be 589.29 nm and 517.45 nm respectively. As an additional check the prominent oxygen line at 777 nm was also used. This gave a general measurement accuracy of approximately ± 0.7 nm.

The bright lines are shown in Figure 4. These are A: Fe 511 nm, B: Mg 517.45 nm, C: Fe 523.3 nm, Na 589.29 nm, D: Si 635.9 nm, E: H 656.3 nm, F not positively identified, G: Fe 667.8 nm (?).

It is clearly seen in Figure 4 that the upper and lower spectra are quite different both in terms of the metal lines and in the atmospheric lines. The corresponding lines seen in both spectra are marked with a raised superscript.

This effect could be a consequence of fragmentation and the variation of composition within the grain being expressed. Or perhaps it is showing a rapid variation in temperature leading to changes in ionisation of the various constituents.Why the bright atmospheric lines and a bright silicon line appear in the lower line without being present in the upper spectrum is unclear. Whilst the iron lines A and C do not appear in the lower line but the iron line at G does. Possibly the line at G could be a misidentification. However

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there are several Fe lines listed in the tables given in the utility (kindly suggested by Regina Rudawska) here; `http://physics.nist.gov/PhysRefData/ASD/lines_form.html`.

This particular difficulty demonstrates the limitations of the measurement at low resolution when there are several closely spaced lines.

It is also appears that in line 4 the two spectra are continuing to separate. There were several more video frames but these had become very faint with no real detail. However it could be seen that the upper line was essentially a stationary afterglow and the lower line was carried forward by some additional momentum, possibly a "explosion" or shock wave of some type but the lower, advancing line, then dissipates completely before the upper line.

In several years of trying to capture meteor spectra this one is unique in my observation. Although the interval between the frames is short the images demonstrate the speed of the changes in the meteor.

I would like to hear from any other (video) spectroscopy observer who has observed such a phenomena before.

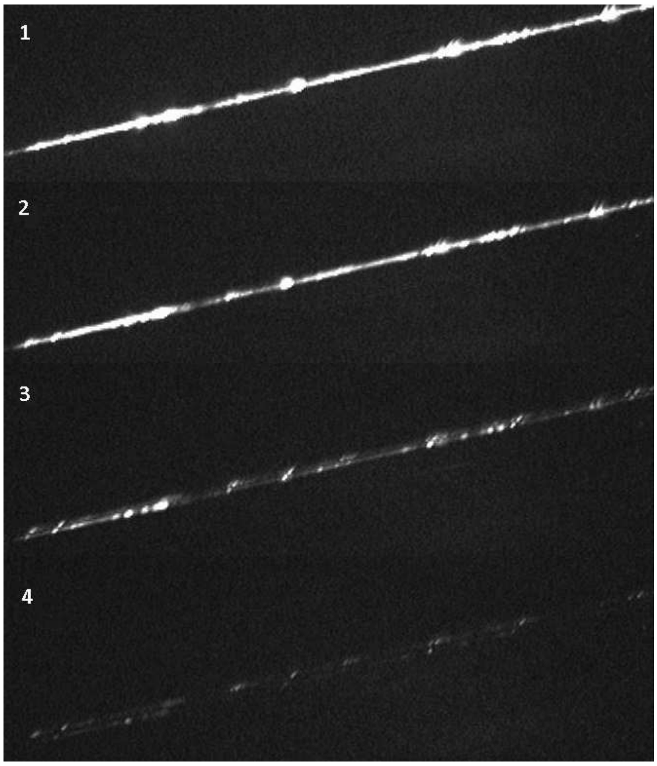

Figure 3 – Sequence of de-interlaced video frames showing evolution of spectrum.

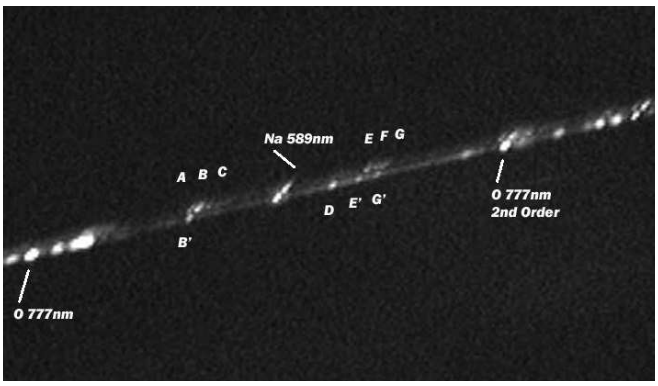

Figure 4 – Enlarged section of Figure 2 with annotations showing assumed lines used for measurements and other line identifiers described in the letter.

Conferences

International Meteor Conference 2013 report

Jure Atanackov [1]

Received 2013 November 16

International Meteor Conference in Poznan, Poland. The conference beckoned, it was time to return. After a very long time. Organized by PKiM you just knew it was going to be great. I have to admit it felt strange at registration, looking at people, faces – somewhat egocentrically – will someone remember me? Anyone unlucky enough to have met me quite some time ago. I felt a bit out of place, but excited.

Feeling out of place? No problem. The welcome drink and the first round of informal socializing took care of that. Then came the programme. The three days long programme served a succession of spectacular presentations on the topics of meteor networks, radio and radar observations and meteor streams, structure and evolution, fireballs, meteor physics and phenomena and last, but most definitely not least meteorites, impacts and parent bodies. Great programme, exciting topics, impressive and very enjoyable presentations. The video work on CAMS systems, various European video networks, the Canadian Star Trek setup are raising meteor work on such a level that I, as a visual observer that has been out of the loop for several years, felt more or less like a dinosaur. One of the highlights for me was also Jeremie Vaubaillon's presentation of the possible upcoming meteor outburst caused by periodic comet 209P/LINEAR on May 24 next year (why, oh why does the parent comet apparently have to be some faint little inactive cometary crumb?). Also the presentation of AMS' new mobile app-based fireball data gathering system by Mike Hankey and Vincent Perlerin was very impressive, taking fireball data gathering from the general public to a whole new level. The various presentations about the Chelyabinsk superbolide were also very interesting, from the released energy estimates to damage surveys, trajectory determinations and meteorite recovery. And Geert Barentsen proved conclusively it is OK to use 'WTF' in presentations on conferences.

The excursion to the Morasko Meteorite Nature Reserve where the Morasko crater field and meteorite strewnfield are located was definitely one of the highlights of the conference. Being a geologist (dealing mostly with Quaternary and Holocene) and meteor enthusiast, it was the perfect blend for me. The presentation at the Institute of Geology gave great insight into the rich history of research of this geological peculiarity. Being only 5000 years old, essentially having formed in historic times, the Morasko crater field is an outstanding reminder of the importance of research work on small bodies of the Solar system.

Figure 1 – The author discussing with Sirko Molau. Credit: Swan Astronomical Society.

Figure 2 – The Slovenian team joined by Ana Žegarac from Serbia pose with the largest of the Morasko meteorites. Credit: Swan Astronomical Society.

The celebrity 262-kg meteorite, the largest of the meteorites recovered from the strewn field so far, garnered so much attention it would put Justin Bieber and Miley Cyrus to shame! The field excursion to the three largest craters, seeing their size and morphology was an interesting and educational departure from the geomorphological types and features I encounter in my work.

The social programme was... well, great! It was great to mix with meteor astronomers and enthusiasts

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Figure 3 – The IMC 2013 group photo at the Institute of Geology lecture hall. Credit: Swan Astronomical Society.

from many different countries, sharing meteor stories. Playing the guitar with Mike Hankey, Jeremie Vaubaillon, Detlef Koschny, Lovro Pavletić and singing with everyone. And 'dancing' Gangam style with the new president of IMO candidate! And discussing (in depth) the local phenomenon known as Miś Pushupek with members of PKIM! It was also quite difficult not to develop a liking for certain kinds of Polish beer!

Things have certainly changed a lot since my last IMC, no less than 12 years ago. The times of Leonid meteor storms are now far past (just to imagine them happening now with all the new equipment and methods...), the entire field of meteor astronomy has changed tremendously. Perhaps in a way meteor astronomy has lost some of its romantic side, with grand and historic Leonid storms and outbursts, but gained in fields where precise video data is essential, such as meteor stream and outburst detection. It was great to see faces I had not seen in a very, very long time and meet new people, whom I knew only by their work or reputation. In all this a certain time paradox stood out – what happened to Sirko, as he looked younger than I remember him 12 years ago (The Curious case of Sirko Molau?)! A big thank you goes to the local organizing committee – Mirosław Krasnowski, Przemysław Żołądek, Mariusz Wiśniewski, Karol Fietkiewicz, Andrzej Skoczewski and Maciej Maciejewski – for preparing an excellent IMC. It was great to be there!

Report on Meteoroids 2013, Poznan, Poland

Paul and Adriana Roggemans [1]

Received 2013 October 5

1 Introduction

When the decision was taken by the IAU Commission 22 to organize Meteoroids 2013 in Poland, the location of the 2013 IMC was chosen to have both meteor conferences connected. Meteor astronomy has been traditionally hosted by colloquia and symposia dedicated to small particles and minor bodies. As ongoing research expanded in number of projects, the common conferences for all related small body topics encountered logistic problems to accommodate the large number of people and topics involved. A first proper conference dedicated to meteor astronomy took place in July 1992 at Smolenice, Slovakia, at the occasion of the 65th birthday of Dr. Lubor Kresak. Several meteor researchers as well as the newly formed International Meteor Organization saw in this conference an opportunity to improve amateur-professional cooperation. The 1992 IMC took place in the same conference facility of the Slovak Academy of Sciences, just before Meteoroids 1992. It proved to be a success formula with a significant participation of professionals at the IMC and of amateurs at Meteoroids. The combination of the two conferences made long distance traveling worthwhile for people coming from other continents. In the early years of the IMO the large attendance by professionals and people from Australia, Canada and Japan was a milestone for the young organization.

The 1992 success inspired for another combination of an IMC with Meteoroids in August 1998 where the IMC started at the end of Meteoroids at Stara Lesna, Slovakia. Overlapping both meetings proved to be less effective. The third combined IMC–Meteoroids took place in June 2007 with the IMC in Barèges, France and Meteoroids in Barcelona, Spain. These three previous experiences lead to the conclusion to have the IMC just before Meteoroids and in the same city.

Meanwhile the IMO celebrated its 25th anniversary in Poznan and the amateur meteor scene has changed significantly since 1992. In recent years many professional meteor researchers attended the IMC as annual meeting. The connection with Meteoroids made it mainly more efficient to optimize traveling costs and efforts. The 2013 IMC aspects are described in a separate report. In this report we focus on Meteoroids from the point of view of amateurs.

While the IMC was hosted with full board at the IOR Hotel just outside the city center, Meteoroids took place in the very nice buildings of the University of Poznan in the center of the city. We walked a bit around on Sunday afternoon trying to locate the registration office between the road construction works of Poznan, just like we wandered around between construction works to reach the IMC host a few days before. More than 40 IMC participants stayed to attend Meteoroids, a far higher number than at the previous combined meetings. In total the IMC got about 20% more registrations than Meteoroids while the latter had a significantly larger number of lectures and posters.

2 The 2013 Meteoroids conference

Monday morning the session opened with Dr Ian Williams as chairman, and seen the significance of the Chelyabinsk event, the first session was dedicated to this superbolide with quite a bit overlap of what we heard at the IMC. A most noted presentation was the study of Peter Brown on the energy estimates of the bolide.

Although a break of 90 minutes was available for lunch, going to some restaurant and waiting to get served made us miss the start of the afternoon session. Peter Jenniskens gave an overview of recent meteorite falls and it was at least for some of us a surprise to hear how frequent documented meteorite droppings occurred in recent years. Another remarkable lecture concerned a meteorite dropping Geminid that was recorded on 2012 December 13 at $04^{h}12^{m}59^{s}$ UT. Although field searches near the German town Gröbenstädt were unsuccessful, it is very likely that a small piece of Phaethon landed as a meteorite on the Earth surface and the case definitely proves that Geminids are likely to generate meteorite dropping fireballs. Whenever a Geminid meteorite can be collected from the ground it will be a most valuable find for scientific analyses saving huge costs of a space mission. Why to go to Phaethon if Phaethon comes to us?

After the coffee break Hutch Kinsman presented a interesting lecture about meteor showers in ancient Maya codices, an historic source of past meteor appearances that was unknown to many of us. One of the highlights of the day and also the Meteoroids conference was the presentation by Sirko Molau about the status and history of the IMO Video Meteor Database. This lecture did not only represent a fabulous effort, but also produced very conclusive results with a lot of consequences for the IAU Meteor Shower list. It should be said that the dedicated efforts made by Sirko and all amateurs involved impressed people and generated a lot of interest from the professional community.

The first day ended with a welcome party where plenty of food and drinks were served while socializing. For IMC participants it feels a bit uncomfortable to see everybody disappear into nowhere after such conference day. Although we sporadically met some other participants here and there in town while going for a drink with a few fellows. This is a big contrast with the enthusiasm of the majority of the IMC people to socialize in the evening. When a conference is rather a profes-

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Figure 1 – The Meteoroids 2013 group photo. Credit: Paweł Kankiewicz.

sional duty, people tend to disappear into the privacy of their hotel room as like the conference just fits in a 9-to-5 office job.

The second day of Meteoroids had a lot of rather technical research papers of the kind that we will not easily hear at an IMC, most of the speakers were unknown names in the amateur community. The highlights of the day came in the late afternoon with presentations about meteor spectra projects by Josep Trigo and Pete Gural. The Wednesday morning session was particularly worthwhile with several interesting talks about Meteoroid stream modeling and parent bodies while the afternoon session was of a rather very technical nature about dust dynamics. Although both the IMC and Meteoroids enjoyed excellent dry summer weather all the time, the law of Murphy applied to the late afternoon excursions. Those who went to the Morasko craters and Geological Museum escaped rain, but for those who chose the visit of the old town city, including most IMC participants that already were at Morasko, their sightseeing ended in an improvised visit to a church where we all escaped in a miraculous way from a very intense rain shower.

Thursday was dedicated to Meteoroid streams, observation techniques, data reductions and methods with several interesting presentations, again with a very big overlap with what we heard at the IMC. Friday, the last conference day, listed another series of most interesting topics, many of which were also covered at the IMC, but with a bit more technical details in the presentations than what we heard at the IMC.

3 Conclusions

Saturated with presentations we left Poznan Friday afternoon to Potsdam to visit and stay with some IMO friends. Sharing the same interests, both amateurs and professionals have major interests in cooperation. While amateurs with a full time job in a completely different domain find their motivation in a passion to understand more about meteor science, many professional researchers live their job in the first place to earn a living which could have been a different domain if they hadn't by chance be hired for meteor research. For this reason the atmosphere at both conferences cannot be compared. For some professional participants Meteoroids is part of their 9-5 job while amateurs use some of their precious holidays to attend and pay all expenses themself. This difference can be noticed from the rather poor socializing aspects at most professional conferences. Contrary to an IMC, a professional conference like Meteoroids offers only the conference at a fee that exceeds the IMC fee which is for full board. With the hotel and meals that have to be reserved and paid separately, a professional conference is a rather expensive event for amateurs. We were surprised to see many announced posters missing and some lectures and some posters made us wonder if and how the SOC screened contributions. As amateurs we became much aware about quality control of our own work and then it is rather surprising to see the flexibility at a professional conference. Another observation is that I missed almost all senior meteor researchers that used to be present at professional meetings in the 1980s and 1990s. Some have died, most are retired and a complete new generation now continues meteor research.

At Meteoroids we spoke with several people who did not know much about IMO and its IMC. We hope that we can welcome the professional astronomers who share that same passion to join us at the IMC to meet amateurs and colleague professionals on annual bases.

Plans were made to have the next Meteoroids conference in June 2016 at ESTEC in the Netherlands which may be connected to the 35th IMC at the occasion of the 70th anniversary of the Dutch Meteor Section. We'll keep you informed on these future plans.

4 Acknowledgement

We wish to thank the organizing committee of Meteoroids 2013 for their work in organizing this conference as a very successful event and for their flexibility and efforts to favour the participation of amateur astronomers.

Details of the Proceedings of the International Meteor Conference, La Palma, Canary Islands, Spain, 20–23 September 2012

Marc Gyssens and Paul Roggemans

The IMC 2012 was organized on the Canary Island of La Palma. It was attended by many active meteor workers from around the world. As last year, the IMC 2012 Proceedings were available before the start of the IMC 2013. They contain so many contributions that the content had to be divided over two volumes. Following are the abstracts of all the contributions.

Those who attended the Conference either received the Proceedings at the IMC 2013 in Poznań. People not present in Poznań should have received their copy a while ago by post, everybody also got a mail with the URL's and access code to download a PDF copy. Others can order the Proceedings from the International Meteor Organization: details are in the lower half of the inside back cover of this Journal and on the IMO website: `http://www.imo.net/imo/publications`.

Meteor shower flux densities and the zenith exponent

Sirko Molau and Geert Barentsen

The MetRec software was recently extended to measure the limiting magnitude in real-time, and to determine meteoroid stream flux densities. This paper gives a short overview of the applied algorithms. We introduce the MetRec Flux Viewer, a web tool to visualize activity profiles on-line. Starting from the Lyrids 2011, high-quality flux density profiles were derived from IMO Video Network observations for every major meteor shower. They are often in good agreement with visual data. Analyzing the 2011 Perseids, we found systematic daily variations in the flux density profile, which can be attributed to a zenith exponent $\gamma > 1.0$. We analyzed a number of meteor showers in detail and found zenith exponent variations from shower to shower in the range between 1.55 and 2.0. The average value over all analyzed showers is $\gamma = 1.75$. In order to determine the zenith exponent precisely, the observations must cover a large altitude range (at least 45°).

All-Sky Meteor Orbit System (AMOS)

Pavol Zigo, Juraj Tóth, and Dušan Kalmančok

In this paper, we present a new development of the Slovak Video Meteor Network. The All-Sky Meteor Orbit System (AMOS) is described from a technical point of view. The system can be used as a portable one on expeditions or as a remotely operated camera installed at a fixed location.

Database of meteor orbits from several European video networks

Leonard Kornoš, Jakub Koukal, Roman Piffl, and Juraj Tóth

EDMOND (European viDeo MeteOr Network Database) is a database of orbits based upon, and computed using, the video data of observed meteors. It is a result of cooperation and data sharing among seven national networks. This is the first version containing processed data from individual stations for the years 2009, 2010, 2011, and the first half of 2012 (until June 30, 2012). A total of 59 stations contributed 267 850 single-station meteors to this database up to date. However, these numbers are not yet final, as data from several stations are still being processed. Combined observations yielded 25 255 reliable orbits, which are published in the first version of the EDMOND database.

Calculating video meteor positions in a narrow-angle field with AIP4Win software–Comparison with the positions obtained by SPOSH cameras in a wide-angle field

Vagelis Tsamis, Anastasios Margonis, and Apostolos Christou

We present an alternative way to calculate the positions of meteors captured in a narrow video field with a Watec camera and a 28 mm aspherical lens (FOV 11°) by using Astronomical Image Processing for Windows, V2, a classic astrometry and photometry software. We have calculated positions for two Perseid meteors in Lyra which were recorded in August 2010, at Mt. Parnon, Greece. We then compare our astrometry position results with the results obtained by SPOSH cameras (FOV 120°) for the same meteors.

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Possible new meteor shower detected from CMN and SonotaCo data

Denis Vida, Filip Novoselnik, Željko Andreić, Damir Šegon, Korado Korlević, Filip Matijević, Džan Jašarević, Anton Perkov, and Ciobanu Tudor

The Croatian Meteor Network was started in 2007, and, since then, 19 055 orbits were obtained. A new meteor shower was detected using CMN and SonotaCo data. Basic orbital and activity data of this shower are described and discussed.

Digital all-sky cameras VII: Putting the camera into operation

Felix Bettonvil

This seventh paper about the development of a digital all-sky camera, built around a Canon EOS 350D, Sigma 4.5 mm $f/2.8$ EX DC fisheye lens and liquid crystal optical chopper, describes the constructed system and the first half year of operation.

The established meteor showers as seen in video meteoroid orbit surveys

Peter Jenniskens, Peter S. Gural, and David Holman

The International Astronomical Union has recognized 95 meteor showers as established. Some of those showers are incidental meteor outbursts, but many are annual meteor showers that show up nicely in the recent meteoroid orbit surveys using multi-station low-light video cameras. Here, we present first year results of our Cameras for Allsky Meteor Surveillance (CAMS) project in California, and combine those data with the 2007–2009 results from the SonotaCo network in Japan to create a set of radiant maps that shows many of the established showers. The video cameras detect meteors in the range of magnitudes $+4$ to -4, i.e., in much the same range as seen by visual observers. These maps serve to help guide visual observations of meteor showers.

Meteor head echo observations with the MU radar and future possibilities with EISCAT_3D

Johan Kero

EISCAT_3D is a three-dimensional imaging radar project for atmospheric and geospace research. It will consist of multiple phased arrays located in northern Fenno-Scandia. The multi-purpose experiment and data analysis approach will enable continuous meteor observations, unique in terms of coverage and quality. The aim of this paper is to establish a channel through which the EISCAT and IMO communities can interact. A presentation of the meteor head echo observations using the Shigaraki Middle and Upper atmosphere (MU) radar in Japan gives a flavor of some of the possibilities of EISCAT_3D.

The BRAMS Viewer: an on-line tool to access the BRAMS data

Hervé Lamy, Emmanuel Gamby, Sylvain Ranvier, Yves Geunes, Stijn Calders, and Johan De Keyser

This short paper focuses on the status of the BRAMS network in 2012, and describes a recently developed on-line tool, called the BRAMS Viewer, which provides access to the BRAMS data.

Radio polarization measurement of meteor trail echoes during the 2012 Perseids

Sylvain Ranvier, Michel Anciaux, Hervé Lamy, Johan De Keyser, Stijn Calders, and Emmanuel Gamby

We present radio polarization measurements of meteor trail echoes with a cross-polarized antenna of BRAMS, a network of radio receiving stations using forward scatter techniques to detect and characterize meteors.

Some radio meteor news

Jean-Louis Rault

Radio meteor observing for astronomy purposes is still alive, despite the fact that traditional TV transmitters used for decades tend to disappear. Radio observers are now starting to develop their own dedicated transmitters, and are using new kinds of transmitters, such as military and radio-navigation systems to continue their studies. Encouraging results are also obtained in the aeronomy/geophysics domain when searching for evidence of modifications of the Earth/ionosphere waveguide by discrete ionized meteor trails.

Sir Bernard Lovell (1913–2012)

Megan Argo

Sir Bernard Lovell, founder and first Director of Jodrell Bank Observatory (UK), died on August 6th, 2012, at the age of 98. Lovell was one of the pioneers of radio astronomy. Much of his observational work in the early days of the Observatory focused on radio meteors. Using ex-army radar equipment, Lovell and his colleagues recorded the spectacular Draconid storm of October 1946 and went on to publish many papers in the field, settling some of the big arguments of the time. Sir Bernard's legacy is immense, extending from his wartime work on military radar systems to his pioneering contributions to radio astronomy, and including his dedication to education and public engagement with scientific research.

Overview of the 2011 Draconids airborne observation campaign

Jérémie Vaubaillon, Pavel Koten, Regina Rudawska, Sylvain Bouley, Lucie Maquet, François Colas, Juraj Tóth, Joe Zender, Jonathan McAuliffe, Dominique Pautet, Peter Jenniskens, Michael Gerding, Jiří Borovička, Detlef Koschny, Arnaud Leroy, Jean Lecacheux, Maria Gritsevich, and František Ďuriš

On October 8, 2011, the Draconids (DRA, IAU#09) erupted in an outburst predicted by meteor shower forecasting models. The first European airborne meteor observation campaign was organized and conducted with two Falcon aircraft, belonging to the French Scientific Research National Council (CNRS) and the German Aerospace Center (DLR), respectively. The objective was to provide data to test prediction models and obtain insight into past activity of the parent comet, 21P/Giacobini-Zinner. The Draconids peaked at around 20^{h} UT (predicted: $19^{\mathrm{h}}57^{\mathrm{m}}$ UT for the 1900-dust encounter), with a peak rate of 300 meteors per hour, about half the predicted level. Light curves are found to be surprisingly flat. Spectroscopy reveals an early release of sodium compared to magnesium, as observed during prior Draconid showers. The mission trajectory was designed so that the CNRS Falcon could cover the time period for the predicted 1873–1894 dust ejecta encounter as well, but no peak was seen with a rate estimate $\mathrm{ZHR}_{\mathrm{max}} < 50$ at 17^{h} UT.

Radiants, orbits, spectra, and deceleration of selected 2011 Draconids

Jiří Borovička, Pavel Koten, Lukáš Shrbený, Rostislav Štork, and Kamil Hornoch

We present radiants and orbits of eight Draconid meteors observed from Northern Italy on October 8, 2011. The radiants agree with theoretical predictions, with a hint that some meteors may belong to the pre-1900 meteoroid trails. The spectra confirm that Draconids have a normal chondritic composition of main elements (Mg, Fe, Na). There are, nevertheless, enormous differences in the temporal evolution of Na line emissions. The differences are correlated with the deceleration rate and can be ascribed to different meteoroid structures.

The 2011 Draconid outburst: UCM group preliminary results from Spain

Francisco Ocaña, Mario F. Palos, Jaime Zamorano, Alejandro Sánchez de Miguel, Jaime Izquierdo, Bárbara Muñoz-Ibáñez, Alejandro Santamaría and Jesús Gallego

The Draconid outburst of October 8, 2011, originating from the 1900 and 1907 trails, took place as predicted (Vaubaillon et al., 2011, and references therein) at approximately 20^{h} UT. The UCM group observed the event from the Observatorio de Sierra Nevada, a well-placed location at an elevation of 2900 m, with the radiant above 40° altitude during the entire outburst. Continuous monitoring was also done from the Observatorio UCM at Madrid. Both stations used video techniques for flux measurements and DSLR imaging for orbit determination purposes. We obtained preliminary values of $(221 \pm 49) \times 10^{-3}$ meteoroids per square kilometer per hour on October 8, 2012, at $20^{\mathrm{h}}06^{\mathrm{m}}$ UT, for meteoroids causing meteors brighter than magnitude +6.5 (meteoroid mass over 5 mg), assuming a population index $r = 2.8$. For meteoroids over 0.2 g, the maximum flux was $(4.9 \pm 1.1) \times 10^{-3}$ $\mathrm{km}^{-2}\mathrm{h}^{-1}$. These results are in good agreement with other preliminary results recently published. Despite the abundance of faint meteors, we recorded seven bright fireballs simultaneously from two or more stations, including a Draconid of magnitude -11 (Madiedo et al., 2012). They are currently being analyzed for trajectory and orbit determination.

Draconids 2011: outburst observations by the Croatian Meteor Network

Damir Šegon, Željko Andreić, Peter S. Gural, Korado Korlević, Denis Vida, Filip Novoselnik, and Ivica Skokić

The predicted Draconid meteor shower outburst during October 2011 was observed by a portion of the Croatian Meteor Network, whose stations encountered clear weather. A total of 88 Dracond orbits have been calculated from 16 contributing stations. We present results for 53 orbits obtained from the fully automatic observation and processing pipeline. Two methods of trajectory estimation were applied, showing better fit results using a linearly changing velocity model versus a constant velocity model. The estimated mean radiant position has been found to be at $\alpha = 262.^\circ6$ and $\delta = +56.^\circ6$, and the estimated geocentric velocity $V_g = 20.9$ km/s.

Large 2011 Draconids outburst observing campaign: ground-based observations of the Paris Observatory team

Arnaud Leroy, Jean Lecacheux, François Colas, Lucie Maquet, Sylvain Bouley, and Regina Rudawska

To support the 2011 Draconids Airborne Campaign, three teams of observers have been deployed. Our goal was to obtain data from the ground stations during the technical interruptions of the airborne campaign (e.g., landing to refuel the airplane) and also to gather more data to compare.

Video observations of the 2011 Draconids by the all-sky camera AMOS

Juraj Tóth, Štefan Gajdoš, Jozef Világi, Pavol Zigo, Dušan Kalmančok, František Ďuriš, and Leonard Kornoš

Our contribution to the 2011 Draconids campaign by using the all-sky camera AMOS of the Slovak Video Meteor Network (SVMN) is presented. The ground-based observations were performed in cooperation with the Central European Meteor Network (CEMeNt), the Polish Fireball Network (PFN) and the Italian Meteor and TLE Network (IMTN). The airborne observations were performed in cooperation with the Astronomical Institute of the Czech Academy of Sciences and the Deutsches Zentrum für Luft- und Raumfahrt, Germany, within the EUFAR program. The processing of the data obtained by the AMOS camera during the Airborne DLR expedition is described.

Results of Draconid 2011 observations from the BRAMS network

Stijn Calders, Cis Verbeeck, Hervé Lamy, Sylvain Ranvier, and Emmanuel Gamby

In this paper, the applicability of the Observability Function (OF) to the BRAMS network is presented. Preliminary results are shown taking into account only geometry. Radiation patterns of the antennas are assumed to be isotropic. Manual counts for the Draconids outburst in 2011 obtained with the BRAMS network data are presented. The differences between the different stations are discussed in terms of the OFs and other parameters.

Global Radio Draconids 2011

Christian Steyaert

Radio counts of the Draconids 2011 outburst from all over the globe show remarkable and consistent details in the activity profile. Simple radio observations sufficiently spread around the world can coarsely identify meteor outbursts.

Draconid 2011 outburst observations from Slovenia

Javor Kac

Our 2011 Draconid outburst observations are presented. From the visual observations, a population index of $r = 2.6 \pm 0.1$ and a maximum ZHR of 460 ± 60 on 2011 October 8 at 20^h11^m UT is obtained. Video observations indicate a radiant at $\alpha = 262.^\circ2 \pm 1.^\circ3$ and $\delta = +56.^\circ0 \pm 1.^\circ3$, and a geocentric velocity of $V_g = (21.0 \pm 0.5)$ km/s. A flux profile is presented based on 358 video Draconids, and a maximum flux of 87 Draconids per 1000 km^2 per hour is found at 20^h15^m UT.

Is it possible to observe meteoroids from Asteroid (3200) Phaethon ejected in 2009?

Galina O. Ryabova

In 2009, Asteroid (3200) Phaethon has shown a short unexpected brightening, which could be interpreted as the ejection of dust particles. A numerical model was constructed to find out whether the dust swarm could have been observed from the Earth.

Call for observations of Asteroid 2012 FZ_{23} and its association with a southern meteor shower

Regina Rudawska, Peter Jenniskens, and Jérémie Vaubaillon

This talk addresses the topic of a meteoroid stream parent body in relation to meteor showers observed in the southern hemisphere. We carry out a further search to investigate the possible genetic relationship of Asteroid 2012 FZ_{23} with the δ Chamaeleontids meteor shower. Finally, we suggest that future investigations need to be directed to observations in southern hemisphere.

Population of hyperbolic meteoroids

Mária Hajduková Jr.

The presence of hyperbolic orbits among detected meteors started an assiduous search for interstellar meteoroids, as a hyperbolic excess above the escape velocity with respect to the Sun reveals a possible interstellar origin. Research into interstellar meteoroids has produced controversial results about their contribution to the Solar System meteoroid population, and in spite of great progress in the development of observational techniques, this problem still remains. Our study, based on analyses of hyperbolic meteor orbits from various catalogues of meteors obtained by different techniques, shows, from the statistical point of view, that the number of possible interstellar meteoroids among the hyperbolic orbits is extremely small. The biggest obstacle in this study is the accuracy of velocity measurements and determinations. The uncertainties which result from measuring errors make discriminating interstellar meteors among hyperbolic orbits very difficult, and even impossible if, in connection with their orbital and geophysical parameters, individual cases are not checked. In most cases, possible interstellar meteoroids can be found only within the error bars of the determined heliocentric velocity. As the value of the heliocentric velocity is very sensitive to the value of semimajor axis, the errors can transfer the orbit over the parabolic limit. It was shown that the hyperbolicity of the vast majority of meteor orbits in the catalogues investigated is the result of inaccurate velocity determination. This conclusion does not necessarily imply large measurement errors, since, especially near the parabolic limit, even a small error in the value of the heliocentric velocity of a meteor can create an artificial hyperbolic orbit that does not really exist. The "very high" meteor velocities produce an apparent hyperbolic population.

Asteroid 2010 TU_{149} in the Taurid Complex

Regina Rudawska, Jérémie Vaubaillon, and Peter Jenniskens

In this talk, we presented a survey of results dealing with investigating the association of Asteroid 2010 TU_{149} with the Taurid meteoroid stream.

Benešov bolide—surprising outcome of exceptional story after twenty years

Pavel Spurný, Jakub Haloda, and Jiří Borovička

We report results of a new analysis of the very bright fireball of absolute magnitude −19.5 which was recorded by four all-sky cameras and two spectral cameras at three Czech stations of the European Fireball Network on May 7, 1991, at $23^h03^m48^s$ UT. This fireball is well known as the Benešov bolide.

Meteorites in Japan

Nagatoshi Nogami

An overview of meteorite falls in Japan is provided, and a few specific meteorites are highlighted.

Meteors in near infrared

Damir Šegon, Željko Andreić, Denis Vida, Filip Novoselnik, and Korado Korlević

Experimental simultaneous video observations were performed by the Croatian Meteor Network in 2009 and 2012 with four cameras in different visual and near-infrared parts of the meteor spectra. These showed that significant parts of the meteor radiation in the near-infrared can be observed by 1004X video cameras. Different light curves were observed in the near-infrared as well as in the visual part of the meteor spectra, without any obvious physical definitions describing these differences. The influence of this additional light collected by video cameras seems to be the main source of the discrepancy between visual and video magnitude estimates, with important consequences for video meteor analysis in its whole.

The 2011 η-Aquariids observing campaign from La Palma

Felix Bettonvil and Thomas Weiland

Because the η-Aquariids, the most prominent stream for Southern Hemisphere observers, are difficult to watch from mid-northern latitudes, a week-long visual observing campaign was carried out in May 2011 from La Palma, Canary Islands, Spain. There, on the grounds of the Observatorio del Roque de Los Muchachos (ORM), at an altitude of more than 2000 m above sea level, observing conditions were nearly perfect. As a consequence, we managed to record more than 300 η-Aquariids in about 30 hours of effective observing time. An impression of the campaign together with a summary of the results is given.

Using BOAM to post meteor data from UFOAnalyzer into the Virtual Meteor Observatory

Stéphane Jouin, Tioga Gulon, Jean Brunet, and Arnaud Leroy

In 2010, a French meteor database called "BOAM" was created. During the preparation of the 2011 International Meteor Conference, we have studied the possibility to write a program to export BOAM data to the Virtual Meteor Observatory. After nearly one year of work, we are ready to export our data.

Development of a fireball database for the NEO segment of ESA's Space Situational Awareness Programme

Gerhard Drolshagen and Detlef Koschny

A fireball database will be developed within the near-Earth objects (NEO) segment of ESA's Space Situational Awareness (SSA) Programme. It will include information on fireballs brighter than magnitude -10 observed since January 1, 2010. This paper presents background information and discusses the context and content of the fireball database.

A meteor propagation model based on fitting the differential equations of meteor motion

Peter S. Gural

The differential equations that describe meteor motion through the atmosphere during the time of luminous flight does not have a closed-form solution to the state propagation vectors. Presented herein is a preliminary model that is an approximate parameterization to the integral solutions that are strictly dependent on the mass loss parameter β. The resultant model for position, and thus velocity, as a function of time and β, can be used to fit meteor and fireball trajectories that show deceleration over the entire visible duration of the flight profile.

Linking meteoroid streams to their parent bodies by means of orbital association software tools

José María Madiedo and Josep Maria Trigo-Rodríguez

A Microsoft-Windows-compatible software, called ORAS (ORbital Association Software), has been developed for verifying possible associations between orbits using different existing criteria. Applying this software revealed a likely association for the orbit of a Northern χ-Orionid (ORN) fireball and Asteroid (PHA) 2008 XM_1. A numerical integration 4000 years backwards in time for the orbital parameters shows that this asteroid is a better match for this Northern χ-Orionid than Asteroid (NEO) 2002 XM_{35}.

Can we detect large meteoroids outside the Earth's atmosphere?

Geert Barentsen

There is increasing evidence to suggest that meteoroid streams may harbor large objects, in addition to small dust grains, if the parent comet underwent fragmentation in its past. It is difficult to obtain empirical statistics on the frequency of such large meteoroids however, because their collisions with the Earth's atmosphere would be very rare events. A method suggested to constrain their frequency is to search for them outside the Earth's atmosphere, by carrying out telescopic surveys during meteor showers. In this contribution, we explore the expected apparent brightness of such detections. In the case of the Draconid stream, we find that large meteoroids with diameters ranging between 10 cm and 100 m can be detected when the objects are within a distance of 4×10^2 km and 10^7 km, respectively.

Comet disintegration and meteor streams

Ayyub S. Guliyev and Ulviyya J. Poladova

The possibilities for disintegration of a cometary nucleus by collision with meteoroid streams, predicted by one of authors (Guliyev, 2010) are considered in three zones of the Solar System. A list of disintegrating comets consisting of 118 cases has been made by the authors. The list contains data about observed cases of comet splitting, comet twins, and data about disappeared comets. Testing the comet parameters by applying the methods of mathematical statistics confirms the hypothesis underlying this article. The frequency of passing through the three zones where there might be a collapse of a proto-comet is rather high for the proto-comets of the Sun-grazer group. The results of the statistical analysis of comet outbursts yields additional arguments in favor of our hypothesis.

Prediction of meteor shower associated with Comet 122P/de Vico

Dušan Tomko and Luboš Neslušan

We model, for a far past, a theoretical stream associated with Comet 122P/de Vico and follow its dynamical evolution until present. Selecting the modeled particles approaching the Earth's orbit at the present, we predict the characteristics of a potential meteor shower and try to identify these particles with the meteors in three databases (photo, radar, and video). Our overall prediction is, however, negative because only the particles released from the comet nucleus before approximately 37 000 years ago are found to evolve into a collision course with the Earth and, therefore, form a possible shower. Meteoroids are known to survive a much shorter time in interplanetary space, unfortunately.

The 2012 Lyrids from non-traditional observing platforms

Danielle E. Moser, Robert M. Suggs, William J. Cooke, and Rhiannon Blaauw

The NASA Meteoroid Environment Office (MEO) observed meteors during the Lyrid meteor shower peak on April 22, 2012, from three different observing platforms: the ground, a helium-filled balloon, and from the International Space Station (ISS). Even though the Lyrids are not noted for spectacular rates, the combination of New Moon and a favorable viewing geometry from ISS presented a unique opportunity to simultaneously image shower meteors from above the atmosphere and below it. In the end, however, no meteors were observed simultaneously, and it was impossible to identify Lyrids with 100% confidence among the 155 meteors observed from ISS and the 31 observed from the balloon. Still, this exercise proved successful in that meteors could be observed from a simple and inexpensive balloon-based payload and from less-than-optimal cameras on ISS.

Two-stage destruction of meteoroids

Lidia Egorova

We consider the following scenario for the destruction of a rather large meteoroid body. During its movement through the atmosphere, the meteoroid suffers from aerodynamic forces, and gets repeatedly crushed. We assume that in this first stage of fragmentation, the meteoroid is divided into several rather big pieces. The resulting cloud of fragments of unknown shape, size, and quantity continues its path into the lower atmosphere. The second stage of fragmentation consists of the sudden destruction of a body into a cloud of small particles and dust. Due to extremely high temperatures at the surface of the fragments and in the gas around them, all of the meteoroids can melt in a short period of time. This phenomenon appears to the observer as a terminal flash.

Deceleration rate of a fireball as a tool to predict consequences of the impact

Maria Gritsevich, Daria Kuznetsova, Vladimir Stulov, and Leonid Turchak

The correct interpretation of fireball observations is a very important task, since it could promptly confirm a fresh meteorite fall, and, furthermore, provide a link to its parent body. Based on the analysis of the fireball aerodynamic equations, we describe the possible results that might accompany collisions of cosmic bodies with the Earth's atmosphere and surface. After integrating, these equations characterize the body's trajectory in the atmosphere very well, while the exact derived dependency of the body's velocity on the height of the fireball can be further compared to the observations. The solution depends on two key dimensionless parameters defining the meteoroid drag and mass loss rate in the atmosphere.

A flexible fireball entry track calculation program

Esko Lyytinen and Maria Gritsevich

A computer program developed by Esko Lyytinen is currently in use for trajectory analysis of meteors collected by the Finnish Fireball Working Group. This paper provides instructions for its use along with processing examples from different phases of the calculation. The program is written in Microsoft Excel and it is available for download via the following link: `http://lyytinen.name/esko/fb_entry_vers_1.zip`.

New Mars meteorite fall in Morocco: collecting observations and determining the spatial distribution in the strewnfield

Abderrahmane Ibhi

The existence of Martian meteorites in the region of Tissint (Tata, Morocco) dropped by a very bright fireball on July 18, 2011, had been notified to a group of scientists of the Ibn Zohr University of Agadir, Morocco, at the beginning of January 2012, by a nomad of Tata who had found a small fragment in the region. As soon as a scientific expedition arrived at the place of the meteorite fall, the members of the laboratory of Geo-heritage and Geo-materials Science started gathering information and collecting the debris of this Martian meteorite. The Tissint fireball has been observed and reported by numerous witnesses across the southeastern Morocco. The event was extremely valuable to the scientific community: it was the brightest and most comprehensively observed fireball in Morocco's known astronomical history. We are now in a position to draw the distribution ellipse of the fall, which starts at Jbel Al Gallab and continues in east-southeastern direction, above big rocky plateaus.

Meteor camera network in Hungary: some considerations about its hardware

Antal Igaz and Ernő Berkó

Since 2009, an efficient meteor camera network was developed in Hungary. Its main characteristics are that it is amateur-owned and -operated, based on commercial security cameras, and part of the IMO Video Network.

Television meteor observations in INASAN

Anna Kartashova

The results of TV observations of meteors during the period 18 July–19 August (activity period of the Perseid meteor shower) in 2011 and 2012 are presented. The wide field-of-view cameras "PatrolCa" were used for the observations. Observations were carried out by the single-station as well as the double-station method. The double-station observations were aimed at determining the individual orbits of the observed meteors. The principle of Index Meteor Activity (IMA) calculations can be used for all meteor showers active during the observing period. We can use the IMA parameter to estimate the influx of meteor particles to the Earth per hour, both for shower and sporadic meteors. The distribution of the influx rate (IMA) for the Perseids to the Earth for the observing periods in 2011 and 2012 is given. Distributions of Perseid meteors by stellar magnitude are also presented.

First scientific results of the Fireball Detection Station at UCM Observatory

Francisco Ocaña, Jaime Zamorano, Alejandro Sánchez de Miguel, Jaime Izquierdo, Mario F. Palos, Gustavo Rodríguez-Coira, Raúl García, Cristian Vázquez, Bárbara Muñoz-Ibáñez, Alejandro Santamaría, Jesús Gallego, Josep Maria Trigo-Rodríguez, and José María Madiedo

Observatorio UCM is one of the nodes of the Spanish Meteor Network (SPMN), an inter-disciplinary research project on interplanetary matter. Since 2008, we are operating a high-sensitivity camera in double-station with UCLM in Toledo, and, since 2010, we are operating the full station with 6 additional cameras. We present the scientific results of the UCM Fireball Detection Station during its first two years of operation. The main event was the observational campaign for the Draconids 2011 outburst with the addition of a mobile station and a stratospheric balloon. This campaign joins the general exploitation of the data generated continuously by the station in collaboration with SPMN. In addition to our outreach efforts in this field and the results obtained, the project has opened up itself even more to the society and students of the Bachelor Degree in Physics at UCM, who have participated in the reduction and analysis of the data as well as in some graduation projects and collaborations.

Collisions of small bodies as a source of hyperbolic meteoroids in the Solar System

Eduard M. Pittich and Nina A. Solovaya

We present the results of the investigation of one possible mechanism which can be the source of meteoroids with hyperbolic orbital velocities: the mutual collisions of Oort Cloud objects, Kuiper Belt objects, or Main Belt asteroids, or their collisions with other populations of small bodies in the Solar System. In our study, we used model orbits for Oort cloud objects, Classical Kuiper Belt objects and Main Belt asteroids with different semi-major axes, and studied the orbital behavior of their fragments after their collision with other small bodies, e.g., bodies on orbits similar to those of Kreutz cometary family. Depending on their direction, the fragments will migrate into the inner or outer part of the Solar System, with different orbital velocities.

Northern Taurids in the IAU Meteor Data Center Database

Ján Svoreň, Zuzana Kaňuchová, and Marek Husárik

The method of indices was used to study the northern branch of the autumn (night) part of the Taurid complex. The procedure is based on mathematical statistics only and was applied to select the Northern Taurid meteor records from the IAU Meteor Data Center Database. Because we wanted to study especially the fine structure of the inner part of the Northern Taurids, we were focused on the interval of the higher activity of the stream—from the end of the activity of the Perseids until the beginning of the Geminids activity. The outlying parts of the complex, active until January according to some authors, were not taken into account. In total, 84 Northern Taurid orbits were selected. Of these 84 orbits, 63 (75%) were sorted into 11 associations found in the stream.

One of the associations consisted of three orbits and was identified as a previously unknown northern branch of the τ-Arietids. We also found an association with orbital characteristics equal to the characteristics of the δ-Piscids North and the χ-Orionids North. The meteors in these associations were observed up to three weeks earlier compared to the currently cataloged data of the showers. The orientation of the mean orbit of a 5-member association with the δ-Piscids North was different from the general trend, indicating that this stream may not be genetically related to other members of the Taurid complex.

Quadrantids 2012

Antoaneta Avramova and Mihail Enimanev

We present some results from our observations of the 2012 Quadrantid meteor shower, and we explain our way to process the data. The radiant position is obtained from photographed meteors.

Spectroscopic observations of the 2011 Draconids meteor shower

Regina Rudawska, Joe Zender, Peter Jenniskens, Jiří Borovička, and Jérémie Vaubaillon

In this presentation, we report on spectroscopic observations of the 2011 Draconids with cameras provided by the IMCCE, the ESA, the SETI Institute, and Ondřejov Observatory.

Double-station meteor observations in Ryazan, Russia

Andrey Murtazov, Alexander Efimov, and Pavel Titov

Optical meteor observation methods and observation equipment characteristics are described. Results of CCD-meteor observations of 2011 and 2012 at two stations are presented. The results of wide-angle bright Perseids observations make it possible to estimate the average meteoroid risk over the period 2007–2012.

Construction and installation of an all-sky meteor camera at the Slovak Central Observatory in Hurbanovo

Teodor Pintér and Mikuláš Mačanský

This contribution describes new observational equipment installed at the Slovak Central Observatory (SCO) in Hurbanovo, Slovakia ($\varphi = 47°53^{m}32^{s}$ N, $\lambda = 18°11^{m}36^{s}$ E). It also briefly outlines the history of meteor observations in Hurbanovo.

Meteor astronomy in the Astronomical Society Labod (ADL)

Jure Atanackov and Matic Smrekar

The Astronomical Society Labod (ADL) is a growing group of active young astronomy enthusiasts based in Ljubljana, Slovenia. An overview is given of its activities with regard to meteor astronomy.

Automated detection and analysis of Moon impact flashes from Spain

José María Madiedo, José Luis Ortiz Moreno, Nicolás Francisco Morales Palomino, and Jesús Cabrera Caño

We are currently performing a monitoring of the night side of the Moon in order to identify flashes produced by the impact of meteoroids on the lunar surface. For this purpose, we employ several telescopes equipped with high-sensitivity CCD video cameras. Software development plays an important role in our project, and, as a result of this, our detection and analysis package has been improved. Some of the results obtained so far are presented here.

Bidirectional reflectance measurements of meteorites acquired by FGI's field goniospectrometer

Maria Gritsevich, Teemu Hakala, Jouni Peltoniemi, Mark Paton, Jarkko Stenman, and Arto Luttinen

Meteorite studies represent a low-cost opportunity for probing the cosmic matter that reaches the Earth's surface, and for revealing the origin of our Solar System. In addition, they complement results of sample-return missions that bring back pristine samples of this material. The main difficulty, however, with interpreting meteorite records is that, apart from a few exceptional cases, we do not know their exact origin, i.e., the parent body a particular sample is coming from. In the present study, we provide results of multi-angular bidirectional reflectance measurements of relatively big meteorite samples, from the Finnish Museum of Natural History, using the field goniospectrometer Figifigo. We discuss possible matches between our measured reflectance spectra of meteorites with the reflectance spectra of asteroids. We discuss the features in the spectra and their relationship to the physical properties of the sample/asteroid.

On short-perihelion meteor streams related to comets and asteroids

Alexandra K. Terentjeva, Elena Bakanas, and Sergey I. Barabanov

The relationship between short-perihelion meteor streams and comets and asteroids was investigated. Out of over 400 meteor and fireball showers (from both photographic and TV observations), 20 had perihelion distances of $q \leq 0.26$ AU. The research showed that 8 of these 20 meteor streams displayed a relationship with small bodies. No such relationship with either comets or asteroids was found for the remaining 12 streams.

Radio meteor scattering with Software Defined Radio based on Open Hardware

Teodor Pintér, Jakub Kákona, Martin Kákona, and Ladislav Křivský

A method is described for SDR-based meteor detection on MLAB, an Open Hardware project.

The power hyperspectral all-sky camera

Ivan Syniavskyi, Yuriy S. Ivanov, and Sergey Chernouss

This study presents a new fish-eye lens for optical atmospheric observations, designed in the Main Astronomical Observatory (MAO) of the National Academy of Science of Ukraine. It has been tested under laboratory conditions in Kiev. The fish-eye lens MAO-08 is intended for observations of faint extended objects in white light or narrow spectral bands with variable passband filters VARISPEC. Besides having high power, this lens can be used for meteor observations. A field test has been conducted in the Polar Geophysical Institute (PGI) observatories located at the Kola Peninsula and Spitsbergen.

Radio observations and evaluation of the meteor showers between May 4 and August 25, 2012

Kerem O. Çubuk, Can Terzioğlu, H. Aziz Kayıhan, Mehmet İ. Selmanoğlu, Sara Bulut, and Ferhat F. Özeren

In this poster, we present the observational data of the meteor showers which occurred between May 4 and August 25, 2012, using two 4-element Yagi antennas with optimum frequencies at 92 MHz and 100 MHz.

The SMA automated station for meteor research

Blanca Troughton, Juan Carlos Aznar, Rafael Padilla, Julia Toval, and Alberto Serrano Castellón

In this paper, we summarize the presented poster regarding the active meteor tracking method and investigation of the SMA since 2006, with a specially devised automated station. We also discuss our collaboration with other tracking stations belonging to the Spanish Meteor and Fireball Network (SPMN), as well as with the Bootes 2 Station (owned by IAA-CSIC, Spain).

Meteor activities within Europlanet

Jürgen Oberst, Apostolos Christou, Maria Gritsevich, Anastasios Margonis, Detlef Koschny, Anita Heward, and Thierry Fouchet

The Europlanet project (`http://www.europlanet-ri.eu/`) is being carried out under the Seventh Framework Programme (FP7) of the European Union with the aim to increase the productivity of planetary projects, improve European scientific expertise in relevant research areas, and increase overall knowledge of planetary environments.

Meteor science

A possible new meteor shower — η Hydrids

Damir Šegon [1], *Željko Andreić* [2], *Korado Korlević* [3], *Filip Novoselnik* [4,5], *Denis Vida* [4,6] *and Ivica Skokić* [4,7]

The radiant analysis that included orbits from the Croatian Meteor Network Catalogues of Orbits 2007 to 2010 plus the orbits from the SonotaCo catalogues for 2007 to 2011 revealed a possible new Hydrid stream with radiant running parallel to, but distinct from, the σ Hydrids. The stream got a temporary IAU designation 529 EHY and the name η Hydrids. We present here the results of our analysis of the new stream.

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1 Introduction

The Croatian Meteor Network (CMN), which started video meteor observations in 2007, is described in Andreić & Šegon (2010) and Andreić et al. (2010). The catalogues of orbits for 2007 (Šegon et al., 2012), 2008 and 2009 (Korlević et al., 2013) are already published. The catalogue for 2010 is ready for publication.

During 2012 the Croatian Meteor Network did an extensive search for new meteor showers from the SonotaCo (SonotaCo, 2009; SonotaCo, 2012) and the CMN video orbit databases, together containing more than 133 000 single meteor data. The search method consisted of visual checking of radiant plots for each degree of solar longitude, such that each plot covers 3° of solar longitude (i.e., 3° bins centered on the longitude in question). Such single degree plots were then inspected by slide show comparison and by reviewing video files containing certain solar longitude intervals. In this way we were able to detect and separate moving radiants from the sporadic background in a more clear way.

While inspecting plots from 240° to 270° of solar longitude, we were easily able to detect the σ Hydrid (16 HYD) radiant and its daily motion. However, we also saw that there is a separate radiant moving almost parallel to the σ Hydrid one, at about 5–10° to the East. We performed a detailed analysis based on the D-criterion (Southworth & Hawkins, 1963), and found out that very probably there are two different showers, very close to each other. Altogether 120 orbits belonging to this new radiant were identified.

This new shower was reported to the IAU Meteor Data Center and received the preliminary designation 529 EHY — η Hydrids. The file with all individual orbits of the new shower mentioned in this article can be downloaded from the CMN download page:
`http://cmn.rgn.hr/downloads/downloads.html`

2 The η Hydrids

A plot of all radiants for solar longitudes 240–270° in the RA–DEC range of σ Hydrids can be seen in Figure 1. Geocentric velocities are color coded. The σ Hydrid radiant positions are obvious, and the radiant motion can be clearly seen. However, if we take a look at radiants in the range of 254–258° solar longitude, as shown in Figure 2, we can see a group of meteor radiants at approximately RA = 132°, Dec = +2°. For meteors in a circle of diameter 5° around that point (i.e. all meteors having their radiant within 2.5° of that point), we calculated the D-criterion values for each meteor orbit pair. Meteors with the highest number of D-criterion values smaller than 0.15 were then used to calculate an initial mean orbit of this new, at the moment hypothetical, meteor shower. Results using UFOOrbit showed that a fraction of the selected meteors were recognized as members of the σ Hydrid shower (the η Hydrids do not yet exist in the UFOOrbit catalogue), so as a first step we compared their orbits to the reference orbit from the IAU database (Jenniskens, 2006). It turned out that these meteors do not belong to the σ Hydrid

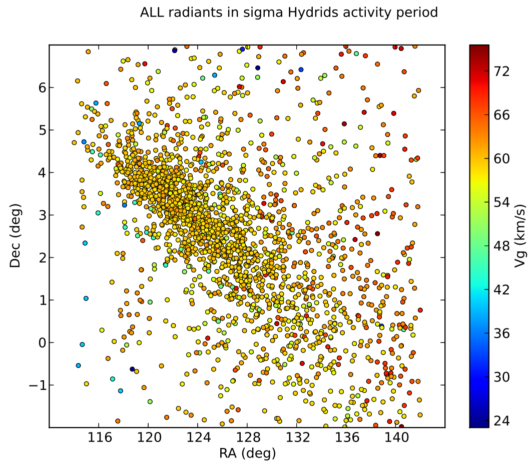

Figure 1 – Plot of all radiants of Hydrids. The geocentric velocity is color coded.

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NASA-ADS bibcode 2013JIMO...41..157S

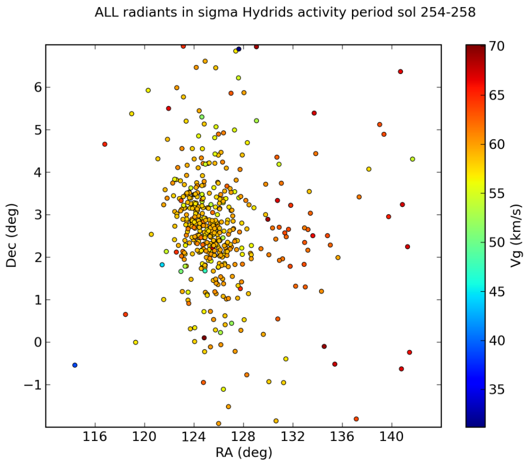

Figure 2 – Plot of Hydrid radiants in the range of 254° to 258° solar longitude. The geocentric velocity is color coded.

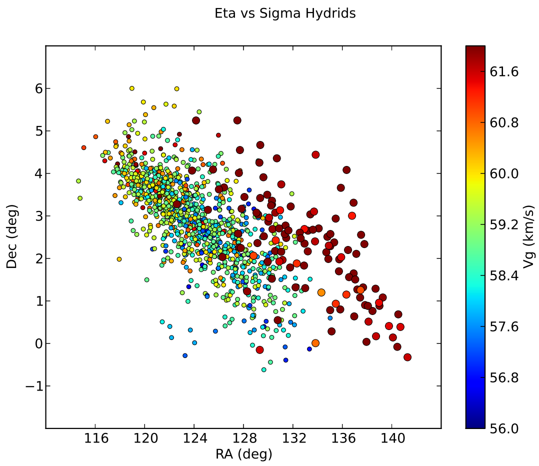

Figure 3 – Plot of Hydrid radiants in equatorial coordinates. The geocentric velocity is color coded. The η Hydrids are labeled by larger circles.

shower, since their D-criterion value surpasses the value of 0.15 (typically more than 0.35).

In order to check the σ Hydrids' orbital parameters and see if there is a significant difference between the two groups of meteors in a more accurate way, we calculated mean orbital parameters for the σ Hydrid shower from all available SonotaCo and CMN datasets and then repeated the D-criterion calculations with the new σ Hydrid mean orbit. This new mean orbit was derived from 1051 σ Hydrid meteors satisfying a D-criterion below 0.15 and is presented in Table 1. The D-criterion values calculated from this σ Hydrid mean orbit and meteors in the hypothetical new shower show that there is a significant difference between these two groups of radiants. After an iterative search for meteors satisfying the new shower's mean orbital parameters by the D-criterion being less than 0.15, we have found 120 meteor orbits. Mean orbital parameters of these 120 meteors are also shown in Table 1. The resulting D-criterion value for these two mean orbits is 0.38, confirming that we have a very probable new shower finding. An RA–DEC comparison plot of σ Hydrids and new shower radiants is presented in Figure 3. The members of the new shower η Hydrids are drawn with larger circles.

Table 1 – The newly calculated mean orbit of the σ Hydrids, compared to the mean orbit of the η Hydrids.

parameter	σ Hydrids	η Hydrids
$\lambda_\odot$ (°)	245–265	244–267
$\lambda_\odot$ max. (°)	254.6	256.9
RA (°)	124.0 ± 3.5	132.9 ± 4.2
DEC (°)	2.9 ± 1.9	2.3 ± 1.2
daily motion in RA (°)	+0.83	+0.79
daily motion in DEC (°)	−0.18	−0.16
v_g (km/s)	59.0 ± 1.0	62.5 ± 0.8
a (AU)	20	15
q (AU)	0.259 ± 0.023	0.383 ± 0.032
e	0.987 ± 0.023	0.974 ± 0.030
ω (peri) (°)	119.0 ± 3.4	103.8 ± 4.0
Ω (node) (°)	74.6 ± 4.1	76.9 ± 5.2
i (°)	129.5 ± 2.3	142.8 ± 2.3

Now the difference in radiant positions is a bit more clearly seen, due to v_g being properly color coded – but the observed difference in radiant positions is small, less than 10°. In order to enhance differences in orbital parameters, we are presenting plots showing that fact in the best way. In Figure 4, the argument of perihelion versus ascending node is presented, with v_g color coded. Two groups of orbits are clearly separated. In Figure 5, the argument of perihelion versus inclination has been plotted, again with v_g color coded. There is a clear separation between the two groups of orbits. Finally, the ascending node versus perihelion distance can been seen in Figure 6, and again the two sets of orbits show a significant difference.

Our search for a main body of the new shower has not returned any possible candidate.

The mean daily motion of the radiant can be described with Equations (1) and (2), and the daily motion of the σ Hydrids by Equations (3) and (4):

$$\mathrm{RA} = 0.79(\lambda_\odot - 256\overset{\circ}{.}9) + 132\overset{\circ}{.}9 \quad (1)$$
$$\mathrm{DEC} = -0.16(\lambda_\odot - 256\overset{\circ}{.}9) + 2\overset{\circ}{.}3 \quad (2)$$

$$\mathrm{RA} = 0.83(\lambda_\odot - 254\overset{\circ}{.}6) + 124\overset{\circ}{.}0 \quad (3)$$
$$\mathrm{DEC} = -0.18(\lambda_\odot - 254\overset{\circ}{.}6) + 2\overset{\circ}{.}9 \quad (4)$$

Finally we checked the IMO Million Meteors pages (IMO, 2012), and found out that the η Hydrid radiant has been detected during the last analysis, too. A very well fitting radiant has been found on two solar longitudes (257° and 258°), with maximal relative strength for $\lambda_\odot = 257°$, corresponding to the mean solar longitude of the activity period found by this analysis.

3 Conclusion

A new shower, running parallel to the σ Hydrids was found in the combined CMN-SonotaCo datatset. The new shower was named η Hydrids. Its radiant is about 9° away from the radiant of the σ Hydrids, running parallel to it and closing up at a rate of $0\overset{\circ}{.}04$ and $0\overset{\circ}{.}02$ per solar longitude degree in RA and Dec respectively. Both radiants are active between November 26 and December 18, with maximum activity around December 8. Moreover, they show almost the same daily motion. The mean orbit of the η Hydrids is similar to the mean

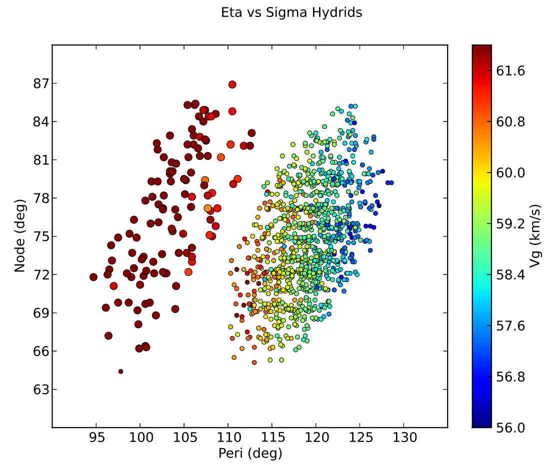

Figure 4 – Plot of longitude of ascending node versus argument of perihelion.

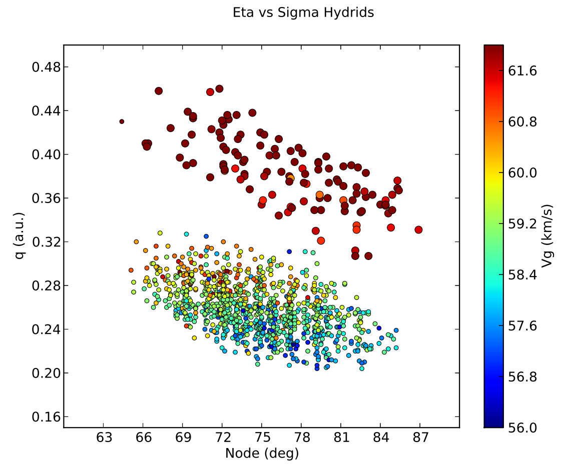

Figure 6 – Plot of perihelion distance versus ascending node.

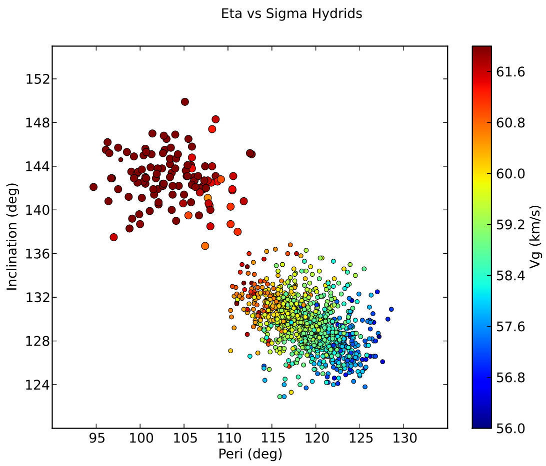

Figure 5 – Plot of inclination versus argument of perihelion.

orbit of the σ Hydrids, having slightly larger perihelion distance and about 3.5 km/s larger geocentric velocity. The D_{SH} for the two mean orbits is 0.38 confirming that the two showers are not identical. However, the similarity of orbital elements indicates that they may be related.

Acknowledgements

Our acknowledgements go to all members of the Croatian Meteor Network, in alphabetical order of first name: Alan Pevec, Aleksandar Borojević, Aleksandar Merlak, Alen Žižak, Berislav Bračun, Dalibor Brdarić, Damir Matković, Damir Šegon, Dario Klarić, Dejan Kalebić, Denis Štogl, Denis Vida, Dorian Božićević, Filip Lolić, Filip Novoselnik, Gloryan Grabner, Goran Ljaljić, Ivica Ćiković, Ivica Pletikosa, Janko Mravik, Josip Belas, Korado Korlević, Krunoslav Vardijan, Luka Osokruš, Maja Crnić, Mark Sylvester, Mirjana Malarić, Reiner Stoos, Saša Švagelj, Sonja Janeković, Tomislav Sorić, VSA group 2007, Zvonko Prihoda, Željko Andreić, Željko Arnautović, Željko Krulić. Also, to Peter Gural for constructive discussions on meteor shower problems.

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High altitude wind traced by a persistent train from a Geminid fireball

Bill Ward [1]

Images of a persistent fireball train obtained during observation of the Geminid meteor shower maximum (13/14 December 2012) are used to determine the wind speed at the assumed height of the fireball.

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1 Introduction

There are many images and examples of persistent trains throughout meteor literature. Often mentioned is the fact that the trains are blown and distorted by the winds at high altitude (Rendtel & Arlt, 2009; Bone, 1993).

During observations of the 2012 Geminid meteor shower maximum from Izaña, Tenerife, several bright fireballs were captured using a DSLR camera. Three were observed to have persistent trains. One in particular produced a long lasting persistent train that was imaged over a 11-minute period and which travelled some distance across the sky. Using this train as a tracer a determination of the winds speed at the fireball altitude was made.

2 Observations

The equipment used was a Canon 1000D DSLR camera equipped with a $f = 30$ mm $f/d = 1.4$ lens at $f/1.4$. The camera was set at ISO 800. The lens also had a 500 lpm plastic film grating attached in an attempt to obtain meteor spectra. Exposures in the sequence were 30 seconds each with a 5 second downloading interval between them. Visually the meteor was estimated to be approximately magnitude −6. The fireball is shown in Figure 1.

Figure 1 – Magnitude −6 Geminid fireball (with enlarged section inset), photographed on 2012 December 13/14, at $23^{h}27^{m}42^{s}$ UT.

The train was observed with the naked eye for over 2 minutes.

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3 Analysis

3.1 Determination of train position

The persistent train was recorded in a sequence of 20 images. Using the planetarium software Cartes du Ciel[a] images were superimposed on the stellar fields and the positions of the train determined by simple visual inspection. As the train distorts and fades with time an "exact" position is difficult to obtain with any precision. In this case the determination was made using the leading edge of the train as a guide.

Figure 2 – Image showing start position of train, photographed on 2012 December 13/14, at $23^{h}28^{m}18^{s}$ UT.

Figure 3 – Image showing end position of train, photographed on 2012 December 13/14, at $23^{h}39^{m}22^{s}$ UT.

As this was a single location observation the exact height of the meteor is unknown. A height of 80 km is assumed (Rendtel & Arlt, 2009) and for simplicity the curvature of the Earth is ignored.

The start position was measured as altitude 37.9 degrees (=a in Figure 4), azimuth 73.1 degrees.

The end position was measured as altitude 25.9 degrees (=b in Figure 4), azimuth 45.1 degrees.

[a]Cartes Du Ciel is available free from `http://www.ap-i.net/skychart/start`

3.2 Determination of distance to train

Using the positions obtained the distance to the start and end points can be determined. As "flat" geometry is being assumed it is straightforward to use the sine identity thus:

$$\frac{80}{\sin 37.9} = \frac{R1}{\sin 90} \tag{1}$$

giving $R1 = 130$ km, and

$$\frac{80}{\sin 25.9} = \frac{R2}{\sin 90} \tag{2}$$

giving $R2 = 183$ km.

With these distances calculated a triangle can now be constructed. The geometry is shown in Figure 4.

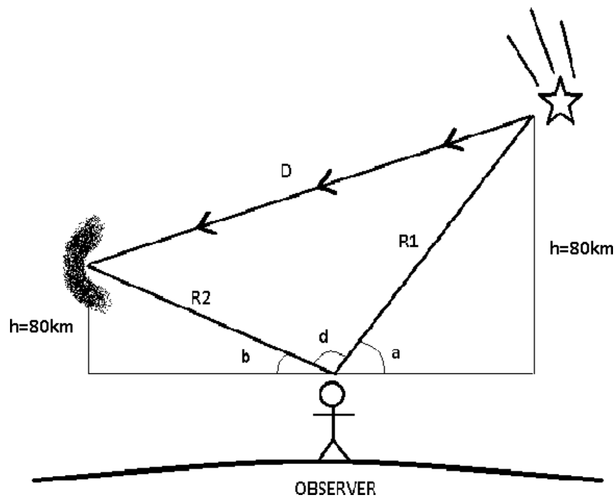

Figure 4 – Geometry of observation. (Foreshortened due to perspective view).

3.3 Distance travelled by train

To find the distance travelled by the train during the interval between the images the cosine identity is used, thus:

$$D = \sqrt{R1^2 + R2^2 - 2\ R1\ R2\ \cos d} \tag{3}$$

Where $d = 73.1 - 45.1 = 28$ degrees, the difference between the two azimuths of position.

Giving $D = 92$ km (= 92 000 m).

3.4 Velocity of wind traced by train

The total interval of time between the first image and last image was 664 seconds. It is now a simple matter to divide the distance travelled by the time taken.

Thus velocity v is

$$v = \frac{92\,000 \text{ m}}{664 \text{ s}} = 139 \text{ m/s} \tag{4}$$

4 Observational errors

4.1 Altitude of fireball

With the altitude of the meteor and train unknown the assumed height, whilst it is felt reasonable, may be in error by a considerable amount. The altitude of fireballs producing persistent trains is quoted as varying between heights of around 110 km to 70 km (Beech, 2006) but in the case of Geminids the average luminous end heights are below 80 km (Betlem et al. 1994b quoted in Rendtel and Arlt, 2009). Therefore 80 km was taken as a representative value. This unknown is in all probability the most significant source of error in this particular calculation. With the variation in possible altitudes it may be in the order of 10 to 20%.

4.2 Train position

The precision of the trains position is ultimately limited by its nature. This is mainly due to it being a feature that is both fading in brightness and evolving in structure over time.

4.3 Geometric approximation

To simplify the calculation a "flat" trajectory is assumed. That is the curvature of the Earth is not taken into account. As such the speed calculated can be considered a lower limit as the curved path would be longer.

5 Conclusion

Using a sequence of images the wind speed at the assumed height of 80 km was determined to be

$$v = 139 \text{ m/s} \pm 20 \text{ m/s}$$

(approximately 499 km/h, or 310 mph).

This is considerably faster than the value of 20 m/s as noted by U. von Zahn (Murad & Williams, 2002) but it comparable to the value of 111 m/s (400 km/h) given as an example by N. Bone (Bone, 1993). This wide range serves to demonstrate the highly variable and dynamic environment that exists in the upper atmosphere.

6 Future work

The observation of several persistent trains from Geminid meteors on the night of 2012 December 13/14 raises a more general issue. It is commonly held that persistent trains are formed only by high velocity meteoroids (Rendtel & Arlt, 2009). However the velocity of the Geminids is relatively slow at 34.6 km/s (Rendtel & Arlt, 2009). Persistent trains from future Geminid showers could be an area for further investigation.

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SPA Meteor Section Results: 2008

Alastair McBeath[1]

A report based on meteor data analyses from 2008 performed by the SPA Meteor Section is given with some discussion. Items detailed comprise: the Quadrantid peak on January 4 which may have had an unusual dip in activity partway through; the Perseid maximum, which seemed to produce two peaks, by far the strongest-recorded of which was around 02^h UT on August 13; a meteor outburst on September 9 probably due to the September ε-Perseids, for which the radio results suggested activity was present at a stronger level for longer than previous visual and video findings had supposed, perhaps with more than one maximum; another stronger than expected return from the Orionids during October, part of the sequence of unusual events begun in 2006; a fresh Taurid "swarm" return in late October to early November, which probably produced somewhat higher activity than normal, if without the increased bright-meteor component observed at some previous returns; strong Leonid activity later in November, from the radio reports, possibly with two peaks; a Geminid maximum in December which showed some curious discrepancies between the limited visual and radio observations; and the Ursids, which may have provided another moderately-enhanced return, with up to four potential peaks recorded by radio observations in the first twelve hours UT of December 22.

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1 Introduction

This paper continues the presentation of results from past years by the SPA Meteor Section with a review of the better-observed meteoric events during 2008. As with matters from 2007 (McBeath, 2013), many were detailed nearer the time in the SPA's Electronic News Bulletins (ENBs) or on the Society's website, and these notes remains freely available via the Meteor Section's webpages (SPA homepage: `www.popastro.com`). However, all the information presented here has been re-evaluated since, in some cases amended and updated, with fresh discussions not published previously particularly regarding the radio analyses. Consequently, this article supersedes all those earlier materials.

Although Assistant Meteor Director David Entwistle persisted with experiments to employ various computational tools for radio meteor analyses on the Section's behalf during 2008, those proved in general problematic, and what findings were possible this way were commonly published in tandem with my own Relative Radio Rate, RRR, method's results. I described this latter most recently in (McBeath, 2012). While not a strictly-computed value, the RRR does make possible the comparison of activity patterns with the visual ZHR, using normalized graphs. Such comparisons have been achieved here using the IMO's "live" shower webpages, where available. A new difficulty with the radio observations was the cessation of Japanese results being published in the RMOBs later in 2008, creating a gap in global radio-meteor coverage which sadly remains unfilled.

As usual over the past couple of decades, a large part of the Section's activities revolved around casual fireball sightings (meteors of at least magnitude −3). Although 102 such events were reported away from standard visual meteor watches in 2008, many by more than one witness, none were well enough reported to allow anything beyond quite vague possible trajectories or overflight zones to be determined, except for one brilliant and very slow meteor on September 25 around 20^h55^m UT, which was reported from 21 sites across southern Britain, the Channel Islands and France. This event, however, had a predetermined trajectory, as it was due to the atmospheric re-entry of part of a Proton rocket launched from Kazakhstan about twelve hours earlier! It generated considerable interest even so, as it was detected by forward-scatter radio observers, and repeatedly imaged, because its lengthy visible flight (three minutes or so from the most favourable places) allowed plenty of time to alert witnesses to its' passing. France was the better observing platform, as even from southern England, this fireball ended far below the horizon.

One non-meteoric event during the year that must be noted here was the tragically early death of long-standing Section observer and correspondent Steve Evans on March 7, whose absence remains an unfilled gap. His obituary was in WGN 36 : 1, p. 1.

2 Observing totals and observers

Increases occurred for both radio and video data reported as compared with 2007, with a somewhat less rosy picture for visual observing, albeit this was quite variable and, as ever, heavily dependent upon observing conditions, including the presence of moonlight, which latter was an especial problem for the major northern hemisphere showers later in the year. The amount of positive still-imaging recorded was well below that in the previous year, for similar reasons. Table 1 provides the chief observing totals.

Observers who contributed to the Section with 2008 data are listed below. Non-visual reports are indicated by the abbreviations 'I' (still-imaging), 'R' (radio) and 'Vi' (video), with '+ V' indicating visual data were provided as well as instrumental ones. A substantial proportion of the reports came as summaries in publications, including the American Meteor Society's (AMS's; `www.amsmeteors.org`) journal *Meteor Trails* via editor Robert Lunsford, the Arbeitskreis Meteore's (AKM's;

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IMO bibcode WGN-415-mcbeath-spams2008
NASA-ADS bibcode 2013JIMO...41..162M

Table 1 – Visual, video and viable radio hours' totals, visual and video meteor numbers recorded (with a partial breakdown of visual types), per month. A maximum of three main showers per month plus the ANT have been listed for the visual breakdowns to conserve space. In addition to these, six meteor trails were still-imaged during August in 2.5 h of photography, five more were caught in 0.5 h during October, with a further six trails imaged in 0.1 h in December.

Month	Visual						Video		Radio hours
	Hours				ANT	Meteors	Hours	Meteors	
		QUA							
January	110.6	1408			88	2231	170.7	674	7892
February	54.0	–			61	316	253.2	925	6336
March	37.4	–			20	136	450.2	768	7706
		LYR	ETA						
April	39.4	19	2		34	232	376.2	636	8289
May	119.9	–	228		117	1096	110.0	405	8745
		JBO							
June	6.0	2			7	25	111.6	356	8477
		SDA	CAP	PER					
July	108.8	260	138	208	150	1575	156.2	1103	6392
August	289.4	208	116	2788	291	5673	144.8	1327	7800
		AUR	DAU	SPE					
September	100.5	19	55	81	89	1024	179.6	906	8335
		ORI	STA	NTA					
October	61.2	265	63	64	–	817	108.7	499	9136
		LEO							
November	12.1	15	5	3	–	139	70.5	362	9591
		GEM	URS	COM					
December	55.8	119	60	38	58	560	86.4	340	10095

`www.meteoros.de`) journal *Meteoros* thanks to Ina Rendtel, and the Radio Meteor Observation Bulletins (RMOBs; `www.rmob.org`) from their editor, Chris Steyaert. Some observers' data was presented in several places, and some observers sent in separate reports directly or via a third person as well, with notable input from North American Meteor Network members (NAMN; `www.namnmeteors.org`) via that group's leader Mark Davis. Cases of duplication are not noted in the list. Electronic reporters sometimes used just a pseudonym, and where no other name could be established, these have been given within quotation marks.

Salvador Aguirre (NAMN; Mexico), Enric Algeciras (RMOB; R; Spain), "AndyCav" (England), "Aristarchus" (I; Greece), Rainer Arlt (AKM; Colorado, USA & Germany), Pierre Bader (AKM; Germany), John Baker (Colorado, USA), Andy Ball (England), Orlando Benitez (RMOB; R; Canary Islands), Peter Bias (AMS; Florida, USA), "blobrana" (UK), Lukas Bolz (AKM; Germany), Steve Bookout (AMS; Iowa & Hawaii, USA), Mike Boschat (RMOB; R; Nova Scotia, Canada), Pat Branch (NAMN; Texas, USA), Jeff Brower (RMOB; Vi + R; British Columbia, Canada), Chris Buckland (I; England), Willy Camps (RMOB; R; Belgium), "Casus Belli" (Scotland), "coldfieldboundary" (Belgium), Colin Cooper (England), Tim Cooper (AMS; South Africa), Mark Davis (AMS; South Carolina, USA), Gaspard De Wilde (RMOB; R; Belgium), "EllyTech" (England), Maurizio Eltri (Vi; Italy), David Entwistle (RMOB; R + V; England), Frank Enzlein (AKM; Germany), Mike Feist (England), Karol Fietkiwicz (RMOB; R; Poland), Stela Frencheva (AKM; Germany), Valter Gennaro (RMOB; R; Italy), Christoph Gerber (AKM; Germany), Thomas Giguere (AMS; Hawaii, USA), Vincent Giovannone (AMS; New York, USA), George Gliba (AMS; West Virginia, USA), Bill Godley (NAMN; Oklahoma, USA), Robin Gray (AMS; Nevada, USA), Wayne Hally (NAMN; New Jersey, USA), "Halo" (England), Dave Hancox (Scotland), Roberto Haver (Vi; Italy), Robert Hays (AMS; Indiana, USA), Carl Hergenrother (AMS; Vi; Arizona, USA), Carl Johannink (AMS; Netherlands), Javor Kac (AMS; Slovenia), André Knöfel (AKM; Germany), Richard Kramer (NAMN; Maine, USA), Alfred Krohmal (RMOB; R; Russia), Robert Lunsford (AMS; Vi + V; California, USA), "Maddie" (England), Ed Majden (RMOB; R; British Columbia, Canada), Tony Markham (England), "markt" (England), Pierre Martin (AMS; Ontario, Canada), Felix Martinez (NAMN; Virginia, USA), Paul Martsching (AMS; Iowa, USA), John Mason (England), Alastair McBeath (England), Bruce McCurdy (NAMN; Saskatchewan, Canada), Conor McDonald (New South Wales, Australia & Northern Ireland), Jim McGraw (AMS; Iowa, USA), Martin McKenna (I + V; Northern Ireland), "Melanie" (England), Sirko Molau (AKM; Germany), Mike Morrow (AMS; Hawaii, USA), Sven Näther (AKM; Germany), Sadao Okamoto (RMOB; R; Japan), Ingo Ortmann (AKM; Germany), Mike Otte (RMOB; R; Illinois, USA), Matthew Phipps (England), "Pro]v[etheus" (England), Jean-Louis Rault (RMOB; R; France), Jürgen Rendtel (AKM; Germany, Scotland & Tenerife), Robin Scagell (I; England), David Scanlan (England), "scanman" (Scotland), Ivan Sergey (RMOB; R + Vi; Belarus), Jonathan Shanklin (England), Andy Smith (RMOB; R; England), Ulrich Sperberg (AKM; Germany), Chris Steyaert (RMOB; R; Belgium), Enrico Stomeo (Vi; Italy), Magda Streicher (AMS; South Africa), Dave Swan (RMOB; R; England), David Swann (NAMN; Texas, USA), Richard Taibi (AMS; Maryland, USA), Ken Tapping (Vi; Ontario, Canada), Istvan Tepliczky (RMOB; R; Hungary), Robert Togni (AMS; Arkansas, USA), Maarten Vanleenhove (RMOB; R; Belgium), Felix Verbelen (RMOB; R; Belgium), Sabine Wächter (AKM; Germany & Italy), Bill Walbeck (NAMN; Pennsylvania, USA), Harry Waldron (NAMN; Texas, USA), John Wardle (RMOB; R; England), Roland Winkler (AKM; Germany), Kim Youmans (AMS; Georgia, USA).

3 Quadrantids

Despite being almost moonless for their expected maximum on January 4, around $06^{\mathrm{h}}30^{\mathrm{m}}$ UT (McBeath, 2007, p. 4), the northern winter weather ruined most Section observers' hopes visually for this shower. Luckily, some IMO observers fared better, if rather fewer than the ideal, so a reasonably robust near-maximum profile could be determined from the "live" webpage data. The radio results, while much less troubled by the weather, suffered a degree of unwanted interference in places, but overall a useful comparison between the two datasets was possible, as shown in Figure 1.

Both suggested a roughly day-long period of readily-detectable activity from the shower on January 3/4, the visual ZHR perhaps peaking around $09^{\mathrm{h}}30^{\mathrm{m}}$ UT on January 4, $\lambda_\odot = 283.^{\circ}28$, when ZHRs were $\sim 82 \pm 8$, with a possible dip in rates before this to ~ 44 near $06^{\mathrm{h}}30^{\mathrm{m}}$, $\lambda_\odot = 283.^{\circ}15$. The less-smooth radio profile suggested the better-detected peak had been in the 06^{h} UT one-hour bin that morning (beginning at $\lambda_\odot = 283.^{\circ}13$) with a second maximum about in-time to the visual one, the two separated by a distinct gap in any unusual activity during the 08^{h} and 09^{h} bins. Parts of the first radio peak were found by observers in the three main geographic regions represented, Europe, North America and Japan (albeit only one complete dataset each was available from the latter two areas), with the earlier of the two stronger phases within it falling in the hour commencing at $04^{\mathrm{h}}00^{\mathrm{m}}$, $\lambda_\odot = 283.^{\circ}05$. The second peak had the radiant below the horizon for Japan, but the North American and European systems all found something during the period from the 10^{h} to 12^{h} UT bins, $\lambda_\odot = 283.^{\circ}30$–$283.^{\circ}43$, with a declining "tail" persisting into the 14^{h} interval. As the $\sim 08^{\mathrm{h}}$–10^{h} dip would fit the typical radio meteor profile for lower detected activity during the radiant's highest elevation for Europe, it may be this has helped give that feature undue prominence, along with the $\sim 06^{\mathrm{h}}$ diurnal sporadic peak for the same region. From the comparison of the visual and radio results though, it remains a possibility that there was a genuine drop in Quadrantid activity shortly before the main visual peak took place.

4 Perseids

August's waxing gibbous Moon left some dark-sky hours for observers near the Perseid maximum, predicted for August 12, around $11^{\mathrm{h}}30^{\mathrm{m}}$–$14^{\mathrm{h}}$ UT (McBeath, 2007, pp. 13–14), but for Britain in particular, the weather was unhelpfully poor, and little useful analysis of the Section's visual results was practical. Fortunately, the IMO's visual reporters were more successful, and their rate results along with the radio data analysed by the SPA are shown in Figure 2.

Perseid ZHRs seemed to have been around seventy or higher for more than a day beginning at $\sim 01^{\mathrm{h}}$ UT on August 12, and produced an unexpectedly late peak, when ZHRs reached ~ 115 at best for an hour or so centred close to 02^{h} on August 13, $\lambda_\odot = 140.^{\circ}58$. (Note that the online "Maximum profile" results using shorter time-bins showed a peak at the same time, but with a ZHR of ~ 130). There was, however, a lengthy gap with just one datapoint in it, from $\sim 09^{\mathrm{h}}20^{\mathrm{m}}$ to $22^{\mathrm{h}}40^{\mathrm{m}}$ on the 12th. While roughly half the radio observers suffered varying degrees of interference, much of it due to late northern summer Sporadic-E, useful amounts of data were available across the expected Perseids' best from all three main geographic zones, Europe, North America and Japan, whose overlapping radiant-detectable intervals helped increase confidence in the results.

A first RRR peak on August 12 was apparent from the 05^{h} to 07^{h} UT binning periods inclusive, surrounded by a spell of seemingly rising and falling activity through to midday, which coincided with the early part of the IMO's elevated ZHRs that day. This pattern perhaps suggested the seeming drop in activity represented by the $\sim 17^{\mathrm{h}}$ visual datapoint was real. Helpfully, the radio data then strongly concurred in finding a very clear, sharp, notably stronger and better-detected prob-

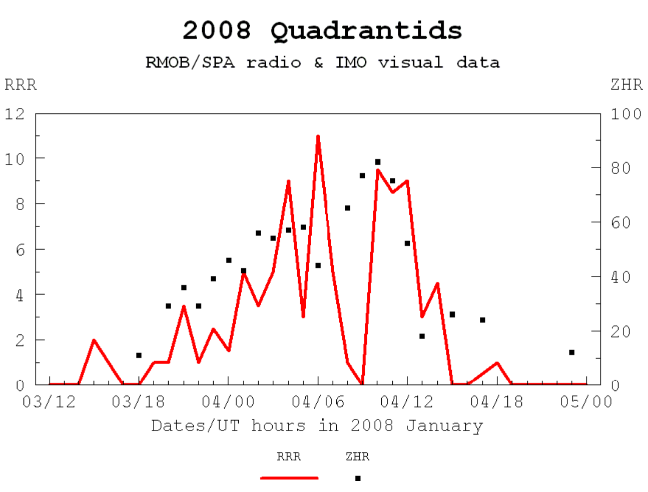

Figure 1 – The "live" IMO online Quadrantid ZHR results compared with the RRR data from midday UT on January 3 to midnight on January 5.

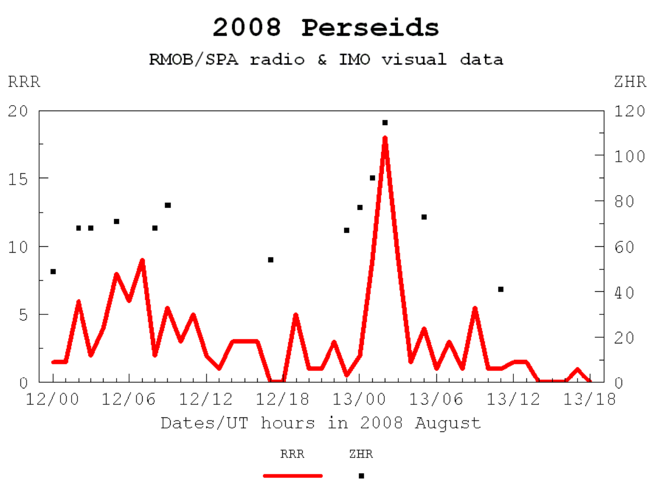

Figure 2 – A comparison of the Perseid RRR with the IMO's "live" Internet ZHR data ("Activity profile" results only, excluding error bars for clarity) between midnight UT on August 12 to 18^{h} on August 13.

able Perseid maximum in the 02^h interval the next UT morning. It is interesting the radio signatures suggested a notably greater difference in activity during this hour compared to the gentler August 12 maximum than did the visual results. There was though little to indicate an abnormal meteoroid population during the August 13 event. For instance, the SPA's limited visual results suggested no significant difference in the Perseid magnitude distributions on August 13 compared to other dates in July–August, and there was no apparent increase in the numbers of underdense radio meteor echoes that might have suggested unusual numbers of fainter meteors were present then. The radio peak's strength thus most likely resulted from it having by-chance occurred during one of the more favourable radiant-geometry periods for Europe, where most of the contributing radio observers were based. The peak's timing shows at least the need for continued vigilance by all observers, and not rely solely on advance expectations!

5 Probable September ε-Perseid outburst

As if to reinforce that last comment, less than a month after the Perseid peak came the wholly unanticipated meteor outburst probably from the shower we currently call the September ε-Perseids, SPE. IMO analyses of the event have naturally been published in this journal previously, notably of the video results by Molau & Kac (2008b) soon after the event, and of many of the, admittedly rather limited, results overall by Rendtel & Molau (2010, especially Table 1, p. 162). This current work seems to have been the first time the bulk of the radio results have been examined, however, with the RRR graph presented in Figure 3. The analysis was carried out using the radiant position for the September ε-Perseids as currently established, rather than the various estimates announced nearer the time, or the IMO's "old" SPE shower, the September Perseids, whose radiant was roughly an hour in Right Ascension northeast of the "current" SPE one, and which was thought initially to have been the likely outburst source.

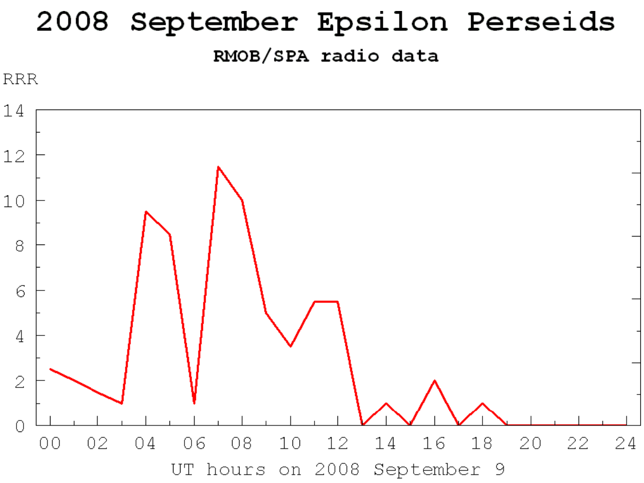

Figure 3 – RRR activity on September 9 probably due to the September ε–Perseids.

While the original findings were for a single SPE maximum rich in brighter meteors, of magnitudes +4 to −8, centred near 08^h20^m–08^h30^m UT on September 9, these radio results are at some variance with those, and perhaps suggest that activity was present at a stronger level for longer than previously supposed. The first RRR peak occurred in the 04^h–05^h UT data bins, probably centred near 04^h30^m, $\lambda_\odot = 166^\circ\!.75$. This interval saw a notably less strong response in the limited longer-duration echo count results than the second RRR peak, so may have had a more "normal" magnitude distribution. It is possible compensating for the usual diurnal sporadic peak around 04^h–08^h UT from Europe has increased the significance of the drop in activity in the 06^h bin, but it is at least as plausible the drop was real, albeit the nature of forward-scatter radio meteor observing means the origin of the activity detected cannot be exclusively attributed to a specific radiant. The absence of other data between 03^h42^m and 04^h55^m UT (the end of Enrico Stomeo's video observing to the start of Paul Martsching's visual watching – see Rendtel & Molau, 2010 for details) meant little more can be said for most of this interval, although Stomeo's video results and Martsching's visual report may hint that activity was starting to rise just before 04^h and was falling again around 05^h–05^h30^m.

The stronger RRR peak fell almost equally across the 07^h–08^h data bins, perhaps marginally better-detected in the 07^h one. This seemed to be approximately in-line with the more detailed report of bright video-meteor activity from Jeff Brower (personal communications, September 2008), whose wide-field camera typically recorded $\sim$ 1–2 sporadic meteors of magnitude −1 or brighter per night in late August to early September, but which on September 9 recorded thirteen meteors associated with the SPE radiant at least this bright between 04^h12^m–12^h26^m, eleven of those between 07^h26^m–09^h21^m, giving a mean centre timing for the latter within a few minutes of 08^h01^m UT. A peak centre timing of $\sim 07^h30^m$ would have equated to $\lambda_\odot = 166^\circ\!.87$, while one around 08^h would have been $\lambda_\odot = 166^\circ\!.89$. Activity dropped fairly quickly after this maximum, but seemed to persist in the RRR findings, possibly with a third, lesser, peak in the 11^h–12^h bins (as with the "first" RRR maximum, likely with a more typical magnitude regime), through to 13^h or so.

6 Orionids

Although quite badly moonlit – last quarter Moon was on October 21 – the Orionid maximum, due around October 20/21 (McBeath, 2007, p. 17), still attracted considerable interest following the stronger than expected returns which began in 2006, and the possibility the shower might be approaching its theoretical twelve-year peak in rates, up to maybe $\sim$ 30 in 2008–2010. While, as ever, Britain's less-than-reliable weather did what it could to hamper observations, enthusiasm and dedication allowed watchers even here to see something of the protractedly healthy activity from the shower in 2008. The IMO's "live" online results suggested ZHRs

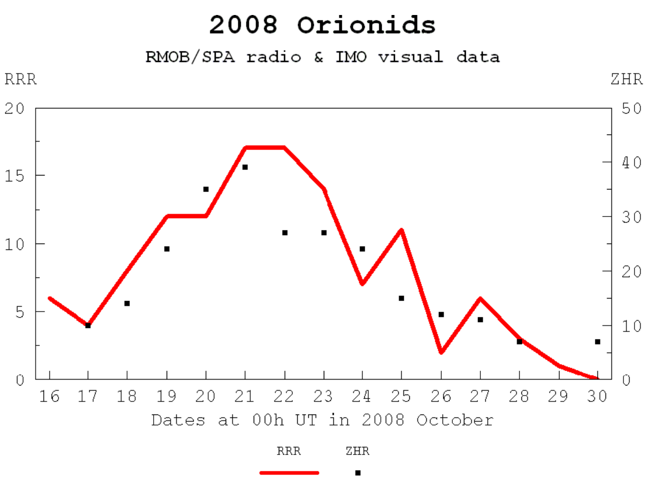

Figure 4 – Orionid epoch RRRs compared to the IMO's "live" website ZHR data from October 16 to 30.

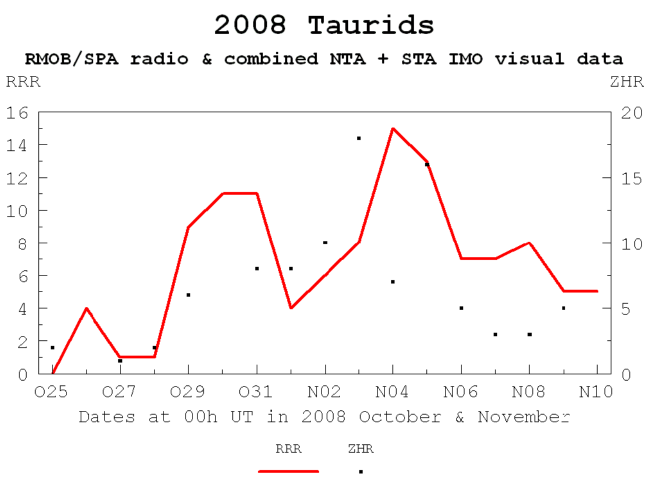

Figure 5 – A graph showing the combined Northern and Southern Taurid ZHRs from the IMO's "live" online reports, condensed into single daily datapoints without error bars, in comparison with the probable Taurid daily RRR trace from October 25 to November 10.

at best were rather lower than those in 2006 or 2007, if still around 35–40 on both October 20 and 21, perhaps marginally better, $\sim 39 \pm 2$, on the latter date. Surrounding this period, rates remained around 25–30 from October 19 to 24 inclusive. These are shown as combined single daily averages, without error bars, in Figure 4, together with the RRR findings.

Initial examinations of the early radio results by David Entwistle and myself suggested that, as often shown previously, while the Orionids failed to give a strong signature in many of the datasets, a general peak was apparent between October 19–23 inclusive. Subsequent investigations indicated a more probable maximum, if marginally-so, on October 22, in contrast to the visual information, with a possible additional minor peak on October 25, maybe because of an increased flux of fainter meteors then (that is, of underdense echoes). In re-examining the data for this paper, including additional reports not available earlier and extending the analysed period through to October 30, the significance of the radio peak on October 22 has diminished somewhat, though activity seemed to have remained similar to that on the previous date. In addition, while October 25 still seemed to have produced somewhat enhanced probable Orionid rates, the "spiky" nature of the declining RRR activity line may suggest instead this was rather less important than initially suspected, since within a moderate level of fluctuation, and aside from October 22, the character of the radio and visual activity patterns otherwise appeared nearly the same.

7 Taurids

Soon after the Orionid maximum was passed, observer anticipation rose swiftly again for a fresh return of the Taurid "swarm" of more and larger meteoroids, perhaps around late October into early or mid November, as predicted by David Asher (cf. McBeath, 2007, pp. 19–20). Given the fireball-rich nature of the previous "swarm" return in 2005 (e.g. McBeath, 2010, pp. 64–65), hopes may have been a little too high for 2008, as despite early claims for brighter than normal Taurid activity in late October to early November, subsequent inspection found little to support the Taurid brightness regime from this time having been anything other than normal (cf. Molau & Kac, 2008a, p. 149 and 2009b, p. 41 for comments based on the IMO results).

However, and applying a degree of caution because of the often unhelpfully small amount of data available, as well as the relatively low ZHR values, the IMO's "live" Internet visual reports for the Southern and Northern Taurids did show combined rates from both sources had reached $\sim$ 15–20 on November 3 and 5, rather better than the usual $\sim$ 5–10 expected for early November. See Figure 5. Whether the seemingly substantial drop in ZHRs on November 4 was genuine is uncertain as it resulted from a lack of reported Northern Taurid data only.

Examining the radio results, also in Figure 5, showed the likelihood of mildly enhanced probable combined Taurid activity from October 29 until November 6, apparently at its best on November 4 and 5. Although great care was taken in the analysis, thanks to the overlap in diurnal detectability between the Taurid and Orionid radiants from the two available radio observing regions, Europe and North America, the late October activity may have been slightly exaggerated because of cross-shower contamination due to the falling Orionid rates then, although that should have diminished with time unlike the rising trend actually found. Interestingly, the radio activity on November 3 seemed distinctly lower than the pattern of visual results might have implied. A closer investigation suggested that while probable Taurid radio rates had not been as strongly-detected that day as on the two subsequent dates, what was found was on average somewhat more persistent temporally through the usual detectable spell then than on either November 4 or 5. Overall, modestly elevated Taurid activity can be suggested from most of the late October to early November epoch, if, for visual observers especially, sadly without the strong bright-meteors component found at times previously.

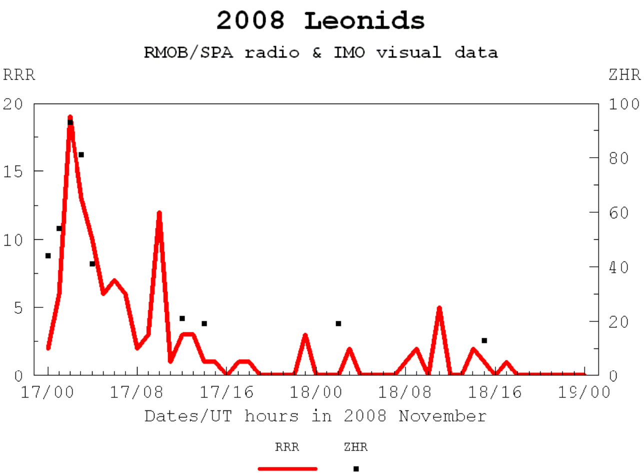

Figure 6 – Plots of the IMO's "live" Internet visual Leonid ZHR data and the RRR results from November 17 and 18.

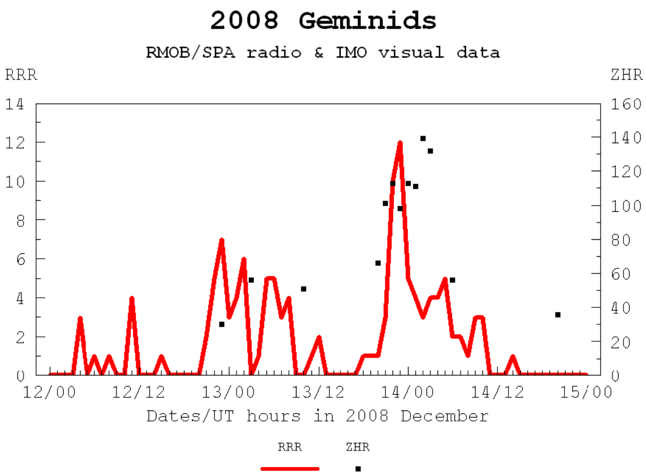

Figure 7 – A graph showing the Geminid RRR and the IMO's "live" ZHRs (without error bars) between zero hours UT on December 12 and 15.

8 Leonids

As with the Orionids, the Leonid maximum suffered badly from bright moonlight; last quarter Moon in November fell on the 19th. However, predictions were in-force for potentially strong ZHRs perhaps up to $\sim 100+$ during the first couple of hours UT on November 17 (see McBeath, 2007, p. 17), with possibly two more "ordinary" activity peaks later that day, including the annual nodal crossing one. Regrettably, if all-too commonly, the weather was what really disappointed observers' hopes. Despite this, and the consequently rather limited "live" IMO visual results, a quite sharp maximum with ZHRs of ~ 80–100 was found close to 02^{h} UT on the 17th. While equally limited in quantity and not quite as clear as the visual data, the IMO video results too suggested a probable Leonid peak between roughly 02^{h} and $03^{\text{h}}30^{\text{m}}$ that day (Molau & Kac, 2009b, pp. 39–40). The visual ZHRs, condensed into single hourly datapoints where more were given, and without error bars for clarity, are shown in comparison to the Leonid RRR activity in Figure 6.

Not unnaturally, the radio results confirmed a very clear, strong, sharp peak in the 02^{h}–03^{h} UT binning interval on November 17, $\lambda_{\odot} = 234.^{\circ}97$–$235.^{\circ}01$, with good but declining meteor echo counts persisting through into the 05^{h} bin. A further strong spike in probable Leonid rates was found in the 10^{h} bin, so $\lambda_{\odot} = 235.^{\circ}31$–$235.^{\circ}35$. While this was tolerably close to the expected node at $\lambda_{\odot} = 235.^{\circ}27$, $\sim 09^{\text{h}}$ UT, the sharpness and strength of the radio response suggested it was unlikely only that event which had been recorded then, although no other predictions had been made close to that interval. As the event was detected equally by North American and European observers at a time when the radiant was not particularly favourably-placed for either region, it seemed probable that a brief resurgence in Leonid activity had occurred then, plausibly with rates some way below the earlier strong peak, if something which sadly passed unobserved by other techniques. No good evidence was apparent for additional Leonid radio maxima after this until midnight on November 18/19 (or indeed, albeit not illustrated here, during November 16), although the possible peak predicted by Jérémie Vaubaillon for $\sim 21^{\text{h}}38^{\text{m}}$ UT on November 18 – 1932 AD dust trail, ZHRs maybe 20 – would likely have passed unrecorded due to a sub-horizon radiant from both the available radio observing regions anyway.

9 Geminids

Rounding-off a dismal northern autumn of moonlit and weather-spoilt major shower peaks, the Geminids (maximum due at about 23^{h} UT on December 13 – McBeath, 2007, p. 18 – full Moon December 12) received very limited visual coverage as well. The IMO's "live" data suggested a peak near 02^{h} on the 14th, when ZHRs of ~ 140 were found, a value noted as probably somewhat overestimated due to the poor observing conditions. Intriguingly, the radio results, while not especially clearly-defined away from it, favoured a maximum rather closer to the prediction, in the 23^{h} one-hour bin on December 13. Lower, if still patchily elevated, echo counts then persisted during the visually-reported better activity, having begun in the 22^{h} interval. As has sometimes been found before, radio system-saturation due to the strength of the Geminids can artificially reduce the meteor counts for a few observers, which may have affected the results here, although more visual results than were available would have been necessary to examine this possibility further. Equally, some unidentified problem with the radio data collected, perhaps interference, may have helped create the unhelpfully spiky nature of the RRR graph. Both this trace and the IMO's visual data are illustrated in Figure 7.

10 Ursids

With no substantial moonlight problems, it was left to the early northern winter weather to prevent much useful visual observing during the 2008 Ursids. However, as in 2006 and 2007, the shower may have again produced a stronger-than-normal return, possibly with several maxima on December 21/22, and peak ZHRs of ~ 30–35 at best, as estimated from visual and video data provided to the SPA. Apart from the expected nodal maximum, due between $\sim 07^h30^m$–10^h UT on December 22 (McBeath, 2007, p. 21), two further predictions were made online for maxima on December 22, by Jérémie Vaubaillon at $\sim 02^h18^m$, and Esko Lyytinen at circa 05^h07^m. ZHRs for both were expected to be in the range $\sim$ 20–30. Curiously, the IMO's "live" Internet visual reports, though seemingly based on similar meteor numbers and computed using the same $r = 2.5$ value as the SPA results, indicated ZHRs no stronger than 10 ± 2 from the shower at 00^h01^m and 10^h17^m UT on the 22nd. This may have been due to the bin-averaging used by the automated IMO system, however, as no data was shown between these times. Two European video Ursid reports have featured in this journal since the event as well (Molau & Kac, 2009a, pp. 43–44 and Andreić et al., 2009), both of which favoured only modest shower activity peaks for several hours centred near $\lambda_\odot = 270\overset{\circ}{.}5$, December 22, $\sim 02^h45^m$. The earlier article, using IMO data, suggested the activity level had been distinctly lower than in either 2006 or 2007.

Although many of the radio results were discussed previously in reports to the SPA's ENBs, these have been completely reanalysed with some additional data here, and the findings given in Figure 8. Nothing significant was apparent during December 21 or 23, but a series of potential peaks were remarkably clear between the 01^h to 09^h UT data-bins on the 22nd, with a possible tail in weaker activity persisting through to $\sim 18^h$. The three stronger spikes were found around 01^h, 07^h and 09^h, these respective one-hour bins centred at $\lambda_\odot = 270\overset{\circ}{.}45, 270\overset{\circ}{.}70$ and $270\overset{\circ}{.}79$, each $\pm 0\overset{\circ}{.}02$. The limited SPA visual reports hinted at ZHRs of $\sim 30 \pm 5$ around 00^h30^m and 07^h–08^h particularly, with what video data was presented directly to the Section favouring peaks around the 00^h and 02^h–03^h intervals, and possibly the 05^h–06^h period as well. The radio results suggested a less-sharp, somewhat lower, peak may have been present during the 03^h–05^h UT period too, roughly coincident with that found by the pair of WGN papers noted above. The radio response in terms of determining a possible strength for these Ursid maxima is very difficult to estimate due to a great many variable, often unmeasurable, factors, though the general clarity of the overall peak time on December 22 could suggest a rather better ZHR than the IMO's "live" visual and video results indicated. This can be only tentatively proposed, however.

11 Conclusion

A year of mixed fortunes for observers, seemingly much as always, but one which provided more than its fair share of unusual, even unpredicted, events. One wonders how many might have become more generally known without the IMO and the active support of the global meteor observing community, given the short timescale of some, and the problematic sky and lunar conditions that accompanied most. The probable September ε-Perseid outburst in particular was a strong reminder of the importance to keep observing even at supposedly "quiet" meteoric times of year. Fulsome thanks go to everyone who contributed discussions and observations to the Section in 2008, and to all observers now, good luck and clear skies!

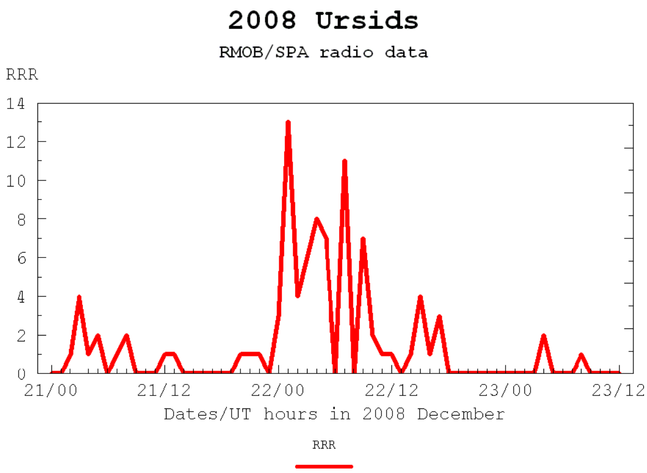

Figure 8 – The Ursid RRR data between 0^h UT on December 21 to 12^h on December 23.

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Preliminary results

Results of the IMO Video Meteor Network — June 2013

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A summary of the 2013 June observations of the IMO Video Meteor Network is presented. An overview of the year-long meteor shower analysis based on more than a million meteors is given, which confirmed 129 MDC meteor showers.

Received 2013 September 10

1 Introduction

In June we finally saw the long-expected turn regarding the weather conditions. After a much too long and cold winter and a much too wet spring, summer started with more than average sunshine and plenty of clear skies. More than half of the 63 cameras in operation that month obtained twenty and more observing nights. Stefano Crivello even observed in every night with his camera STG38. In total, we obtained 5 400 hours of effective observing time, which is just 200 hours short of the result from 2012 (Molau et al., 2012), and also the meteor yield was with 14 000 a little lower than last year (Table 1 and Figure 1). The reason is that in 2012 we had six cameras more in operation.

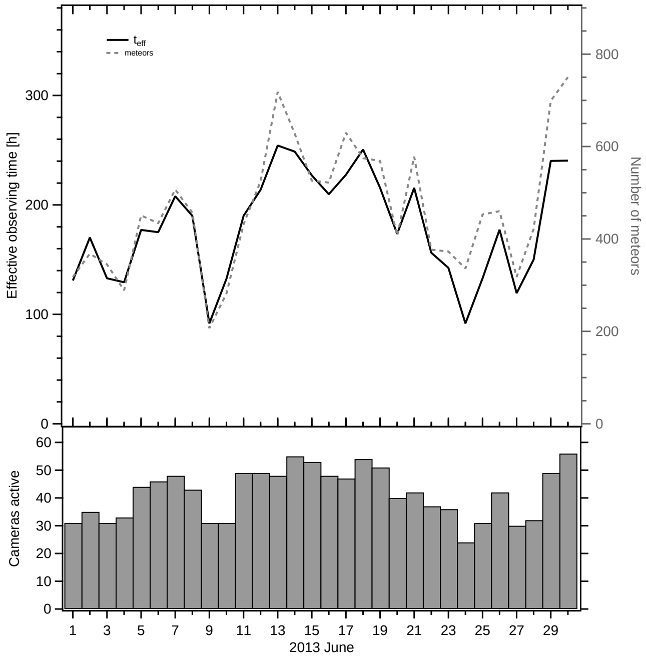

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2013 June.

2 Meteor shower list revisited

In the last few monthly reports we analysed step-by-step the meteor showers which were automatically detected in over a million single station video meteors recorded until the end of 2011. The parameters of the `strmfind` tool were set such that a shower had to last for at least five degrees in solar longitude. The identified showers were manually checked and "fine-tuned" (e.g. by shortening the activity interval and recalculating the shower parameters).

Just before the 2013 IMC in Poznan, the meteor shower list was further completed. At first, all MDC showers with status "established" were analysed in detail. In this step we identified six additional showers in our data, which are active in only a short time interval and therefore fell through the cracks of the automated search.

Then we checked for every of the few hundred showers from the MDC list that were not yet detected, if there are matching radiants in the IMO Network data. This way, we could confirm another 22 showers from the MDC list. The comparison was laborious in the beginning, because there is no tool which supports a targeted search in the MDC list. Thus, the complete MDC list of meteors showers (ignoring incomplete entries) and radiants found in our data were imported into an Excel file, and a simple search function was implemented. It finds:

- the best fitting shower from the MDC list, given an IMO Network radiant,
- the best fitting IMO Network radiant, given a shower from the MDC list,
- the best fitting MDC shower resp. IMO Network radiant given an arbitrary tuple of solar longitude / right ascension / declination / velocity.

The file can be downloaded from the IMO Network homepage `www.imonet.org` for further use.

Overall 365 000 out of the 1.06 million meteors where assigned to a meteor shower. That is, two out of three

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IMO bibcode WGN-415-molau-vidjun
NASA-ADS bibcode 2013JIMO...41..169M

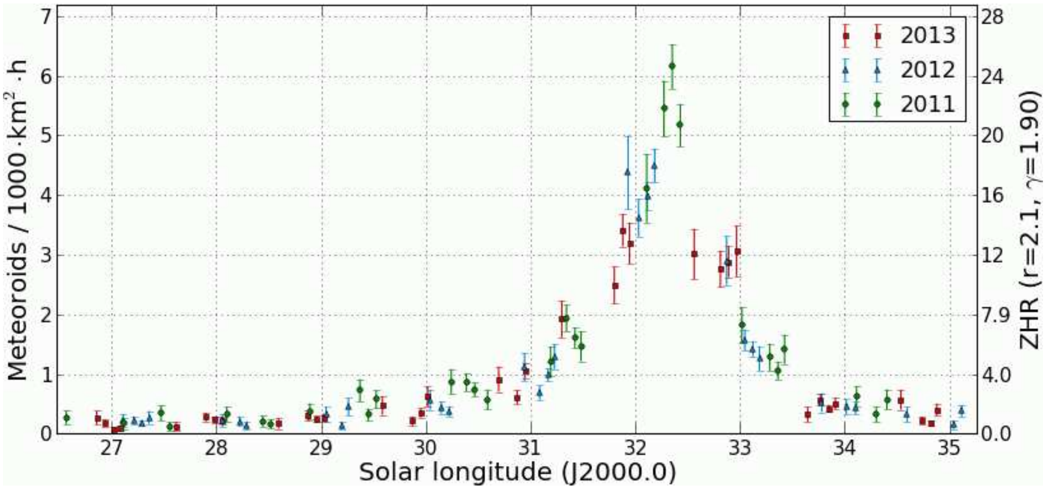

Figure 2 – Flux density profile of the Lyrids 2011–2013, created with the new MetRec flux viewer.

meteors recorded by the IMO Network are sporadic. Ignoring the Antihelion source, we could find 106 meteor showers, which correspond to 39 "established" and 77 "working list" MDC showers. There were another 23 individual sources belonging to the Antihelion source. Among these are two "established" showers (NTA and STA), 18 "working list" showers and six sources without a counterpart in the MDC list.

The reason why the sums are not identical is that we found some inconsistencies during our analysis. Based on our data we suggest that the following pairs of MDC showers are in fact one and the same shower:

- April ρ-Cygnids (348 ARC) and ν-Cygnids (409 NCY),
- c-Andromedids (411 CAN) and υ-Andromedids (507 UAN),
- July Pegasids (175 JPE), August Piscids (415 AUP) and Southern α-Pegasids (522 SAP),
- Southern δ-Aquariids (5 SDA) and August ι-Cetids (505 AIC),
- Perseids (7 PER) and ζ-Cassiopeiids (444 ZCS),
- Orionids (8 ORI), ζ-Taurids (226 ZTA) and ν-Eridanids (337 NUE),
- Southern Taurids (2 STA), Southern October δ-Arietids (28 SOA) and ω-Taurids (286 FTA),
- η-Virginids (11 EVI) and λ-Virginids (49 LVI), and
- α-Scorpiids (55 ASC) and Southern May Ophiuchids (150 SOP).

Meteor showers are reported twice, because the shower has typically a long activity interval, and one shower fits to the early or late part of the other shower.

Thirty-five "established" MDC showers as of June 2012 were not found. Among these are 13 daytime showers (which can only be observed by radar), 12 showers that were detected by radar (and which are probably invisible in the visual range) and 4 showers in the far southern hemisphere (for which our data set may be insufficient). Of the remaining 6 showers, 3 were only active in the past. In question (because we did not detect them) are, thus, only the κ-Serpentids (27 KSE), Pisces Austrinids (183 PAU) and April Lyncids (252 ALY).

The results are currently being prepared for the IMC proceedings. However, the presentation and the meteor shower list can already be downloaded from the homepage of the IMO Network.

Right after the IMC and in the same city of Poznan, the "Meteoroids" conference took place. The first author was invited to talk about the history and current status of the IMO Network. In parallel, Geert Barentsen presented a poster on the new MetRec flux viewer tool including a number of flux density profiles from the past three years. The new tool version is not only significantly faster than the old one thanks to a database redesign, but it also offers a number of new features. It is now possible, for example, to analyse the data of different years, whereby the data can either be shown independently, or as an average value. Looking at the Lyrids (Figure 2), for example, it can be seen immediately how the observations of the last three years make up for almost a complete activity profile without lengthy parameter tweaking.

Currently the tool is migrated to another server, and then it is permanently available.

References

Molau S., Kac J., Berko E., Crivello S., Stomeo E., Igaz A., and Barentsen G. (2012). "Results of the IMO Video Meteor Network – June 2012". *WGN, Journal of the IMO*, **40:5**, 176–180.

Handling Editor: Javor Kac

Table 1 – Observers contributing to 2013 June data of the IMO Video Meteor Network. Eff.CA designates the effective collection area.

Code	Name	Place	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
BERER	Berkó	Ludányhalászi/HU	HULUD1 (0.8/3.8)	5542	4.8	3847	17	78.2	310
			HULUD2 (0.95/4)	3398	3.8	671	14	72.3	103
BIRSZ	Biro	Agostyán/HU	HUAGO (0.75/4.5)	2427	4.4	1036	22	87.7	121
BOMMA	Bombardini	Faenza/IT	MARIO (1.2/4.0)	5794	3.3	739	24	110.0	370
BREMA	Breukers	Hengelo/NL	MBB3 (0.75/6)	2399	4.2	699	12	42.7	81
			MBB4 (0.8/8)	1470	5.1	1208	14	55.9	85
BRIBE	Brinkmann	Herne/DE	HERMINE (0.8/6)	2374	4.2	678	22	75.4	122
		Bergisch Gladbach/DE	KLEMOI (0.8/6)	2286	4.6	1080	20	45.4	112
CASFL	Castellani	Monte Baldo/IT	BMH2 (1.5/4.5)*	4243	3.0	371	20	83.2	138
CRIST	Crivello	Valbrevenna/IT	BILBO (0.8/3.8)	5458	4.2	1772	29	149.9	425
			C3P8 (0.8/3.8)	5455	4.2	1586	28	128.1	298
			STG38 (0.8/3.8)	5614	4.4	2007	30	159.9	592
GONRU	Goncalves	Tomar/PT	TEMPLAR1 (0.8/6)	2179	5.3	1842	23	139.1	426
			TEMPLAR2 (0.8/6)	2080	5.0	1508	24	143.7	331
			TEMPLAR3 (0.8/8)	1438	4.3	571	25	141.6	257
			TEMPLAR4 (0.8/3.8)	4475	3.0	442	24	140.4	385
GOVMI	Govedič	Središče ob Dravi/SI	ORION2 (0.8/8)	1447	5.5	1841	23	111.0	283
			ORION3 (0.95/5)	2665	4.9	2069	20	90.1	135
			ORION4 (0.95/5)	2662	4.3	1043	22	77.6	188
IGAAN	Igaz	Baja/HU	HUBAJ (0.8/3.8)	5552	2.8	403	24	99.4	173
		Debrecen/HU	HUDEB (0.8/3.8)	5522	3.2	620	24	89.7	119
		Hódmezővásárhely/HU	HUHOD (0.8/3.8)	5502	3.4	764	23	113.0	131
		Budapest/HU	HUPOL (1.2/4)	3790	3.3	475	16	68.5	34
JONKA	Jonas	Budapest/HU	HUSOR (0.95/4)	2286	3.9	445	24	105.2	142
KACJA	Kac	Ljubljana/SI	ORION1 (0.8/8)	1402	3.8	331	15	47.8	36
		Kamnik/SI	CVETKA (0.8/3.8)	4914	4.3	1842	18	78.8	302
			REZIKA (0.8/6)	2270	4.4	840	21	91.3	459
			STEFKA (0.8/3.8)	5471	2.8	379	19	82.1	249
		Kostanjevec/SI	METKA (0.8/12)*	715	6.4	640	5	28.4	73
KISSZ	Kiss	Sülysáp/HU	HUSUL (0.95/5)*	4295	3.0	355	22	96.1	63
KOSDE	Koschny	Izana Obs./ES	ICC7 (0.85/25)*	714	5.9	1464	29	229.2	1643
		Noordwijkerhout/NL	LIC4 (1.4/50)*	2027	6.0	4509	10	25.1	50

Table 1 – Observers contributing to 2013 June data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Place	Camera	FOV [°2]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
MACMA	Maciejewski	Chelm/PL	Pav35 (1.2/4)	4383	2.5	253	19	38.8	69
			Pav36 (1.2/4)*	5732	2.2	227	21	89.0	178
			Pav43 (0.95/3.75)*	2544	2.7	176	19	80.5	62
MARGR	Maravelias	Lofoupoli-Crete/GR	Loomecon (0.8/12)	738	6.3	2698	19	92.5	288
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	13	24.0	92
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	14	54.4	486
			Mincam1 (0.8/8)	1477	4.9	1084	17	75.5	184
		Ketzür/DE	Remo1 (0.8/8)	1467	5.9	2837	20	72.9	349
			Remo2 (0.8/8)	1478	6.3	4467	22	75.7	271
			Remo3 (0.8/8)	1420	5.6	1967	19	63.3	84
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	25	124.5	176
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	10	7.8	55
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	20	82.0	192
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	13	60.4	194
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	20	91.0	229
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	17	51.6	78
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	22	125.6	188
			Ro2 (0.75/6)	2381	3.8	459	24	150.9	252
			Sofia (0.8/12)	738	5.3	907	22	129.3	129
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	16	59.0	94
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	20	77.3	186
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	10	43.4	64
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	27	119.9	451
			Noa38 (0.8/3.8)	5609	4.2	1911	28	119.7	360
			Sco38 (0.8/3.8)	5598	4.8	3306	28	125.6	481
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2362	4.6	1152	15	46.6	52
			Mincam3 (0.8/6)	2338	4.5	1199	17	41.4	47
			Mincam4 (1.0/2.6)	9791	2.7	552	17	37.2	46
			Mincam5 (0.8/6)	2349	5.0	1896	18	47.5	100
TEPIS	Tepliczky	Budapest/HU	Humob (0.8/6)	2388	4.8	1607	23	85.1	242
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	8	36.2	41
						Overall	30	5 415.5	13 956

* active field of view smaller than video frame

Results of the IMO Video Meteor Network — July 2013

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

The 2013 July observations of the IMO Video Meteor Network are summarized. Flux density profiles for the α-Capricornids and Southern δ-Aquariids are presented and compared over the last three years.

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1 Introduction

July was the month that all the video observers had eagerly waited for: after we seriously fell behind the results of the previous year in the first half of 2013, or achieved a similar result at best, we could clearly improve the outcome in July 2013. That was particularly thanks to the overwhelming observing conditions. A whopping 60 of 70 active video cameras managed to observe in twenty nights and more than half of the cameras in twenty-five or more nights. Four Hungarian cameras (Hudeb, Hohod, Husor, Huful) even observed in all of July without a break.

There were plenty of nights were fifty cameras were operating in parallel, and the peak was reached on July 22 with sixty-one cameras. Hence, we obtained with almost 8 000 hours of effective observing time, an increase of 15% compared to July 2012, which was already a great month. Regarding the number of meteors, the increase was more than 25% to 35 000 (Table 1 and Figure 1). That was not sufficient to overcome 2012, but the gap has at least become smaller.

These great statistics are also thanks to a new camera: Detlef Koschny has now provided all data back until February 2013 from Icc9. That is the camera operated at La Palma which we visited during the IMC excursion last year (Figure 2). Currently this camera is the standard by which other cameras are measured thanks to the perfect observing conditions at 2 000 m altitude and the high sensitivity of the image-intensifier. Together with the twin-camera Icc7 at Tenerife it rocketed Detlef to the top of the observing statistics. Let us see whether this holds in the second half of the year when we have the long and meteor-rich nights in Europe.

In addition, Jakub Koukal has provided a first test observation to the IMO Network. The renowned visual observer from the Czech Republic is now operating both a camera with UFOCapture and Sylvie with MetRec. Jakub also plans to reactivate the camera of the late Milos Weber.

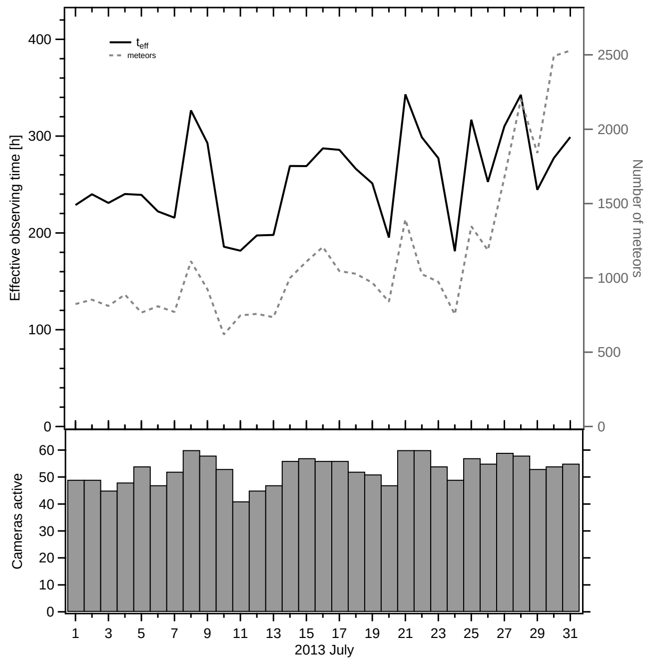

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2013 July.

Figure 2 – Visiting Icc9 on La Palma during the 2012 IMC.

2 α-Capricornids

The α-Capricornids, the number one shower in the MDC list, was found in our 2012/13 analysis between 113°

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[5]via Umbria 21/d, 30037 Scorze (VE), Italy. Email: stom@iol.it
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[7]University of Hertfordshire, Hatfield AL10 9AB, United Kingdom. Email: geert@barentsen.be
[8]Urbanizacao da Boavista, Lote 46, Linhaceira, 2305-114 Asseiceira, Tomar, Portugal. Email: rui.goncalves@ipt.pt

IMO bibcode WGN-415-molau-vidjul
NASA-ADS bibcode 2013JIMO...41..173M

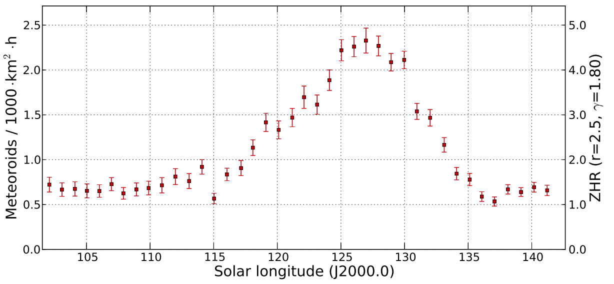

Figure 3 – Flux density profile of the α-Capricornids, averaged over three years 2011–2013.

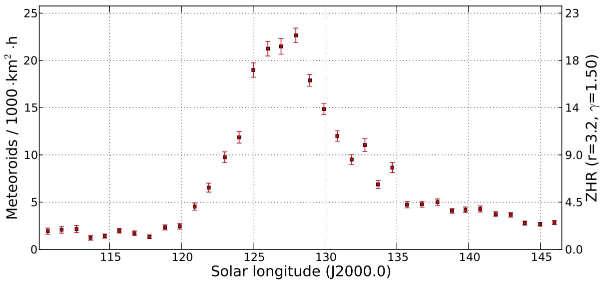

Figure 5 – Flux density profile of the Southern δ-Aquariids, averaged over three years 2011–2013.

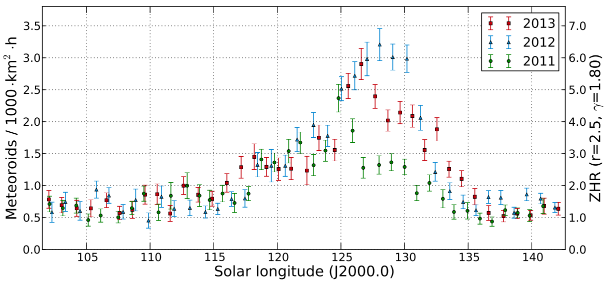

Figure 4 – Flux density profile of the α-Capricornids, shown independently for the three years 2011–2013.

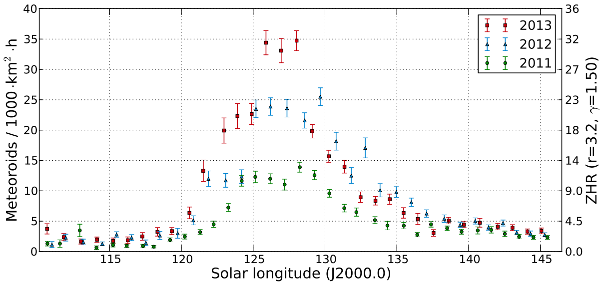

Figure 6 – Flux density profile of the Southern δ-Aquariids, shown independently for the three years 2011–2013.

and 137° solar longitude. The flux density profile averaged over the last three years, which requires no more than a mouse click with the new MetRec Flux Viewer (`http://meteorflux.io`), is shown in Figure 3. It indeed shows a profile that starts to emerge from the background at 114° and returns to it at 136° solar longitude. The peak is reached somewhere between 125° and 128° and the activity profile is slightly asymmetric with a shallow increase followed by a steeper decrease.

However that is only half of the story: last year we recognized that the activity profiles of 2011 and 2012 differed (Molau et al., 2012). Now we have an additional data set to confirm the result. We take the same flux viewer settings as for Figure 3 and only remove the option to average the data to obtain Figure 4. We see that the 2013 profile is somewhere in between 2011 and 2012: Until a solar longitude of 125° all three profiles look similar. However, whereas activity starts to fall at this point in time in 2011, it further increases until 127° this year and even until 128° solar longitude last year. By 136°, all three profiles have reached a minimum again. Therefore you cannot always average the activity profiles as annual variations may get lost this way.

3 Southern δ-Aquariids

The case of the Southern δ-Aquariids is similar. Also here we found last year significant deviations between 2011 and 2012 (Molau et al., 2012). The averaged profile from 2011 to 2013 shows an increase starting at roughly 120° solar longitude (Figure 5). After the peak at 128° solar longitude the activity falls almost as fast as it was rising before, but only until 135° solar longitude. Thereafter we see some remaining activity that can be traced until 145° at least.

The profiles of the individual years show an increase in peak activity from one year to the next (Figure 6). Whereas the maximum flux density in 2011 was measured at 13 meteoroids per 1 000 km^2 per hour, it was 25 in the last year, and even 35 meteoroids per 1 000 km^2 per hour in this year!

Unfortunately, there is no IMO Quick Look Analysis from visual data available for this shower, but the η-Aquariids have confirmed that such significant deviations can typically be confirmed by both observing techniques. We shall note, that the increase in ETA peak activity by a factor of two to three was not as unexpected as we reported in the August WGN (Molau et al., 2013). At the Meteoroids conference in Poznan we learned that Japanese Mikiya Sato had predicted just days before the peak enhanced activity by about a factor of two on 2013 May 6, thanks to some 3 000 years old dust trails. What an excellent confirmation of his prediction, which was published so late because the author did apparently not fully trust his own calculations.

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Molau S., Kac J., Berko E., Crivello S., Stomeo E., Igaz A., and Barentsen G. (2012). “Results of the IMO Video Meteor Network – July 2012”. *WGN, Journal of the IMO*, **40:5**, 181–186.

Molau S., Kac J., Berko E., Crivello S., Stomeo E., Igaz A., and Barentsen G. (2013). “Results of the IMO Video Meteor Network – May 2013”. *WGN, Journal of the IMO*, **41:4**, 133–138.

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BANPE	Bánfalvi	Zalaegerszeg/HU	Huvcse01 (0.95/5)	2423	3.4	361	26	107.1	231
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	29	165.7	1410
			Hulud2 (0.95/4)	3398	3.8	671	29	168.3	459
			Hulud3 (0.95/4)	4357	3.8	876	14	76.3	119
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BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	22	88.8	545
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			Mbb4 (0.8/8)	1470	5.1	1208	23	84.2	165
BRIBE	Brinkmann	Herne/DE	Hermine (0.8/6)	2374	4.2	678	27	117.0	361
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	27	107.3	405
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	11	65.3	349
			Bmh2 (1.5/4.5)*	4243	3.0	371	24	109.5	366
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	30	169.0	773
			C3P8 (0.8/3.8)	5455	4.2	1586	30	152.8	597
			Stg38 (0.8/3.8)	5614	4.4	2007	30	181.5	1112
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	15	49.5	498
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	25	145.7	638
			Templar2 (0.8/6)	2080	5.0	1508	26	155.1	601
			Templar3 (0.8/8)	1438	4.3	571	28	155.7	463
			Templar4 (0.8/3.8)	4475	3.0	442	25	151.6	612
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			Orion4 (0.95/5)	2662	4.3	1043	26	120.8	456
IGAAN	Igaz	Baja/HU	Hubaj (0.8/3.8)	5552	2.8	403	23	75.7	198
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		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	31	164.4	382
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			Stefka (0.8/3.8)	5471	2.8	379	26	126.5	616
		Kostanjevec/SI	Metka (0.8/12)	715	6.4	640	5	32.1	100
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	29	144.8	166
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	27	223.7	1820
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	27	195.4	2634
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	9	20.5	107

Table 1 – Observers contributing to 2013 July data of the IMO Video Meteor Network – continued from previous page.

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KOUJA	Koukal	Kroměříž/CZ	Sylvie (4/0.98)	4280	3.5	381	1	3.0	14
MACMA	Maciejewski	Chelm/PL	Pav35 (1.2/4)	4383	2.5	253	24	73.2	144
			Pav36 (1.2/4)*	5732	2.2	227	25	109.4	337
			Pav43 (0.95/3.75)*	2544	2.7	176	22	79.9	162
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			Remo2 (0.8/8)	1478	6.3	4467	27	111.9	649
			Remo3 (0.8/8)	1420	5.6	1967	24	96.9	201
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	31	186.8	407
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	29	116.0	569
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	27	151.4	929
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	25	125.6	624
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	24	87.6	211
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	20	109.0	364
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			Sofia (0.8/12)	738	5.3	907	21	128.4	312
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SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	27	107.7	401
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	24	120.2	218
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	29	150.6	1074
			Noa38 (0.8/3.8)	5609	4.2	1911	29	151.1	842
			Sco38 (0.8/3.8)	5598	4.8	3306	27	141.6	1029
STORO	Štork	Ondřejov/CZ	Ond1 (1.4/50)*	2195	5.8	4595	1	3.7	43
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2362	4.6	1152	27	102.2	204
			Mincam3 (0.8/6)	2338	4.5	1199	24	83.6	289
			Mincam4 (1.0/2.6)	9791	2.7	552	25	79.6	163
			Mincam5 (0.8/6)	2349	5.0	1896	28	98.7	319
TEPIS	Tepliczky	Budapest/HU	Humob (0.8/6)	2388	4.8	1607	30	154.3	789
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	2	1.7	11
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	5	17.3	50
						Overall	31	7983.9	35275

* active field of view smaller than video frame

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