journal of the international meteor organization

WGN

46:3
june 2018

Ten years of the Croatian Meteor Network
August–September IMO video meteors
Meteor reports in *The Astronomer* magazine

ISSN 1016-3115

WGN Vol. 46, No. 3, June 2018, pp. 87 – 110

Administrative

Ongoing meteor work

Preliminary results

History

Front cover photo

Antihelion fireball of 2018 May 13, $07^{\rm h}50^{\rm m}$ UT from Sierra Vista, AZ. Canon 350D, 30 s exposure at ISO 1600, and Canon EF 16-35 mm L 1:2.8 lens set to 17 mm and wide open ($f/2.8$). Photo courtesy: James Barba.

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 **45:1**, 1–5, and at `http://www.imo.net/docs/writingforwgn.pdf` .

Copyright It is the aim of WGN to increase the spread of scientific information, not to restrict it. When material is submitted to WGN for publication, this is taken as indicating that the author(s) grant(s) permission for WGN and the IMO to publish this material any number of times, in any format(s), without payment. This permission is taken as covering rights to reproduce both the content of the material and its form and appearance, including images and typesetting. Formats include paper, CD-ROM and the world-wide web. Other than these conditions, all rights remain with the author(s).
When material is submitted for publication, this is also taken as indicating that the author(s) claim(s) the right to grant the permissions described above.

Legal address International Meteor Organization, Jozef Mattheessensstraat 60, 2540 Hove, Belgium.

Ongoing meteor work

Ten Years of the Croatian Meteor Network

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

The article describes the birth and the evolution of the Croatian Meteor Network (CMN) in its first 10 years of existence. It is an expanded version of talk given on the IMC conference in Petnica (Serbia, 21–24 September 2017). The article pays tribute to all participants in this process and also briefly describes the main achievements of the CMN, as we see it. Among these achievements are software/hardware development of cheap and fully automated observing stations, work on meteor orbit databases and search for possible new showers, and lucky recovery of Križevci meteorite.

Received 2018 February 2

1 Introduction

About ten years ago, during the maximum night (2006 August 12/13) of Augusts' Perseids, the first tests of video meteor observing with cheap CCTV cameras (model 1004x) were carried on at the astronomical observatory of Pula. Although the night was far from optimal, with an almost full Moon and extreme humidity in the atmosphere, with unsuitable lenses on the cameras (2mm F/2), the first three meteors ever were recorded with this method (Figure 1) and the seed for the Croatian Meteor Network was planted.

These three meteors inspired us to continue experimenting with the cameras and computer software. Using better lenses, we got 44 meteors in the morning hours on the night of Orionid maximum (Figure 2). Soon we defined the final camera version, with 4 mm F/1.2 lenses and cameras modified by Filip Lolić, that was used to gather 192 meteors during the night of Geminid maximum 2006.

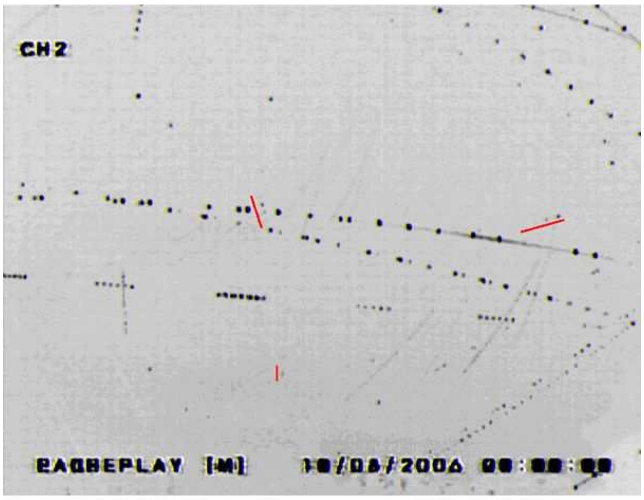


Figure 1 – Three meteors recorded on the night of 2006 August 12/13 mark the "morning twilight" of the Croatian Meteor Network. Red lines are drawn in parallel with meteors, which are otherwise hard to see.

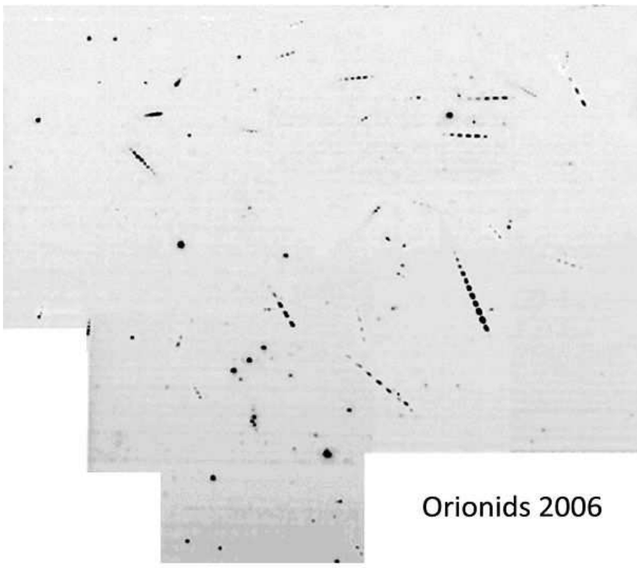


Figure 2 – Orionids 2006, recorded in the testing phase.

2 Early years

A short time after these first steps, the Višnjan Science and Education Center, that itself has a long tradition of meteor observing dating back into 80-ies of the last century, initiated the project of the Croatian Meteor Network (CMN). At first, only 5 cameras were included in the network (some are on the Figure 3), increasing over time to include more than 40 locations

[1]Astronomical Society Istra Pula, Park Monte Zaro 2, 52100 Pula, Croatia.
Višnjan Science and Education Center, Istarska 5, 51463 Višnjan, Croatia.
Email: damir.segon@pu.htnet.hr
[2]Višnjan Science and Education Center, Istarska 5, 51463 Višnjan, Croatia.
Email: korado@astro.hr
[3]University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10000 Zagreb, Croatia.
Email: zandreic@rgn.hr
[4]Department of Earth Sciences, University of Western Ontario, London, Ontario, N6A 5B7, Canada.
Email: dvida@uwo.ca
[5]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia and Faculty of Electrical Engineering, University of Osijek, Kneza Trpimira 2B, 31000 Osijek, Croatia.
Email: filip.novoselnik@gmail.com
[6]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia.
Email: ivica.skokic@gmail.com

IMO bibcode WGN-463-segon-cmn
NASA-ADS bibcode 2018JIMO...46...87S

that contribute or did contribute to the CMN databases: Bačka Palanka, Brač, Broćanac, Čiovo, Daruvar, Duino, Hum, Kaštelir, Koprivnica, Križevci, Makarska, Mali Lošinj, Merenje, Ogulin, Osijek (3), Petrovsko, Pula (3), Rijeka (2), Rovinj, Rovišće, Sisak (2), Stalis, Šibenik (2), Šolta, Tičan, Valpovo, Varaždin, Velika Pisanica, Veli Lošinj, Virovitica, Vis, Višnjan (2), Zagreb (4) and Žrnovnica. This does not mean that 40 cameras are running continuously (we have only 30 modified cameras at our disposal) but that some cameras were moved from one location to another, with observing logs ranging from 0 (no observations made at all) to many years of active work in length (Figure 4).

Figure 3 – The "evolution" of CMN camera cases, starting with the basic (left) to the currently used (right).

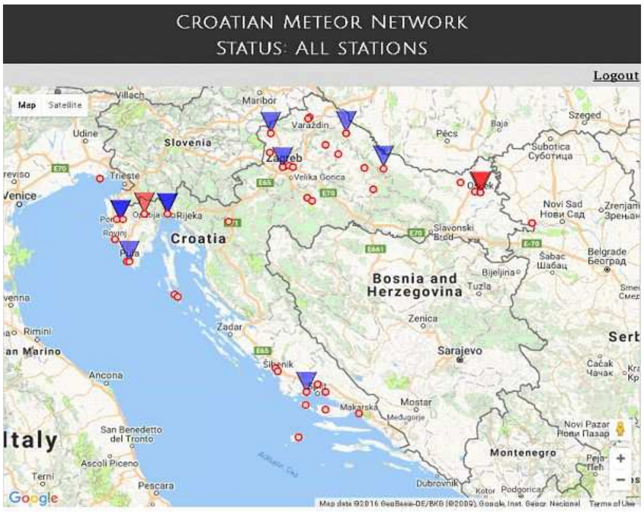


Figure 4 – The locations of all (current and past) CMN observing stations.

From the start onwards, the main goal of the CMN was determination of meteoroid's orbits, which means that each particular meteor has to be recorded by at least two significantly separated cameras (on the order of tens of km at least). In performing this task, one of the basic questions is how to cover as large as possible volume of the atmospheric layer (say between 90 and 110 km above the ground) in which meteors mostly occur. This provides the largest number of double-station recordings possible. The problem translates into defining azimuths and elevations of the optical axis and the field of view (FOV) of each camera in the network. The initial 5 cameras had no chance to cover all of the sky over Croatia, which itself has a very difficult shape of a boomerang (or hook, or whatever you would like to call it). One would have to use a lot of all-sky cameras for such a purpose, a number that was beyond our reach at that time. Although the limiting magnitude varies between individual cameras, all have the same field of view of $64 \times 48°$ (Figure 5) that roughly corresponds to the useful FOV of the naked eye.

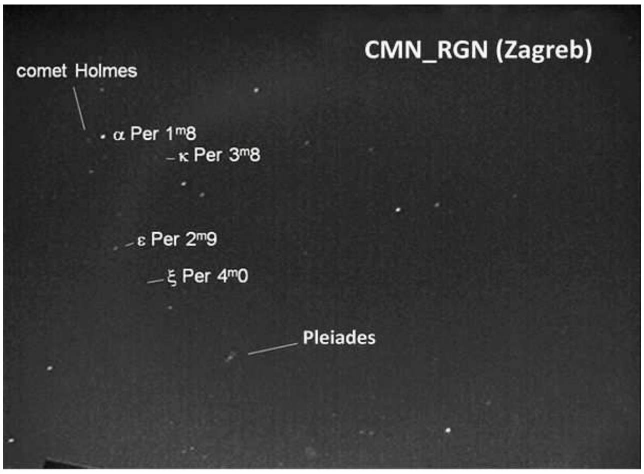


Figure 5 – An example of the images produced by a CMN camera, with a limiting magnitude of about 4. Interestingly, a comet was also captured on the image. Note that this particular camera is near the center of Zagreb, the capital of Croatia with about 1 million inhabitants and a lot of light pollution.

At the beginning of the CMN, cameras worked in separate pairs to allow for the triangulation. The very first double station meteor was recorded on 2007 March 13 (so much about unlucky date 13th) with cameras from Rovišće, near Bjelovar, operator Denis Štogl and Višnjevac, near Osijek, operator Dario Klarić. We consider this date the birthday of CMN, although later comparisons with the data from nearby networks had shown that we had double-station meteors with them even before that date.

Only after more cameras became active, were cameras reoriented for more complete coverage of the Croatian sky. We thus achieved the full coverage of the Croatian sky at heights of about 100 km somewhere in the middle of 2008 (Figure 6).

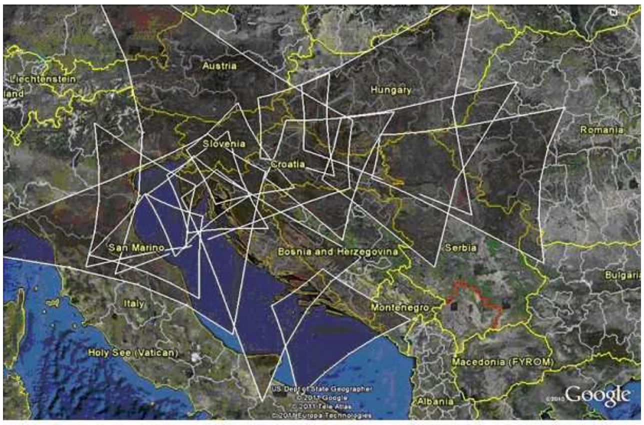


Figure 6 – The sky coverage of the CMN cameras in the middle of 2008.

In 2007 there were just a few active video meteor networks world-wide, basically divided according to the detection software they used for recording and detection of meteors. The Japan SonotaCo Network was (and still is) based on the so called UFO software suite[a] (Capture, Analyzer and Orbit module) and is spread across all the Japan with over 100 cameras/stations. International meteor Organization (IMO[b]) Video Network is active mainly in Europe and is based on MetRec software[c] (Sirko Molau) with over 50 cameras/stations. Unfortunately, CMN members were not able to adopt one of these two options, due to the high cost of required hardware (even today most hardware in the CMN is financed by private funds of its members). Instead, we start using abandoned SkyPatrol software (written by Mark Vornhusen, Figure 7) which is able to run on old, used, or donated, PC's available at that time locally. More, it worked with a lot of cheap video capture cards, which were readily available and easy to set-up. On the other hand, SkyPatrol is a detection software that provides nothing more than (sometimes unreliable) meteor detection and captured images in a special compressed format. There is no information whatsoever about positions of stars on the image, distortion correction or star/meteor photometry. This was, however, just another challenge for CMN, to seek the solutions to these problems. The first such solution was SkyPatrol Analyser (SPA) software written by Igor Terlević, that allowed for manual analysis of captured images. It is precise, but tedious job which is nowadays done only in exceptional cases. In 2008. we started cooperation with Peter Gural, a software guru in the field of video meteor astronomy (he is the author of the first meteor capture and detection software – MeteorScan, which ran on MAC computers).

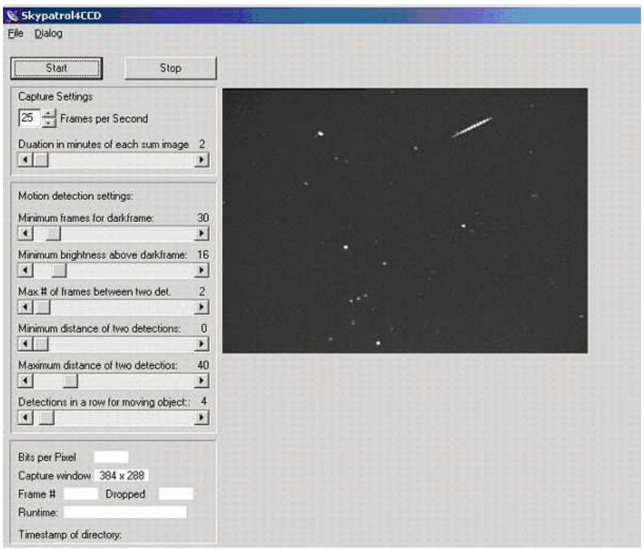


Figure 7 – The Skypatrol GUI, as it looks on the PC screen.

With the help of SPA we were able to extract all information we needed for meteor detection and analysis from SkyPatrol images, thus allowing us to develop other original software solutions (like SkyFit, the software that finds the initial astrometric solution, Figure 8). Later on Peter Gural used his CMN experiences in his work on the CAMS system, by improving unique video compression used by SkyPatrol enabling better astrometric and photometric analysis in CAMS software (Jenniskens et al., 2011).

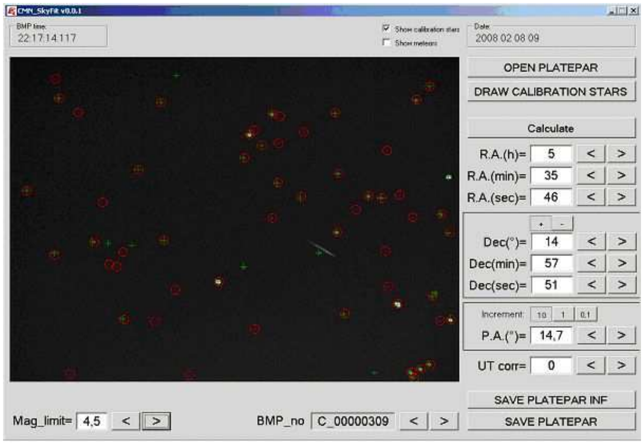


Figure 8 – The SkyFit GUI, as it looks on the PC screen.

While SonotaCo network is oriented towards meteoroid orbits, which requires at least double-station detection of a particular meteor, IMO network is primarily focussed on single station detections, obtaining the radiant information from the assumed mean height of the meteor and its angular velocity. Ever since the time CMN was started, it has contributed significantly to meteoroid orbit databases on global level. For instance, 63% of all orbits of meteoroids detected above Europe in 2008 was provided by the CMN (see Figure 9). As other networks grew, this percentage naturally dropped, going below 10% somewhere around 2012.

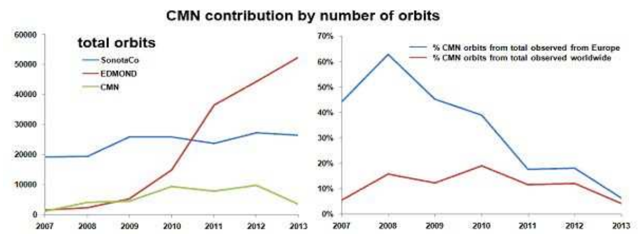


Figure 9 – CMN contribution to global meteoroid orbit databases through years.

3 Growth and refinement years

From 2011 on the critical mass of observers using UFO software appeared in Europe too, mostly by reorienting national networks (Slovakia, Poland, Czech Republic, Hungary) or through newly formed networks (Italy, France). It should be said here that data collected by the MetRec software can be transferred into UFO format, so that under leadership of observers from Czech republic and Slovakia EDMOND database[d] was created. This database unites all observations made from Europe, resulting in significant increase of new orbits obtained every year (currently about 50 000 orbits per year, compared to 25 000 orbits form Japan). In October 2010 CAMS system started working on the west

[a]`http://sonotaco.com/e_index.html`
[b]`http://www.imonet.org/`
[c]`http://www.metrec.org/`

[d]`http://www.daa.fmph.uniba.sk/edmond`

coast of the USA, thus filling the “gap” between the time zones of Europe and Japan. The CMN observations from 2007–2011 were forwarded to EDMOND in UFOOrbit `csv` format and those are now incorporated in their meteor orbit database.

Figure 10 – A new sky coverage after cameras were repositioned to get better coverage of lower atmospheric layers.

As a result of this, the percentage contribution of the CMN to the European and world databases rapidly drops and it is not considered the primary goal of the CMN anymore.

4 Later years

One of CMN major achievements has been the recovery of the Križevci meteorite (The meteoritical Society, 2017) about which we will discuss later on in this paper. The lesson learned on the Križevci meteorite taught us that we need atmospheric coverage at lower heights, at least down to 20 km, or even lower. We currently try to cover that “low” part of the atmosphere by modifying camera orientations. The main problem with cameras that look at lower atmosphere layers is that in such a case they also look at meteors that are more distant from the camera, meaning that the brightness of meteors will be lessened by the long light path from the meteor to the camera (remember inverse square law!). More, atmospheric absorption is generally much larger on a such long path passing through the lower atmosphere layers, where absorption is at its largest. On the other hand, the star brightness is not affected as much. Here, the change in distance plays no role as stars are too far away for the effect of the path difference be noticeable et all, so only atmospheric absorption remains. With meteors, it is not unusual that a nearby station registers a bolide (meteor brighter than Venus or brighter than about -4^m) passing close to the zenith, while a distant station barely registers the same meteor as a faint trail near the horizon. For example, if a meteor passes through zenith for one station, it is about 100 km away from the camera. If some other camera sees the same meteor at height of about 30 degrees, it will be about 200 km from the camera, and about 1.5^m fainter. If we go even lower, the brightness drop is much more pronounced. This means that the camera that looks at low elevations near the horizon will detect only brighter meteors, and faint ones will be lost. This conclusion was confirmed after we realigned our cameras to lower atmospheric layers. Afterwards, the number of double station meteors dropped significantly. However, the orbits we get with this new approach are in most cases more precise because brighter meteors usually last longer and have larger angular lengths.

Concerning the cameras, the same basic model is used even today: a modified 1004X surveillance camera based on 1/2” Ex-View HAD Sony ICX255 sensor. Two years ago we started testing new (but also cheap) cameras on the market, resulting in selecting Sony ICX673 Ex-View HAD II camera for the future use. So far, three CMN stations use these new cameras, but after gathering some experience and defining the fine adjustment of camera parameters (old cameras could not be fine-adjusted) we plan to gradually change all old cameras for the new ones. The old cameras will find new uses in our future projects. With evolution of CAMS software we gradually change the software that our stations use, primarily by replacing the SkyPatrol software with ADAPT program that records, detects, performs astrometry and photometry and uploads the data to CMN server automatically. ADAPT was written by Denis Vida who presented it on the IMC in Giron in 2014 together with the BinViewer software (Vida et al., 2014) for analyzing FF files produced by CAMS package (Figure 11). Denis takes care of refining and improving ADAPT further.

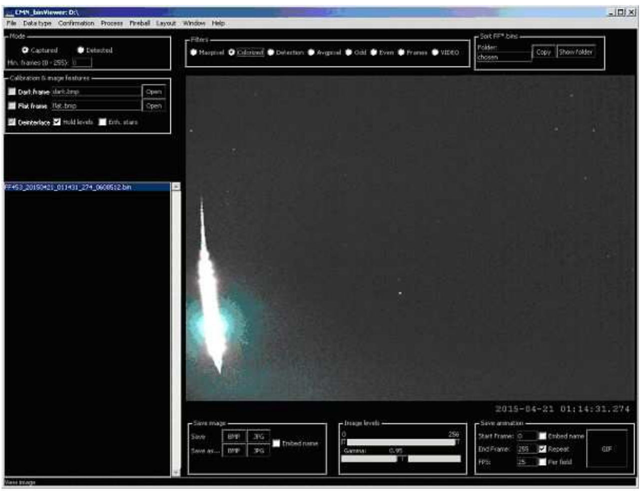


Figure 11 – The BinViewer GUI, as it looks on the PC screen.

5 CMN in meteor science

Soon after the CMN was started we joined the IMO and for the first time presented CMN on the IMC conference in Sachticka, Slovakia in 2008 (Figure 12, (Andreić & Šegon, 2010)).

In the next year we had the privilege of organizing the IMC 2009. in Poreč, and after that we are regularly present on IMC conferences and, with our articles, in the WGN.

During the night of 2011 February 4/5, astronomers all over the World were busy observing the very close passage of asteroid 2011 CQ1, that passed at the minimum distance of only 5471 km from the Earth. In the

Figure 12 – Ž. Andreić (standing on the left image) and D. Šegon (sitting, 2nd row in the middle, right image) presented the freshly formed CMN on IMC 2008 in Sachticka.

Figure 13 – Group photographs from the IMC 2009 that was organized by the CMN members and that took place in Poreč, Croatia.

same night, several CMN cameras at $23^{h}20^{m}40^{s}$ UT registered a very bright bolide somewhere above Križevci, the small town in the northern Croatia. The estimated maximum brightness was above -14^{m}, about 5 times more luminous than the full Moon. Many people saw the bolide, and it was also seen, and recorded, by our colleges from Slovenia. After some frenetic internet/ skype activities (one colleague compared it with the Rosevell case, after seeing images downloaded from his CMN camera) we had images from 5 CMN cameras that recorded the bolide, and we manually determined the rough trajectory and possible fall site. Luckily we already had SkyPatrolAnalyser software at hand, and it was crucial in the success of finding the actual meteorite afterwards.

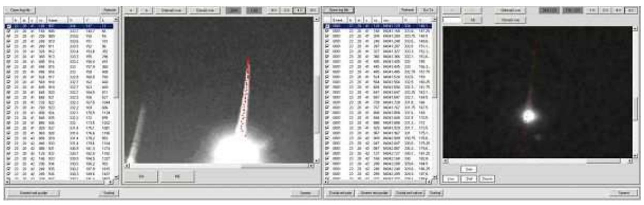


Figure 14 – Screen shots of the first analysis of the Križevci bollide.

We were in extreme hurry, as any snowfall (it was February after all) would make searching impossible. More, locals already started to plow their fields which could also cower the meteorite and prevent its finding. Curiously, only about a month before, astronomical club "Perseids" was formed in Križevci and its members were very active in the following searches, together with members of "Explora" club from Novigrad (in Istria peninsula) and many amateur astronomers from all over Croatia. After only 7 days of frenetic calculations, phone calls and tons of e-mails, the first search was organized, but due to the lack of data about wind directions and velocities the expedition has been prevalently of training character. As expected, the first search revealed nothing, but the second one, 15 days after the fall itself (Reponj, 2011) was a success, resulting with a 291 g meteorite fragment that now carries the official name "Križevci" (Figure 15).

Figure 15 – The second search team (left) and the first picture of newly found meteorite (right).

The first data about Križevci meteorite were published in the WGN (Šegon et al., 2011) and presented on the IMC 2011 in Sibiu. This case taught us a lot about use of a video network for finding meteorites from bolide recordings (Šegon, 2011). First, and the most important, CMN had demonstrated that it is possible to find a meteorite from video observations only. It also underlines the importance of a good coverage of the atmosphere at heights smaller than about 30 km and the rapid gathering and processing of bolide data. International cooperation was also an important factor, as is obtaining good wind data (needed for predicting the final, dark, part of the meteorite trajectory and its impact point on the ground). With Križevci meteorite, we had unusual luck that the official meteorological balloon was rising and measuring this very data at the moment the meteorite fell, and so only about 40 km from the town of Križevci! What followed took much more time (and nerves). First, small samples were analyzed isotopically, the meteorite was classified (a H6 chondrite) and Ian Lyon form the University of Manchester did the first ever 3D roentgen tomography of the meteorite. In the meantime, the Meteoritical society[e] reached consensus on the meteorite name so that from the 2014 June 26, the meteorite is officially named "Križevci". After that, in a large international cooperation all details about the fall of Križevci meteorite were published in "Meteoritics and Planetary Science" (Borovička et al., 2015). The leading authors of that paper are word experts in the field of meteoritics, Jiri Borovička and Pavel Spurny, with coauthors from CMN and Slovenian meteor network. We finish the part about Križevci meteorite and its significance for the CMN with two quotes from the MAPS article: "Križevci became the first meteorite recovered on the basis of amateur meteor network" and "In result, Križevci belongs to the top ten instrumentally observed falls in terms of precision and complexity of obtained data". At the time, it was only 19th meteorite with the known orbit (today the number has grown to 25 or so known orbits). We at the CMN are very proud of this achievement.

Another significant contribution of CMN to meteor science was the observation of Draconid outburst in 2011. The passage of Earth through meteoroid cloud

[e] `http://meteoriticalsociety.org/`

released from comet 21P Giacobini-Zinner during its perihelion passages in 19th century and 1900 and 1913 passages was predicted to happen on 2011 October 8. The meteor outburst was successfully recorded by CMN cameras. Despite bad weather conditions (a cloud front with lightning and rain passed over Croatia at that time) 53 Draconid orbits were obtained, plus some sprite photographs. Preliminary results were presented in IMC 2012 in La Palma, while the more complete results were published in "Earth, Moon and Planets" (Šegon et al., 2014). Comparison of our results with results of other networks in the world (Vaubaillon et al., 2014) confirmed that our orbits have similar precision to other amateur networks and are close to professional network results (at that time, of course).

One of the main goals of the CMN in the past years has been the search for new meteor showers. Initially, such a search was performed visually, using graphical plots of meteor radiants for a certain night or several nights in succession. Basically, such a plot is formed by plotting radiant point for each meteor on an appropriate star map. Additionally, we usually color coded the geocentric velocity, i.e. the radian point had color that corresponds to the particular geocentric velocity. It is very easy to see any grouping of individual radiants on such a plot. However, this is a qualitative, and to some extent subjective, criterion, as is the number of meteors that cluster near a common radiant point that is required for the grouping to be declared a possible new shower. We soon changed to more objective methods, using one or several so called similarity criteria (first such criterion was defined by Southworth and Hawkins in 1963, (Southworth & Hawkins, 1963)), together with the lower limit of the meteors in group. The first CMN catalogue of meteor orbits was for the year 2007. It indicated existence of a shower preceding Perseids that was so obvious that we delayed reporting it while checking if it is actually a separate shower, or simply a gathering of early Perseids. Only after we gathered (in our opinion!) enough orbits of this supposed new shower, and checked for its existence in SonotaCo catalogue (Šegon et al., 2012) did we report it to the IAU Minor Planet Center (MDC), an IAU body that takes care of meteor related data. The shower was named zeta Cassiopeids, IAU MDC #444[f] (see Figure 16).

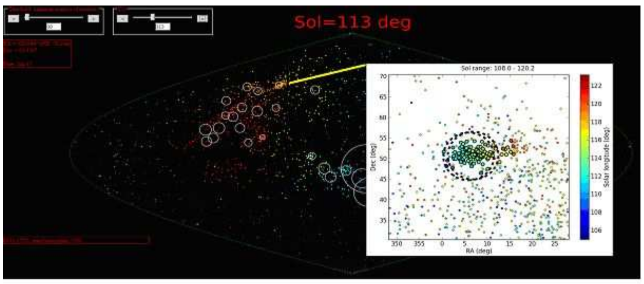


Figure 16 – The graphical representation of the zeta Cassiopeids as the result of the CMN 2013 search for meteor showers.

[f]https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00444

Interestingly, at the same time the existence of this shower was discovered independently by the Polish meteor network[g] and was published in the same WGN issue as our article, but with a different title (Zoladek & Wisniewski, 2012). A part of scientific community still thinks that zeta Cassiopeids are early Perseids. We are hoping that it will be recognized by the IAU MDC as a separate shower during the next general assembly of the IAU (scheduled for 2018), and that it will be moved to the list of established showers of the IAU MDC (IAU MDC, 2017).

In the same year, on the IMC conference in La Palma, we reported another new shower candidate, August iota Cetids (Vida et al., 2012) and soon after in WGN announced another eight candidates (Šegon et al., 2013).

We soon concluded that the search method described before is not good enough for fully analyzing all the data we had at hand. Thus, during 2013 we changed our approach to the problem of new minor showers and did a complete analysis of data set of about 130 000 orbits (all our and SonotaCo catalogues up to date combined together). The idea of the new analysis is that each individual meteor orbit is compared with all the other orbits in the database, using strictly defined similarity criteria (three different criteria had to be satisfied simultaneously). Through an iterative process the mean shower orbits are then extracted. In the process, the mean orbits obtained this way were also compared to the orbits of the known NEO objects (both asteroids and comets) to see if there exist a potential parent body for the shower in question. It should be stressed here that this analysis alone is not enough to define the parent body (if it exists). Each case has to be analyzed in detail separately, a process that is constantly in progress. At the time about 500 showers were on the IAU MDC list of all showers (known + potential ones) that were discovered by different methods (photography, video, radar). Our approach confirmed most of them (Figure 17) and for some pointed to possible parent bodies.

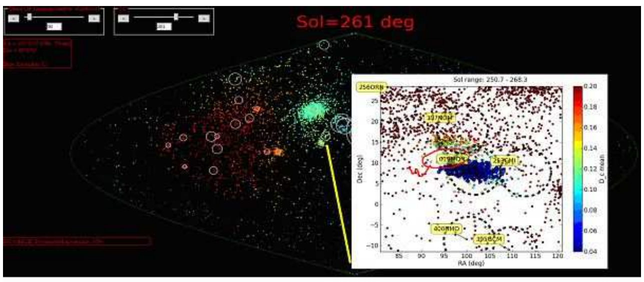


Figure 17 – Example plot from the CMN 2013 search for meteor showers representing the meteor radiants for solar longitude 261° and details for the December Monocerotids shower (MON, IAU #019).

The confirmation of known showers justified reporting of a large number of new potential minor showers found by this approach and, in some cases, of their potential parent bodies. Complete results of the search

[g]http://www.pkim.org/

were presented on the IMC 2013 in Poznan (Figure 18) and presented on the Meteorids 2013 conference (Šegon et al., 2013). The detailed analysis of link between some showers and their potential parent bodies was carried out in cooperation with J. Vaubaillon (Paris Observatory and Institute for Celestial Mechanics France) and published in A&A (Šegon et al., 2017; Figure 18). The link was confirmed for 7 of 13 analyzed cases. In three cases parent bodies are comets, in 4 asteroids on Jupiter family orbits, so there exist possibility that they are not asteroids but extinct comets.

Figure 18 – Socializing during the IMC 2013 in Poznan. International Meteor Conferences are ideal place to learn and exchange thoughts not only with amateur astronomers but professional ones as well.

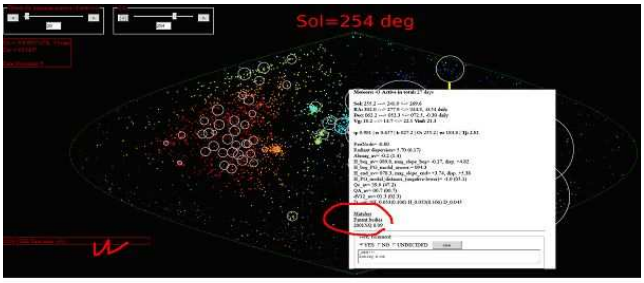


Figure 19 – Example plot from the CMN 2013 search for meteor showers representing the meteor radiants for solar longitude 254° and details for the possibly new shower 66 Draconids (SSD, IAU #541) which has been found as possibly connected with asteroid 2001XQ.

In the end, we reported more than 100 possible new showers. This naturally raises the question about the versatility of the search procedure and reality of the candidate showers. This is where scientific community steps in. Thus EDMOND people carried on a similar search, but based on a different set of orbits which are not included in our combined dataset. In their search they used two different methods, Kornoš using classical D-criterion which is based on Keplerian orbital elements (Kornoš et al., 2013) and Rudawska with the new criterion based on geocentric data (sol, RA, DEC, v_g). In 4 papers published in Icarus P. Jenniskens (NASA-CAMS) also checked the existence of showers in IAU MDC database, using a search method similar to ours, only without the final iterative process. He used 74 000 orbits in CAMS dataset. Results of these independent searches are very interesting: P. Jenniskens found all showers we found by our first search, but missed most we found in the second search. Kornoš and Rudawska on the other hand, have found about 75% of all showers reported as new by CMN, using a little smaller dataset than ours. Last, but not least, the number of showers that IAU added to the "established" list on the last general assembly (Hawaii, 2015) is also important. From the total of 18 showers added to the "established" list, 8 were discovered by CMN. They are #510 JRC – June rho Cygnids[h], #512 RPU – rho Puppids[i], #524 LUM – lambda Ursae Majorids[j], #526 SLD – Southern lambda Draconids[k], #529 EHY – eta Hydrids[l], #533 JXA – July xi Arietids (connected with comet C/1964N1 Ikeya)[m], #549 FAN – 49 Andromedids (connected with comet C/2001 W2 (BATTERS))[n] and #569 OHY – omicron Hydrids[o]. We are eagerly waiting for the general assembly in Vienna 2018.

During this work we also contributed a lot to the IAU MDC list itself, by finding inconsistencies, typographic or logical errors, doubly reported showers, etc.

6 Latest developments

Last, but not least, we are finishing our own recording and meteor detection software. The idea behind is to round-up our software, and to move from PC based recording, with all the troubles it brings with itself (high costs, unreliability, problems with ever-changing OS's, etc.) to Raspberry Pi (RPi) minicomputers. RPi's are built with mobile phone components and were originally meant to be hardware/software learning devices, but are in the meantime so powerful that a lot of very serious applications run on them. They used a modified Linux as their OS, everything being in the public domain. The complete system currently costs about 150 EUR (Figure 20).

Figure 20 – Dario Zubović during the IMC 2015 presentation of the Raspberry Pi based meteor station. The complete recording station based on RPI minicomputer is shown on the right.

The low cost radiometer project presented at IMC 2015 is being developed even further, with first fireball light curves produced during late 2017 (Vida et al., 2015). As we are writing this paper, the RPi based system produced its first orbits, exactly 10 years after CMN was born. A nice 10th anniversary, indeed!

[h] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00510`

[i] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00512`

[j] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00524`

[k] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00526`

[l] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00529`

[m] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00533`

[n] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00549`

[o] `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/pojedynczy_obiekt.php?kodstrumienia=00569`

7 Education

From the beginning on CMN was more than a scientific network. It served as an educational tool and sometimes most of its members were pupils, students or primary and secondary school teachers, whose main goal was not the science itself, but introduction to scientific work and communication. The main burden of educational activities is carried on by the Višnjan school of Astronomy (Figure 21), that from its very beginning has a tradition of meteor work, from purely visual at the beginning, to radio and video observations today.

Figure 21 – The meteor group at the Višnjan school of astronomy, working with CMN records and data.

8 Conclusions

Last, but not least, a complete list of publications (updated a few times yearly), catalogues and a lot of information about CMN and its activities can be found on the CMN webpages[p].

Acknowledgements

We would like to say a big THANK YOU to all Croatian Meteor Network members, in alphabet order: Alan Pevec, Aleksandar Borojević, Aleksandar Merlak, Alen Žižak, late Berislav Bračun, Dalibor Brdarić, Damir Matković, Danijel Reponj, Dario Klarić, Dario Zubović, Dejan Kalebić, Denis Štogl, Denis Vida, Dorian Božičević, Filip Lolić, Filip Novoselnik, Gloryan Grabner, Goran Ljaljić, Ivan Gašparić, Ivica Ćiković, Janko Mravik, Josip Belas, Korado Korlević, Mladen Korlević, Igor Karasi, Igor Terlević, Krunoslav Vardijan, Luka Osokruš, Maja Crnić, Mark Sylvester, Mirjana Malarić, Reiner Stoos, Rajko Sušanj, Saša Švagelj, Sonja Janeković, Tomislav Sorić, Zvonko Prihoda, Željko Andreić, Željko Arnautović, Željko Krulić and all other people that helped us in any way.

Special thanks go to Pete Gural, without who many of our achievements would not be possible.

This work was partially supported by the Ministry of Science, Education and Sports of the Republic of Croatia, Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Višnjan Science and Education Center and by private funds of CMN members. Ž.A. was also supported by the University of Zagreb support "Mathematical research in Geology" (head T. Malvić) for 2016 and "Mathematical research in Geology II" (head T. Malvić) for 2017.

[p] `http://cmn.rgn.hr/`

References

Andreić Ž. and Šegon D. (2010). "The first year of Croatian Meteor Network". In Kaniansky S. and Zimnikoval P., editors, *Proceedings of the International Meteor Conference, Šachtička, Slovakia, 18–21 September 2008*. IMO, pages 16–23.

Borovička J., Spurny P., Šegon D., Andreić Ž., Kac J., Atanackov J., Kladnik G., Mucke H., Vida D., and Novoselnik F. (2015). "The instrumentally recorded fall of the Križevci meteorite, Croatia, February 4, 2011". *Meteoritics and Planetary Science*, **50:7**, 1244–1259.

IAU MDC (2017). "IAU MDC list of all showers". `https://www.ta3.sk/IAUC22DB/MDC2007/Roje/roje_lista.php?corobic_roje=1&sort_roje=0` .

Jenniskens P., Gural P. S., Dynneson L., Grigsby B. J., Newman K. E., Borden M., Koop M., and Holman D. (2011). "CAMS: Cameras for Allsky Meteor Surveillance to establish minor meteor showers". *Icarus*, **216**, 40–61.

Kornoš L., Matlovič P., Rudawska R., Tóth J., Hajduková M. J., Koukal J., and Piffl R. (2013). "Confirmation and characterization of IAU temporary meteor showers in EDMOND database". In Jopek T. J., Rietmeijer F. J. M., Watanabe J., and Williams I. P., editors, *Proceedings of the Meteoroids 2013 Conference, Aug. 26-30, 2013, A. M. University, Poznań, Poland (in print)*. A.M. University, Poznań, Poland, pages 225–233.

Reponj D. (2011). "Astronomi kod Križevaca pronašli meteorit". `http://www.zvjezdarnica.com/astronomija/aktivnosti-astronoma/astronomi-kod-krizevaca-pronasli-meteorit/1259` . (Križevci meteorite discovery note (in Croatian)).

Šegon D., Gural P., Andreić Ž., Skokić I., Korlević K., Vida D., and Novoselnik F. (2013). "A parent body search across several video meteor data bases". In Jopek T. J., Rietmeijer F. J. M., Watanabe J., and Williams I. P., editors, *Proceedings of the Meteoroids 2013 Conference, Aug. 26-30, 2013, A. M. University, Poznań, Poland (in print)*. A.M. University, Poznań, Poland, pages 251–262.

Southworth R. B. and Hawkins G. S. (1963). "Statistics of meteor streams". *Smithson. Contrib. Astrophys.*, **7**, 261–285.

The meteoritical Society (2017). "Križevci meteorite web page". https://www.lpi.usra.edu/meteor/metbull.php?code=60213 .

Vaubaillon J., Koten P., Margonis A., Toth J., Rudawska R., Gritsevich M., Zender J., McAuliffe J., Pautet P.-D., Jenniskens P., Koschny D., Colas F., Bouley S., Maquet L., A L., Lecacheux J., Borovička J., Watanabe J., and Oberst J. (2014). "The 2011 Draconids: The First European Airborne Meteor Observation Campaign". *Earth, Moon and Planets*, **112:3-4**, 137–157.

Vida D., Novoselnik F., Andreić Ž., Šegon D., Korlević K., Matijević F., Jašarević D., Perkov A., and Tudor C. (2012). "A possible new meteor shower detected from CMN and SonotaCo data". In *International Meteor Conference, La Palma Island, Canary, Spain, September 20-23*. International Meteor Organization.

Vida D., Turčinov R., Šegon D., and Siladji E. (2015). "Low-cost meteor radiometer". In *International Meteor Conference, Mistelbach, Austria, August 27-30, 2015*. International Meteor Organization, pages 180–184.

Vida D., Šegon D., Gural P. S., Martinović G., and Skokić I. (2014). "CMN_ADAPT and CMN_binViewer software". In *International Meteor Conference, Giron, France, September 18-21*. International Meteor Organization, pages 59–63.

Šegon D. (2011). "On the meteorite fall in Croatia". https://www.imo.net/imcs/imc2011/presentations/Damir%20Segon%20-%20On%20the%20Meteorite%20Fall%20in%20Croatia.pdf .

Šegon D., Andreić Ž., Gural P. S., Vida D., Novoselnik F., and Skokić I. (2014). "Draconids 2011: Outburst observations by the Croatian Meteor Network". *Earth, Moon and Planets*, **112:1-4**, 33–44.

Šegon D., Andreić Ž., Korlević K., Novoselnik F., Vida D., and Skokić I. (2012). "New shower in Cassiopeia". *WGN, Journal of the IMO*, **40:6**, 195–200.

Šegon D., Andreić Ž., Korlević K., Novoselnik F., Vida D., and Skokić I. (2013). "8 new showers from the Croatian Meteor Network data". *WGN, Journal of the IMO*, **41:3**, 70–74.

Šegon D., Korlević K., Andreić Ž., Kac J., Atanackov J., and Kladnik G. (2011). "Meteorite-dropping bolide over north Croatia on 4th February 2011". *WGN, Journal of the IMO*, **39:4**, 98–99.

Šegon D., Vaubaillon J., Gural P. S., Vida D., Andreić Ž., Korlević K., and Skokić I. (2017). "Dynamical modeling validation of parent bodies associated with newly discovered CMN meteor showers". *Astronomy and Astrophysics*, **598**, A15–1..A15–13.

Zoladek P. and Wisniewski M. (2012). "The new July meteor shower". *WGN, Journal of the IMO*, **40:6**, 189–196.

Handling Editor: Javor Kac
This paper has been typeset from a LaTeX file prepared by the authors.

Preliminary results

Results of the IMO Video Meteor Network — August 2017

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

The IMO Video Meteor Network cameras recorded over 78 000 meteors in more than 12 700 hours of observing time during 2017 August. The flux density profiles and population index profiles are presented for the 2017 α-Capricornids, Southern δ-Aquariids, and Perseids.

Received 2018 May 4

1 Introduction

With regards to the effective observing time, we achieved another record in August 2017. Once more we enjoyed unusually perfect weather – 75 (!) out of 78 cameras managed to observe during twenty or more observing nights and 17 cameras even managed every night. The number of meteor cameras was also increasing. Stefano Crivello started to operate Arci, another Mintron camera with 3.8 mm $f/0.8$ c-mount lens. The camera Tacka, which was last active in 2012, was taken over and resurrected by Jure Zakrajšek. It consists of a Mintron camera as well, equipped with a 12 mm $f/0.8$ c-mount lens. Even with these added, we were still 10 cameras short of the all-time high, but the output of more than 12 700 hours of effective observing time (Table 1 and Figure 1) was better than in the previous years and in the long-term statistics August 2017 ranks third. With 6.2 meteors per hour, the average meteor count was well below the average of the previous years, however. For this reason, we recorded "only" 78 000 meteors, which is 20% less than in August 2016. We cannot derive a general trend from this, since there were some cameras which recorded more and others which recorded less meteors. One important factor was the outage of all CILBO cameras on the Canary Islands, which alone recorded over 11 000 meteors in August 2016.

The analysis of the data took longer than usual because we did not have access to the flux viewer anymore. For this reason, we ordered a server in the AWS cloud, and Vladimir Nikolić from the Petnica team newly installed and adapted the software such that we have the same functionality as before. Access is now given under the URL `meteorflux.org`. On the new server, we can load and ingest data ourselves, which will make us faster and more flexible in the future. Time permitting, Vladimir may also implement step-by-step new functions in the weeks and months to come.

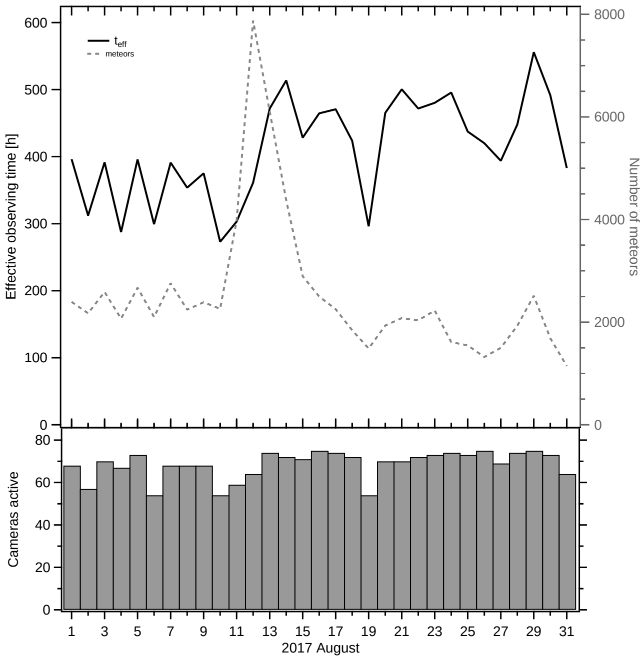


Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2017 August.

2 α-Capricornids and Southern δ-Aquariids

Let us now have a look at the meteor showers which peak at the July-August border. Figure 2 compares the average flux density profile of the α-Capricornids in the years 2011–2016 (lighter/green) with the profile of 2017 (darker/red). Whereas the descending activity branch matches perfectly, we see lower activity in the ascending branch of 2017. The maximum occurs at 126° solar longitude in the averaged profile. In 2017, the rates were at a constantly high level between 125° and 129° solar longitude (July 27 to August 1).

Figure 3 presents the average r-profile for the years 2011 to 2017. Whereas the Capricornid population index differs only marginally from the sporadic meteors until 124° and after 133° solar longitude ($r = 2.5$), it is about 0.3 lower in the intervening period ($r = 2.2$). That is also the population index value at the activity peak.

[1] Abenstalstr. 13b, 84072 Seysdorf, Germany. Email: `sirko@molau.de`
[2] Via Bobbio 9a/18, 16137 Genova, Italy. Email: `stefano.crivello@libero.it`
[3] Urbanizacao da Boavista, Lote 46, Linhaceira, 2305-114 Asseiceira, Tomar, Portugal. Email: `rui.goncalves@ipt.pt`
[4] Rua Aquilino Ribeiro, 23 - 1 Dto. 2790028 Carnaxide, Portugal. Email: `carlos.saraiva@netcabo.pt`
[5] via Umbria 21/d, 30037 Scorze (VE), Italy. Email: `stom@iol.it`
[6] Na Ajdov hrib 24, 2310 Slovenska Bistrica, Slovenia. Email: `javor.kac@orion-drustvo.si`

IMO bibcode WGN-463-molau-vidaug
NASA-ADS bibcode 2018JIMO...46...96M

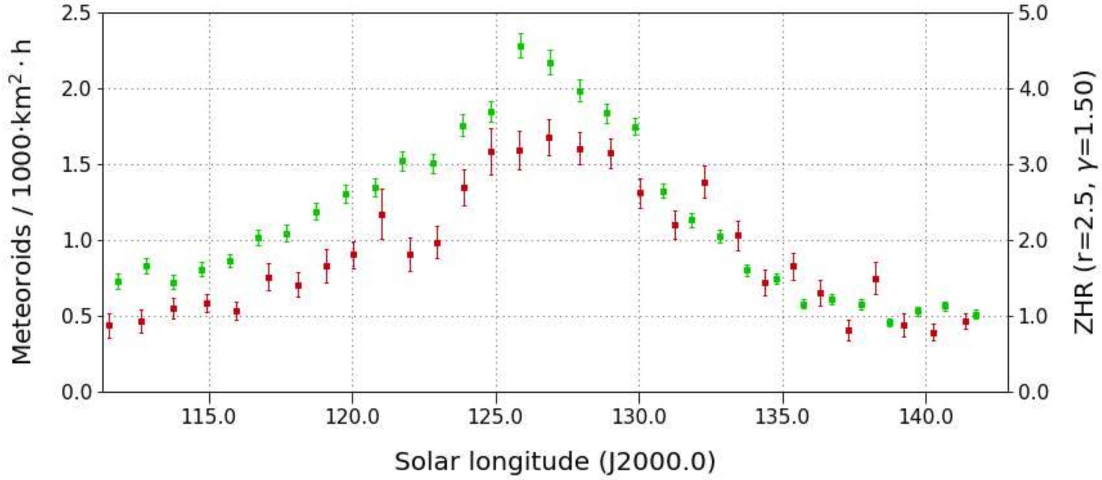


Figure 2 – Flux density profile of the α-Capricornids 2011–2016 (lighter/green) and 2017 (darker/red), derived from video data of the IMO Network.

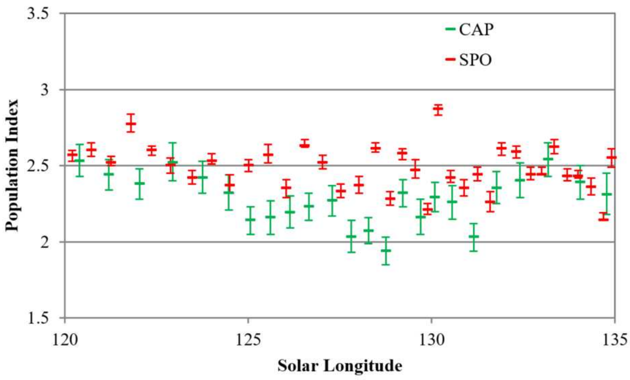


Figure 3 – Comparison of the population index profile of the α-Capricornids (lighter/green) and sporadic meteors (darker/red) in the years 2011–2017.

Figure 4 compares the average activity profile of the Southern δ-Aquariids in the years 2011–2016 (lighter/green) and 2017 (darker/red). The peak time of 126° to 127° solar longitude (July 29/30) was in 2017 identical to the long-term average. The scatter of data in the averaged profile is somewhat larger than in the case of the α-Capricornids, and peak activity in 2017 is also a bit lower than on average. This time it cannot be attributed to the lunar phase because New Moon occurred on July 23. Possibly we see here a side effect of the outage of the CILBO cameras which are not only particularly powerful, but are also favorably positioned for the observation of these southern meteor showers.

With $r = 2.15$, the population index of the Southern δ-Aquariids (Figure 5) is lower than that of the sporadic meteors throughout the whole activity period and is comparable with the α-Capricornids. Note that the flux density during the analysed observing interval is higher than the peak value for the Capricornids. The "sporadic dilution" at the beginning and end of the interval is thus significantly smaller.

3 Perseids

Finally, we shall have a look at the Perseids, which were severely hampered by the moon in mid-August 2017. Figure 7 compares the high-resolution activity profile close to the peak for the years 2011 to 2015 (lighter/green) with that for 2017 (darker/red) – 2016 was omitted due to the enhancements caused by individual dust trails. We see that the rates in 2017 were in general relatively low, which is confirmed by IMO visual observations which revealed a ZHR barely exceeding 80 (International Meteor Organization, 2017). However, the graph shows clearly that we simply missed the peak in Europe. During the night of 2017 August 11/12, the flux density was on the rise, and during the following night it was already declining. Interestingly, the rate in the post-maximum night actually grew somewhat from dusk till dawn when using the typical zenith exponent of $\gamma = 1.5$. Only with a value of $\gamma = 1.8$ does it match well to the long-term profile. That confirms the result of the first zenith exponent analysis in 2012 (Molau et al., 2012), which delivered the same result for the Perseids.

Thanks to the high meteor count we can compute a population index profile for the year 2017 alone. In the complete analysed interval between 130° and 145° solar longitude (August 2–17), the population index of the Perseids is clearly lower with $r = 1.8$ than that of the sporadic meteors ($r = 2.4$). In fact, the population index sometimes reaches values as low as $r = 1.5$. However, if we only look at the post-maximum night between $140\overset{\circ}{.}2$ and $140\overset{\circ}{.}36$ solar longitude, we obtain an almost constant value of $r = 1.75 \pm 0.03$.

References

International Meteor Organization (2017). "Perseids 2017 campaign live graph". `http://www.imo.net/members/imo_live_shower/summary?shower=PER&year=2017` .

Molau S., Kac J., Berko E., Crivello S., Stomeo E., Igaz A., and Barentsen G. (2012). "Results of the IMO Video Meteor Network – August 2012". *WGN, Journal of the IMO*, **40:6**, 201–206.

Handling Editor: Javor Kac

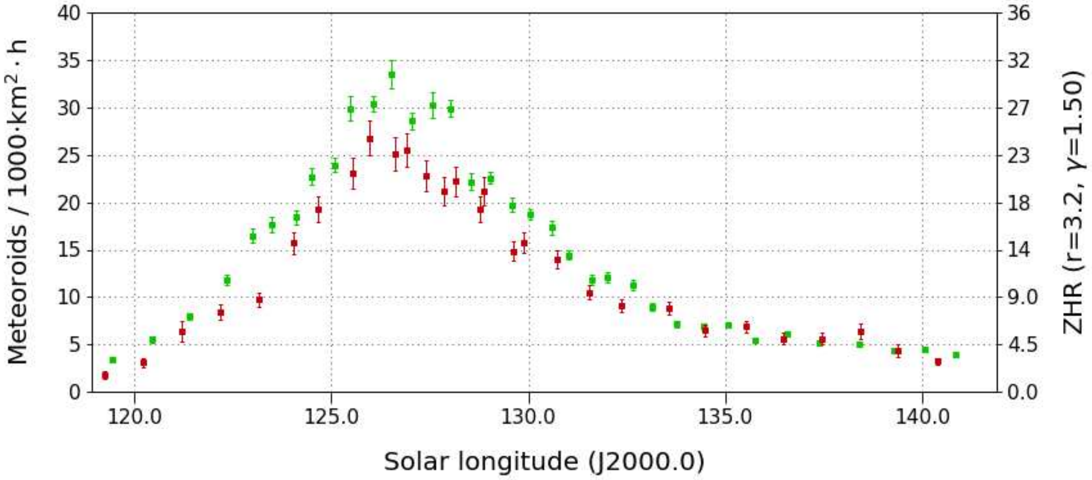


Figure 4 – Flux density profile of the Southern δ-Aquariids 2011–2016 (lighter/green) and 2017 (darker/red), derived from video data of the IMO Network.

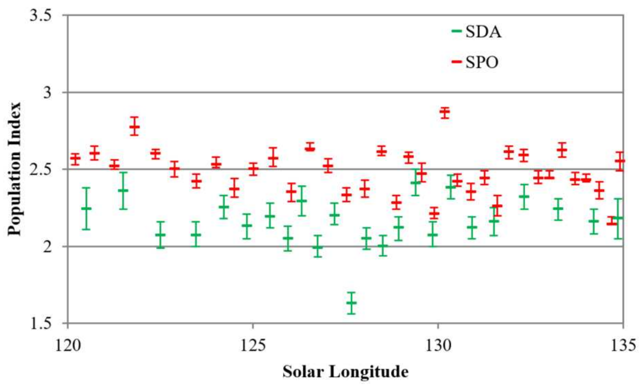


Figure 5 – Comparison of the population index profile of the Southern δ-Aquariids (lighter/green) and sporadic meteors (darker/red) in the years 2011–2017.

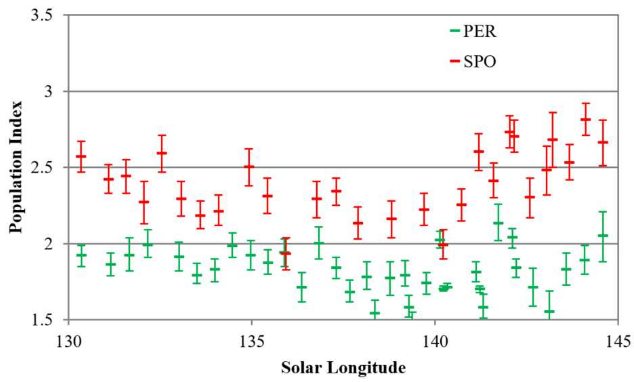


Figure 6 – Comparison of the population index profile of the Perseids (lighter/green) and sporadic meteors (darker/red) in 2017.

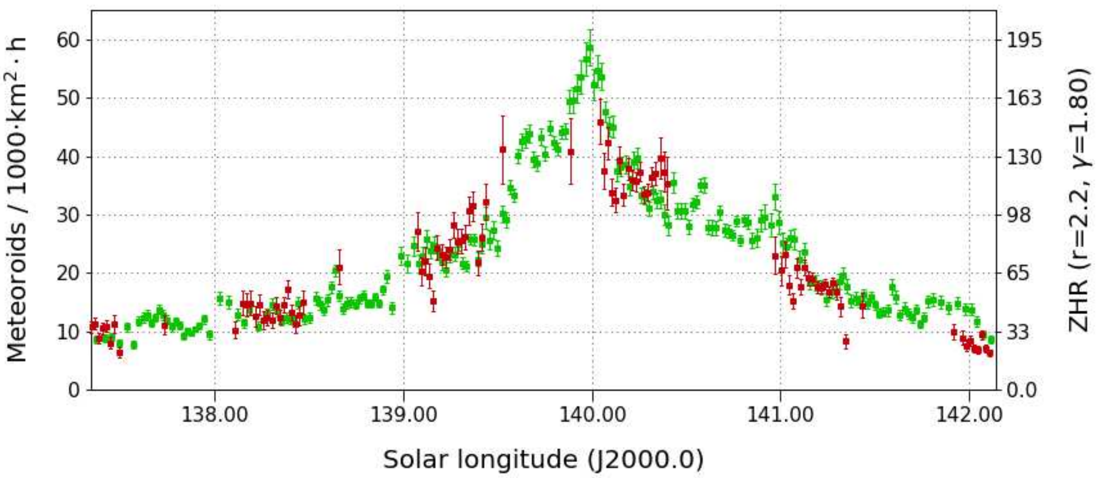


Figure 7 – Flux density profile around the Perseid maximum 2011–2015 (lighter/green) and 2017 (darker/red), derived from video data of the IMO Network. The plot was obtained with a zenith exponent of $\gamma = 1.8$.

Table 1 – Observers contributing to 2017 August data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

Code	Name	Location	Camera	FOV [$^{\circ 2}$]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	29	122.4	946
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	24	166.7	1724
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	31	228.1	2153
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	28	138.9	611
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	26	126.3	646
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	26	122.2	593
CARMA	Carli	Monte Baldo/IT	Bmh2 (1.5/4.5)*	4243	3.0	371	31	203.5	2181
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	31	201.4	1101
CINFR	Cineglosso	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	31	206.5	1134
CRIST	Crivello	Valbrevenna/IT	Arci (0.8/3.8)	5566	4.6	2575	21	150.4	1195
			Bilbo (0.8/3.8)	5458	4.2	1772	31	215.4	1923
			C3P8 (0.8/3.8)	5455	4.2	1586	31	185.4	1305
			Stg38 (0.8/3.8)	5614	4.4	2007	31	224.1	2440
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	31	198.7	1491
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	22	129.8	912
GONRU	Goncalves	Foz do Arelho/PT	Farelho1 (0.75/4.5)	2286	3.0	208	6	24.6	28
		Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	31	224.1	1445
			Templar2 (0.8/6)	2080	5.0	1508	31	229.2	1224
			Templar3 (0.8/8)	1438	4.3	571	31	215.3	591
			Templar4 (0.8/3.8)	4475	3.0	442	31	222.6	1587
			Templar5 (0.75/6)	2312	5.0	2259	31	208.3	1229
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	28	176.1	890
			Orion4 (0.95/5)	2662	4.3	1043	27	168.5	681
HERCA	Hergenrother	Tucson/US	Salsa3 (0.8/3.8)	2336	4.1	544	25	150.2	414
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	27	139.2	812
IGAAN	Igaz	Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	29	155.2	669
			Hupol (1.2/4)	3790	3.3	475	28	166.0	302
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	28	177.1	686
			Husor2 (0.95/3.5)	2465	3.9	715	27	190.6	758
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1399	3.8	268	29	177.5	1364
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	24	135.4	1236
			Rezika (0.8/6)	2270	4.4	840	23	135.0	1484
			Stefka (0.8/3.8)	5471	2.8	379	24	133.9	977
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	29	181.8	873
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	17	97.4	809
LOPAL	Lopes	Lisbon/PT	Naso1 (0.75/6)	2377	3.8	506	24	183.9	633
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	29	149.9	1088
			Pav36 (0.8/3.8)*	5668	4.0	1573	30	179.4	1812
			Pav43 (0.75/4.5)*	3132	3.1	319	29	167.7	817
			Pav60 (0.75/4.5)	2250	3.1	281	29	174.7	1105

Table 1 – Observers contributing to 2017 August data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Location	Camera	FOV [$^{\circ 2}$]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
MARRU	Marques	Lisbon/PT	Cab1 (0.75/6)	2362	4.8	1517	31	240.8	1500
			Ran1 (1.4/4.5)	4405	4.0	1241	27	193.7	1216
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	24	111.5	820
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	29	147.4	1682
			Escimo2 (0.85/25)	155	8.1	3415	26	72.6	351
			Mincam1 (0.8/8)	1477	4.9	1084	27	144.8	989
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	28	119.0	954
			Remo2 (0.8/8)	1478	6.4	4778	28	135.0	1059
			Remo3 (0.8/8)	1420	5.6	1967	29	154.9	1131
			Remo4 (0.8/8)	1478	6.5	5358	29	152.3	1371
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	30	191.6	707
MOSFA	Moschini	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	30	196.2	832
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	19	126.1	533
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	29	146.8	404
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	29	192.2	1350
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	24	114.9	423
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	28	215.8	748
			Ro2 (0.75/6)	2381	3.8	459	29	231.6	1187
			Ro3 (0.8/12)	710	5.2	619	30	231.3	1183
			Ro4 (1.0/8)	1582	4.2	549	30	209.2	613
			Sofia (0.8/12)	738	5.3	907	28	173.0	715
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	27	170.6	456
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	27	120.2	692
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	26	144.5	837
			Kayak2 (0.8/12)	741	5.5	920	29	190.8	418
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	31	204.7	2197
			Noa38 (0.8/3.8)	5609	4.2	1911	31	205.9	2204
			Sco38 (0.8/3.8)	5598	4.8	3306	31	206.7	2131
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	28	143.7	1035
			Mincam3 (0.8/6)	2338	5.5	3590	28	132.2	705
			Mincam4 (0.8/6)	2306	5.0	1412	26	112.3	349
			Mincam5 (0.8/6)	2349	5.0	1896	28	130.0	569
			Mincam6 (0.8/6)	2395	5.1	2178	28	127.2	694
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	26	173.7	668
			Humob (0.8/6)	2388	4.8	1607	26	167.8	923
WEGWA	Wegrzyk	Nieznaszyn/PL	Pav78 (0.8/6)	2286	4.0	778	27	101.0	495
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	8	23.2	83
ZAKJU	Zakrajšek	Petkovec/SI	Tacka (0.8/12)	714	5.3	783	22	112.9	411
* active field of view smaller than video frame						Overall	31	12 751.6	78 504

Results of the IMO Video Meteor Network — September 2017

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

The IMO Video Meteor Network cameras recorded almost 36 000 meteors in nearly 10 000 hours of effective observing time during 2017 September. The flux density profiles are presented for the 2017 α-Aurigids and September Perseids. In addition, the population index profiles for these two showers are calculated based on data obtained from 2011 to 2017.

Received 2018 May 29

1 Introduction

Whereas September had produced outstanding results in the previous two years, September 2017 was just average. 39 observers with 77 active video cameras recorded almost 36 000 meteors in nearly 10 000 hours of effective observing time (Table 1 and Figure 1). In particular east European observers had to endure larger gaps in their observing statistics. 49 cameras observed on twenty or more nights, and eleven missed no more than one night. The average of 3.6 meteors per hour was again well below the average of the previous years.

The IMO "Working List of Meteor Showers" (Rendtel, 2016) lists two showers in September with variable activity. We are going to have a closer look at their activity in 2017 in the next sections.

2 α-Aurigids

The α-Aurigids are active between August 25 and September 7. Their average activity profile for the years 2011 to 2016 (Figure 2, lighter/green) shows just a small increase of flux density over the sporadic background. Peak values are observed between 157° and 158° solar longitude, i.e. in the last few days of August. In 2017 we find the peak at the same time, plus a similarly high value at 163° solar longitude.

A look at the population index (Figure 3) proves that the α-Aurigids do indeed stand out from the sporadic background. Each data point is based on 500 shower meteors and 3 000 sporadic meteors. Whereas the sporadic population index scatters around $r = 2.5$, we yield an average population index of $r = 2.0$ for the α-Aurigids if we omit the values at the beginning and end of the activity interval.

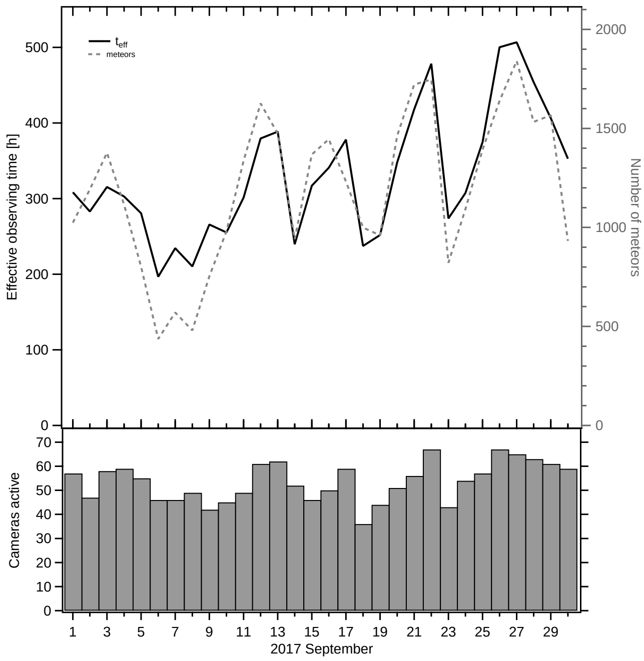


Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2017 September.

3 September Perseids

A similar result is obtained for the September Perseids (Figure 5). In this case we omitted the data set of 2013 when the shower underwent a short but intense outburst at 167.°2 solar longitude. The average activity profile of the September Perseids shows a peak at September 9 (167° solar longitude) with a higher absolute value than the α-Aurigids. Maximum activity in 2017 had already been observed by the night of September 7/8.

Also in case of this shower the population index clearly deviates from that of the sporadic meteors (Figure 4). Whereas the sporadic value is $r = 2.6$ with slightly smaller scatter than during the activity period of the α-Aurigids a few days before, we obtain the same population of $r = 2.0$ for the September Perseids as for the α-Aurigids.

References

Rendtel J. (2016). "2017 Meteor Shower Calendar". International Meteor Organization. IMO INFO(2-16).

Handling Editor: Javor Kac

[1] Abenstalstr. 13b, 84072 Seysdorf, Germany. Email: sirko@molau.de
[2] Via Bobbio 9a/18, 16137 Genova, Italy. Email: stefano.crivello@libero.it
[3] Urbanizacao da Boavista, Lote 46, Linhaceira, 2305-114 Asseiceira, Tomar, Portugal. Email: rui.goncalves@ipt.pt
[4] Rua Aquilino Ribeiro, 23 - 1 Dto. 2790028 Carnaxide, Portugal. Email: carlos.saraiva@netcabo.pt
[5] via Umbria 21/d, 30037 Scorze (VE), Italy. Email: stom@iol.it
[6] Na Ajdov hrib 24, 2310 Slovenska Bistrica, Slovenia. Email: javor.kac@orion-drustvo.si

IMO bibcode WGN-463-molau-vidsep
NASA-ADS bibcode 2018JIMO...46..101M

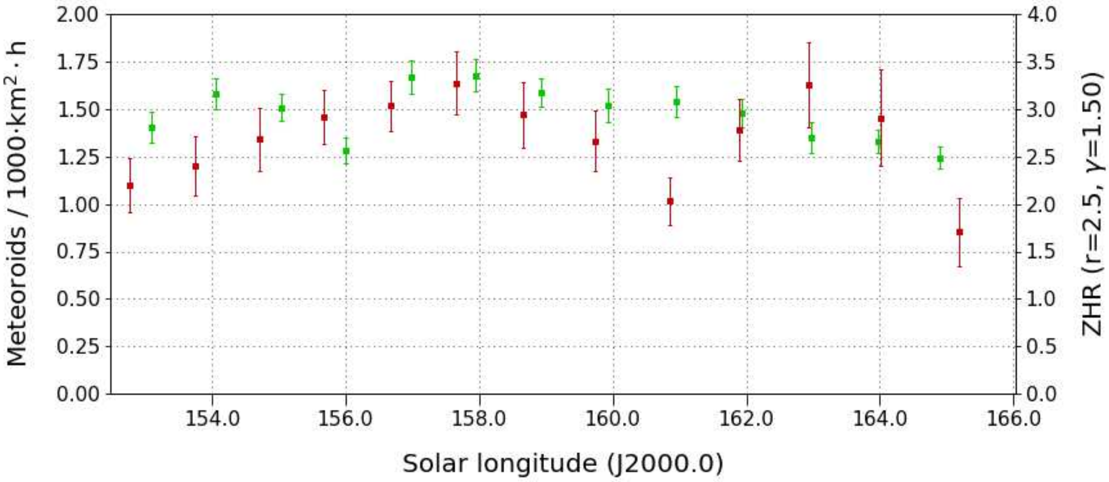


Figure 2 – Flux density profile of the α-Aurigids 2011–2016 (lighter/green) and 2017 (darker/red), derived from video data of the IMO Network.

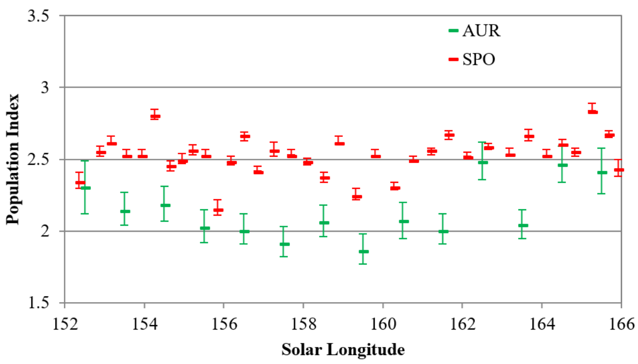


Figure 3 – Comparison of the population index profile of the α-Aurigids (lighter/green) and sporadic meteors (darker/red) for the years 2011–2017.

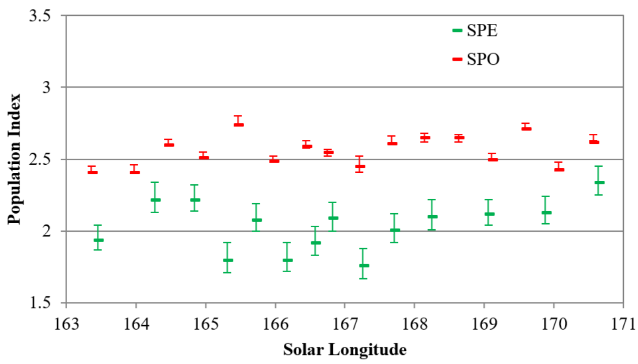


Figure 4 – Comparison of the population index profile of the September Perseids (lighter/green) and sporadic meteors (darker/red) for the years 2011–2017 (without 2013).

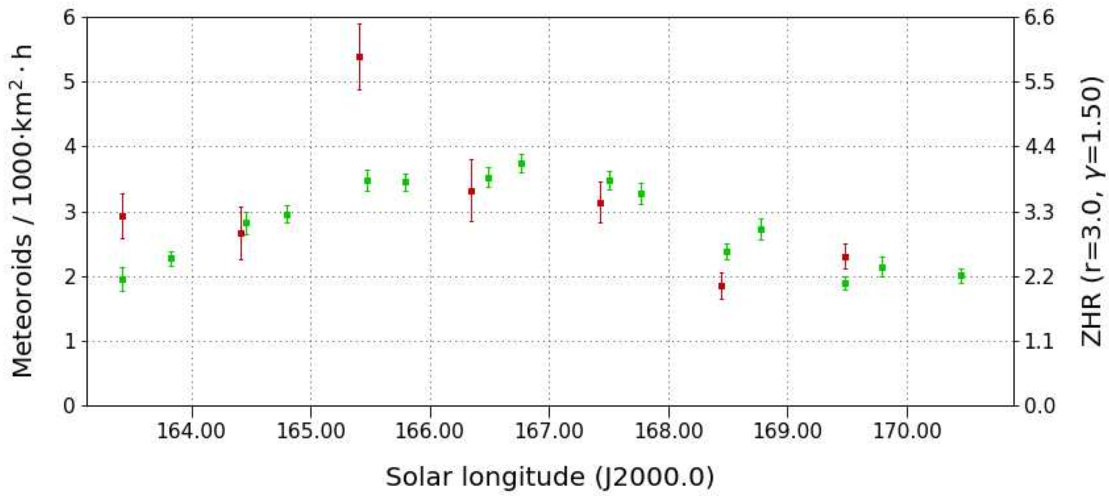


Figure 5 – Flux density profile of the September Perseids 2011–2016 (lighter/green, without 2013) and 2017 (darker/red), derived from video data of the IMO Network.

Table 1 – Observers contributing to 2017 September data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

Code	Name	Location	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	28	130.7	917
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	5	34.1	167
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	26	168.5	891
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	21	111.2	277
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	22	117.0	414
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	21	105.1	361
CARMA	Carli	Monte Baldo/IT	Bmh2 (1.5/4.5)*	4243	3.0	371	23	138.4	798
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	9	64.6	191
CINFR	Cineglosso	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	26	90.1	786
CRIST	Crivello	Valbrevenna/IT	Arci (0.8/3.8)	5566	4.6	2575	26	200.0	719
			Bilbo (0.8/3.8)	5458	4.2	1772	27	189.6	824
			C3P8 (0.8/3.8)	5455	4.2	1586	26	138.4	516
			Stg38 (0.8/3.8)	5614	4.4	2007	21	162.7	1058
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	15	105.6	359
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	23	115.6	523
GONRU	Goncalves	Foz do Arelho/PT	Farelho1 (0.75/4.5)	2286	3.0	208	16	90.7	60
		Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	30	260.0	1101
			Templar2 (0.8/6)	2080	5.0	1508	30	259.6	727
			Templar3 (0.8/8)	1438	4.3	571	30	232.2	354
			Templar4 (0.8/3.8)	4475	3.0	442	30	257.8	827
			Templar5 (0.75/6)	2312	5.0	2259	29	222.2	758
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	23	119.2	425
			Orion4 (0.95/5)	2662	4.3	1043	13	63.7	157
HERCA	Hergenrother	Tucson/US	Salsa3 (0.8/3.8)	2336	4.1	544	28	247.1	427
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	24	142.3	599
IGAAN	Igaz	Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	19	50.7	146
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	8	45.2	37
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	18	91.4	205
			Husor2 (0.95/3.5)	2465	3.9	715	17	110.5	172
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1399	3.8	268	12	52.3	155
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	8	39.4	207
			Rezika (0.8/6)	2270	4.4	840	7	35.8	213
			Stefka (0.8/3.8)	5471	2.8	379	2	4.6	5
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	19	100.8	386
LOPAL	Lopes	Lisbon/PT	Naso1 (0.75/6)	2377	3.8	506	25	210.3	278
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	9	52.6	172
			Pav36 (0.8/3.8)*	5668	4.0	1573	11	78.6	319
			Pav43 (0.75/4.5)*	3132	3.1	319	9	64.4	155
			Pav60 (0.75/4.5)	2250	3.1	281	11	78.2	275

Table 1 – Observers contributing to 2017 September data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Location	Camera	FOV [$^{\circ 2}$]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
MARRU	Marques	Lisbon/PT	Cab1 (0.75/6)	2362	4.8	1517	29	262.0	993
			Ran1 (1.4/4.5)	4405	4.0	1241	29	222.1	803
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	13	42.3	217
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	27	166.5	1350
			Escimo2 (0.85/25)	155	8.1	3415	23	146.2	276
			Mincam1 (0.8/8)	1477	4.9	1084	26	145.2	554
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	28	124.2	843
			Remo2 (0.8/8)	1478	6.4	4778	24	137.4	1040
			Remo3 (0.8/8)	1420	5.6	1967	26	159.8	917
			Remo4 (0.8/8)	1478	6.5	5358	28	157.9	1257
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	17	107.6	179
MOSFA	Moschini	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	20	110.0	219
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	7	14.4	29
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	25	139.7	260
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	22	111.7	320
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	21	134.6	440
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	28	249.7	482
			Ro2 (0.75/6)	2381	3.8	459	29	262.2	689
			Ro3 (0.8/12)	710	5.2	619	29	262.4	924
			Ro4 (1.0/8)	1582	4.2	549	29	222.7	314
			Sofia (0.8/12)	738	5.3	907	29	248.4	512
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	23	116.3	165
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	23	118.0	356
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	11	40.0	240
			Kayak2 (0.8/12)	741	5.5	920	13	52.5	67
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	22	113.5	738
			Noa38 (0.8/3.8)	5609	4.2	1911	24	110.4	546
			Sco38 (0.8/3.8)	5598	4.8	3306	27	124.3	793
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	26	142.3	751
			Mincam3 (0.8/6)	2338	5.5	3590	26	129.2	384
			Mincam4 (0.8/6)	2306	5.0	1412	28	108.9	268
			Mincam5 (0.8/6)	2349	5.0	1896	24	134.4	482
			Mincam6 (0.8/6)	2395	5.1	2178	26	131.4	386
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	19	107.2	248
			Humob (0.8/6)	2388	4.8	1607	13	96.3	302
WEGWA	Wegrzyk	Nieznaszyn/PL	Pav78 (0.8/6)	2286	4.0	778	16	46.2	182
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	14	75.3	273
ZAKJU	Zakrajšek	Petkovec/SI	Tacka (0.8/12)	714	5.3	783	15	52.3	98
* active field of view smaller than video frame						Overall	30	9 906.7	35 858

History

A History of Meteor Reports in The Astronomer magazine: part 1 1964–1974

Tracie Heywood[1]

The magazine "The Astronomer" is a monthly magazine published in the UK whose aim is the rapid publication of observations made by amateur astronomers. It was first published in 1964. This article provides an overview of the magazine's meteor content during its first decade.

Received 2018 April 23

1 Introduction

The Astronomer magazine (TA) started its life in May 1964 under the name of The Casual Astronomer (CA). James Muirden was the Editor, with John Larard acting as Secretary. The annual subscription was 15 shillings. It originated from a dissatisfaction with the long delays, typically of many years, between observations being submitted to national groups, such as the British Astronomical Association (BAA), and the publication of the corresponding analytical reports.

The Editorial (Muirden, 1964) in the first issue stated *"The Casual Astronomer . . . exists simply to collect such observations . . . and publish them as soon as possible in the regular (it is hoped monthly) bulletin"*. The layout in the early years could often appear somewhat chaotic. This was a consequence of the short time gap between the receipt of observations and the magazine's publication date, combined with the production method used. Observations received at the last minute would be added sequentially at the end of the magazine or squeezed into gaps at the end of the stencils for earlier pages.

2 Meteor content in the early years

Most of the reports in the early issues of the magazine relate to observations of the planets, deep sky objects and variable stars. The first meteor reports appear in the third issue (1964 July). Keith Hindley describes a fireball seen during the night of 1963 September 12-13 (Hindley, 1964b), while George Alcock provides a magnitude distribution for 31 "telescopic" meteors seen while comet-searching using binoculars and describes bright meteors seen on 1964 June 15 and 1964 July 6 during this work (Alcock, 1964). Keith Hindley also provides a report on the 164 telescopic meteors that he had recorded while comet searching during the 12 months to 1964 June 30 (Hindley, 1964a).

The first meteor shower reports appear in the 1964 September issue. These were for the Perseids, with several observers reporting their results (The Casual Astronomer, 1964). Maximum night (August 11-12) seems to have been overcast for all of the observers involved, however. In the 1964 December issue, Tom Lloyd-Evans reports the results of his Leonid meteor watches (Lloyd-Evans, 1964). For the night of maximum, he reports seeing 29 Leonids and 5 other meteors in a total of 1 hour's observing, spread across 5 hours, and estimates the corrected Leonid ZHR for the final 25 minutes before dawn to have been 50. He also reports capturing photographic images of two Leonids close to dawn on November 17, plus a spectrum of a Leonid meteor. The image of the spectrum contained 18 lines of which the H and K lines of calcium were by far the strongest. Geminid and Quadrantid reports appear in the 1965 January issue (The Casual Astronomer, 1965) and mostly feature telescopic observations by Keith Hindley. For the Quadrantids, he reports a very diffuse radiant, while for the Geminids he reports that on all three nights that he observed, the radiant appeared to consist of two centers, separated by 5 degrees.

In the 1966 January issue, A R and M F Pace report on their visit to the village of Barwell, Leicestershire, 19 days after the meteorite fall that had occurred there on Christmas Eve 1965 (Pace & Pace, 1966). Although the site had already been extensively searched, they managed to find several small fragments in a nearby field. They also spoke to a resident of the High Street in front of whose house one fragment had fallen.

Early issues of the magazine had only featured text on the front cover, but during 1966 several issues feature sketches and graphs. The cover of the September issue (Figure 1) features graphs showing observed rates, magnitudes and train durations for that year's Perseids (The Casual Astronomer, 1966).

3 Prospects for the 1966 Leonids

In addition to several pages of Perseid reports, the 1966 September issue also includes a request (The Casual Astronomer, 1966) (probably from the Editor) for observers to make a special effort for the Leonids during November 14-18:

"A crucial night for meteor astronomy will be that of November 16-17, the predicted maximum of the Leonid shower. We may confidently expect the return of the main swarm which gave such memorable displays in 1833 and 1866; the meteors will not equal those showers, but they may well be denser than anything seen for many years."

[1] 20 Hillside Drive, Leek, ST13 8JQ, UK.
Email: `tracieheywood832@gmail.com`

IMO bibcode WGN-463-heywood-ta1
NASA-ADS bibcode 2018JIMO...46..105H

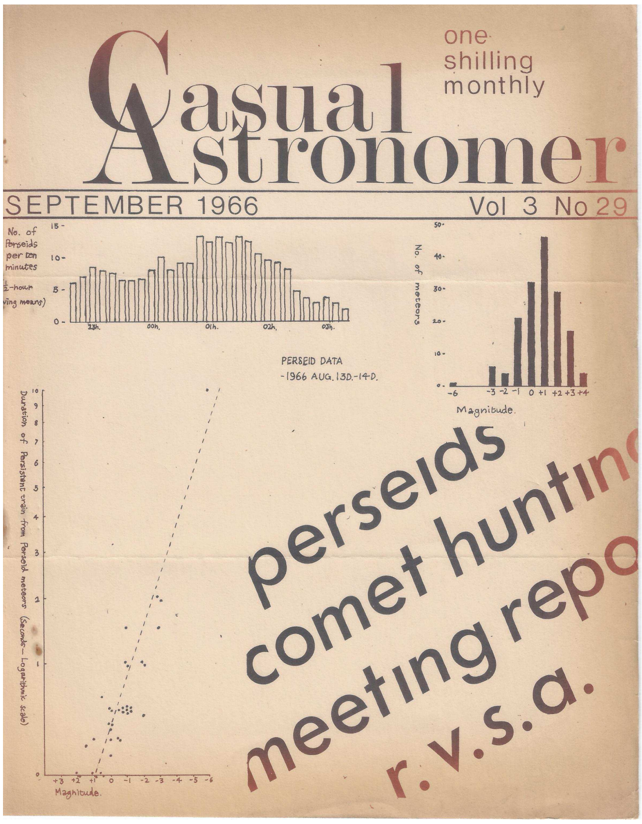


Figure 1 – September 1966 issue cover.

Keith Hindley provides a longer preview via a last-minute insert (Hindley, 1966b) included with the October issue, noting Leonid rates in preceding years as being 1962 (16), 1963 (19), 1964 (35) and 1965 (85), adding that if an intense shower was to occur in 1966, then it would consist of a sharp peak lasting only a few hours superimposed on the normal rise and fall. Noting the lack of storm activity from the returns of 1899 and 1932, however, he cautions:

"It seems rather unlikely, therefore, that we shall witness a really spectacular display in November, although there is always the remote possibility that we may come across an isolated swarm somewhat separated from the main stream."

4 The magazine changes its name

The Editorial in the 1966 October issue had announced that following that issue, the magazine would switch to a new printing process and would be renamed as *"The Astronomer"*. Unfortunately, due to dissatisfaction with the results of the new printing process, the November issue was not sent out but, in any case, would have preceded the Leonid peak.

The first issue of *The Astronomer* was therefore the 1966 December issue and this includes a number of Leonid reports (The Astronomer, 1966). As had by then become clear, an intense storm had been observed from North America, but this enhancement had come too late to be observed from European longitudes. The weather had also been somewhat uncooperative for UK based observers. Cloud had hindered observations from most locations but some results are reported. Observing with a group on the Isle of Man, Keith Hindley reports the Leonid rate on the morning of November 17 rising to 30–35 per hour (LM 6.5) before cloud ends observations at 4.30am. By the following night, with the outburst having passed, high, but declining, Leonid rates are noted by Hindley and others.

5 Fireball reports

Intermittent fireball reports appear during the early years. Most are only reported by single observers and there is uncertainty sometimes as to whether multiple reports refer to single or multiple events. In the 1967 January issue, for example, Harold Ridley lists six reports received by the BAA Meteor Section from the evening of 1966 December 4 (Ridley, 1967). These have a spread in their reported times of nearly 2.5 hours. Additional reports are requested in order to clarify the true number of events.

In the 1968 December issue, Ian Ridley reports seeing a group of around 10 fireballs passing through Perseus and speculates that this might have been a rocket re-entry (Ridley, 1968). Geoffrey Falworth confirms this in the following issue and links it to the reentry of Cosmos 253 (Falworth, 1969).

6 Articles

Keith Hindley had for some time been a regular observer of telescopic meteors and in a series of articles, starting in the 1967 March issue (Hindley, 1967c), encourages others to follow suit. The title of the first part *"Visual Observations – Adapt or perish!"* very much sets the tone. He goes on to claim that *"meteor work with photography and radar have shown such vast improvements over the naked eye that 'classical' observations have become redundant"*. Additional sections of this article are published in the April, May and June issues.

Another series of articles by Keith Hindley starts in the 1967 October issue and is titled *"Meteor Photography and the Amateur Astronomer"* (Hindley, 1967a). Additional sections of this article appear in the 1967 November issue and in the 1968 May and 1968 June issues (Hindley, 1967b; Hindley, 1968a; Hindley, 1968b).

7 Minor Showers

Although the discovery of the June Lyrid minor meteor shower is generally attributed to Stan Dvorak in 1966, the attention drawn to this shower in 1969 by Keith Hindley seems to have led to it being referred to in TA as the *"Hindley Lyrids"*. In the 1969 June issue, Lionel Wilson, Robin Scagell and others report confirming the existence of the shower during meteor watches on June 13-14 and June 14-15 (Wilson et al., 1969). An additional report by R R Scoular appears in the July issue (Scoular, 1969a). A preliminary analysis of the 1969 display is provided by Keith Hindley in the August issue (Hindley, 1969c), crediting Stan Dvorak with its discovery and referring to the shower as the June Lyrids. This analysis indicates a broad peak centered

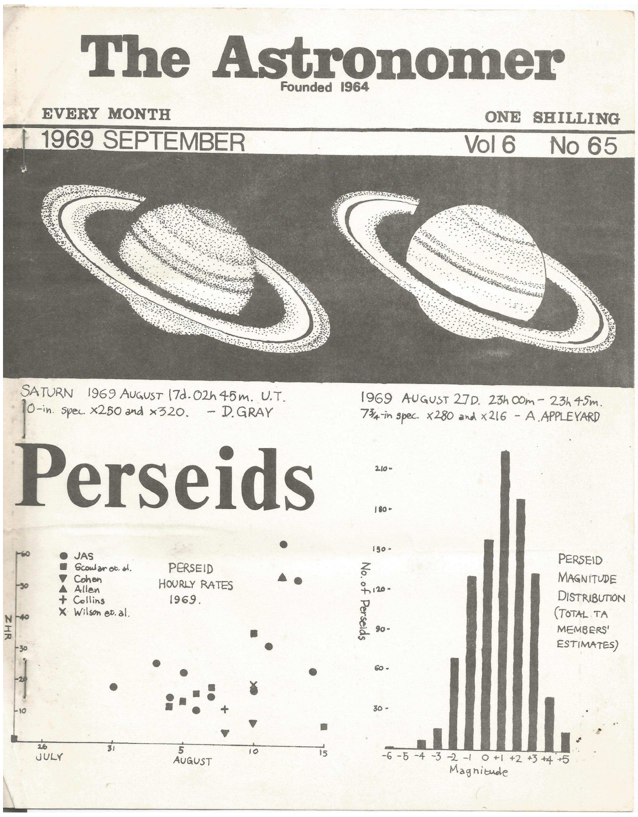


Figure 2 – September 1969 issue cover.

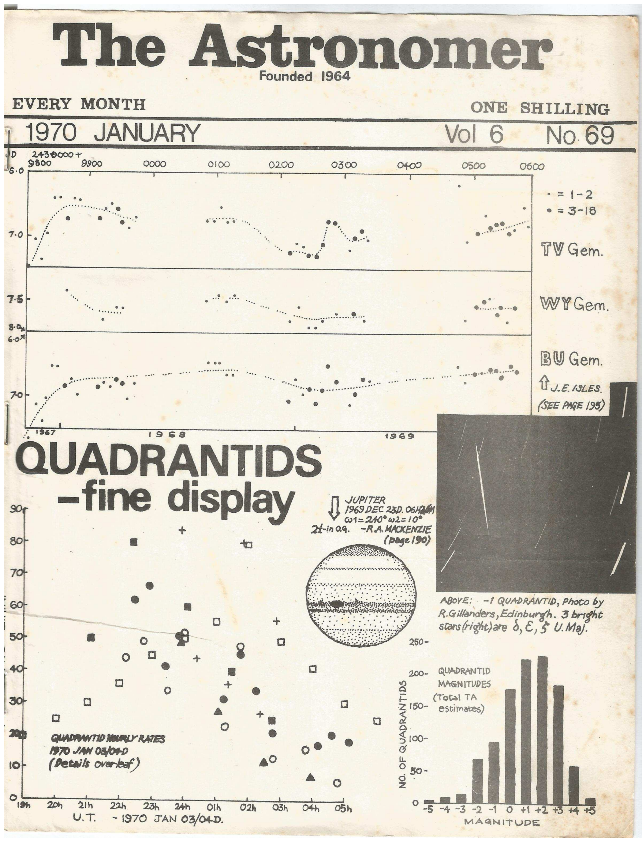


Figure 3 – January 1970 issue cover.

at around midnight on June 16. It is noted that although the magnitude distribution of the reported June Lyrids is very similar to that of the sporadics, a higher proportion (32%) of June Lyrids left persistent trains compared with only 11% of sporadics.

R R Scoular also writes a short article in the 1969 July issue (Scoular, 1969b) in which he encourages observers to pay more attention to the summer's minor showers, listing these as the Alpha Capricornids, Kappa Cygnids and the Alpha Cygnids. He describes the Alpha Cygnids as being active during the last week of July and the first week of August. Although not generally recognized nowadays, the Alpha Cygnids make frequent appearances in July and August meteor watch reports during the 1970s.

8 Controversy and New Methods

By mid-1969, other commitments had led James Muirden to temporarily step down as Editor, with Alison Brown and John Murray taking over the role for a year. A somewhat controversial Editorial (Brown, 1969) in the 1969 August issue bemoans the limited accuracy of individual visual meteor reports and calls for increased focus on photographic and spectral work, along with the creation of a national group dedicated to meteor observing, concluding *"While a few observers produce scattered observations we can never hope to get meaningful ZHRs and mag distributions, but with many observers and much more data, meteor work will at last yield results which have some significance"*.

The 1969 September issue has seven pages devoted to Perseid reports (The Astronomer, 1969a). These include a report by John Murray on attempts at visual meteor triangulation carried out during the Perseids from two observing sites separated by 164 km. Nine meteors had their positions recorded from both sites, but the conclusion reached was that uncertainties in the start and end points of the meteors had seriously hindered the accuracy of their derived heights.

Keith Hindley, by now BAA Meteor Section Director, reacts to the 1969 August Editorial via an article titled *"Modern Meteor Observing"*, split between the October and November issues (Hindley, 1969a; Hindley, 1969b). In addition to challenging the claims about poor accuracy, he outlines the current state of the BAA Meteor Section. He reports the section as having around 170 active members, with around 45% of observations being made in the UK and 40% in the USA. A total of 1030 meteors had been recorded by 44 observers during the Lyrids in April 1969 and around 7200 meteors had been recorded by 137 observers during the 1969 Perseids. Six section members are operating spectrographs, with more being built. He also mentions that the section has access to a IBM 360/65 computer at Liverpool University for the reduction of photographic, telescopic and fireball observations. The debate makes little difference for most observers, however. The simplicity of naked-eye meteor observing is such that that most observers continue to use this method and we see examples of meteor shower analyses, derived from naked-eye observations, on the covers of the 1969 September issue (Figure 2) and the 1970 January issue (Figure 3).

9 Unusual Meteors and New Showers

Unusual meteors are sometimes reported. Peter York mentions the controversial issue of simultaneous meteor sounds in the 1966 May issue (York, 1966), adding that he has heard such sounds, and reports that he has been informed by BAA Meteor Section Director Harold Ridley that such sounds may not be anomalous in all cases. Keith Hindley addresses the subject at more length in the 1966 October issue (Hindley, 1966a). The 1969 December issue includes reports, by Colin Henshaw, Graham Winstanley and Paul Sutherland, of three different "nebulous" meteors (The Astronomer, 1969b). The Editor expresses skepticism regarding these, suggesting night-flying birds are responsible for most such reports. Additional reports of nebulous meteors appear in the 1970 January issue (The Astronomer, 1970). More "mystery/nebulous objects" are reported in the 1971 February/March, 1971 April and 1971 May issues (The Astronomer, 1971a; Northwood, 1971; The Astronomer, 1971b), some of which are linked to satellites. By the 1971 June issue, the Editor comments *"I am getting rather swamped with reports of mysterious objects in the sky and they will have to wait in the queue".* Further reports appear intermittently. In the 1971 August issue, James Shepherd reports his observation of a bright yellow meteor on 1971 April 13 whose path appeared to contain five or six twists (Shepherd, 1971).

Possible new meteor showers are reported from time to time. In the 1972 August issue, Michael Pace reports that he and Chris Hall had noted a sudden burst of six meteors in four minutes moving through Cassiopeia and Ursa Minor during the night of 1972 July 17-18 (Pace, 1972). In the next issue, Robert McNaught reports that his observations in 1972 appear to support the existence in mid-August of a radiant near Delta Cassiopeiae that he had first suspected in 1971 (McNaught, 1972). Further reports of proposed new showers appear during 1973, including a shower in Ursa Major on March 7-8 reported by George Spalding (The Astronomer, 1973c), a shower in Gemini during March 22-24 reported by Janos Papp (The Astronomer, 1973a) and a shower in Pegasus in mid to late July reported by Neil Bone (The Astronomer, 1973b). Further activity from the latter shower is reported in 1974 (The Astronomer, 1974a).

10 Meteors at the 1973 AGM

The 1973 May issue includes a summary of Keith Hindley's talk at the 1973 March AGM (The Astronomer, 1973d). In this talk, he had referred to plans to set up an "International Centre for Meteor Observers" before going on to review the current understanding of the Quadrantid meteor shower, highlighting how radar results had shown the radar peak to occur 8 hours before the visual peak. The talk had also included an overview of fireball and meteorite studies, mentioning one recovered meteorite whose analysis revealed a considerable amount of organic material, particularly on the surface. The presence, however, of a yellow stainsuggested that a dog had found the meteorite before the scientists arrived!

11 Fireball discussions

Although intermittent fireball reports had appeared in many earlier issues, the 1974 January issue stands out by devoting over two pages to fireball reports (Hindley, 1974). Around half of this is devoted to a report by Keith Hindley on the BAA Meteor Section's analysis of a spectacular fireball that crossed Scotland on 1973 December 27. The reports of a sonic boom, together with a low calculated end-height pointed to the possibility of a meteorite fall in Northern Ireland. The second page includes 12 reports of other fireballs seen between mid-November and mid-January. The usefulness of these latter reports is questioned by Martin Ince and Derek Hufton in the 1974 March issue (The Astronomer, 1974b). The Editor responds, however, by mentioning the possibility that such reports might alert photographers of other objects to check any images secured at such times.

12 A dedicated sub-editor

The 1974 August issue was a landmark event for meteor and fireball reports in TA. For the first time, a dedicated sub-editor is listed for meteor and fireball reports. This is Graham Winstanley. In the 1974 September issue (Winstanley, 1974), he writes:
"Meteor and fireballs have been promoted from 'Miscellanea'. This is a big step considering the small amounts included in the past, and more contributors will be required to meet the standard set by the other sections of TA . . . "

13 And finally . . .

Mention should be made of a book review (Muirden, 1971) that appeared in the 1971 August issue. The book in question was *Operation Trojan Horse* by John A Keel. The review highlights some of the author's bizarre beliefs, including his acceptance of a claim by a 1966 fireball witness to have seen a head looking out of a porthole during the fireball's descent, his assertion that meteors cannot be tracked by radar and his suggestion that the regularity of meteor activity during the year indicates an intelligent alien plan "of some sort"!

14 Summary

Although the creation of the magazine had been driven primarily by observers of other astronomical phenomena, meteor and fireball reports had quickly gained a significant foothold in the magazine, culminating in the designation in 1974 of a dedicated sub-editor. Meteor and Fireball reports were thus well established by the time that a new main editor took control in early 1975.

Back issues of most issues of the magazine have been uploaded to the NASA ADS system and can be downloaded via this link on the magazine's home page:
`http://www.theastronomer.org/post/NASA%20ADS/`

Unfortunately, the page-ids stored in the NASA ADS system don't always directly match the page numbers from the printed magazine. To help mitigate this problem, those page-ids that differ from the printed values have been included (when available) in brackets at the end of each reference.

References

Alcock G. E. D. (1964). "Telescopic meteors". *The Casual Astronomer*, **1:3**, 11. [B11].

Brown A. (1969). "Editorial comment". *The Astronomer*, **6:64**, 63–64.

Falworth G. (1969). "Rocket re-entry". *The Astronomer*, **5:57**, 128. [128].

Hindley K. B. (1964a). "Comet searches and telescopic meteors". *The Casual Astronomer*, **1:3**, 11–13. [B11-13].

Hindley K. B. (1964b). "Exploding fireball". *The Casual Astronomer*, **1:3**, 4. [B4].

Hindley K. B. (1966a). "Acoustic effects of meteors". *The Casual Astronomer*, **3:30**, 12–13. [F12-F13].

Hindley K. B. (1966b). "The Leonid meteor stream". *The Casual Astronomer*, **3:30**. supplement [F2.1].

Hindley K. B. (1967a). "Meteor photography and the amateur astronomer (part 1)". *The Astronomer*, **4:42**, 120–123.

Hindley K. B. (1967b). "Meteor photography and the amateur astronomer (part 2)". *The Astronomer*, **4:43**, 143–145.

Hindley K. B. (1967c). "Telescopic meteors and the amateur astronomer". *The Astronomer*, **3:35**, 15–18. [J15-J18].

Hindley K. B. (1968a). "Meteor photography and the amateur astronomer (part 3)". *The Astronomer*, **5:49**, 16–18.

Hindley K. B. (1968b). "Meteor photography and the amateur astronomer (part 4)". *The Astronomer*, **5:50**, 34–36.

Hindley K. B. (1969a). "Modern meteor observing". *The Astronomer*, **6:66**, 130–132.

Hindley K. B. (1969b). "Modern meteor observing". *The Astronomer*, **6:67**, 151–152.

Hindley K. B. (1969c). "Report on the June Lyrids". *The Astronomer*, **6:64**, 77–79.

Hindley K. B. (1974). "Recent fireballs". *The Astronomer*, **10:117**, 197–199. [1:197-1:199].

Lloyd-Evans T. (1964). "Leonid meteors". *The Casual Astronomer*, **1:8**, 5–6. [G5-G6].

McNaught R. H. (1972). "New meteor shower?". *The Astronomer*, **9:101**, 94.

Muirden J. (1964). "Editorial". *The Casual Astronomer*, **1:1**, 1–2.

Muirden J. (1971). "Book review". *The Astronomer*, **8:88**.

Northwood D. J. (1971). "Another mystery object". *The Astronomer*, **7:84**, 203.

Pace A. R. and Pace M. F. (1966). "The Barwell Meteorite". *The Casual Astronomer*, **2:21**, 5. [I5].

Pace M. (1972). "Meteor burst". *The Astronomer*, **9:100**, 69.

Ridley H. B. (1967). "Bright meteors observed on 1966 December 4". *The Astronomer*, **3:33**, 8. [H8].

Ridley I. (1968). "Rocket re-entry?". *The Astronomer*, **5:56**, 114.

Scoular R. R. (1969a). "More Hindley Lyrids, June 1969". *The Astronomer*, **6:63**, 53.

Scoular R. R. (1969b). "The observation of minor meteor showers". *The Astronomer*, **6:63**, 55–56.

Shepherd J. (1971). "Curious yellow". *The Astronomer*, **8:88**, 64.

The Astronomer (1966). "Leonid meteor reports". *The Astronomer*, **3:31/32**, 12–16. [G12-G16].

The Astronomer (1969a). "Perseid meteor shower 1969". *The Astronomer*, **6:65**, 87–93. [87-93].

The Astronomer (1969b). "Three nebulous meteors". *The Astronomer*, **6:68**, 177.

The Astronomer (1970). "Meteor notes". *The Astronomer*, **6:69**, 199.

The Astronomer (1971a). "Mystery object". *The Astronomer*, **7:82/83**, 200.

The Astronomer (1971b). "Nebulous object". *The Astronomer*, **8:85**, 19.

The Astronomer (1973a). "Meteor notes". *The Astronomer*, **10:109**, 1–2. [not available].

The Astronomer (1973b). "Meteor notes". *The Astronomer*, **10:112**, 75–76. [not available].

The Astronomer (1973c). "Meteors". *The Astronomer*, **9:107**, 233.

The Astronomer (1973d). "Report of the meeting held at the Alliance Hall, London, 1973 March 31". *The Astronomer*, **10:109**, 3–4. [not available].

The Astronomer (1974a). "Meteors and fireballs". *The Astronomer*, **11:125**, 87.

The Astronomer (1974b). "Miscellanea". *The Astronomer*, **10:119**, 246. [2:246].

The Casual Astronomer (1964). "Perseid meteors 1964". *The Casual Astronomer*, **1:5**, 5–6. [D5-D6].

The Casual Astronomer (1965). "Geminid meteors 1964, Quadrantid meteors 1965". *The Casual Astronomer*, **1:9**, 8–12. [H8-H12].

The Casual Astronomer (1966). *The Casual Astronomer*, **3:29**. Front Cover [E1].

The Casual Astronomer (1966). "Leonid shower 1966 Nov 14-18". *The Casual Astronomer*, **3:29**, 13. [E13].

Wilson L., Scagell R., et al. (1969). "The Hindley Lyrids – a new meteor shower". *The Astronomer*, **6:62**, 34.

Winstanley G. (1974). "Meteors and fireballs". *The Astronomer*, **11:125**, 88.

York P. B. (1966). "Casual comments". *The Casual Astronomer*, **3:25**, 13. [A13].

Handling Editor: Javor Kac

The International Meteor Organization

www.imo.net

Follow us on Facebook
InternationalMeteorOrganization

Follow us on Twitter
@IMOMeteors

Council

President: Cis Verbeeck,
Bogaertsheide 5, 2560 Kessel, Belgium.
e-mail: `cis.verbeeck@scarlet.be`

Vice-President: Juraj Tóth,
Fac. Math., Phys. & Inf., Comenius Univ.,
Mlynska dolina, 84248 Bratislava, Slovakia.
e-mail: `toth@fmph.uniba.sk`

Secretary-General: Robert Lunsford,
14884 Quail Valley Way, El Cajon,
CA 92021-2227, USA. tel. +1 619 755 7791
e-mail: `lunro.imo.usa@cox.net`

Treasurer: Marc Gyssens, Heerbaan 74,
B-2530 Boechout, Belgium.
e-mail: `marc.gyssens@uhasselt.be`
BIC: GEBABEBB
IBAN: BE30 0014 7327 5911
Bank transfer costs are always at your expense.

Other Council members:

Megan Argo, Jodrell Bank Centre for Astrophysics, Alan Turing building, University of Manchester, Oxford Road, Manchester, M13 9PL, UK. e-mail: `megan.argo@gmail.com`

Javor Kac (see details under WGN)

Detlef Koschny, Zeestraat 46, NL-2211 XH Noordwijkerhout, Netherlands. e-mail: `detlef.koschny@esa.int`

Masahiro Koseki, 4-3-5 Annaka, Annaka-shi, Gunma-ken 379-0116, Japan. e-mail: `geh04301@nifty.ne.jp`

Sirko Molau, Abenstalstraße 13b, D-84072 Seysdorf, Germany. e-mail: `sirko@molau.de`

Jean-Louis Rault, Société Astronomique de France, 16, rue de la Vallée, 91360 Epinay sur Orge, France. e-mail: `f6agr@orange.fr`

Jürgen Rendtel, Eschenweg 16, D-14476 Marquardt, Germany. e-mail: `jrendtel@aip.de`

Paul Roggemans, Pijnboomstraat 25, 2800 Mechelen, Belgium, e-mail: `paul.roggemans@gmail.com`

Galina Ryabova, Res. Inst. of Appl. Math. & Mech., Tomsk State University, Lenin pr. 36, build. 27, 634050 Tomsk, Russian Federation. e-mail: `ryabova@niipmm.tsu.ru`

Damir Šegon, J. Rakovca 3, 52100 Pula, Croatia. e-mail: `damir.segon@pu.t-com.hr`

Commission Directors

Visual Commission: Rainer Arlt (`rarlt@aip.de`)
Generic e-mail address: `visual@imo.net`
Electronic visual report form:
`http://www.imo.net/visual/report/electronic`

Video Commission: Sirko Molau (`video@imo.net`)

Photographic Commission: Bill Ward
(`William.Ward@glasgow.ac.uk`)
Generic e-mail address: `photo@imo.net`

Radio Commission: Jean-Louis Rault (`radio@imo.net`)

Fireballs: Online fireball reports:
`http://fireballs.imo.net`

Outreach Officer

Jure Atanackov, e-mail: `jureatanackov@gmail.com`

Webmaster

Karl Antier, e-mail: `webmaster@imo.net`

WGN

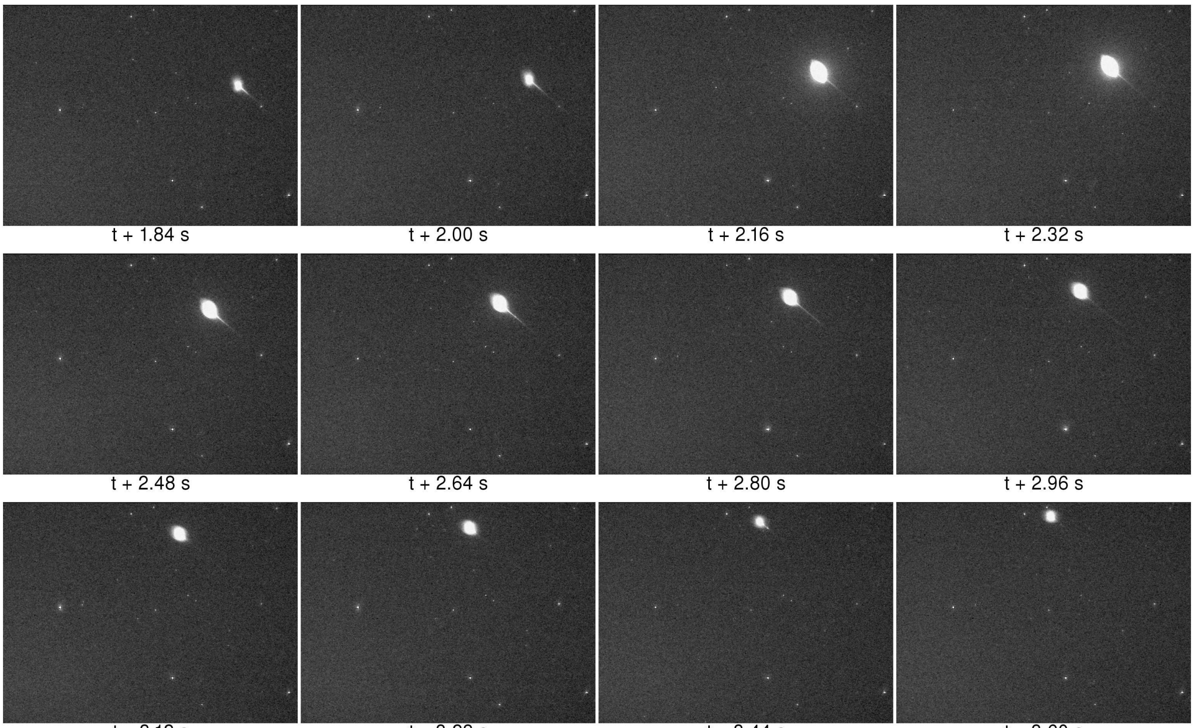
Editor-in-chief: Javor Kac
Na Ajdov hrib 24, SI-2310 Slovenska Bistrica,
Slovenia. e-mail: `wgn@imo.net`;
include METEOR in the e-mail subject line

Editorial board: Ž. Andreić, M. Argo, D.J. Asher, F. Bettonvil, J. Correira, M. Gyssens, C. Hergenrother, T. Heywood, J.-L. Rault, J. Rendtel, C. Verbeeck, S. de Vet, D. Vida.

IMO Sales

Available from the Treasurer or the Electronic Shop on the IMO Website	€	$
IMO membership, including subscription to WGN Vol. 46 (2018)		
Surface mail	26	35
Air Mail (outside Europe only)	49	65
Electronic subscription only	21	25
Proceedings of the International Meteor Conference on paper		
1990, 1991, 1993, 1995, 1996, 1999, 2000, 2002, 2003, per year	9	12
2007, 2010, 2011, per year	15	20
2012, 2013, 2014, 2015 per year	25	34
Proceedings of the Meteor Orbit Determination Workshop 2006	15	20
Radio Meteor School Proceedings 2005	15	20
Handbook for Meteor Observers	15	20
Meteor Shower Workbook	12	16
Electronic media		
Meteor Beliefs Project ZIP archive	6	8

2017 November 14 Taurid fireball over Slovenia



This bright Taurid fireball on 2017 November 14 at $23^{h}56^{m}20^{s}$ UT. The top image shows all-sky image of the fireball. The bottom image shows selected individual frames of the Rezika meteor camera video record, which are separated by 0.16 s. Labels below each frame mark the time elapsed since the start of the detection. Photos courtesy: Javor Kac/Rezman Observatory.