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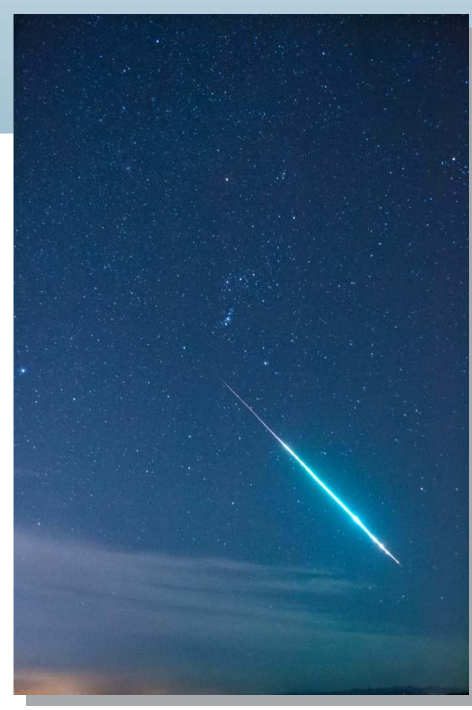

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IMC 2014 Proceedings abstracts
Outburst of the April α-Capricornids
Further new showers found in CMN and SonotaCo databases
Possible new shower reported from Eridanus-Orion border
July–August video meteors

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Front cover photo

This bright fireball was photographed from Milton, VT, USA on 2014 February 24 at $01^{h}45^{m}$ UT using Nikon D3100 equipped with 18-mm $f/3.5$ lens with a 15 s exposure at ISO 3200. Image courtesy: Ethan Rogati.

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` .

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

From the Treasurer — IMO Membership/WGN Subscription Renewal for 2015

Marc Gyssens

We invite all our members/subscribers to renew for 2015. 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 2015				
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-426-gyssens-renewals NASA-ADS bibcode 2014JIMO...42..205G

Solar Longitudes for 2015

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 2015. 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-426-arlt-solarlong
NASA-ADS bibcode 2014JIMO...42..205A

Solar longitudes 2015. Dates refer to 00^h UT.

Jan	1	280.02	Mar	1	339.87	May	1	40.11	Jul	1	98.66	Sep	1	158.04	Nov	1	218.02
Jan	2	281.04	Mar	2	340.87	May	2	41.08	Jul	2	99.62	Sep	2	159.01	Nov	2	219.02
Jan	3	282.06	Mar	3	341.87	May	3	42.05	Jul	3	100.57	Sep	3	159.98	Nov	3	220.02
Jan	4	283.08	Mar	4	342.87	May	4	43.02	Jul	4	101.52	Sep	4	160.95	Nov	4	221.02
Jan	5	284.10	Mar	5	343.88	May	5	43.99	Jul	5	102.48	Sep	5	161.92	Nov	5	222.03
Jan	6	285.12	Mar	6	344.88	May	6	44.96	Jul	6	103.43	Sep	6	162.89	Nov	6	223.03
Jan	7	286.14	Mar	7	345.88	May	7	45.92	Jul	7	104.38	Sep	7	163.86	Nov	7	224.03
Jan	8	287.16	Mar	8	346.88	May	8	46.89	Jul	8	105.34	Sep	8	164.83	Nov	8	225.04
Jan	9	288.18	Mar	9	347.88	May	9	47.86	Jul	9	106.29	Sep	9	165.80	Nov	9	226.04
Jan	10	289.19	Mar	10	348.88	May	10	48.83	Jul	10	107.24	Sep	10	166.77	Nov	10	227.04
Jan	11	290.21	Mar	11	349.88	May	11	49.79	Jul	11	108.20	Sep	11	167.74	Nov	11	228.05
Jan	12	291.23	Mar	12	350.88	May	12	50.76	Jul	12	109.15	Sep	12	168.71	Nov	12	229.06
Jan	13	292.25	Mar	13	351.88	May	13	51.73	Jul	13	110.10	Sep	13	169.69	Nov	13	230.06
Jan	14	293.27	Mar	14	352.87	May	14	52.69	Jul	14	111.06	Sep	14	170.66	Nov	14	231.07
Jan	15	294.29	Mar	15	353.87	May	15	53.66	Jul	15	112.01	Sep	15	171.63	Nov	15	232.08
Jan	16	295.31	Mar	16	354.87	May	16	54.62	Jul	16	112.97	Sep	16	172.61	Nov	16	233.08
Jan	17	296.33	Mar	17	355.86	May	17	55.59	Jul	17	113.92	Sep	17	173.58	Nov	17	234.09
Jan	18	297.34	Mar	18	356.86	May	18	56.55	Jul	18	114.87	Sep	18	174.56	Nov	18	235.10
Jan	19	298.36	Mar	19	357.85	May	19	57.51	Jul	19	115.83	Sep	19	175.54	Nov	19	236.11
Jan	20	299.38	Mar	20	358.85	May	20	58.48	Jul	20	116.78	Sep	20	176.51	Nov	20	237.12
Jan	21	300.40	Mar	21	359.84	May	21	59.44	Jul	21	117.74	Sep	21	177.49	Nov	21	238.12
Jan	22	301.42	Mar	22	0.84	May	22	60.40	Jul	22	118.69	Sep	22	178.47	Nov	22	239.13
Jan	23	302.43	Mar	23	1.83	May	23	61.36	Jul	23	119.65	Sep	23	179.45	Nov	23	240.14
Jan	24	303.45	Mar	24	2.82	May	24	62.32	Jul	24	120.60	Sep	24	180.42	Nov	24	241.15
Jan	25	304.47	Mar	25	3.81	May	25	63.29	Jul	25	121.56	Sep	25	181.40	Nov	25	242.17
Jan	26	305.49	Mar	26	4.81	May	26	64.25	Jul	26	122.51	Sep	26	182.38	Nov	26	243.18
Jan	27	306.50	Mar	27	5.80	May	27	65.21	Jul	27	123.47	Sep	27	183.36	Nov	27	244.19
Jan	28	307.52	Mar	28	6.79	May	28	66.17	Jul	28	124.42	Sep	28	184.34	Nov	28	245.20
Jan	29	308.54	Mar	29	7.77	May	29	67.13	Jul	29	125.38	Sep	29	185.32	Nov	29	246.21
Jan	30	309.55	Mar	30	8.76	May	30	68.09	Jul	30	126.33	Sep	30	186.30	Nov	30	247.22
Jan	31	310.57	Mar	31	9.75	May	31	69.04	Jul	31	127.29						
Feb	1	311.58	Apr	1	10.74	Jun	1	70.00	Aug	1	128.25	Oct	1	187.29	Dec	1	248.24
Feb	2	312.60	Apr	2	11.73	Jun	2	70.96	Aug	2	129.20	Oct	2	188.27	Dec	2	249.25
Feb	3	313.61	Apr	3	12.71	Jun	3	71.92	Aug	3	130.16	Oct	3	189.25	Dec	3	250.26
Feb	4	314.62	Apr	4	13.70	Jun	4	72.88	Aug	4	131.11	Oct	4	190.24	Dec	4	251.28
Feb	5	315.64	Apr	5	14.68	Jun	5	73.83	Aug	5	132.07	Oct	5	191.22	Dec	5	252.29
Feb	6	316.65	Apr	6	15.67	Jun	6	74.79	Aug	6	133.03	Oct	6	192.21	Dec	6	253.31
Feb	7	317.66	Apr	7	16.65	Jun	7	75.75	Aug	7	133.99	Oct	7	193.19	Dec	7	254.32
Feb	8	318.68	Apr	8	17.63	Jun	8	76.70	Aug	8	134.95	Oct	8	194.18	Dec	8	255.34
Feb	9	319.69	Apr	9	18.62	Jun	9	77.66	Aug	9	135.90	Oct	9	195.17	Dec	9	256.35
Feb	10	320.70	Apr	10	19.60	Jun	10	78.62	Aug	10	136.86	Oct	10	196.15	Dec	10	257.37
Feb	11	321.71	Apr	11	20.58	Jun	11	79.57	Aug	11	137.82	Oct	11	197.14	Dec	11	258.39
Feb	12	322.73	Apr	12	21.56	Jun	12	80.53	Aug	12	138.78	Oct	12	198.13	Dec	12	259.40
Feb	13	323.74	Apr	13	22.54	Jun	13	81.48	Aug	13	139.74	Oct	13	199.12	Dec	13	260.42
Feb	14	324.75	Apr	14	23.52	Jun	14	82.44	Aug	14	140.70	Oct	14	200.11	Dec	14	261.44
Feb	15	325.76	Apr	15	24.50	Jun	15	83.40	Aug	15	141.66	Oct	15	201.10	Dec	15	262.45
Feb	16	326.77	Apr	16	25.48	Jun	16	84.35	Aug	16	142.62	Oct	16	202.09	Dec	16	263.47
Feb	17	327.78	Apr	17	26.46	Jun	17	85.31	Aug	17	143.58	Oct	17	203.09	Dec	17	264.49
Feb	18	328.79	Apr	18	27.44	Jun	18	86.26	Aug	18	144.55	Oct	18	204.08	Dec	18	265.51
Feb	19	329.80	Apr	19	28.42	Jun	19	87.22	Aug	19	145.51	Oct	19	205.07	Dec	19	266.52
Feb	20	330.81	Apr	20	29.40	Jun	20	88.17	Aug	20	146.47	Oct	20	206.06	Dec	20	267.54
Feb	21	331.82	Apr	21	30.37	Jun	21	89.13	Aug	21	147.43	Oct	21	207.06	Dec	21	268.56
Feb	22	332.82	Apr	22	31.35	Jun	22	90.08	Aug	22	148.40	Oct	22	208.05	Dec	22	269.58
Feb	23	333.83	Apr	23	32.32	Jun	23	91.04	Aug	23	149.36	Oct	23	209.05	Dec	23	270.60
Feb	24	334.84	Apr	24	33.30	Jun	24	91.99	Aug	24	150.32	Oct	24	210.04	Dec	24	271.61
Feb	25	335.85	Apr	25	34.27	Jun	25	92.94	Aug	25	151.29	Oct	25	211.04	Dec	25	272.63
Feb	26	336.85	Apr	26	35.25	Jun	26	93.90	Aug	26	152.25	Oct	26	212.03	Dec	26	273.65
Feb	27	337.86	Apr	27	36.22	Jun	27	94.85	Aug	27	153.22	Oct	27	213.03	Dec	27	274.67
Feb	28	338.86	Apr	28	37.19	Jun	28	95.80	Aug	28	154.18	Oct	28	214.03	Dec	28	275.69
			Apr	29	38.17	Jun	29	96.76	Aug	29	155.15	Oct	29	215.03	Dec	29	276.71
			Apr	30	39.14	Jun	30	97.71	Aug	30	156.11	Oct	30	216.02	Dec	30	277.73
									Aug	31	157.08	Oct	31	217.02	Dec	31	278.74

Details of the Proceedings of the International Meteor Conference, Giron, France, 18–21 September 2014

Jean-Louis Rault and Paul Roggemans, editors

The main purpose of the International Meteor Conference is to exchange knowledge and information. The lectures and posters however are a summary of some topics which need more in-depth description in the form of an article in the conference Proceedings. The first Meteor Seminar got Proceedings which added great value to this meeting and that created the motivation to have a second seminar. Unfortunately Proceedings failed to materialize after the 2nd meeting in 1980, the 3rd meeting in 1982, the 4th meeting in 1983 and the 5th meeting in 1985. All these conferences struggled to get a follow up as without any written account of all the interesting talks, the meetings looked of too little value. In 1986 it was clearly understood that the IMC, or International Meteor Weekend like it was called in that time, had no future if no Proceedings could be produced.

Ever since 1986 the IMC organizers did all efforts they could to collect papers for all presentations and to produce the Proceedings few months after the conference. The number of presentations was smaller than today, but without e-mail or internet, text processors or computers, the time and work required was more efforts than in recent years. This went all well until 1997. End 1990s the IMO failed and did not bother to collect all presentations anymore and the time required to get the Proceedings edited and printed passed beyond any acceptable limit. Some years ago the IMC proceedings got a coverage of barely 40% of the conference presentations and although very incomplete, still kept IMC participants to wait as long as over one year before seeing anything of it. In these circumstances the future of the IMC Proceedings became questionable. Without Proceedings it would be just a matter of time to see the IMC disappear.

With the 2014 Giron Proceedings the editors wanted to prove that it is still possible to produce Proceedings almost complete and within a few months, although the number of presentations is more as twice the number it was 20 years ago. Actually these 2014 Proceedings were ready two months after the conference, which is an historically early delivery of this publication. This was possible mainly thanks to the efforts of all authors involved, for which we very warmly thank them all, secondly we worked with MS Word instead of LaTeX. Word is preferred by 90% of all our authors while only a handful of IMO members master LaTeX. Most huge delays in the past were due to the lack of time of those very few LaTeX adepts, by not using LaTeX we avoided 6 to 9 months of dead time. Hence we are very pleased to offer you these IMC Proceedings, early on time and as complete as was ever been possible.

Following are the abstracts of all the contributions published in the IMC 2014 Proceedings. You can order a copy of the Proceedings from the International Meteor Organization: details are in the lower half of the inside back cover of this Journal and on the IMO website `http://www.imo.net/imo/publications`.

CILBO - Lessons learned from a double-station meteor camera setup in the Canary Islands

Detlef Koschny, Jonathan Mc Auliffe, Esther Drolshagen, Felix Bettonvil, Javier Licandro, Cornelis van der Luijt, Theresa Ott, Hans Smit, Hakan Svedhem, Olivier Witasse, and Joe Zender

We have been operating a double-station meteor camera setup and have collected more than 12 months of simultaneous observations until mid-2014. First science is being produced. In this paper we report on the lessons learned and provide information on what went well and what did not. The intention is to help other teams considering setting up similar systems to avoid the same issues.

Meteor velocity distribution from CILBO double station video camera data

Esther Drolshagen, Theresa Ott, Detlef Koschny, Gerhard Drolshagen, and Bjoern Poppe

This paper is based on data from the double-station meteor camera setup on the Canary Islands – CILBO. The data has been collected from July 2011 until August 2014. The CILBO meteor data of one year (1 June 2013 – 31 May 2014) were used to analyze the velocity distribution of sporadic meteors and to compare the distribution to a reference distribution for near-Earth space. The velocity distribution for 1 AU outside the influence of Earth derived from the Harvard Radio Meteor Project (HRMP) was used as a reference. This HRMP distribution was converted to an altitude of 100 km by considering the gravitational attraction of Earth. The new, theoretical velocity distribution for a fixed meteoroid mass ranges from 11 – 71 km/s and peaks at 12.5 km/s. This represents the predicted velocity distribution. The velocity distribution of the meteors detected simultaneously by both cameras of the CILBO system was examined. The meteors are sorted by their stream association and especially the velocity distribution of the sporadics is studied closely. The derived sporadic velocity distribution has a maximum at 64 km/s. This drastic difference to the theoretical curve confirms that fast meteors are usually

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greatly over-represented in optical and radar measurements of meteors. The majority of the fast sporadics are apparently caused by the Apex contribution in the early morning hours. This paper presents first results of the ongoing analysis of the meteor velocity distribution.

Meteoroid flux determination using image intensified video camera data from the CILBO double station

Theresa Ott, Esther Drolshagen, Detlef Koschny, Gerhard Drolshagen, and Bjoern Poppe

The double-station meteor camera setup on the Canary Islands, called CILBO, has been active since July 2011. This paper is based on the meteor data of one year (1.6.2013 – 31.5.2014). As a first step the statistical distribution of all observed meteors from both cameras was analyzed. Parameters under investigation include: the number of meteors observed by either one or both cameras as a function of the months, magnitude and direction. In a second step the absolute magnitude was calculated. It was found that ICC9 (La Palma) detects about 15% more meteors than ICC7 (Tenerife). A difference in the camera setting will be ruled out as a reason but different pointing directions are taken into consideration. ICC7 looks to the north-west and ICC9 looks to the south-east. A suggestion was that ICC9 sees more of the meteors originating from the Apex contribution in the early morning hours. An equation by Verniani (1973) has been used to convert brightness and velocity to the mass of the incident particle. This paper presents first results of the meteor flux analysis and compares the CILBO flux to well-known reference models (Grün et al., 1985) and (Halliday et al., 1996). It was found that the measured CILBO data yield a flux which fits the reference model from Grün et al. quite well.

High resolution photographic imaging

Felix Bettonvil

A high-resolution camera is described, based on DSLR technology and long focal length lens together with a 200 cycles/sec optical shutter, with the aim to collect higher accuracy orbital elements. The paper describes the design considerations, test setup, and analyses and discusses the first results.

The FRIPON and Vigie-Ciel networks

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

FRIPON (Fireball Recovery and interplanetary Observation Network) is a French fireball network recently founded by ANR (Agence Nationale de la Recherche). His aim is to connect meteoritical science with asteroidal and cometary sciences in order to better understand the solar system formation and evolution. The main idea is to cover all the French territory in order to collect a large number of meteorites (one or two per year) with an accurate orbit computation allowing us to pinpoint the parent bodies of the meteorites. About 100 allsky cameras will be installed in 2015 to create a dense network with an average distance of 100 km between two stations. In order to maximize the accuracy of orbit determination, we will mix our optical data with radar data from the GRAVES beacon received by 25 stations (Rault, 2014). As the network installation and the creation of the research teams for meteorites need many persons, at least much more than our small team of professionals, we will develop in parallel a participative science network for amateurs called Vigie-Ciel. As FRIPON is an open project, anybody will be able to buy a "FRIPON like" camera to be within the network, using our FreeTure detection software (Audureau, 2014; Kwon, 2014). Vigie-Ciel will also be used by observers using other types of cameras and by teams of meteorite researchers. Finally we will use the public affinity with meteors and meteorites to develop scientific activities to popularize science.

FreeTure: A Free software to capTure meteors for FRIPON

Yoan Audureau, Chiara Marmo, Sylvain Bouley, Min-Kyung Kwon, François Colas, Jérémie Vaubaillon, Mirel Birlan, Brigitte Zanda, Pierre Vernazza, Stephane Caminade, Jérôme Gattecceca

The Fireball Recovery and Interplanetary Observation Network (FRIPON) is a French project started in 2014 which will monitor the sky, using 100 all-sky cameras to detect meteors and to retrieve related meteorites on the ground. There are several detection software all around. Some of them are proprietary. Also, some of them are hardware dependent. We present here the open source software for meteor detection to be installed on the FRIPON network's stations. The software will run on Linux with gigabit Ethernet cameras and we plan to make it cross platform. This paper is focused on the meteor detection method used for the pipeline development and the present capabilities.

Offbeat and wacky projects using a video meteor camera

Peter S. Gural

The proliferation of low cost video cameras for nightly meteor collection has almost exclusively been deployed for either moderate or all-sky fields of view. This presentation reviews various concepts using the latest off-the-shelf cameras typically used by meteorists, for some unconventional experiments in meteor detection, spectroscopy, high space-time resolution imaging, as well as non-meteor related projects.

Low dispersion meteor velocity measurements with CABERNET

Auriane Egal, Jérémie Vaubaillon, François Colas, Prakash Atreya

We present here a method to determine the meteor velocities in a more robust way than what is usually done, working with the images provided by the CABERNET project. Thanks to an electronic shutter coupled to the cameras, meteors look like a succession of centroids in the photographic records. We are able to determine the position of the meteor in the image across the time, as well as its apparent velocity, by plotting the light curve along the track of the meteor. To minimize the measurement errors in the centroid's position, we use the RANSAC algorithm to fit the apparent velocity. Thanks to this fit, the position that the meteor would have at a time t + δt is computed. Following an astrometric reduction process, we finally obtain two sets of values (t, α, δ) and (t + δt, α, δ). By projecting these positions at time t and t + δt on the 3-D trajectory, we compute a 3-D velocity that is not as sensitive to the measurement errors as other methods and which shows a lower data dispersion.

Expeditions during 2014 with AMOS cameras

Juraj Tóth, Pavol Zigo, Leonard Kornoš, Jozef Világi

Slovak Video Meteor Network (SVMN) is a project of the Comenius University in Bratislava for continuous monitoring of meteor activity over Slovakia and surrounding countries. The network is based on AMOS (All-sky Meteor Orbit System) Cameras, which astrometric precision was calibrated using several commonly observed fireballs within the European Fireball Network. We cooperate with other national video networks and amateur observers and submit all data to the EDMOND video meteor database. The extension of the AMOS Cameras to the Canary Islands and Chile to cover the Southern hemisphere is planned. We present preliminary results from the expedition on the Canary Islands (April 2014) and from Canada (Camelopardalids, May 2014).

CAMS BeNeLux

Felix Bettonvil, Carl Johannink, Martin Breukers

This paper gives an overview of the current status of the BeNeLux CAMS video meteor network as operated in the Netherlands and Belgium, and part of the NASA funded automated meteor video surveillance project CAMS.

CMN_ADAPT and CMN_binViewer software

Denis Vida, Damir Šegon, Peter S. Gural, Goran Martinović, Ivica Skokić

As the main focus of the Croatian Meteor Network (CMN) shifted from data collection to data analysis, primarily to the discovery of new meteor showers, it became clear that the current data processing pipeline was slow and outdated. In this paper new software for fully automatic data acquisition and processing is presented. Furthermore, a new tool for viewing the data acquired with the CAMS capture and compression software is described and a link is given for free download from the CMN webpage.

Slovak video meteor network – meteor spectra

Regina Rudawska, Juraj Tóth, Dušan Kalmančok and Pavol Zigo

With the updated All-Sky Meteor Orbit System (AMOS) (called AMOS-Spec) we aim to measure the main element abundances of meteors. Here we report the best eight cases.

Performance of new low-cost 1/3" security cameras for meteor surveillance

Dave Samuels, James Wray, Peter S. Gural, Peter Jenniskens

It has been almost 5 years since the CAMS (Cameras for All-sky Meteor Surveillance) system specifications were designed for video meteor surveillance. CAMS has been based on a relatively expensive black-and-white Watec WAT-902H2 Ultimate camera, which uses a 1/2" sensor. In this paper, we investigate the ability of new, lower cost color cameras based on smaller 1/3" sensors to be able to perform adequately for CAMS. We did not expect them to equal or outperform the sensitivity for the same field of view of the Watec 1/2" camera, but the goal was to see if they could perform within the tolerances of the sensitivity requirements for the CAMS project. Their lower cost brings deployment of meteor surveillance cameras within reach of amateur astronomers and makes it possible to deploy many more cameras to increase yield. The lens focal length is matched to the elevation angle of the camera to maintain an image scale and spatial resolution close to that of the standard CAMS camera and lens combination, crucial for obtaining sufficiently accurate orbital elements. An all-sky array based on 16 such cameras, to be operated from a single computer, was built and the performance of individual cameras was tested.

Obtaining population indices from video observations of meteors

Sirko Molau, Geert Barentsen, Stefano Crivello

We present a novel approach for the determination of the population index from meteor showers, which is particularly useful for video camera networks with a large range of limiting magnitudes. Unlike previous approaches in the visual domain, it compares the meteor counts from cameras with different limiting magnitudes to derive the population index. Thus, it is totally independent of the meteor brightness estimate and also resistant to systematic errors in the limiting magnitude calculation or the detection efficiency close to the limiting magnitude of a camera. We derive the new approach step-by-step and present a number or refinements to improve the basic algorithm. Using the Poisson distribution gives the approach a solid probabilistic base and weights each data set according to its contribution to the population index. Finally we present and discuss first preliminary population index profiles obtained from the IMO Video Meteor Network.

A possible new shower on Eridanus-Orion border

Damir Šegon, Peter Gural, Željko Andreić, Denis Vida, Ivica Skokić, Filip Novoselnik and Luciano Gržinić

Three showers on the border between constellations of Eridanus and Orion were found during extensive search for new showers in SonotaCo and CMN video meteor orbit databases. Our results suggest that two of these three showers represent ν Eridanids shower (337 NUE), while third one represents separate possible new shower which has been named π^6 Orionids (552 PSO).

Camelopardalids expedition

Mariusz Wiśniewski, Przemysław Żołądek and Zbigniew Tymiński

This paper describes preliminary results of the Polish Fireball Network expedition to observe the outburst of the particles stream of comet 209P/LINEAR. According to the theoretical calculations the predicted shower radiated from Camelopardalis constellation and reached its maximum on May 24th 2014. The selection of observation sites and equipment is presented. Eleven analog cameras, digital cameras and DSLR cameras were used in the double station observing system. As a result 174 meteors were recorded, 32 of them were Camelopardalids. Using data from the maximum night the 15 orbits of meteors were calculated – 5 orbits have orbital parameters similar to the expected values for Camelopardalids.

Camelopardalids 2014, the radio view

Bill Ward

Observations of the predicted encounter with dust tails from comet 209P/LINEAR on 24th May 2014 were made using radio forward scatter.

Future plans of the Polish Fireball Network

Przemysław Żołądek

The current status and the future plans of the Polish Fireball Network have been presented. A new funding became available and new equipment will be purchased next year. We are testing three megapixel cameras which are sufficiently sensitive for meteor research. We plan to create more than 10 fireball stations equipped with digital megapixel cameras with high quality lenses.

Geminids 2012 – a spectacular show from Oman

Thomas Weiland, Felix Bettonvil

The Geminids are the most reliable prominent meteor shower currently visible. They can be observed from the whole northern hemisphere and even low southern latitudes as well. Nevertheless, as the weather is often unfavourable in Central Europe during December, a six-day-long visual observing campaign was carried out from Oman in 2012. There observing conditions were nearly perfect, especially in the Rub al-Khali desert in the western part of the country. As a consequence, we managed to record more than 1800 Geminids within almost 45 hours of effective observing time. An impression of the campaign together with a summary of the results is given.

Daytime meteor showers

Jürgen Rendtel

Radiants of daytime meteor showers are located typically about 20–30° west of the Sun. Radiants and orbits are known from radar observations, but information about the activity and the population index or mass index are missing or incomplete. Two of the daytime showers, the Daytime Arietids (171 ARI) in early June and the Daytime Sextantids (221 DSX) end September to early October are active and are accessible with radio (forward scatter), radar and optical methods. Both the ARI and DSX appear in regular video data analyses. Observations obtained with different methods should allow to calibrate and to combine data to derive a comprehensive meteoroid stream description.

Independent identification of meteor showers in EDMOND database

Regina Rudawska, Pavol Matlovič, Juraj Tóth and Leonard Kornoš

This paper presents the results obtained by a proposed new independent method of meteor showers identification, which is applied to the current version of the database (EDMOND 5.0). In the first step of the survey we used the DSH criterion to find groups around each meteor within the similarity threshold. Mean parameters of the groups were calculated and compared using a new function based on geocentric parameters (λ, α, δ, and V_g). Similar groups were merged into final clusters (representing meteor showers), and compared with the IAU Meteor Data Center list of meteor showers.

Meteor television observations in Russia

Anna Kartashova

The meteor television observations are carried out at several Russian observatories. The Institute of Astronomy RAS carries out meteor observations and supports observations by the Geophysical observatory IDG RAS and the Irkutsk State University. Ryazan State University participates in these observations too. Mikhail Maslov takes active part in television meteor observations in Novosibirsk. The results of INASAN observations are presented.

Software for analysis of visual meteor data

Kristina Veljković, Ilija Ivanović

In this paper, we will present new software for analysis of IMO data collected from visual observations. The software consists of a package of functions written in the statistical programming language *R*, as well as a *Java* application which uses these functions in a user friendly environment. R code contains various filters for selection of data, methods for calculation of Zenithal Hourly Rate (ZHR), solar longitude, population index and graphical representation of ZHR and distribution of observed magnitudes. The Java application allows everyone to use these functions without any knowledge of *R*. Both *R* code and the *Java* application are open source and free with user manuals and examples provided.

Atmospheric research and meteoric dust detection by all-sky polarization measurements of the twilight sky

Oleg S. Ugolnikov, Igor A. Maslov

The paper describes the results of wide-field polarization measurements of scattered emission in the upper atmosphere during the dark period of twilight. The field of single scattering makes it possible to retrieve the temperature profile of the mesosphere and to estimate the contribution of dust particles. An increase in dust concentration was noticed during the Perseid shower activity period in 2013. The maximum of the dust depolarization effect precedes the visual Perseid maximum but it is in good agreement with the meteor activity index in a nearby location.

April ρ Cygnids

Maria Hajdukova Jr., Regina Rudawska, Leonard Kornos, Juraj Toth

We examined the recently-established April ρ Cygnids meteor shower (ARC, IAU#348), discovered by the Canadian Meteor Orbit Radar survey (CMOR; Brown et al., 2010), and later confirmed by video observations made by the Cameras for Allsky Meteor Surveillance project (CAMS; Phillips et al., 2011). As reported by Neslusan and Hajdukova (2014), the ARC is suspected to be a part of a broader meteor shower complex, possibly associated with the long-period comet C/1917 F1 (Mellish). According to their model, one of the filaments of the meteoroid stream originating from the comet corresponds to the April ρ Cygnids. However, the similarity between the mean characteristics of the predicted and the real showers is not clear. Here, we present a dynamical study of the April ρ Cygnids orbits, extracted from several catalogues, using the Rudawska et al. (2014) identification method. The catalogues used include the EDMOND database (Kornos et al., 2014 a, b) and the SonotaCo shower catalogue (SonotaCo, 2009). The results of the orbital evolution of the comet and orbits of the ARC, including published orbits of the ARC from CMOR and CAMS, are presented. The conclusion as to their common origin is also discussed.

Activity and observability of meteor showers throughout the year

Peter Zimnikoval

Diagrams on the poster present the activity periods of meteor showers as well as the rising and setting times of meteor shower radiants. Plotted are sunrises, sunsets and the period of twilight. It was constructed according to data from the IMO Meteor Shower Working List. More active showers are displayed in red and less active showers in green. The diagrams are calculated for geographic latitudes of 40° N, 0° and 40° S. The time scale is given as local time at the relevant zonal meridian and supplemented by local daylight saving time. The diagrams contain rounded values of solar longitude J2000. The star chart shows the radiant positions and drift of IMO meteor showers while the other diagrams display shower activity and date of maximum.

Observations of Leonids, Draconids, α-Monocerotids, ε-Perseids and meteors of comet C/2012 S1 (ISON)

Alexander Golubaev, Ivan Bryukhanov, Anastasia Tabolich, Valentin Tabolich, Anastasia Kulakovskaya, Dmitry Akulich, Ivan Sergey

Our group presents new results of the "All-Sky Beobachter" astronomical project which is based on previous experience with different wide-field cameras (All-Sky). In this project we search for meteor phenomena in images obtained with All-Sky cameras. As a result coordinates of radiants of active meteor showers are calculated. In this paper we provide the final result for meteors of comet C/2012 S1 (ISON) found in the period from 05 to 27 January, 2014. Also, we present three possible candidates for the radiant of meteors of comet C/2012 S1 (ISON).

Automatic detection of meteors using artificial neural networks

Victor Ștefan Roman, Cătălin Buiu

Automatic meteor detection is an important activity in the field of meteor studies. In recent years, various studies have been made on this topic, underlining the interest for the automatic detection of meteors in radio or video recordings of the sky. In this paper, three novel automatic meteor detection solutions using artificial neural networks are presented. The proposed solutions are trained to analyze radio recordings and extract the meteor samples found within. Two different types of neural networks are tested in this paper, each having its own take on how it detects meteors. Test results report high meteor detection rates on average, of above 70% for all three techniques.

A statistical walk through the IAU MDC database

Željko Andreić, Damir Šegon, Denis Vida

The IAU MDC database is an important tool for the study of meteor showers. Though the history, the amount of data in the database for particular showers, and also their extent, varied significantly. Thus, a systematic check of the current database (as of 1st of June, 2014) was performed, and the results are reported and discussed in this paper. The most obvious one is that the database contains showers for which only basic radiant data are available, showers for which a full set of radiant and orbital data is provided, and showers with data span anywhere in between. As a lot of current work on meteor showers involves D-criteria for orbital similarity, this automatically excludes showers without the orbital data from such work. A test run to compare showers only by their radiant data was performed, and was found to be inadequate in testing for shower similarities. A few inconsistencies and typographic errors were found and are briefly described here.

Update on recent-past and near-future meteor shower outbursts on Earth and on Mars

Jérémie Vaubaillon, Rachel Soja, Lucie Maquet, Auriane Egal, Aswin Sekhar, Pavel Koten, Regina Rudawska, François Colas and Bérénice Reffet

This work presents a brief reflection on the 2014 Camelopardalids and the Mars encounter with comet C/2013 A1 Siding Spring expected in October 2014. These two events were first thought to display an exceptional amount of meteors and later works showed that it would not be the case, at least in optical wavelength. Observation biases and low activity of the comet can explain those differences, but care must be taken when announcing any future meteor shower and close co-operation with other scientists is needed to strengthen the case.

A new meteor detection algorithm for shuttered photography

Berénice Reffet, Jérémie Vaubaillon, François Colas

This paper presents a new meteor detection algorithm used on CCD camera images. We detail some methods used on CCD images but also on other types of images. Then we explain the algorithm which applies image difference and then the Hough transform.

The prediction of meteor showers from all potential parent comets

Luboš Neslušan, Mária Hajduková, Dušan Tomko, Zuzana Kaňuchová and Marián Jakubík

The objectives of this project are to predict new meteor showers associated with as many as possible known periodic comets and to find a generic relationship of some already known showers with these comets. For a potential parent comet, we model a theoretical stream at the moment of its perihelion passage in a far past, and follow its dynamical evolution until the present. Subsequently, we analyze the orbital characteristics of the parts of the stream that approach the Earth's orbit. Modelled orbits of the stream particles are compared with the orbits of actual photographic, video, and radar meteors from several catalogues. The whole procedure is repeated for several past perihelion passages of the parent comet. To keep our description compact but detailed, we usually present only either a single or a few parent comets with their associated showers in one paper. Here, an overview of the results from the modelling of the meteor-shower complexes of more than ten parent bodies will be presented. This enables their diversities to be shown. Some parent bodies may associate meteor showers which exhibit a symmetry of their radiant areas with respect to the ecliptic (ecliptical, toroidal, or showers of an ecliptic-toroidal structure), and there are showers which have no counterpart with a similar ecliptical longitude on the opposite hemisphere. However, symmetry of the radiant areas of the pair filaments with respect to the Earth's apex is visible in almost all the complexes which we examined.

The Interplanetary Meteoroid Environment for eXploration – (IMEX) project

Rachel H. Soja, Maximilian Sommer, Julian Herzog, Ralf Srama, Eberhard Grün, Jens Rodmann, Peter Strub, Jérémie Vaubaillon, Andreas Hornig, Lars Bausch

The 'Interplanetary Meteoroid Environment for eXploration' (IMEX) project, funded by the European Space Agency (ESA), aims to characterize dust trails and streams produced by comets in the inner solar system. We are therefore developing a meteoroid stream model that consists of a large database of cometary streams from all known comets in the inner solar system. This model will be able to predict meteor showers from most known comets, that can be observed anywhere in the inner solar system, at any time 1980–2080. This is relevant for investigating meteor showers on the Earth, on other planets, or at spacecraft locations. Such assessment of the dust impact hazard to spacecraft is particularly important in the context of human exploration of the solar system.

Meteor observations from double station in Morocco

Meryem Guennoun, Zouhair Benkhaldoun, Jérémie Vaubaillon

We present here a summary description of two first stations dedicated to build the first meteor network in Morocco and the whole African continent. Optimizing the direction of the cameras, in order to conduct permanent meteor observations from double stations, is one of our main goals.

Don Quixote – a possible parent body of a meteor shower

Regina Rudawska, Jérémie Vaubaillon

Here we are interested in whether the meteoroid stream of (3552) Don Quixote can generate some observed meteor showers. We have showed that particles originating from Don Quixote particles produce two meteor showers at Earth: κ Lyrids and August μ Draconids.

Meteorite-producing fragment on the orbit of Apophis

Alexandra Terentjeva, Elena Bakanas

A meteorite-producing object moving along an orbit almost coinciding with that of the Apophis asteroid (99942) was found. The object may be a fragment of Apophis. It is shown that the orbit of Apophis has approaches to the Earth's orbit (up to the indicated limit of $\rho \leq 0.20$ AU) within a long time interval.

A new approach to meteor orbit determination

Vasily Dmitriev, Valery Lupovka, Maria Gritsevich

It is known that orbits of meteoroids colliding with the Earth are exposed to significant perturbations prior to impact, primarily under the influence of gravity and atmospheric drag at the end of the trajectory. Standard methods of pre-impact meteor orbit computation (Ceplecha, 1987) are traditionally based on a set of static corrections applied to the observed velocity vector, see e.g. (Andreev, 1991). In particular, the popular concept of so-called "zenith attraction" is used to correct the direction of the meteoroid trajectory and its apparent velocity in the Earth's gravitational field. In this work we carry out explicit trajectory integrations of meteoroids with the aim of investigating the magnitude of errors involved by choosing the mentioned simplifications.

IMO Fireball Reports

Mike Hankey, Vincent Perlerin

In 2013, the American Meteor Society (AMS) offered use of its online fireball report to the International Meteor Organization. The AMS and IMO agreed to extend the capabilities and reach of the application worldwide by enhancing the form to support a multi-lingual user interface.

First meteorite recovery based on observations by the Finnish Fireball Network

Maria Gritsevich, Esko Lyytinen, Jarmo Moilanen, Tomáš Kohout, Vasily Dmitriev, Valery Lupovka, Steinar Midtskogen, Nikolai Kruglikov, Alexei Ischenko, Grigory Yakovlev, Victor Grokhovsky, Jakub Haloda, Patricie Halodova, Jouni Peltoniemi, Asko Aikkila, Aki Taavitsainen, Jani Lauanne, Marko Pekkola, Pekka Kokko, Panu Lahtinen, Mikhail Larionov

We present a summary of the trajectory reconstruction, dark flight simulations and pre-impact orbit for a bright fireball that appeared in the night sky over the Kola Peninsula, close to the Finnish border, on April 18 2014, at $22^{h}14^{m}13.0^{s}$ (UTC). The fireball was instrumentally recorded in Finland from Kuusamo, Mikkeli and Muhos observing sites belonging to the Finnish Fireball Network. Additionally, a publicly available video made by Alexandr Nesterov in Snezhnogorsk (Russia), from the opposite side of the fireball track, was carefully calibrated and taken into account in the trajectory reconstruction. Based on a thorough analysis of the fireball, it was concluded that part of the meteoroid survived atmospheric entry and reached the ground. To further specify an impact area for a dedicated expedition, dark flight simulations were done to build a strewn field map showing the most probable distribution of fragments. A 5-day expedition with 4 participants from Russia and Finland took place at the end of May following snow melt and preceding vegetation growth. On May 29, 2014, a first 120.35 g meteorite fragment was found on a local forest road within the predicted impact area. A second 47.54 g meteorite fragment, fully covered with a fusion crust, was recovered nearby on the following day. Both pieces were preserved in very good condition without apparent weathering.

Early education opportunities in metoritics

Chris Peterson

Cloudbait Observatory and the Denver Museum of Nature and Science have been operating an allsky camera network in Colorado since 2001. Most of the cameras are hosted at middle schools (ages 12–14) and high schools (ages 15–18), with some notable exceptions targeting even younger students. In addition to generating a rich collection of scientific data, this program has been very successful at introducing students to "real science", where relevant data is collected and analyzed, and the opportunity for new discovery and even publication is present. I will discuss our experience with exploring meteoritics with pre-college age students and the value to both our science program and to early science education.

Tighert: A new eucrite meteorite fall from Morocco

Abderrahmane Ibhi

The fall of the Tighert meteorite took place in the night of 9 July 2014 at $22^{h}30^{m}$. The bolide traveled from North-West to South-East and experienced several fragmentation events along its atmospheric trajectory. Eyewitnesses in several localities of the Guelmim-Es-Semara (Tata, Tirhert, Foum El Hisn, Douar Imougadir, Taghjijt, Assa, etc.) saw the bolide and heard audible detonations a few minutes later. Immediately after the fireball event the authorities of the area organized a field search to check for possible security problems. Detailed mineralogical and petrological examination of the meteorite have revealed that it is comparable to an eucrite "magmatic" meteorite that comes from the asteroid belt, exactly Vesta-4.

Meteor Terminology poster translated into different languages

Vincent Perlerin, Mike Hankey

The American Meteor Society (AMS) has created an educational poster that defines the major terms of the meteor terminology. This poster is an educational tool made available for free on the AMS website. We offer this poster to be translated and shared among the IMO members.

The Košice meteoroid investigation: from trajectory data to analytic model

Daria Kuznetsova, Maria Gritsevich, Vladimir Vinnikov

Impact rate estimates for the upper atmosphere are significantly higher than for the Earth's surface due to the presence of the atmosphere. Thus to account for this properly, one needs to model drag and ablation processes along the atmospheric trajectory (e.g. Bland and Artemieva, 2003). The best way to validate the resulting model is to apply it to meteorite-producing fireballs with a complete observational record. We consider the recent meteorite fall – Košice (2010). In this investigation, we propose a special model based on the analytical solution of the drag and mass-loss equations (Gritsevich, 2009; Gritsevich et al., 2012). Using the available trajectory data (Borovička et al., 2013), two key dimensionless parameters (the ballistic coefficient and mass loss parameter) are obtained which allow us to describe the mass and velocity changes of the main fragment of the meteoroid entering the atmosphere, as well as to estimate the pre-atmospheric meteoroid mass. Good agreement between the calculated functions and real trajectory characteristics is shown. We also apply statistical methods to describe the fragmentation process and provide insights into the pre-atmospheric meteoroid shape (Vinnikov et al., 2014). Furthermore, the most probable scenario suggests that the Košice meteoroid, prior to further extensive fragmentation in the lower atmosphere, consisted of two independent pieces with cumulative residual masses of approximately 2 kg and 9 kg respectively (Gritsevich et al., 2014a). The conducted analysis leads to the conclusion that two to three larger Košice fragments of 500–1000 g each should exist in addition to the already reported meteorite finds.

Detection of spectral UV from meteors by a nanosatellite

Nicolas Rambaux, Dimitri Galayko, Jean-François Mariscal, Michel-Andres Breton, Jérémie Vaubaillon, Mirel Birlan, François Colas and Thierry Fouchet

Here, we present a cubesat space mission concept devoted to the UV detection of meteors from space. Space observations have the advantages of being able to continuously observe meteors independently of weather conditions on large portions of the atmosphere and, specifically, to perform ultra-violet light measurement as it is above the ozone layer. The UV spectrum is interesting for the detection of chemicals such as iron, carbon and hydroxide that can yield a signature of elements present during the solar system's formation.

Radio set-up design for the FRIPON project

Jean-Louis Rault, François Colas, Jérémie Vaubaillon

The French FRIPON (Fireball Recovery and InterPlanetary Observation Network) project consists of about 100 allsky cameras which are currently being installed at various locations in France. The purpose of FRIPON is to detect large meteors thanks to optical systems, to compute the orbits of their parent bodies, and to predict as precisely as possible the impact locations of the related meteorites, if any. Video cameras deliver accurate target positions but lack the precision required for accurate meteor velocity measurements, a precision which is mandatory for good meteoroid orbits and meteorite location assessments. Therefore 25 radio systems, which are in charge to deliver accurate meteor velocities data, are being installed to complement the FRIPON video network.

EARS, MARS combined radio observations – 2014

Giancarlo Tomezzoli

The Lyrid meteor shower was generated on 21–22 April 2014 by the passage of the Earth through the path of the debris of the comet C/1861 G1 (Thatcher). The Camelopardalids meteor shower was generated on 23–24 May 2014 by the passage of the Earth through the path of the debris of the comet 209P/Linear. The EurAstro Radio Station (EARS) and the Malta Astro Radio Station (MARS) were operated in parallel for two combined radio observation campaigns. The campaigns revealed that further combined radio observation campaigns are necessary to solve the problem of estimating the number of lost radio meteor echoes.

The Global Radio Camelopardalids 2014

Christian Steyaert

The on-line hourly radio counts are analyzed for the presence of the predicted May 24 Camelopardalids. Selection criteria are developed and an averaging method is proposed. Meteor activity is indeed detected during the predicted period. The method works for short duration outbursts and almost stationary radiants.

Automatic detection of meteors in the BRAMS data

Stijn Calders, Hervé Lamy

BRAMS is a Belgian network consisting of one beacon and 26 receiving stations to detect radio meteors by forward scattering. Because of the large amount of data generated by these stations, a good automatic detection algorithm is needed. In this paper, four algorithms currently under test are briefly described. Application of three of them to an example of BRAMS data is shown with a comparison to manual count in order to emphasize the advantages and disadvantages of each method.

Meteor detection for BRAMS using only the time signal

Tom Roelandts

Approaches for meteor detection in the BRAMS project often start from a spectrogram, since that is the default view of the received signal. In this paper, we argue that it is better to use the original time signal for detection. We define an indicator signal that consists of the ratio of received energy in a short time interval that is the length of a typical underdense meteor, and a longer time interval that represents the background signal. A simple threshold can then be used to detect underdense meteors, also in the presence of the carrier and reflections on planes.

Modeling and calibration of BRAMS antenna systems

Antonio Martínez Picar, Sylvain Ranvier, Michel Anciaux, Hervé Lamy

Because of the geometry associated with the forward-scatter method for observing meteors via radio, knowing the radiation pattern of the involved antennas is essential to obtain parameters of scientific interest such as the meteoroid flux density. In this paper results of simulations of the antennas belonging to the Belgian RAdio Meteor Stations network (BRAMS) that are directly managed by the Belgian Institute for Space Aeronomy (BISA) are presented, as well as plans for verifying their patterns using an Unmanned Aerial Vehicle (UAV).

Report on radio observation of meteors (Iža, Slovakia)

Peter Dolinský, Ivan Dorotovič, Marian Vidovenec

During the period from 1 to 17 August 2014 meteors were experimentally registered using radio waves. This experiment was conducted in the village of Iža, Slovakia. Its main objective was to test the technical equipment intended for continuous registration of meteor echoes, which will be located in the Slovak Central Observatory in Hurbanovo. These tests are an indirect continuation of previous experiments of observation of meteor showers using the technology available in Hurbanovo at the end of the 20th and the beginning of the 21st century. The device consists of two independent receiver systems. One recorded echoes of the transmitter Graves 143.050 MHz (N47.3480° E5.5151°, France) and the second one recorded echoes of the TV transmitter Lviv 49.739583 MHz (N49.8480° E24.0369°, Ukraine). The apparatus for tracking radio echoes of the transmitter Graves consists of a 9-element Yagi antenna with vertical polarization (oriented with an elevation of 0° at azimuth 270°), the receiver Yaesu VR-5000 in CW mode, and a computer with registration using the program HROFFT v1.0.0f. The second apparatus recording the echoes of the transmitter Lviv consists of a LP (log-periodic) antenna with horizontal polarization (elevation of 0° and azimuth of 90°), the receiver ICOM R-75 in the CW mode, and also a computer with registration using HROFFT v1.0.0f. A total of about 78000 echoes have been registered during around 700 hours of registration. Probably not all of them are caused by meteors. These data were statistically processed and compared with visual observations in the IMO database. Planned own visual observations could not be performed due to unfavourable weather conditions lasting from 4 to 13 August 2014. The registered data suggest that observations were performed in the back-scatter mode in this configuration and not in the planned forward-scatter mode. Deeper analysis and longer data sets are, however, necessary to calibrate the observation system and this will be subject of our future work. A realization of a custom radio system similar to the BRAMS system is also being considered.

RETRAM: recognition and trajectories of meteors

Jean-Jacques Maintoux, Sylvain Azarian, Jérémy Maintoux, Frédéric Rible

Meteor detection and tracking is the main activity of the RETRAM group, part of the French ARRL organization. Our project uses passive radar techniques and real-time processing to detect and recognize falling objects and tries to estimate their trajectory to help in fireball recovery. The experiment started in the vicinity of Paris, France. This paper shows our observations and analyses, then it describes our technical approach, our first passive radar station and first meteor 3D localization. Finally, we describe the evolution of the system and subsequently its extension in the form of a network of stations grouping radio and optical detectors.

25 years since IMO's Founding General Assembly

Paul Roggemans

In 2014 we remembered the Founding General Assembly of the International Meteor Organization which took place 25 years ago, on Saturday 7 October 1989 at Balatonföldvár in Hungary.

Meteor science

A possible new shower on Eridanus-Orion border

Damir Šegon[1,2], *Peter Gural*[3], *Željko Andreić*[4], *Denis Vida*[5,6], *Ivica Skokić*[7], *Filip Novoselnik*[5,8], *and Luciano Gržinić*[1,9]

Three showers on the border between constelations of Eridanus and Orion were found during extensive search for new showers in SonotaCo and CMN video meteor orbit databases. Our results suggest that two of them represent ν Eridanids shower (337 NUE), while third one represents possible new shower which has been named π^6 Orionids (552 PSO).

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1 Introduction

During the spring of 2013, members of Croatian Meteor Network (CMN) did an extensive, automatic D-criterion based search through SonotaCo and CMN video meteor orbit databases covering years 2009–2011 (SonotaCo 2007–2013; SonotaCo 2009; Šegon et al., 2012; Korlević et al., 2013), explained in detail in Šegon et al. (2014). Every single meteoroid orbit was compared to all other meteoroid orbits from the database, containing more than 133 thousand orbits. In cases when there were more than 10 meteoroid orbits satisfying all three D-criteria used (Southworth & Hawkins, 1963; Drummond, 1981; Jopek, 1993), their arithmetic mean orbital parameters were used to start iterative search through the database, in order to establish if there is an stable, unchanged set of meteoroid orbits. This search found a high percentage of known showers, but also quite a large number of possible new meteor showers. A very interesting case of three, at glance very similar meteor radiant groups, at the border of constellations of Eridanus and Orion, deserved more detailed analysis, which we provide here.

2 ν Eridanids

The ν Eridanids shower has been discovered by SonotaCo, as presented in his first article on SonotaCo Network (SonotaCo, 2009). In his search SonotaCo used clustering method, which pointed out existence of a meteor shower with 29 members, at the mean radiant position of RA = $68\overset{\circ}{.}7$, Dec = $1\overset{\circ}{.}1$, active from $\lambda_\odot = 156\overset{\circ}{.}8$ to $\lambda_\odot = 174\overset{\circ}{.}5$, with the mean geocentric velocity of 65.9 km/s. The daily motion of the radiant was found to be dRA = $+0\overset{\circ}{.}14$ and dDec = $-0\overset{\circ}{.}13$. It shows unusually small motion in RA, which at low declination is typically about 1° for well known showers. Matching between known showers and possible new meteor showers has been done in two ways: (i) by calculating D-criterion for showers with known mean orbital parameters, or (ii) by matching new shower's mean radiant positions with that of known showers recalculated for the mean solar longitude. Moreover, detailed plots were made in order to visually inspect known showers with radiants in the vicinity of the new ones. According to results and after visual check of respective plots, three possible showers (CMN internal group designations #1223, #1685 and #1738) were found very close to ν Eridanids shower. Since SonotaCo has not published data on orbital parameters for ν Eridanids, we had to rely only on mean solar longitude, RA and Dec to compare for shower's similarity.

The difference in radiant position between group #1738 and ν Eridanids is only $0\overset{\circ}{.}4$, for the mean solar longitude of $167\overset{\circ}{.}9$. Data on mean radiant position and activity are summarized in the Table 1.

Apart from the radiant positions, activity period and v_g also match very well, which is expected since part of the searched dataset contains data used in SonotaCo's search as well (but not only them!). The number of meteors in SonotaCo dataset is 29, and the one in our complete dataset is 89, meaning that we found additional 60 NUE meteors in the combined dataset. However, it is very interesting that the radiant drift found by our search (mainly in RA) significantly differs from the one originally found by SonotaCo. Despite this discrepancy, probably caused by larger number of meteors, we may conclude that CMN #1738 indeed represents the already known shower 337 NUE. Mean orbital parameters for IAU shower 337 ν Eridanids as found by CMN search based on 89 meteoroid orbits are summarized in the Table 2.

Once we had the mean orbital parameters for 337 NUE, it was possible to check the status of the two remaining groups of meteors.

As can be seen from Figure 1 (second plot), a possible new shower #1223 seems to be close to 337 NUE, so we calculated D-criteria values for this combination

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Table 1 – Comparison of basic data for the ν Eridanids (337 NUE) as derived by SonotaCo and CMN group #1738.

Source	$\lambda_\odot+$	$\lambda_\odot-$	$\lambda_\odot$	RA	Dec	dRA	dDec	v_g
SonotaCo	156°.8	174°.5	167°.9	68°.7	+1°.1	+0°.14	−0°.13	65.9 km/s
CMN #1738	157°.0	179°.1	168°.6	69°.0	+0°.8	+0°.70	+0°.18	66.2 km/s

Table 2 – Orbital elements of the ν Eridanids as derived by the CMN.

Shower	q	e	i	Ω	ω
337 NUE	0.909 AU	0.922	142°.7	348°.6	36°.8

of mean orbits. The obtained values ($D_{SH}/2 = 0.073$, $D_H/2 = 0.070$ and $D_D = 0.052$) suggest that group #1223 may be a part of same shower, 337 NUE.

Figure 2 shows the radiant positions color coded by solar longitude. Circles represent the possible new shower #1685, while upwards and downwards oriented triangles representing 337 NUE related groups (#1223 and #1738, respectively). Clear overlap can be seen between two 337 NUE related (triangles) groups, containing same meteors in that part of their activity. Despite those facts we think that more detailed analysis should be done in order to confirm group #1223 is a part of 337 NUE. However, since this is not the goal of this paper, it will be presented in separate one.

3 π^6 Orionids (522 PSO)

All the relevant data found about three groups are summarized in the Table 3.

The comparison of the D-criteria of the third group, #1685, to the two NUE ones suggest that it is different from them. For group #1738 vs. #1685 we have $D_{SH}/2 = 0.248$, $D_H/2 = 0.245$ and $D_D = 0.164$ while for group #1223 vs. #1685 we have $D_{SH}/2 = 0.200$, $D_H/2 = 0.199$ and $D_D = 0.131$. Different radiant positions for possible new showers also show different trend in daily motion of the radiant, #1685 having about two times smaller declination drift compared to the 337 NUE.

If we compare orbital parameters of all three groups (from Table 3), we can see that they are very similar regarding inclination and longitude of the ascending node, that there are some differences in perihelion distance and eccentricity but most obvious difference can be seen in argument of perihelion.

Figure 3 shows the same three groups, with longitude of ascending node of individual meteors on x-axis, perihelion distance on y-axis, and eccentricity color-coded. There is no obvious difference in trends for the two 337 NUE groups (upwards and downwards oriented triangles, #1223 and #1738), while the trend for the group #1685 if obviously a different one. It can also be seen that those two sets of data are not overlapping at all. Moreover, there's significant difference in perihelion distances spreads for two datasets, group #1685 having less spread than two 337 NUE groups.

Figure 4 shows argument of perihelion plotted on x-axis, longitude of ascending note plotted on y-axis, color coded by perihelion distance for all three groups.

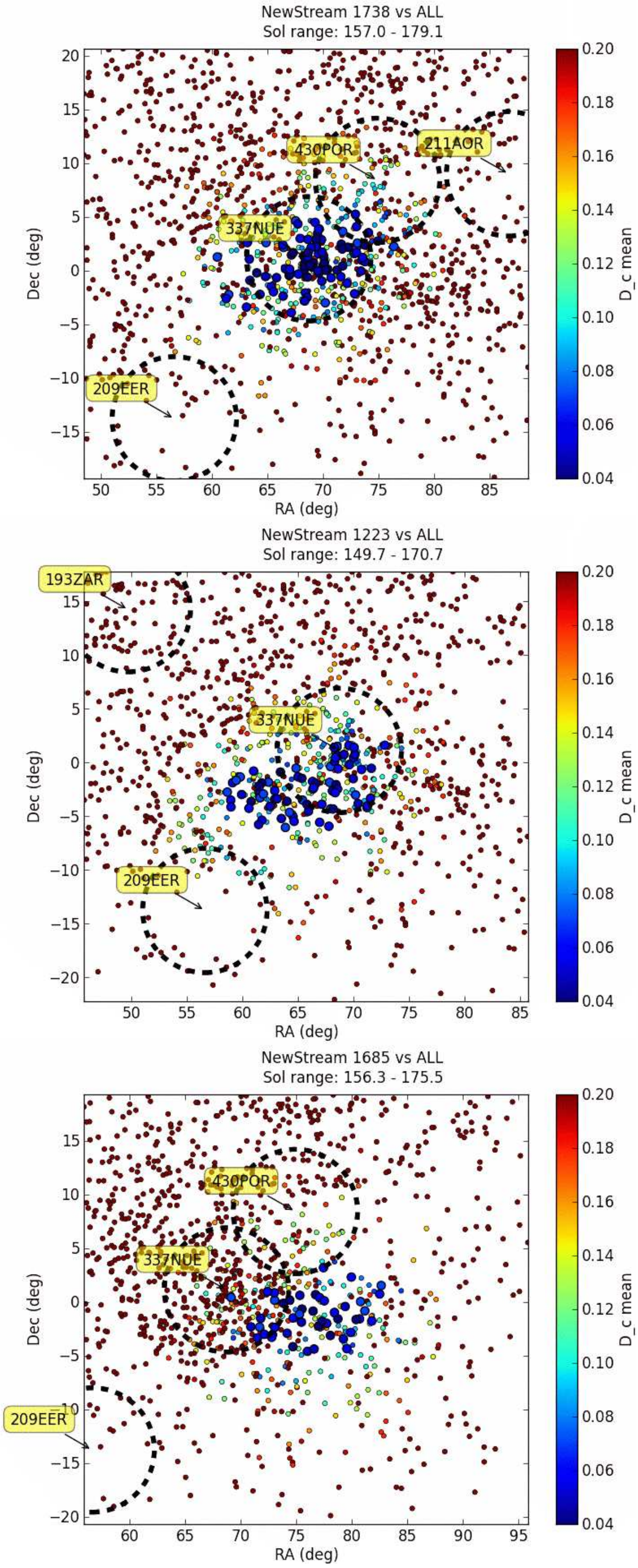

Figure 1 – Radiant plots of the three CMN groups discussed in the article. The mean value of D-criteria is color coded.

Table 3 – Comparison of all available data for the three CMN groups.

CMN#	N	$\lambda_\odot-$ [°]	$\lambda_\odot+$ [°]	$\lambda_\odot$ [°]	RA [°]	Dec [°]	dRA [°]	dDec [°]	v_g [km/s]	q [AU]	e	i [°]	Ω [°]	ω [°]
1738	89	157.0	179.1	168.6	69.0	+0.8	+0.70	+0.18	66.2	0.909	0.922	142.7	348.6	36.8
1223	71	149.7	170.7	161.2	65.7	−2.4	+0.65	+0.17	65.7	0.959	0.910	138.9	341.2	25.6
1685	46	156.3	175.5	166.3	76.3	−1.3	+0.64	+0.09	66.5	1.003	0.944	139.0	346.3	5.1

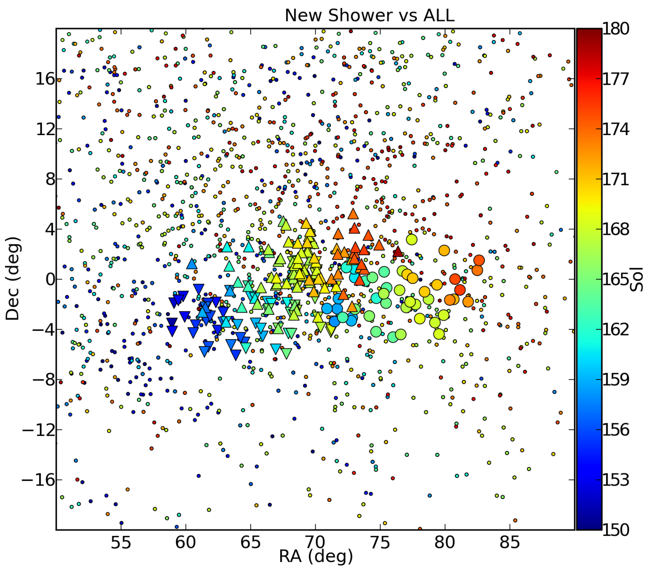

Figure 2 – Radiant plot of the three CMN groups. The solar longitude is color coded.

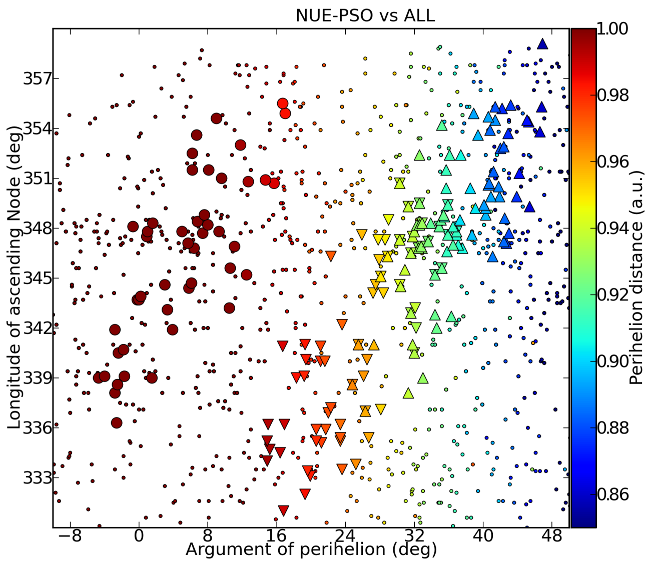

Figure 4 – Argument of perihelion versus longitude of ascending node, with perihelion distance color coded, for individual meteors from all three groups.

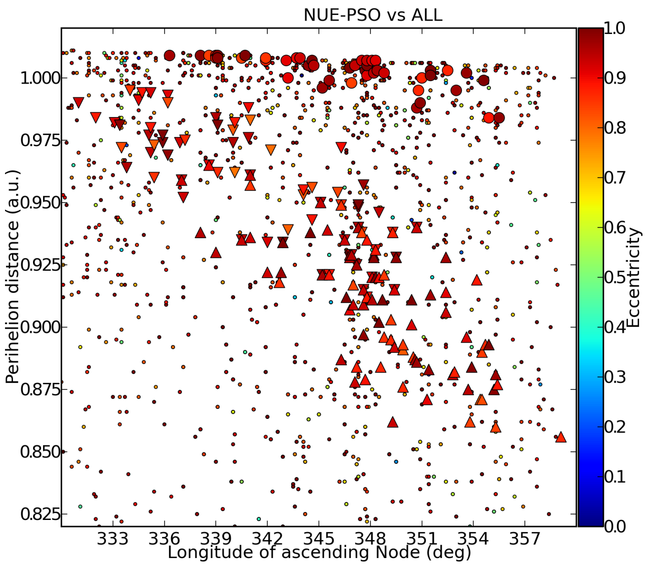

Figure 3 – Longitude of ascending node versus perihelion distance, with eccentricity color coded, for individual meteors from all three groups.

In this case, the difference between 337 NUE (#1738 and #1223) and #1685 is obvious again.

We thus conclude that CMN group #1685 is a possible new shower. These data were sent to IAU, and this new shower was named π^6 Orionids (552 PSO). The 552 PSO shower is found to be active from August 29 to September 18, having maximal activity on September 10. Search for possible parent body was tried, but none of known NEOs has been found to match either 337 NUE or 552 PSO.

4 Conclusions

Based on analysis done on three possible meteor showers found by CMN automated search, the existence of one new shower was found. This shower is put on the IAU MDC working list of showers with the name and designation π^6 Orionids (552 PSO). One of remaining meteor showers found represents 337 NUE, while detailed analysis based on more observations should be done for the third one.

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Observation of April alpha Capricornids (IAU#752 AAC)

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A short duration outburst of 15 meteors was observed over 2 hours 34 minutes on 2014 April 7 from $16^{h}59^{m}$ to $19^{h}33^{m}$ UT by SonotaCo Network in Japan. Radiants of the 15 meteors were in the range of RA = $304^{\circ}\!\!.5 \pm 3^{\circ}\!\!.3$, Dec = $-12^{\circ}\!\!.7 \pm 1^{\circ}\!\!.1$, with $v_g = 69.1 \pm 0.9$ km/s at $\lambda_{\odot} = 16^{\circ}\!\!.65 \pm 0^{\circ}\!\!.6$. The orbit parameters of the brightest shower meteor with the least amount of observation uncertainty was RA = $303^{\circ}\!\!.80 \pm 0^{\circ}\!\!.04$, Dec = $-12^{\circ}\!\!.80 \pm 0^{\circ}\!\!.03$, $v_g = 69.4 \pm 0.2$ km/s, $1/a = 0.004 \pm 0.017$ 1/AU, $q = 0.80 \pm 0.01$ AU, $e = 0.9968 \pm 0.014$, $\omega = 126^{\circ}\!\!.5 \pm 0^{\circ}\!\!.5$, $\Omega = 17^{\circ}\!\!.63$, $i = 167^{\circ}\!\!.3 \pm 0^{\circ}\!\!.1$. There are no known nearby shower radiants so the IAU MDC assigned the name of this new shower as the April alpha Capricornids (IAU#752 AAC).

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1 Introduction

SonotaCo Network began video meteor observations in 2003. After 4 years of experiments, continuous video observations using 50 to 60 hi-sensitivity video cameras with standard or narrow FOV lens at about 20 stations in Japan began in 2007. It has used the same setup and scale for nightly observations over 7 years up to now. It records 160 000 to 180 000 single station meteors per year and 19 000 to 27 000 multi-station simultaneous observation orbits per year. The resulting data sets are published annually on the internet as "SonotaCo Network Simultaneously Observed Meteor Data Sets (SNM20xx)" (SonotaCo, 2014a). This data base has been used for a variety meteor science purposes by multiple researchers around the world. The discovery of more than 30 new meteor showers from it have been reported (SonotaCo, 2009; Greaves, 2012; Šegon et al., 2013; Andreić et al., 2013). Continuous observation enables the recording of un-expected events such as bolides or new meteor shower. The observation of short time concentrated outburst from unknown radiant is especially important because it suggests the possible existence of an unknown hazardous comet (Jenniskens et al., 2011).

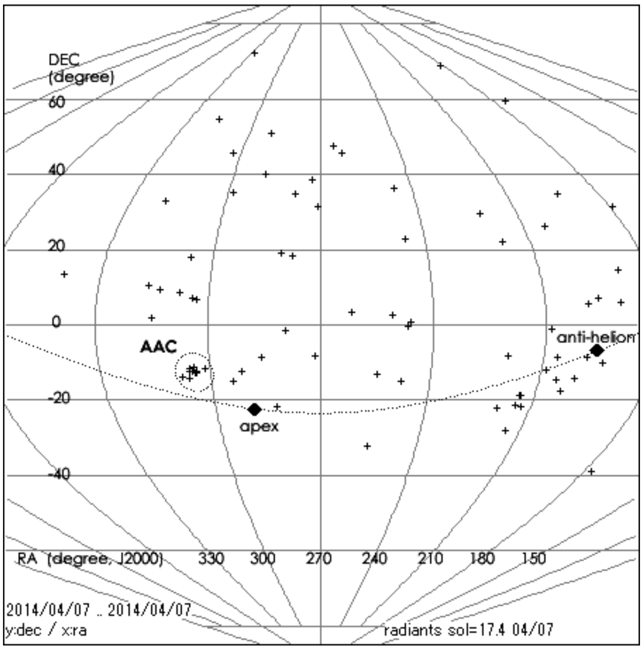

Figure 1 – 15 shower meteors relative to all 79 meteors observed on 2014 April 7.

2 Observation

On the night of 2014 April 7 UT, the Moon age was 7.3 days and the Moon had set 2 hours before the outburst. The network cameras were working as usual. 19 stations had clear sky and 53 cameras captured 357 single station meteors during the night. 79 orbits at $\lambda_{\odot}$ range of $17^{\circ}\!\!.33$ to $17^{\circ}\!\!.72$ were reduced from it. As is shown in Figure 1, a radiant of 15 meteors of the 79 total meteors was concentrated in a compact area of RA = $304^{\circ}\!\!.5 \pm 3^{\circ}\!\!.3$, Dec = $-12^{\circ}\!\!.7 \pm 1^{\circ}\!\!.1$. Also the geocentric velocity of the 15 meteors was in the range

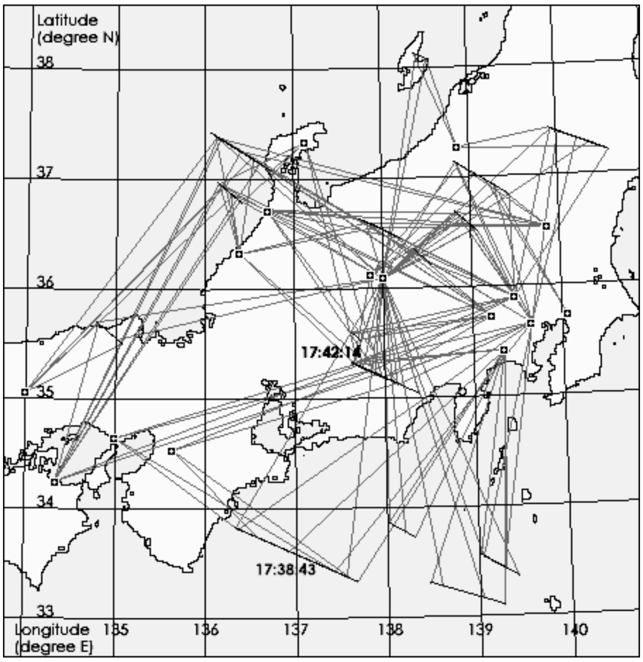

Figure 2 – Geometric relation between the 15 shower meteors and stations.

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Table 1 – Stations and observers that records AAC meteors. Nc: number of cameras on the station, Nm: number of meteors recorded on 2014 April 7, Nca: number of cameras that recorded AAC meteors, Nma: number of recorded AAC meteors.

Station	Observer	Nc	Nm	Nca	Nma
Nagano1	T. Masuzawa	8	68	7	18
Tokyo1	SonotaCo	8	25	5	9
Saitama1	Takashi Sekiguchi	4	34	2	7
Kagawa1	Sanbonmatsu High School	2	15	2	5
Kanagawa1	Hiroyuki Inoue	4	23	2	5
Tokyo6	Naoya Saito	1	12	1	5
Ishikawa5	Kazuhiko Yoneguchi	2	9	2	4
Tochigi1	Hidechika Ito	1	7	1	4
Ishikawa1	Hideaki Muroishi	1	10	1	3
Ishikawa2	Hiroshi Yamakawa	4	16	1	3
Nagano4	Chikara Shimoda	1	7	1	3
Okayama1	Junichi Yokomichi	1	8	1	3
Hyogo3	Yasuo Shiba	1	4	1	2
Niigata2	Toshio Kamimura	3	4	2	2
Osaka3	Masayoshi Ueda	4	10	1	2
Chiba3	Shinsuke Abe	1	7	1	1

of 69.1 ± 0.9 km/s. There was no known shower radiant around there. It was very clear that this is a new shower originating from the same body.

IAU MDC assigned the name of this shower as April alpha Capricornids (IAU#752 AAC). The AAC 15 meteors were observed by 31 cameras at 16 stations. Figure 2 shows the geometric relation among stations and the meteors, and Table 1 shows the observers at the stations. The average number of simultaneous observations per meteor was 5.1. The meteor observed by the most cameras occurred at $17^h42^m14^s$ UT. It was recorded by 15 cameras simultaneously.

3 Shower duration

All shower meteors occurred in the period of 16^h59^m to 19^h33 UT, corresponding to $\lambda_\odot$ 17°.60 to 17°.70. It had a duration of 2 hours 34 minutes. The Sun rise time for Tokyo on that day was 20^h10^m UT so the end time of the shower can be hours later. On the previous and following nights, SonotaCo Network recorded 128 orbits from 2014 April 4 to 6 UT and 160 orbits from 2014 April 8 to 10 UT, but there are no similar orbits. During the past 7 years, there are two similar orbits in the 168 000 orbits on SNM2007-2013. But those two were in different year and no concentration was confirmed. Also, P. Jenniskens reports in CBET 3853 that no candidate shower members were detected in 2011–2012 by the California All-sky Meteor Surveillance project (Sato & Jenniskens, 2014).

From these, this outburst can be thought as the crossing of a very young and narrow dust tube such as a one-revolution dust trail of a long-period comet.

4 Orbit and uncertainty

A newly developed experimental program, which computes the orbit parameter and its uncertainty, was used for these shower meteors. It propagates the observation uncertainty to orbit parameter uncertainty using Monte Carlo simulation method. In the process, one thousand trials were done on each single station observation pole computation and another one thousand trials were done on the unified radiant and orbital parameter computation. Finally, the standard deviation among one thousand results was computed. Figure 3 and Table 2 show its result. The source uncertainty value is the direction measurement residual computed using reference stars on each event and the trajectory linearity error computed in the least square method of observation plane determination. Though, the precise evaluation of this method should be done in the near future, it successfully computed the uncertainty of the radiant of the AAC shower from the measured observation uncertainty.

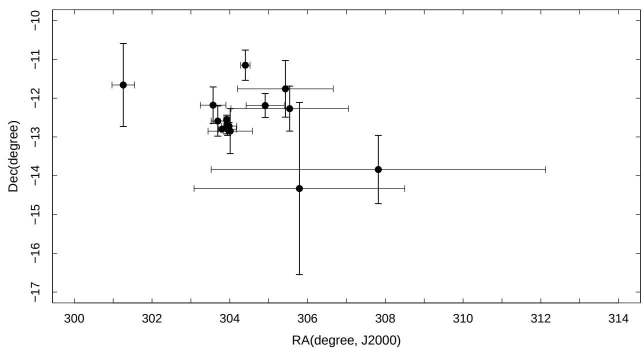

Figure 3 – AAC 15 meteor radiants with uncertainty.

As is shown in the Table 2, uncertainty differs very much among the meteors. It is because dominant factors, such as number of observed frames, distance between station and the meteor, number of observed cameras, and the observation cross angle, are quite different for each meteor. So taking a simple mean or median might not be appropriate for those. On the contrary, it means, there can be some very accurate results for meteors with very good observation conditions.

Hence, we would like to point out the orbit of the $17^h38^m43^s$ UT meteor as the most accurate data to be recorded. It is RA = 303°.80 ± 0°.04, Dec = −12°.80 ± 0°.03, at $\lambda_\odot$ = 17°.629, $v_g = 69.4 \pm 0.2$ km/s, $1/a = 0.004 \pm 0.017$ /AU, $q = 0.80 \pm 0.01$ AU, $e = 0.9968 \pm 0.014$, ω = 126°.5 ± 0°.5, Ω = 17°.629, i = 167°.3 ± 0°.1. This orbit is obtained from the brightest and longest meteor in the shower. Its absolute magnitude was −3.5, duration time was 1.8 second, trajectory length 128.3 km and it was observed by 5 cameras simultaneously. Its period was computed as 4014 years. Though the orbit parameters of this meteor have very little uncertainty, the velocity was very close to the escape velocity of Solar system so the period can be any value in the range of several hundred years to infinite. The orbit parameter shows that it is a retrograde orbit and the meteor body collides with the Earth almost one month after its perihelion passage. It can be periodic or non-periodic either.

Table 2 – AAC meteor orbit parameters, Ncam: number of simultaneous observation, Nstar: number of reference starts, Qc: Simultaneous observation cross angle.

Time (UT)	$\lambda_\odot$ (°)	RA (°)	Dec (°)	V_g (km/s)	$1/a$ (1/AU)	q (AU)	e	ω (°)	Ω (°)	i (°)	$A_{\rm mag}$	Dur (s)	H_1 (km)	H_2 (km)	L (km)	Ncam	Nstar	Qc (°)
$16^h59^m06^s$	17.602	305.43 ± 1.23	-11.76 ± 0.73	68.4 ± 1.3	0.044 ± 0.121	0.75 ± 0.03	0.9673 ± 0.0900	119.3 ± 4.9	17.60	165.7 ± 1.4	−1.3	1.1	112.6	104.6	80.0	2	72	4.6
$17^h16^m40^s$	17.614	304.40 ± 0.12	-11.15 ± 0.39	69.7 ± 0.8	-0.066 ± 0.076	0.79 ± 0.01	1.0520 ± 0.0600	125.7 ± 2.1	17.61	164.5 ± 0.7	−0.8	0.9	113.2	102.2	64.7	4	87	37.5
$17^h38^m43^s$	17.629	303.80 ± 0.04	-12.80 ± 0.03	69.4 ± 0.2	0.004 ± 0.017	0.80 ± 0.00	0.9968 ± 0.0137	126.5 ± 0.5	17.63	167.3 ± 0.1	−3.5	1.8	118.0	90.7	128.3	5	64	40.9
$17^h39^m25^s$	17.629	301.26 ± 0.29	-11.66 ± 1.07	67.3 ± 1.2	0.226 ± 0.108	0.82 ± 0.02	0.8138 ± 0.0858	127.3 ± 4.3	17.63	164.2 ± 2.0	−0.2	0.2	100.0	96.1	15.8	2	68	32.2
$17^h42^m14^s$	17.631	303.98 ± 0.20	-12.72 ± 0.09	69.1 ± 1.8	0.029 ± 0.165	0.79 ± 0.02	0.9769 ± 0.1295	125.2 ± 5.3	17.63	167.2 ± 0.3	−1.7	0.5	107.6	99.1	38.1	15	46	83.8
$17^h47^m48^s$	17.635	303.57 ± 0.33	-12.18 ± 0.47	68.5 ± 0.6	0.080 ± 0.057	0.79 ± 0.01	0.9366 ± 0.0447	124.7 ± 2.0	17.63	166.0 ± 0.9	−0.6	0.7	114.4	102.5	48.7	6	51	74.8
$18^h12^m13^s$	17.652	303.69 ± 0.17	-12.59 ± 0.39	69.5 ± 0.1	-0.008 ± 0.013	0.80 ± 0.00	1.0066 ± 0.0104	127.2 ± 0.5	17.65	166.9 ± 0.7	−1.9	1.0	119.6	98.0	68.1	6	93	54.4
$18^h16^m01^s$	17.654	304.91 ± 0.49	-12.19 ± 0.31	68.3 ± 1.0	0.075 ± 0.088	0.76 ± 0.02	0.9429 ± 0.0661	120.4 ± 3.2	17.65	166.3 ± 0.6	−2.7	0.7	115.7	100.1	44.7	3	66	13.3
$18^h18^m33^s$	17.656	305.54 ± 1.51	-12.27 ± 0.58	68.9 ± 0.7	0.010 ± 0.078	0.76 ± 0.03	0.9924 ± 0.0587	120.5 ± 4.4	17.65	166.8 ± 1.2	−0.5	0.5	113.2	102.2	33.0	2	74	11.3
$18^h25^m45^s$	17.661	303.92 ± 0.07	-12.55 ± 0.11	69.0 ± 0.5	0.038 ± 0.048	0.79 ± 0.01	0.9699 ± 0.0377	125.1 ± 1.5	17.66	166.8 ± 0.2	−2.3	0.9	117.6	97.6	62.7	9	52	87.8
$19^h02^m49^s$	17.686	304.01 ± 0.57	-12.85 ± 0.58	69.5 ± 0.8	-0.009 ± 0.075	0.80 ± 0.01	1.0073 ± 0.0598	126.5 ± 2.5	17.68	167.5 ± 1.1	−1.5	0.5	115.0	99.9	34.3	9	69	81.4
$19^h04^m45^s$	17.687	303.94 ± 0.23	-12.80 ± 0.16	68.8 ± 0.1	0.054 ± 0.013	0.79 ± 0.01	0.9571 ± 0.0099	124.8 ± 0.7	17.69	167.3 ± 0.3	−1.3	0.5	112.8	98.5	34.1	6	59	88.5
$19^h09^m20^s$	17.690	305.79 ± 2.71	-14.33 ± 2.22	70.0 ± 0.4	-0.077 ± 0.076	0.77 ± 0.06	1.0592 ± 0.0536	123.6 ± 6.8	17.69	170.8 ± 4.1	−0.1	0.3	111.4	101.3	23.9	2	93	38.2
$19^h12^m24^s$	17.693	303.91 ± 0.06	-12.75 ± 0.17	69.0 ± 0.7	0.037 ± 0.066	0.79 ± 0.01	0.9709 ± 0.0523	125.4 ± 2.0	17.69	167.2 ± 0.3	−2.2	0.5	114.5	98.1	37.4	3	73	78.5
$19^h33^m01^s$	17.707	307.82 ± 4.30	-13.84 ± 0.88	69.2 ± 0.4	-0.051 ± 0.117	0.72 ± 0.09	1.0363 ± 0.0735	116.2 ± 10.4	17.70	170.5 ± 2.4	+0.1	0.2	111.6	105.6	13.0	2	33	6.4

5 Discovery and report process

On the SonotaCo Network, nightly captured data was stored at each station individually. Typically it is analyzed the next morning and sent to the data hub of the SonotaCo Network after manual checks by the observers. The AAC outburst from 16^h59^m to 19^h33^m UT on 2014 April 7 corresponds to 1^h59^m to 4^h33^m April 8 local time in Japan. Before 8^h03^m LT, that night's data from 3 stations were uploaded to the hub by each observer (Chikara Shimoda, Hiroyuki Inoue, and SonotaCo). Inoue added a short comment "There were many meteors coming from east". SonotaCo also added a comment "Bright meteors appeared beyond my expectation for Japanese spring". Shimoda read these comments and ran the orbit computation program UFOOrbitV2 on those 3 station's data. There he discovered a sharp concentration of 5 meteors. At 8^h27^m LT Shimoda posted a new topic to the SonotaCo Network forum for discussion of this event with the title "Emerging fast meteor shower outburst from south of Aquila 20140408". That was 6 hours after the beginning of the shower. SonotaCo did the confirmation of this discovery by comparing with the latest IAU MDC data and at 10^h51^m LT SonotaCo issued a brief report of this discovery as "Possible new shower Report" to 10 relevant people, including IMO and MDC, by e-mail. Because it was already daytime in Japan, succeeding observations in other countries were expected, but did not happen. Roman Piffl of EDMOND reported in a personal mail with SonotaCo "we are looking for data from that night, in Central Europe was bad weather, but in UK was clear night, but UK is already very west". By April 10, all Japanese station data concerning this shower was uploaded to the hub and the 15 shower meteors were reduced from it. There was a station that is operated by T. Masuzawa, recorded 18 clips of 14 meteors of this shower by 7 cameras on one station. It contributed to the overall accuracy a lot. SonotaCo issued an update of the report on April 10. IAU MDC assigned the new shower name on April 11 and IAU CBET 3853 was issued on April 12.

In the prompt report, SonotaCo used code "1uky" as the short name of this shower. This code is named "Universal 4D meteor Shower Code"(U4SC). As is shown in the reference (SonotaCo, 2014b), it represents the shower peak position in the four dimensional space of [$\lambda_\odot$, RA, Dec, V_g]. It is 4 digits of 36 notation character [0-9a-z]. Each digit corresponding [$\lambda_\odot$: 0–360°, 10 g step], [RA: 0–360°, 10° step], [Dec: +90–−90°, 5° step], [Vg: 0–72 km/s, 2 km/s step]. So "1uky" means $\lambda_\odot = 15° \pm 5°$, RA $= 305° \pm 5°$, Dec $= -12\overset{\circ}{.}5 \pm 2\overset{\circ}{.}5$, $v_g = 69 \pm 1$ km/s. Originally, U4SC was invented for automated clustered showers by SonotaCo, but it universally points out most of the showers without ambiguity. It is useful for these reportings before an IAU name decision.

Table 3 – Distribution of one-revolution dust trail.

Approaching Time			R*
Year, Date	Time (UT)	$\lambda_\odot$ (°)	(AU)
1980, April 7	01^h	17.6	+0.0010
1990, April 7	13^h	17.6	+0.0011
2004, April 7	05^h	17.7	−0.0006
2014, April 7	18^h	17.6	0.0000
2025, April 7	13^h	17.6	−0.0019
2032, April 7	12^h	17.8	+0.0015
2039, April 7	05^h	17.7	−0.0008
2049, April 7	17^h	17.6	−0.0010

*R: The distance at plane of the ecliptic between dust trail and the Earth orbit.

6 Discussion

6.1 Dust Trail

In the case of a short period outburst like this shower, it was often brought about from the crossing of a one-revolution dust trail from a long-period comet. For example, the Aurigids (IAU #206, AUR) originated from parent body C/1911 N1 (Kiess). The outbursts of Aurigids occurred in 1935, 1986, 1994 and 2007, these are explained by approaching the one-revolution dust trail from C/1911 N1 (Lyytinen & Jenniskens, 2003; Jenniskens & Vaubaillon, 2007).

Moreover, the outbursts were explained by a dust trail from an undiscovered comet whose orbit is assumed to long-period comet like alpha Monocerotids (IAU #246, AMO) (Lyytinen & Jenniskens, 2003). Actually, it was shown that some meteors of AAC obtained by this observation have long period, they are over hundreds of years. Hence, we tried to investigate the distribution of a one-revolution dust trail from an undiscovered parent by assuming a long-period orbit. The assumed orbit of the parent was determine by integrating back in time from the orbit of the meteor which appeared on 2014 April 7 at $17^h38^m43^s$ UT. As a result of taking into account perturbations, it was assumed that its perihelion passage that priduced the one-revolution trail happened in −720 (721 BC).

Table 3 shows results for the approaching time and distance on the plane of the ecliptic between the dust trail and the Earth orbit. The possibility of observed meteors from this shower in 1980, 1990 and 2004 is shown in the past. However, observed meteors were not found. In the future, a possibility of appearance in 2025, 2032, 2039 and 2049 is shown. If outbursts are observed in these years, the cause of this meteor shower will become clear.

6.2 Candidate Parent Body

Roman Piffl reported in a personal mail to SonotaCo that "We have Jakub Algol Koukal and Mikhail Maslov's calculations that shows the link between the new shower and comet C/1917 H1 (Schaumasse)". The orbit of this comet was calculated as parabolic, however, it could be assumed to be a long-period orbit. Hence, we investigate the orbit at the time of perihelion in 1917 from the orbit with perihelion in −720. Table 4 shows a result of this simulation. The orbital element simulated from −720 was comparatively similar to the value of C/1917 H1. However, these two orbits were not linked completely. For example, the value of the ascending node is different about 7 degrees. It means that the appearance day of meteor shower differs for about seven days. Therefore, from this method, it was not able to conclude that the parent body was C/1917 H1. It will be necessary to study the parent of this new shower in more detail.

7 Conclusions

A new meteor shower was discovered and accurate orbits were obtained. It has a very compact radiant area and short time duration. The shower meteors were in retrograde orbits and collided with the Earth a month after their perihelion passage. Their geocentric velocity was very close to the escape velocity of Solar system and the period can be several hundred years to infinite. An encounter of a one-revolution dust trail of a long-period comet is most likely. There is currently no known probable parent body candidate. It means we should prepare for the encounter of an unknown object with a similar orbit.

Acknowledgements

The continuous observation of the SonotaCo Network is entering its 8th year. Though it nearly exceeds the standard life time of hardware components, systems are maintained by individual observers and have kept their overall sensitivity and accuracy. The constancy and continuity reduces the biases of optical observation and makes possible the determination of diffuse or minor shower. We have great respect for those pocket budget scientists who observe every night and publish the results. Also, we appreciate the researchers who use our observation results and produce scientific publications, listed in this reference. Scientific results are the most precious reward for non-professional observers, the progress encourage them a lot.

As for AAC confirmation, we are very grateful to Roman Piffl of EDMOND and Sirko Molau of IMO who responded quickly to our prompt report. We also acknowledge the effort of Tadeusz Jopek of MDC and Peter Jenniskens of SETI Institute, who assigns the IAU code and handled this discovery rapidly and properly.

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Table 4 – Orbital elements simulated from −720 and C/1917 H1.

Data	Time of Perihelion Passage	q (AU)	e	ω (°)	Ω (°)	i (°)
Simulation (from −720)	1917 May 18.7	0.82	0.99	125.93	17.53	167.54
C/1917 H1 (Schaumasse)*	1917 May 18.7103	0.76	1	119.16	10.84	158.74

* : JPL Small-body Database Browser

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Results of CMN 2013 search for new showers across CMN and SonotaCo databases III

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This is the third paper (out of three) of a report series presenting the results on the discovery of new meteoroid streams across a variety of video meteor data bases. The search method used compared each meteor to all others in the same data base that was constructed by combining Croatian Meteor Network databases for 2007 to 2010 and SonotaCo databases for 2007 to 2011. The last set of 24 possible new showers is described in this article.

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1 Introduction

The background and processing procedures are described in the first article in this series (Andreić et al., 2014). The second set of new showers is described in (Gural et al., 2014). The last set of 24 possible new showers is presented here. The file with all individual orbits of the new showers can be found at the CMN download page:
`http://cmn.rgn.hr/downloads/downloads.html`

The orbital elements of showers discussed in this article are summarized in Table 1. Members of all showers discussed here were also detected through analysis of the IMO single station observation data base.

The radiant plots are grouped together to save space. As in the previous two papers, the value of generic D-criterion is coded in gray scale (color-coded in the electronic edition). Radiants that belong to the new shower are indicated by larger circles.

2 Descriptions of new showers

2.1 72 Ophiuchids (599 POS)

18 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.5. The radiant plot does not reveal any structure. Active from March 30 to April 11, the mean corresponding to April 5.

2.2 43 Aurigids (600 FAU)

18 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.5 orbits per day. The radiant plot does not reveal any structure apart from the effects of daily motion. Active from October 17 to 30, the mean corresponding to October 23.

Several radiants are active nearby at roughly the same solar longitudes: 23 EGE, 228 OLY, 229 NAU, 425 PSA, 511 FLY and 537 KAU. However, the most similar one, 229 NAU, differs by D_{SH} of 0.87, too much to be considered related to 600 FAU. There are no orbital elements for 425 PSA, but at the mean solar longitude of 425 PSA radiants are more than 20° away, so clearly it is a different shower.

2.3 ι Craterids (601 ICT)

31 meteors spread over 21 days are associated with this shower. The number of orbits per day is about 1.5. The radiant plot is heavily stretched by daily motion. Active from December 24 to January 13, the mean corresponding to January 2.

About 7° to the north is the radiant of 540 TCR. However, the two showers differ by D_{SH} of 0.29 too much for them to be considered identical, but also low enough to indicate some kind of relation between them can exist. Together with the fact that the 602 KCR has its radiant at exactly the same place as 601 ICT (see discussion in the next subsection) these three showers are an interesting object for further studies.

2.4 κ Craterids (602 KCR)

21 meteors spread over 15 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is heavily stretched by daily motion. Active from January 5 to 20, the mean corresponding to January 12.

About 7° to the north is the radiant of 540 TCR. However, the two showers differ by D_{SH} of 0.47, too much for them to be considered identical. Also, 601 ICT apparently has its radiant at exactly the same place as 602 KCR. But, by recalculating the position of 601 ICT for the mean solar longitude of 602 KCR, we see that the radiants are actually separated by more than 10°. This, together with a D_{SH} of 0.44 between their mean orbits, makes it clear that we deal with two separate showers. However, similarities in radiant data and orbital elements do exist, so they are probably related to each other in some way. To confirm (or not) this relation, more elaborate further studies are required.

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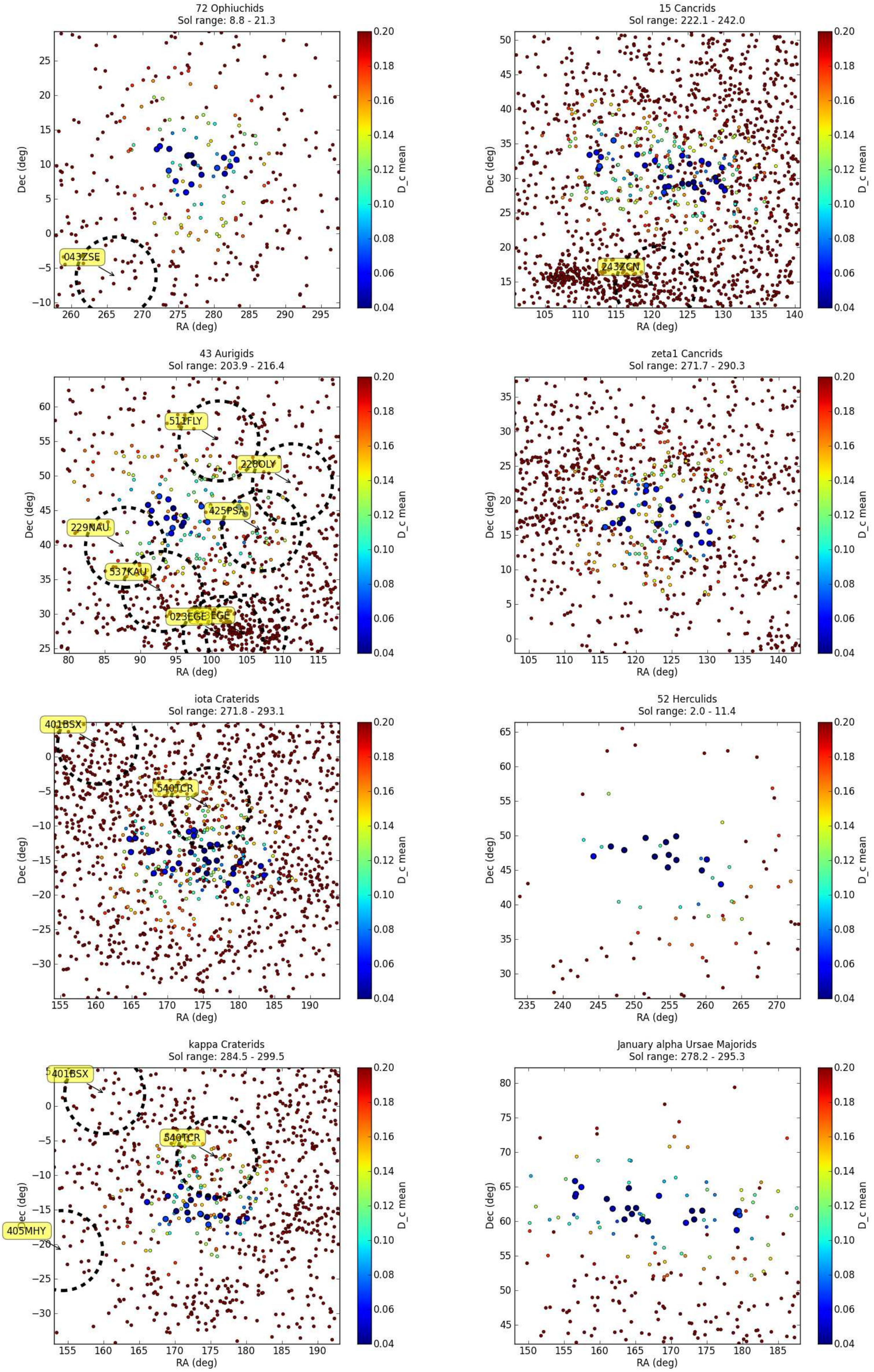

Figure 1 – Radiant plots of showers 599 POS to 606 JAU.

2.5 15 Cancrids (603 FCR)

29 meteors spread over 20 days are associated with this shower. The number of orbits per day is about 1.5. The radiant plot is stretched by daily motion. Active from November 5 to 24, the mean corresponding to November 16.

2.6 ζ^1 Cancrids (604 ACZ)

26 meteors spread over 18 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is stretched by daily motion. Active from December 24 to January 11, the mean corresponding to January 2.

Two NEAs are candidates for a possible parent body, 2011 YX_{62} with a D_{SH} of 0.09 and 2012 TO_{139} with a D_{SH} of 0.13. However, recent numerical modeling by Vaubaillon (personal communication, 2014) ruled out the possibility that 2011 YX_{62} is the parent body for this shower.

2.7 52 Herculids (605 FHR)

13 meteors spread over 9 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from March 23 to April 1, the mean corresponding to March 28.

2.8 January α Ursae Majorids (606 JAU)

23 meteors spread over 17 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from December 30 to January 14, the mean corresponding to January 7.

2.9 12 Bootids (607 TBO)

20 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is compact, without noticeable effects of daily motion. Active from January 12 to 27, the mean corresponding to January 18.

2.10 14 Aurigids (608 FAR)

20 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. Active from September 28 to October 12, the mean corresponding to October 7.

2.11 37 Comae Berenicids (609 BOT)

20 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from January 3 to 17, the mean corresponding to January 10.

2.12 68 Geminids (610 SGM)

20 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from December 8 to 23, the mean corresponding to December 15.

This shower has a very small perihelion distance of only 0.083 AU, and with aphelion of 4.4 AU comes near Jupiter's orbit, making it interesting for dynamical studies. Several radiants are active nearby at roughly the same solar longitudes: 16 HYD, 19 MON, 253 CMI and 397 NGM. All except 253 CMI have very different orbital elements. Concerning 253 CMI, there are no orbital elements in the IAU MDC, nor the reference to its description. Based on the scarce data available, the radiants at the same $\lambda_\odot$ are separated by about 10°, and geocentric velocities differ by only 0.7 km/s. This may indicate some connection between them, but without more data about 253 CMI no further conclusions can be drawn.

2.13 4 Canum Venaticids (611 VCF)

17 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is stretched by daily motion. Active from December 15 to 27, the mean corresponding to December 22.

2.14 19 Canum Venaticids (612 NCA)

17 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.4. Active from November 30 to December 12, the mean corresponding to December 6.

2.15 31 Lyncids (613 TLY)

17 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is stretched by daily motion. Active from October 10 to 22, the mean corresponding to October 15.

Two known radiants are active nearby: 228 OLY ($D_{SH} = 0.73$) and 480 TCA ($D_{SH} = 0.51$), but their orbits are different enough to exclude possible connections.

2.16 January ω Serpentids (614 JOS)

17 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is compact. Active from January 21 to February 2, the mean corresponding to January 28.

2.17 35 Comae Berenicids (615 TOR)

21 meteors spread over 15 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is heavily stretched by daily motion. Active from January 6 to 18, the mean corresponding to January 12.

About 6° to the South is the radiant of 90 JCO. The orbital elements of 90 JCO are incomplete, so it is not possible to calculate the D_{SH}. However, there is a large difference in perihelion distances of about 0.23 AU, so we do not consider them connected. More, the known parameters of 90 JCO are deduced from only 3 meteor orbits, making them highly uncertain.

615 TOR apparently has its radiant at exactly the same place as 616 TOB. But, by recalculating the posi-

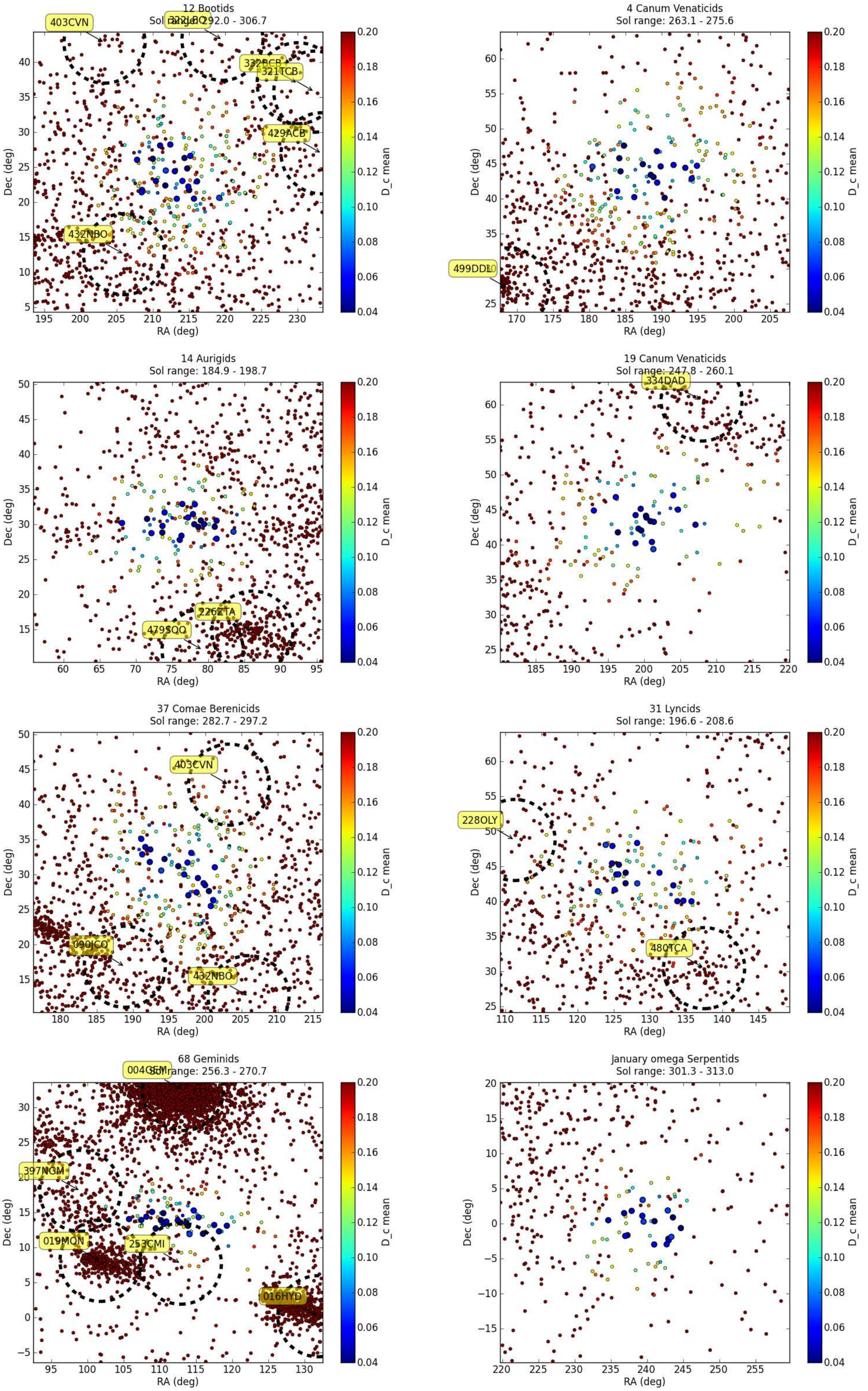

Figure 2 – Radiant plots of showers 607 TBO to 614 JOS.

tion of the 615 TOR for the mean $\lambda_\odot$ of 616 TOB, we find that the radiants are actually separated by about 5°. The D_{SH} of their mean orbits is 0.32, enough to support the conclusion that we deal with two different showers. However, similarities in radiant data and orbital elements do exist, so they are probably related to each other in some way. To confirm (or not) this relation, more elaborate further studies are required.

Another radiant nearby is 432 NBO, with D_{SH} = 0.47.

2.18 23 Comae Berenicids (616 TOB)

15 meteors spread over 11 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is stretched by daily motion. Active from January 14 to 25, the mean corresponding to January 20.

Apart from the radiant of 615 TOR, that is already discussed in the previous section, about 6° to the south is the radiant of 90 JCO. The orbital elements of 90 JCO are incomplete, so it is not possible to calculate the D_{SH}. The known parameters of 90 JCO are similar to 616 TOB, but they are deduced from only 3 meteor orbits, making more concrete conclusions impossible.

Another radiant nearby is 432 NBO, with D_{SH} = 0.71.

2.19 ι Ursae Majorids (617 IUM)

18 meteors spread over 13 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is stretched by daily motion. Active from November 2 to 15, the mean corresponding to November 9.

About 15° away is the radiant of 445 KUM, for which only radiant position and v_g are known, and these data differ enough for them to be different showers.

2.20 12 Hydrids (618 THD)

11 meteors spread over 8 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is quite compact. Active from November 21 to 29, the mean corresponding to November 26.

A possible parent body, with $D_{SH} = 0.20$, is comet C/1943 W1 (van Gent-Peltier-Daimaca).

About 7° away is the radiant of 245 NHD, a shower with a D_{SH} of 0.27 indicating that some link can exist between it and 618 THD. Interestingly, the same comet is quoted as a possible parent body. A little farther is the radiant of 340 TPY, another shower without any orbital data published, but based on radiant position and v_g, it is quite different from 618 THD.

2.21 7 Leonis Minorids (619 SLM)

20 meteors spread over 15 days are associated with this shower. The number of orbits per day is about 1.3. The radiant plot is visibly stretched by daily motion. Active from December 5 to 20, the mean corresponding to December 12.

2.22 σ Bootids (620 SBO)

16 meteors spread over 12 days are associated with this shower. The number of orbits per day is about 1.3. The radiant plot is stretched by daily motion. Active from January 22 to February 2, the mean corresponding to January 28.

2.23 73 Ursae Majorids (621 SUA)

19 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from January 19 to February 2, the mean corresponding to January 27.

2.24 ϕ Ursae Majorids (622 PUA)

19 meteors spread over 14 days are associated with this shower. The number of orbits per day is about 1.4. The radiant plot is strongly stretched by daily motion. Active from November 21 to December 4, the mean corresponding to November 28.

About 6° away is the radiant of 527 UUM, a shower with a D_{SH} of 0.27 indicating that some link can exist between it and 622 PUA. A little farther are another three radiants (437 NLY, 440 NLM and 494 DEL), but D_{SH} for all three is very large.

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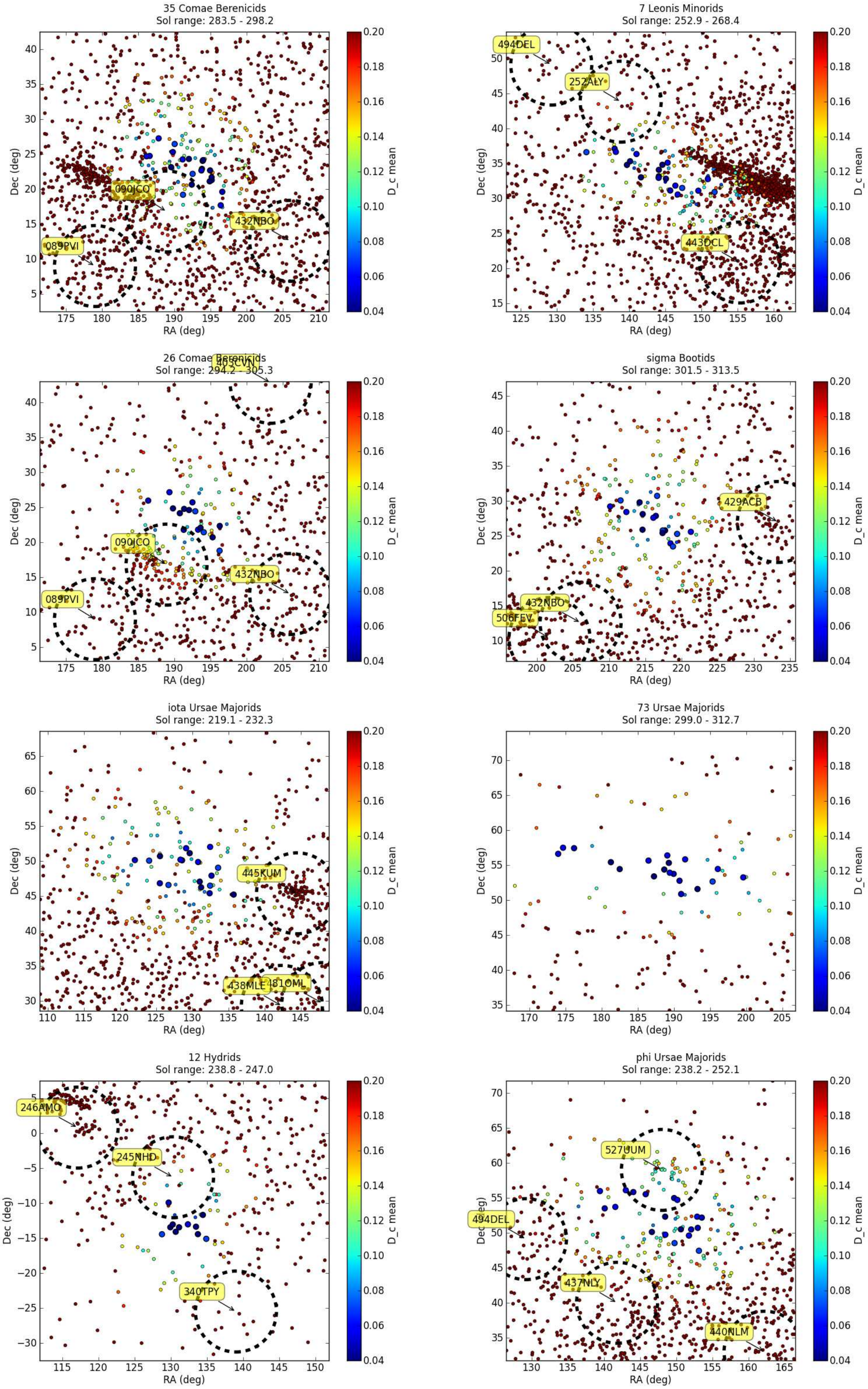

Figure 3 – Radiant plots of showers 615 TOR to 622 PUA.

Table 1 – Mean orbits of the new showers. ID and name are the IAU identification and name of the shower, $\lambda_\odot$ the solar longitude range, $\overline{\lambda_\odot}$ average solar longitude, RA and DEC coordinates of the mean radiant, dRA and dDEC daily motion of the radiant in RA and DEC, v_g is geocentric velocity, q perihelion distance, e eccentricity, ω argument of perihelion, Ω longitude of ascending node, i inclination and N is the number of known orbits. The error values are standard deviations of the corresponding value. In the case of RA and DEC there is a contribution of the daily motion to the dispersion of the radiants. All angular values are given in degrees, and v_g is in km/s.

ID	Name	$\lambda_\odot$	$\overline{\lambda_\odot}$	RA	DEC	dRA	dDEC	v_g	q	e	ω	Ω	i	N
599 POS	72 Ophiuchids	9– 21	15	277.5 ± 3	10.0 ± 1.9	0.79	−0.04	62.3 ± 1.0	0.982 ± 0.008	0.897 ± 0.050	195.4 ± 4	15.2 ± 4	122.9 ± 3.1	18
600 FAU	43 Aurigids	204–216	209	96.0 ± 4	44.2 ± 1.4	0.97	0.08	63.0 ± 1.1	0.615 ± 0.034	0.934 ± 0.065	257.9 ± 4	209.2 ± 3	136.3 ± 3.5	18
601 ICT	ι Craterids	272–293	282	173.7 ± 5	-14.6 ± 2.2	0.88	−0.23	67.5 ± 0.8	0.864 ± 0.019	0.824 ± 0.039	42.9 ± 4	101.9 ± 6	151.0 ± 3.9	31
602 KCR	κ Craterids	285–299	292	173.4 ± 3	-14.8 ± 1.5	0.83	−0.20	65.8 ± 1.1	0.640 ± 0.032	0.927 ± 0.050	74.1 ± 4	112.2 ± 4	146.9 ± 3.1	21
603 FCR	15 Cancrids	222–242	233	122.4 ± 6	30.8 ± 2.1	0.96	−0.23	65.4 ± 0.7	0.531 ± 0.035	0.944 ± 0.037	267.4 ± 4	233.1 ± 6	156.9 ± 3.7	29
604 ACZ	ζ^1 Cancrids	272–290	282	123.2 ± 5	16.9 ± 1.8	0.88	−0.16	33.8 ± 1.2	0.206 ± 0.014	0.899 ± 0.018	132.1 ± 3	101.7 ± 5	5.2 ± 2.9	21
605 FHR	52 Herculids	2– 11	7	253.9 ± 5	47.1 ± 1.9	1.51	−0.31	39.2 ± 1.4	0.958 ± 0.014	0.978 ± 0.030	203.1 ± 4	7.2 ± 3	62.8 ± 3.0	13
606 JAU	January α													
	Ursae Majorids	278–295	286	167.9 ± 8	61.9 ± 1.8	1.41	−0.31	38.8 ± 1.1	0.700 ± 0.028	0.898 ± 0.039	246.9 ± 3	286.1 ± 5	59.2 ± 2.4	23
607 TBO	12 Bootids	292–307	298	212.9 ± 3	23.8 ± 2.4	0.64	−0.37	61.7 ± 1.2	0.962 ± 0.009	0.852 ± 0.053	197.6 ± 4	297.6 ± 4	120.0 ± 3.6	20
608 FAR	14 Aurigids	185–199	194	76.8 ± 4	30.1 ± 1.4	0.90	−0.03	65.0 ± 0.7	0.511 ± 0.038	0.938 ± 0.046	270.6 ± 4	193.9 ± 4	164.0 ± 3.0	20
609 BOT	37 Comae Berenicids	283–297	290	196.8 ± 3	30.4 ± 2.7	0.69	−0.46	60.9 ± 1.1	0.842 ± 0.023	0.923 ± 0.049	225.4 ± 4	289.8 ± 5	117.2 ± 2.9	20
610 SGM	68 Geminids	256–271	263	112.5 ± 4	13.6 ± 0.9	0.84	−0.08	40.7 ± 2.2	0.083 ± 0.005	0.963 ± 0.016	150.2 ± 2	83.0 ± 4	28.0 ± 3.4	20
611 VCF	4 Canum Venacitids	263–276	270	188.3 ± 4	43.9 ± 2.0	1.07	−0.16	56.2 ± 1.2	0.919 ± 0.009	0.838 ± 0.047	211.1 ± 2	269.6 ± 3	104.6 ± 3.6	17
612 NCA	19 Canum Venacitids	248–260	254	200.1 ± 3	43.3 ± 2.1	0.69	−0.32	53.3 ± 1.1	0.945 ± 0.012	0.785 ± 0.045	155.4 ± 4	254.1 ± 3	98.0 ± 3.3	17
613 TLY	31 Lyncids	197–209	202	128.0 ± 4	43.7 ± 2.6	0.83	−0.38	64.0 ± 0.9	0.958 ± 0.019	0.718 ± 0.047	155.7 ± 6	202.0 ± 4	137.1 ± 3.8	17
614 JOS	January ω Serpentids	301–313	308	240.4 ± 3	-0.3 ± 1.9	0.74	−0.19	65.6 ± 0.8	0.718 ± 0.029	0.939 ± 0.050	116.1 ± 4	308.3 ± 4	141.1 ± 3.2	17
615 TOR	35 Comae Berenicids	283–298	292	192.3 ± 3	22.9 ± 2.3	0.64	−0.40	63.6 ± 0.8	0.741 ± 0.029	0.924 ± 0.047	240.8 ± 4	292.2 ± 4	130.2 ± 3.0	21
616 TOB	26 Comae Berenicids	294–305	300	192.3 ± 3	23.4 ± 2.2	0.61	−0.49	61.2 ± 0.6	0.592 ± 0.033	0.950 ± 0.048	259.6 ± 4	299.7 ± 4	123.7 ± 2.4	15
617 IUM	ι Ursae Majorids	219–232	226	129.6 ± 4	48.7 ± 2.2	0.92	−0.29	62.2 ± 1.1	0.811 ± 0.025	0.895 ± 0.054	231.9 ± 4	226.5 ± 3	125.5 ± 3.5	18
618 THD	12 Hydrids	239–247	243	131.8 ± 2	-13.3 ± 1.4	0.64	−0.15	64.1 ± 0.7	0.870 ± 0.023	0.991 ± 0.046	40.2 ± 4	63.2 ± 3	126.3 ± 2.2	11
619 SLM	7 Leonis Minorids	253–268	260	143.9 ± 4	33.6 ± 2.1	1.09	−0.46	60.4 ± 1.1	0.363 ± 0.020	0.965 ± 0.040	286.7 ± 3	259.5 ± 4	132.1 ± 3.1	20
620 SBO	σ Bootids	302–314	308	216.0 ± 3	27.1 ± 2.1	0.80	−0.52	58.6 ± 1.2	0.892 ± 0.017	0.881 ± 0.064	216.8 ± 3	308.3 ± 3	110.6 ± 2.6	16
621 SUA	73 Ursae Majorids	299–313	307	187.7 ± 7	54.5 ± 1.8	1.42	−0.32	38.9 ± 1.3	0.716 ± 0.027	0.916 ± 0.050	244.6 ± 4	306.9 ± 4	58.9 ± 2.7	19
622 PUA	ϕ Ursae Majorids	238–252	246	148.1 ± 4	52.3 ± 2.6	1.01	−0.47	57.2 ± 1.1	0.743 ± 0.026	0.921 ± 0.041	240.9 ± 4	245.9 ± 4	108.1 ± 3.4	19

Preliminary results

Results of the IMO Video Meteor Network — July 2014

Sirko Molau[1], *Javor Kac*[2], *Stefano Crivello*[3], *Enrico Stomeo*[4], *Geert Barentsen*[5], *Rui Goncalves*[6], *Antal Igaz*[7], *Carlos Saraiva*[8], *Maciej Maciewski*[9], *and Mikhail Maslov*[10]

The 2014 July results are presented for the IMO Video Meteor Network observations, based on more than 30 000 meteors recorded in over 6 700 observing hours by 77 cameras. The flux density and population index profiles are presented for the α-Capricornids and Southern δ-Aquariids, based on data between 2011–2014.

Received 2014 November 20

1 Introduction

The weather continued to remain cooperative to observers in July. A short glimpse at Figure 1 shows that there are hardly any big "holes" in the monthly statistics, i.e. that there were continuously good observing conditions. This is also reflected by the fact, that more than 2/3 of the 77 cameras were active on twenty or more observing nights. With 69 active cameras, July 3/4 was the best night.

Despite the good conditions, the total number of meteors detected in 2014 was only comparable to that of July 2012, clearly falling short of the totals of 2013. The total of more than 6 700 observing hours is 15% less than in July 2013, and the overall number of meteors detected is reduced by the same percentage to 30 000 (Table 1 and Figure 1).

With the α-Capricornids and Southern δ-Aquariids, July offers two well-known meteor showers that peak at the end of the month. We will look at them in more detail in the following sections.

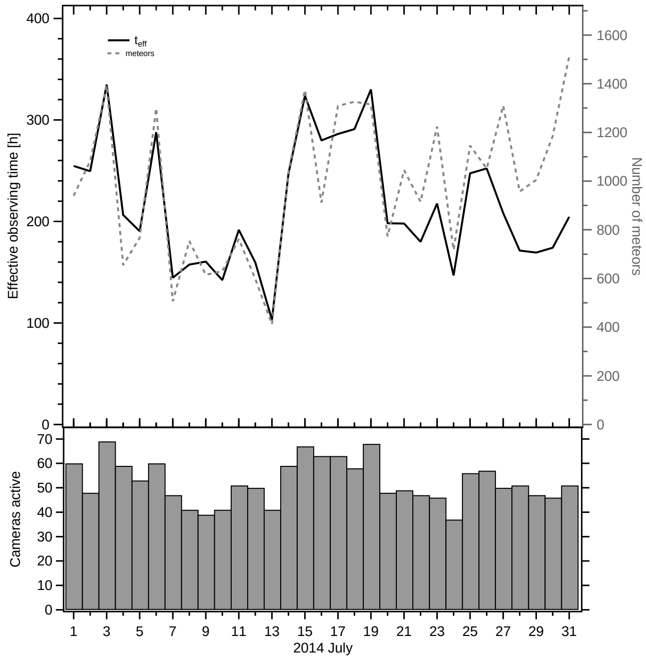

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2014 July.

2 α-Capricornids

The activity interval of the Capricornids lasts from early July to mid-August, but only at the July/August border do the rates stand out clearly from the sporadic background. Figure 2 shows the activity profile of the last four years (computed with $\gamma = 1.5$), which shows a significant variation of the peak flux density. Whereas in 2013 and 2014 identical values of about 2 meteoroids per 1 000 km^2 per hour were reached, the peak was clearly lower in 2011 (resp. the peak occurred earlier) and, with 2.5 meteoroids/1 000 km^2/hour, clearly higher in 2012.

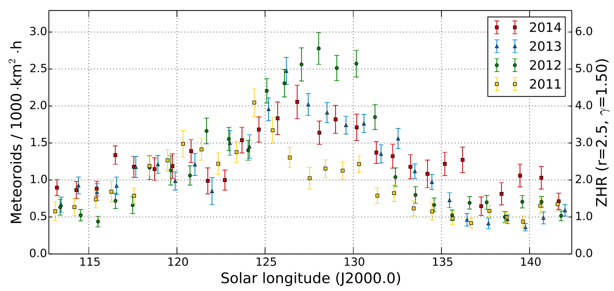

Figure 2 – Flux density profile of the α-Capricornids, obtained from IMO Network video observations 2011–2014.

If all four profiles are averaged, we obtain the expected smooth curve with an activity plateau between 125 and 130° solar longitude (Figure 3). Note that we obtained a similar profile in our 2009 meteor shower analysis (Molau & Rendtel, 2009), but there the plateau

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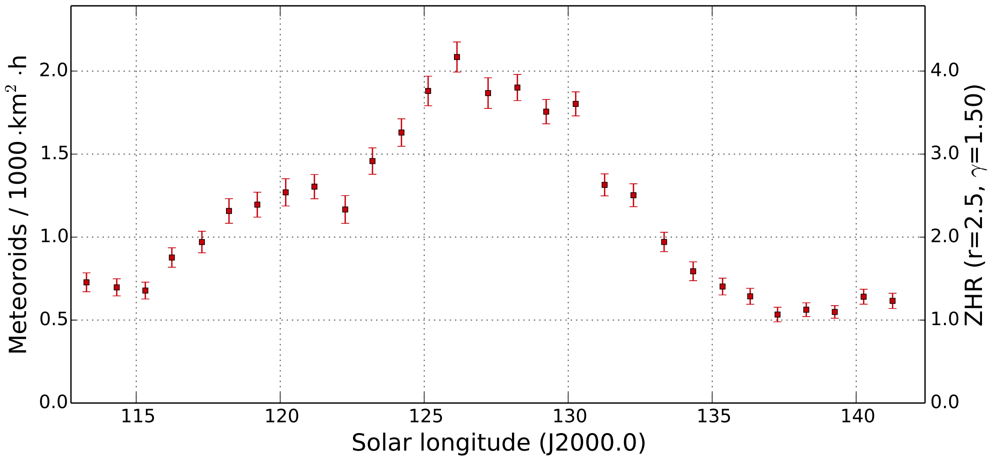

Figure 3 – Flux density profile of the α-Capricornids, averaged over the years 2011–2014.

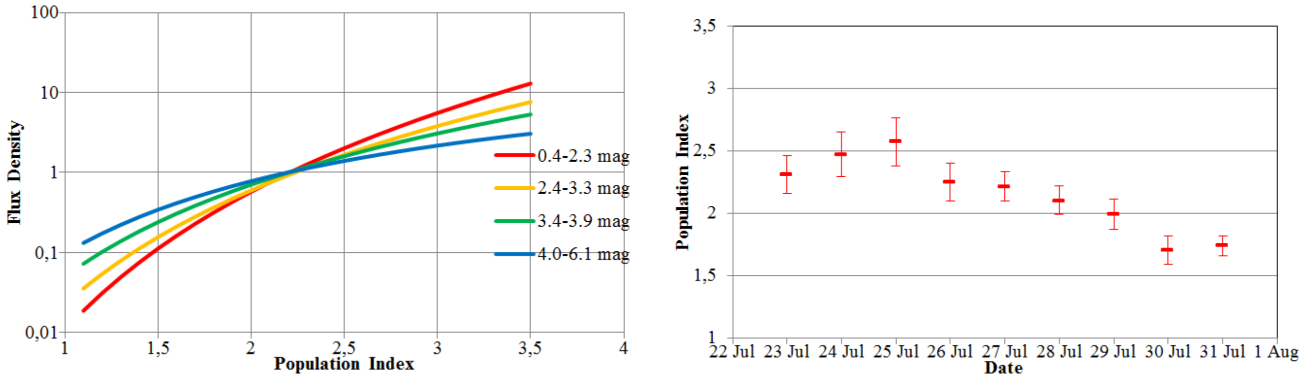

Figure 4 – Flux density vs. population index for different limiting magnitudes on July 26/27 (left) and the complete population index profile of the α-Capricornids (right), obtained from IMO Network data of 2011 till 2014.

occurred between 120 and 125° solar longitude. Did the Capricornids arrive late in the past few years (which would explain the early peak in 2011)? Looking at the MDC shower list we find four parameter sets all referring to solar longitude 127° (Meteor Data Center, 2014), which corresponds to the current activity profile.

The population index was not easy to determine. The 2014 data alone, with less than 100 Capricornids per night, were not sufficient to obtain reliable values. If the observations from 2011 to 2014 are combined, however, we have a data set of 300 to 500 Capricornids per night, which yields a good r-value for most nights. the functions which relate the dependency of the flux density to the population index for different limiting magnitudes often intersect at a single point (e.g. on July 26/27, Figure 4 left). The overall profile (Figure 4, right) presents another surprise, since the population index decreases almost all the time. It starts with values from 2.5 and reaches a minimum of 1.7. So maybe the Capricornids show some mass sorting effect like the Geminids, such that the percentage of larger meteoroids after the peak is higher than before the peak. The IMO Meteor Shower Workbook lists a population index of $r = 2.5$ and points out that many bright α-Capricornids can be seen (Rendtel, 2014).

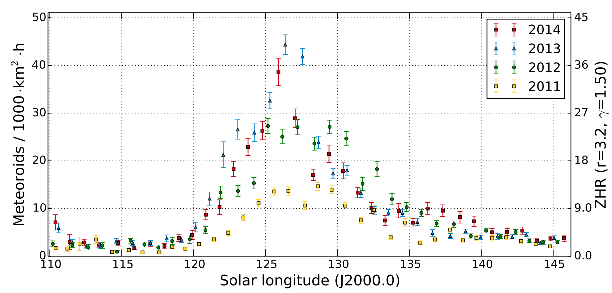

Figure 5 – Flux density profile of the Southern δ-Aquariids, obtained from IMO Network video observations 2011–2014.

3 Southern δ-Aquariids

The Southern δ-Aquariids are active from mid-July until mid-August. Here we also find variations in the peak flux density, whereby 2011 is a lower outlier with just 15 meteoroids per 1 000 km² per hour and the years 2012 till 2014 yield peak rates between 30 and 45 (Figure 5).

The averaged flux density profile (Figure 6) shows the well-known asymmetric shape where the descending branch is shallower than the ascending. Even at the Perseids' peak, the shower still stands out from the sporadic background.

There were more data available to calculate the population index profile of the Southern δ-Aquariids than

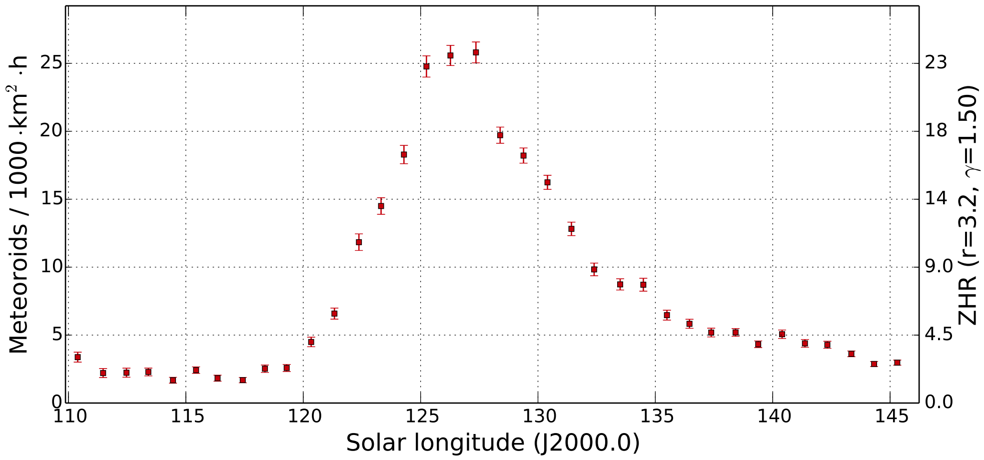

Figure 6 – Flux density profile of the Southern δ-Aquariids, averaged over the years 2011–2014.

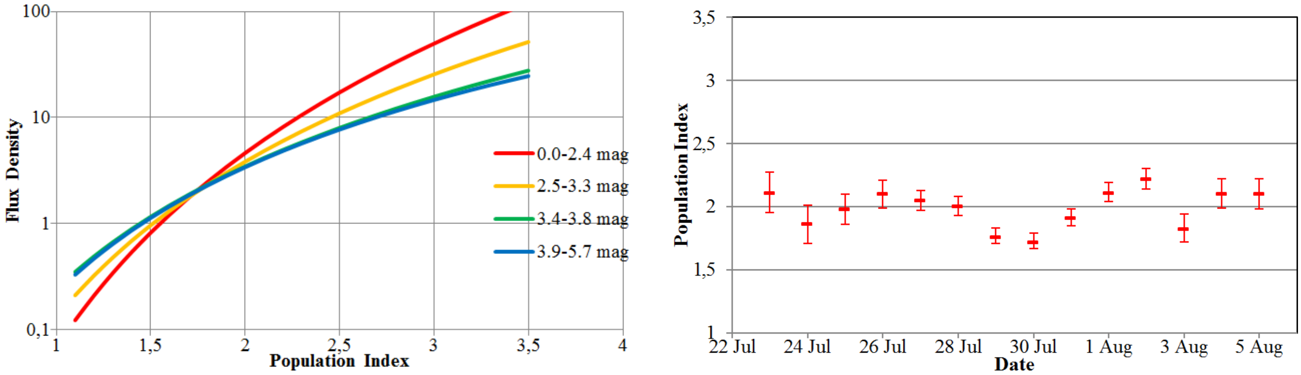

Figure 7 – Flux density vs. population index for different limiting magnitudes on July 26/27 (left) and the complete population index profile of the Southern δ-Aquariids (right), obtained from IMO Network data of 2011 till 2014.

for the α-Capricornids – between 200 and 1 000 meteors per night if the observations from the last four years are combined. In some cases the intersection point of the curves that depict the dependency of the flux density on the population index was well defined again (e.g. on July 28/30, Figure 7 left), but in others it was not.

The overall population index profile (Figure 7, right) has a different shape than the profile of the Capricornids. Here the population index r wobbles around 2.0 and reaches smaller values of about 1.75 towards their maximum at the end of July. Still there is a large discrepancy compared to the data given in the IMO Meteor Shower Workbook (Rendtel, 2014): with $r = 3.2$ the Southern δ-Aquariids have the largest population index in the IMO working list of meteor showers, i.e. they have a bigger fraction of faint meteors than any other shower and the sporadic meteors. This cannot be confirmed from our data, however.

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Table 1 – Observers contributing to 2014 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 [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	27	96.2	706
BANPE	Bánfalvi	Zalaegerszeg/HU	Huvcse01 (0.95/5)	2423	3.4	361	21	25.5	184
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	18	91.9	603
			Hulud3 (0.95/4)	4357	3.8	876	18	86.9	167
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	29	117.7	729
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	20	65.6	145
			Mbb4 (0.8/8)	1470	5.1	1208	22	60.6	144
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	15	62.2	190
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	20	83.5	283
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	21	71.2	298
			Bmh2 (1.5/4.5)*	4243	3.0	371	23	70.1	258
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	29	111.4	535
			C3P8 (0.8/3.8)	5455	4.2	1586	24	93.5	441
			Stg38 (0.8/3.8)	5614	4.4	2007	29	122.0	655
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	26	128.3	814
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	20	69.5	263
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	17	71.3	302
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	29	155.0	697
			Templar2 (0.8/6)	2080	5.0	1508	26	153.1	590
			Templar3 (0.8/8)	1438	4.3	571	25	126.5	260
			Templar4 (0.8/3.8)	4475	3.0	442	27	154.5	603
			Templar5 (0.75/6)	2312	5.0	2259	25	136.8	563
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	11	42.7	209
			Orion3 (0.95/5)	2665	4.9	2069	10	34.5	61
			Orion4 (0.95/5)	2662	4.3	1043	24	90.4	198
HERCA	Hergenrother	Tucson/US	Salsa3 (1.2/4)*	2198	4.6	894	26	103.0	219
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	25	86.3	378
IGAAN	Igaz	Baja/HU	Hubaj (0.8/3.8)	5552	2.8	403	24	115.1	260
		Debrecen/HU	Hudeb (0.8/3.8)	5522	3.2	620	26	119.0	277
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	27	109.4	218
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	22	115.8	99
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	24	110.2	227
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	18	73.5	101
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	15	67.1	409
			Rezika (0.8/6)	2270	4.4	840	16	75.0	477
			Stefka (0.8/3.8)	5471	2.8	379	12	49.6	204
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	1	6.3	28
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	19	73.2	91
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	28	176.8	1989
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	28	190.6	2495

Table 1 – Observers contributing to 2014 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
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	15	58.4	142
MACMA	Maciejewski	Chełm/PL	Pav35 (0.8/3.8)	5495	4.0	1584	17	52.9	236
			Pav36 (0.8/3.8)*	5668	4.0	1573	19	79.3	404
			Pav60 (0.75/4.5)	2250	3.1	281	22	75.1	439
MARGR	Maravelias	Lofoupoli-Crete/GR	Loomecon (0.8/12)	738	6.3	2698	5	28.6	103
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	19	47.0	263
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	23	100.5	1150
			Mincam1 (0.8/8)	1477	4.9	1084	24	99.5	464
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	28	97.0	830
			Remo2 (0.8/8)	1478	6.4	4778	28	91.7	515
			Remo3 (0.8/8)	1420	5.6	1967	4	11.8	22
			Remo4 (0.8/8)	1478	6.5	5358	26	94.1	607
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	22	27.2	184
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	16	40.3	119
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	22	108.6	322
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	23	103.3	483
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	9	36.5	112
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	17	72.9	198
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	23	150.5	350
			Ro2 (0.75/6)	2381	3.8	459	25	163.3	489
			Ro3 (0.8/12)	710	5.2	619	25	165.1	726
			Sofia (0.8/12)	738	5.3	907	24	150.4	323
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	21	64.1	212
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	20	71.7	254
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	27	85.1	618
			Noa38 (0.8/3.8)	5609	4.2	1911	26	81.9	448
			Sco38 (0.8/3.8)	5598	4.8	3306	27	84.9	620
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	23	91.7	324
			Mincam3 (0.8/6)	2338	5.5	3590	24	86.0	420
			Mincam4 (1.0/2.6)	9791	2.7	552	22	85.8	301
			Mincam5 (0.8/6)	2349	5.0	1896	21	78.2	264
			Mincam6 (0.8/6)	2395	5.1	2178	24	87.0	308
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	22	100.3	242
		Budapest/HU	Humob (0.8/6)	2388	4.8	1607	26	62.1	430
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	19	63.4	191
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	8	12.6	24
			Huvcse04 (1.0/4.5)	1484	4.4	573	6	8.4	21
* active field of view smaller than video frame						Overall	31	6 709.0	30 528

Results of the IMO Video Meteor Network — August 2014

Sirko Molau[1], *Javor Kac*[2], *Stefano Crivello*[3], *Enrico Stomeo*[4], *Geert Barentsen*[5], *Rui Goncalves*[6], *Antal Igaz*[7], *Carlos Saraiva*[8], *Maciej Maciewski*[9], and *Mikhail Maslov*[10]

The IMO Video Meteor Network cameras observed for almost 10 000 hours and recorded more than 70 000 meteors in 2014 August. The flux density and population index profiles are presented for the Perseids, based on observations covering years 2011–2014.

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1 Introduction

Participation in the IMO Network reached another high in August 2014, with 83 cameras being active. One camera appeared for the first time in the statistics – after a longer break we could welcome a new observer again. Rui Marques of Portugal is operating the Watec camera RAN1 with a 4.5 mm $f/1.4$ lens from a suburb of Lisbon.

Between August 11 and 18 (with one exception), 70 or more of the mentioned 83 cameras were in operation. More than three quarters of all cameras achieved twenty or more observing nights, and five cameras (all in Italy) could even observe without any break. This was a clear demonstration that the weather was sympathetic to the observers in the summer months.

However, despite the effective observing time being 9 700 hours, it was still 100 hours short of the 2013 total, and the gap to the record breaking August 2012 was almost 1 000 hours. In addition, with the Perseids having occurred at the time of full Moon, the total meteor count was smaller than in the previous two years. Thanks to the average rate of 7.3 meteors per hour, we gathered nearly 71 000 meteors (Table 1 and Figure 1) which was just 5% below the outcome of 2012 and 2013. So once more August marked the highlight of the year.

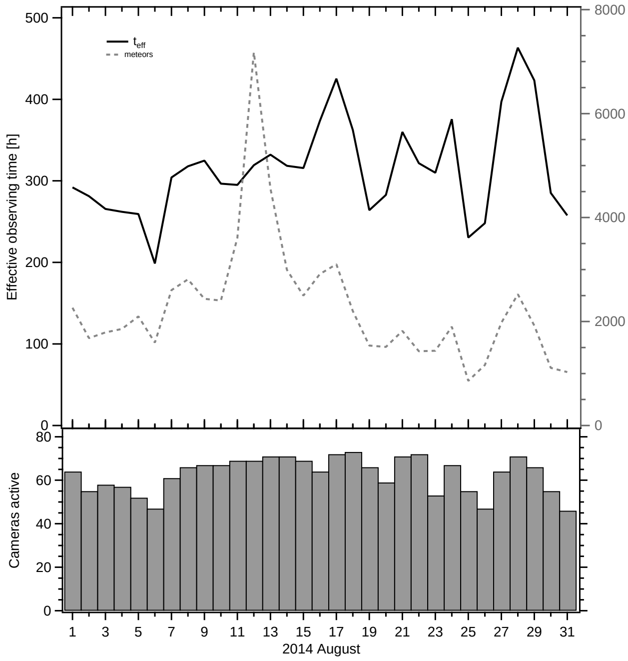

Figure 1 – Monthly summary for the effective observing time (solid black line), number of meteors (dashed gray line) and number of cameras active (bars) in 2014 August.

2 Perseids

Years in which the Perseids coincide with full moon, are no so attractive for visual observers. In addition, the calculated peak ZHR is such years is typically smaller than in years with dark skies. This effect was observed in 2014 again – the IMO quick look analysis (International Meteor Organization, 2014) yielded a peak ZHR below 80. It can be assumed that the ZHR is in reality not smaller, but that the correction of the lower limiting magnitude introduces larger systematic errors. Before we focus on that, we first want to check the strength of the 2014 Perseid peak in our video data. Figure 2 compares the flux densities of the last four years. In fact, the video data shows the opposite result: with flux densities of up to 50 meteoroids per 1 000 km^2 per hour (calculated with a zenith exponent of $\gamma = 1.5$), the days near the 2014 Perseid peak perform better than in the three previous years.

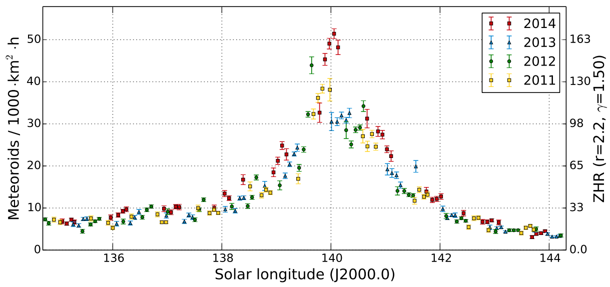

Figure 2 – Flux density profiles of the Perseids for the years 2011 to 2014, obtained from observations of the IMO Video Meteor Network.

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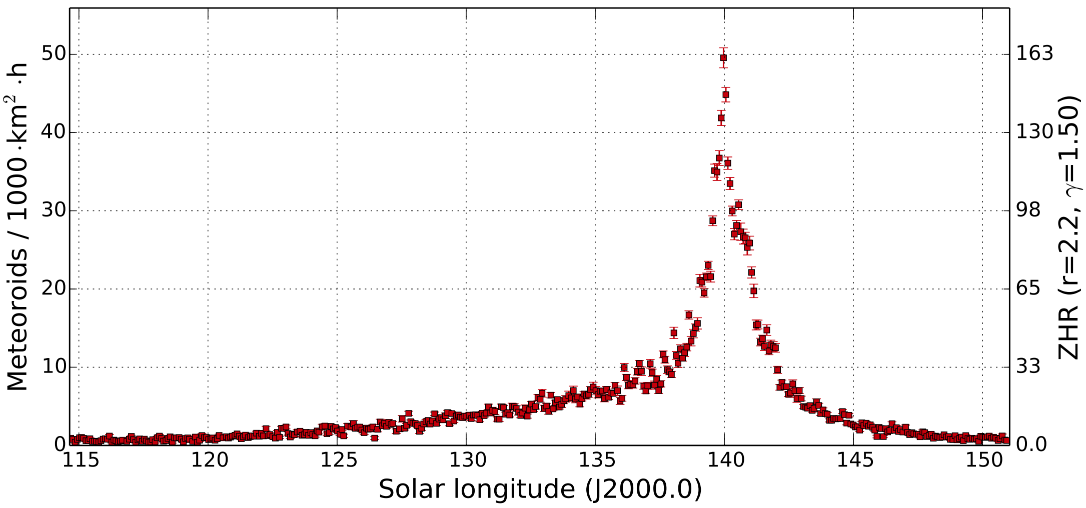

Figure 3 – Averaged flux density profile of the Perseids for the years 2011 to 2014.

For the sake of completeness, Figure 3 presents the full Perseid profile, averaged over the last four years.

We need to discover why the visual ZHR in full moon years is smaller than in others. A possible explanation is that although diligent observers were able to detect the faintest stars in the star fields, the detection of faint meteors suffers stronger from the bright, low-contrast background. In particular faint meteors may be more easily overlooked. If that is the case, the population index obtained from visual observations should also slightly decrease. Hence it would be worthwhile to compare the population index alongside the flux density in years with full moon.

Of course, we also checked which population index we obtain from our video data. The analysis was carried out for the interval of August 3/4 to August 18/19, during which the Perseids clearly stand out from the sporadic background. Figure 4 shows the population index profile for the years 2011 to 2014.

We first notice that the r-value is overall very small. It often shows values between 1.7 and 1.8 and jumps only occasionally above 2. Whereas the population index of 2011 and 2012 shows a clear minimum at the peak and in the days before, it is relatively constant at that time in 2013 and 2014.

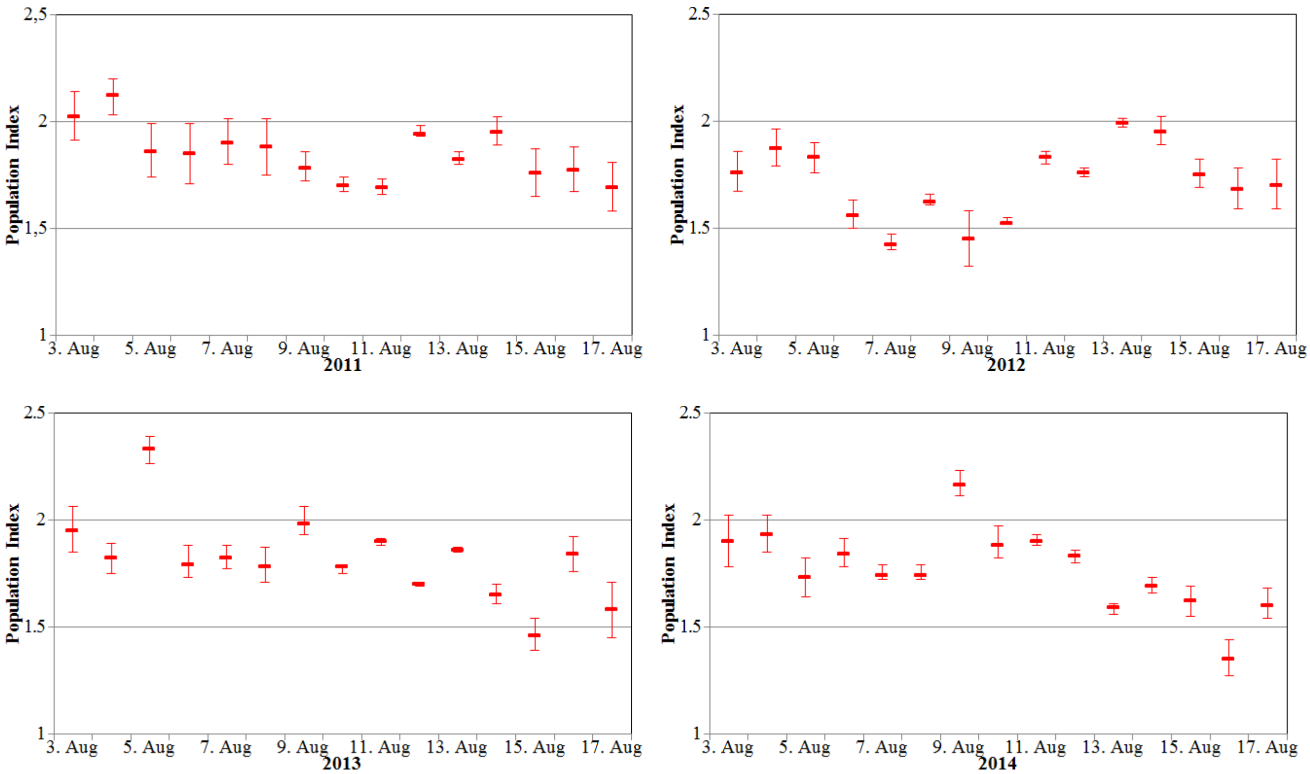

Figure 4 – Population index profile of the Perseids for the years 2011 (top left) to 2014 (bottom right).

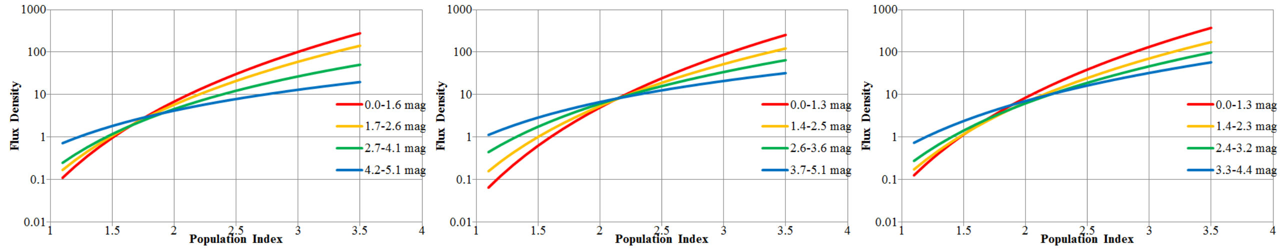

Figure 5 – Dependency of the flux density on the population index for different meteor limiting magnitudes on August 8/9 (left), 9/10 (center), and 10/11 (right).

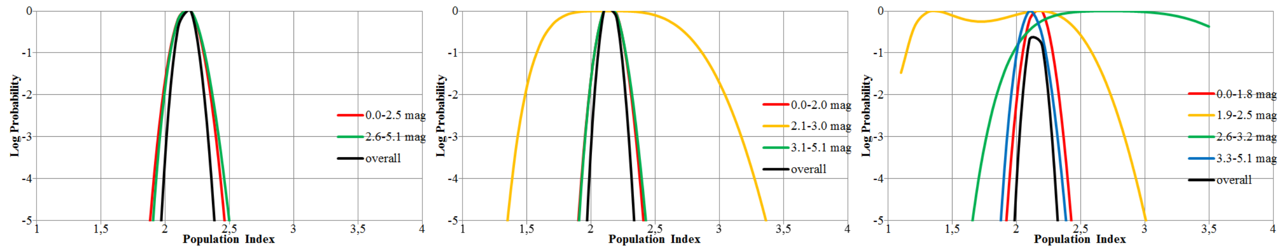

Figure 6 – Probability of individual limiting magnitude classes on August 9/10 for two (left), three (center) and four (right) classes. In case of two classes, all intervals contribute, whereas in case of three or four classes the intervals with average limiting magnitude (yellow resp. yellow and green line) have only a small impact on the determination of the r-value.

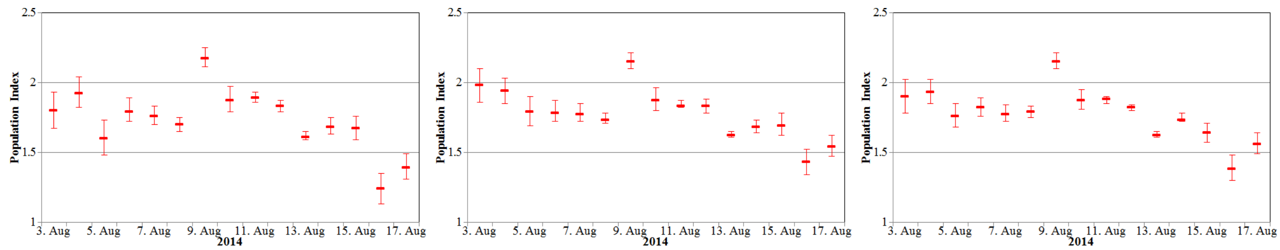

Figure 7 – Population index profile of the Perseids in 2014, calculated with two (left), three (center) and four (right) limiting magnitude classes.

In all years, the r-value is decreasing at the end of the activity interval. It often falls to even smaller values than at the Perseid peak (including 2014). That is particularly remarkable, since at the end of the activity interval the "sporadic contamination" is increasing, which should rather push the r-value upwards.

In most cases, the r-profile is smooth and continuous – subsequent nights often have similar values. However, there are also clear outliers. The population index of 2014 August 9/10, for example, is 0.3 to 0.4 higher than in the nights before and thereafter. This result is not related to the quality or size of the data set: in all three nights we could use almost a thousand Perseids, and the curves for different limiting magnitude classes intersect perfectly (Figure 5).

Indeed it is questionable whether the r-value of that particular night really deviated by such a large amount. Hence, we needed to look for alternative explanations for the outlier.

To eliminate the impact of individual cameras we reduced the data set for testing to those cameras that were active on all three nights. The result was virtually the same.

Since the limiting magnitude classes are adapted to the available data set, the intervals are cut slightly different for each night. For example, the interval for the most sensitive cameras starts at +4.2 mag on August 8/9, at +3.7 mag on the next night and at +3.3 mag on August 10/11. However, when the intervals are fixed over all nights, the picture does still not change.

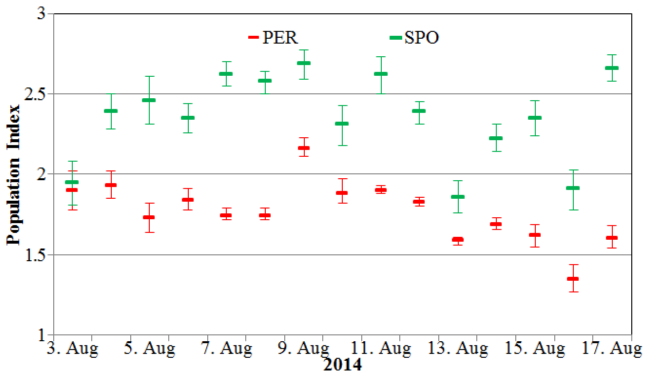

Figure 8 – Population index profile of the Perseids and sporadics in August 2014.

Next we analysed whether the number of limiting magnitude classes has an impact on the outcome. For that we split the observing intervals into two, three and four limiting magnitude classes. In case of two, the r-values deviate slightly stronger from night to night, but the result for three and four classes was virtually identical (Figure 7). The reason is, probably, that cameras whose limiting magnitude is near the average provide almost no information about the population index in this kind of analysis and so have little impact when three or four classes are used. Only the more sensitive and less sensitive cameras count (Figure 6). Still, the outlier on August 9/10 remains visible in all three cases.

Finally we calculated the population index profile of sporadic meteors for comparison. Note that for sporadics no real flux density can be calculated, since there is no defined radiant and, thus, no correction for the impact of the radiant altitude. The workaround of MetRec is to model sporadic meteors as an empirically weighted mix of sporadic sources with known position (N/S Apex, Helion and Antihelion, N/S Toroidal).

It is surprising that the sporadic population index in August (Figure 8) is relatively small – instead of the expected typical r-values near 3 it scatters around 2.5. On August 9/10 there is no particularly large population index, but on the following night it breaks down significantly. Later both the Perseid and the sporadic population index profiles show similar deviations, e.g. particularly small values on August 13/14 and 16/17.

Hence there is no satisfying explanation for the outlier in the population profile on August 9/10, 2014. Our analysis has shown, however, that the algorithm applied by us is relatively robust. Even if different parameters are changed, the obtained r-values change only a little.

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International Meteor Organization (2014). “Perseids 2014: visual data quicklook”. `http://www.imo.net/live/perseids2014` .

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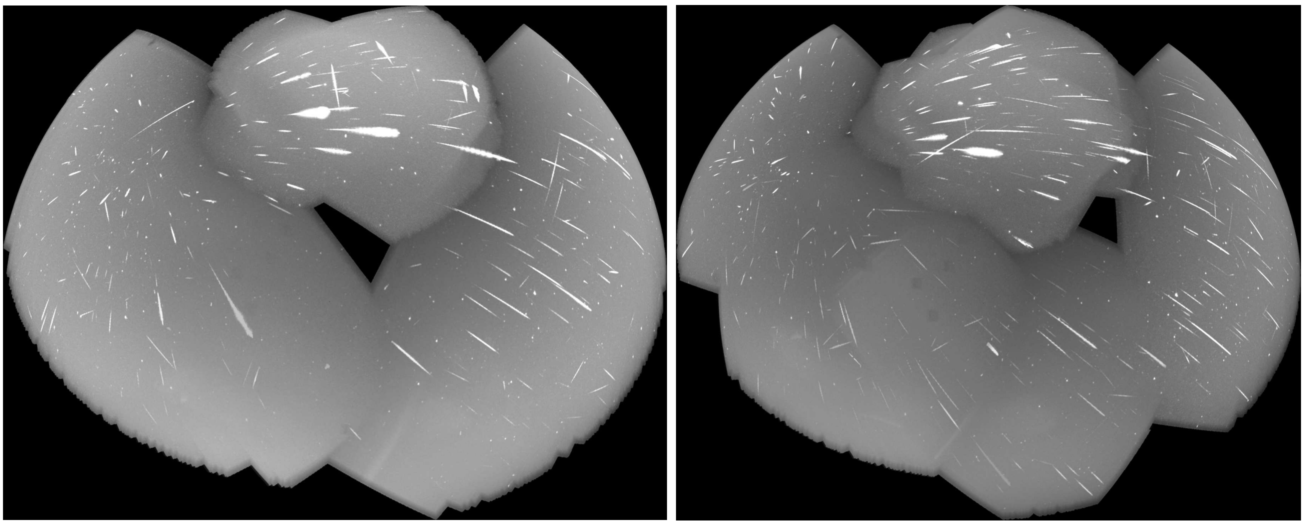
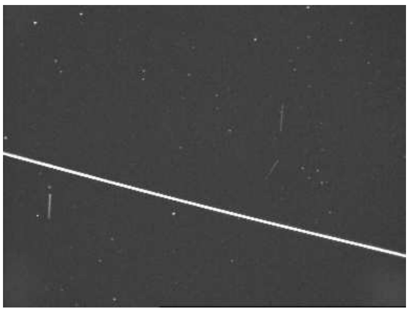
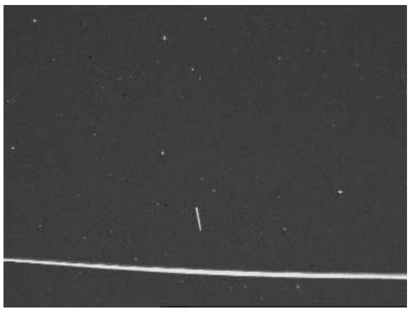


Panoramic stacked images of the 2014 Perseids from August 11/12 (left) and August 12/13 (right), based on recordings of three cameras Remo1, Remo3, Remo4 in Ketzür.

A Perseid triplet recorded on 2014 August 14 at $22^{\rm h}44^{\rm m}08^{\rm s}$ UT by Rosta Štork with Ond1.



Extremely long-lasting meteor (7.6 s inside field of view), recorded on 2014 August 7 at $00^{\rm h}25^{\rm m}18^{\rm s}$ UT by Rainer Arlt with Ludwig2.



The same long-lasting meteor as on the left image, recorded about 30 km away with Remo2 by Sirko Molau, where it spent 7.8 s inside the field of view.

Figure 9 – Collection of interesting meteor captures by the IMO Video Meteor Network cameras in 2014 August.

Table 1 – Observers contributing to 2014 August data of the IMO Video Meteor Network. Eff.CA designates the effective collection area; the overall number of nights is the number of nights with at least one camera operating, the overall observing time and number of meteors are sums over all cameras.

Code	Name	Location	Camera	FOV [°²]	Stellar LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	Ludwig2 (0.8/8)	1475	6.2	3779	27	133.2	1394
BANPE	Bánfalvi	Zalaegerszeg/HU	Huvcse01 (0.95/5)	2423	3.4	361	23	53.2	449
BERER	Berkó	Ludányhalászi/HU	Hulud1 (0.8/3.8)	5542	4.8	3847	21	124.8	1165
			Hulud3 (0.95/4)	4357	3.8	876	21	121.4	383
BOMMA	Bombardini	Faenza/IT	Mario (1.2/4.0)	5794	3.3	739	31	218.2	2513
BREMA	Breukers	Hengelo/NL	Mbb3 (0.75/6)	2399	4.2	699	25	125.7	621
			Mbb4 (0.8/8)	1470	5.1	1208	25	130.6	714
BRIBE	Klemt	Herne/DE	Hermine (0.8/6)	2374	4.2	678	21	87.0	521
		Bergisch Gladbach/DE	Klemoi (0.8/6)	2286	4.6	1080	23	83.3	549
CASFL	Castellani	Monte Baldo/IT	Bmh1 (0.8/6)	2350	5.0	1611	31	136.4	858
			Bmh2 (1.5/4.5)*	4243	3.0	371	30	122.1	733
CRIST	Crivello	Valbrevenna/IT	Bilbo (0.8/3.8)	5458	4.2	1772	31	165.3	1357
			C3P8 (0.8/3.8)	5455	4.2	1586	29	121.1	788
			Stg38 (0.8/3.8)	5614	4.4	2007	31	180.0	1517
CSISZ	Csizmadia	Baja/HU	Huvcse02 (0.95/5)	1606	3.8	390	24	61.8	522
DONJE	Donani	Faenza/IT	Jenni (1.2/4)	5886	3.9	1222	31	228.0	2733
ELTMA	Eltri	Venezia/IT	Met38 (0.8/3.8)	5631	4.3	2151	26	155.1	1320
FORKE	Förster	Carlsfeld/DE	Akm3 (0.75/6)	2375	5.1	2154	18	44.9	452
GONRU	Goncalves	Tomar/PT	Templar1 (0.8/6)	2179	5.3	1842	30	201.5	1175
			Templar2 (0.8/6)	2080	5.0	1508	27	177.2	1134
			Templar3 (0.8/8)	1438	4.3	571	30	183.2	694
			Templar4 (0.8/3.8)	4475	3.0	442	30	202.0	1610
			Templar5 (0.75/6)	2312	5.0	2259	30	185.3	1390
GOVMI	Govedič	Središče ob Dravi/SI	Orion2 (0.8/8)	1447	5.5	1841	25	133.9	996
			Orion3 (0.95/5)	2665	4.9	2069	24	115.2	491
			Orion4 (0.95/5)	2662	4.3	1043	26	114.4	516
HERCA	Hergenrother	Tucson/US	Salsa3 (1.2/4)*	2198	4.6	894	28	160.3	583
HINWO	Hinz	Schwarzenberg/DE	Hinwo1 (0.75/6)	2291	5.1	1819	26	103.6	771
IGAAN	Igaz	Baja/HU	Hubaj (0.8/3.8)	5552	2.8	403	11	56.5	381
		Hódmezővásárhely/HU	Huhod (0.8/3.8)	5502	3.4	764	13	72.4	567
		Budapest/HU	Hupol (1.2/4)	3790	3.3	475	25	116.4	212
JONKA	Jonas	Budapest/HU	Husor (0.95/4)	2286	3.9	445	24	139.5	632
KACJA	Kac	Ljubljana/SI	Orion1 (0.8/8)	1402	3.8	331	19	69.5	209
		Kamnik/SI	Cvetka (0.8/3.8)*	4914	4.3	1842	16	65.1	640
			Rezika (0.8/6)	2270	4.4	840	15	66.5	607
			Stefka (0.8/3.8)	5471	2.8	379	10	40.9	245
		Kostanjevec/SI	Metka (0.8/12)*	715	6.4	640	3	20.1	120
KISSZ	Kiss	Sülysáp/HU	Husul (0.95/5)*	4295	3.0	355	27	147.9	338
KOSDE	Koschny	Izana Obs./ES	Icc7 (0.85/25)*	714	5.9	1464	30	223.9	2336
		La Palma/ES	Icc9 (0.85/25)*	683	6.7	2951	28	170.3	1982
		Noordwijkerhout/NL	Lic4 (1.4/50)*	2027	6.0	4509	23	91.3	506
LOJTO	Łojek	Grabniak/PL	Pav57 (1.0/5)	1631	3.5	269	15	51.8	209

Table 1 – Observers contributing to 2014 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	25	98.3	611
			Pav36 (0.8/3.8)*	5668	4.0	1573	30	118.0	1205
			Pav60 (0.75/4.5)	2250	3.1	281	26	96.0	620
MARGR	Maravelias	Lofoupoli-Crete/GR	Loomecon (0.8/12)	738	6.3	2698	29	233.7	620
MARRU	Marques	Lisbon/PT	Ran1 (1.4/4.5)	4405	4.0	1241	19	125.6	766
MASMI	Maslov	Novosibirsk/RU	Nowatec (0.8/3.8)	5574	3.6	773	22	93.5	1063
MOLSI	Molau	Seysdorf/DE	Avis2 (1.4/50)*	1230	6.9	6152	25	116.5	1364
			Mincam1 (0.8/8)	1477	4.9	1084	25	104.2	881
		Ketzür/DE	Remo1 (0.8/8)	1467	6.5	5491	29	144.2	1772
			Remo2 (0.8/8)	1478	6.4	4778	27	139.5	1102
			Remo3 (0.8/8)	1420	5.6	1967	17	97.0	707
			Remo4 (0.8/8)	1478	6.5	5358	29	146.5	1429
MOSFA	Moschner	Rovereto/IT	Rover (1.4/4.5)	3896	4.2	1292	25	65.3	574
OCHPA	Ochner	Albiano/IT	Albiano (1.2/4.5)	2944	3.5	358	22	87.6	305
OTTMI	Otte	Pearl City/US	Orie1 (1.4/5.7)	3837	3.8	460	26	106.1	310
PERZS	Perkó	Becsehely/HU	Hubec (0.8/3.8)*	5498	2.9	460	19	115.6	1105
PUCRC	Pucer	Nova vas nad Dragonjo/SI	Mobcam1 (0.75/6)	2398	5.3	2976	21	98.4	788
ROTEC	Rothenberg	Berlin/DE	Armefa (0.8/6)	2366	4.5	911	22	127.9	548
SARAN	Saraiva	Carnaxide/PT	Ro1 (0.75/6)	2362	3.7	381	26	167.6	554
			Ro2 (0.75/6)	2381	3.8	459	29	197.9	1054
			Ro3 (0.8/12)	710	5.2	619	29	210.9	1223
			Sofia (0.8/12)	738	5.3	907	27	182.5	658
SCALE	Scarpa	Alberoni/IT	Leo (1.2/4.5)*	4152	4.5	2052	16	81.9	637
SCHHA	Schremmer	Niederkrüchten/DE	Doraemon (0.8/3.8)	4900	3.0	409	26	112.2	1075
SLAST	Slavec	Ljubljana/SI	Kayak1 (1.8/28)	563	6.2	1294	14	50.4	253
STOEN	Stomeo	Scorze/IT	Min38 (0.8/3.8)	5566	4.8	3270	30	167.3	2171
			Noa38 (0.8/3.8)	5609	4.2	1911	30	166.2	1813
			Sco38 (0.8/3.8)	5598	4.8	3306	27	170.9	2376
STORO	Štork	Kunžak/CZ	Kun1 (1.4/50)*	1913	5.4	2778	1	4.9	71
		Ondřejov/CZ	Ond1 (1.4/50)*	2195	5.8	4595	1	9.0	132
STRJO	Strunk	Herford/DE	Mincam2 (0.8/6)	2354	5.4	2751	29	126.4	733
			Mincam3 (0.8/6)	2338	5.5	3590	29	109.7	938
			Mincam4 (1.0/2.6)	9791	2.7	552	29	106.5	770
			Mincam5 (0.8/6)	2349	5.0	1896	29	115.3	693
			Mincam6 (0.8/6)	2395	5.1	2178	29	118.5	847
TEPIS	Tepliczky	Agostyán/HU	Huago (0.75/4.5)	2427	4.4	1036	28	80.7	457
		Budapest/HU	Humob (0.8/6)	2388	4.8	1607	28	94.9	781
TRIMI	Triglav	Velenje/SI	Sraka (0.8/6)*	2222	4.0	546	20	96.2	406
YRJIL	Yrjölä	Kuusankoski/FI	Finexcam (0.8/6)	2337	5.5	3574	11	34.8	294
ZELZO	Zelko	Budapest/HU	Huvcse03 (1.0/4.5)	2224	4.4	933	7	23.3	104
			Huvcse04 (1.0/4.5)	1484	4.4	573	6	20.2	78
* active field of view smaller than video frame						Overall	31	9 762.9	70 821

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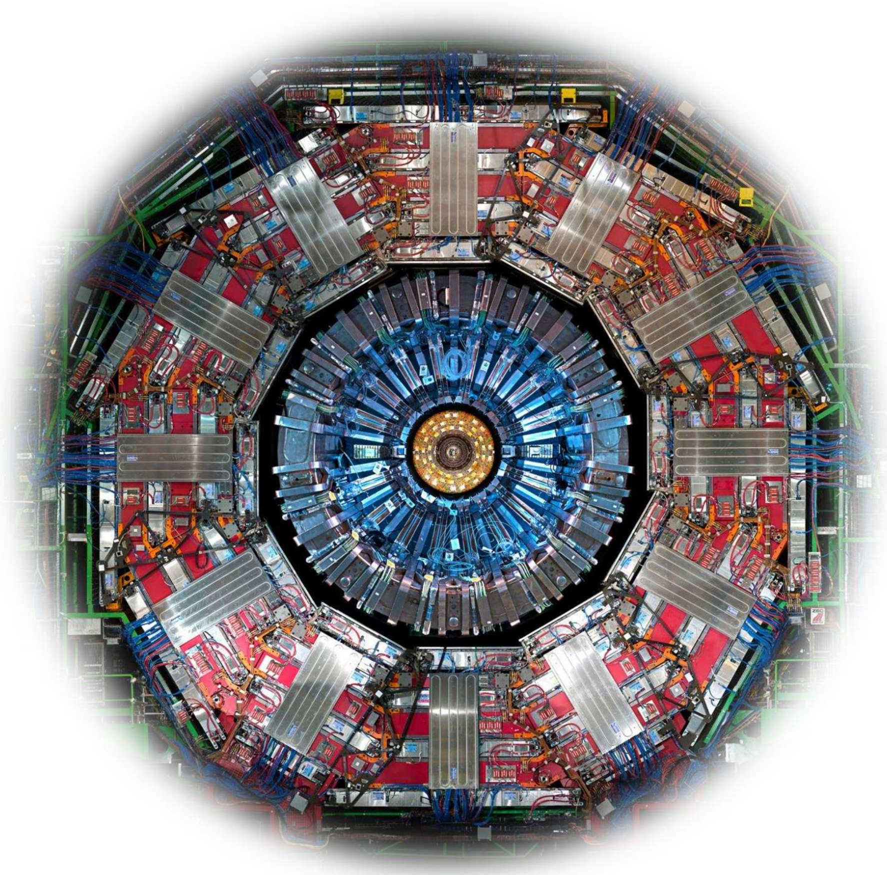

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