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Solar longitudes for 2016
IMC 2015 Proceedings abstracts
Chi-Cygnids observed from Japan
Visual observations of the Kappa-Cepheids
July–August video meteors

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Front cover photo

Green and blue persistent train of a Perseid meteor captured on 2013 August 11 at $20^{\text{h}}45^{\text{m}}$ UT from Derbyshki town within the city of Kazan, Republic of Tatarstan, Russian Federation. The Samyang 85 mm/1.4 Aspherical IF lens and Canon EOS 400D camera were used for a 4 s exposure at ISO 800. Image courtesy: Vladimir Usanin, Kazan Federal University.

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

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From the Treasurer — IMO Membership/WGN Subscription Renewal for 2016

Marc Gyssens

We invite all our members/subscribers to renew for 2016. The fees are as tabulated below. We are happy that we can offer WGN at the same cost as last year. We also continue to offer an electronic-only subscription at a reduced rate.

IMO Membership/WGN Subscription 2016				
Electronic + paper with surface mail delivery:		€26		US$ 39
Electronic + paper with airmail delivery (outside Europe only):		€49		US$ 69
Electronic only:		€21		US$ 29
Supporting membership:	add	€26	add	US$ 39

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

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

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

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

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

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

IMO bibcode WGN-436-gyssens-renewals NASA-ADS bibcode 2015JIMO...43..161G

Solar Longitudes for 2016

Compiled by Rainer Arlt

A conversion table of dates to solar longitudes using (Steyaert, 1991) is given as every year. The longitudes are given on the next page; they are only valid for 2016. The conversion formulae for any time of the day are repeated here for your convenience.

If you want to calculate the solar longitude $\lambda_\odot$ of a specific time of the day, you may use a linear interpolation between two dates. Suppose you have a certain *Date* and the *Time* in hours (UT), you get the solar longitude by

$$\lambda_\odot = \lambda_{\odot,\mathrm{Date}} + (\lambda_{\odot,\mathrm{NextDay}} - \lambda_{\odot,\mathrm{Date}}) \times \frac{\mathrm{Time}}{24^{\mathrm{h}}}.$$

Alternatively, if you want to convert a certain solar longitude $\lambda_\odot$ into a time of the day, look up the *Date* with the next-smaller solar longitude in the table and calculate

$$\mathrm{Time} = \frac{(\lambda_\odot - \lambda_{\odot,\mathrm{Date}})}{(\lambda_{\odot,\mathrm{NextDay}} - \lambda_{\odot,\mathrm{Date}})} \times 24^{\mathrm{h}}.$$

The solar longitudes of 1988–2020 are given in two-hour increments and with three decimals at `http://www.imo.net/data/solar`.

References

Steyaert C. (1991). "Calculating the solar longitude 2000.0". *WGN, Journal of the IMO*, **19:2**, 31–34.

IMO bibcode WGN-436-arlt-solarlong
NASA-ADS bibcode 2015JIMO...43..161A

Solar longitudes 2016. Dates refer to 00^{h} UT.

Jan	1	279.76	Mar	1	340.61	May	1	40.83	Jul	1	99.37	Sep	1	158.76	Nov	1	218.77
Jan	2	280.78	Mar	2	341.62	May	2	41.80	Jul	2	100.32	Sep	2	159.73	Nov	2	219.77
Jan	3	281.80	Mar	3	342.62	May	3	42.77	Jul	3	101.28	Sep	3	160.70	Nov	3	220.77
Jan	4	282.82	Mar	4	343.62	May	4	43.74	Jul	4	102.23	Sep	4	161.67	Nov	4	221.77
Jan	5	283.84	Mar	5	344.62	May	5	44.71	Jul	5	103.18	Sep	5	162.64	Nov	5	222.77
Jan	6	284.86	Mar	6	345.63	May	6	45.68	Jul	6	104.14	Sep	6	163.61	Nov	6	223.78
Jan	7	285.88	Mar	7	346.63	May	7	46.65	Jul	7	105.09	Sep	7	164.58	Nov	7	224.78
Jan	8	286.90	Mar	8	347.63	May	8	47.61	Jul	8	106.04	Sep	8	165.55	Nov	8	225.78
Jan	9	287.92	Mar	9	348.63	May	9	48.58	Jul	9	107.00	Sep	9	166.52	Nov	9	226.79
Jan	10	288.94	Mar	10	349.63	May	10	49.55	Jul	10	107.95	Sep	10	167.49	Nov	10	227.79
Jan	11	289.96	Mar	11	350.63	May	11	50.52	Jul	11	108.91	Sep	11	168.46	Nov	11	228.80
Jan	12	290.98	Mar	12	351.63	May	12	51.48	Jul	12	109.86	Sep	12	169.44	Nov	12	229.80
Jan	13	292.00	Mar	13	352.62	May	13	52.45	Jul	13	110.81	Sep	13	170.41	Nov	13	230.81
Jan	14	293.02	Mar	14	353.62	May	14	53.41	Jul	14	111.77	Sep	14	171.38	Nov	14	231.82
Jan	15	294.03	Mar	15	354.62	May	15	54.38	Jul	15	112.72	Sep	15	172.36	Nov	15	232.82
Jan	16	295.05	Mar	16	355.61	May	16	55.34	Jul	16	113.67	Sep	16	173.33	Nov	16	233.83
Jan	17	296.07	Mar	17	356.61	May	17	56.30	Jul	17	114.63	Sep	17	174.30	Nov	17	234.84
Jan	18	297.09	Mar	18	357.60	May	18	57.27	Jul	18	115.58	Sep	18	175.28	Nov	18	235.84
Jan	19	298.11	Mar	19	358.60	May	19	58.23	Jul	19	116.53	Sep	19	176.26	Nov	19	236.85
Jan	20	299.13	Mar	20	359.59	May	20	59.19	Jul	20	117.49	Sep	20	177.23	Nov	20	237.86
Jan	21	300.14	Mar	21	0.59	May	21	60.15	Jul	21	118.44	Sep	21	178.21	Nov	21	238.87
Jan	22	301.16	Mar	22	1.58	May	22	61.12	Jul	22	119.40	Sep	22	179.19	Nov	22	239.88
Jan	23	302.18	Mar	23	2.57	May	23	62.08	Jul	23	120.35	Sep	23	180.17	Nov	23	240.89
Jan	24	303.19	Mar	24	3.56	May	24	63.04	Jul	24	121.31	Sep	24	181.15	Nov	24	241.90
Jan	25	304.21	Mar	25	4.55	May	25	64.00	Jul	25	122.26	Sep	25	182.12	Nov	25	242.91
Jan	26	305.23	Mar	26	5.54	May	26	64.96	Jul	26	123.22	Sep	26	183.11	Nov	26	243.93
Jan	27	306.24	Mar	27	6.53	May	27	65.92	Jul	27	124.17	Sep	27	184.09	Nov	27	244.94
Jan	28	307.26	Mar	28	7.52	May	28	66.88	Jul	28	125.13	Sep	28	185.07	Nov	28	245.95
Jan	29	308.28	Mar	29	8.51	May	29	67.84	Jul	29	126.08	Sep	29	186.05	Nov	29	246.96
Jan	30	309.29	Mar	30	9.50	May	30	68.80	Jul	30	127.04	Sep	30	187.03	Nov	30	247.98
Jan	31	310.31	Mar	31	10.49	May	31	69.75	Jul	31	128.00						
Feb	1	311.32	Apr	1	11.47	Jun	1	70.71	Aug	1	128.95	Oct	1	188.02	Dec	1	248.99
Feb	2	312.34	Apr	2	12.46	Jun	2	71.67	Aug	2	129.91	Oct	2	189.00	Dec	2	250.01
Feb	3	313.35	Apr	3	13.45	Jun	3	72.63	Aug	3	130.87	Oct	3	189.98	Dec	3	251.02
Feb	4	314.37	Apr	4	14.43	Jun	4	73.59	Aug	4	131.82	Oct	4	190.97	Dec	4	252.03
Feb	5	315.38	Apr	5	15.42	Jun	5	74.54	Aug	5	132.78	Oct	5	191.95	Dec	5	253.05
Feb	6	316.40	Apr	6	16.40	Jun	6	75.50	Aug	6	133.74	Oct	6	192.94	Dec	6	254.06
Feb	7	317.41	Apr	7	17.39	Jun	7	76.46	Aug	7	134.70	Oct	7	193.93	Dec	7	255.08
Feb	8	318.42	Apr	8	18.37	Jun	8	77.42	Aug	8	135.66	Oct	8	194.91	Dec	8	256.10
Feb	9	319.44	Apr	9	19.35	Jun	9	78.37	Aug	9	136.62	Oct	9	195.90	Dec	9	257.11
Feb	10	320.45	Apr	10	20.33	Jun	10	79.33	Aug	10	137.57	Oct	10	196.89	Dec	10	258.13
Feb	11	321.46	Apr	11	21.32	Jun	11	80.29	Aug	11	138.53	Oct	11	197.88	Dec	11	259.14
Feb	12	322.47	Apr	12	22.30	Jun	12	81.24	Aug	12	139.49	Oct	12	198.87	Dec	12	260.16
Feb	13	323.49	Apr	13	23.28	Jun	13	82.20	Aug	13	140.45	Oct	13	199.86	Dec	13	261.18
Feb	14	324.50	Apr	14	24.26	Jun	14	83.15	Aug	14	141.41	Oct	14	200.85	Dec	14	262.19
Feb	15	325.51	Apr	15	25.24	Jun	15	84.11	Aug	15	142.37	Oct	15	201.84	Dec	15	263.21
Feb	16	326.52	Apr	16	26.22	Jun	16	85.06	Aug	16	143.33	Oct	16	202.83	Dec	16	264.23
Feb	17	327.53	Apr	17	27.19	Jun	17	86.02	Aug	17	144.30	Oct	17	203.82	Dec	17	265.24
Feb	18	328.54	Apr	18	28.17	Jun	18	86.97	Aug	18	145.26	Oct	18	204.81	Dec	18	266.26
Feb	19	329.55	Apr	19	29.15	Jun	19	87.92	Aug	19	146.22	Oct	19	205.80	Dec	19	267.28
Feb	20	330.55	Apr	20	30.12	Jun	20	88.88	Aug	20	147.18	Oct	20	206.80	Dec	20	268.30
Feb	21	331.56	Apr	21	31.10	Jun	21	89.83	Aug	21	148.14	Oct	21	207.79	Dec	21	269.31
Feb	22	332.57	Apr	22	32.08	Jun	22	90.79	Aug	22	149.11	Oct	22	208.79	Dec	22	270.33
Feb	23	333.58	Apr	23	33.05	Jun	23	91.74	Aug	23	150.07	Oct	23	209.78	Dec	23	271.35
Feb	24	334.58	Apr	24	34.02	Jun	24	92.69	Aug	24	151.03	Oct	24	210.78	Dec	24	272.37
Feb	25	335.59	Apr	25	35.00	Jun	25	93.65	Aug	25	152.00	Oct	25	211.77	Dec	25	273.39
Feb	26	336.59	Apr	26	35.97	Jun	26	94.60	Aug	26	152.96	Oct	26	212.77	Dec	26	274.41
Feb	27	337.60	Apr	27	36.94	Jun	27	95.55	Aug	27	153.93	Oct	27	213.77	Dec	27	275.43
Feb	28	338.60	Apr	28	37.92	Jun	28	96.51	Aug	28	154.89	Oct	28	214.77	Dec	28	276.45
Feb	29	339.61	Apr	29	38.89	Jun	29	97.46	Aug	29	155.86	Oct	29	215.77	Dec	29	277.47
			Apr	30	39.86	Jun	30	98.41	Aug	30	156.83	Oct	30	216.77	Dec	30	278.49
									Aug	31	157.79	Oct	31	217.77	Dec	31	279.50

Conferences

International Meteor Conference 2015 report

Debora Pavela [1]

Received 2015 December 6

Figure 1 – Miroslav Živanović and Debora Pavela during her talk at the IMC. Credit: Axel Haas.

Firstly I would like like to thank the WGN editor Javor Kac, for giving me the opportunity to write my own personal experience from meteor conference. In the following article, I set aside some of the most interesting things that have happened to me, and the overall impression of the conference as one of the youngest participants.

If someone told me last year that I will participate on International Meteor Conference just less than year from then I would not have believed him. For me, this conference was a big step forward. The first big step in meteor astronomy. It was my first Meteor Conference, actually my first conference ever to participate as a lecturers. As high schooler I have been attending seminars of Astronomy in Petnica Science Center. Last summer my coworker Miroslav and I joined Petnica Meteor Group. At first we were doing mini projects, but by focusing on telescopic observation of meteors, Branislav Savić and Vlado Lukić told us about the IMC a few times and saw opportunity for us to participate. By listening to stories from the conference of people who have already participated several times, viewing pictures from past conferences and reading the papers on it we have gained a very confusing impression. It was not clear how on so professional conference and serious people, people are well entertaining.

After exhausting trip of 15 hours and preparing presentation in bus, we finally arrived at Mistelbach. When we finally arrived at the station, the first thing that went through my head was, man, how do I now get to school. But luck was just behind corner. Along the way we met the hosts, which we recognized by the shirts. T-shirts very gaudy green color, I just thought and hoped that we do not get the same color. As we were late on opening the conference, we went immediately after arrival to settled. The rooms were big, and had nice view on Mistelbach. Hosts were very friendly and pleasant-minded.

Next day, we were among the first who presented. Before the presentation I had a very big problem in pronunciation and preparing a presentation, and very was very nervous. Miroslav comforted me, and told not to be afraid of anything, we're going to do well on the presentation, but I knew that he had bigger stage fright than me. We were talking about problem of counting meteors in reduced field of view. There was a technical problem at our presentation. They moved us to next session. After the coffee break, friendly socializing and comfort of older lecturers we started with the presentation. And we nailed it. After presentation everything went smooth, whole day was filled with lectures and workshops. Just before dinner there was a poster session, a few people came to talk to us about our lecture, giving us great suggestions and proposals, and even some criticism.

Since I am of the Slovak nationality but live in Serbia, I had the opportunity to speak at a conference with people in Slovak. Second day of presentations we went to a National History Museum of Wien. We found it interesting and exciting. One very funny moment was when we went to Vienna. When we went up to the bus, we walked past a farm. At one point we passed the various domestic animals, including pigs. How little in front of me went people from Slovakia, with whom I began to comment on the order of these pigs was nice sausage, ham, bacon and pork cracklings. What can I say to this, Slovaks like to eat meat.

Collection of meteorites that is in the museum is breath taking. Never in our life we haven't seen so many

Figure 2 – The author admiring the meteorite collection in the Vienna Museum of Natural History. Credit: Javor Kac.

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Figure 3 – Jürgen Rendtel thanking the IMC 2015 local organizing committee. Credit: Axel Haas.

meteorites in one place, there were at least a thousand gathered from different places. A two hour tour of the museum was not enough, the museum is full of interesting meteor various kinds. In one moment by looking one meteorite, there was a reflection in It, because it was polished, so we took a picture in it. Guide who led us through the museum is also a lover of meteorites, and told throughout the tour as he has all kinds of meteorites still in his office, and talked more about his love for meteorites than on meteorites.

After the museum we went to dinner at a nearby restaurant. In addition to the dinner, which was deli-

Figure 4 – Jeremie Vaubaillon and Sylvain Bouley performing the 2015 version of the IMC song after the dinner. Credit: Christoph Niederhametner.

Figure 5 – The IMC 2015 group photo in front of the MAMUZ Museum. Credit: Christoph Niederhametner.

cious, there were many interesting stories from the life. At that dinner it was wonderful. We spoke of meteors to that put men landed on the moon. It had been a lot of fun, especially as it was guitar present among people, so with the dinner there was we sang. But the most beautiful is nevertheless a lunar meteorite that we saw later at dinner. It was an honor to hold it in hand. After dinners and during the coffee breaks, we met people who has for many years dealing with meteor astronomy and in other areas, and it's very interesting that people even if you're an amateur astronomer talking to you like you're on level of study.

I liked the presentations. The stories were from the visual to the video meteor astronomy. From what I noticed, lately more and more people are engaged in video observations. What led to this, that there are now a variety of variants of calibration and data processing. Even people use various systems for the cameras observation. There were stories about word processing visual information. That's what I really like, because it is easier to access the entire database. Also interesting were the stories about bolids and hence meteor networks.

The last day was the presentation of the IMC in 2016. After that Kristina, Miroslav and I presented the IMC in 2017. We were not prepared, we went out and told all about Petnica from personal experience lifes. Hhah, so there was a small lapsus-lingue, in which I said that the Petnica Science Center is the oldest institutions in this field. But I thought only in Serbia, but it turned out that the Petnica is institution that deals with meteors from immemorial. As I had a little stage fright, I said Petnica has a very large library, which is in about 40 thousand books, in order that Miroslav retorting that no one cares how much it has books, no one at the conference won't sit in the library and read books. We agreed that we will not talk about the order, so it was a bit of abducting microphone. But in the end everything went well, even were the positive comments after all.

It is priceless, specially for me to establish so many contacts from all around the world. Personal impression on conference: breath taking, amazing. We had really amazing time, enjoying and working on conference. Specially enjoying the talks with people from all around world and from all kinds of fields of interests. Acquaint yourself with people who work in the ESA, Max Planck etc. but also with people who work on smaller projects and thereby important for meteor astronomy is simply indescribable. The enthusiasm of the people, even those who are dealing aa an amateur, is at a high level. The right place for geeks who love meteors. I am very happy that I talked to these people. It was a great catch for us, with our short time in meteor astronomy. We would regretted that we did not go to the conference, it was very beautiful.

I hope to next year, I have more opportunity to hang out with all the people. We are looking forward for next conference in Netherlands, and also hoping to be the organizers of the 2017 IMC – it will be twenty years since the last time it was in Petnica.

One wishing note to everyone: Clear skies!

Details of the Proceedings of the International Meteor Conference, Mistelbach, Austria, 27–30 August 2015

Paul Roggemans and Jean-Louis Rault, editors

The 34th International Meteor Conference took place in Mistelbach, Austria and was attended by as many as 125 participants from 27 different countries. The editors wish to thank all the authors and especially the proofreaders Megan Argo, Bob Lunsford and Tony Markham for their time and patience to improve the English language of many contributions. For the 2015 Mistelbach Proceedings we could benefit from the experience with the 2014 edition and optimize the editing procedure. It is our pleasure to offer the IMC Proceedings within two months after the conference. All papers have been reported to the ADS abstract service and remain available as references for future work.

These IMC Proceedings are the 30th published Proceedings of the IMCs. Only in the early years four IMCs never got documented by Proceedings (1980, 1982, 1983 and 1985). Since 1986 all meetings had the Proceedings published. The publication of such Proceedings is crucial to justify the time, efforts and money spent by participants to attend the meetings. Indeed, although that the personal contacts make such conferences worthwhile, the knowledge which is shared by the lectures and posters is completely lost if not preserved in some written form. In the past, some Proceedings did not cover half of all presentations and to make things worse, huge delays in editing these Proceedings made it difficult to motivate authors to deliver a paper.

The vicious circle of delays and incompleteness was broken with the 2011 Sibiu IMC Proceedings when all topics of the conference could be included and the publication was available within a year after the conference. For the Giron IMC Proceedings the editors managed to optimize the editing procedure and had the 2014 Giron Proceedings ready about two months after the conference. LaTeX was replaced by MS Word to edit the publication which has proven to be much easier for most authors.

Can we still improve without asking any extra work, time or effort from the authors? The answer is definitely yes! Having reserved a period of two months to edit these Proceedings, the procedure went well during the first three weeks only, then the editors had to wait for authors who did not mind the deadline they had registered to submit their paper. Although the number of reminders sent by the editors was much less than previous year, still the number of e-mail interactions consumes a lot of time during the editing procedure. This could be prevented if everyone would submit the IMC paper, or at least a draft of this, before the IMC as that would allow the editors to discuss editing issues during the IMC, rather than by time consuming e-mail after the IMC. This requires not any single minute of extra work from the authors; it requires only a change in the habits to start working on the paper before the IMC instead of postponing this until after the IMC. Input obtained during the IMC can easily be taken into account after the IMC without having to write the paper from scratch. The editors experienced that the longer it takes after an IMC for an author to start writing her or his paper, the more difficult it becomes to get a long overdue task still finished in between many other new duties and jobs. Hence, we wish to get as many authors as possible to work on their paper before the IMC. It requires no extra efforts; on the contrary, the authors will feel free of the stress of having an incomplete piece of working hanging over them. Done is done, and that makes everybody happy, especially the editors who escape from writing endless e-mails as reminders. This will minimize the dead time during which the editors cannot do anything else than to wait for delayed papers.

For the 2016 IMC Proceedings we strongly recommend all contributing authors to prepare their paper, or at least a draft of the paper, at latest in May, some weeks before the IMC. The editing work on the 2016 Proceedings should be finished by end of June 2016. We can achieve this if everybody makes an effort to work early on her or his paper. The editors will be very grateful if all authors cooperate to respect the deadlines.

Population index reloaded

Sirko Molau

This paper describes results from the determination of population indices from major meteor showers in 2014–2015. In many cases we find outliers that cannot be explained easily by the data set or the used algorithm. Alternative approaches are presented to check, if the outliers are real or instrumental errors. There is no conclusive result, though. An outlook is given, how the testing setup may be improved.

The American Meteor Society's filter bank spectroscopy project

Peter Gural

The American Meteor Society (AMS) has sponsored the development of an alternative method of meteor spectroscopy that relies on a set of eight very narrow band wavelength filters. The interference filters used are tuned to the dominant meteoric emission lines of Ca+, two Fe line regions, Mg, Na, Si+, the forbidden O line, and

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atmospheric O_{777}. Discussion will include the design trade-offs, construction of the instrument, first light testing, and initial results.

Video meteor detection filtering using soft computing methods

Emil Silađi, Denis Vida and Emmanuel Karlo Nyarko

In this paper we present the current progress and results from the filtering of Croatian Meteor Network video meteor detections using soft computing methods such as neural networks and support vector machines (SVMs). The goal is to minimize the number of false-positives while preserving the real meteor detections. This is achieved by pre-processing the data to extract meteor movement parameters and then recognizing patterns distinct to meteors. The input data format is fully compliant with the CAMS meteor data standard, and as such the proposed method could be utilized by other meteor networks of the similar kind.

Improvement of software for analysis of visual meteor data

Kristina Veljković and Ilija Ivanović

In this paper, we present improvements made on our software for the analysis of visual meteor data. R package MetFns received major updates. Selection filters and algorithms for calculation of zenithal hourly rate and population index, as well as accompanying graphics, are corrected and their performance is improved. Web application MetRApp contains a completely remade user interface and some new features. Also, calculation performances are optimized.

Correlating video meteors with GRAVES radio detections from the UK

Richard Fleet

The area of meteor ablation layer illuminated by the GRAVES radar is low on the horizon from southern UK. A number of simultaneous video meteor and radio detections suggested that it was possible to record common events despite the unfavorable relative positions. This was investigated further to see what the constraints are and whether there is any prospect of obtaining useful data.

Effective number of meteors in a reduced field of view

Debora Pavela and Miroslav Živanović

A reduced field of view, such as in telescopic or video observations, causes an overestimation of the ZHR because partially observed meteor trails are counted as a whole rather than a portion of a meteor. Given that the observer does not know which portion of a meteor trail is observed, or if its mid-point is in the field of view or outside of it, the most probable number of meteors with the mid-points inside the field of view can be estimated by correcting the number of the observed meteors. We simulated an observation of a meteor shower, approximating the sky as a two-dimensional plane. Two parameters have been varied: a ratio of the radiant distance from the center of the field of view to the diameter of the field of view, and a ratio of the meteor trail length to its distance from the radiant. Observed meteors are classified in four classes, depending on which part of a meteor is in the field of view, and correction coefficients for each meteor class are computed.

French fireball network FRIPON

François Colas, Brigitte Zanda, Jérémie Vaubaillon, Sylvain Bouley, Chiara Marmo, Yoan Audureau, Min Kyung Kwon, Jean-Louis Rault, Stéphane Caminade, Pierre Vernazza, Jérôme Gattacceca, Mirel Birlan, Lucie Maquet, Auriane Egal, Monica Rotaru, Cyril Birnbaum, François Cochard and Olivier Thizy

FRIPON (Fireball Recovery and Interplanetary Observation Network) was recently founded by ANR (Agence Nationale de la Recherche), its aim being to connect meteoritical science with asteroidal and cometary sciences, in order to better understand our solar system formation and evolution. The main idea is to cover all the French territory to collect a large number of meteorites (one or two per year) with an accurate orbit determination, allowing to pinpoint possible parent bodies. 100 all-sky cameras will be installed at the end of 2015, creating a dense network with an average distance of 100 km between the stations. To maximize the accuracy of the orbit determination, we will mix our optical data with radar data from the GRAVES transmitter received by 25 stations (Rault et al., 2015). As the network installation and the creation of research teams for meteorites involves many persons, at least many more than our small team of professionals, we will develop a participative science network for amateurs called Vigie-Ciel (Zanda et al., 2015). It will be possible to simply use our data, participate in research campaigns or even add cameras to the FRIPON network.

Status of the CAMS-BeNeLux network

Paul Roggemans, Carl Johannink and Martin Breukers

The CAMS-BeNeLux network currently contributes about 10% of all heliocentric orbit data to the global CAMS project. In June 2015 the network has expanded to 45 cameras installed at 14 sites, which all together yielded over 23000 accurate meteor orbits since the first couple of cameras started in March 2012. Some results of the past 12 months are highlighted such as the κ-Cygnids of 2014, the possible occurrence of a dust filament of the Leonids, the Quadrantids of 2015, the Lyrids of 2015 as well as some minor showers which were discovered in recent years.

Croatian Meteor Network: ongoing work 2014 – 2015

Damir Šegon, Željko Andreić, Korado Korlević and Denis Vida

Ongoing work mainly between 2014–2015 International Meteor Conferences (IMC) has been presented. Current sky coverage, software updates, orbit catalogues updates, shower search updates, international collaboration as well as new fields of research and educational efforts made by the Croatian Meteor Network are described.

Recent fireballs registered by the Polish Fireball Network

Przemysław Żołądek, Mariusz Wiśniewski, Arkadiusz Olech, Zbigniew Tymiński and Marcin Stolarz

This is a preliminary overview of the most interesting fireballs and meteors registered by the Polish Fireball Network in the years 2014 and 2015. Some of the fireballs have calculated trajectories and orbital elements, other have been observed as a single station event or as a very distant one, however also these fireballs are shortly described as a very bright, possibly meteorite dropping event.

Latest developments in Polish Fireball Network

Mariusz Wiśniewski and Przemysław Żołądek

The Polish Fireball Network started in March 2004. Most of its observers are amateurs, members of the Comets and Meteors Workshop. The network consists of 40 continuously working stations, where nearly 70 sensitive CCTV video and digital cameras operate. The new cameras for digital meteor spectroscopy were tested. We use technology of crossed grids to have better chances to register a meteor spectrum. A resolution of 8 A/pixel + 5.5 A/pixel was achieved. For the meteor patrol we have chosen the DMK 23GX236 with a chip resolution of 1920x1200 pixels. Two new cameras will be able to cover almost the whole sky with a resolution 4'/pixel.

5 months of AMOS on the Canary Islands

Juraj Tóth, Pavol Zigo, Dušan Kalmančok, Jaroslav Šimon, Leonard Kornoš, Jozef Világi, Regina Rudawska, Miquel Serra-Ricart, Juan Carlos Perez and Javier Licandro

We present the technology, its installation and the first results from the AMOS meteor system on the Canary Islands. Since March 15 2015, a pair of AMOS automatic all-sky cameras (at Observatory Teide (Tenerife) and Roque de los Muchachos (La Palma) of the Astronomical Institute of Canary Islands) has been observing regularly to record meteors on every clear night.

Meteor storms and showers with the IMEX model

Rachel Halina Soja, Julian Tobias Herzog, Maximilian Sommer, Jens Rodmann, Jeremie Vaubaillon, Peter Strub, Thomas Albin, Veerle Sterken, Andreas Hornig, Lars Bausch, Eberhard Grün and Ralf Srama

The Interplanetary Meteoroid Environment for Exploration (IMEX) provides a model of meteoroid streams in the inner solar system. It is primarily designed to provide hazard estimations for interplanetary spacecraft. However, such a model is also suited for studying the impact of recently created meteoroid streams at the Earth. It also allows us to study meteor storms, and to automatically determine the streams that can be observed at the Earth at any time. Here we describe the application to Leonid meteor storms of 1999-2002, and provide the results of the automatic stream determination for 2015.

Kappa-Cygnids: search for periodic activity

Jürgen Rendtel and Rainer Arlt

Various observations of the kappa Cygnids – most recently in 2007 and 2014 – have been considered as a hint at periodic rate/flux enhancement which may also be explained from model calculations. We analyzed visual data back to 1977 and found slightly enhanced rates in 1985, 1989 and 2014. This does neither correspond with any of the proposed periods nor can this be associated with a periodic appearance at all.

The 2015 February 5 event

Christian Steyaert

The past few years have seen predicted meteor outbursts which were extensively observed optically being confirmed by forward scatter radio observations. A more interesting possibility is to discover new streams via radio methods. Although discovery opportunities will be rare and will only be possible when no other major streams are active, such an event was observed on February 5 2015. Optical observations were sparse, but hopefully this stream will also be recorded optically in the future.

High resolution orbits of Perseids and Geminids with CHIPOlAtA

Felix Bettonvil

This paper focuses on the first results of the high-resolution camera project CHIPOlAtA that aims at measuring velocity with high accuracy, based on a setup with a fast liquid crystal optical chopper. So far three campaigns were carried out during the Perseid and Geminid maxima. The preliminary results, data reduction, a sensitivity analysis and the development of a data reduction pipeline are discussed.

Could the Geminid meteoroid stream be the result of long-term thermal fracture?

Galina Ryabova

The previous models by Ryabova have shown that the Geminid meteoroid stream has a cometary origin, so asteroid (3200) Phaethon (the Geminids' parent body) is probably a dead comet. Recently (in 2009 and 2012) some weak activity was observed (Jewitt and Li, 2010, 2013), but it was not a cometary activity. Recurrent brightening of Phaethon at perihelion could be the result of thermal fracture and decomposition. In this study we model the long term dust release from Phaethon based on this mechanism. It is unlikely that the Geminid meteoroid stream (or its low-active wide component) was generated by long-time thermal fracture.

Precession of parent bodies from historical meteor outbursts

Sang-Hyeon Ahn

We collect records of meteor outbursts from world-wide historical archives, and analyzed them to see which meteor outbursts have existed during the last two millennia. We calculate the dates of occurrence within the sidereal year for each record, and find four prominent major meteor streams having existed continuously. The prominent and continuous meteor streams are the Lyrids, the Perseids, the Leonids, and the eta-Aquariids/Orionids pair. We also check the regression of nodal points of these streams, and find that both the Leonids and the eta-Aquariids/Orionids pair have relatively large precession rates, while the other streams have small rates. We discuss that the near-type outbursts have occurred more frequently than the far-type outbursts.

QHY (5L-II-M) CCD camera for video meteor observation

Matej Korec

A new digital camera and lens has been tested for video meteor observing. A Tamron M13VG308 lens combined with a QHY 5L-II-M digital camera proved to be the best combination. Test observations have shown this to be superior to the best analog Watec 902H2 Ultimate camera.

NFC – Narrow Field Camera

Jakub Koukal, Jiří Srba and Sylvie Gorková

We have been introducing a low-cost CCTV video system for faint meteor monitoring and here we describe the first results from 5 months of two-station operations. Our system called NFC (Narrow Field Camera) with a meteor limiting magnitude around +6.5mag allows research on trajectories of less massive meteoroids within individual parent meteor showers and the sporadic background. At present 4 stations (2 pairs with coordinated fields of view) of NFC system are operated in the frame of CEMeNt (Central European Meteor Network). The heart of each NFC station is a sensitive CCTV camera Watec 902 H2 and a fast cinematographic lens Meopta Meostigmat 1/50 – 52.5 mm (50 mm focal length and fixed aperture f/1.0). In this paper we present the first results based on 1595 individual meteors, 368 of which were recorded from two stations simultaneously. This data set allows the first empirical verification of theoretical assumptions for NFC system capabilities (stellar and meteor magnitude limit, meteor apparent brightness distribution and accuracy of single station measurements) and the first low mass meteoroid trajectory calculations. Our experimental data clearly showed the capabilities of the proposed system for low mass meteor registration and for calculations based on NFC data to lead to a significant refinement in the orbital elements for low mass meteoroids.

Advances in the development of a low-cost video meteor station

Dario Zubović, Denis Vida, Peter Gural and Damir Šegon

Recent advances in the field of single board computers, have enabled the development of a low-cost video meteor station with real-time processing capabilities. In this paper, an overview of different capture and computing hardware is given. Furthermore, we present the current state of new open-source software for video meteor capture, multi-frame compression and real-time detection. The software is compatible with the existing Croatian Meteor Network processing package.

ROAN: A calibration unit for a meteor camera

Tudor Georgescu, Ana Georgescu, Florin Pincu, Mirel Birlan, Dan Savastru, Cosmin Banica and Claudiu Dragasanu

ROAN's main objective is the deployment of a network of systems (optics and radio) for monitoring meteors. Several steps are included into the deployment of this network such as the development of detectors, stress test of the components and the calibration in the laboratory. The article presents the evolution of the project for the improvement of the technical solution for the calibration in the laboratory.

Astrometric precision and orbit determination by AMOS

Leonard Kornoš, František Ďuriš and Juraj Tóth

The astrometric precision of the new version of the all-sky AMOS camera is evaluated. The 4$^{\text{th}}$ polynomial astrometric reduction in UFOAnalyzer (SonotaCo, 2009) and all-sky procedure (Borovička et al., 1995) is compared. In addition the uncertainty of a bolide atmospheric trajectory observed by cameras of the European Fireball Network and Slovak Video Meteor Network is assessed. A new program is presented which determines meteor orbits and also reports the uncertainties in the orbital parameters. One particular bolide orbit is compared with the result obtained by the Ondřejov Observatory.

Meteor spectra from AMOS video system

Pavol Matlovič, Regina Rudawska, Juraj Tóth, Pavol Zigo and Dušan Kalmančok

We introduce the updated spectral All-Sky Meteor Orbit System (AMOS-Spec) and present its capability to measure the relative abundances of the main elements in meteoroids. Initial results from the spectroscopic observations are presented and are compared with independently measured meteoroid trajectories, heliocentric orbits and material strength parameters in data collected by the Slovak Video Meteor Network and the Central European Meteor Network. We aim to use this complex set of data to define the various meteoroid streams both dynamically and physically, and thus to identify the link between a meteoroid stream and its parent body.

3000000 light curves in the EDMOND database

Roman Piffl

The EDMOND database already contains around 3 million records of meteors. However, these are only used for triangulation, for orbit determination (EDMOND) and for statistics of meteor streams (Molau, 1999). In addition to the geometric measurements, the data also includes information about meteor brightness.

On the structure of hyperbolic and near-parabolic dust streams

Eduard Pittich and Nina Solovaya

The only type of concentration of cometary dust with a reasonable probability of being detected by cosmic probes, are the dust tails emanating from passing comets. Essentially all the dust released from long-period comets leaves the solar system on hyperbolic orbits, because the radiation pressure limit is high. For short-period comets the dynamical conditions for retention of emitted particles within the solar system are much more favorable. But those which remain in circum-solar orbits tend to disperse rather rapidly. We present the results of an investigation of the evolution of dust streams produced by low-velocity emission from comets moving in near-parabolic and hyperbolic orbits. In order to get a clearer insight into the geometry and detectability of dust tails, some model computation have been performed.

Video meteor spectroscopy

Bill Ward

Observational examples produced by the Kilwinning Spectroscopic Survey for Meteors are presented.

Temporal and spatial distribution of meteorites falls in Africa

Fouad Khiri, Abderrahmane Ibhi and Lahcen Ouknine

158 meteorites falls were recorded during the period 1801–2014 in Africa. Their mass ranges from 150 g to 175 kg. The number of meteorites' falls is variable in time and in space. It continues to grow since 1801. More, this number seems to be cyclic since 1940. The average rate of falls is low in Africa with only 0.024 per million km^2 per year. This rate is high in countries, which exhibit croplands and sparse grasslands. Other factors are also involved in the spatial variation of those meteorites falls' recuperation: the population, the percentage of forest. Moreover, the African meteorites' falls as in the worldwide falls are dominated by chondrites (78%).

A new analysis of Monturaqui Meteorites

Stanislav Kaniansky and Kristian Molnár

The Monturaqui meteorite crater, located in the Andes Mountains, is known to host corroded iron meteorites (Koch and Buchwald, 1994), of probable IAB type. Over three hundred suspicious rocks with an exterior appearance were collected during the two expeditions to Monturaqui crater. A sample has been analyzed in the Department of Earth and Atmospheric Sciences, University of Alberta, Canada. The analyses support the conclusion that the Monturaqui rocks are corroded iron meteorites.

Radio observation of meteors at the Slovak Central Observatory in Hurbanovo

Peter Dolinský

From 4 November 2014, we started registration of meteors using radio waves at the Slovak Central Observatory in Hurbanovo. Our system records meteoric echoes from the TV transmitter Lviv 49.739583 MHz (N49.8480° E24.0369°, Ukraine), using a 4-element Yagi antenna with horizontal polarization (elevation of 0° and azimuth of 60°), receiver ICOM R-75 in the CW mode, and a computer with registration using HROFFT v1.0.0f. Received data were statistically processed and compared with shower activity. Not all of the echoes have meteoric origin, but are caused also by ionospheric Es layer. Registrations are also disturbed by lightning.

Meteor observations of forward-scattered FM-radio echo in Busan (Korea)

Kyoung-Mo Kim, Mingyu Cho, Taegi Kim, Jinyoung Hong, Yong-woo Kang, Sang-Hyeon Ahn, Sang Hyun Lee and In-Ok Song

The detection system of forward-scattered FM-radio signals has been newly set up in Korea Science Academy of KAIST in Busan, Korea. The meteor observations using a 2.5m-long Yagi antenna have been carried out since May, 2015. The radio station we use is the NHK broadcasting station (85.20MHz) located in Hokkaido, Japan which is approximately 1,400 km away from Busan and is well below the local horizon. The detection is successfully running, and we examine the observed data reliability by simply checking long-lasting echoes. An additional observing station is being installed in the nearby city of Ulsan to make a cross-check. We analyze the results to find the diurnal and daily variation of the meteor rates. We are planning to pursue long-term observations in order to educate students.

Start values for four meteor showers as determined from TWEET's data

I-Ching Yang, Kai-Shiang Lai, Chun-Nan Lin, Loren Cheewei Chang and Kun-Lin Hsieh

Based on 202 meteor shower trajectories acquired by TWEET in 2013, of which 91 were Perseids, 40 were Southern Delta Aquariids, 34 were Orionids and 37 were Southern Taurids, we determined the beginning height distributions and average geocentric velocity for these four meteor showers. Using p-value of t-test, we would divide the 4 meteor showers into two groups: (a) Perseids and Orionids, and (b) Southern Delta Aquariids and Southern Taurids. The average beginning height and average geocentric velocity in group (a) is greater than in group (b).

2015 Easter bolide over North Hungary

Tibor Hegedüs, Szilárd Csizmadia, Zoltán Zelkó, Zsolt Kereszty and Zsófia Bíró

On Easter Monday, April 6, 2015, at UTC $17^{\rm h}31^{\rm m}$ (near sunset) there was a bright (peak magnitude $-12 \sim -14$) bolide which also produced a sonic boom, over North Hungary, close to Miskolc, above the Bükk mountains. The event was witnessed by many people, and recorded by several car dashboard-, meteorological and all sky cameras from as far away as Farád (North-West Hungary) and Görbeháza (North-East Hungary). Unfortunately, with the event having occurred only a few minutes after sunset, the sky was still bright and therefore the Hungarian Video meteor network cameras were not yet operating. Our team has collected and re-calibrated as much video and photo material as possible. Since there were very few direct images of the bolide itself, but more photos and videos of the persistent train left behind, these latter images were also used, in certain circumstances, in our calculations. The deduced final atmospheric path and heliocentric orbit are presented, along with the estimation of the errors.

Ursid 2014 observations using the AMOS all-sky camera

Štefan Gajdoš, Juraj Tóth and Leonard Kornoš

We present a report on the observation of enhanced activity from the Ursids meteor shower using the all-sky camera, at the AGO Modra, on Dec. 22–23, 2014. The time of maximum is in good accordance with the predictions of some authors. We derived a single-station meteor radiant, RA $= 217.9° \pm 0.1°$, DEC $= +76.4° \pm 0.1°$ at solar longitude $\lambda_\odot = 270.9°$, along with the activity profile of the Ursid outburst with the maximum occurring at Dec. $23^{\rm th}$, $00^{\rm h}40^{\rm m}$ UT $\pm$ 30 min.

Parallel processing of signals from video cameras to create still images

Roman Piffl

A simple method to increase the efficiency of MetRec and UFO Capture.

HHEBBES! All sky camera system: status update

Felix Bettonvil

A status update is given of the HHEBBES! All sky camera system. HHEBBES!, an automatic camera for capturing bright meteor trails, is based on a DSLR camera and a Liquid Crystal chopper for measuring the angular velocity. Purpose of the system is to a) recover meteorites; b) identify origin/parental bodies. In 2015, two new cameras were rolled out: BINGO! -alike HHEBBES! also in The Netherlands-, and POgLED, in Serbia. BINGO! is a first camera equipped with a longer focal length fisheye lens, to further increase the accuracy. Several minor improvements have been performed and the data reduction pipeline were used for two prominent Dutch fireballs.

Meteorite search campaigns of the Polish Fireball Network

Zbigniew Tymiński, Marcin Stolarz, Przemysław Żołądek, Mariusz Wiśniewski, Arkadiusz Olech, Tomasz Kubalczak, Paweł Zaręba, Maciej Myszkiewicz, Krzysztof Polakowski and Janusz W. Kosiński

Video registrations of bright fireballs capable of producing meteorite falls over Poland have been observed since the Polish Fireball Network was established. The bolides selected as being worthy of further investigation have been those for which the PyFN software analysis indicated that the meteorite fall would have a total mass in the range of about 300 g – 10 kg. This article describes the main meteorite search campaigns of PFN carried out following detailed analyses of such events. Some expeditions originally organized for meteorite search training but which produced positive results are also described.

Double-station meteor observations by INASAN

Anna Kartashova and Galina Bolgova

The results of double-station meteor observations by INASAN are presented. The television meteor system PatrolCa (Watec LCL-902HS as camera with a Computar 6/0.8 lens) with a field of view of 50° x 40° and a limiting magnitude (for stars) of +5.5m was used for observations. Double-station observations by INASAN (using the Zvenigorodskaya observatory INASAN and the 20 km distant "Istra" station) started in 2011. Multi-station observations with three stations were carried out in 2014. Over four years about 5000 meteors have been detected.

Meteor spectra in the EDMOND database

Jakub Koukal, Sylvie Gorková, Jiří Srba, Martin Ferus, Svatopluk Civiš and Carlos Augusto di Pietro

We present a selection of five interesting meteor spectra obtained in the years 2014 and 2015 via CCTV video systems with a holographic grating, working in CEMENT and BRAMON meteor observation networks. Based on the EDMOND multi stations video meteor trajectory data an orbital classification of these meteors was performed. Selected meteors are members of the LYR, SPE, DSA and LVI meteor streams, one meteor is classified as sporadic background (SPO). In calibrated spectra the main chemical components were identified. Meteors are chemically classified based on relative intensities of the main spectral lines (or multiplets): Mg I (2), Na I (1), and Fe I (15). Bolide EN091214 is linked with the 23rd meteorite with known orbit (informally known as "Žd'ár"), two fragments of the parent body were found in the Czech Republic so far (August, 2015). For this particular event a time resolved spectral observation and comparison with laboratory spectra of LL3.2 chondritic meteorite are presented.

Assessing risk from dangerous meteoroids in main meteor showers

Andrey Murtazov

The risk from dangerous meteoroids in main meteor showers is calculated. The showers were: Quadrantids–2014; Eta Aquariids–2013, Perseids–2014 and Geminids–2014. The computed results for the risks during the shower periods of activity and near the maximum are provided.

Bolidozor radio meteor detection network

Jakub Kákona, Martin Kákona, Martin Povišer, Jan Milík, Roman Dvořák, Jan Štrobl, Pavel Kovář, Josef Szylar, Petr Bednář, Ladislav Křivský and Jan Chroust

Radio meteor detection networks could improve the knowledge about meteors under daylight or inconvenient weather conditions. We present a new approach to the meteor detection system. The hardware described in this paper has unique features for time synchronization of multiple nodes, therefore meteor trajectory calculation is possible in case of appropriate network deployment.

Global conditions for the observation of the main meteor showers

Peter Zimnikoval

The geometrical conditions for the observability of most active meteor showers are presented. The regions of the Earth's surface where radiants reach suitable values of altitude above the horizon are drawn on a texture map of the Earth's surface (NASA). The radiant positions were taken from the IMO 2015 Meteor Shower Calendar (McBeath, 2014).

No sign of the 2014 Daytime Sextantids and mass indexes determination from radio observations

Giancarlo Tomezzoli and Cis Verbeeck

In reply to the invitation made by Rendtel at the IMC 2014 in Giron (France) to observe the Daytime Sextantids (DSX 221) by any possible means, the EurAstro Radio Station (EARS) in Munich performed radio observations in the recording period 30/09/2014, $07^{\rm h}00^{\rm m}$ UT – 05/10/2014, $16^{\rm h}00^{\rm m}$ UT. This paper presents the results of the EARS radio observations. A comparison of the number of meteor reflections when the Daytime Sextantid radiant was above and below the horizon showed no sign of the 2014 Daytime Sextantids. Since no significant other showers were active during the observation period, the meteor reflections can be considered as sporadic meteors. A new data reduction method was employed and illustrated to derive sporadic mass indexes in said recording period. This method is also valid for the determination of the mass index of meteor showers from radio observations.

Recent advances in the BRAMS network

Hervé Lamy, Michel Anciaux, Sylvain Ranvier, Stijn Calders, Emmanuel Gamby, Antonio Martinez Picar and Cis Verbeeck

BRAMS is a radio network using forward scattering techniques to detect and characterize meteoroids falling into the Earth's atmosphere, roughly above Belgium. In this article the most recent advances in the BRAMS network and analyzing BRAMS data are presented. First, a calibrator that has been added to all receiving stations is described. It aims at providing a reference for both amplitude and frequency. The importance of this calibrator in future analysis of underdense meteor echoes is explained. Second, a description of the interferometer in Humain is provided as well as details of future calibration using a UAV and the calibrator. Finally, tests of the method proposed by Roelandts (2014) for automatic detection of meteor echoes in BRAMS data are discussed.

The BRAMS Zoo, a citizen science project

Stijn Calders

Currently, the BRAMS network comprises around 30 receiving stations, and each station collects 24 hours of data per day. With such a large number of raw data, automatic detection of meteor echoes is mandatory. Several algorithms have been developed, using different techniques. (They are discussed in the Proceedings of IMC 2014.) This task is complicated because of the presence of parasitic signals (mostly airplane echoes) on one hand and the fact that some meteor echoes (overdense) exhibit complex shapes that are hard to recognize on the other hand. Currently, none of the algorithms can perfectly mimic the human eye which stays the best detector. Therefore we plan to collaborate with Citizen Science in order to create a "BRAMS zoo". The idea is to ask their very large community of users to draw boxes around meteor echoes in spectrograms. The results will be used to assess the accuracy of the automatic detection algorithms on a large data set. We will focus on a few selected meteor showers which are always more fascinating for the large public than the sporadic background. Moreover, during meteor showers, many more complex overdense echoes are observed for which current automatic detection methods might fail. Finally, the dataset of manually detected meteors can also be useful e.g. for IMCCE to study the dynamic evolution of cometary dust.

Directional pattern measurement of the BRAMS beacon antenna system

Antonio Martínez Picar, Christophe Marqué, Michel Anciaux and Hervé Lamy

The typical methods for measuring antenna characteristics are mostly based on the use of remote transmitters or receivers. For antennas used in radio communications, calibrations are usually done on an antenna test stand using transmitters with known power output. In order to minimize the ground effects while performing measurements, it is necessary to place the transmitter or receiver high above ground with the aid of aircrafts. It is, however, necessary to determine precisely the coordinates of the airborne devices as well as to maintain high stability. This used to be excessively difficult to carry out, but recent advances in Unmanned Aerial Vehicle (UAV) technologies have brought a feasible option. In this paper, the results of using a low-cost system for measuring the directional pattern of BRAMS beacon antenna system based on an UAV are presented.

Low-cost meteor radiometer

Denis Vida, Renato Turčinov, Damir Šegon and Emil Silađi

In this paper we discuss possibilities of building a low-cost system for radiometric observations of meteors. A meteor radiometer is a high time-resolution photometer for measuring sky brightness. As the radiometers have proven to be an invaluable source of data during the fireball fragmentation modelling, and yet there are so few radiometers operational, we propose using inexpensive photodiodes, operational amplifiers and microcontroller boards. We present the prototype's electronics design, give the source code and discuss the testing results.

An independent identification method applied to EDMOND and SonotaCo databases

Regina Rudawska, Pavol Matlovič, Juraj Tóth and Leonard Kornoš

Here we report our initial results derived by applying an independent identification method (Rudawska et al., 2014, 2015) to the EDMOND database (Kornos et al., 2014a, 2014b), to the SonotaCo database (SonotaCo, 2009), and to both datasets combined, in order to identify existing meteor showers in both databases. The final clusters (meteor showers) found have been compared with the recently updated IAU MDC list of meteor showers.

On the frequency of the superfireballs: more than 150 years of reports

Sandra Zamora, Francisco Ocaña, Alejandro Sánchez de Miguel and Maruška Mole

Superfireballs are rare phenomena for which the reports are scarce and the estimation of their abundance has a huge margin of uncertainty. As a citizen science project we have gathered >500 reports from newspapers in the 1850-2000 period. This database shows how some superfireball abundances are constant during the period, though the reference newspapers have changed in the last two centuries. We have tentatively related some fireball sources to well-known meteor showers (Perseids, Geminids and Leonids), while superfireball sources may be related to minor or unknown showers, probably of asteroidal origin.

IMO Fireball report form: results and prospects

Mike Hankey and Vincent Perlerin

At the 2014 IMC, we presented the new IMO (International Meteor Organization) online, Fireball report (available at fireballs.imo.net). This fireball report form was specifically designed for use by people with no astronomy experience who witnessed a fireball, a bolide or a suspected similar phenomenon. The IMO version of the form has been officially launched in February 2015. Since then, the form has been translated in different languages and customized for organizations around the world. In this paper, we will present preliminary results of the form and provide tips to improve the online presence of local organizations, in order to promote usage. We will also highlight procedures to be followed by local organizations to get a custom version of the form.

First results of Bosnia-Herzegovina Meteor Network (BHMN)

Nedim Mujić and Muhamed Muminović

Inspired by similar networks in the region, a video meteor network began since the spring of 2013 in Bosnia and Herzegovina which currently includes eight stations. Further expansion of the network is under preparation by setting up another 2 stations. The Network is managed by the Astronomical Society Orion Sarajevo together with the Federal Hydrometeorological Institute in Sarajevo whose meteorological stations were used for the installation of the cameras. By mid-June 2015 the cameras of the BH meteor network had recorded over 20000 meteors and we had calculated more than 4000 orbits. In this paper we present the results of the first two years of operation of our meteor network.

Phenomenologic approach of the meteor phenomenon

Jérémie Vaubaillon

Current activities at the ESA/ESTEC Meteor Research Group

Detlef Koschny, Thomas Albin, Esther Drolshagen, Gerhard Drolshagen, Sandra Drolshagen, Julius Koschny, Jana Kretschmer, Cornelis van der Luijt, Cosette Molijn, Theresa Ott, Bjoern Poppe, Hans Smit, Hakan Svedhem, Andrea Toni, Fritz de Wit and Joe Zender

The Meteor Research Group of ESA/ESTEC has been active in the field of meteor research since the year 1998. Currently we are focusing on several activities: (a) Data analysis of the double-station data of our CILBO setup (Canary Island Long-Baseline Observatory): Determining the flux density of meteoroids, comparing it to other data sources, and determining whether the optical data can be used to constrain meteoroid models; testing the quality of the orbits computed from these cameras; producing a processing pipeline for the analysis of meteor spectra. (b) Expansion of the CILBO setup with wider-angle cameras that are better suited for the flux measurements. We modify existing cameras to be robust enough to survive the environmental conditions on the Canary Islands and install them in the existing CILBO hut. (c) We are supporting studies for lunar impact flash observations on the Moon, both ground-based and possibly space-based. (d) The meteor data archiving system at ESTEC is being upgraded to be conforming to modern network security standards. - This paper will give an overview of the activities and will put more detailed papers by other members of the group in context.

De-biasing CILBO meteor observational data to mass fluxes

Jana Kretschmer, Sandra Drolshagen, Detlef Koschny, Gerhard Drolshagen and Björn Poppe

The goal of this paper is to estimate for different mass ranges the percentage of meteors that are not detected by video observations and to derive un-biased mass fluxes. The work is based on the data from the Canary Island Long-Baseline Observatory (CILBO), which is a double-station camera setup for meteor observations and a project by Detlef Koschny at the European Space Agency. Moreover the work by Drolshagen et al. and Ott et al. (2014) on the meteor observational data by the CILBO is used. In a paper presented at the IMC 2014 Drolshagen et al. used a formula by Verniani (1973) to determine the mass of the detected meteoroids and plotted the velocity distribution for big meteoroids only. They found that it fits the reference velocity distribution from the ECSS (European Cooperation for Space Standardization) Space Environment Standard which indicates that it is a realistic model. The data set that Drolshagen et al. and Ott et al. were using (1 June 2013 – 31 May 2014) was expanded to a longer time range and the mass of each meteoroid detected by the CILBO was calculated applying the formula by Verniani. Afterwards the velocity distribution of the CILBO data was plotted for different mass ranges and compared to the ECSS velocity distribution to estimate the missing percentage for different meteoroid mass ranges. For the smallest masses a very large fraction of the meteoroids were not detected by the CILBO double-station. In a second step the number of meteoroids in each mass range was corrected to account for the slower meteoroids. From these results, the 'de-biased' flux was derived and compared to the flux model by Grün et al. (1985). The slope of the 'de-biased' CILBO flux is similar to the one of the Grün et al. model but the calculated flux values are higher.

De-biasing of the velocity determination for double station meteor observations from CILBO

Thomas Albin, Detlef Koschny, Gerhard Drolshagen, Rachel Soja, Bjoern Poppe and Ralf Srama

The Canary Islands Long-Baseline Observatory (CILBO) has been in operation since the end of 2011 and continuously working since January 2013 (Koschny et al., 2013). CILBO consists of two cameras on the island of Tenerife (camera ICC7) and La Palma (ICC9). To date, approximately 12000 meteors have been simultaneously measured, allowing precise orbit reconstruction. Certain meteors like Perseids show mostly persistent trains or wakes that may cause a position determination bias in the software. Large and fast meteors decelerate significantly during their appearance and cause an additional observational bias possibly by saturation effects on the CCD chips. Here we analyze these biases in the CILBO data and determine whether orbit reconstructions need to be corrected as a function of velocity, brightness or meteor shower.

Mass accumulation of Earth from interplanetary dust, meteoroids, asteroids and comets

Sandra Drolshagen, Jana Kretschmer, Detlef Koschny, Gerhard Drolshagen, Björn Poppe

The goal of this paper is to determine the mass that reaches the Earth as interplanetary material. For the large objects the flux model by Brown et al. (2002) was used which is valid for bodies greater than 1 m and is based on sensor data of fireballs that entered the Earth atmosphere. For the small sizes the flux model by Grün et al. (1985) was used, which describes the mass flux at 1 AU for meteoroids in the mass range 10^{-18} g to about 100 g. The Grün flux was converted to 100 km height by taking the Earth attraction into account and all units were adjusted to compare the model with the one by Brown. In a second step both models were combined by an interpolation, which lead to a flux model that covers 37 orders of magnitude in mass. Using recent measurements and alternative flux models the uncertainties of the obtained model was estimated. Recent measurements include in-situ impact data on retrieved space hardware and optical meteor data. Alternative flux models are e.g. a NASA model for large sizes that is an extrapolation of known Near-Earth Objects (NEOs) and a model by Halliday et al. (1996) which is based on optical measurements of fireballs. Up to a diameter of 1 km the total calculated mass influx is 54 tons per day.

Influence of the pointing direction and detector sensitivity variations on the detection rate of a double station meteor camera

Thomas Albin, Detlef Koschny, Gerhard Drolshagen, Rachel Soja, Ralf Srama and Bjoern Poppe

The Canary Islands Long-Baseline Observatory (CILBO) is a double station meteor observation site on Tenerife and La Palma (Koschny et al., 2013; Koschny et al., 2014). Meteors are detected within the 40 ms long video frames of the identically built cameras using MetRec (Molau, 1999). MOTS (version 3, Koschny & Diaz, 2002) is used to determine the meteor trajectories of double-station observations. First scientific results regarding the velocity distribution and meteoroid flux have been published by Drolshagen et al., 2014 and Ott et al., 2014. Both authors found effects related to the Apex direction, such as an increasing number of detections in the morning hours. Sporadic meteors from the Apex cause additional observational bias, including in the velocity-magnitude domain and the meteor trail length determination. We show how the detection threshold conditions vary depending on the pointing direction of the cameras for both CILBO cameras. The angular velocity distribution of the meteors depends on the camera orientation. Meteors with a smaller angular velocity illuminate less CCD pixels in the same time interval than faster meteors causing a higher Signal-to-Noise ratio and consequently better detection threshold conditions. Additionally, we analyzed the detection distribution within the field of view of the CILBO cameras. We quantified this effect, which can be attributed mainly to vignetting in the wide-angle system.

Meteor science

Minor kappa-Cepheid (751 KCE) activity on 2015 September 21

Jürgen Rendtel[1]

The κ-Cepheid (751 KCE) meteor shower showed visually recognizeable activity on 2015 September 21, with a maximum ZHR of 14 ± 7 for about one hour centered at $03^{\rm h}$ UT.

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1 Introduction

I noted an apparently minor detail mentioned by Damir Šegon during his lecture at the IMC 2015. One of the slides (Figure 1) showed results of a model calculation by Jérémie Vaubaillon concerning dust of the minor planet 2009 SG_{18} (see `http://www.imo.net/imc2015/lectures/Segon_Damir.pdf` as well as the respective Proceedings paper Šegon et al. (2015)).

Unfortunately, this prediction was not made public, because Damir wanted to find out whether such an event would pass unnoticed by other observers and the many (video) networks that might be able to detect it.

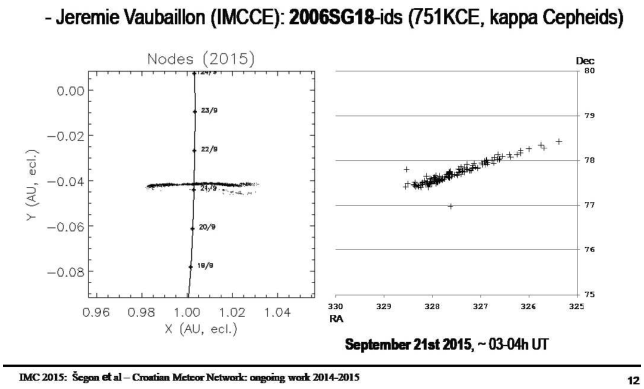

Figure 1 – Data for the possible κ-Cepheid activity from Damir Šegon's talk at the IMC.

The conditions were favourable for observers at European longitudes as the predicted time of the event fell into the night time of September 21 between $3^{\rm h}$ and $4^{\rm h}$ UT, and the northern radiant is circumpolar.

Currently, the κ-Cepheid (0751 KCE) shower is listed in the IAU meteor shower data base (website `http://www.astro.amu.edu.pl/~jopek/MDC2007/`) and has the status "working" with a maximum position at $\lambda_\odot = 174\overset{\circ}{.}4$. This position was reached about four days earlier on 2015 September 17, at $20^{\rm h}$ UT. The radiant listed in the IAU list is at $\alpha = 318\overset{\circ}{.}5$, $\delta = 77\overset{\circ}{.}5$, i.e. a bit off the position shown in Figure 1.

2 Observational data

During September I stayed more than two weeks at the observatory Izaña at Tenerife at about 2400 m elevation.

Table 1 – Possible meteors of the κ-Cepheids in the morning of September 21. ("other meteors" are STA, SPE, DAU and SPO.)

Interval UT	$T_{\rm eff}$ (h)	LM	KCE	others
0025–0055	0.50	6.49	1	8
0055–0125	0.50	6.48	1	6
0125–0155	0.50	6.48	1	8
0155–0225	0.50	6.50	2	7
0225–0255	0.50	6.51	3	10
0255–0325	0.50	6.52	4	8
0325–0355	0.50	6.53	1	10
0355–0425	0.50	6.53	1	11
0425–0455	0.50	6.53	0	14
Total	4.50	6.51	14	82

Table 2 – Magnituides of the meteors identified as κ-Cepheids.

mag	+1	+2	+3	+4	+5	+6
N	2.5	3.5	0.0	5.0	3.0	0.0

At this location, the radiant elevation became lower towards the morning, but was still higher than 30° at the end of my observing period shortly before $05^{\rm h}$ UT. So I decided to observe visually to provide additional data to the possibly many video data.

The night September 20–21 was clear at the location, but not cloudless. Due to a southern airflow, an orographic cloud formed north of the island and remained there for more than a day (see `http://epod.usra.edu/blog/2015/10/lenticular-cloud-over-tenerife-canary-islands.html`). Hence I could not choose my field of view close to the radiant. Instead, I observed almost towards the opposite direction. Possible shower meteors were far from the radiant, but caused long apparent trails. I also "noted" the antiradiant point (to which the trails had to converge).

My observation lasted for 4.5 hours during which I noted 14 meteors fitting the shower parameters well (Table 1). The meteors stood out also because in the previous nights no meteors at all came from this sector of the sky.

In essentially the same period of the morning of September 22, I noted just one meteor fitting the expected parameters of the KCE radiant and velocity within 3.25 hours (similar observing conditions). There

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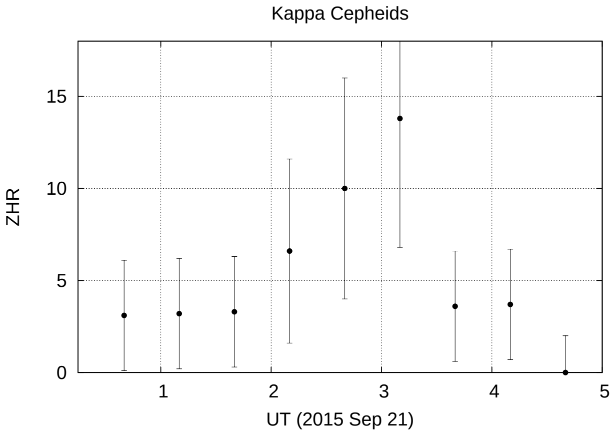

Figure 2 – ZHR of the κ-Cepheids in the morning of 2015 September 21.

was no fitting meteor in the previous nights. Activity was detectable only during the hours analysed above.

3 Conclusions

The data suggest that the shower ideed showed a visually recognizeable activity close to the predicted period. The small sample indicates a maximum ZHR of the order of 10–14 (Figure 2) lasting for about one hour (roughly estimated FWHM) centered at 03^{h} UT. In the case of this data set, the population index r has no effect on the calculated rate as the limiting magnitude was almost identical with the reference value of +6.5 mag.

On September 21, Jérémie Vaubaillon wrote: "I had 6 detections yesterday at Pic du Midi with CABERNET, which is unusual, since I usually got 1–3 meteors per night. The pipeline to reduce the data is currently under development [...] and will not be ready before a few months still, so I cannot say anything for now." Nevertheless, more details are to be expected from the analysis of the video networks data.

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χ Cygnids observation in Japan

Yasuo Shiba[1]

The χ Cygnids (IAU MDC code: 00757 CCY) are a new meteor shower reported by Green (2015) in 2015 September. I find members of the χ Cygnids in the 2015 data of the Japanese TV meteor observing network the 'SonotaCo network'. Additionally a few meteors from this shower were observed in 2010.

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1 Introduction

NASA's all sky meteor shower survey TV camera system 'CAMS' (Jenniskens et al., 2011) detected a new meteor shower the 'χ Cygnids' at 2015 September $14^{d}21^{h}$ – $15^{d}11^{h}$ UT (Green, 2015). The 'SonotaCo network' is a Japanese automatic TV meteor observation network operating since 2007 (SonotaCo, 2009). 17 TV network camera operators uploaded data for 2015 September on SonotaCo network's upload site. I downloaded these data and calculated orbits by using UFOOrbit V2.

2 Results

I found a concentration of radiants consisting of five meteors from 13 to 21 September, 2015. These data are shown in Table 1, where YMD_hms (UT) is date and time of meteor, $\lambda_{\odot}$ is solar longitude (equinox 2000.0), corrected (i.e., geocentric) radiants describe right ascension and declination (equinox 2000.0), V_g is geocentric velocity [km/s], M_{abs} is absolute magnitude (100 km distance), H_{beg} is beginning height above sea level [km], H_{end} is ending height [km], a is semi-major axis [AU], q is perihelion distance [AU], e is eccentricity, P is period [yr], peri is argument of perihelion [degrees], node is longitude of the ascending node [degrees], incl is inclination [degrees].

The five detected meteors appeared from a compact radiant area in a very short period of time in what is generally a sparse sporadic meteor radiant field. Figure 1 shows a radiant map of SonotaCo network observation results from 2007 to 2015 including all meteors in the χ Cygnids radiant area. A few concentrated radiants were detected also from 2010, near the 2015 position. These meteor data too are shown in Table 1. One of these data, '20100916_152742' has an especially fast geocentric velocity which may not belong to this common meteor stream. The radiant drift is in a strange direction. Ordinarily a meteor shower drifts to the east in celestial coordinates with an increase in solar longitude, but χ Cygnids drift to the north-west.

Acknowledgements

The SonotaCo network is managed by Mr. SonotaCo who also made the observing software UFOCapture V2, analyzing software UFOAnalyzer V2 and orbit calculation software UFOOrbit V2. About 20 amateur meteor astronomers observe and contribute analyzed data to the SonotaCo network day after day. I used these software and data in this paper. Mr. SonotaCo and Mr. Uehara gave me worthwhile suggestions. Dr. Jopek and Dr. Hasegawa kindly drew my attention to the CBET information. I thank all observers and supporting persons.

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Table 1 – χ Cygnid meteors in SonotaCo network data from 2010 and 2015.

YMD_hms (UT)	$\lambda_\odot$	Corrected radiant		V_g	$M_{\rm abs}$	$H_{\rm beg}$	$H_{\rm end}$
20150913_200320	170.1359	298.12	+36.86	17.2	0.6	93.7	82.9
20150919_163820	176.2138	299.63	+35.29	14.8	−1.0	93.2	86.4
20150920_130504	177.0460	299.72	+36.36	16.6	−1.1	89.5	75.5
20150920_151242	177.1326	298.80	+36.19	14.7	−0.0	87.2	69.6
20150921_161503	178.1523	295.38	+37.47	16.5	0.3	91.5	84.5
20100916_131337	173.4254	299.91	+34.23	15.7	−4.8	87.7	76.9
20100916_142553	173.4744	299.30	+32.70	12.8	−2.7	84.8	76.0
20100916_152742	173.5162	297.82	+37.86	20.2	−0.9	90.2	79.9
20100918_185221	175.6059	298.80	+33.83	14.4	−0.7	91.7	84.9
Green (2015)		301.0	+32.6	15.1			

YMD_hms (UT)	a	q	e	P	peri	node	incl
20150913_200320	3.71	0.956	0.742	7.14	208.04	170.135	21.97
20150919_163820	2.78	0.963	0.654	4.65	206.30	176.212	18.68
20150920_130504	3.89	0.962	0.752	7.67	205.52	177.045	20.70
20150920_151242	2.77	0.967	0.651	4.61	205.11	177.131	18.87
20150921_161503	4.16	0.974	0.766	8.48	201.32	178.151	20.95
20100916_131337	3.18	0.957	0.699	5.66	208.02	173.425	19.40
20100916_142553	2.18	0.963	0.559	3.23	208.08	173.474	16.17
20100916_152742	18.4	0.959	0.948	78.7	205.18	173.516	24.83
20100918_185221	2.79	0.965	0.654	4.66	205.90	175.605	17.98
Green (2015)	2.75	0.949	0.655		209.9	171.64	18.6

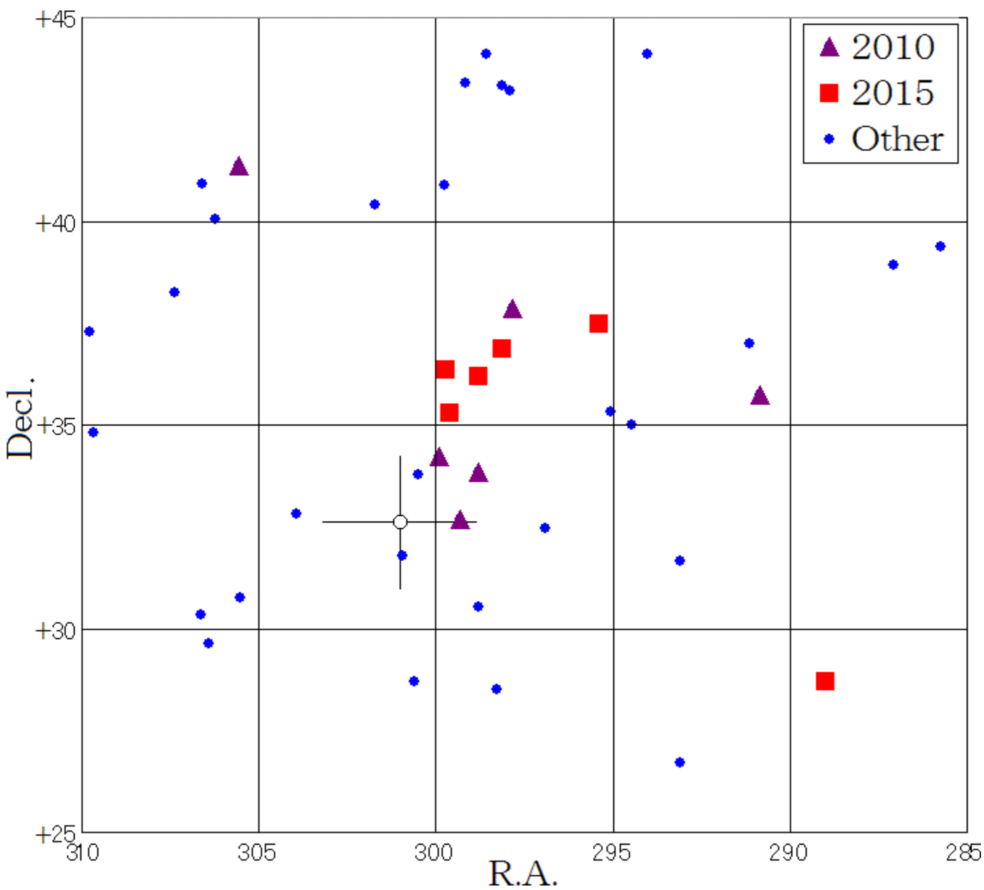

Figure 1 – χ Cygnid radiant area observed by SonotaCo network in 2007–2015 including meteors with all velocities. Duration is from September 10 to 25. Small circle with error bar is CAMS result (Green, 2015).

Preliminary results

Results of the IMO Video Meteor Network — July 2015

Sirko Molau[1], *Javor Kac*[2], *Stefano Crivello*[3], *Enrico Stomeo*[4], *Geert Barentsen*[5], *Rui Goncalves*[6], *Carlos Saraiva*[7], *Maciej Maciejewski*[8], *and Mikhail Maslov*[9]

The July 2015 overview of IMO Video Meteor Network observations is presented, covering more than 9 300 hours of observations with more than 36 000 meteors being recorded. A video camera's perception coefficient concept is introduced, with the aim to improve the flux density calculations.

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1 Introduction

July also produced unusually good observing conditions. Best weather conditions occurred in southern Europe, where a few cameras observed without any break. For other locations also there are hardly any breaks in the observing statistics. An amazing 75 out of 84 cameras managed to observe on twenty or more nights, 13 of these on thirty or more nights. On about half of the nights, at least 70 cameras were active, on two nights as many as 79 cameras.

The overall effective observing time increased to 9 300 hours, which is 15% more than in the previous record year 2013. With regards to the number of meteors, the increase is smaller because the hourly average of 3.9 meteors was well below the long-term July average. Overall, the video observers collected almost 37 000 meteor records (Table 1 and Figure 1).

Our Hungarian friends could add a new observer in July. Rafael Schmall observes from the Hungarian village of Kaposfő and provides data to the IMO Network. His camera Huvcse05 consists of a KPC-350B video camera with a 4 mm $f/1.0$ Tamron lens.

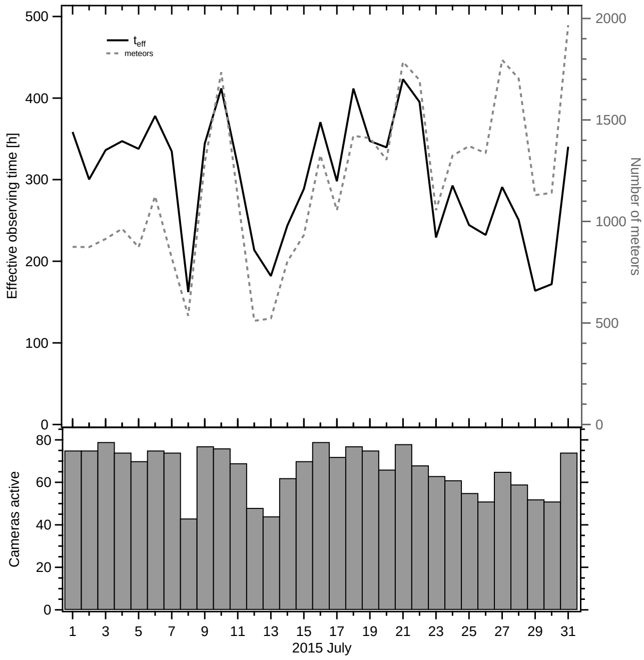

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2015 July.

2 Camera perception coefficient

With the α-Capricornids and Southern δ-Aquariids, July offers two showers with a well-defined activity profile. However, both showers reach their peak at the end of the month, so that we have only half activity profiles from 2015 so far. For this reason we postpone their analysis by one month and think in this analysis about the perception coefficient instead.

It is a well-known phenomenon in visual observation that two observers with the same limiting magnitude do not necessarily see the same number of meteors. Some observers struggle to see weak static objects (stars), but they perform well in detecting moving objects (meteors). For other observers it is vice versa. Hence, a personal factor was introduced to correct the ZHR of an observer: the perception coefficient P. To determine P, a mean ZHR profile is computed from a large set of visual observations, and then the deviation of the ZHR values from individual observers is calculated. The perception coefficient can be represented as a correction factor for the ZHR, but also as an offset to the limiting magnitude of the observer.

In case of video observations , for a long time we resisted the introduction of such a correction factor. The limiting magnitude is calculated in the same way for all cameras, and meteor detection is also based on the same algorithm. When everything works fine, there is no need for something like a perception coefficient. However, the current algorithm for limiting magnitude calculation is not perfect as we found out in our April

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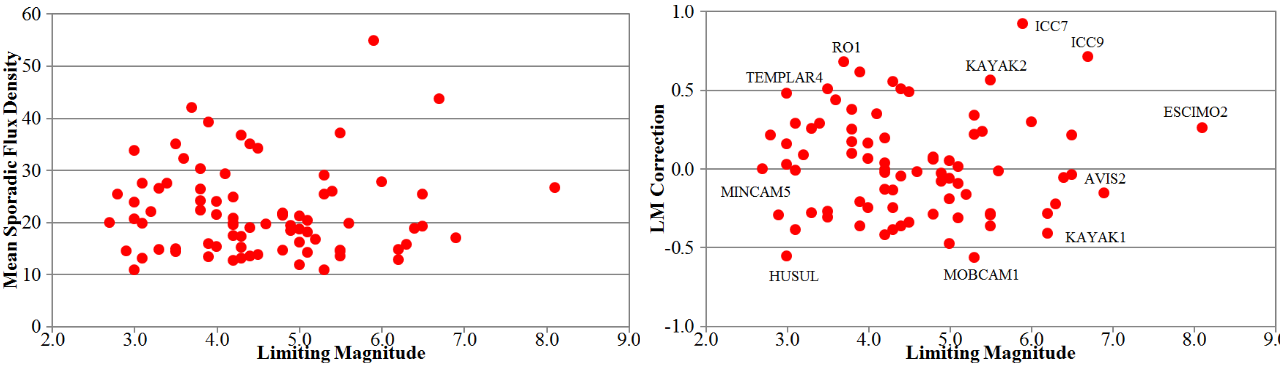

Figure 2 – Mean sporadic flux density from January till July 2015, plotted over the limiting magnitude of the camera (left). The deviation from the mean flux density can be displayed as a correction of the camera's limiting magnitude (right).

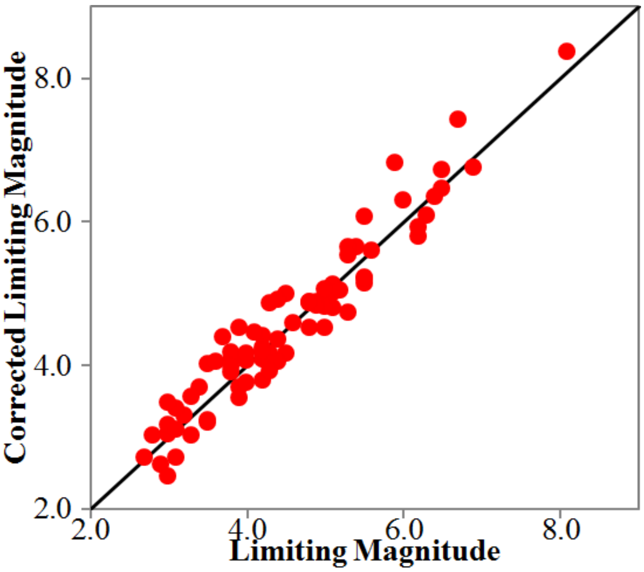

Figure 3 – Corrected vs. original limiting magnitude of the IMO Network cameras.

analysis (Molau et al., 2015). Changing the start value of the "NoiseLevel" parameter is sufficient to change the resulting limiting magnitude by half a magnitude. For this reason we now check to see if there is systematic deviation between the video cameras. As almost all of our cameras are automated and observe on every clear night, we have large data sets from most of them available for analysis.

As the first step, we calculated the average sporadic flux density from January to July 2015, which yielded a value of about 20. This exercise was then repeated for every single camera, and we plotted the deviation from the average flux density against the limiting magnitude of the camera (Figure 2, left). There is indeed a significant variation of the flux density ranging from ten to more than fifty, but there is no dependency on the limiting magnitude of the camera. If the deviation is plotted as a limiting magnitude offset, we obtain corrections between -0.5 and $+1.0$ mag (Figure 2, right). Some example cameras are labelled in the plot.

Figure 3 is another representation, in which the corrected limiting magnitude is plotted against the original limiting magnitude of the camera.

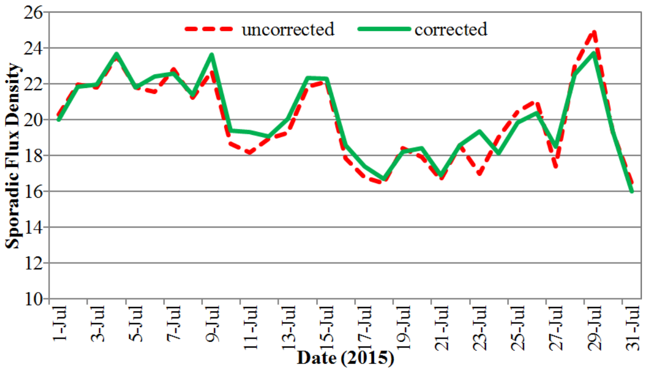

Figure 4 – Sporadic flux density in 2015 July with and without correction of the perception coefficients.

The next step was to determine the impact this perception coefficient has on the meteor shower parameters that we routinely determine. We calculated the sporadic flux density in 2015 July with and without correction of the perception coefficients (Figure 4). The scatter becomes smaller, but there is no significant change in the flux density profile.

The same picture is obtained, when we extend the analysis to the full interval from 2015 January to July (Figure 5). The variance of the flux density is reduced by 40% on average.

And what about the population index? A comparison of the sporadic r-profile in 2015 July shows a clearly larger impact of the perception coefficients than for the flux density (Figure 6). Not only is there a tendency for the population index to increase, there is also a significant reduction in the scatter.

This is confirmed when the sporadic population index is compared for the full interval from 2015 January to July (Figure 7). Outliers in the population index profile, which have been discussed several times before, do not completely disappear, but become significantly less divergent. In numbers, the variance of the data is halved!

When the corrected r-values are plotted as usual with error bars, they also disclose clear periodic variations with a monthly cycle (Figure 8).

To enhance this effect, we calculated a sliding mean over five days to level out short-term variations. This

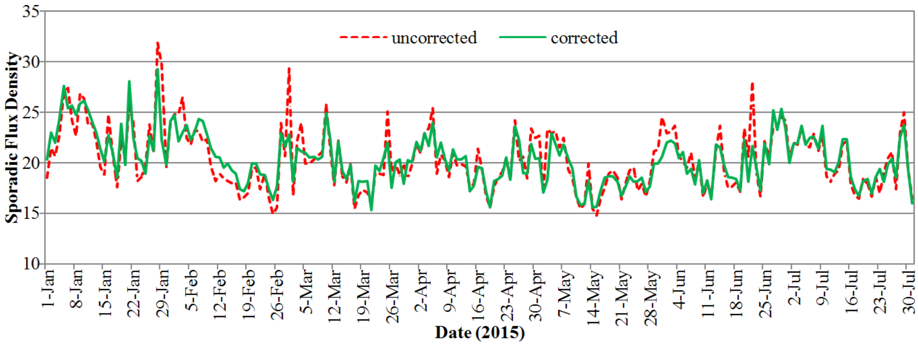

Figure 5 – Sporadic flux density from 2015 January to July with and without correction of the perception coefficients.

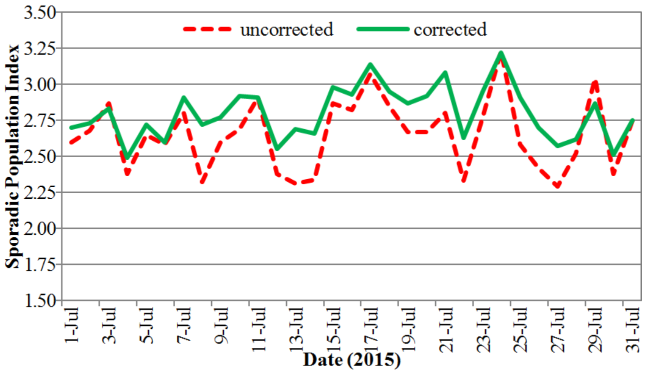

Figure 6 – Sporadic population index in 2015 July with and without correction of the perception coefficients.

confirmed that the sporadic population index varies by about 0.4 on a monthly basis (Figure 9), giving rise to the suspicion that the population index is affected by the lunar phase. For this reason we plotted the lunar phase additionally as pictograms and as a sine wave in the diagram. The agreement is obvious. At new moon when skies are darkest we observe larger r-values than at full moon. The effect becomes smaller in the summer months, when the low altitude full moon has a smaller impact.

To make the effect even more evident, we plotted the average sporadic population index from January till July over the lunar phase (new moon = 0/1, full moon = 0.5) in Figure 10.

If the long-term variations from the 5-days sliding mean are removed from the population index profile, we obtain a consistent picture with only few outliers (Figure 11).

This effect would be difficult to explain if it was to only affect the population index and not the flux density. We therefore also calculated a 5-day sliding mean for the flux density (Figure 12). This did indeed show a correlation with the lunar phase albeit to a lesser extent. The flux density (calculated with a population index of 3.0) varied depending on the lunar phase by 25%, with the highest values being measured at full moon.

In addition, the flux density can be averaged over the lunar phase (new moon = 0/1, full moon = 0.5, Figure 13). We see that the largest values do not occur directly at full moon, but a few days later.

At the moment we cannot pin down the effect any further. A spot-check analysis only reveals, that the lunar phase effect could be linked to the limiting magnitude of a camera. Cameras like Remo1 to Remo4 in Ketzür/DE with a small field of view (8 mm lens and 1 450 square degrees) show only a small dependency on the lunar phase (Figure 14, left), whereas the flux density of Min38, Noa38 and Sco38 in Scorce/IT with large fields of view (3.8 mm lens and 5 500 square degrees) depends much stronger on the lunar phase (Figure 14, right).

In summary we got the following insight:

- The perception coefficient is also helpful for video observations as long as there are systematic deviations in the limiting magnitude calculation.
- The correction of the perception coefficients as a fixed limiting magnitude offset for each camera does not change the profile of the flux density, but it reduces the scatter by 40%. The population index increases by 0.1 and the variance is halved. Outliers in the population index profile, which have been regularly observed in the past and could not be explained so far, are significantly diminished.
- Both the flux density and the population index show a significant correlation with the lunar phase. Whereas the sporadic flux density at full moon is about 25% higher than at new moon, we see a reduction of the population index by about 0.4. In nights with moonlit skies, the limiting magnitude is significantly underestimated, with sensitive cameras with small fields of view being affected to a lesser extent than weak or wide-field cameras. That leads in total to the observed variation in the population index. The root cause for this shift is not yet fully understood, however.

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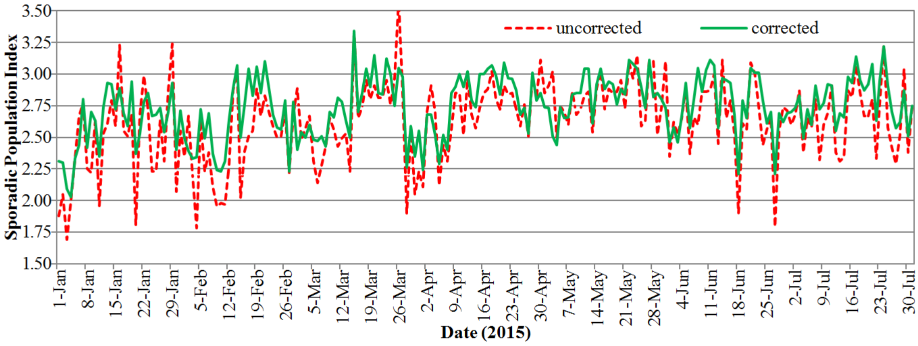

Figure 7 – Sporadic population index from 2015 January to July with and without correction of the perception coefficients.

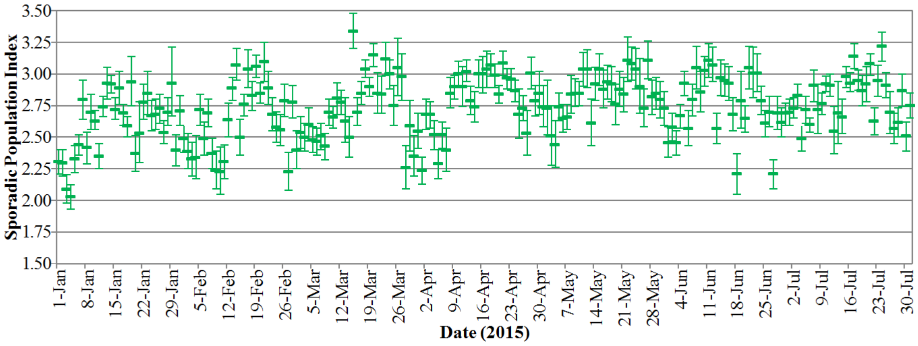

Figure 8 – Sporadic population index from 2015 January to July with correction of the perception coefficients and with error bars.

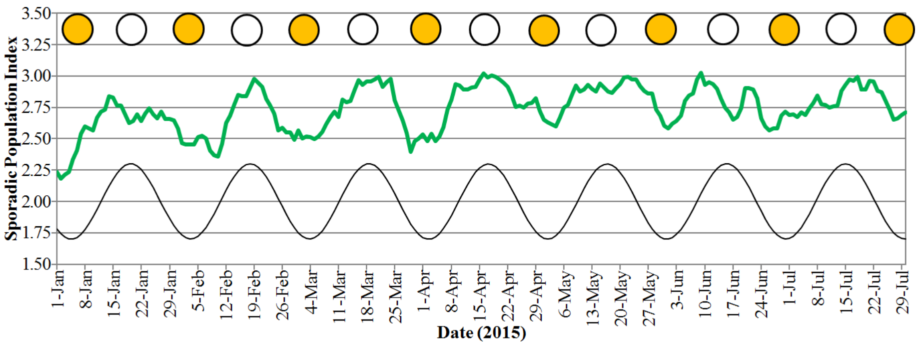

Figure 9 – Smoothed sporadic population index (sliding 5-days-average) from 2015 January to July with correction of the perception coefficients. The lunar phase is shown in parallel.

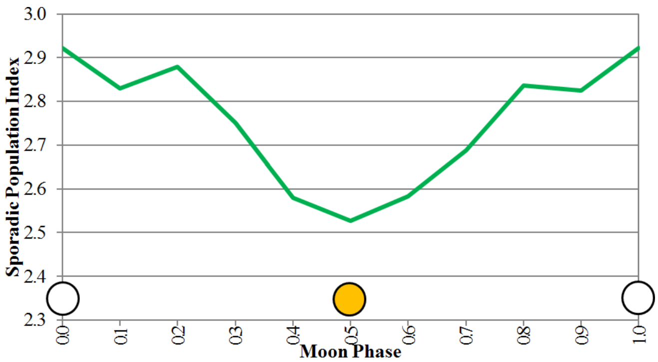

Figure 10 – Sporadic population index from 2015 January to July (corrected for the perception coefficients) plotted over the lunar phase.

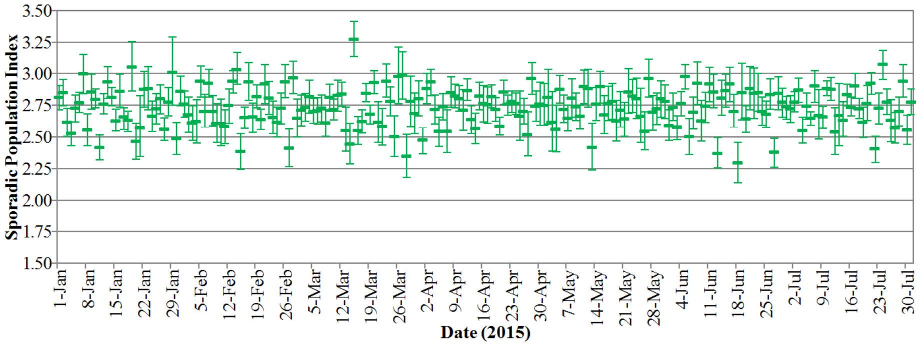

Figure 11 – Sporadic population index from 2015 January to July with correction of the perception coefficients and elimination of long-term variations due to the lunar phase.

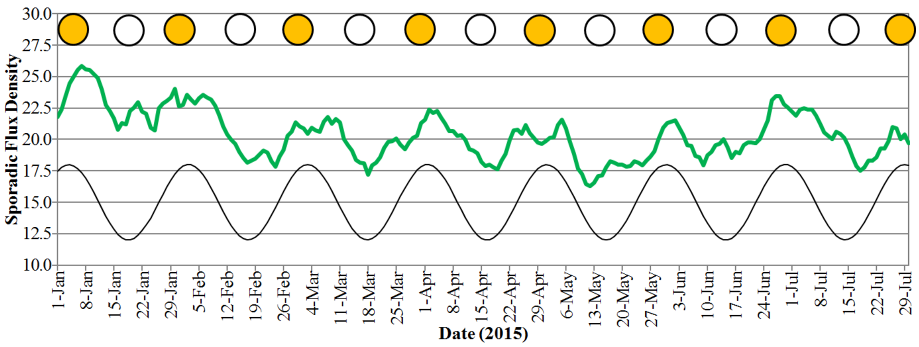

Figure 12 – Smoothed sporadic flux density (sliding 5-days-average) from 2015 January to July with correction of the perception coefficients. The lunar phase is shown in parallel.

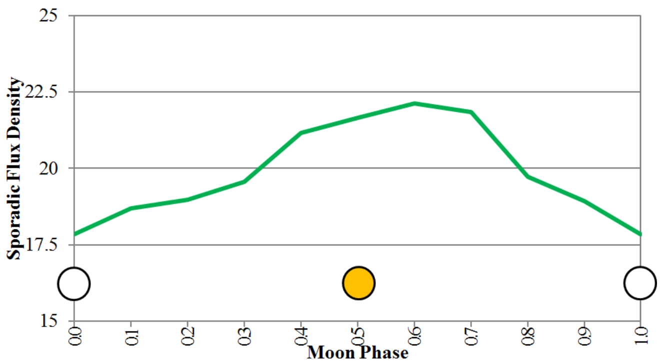

Figure 13 – Sporadic flux density from 2015 January to July (corrected for the perception coefficients) plotted over the lunar phase.

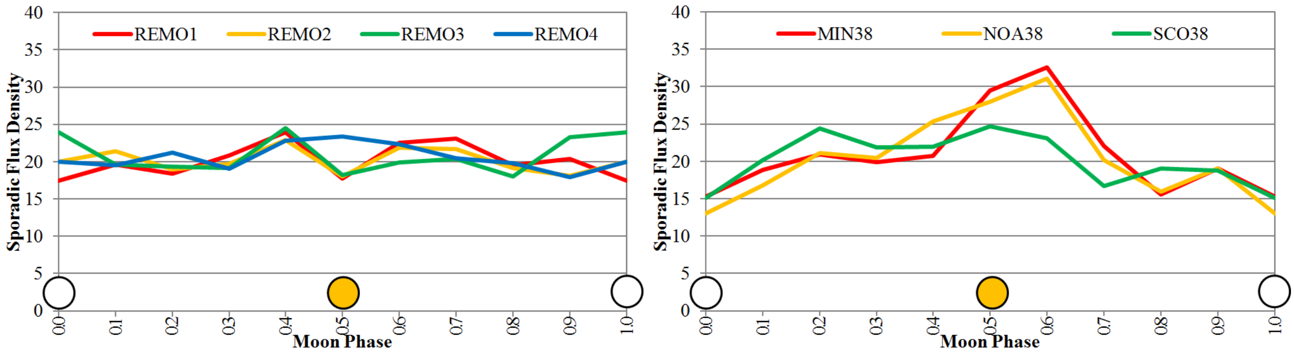

Figure 14 – Sporadic flux density from 2015 January to July (corrected for the perception coefficients) plotted over the lunar phase for selected cameras. Left four cameras with 8 mm lens and small field of view, right three cameras with 3.8 mm lens and large field of view.

Table 1 – Observers contributing to 2015 July 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	24	83.9	599
BANPE	Bánfalvi	Zalaegerszeg/HU	Huvcse01 (0.95/5)	2423	3.4	361	18	21.0	154
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	18	99.1	766
			Hulud3 (0.95/4)	4357	3.8	876	18	96.9	213
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	25	144.5	722
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	24	72.8	195
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	26	89.1	350
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	23	84.7	301
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	28	144.1	457
			Bmh2 (1.5/4.5)*	4243	3.0	371	28	138.0	365
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	31	161.1	684
			C3P8 (0.8/3.8)	5455	4.2	1586	29	141.1	489
			Stg38 (0.8/3.8)	5614	4.4	2007	30	165.5	1263
CSISZ	Csizmadia	Baja/HU	Huvcse02 (0.95/5)	1606	3.8	390	22	96.8	237
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	29	191.8	1137
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	28	131.0	391
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	23	87.3	402
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	31	182.2	854
			Templar2 (0.8/6)	2080	5.0	1508	31	182.5	632
			Templar3 (0.8/8)	1438	4.3	571	25	143.5	280
			Templar4 (0.8/3.8)	4475	3.0	442	30	173.0	748
			Templar5 (0.75/6)	2312	5.0	2259	28	151.0	591
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	28	118.9	452
			Orion3 (0.95/5)	2665	4.9	2069	21	77.5	180
			Orion4 (0.95/5)	2662	4.3	1043	21	83.7	225
HERCA	Hergenrother	Tucson/US	Salsa3 (0.8/3.8)	2336	4.1	544	25	113.3	316
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	21	85.6	418
IGAAN	Igaz	Debrecen/HU	Hudeb (0.8/3.8)	5522	3.2	620	26	123.0	279
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	25	107.7	272
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	23	119.7	114
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	20	90.4	225
			Husor2 (0.95/3.5)	2465	3.9	715	26	139.2	278
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	24	104.5	212
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	20	88.3	467
			Rezika (0.8/6)	2270	4.4	840	19	88.2	508
			Stefka (0.8/3.8)	5471	2.8	379	18	82.5	308
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	4	13.3	29
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	27	130.6	168
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	25	143.1	1040
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	25	144.8	1406
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	20	59.7	162
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	12	51.5	71

Table 1 – Observers contributing to 2015 July data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Location	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	29	108.2	680
			Pav36 (0.8/3.8)*	5668	4.0	1573	28	105.9	658
			Pav43 (0.75/4.5)*	3132	3.1	319	26	103.8	398
			Pav60 (0.75/4.5)	2250	3.1	281	29	106.4	668
MARGR	Maravelias	Lofoupoli-Crete/GR	Loomecon (0.8/12)	738	6.3	2698	28	216.4	620
MARRU	Marques	Lisbon/PT	Cab1 (0.8/3.8)	5291	3.1	467	30	197.5	862
			Ran1 (1.4/4.5)	4405	4.0	1241	28	159.1	431
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	24	50.1	250
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	26	104.0	1054
			Escimo1 (0.85/25)	155	8.1	3415	25	108.1	368
			Mincam1 (0.8/8)	1477	4.9	1084	20	82.5	469
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	25	93.9	808
			Remo2 (0.8/8)	1478	6.4	4778	24	93.2	538
			Remo3 (0.8/8)	1420	5.6	1967	22	93.5	373
			Remo4 (0.8/8)	1478	6.5	5358	24	94.0	730
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	26	121.7	237
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	26	31.4	215
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	19	68.4	224
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	24	118.9	311
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	21	110.4	393
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	23	126.8	200
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	20	78.6	226
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	31	179.0	361
			Ro2 (0.75/6)	2381	3.8	459	30	173.6	495
			Ro3 (0.8/12)	710	5.2	619	31	183.7	680
			Sofia (0.8/12)	738	5.3	907	31	155.3	324
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	22	97.4	182
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	29	71.0	303
SCHRA	Schmall	Kaposfő/HU	Huvsce05 (1.0/4)	2777	3.5	632	11	30.9	75
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	22	111.8	302
			Kayak2 (0.8/12)	741	5.5	920	24	128.6	156
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	30	145.0	776
			Noa38 (0.8/3.8)	5609	4.2	1911	30	148.9	550
			Sco38 (0.8/3.8)	5598	4.8	3306	30	143.4	783
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	26	81.0	222
			Mincam3 (0.8/6)	2338	5.5	3590	23	64.8	239
			Mincam4 (1.0/2.6)	9791	2.7	552	21	58.6	119
			Mincam5 (0.8/6)	2349	5.0	1896	25	69.2	196
			Mincam6 (0.8/6)	2395	5.1	2178	23	71.8	218
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	25	135.4	275
			Humob (0.8/6)	2388	4.8	1607	27	118.5	628
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	20	71.5	168
* active field of view smaller than video frame						Overall	31	9 358.6	36 725

Results of the IMO Video Meteor Network — August 2015

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

Observations of the IMO Video Meteor Network are presented for 2015 August. A record of almost 89 000 meteors were captured in over 12 000 hours of observations. The flux density profiles are presented for the α-Capricornids, Southern δ-Aquariids and Perseids. A short-term peak is noted for the Perseids at $\lambda = 139\fdg89$. Population index profiles are calculated for the α-Capricornids, Southern δ-Aquariids and Perseids, and for the sporadic meteors of July and August.

Received 2015 December 2

1 Introduction

If all good things come together in one month – many observers, perfect weather conditions, a major shower with new moon at peak – then the outcome will be record-breaking. That is what happened in August 2015.

Traditionally, the number of cameras peaks in August because occasional observers (which are rare in the IMO Network) activate their cameras for the Perseids. This year 86 video cameras were in operation plus one additional camera whose data is still missing.

The weather was perfect in the first half of the month. The statistics show only minor gaps – typically the failure of complete cameras as in case of Mincam1 which was down because of an operator mistake. There were a few gaps at the middle of August, so that for example in Germany some observers missed the Perseid peak night. In the second half of the month the gaps shrunk again. To put it in figures: 70 out of 86, i.e. 80% of the cameras managed to obtain twenty or more observing nights. Ten cameras even observed in thirty or more nights, five of these from Rui Goncalves, three from Maciej Maciejewski and two from Enrico Stomeo. In 16 nights 70 or more cameras were in operation, with peak activity on August 5 and 6 with 81 and 82 cameras, respectively.

New moon was on August 14, so that the Perseid peak was undisturbed by the moon. The output of the IMO Network was accordingly plentiful. On August 12/13 alone we recorded almost 13 000 meteors, which is for the first time a five-digit daily count. Together with the nights before and after it was almost 27 000 meteors. In August, 36 cameras recorded 1 000 or more meteors, six of these even more than 2 000. On top of the list was Avis2 with almost 2 500 meteors, closely followed by Sco38, Stg38 and Jenni. Sco38 and Hulud1 managed to capture over 400 meteors in a single night.

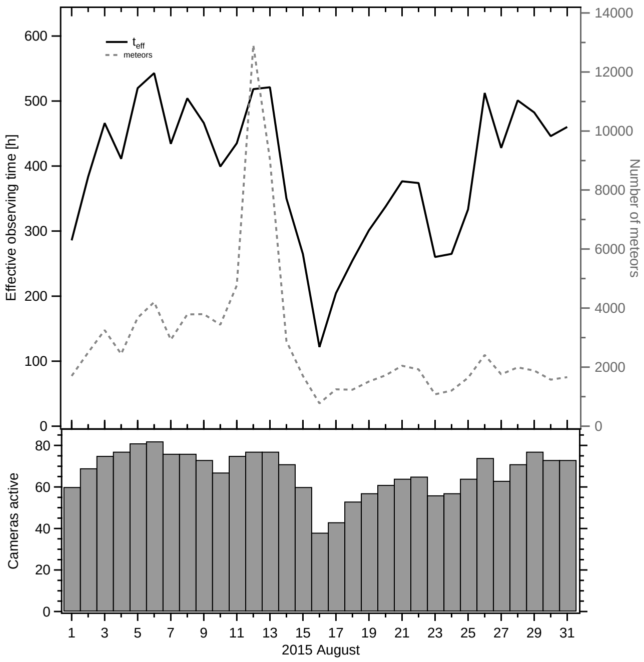

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2015 August.

That yields a total of over 12 100 observing hours in August (Table 1 and Figure 1), which is not only by far the best August outcome, but the best month of the IMO Network ever. A yield of almost 89 000 meteors is an increase of 15% compared to the now second best month of August 2012. That is what meteor observation makes fun!

2 α-Capricornids

As announced in the July report (Molau et al., 2015) we will start the analysis with two showers which are active both in July and August. Figure 2 shows a detailed activity profile of the α-Capricornids. The shower emerges from the sporadic background around July 20, reaches peak activity at the border between July and August and ceases around August 6. At maximum the α-Capricornids reach the flux density of about three meteoroids per 1 000 km^2 per hour.

Figure 3 compares the flux density profile of the last four years. The 2015 peak is a shade stronger than the last peaks and the dip near 123° solar longitude is

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IMO bibcode WGN-436-molau-vidaug
NASA-ADS bibcode 2015JIMO...43..188M

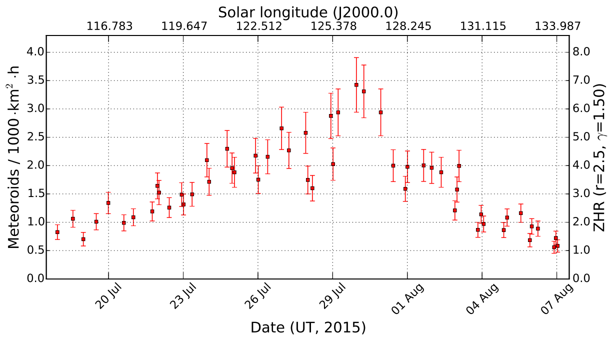

Figure 2 – Flux density profile of the α-Capricornids 2015, derived from observations of the IMO video Network.

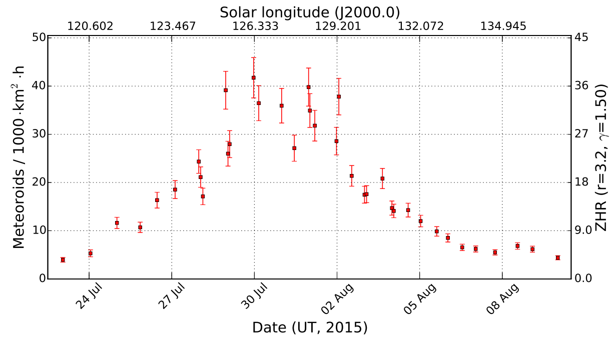

Figure 4 – Flux density profile of the Southern δ-Aquariids 2015, derived from observations of the IMO Video Network.

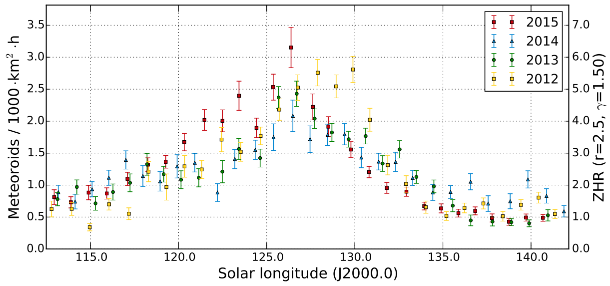

Figure 3 – Flux density profile of the α-Capricornids 2012–2015, derived from observations of the IMO Video Network.

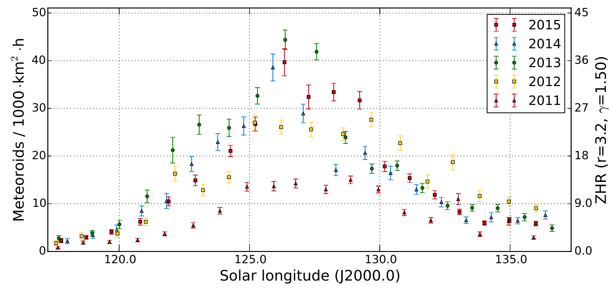

Figure 5 – Flux density profile of the Southern δ-Aquariids 2011–2015, derived from observations of the IMO Video Network.

not visible, but otherwise the shower shows hardly any variation from one year to the next.

3 Southern δ-Aquariids

The Southern δ-Aquariids start in the last third of July. They reach their peak at the border of July and August as well and disappear around August 7 in the sporadic background. The profile of the Southern δ-Aquariids is almost symmetric and their peak is not sharp but rather plateaus with a two-day maximum (Figure 4). The flux density reaches peak values of 40 meteoroids per 1 000 km^2 per hour, which is more than ten times the flux density of the α-Capricornids.

Contrary to the α-Capricornids, the activity of the Southern δ-Aquariids varies significantly from one year to the next. The activity seems to grow steadily, tripling since 2011 (Figure 5).

4 Perseids

The activity interval of the Perseids starts in mid-July, but we will focus first on the time of maximum (Figure 6). It can be easily seen that the activity rises steadily in the European nighttime hours of August 12/13 and reaches the peak at dawn. In the following night, the rate is decreasing again.

Figure 7 zooms directly into the maximum night with a high resolution of ten minutes per bin, which reveals an interesting feature in the morning hours. The flux density is growing steadily with only small fluctuations. However, before the maximum disappears in morning twilight, we have a short-term peak at 03$^{\rm h}$45$^{\rm m}$ UT (139$^\circ\!\!.$89 solar longitude) with rates almost twice as high.

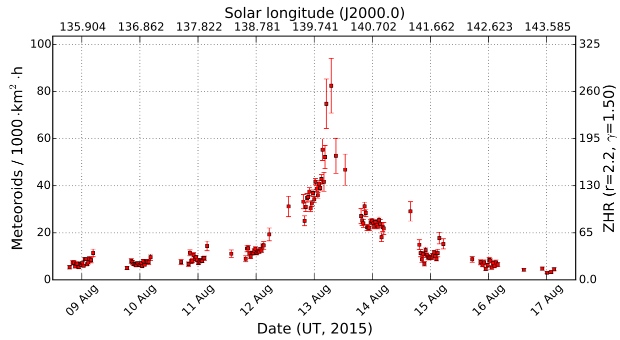

Figure 6 – Flux density profile close the peak of the Perseids 2015, derived from observations of the IMO Video Network.

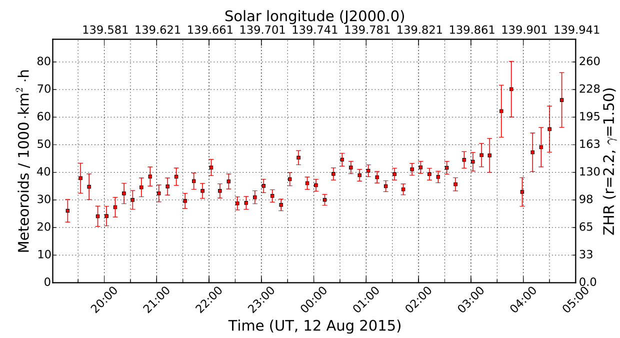

Figure 7 – High resolution flux density profile of the Perseid maximum night 2015 August 12/13, derived from observations of the IMO Video Network.

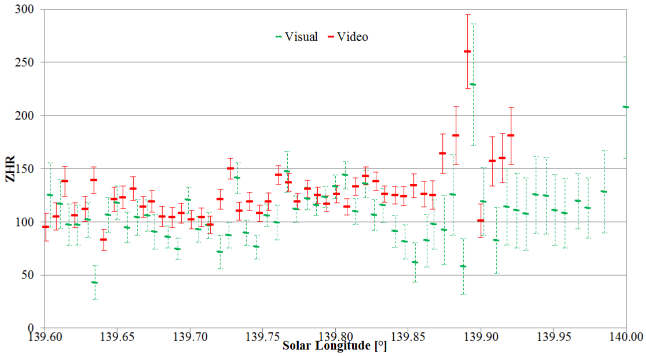

Figure 8 – Activity profile of the Perseid peak, derived from visual and video observations of IMO on 2015 August 12/13.

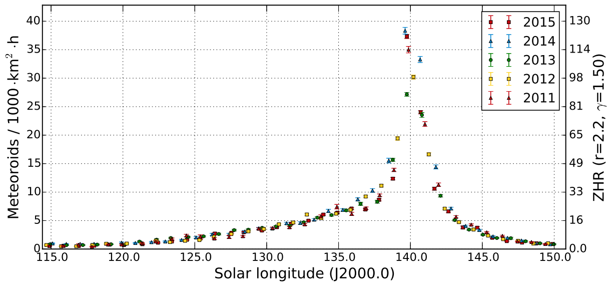

Figure 9 – Flux density profile of the Perseids 2011–2015, derived from observations of the IMO Video Network.

Rainer Arlt provided a high-resolution ZHR profile from visual Perseid observations submitted to IMO for comparison, which only uses observations with 10 min intervals or less. Indeed this profile shows the same phenomenon (Figure 8). Taken by themselves, both outliers would probably be considered measurement errors, but together they give a strong hint that this must have been a real feature. Visual data from Europe and Northern America yield a continuous visual profile that does not end at European dawn hours as in case of our video data.

Finally, a comparison of the full Perseid activity from the last five years shows hardly any difference in the profiles. Only at solar longitude 136° to 137° there seem to be two different regimes of the snap off point.

5 κ-Cygnids

Last but not least, we confirmed that the κ-Cygnids of 2015 are back at the normal level, after they showed significantly enhanced rates in 2014 (Figure 10).

6 Population index calculations

Before we take a detailed look at the population index of the three important showers, we will have another look at the sporadic meteors first. In the July report we showed that the scatter in r-values can be reduced significantly by introducing camera-specific perception coefficients. That is confirmed by the August data: Figure 11 left shows the uncorrected sporadic r-profile in July and August. The scatter is smaller in August because of the larger number of active cameras, but once more there is a severe outlier on August 16/17. At the

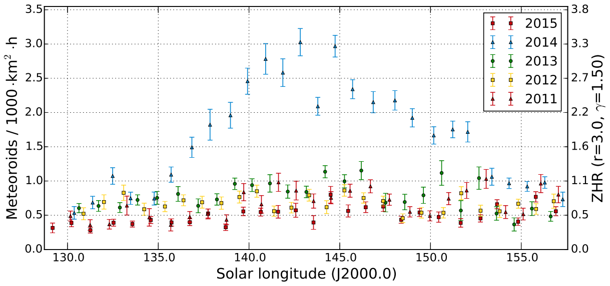

Figure 10 – Flux density profile of the κ-Cygnids 2011–2015, derived from observations of the IMO Video Network.

right side we see the corrected r-profile for comparison. The outlier is still there (in that particular night we had hardly any cameras with consistently clear skies), but damped. The day-to-day variations have become smaller and long-term variations correlated to the lunar phase become more prominent.

With a help of a low-pass filter (sliding 5-day-average excluding the outlier) we can identify long-term variations (Figure 12, left). If these variations are removed we obtain the final sporadic r-profile with variations between 2.5 and 3.0 (Figure 12, right).

Let us now calculate the population index profiles for the individual showers. On the left side you see the uncorrected profile, on the right side the profile that is corrected for the perception coefficient and long-term variations. In case of the α-Capricornids (Figure 13) we have the smallest number of meteors, which results in larger variations. From the begin of activity until the peak, the r-values are smaller than the sporadic values. At peak time the population index is about 2.3, which fits nicely to the value of $r = 2.5$ given in the IMO meteor shower list (Rendtel, 2014). Right after the peak, there is hardly any difference in the sporadic population index.

In the case of the Southern δ-Aquariids (Figure 14) the scatter is smaller, since there are more shower meteors. Towards the begin and end of the activity interval, the r-values agree with the sporadic values. This comes as no surprise, since at these times the sporadic dilution is strongest, i.e. there are many chance alignments of sporadic meteors with the shower radiant. The closer we come to the peak, the smaller is the population index. At the turn of month r-values of 2.1 are obtained, which deviates strongly from $r = 3.2$ given in the IMO meteor shower list (Rendtel, 2014).

In case of the Perseids we have the same effect in the last few days of July, i.e. the population index is slowly shrinking and deviating from the sporadic values (Figure 15). At the same time, the error bars are shrinking thanks to the increasing meteor counts. In the first half of August we see only small variations of the population index, at peak it varies between 2.1 and 2.2. Towards the end of the activity interval, the deviation from the sporadic r-values persists amazingly. It seems that the Perseids keep their large percentage of bright meteors and dominate the sporadic background until the end of their activity interval.

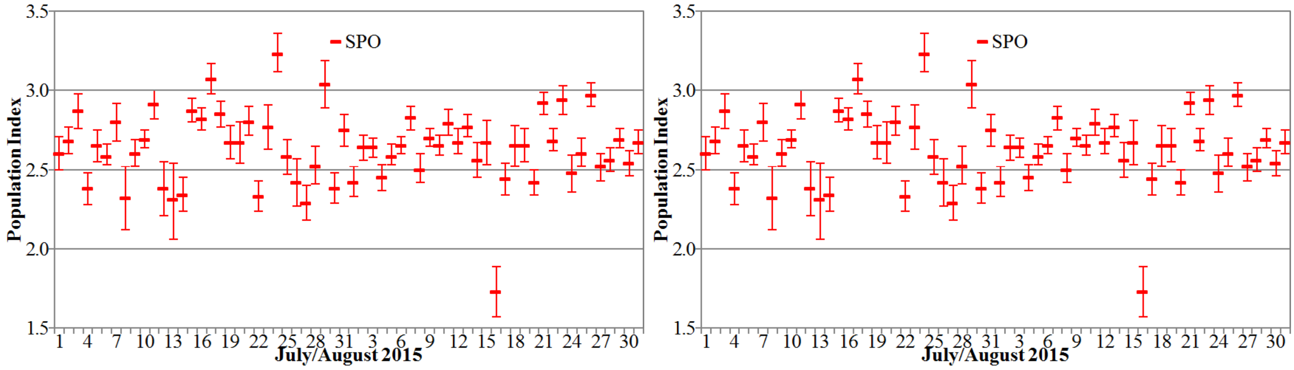

Figure 11 – Sporadic population index in July/August 2015. Left the original, right the perception coefficient corrected profile.

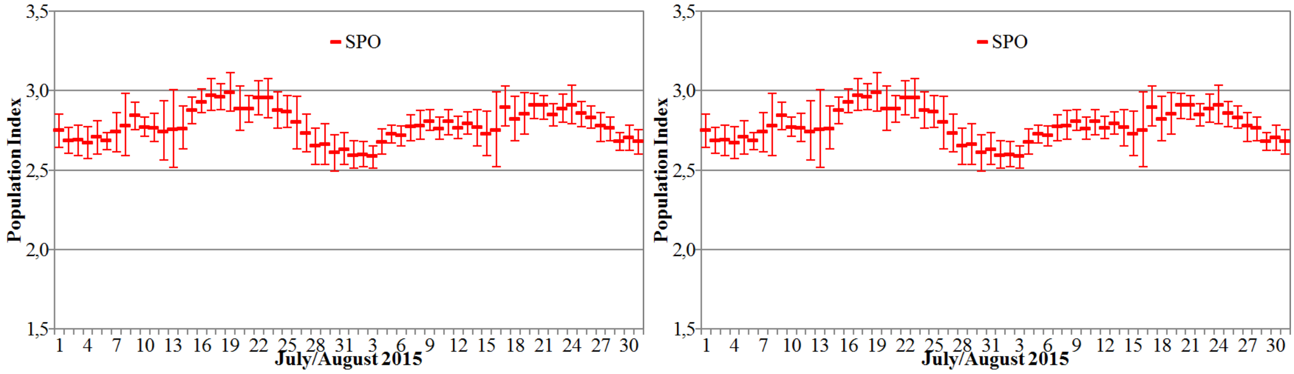

Figure 12 – With a low-pass filter smoothed sporadic population index (left) and final sporadic r-profile in July/August 2015, corrected for the perception coefficient and long-term variations.

Since there is a sufficiently large data set available for the Perseid peak, we finally calculated a high-resolution population index profile for August 12/13 and 13/14. The step size was $0\overset{\circ}{.}02$ in solar longitude, or about 30 minutes. For comparison, Kristina Veljković calculated a high resolution r-profile from visual observations submitted to IMO, based on the average distance between the meteor brightness and the limiting magnitude. Both the visual and video r-values scatter around 2.0 on August 12/13 (Figure 16, left), whereby the video population index is on average 0.1 larger than the visual. In the following night (Figure 16, right) the visual r-values start at 1.9 and slowly reduce to 1.8 at the end of night. Video observations start at 2.2 in this night, but decrease continuously towards the same end value. Hence, the measurements basically agree with one another.

A more detailed analysis of the 2015 Perseids will be presented in a dedicated WGN paper.

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Rendtel J. (2014). *Meteor Shower Workbook 2014*. International Meteor Organization, Potsdam.

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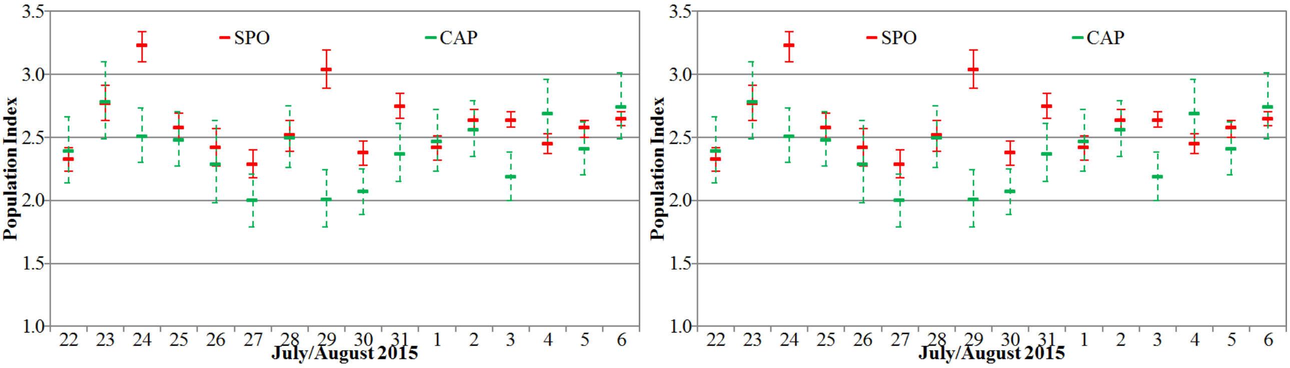

Figure 13 – Population index of the α-Capricornids and sporadic meteors in July/August 2015, derived from IMO video observations. Left the original profiles, right the profiles corrected for the perception coefficient and long-term variations.

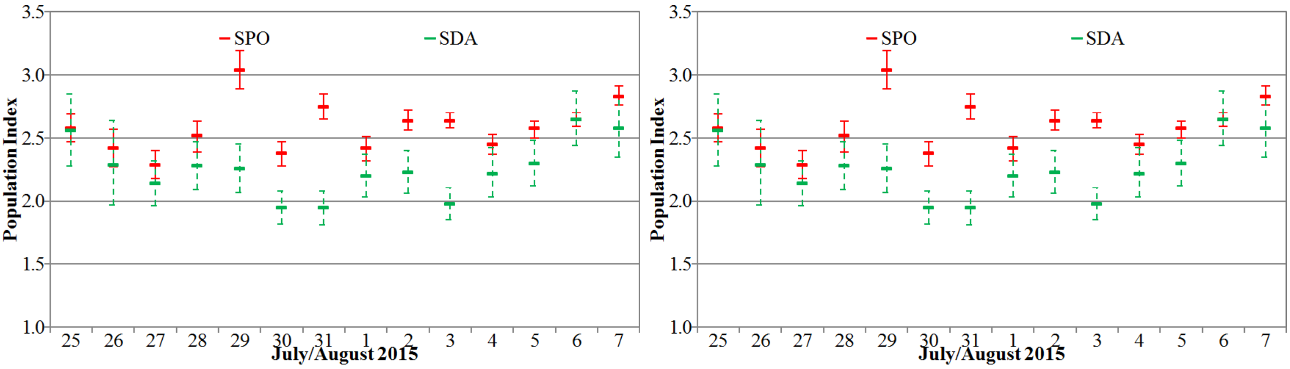

Figure 14 – Population index of the Southern δ-Aquariids and sporadic meteors in July/August 2015, derived from IMO video observations. Left the original profiles, right the profiles corrected for the perception coefficient and long-term variations.

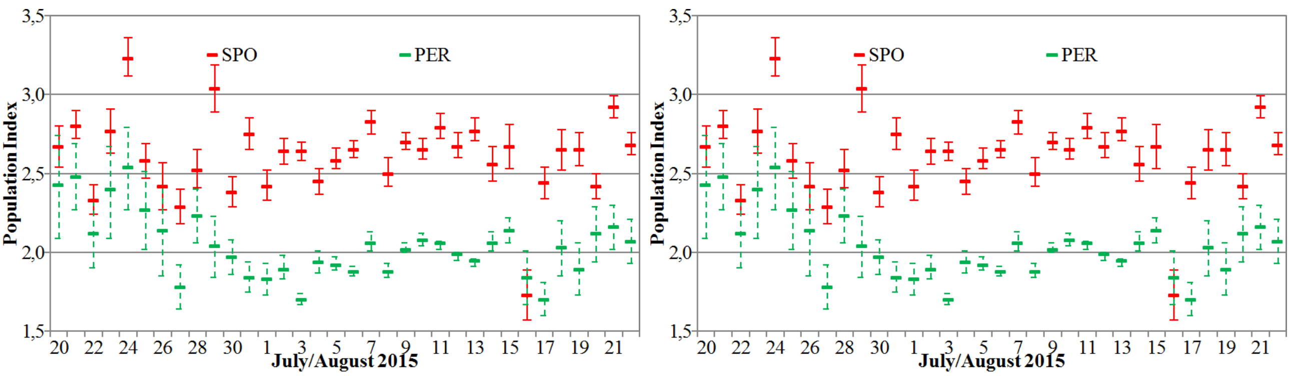

Figure 15 – Population index of the Perseids and sporadic meteors in July/August 2015, derived from IMO video observations. Left the original profiles, right the profiles corrected for the perception coefficient and long-term variations.

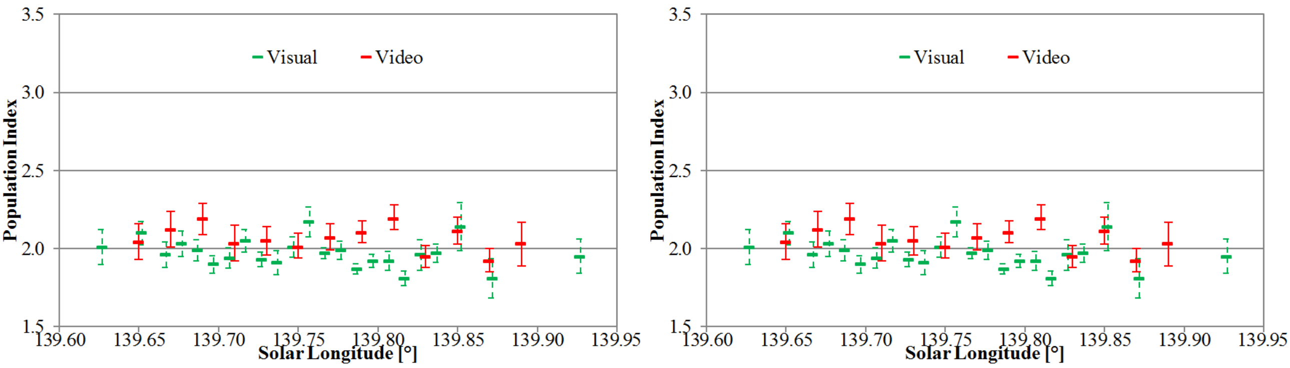

Figure 16 – r-value profile of the Perseid peak, derived from visual and video observations of IMO on 2015 August 12/13 (left) and August 13/14 (right).

Table 1 – Observers contributing to 2015 August data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

Code	Name	Location	Camera	FOV [$°^2$]	Stellar LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	27	135.6	1215
BANPE	Bánfalvi	Zalaegerszeg/HU	Huvcse01 (0.95/5)	2423	3.4	361	19	40.0	324
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	18	116.1	1896
			Hulud3 (0.95/4)	4357	3.8	876	18	115.5	604
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	27	194.2	1831
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	20	98.4	551
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	24	108.7	651
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	25	115.3	727
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	29	172.0	1162
			Bmh2 (1.5/4.5)*	4243	3.0	371	28	156.8	971
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	28	194.2	1601
			C3P8 (0.8/3.8)	5455	4.2	1586	28	170.6	1198
			Stg38 (0.8/3.8)	5614	4.4	2007	28	193.0	2348
CSISZ	Csizmadia	Baja/HU	Huvcse02 (0.95/5)	1606	3.8	390	14	96.7	256
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	28	207.1	2301
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	28	155.7	1353
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	21	122.7	1181
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	31	215.3	1563
			Templar2 (0.8/6)	2080	5.0	1508	31	218.8	1337
			Templar3 (0.8/8)	1438	4.3	571	30	206.3	685
			Templar4 (0.8/3.8)	4475	3.0	442	31	216.0	1756
			Templar5 (0.75/6)	2312	5.0	2259	31	199.0	1490
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	23	146.8	1137
			Orion3 (0.95/5)	2665	4.9	2069	27	160.4	954
			Orion4 (0.95/5)	2662	4.3	1043	29	170.1	970
HERCA	Hergenrother	Tucson/US	Salsa3 (0.8/3.8)	2336	4.1	544	28	167.0	737
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	26	142.5	1224
IGAAN	Igaz	Debrecen/HU	Hudeb (0.8/3.8)	5522	3.2	620	25	150.7	855
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	16	86.9	707
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	6	37.1	92
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	26	160.6	663
			Husor2 (0.95/3.5)	2465	3.9	715	26	165.9	621
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	10	59.8	133
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	17	121.8	1659
			Rezika (0.8/6)	2270	4.4	840	17	122.5	1550
			Stefka (0.8/3.8)	5471	2.8	379	17	124.7	1368
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	6	43.3	149
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	20	123.5	495
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	28	194.7	1870
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	25	155.3	1579
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	19	77.1	491
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	20	110.9	506
LOPAL	Lopes	Lisboa/PT	Naso1 (0.75/6)	2377	3.8	506	27	134.8	459

Table 1 – Observers contributing to 2015 August data of the IMO Video Meteor Network – continued from previous page.

Code	Name	Location	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	31	184.7	1754
			Pav36 (0.8/3.8)*	5668	4.0	1573	31	184.1	2027
			Pav43 (0.75/4.5)*	3132	3.1	319	29	183.6	1128
			Pav60 (0.75/4.5)	2250	3.1	281	31	190.7	1813
MARGR	Maravelias	Lofoupoli-Crete/GR	Loomecon (0.8/12)	738	6.3	2698	24	184.5	645
MARRU	Marques	Lisbon/PT	Cab1 (0.8/3.8)	5291	3.1	467	29	198.3	1672
			Ran1 (1.4/4.5)	4405	4.0	1241	28	167.7	949
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	18	83.7	588
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	27	162.8	2446
			Escimo2 (0.85/25)	155	8.1	3415	25	155.4	618
			Mincam1 (0.8/8)	1477	4.9	1084	7	49.2	323
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	26	144.7	1789
			Remo2 (0.8/8)	1478	6.4	4778	27	143.7	1122
			Remo3 (0.8/8)	1420	5.6	1967	26	136.5	1018
			Remo4 (0.8/8)	1478	6.5	5358	27	152.4	1474
MORJO	Morvai	Fülöpszállás/HU	Huful (1.4/5)	2522	3.5	532	24	137.7	569
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	24	57.5	532
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	12	48.3	488
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	26	146.4	543
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	26	169.8	1828
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	22	141.5	707
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	27	146.5	520
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	27	175.3	596
			Ro2 (0.75/6)	2381	3.8	459	26	176.4	828
			Ro3 (0.8/12)	710	5.2	619	28	195.9	849
			Sofia (0.8/12)	738	5.3	907	25	165.2	612
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	28	142.5	627
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	27	106.0	915
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	26	147.8	643
			Kayak2 (0.8/12)	741	5.5	920	25	155.8	338
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	29	153.7	2042
			Noa38 (0.8/3.8)	5609	4.2	1911	30	167.9	1991
			Sco38 (0.8/3.8)	5598	4.8	3306	30	170.1	2379
STORO	Štork	Ondřejov/CZ	Ond1 (1.4/50)*	2195	5.8	4595	2	12.8	664
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	25	116.2	702
			Mincam3 (0.8/6)	2338	5.5	3590	26	101.8	717
			Mincam4 (1.0/2.6)	9791	2.7	552	23	86.7	301
			Mincam5 (0.8/6)	2349	5.0	1896	27	104.4	584
			Mincam6 (0.8/6)	2395	5.1	2178	26	107.1	569
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	28	184.7	829
			Humob (0.8/6)	2388	4.8	1607	29	180.1	1363
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	26	135.1	662
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	23	101.4	704
* active field of view smaller than video frame						Overall	31	12 161.0	88 688

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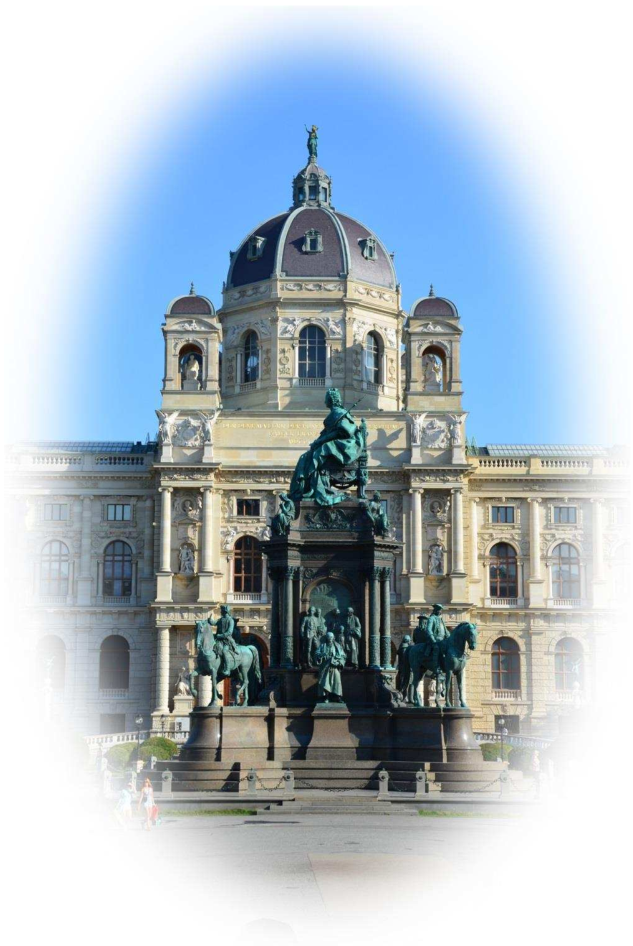

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