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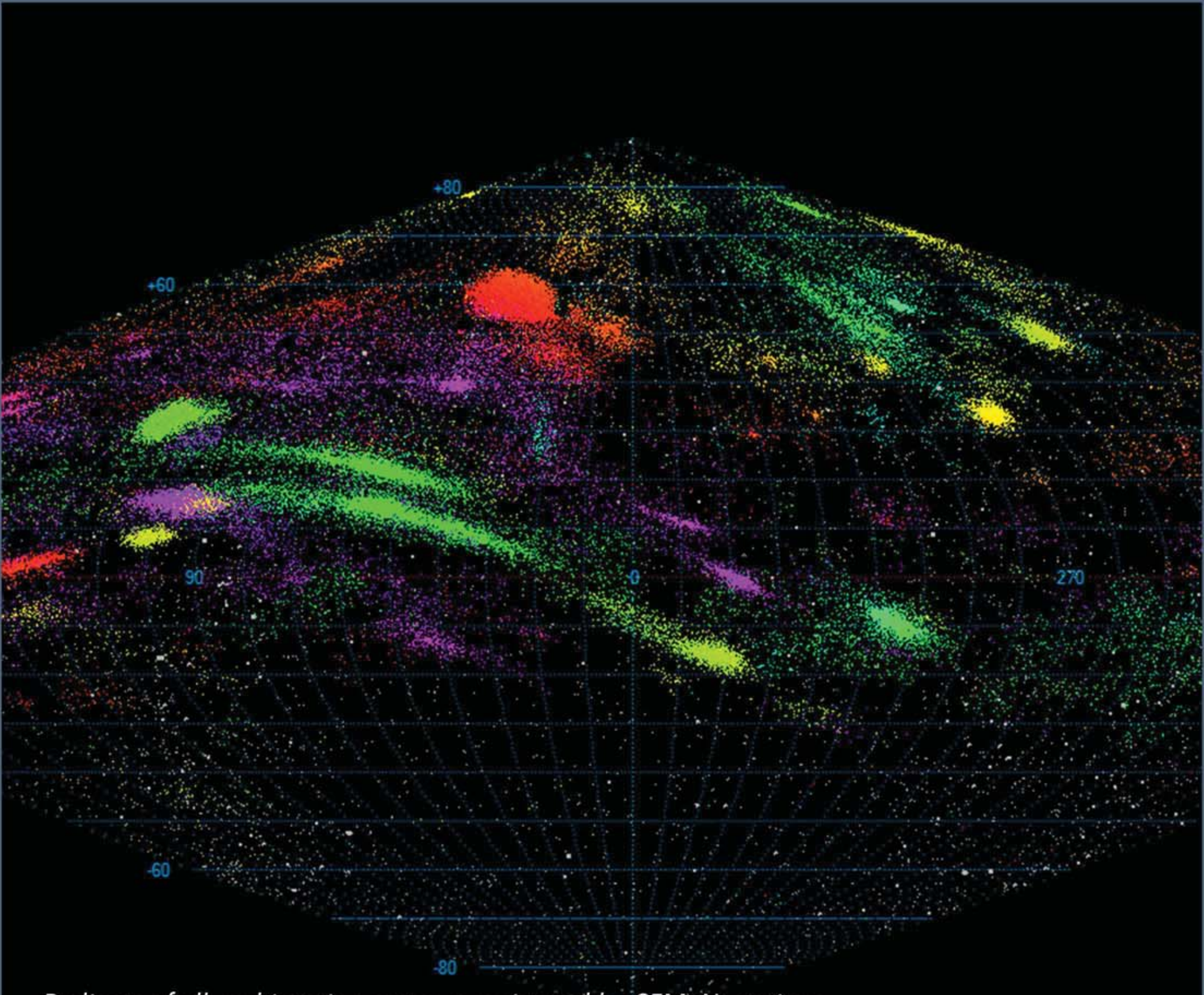

Radiants of all multi-station meteors registered by CEMeNt stations from 2010 to 2016 (36321 orbits).
Author: Jakub Koukal.

- CEMeNt 2016
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- Established meteor shower activity periods and orbits
- CAMS BeNeLux news
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Front cover picture: Radiants of all multi-station meteors registered by CEMeNt stations from 2010 to 2016 (36321 orbits). Author: Jakub Koukal.

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CEMeNt 2016 – general overview

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`j.koukal@post.cz`

The results of the Central European video Meteor Network (CEMeNt) for 2016 are summarized and compared with the overall results of the CEMeNt network for the period 2010-2016. During 2016 the network collected 9884 orbits.

1 Introduction

The Central European video Meteor Network (CEMeNt) established in 2010 is a platform for cross-border cooperation in the field of video meteor observations between the Czech Republic and Slovakia. From the beginning the CEMeNt observational activities have been coordinated together with the professional Slovak Video Meteor Network (SVMN) (Tóth et al., 2008) as well as with other similar networks in central European region, especially the Hungarian Meteor Network, HMN (Igaz, 2012) and the Polish Fireball Network, PFN (Olech, 2005). During six years of operation the CEMeNt network went through an extensive development. In total 33 video systems were working on 17 permanent stations located in the Czech Republic and Slovakia during 2016.

2 Equipment and results

The Central European video Meteor Network (CEMeNt) was established in 2010 by Roman Piffl (Slovakia) and Jakub Koukal (Czech Republic, Society for Interplanetary Matter, SMPH, z. s.) as a non-institutional platform for cross-border cooperation in the field of video meteor observations in central Europe. From the beginning the CEMeNt has been organized as a network of mostly amateur astronomers with low-cost wide field video-systems for meteor activity monitoring. The acquired meteor data enabled to obtain high precision positions and velocity observations for multi-station meteor orbit calculations.

The video-systems used in CEMeNt are based on various types of sensitive CCTV video cameras with a 1/3” or 1/2” chip and fast (~ f/1.0) varifocal lenses. For detection and analysis the UFOTools software pack by SonotaCo[1] (SonotaCo, 2009) is used. Most of the stations are “wide field” with diagonal field of view about 60–90 deg. Camera systems are sheltered in weatherproof and heated housings (generally used for security camera systems). In the region of central Europe these stations are able to work for the whole year without any climatic limitations. Some of the stations can be also operated online with necessary technical service only. All meteor data produced by the CEMeNt network are available in the open database EDMONd (Kornoš et al., 2014).

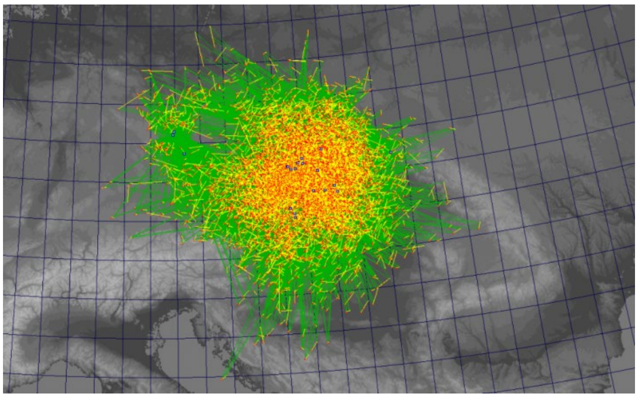

Figure 1 – Ground map (central Europe) of all multi-station meteors registered by CEMeNt stations in 2016 (9884 orbits). Overall stations positions are marked (blue circles). Author: *Jakub Koukal*.

The results of the observations of the CEMeNt network are listed below for the period 2010–2016, as well as separately for the year 2016.

Acknowledgment

We would like to thank all station owners, operators and observers for the long term and precise work enabling the independent operation of the CEMeNt network. Also we would like to thank all institutions involved for the still growing support of network activities.

Projects KOSOAP (Cooperating Network of Astronomic Observational Projects, in Czech: Kooperující síť v oblasti astronomických odborně-pozorovatelských programů) and RPKS (Evolvement of the Cross Border Network for Scientific Work and Education, in Czech: Rozvoj přeshraniční kooperující sítě pro odbornou práci a vzdělávání) realized by Valašské Meziříčí Observatory (CZ) and Kysuce Observatory (SK) in cooperation with with the Society for Interplanetary Matter (SMPH) were co-funded by the European Union (Cross-border Cooperation Programme Slovak Republic – Czech Republic 2007–2013).

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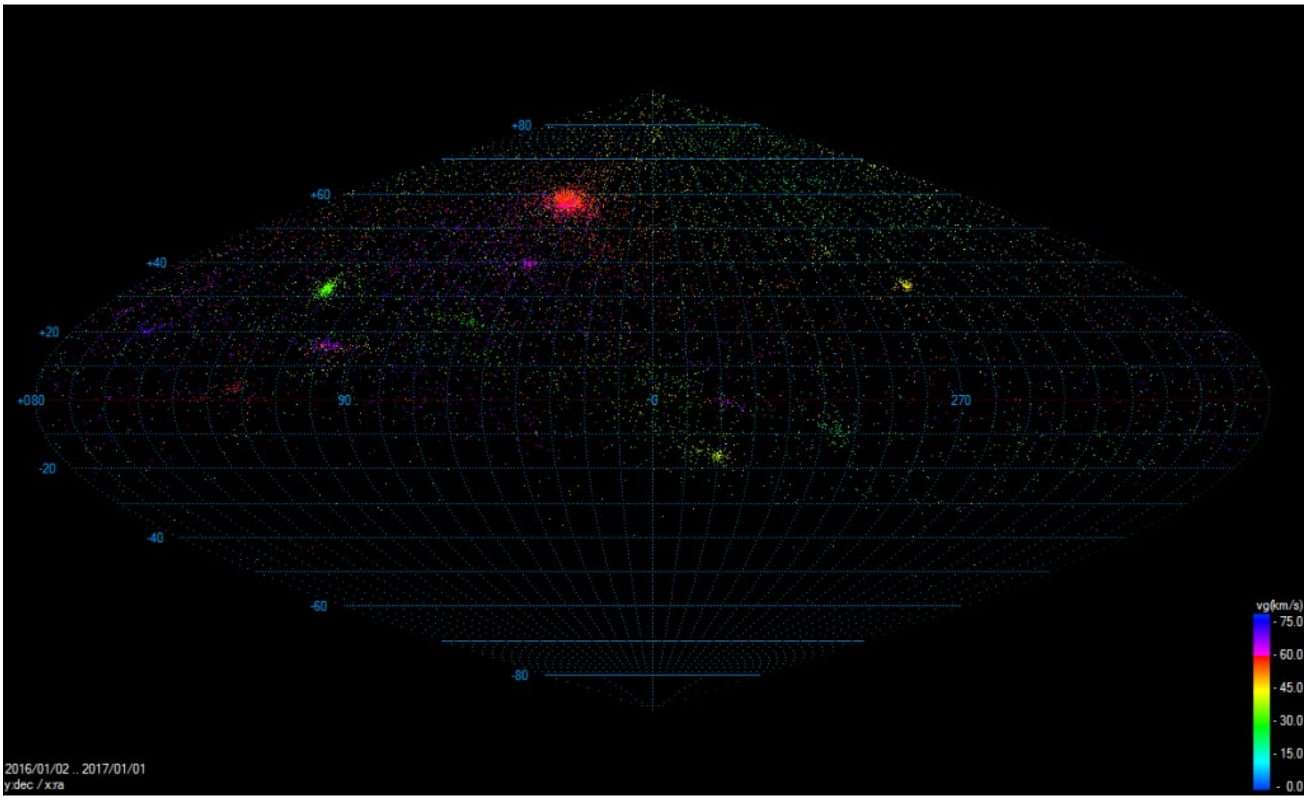
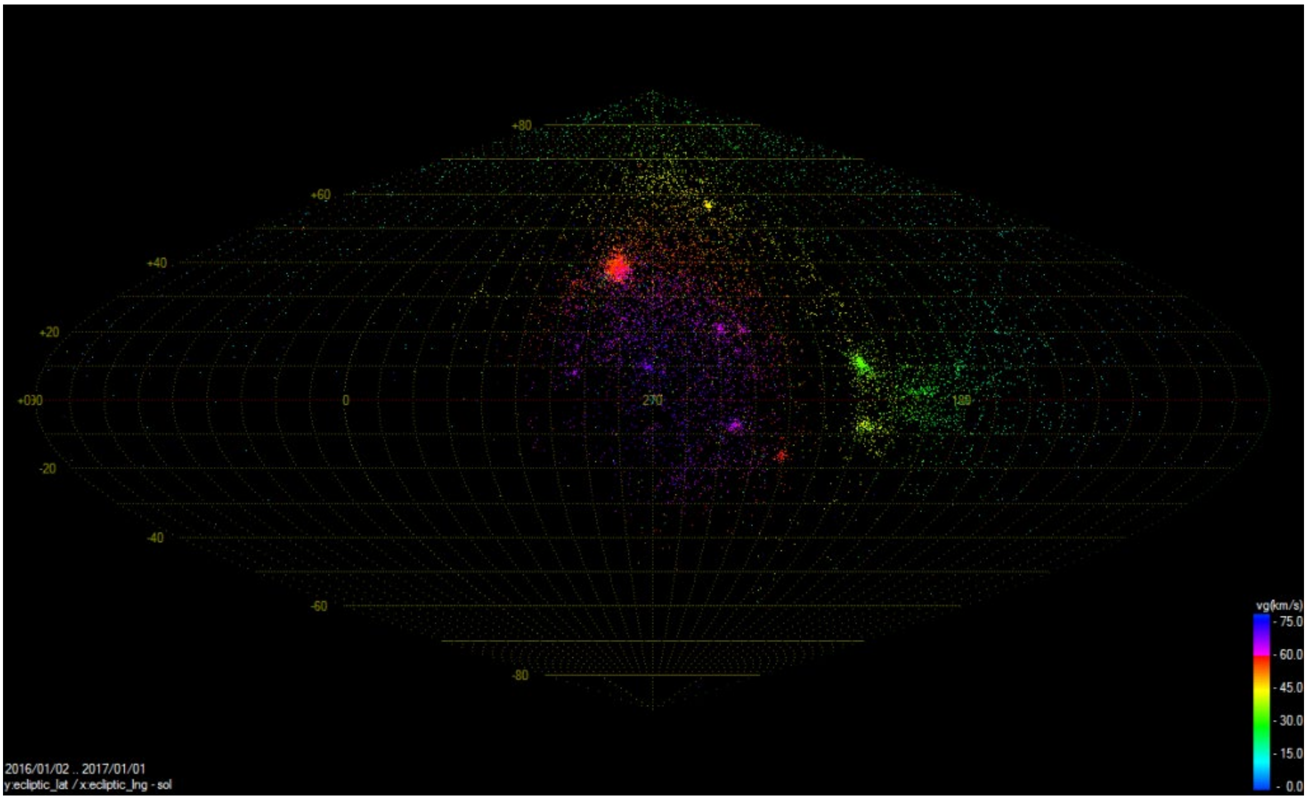
[1] www.sonotaco.com

Table 1 – CEMeNt 2009-2016 wide field stations and observation statistics. Author: *Jakub Koukal*.

Station location	2009	2010	2011	2012	2013	2014	2015	2016	Total
Vartovka				1 264	2 192	1 342	1 810	2 336	8 944
Karlovy Vary				691	3 793	2 839	4 066	4 182	15 571
Ostrov							152	246	398
Otrokovice					842	893	2 134	92	3 961
Blahová						364	7 561	7 956	15 881
Kostolné Kračany							981	1497	2 478
Kroměříž		2 067	3 182	5 964	4 467	3 363	4 370	2 717	26 130
Lovčica			73	151	596	336	609	86	1 851
Maruška				4 292	5 730	4 742	4 552	3 604	22 920
Nýdek		1 909	1 126	180	2 369	3 539	7 424	5 831	22 378
Plzeň				837	1 854	1 499	1 186	300	5 676
Roztoky								1 871	1 871
Senec							2 791	6 036	8 827
Sokolov							32		32
Toužim							356		356
Valašské Meziříčí			520	1 799	6 051	5 713	8 007	7 444	29 534
Vsetín					1 257	1 033	1 110	873	4 273
Zlín						743	1 526	3 024	5 293
Zákopčie				431					431
Zvolenská Slatina				515	478	605	1 765	1 232	4 595
Mobile stations (total)		805	432	739	70	119	355	225	2 745
Bratislava	660								660
Dunajská Lužná		153	318	1 017	432				1 920
Mariánka		777	258						1 035
Stochov		442	433	1 424	133				2 432
Bílý Kříž				1 439	2 177	142			3 758
Havlíčkův Brod				451	925	609			1 985
Barrandov					1 474	1 016			2 490
Single meteors total	**660**	**6 153**	**6 342**	**21 194**	**34 840**	**28 897**	**50 787**	**49 552**	**198 425**
Paired single meteors	0	405	660	7 796	14 847	12 282	23 909	23 956	83 855
Multi-station orbits	0	194	325	3 574	6 576	5 647	10 121	9 884	36 321
Efficiency	0,00%	6,58%	10,41%	36,78%	42,61%	42,50%	47,08%	48,35%	42,26%
Stations / orbit	0,00	2,09	2,03	2,18	2,26	2,17	2,36	2,42	2,31


+80
+60
+40
+20
+080
90
0
270
-20
-40
-60
-80
vg(km/s)
75.0
60.0
45.0
30.0
15.0
0.0
2016/01/02 .. 2017/01/01
y:dec / x:ra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+60
+40
+20
+090
0
270
180
-20
-40
-60
-80
vg(km/s)
75.0
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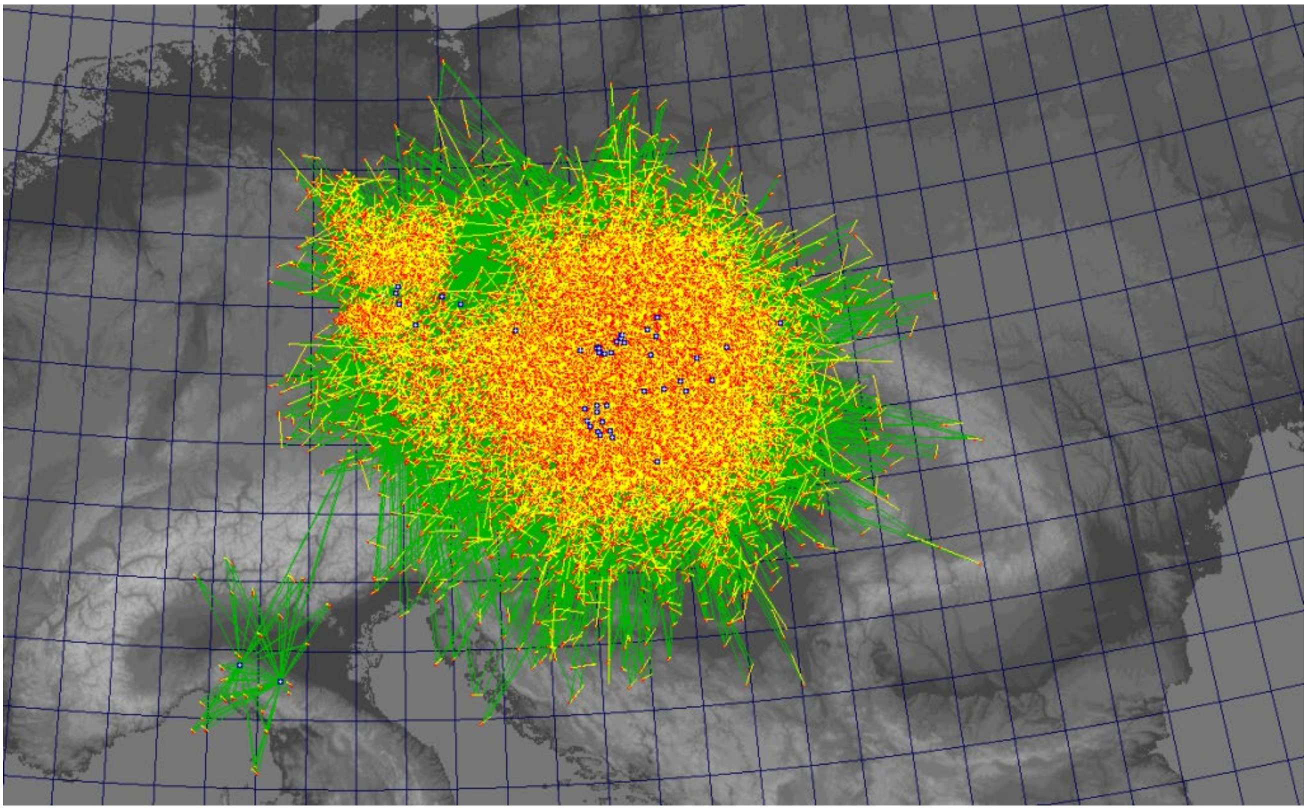
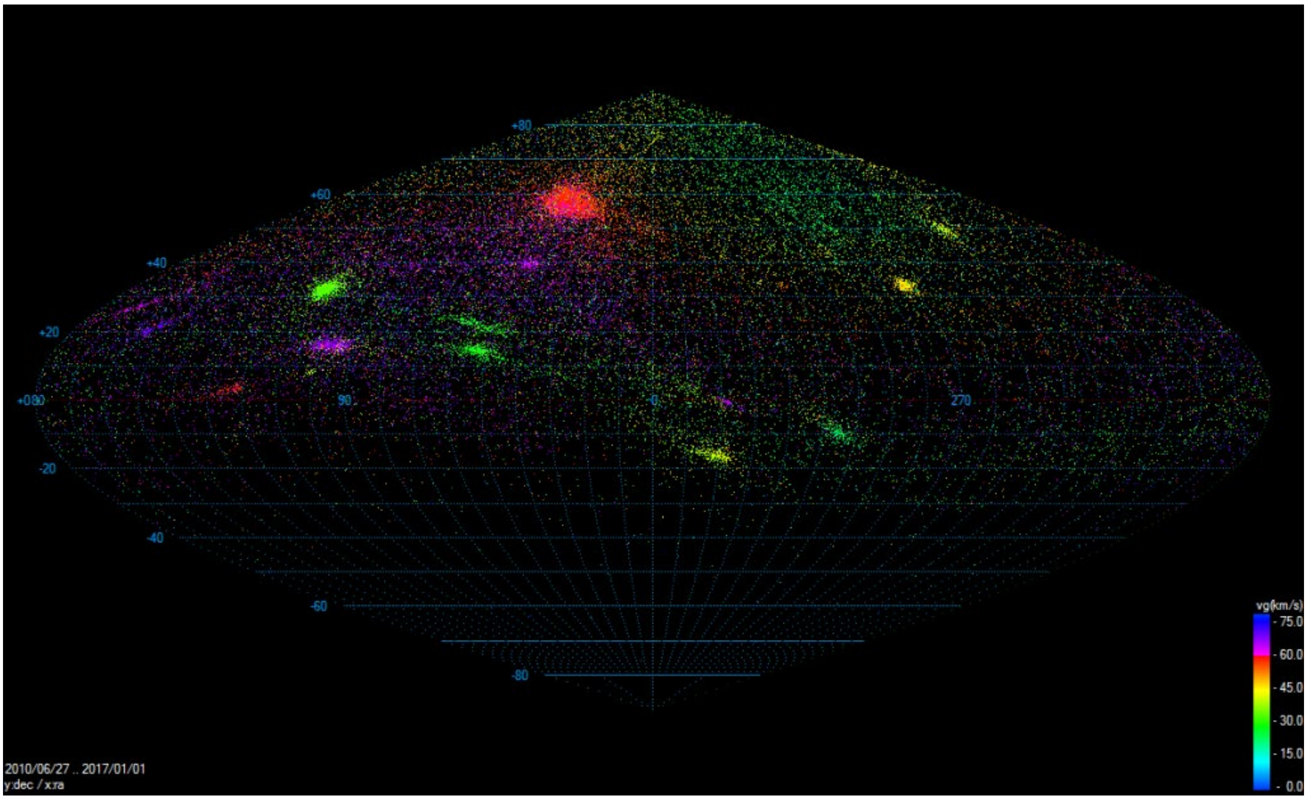
15.0
0.0
2016/01/02 .. 2017/01/01
y:ecliptic_lat / x:ecliptic_lng - sol

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+20
+000
90
0
270
-20
-40
-60
-80
vg(km/s)
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60.0
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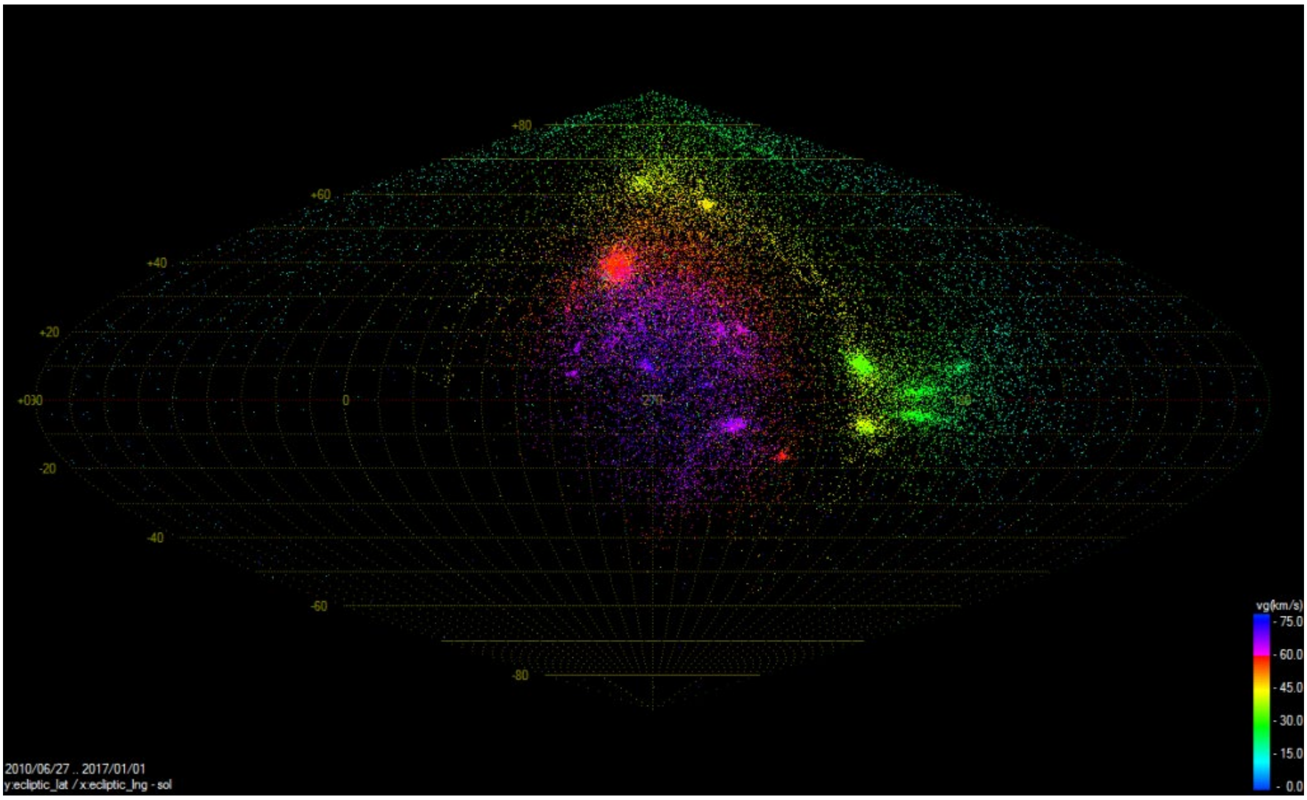
30.0
15.0
0.0
2010/06/27 .. 2017/01/01
y:dec / x:ra



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Olech A., Żołądek P., Wiśniewski M., Krasnowski M., Kwinta M., Fajfer T., Fietkiewicz K., Dorosz D., Kowalski L., Olejnik J., Mularczyk K. and Złoczewski K. (2006). "Polish Fireball Network". In Bastiaens L., Verbert J., Wislez J.-M. and Verbeeck C., editors, *Proceedings of the International Meteor Conference*, Oostmalle, Belgium, 15-18 September 2005. IMO, pages 53–62.

SonotaCo (2009). "A meteor shower catalog based on video observations in 2007-2008". *WGN, Journal of the IMO*, **37**, 55–62.

Tóth J., Kornoš L., Gajdoš Š., Kalmančok D., Zigo P., Világi J. and Hajduková M. Jr. (2008). "TV Meteor Observations from Modra". *Earth Moon Planet*, **102**, 257–261. DOI: 10.1007/s11038-007-9160-8.

R suite for analysis of the EDMOND database

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This article presents the results of statistical analysis of the EDMOND database. The growing amount of data in the database requires an effective tool for analysis and data management. This instrument is a library of scripts in the R language, developed by members of UKMON. Scripts allow elimination of bad data and an efficient statistical analysis of the database.

1 Introduction

R is a language and environment for statistical computing and graphics. It is a GNU project which is similar to the S language and environment which was developed at Bell Laboratories (formerly AT&T, now Lucent Technologies) by John Chambers and colleagues. R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, etc.) and graphical techniques, and it is highly extensible. One of R's strengths is the ease with which well-designed publication-quality plots can be produced, including mathematical symbols and formulae where needed. Great care has been taken about the defaults for the minor design choices in graphics, but the user retains full control. R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

2 Library of scripts for analysis

For the purpose of reduction and statistical analysis of the meteor database, a number of scripts were developed (Campbell-Burns et al., 2016) which use R language. Scripts allow the creation of statistical outputs in the form of graphs, such as tables. These outputs can be created for a global database (national, worldwide) and also for the individual stations. Huge benefit is a significant reduction in the time required for creating these outputs. Statistical analysis of the entire EDMOND database (Kornoš et al., 2014a) was performed globally as well as for the selected well-known (or very active) meteor showers (*Table 1*).

3 Description of the EDMOND database

The European viDeo Meteor Observation Network (EDMONd) has been established only recently (Kornoš et al., 2014a,b). The network originates from spontaneous cooperation between observers in several parts of Europe. The EDMONd Network has been enlarged in recent years and at present consists of observers from 14 national networks and the whole IMO VMN database which uses the MetRec detection software (Molau, 1999) has been implemented in the EDMOND database. Nowadays, due to the international cooperation, meteor activity is monitored over almost entire Europe. Consequently, in recent years, multi-national networks of video meteor observers have contributed many new data. As a result, the latest version of EDMOND database (v5.03, April 2016) contains 3833098 single meteors and 252425 orbits (*Figure 1*) collected from 2001 to 2015[2].

Table 1 – List of used scripts for the EDMOND database analysis, the use for complex or partial analysis is marked (EDMOND, meteor showers or both options).

Analysis type	Summary	Application
Simple counts	Meteor counts by solar longitude	EDMOND
	Number of matched observation (UNIFIED_2, UNIFIED_3, etc)	EDMOND
Magnitude	Count of stream meteors with magnitudes less than or equal to -4 (all streams)	EDMOND
	Count of meteors with magnitudes less than or equal to -4 (by stream)	EDMOND
	Scatter plot of absolute magnitude (amag) against start height (H_1) and amag against end height (H_2) for individual meteors with a least squares line fit	meteor showers
	Frequency distribution of absolute magnitudes (amag)	EDMOND
Orbital	Frequency distribution of semi-major axis (a) with a fixed (configurable) bin size	EDMOND, meteor showers
	Length of observed trajectory in the Earth´s atmosphere	EDMOND
	Scatter plot of semi-major axis (a) vs ascending node (node)	EDMOND
	Scatter plot of semi-major axis (a) vs inclination (incl)	EDMOND
Velocity	Frequency distribution of heliocentric velocity (v_s)	EDMOND
	Frequency distribution of geocentric velocities (v_g)	EDMOND, meteor showers

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

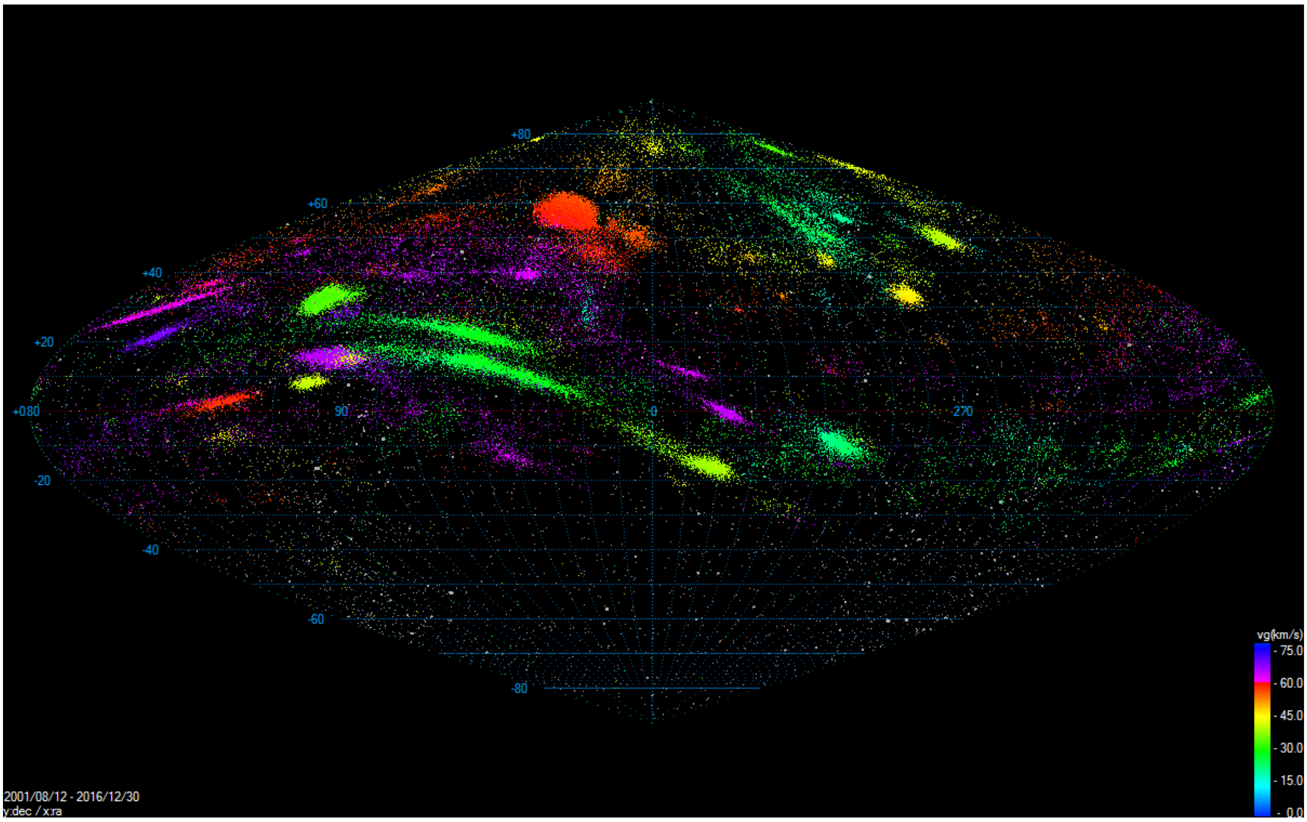


Figure 1 – Radiants of all multi-station meteors belonging to the known meteor showers between years 2001 and 2015. Hammer projection in equatorial coordinates has been applied. Author: *Jakub Koukal.*

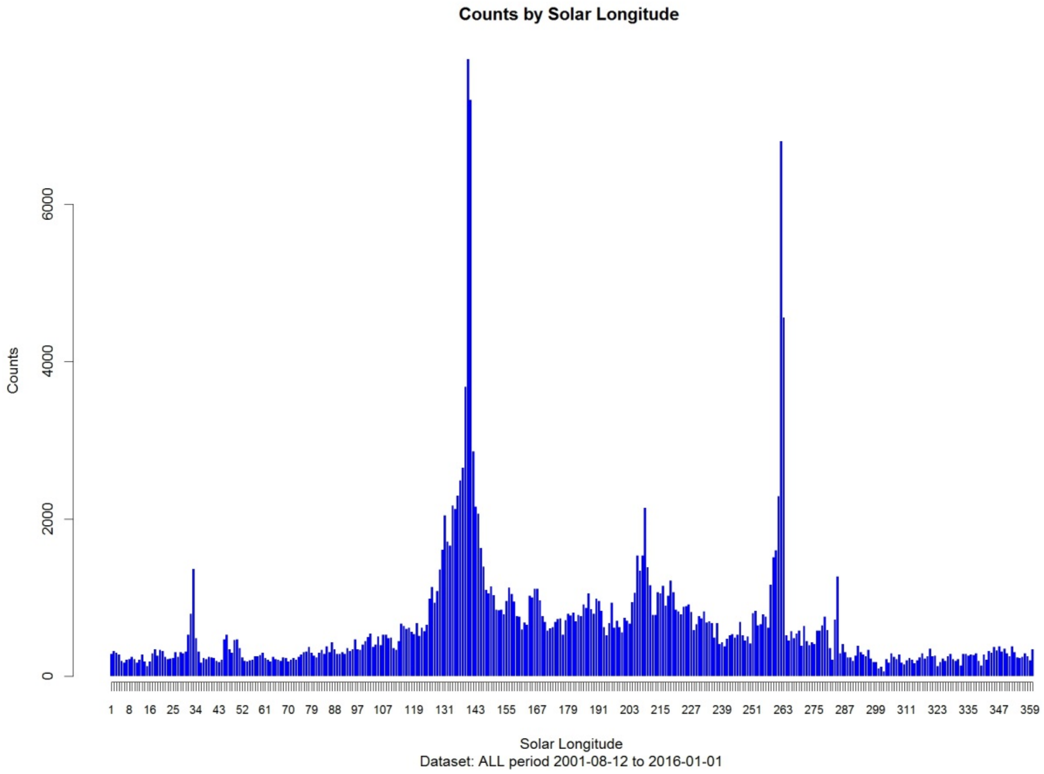


Figure 2 – Meteor counts by solar longitude (sollong). Author: *Jakub Koukal.*

4 Results – EDMOND database

The statistical analysis from the subgroup of scripts called “simple counts” is focused on the layout of overall activity of meteor showers and the sporadic background. The dependence of recorded multi-station orbits number on the solar longitude (*Figure 2*) shows the performance of meteor activity during the year and positions of strong meteor showers peaks. Significant peaks are evident around $\lambda_\odot$ of 32° (Lyrids/LYR), 140° (Perseids/PER), 208° (Orionids/ORI), 262° (Geminids/GEM) and 283° (Quadrantids/QUA). The activity of other well-known (or strong) meteor showers (e.g. Leonids/LEO or Taurids/NTA+STA) is not so markedly visible. This is caused by the irregular activity (Leonids) or long duration of activity and lower frequencies (Taurids). The graph of the stations number per one multi-station orbit (*Figure 3*) shows the performance of multi-station orbits recorded from the larger amount of stations. Approximately 75% of all multi-station orbits were recorded only from two stations, from three stations it is about 12% of the total number of multi-station orbits. Long (or bright) meteors are in many cases recorded from more than 10 stations, the highest number is a bolide recorded from 18 stations (20130817_011704).

The statistical analysis from the subgroup of scripts called "magnitude" is focused on the statistical analysis of recorded meteors absolute magnitude. The graph of the bolides number (amag less than or equal to -4) in the individual months during the year (*Figure 4*) shows the highest number of bolides in August. This is related to the Perseids swarm activity and activity of other meteor showers with a high proportion of bolides (α Capricornids/CAP, κ Cygnids/KCG, etc.). The other months with a high incidence of bolides are October (Draconids/DRA), November (Leonids, Taurids) and December (Geminids). The graph of bolides divided into individual meteor showers (*Figure 5*) shows the contribution of individual meteor showers (and sporadic meteors) to the total number of observed bolides. The highest number of bolides is in the sporadic background, because sporadic meteors make up the bulk of observed orbits. The largest number of bolides within the meteor showers is produced by the following swarms: Perseids, southern Taurids (STA), Leonids, Geminids, Orionids, northern Taurids (NTA), Comae Berenicids (COM), Quadrantids and κ Cygnids. The histogram of absolute magnitude distribution (*Figure 6*) shows the overall shape of the absolute magnitude of observed meteors (including sporadic background).

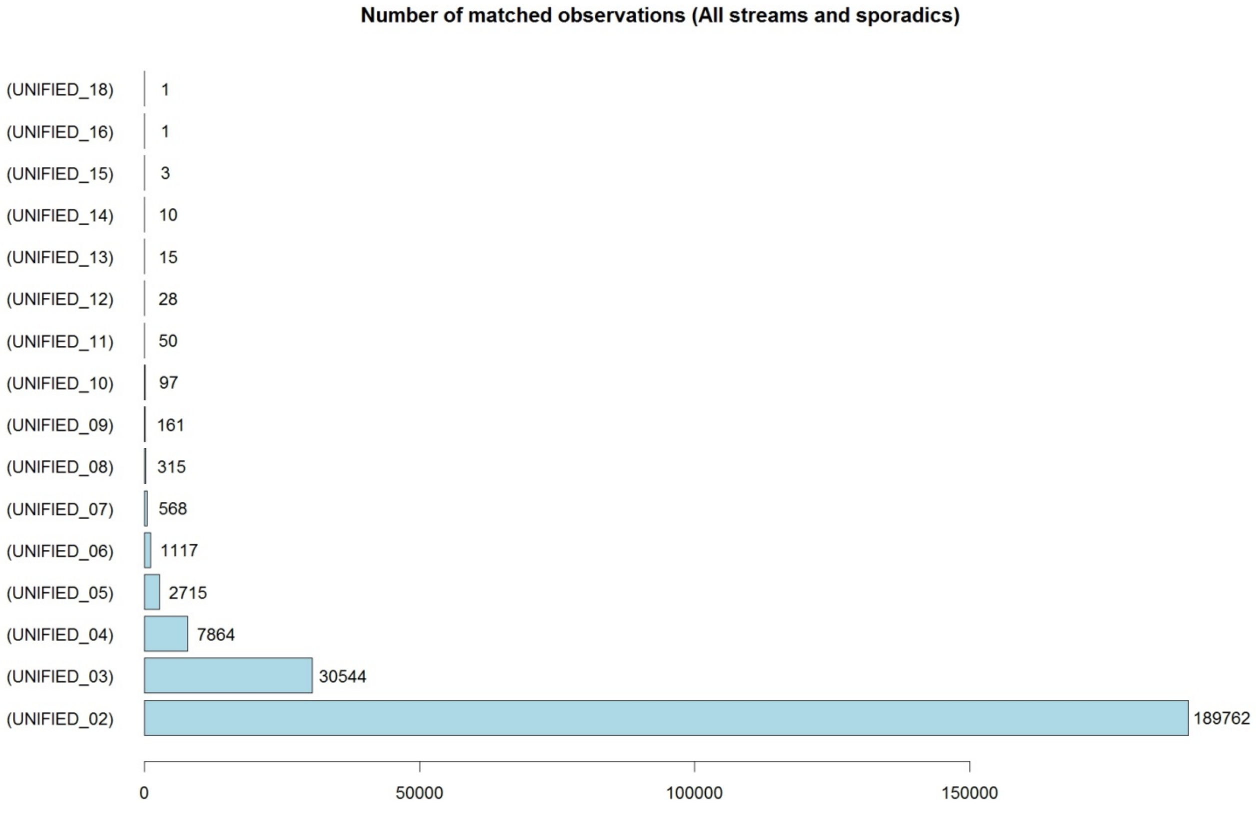


Figure 3 – Graph of the stations number per one multi-station orbit. Author: *Jakub Koukal*.

The statistical analysis from the subgroup of scripts called "*orbital*" is focused on the analysis of the orbital elements of observed meteor orbits. The histogram of the semi-major axis distribution (*Figure 7*) shows that the major part of observed meteors has a semi-major axis in the range of 1 to 6 AU. Significant peaks are in the range of 1.2 to 1.4 AU (e.g. Geminids) and also in the range of 2.0 to 2.4 AU (e.g. Taurids). In this range we find also the orbits of meteors coming from the Antihelion source (meteor showers and sporadic background) with parent bodies in the main asteroid belt or in the Jupiter's family comets. The graph of length of observed meteor trajectory in the Earth's atmosphere (*Figure 8*) shows that a length of the trajectory between 10 and 20 km is typical. The dependence of the semi-major axis on the length of the ascending node (*Figure 9*) shows mainly meteor showers with the long-period parent bodies. Clearly visible are especially Perseids, Lyrids, η Aquarids (ETA), Orionids, etc. The dependence of the inclination on the semi-major axis (*Figure 10*) again shows clearly the long-period meteor showers, e.g. Perseids, Lyrids, η Aquarids, Orionids, etc.

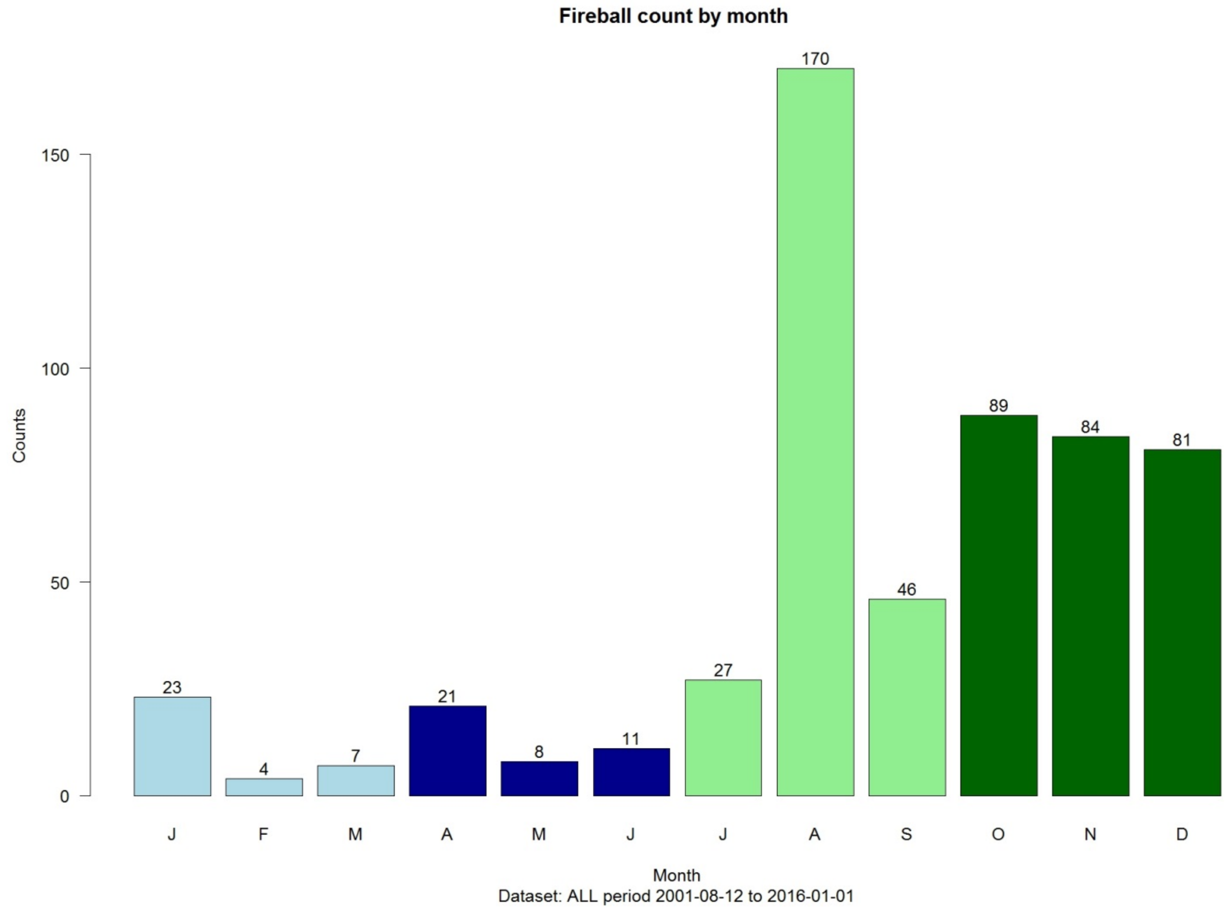


Figure 4 – Count of stream meteors with magnitudes less than or equal to -4 (all streams). Author: *Jakub Koukal*.

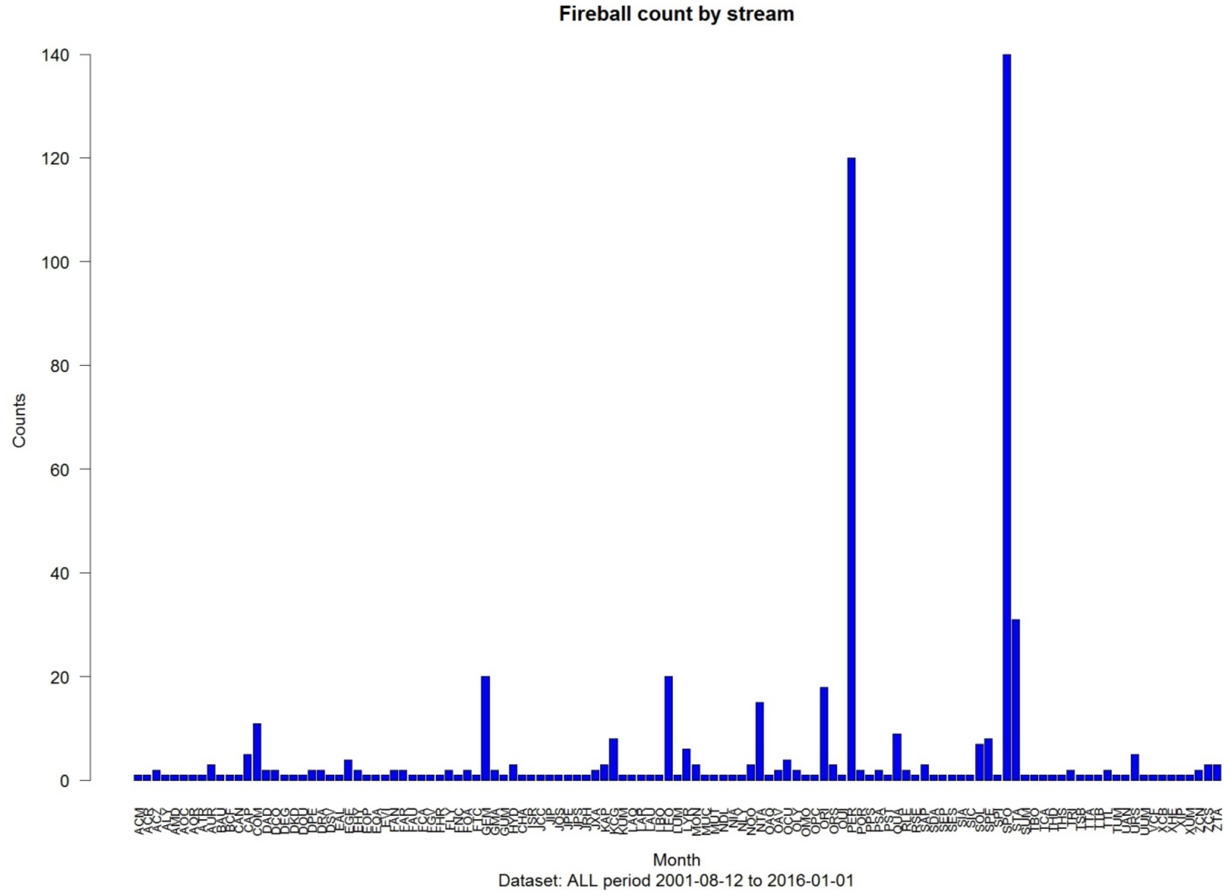


Figure 5 – Count of meteors with magnitudes less than or equal to -4 (by stream). Author: *Jakub Koukal*.

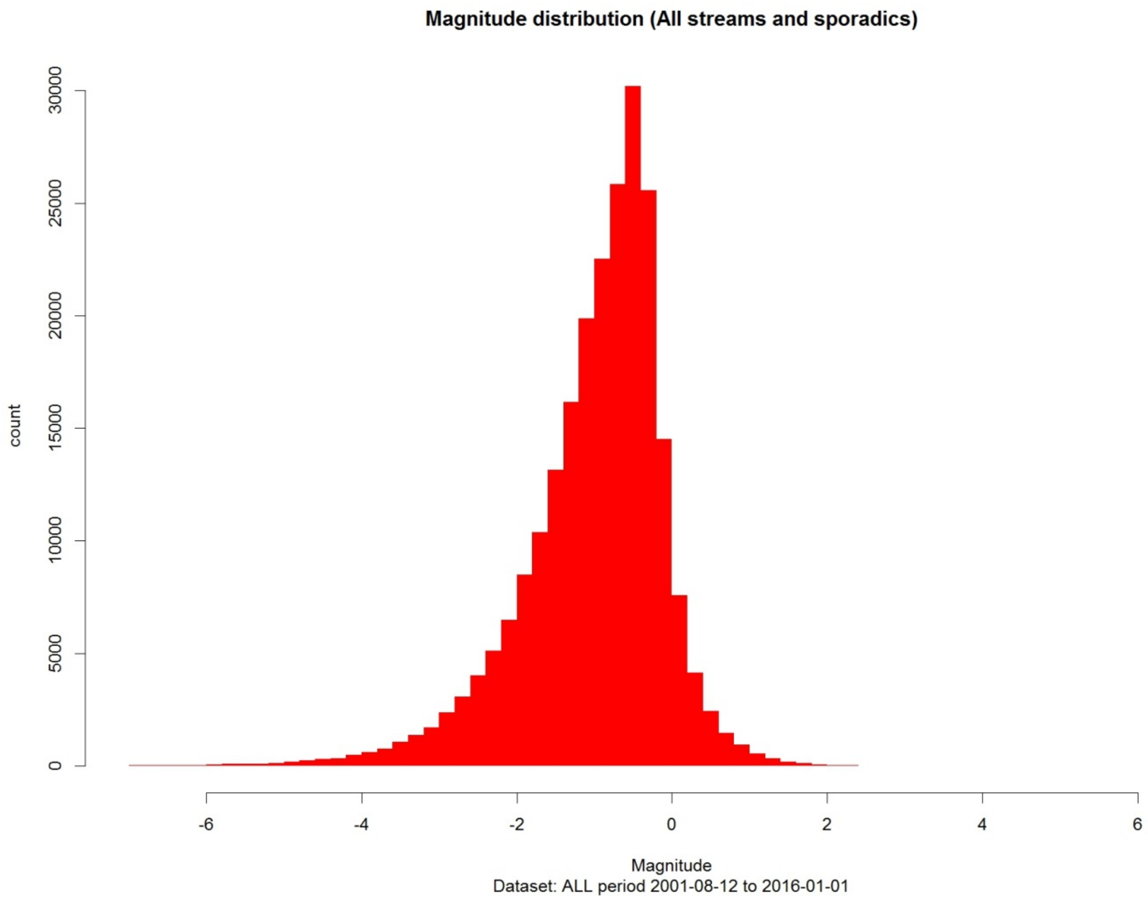


Figure 6 – Frequency distribution of absolute magnitudes (amag). Author: *Jakub Koukal*.

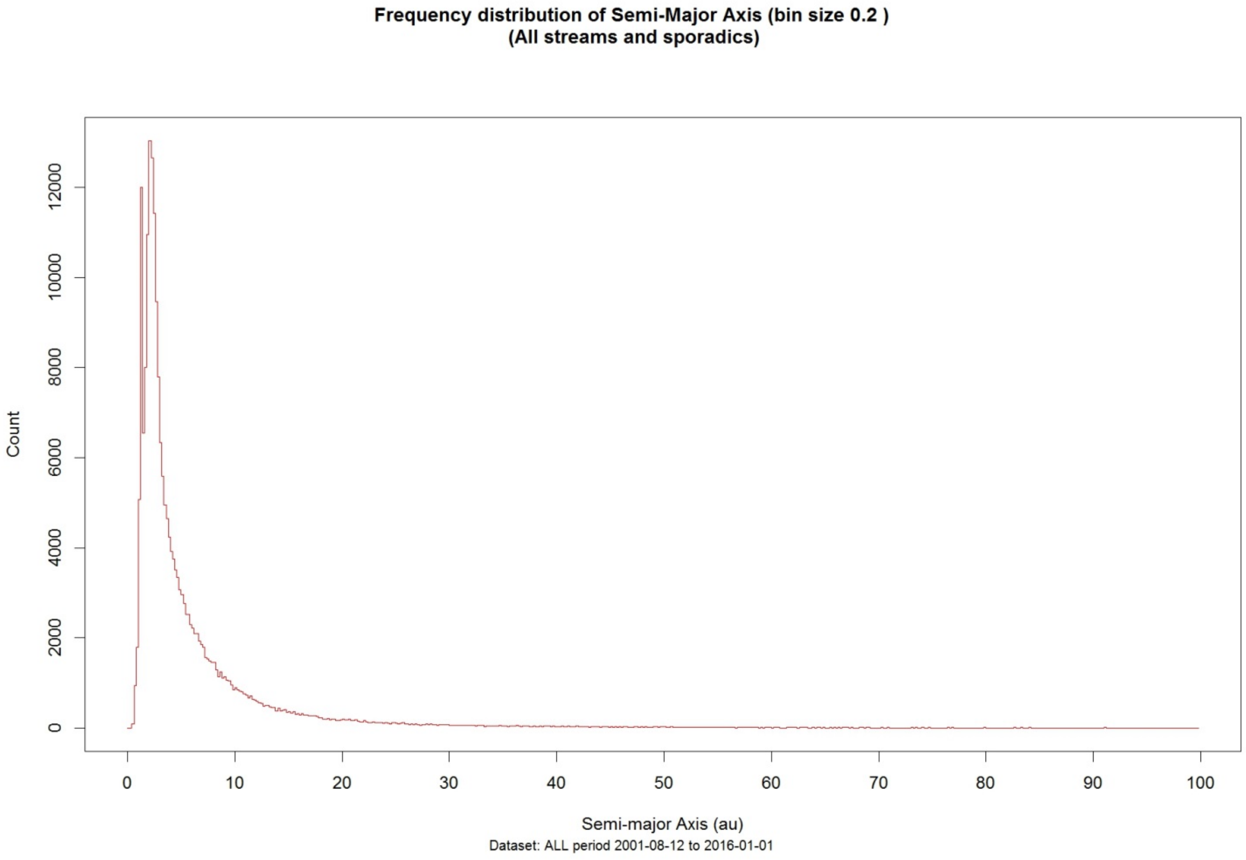


Figure 7 – Frequency distribution of semi-major axis (a) with a fixed (configurable) bin size. Author: *Jakub Koukal*.

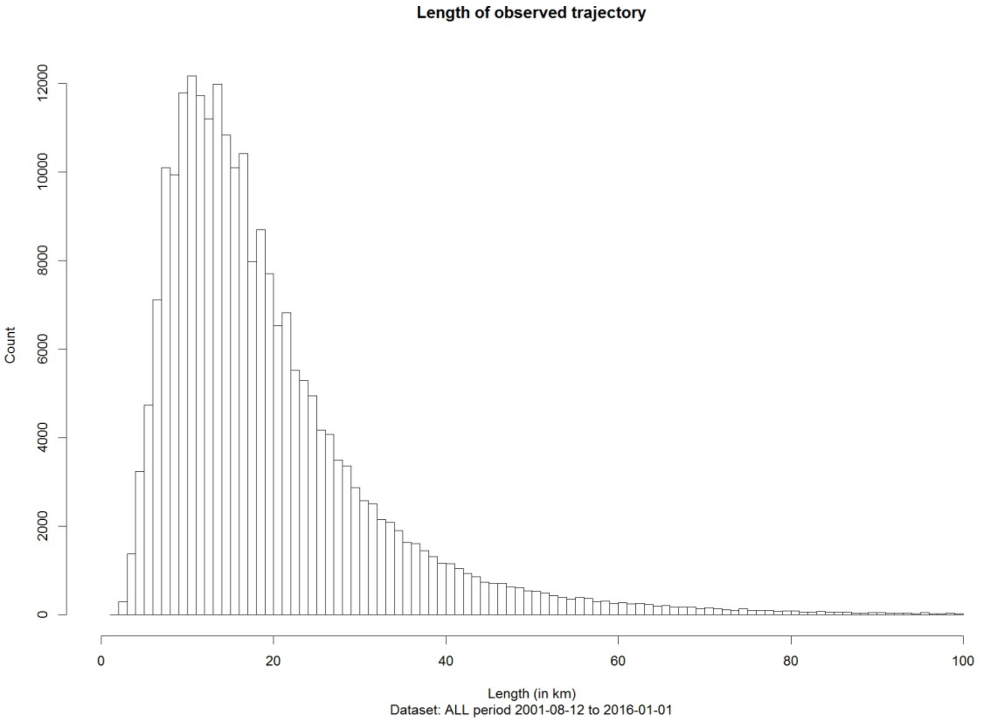
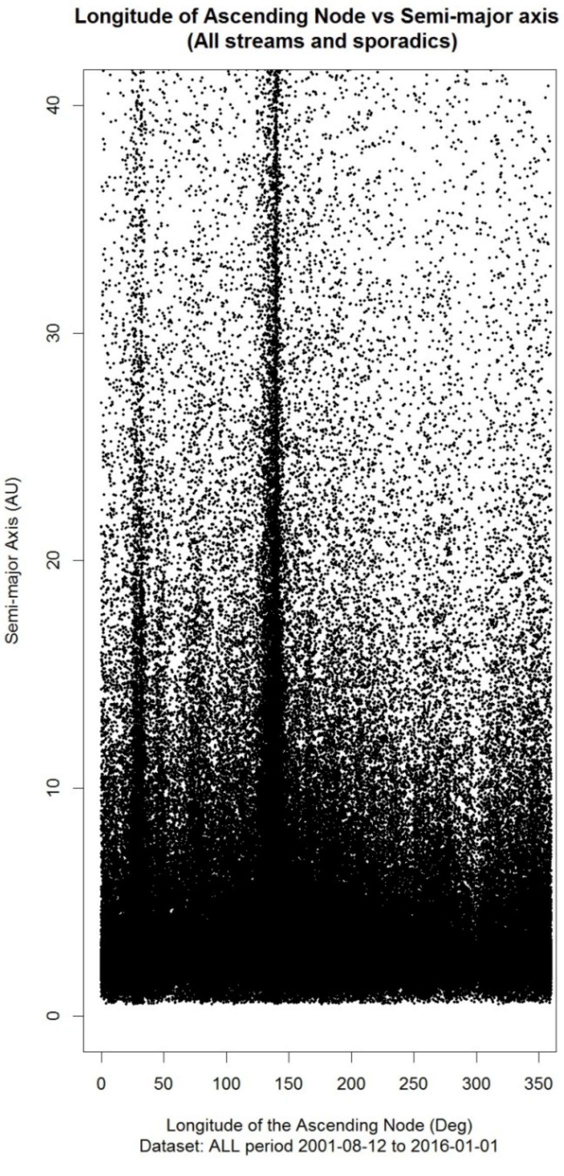


Figure 8 – Length of observed trajectory in the Earth´s atmosphere. Author: *Jakub Koukal*.



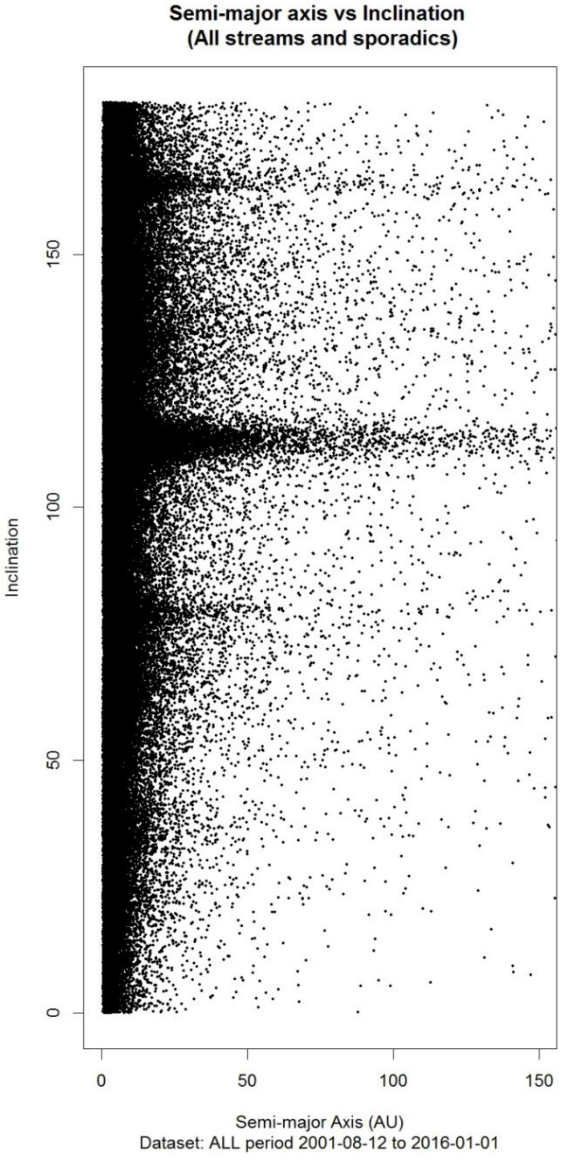


Figure 9 – Scatter plot of semi-major axis (a) vs ascending node (node). Author: *Jakub Koukal*.

Figure 10 – Scatter plot of semi-major axis (a) vs inclination (incl). Author: *Jakub Koukal*.

The statistical analysis from the subgroup of scripts called "*velocity*" shows the histogram of heliocentric (*Figure 11*) and geocentric (*Figure 12*) velocity of meteors in the EDMOND database, including the sporadic background. The histogram of the heliocentric velocity shows all hyperbolic orbits (v_h is higher than 42.14 km/s) and could show orbits of interstellar meteors (v_h is higher than 46.6 km/s). In fact, the hyperbolic orbits are only a result of the measurement errors of the individual orbits. Some meteor showers (e.g. Perseids) have a heliocentric velocity very close to the hyperbolic limit.

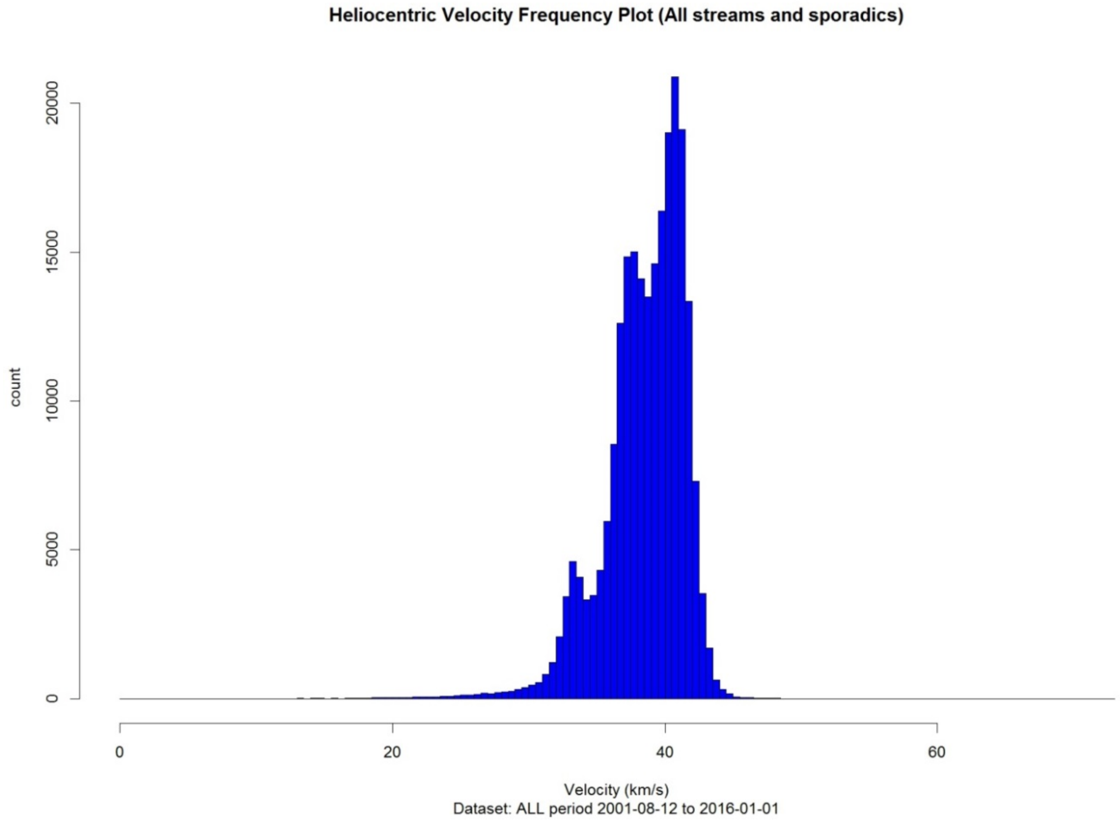


Figure 11 – Frequency distribution of heliocentric velocity (vs). Author: *Jakub Koukal*.

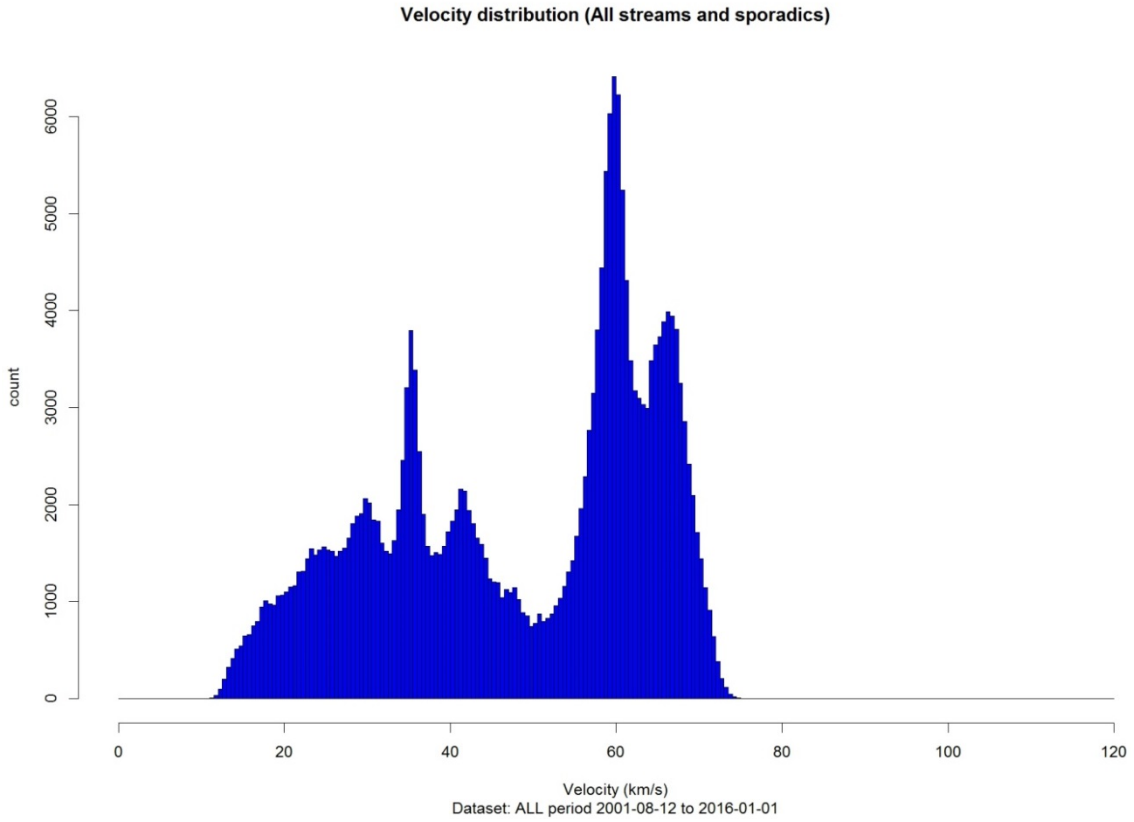


Figure 12 – Frequency distribution of geocentric velocities (v_g). Author: *Jakub Koukal*.

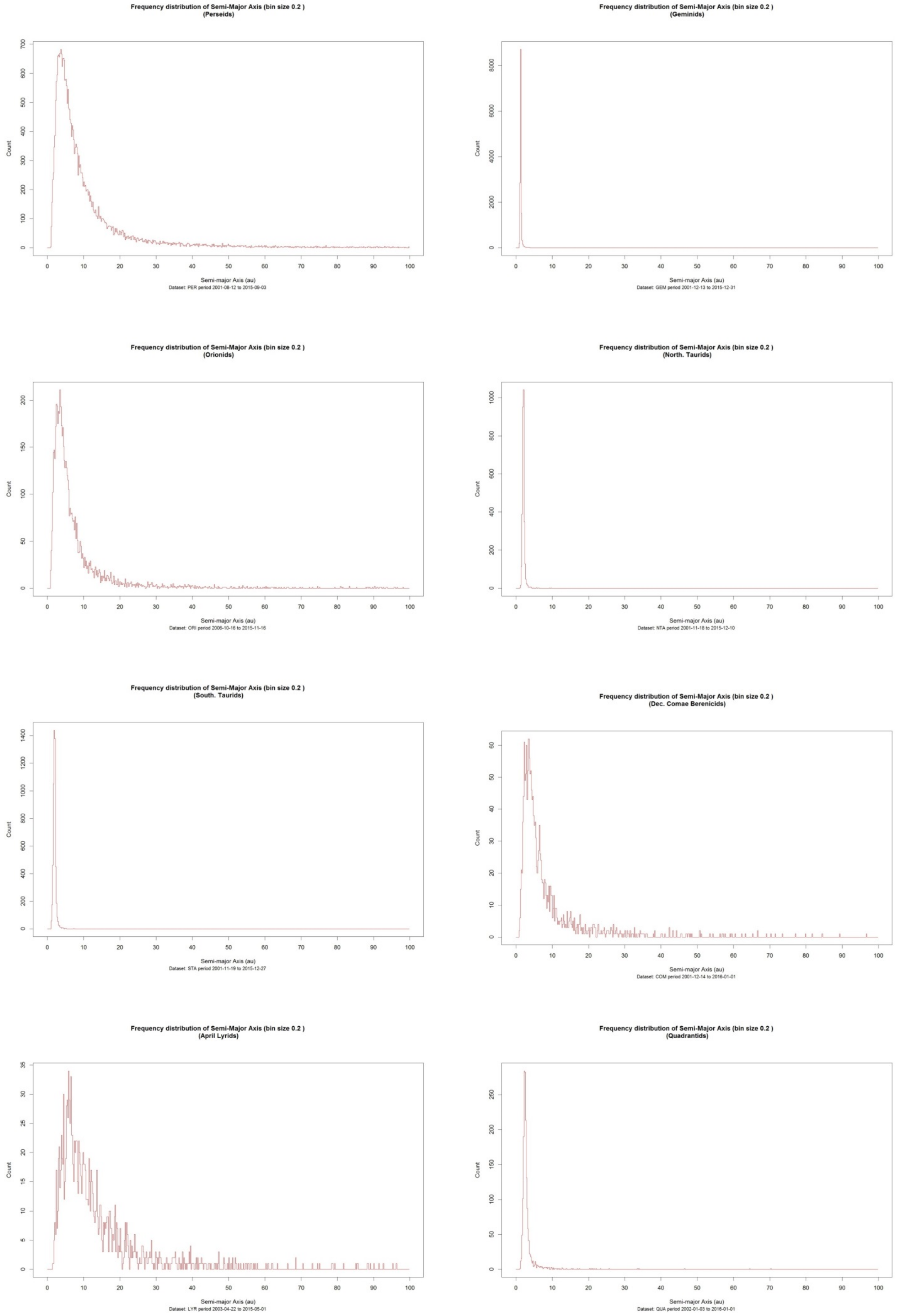


Figure 13 – Frequency distribution of the semi-major axis (a) with a fixed bin size. Author: *Jakub Koukal*.

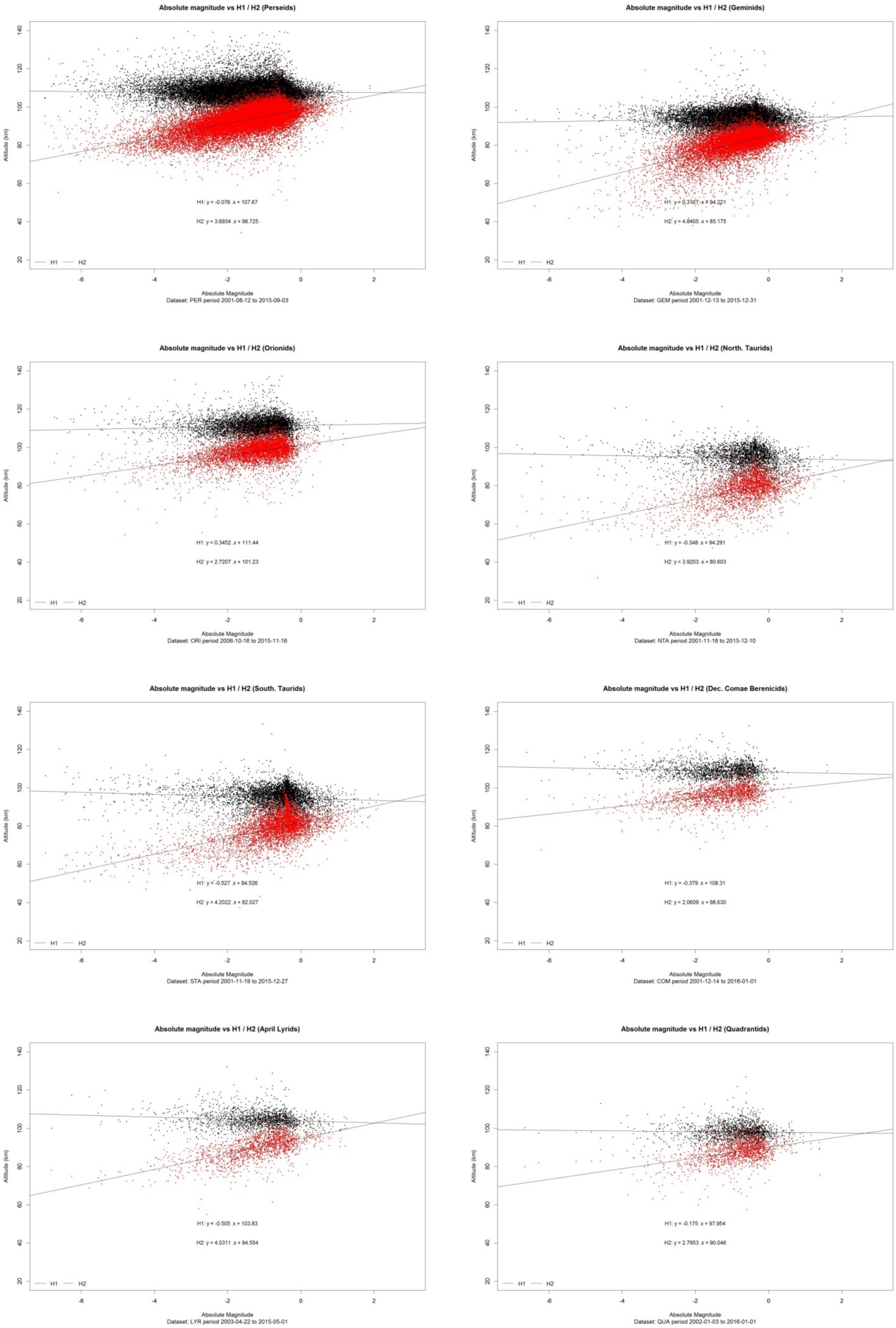


Figure 14 – Scatter plot of absolute magnitude (amag) vs start height (H_1) and end height (H_2). Author: *Jakub Koukal*.

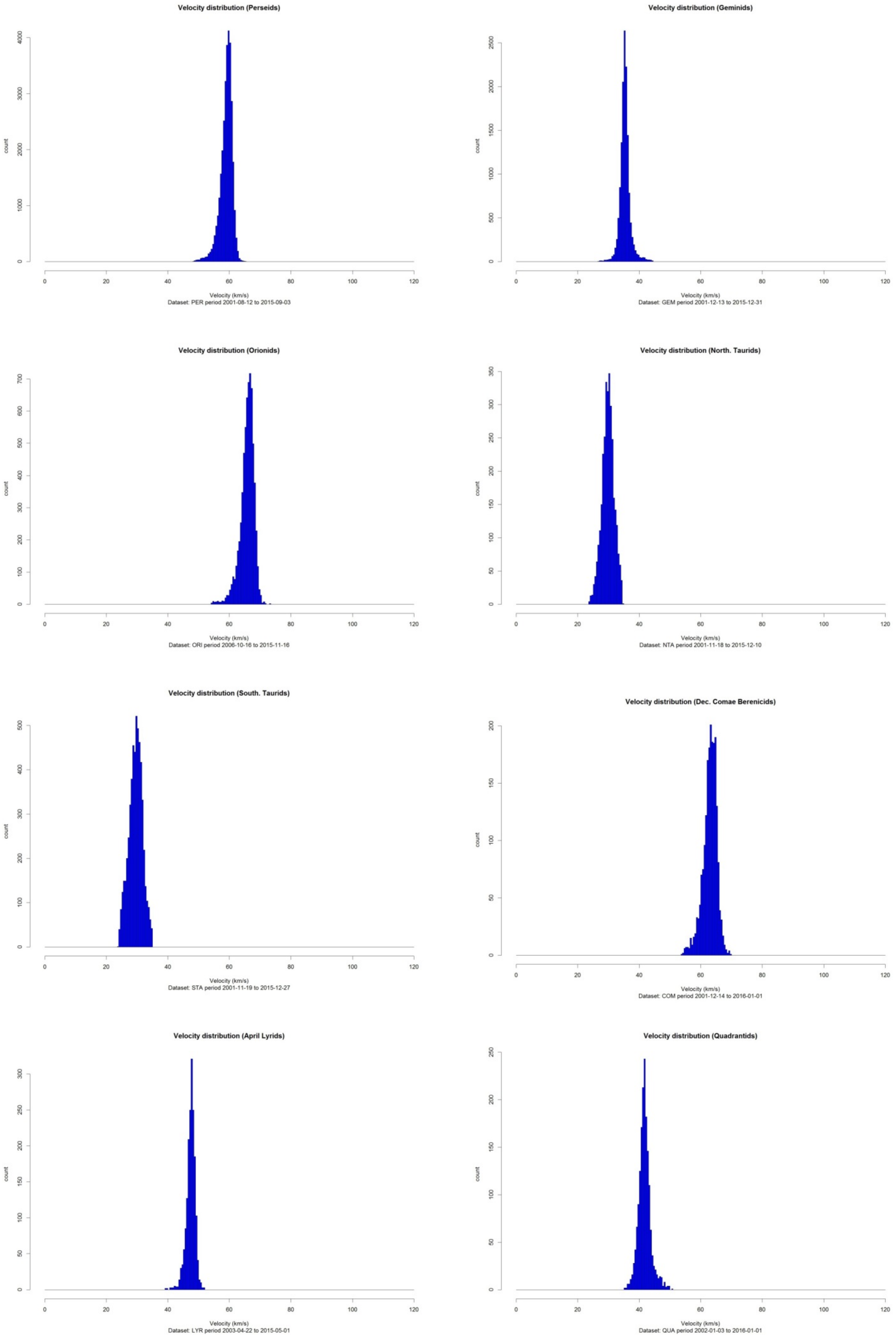


Figure 15 – Frequency distribution of geocentric velocities (v_g). Author: *Jakub Koukal*.

5 Results – meteor showers

Within the statistical analysis of each meteor shower there were 8 representatives selected, mainly well-known or very active meteor showers. The following meteor showers have been selected: Perseids, Geminids, Orionids, northern Taurids, southern Taurids, Comae Berenicids, Lyrids and Quadrantids. A comparison of the semi-major axis histograms was performed for the selected swarms (*Figure 13*), the comparison of the dependence of starting height and ending height of the atmospheric trajectory on the absolute magnitude (*Figure 14*) and the comparison of the geocentric velocity histograms (*Figure 15*).

Acknowledgment

We would like to thank all operators of all national networks and independent databases that are listed in the “European Video Meteor Network Database” whose long term and precise work enabled the compilation of the EDMOND database. Also we would like to thank all institutions involved for their still growing support of network activities.

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Established meteor shower activity periods and orbits

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The CAMS dataset of 111233 orbits collected in the period 2010-2013 has been checked to verify the online data of the IAU meteor shower list. The activity periods for all meteor streams detected in CAMS data has been derived from the solar longitudes of the individual orbits that were associated with the meteor stream. For meteor showers that were absent in the CAMS data, mainly daylight meteor streams, CMOR data has been used to complete the information. To make future associations easier and to avoid mixing up shower data, the official naming and IAU code with the orbital elements are listed in this contribution.

1 Introduction

Some CAMS-tools need a meteor shower list as reference to associate single station meteors with active radiants. So far a list has been used based on the IMO Shower Calendar. As this source proved to be rather incomplete and not up-to-date, the author prepared a new reference list based on the IAU meteor shower list[3] on request of Pete Gural, the CAMS software engineer. In order to double check the data in the published online version of the IAU meteor shower list, the original sources were consulted. Most of the currently established meteor showers (status as January 2017) have data based on recently published CAMS data (Jenniskens et al., 2016) and CMOR data (Brown et al., 2008, 2010). For a few cases that were not covered by either CAMS or CMOR, the historic data was provided by Peter Jenniskens.

Going through the official online list and the references, a number of inconsistencies were noticed which required clarification. For the CAMS data the most efficient checkup was to use the dataset made public on the NASA SETI-CAMS website. The CAMS dataset lists 111233 orbits obtained in 2010–2013. The orbits were extracted for each meteor shower and the median value has been calculated for a number of parameters. This way the inconsistencies between the online IAU list and the published references could be verified and corrected.

Regarding the CMOR data, Peter Brown provided a working list with up-to-date CMOR results which allowed checking this data too.

The survey of all the data resulted in some extra information that is not published in the online IAU Shower list. Since this extra information is definitely useful for anyone working on this topic, we share the data in this contribution. Although the information is available online, it may be practical to have the data printed on paper.

2 Activity periods for all meteor showers

The IAU Meteor shower list provides only the solar longitude valid for the orbital elements. In most cases this solar longitude is the median value of all solar longitudes of the individual orbits. In some cases this solar longitude was replaced by the solar longitude derived from the time of the observed maximum activity which is not necessarily the same as the median value. Nothing is mentioned about the activity period of the meteor showers in the IAU list.

Since CAMS collected many orbits for most of the established meteor showers, we have a reliable idea about the interval in solar longitude during which orbits could be identified for most established meteor showers. Since the criteria to associate an orbit with some meteor shower are very strict this method is far more rigorous than the assumptions based on statistics from single station meteor observations. The shower identification in the dataset we use has been done by Dr. Peter Jenniskens and the method used has been described in a recently published paper (Jenniskens et al., 2016).

In *Table 1* the activity periods are listed as derived mainly from the original CAMS dataset or the CMOR working list. Data based on CAMS is indicated with '*C*', data from CMOR with '*R*' and the few cases with older historic data with '*H*'. In most cases the number of orbits is statistical significant, but be aware that for some established meteor showers only few orbits have been collected by CAMS. The number of orbits is given in the last column of *Table 1*. The data is based on this number of orbits available and should not be interpreted in a restrictive way, but rather as the time span during which the orbits were collected in the above mentioned datasets. It is very likely that orbits will be identified in the future collected at solar longitudes before or after the current time span.

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[3] https://www.ta3.sk/IAUC22DB/MDC2007/

Table 1 – The activity periods in solar longitude for all 112 established meteor showers. The radiant position valid at $\lambda_{\odot\text{-m}}$ is given together with the radiant drift $\Delta\alpha$ and $\Delta\delta$ and the geocentric velocity V_g. Column N indicates the source for the data, 'C' stands for CAMS, 'R' for CMOR and 'H' for historic data, the number of orbits on which the data has been based is mentioned.

Shower (IAU code)	$\lambda_{\odot\text{-b}}$ (°)	$\lambda_{\odot\text{-m}}$ (°)	$\lambda_{\odot\text{-e}}$ (°)	α (°)	δ (°)	$\Delta\alpha$ (°)	$\Delta\delta$ (°)	V_g Km/s	N
κ-Serpentids (KSE – 27)	3	20	27	242.7	+16.8	+0.81	–0.20	46.7	C21
Daytime April Piscids (APS – 144)	16	26	38	4.9	+5.5	+0.94	+0.42	29.2	R2608
α-Virginids (AVB – 21)	25	32	37	203.5	+2.9	+0.91	–0.36	18.8	C12
April Lyrids (LYR – 6)	21	32.3	45	272.0	+33.4	+0.66	+0.02	46.7	C257
π-Puppids (PPU – 137)	26	33.6	40	110.4	–45.1	+0.54	–0.14	15.0	H
April ρ-Cygnids (ARC – 348)	36	38	44	322.1	+46.6	+0.66	+0.32	40.9	C42
h-Virginids (HVI – 343)	38	40	44	204.8	–11.5	+0.95	–0.36	17.2	C11
η-Aquariids (ETA – 31)	27	46.2	64	338.1	–0.8	+0.92	+0.37	65.7	C936
North. Daytime ω-Cetids (NOC – 152)	16	49	61	11.8	+18.9	+0.99	+0.36	36.2	R2279
South. Daytime ω-Cetids (OCE -153)	11	49	65	23.4	–4.3	+0.91	+0.46	37.0	R2205
η-Lyrids (ELY – 145)	47	50	53	289.9	+43.4	+0.56	+0.14	43.7	C39
South. Daytime May Arietids (SMA – 156)	36	54	59	36.3	+10.8	+0.96	+0.30	28.0	R3289
ε-Aquilids (EAU – 151)	58	63	73	294.1	+20.4	+0.78	+0.17	31.5	C11
τ-Herculids (TAH – 61)	58	72	83	228.5	+39.8	+0.67	–0.26	15.0	H14
Daytime ζ-Perseids (ZPE – 172)	56	74.5	90	56.6	+23.2	+0.99	+0.23	27.1	R2304
June μ-Cassiopeiids (JMC – 362)	58	77	84	15.8	+55.4	+1.08	+0.38	41.7	C32
Daytime Arietids (ARI – 171)	62	81	99	45.7	+25.0	+0.86	+0.18	41.1	C31
June ρ-Cygnids (JRC – 510)	82	84	87	320.5	+44.1	+0.67	+0.31	50.9	C14
β-Equuleids (BEQ – 327)	77	84	98	301.1	+0.1	+0.91	+0.23	33.2	C38
Daytime λ-Taurids (DLT – 325)	71	85.5	98	57.3	+11.4	+0.85	+0.33	35.6	R2059
South. μ-Sagittariids (SSG – 69)	77	86	104	273.2	–29.5	+1.14	+0.03	25.1	C70
Corvids (COR – 63)	79	86	95	205.8	+0.2	+0.92	–0.36	8.7	C12
ε-Perseids (EPR – 324)	86	88	91	53.8	+37.8	+1.17	+0.23	43.8	C4
Daytime β-Taurids (BTA – 173)	89	93.5	101	82.8	+20.1	+0.82	+0.05	26.8	R1386
June ι-Pegasids (JIP – 431)	91	94	96	332.1	+29.1	+0.81	+0.35	58.5	C11
June Bootids (JBO – 170)	94	96.3	98	222.9	+47.9	+0.62	–0.29	14.1	H
North. June Aquilids (NZC – 164)	75	101	119	309.7	–5.3	+0.95	+0.26	38.3	C404
φ-Piscids (PPS – 372)	78	103	130	17.0	+25.0	+0.97	+0.38	66.5	C379
South. June Aquilids (SZC – 165)	79	104	115	319.3	–27.6	+1.05	+0.30	39.2	C89
c-Andromedids (CAN – 411)	94	107	124	28.6	+47.7	+1.13	+0.35	57.5	C169
ε-Pegasids (EPG – 326)	101	109	120	330.2	+13.0	+0.87	+0.35	28.4	C33
α-Lacertids (ALA – 328)	100	109	121	348.0	+51.6	+1.10	+0.42	37.4	C2
July χ-Arietids (JXA – 533)	100	111	129	35.4	+8.8	+0.97	+0.30	68.9	C20
July Pegasids (JPE – 175)	98	112	143	346.5	+12.1	+0.90	+0.39	64.0	C104
49 Andromedids (FAN – 549)	104	118	141	25.3	+48.2	+1.07	+0.37	60.2	C76
ψ-Cassiopeiids (PCA – 187)	103	119	135	35.0	+73.3	+1.68	+0.32	42.0	C36
July γ-Draconids (GDR – 184)	119	124	127	280.1	+50.3	+0.45	+0.07	27.5	C40
α-Capricornids (CAP – 1)	101	125	138	304.6	–9.6	+0.97	+0.24	23.0	C646
Southern δ-Aquariids (SDA – 5)	117	127	146	340.0	–16.3	+0.95	+0.38	41.3	C1382
Piscis Austrinids (PAU – 183)	125	136	146	352.5	–20.5	+0.94	+0.40	43.9	C23
Daytime χ-Orionids (XRI -188)	128	137	140	107.5	+16.2	+0.70	–0.10	43.8	R1089
η-Eridanids (ERI – 191)	118	138	174	44.1	–12.4	+0.86	+0.29	64.5	C214
Perseids (PER – 7)	115	140	158	48.2	+58.1	+1.40	+0.26	59.1	C4366

Shower (IAU code)	$\lambda_{\Theta\text{-b}}$ (°)	$\lambda_{\Theta\text{-m}}$ (°)	$\lambda_{\Theta\text{-e}}$ (°)	α (°)	δ (°)	Δα (°)	Δδ (°)	V_g Km/s	N
Northern δ-Aquariids (NDA – 26)	120	141	154	347.3	+2.3	+0.91	+0.39	38.4	C251
κ-Cygnids (KCG – 12)	136	141	144	277.5	+52.8	+0.40	+0.05	20.9	C25
August Draconids (AUD – 197)	140	143	146	271.7	+58.9	+0.26	+0.01	21.1	C17
Northern ι-Aquariids (NIA – 33)	133	148	160	346.7	–1.2	+0.92	+0.39	31.3	C94
β-Hydrids (BHY – 198)	142	143.8	146	36.3	–74.5	+0.08	+0.32	22.8	H
Aurigids (AUR – 206)	145	158.6	164	90.9	+38.6	+1.24	–0.01	65.6	C19
Daytime ζ-Cancrids (ZCA – 202)	140	160	167	136.1	+11.7	+0.92	–0.18	42.1	R949
September ε-Perseids (SPE – 208)	161	168	190	48.8	+39.7	+1.17	+0.26	64.8	C85
ν-Eridanids (NUE – 337)	150	181	234	77.1	+6.4	+0.95	+0.19	67.1	C291
Daytime κ-Leonids (KLE – 212)	164	183	200	162.3	+14.9	+0.62	–0.30	43.3	R1366
Daytime Sextantids (DSX – 221)	174	186	197	154.1	–1.5	+0.91	–0.37	32.9	C14
October Capricornids (OCC – 233)	177	189.7	201	303.0	–10.0	+0.98	+0.22	10	H
October Camelopardalids (OCT – 281)	192	193	196	166.0	+79.1	+1.38	–0.39	46.6	H
October Draconids (DRA – 9)	195	195	196	262.9	+55.7	+0.34	–0.05	20.7	H
ε-Geminids (EGE – 23)	187	198	212	93.8	+28.1	+1.13	–0.03	69.6	C31
October Ursae Majorids (OCU – 333)	201	202	203	145.0	+64.8	+1.39	–0.33	55.6	C9
Orionids (ORI – 8)	180	209	245	95.9	+15.7	+1.03	–0.05	66.3	C3024
Leonis Minorids (LMI – 22)	199	209	223	159.9	+36.6	+1.02	–0.38	61.9	C64
χ-Draconids (XDR – 242)	209	210.8	215	171.2	+70.6	+0.98	–0.63	37.1	R1363
λ-Ursae Majorids (LUM – 524)	213	214	215	157.8	+50.2	+1.09	–0.37	60.9	C4
Southern Taurids (STA – 2)	180	216	272	47.9	+12.8	+0.99	+0.26	26.6	C916
Northern Taurids (NTA – 17)	181	220	267	48.9	+20.7	+1.03	+0.26	28.0	C509
χ-Taurids (CTA – 388)	207	221	235	63.0	+26.2	+1.09	+0.18	41.1	C52
Southern λ-Draconids (SLD – 526)	219	221	222	162.0	+68.2	+1.21	–0.38	49.1	C13
o-Eridanids (OER – 338)	201	222	242	54.0	–1.5	+0.92	+0.20	29.1	C94
Andromedids (AND – 18)	213	223	235	20.7	+28.0	+1.00	+0.37	18.2	C39
κ-Ursae Majorids (KUM – 445)	221	225	228	147.2	+45.0	+1.13	–0.34	65.7	C8
ρ-Puppids (RPU – 512)	226	231	237	130.4	–26.3	+0.77	–0.26	57.8	C22
Leonids (LEO – 13)	220	235.3	248	153.8	+21.8	+0.99	–0.36	70.2	C268
α-Monocerotids (AMO – 246)	238	239.3	240	116.8	+0.9	+0.97	–0.09	63.0	H
Southern χ-Orionids (ORS – 257)	238	243	268	73.0	+17.8	+1.04	+0.11	27.9	C97
November θ-Aurigids (THA – 390)	229	244	249	95.7	+34.7	+1.19	–0.04	32.5	C82
November Orionids (NOO – 250)	225	247	265	90.6	+15.2	+1.03	–0.01	42.5	C369
December κ-Draconids (DKD – 336)	250	252	255	187.2	+70.2	+0.77	–0.39	43.8	C36
December φ-Cassiopeiids (DPC – 446)	246	252	258	19.5	+57.7	+1.14	+0.37	16.5	C68
Phoenicids (PHO – 254)	252	253	254	15.6	–44.7	+0.81	+0.38	11.7	H
ψ-Ursae Majorids (PSU – 339)	250	253	258	169.8	+42.4	+0.98	–0.39	61.7	C18
December α-Draconids (DAD – 334)	248	256	263	210.8	+58.6	+0.58	–0.34	40.8	C47
η-Hydrids (EHY – 529)	248	257	274	132.3	+2.5	+0.93	–0.27	62.4	C83
December Monocerotids (MON – 19)	246	261	275	102.9	+7.8	+0.97	–0.09	41.4	C240
December σ-Virginids (DSV – 428)	249	261.8	271	200.8	+5.8	+0.90	–0.37	66.2	C22
Geminids (GEM – 4)	243	262.2	270	113.5	+32.3	+1.15	–0.16	33.8	C5103
σ-Hydrids (HYD – 16)	188	266	275	134.4	–0.1	+0.92	–0.28	58.9	C529
December χ-Virginids (XVI – 335)	248	267	280	194.3	–12.0	+0.94	–0.39	69.1	C46
Ursids (URS – 15)	267	270.1	272	219.9	+75.4	+0.05	–0.31	32.9	C62

Shower (IAU code)	$\lambda_{\odot\text{-b}}$ (°)	$\lambda_{\odot\text{-m}}$ (°)	$\lambda_{\odot\text{-e}}$ (°)	α (°)	δ (°)	Δα (°)	Δδ (°)	V_g Km/s	N
α-Lyncids (ALY – 252)	266	272	274	140.4	+39.8	+1.13	–0.31	49.5	C3
σ-Serpentids (SSE – 330)	272	273	275	242.6	–4.8	+0.95	–0.16	45.5	C3
Comae Berenicids (COM – 20)	252	274	302	167.0	+28.0	+0.96	–0.39	63.3	C497
ω-Serpentids (OSE – 320)	277	279	281	252.3	–5.8	+0.99	–0.37	45.0	C2
January Leonids (JLE – 319)	279	283	287	147.7	+24.1	+1.01	–0.34	51.4	C13
α-Hydrids (AHY – 331)	265	283	297	126.9	–8.7	+0.87	–0.24	43.3	C119
Quadrantids (QUA – 10)	270	283.2	297	230.2	+49.5	+0.56	–0.25	40.7	C1029
Daytime χ-Sagittariids (XSA – 100)	278	288	296	282.3	–16.3	+0.77	+0.12	25.3	R896
Southern δ-Cancrids (SCC – 97)	278	289	298	125.0	+14.4	+1.00	–0.23	27.0	C69
χ-Coronae Borealids (XCB – 323)	293	296	300	250.9	+29.7	+0.70	–0.13	45.1	C26
Northern δ-Cancrids (NCC – 96)	273	296	303	127.6	+21.5	+1.04	–0.25	27.2	C74
θ-Coronae Borealids (TCB – 321)	287	296	304	233.6	+34.4	+0.30	+0.16	37.7	R3560
λ-Bootids (LBO – 322)	280	296	297	221.5	+42.4	+1.04	–0.76	40.7	R2743
γ-Ursae Minorids (GUM – 404)	289	298	300	228.3	+69.2	+0.14	–0.26	28.8	C26
January χ-Ursae Majorids (XUM – 341)	295	298	302	168.7	+33.0	+0.97	–0.39	40.9	C30
η-Corvids (ECV – 530)	296	302	309	192.2	–17.3	+0.95	–0.39	68.1	C15
α-Antliids (AAN – 110)	304	312	328	157.2	–9.5	+0.89	–0.37	45.0	C34
o-Hydrids (OHY – 569)	306	313	319	179.2	–34.9	+0.92	–0.40	58.2	C12
February ε-Virginids (FEV – 506)	300	314	328	200.4	+11.0	+0.89	–0.37	62.9	C55
February η-Draconids (FED – 427)	314	315	316	239.6	+62.4	+0.26	–0.20	35.1	C9
α-Centaurids (ACE – 102)	313	319.4	330	210.9	–58.2	+1.26	–0.34	59.3	H
Daytime κ-Aquariids (MKA – 128)	346	350	5	332.0	–8.4	+1.75	+0.39	31.4	R1457
x Herculids (XHE – 346)	348	350	352	253.0	+49.2	+0.48	–0.10	35.2	C4
η-Virginids (EVI – 11)	350	357	4	184.8	+3.9	+0.92	–0.40	26.6	C54

The value $\lambda_{\odot\text{-m}}$ is the median value for all orbits, unless observations allowed determining the solar longitude of the maximum activity in a more precise way. $\lambda_{\odot\text{-b}}$ is the integer value of the solar longitude at which the earliest orbit has been recorded and $\lambda_{\odot\text{-e}}$ the integer value of the solar longitude after the solar longitude of the last orbit, e.g. if the last $\lambda_{\odot}$ was 26.3° then $\lambda_{\odot\text{-e}}$ was set as 27°.

For some showers which are labelled as daylight stream we used CAMS data where possible. Some of these showers produced enough meteors for CAMS to derive a relevant orbit. Most daylight streams were documented from CMOR data only. In cases with CMOR data for nighttime streams, the absence of CAMS data is most likely due to the fact that CMOR detects data from many more faint meteors while CAMS detects meteors in the fireball range up to magnitude +5.0. Showers that produce mainly meteors fainter than +5.0 will not easily show up in CAMS data.

3 Orbits for all showers

Checking for the activity period of each shower offered an easy bonus to have the orbital elements checked again based on the original dataset. The results are listed in *Table 2*. The median value has been calculated for each orbital element. *Table 2* is complementary to *Table 1* and can be compared using the IAU code. The values for $\lambda_{\odot\text{-m}}$ and V_g are displayed in *Table 2* as well. The number of orbits available and listed under N in *Table 1* should be observed to consider the relevance of the orbit for the stream. Many of these minor showers will benefit from additional orbits collected since 2013.

During past 10 years the video meteor networks such as CAMS allowed to discover or to confirm many different meteor showers. Many of these shower names are not familiar at all to most amateurs. The IAU code provides a short unique identification, but still the multiple new minor meteor showers risk to confuse amateurs and even professional meteor workers. Such a situation occurred with the prediction of a possible shower activity from a radiant not listed among the established meteor showers, but which by mistake got announced as a possible enhanced activity of the December φ-Cassiopeiids (DPC – 446). Both activity period and radiant position were wrong, but in spite of this obvious erroneous name association, the mistake remained unnoticed until some amateur claimed having observed activity long after the predicted date. This weird story caused even more

Table 2 – The orbital elements for all 112 established meteor showers.

IAU code	$\lambda_{\odot\text{-}m}$ (°)	V_g Km/s	a A.U.	q A.U.	i (°)	e	ω (°)	Ω (°)	Π (°)	T_j
KSE – 27	20	46.7	7.90	0.489	72.5	0.971	273.4	20.1	292.1	1.41
APS – 144	26	29.2	1.53	0.249	4.5	0.837	049.5	26.0	75.5	3.99
AVB – 21	32	18.8	2.55	0.744	7.0	0.716	247.9	30.0	278.3	3.03
LYR – 6	32.3	46.7	10.80	0.921	79.4	0.956	214.0	32.3	246.1	0.47
PPU – 137	33.6	15.0	2.97	1.000	21.0	0.663	359.0	213.6	-	-
ARC – 348	38	40.9	6.14	0.842	69.7	0.864	130.3	39.4	169.6	1.21
HVI – 343	40	17.2	2.28	0.742	0.9	0.659	72.7	218.2	290.9	3.28
ETA – 31	46.2	65.7	7.41	0.587	163.6	0.955	98.4	46.2	144.9	-0.49
NOC – 152	49	36.2	1.44	0.117	34.8	0.919	32.1	49.0	81.1	3.95
OCE -153	49	37.0	1.70	0.128	34.8	0.924	215.2	229.0	84.2	3.43
ELY – 145	50	43.7	21.42	0.999	74.1	0.954	192.3	50.1	242.7	0.59
SMA – 156	54	28.0	1.61	0.296	4.4	0.817	235.0	234.0	109.0	3.86
EAU – 151	63	31.5	0.82	0.405	64.6	0.513	322.8	62.5	26.3	6.55
TAH – 61	72	15.0	2.69	0.970	19.6	0.640	204.2	72.6	276.1	-
ZPE – 172	74.5	27.1	1.65	0.331	3.9	0.800	58.8	74.0	132.9	3.83
JMC – 362	77	41.7	6.04	0.629	68.5	0.913	100.6	77.4	175.1	1.03
ARI – 171	81	41.1	2.67	0.078	27.7	0.974	28.7	79.1	106.7	2.21
JRC – 510	84	50.9	1.03	0.157	46.5	0.849	327.6	84.8	55.0	5.39
BEQ – 327	84	33.2	12.00	1.006	89.3	0.996	191.0	84.5	275.3	0.03
DLT – 325	85.5	35.6	1.50	0.112	22.6	0.925	211.7	266.0	117.7	3.84
SSG – 69	86	25.1	2.35	0.999	2.6	0.571	193.7	91.8	284.2	3.33
COR – 63	86	08.7	2.02	0.457	6.0	0.769	104.5	266.4	10.8	3.39
EPR – 324	88	43.8	9.05	0.167	53.0	0.982	46.8	87.9	134.8	0.87
BTA – 173	93.5	26.8	1.94	0.383	3.5	0.802	246.5	274.0	160.5	3.41
JIP – 431	94	58.5	7.44	0.903	112.8	0.928	219.9	094.1	313.9	-0.02
JBO – 170	96.3	14.1	3.30	1.016	18.4	0.692	183.6	96.0	-	-
NZC – 164	101	38.3	1.80	0.114	38.8	0.937	326.9	101.7	67.7	3.21
PPS – 372	103	66.5	6.63	0.889	150.4	0.882	136.9	102.9	240.7	-0.28
SZC – 165	104	39.2	2.04	0.105	36.1	0.952	148.2	282.8	71.7	2.87
CAN – 411	107	57.5	8.40	0.687	112.9	0.938	109.1	107.4	215.2	0.10
EPG – 326	109	28.4	0.73	0.144	49.0	0.806	337.8	109.3	88.4	7.39
ALA – 328	109	37.4	1.07	0.976	77.7	0.088	122.2	114.5	236.8	5.05
JXA – 533	111	68.9	10.65	0.860	170.4	0.955	312.3	291.3	241.7	-0.83
JPE – 175	112	64.0	7.26	0.562	149.2	0.960	265.0	112.4	20.9	-0.43
FAN – 549	118	60.2	7.71	0.898	117.9	0.922	139.8	118.0	261.4	-0.08
PCA – 187	119	42.0	4.07	0.829	74.0	0.802	125.0	119.3	245.3	1.58
GDR – 184	124	27.5	16.42	0.977	40.3	0.967	202.5	124.7	327.4	1.12
CAP – 1	125	23.0	2.54	0.578	7.5	0.774	268.9	125.4	33.7	2.93
SDA – 5	127	41.3	2.59	0.069	29.0	0.975	152.9	306.6	98.9	2.16
PAU – 183	136	43.9	5.66	0.132	53.1	0.980	139.1	315.2	94.4	1.05
XRI -188	137	43.8	3.24	0.046	32.2	0.986	202.7	317.0	159.7	1.83
ERI – 191	138	64.5	10.33	0.953	132.7	0.945	28.4	317.7	343.0	-0.53
PER – 7	140	59.1	9.57	0.949	113.1	0.950	150.4	139.3	288.7	-0.19
NDA – 26	141	38.4	2.95	0.995	32.5	0.662	196.9	140.0	337.4	2.73

IAU code	$\lambda_{\Theta\text{-m}}$ (°)	V_g Km/s	a A.U.	q A.U.	i (°)	e	ω (°)	Ω (°)	Π (°)	T_j
KCG – 12	141	20.9	1.99	0.090	22.3	0.955	330.7	140.8	111.1	2.95
AUD – 197	143	21.1	2.82	1.008	33.8	0.644	188.7	142.6	331.2	2.77
NIA – 33	148	31.3	3.25	0.966	35.0	0.703	27.3	323.8	-	-
BHY – 198	143.8	22.8	1.76	0.234	5.9	0.874	310.5	147.8	97.9	3.51
AUR – 206	158.6	65.6	13.23	0.663	149.1	0.956	107.3	156.2	263.9	-0.51
ZCA – 202	160	42.1	4.64	0.088	16.6	0.981	212.6	340.0	192.6	1.47
SPE – 208	167	64.8	8.81	0.718	139.9	0.979	245.3	168.2	54.7	-0.62
NUE – 337	181	67.1	7.04	0.867	150.7	0.916	43.7	0.6	43.2	-0.47
KLE – 212	183	43.3	6.79	0.091	24.1	0.987	33.8	183.0	216.8	1.10
DSX – 221	186	32.9	1.14	0.147	24.3	0.874	214.3	6.4	219.1	4.96
OCC – 233	189.7	10	4.26	0.987	0.8	0.769	190.8	203.8	-	-
OCT – 281	193	46.6	50.00	0.993	79.3	0.980	170.5	192.6	-	-
DRA – 9	195	20.7	3.15	0.996	31.4	0.706	173.2	195.0	8.3	2.52
EGE – 23	198	69.6	11.30	0.813	171.2	0.957	230.9	198.4	68.8	-0.79
OCU – 333	202	55.6	12.63	0.982	100.6	0.967	165.9	202.2	8.2	-0.05
ORI – 8	209	66.3	6.87	0.578	163.9	0.944	82.2	28.3	111.0	-0.38
LMI – 22	209	61.9	10.60	0.620	125.2	0.989	104.3	208.2	313.4	-0.46
XDR – 242	210.8	37.1	1.28	0.986	71.9	0.231	162.3	211.0	13.3	4.36
LUM – 524	214	60.9	3.10	0.920	114.5	1.008	148.5	213.5	4.1	-0.54
STA – 2	216	26.6	1.95	0.353	5.3	0.798	116.6	34.4	149.6	3.40
NTA – 17	220	28.0	2.13	0.355	3.0	0.829	294.6	220.6	158.5	3.16
CTA – 388	221	41.1	4.76	0.100	15.0	0.980	324.7	220.9	191.2	1.41
SLD – 526	221	49.1	4.47	0.987	89.0	0.779	188.5	221.1	50.3	1.21
OER – 338	222	29.1	3.73	0.476	20.4	0.872	95.9	42.3	140.3	2.17
AND – 18	223	18.2	2.99	0.759	9.4	0.742	243.7	222.5	106.8	2.74
KUM – 445	225	65.7	-	0.988	129.6	1.000	185.9	224.0	50.7	-0.79
RPU – 512	231	57.8	9.40	0.987	107.0	0.915	349.4	50.8	50.3	0.09
LEO – 13	235.3	70.2	6.63	0.983	162.2	0.867	170.8	234.5	45.2	-0.42
AMO – 246	239.3	63.0	50.00	0.488	134.1	0.999	90.7	59.3	150.0	-0.59
ORS – 257	243	27.9	2.16	0.381	5.3	0.828	111.3	64.3	175.3	3.11
THA – 390	244	32.5	1.12	0.142	24.9	0.879	327.5	243.6	210.7	5.03
NOO – 250	247	42.5	8.36	0.116	24.4	0.990	140.4	67.6	207.8	0.83
DKD – 336	252	43.8	10.31	0.929	73.1	0.914	208.5	251.5	100.0	0.84
DPC – 446	252	16.5	3.10	0.896	18.0	0.714	218.7	252.1	110.9	2.71
PHO – 254	253	11.7	2.96	0.990	13.0	0.666	359.0	74.0	-	-
PSU – 339	253	61.7	9.13	0.928	119.4	0.901	208.9	253.8	103.1	0.01
DAD – 334	256	40.8	2.48	0.983	71.8	0.603	177.4	254.8	74.2	2.37
EHY – 529	257	62.4	9.98	0.362	142.2	0.981	106.1	78.4	184.7	-0.32
MON – 19	261	41.4	8.20	0.191	35.2	0.983	128.7	78.5	207.4	0.90
DSV – 428	261.8	66.2	8.18	0.565	151.5	0.971	97.9	261.8	6.4	-0.57
GEM – 4	262.2	33.8	1.31	0.145	22.9	0.889	324.3	261.7	225.8	4.41
HYD – 16	266	58.9	9.08	0.257	128.7	0.985	119.5	76.5	195.7	-0.08
XVI – 335	267	69.1	6.24	0.663	169.1	0.985	290.3	86.5	24.9	-0.87
URS – 15	270.1	32.9	4.87	0.940	52.6	0.807	205.6	270.1	115.8	1.77
ALY – 252	272	49.5	6.78	0.213	84.0	0.969	306.4	272.2	217.0	0.83

IAU code	$\lambda_{\odot\text{-m}}$ (°)	V_g Km/s	a A.U.	q A.U.	i (°)	e	ω (°)	Ω (°)	Π (°)	T_j
SSE – 330	273	45.5	4.30	0.123	60.0	0.972	39.1	273.3	311.3	1.43
COM – 20	274	63.3	8.58	0.557	135.3	0.962	263.5	272.2	176.6	-0.29
OSE – 320	279	45.0	15.70	0.151	50.3	0.990	45.4	278.8	324.1	0.67
JLE – 319	283	51.4	5.43	0.048	100.1	0.991	335.7	283.4	259.3	0.93
AHY – 331	283	43.3	7.07	0.297	58.1	0.971	114.6	103.2	217.3	0.85
QUA – 10	283.2	40.7	2.82	0.979	71.2	0.657	171.4	283.3	94.6	2.19
XSA – 100	288	25.3	2.18	0.471	6.0	0.784	79.3	288.0	7.3	3.18
SCC – 97	289	27.0	2.26	0.430	4.7	0.811	105.0	109.3	215.4	3.08
XCB – 323	296	45.1	2.23	0.410	2.7	0.814	286.6	290.0	217.6	3.11
NCC – 96	296	27.2	1.04	0.860	76.0	0.172	98.2	296.0	34.2	5.22
TCB – 321	296	37.7	1.36	0.965	78.3	0.291	203.9	296.0	139.9	4.02
LBO – 322	296	40.7	4.25	0.784	78.0	0.812	122.7	296.1	59.3	1.46
GUM – 404	298	28.8	1.50	0.217	66.8	0.857	313.2	298.0	251.6	3.70
XUM – 341	298	40.9	2.88	0.952	47.1	0.671	203.4	298.8	142.4	2.56
ECV – 530	302	68.1	5.44	0.823	158.1	0.853	49.8	122.5	171.6	-0.03
AAN – 110	312	45.0	3.57	0.143	58.6	0.965	138.3	133.4	272.1	1.62
OHY – 569	313	58.2	6.20	0.673	114.0	0.891	70.9	133.3	205.1	0.45
FEV – 506	314	62.9	8.28	0.491	138.0	0.954	272.5	312.6	224.6	-0.15
FED – 427	315	35.1	18.58	0.971	54.7	0.975	194.3	315.1	149.3	0.83
ACE – 102	319.4	59.3	14.00	0.977	107.0	0.930	348.9	138.9	-	-
MKA – 128	350	31.4	1.83	0.234	4.6	0.872	50.1	350.0	40.1	3.43
XHE – 346	350	35.2	2.99	0.975	59.8	0.673	196.7	350.0	186.5	2.30
EVI – 11	357	26.6	2.46	0.460	5.5	0.813	281.0	356.8	277.5	2.92

confusion about the discrepancies of the predicted radiant and the December φ-Cassiopeiids data.

To make it easy to check the radiant data, names, IAU codes and orbital data, both tables in this contribution may help to avoid such confusing situations in the future. It can be handy to have this shower list at hand, with the activity periods, radiant, geocentric velocity and the orbital elements in a single document.

4 Conclusion

The large number of newly discovered and confirmed minor meteor showers should be further monitored to improve the statistical significance of the orbital data. The currently available data listed in this contribution may be helpful for meteor workers to check future shower associations.

Although the radar and video meteor data allowed to complete a lot of formerly missing data such as reliable orbital elements for minor showers, future data will definitely require a regular revision of the data listed in this contribution.

Acknowledgment

The author thanks Peter Brown for providing the recent CMOR data and Peter Jenniskens for providing the historic data for a number of meteor streams.

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CAMS meeting 12 March 2017

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The CAMS BeNeLux network had started with its first two cameras in the night of 14-15 March 2012 at the first two CAMS stations Ooltgenplaat and Oostkapelle. Five years and more than 60000 orbits later, the network participants had the CAMS coordination meeting at Oostkapelle on 12 March. Results have been presented, the structure of the network fine-tuned and hardware has been exchanged.

1 Introduction

The CAMS BeNeLux network was invited for its coordination meeting at the facilities in Oostkapelle (Netherlands) by Klaas Jobse. The March 2017 meeting was special in many ways. First of all it was 5 years ago that the CAMS network was started in March 2012 with two Watecs, one in Oostkapelle by Klaas Jobse and the one in Ooltgenplaat by Piet Neels. We had something to celebrate as the CAMS network rapidly expanded and has 60+ operational cameras today. The number of orbits collected exceeds the wildest expectations with over 63000 orbits so far. After the welcoming by Klaas Jobse, we had Romanian sparkling wine (Zarea) and Koen Miskotte had prepared a marvelous cake to celebrate 5 years of CAMS BeNeLux network (*Figure 3*).

2 Summary of the meeting

The meeting started with a presentation by Carl Johannink about a number of points of attention for all stations when reporting detection data. An overview was presented of a selection of minor shower orbits collected by CAMS BeNeLux observed in recent months, compared to the global CAMS results published so far. Martin Breukers gave a demo of the coincidence procedure, how double station meteors are being identified by the CAMS software and how the final selection to decide if a meteor is effectively multiple station is made based on a number of parameters and graphics displayed by the software.

Figure 1 – Klaas Jobse welcomes everybody (photo *Adriana Roggemans*).

Figure 2 – A toast on the successful CAMS network, with Romanian sparkle wine Zarea (Photo *Jean-Marie Biets*).

Figure 3 – To celebrate the 5th anniversary of CAMS BeNeLux, Koen Miskotte prepared a delicious cake for all participants! (Photo *Adriana Roggemans*).

Figure 4 – Martin Breukers giving a demo of the Coincidence procedure (Photo *Jean-Marie Biets*).

Figure 5 – The lunch with from left to right Felix Bettonvil, Carl Johannink, Hans Betlem, Koen Miskotte, Klaas Jobse, Jos Nijland (middle) and Jean-Marie Biets (front right). (Photo *Adriana Roggemans*).

After the talk of Martin, the group made a walk to the North Sea beach where Klaas Jobse offered a lunch. On the way to the lunch Klaas gave explanation about the region and its touristic aspects. Lunch time offered plenty of time for informal chat.

After the lunch the meeting continued with the witness report of a terrible disaster that happened to our friend and CAMS participant Jos Nijland. An immense fire destroyed his own and his neighbors houses in the night of 31 December. The fire was horrible intense and propagated fast around so that Jos and his family could barely save themselves and escape just in time. The house, all personal belongings, the all sky and CAMS station, everything was totally destroyed. Reconstruction has been prepared, but a lot of archives, memories will remain lost forever.

One purpose of the CAMS meeting is to coordinate the aiming of all the cameras, something which proves to be best done with all people involved around the table. With many cameras and many stations, this is worthwhile the time to optimize the orientation of all the cameras. The author had prepared plots with Google Earth to visualize the current position of all the camera fields. This was also a good opportunity to discuss future expansion of the network.

At the end of the meeting Klaas Jobse guided us to his observatory where also the CAMS 331, 332, 337, 338 and 339 are installed.

The CAMS meeting is a typical very warm and friendly meeting and also this meeting was very much enjoyed by everybody involved. We all thank Klaas Jobse for his hospitality and generosity to offer a lunch for all participants.

Figure 6 – CAMS-meeting group photo March 2017: from left to right: Erwin van Ballegoij, Luc Gobin, Jean-Marie Biets, Klaas Jobse, Hans Betlem, Jos Nijland, Carl Johannink, Robert Haas, Sylvia Los, Adriana Roggemans, Martin Breukers, Paul Roggemans, Felix Bettonvil, Piet Neels and Koen Miskotte (photo *Carl Johannink*).

CAMS BeNeLux
Quarterly report 2017Q1 – January-March

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The first quarter of 2017 allowed successfully collecting orbits during 65 nights on a total of 90 nights. 3823 orbits were added to the CAMS database in this period. While a fair number of clear nights appeared in January and during the last 10 days of March, the period in between was characterized by poor weather conditions. February 2017 was in particular unfavorable for any astronomy work.

1 Introduction

Although the nights are long during the winter months, the number of meteors collected by any camera network is much lower in the first quarter of the year. Except for the Quadrantids, no major showers are active and the overall background activity gets at its lowest level of the year towards the end of the first quarter. The low activity level makes this period of the year the least interesting for visual meteor observing. Most very active meteor observers tend to take a break in this period with as a consequence that during this part of the year Earth crosses a rather unexplored region of the solar system regarding the meteoroid population.

Permanently operated camera networks such as CAMS improved the knowledge about meteor activity in this time of the year. Although weather circumstances tend to be poor in these winter months, we still manage to collect significant numbers of orbits.

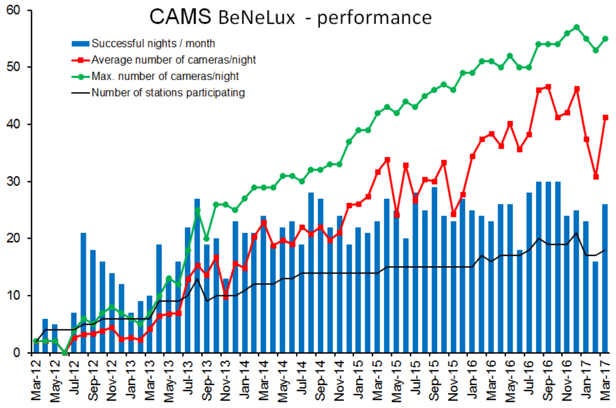

Figure 1 – Performance graph of CAMS BeNeLux: number of nights that produced orbits (blue bars), number of CAMS stations active (black line), average number of cameras operated during the month (red line) and the maximum number of cameras operated in this month (green line).

2 January 2017

The number of nights that allowed collecting meteor orbits was comparable to January in previous 3 years, but the number of collected orbits was significantly better, about twice as many as in previous years. The Quadrantids night 3-4 January was spoiled by bad weather. The large number of orbits was obtained thanks to a number of network wide, clear nights with about 200 or more orbits a night. The night 2-3 January was very productive with 303 orbits, including a likely meteorite dropping fireball (see Roggemans, 2017).

January offers very long observing nights with a still rich overall meteor activity, to score large numbers of orbits is a matter of having network wide clear nights that allow all cameras at all stations to run simultaneously. With an average of 37.4 of the 55 available cameras capturing, January 2017 was doing less good than December 2016 when on average 46.3 cameras (on 57 operational) could capture. Reason for this is unstable weather that prevented several stations from successfully recording meteors. The bulk of the January orbits were obtained during 7 overall clear nights.

3 February 2017

Each year of the 5 year CAMS history has a period of time with the worst possible weather circumstances. For 2017 the month of February proves a good candidate to become the worst month of 2017.

Only 16 nights allowed to collect orbits and on average 30.9 cameras of the 53 operational cameras could run. A much worse February than what we got past few years. Only one night, 13-14 February offered a network wide clear night. 717 orbits for an entire month is a rather poor result when considering the number of cameras currently available. All we need is favorable weather and that we did not get this month.

4 March 2017

March continued the rather poor weather from February until 15-16 March when a first clear night allowed all stations to capture meteors. The last 10 nights of March brought an improvement and ended March 2017 with a better score than previous years. 41.3 cameras on average could run on a total of 55 operational cameras. As many as 26 nights produced orbits this month.

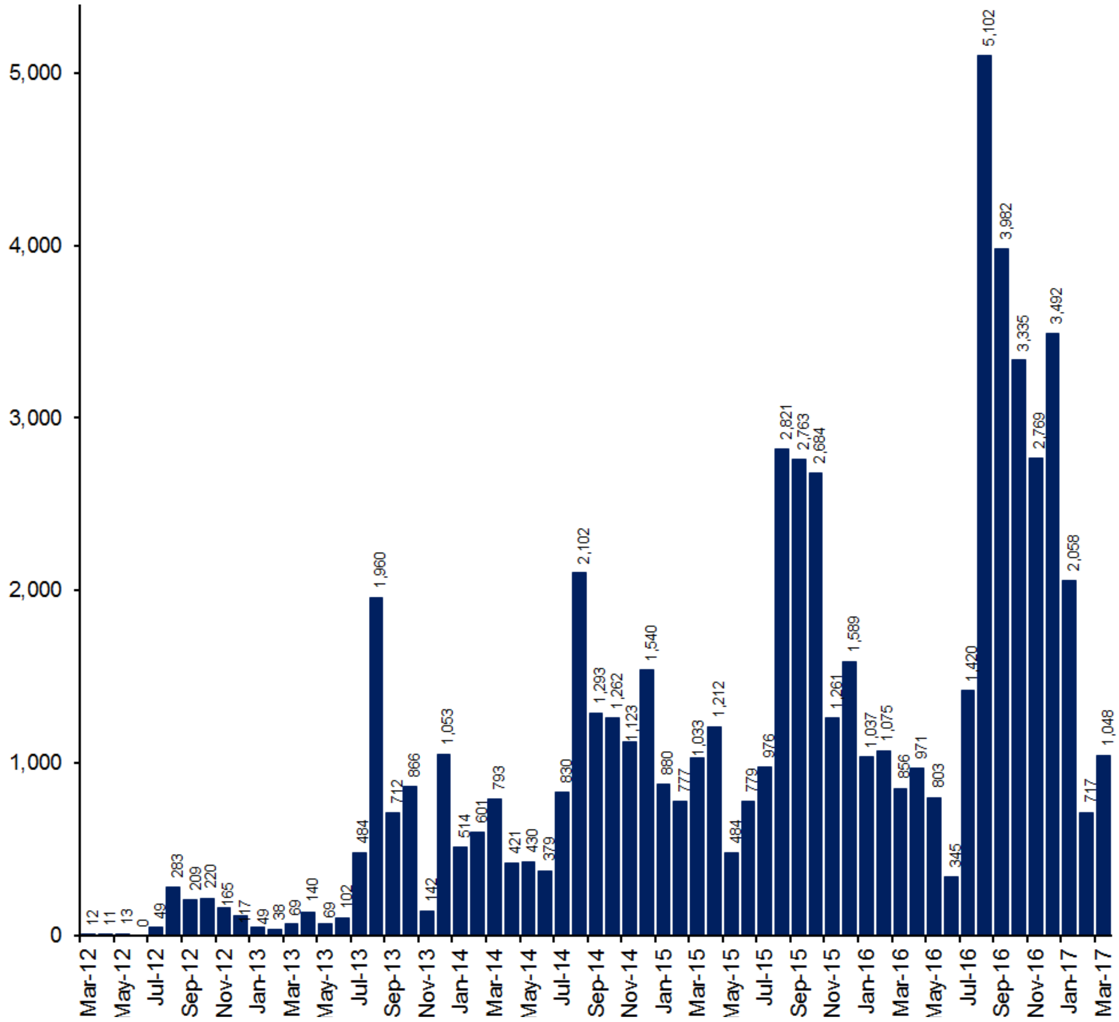

Figure 2 – Number of orbits per month collected by CAMS BeNeLux.

On March 12 the CAMS network had its coordination meeting in Oostkapelle, Netherlands, hosted by Klaas Jobse. See MeteorNews for the report on this meeting.

End of March a new CAMS station joined the network at Niederkruechten in Germany with CAMS 803 operated by Hans Schremmer.

5 Conclusion

The first quarter of 2017 was affected by several weeks of rather poor weather. The number of collected orbits did not reflect the increased capacity of the network with several extra cameras compared to previous years. However, weather remains what it is in our climate. Taking our climate into account it still remains amazing how many nights we manage to obtain some orbits!

Acknowledgment

The CAMS@BeNeLux team that contributed orbits for the quarter 2017Q1:

Cees Bassa (Dwingeloo, operating CAMS 346), *Hans Betlem* (Leiden, operating CAMS 371, 372 and 373), *Jean-Marie Biets* (Wilderen, operating CAMS 381 and 382), *Bart Desoy* (Zoersel, operating CAMS 397 and 398), *BISA – Hervé Lamy & Stijn Calders* (Dourbes, operating CAMS 394 and 395, Uccle, operating CAMS 393), *Martin Breukers* (Hengelo, operating CAMS 320, 321, 322, 323, 324, 325, 326 and 327), *Franky Dubois* (Langemark, operating CAMS 386), *Luc Gobin* (Mechelen, operating CAMS 390 and 391), *Robert Haas* (Alphen aan de Rijn, operating CAMS 360, 361, 362, 363, 364, 365 and Burlage 801 and 802), *Klaas Jobse* (Oostkapelle, operating CAMS 331, 332, 337, 338 and 339), *Carl Johannink* (Gronau, coordinator and operating CAMS 311, 312, 313, 314, 315, 316, 317 and 318), *Koen Miskotte* (Ermelo, operating CAMS 351 and 352), *Piet Neels* (Ooltgenplaat, operating CAMS 341, 342, 343 and 344), *Tim Polfliet* (Gent, operating CAMS 396), *Steve Rau* (Zillebeke, operating CAMS 385 and 387), *Paul Roggemans* (Mechelen, operating CAMS 383, 384, 388, 389 and 399), *Hans Schremmer* (Niederkruechten, operating CAMS 803) and *Erwin Van Ballegoij* (Heesch, operating CAMS 347 and 348).

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Meteor observing in 2016: another very successful year!

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A summary is presented of meteor observations done in 2016 which resulted in a record number of observations for the author.

1 Introduction

Just like 2015, 2016 was an excellent year to observe meteors and there were several highlights. To recall a few: of course the impressive Perseid outburst in the night of 11-12 August 2016, a spectacular fireball of magnitude –12 on 7 August 2016 which I could observe visually and photographically (see *Figure 3*), the number of hours that I could observe which outnumbers my record number of observed hours of 1984 and my 80000th observed meteor since 1980.

2 All-sky camera EN-98

31 fireballs were recorded between 16 March 2016 and 12 March 2017. Three of these were in the category of very bright events. On 17 March 3^h16^m UT a part of the trail of the famous St Patricks' day fireball was recorded through a row of trees. A few days later, on 25 March 2016 at 23^h01^m UT a sporadic fireball of –8 was registered. This fireball appeared above Dutch/Belgian territory and has probably dropped some meteorites.

The all-sky was active in the night of 22-23 December 2016 with a great surprise as a fireball trail was very well visible on an exposure with a completely cloudy sky. This sporadic –10 bolide may have dropped meteorites, unfortunately into the IJsselmeer (the largest lake of the Netherlands).

Figure 1 – March 25, 2016 23:00 UT fireball.

The fireball of 28 November 2016 was a special case. At $4^h40^m40^s$ UT (according to my own time estimate) I noticed 'something' bright moving in the corner of my eye. I look quickly in that direction and for a moment I thought about an iridium flare. But no, the object accelerated. I had never experienced this live in the field… I saw a bright ball of –5 moving slowly, but faster than an iridium flare, suddenly a very short flash and immediately four or five yellow/red colored fragments appeared right after the fireball. I shouted out 'Wow'. The bright fireball moved further and finally disintegrated in four fragments which extinguished each separately. This was the most beautiful Earth grazer that I ever saw since the Leonids 2001 in China. This fireball was also photographed from Benningbroek (Jos Nijland), Bussloo (Jaap van 't Leven), Oostkapelle (Klaas Jobse), Utrecht (Felix Bettonvil), Borne (Peter van Leuteren) and Twisk (Marco Verstraaten). I could track this fireball visually during about 7 or 8 seconds, but according to the calculations by Marco Langbroek based on the photographic data, this meteor had a duration of at least 13 seconds.

Figure 2 – Very slow and earthgrazing fireball of November 28, 2016. Camera: Canon EOS 40D, Sigma ET-X 4.5 mm. fish eye lens. The rotating shutter makes 8.333 breaks a second.

Figure 3 – Bright sporadic fireball of magnitude –12. Camera: Canon 6D. Lens: Canon EF 8-15 mm F 4.0 zoom fish eye lens. Exposure time: 29 seconds. ISO: 2000. F: 4.5.

3 Visual observations

As said above, 2016 became a record year. In total I could observe 170.10 hours during 58 sessions, improving my previous record that dated from 1984 (!) which was 158.43 hours and 47 sessions. See also *Table 1*.

Table 1 – Visual observations Koen Miskotte 1980–2016.

Year	Number sessions	Number hours	Number meteors	Number fireballs
1980	8	19,72	103	0
1981	3	11,17	44	2
1982	8	28,07	77	2
1983	16	56,93	579	7
1984	47	158,43	2551	11
1985	36	141,58	3639	12
1986	34	137,42	4985	11
1987	0	0,00	0	0
1988	4	11,63	146	0
1989	5	15,38	373	3
1990	16	50,22	696	1
1991	34	90,83	1538	4
1992	19	53,87	746	4
1993	28	97,72	2358	30
1994	16	47,10	1061	15
1995	49	144,63	3162	17
1996	27	64,83	2152	20
1997	43	116,52	3097	16
1998	34	97,25	3095	112
1999	37	76,41	3185	14
2000	36	82,23	1734	10
2001	52	145,13	6900	180
2002	16	53,63	1326	7
2003	33	115,83	2709	7
2004	16	42,20	1827	25
2005	31	68,38	1110	10
2006	32	105,05	2507	13
2007	31	91,13	3486	32
2008	33	100,63	2922	15
2009	47	144,78	3617	27
2010	33	103,68	2650	22
2011	38	111,38	2836	12
2012	28	58,28	1104	9
2013	35	93,72	2550	22
2014	40	99,07	1529	5
2015	42	130,66	3324	30
2016	58	170,10	4272	45
Total	1065	3135,59	80020	752

4 Highlights

I could enjoy a number of clear nights at the beginning of May during the Eta Aquariids activity. A number of nice Earth grazing ETAs were noticed. For a detailed report, see: http://meteornews.org/the-%CE%B7-aquariids-2016-from-ermelo-netherlands/

The Perseid watch which I enjoyed together with Michel Vandeputte from Revest du Bion in Southern France was an unprecedented success. We could observe during all the nights. In the nights before the Perseid maximum we observed two impressive fireballs: a –8 sporadic fireball on August 4 and a –12 green colored sporadic on August 6.

The Perseids displayed an exceptional nice outburst in the night of 11–12 August. I counted as many as 800 meteors this night. The highest ZHR occurred on August 11, 2016 at 23^h20^m UT, the 4th rev peak. A detailed report can be read here: http://meteornews.org/perseid-observing-expedition-at-revest-du-bion-provence-southern-france/

At this moment a detailed analyzes is being prepared.

Furthermore, the months of September and October offered a record number of clear nights in the Netherlands. Unfortunately the weather failed during the Orionids, the Taurids, the Leonids and the Geminids.

Visual observing reports: Lyrids 2017

Paul Jones

A summary of observing reports for the 2017 Lyrids has been compiled.

1 April 20/21, 2017 Pre-max April Lyrid observations from north Florida

It was indeed great to be out once again under the starry heavens at Matanzas Inlet, Florida (MI) this morning! I picked out a new observing location this time, around the “back” or west bank of MI on the park boundary between the Helen Mellon Schmidt County Park and the Fort Matanzas National Monument. I set up right alongside the Intracoastal Waterway (ICW) in an ideal setting, except for a few of the persistent MI sand gnats…:o(. Jumping mullet in the ICW right next to me kept me company all morning long…;o).

The skies however, were sensational as always and the full 360 degree horizons in all directions allowed me to catch two real prizes during the watch! I wasn’t sure exactly what to expect as I have had very few pre-max April Lyrid (LYR) observing session opportunities in the past, yet they surprised me pleasantly to say the least!

I started in right at 2:00 a. m., EDT and my first meteor about ten minutes later was a beautiful yellow/orange, -2 LYR low in the SSW sky in Centaurus – a great way to start the watch indeed! It hit at least 80 to 90 degrees away from the radiant position at that point. The wide MI skies were the only reason I was able to catch that baby…;o). And more was to come… Here is the data:

April 20/21, 2017, Observer: Paul Jones, Location next to west bank of Matanzas Inlet and east bank of the Intracoastal Waterway, Fort Matanzas National Monument, St. Augustine, Florida, Latitude: 29 degrees, 42 minutes N, Longitude: 81 degrees,14 minutes W (15 miles south of St. Augustine, Florida),

Observed for radiants:

- LYR: April Lyrids
- ANT: Anthelion radiant
- SLE: sigma Leonids
- AEC: April Rho Cygnids
- SPO: sporadic meteors

0200 – 0300 EDT (0600 – 0700 UT) T_{eff}: 1.0 hour, no breaks, Limiting Magnitude 6.5, sky conditions: clear, facing south

- 7 LYR: -2, +2, +3(2), +4(2), +5
- 1 ANT: +3
- 8 SPO: +3(2), +43), +5(3)
- 16 total meteors

The minus two LYR was yellow/orange in color and left a short train, path length: 14 degrees

0300 – 0400 EDT (0700 – 0800 UT) T_{eff}: 1.0 hour, no breaks, Limiting Magnitude: 6.5, sky conditions: clear, facing south

- 8 LYR: -5, +1, +2, +3(3). +4, 5
- 1 ANT: zero magnitude
- 1 SLE: +2
- 9 SPO: +2, +3(3), +4(3), +5(2)
- 19 total meteors

The minus five LYR fireball appeared low in the east at 3:49 a.m. EDT (7:49 UT) and blazed a bright blue-white in color with a short train dropping straight into the eastern horizon at about 60 degrees azimuth. The initial -5 burst was what caught my eye and was the most intense flare, it faded out in a secondary burst of about –2, total path length was about fifteen degrees – an AWESOME meteor and right out of the LYR radiant! I let out a hoot like an owl on that one for sure!!

The zero magnitude ANT in hour two was also a stunning meteor, streaking slowly due east through Ophiuchus with a nice train and a 25 degree long path length – I LOVE them like that! Only a few minutes before, I caught the one lone SLE dropping very slowly south straight out of the radiant near zeta Virginis – a classic line-up! Overall, the LYR meteors I saw were rather short in path length and appeared very Geminid-like in their velocities. With the exception of the two negative magnitude LYRs, which both exhibited some noticeable flaring in their path, the rest of the LYRs I saw were very evenly bright along their path, usually about five or six degrees or so in length and stood out very well against the jet black sky behind them.

After the second hour, the rising, waning crescent moon in the ESE began to interfere somewhat with the pristine skies and the damp, cool air began to get to me, so I wrapped it up for the night, very pleased indeed overall with what I saw! Brenda and Dave Branchett also got out for a bit this morning albeit after moonrise, and they came away with a few more nice LYRs after I packed it in. Here is their report from Deltona, Florida:

Date: April 21, 2017, Location: Deltona, Florida

Sky conditions—partial moon, 60 percent sky visible, 4.5 mag star visible

Dave Branchett: Time 4:30-5:00 a.m.

- Lyrid: 1
- Sporadic: 1
- Total: 2

Brenda Branchett: 5:00-5:30 a.m.

- Lyrids: 7 (magnitude averaged 3rd, did see one 2nd magnitude.)
- Sporadic: 4
- Total: 11

2 April 21/22, 2017 April Lyrid maximum from north Florida

Five members of the Ancient City Astronomy Club (ACAC), St. Augustine, Florida had a pretty good look at the 2017 April Lyrid (LYR) maximum on Friday night/Saturday morning, April 21/22, even though sky conditions were a bit hazy and cloudy off and on throughout the night. Overall, the LYRs performed pretty much as expected with no evidence of any type of outburst noted, not at least from our area, that is.

I joined Bob and Michelle Wolski at their home on the fairway of the St. Johns Country Club and we hung in there until 0430 on Saturday morning, seeing brief spurts of good LYR activity, interspersed with long lulls of inactivity. My best hourly count during the session was 17 LYRs between 0200 and 0300 EDT. After 4:00 a.m. though, clouds began to come in worse so we packed it in for the morning.

Brenda and Dave Branchett also got out at their home in Deltona, Florida in the pre-dawn hours of Saturday morning and they logged 18 LYRs during their best hour's count, which agrees well with what I was seeing from St. Augustine. Here is everyone's data:

April 21/22, 2017 Observer: Paul Jones. Location: Cypress Lakes Subdivision, Elkton, Florida, Lat: 29.47.51 N, Long: 81.22.31 W (8 miles SW of St. Augustine, Florida)

Observed for radiants:

- LYR: April Lyrids
- SLE: sigma Leonids
- ANT: Anthelions
- ARC: April rho Cygnids
- SPO sporadic meteors

0100 – 0200 EDT (0500 – 0600 UT) T_{eff}: 1.0 hour, no breaks, LM: 6.0 sky conditions: clear, slight haze, facing: south

- 9 LYR: +2(2), +3(2), +4(5)
- 1 ANT: +3
- 6 SPO: +3(3), +4(3)
- 16 total meteors

0200 – 0300 EDT (0600 – 0700 UT) T_{eff}: 1.0 hour, no breaks, LM: 6.2 sky conditions: clear, slight haze, facing: south

- 17 LYR: -1, +1, +2(3), +3 (5), +4(7)
- 2 SLE: +2, +3
- 1 ANT: +2
- 6 SPO: +2, +3(4), +4
- 26 total meteors

0300 – 0400 EDT (0700 – 0800 UT) T_{eff}: 1.0 hour, no breaks, LM: 6.0 sky conditions: 15% clouds, slight haze, facing: south

- 15 LYR: -2, -1, 0, +1, +2(3), +3(4), +4(4)
- 1 ANT: +2
- 1 SLE: +3
- 8 SPO: +1, +2, +3(2), +4 (4)

0400 – 0430 EDT (0800 – 0830 UT)

- 5 LYR: 0, +2, +3(3)
- 3 SPO: -1, +3(2)

Overall, 11 of the 46 LYRs I had left visible trains, with blue white being the most commonly observed color. Most of the Lyrids were short and faint; however, the –1 LYR in the third hour was a beauty – over 15 degrees long and left a 2 second train on the sky. Also, the –2 LYR was seen low in the SW just five degrees away from Jupiter and equally as bright!

I was very proud of Bob, who hung in there with me right up until we called it quits about 4:30 a.m. He was unfazed by the long lulls in activity and is anxious to get back out for upcoming showers! Way to go, Bob!!

Meanwhile, down in Deltona, Florida Brenda and Dave Branchett also monitored the pre-dawn LYR activity on Saturday morning and did pretty well from down there. Here are their results:

Date: April 22, 2017, Observer: Brenda Branchett, Location: Deltona, Florida, Lat: 28.9005 deg N, Long: 81.2637 deg W

Time: 4:30-5:30 a.m. (0830 – 0930 UT)

Sky Conditions: 70 percent sky visible. Magnitude of stars visible is 4.5-5.0 Did have a few minutes of passing cloud.

- Lyrids : 18 (Best I had was two 1st magnitude. Rest were 2nd or 3rd. Dave and I did see at two different times simultaneous Lyrids coming right out of the radiant. Then we had a low for 15 minutes with nothing! Patience is needed when meteor observing!!!)
- Sporadics : 6
- Total : 24

And Dave's data (same location): 2017 Lyrid Meteor Maximum Observation Report

Location: Lat 28.9005 deg N Lat 81.2637 deg W

Date: April 22 2017 Observer: Dave Branchett

Time: 07h30m UT (03h30m am EDT), Duration: 30 minutes, Seeing: Good.

- Lyrids: 6
- Sporadic 1

Time: 08h00m UT (04h00m am EDT), Duration: 1 hour

Seeing: Fair.

- Lyrids: 5
- Sporadic 1

Note: Ten minutes into the hour clouds rolled in from the southeast, these clouds were low and for the most part scattered and moved a steady pace in a NNW direction.

Time: 09h00m UT (05h00m am EDT), Duration: 30 minutes, Seeing: Fair

- Lyrids: 3
- Sporadic: 0

Note: The highlight of this session occurred shortly after it had begun when a simultaneous pair of meteors from the Lyrid shower appeared just south of Vega the fainter estimated mag 3 followed closely by the brighter approx mag 2. Shortly after this it was as though the radiant just turned off, even the sporadic meteors appeared to be in shut down mode.

For the most part during this third and final session the clouds had dispersed only to reappear again before day break.

A huge thank you to all the ACAC members who got out to record data on the 2017 April Lyrids Now it is on to the 2017 eta Aquariids, the first weekend in May. More to come from the citizen scientists of the ACAC!!

April 22-23 2017 Lyrid observations from Sweden

Kai Gaarder

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A report is given on the observing efforts for the 2017 Lyrid maximum from Sweden.

1 Introduction

The April Lyrids are the last meteor shower of the season that can be viewed under dark sky conditions from these northern longitudes. After 2 successful pre-maximum nights on April 18/19 and April 20/21, I crossed my fingers for clear skies the next two “maximum” nights. Unfortunately, April 21/22 was completely clouded out from my observation site in Norway, and the forecast for the coming night, was also very uncertain. I therefore decided to hit the road, and drive some 225 kilometers further east, across the border to Sweden.

2 The Lyrid observations

Outside the small town of Sunne, I found an excellent observing site on a hilltop ranging over 200 meters over the surroundings. After driving the steep and winding road to the top, I observed the first Lyrid when unloading my observation gear from the car at about 20:30 UT. It was a beautiful, reddish, slow moving meteor low in the northern sky. The next half hour, I used to set up my camera equipment and take some test pictures, while waiting for dark enough skies to start my visual observations. In this period, I observed another 1 mag Lyrid in Ursa Major, followed up by an amazing yellow/green –3 Mag Lyrid, that streaked across the sky from Draco and throughout Ursa Major, leaving a smoke train for several seconds! Unfortunately, my camera field was a bit too low in the sky, so I did only catch the first half of the meteor path on camera.

I had high hopes for more bright meteors, when starting my observations at 21:00 UT. However, it soon became clear that the show of bright meteors was over. In the coming 3 hours I saw 20 Lyrids, and among them only 3 were of magnitude 2 or brighter. The brightest one being a 0 magnitude, white, slow moving, near radiant meteor at 22:11 UT. Also among the sporadic, there was a lack of bright meteors, the best one being a 1 mag in the outskirts of my observation field at 22:40 UT. Despite the lack of bright meteors, I managed to catch 7 Lyrids and 2 Sporadic meteors on camera, using a Nikon D3100, with a Samyang 16mm, F 2.0 lens. A great result, considering most of these meteors are at the very detection limit for my camera lens!

The observing season is now almost over from Norway, due to bright summer skies. I am therefore very pleased to have won the race with the clouds this evening, getting 3 hours under good sky conditions, resulting in 20 Lyrids and 10 Sporadic meteors. Hopefully I will be able to observe some meteors during my vacation in Morocco in July, before the dark skies return to Norway in the middle of August. Details from my observation are presented below. Clear skies, and lucky Eta Aquariid hunting for those of you situated on more southerly longitudes!

21:00 – 22:00. T_{eff} 1.00, F 1.00, Lm 6.06. Facing East.

- 5 Lyrids: 2(2), 3, 5, 6
- 0 Sporadics!

22:00 – 23:00. T_{eff} 1.00, F 1.00, Lm 6.28. Facing East.

- 8 Lyrids: 0, 2, 3, 4(3), 5(2)
- 4 Sporadics: 1, 4, 5, 6

23:00 – 00:00. T_{eff} 0.966, F 1.00, Lm 6.17. Facing East.

- 7 Lyrids: 3(2), 4(4), 5
- 6 Sporadics: 3(3), 4(2), 5

Radio meteor observations in the world: Monthly Report for February and March 2017

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Radio Meteor Observations in the World: Monthly Reports for February and March 2017 by the International Project for Radio Meteor Observation. In these months, there was no unusual and no major meteor shower activity. It was impossible to distinguish meteor showers that are less active than ZHR=20.

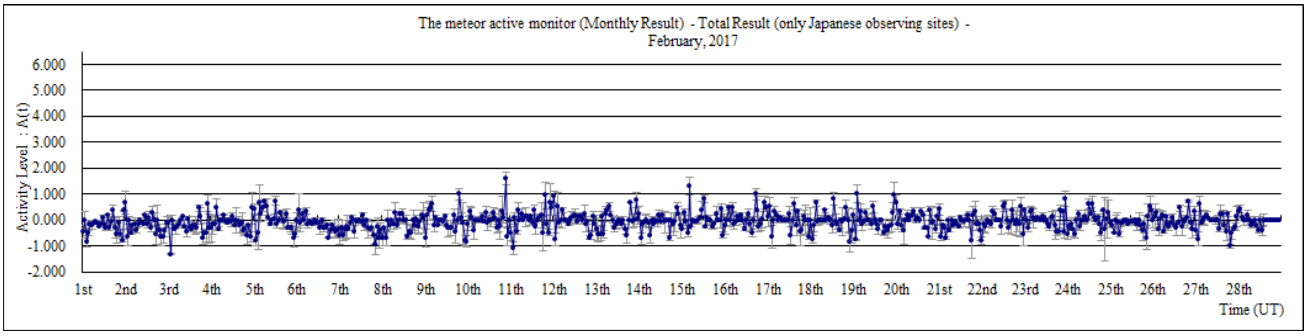

Figure 1 – Monitored result for February (only Japan).

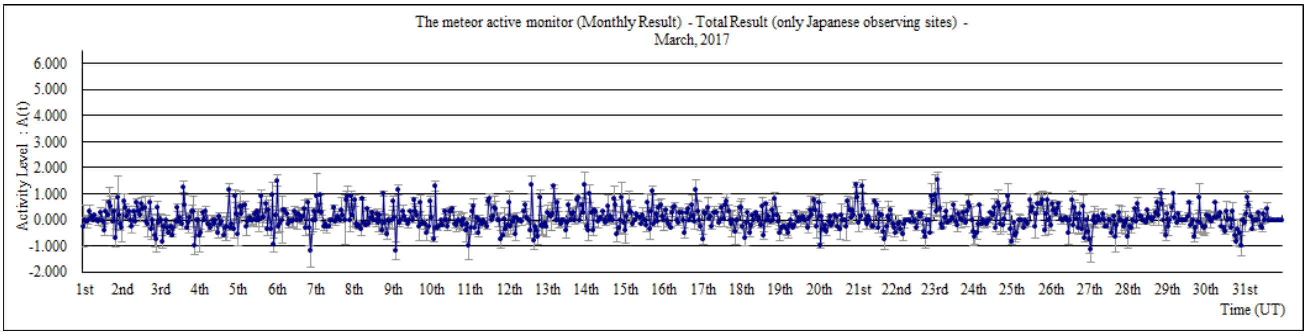

Figure 2 – Monitored result for March (only Japan).

1 February, 2017

The above graph (*Figure 1*) displays the monitored result (using ONLY Japanese stations) in February. There was no unusual activity observed in Japan. Although some high activity levels which were above the usual level (0.0±0.4) have been recorded, it was uncertain whether or not some meteor activity was observed or if these were due to observing errors.

2 March, 2017

The above graph (*Figure 2*) displays the monitored result (using ONLY Japanese stations) in March. There was also no unusual activity observed in Japan.

Acknowledgment

- Radio Meteor Observing Bulletin (RMOB)
- Radio Meteor Observation in Japan (RMOJ)
- All radio meteor observers

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