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Composition of 4 Perseids and aurora captured during August 12–13, with a Sony Alpha A7 IIs with a Sigma 20 mm ART F 1.4 lens. Camera set at 2.0, ISO 2000, 20 sec exposure time. © Koen Miskotte.

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Editorial

Editorials are not common in *eMeteorNews* since the last one appeared in the very first issue in 2016. At the start of volume 10 some reflection about the past and future of *eMeteorNews* seems appropriate. The original vision of *eMeteorNews* has never changed over the years. Thanks to the efforts of many authors 705 articles could be published in the pdf Journal, indexed with NASA ADS Abstract Service. 1607 posts appeared on the website. This content represents a huge amount of work contributed by all authors who made *eMeteorNews* what it is today, a success.

eMeteorNews was originally started out of dissatisfaction with magazines suffering unreasonable delays in publication and being only accessible to paying subscribers. Almost ten years later this situation did not improve so we can conclude that the efforts to create and maintain *eMeteorNews* were worthwhile. Since the content is free accessible online for anyone interested, it is difficult to estimate how many readers with serious interest in meteors we reach. Web statistics indicate far over 1000 users, a weekly newsletter which was cancelled in early 2023 for instance had more than 1200 registrations.

Apart from being easy to consult, the journal is also very accessible for authors. The easiest and fastest way to publish with *eMeteorNews* is to prepare a text and pictures offline and post these on the website blog in WordPress. This online editing tool has very basic and self-explanatory options for lay-out, very simple to use. Authors who need help with English can post their work as a draft and get help to improve the English language before publishing. The WordPress version is sufficient to make the version for the pdf-journal. This journal respects the general standards for scientific publications. The editing work includes a review by the editor to improve the readability, checking the references and to clarify any ambiguities. The editor corrects typos, language aspects and makes sure all content has a consistent style and look. The editor does not interfere with the content aspects which are left entirely at the responsibility of the author. None-meteor related topics could be refused but in practice not a single contribution has been refused for the first 9 volumes.

2024 was a difficult year mainly because of a lack of time on my behalf. Therefore, an advisory board has been created to assist me as editor. As our former hosting proved unreliable, we got a new hosting, technically worked out by our webmaster Radim Stane. Since the journal had been produced and published in Belgium since 2016, we also regularized our ISSN registration which had to be in the country where the publication is effectively produced and published. For references we use our ADS journal identification as *eMetN Meteor Journal*.

The first nine volumes of *eMeteorNews* cover 49 issues with in total 3316 pages of articles, representing an impressive amount of work delivered by authors as well as a lot of work on behalf of the editor. The January 2025 issue is the 50th issue since the start with this publication which has proven its usefulness in meteor astronomy. I hope we can continue these efforts for many more years. I thank all authors and people who helped in one way or another, especially in 2024 when some technical aspects got solved for which I had neither time nor the technical know-how.

I wish all meteor enthusiasts a happy, healthy and meteor rich 2025!

Paul Roggemans

31 December 2024

A short report of news in the IAU Meteor Data Center in 2024

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During 2023, the IAU Meteor Data Center team went on an effort to upgrade the databases which it maintains and improved its website. In this short report, the activities of the team are briefly described.

1 Introduction

The IAU Meteor Data Center (MDC) is a central repository of the orbital and other data of individual meteors (MO part of the MDC) and the official database of known meteor showers (SD part). During 2024, the MDC team continued to innovate the data and improve the website providing them.

2 Work of the Meteor-Orbit part

The MDC team of the MO part added the set of the data collected by the SonotaCo team during the previous year, 2023; version 2024 was released. This version contains: 6345 photographic meteors, 962773 video meteors, and 11057023 radio meteors. The database of video meteors consists of 471582 records published by the Cameras for Allsky Meteor Surveillance (CAMS) group (Gural, 2011; Jenniskens et al., 2011, 2016a, 2016b; Jenniskens and Nénon, 2016; Jenniskens et al., 2016c), 490283 records by the SonotaCo group (SonotaCo, 2009, 2016, 2017; SonotaCo et al., 2021), and 908 records by the Dutch Meteor Society (DMS)[1]. The database of radio meteors consists of the sample of 8916 meteors observed at the Hissar observatory, Tajikistan, (Narziev and Chebotarev, 2019; Narziev et al., 2020) and 11048107 records by the Southern Argentina Agile Meteor Radar (SAAMER) team (Janches et al., 2020; Bruzzone et al., 2020).

3 Work of the Shower-Database part

The MDC team of the SD part worked to improve the classification of showers in the MDC list (Jopek et al., 2024; Neslušan et al., 2024; Ďurišová et al., 2024). This work was a continuation of the previous effort of the MDC team. (Neslušan et al., 2020; Rudawska et al., 2021; Hajduková et al., 2023; Jopek et al., 2023; Neslušan et al., 2023). It is well-known that the characteristics of some showers in the list were determined by more than a single author team. The set of the characteristics published by one author team is referred as a “solution” of the shower. When a new shower is found in a meteor database, the author must answer the question whether this shower is the first solution of a new, not-yet known shower or whether it is another solution of an already known shower. After the authors do the classification of their showers, then they can submit them to the MDC. Newly discovered showers receive a preliminary designation based on the new nomenclature rules (Jopek et al., 2023) and are added to the Working List. New sets of parameters for known meteor showers are added under the shower’s appropriate designation in either the Working List or the List of Established Showers, depending on the status of the shower.

The classification has always been done by the authors using their own criteria, which sometimes differed considerably. This caused that some solutions of already known showers were classified as newly discovered, autonomous showers or the really autonomous showers became the solutions of known showers and did not obtain a new name. The MDC team searches for the unique criteria to correctly classify the newly found showers, as well as showers already on the MDC list. The search is not over, yet. It will go on in a collaboration with the Working Group on Meteor Shower Nomenclature[2].

Astronomers who observe meteors and collect meteor databases can significantly contribute to the correct classification of the showers in the list, when they post to the MDC not only the newly discovered showers, but also the new solutions of already known showers. If there are several independent solutions for a given shower, its

[1] https://dmsweb.home.xs4all.nl/index.html

[2] https://www.iau.org/science/scientific_bodies/working_groups/276/

reliability has been proven much better than a shower with only a single solution.

The MDC team also searched for the parent bodies of the meteor showers. They discovered 81 new associations between the showers and comets. As part of this research, 84 already known associations were confirmed (Ďurišová et al., 2024). Besides this study, a comprehensive search for the parent bodies in the literature was performed. Based on these results, a new list of the parent bodies will be created and the webpages will be upgraded with this information.

4 New webpages

In 2024, the MDC team of the SD part created the new, BETA, version of the web pages that provide the list of showers. Users of these pages can utilize some new services such as extracting a list of currently active showers, selection of the showers within the defined intervals of parameters, calculation of the similarity of mean orbits of showers (using the *D* functions) or check the internal consistency between the geocentric and orbital parameters of shower.

5 Availability and future plans

We recall the URL of the MDC web site, title page[3], and, directly, to the MO part[4] or SD part[5], eventually to the BETA version of SD part[6].

All the content of this site is public-domain. Although many catalogs (CAMS, SonotaCo, DMS, GMN...) can be downloaded from the native web pages of the groups performing the meteor observation and data collection, the catalogs mirrored at the MDC can be downloaded in a uniform format and their version (exact content) can be well identified by whoever whenever (although the content is upgraded from time to time). Verification of the result, i.e. the process required in the scientific research, can thus be done in a rigorous way, using exactly the same data.

In 2025, the upgrade of the data on the individual meteors will continue with the addition of EDMOND, SonotaCo 2024, and GMN data. The list of showers will be improved, especially with a more complete information about the parent bodies.

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[3] https://www.iaumeteordatacenter.org/
[4] https://ceres.ta3.sk/iaumdcdb/
[5] https://www.ta3.sk/IAUC22DB/MDC2022/
[6] https://ceresiaumdc.ta3.sk/

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New meteor shower in Cassiopeia, 4 September 2024

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A new meteor shower with a Mellish type comet orbit (T_J = 1.55 ± 0.18) orbit has been detected during September 3–5 by the Global Meteor Network. Meteors belonging to the new meteor shower were observed between 161° < λ_O < 163° from a radiant at R.A. = 21° and Decl.= +74° in the constellation of Cassiopeia, with a geocentric velocity of 45.5 km/s. The new meteor shower has been submitted to the IAU MDC for inclusion in the Working List of Meteor Showers.

1 Introduction

On 8 September 2024, Peter Jenniskens and Nick Moskovitz announced the detection of a meteor outburst from a radiant in Cassiopeia, near the star psi Cas (Jenniskens and Moskovitz, 2024a;2024b). Nine meteors of this shower had been recorded by Lowell Observatory CAMS in Arizona and four more meteors by CAMS California. These meteors were recorded during a short time interval 161.88° < λ_O < 162.14° (2024, September 4). CAMS at Lowell Observatory is equipped with RMS cameras reporting meteor data to both the Global Meteor Network and the CAMS project, allowing us to perform a detailed analysis of this shower using the same data used for discovery.

An independent confirmation of this new shower came from SonotaCo with 6 orbits recorded between 162.0° < λ_O < 162.4 (Sekiguchi, 2024). One of these meteors was recorded with a spectrum and Sekiguchi suggested asteroid 2010OA101 as a possible parent body.

The new nomenclature rules for meteor showers were approved by members of the F1 Commission by vote, which took place electronically from July 15 to July 20, 2022. However, this new shower has not been reported to the IAU MDC according to these rules. Therefore, the authors decided to submit the GMN data for inclusion into the Working list of meteor showers, for the purposes of database completion. We are leaving the priority of discovery to the original shower discoverers.

The GMN radiant plot[7] for 161.0° < λ_O < 162.0 (September 3–4) shows a clear radiant concentration (*Figure 1*, top). The activity was even stronger the next night, 162.0° < λ_O < 163.0 (September 4–5) (*Figure 1*, bottom). The nights before or after these two nights, no trace of any active radiant appears on these plots. Meteors from this new shower were recorded on cameras in 20 countries: Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Germany, Hungary, Ireland, Italy, Portugal, Romania, Russia, Slovakia, Slovenia, South Korea, Spain, the Netherlands, the United Kingdom and the USA. The meteors had an average absolute magnitude of –0.54, within a range of –3.0 to +1.5.

2 Extraction of the shower from the background

We used the procedure as described for some recent cases of possibly new showers in Boötes and Draco (Šegon et al., 2023). The Drummond dissimilarity criteria D_D has been chosen for the analysis of the new radiant concentration. A first iteration revealed a clear concentration of orbits, as it can be seen on *Figure 2*. The Rayleigh distribution fit pointed at a D_D value of 0.06 as the orbital similarity cutoff (*Figure 3*), which resulted in 51 orbits representing the possibly new meteor shower.

The presence of non-shower radiants in the area around the possibly new shower (*Figure 4*) shows the cutoff to be reliable since the density of meteor radiants does not look affected after removing shower members (plotted as pale diamonds). The plot of the shower meteor radiants in equatorial coordinates shows a very compact group, with a standard deviation of the distances from the average radiant position of about a single degree (see *Figure 5*). The spread in right ascension is due to the high declination. The *Π–i* diagram shows a compact group of radiants too (*Figure 6*), without any other groups of radiants to be seen.

[7] https://globalmeteornetwork.org/data/plots/

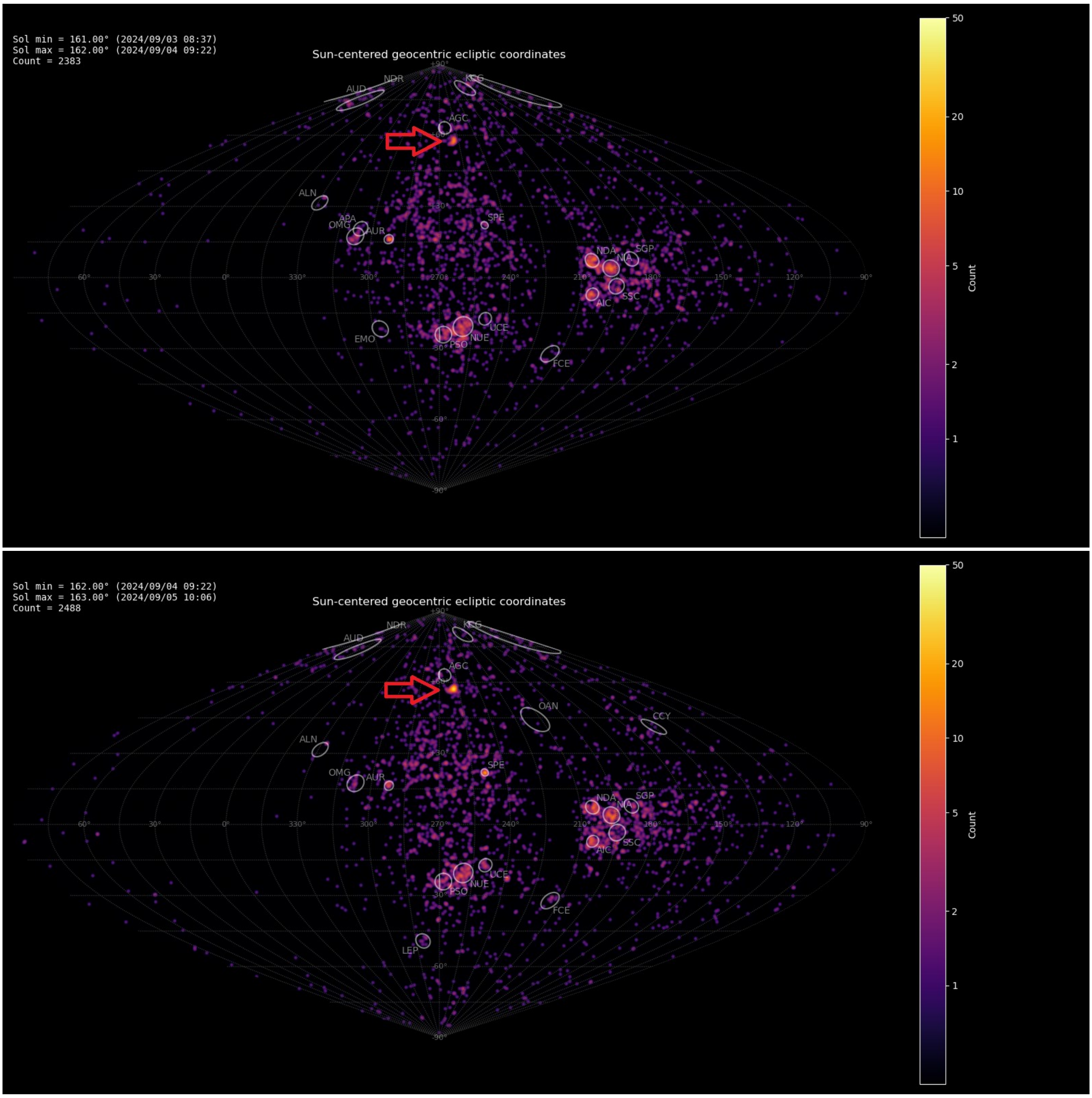

Figure 1 – Radiant plots of the Global Meteor Network data for 2024 September 3–5 in Sun-centered geocentric ecliptic coordinates. The new radiant is visible at high ecliptic altitude and marked by a red arrow.

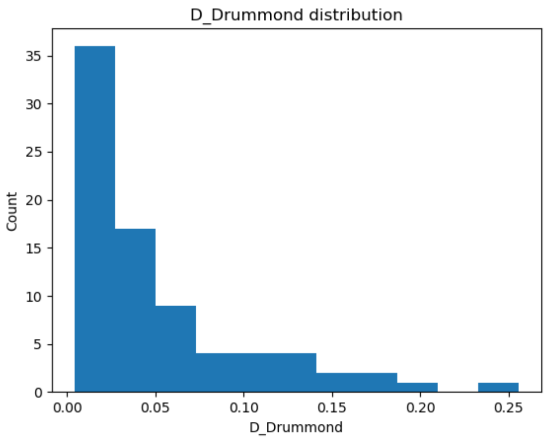

Figure 2 – Histogram of the distribution of the Drummond D_D criterion values valid for the final mean orbit.

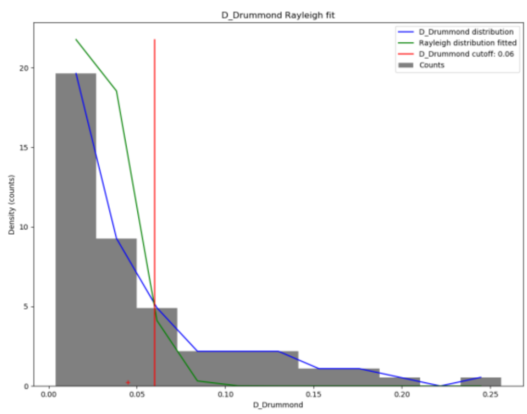

Figure 3 – Rayleigh distribution fit and Drummond D_D criterion cutoff.

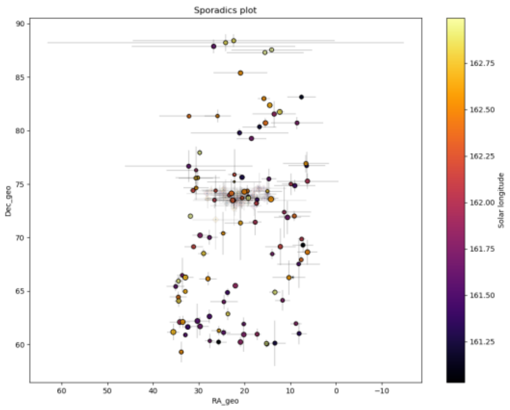

Figure 4 – All non shower meteor radiants in geocentric equatorial coordinates during the shower activity. The pale diamonds represent the new shower radiants plots, error bars represent two sigma values in both coordinates.

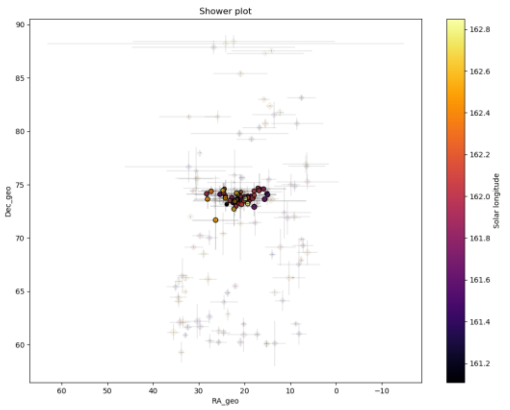

Figure 5 – The reverse of *Figure 4*, now the shower meteors are shown as circles and the non shower meteors as grayed out diamonds. Note that there are no other groups of meteor radiants to be seen in the vicinity of the possibly new meteor shower.

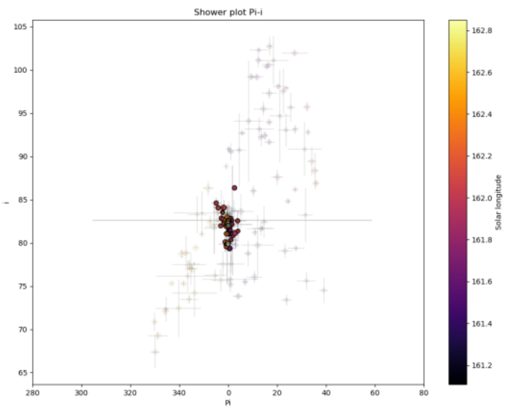

Figure 6 – The diagram of the inclination *i* against longitude of perihelion *Π* shows a distinct group of radiants without any other groups to be seen.

The activity period (*Figure 7*) considered in the first analysis was limited to the interval 161.1° < $\lambda_\odot$ < 162.85° (2024, September 3–5) no more related events were detected outside this observing window. The first analysis provided solid proof that a thus far unknown shower had been detected.

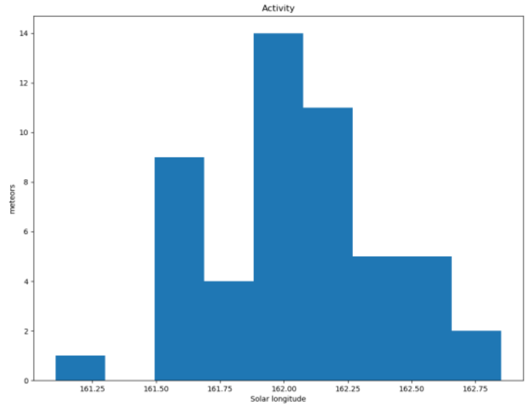

Figure 7 – The activity period with the number of orbits identified as new shower members.

The only nearby meteor shower, August gamma-Cepheids (AGC#0523) has its main activity at solar longitude 155°–156° and its activity period ends at solar longitude 162°. Its orbit has a higher eccentricity and lower inclination and therefore the similarity criteria indicate no connection to the new meteor shower. Some other meteor showers in the neighborhood of the new meteor shower radiant differ even more in activity period and orbit parameters.

3 Another search method

Another method has been applied to check this new meteor shower discovery. The starting point here can be any visually spotted concentration of radiant points or any other indication for the occurrence of similar orbits. The method has been described before (Roggemans et al., 2019). The main difference with the method applied in *Section 2* is that three different discrimination criteria are combined in order to have only those orbits which fit different criteria. The D-criteria that we use are these of Southworth and Hawkins (1963), Drummond (1981) and Jopek (1993) combined. Instead of using a cutoff value for the D-criteria these values are considered in different classes with different thresholds of similarity. Depending on the dispersion and the type of orbits, the most appropriate threshold of similarity is selected to locate the best fitting mean orbit as the result of an iterative procedure.

This method detects 65 candidate orbits with similarity criteria better than $D_D < 0.06$, $D_{SH} < 0.15$ and $D_J < 0.15$. The concentration of these radiants (red and yellow dots) is obvious in *Figures 8 and 9*. *Table 1* compares the average orbit parameters obtained by the method of Šegon et al. (2023), listed as GMN (Šegon) with the mean orbit computed according to Jopek et al. (2006) for the selection obtain by the method of Roggemans et al. (2019), listed as GMN (Roggemans) given for the Drummond cutoff $D_D < 0.06$ and for the 23 best matching orbits with

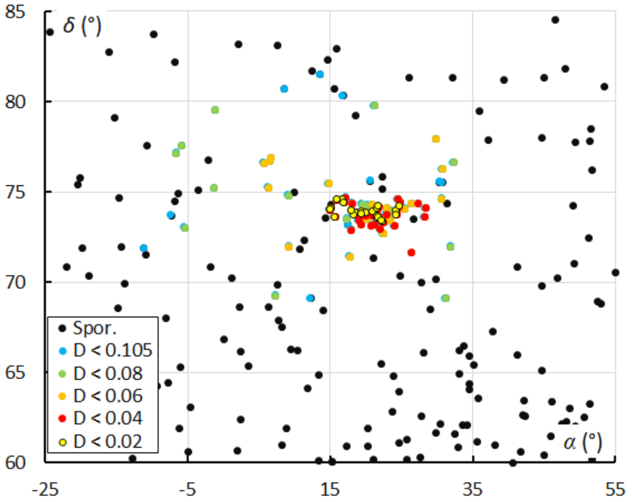

Figure 8 – Radiant plot in geocentric equatorial coordinates for different similarity thresholds.

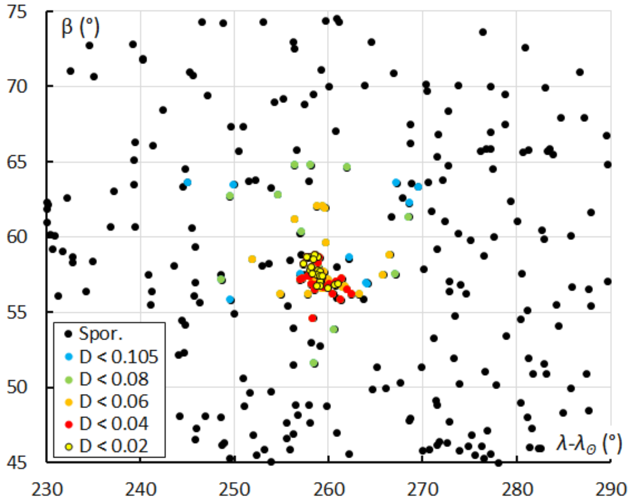

Figure 9 – Radiant plot in geocentric Sun-centered ecliptic coordinates for different similarity thresholds.

Table 1 – The mean orbit for the new meteor shower, derived by two different methods and compared to the results published by CAMS and by SonotaCo. Note that Šegon and Sekiguchi use averaged values while Roggemans uses the mean orbit (Jopek et al., 2006) and Jenniskens uses median values.

	GMN (Šegon)	GMN (Roggemans)		CAMS (Jenniskens)	SonotaCo (Sekiguchi)
		$D_D < 0.06$	$D_D < 0.02$		
$\lambda_\odot$ (°)	161.98	162.0	162.0	162.104 ± 0.005	162.198 ± 0.114
$\lambda_{\odot b}$ (°)	161.11	161.1	161.54	–	–
$\lambda_{\odot e}$ (°)	162.85	163.0	162.66	–	–
α_g (°)	21.0 ± 3.3	20.9 ± 5.4	19.9 ± 2.9	20.6 ± 0.6	23.23 ± 1.94
δ_g (°)	+73.8 ± 0.5	+73.9 ± 1.1	+73.9 ± 0.3	+73.5 ± 0.2	74.04 ± 0.52
$\Delta\alpha_g$ (°)	–	–	–	–	–
$\Delta\delta_g$ (°)	–	–	–	–	–
H_b (km)	106.4 ± 2.0	106.3 ± 3.1	106.5 ± 1.9	–	106.4
H_e (km)	92.4 ± 3.0	93.0 ± 3.4	90.6 ± 3.1	–	91.8
v_g (km/s)	45.5 ± 0.8	45.4 ± 1.1	45.4 ± 0.4	46.4 ± 0.3	45.30 ± 0.44
λ (°)	61.2 ± 1.3	61.1 ± 2.1	60.8 ± 1.0		–
$\lambda_g - \lambda_\odot$ (°)	259.1 ± 1.3	259.0 ± 2.1	258.9 ± 0.8	258.6 ± 0.3	–
β_g (°)	+57.3 ± 0.8	+57.3 ± 1.4	+57.5 ± 0.7	+57.2 ± 0.2	–
a (A.U.)	3.73 ± 0.51	3.78 ± 0.66	3.74 ± 0.18	5.3 ± 0.4	3.37 ± 0.33
q (A.U.)	0.988 ± 0.004	0.988 ± 0.006	0.988 ± 0.002	0.987 ± 0.001	0.991 ± 0.004
e	0.736 ± 0.033	0.739 ± 0.040	0.736 ± 0.013	0.812 ± 0.018	0.704 ± 0.029
i (°)	82.0 ± 1.4	81.6 ± 2.2	81.5 ± 1.1	82.4 ± 0.3	82.1 ± 0.5
ω (°)	197.6 ± 1.7	197.2 ± 2.9	197.7 ± 0.9	197.8 ± 0.5	196.76 ± 1.79
Ω (°)	162.1 ± 0.4	162.1 ± 0.4	162.0 ± 0.3	162.07 ± 0.04	162.20 ± 0.11
Π (°)	359.7 ± 1.7	359.3 ± 3.0	359.7 ± 0.9	359.6 ± 0.5	1.71 ±
T_j	1.55 ± 0.18	1.54 ± 0.22	1.56 ± 0.06	1.15 ± 0.10	1.71 ± 0.16
λ_Π	344.6	344.6 ± 0.8	344.8 ± 0.4	–	344.57 ±0.34
β_Π	–17.5	–17.0 ± 2.9	–17.6 ± 0.9	–	–16.6 ±1.76
N	51	65	23	13	6

$D_D < 0.02$. The dispersion of the radiants with less good similarity (blue and green dots) are also shown in *Figures 8 and 9*, but these orbits were not used to compute the mean orbit to avoid contamination with sporadics. The concentration of the orbits of the newly discovered meteor shower appears very distinctly in the diagrams of the inclination i against the longitude of perihelion Π (*Figure 10*).

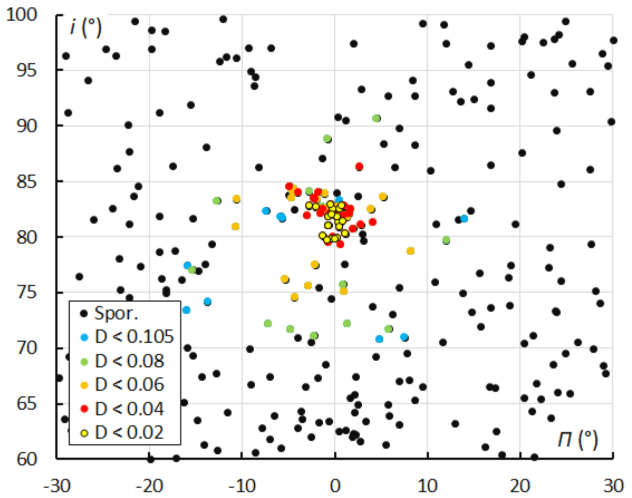

Figure 10 – Diagram of the inclination i against the longitude of perihelion Π.

A few more matching orbits were found before and after the outburst interval, six orbits during the nights before $\lambda_{\odot} = 261°$ and four orbits after $\lambda_{\odot} = 263°$. These orbits were not used to compute the mean orbit as these may either be dispersed meteoroids from this stream or pure chance matching sporadics. These small numbers are statistically not significant to define a meteor shower activity period. The activity profile (*Figure 11*) shows a distinct peak activity during the interval $161.8° < \lambda_{\odot} < 162.2°$ corresponding to roughly 2024, September 04, $09^h \pm 5^h$. This explains why most of the orbits were recorded by South Korean and American GMN cameras.

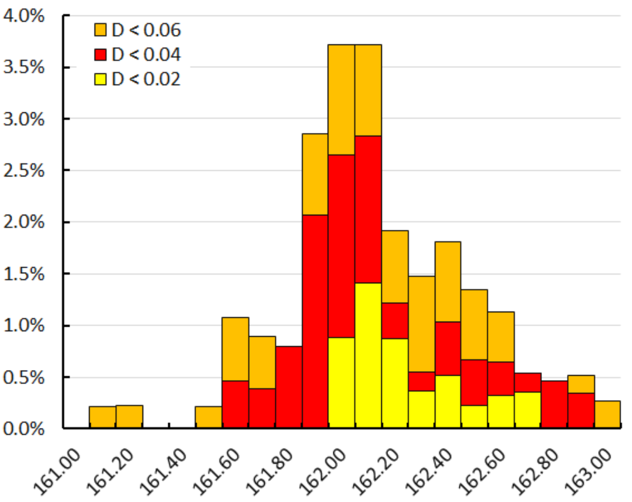

Figure 11 – The activity profile with the percentage of new shower orbits relative to the total number of orbits available during each time interval of 0.2° in solar longitude.

Table 1 compares the GMN results obtained by the two methods with the results published by CAMS and SonotaCo. Note that nine of the 13 orbits used by CAMS were recorded on RMS cameras at Lowell Observatory in Arizona which are also included in the GMN dataset. All results are in very good agreement, although CAMS has a slightly higher velocity resulting in a larger semi major axis a and larger eccentricity e.

In his report on this new meteor shower, Peter Jenniskens wrote: "*These meteors have an entry speed below that of most of the sporadic background in that direction*". To visualize this velocity difference, we plotted the diagrams of Sun-centered geocentric coordinates (*Figure 12*) and inclination i against the longitude of perihelion Π (*Figure 13*), both color-coded for the geocentric velocity v_g. However, no distinct difference in geocentric velocity for the new meteor shower concentration can be seen in these diagrams. The velocities are in the range of what can be expected from this direction.

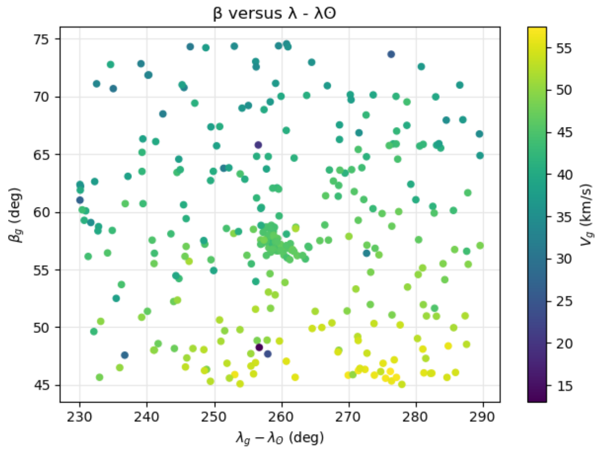

Figure 12 – Diagram of the Sun-centered geocentric longitude $\lambda_g - \lambda_{\odot}$ against the geocentric altitude β, color-coded for the geocentric velocity v_g.

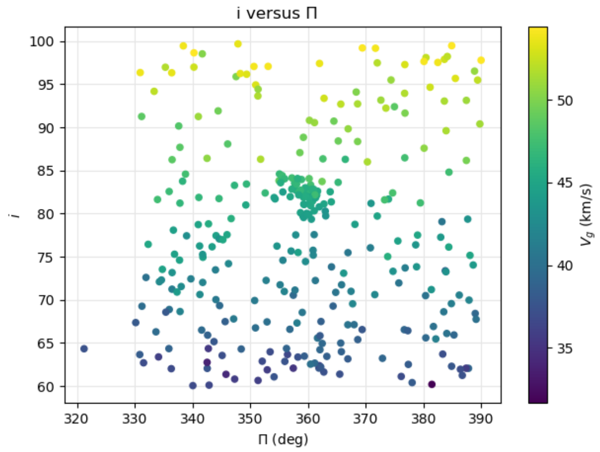

Figure 13 – Diagram of the inclination i against the longitude of perihelion Π, color-coded for the geocentric velocity v_g.

4 Comparing older data and other datasets

Looking up past years orbit data for Global Meteor Network (2018–2023, 1174206 orbits), we find 74 orbits with $D_D < 0.06$. Three (1) in 2019, seven (3) in 2020, 23 (6) in

2021, 18 (6) in 2022 and 23 (4) in 2023, spread over different nights. The number of orbits recorded within the outburst interval of 2024, 162.0° < λ_O < 163.0, is mentioned in brackets. The SonotaCo net orbit data (2007–2023, 490283 orbits) has only 12 orbits with D_D < 0.06, recorded in different years. EDMOND (2001–2023, 508266 orbits), has 33 orbits with D_D < 0.06 in different years, two (0) in 2010, two (0) in 2011, three (1) in 2013, twelve (9) in 2014, eight (0) in 2015 and six (0) in 2016. The CAMS orbit data (2010–2016, 471582 orbits), has 28 orbits with D_D < 0.06, seven (3) in 2013, seven (5) in 2014, ten (7) in 2015 and four (2) in 2016.

The shower has been active in past years but the level of activity was too low for the major video camera networks to identify it as a meteor shower. There is some indication that the shower produced some enhanced activity in 2014 according to EDMOND and CAMS data, but beyond the threshold to detect it as a new meteor shower.

5 Conclusion

The Global Meteor Network provided convincing evidence for the occurrence of a new meteor shower outburst on 2024 September 4. The Tisserand relative to Jupiter with T_J = 1.55 suggests a Mellish type cometary orbit. Past observations indicate some weak annual activity with an indication for a possible earlier outburst in 2014. The new meteor shower has been reported on behalf of the Global Meteor Network to the IAU MDC for inclusion in the Working List of Meteor Showers.

Acknowledgment

This report is based on the data of the Global Meteor Network (Vida et al., 2020a; 2020b; 2021) which is released under the CC BY 4.0 license[8]. We thank all 825 participants in the Global Meteor Network project for their contribution and perseverance. This list of operators whose cameras provided the data used in this work and contributors who made important code contributions are mentioned elsewhere in this issue (Šegon et al., 2025).

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New meteor shower in Ursa Minor, 23–24 September 2024

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A new meteor shower on a Jupiter-family comet orbit ($T_J = 2.34 \pm 0.16$) orbit has been detected during September 23–24 by the Global Meteor Network. Meteors belonging to the new shower were observed between $176° < \lambda_\odot < 187°$ (2024, September 19–29) from a radiant at R.A. = 240° and Decl.= +77° in the constellation of Ursa Minor, with a geocentric velocity of 32 km/s. The new meteor shower has been listed in the Working List of Meteor Showers under the temporary name-designation: M2024-S1.

1 Introduction

On 26 September 2024, Yury Harachka from Belarus reported that the Belarusian meteor network registered a distinct group of three radiants in the constellation of Ursa Minor during the night of 24-25 September. No corresponding known meteor shower could be found. A fourth registration came from Odessa, Ukraine (Harachka et al., 2024).

At the same time the Global Meteor Network radiant plot for 23-24 September displayed a radiant hot spot not related to any other meteor shower (*Figure 1*). A quick analysis of the available orbit revealed a concentration of 31 orbits recorded during the nights of 2024 September 23–25 (GMN website[9]). All meteors appeared during the solar-longitude interval 181.0° – 183.0°, with a peak at 181.9°. The shower is similar to but distinct from epsilon-Ursae Minorids (EPU#1044) which have been observed 5 degrees away in 2020 and 2022. A CBET announcement was prepared and published (Vida and Šegon, 2024) and the new meteor shower was registered by the IAU Meteor Data Center and got the temporary identification M2024-S1.

The shower was independently observed by cameras in 18 countries worldwide (Belgium, Bulgaria, Canada, Croatia,

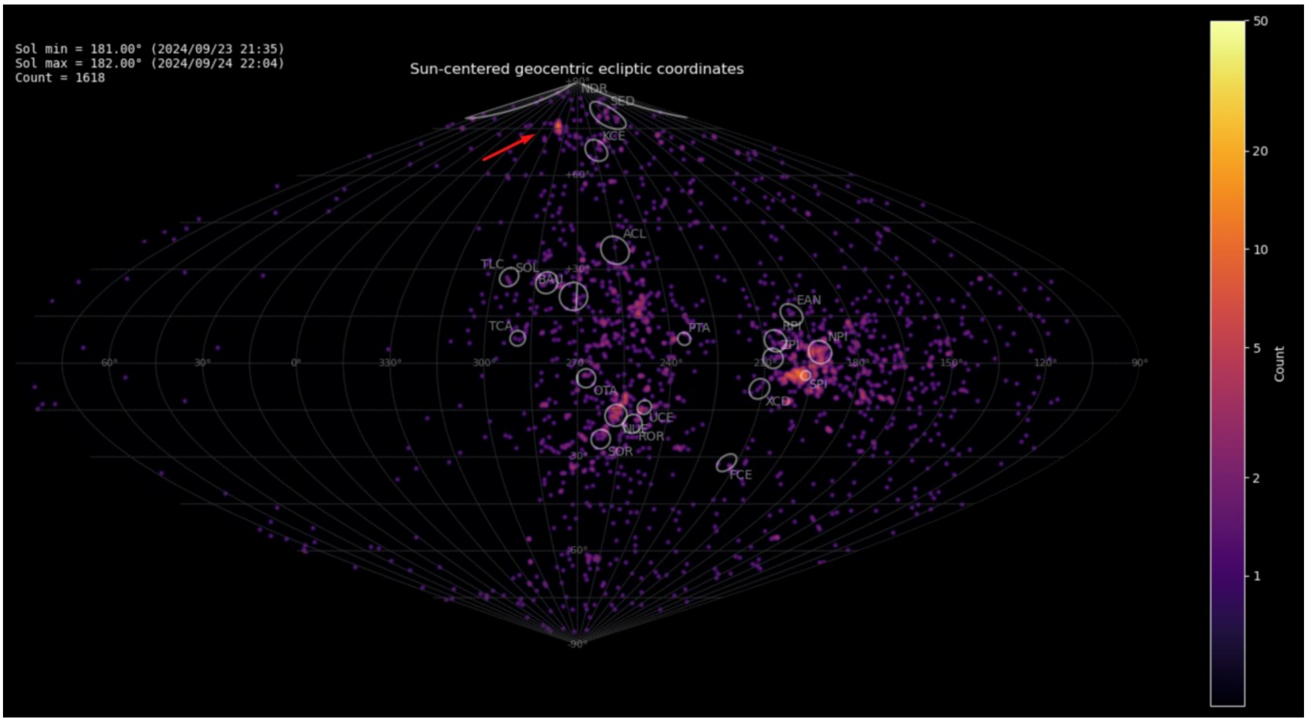

Figure 1 – Radiant plot of the Global Meteor Network data for 2024 September 23–24 in Sun-centered geocentric ecliptic coordinates. The new radiant is visible at high ecliptic altitude and marked by a red arrow.

[9] https://globalmeteornetwork.org/data/

Czech Republic, Denmark, France, Germany, Greece, Hungary, Luxembourg, Mexico, Slovakia, Slovenia, South Korea, the Netherlands, United Kingdom and the USA). The meteors were bright, most having peak magnitudes brighter than +0.0.

2 Discovery and first analysis

We used the procedure as described for some recent cases of possibly new showers in Bootes and Draco (Šegon et al., 2023). The Drummond dissimilarity criteria D_D has been chosen for the analysis of the new radiant concentration. A first iteration revealed a clear concentration of orbits, as it can be seen on *Figure 2*. The Railey distribution fit pointed at a D_D value of 0.05 as the orbital similarity cutoff (*Figure 3*), which resulted in 31 orbits representing the possibly new meteor shower.

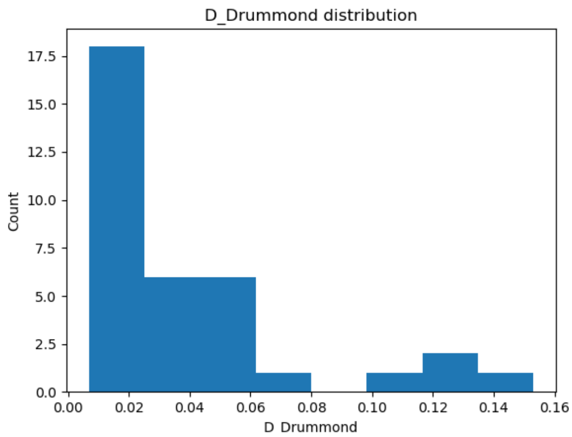

Figure 2 – Histogram of the distribution of the Drummond D_D criterion values valid for the final mean orbit.

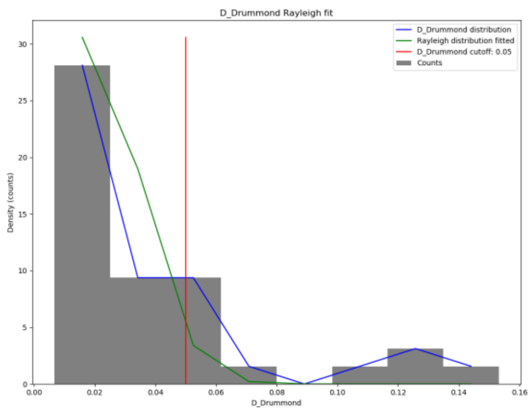

Figure 3 – Rayleigh distribution fit and Drummond D_D criterion cutoff.

The presence of non-shower radiants in the area around the possibly new shower (*Figure 4*) shows the cutoff to be reliable since the density of meteor radiants does not look affected after removing shower members (plotted as pale diamonds). The plot of the shower meteor radiants in equatorial coordinates shows a very compact group, with a standard deviation of the distances from the average radiant position of about a single degree (see *Figure 5*). The Π–i diagram shows a compact group of radiants too (*Figure 6*), without any other groups of radiants to be seen.

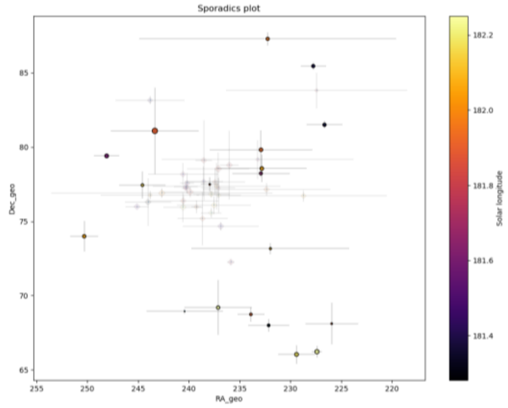

Figure 4 – All non shower meteor radiants in geocentric equatorial coordinates during the shower activity. The pale diamonds represent the new shower radiants plots, error bars represent two sigma values in both coordinates.

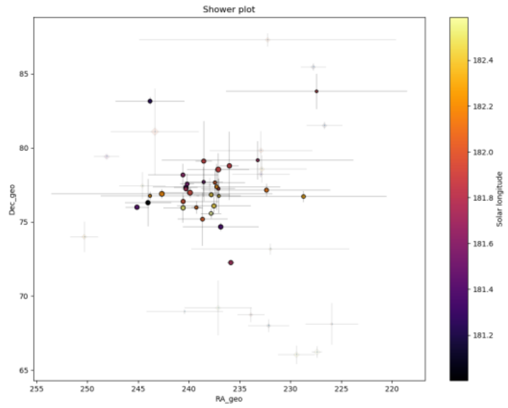

Figure 5 – The reverse of *Figure 4*, now the shower meteors are shown as circles and the non shower meteors as grayed out diamonds. Note that there are no other groups of meteor radiants to be seen in the vicinity of the possibly new meteor shower.

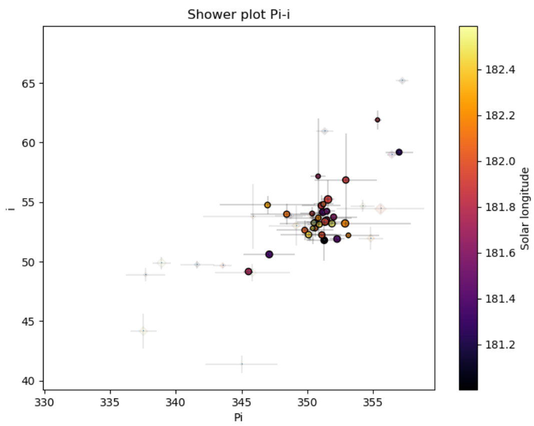

Figure 6 – The diagram of the inclination i against longitude of perihelion Π shows a distinct group of radiants without any other groups to be seen.

The activity period (*Figure 7*) considered in the first analysis on the first available orbit data was limited to the interval $181° < \lambda_{O} < 183°$ (2024, September 23–24) but it was noticed that more related events could have been detected outside this observing window. A second more in depth analysis was postponed until all orbit data for this period had been processed. The first analysis provided solid proof that a thus far unknown shower had been detected.

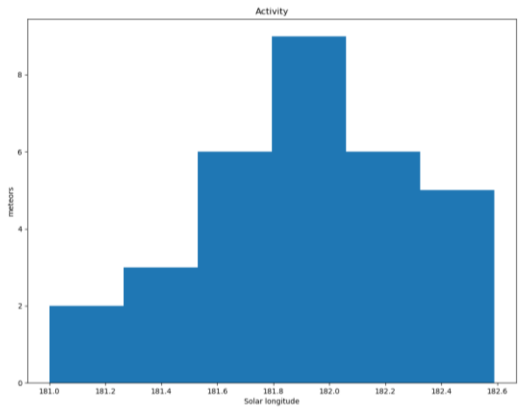

Figure 7 – The activity period with the number of orbits identified as new shower members.

The only nearby meteor shower, epsilon-Ursae Minorids (EPU#1044), observed 5 degrees away in 2020 and 2022. The new shower is similar to but distinct from these epsilon-Ursae Minorids, with orbital elements outside of the measurement errors of our new shower (*Table 1*), although we do not exclude the possibility of the showers being dynamically related.

Table 1 – Known neighboring shower, epsilon-Ursae Minorids (EPU#1044), (Shiba, 2022), compared to the new meteor shower, derived by two different methods.

	EPU	New (Šegon)	New (Roggemans)
$\lambda_\odot$ (°)	181.9	181.9	181.4
$\lambda_{\odot b}$ (°)	181.02	181.0	176.2
$\lambda_{\odot e}$ (°)	182.99	182.6	186.8
α_g (°)	255.0	238.3	240.3
δ_g (°)	+82.6	+77.3	+77.3
$\Delta\alpha_g$ (°)	–3.35	–	
$\Delta\delta_g$ (°)	–0.41	–	
v_g (km/s)	33.6	32.0	31.7
λ (°)	96.8	118.5	117.1
$\lambda_g - \lambda_\odot$ (°)	274.9	296.6	295.5
β_g (°)	73.6	75.7	76.1
a (A.U.)	2.756	3.11	3.01
q (A.U.)	1.003	0.994	0.995
e	0.636	0.680	0.669
i (°)	57.8	53.9	53.4
ω (°)	178.7	169.2	169.7
Ω (°)	181.9	181.8	181.0
Π (°)	0.6	351.0	350.8
T_j	2.49	2.34	2.40
N	10	31	55

3 Another search method

Another method has been applied to check this new meteor shower discovery. The starting point here can be any visually spotted concentration of radiant points or any other indication for the occurrence of similar orbits. The method has been described before (Roggemans et al., 2019). The main difference with the method applied in *Section 2* is that three different discrimination criteria are combined in order to have only those orbits which fit different criteria. The D-criteria that we use are these of Southworth and Hawkins (1963), Drummond (1981) and Jopek (1993) combined. Instead of using a cutoff value for the D-criteria these values are considered in different classes with different thresholds of similarity. Depending on the dispersion and the type of orbits, the most appropriate threshold of similarity is selected to locate the best fitting mean orbit as the result of an iterative procedure.

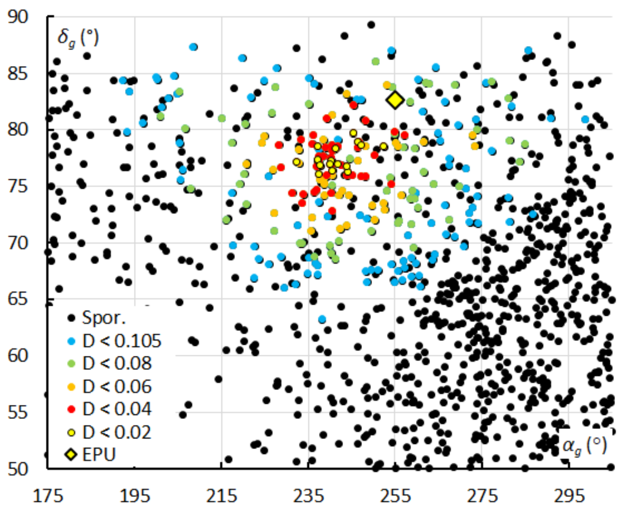

Figure 8 – Radiant plot in geocentric equatorial coordinates for different similarity thresholds, the radiant of the epsilon-Ursae Minorids (EPU#1044) is marked as a yellow diamond.

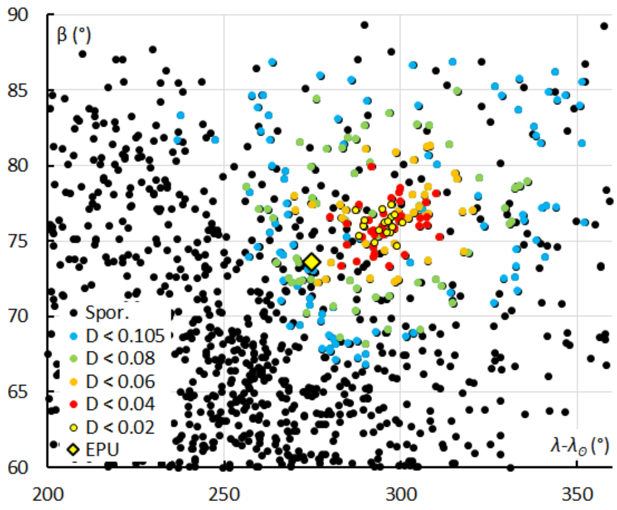

Figure 9 – Radiant plot in geocentric Sun-centered ecliptic coordinates for different similarity thresholds, the radiant of the epsilon-Ursae Minorids (EPU#1044) is marked as a yellow diamond.

This method detects 55 candidate orbits with similarity criteria better than $D_D < 0.04$, $D_{SH} < 0.1$ and $D_J < 0.1$. The concentration of these radiants (red and yellow dots) is obvious in *Figures 8 and 9*, away from the radiant of the epsilon-Ursae Minorids (marked as a yellow diamond). The mean orbit computed according to Jopek et al. (2006) for the orbits selected using the method of Šegon et al. (2023)

is listed as New (Šegon) in *Table 1*, the mean orbit for the selection using the method of Roggemans et al. (2019) is listed under New (Roggemans). The dispersion of radiants with less good similarity are also shown in *Figures 8 and 9*, but these orbits were not used to compute the mean orbit to avoid contamination with sporadics. As expected, similar orbits were detected over a longer time span, 176.2° < λ_O < 186.8° (2024, September 19–29).

The concentration of the orbits of the newly discovered meteor shower appears very distinctly in the diagrams of the inclination *i* against the longitude of perihelion *Π* (*Figure 10*). The position of the epsilon-Ursae Minorids is marked as a yellow diamond and appears clearly offset from the new meteor shower orbits. Looking at the velocity distribution for the 55 orbits (*Figure 11*), the higher the inclination, the higher the velocity, the EPU is outside this diagram.

Looking at a couple less common diagrams like eccentricity *e* against the longitude of perihelion *Π* (*Figure 12*) and inclination *i* against the perihelion distance *q* (*Figure 13*), clearly shows the distance between the concentration of the new meteor shower orbits and the epsilon-Ursae Minorid position.

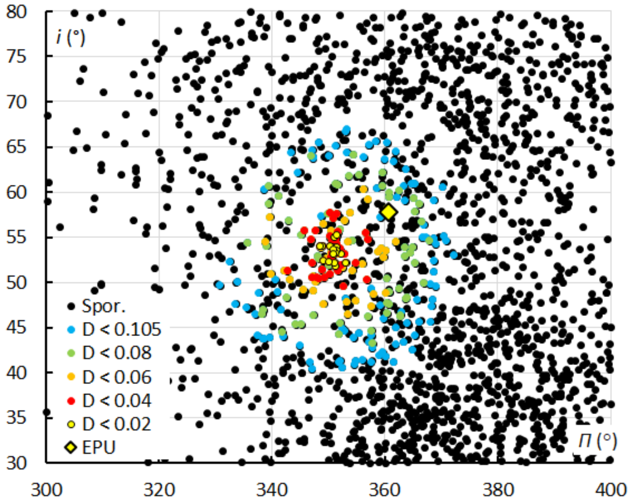

Figure 10 – Diagram of the inclination *i* against the longitude of perihelion *Π*, the radiant of the epsilon-Ursae Minorids (EPU#1044) is marked as a yellow diamond.

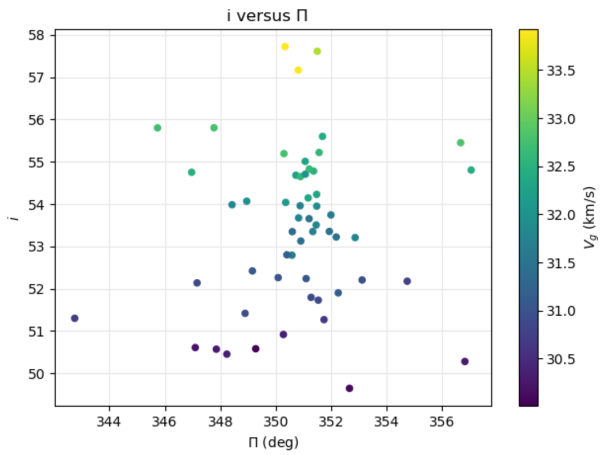

Figure 11 – Diagram of the inclination *i* against the longitude of perihelion *Π*, colorcoded for the geocentric velocity v_g.

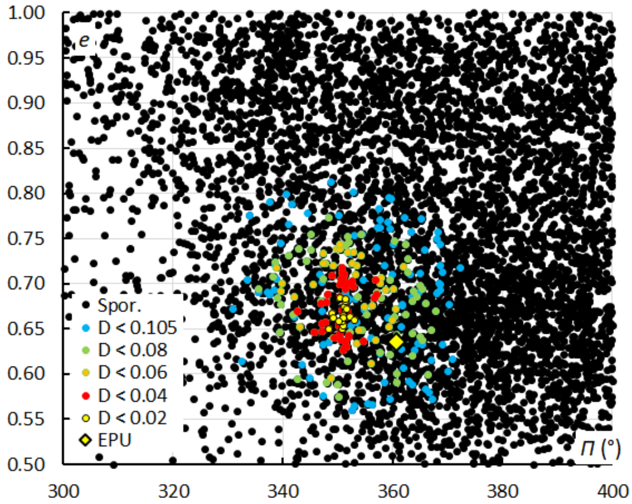

Figure 12 – Diagram of the eccentricity *e* against the longitude of perihelion *Π*, the radiant of the epsilon-Ursae Minorids (EPU#1044) is marked as a yellow diamond.

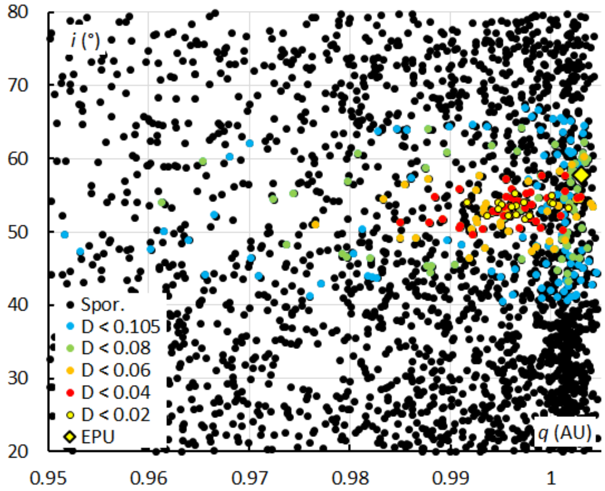

Figure 13 – Diagram of the inclination *i* against the perihelion distance *q*, the radiant of the epsilon-Ursae Minorids (EPU#1044) is marked as a yellow diamond.

4 Comparing older data and other datasets

Looking up past years orbit data for Global Meteor Network (2018–2023, 1174206 orbits), we find 68 orbits with D_D < 0.04. Two in 2019, 1 in 2020, 9 in 2021, 25 in 2022 and 31 in 2023, spread over different nights. This increase from year to year reflects the expansion of the GMN network. With 8 or 9 orbits in single nights in 2022 and 2023, this shower remained just under the detectability threshold. The SonotaCo net orbit data (2007–2022, 443197 orbits) has only 6 orbits with D_D < 0.04, recorded in different years. EDMOND (2001–2023, 508266 orbits), has 15 orbits with D_D < 0.04 in different years. The CAMS orbit data (2010–2016, 471582 orbits), has 12 orbits with D_D < 0.04, recorded in different years between 2011 and 2016.

The shower has been active in past years but the level of activity was too low for the major video camera networks. The large number of cameras of GMN in 2024 made it possible to detect this weak activity.

5 Parent body

The parent body search suggests a possible parent body to be 2021 HK12. This object matches the new meteor shower orbit with a similarity criterion $D_{SH} = 0.15$ (Southworth and Hawkins, 1963) and has orbital parameters:

- $q = 1.036$ AU,
- $e = 0.685$,
- $i = 47°$,
- $\omega = 168.8°$,
- $\Omega = 187.1°$.

6 Discussion

The nearby epsilon-Ursae Minorids (EPU#1044) with its Jupiter-family comet orbit, and the new meteor shower M2024-S1 maybe dynamically related, but there is a clear offset between both orbits. When we use the orbit given by Shiba (2022) as feed to locate similar orbits we find 11 orbits applying the same similarity criteria as for the new meteor shower. This dataset of 11 orbits has no orbits in common with the dataset with 55 orbits that define the new meteor shower.

The original detection of the epsilon-Ursae Minorids (EPU#1044) by Sato in 2019 (Sato, 2020) was based on 12 orbits recorded by SonotaCo and 7 orbits by CAMS. Shiba (2022) used 10 orbits from 2019 to compute the orbit for EPU#1044. These numbers are very small and at the very limit to estimate a mean orbit for such meteor shower. The number of orbits used to define this new meteor shower is larger and therefore statistically more significant. A too small sample of orbits could imply a selection effect resulting in a slightly different orbit.

Jenniskens (2025) compared the observed variation in ecliptic longitude of the shower radiants in the past and suggests that the 2024 outburst can be a return of the epsilon-Ursae-Minorids, rather than a new meteor shower. The number of detected orbits of this shower can be partly explained as due to the expansion of the GMN camera network but the activity level of this shower in 2024 between solar longitude 181° and 183° was definitely higher than in previous years. In past years meteor orbits were recorded from this new shower but the activity level was too low to catch anyone's attention.

7 Conclusion

A possibly new meteor shower in the constellation of Ursa Minor active during 10 days, has been detected in the Global Meteor Network orbit data for September 19–29, 2024. The resulting orbit is a Jupiter-family comet orbit one, with as possible parent body the asteroid be 2021 HK12. The new meteor shower has been listed in the Working List of Meteor Showers under the temporary identification M2024-S1[10].

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[10] https://www.ta3.sk/IAUC22DB/MDC2022/Roje/pojedynczy_obiekt.php?lporz=01715&kodstrumienia=01226

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Short note on what appears to have been a 2024 outburst of epsilon-Ursae-Minorids (IAU#1044)

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A meteor outburst with a radiant in Ursa Minor was detected by low-light level video cameras of the Global Meteor Network and by Belarusian and Ukranian meteor camera networks on September 23–25, 2024. Here, we report on the results from the CAMS network and discuss the possible association with the epsilon-Ursae-Minorids outburst observed in 2019. If this is the same stream, a return of the shower is expected in 2025, and again in 2030/2031.

1 Introduction

On October 1, 2024, Vida and Segon (2024) and Harachka et al. (2024) independently reported on the detection of a possible new shower with a radiant in Ursa Minor. The shower was rich in bright meteors. A possible parent body was proposed as asteroid 2021 HK12. According to Vida and Segon, this was not a return of the epsilon-Ursae-Minorids (IAU#1044), detected as an outburst in 2019 by Sato (2020), even though the time of maximum and entry speed were much the same. Here, we briefly look into whether or not both showers can be related.

2 Methods

The CAMS camera network detected this event as a compact shower with 1 triangulation in CAMS Florida, 9 triangulations in CAMS BeNeLux and 6 triangulations in LO-CAMS. Because both CAMS BeNeLux and LO-CAMS deploy many RMS cameras among the CAMS Watec cameras, these results are not fully independent. Only three of the meteors are independent triangulations from the Global Meteor Network results (Vida and Segon, 2024). All were triangulated with the CAMS software.

3 Results

The shower activity ranged from 2024 September 22 – 25, corresponding to solar longitude 180.0 to 182.5º (Equinox J2000.0), with most activity (N = 10) during 180.9–182.2º. Median orbital elements are given in *Table 1*, and are in good agreement with earlier reported results.

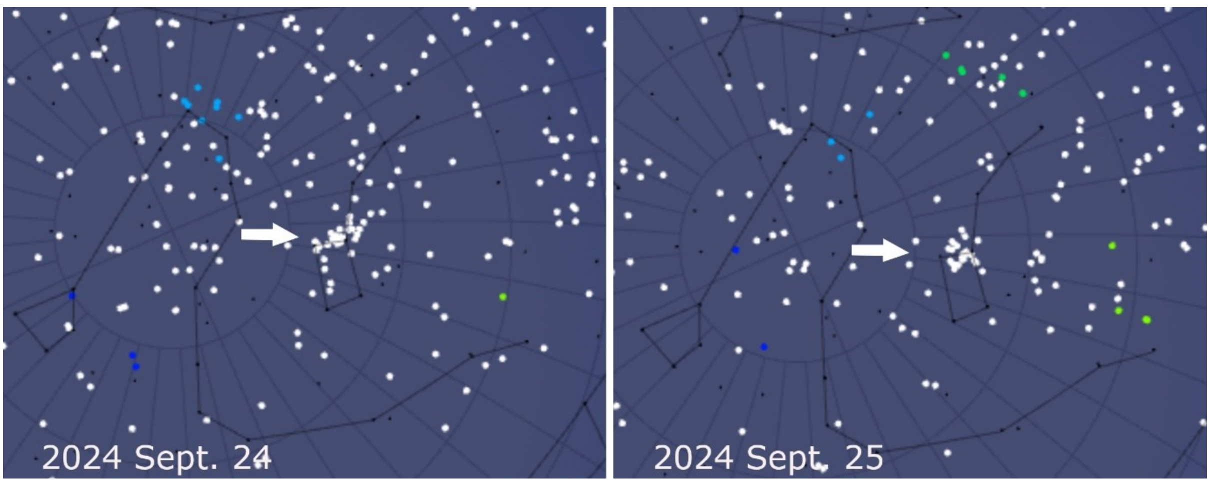

Figure 1 – Daily shower map of 2024 September 24 and 25 (see online[12]). The arrow marks the 2024 outburst discussed here. Meteors marked green (IAU#751), light green (IAU#745), light blue (#796) and dark blue (#220) were automatically assigned to uncertain proposed showers not included in Jenniskens (2023).

[12] http://cams.seti.org/FDL/

Table 1 – The median orbital elements (Equinox J2000.0) of the 2024 shower with a radiant in Ursa Minor.

	2024 Vida and Segon (2024)	2024 Harachka et al. (2024)	2024 CAMS	EPU: 2019 (Sato 2020)	EPU: 2019 (Shiba 2022)	2021 HK12
λ_Θ (°)	181.8 ± 0.4	181.93 ± 0.12	181.44 ± 0.70	182	181.9	187.08
α_g (°)	238.27 ± 5.4	238.37 ± 1.32	241.3 ± 3.6	252	255	243.8
δ_g (°)	+77.26 ± 1.2	+77.35 ± 0.15	+77.3 ± 1.2	+83	82.6	72.1
v_g (km/s)	32.0 ± 1.2	31.08 ± 1.12	31.9 ± 1.4	33	33.6	28.1
$\lambda - \lambda_\Theta$ (°)	296.63	–	296.1 ± 4.0	276.3	–	–
β (°)	75.72	–	+76.2 ± 1.0	+73.5	–	–
a (AU)	2.34 ± 0.16	2.73 ± 0.41	3.51	2.5	2.756	3.286
q (AU)	0.994 ± 0.03	0.996 ± 0.001	0.997 ± 0.002	1	1.003	1.038
e	0.68 ± 0.03	0.629 ± 0.055	0.717 ± 0.068	0.61	0.636	0.684
ω (°)	169 ± 2	168.74 ± 0.68	169.8 ± 1.8	178.3	178.7	168.8
Ω (°)	181.8 ± 0.4	181.93 ± 0.12	181.4 ± 0.7	182	181.9	187.1
i (°)	53.9 ± 2.4	52.8 ± 1.4	53.7 ± 2.0	57.6	57.8	47
Π (°)	350.8	350.7	351.2 ± 1.7	360.3	360.6	355.9
T_j	–	–	2.18 ± 0.37	–	–	2.37
N	31	4	16	13	10	–

4 Discussion

The epsilon-Ursae-Minorid shower is not included in the Atlas of Jenniskens (2023). That appears to be an omission. Looking back at the past 2007–2020 SonotaCo, EDMOND, and CAMS data shows a distinct shower between solar longitudes 178 and 184 degrees, centered on a radiant at ecliptic coordinates 271.7, +73.9 degrees and v_g = 33.6 km/s. The number of meteors per year, starting in 2007 are: 4, 0, 0, 0, 1, 0 11, 1, 1, 2, 1, 1, 32, 1. Hence, the epsilon-Ursae-Minorids shower appears to be episodic and was in outburst in (2007,) 2013, and 2019. A periodicity of 6.0 ± 0.4 years is suggested. The year 2024 would fit in this sequence if the periodicity is about 5.7 years (semi-major axis a ~ 3.19 AU), or if the concentration of dust along the orbit is wide enough dispersed to give activity at Earth in both 2024 and 2025.

The 2024 outburst was at a Sun-centered ecliptic radiant of 296.1 ± 4.0, +76.2 ± 1.0 degrees around 181.4º (*Table 1*). In 2007, the radiant was at about 270.6, +74.1 degrees around solar longitude ~180.5º, while the radiant was centered at 264.1, +73.9 degrees around 181.1º in 2013, and at 271.9, +73.8 degrees around 181.5º in 2019. That observed variation in ecliptic longitude of past shower radiants suggests that the 2024 outburst can be a return of the epsilon-Ursae-Minorids.

Asteroid 2021 HK12, identified by Vida and Segon (2024) as a possible parent body, appears to be a fair match to the stream. The longitude of perihelion is in between that of the epsilon-Ursae-Minorids and the 2024 shower. The asteroid has a Tisserand parameter with respect to Jupiter in the Jupiter-family comet range and has a semi-major axis of 3.286 AU (corresponding to an orbital period P = 5.96 years).

The observed meteoroids must have been ejected some time ago given the significant difference in inclination between the current parent body orbit and that of the stream. If so, then the dust is likely not that of recent dust ejecta, but rather dust from older ejecta accumulated in the 2:1 mean-motion resonance with Jupiter. That would predict a more regular pattern of outbursts with the period of the resonance (6 y). In that case, we may expect to see this shower again in 2025. And if it does, the shower is likely to return also in 2030 and/or 2031.

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While only three of the CAMS networks captured this September 2024 outburst, the detection was made possible by the concerted effort of all CAMS network and station operators as well as by efforts from Dave Samuels and Steve Rau, who continue to maintain the CAMS networks.

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New meteor shower in Lyra, 26–27 October 2024

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A new meteor shower on a Jupiter-family comet orbit ($T_J = 2.9 \pm 0.1$) orbit has been detected during October 26–27, 2024 by the Global Meteor Network. Meteors belonging to the new shower were observed between $213.4° < \lambda_\odot < 214°$ from a radiant at R.A. = 289° and Decl.= +37° in the constellation of Lyra, with a geocentric velocity of 13 km/s. The new meteor shower has been listed in the Working List of Meteor Showers under the temporary name-designation: M2024-U1.

1 Introduction

An unexpected concentration of radiants appeared on the radiant plot of the Global Meteor Network data for 2024 October 26–27 in Sun-centered geocentric ecliptic coordinates. No trace of this activity could be seen on these maps for previous or later days. A first analysis identified 17 meteors within a narrow time interval of about a half day, between solar-longitude interval 213.42° – 213.94°, with a peak around 213.55°. The shower was independently observed by cameras in 9 countries across the globe (Belgium, Canada, France, Germany, Greece, Romania, the Netherlands, United Kingdom and the USA). A CBET announcement was prepared and published (Vida and Šegon, 2024) and the new meteor shower was registered by the IAU Meteor Data Center and got the temporary identification M2024-U1.

2 Discovery and first analysis

We used the procedure as described for some recent cases of possibly new showers in Bootes and Draco (Šegon et al., 2023). The Drummond dissimilarity criteria D_D has been chosen for the analysis of the new radiant concentration. A first iteration revealed a clear concentration of orbits, as it can be seen on *Figure 2*. The Rayleigh distribution fit pointed at a D_D value of 0.01 as the orbital similarity cutoff (*Figure 3*), which is unusually narrow and resulted in 17 orbits representing the possibly new meteor shower.

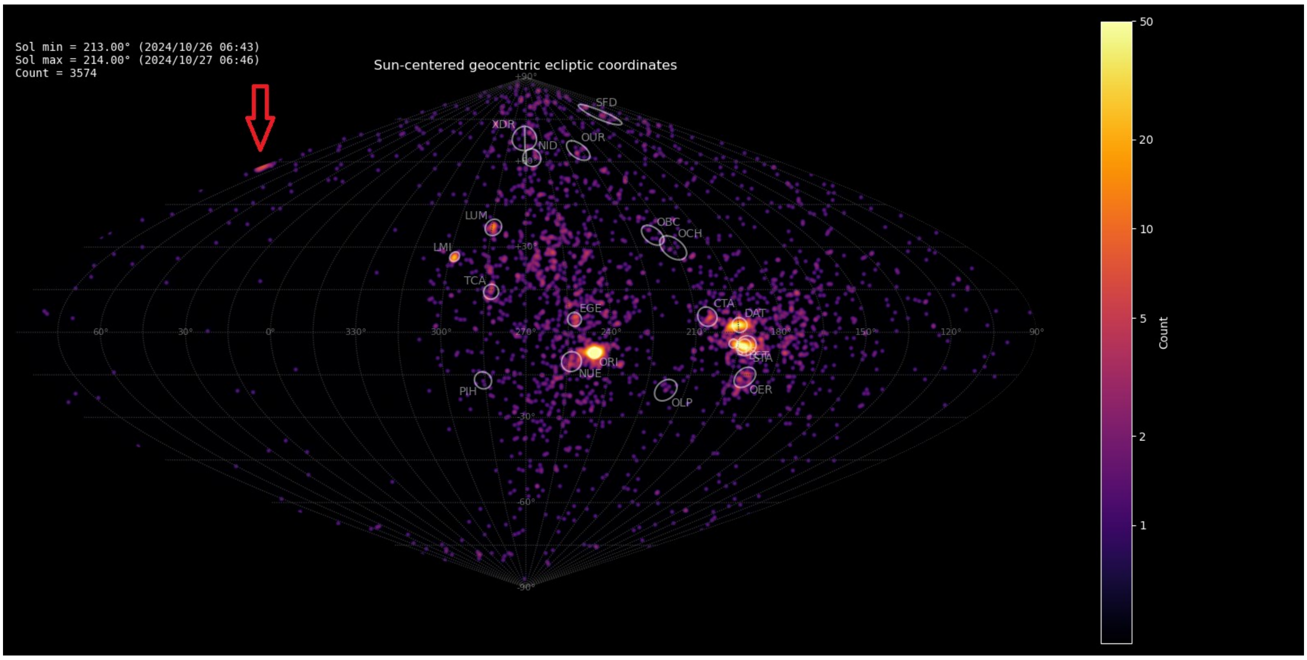

Figure 1 – Radiant plot of the Global Meteor Network data for 2024 October 26–27 in Sun-centered geocentric ecliptic coordinates. The new radiant is visible at the edge of the map and marked by a red arrow.

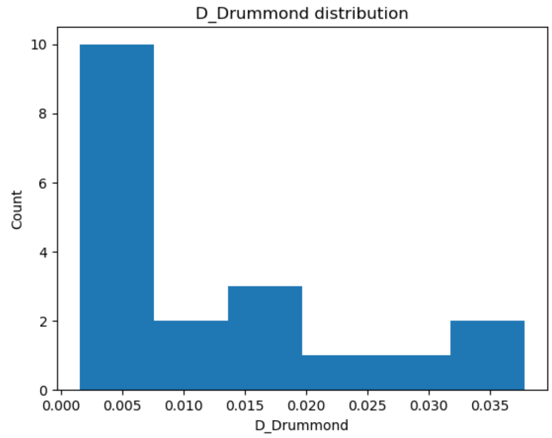

Figure 2 – Histogram of the distribution of the Drummond D_D criterion values valid for the final mean orbit.

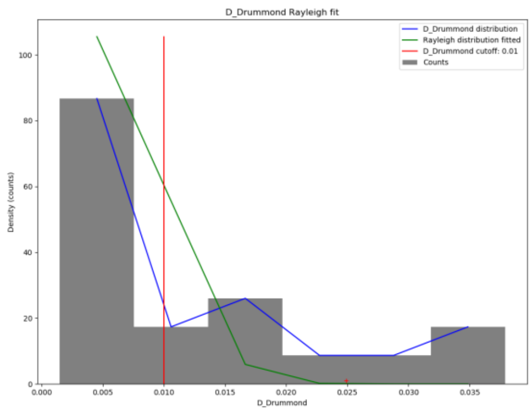

Figure 3 – Rayleigh distribution fit and Drummond D_D criterion cutoff with an exceptional narrow discriminiation interval.

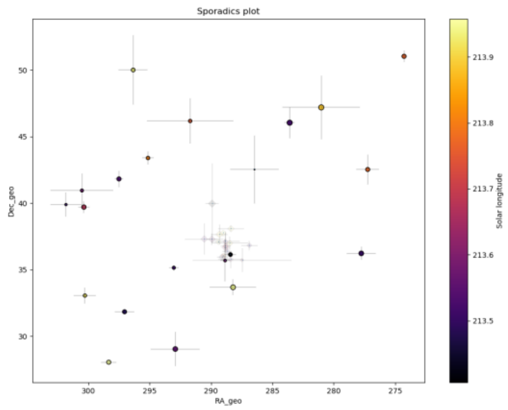

Figure 4 – All non shower meteor radiants in geocentric equatorial coordinates during the shower activity. The pale diamonds represent the new shower radiants plots, error bars represent two sigma values in both coordinates.

The presence of non-shower radiants in the area around the possibly new shower (*Figure 4*) shows the cutoff to be reliable since the density of meteor radiants does not look affected after removing shower members (plotted as pale diamonds). The plot of the shower meteor radiants in equatorial coordinates shows a very compact group (see *Figure 5*). The *Π*–*i* diagram also shows a compact group of radiants (*Figure 6*), without any other groups of radiants to be seen.

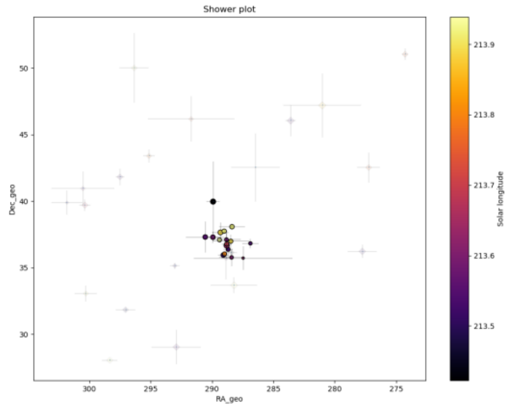

Figure 5 – The reverse of *Figure 4*, now the shower meteors are shown as circles and the non shower meteors as grayed out diamonds. Note that there are no other groups of meteor radiants to be seen in the vicinity of the possibly new meteor shower.

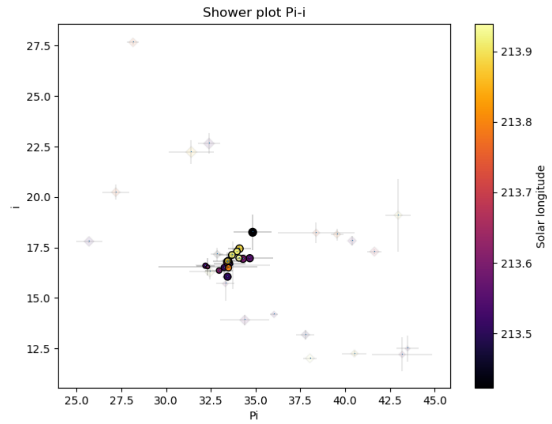

Figure 6 – The diagram of the inclination i against longitude of perihelion Π shows a distinct group of radiants without any other groups to be seen.

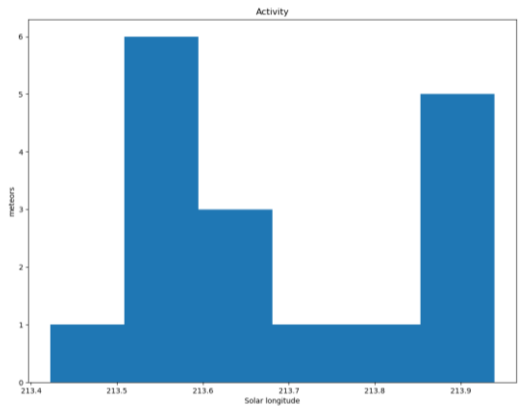

Figure 7 – The activity period with the number of orbits identified as new shower members.

The activity period (*Figure 7*) was limited to the interval $213.4° < \lambda_{\odot} < 214°$ (2024, October 26–27). The first analysis provided solid proof that a thus far unknown shower had been detected.

Looking for similar orbits of known meteor showers in the IAU MDC list of meteor showers, the best matching case with $D_D = 0.05$ are the delta-Cygnids (DCY#0282). However, this meteor shower had been removed from the working list because no original references were given for it. Moreover, the orbit was based on as few as 5 orbits which is far too little to define a meteor shower. Its activity date at $\lambda_O = 200.8°$ differs about two weeks from the detected new meteor shower and the radiant positions are far apart. A second matching meteor shower with $D_D = 0.06$, the October Cygnids (OCG#0083) is even further off in both activity period and radiant position. The third possible match with $D_D = 0.07$ for the iota-Cygnids (ICY#0525) is closer in time with $\lambda_O = 218.4°$, but the radiant position differs too much. Andreic et al. (2013) concluded that the radiant plot was very diffuse and that all three above mentioned meteor showers are most probably just one shower. It should be noted that the available discrimination criteria are very tricky with this type of low inclination Jupiter Family Comet orbits. There are plenty of this type of orbits that may produce pure chance D-criteria matches. We can conclude that no known meteor shower can be associated with the newly detected activity.

Table 1 – The new meteor shower, derived by two different methods.

	New (Šegon)	New (Roggemans) $D_D < 0.02$	New (Roggemans) $D_D < 0.01$
λ_O (°)	213.55	213.64	213.63
λ_{Ob} (°)	213.42	210.6	210.6
λ_{Oe} (°)	213.94	222.4	213.94
α_g (°)	288.9	289.0	289.0
δ_g (°)	+37.0	+37.1	+37.0
$\Delta\alpha_g$ (°)	–	–	–
$\Delta\delta_g$ (°)	–	–	–
v_g (km/s)	13.1	13.1	13.1
λ (°)	299.7	300.2	299.8
$\lambda_g - \lambda_O$ (°)	86.0	86.3	86.0
β_g (°)	+58.2	+58.5	+58.5
a (A.U.)	2.88	2.91	2.91
q (A.U.)	0.9938	0.9932	0.9938
e	0.6545	0.6598	0.6589
i (°)	16.9	16.8	17.0
ω (°)	179.9	180.3	180.5
Ω (°)	213.7	213.9	213.3
Π (°)	33.6	34.2	33.8
T_j	2.89	2.86	2.86
N	17	23	14

3 Another search method

Another method has been applied to check this new meteor shower discovery. The starting point here can be any visually spotted concentration of radiant points or any other indication for the occurrence of similar orbits. The method has been described before (Roggemans et al., 2019). The main difference with the method applied in *Section 2* is that three different discrimination criteria are combined in order to have only those orbits which fit different criteria. The D-criteria that we use are these of Southworth and Hawkins D_{SH} (1963), Drummond D_D (1981) and Jopek D_J (1993) combined. Instead of using a cutoff value for the D-criteria these values are considered in different classes with different thresholds of similarity. Depending on the dispersion and the type of orbits, the most appropriate threshold of similarity is selected to locate the best fitting mean orbit as the result of an iterative procedure.

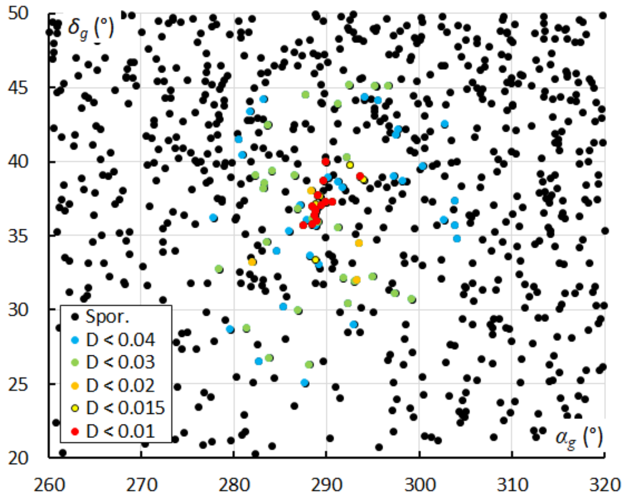

Figure 8 – Radiant plot in geocentric equatorial coordinates for different similarity thresholds, This plot shows all radiant points collected in solar longitude between 196°–228°.

This method detects 84 candidate orbits with similarity criteria better than $D_D < 0.04$, $D_{SH} < 0.1$ and $D_J < 0.1$, detected during a time interval of about a month, $196° < \lambda_O < 228°$. *Figure 8* shows all the radiants detected during this interval, the spread in time and dispersion of the radiant points suggests that most of these orbits marked in blue ($D_D < 0.04$) and green ($D_D < 0.03$) are sporadics that fit the D-criteria by pure chance. The explanation for this is in the type of orbits, low inclination JFC orbits. The usual cutoff values for D-criteria orbit similarities are not valid for this type of orbits. With other words, using D-criteria in this case is tricky and requires a careful approach to avoid combining randomly unassociated orbits into a new shower detection. This may explain the unconfirmed origin of the neighboring meteor showers found in the IAU MDC working list of meteor showers based on poorly interpreted D-criteria.

The D_{SH} and D_J criteria are not very helpful for these types of orbits. For this case we must consider more strict similarity classes with the Drummond D_D criterion as main discriminator. We consider the following classes:

- $D_D < 0.03$, $D_{SH} < 0.05$ and $D_J < 0.05$ (green dots);
- $D_D < 0.02$, $D_{SH} < 0.05$ and $D_J < 0.05$ (orange dots);
- $D_D < 0.015$, $D_{SH} < 0.05$ and $D_J < 0.05$ (yellow dots);
- $D_D < 0.01$, $D_{SH} < 0.05$ and $D_J < 0.05$ (red dots).

In *Figure 8* we see a concentration of radiants with D_D values better than $D_D < 0.02$. This is also very obvious in *Figure 9* where we plot the radiants limited to the interval $210° < \lambda_{\odot} < 215°$. The concentration is also very well visible in the diagram of the inclination i against the longitude of perihelion Π (*Figure 10*). 14 of the 19 orbits with $D_D < 0.015$ were detected during the interval, $213.4° < \lambda_{\odot} < 214.0°$, four more were detected earlier and one later.

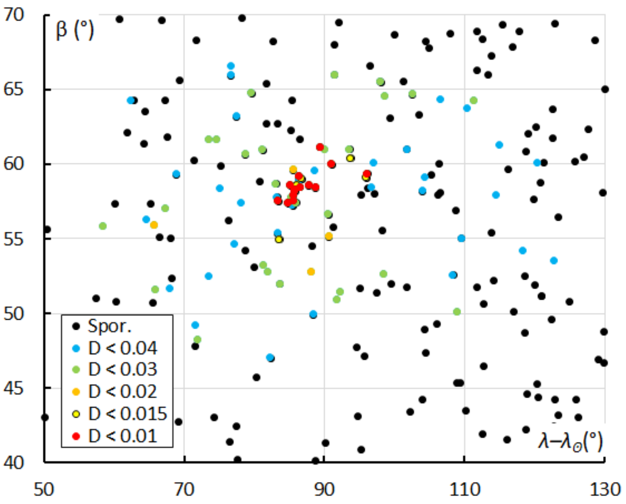

Figure 9 – Radiant plot in geocentric Sun-centered ecliptic coordinates for different similarity thresholds. This plot shows all radiant points collected in solar longitude between 210°–215°.

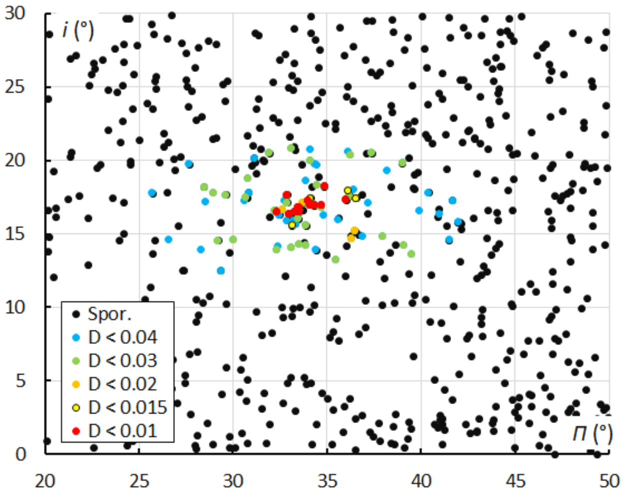

Figure 10 – Diagram of the inclination i against the longitude of perihelion Π. This plot shows all radiant points collected in solar longitude between 210°–215°.

The mean orbit computed according to Jopek et al. (2006) for the orbits selected using the method of Šegon et al. (2023) is listed as New (Šegon) in *Table 1*, the mean orbit for the selection using the method of Roggemans et al. (2019) is listed under New (Roggemans) and compares the mean orbit obtained for $D_D < 0.02$ with the result for $D_D < 0.01$. The dispersion of radiants with less good similarity are also shown in *Figures 8 and 9*, but these orbits were not used to compute the mean orbit to avoid contamination with sporadics. The three mean orbits are almost identical, so the few outliers detected before and after the main concentration do not influence the final orbit.

4 Comparing older data and other datasets

Looking up past years orbit data for Global Meteor Network (2018–2023, 1174206 orbits), we find 10 orbits with $D_D < 0.02$. Two in 2019, one in 2020, one in 2021, two in 2022 and four in 2023, spread in time at different solar longitudes several days apart. The SonotaCo net orbit data (2007–2023, 490283 orbits) has only one orbit with $D_D < 0.02$, recorded in 2022. EDMOND (2001–2023, 508266 orbits), has one orbit with $D_D < 0.02$ in 2016. The CAMS orbit data (2010–2016, 471582 orbits), also has one orbit with $D_D < 0.02$, recorded in 2016.

The few similar orbits found in previous years in different datasets all appeared spread in time. There is no trace of any previous recorded annual activity or outburst. These few isolated cases may be just sporadics that fulfill the similarity criteria by pure chance.

5 Discussion

This new meteor shower is a good example to demonstrate the risks of using discrimination criteria without considering the cutoff value. Any meteoroid stream search on this type of low inclination JFC orbits will result in many positive matching sporadic orbits, good for defining spurious meteor showers. For the same reason the parent body search did not result in any certain association. 2014 UR36 ($D_{SH} = 0.07$) or 185P/Petriew ($D_{SH} = 0.1$) were the only two objects with orbit similarity, but again the Southworth and Hawkins criterion is not working well for this type of orbits and the similarity is far from the cutoff value used for the meteoroid orbits.

Meteor showers like this are a challenge to detect as the number of meteors is very low with a radiant near the antapex where meteoroids enter the atmosphere with very low entrance velocities as the particles must catch up with the Earth from the rear. The same particle concentration encountered head-on would produce much faster and thus brighter and easier to detect meteors.

6 Conclusion

A possibly new meteor shower in the constellation of Lyra active during $213.4° < \lambda_{\odot} < 214°$, has been detected in the Global Meteor Network orbit data for October 26–27, 2024. The resulting orbit is a Jupiter-family comet orbit one. The new meteor shower has been listed in the Working List of Meteor Showers under the temporary identification M2024-U1[13].

Acknowledgment

This report is based on the data of the Global Meteor Network (Vida et al., 2020a; 2020b; 2021) which is released under the CC BY 4.0 license[14]. We thank all 825 participants in the Global Meteor Network project for their contribution and perseverance. This list of operators whose cameras provided the data used in this work and contributors who made important code contributions are mentioned elsewhere in this issue (Šegon et al., 2025).

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Short note on P/2024 OC_2 and the alpha Capricornid meteor shower

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The very remarkable similarity of the preliminary orbit of Near Earth Asteroid P/2024 OC_2 and the alpha Capricornid meteor shower (CAP,#1) is outlined.

1 Discussion

Following a thread online[15] started on November 11th 2024 on the COMETS-ML group by Peter Bertwhistle on the possibility of P/2024 OC_2 showing cometary activity a master database of approximately three million multi-station meteor orbits (including Harvard Photographic, GMN (Vida et al., 2021), SonotaCo (2009), EDMOND (Kornoš et al., 2014) and CAMS (Jenniskens et al., 2018) publicly available data) was tested against the preliminary orbit given by the Minor Planet Center[16] using the Jopek 1993 D criterion. Since article submission the cometary activity has been confirmed in MPEC 2024-V174[17]. Accordingly, the object's current designation has been updated to P/2024 OC_2 here.

Using a D criterion threshold of 0.100 it was found that over 13506 orbits could be matched with the orbit of P/2024 OC_2 and that the object is in fact strongly associated with the alpha Capricornid meteor shower (CAP,#1). Several potential candidates for this shower appear in the literature but none of the previously suggested objects match the shower as well as this object and further tests against all other cometary orbits and this object did not match to better than $D = 0.100$ (16P/NEAT and P/2003 T12 were the nearest comets but with Jopek D Criterion values (Jopek, 1993) of roughly 0.12 for both). Results for potential matches given as number per Jopek D Criterion value range are given in *Table 1*. It should be noted that the vast majority, over 90%, of these orbits had already been categorized as alpha Capricornids by the respective reporting surveys.

Table 1 – Number of orbits per Jopek D criterion range when matched to the Orbit of P/2024 OC_2.

D value	Number
0.020 – 0.100	13506
0.020 – 0.080	10561
0.020 – 0.060	7029
0.020 – 0.040	2565
0.020 – 0.030	762

Analysis of the current published orbit of the prospective comet (at time of writing) appears to be inherently very faint, so faint that it is rarely detectable from Earth at magnitudes brighter than approximately 22, barely lasting a week brighter than magnitude 16 when a favorable close approach occurs (probable ones occurred in 1922 and 1973 though no literature notifications of enhanced activity seem to appear for either those or the following years) and barely reaching magnitude 14.5 for around a day at such times. This suggests that the object is both quite small and of very low mass. Such a case would therefore lead to the conclusion of it being an impressively sized meteoroid rather than the parent body of the shower, possibly a fragment of any putative parent body.

Acknowledgment

The publicly available datasets of meteor orbits provided up to current and near current times by GMN, SonatoCo and EDMOND and CAMS 3.0 which lists orbits only up to 2016 were invaluable in this analysis, with the GMN data strongly predominating in number.

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Perseid expedition 2024
A return to the Provence

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A report is presented on the 2024 Perseid observations by the authors at Saint Trinit, France from 10 till 16 August.

1 Introduction

The idea for a week of observing the Perseids in the Provence already took shape in the summer of 2023. Reasonably favorable lunar conditions, maximum of the Perseids outside the weekend, good chances on clear skies and the somewhat more favorable holiday options, brought the total number of participating meteor enthusiasts to 6 people. Exactly enough to occupy a house in Saint Trinit. Peter van Leuteren's family had already stayed there in 2018. According to Peter, the location was ideally suited for observing the Perseids. Selma Koelers, Sietse Dijkstra, Koen Miskotte and Carl Johannink wanted to see that. Initially, Simon Dijkstra, Sietse's son, was also going to come along, but he was forced to cancel due to an accident in mid-July. A van was arranged for our travel purpose.

The aforementioned quintet finally left Selma Koelers' home on Friday morning, August 9 at 6^h local time sharp for the trip to Provence. The journey on Friday went very smoothly. No traffic jams, and a route via Germany and Luxembourg brought us around 15^h local time to our overnight address in Burgundy, called Tournus. This town is only 2 km from the motorway to the south. According to the planning, it would then be another 4 hours' drive to our spot.

On Tournus we had a simple but good hotel. And enough time to explore this town by walking (Sietse, Koen, Selma and Carl) and by bike in the area (Peter). We met again around half past five in the afternoon on a pleasant square next to the beautiful Romanesque basilica of this town. Dinner was also enjoyed here. After some more site-seeing we returned back to the hotel.

2 August 10, 2024

After a good breakfast with various sandwiches, toppings and other things, we drove out of Tournus around 08^h45^m for the last four hours... Well at least, that's what we hoped... But that turned out to be a bit optimistic. After driving 60 km, just before Lyon, a 130 km long 'stop and go' stretch began before we could leave the motorway at Orange. We reached Sault, at the foot of Mont Ventoux, fairly quickly via the provincial roads. At the local supermarket, we bought groceries for the weekend, and prepared ourselves for the last few kilometers. At around 16^h local time we were welcomed by the owner of the house where we would be staying.

What a beautiful place! A house that was well equipped with all the necessary things for cooking, eating, drinking and cleaning. The house was on the grounds of a sheep farm, a large herd walked in the meadow in front of the house. Then Sietse and Peter started briskly setting up their telescopes and cameras for deep sky and meteor photography. In the meantime, Koen and Carl prepared a macaroni dish with minced meat and vegetables. It was still quite warm at 20^h local time. We drank tea or coffee on the terrace of the house. Then everyone went their own way to prepare for the night of observing, either by setting up the equipment or by taking a nap before the start of the observations. Visual meteor observations would be started around 23^h UT.

Figure 1 – Our rented house and part of the observing site.

August 10–11

Peter and Koen were the first signing in for the first meteor session. Carl followed shortly afterwards, Sietse and Selma were only finished with all the preparations around midnight, so they napped until roughly 0^h UT. Incidentally, Peter had made an improvised fence at the access road to our holiday residence. Two donkeys were walking around freely on the grounds and they might be interested in Peter's telescope and other equipment that were in the field 24/7.

What did they see? The starry sky was beautiful: the location is very dark and has an unobstructed view between the northwest and east. There was no direct light, except now and then when a car drove on a road a few kilometers north of us. In the southeast and south there are some trees that covered a small part of the sky. The Milky Way was richly structured as expected. The sky was not perfect, by the way, at lower altitudes there were some dust veils and, in the south, some approaching cirrus that largely dissolved when it came closer. Nevertheless, the observers reached limiting magnitudes between 6.4 and 6.5 and SQM readings mostly reaches 21.40 to 21.50.

Figure 2 – Peter and Sietse working on their visual data.

Good activity of the Perseids, interspersed with some beautiful Capricornids, Aquariids and also a sporadic kappa Cygnid. With some regularity a slightly negative magnitude meteor also shot through the firmament, much to the delight of the spectators on the ground.

The activity of the Perseids was good and seemed it was better than in other years. Everyone agreed on that. After more than 3 or 4 hours of observing, dusk set in and the observers ended their sessions for a well-deserved night's rest, or should we call this morning rest?

August 11–12

Sunday was used to further settle in at the rented house, to process the first data, and for Peter for a bike ride along a number of 3rd category mountains. However, it was quite warm during the day, so Peter admitted he was a bit 'empty' after a 2-hour ride.

The night of 11–12 August was clear despite some very thin cirrus clouds and went completely according to expectations: normal Perseid activity, but also with longer 'quiet' periods. The highlight was a very beautiful meteor of –2 that slowly moved to the northwestern horizon. This meteor had a strong 'kappa Cygnid-like' appearance.

The northern horizon was rather grey in color, which we all noticed. The next day it became clear that there had been a lot of auroras visible in Europe. On images by Peter and Sietse aurora was also visible up to about 15 degrees altitude! The quality of the sky was a lot better than the previous night. We also saw a Starlink train passing through the zenith around 02^{h}05^{m} UT.

August 12–13

Processing data and doing groceries filled that Monday day. The maximum night of 12–13 August lived up to its name, although the Perseid activity could not reach the level that we had seen in other years. Koen was already in the field early for an all-nighter. The dust veils and the cirrus low south were hardly present after 23^{h} hours. As a result, the half-Full Moon hardly disturbed and the limiting magnitude was soon above 6.0. It is always a special experience for Koen to observe with moonlight. The fact that the landscape is illuminated like a fairy tale gives the night a different experience. This night also no overly bright meteors were

Figure 3 – August 12, 2024: promising skies over Saint Trinit. Koen's equipment is ready for the night.

Figure 4 – Composition of 6 Perseids captured during August 11–12, with a Sony Alpha A7 IIs with a Sigma 20 mm ART F 1.4 lens set at 1.6, 3200 ISO, 20 sec exposure time. © Koen Miskotte.

Figure 5 – Composition of 4 Perseids and aurora captured during August 12–13, with a Sony Alpha A7 IIs with a Sigma 20 mm ART F 1.4 lens. Camera set at 2.0, ISO 2000, 20 sec exposure time. © Koen Miskotte.

seen, the brightest meteors were a few Perseids of –4. Again, a Starlink train was visible, but much weaker than the one of the previous night. And again, aurora has been visible on the northern horizon. Selma, Sietse, Peter and Koen captured this on their camera's. It was annoying that exactly around the maximum aurora activity a car with a large searchlight drove around the terrain north of our house. Inquiries with the owner of the holiday residence revealed that it was about counting the numbers of hares. If the numbers are too high, they may be hunted. All in all, a nice Perseid maximum with ZHR's (roughly estimated) between de 50 and 70.

August 13–14

Tuesday 13 August the weather became unstable during the day. We made a trip to Banon for some sight-seeing and a bite to eat. The cold salmon tartare was a very experimental meal for some, although apparently common in that region. On the way back we regularly stopped for photos

Figure 6 – Sietse Dijkstra working under a bright sky. Nice composite photo taken by Peter van Leuteren, during the night August 13–14 2024.

to capture the gigantic cumuli. It cleared up again only briefly during the night, and Koen, Peter,Sietse and Selma were still able to observe some meteors and take some deep-sky shots. Too bad it only cleared up briefly, because this night we could look exactly into the same time window in which the intense Perseid outburst (ZHR 230) was observed above North America in 2021. However, the 50-minute clear sky showed normal Perseid activity.

August 14–15

Again, a clear sky, but with orographic clouds increasingly visible in the northwest. It was a warm and humid night. Everyone could add some observations to his/her series. This night the nocturnal atmosphere at our observing site was enhanced by a fox, a howling wolf pack, and the peculiar sound of a Scops Owl. We could actually hear the owl ‘singing’ in the background for several hours every night. In addition, there was of course the sound of the Crickets and the bells of the sheep every night. And for the third time, a Starlink train was seen.

August 15–16

On the morning of Thursday 15 August Peter did a ride up the mountain “Montagne de Lure” on his racing bike. The others met him at the top. You have a fantastic view from that mountain to the north! We had lunch together in Sisteron, before we started our way back to Saint Trinit. Later that afternoon we were visited by our friends Michel Vandeputte and Inneke Vanderkerken with their kids Laurien and Boris. It was a pleasant afternoon with coffee, cake, nuts and drinks.

The following night it only cleared up late at night. Although the viewing conditions were comparable to the previous nights, the zodiacal light was best visible that night. Also, the last meteors were collected that night. On Friday, Selma, Peter and Carl treated themselves to a trip to the Mont Ventoux. Later that afternoon we all enjoyed a sorbet on a terrace in Sault to celebrate our succes with the Perseids 2024. And then time to clean up.

We left early Saturday morning at 04^h40^m for home. The return trip went smoothly. Without any real traffic jams, we arrived in Enschede around 17^h45^m. Here everyone went their own way, knowing that we had enjoyed a beautiful week in the Provence.

Figure 7 – Group photo! From left to right, Selma Koelers, Sietse Dijkstra, Koen Miskotte, Carl Johannink and Peter van Leuteren.

Autumn meteor and aurora observations from Ermelo and Texel in the Netherlands

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The author presents a report on his autumn visual meteor and aurora observations.

1 Introduction

During the second half of September little could be observed due to moonlight and bad weather. Fortunately, chances for a clear night increased at the beginning of October when a series of clear nights was expected. In July, we booked a late holiday between 4 and 11 October 2024, again on Texel, a Dutch island between the Wadden sea and North Sea. This time we were not at our usual spot in the hamlet of Midden Eierland, about 4 km south of De Cocksdorp. This time we had rented a 4-person house at the Landal holiday park De Sluftervallei, which is about 3 km from the northernmost point of Texel and the lighthouse. Although it was a holiday, I of course also looked at possible locations where I could observe meteors in case of a clear night. The park is not suitable given the lighting and trees. The park is somewhat hidden in the woods and there were enough dark locations with SQM values above 21 within walking distance.

As early as October 2, the sky began to clear and the first observations could be made from the "meteor roof" on the dormer at home.

2 October 2–3, 2024

After a short night's sleep, I checked the weather: the sky was clear! The sky was very transparent, the limiting magnitude was 6.3. The SQM values were slightly disappointing with 20.34 as a maximum and the temperature dropped from +4 to 0 degrees Celsius. The observations started at 00^h15^m and ended at 03^h50^m UT, effectively exactly 3.5 hours. Thanks to the transparency, a fair number of meteors were seen, hourly counts increased to 11, 13, 15 and 6 (half hour) respectively. Of these, there were 2 southern Taurids (STA), 0 northern Taurids (NTA), 0 October Camelopardalids (OCT), 6 delta Aurigids (DAU) and 4 early Orionids. Few bright meteors, but a fireball was seen! A fast sporadic (SPO) –4 fireball appeared in Gemini at 02^h32^m UT and left a 4-second trail. A little earlier, a slow magnitude 0 SPO appeared in the Ursa Minor.

3 October 3–4, 2024

Another clear night, it was decided to have a somewhat shorter session because we would also travel to Texel today. Observations took place between 00^h57^m and 03^h36^m UT. The conditions were the same as the previous night. Maximum SQM 20.32 and limiting magnitude 6.3. Nevertheless, the hourly counts were lower than the previous night with 7, 10 and 8 (0.6 hours) per hour respectively. A total of 25 meteors of which 3 ORI, 4 STA and 1 DAU. Again, few bright meteors, an Orionid of +1 in Pegasus was the brightest. Incidentally, the observations were briefly disturbed by the well-known blue light column of ProRail, a train with a huge blue beam of light directed upwards to check the overhead lines of the track. Again, the temperature dropped to 0 degrees Celsius. Also, a part of a Starlink train passed by with satellites with a maximum magnitude of +2.

4 October 4–5, 2024

After arriving and settling at the holiday park de Sluftervallei, I took a walk along the Krimweg. There were plenty of spots there, but I was wary of cars passing by. On the way back I saw a cycle path that went into the dunes to the left of the Krimweg. There I walked a bit where you immediately went up a high dune. Just behind the dune top was a flat piece of grassland/star moss. Yes, this will be the observation location, the lighthouse nicely behind the dune top and a good view in all directions.

After a short sleep I woke up at 23^h50^m UT: the sky was clear, so I quickly got dressed and went to the dunes. The observations started at 00^h16^m UT. The sky was crystal clear with a limiting magnitude of 6.6 and an SQM of 21.30. The sky was perfect up to 10 degrees altitude, but in an easterly direction the sky background was a bit lighter due to the holiday parks. And in a southerly direction a light dome up to 20 degrees altitude of the city Den Helder at the main land and the greenhouses behind it was visible. I have been visiting Texel for over 14 years now and I see that the light pollution has increased considerably in that direction. During the session the sky became a bit hazier below 20 degrees, perhaps due to the warm sea water in combination with the cold air? I positioned myself in a south-easterly direction so that I was not too disturbed by the lighthouse. A few times I looked to the north because the northern lights were also expected after a heavy X9.1 explosion on the Sun a few days earlier. It also became cold; the wind was almost absent and the temperature eventually dropped to 0 degrees Celsius. Observations were carried out between 00^h16^m and 04^h21^m UT, exactly 4 hours of effective observation time. The limiting magnitude gradually dropped from 6.6 to 6.4. Thanks to the high transparency the hourly counts were very nice with 18, 16, 23 and 12 meteors respectively. Of these there were 5 Orionids (max 3 per hour), 5 STA, 2 OCT, 1 DRA and 1 EGE. Again, a lot of faint stuff and a few bright meteors. For example, there was a fast possible October Camelopardalid of magnitude 0 with 2 seconds of a persistent train and a +1 SPO in Monoceros at 02^h28^m UT. However, the most beautiful meteor was, thanks to another aurora inspection, on the northern horizon. A very slow earth grazer moving from Canes Venatici just under the star Alkaid and extinguishing just under the head of the Dragon. The meteor showed a wake and fragmented into two pieces. These kinds of appearances make a session worthwhile. Around 03^h15^m UT I saw a first hint of the zodiacal light. Half an hour later it was clearly visible from Leo to Cancer, with the best visibility around 4^h UT. After that it quickly disappeared again in the upcoming twilight. All in all, it was a very nice session!

5 October, 5–6 2024

In the evening, the cumulus clouds quickly dissolved again and the sky became clear. There was a chance that I would have to stop earlier with the approaching front. Observations were done between 23^h58^m and 03^h07^m UT, exactly 3 hours effective. The entire session there was a varying amount of cirrus visible in the southwest, but as it came closer the cirrus clouds dissolved. Ultimately, the session was terminated when the cirrus finally entered my field of view.

The sky was slightly less than the previous night with a maximum limiting magnitude of 6.5 and SQM 21.20. Hourly counts of 10, 14 and 14. A total of 38 meteors of which 3 ORI, 6 STA, 5 DAU, 2 OCT, 1 EGE and 0 DRA (low radiant position). Again, only a few bright meteors. A +2 DAU with short persistent train in Auriga and at 02^h15^m UT a +1 SPO in the Big Dipper. However, the highlight was at the end of the session at 02^h57^m UT. A beautiful magnitude –1 orange teardrop-shaped STA moved from Gemini via Cancer to the crescent of Leo where it ended in a final flare of –2. A nice end to the session!

October 6–7, 2024 was completely cloudy with rain at night. That didn't matter because after 4 nights I had to get some sleep.

6 October 7, 2024 in the evening: Aurora!

With some delay, the CME of the X9.1 explosion on the Sun of October 3rd arrived. At first, nothing seemed to happen, but after a report on a Dutch site about weather[18] that there might be aurora to be seen, I looked outside. There were some clearings, but with clouds coming in from the west. I quickly walked 10 minutes to the dark location. In a large gap in the clouds, the Big Dipper and surroundings were visible. A grayish light band was visible in it. Cirrus or Northern Lights? Suddenly, a number of very fine lines appear in the luminous band, which then also clearly turned reddish. Unfortunately, the clouds quickly made the clearing smaller. What to do? I quickly got a camera, but back on location it was largely overcast. Low northwest, an elongated clearing that turned greenish was visible. The images from the camera indeed confirmed that it was aurora.

7 October 8–9: Draconids active (well a bit…)!

The 2024 IMO Meteor Calendar stated that on October 8 between 6^h and 7^h UT the Earth would pass through a few old dust trails of comet 21P/Giacobini-Zinner. Indeed, the author received a message via Messenger around 11^h30^m UT from the Canadian meteor observer Pierre Martin that he had seen a number of Draconids despite low radiant position (and aurora!). This message gave me extra energy to do something in the evening hours. It looked like that in the evening the sky would become clear for 2 or 3 hours before the clouds moved in again.

In the evening twilight I walked to the observation location and I signed on at 18^h28^m UT. There was still some twilight but the limiting magnitude was already at 6.3 and quickly rose further to 6.5. At the end of the session the limiting magnitude dropped a bit to 6.4. SQM remained around 21.02. Transparency was good and I was looking in a north-northwesterly direction. Observations were possible until 20^h31^m UT when some clouds moved into the field of view. Some lightning was also visible from thunderstorms off the English coast. In those two hours, 14 meteors were counted, of which 2 were Draconids, 1 in each hour. Both were of magnitude +3. The first appeared just below the duo Alcor/Mizar with a short trail. The second appeared slightly to the right of the imaginary line between the stars ksi and beta Hercules.

Again, a fragmenting +2 SPO earth grazer was seen, this time from beta Boötes to Alkaid (epsilon UMA). And at the end a fast magnitude –1 blue-yellow SPO with a 4-second persistent train. This was also the last meteor observed from Texel this year.

[18] weerwoord.nl

Figure 1 – Aurora on October 10, 2024 at 20^h46^m UT from the edge of the Landal park. Camera: Sony Alpha A7 II7 with Sigma 20mm f/1.4 DG DN Art lens.

Figure 2 – Aurora on October 10, 2024 at 21^h39^m UT as seen from the observing site. Camera: Sony Alpha A7 II7 with Sigma 20mm f/1.4 DG DN Art lens.

8 October 10–11, 2024: A beautiful aurora display!

On October 8, 2024 at 01^h56^m Universal Time (03^h56^m local time), sunspot 3848 caused a powerful explosion. It was a flare of the most powerful kind, this time an X1.8. This explosion lasted four hours and caused a large CME (Coronal Mass Ejection) in which a cloud of particles was blown from the Sun's surface into space. The CME was aimed exactly at Earth and NOAA and NASA models predicted that the cloud of particles would reach the Earth's atmosphere on October 10 around 14^h UT (16^h local time) with a high probability of a geomagnetic storm and bright aurora.

Indeed, on October 10, 2024 at 15^h15^m UT (17^h15^m local time) the CME hit Earth. In no time, reports of bright aurora were coming in. The author was geographically very well positioned to see the aurora: 53 north and a dark sky. The disadvantage was the weather. As soon as it got dark, it remained mostly cloudy with occasional rain showers. Only at 18^h48^m UT (20^h48^m local time) there were a few small clearings in the north. But those clearings looked greenish!

On SAT 24 I kept an eye on the cloud pictures. Around 20^h35^m UT some small clearings arrived at my location and I took a short walk to the observation location, this time with camera and tripod (a Sony Alpha A7 S II camera with a Sigma 20mm F/1.4 DG HSM ART lens controlled by a HAMA DCCS timer).

Despite the ample cloud cover, the greenish glow was clearly visible, as well as the rapid emergence of red streamers in the northeast. This was all beautifully seen and photographed between 20^h40^m and 21^h00^m UT (22^h40^m and 23^h00^m local time). Despite the fact that it was almost completely cloudy around 21^h UT, I could still see bright red glow behind the clouds. Then I went quickly inside for approaching rainshowers.

Shortly afterwards I was able to return to the dark location and beautiful shots were taken of green and red aurora borealis. Sometimes there were rain showers visible at some distance while it was clear above me and yet it was raining! The wind was so strong that the drops blew away from under the storms. Around 23^h00^m UT there was a big revival in the aurora borealis. I checked the sky again after a few rain showers and large parts of the sky was bright red! A shot of it was taken at 23^h35^m UT. A minute later another photo was taken with exactly the same camera settings and the aurora borealis was already a lot less bright.

At 00^h30^m UT there was less activity and I decided to finally get some sleep. I heard from friends that the aurora borealis had been active all night. This aurora borealis observation will definitely be in my top 5. A very nice end of our holiday!

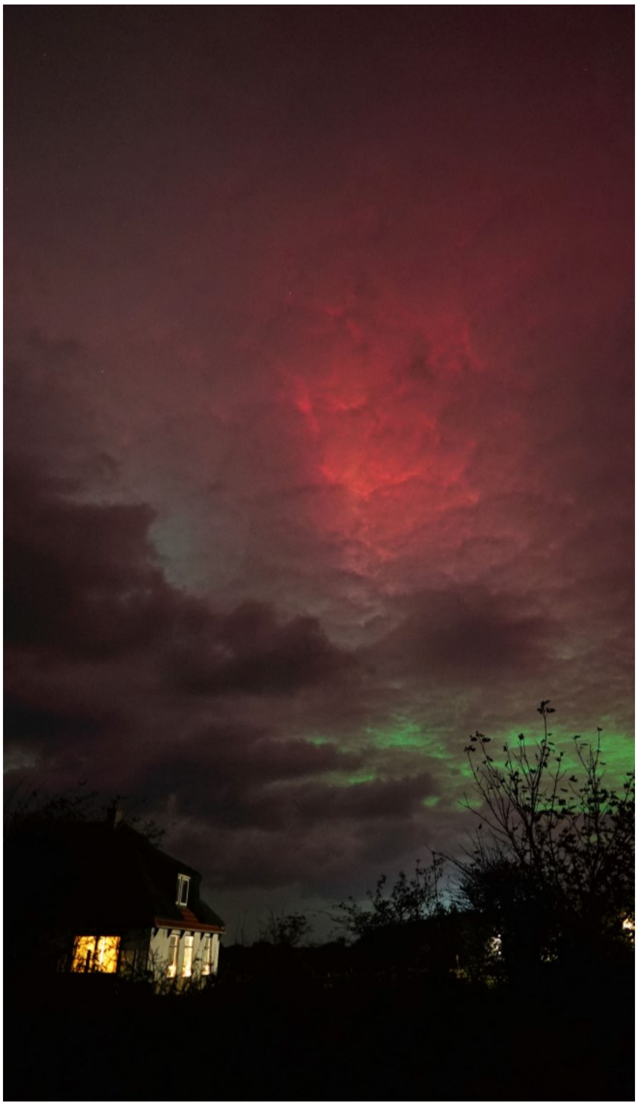

Figure 3 – Aurora through the cumulus clouds on October 10, 2024 at 21^h55^m UT. Camera: Sony Alpha A7 II7 with Sigma F 1.4/20 mm wide-angle lens.

Figure 4 – Aurora on October 10, 2024 at 23^h36^m UT at our rented house. Camera: Sony Alpha A7 II7 with Sigma 20mm f/1.4 DG DN Art lens.

9 November 02–03, 2024

A nice 3.5-hour session under good transparent conditions, with the limiting magnitude lagging behind again. Observations were made between 00^h40^m and 04^h15^m UT and that yielded 43 meteors of which 10 Orionids, 4 southern and 2 Northern Taurids. An early Leonid was also spotted. The brightest meteors were a 0 STA, 1 NTA and a 0 and +1 SPO.

10 November 03–04, 2024

A somewhat hazy and misty night with the limiting magnitude fluctuating between 6.0 and 6.1. Between 01^h34^m and 04^h36^m UT 29 meteors were counted. An early –1 Leonid and –1 SPO were the most beautiful meteors seen.

After these two sessions bad weather set in. The month of December 2024 was one of the cloudiest ever in the Netherlands. The Geminid (and Ursid) maximum took place under gray skies. In the evening of December 14th sky cleared up a partly, but no observations were made.

October 2024 report CAMS-BeNeLux

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A summary of the activity of the CAMS-BeNeLux network during the month of October 2024 is presented. This month we collected a total of 34577 multi-station meteors resulting in 10605 orbits.

1 Introduction

Sporadic meteor activity is near its peak this month. Some major showers, such as the Orionids and Taurids, are also visible. Meanwhile observations are possible for more than 12 hours from our latitudes. These facts make October one of the finest months for meteor observing. We looked forward to see what this month would bring this year.

2 October 2024 statistics

The main character of this month was its mostly unstable weather. But for the first time we could collect orbits in every night this month.

The best circumstances were at the start of the month and just at, and shortly after the Orionid maximum. On October 3–4, 4–5, and 22–23 this resulted in each night in more than 900 orbits. The highest number of orbits (1299) was recorded on October 23–24. CAMS-BeNeLux captured in October a grand total of 34577 multi-station meteors, resulting in 10605 orbits.

On average 120 cameras were active each night. This number is approximately 20% higher than last year. The highest number of active cameras was 127, and the smallest number of active cameras was 113. Both numbers are also remarkable higher than last year. See *Table 1* and *Figure 1*.

This is a result of the expansion of our network in England during the last months and in France last year. The difference between the highest and lowest number of active cameras per night reflects also the fact that although weather wasn't very stable, most of the cameras function all nights regardless the weather. There were always clear periods in the regions where our cameras are active.

However, there are minor technical problems here and there, as a result of which some cameras were out of service for a shorter or longer period of time. It is striking that the RMS cameras have also been increasingly suffering from malfunctions in recent months.

The number of camera stations this month was 49, equal to this number in September.

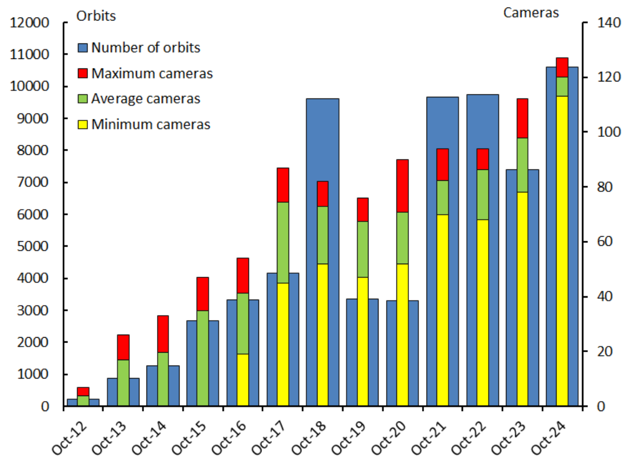

Figure 1 – Comparing October 2024 to previous months of October in the CAMS-BeNeLux history. The blue bars represent the number of orbits, the red bars the maximum number of cameras capturing in a single night, the green bars the average number of cameras capturing per night and the yellow bars the minimum number of cameras.

Table 1 – Number of orbits and active cameras in CAMS-BeNeLux during the month of October in the period 2012–2024.

Year	Nights	Orbits	Stations	Max. Cams	Min. Cams	Mean Cams
2012	16	220	6	7	–	3.9
2013	20	866	10	26	–	16.8
2014	22	1262	14	33	–	19.7
2015	24	2684	15	47	–	34.8
2016	30	3335	19	54	19	41.3
2017	29	4163	22	87	45	74.4
2018	29	9611	21	82	52	73.0
2019	29	3344	20	76	47	67.5
2020	29	3305	23	90	52	70.9
2021	29	9669	26	94	70	82.2
2022	30	9749	31	94	68	86.4
2023	30	7404	38	112	78	97.9
2024	31	10605	49	127	113	120.1
Total	348	66217				

Beside the regular activity of the Orionids and the Taurids in the second half of this month, we could collect data from the October Camelopardalids (OCT(#281) in the evening hours of October 5. *Figure 2* shows a sudden decrease in activity of this meteoroid stream after 22^{h} UT.

With the help of data of stations more to the east in Europe obtained by GMN, it seems that this stream didn't show much activity before 17^{h} UT. So, we could see meteors from this shower only for a few hours this year.

Interesting to see what results we can obtain for this stream next year, although maximum activity will coincidence with a Full Moon then.

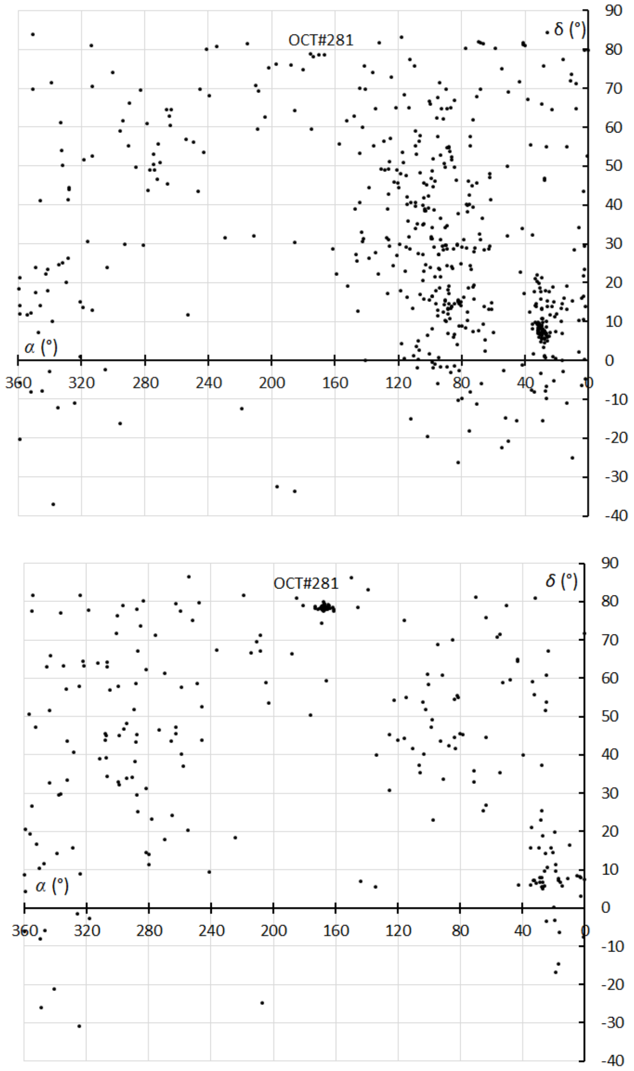

Figure 2 – CAMS-BeNeLux data 5–6 October 2024, 18^{h}–22^{h} UT (Bottom) and for 5–6 October 2024 22^{h}–06^{h} UT (Top).

3 Conclusion

Results for October 2024 were the best scores ever for this month by CAMS-BeNeLux.

Acknowledgement

Many thanks to all participants in the CAMS-BeNeLux network for their dedicated efforts. The CAMS-BeNeLux team was operated by the following volunteers during the month of October 2024:

Stéphane Barré (Colombey-Les-Belles, France, RMS 3907), *Hans Betlem* (Woold, Netherlands, Watec 3071, 3072, 3073, 3074, 3075, 3076, 3077 and 3078), *Jean-Marie Biets* (Engelmanshoven, Belgium, Watec 3180, 3181, 3182 and 3183), *Ludger Boergerding* (Holdorf, Germany, RMS 3801), *Günther Boerjan* (Assenede, Belgium, RMS 3823), *Martin Breukers* (Hengelo, Netherlands, Watec 320, 321, 322, 323, 324, 325, 326 and 327, RMS 319, 328 and 329), *Jean Brunet* (Fontenay le Marmion, France, RMS 3911), *Seppe Canonaco* (Genk, RMS 3818 and 3819), *Steve Carter* (Welwyn Garden City, England, RMS 3706), *Eduardo Fernandez del Peloso* (Ludwigshafen, Germany, RMS 3805), *Pierre de Ponthiere* (Lesve, Belgium, RMS 3816 and 3826), *Bart Dessoy* (Zoersel, Belgium, Watec 805 and 806), *Jürgen Dörr* (Wiesbaden, Germany, RMS 3810, 3811 and 3812), *Isabelle Ansseau, Jean-Paul Dumoulin, Dominique Guiot* and *Christian Wanlin* (Grapfontaine, Belgium, Watec 814, 815, RMS 3817, 3843, 3844 and 3845), *Miles Eddowes* (Reading, England, RMS 3709), *Uwe Glässner* (Langenfeld, Germany, RMS 3800), *Roel Gloudemans* (Alphen aan de Rijn, Netherlands, RMS 3197), *Luc Gobin* (Mechelen, Belgium, Watec 3890, 3891, 3892, 3893 and 3894), *Tioga Gulon* (Nancy, France, Watec 3900 and 3901), *Tioga Gulon* (Chassignolles, France, RMS 3910), *Robert Haas* (Alphen aan de Rijn, Netherlands, Watec 3160, 3161, 3163, 3164, 3165 and 3166), *Robert Haas* (Burlage, Germany, RMS 3803 and 3804), *Kees Habraken* (Kattendijke, Netherlands, RMS 3780, 3781, 3782 and 3783), *Erwin Harkink* (Elst, Netherlands, RMS 3191), *Nick James* (Chelmsford, England, RMS 3710), *Carl Johannink* (Gronau, Germany, Watec 3100, 3101, 3102), *Reinhard Kühn* (Flatzby, Germany, RMS 3802), *Hervé Lamy* (Dourbes, Belgium, Watec 394 and 395, RMS 3825, 3841, 3895, 3896, 3897 and 3898), *Hervé Lamy* (Humain, Belgium, RMS 3821 and 3828), *Hervé Lamy* (Ukkel, Belgium, Watec 393 and 817), *Hartmut Leiting* (Solingen, Germany, RMS 3806), *Arnoud Leroy* (Gretz-Armainvielliers, France, RMS 3909), *Alan Maunder* (Catherington, England, RMS 3707-3708), *Horst Meyerdierks* (Osterholz-Scharmbeck, Germany, RMS 3807), *Koen Miskotte* (Ermelo, Netherlands, Watec 3051, 3052, 3053 and 3054), *Jamie Olver* (Redhill, England, RMS 3705), *Pierre-Yves Péchart* (Hagnicourt, France, RMS 3902, 3903, 3904, 3905, 3906 and 3908), *Holger Pedersen* (Otterup, Denmark, RMS 3501), *Tim Polfliet* (Gent, Belgium, Watec 396, RMS 3820 and 3840, *Steve Rau* (Oostende, Belgium, RMS 3822), *Paul and Adriana Roggemans* (Mechelen, Belgium, RMS 3830, Watec 3832, 3833, 3834, 3835, 3836 and 3837), *Jim Rowe* (Eastbourne, England, RMS 3703), *Nick Russell* (Seaford, England, RMS 3704), *Philippe Schaack* (Roodt-sur-Syre, Luxemburg, RMS 3952), *Romke Schievink* (Bruchhausen Vilsen, Germany, RMS 3808 and 3809), *Hans Schremmer* (Niederkruechten, Germany, Watec 803), *Rob Smeenk* (Assen, Netherlands, RMS 3190 and 3196), *Rob Smeenk* (Kalenberg, Netherlands, RMS 3192, 3193, 3194 and 3195), *Erwin van Ballegoij* (Heesh, Netherlands Watec 3148 and 3149, RMS 3189), *Andy Washington* (Clapton, England, RMS 3702).

November 2024 report CAMS-BeNeLux

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A summary of the activity of the CAMS-BeNeLux network during the month of November 2024 is presented. This month we collected a total of 22460 multi-station meteors resulting in 7010 orbits.

1 Introduction

In November the chances for many clear nights is rather small. A series of clear nights can only exist in special meteorological circumstances. Meteor activity this month, is high, so one can be sure that under good conditions the number of orbits will reach several hundred in one night. Beside the sporadic activity, we also see activity from the major streams Taurids and Leonids. This makes November one of the most interesting months for meteor observing.

2 November 2024 statistics

At times, November 2024 was indeed a fairly gloomy month. 11 of the first 16 nights had a result in which less than 10% of all cameras were able to capture meteors. From November 6 until November 8 no a single orbit was obtained at all.

Because our network meanwhile covers an area from the eastern parts of England to central Germany, and from the North Sea to central France, these results show that we can speak of a remarkable great clouded area in Europe.

On the other side, some fine clear nights with many orbits could be registered. Especially during the nights November 3–4, 28–29 and November 30–December 1 we could collect more than 700 orbits. On November 29–30, we could collect more than 1200 orbits, a new record for November.

CAMS-BeNeLux captured 22460 multi-station meteors, resulting in 7010 orbits. Compared with other November month this is the highest number of orbits for this month. On average 118 cameras at 48 stations were active during this month.

At least 110 cameras were active each night. The highest number of active cameras was 124 on November 11–12 and November 12–13. This number is significantly higher than last year due to the recent expansion of our network. See *Figure 1* and *Table 1*.

55,6% of all simultaneous orbits were captured by at least 3 stations. In *Figure 2* we see a radiant plot of all data captured in the period November 2–4. From this plot we see that the activity of the southern Taurids was nearly equal to the activity of the northern branch of the Taurids, a picture like in 2022.

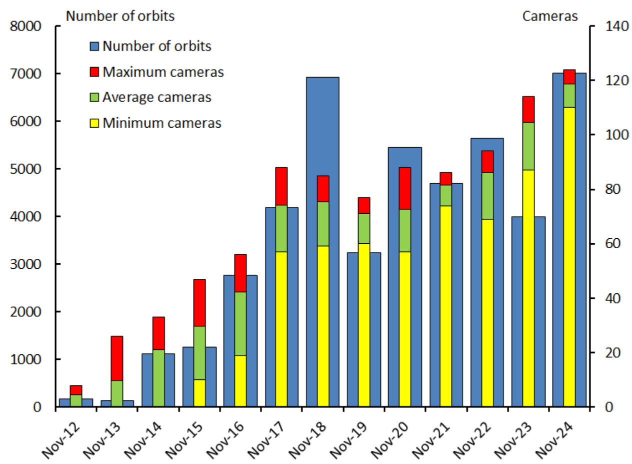

Figure 1 – Comparing November 2024 to previous months of November in the CAMS-BeNeLux history. The blue bars represent the number of orbits, the red bars the maximum number of cameras capturing in a single night, the green bars the average number of cameras capturing per night and the yellow bars the minimum number of cameras.

Table 1 – Number of orbits and active cameras in CAMS-BeNeLux during the month of November in the period 2012–2024.

Year	Nights	Orbits	Stations	Max. Cams	Min. Cams	Mean Cams
2012	14	165	6	8	–	4.4
2013	13	142	10	26	–	9.8
2014	24	1123	14	33	–	21.1
2015	23	1261	15	47	10	29.8
2016	24	2769	19	56	19	42.2
2017	26	4182	22	88	57	74.2
2018	28	6916	21	85	59	75.3
2019	27	3237	20	77	60	71.1
2020	28	5441	23	88	57	72.6
2021	24	4691	26	86	74	81.6
2022	29	5635	31	94	69	86.2
2023	29	3991	41	114	87	104.7
2024	27	7010	48	124	110	118.6
Total	316	46563				

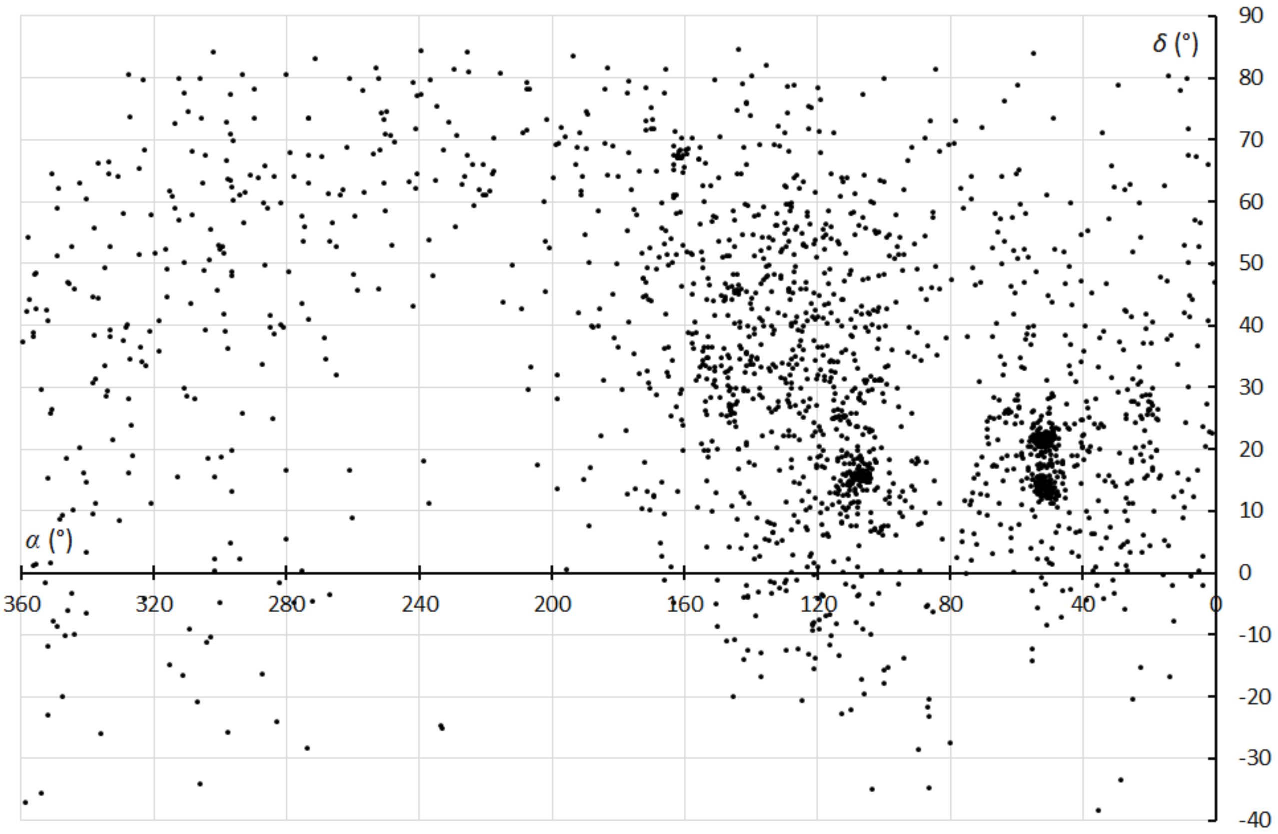

Figure 2 – Radiantplot of all meteor orbits captured between November 2–4, 2024 (1981 orbits, data CAMS-BeNeLux).

3 Conclusion

The results for November 2024 are the best in the CAMS-BeNeLux history, because of a significant expansion of our network in France, England, and Germany.

Acknowledgement

Many thanks to all participants in the CAMS-BeNeLux network for their dedicated efforts. The CAMS-BeNeLux team was operated by the following volunteers during the month of November 2024:

Stéphane Barré (Colombey-Les-Belles, France, RMS 3907), *Hans Betlem* (Woold, Netherlands, Watec 3071, 3072, 3073, 3074, 3075, 3076, 3077 and 3078), *Jean-Marie Biets* (Engelmanshoven, Belgium, Watec 3180, 3181, 3182 and 3183), *Ludger Boergerding* (Holdorf, Germany, RMS 3801), *Günther Boerjan* (Assenede, Belgium, RMS 3823), *Martin Breukers* (Hengelo, Netherlands, Watec 320, 321, 322, 323, 324, 325, 326 and 327, RMS 319, 328 and 329), *Jean Brunet* (Fontenay le Marmion, France, RMS 3911), *Seppe Canonaco* (Genk, RMS 3818 and 3819), *Steve Carter* (Welwyn Garden City, England, RMS 3706), *Eduardo Fernandez del Peloso* (Ludwigshafen, Germany, RMS 3805), *Pierre de Ponthiere* (Lesve, Belgium, RMS 3816 and 3826), *Bart Dessoy* (Zoersel, Belgium, Watec 805 and 806), *Jürgen Dörr* (Wiesbaden, Germany, RMS 3810, 3811 and 3812), *Isabelle Ansseau, Jean-Paul Dumoulin, Dominique Guiot* and *Christian Wanlin* (Grapfontaine, Belgium, Watec 814, 815, RMS 3817, 3843, 3844 and 3845), *Miles Eddowes* (Reading, England, RMS 3709), *Uwe Glässner* (Langenfeld, Germany, RMS 3800), *Roel Gloudemans* (Alphen aan de Rijn, Netherlands, RMS 3197), *Luc Gobin* (Mechelen, Belgium, Watec 3890, 3891, 3892, 3893 and 3894), *Tioga Gulon* (Nancy, France, Watec 3900 and 3901), *Tioga Gulon* (Chassignolles, France, RMS 3910), *Robert Haas* (Alphen aan de Rijn, Netherlands, Watec 3160, 3161, 3163, 3164, 3165 and 3166), *Robert Haas* (Burlage, Germany, RMS 3803 and 3804), *Kees Habraken* (Kattendijke, Netherlands, RMS 3780, 3781, 3782 and 3783), *Erwin Harkink* (Elst, Netherlands, RMS 3191), *Nick James* (Chelmsford, England, RMS 3710), *Carl Johannink* (Gronau, Germany, Watec 3100, 3101, 3102), *Reinhard Kühn* (Flatzby, Germany, RMS 3802), *Hervé Lamy* (Dourbes, Belgium, Watec 394 and 395, RMS 3825, 3841, 3895, 3896, 3897 and 3898), *Hervé Lamy* (Humain, Belgium, RMS 3821 and 3828), *Hervé Lamy* (Ukkel, Belgium, Watec 393 and 817), *Hartmut Leiting* (Solingen, Germany, RMS 3806), *Arnoud Leroy* (Gretz-Armainvielliers, France, RMS 3909), *Alan Maunder* (Catherington, England, RMS 3707-3708), *Horst Meyerdierks* (Osterholz-Scharmbeck, Germany, RMS 3807), *Koen Miskotte* (Ermelo, Netherlands, Watec 3051, 3052, 3053 and 3054), *Jamie Olver* (Redhill, England, RMS 3705), *Pierre-Yves Péchart* (Hagnicourt, France, RMS 3902, 3903, 3904, 3905, 3906 and 3908), *Tim Polfliet* (Gent, Belgium, Watec 396, RMS 3820 and 3840, *Tim Polfliet* (Grimbergen, Belgium, RMS 3846), *Steve Rau* (Oostende, Belgium, RMS 3822), *Paul and Adriana Roggemans* (Mechelen, Belgium, RMS 3830, Watec 3832, 3833, 3834, 3835, 3836 and 3837), *Jim Rowe* (Eastbourne, England, RMS 3703), *Nick Russell* (Seaford, England, RMS 3704), *Philippe Schaack* (Roodt-sur-Syre,

Luxemburg, RMS 3952), *Romke Schievink* (Bruchhausen Vilsen, Germany, RMS 3808 and 3809), *Hans Schremmer* (Niederkruechten, Germany, Watec 803), *Rob Smeenk* (Assen, Netherlands, RMS 3190 and 3196), *Rob Smeenk* (Kalenberg, Netherlands, RMS 3192, 3193, 3194 and 3195), *Erwin van Ballegoij* (Heesh, Netherlands Watec 3148 and 3149, RMS 3189), *Andy Washington* (Clapton, England, RMS 3702).

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October 2024 CARMELO report

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The CARMELO network (Cheap Amateur Radio Meteor Echoes LOgger) is a collaboration of SDR radio receivers aimed at detecting meteor echoes. This report presents the data for October 2024.

1 Introduction

The CARMELO network not only records individual meteoric echoes but also calculates the hourly rate of meteoric activity. October is the month of the Orionids (ORI) shower. The October readings reveal a pattern consistent with the predictions of this shower, but they show an unusual activity that seems similar to what occurred 31 years ago also with the Orionids.

In addition, this report comments on the observation of an unexpected outburst last September 4.

2 Methods

The CARMELO network consists of SDR radio receivers. In them, a microprocessor (Raspberry) performs three functions simultaneously:

- By driving a dongle, it tunes the frequency on which the transmitter transmits and tunes like a radio, samples the radio signal and through the FFT (Fast Fourier Transform) measures frequency and received power.
- By analyzing the received data for each packet, it detects meteoric echoes and discards false positives and interference.
- It compiles a file containing the event log and sends it to a server.

The data are all generated by the same standard, and are therefore homogeneous and comparable. A single receiver can be assembled with a few devices whose total current cost is about 210 euros.

To participate in the network read the instructions online[19].

3 October data

In the plots that follow, all available online[20], the abscissae represent time, which is expressed in UT (Universal Time), and the ordinates represent the hourly rate, calculated as the total number of events recorded by the network in an hour divided by the number of operating receivers.

In *Figure 1*, the trend of signals detected by the receivers has been plotted for the month of October.

4 Orionids

The star of the month of October was the Orionids (ORI) shower, an annual meteor shower originating from Halley's

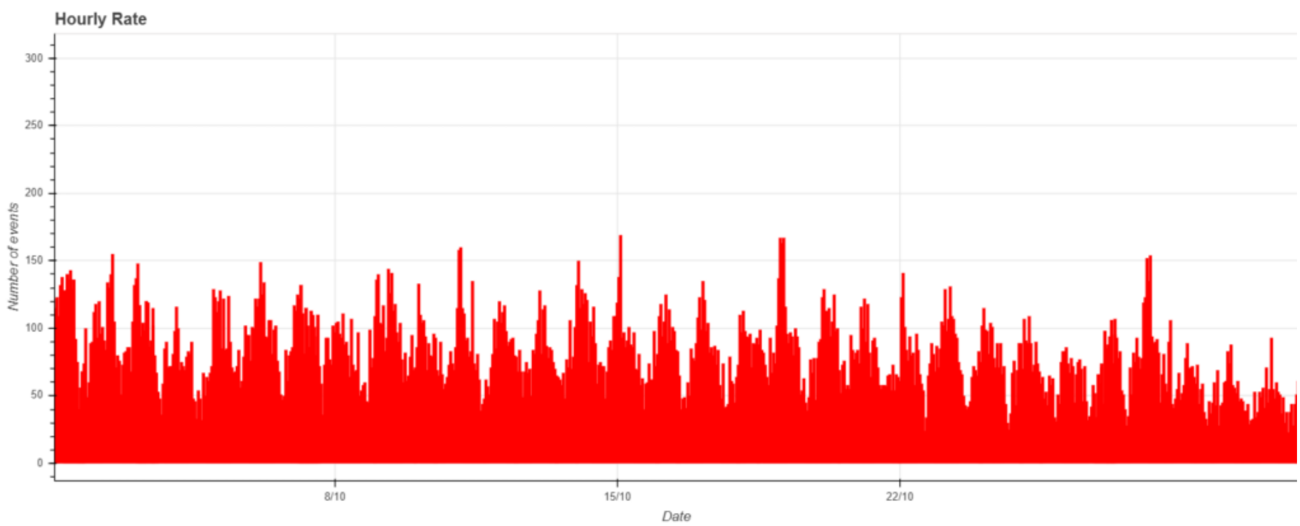

Figure 1 – October data trend.

[19] http://www.astrofiliabologna.it/about_carmelo

[20] http://www.astrofiliabologna.it/graficocarmelohr

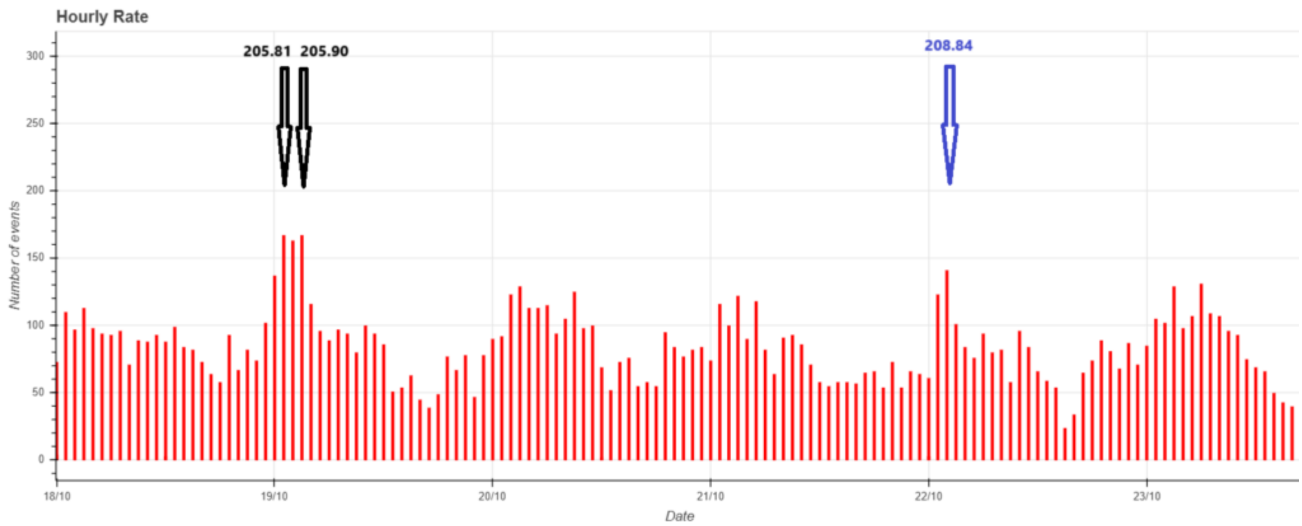

Figure 2 – Peaks of the Orionid meteor shower on October 19 and 22, with respective solar longitude.

Comet (1P/Halley), one of the best-known and most studied comets in our Solar System. This shower is generally active between October 2 and November 7, with peak activity usually occurring in the days around October 21. During the peak, under ideal conditions, up to 20 meteors per hour can be observed[21,22].

The Orionids' radiant is located in the Orion constellation, near the bright star Betelgeuse. This means that the meteors appear to originate from this area of the sky. For observers in the northern hemisphere, such as the CARMELO network, the radiant rises late in the evening and reaches maximum elevation in the hours just before sunrise.

The hourly rate recorded by the CARMELO network shows an outburst on October 19 between 1^h and 3^h UT, or solar longitude between 205.81° and 205.90°, and then a second, smaller peak on October 22 around 2^h UT, or solar longitude 208.84°, as shown in *Figure 2*.

This increase in activity on October 19 is reminiscent of that recorded by visual observations by Koen Miskotte in 1993. He observed between twice and three times the normal activity at approximately solar latitude 204.5° (Jenniskens, 2006). Should other observers also have come across the same observation, it would be interesting to investigate, 31 years later, the possible existence of a filament.

The peak of the epsilon Orionids (947 EPO), a meteor shower derived from comet C/1914 J1 (Zlatinsky), was also expected on October 19. The temporal overlap of these showers could explain the observed increase in activity.

The Orionid shower is then particularly interesting because of the high velocity of the meteors (about 66 km/s), which sometimes exceeds even the Perseids in terms of the rapidity of atmospheric impact. This high speed often produces bright meteors with persistent trails. An example is the one in *Figure 3*.

The plot shows a meteor recorded on October 19 at $05^h59^m26^s$ UT by the receiver of the Associazione Astrofili Bolognesi in Bologna, characterized by a long duration. The

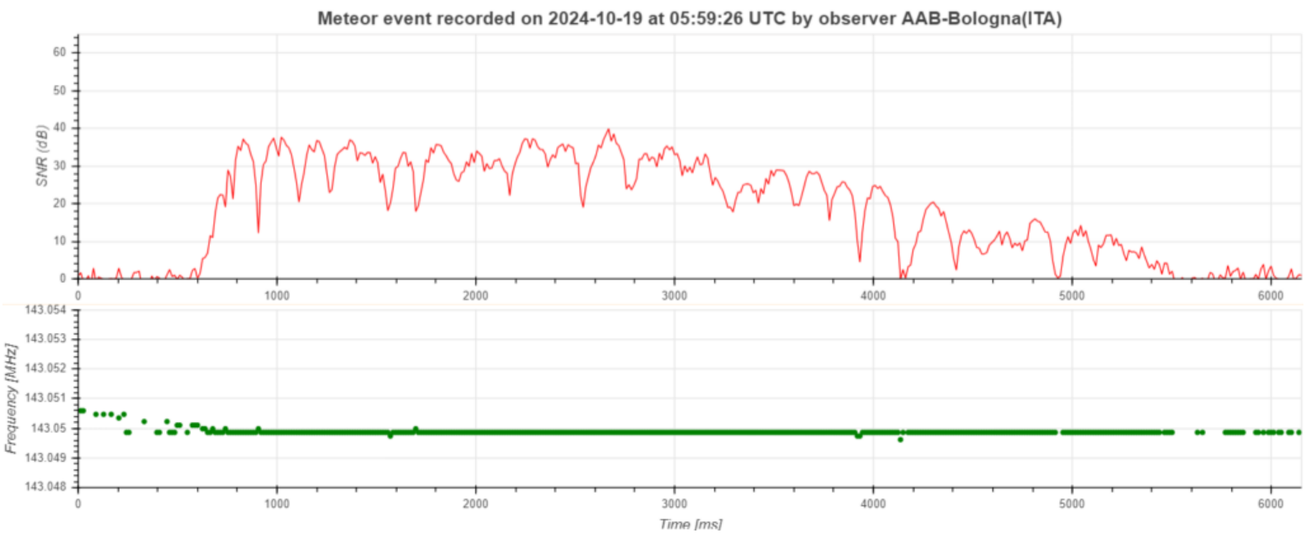

Figure 3 – Meteor event recorded on October 19 at $5^h59^m26^s$ UT in Bologna.

[21] https://www.iaumeteordatacenter.org/

[22] https://cneos.jpl.nasa.gov/

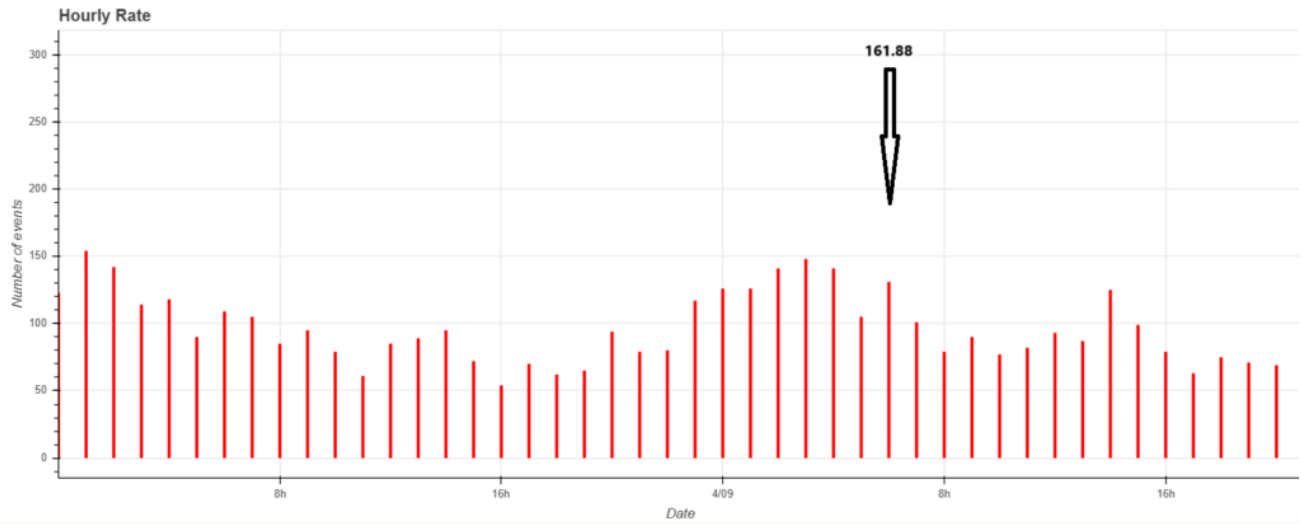

Figure 4 – Outburst detected on September 4 at solar longitude 161.88°.

signal-to-noise ratio (SNR) plot, at the top of *Figure 3*, peaks at 40 dB and remains high for more than 5 seconds, generated by a particularly saturated cylinder of plasma. In the early part of the plot, the meteor head echo is visible. In addition, fragmentation can also be seen, suggested by amplitude fluctuations due to the beat between contributions from paths of different lengths generated by a little "train" of fragments.

The scattered nature of the Orionids meteor shower can be traced to the numerous passes of Comet Halley, which over time has released large amounts of debris, which by crossing Earth's orbit create a relatively large meteoric flux. As is well known, we will encounter it again in the spring when it generates the Eta Aquariids.

5 The September 4 outburst

On September 4, 2024, an outburst with radiant in the Cassiopeia constellation, belonging to an unexpected meteor shower and named September psi-Cassiopeiids (SPC), was detected by several radiometeor detection networks, as reported by P. Jenniskens and N. Moskovitz (2024a; 2024b) from America and T. Sekiguchi from Japan (2024).

Jenniskens and Moskovitz write that the event had a short duration, with a period of activity between solar longitude 161.88° and 162.14° degrees. The meteors were detected between 6^h and 13^h UT.

The CARMELO network also seems to have detected this outburst. There is a spike in the number of events recorded at solar longitude 161.88°, at 6^h UT, on September 4 (*Figure 4*).

6 The CARMELO network

The network currently consists of 14 receivers, 13 of which are operational, located in Italy, the UK, Croatia and the USA. The European receivers are tuned to the Graves radar station frequency in France, which is 143.050 MHz. Participating in the network are:

- Lorenzo Barbieri, Budrio (BO) ITA;
- Associazione Astrofili Bolognesi, Bologna ITA;
- Associazione Astrofili Bolognesi, Medelana (BO) ITA;
- Paolo Fontana, Castenaso (BO) ITA;
- Paolo Fontana, Belluno (BL) ITA;
- Associazione Astrofili Pisani, Orciatico (PI) ITA;
- Gruppo Astrofili Persicetani, San Giovanni in Persiceto (BO) ITA;
- Roberto Nesci, Foligno (PG) ITA;
- MarSEC, Marana di Crespadoro (VI) ITA;
- Gruppo Astrofili Vicentini, Arcugnano (VI) ITA;
- Associazione Ravennate Astrofili Theyta, Ravenna (RA) ITA;
- Akademsko Astronomsko Društvo, Rijeka CRO;
- Mike German a Hayfield, Derbyshire UK;
- Mike Otte, Pearl City, Illinois USA.

The authors' hope is that the network can expand both quantitatively and geographically, thus allowing the production of better-quality data.

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Jenniskens P., Moskovitz N. (2024a). Meteor shower outburst with radiant in Cassiopeia. CBET 5442. Ed. D. W. E. Green, IAU Central Bureau for Astronomical Telegrams.

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Sekiguchi T. (2024). "2024 outburst of September psi-Cassiopeiids by SonotaCo Network in Japan". *eMetN Meteor Journal*, **9**, 400–402.

November 2024 CARMELO report

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The CARMELO network (Cheap Amateur Radio Meteor Echoes LOgger) is a collaboration of SDR radio receivers aimed at detecting meteor echoes. This report presents the data for November 2024.

1 Introduction

November is dominated by the Leonid meteor shower (LEO), the maximum of which was observed by the CARMELO network on November 17. Data collected confirm activity consistent with predictions.

2 Methods

The CARMELO network consists of SDR radio receivers. In them, a microprocessor (Raspberry) performs three functions simultaneously:

- By driving a dongle, it tunes the frequency on which the transmitter transmits and tunes like a radio, samples the radio signal and through the FFT (Fast Fourier Transform) measures frequency and received power.
- By analyzing the received data for each packet, it detects meteor echoes and discards false positives and interference.
- It compiles a file containing the event log and sends it to a server.

The data are all generated by the same standard, and are therefore homogeneous and comparable. A single receiver can be assembled with a few devices whose total current cost is about 210 euros.

To participate in the network read the instructions on this page[23].

3 November data

In the plots that follow, all available at this page[24], the abscissae represent time, which is expressed in UT (Universal Time), and the ordinates represent the hourly rate, calculated as the total number of events recorded by the network in an hour divided by the number of operating receivers.

In *Figure 1*, the trend of signals detected by the receivers is shown for the month of November.

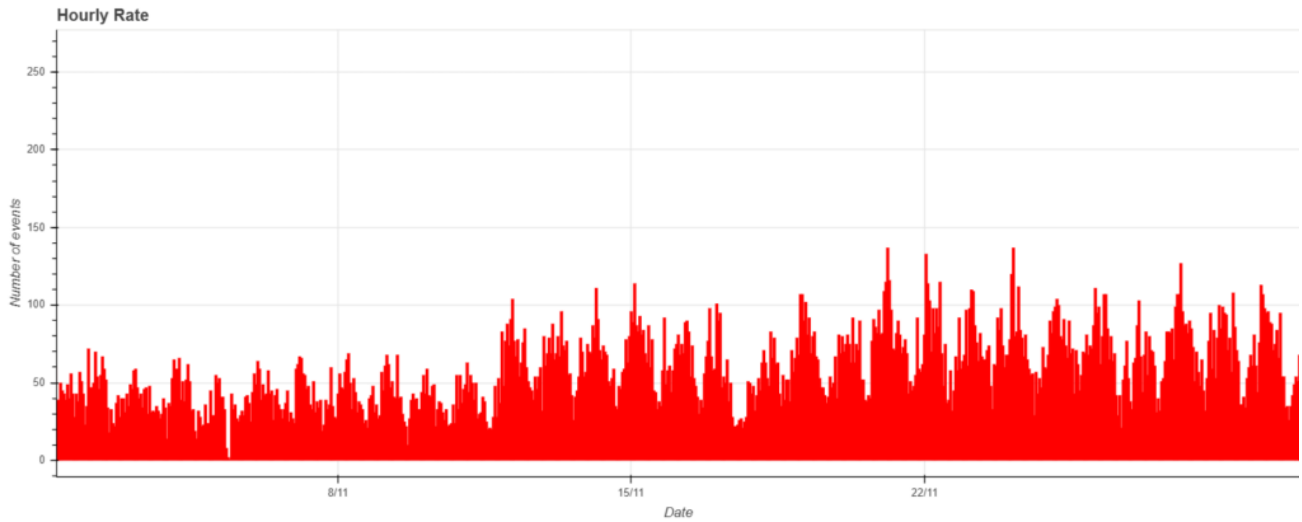

Figure 1 – November 2024 data trend.

[23] http://www.astrofiliabologna.it/about_carmelo

[24] http://www.astrofiliabologna.it/graficocarmelohr

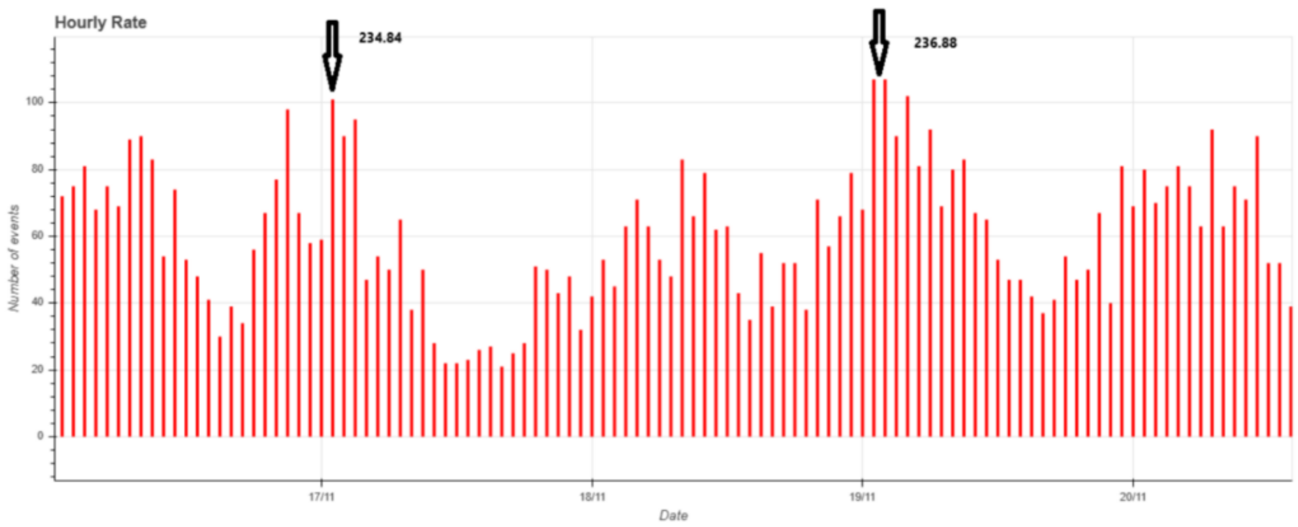

Figure 2 – Period of maximum Leonids shower activity on Nov. 17 and increased activity on Nov. 19, with respective solar longitude.

4 Leonids

In November, the main character is the ancient Leonid meteor shower (LEO). The shower originated from the periodic Halley-type comet called 55P/Tempel-Tuttle, which is characterized by an orbital period of about 33 years.

Over the past two decades, the number of fragments left behind by the comet has been gradually decreasing, consequently causing the shower to lose intensity until it has been reduced to an activity of 15-20 meteors per hour. We will have to wait until the comet's next passage, expected in 2031, to replenish the "reservoir" and return to witness increased activity.

Leonids are meteors known for their high entry speed into the atmosphere, between 70 and 72 km/s, which often produces bright meteors and persistent trails. They have also been the subject of a space mission: in November 1997, the Midcourse Space Experiment (MSX) satellite was deployed to observe the meteor shower from space, a mission that lived up to expectations because it observed numerous very bright fireballs. Twenty-nine meteors were detected by a wide-angle, visible-wavelength camera over a 48-minute interval (Jenniskens et al., 1998).

The radiant of the Leonids, on the other hand, or the apparent position in the sky from which they appear to come, is in the constellation Leo, rising around 22^h30^m UT in Italy.

CARMELO network receivers recorded activity consistent with predictions. The peak of maximum activity was observed on November 17 between 01^h and 03^h UT, corresponding to a solar longitude between 234.84° and 234.93°, as in *Figure 2*.

On the night of November 19–20, for a couple of hours, there was higher activity in both hourly rate and duration than on the 17^{th}. This activity could be attributed to the passage of 55P/Tempel-Tuttle in 1733.

5 Outbursts and shutdowns

As visible in the November trend in *Figure 1*, during the month there were:

- A transmitter shutdown, possibly due to maintenance, on November 5 around 10^h UT, at which time there is then an abrupt disappearance of recorded signals.
- A series of outbursts that were not natural, but caused by an overlap of several false positives from the Hayfield station, part of the CARMELO network. An example is that of November 9 at 10^h UT.

6 The CARMELO network

The network currently consists of 14 receivers, 13 of which are operational, located in Italy, the UK, Croatia and the USA. The European receivers are tuned to the Graves radar station frequency in France, which is 143.050 MHz. Participating in the network are:

- Lorenzo Barbieri, Budrio (BO) ITA;
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- Mike German a Hayfield, Derbyshire UK;
- Mike Otte, Pearl City, Illinois USA.

The authors' hope is that the network can expand both quantitatively and geographically, thus allowing the production of better-quality data.

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Jenniskens P., Nugent D., Tedesco E., Murthy J. (1998). "1997 Leonid Shower from Space". *Earth, Moon, and Planets*, **82**, 305–312.

Radio meteors October 2024

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An overview of the radio observations during October 2024 is given.

1 Introduction

The graphs show both the daily totals (*Figure 1 and 2*) and the hourly numbers (*Figure 3 and 4*) of "all" reflections counted automatically, and of manually counted "overdense" reflections, overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during the month of October 2024.

The hourly numbers, for echoes shorter than 1 minute, are weighted averages derived from:

$$N(h) = \frac{n(h-1)}{4} + \frac{n(h)}{2} + \frac{n(h+1)}{4}$$

Local interference and unidentified noise remained generally low, and no lightning activity was recorded this month.

During the night of October 10–11, visual observers could admire a rather strong display of the aurora borealis, which was also detected on the frequency of our beacon. *Figure 5* is a recording between 2024 October 10, 23^h00^m UT and 2024 October 11, 02^h00^m UT.

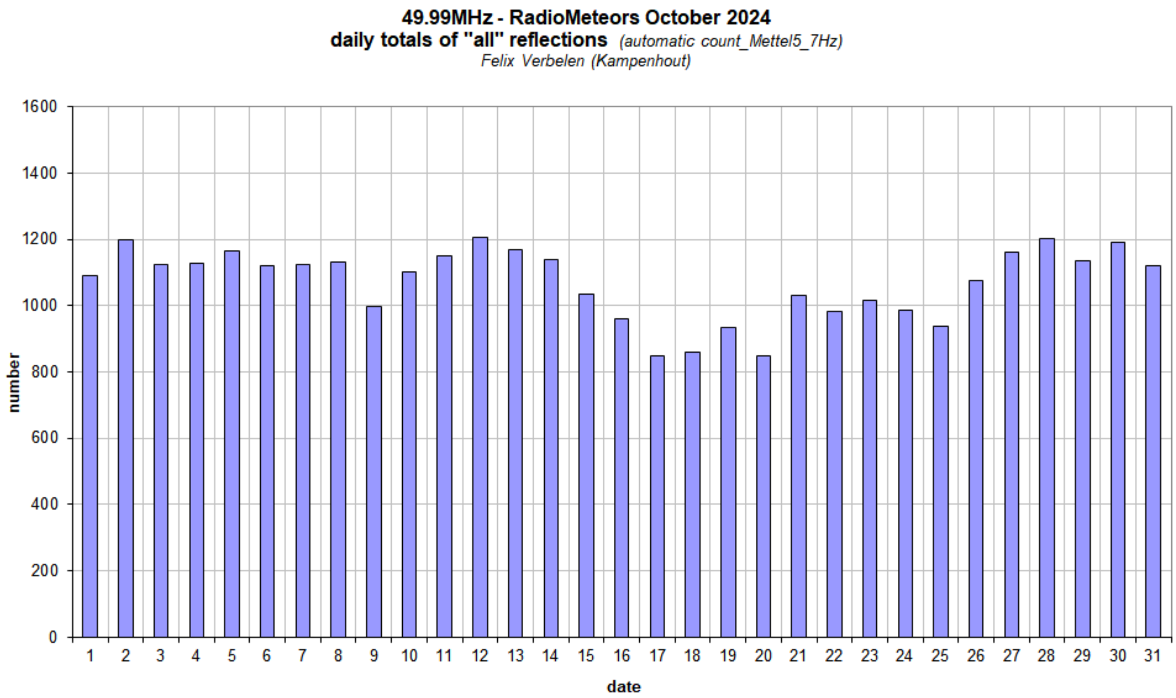
The activity of both the Draconids and Orionids was rather limited this year, although there was an increase in long-duration reflections (> 1 minute) around the Orionid maximum on October 22–23.

Further investigation also reveals various interesting minor showers, the most notable around October 29 between 18^h and 24^h UT. The increased activity consisted mainly of rather weak underdense reflections.

Over the entire month 27 reflections longer than 1 minute were recorded here. A selection of these, along with some other interesting reflections is included (*Figures 6 to 23*). More of these are available on request.

In addition to the usual graphs, you will also find the raw counts in cvs-format[25] from which the graphs are derived. The table contains the following columns: day of the month, hour of the day, day + decimals, solar longitude (epoch J2000), counts of "all" reflections, overdense reflections, reflections longer than 10 seconds and reflections longer than 1 minute, the numbers being the observed reflections of the past hour.

[25] https://www.emeteornews.net/wp-content/uploads/2024/10/202410_49990_FV_rawcounts.csv



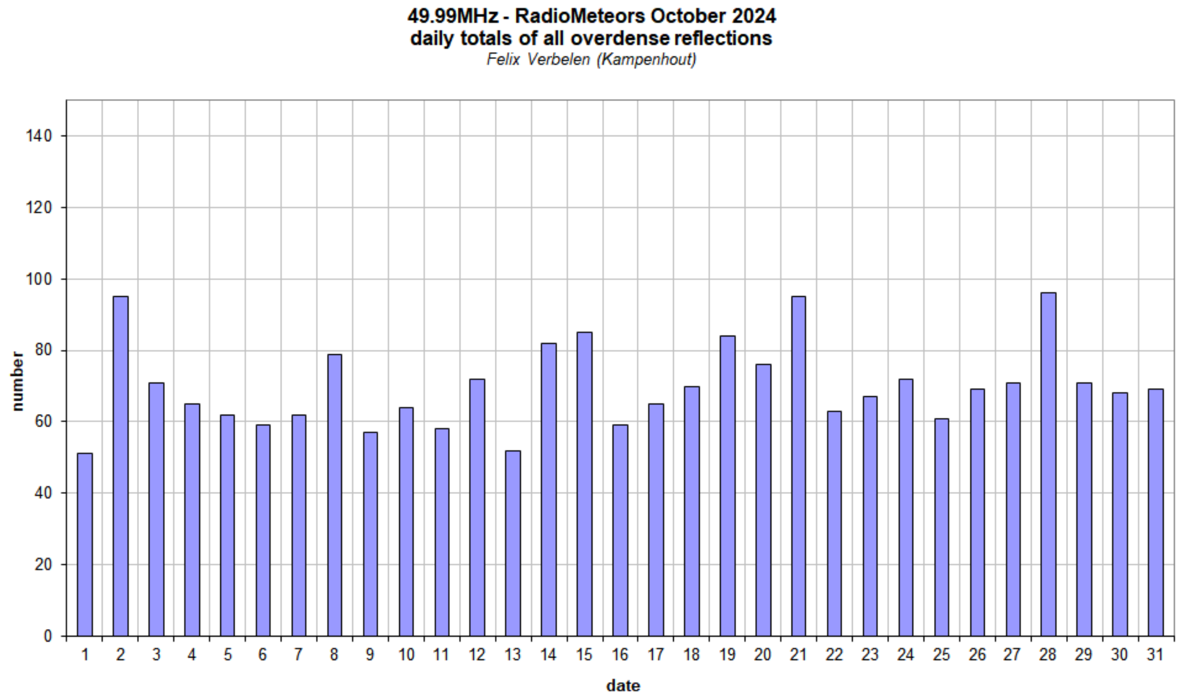
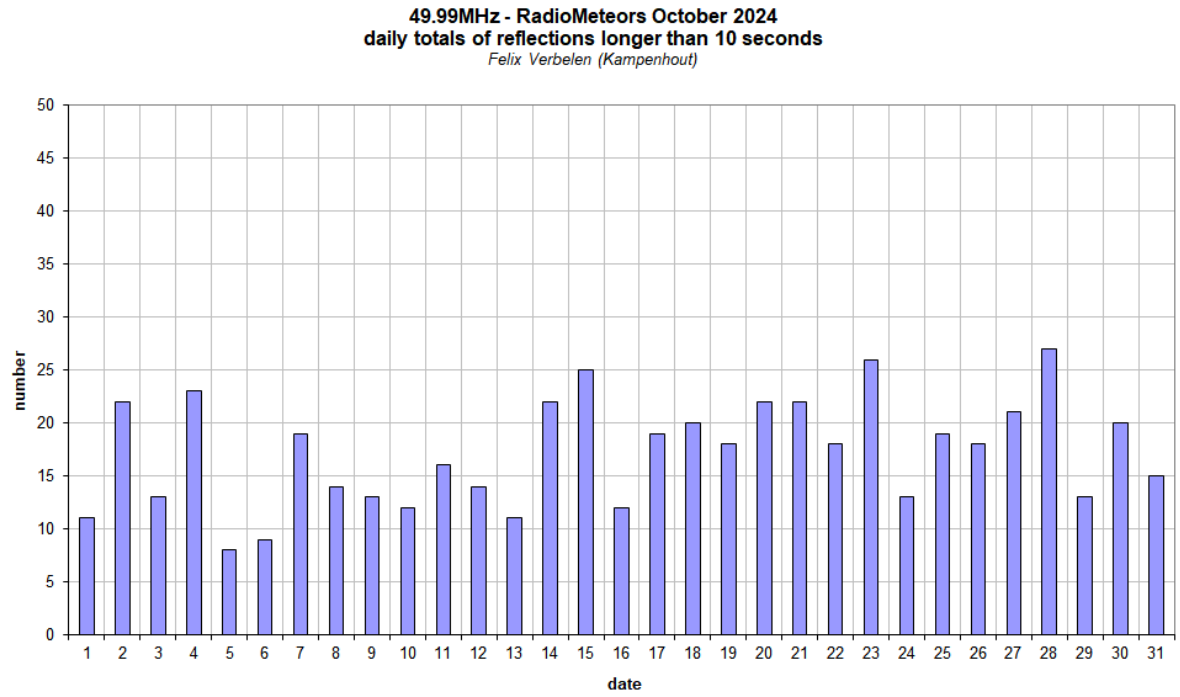


Figure 1 – The daily totals of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during October 2024.



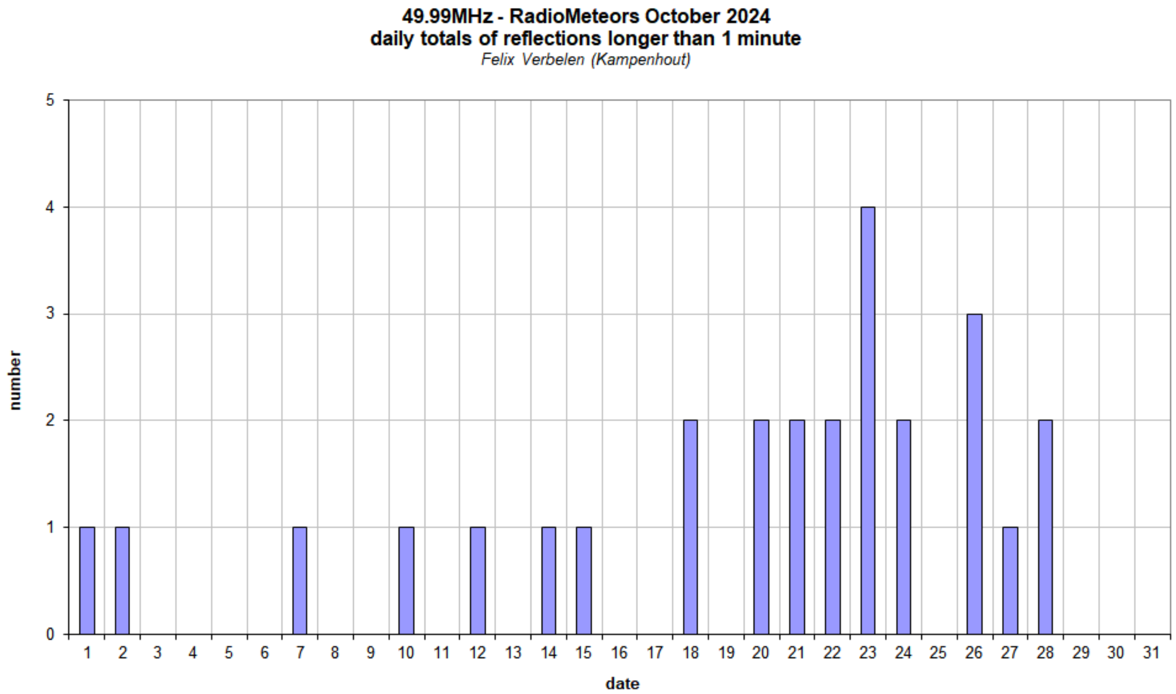
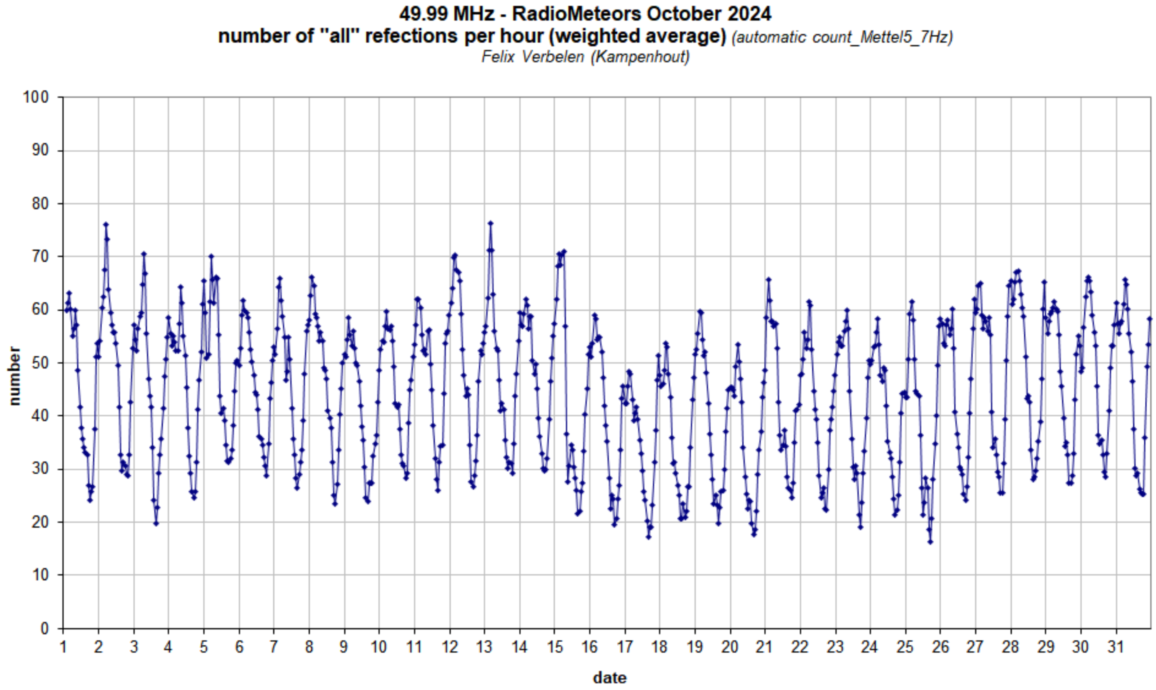


Figure 2 – The daily totals of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during October 2024.



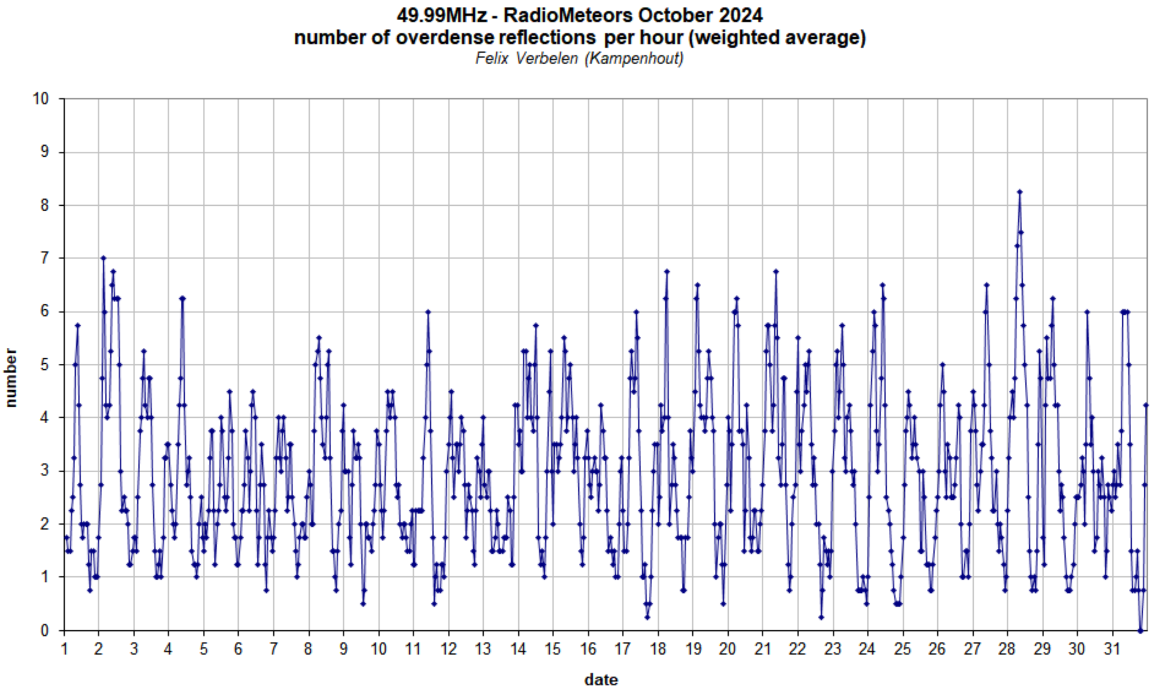
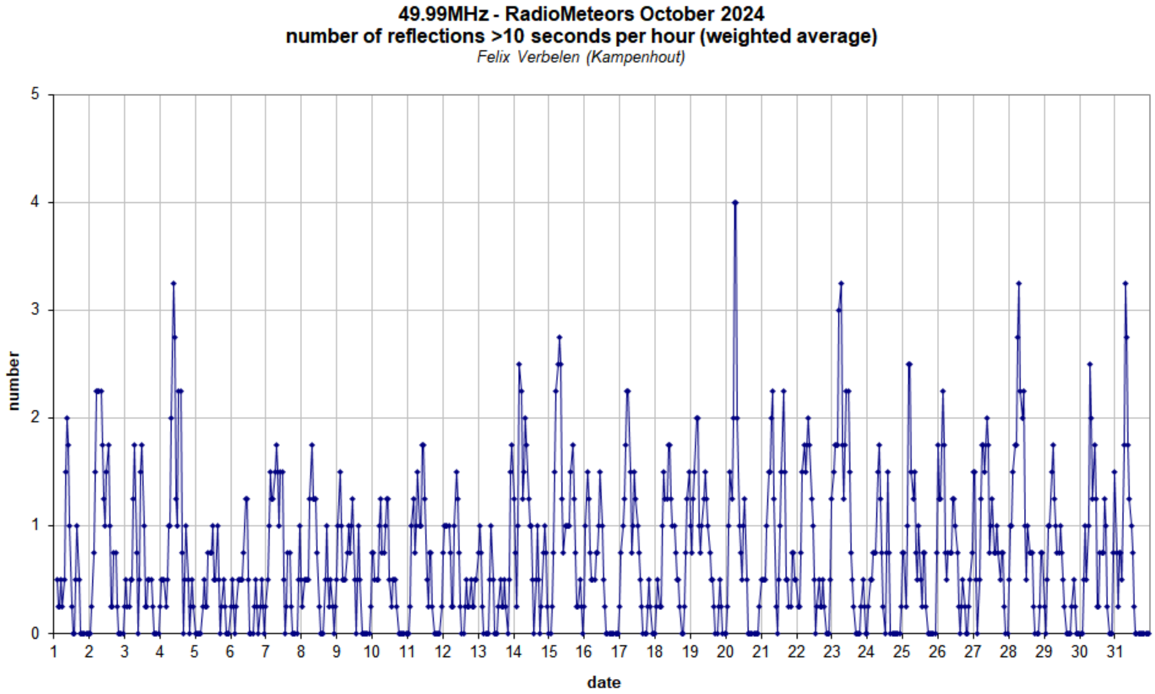


Figure 3 – The hourly numbers of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during October 2024.



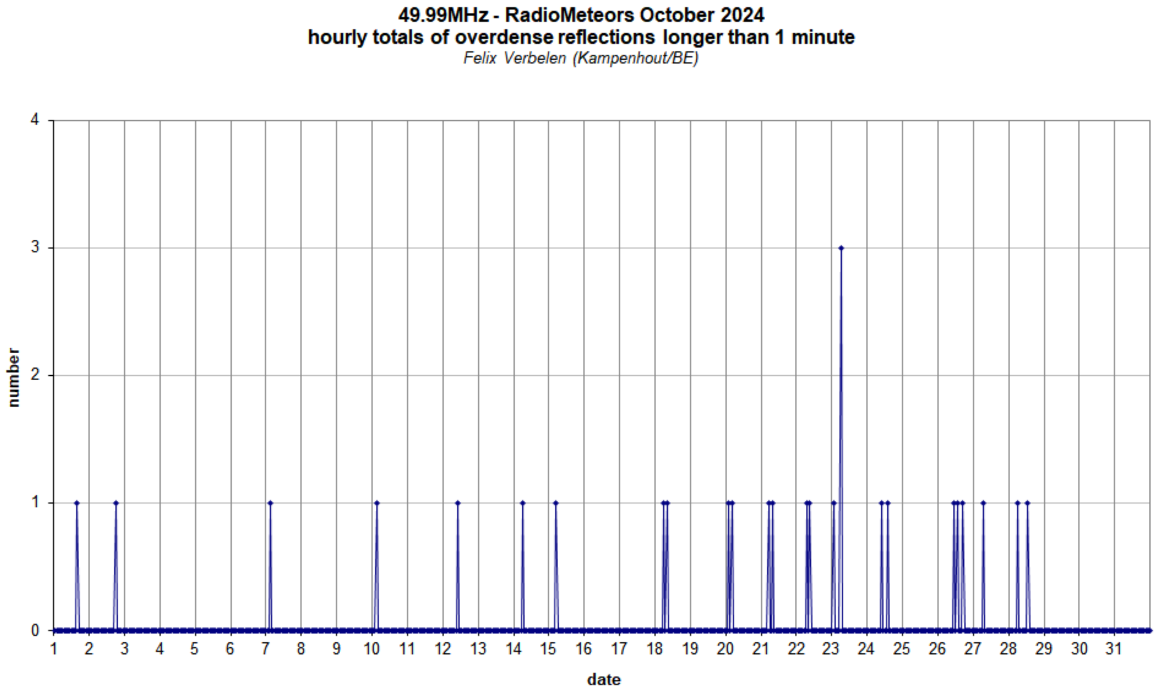


Figure 4 – The hourly numbers of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during October 2024.

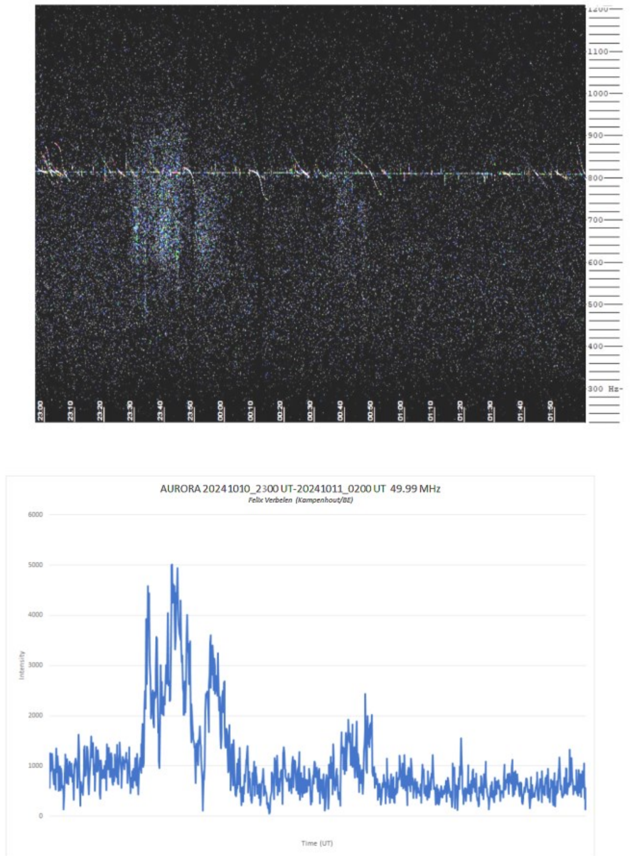


Figure 5 – During the night of October 10–11, visual observers could admire a rather strong display of the aurora borealis, which was also detected on the frequency of our beacon.

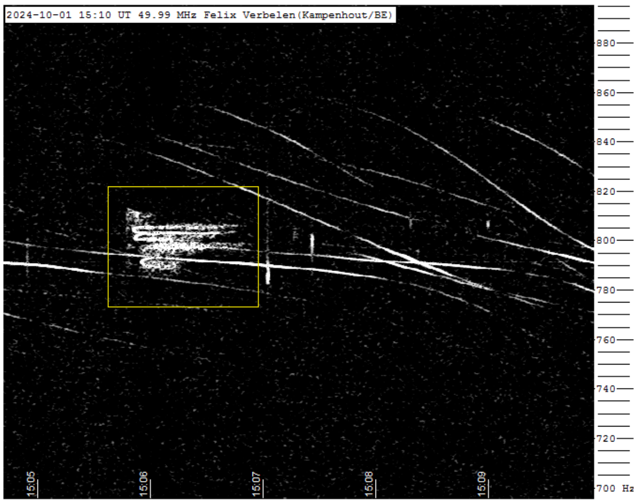


Figure 6 – Meteor echoes October 1, 15^{h}10^{m} UT.

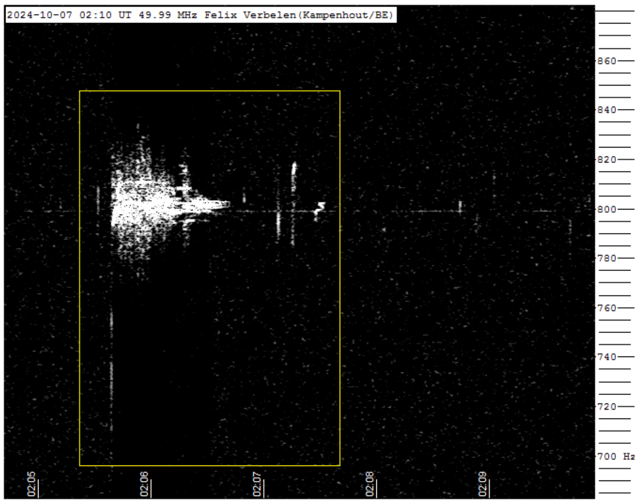


Figure 7 – Meteor echoes October 7, 02^{h}10^{m} UT.

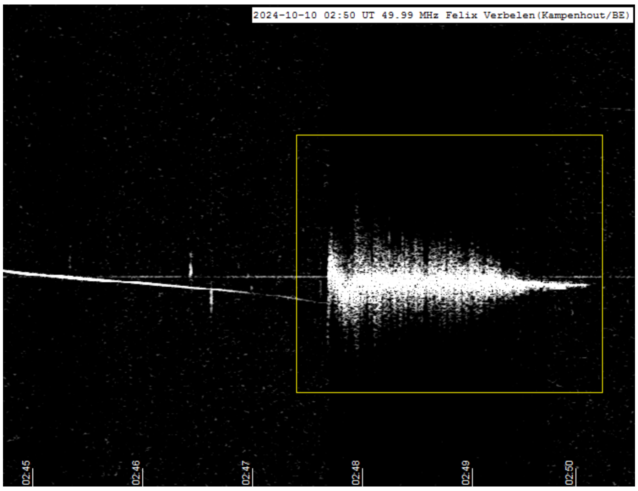


Figure 8 – Meteor echoes October 10, 02^{h}50^{m} UT.

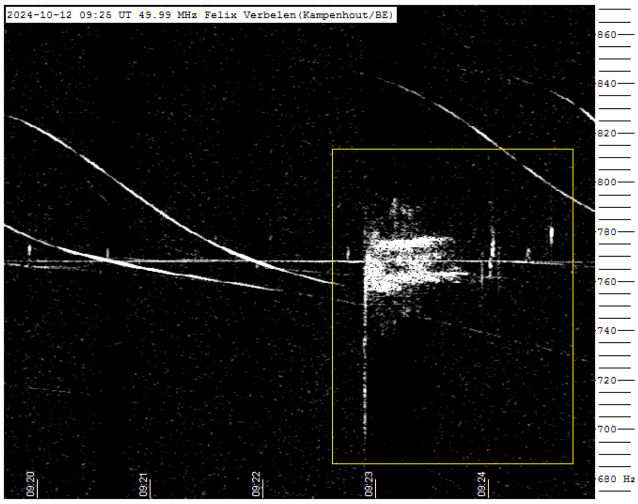


Figure 9 – Meteor echoes October 12, 09^{h}25^{m} UT.

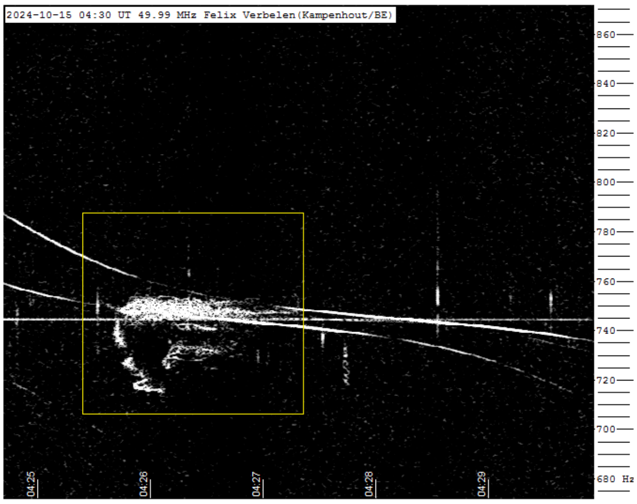


Figure 10 – Meteor echoes October 15, 04^{h}30^{m} UT.

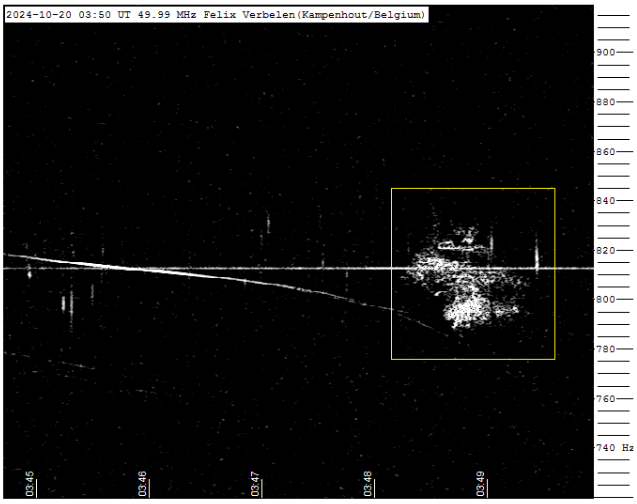


Figure 11 – Meteor echoes October 20, 03^{h}50^{m} UT.

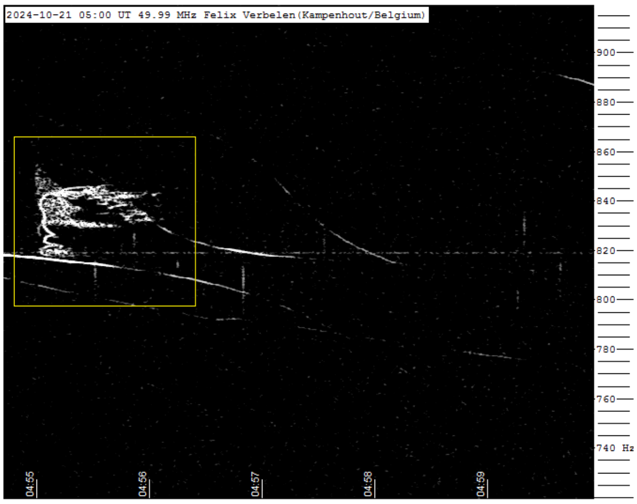


Figure 12 – Meteor echoes October 21, 05^{h}00^{m} UT.

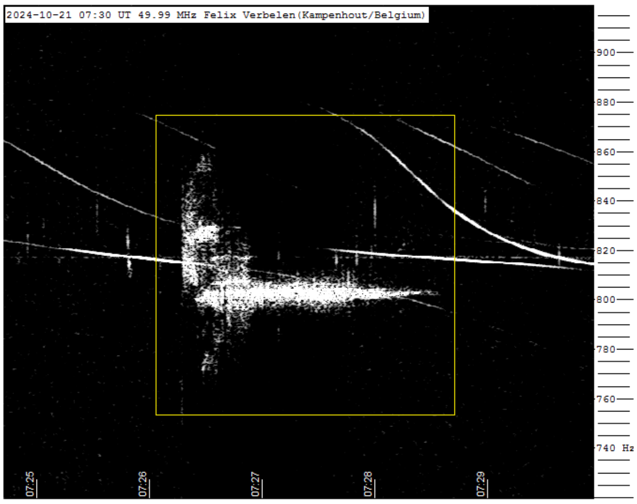


Figure 13 – Meteor echoes October 21, 07^{h}30^{m} UT.

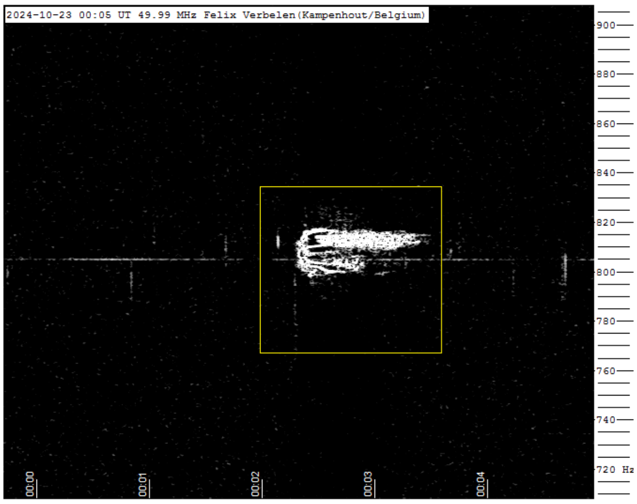


Figure 14 – Meteor echoes October 23, 00^{h}05^{m} UT.

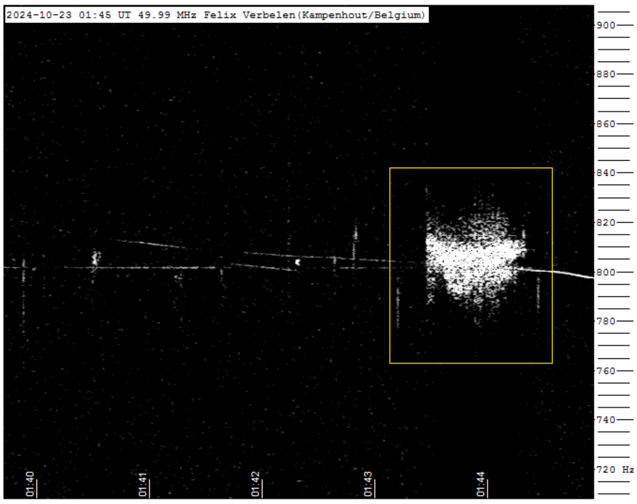


Figure 15 – Meteor echoes October 23, 01^{h}45^{m} UT.

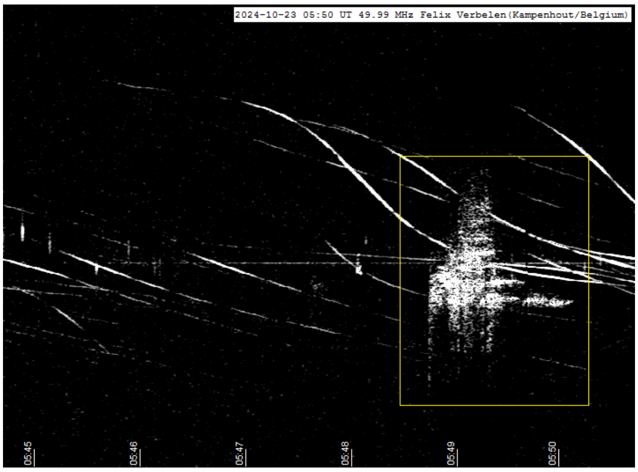


Figure 16 – Meteor echoes October 23, 05ʰ50ᵐ UT.

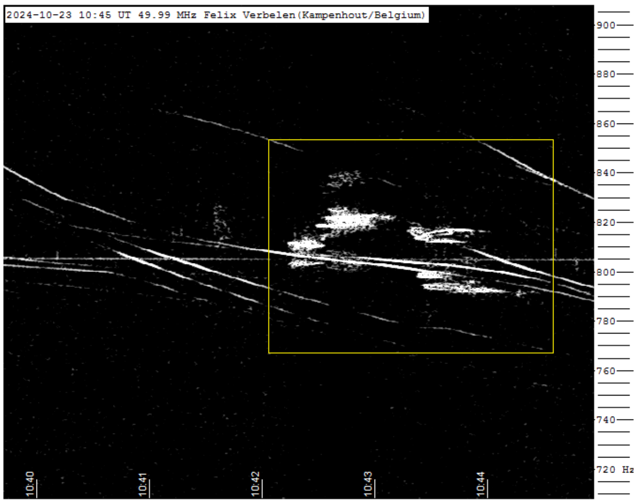


Figure 17 – Meteor echoes October 23, 10ʰ45ᵐ UT.

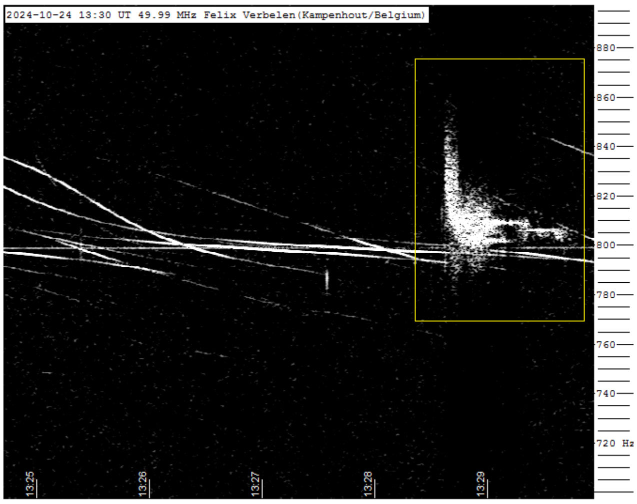


Figure 18 – Meteor echoes October 24, 13ʰ30ᵐ UT.

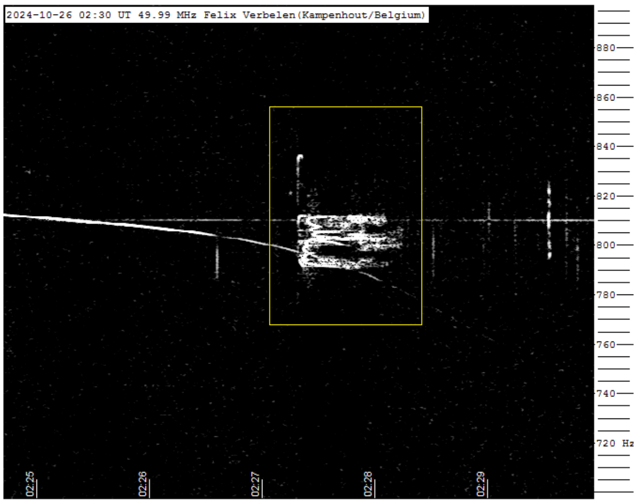


Figure 19 – Meteor echoes October 26, 02ʰ30ᵐ UT.

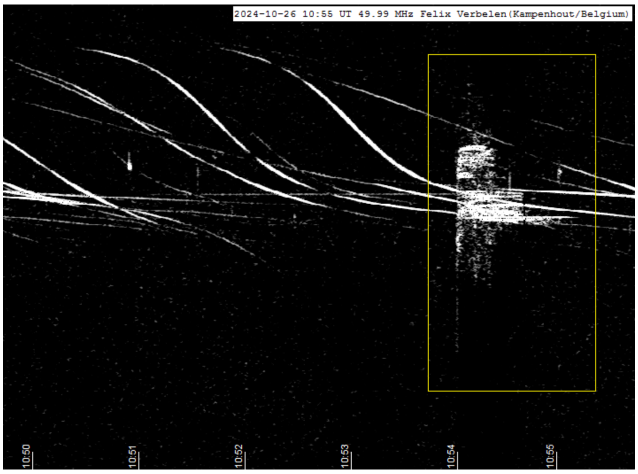


Figure 20 – Meteor echoes October 26, 10ʰ55ᵐ UT.

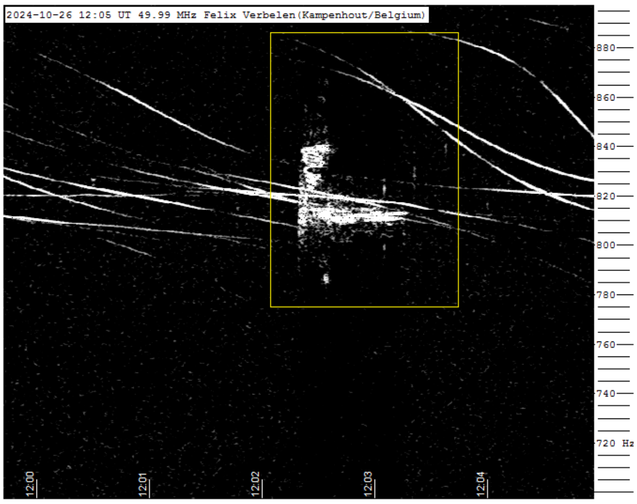


Figure 21 – Meteor echoes October 26, 12ʰ05ᵐ UT.

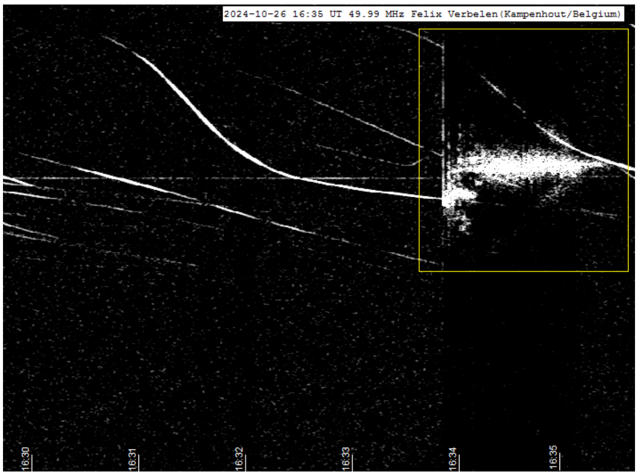


Figure 22 – Meteor echoes October 26, 16^h35^m UT.

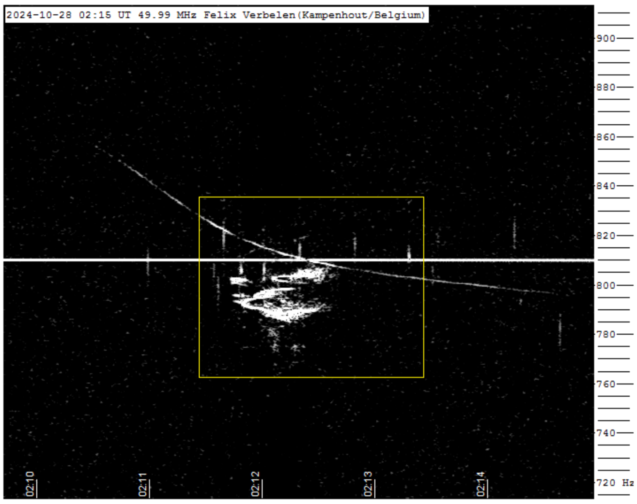


Figure 23 – Meteor echoes October 28, 02^h15^m UT.

Radio meteors November 2024

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An overview of the radio observations during November 2024 is given.

1 Introduction

The graphs show both the daily totals (*Figure 1 and 2*) and the hourly numbers (*Figure 3 and 4*) of "all" reflections counted automatically, and of manually counted "overdense" reflections, overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during the month of November 2024.

The hourly numbers, for echoes shorter than 1 minute, are weighted averages derived from:

$$N(h) = \frac{n(h-1)}{4} + \frac{n(h)}{2} + \frac{n(h+1)}{4}$$

Local interference and unidentified noise remained generally low, with weak lightning activity recorded on only 2 days. As in previous months fairly strong noise due to solar flares, mostly of type III, was recorded every day.

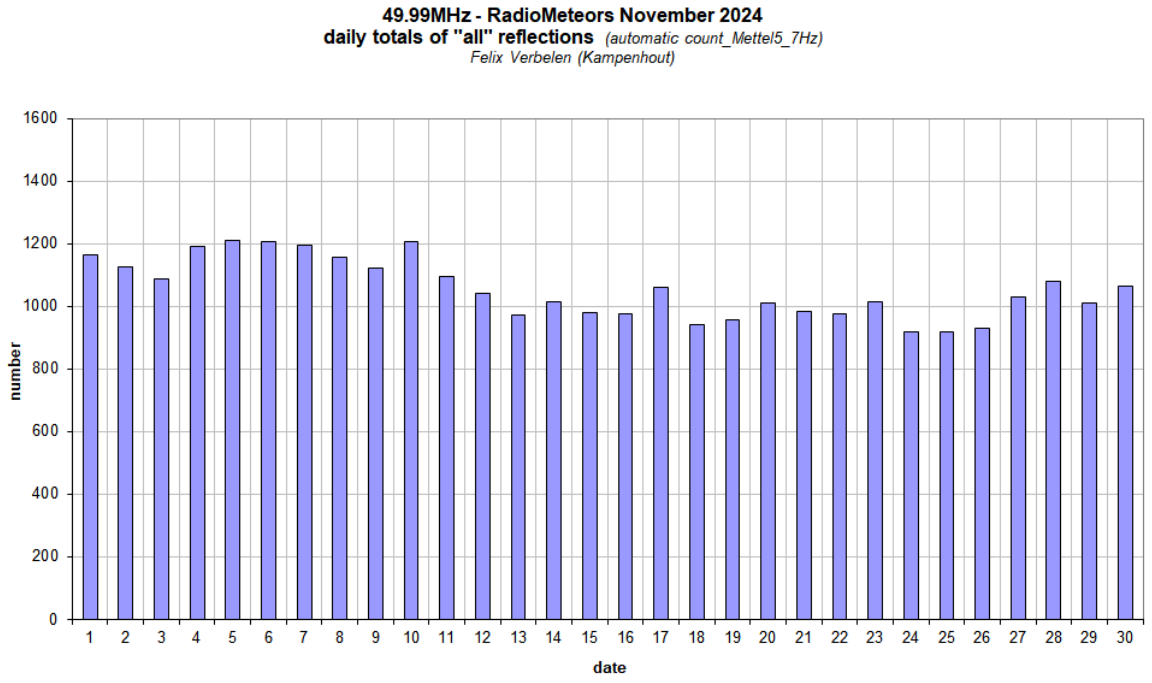
The best-known meteor showers, such as the Northern and Southern Taurids at the beginning of the month and the Leonids around 18 November showed a significant increase in the number of recorded reflections lasting 10 seconds or more (10 seconds and longer).

Further analysis also reveals several interesting smaller showers.

Over the entire month 23 reflections longer than 1 minute were recorded here. A selection of these, along with some other interesting reflections is included (*Figures 5 to 22*). More of these are available on request.

In addition to the usual graphs, you will also find the raw counts in cvs-format[26] from which the graphs are derived. The table contains the following columns: day of the month, hour of the day, day + decimals, solar longitude (epoch J2000), counts of "all" reflections, overdense reflections, reflections longer than 10 seconds and reflections longer than 1 minute, the numbers being the observed reflections of the past hour.

[26] https://www.emeteornews.net/wp-content/uploads/2024/12/202411_49990_FV_rawcounts.csv



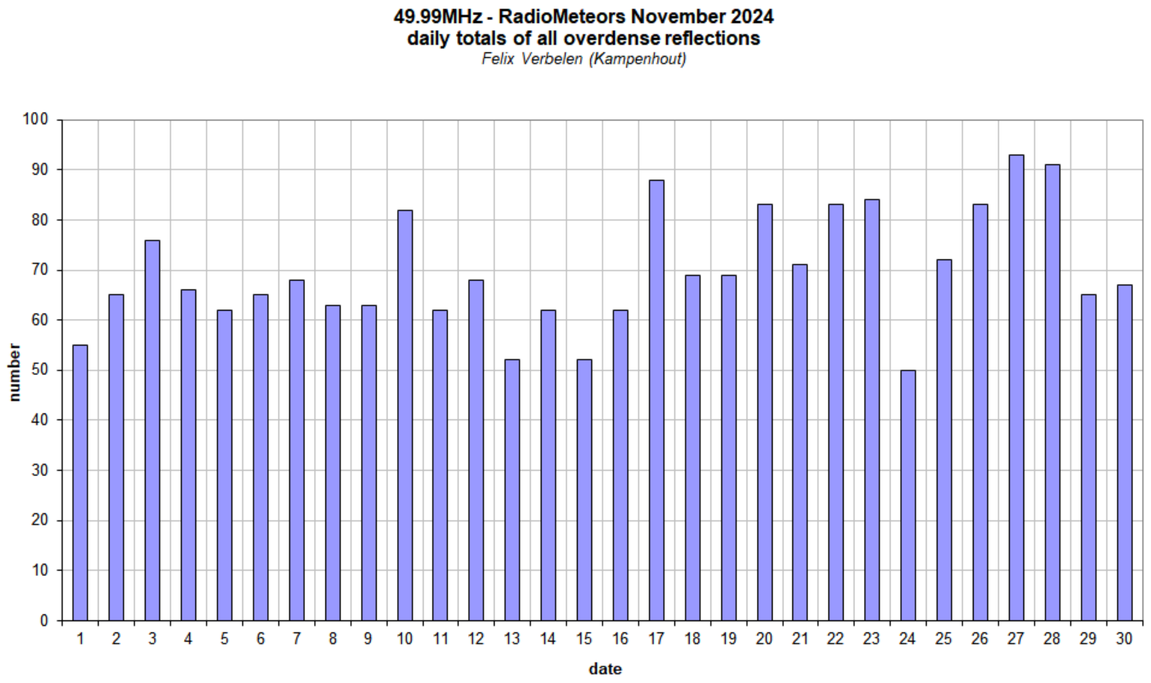
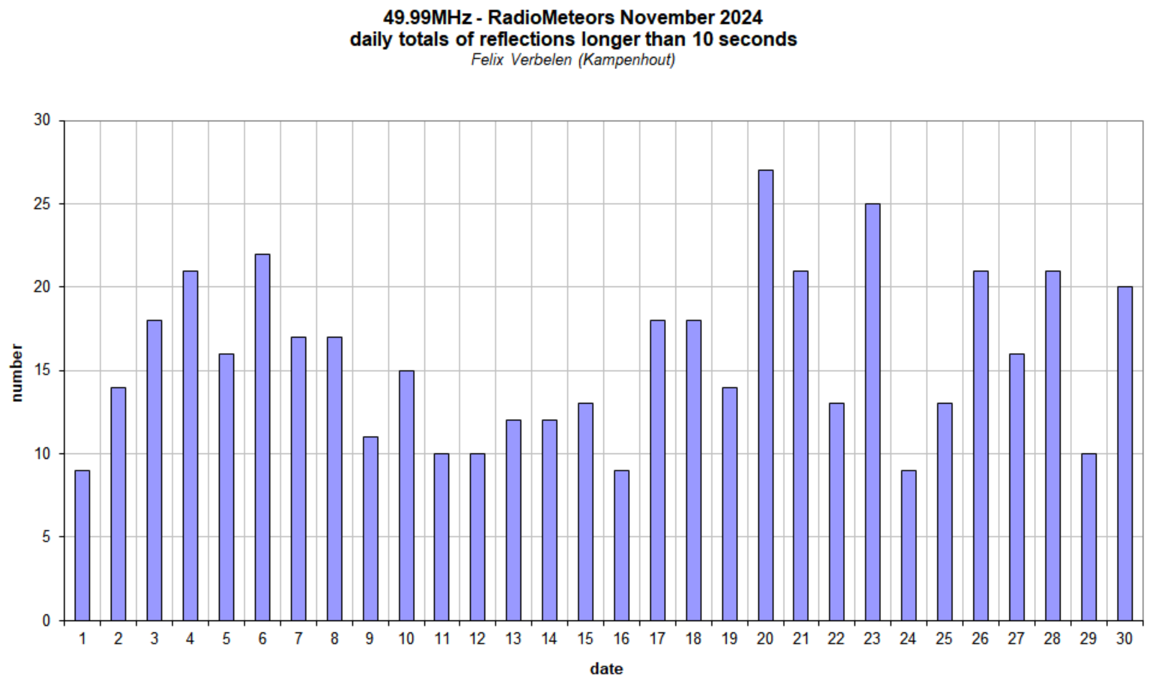


Figure 1 – The daily totals of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during November 2024.



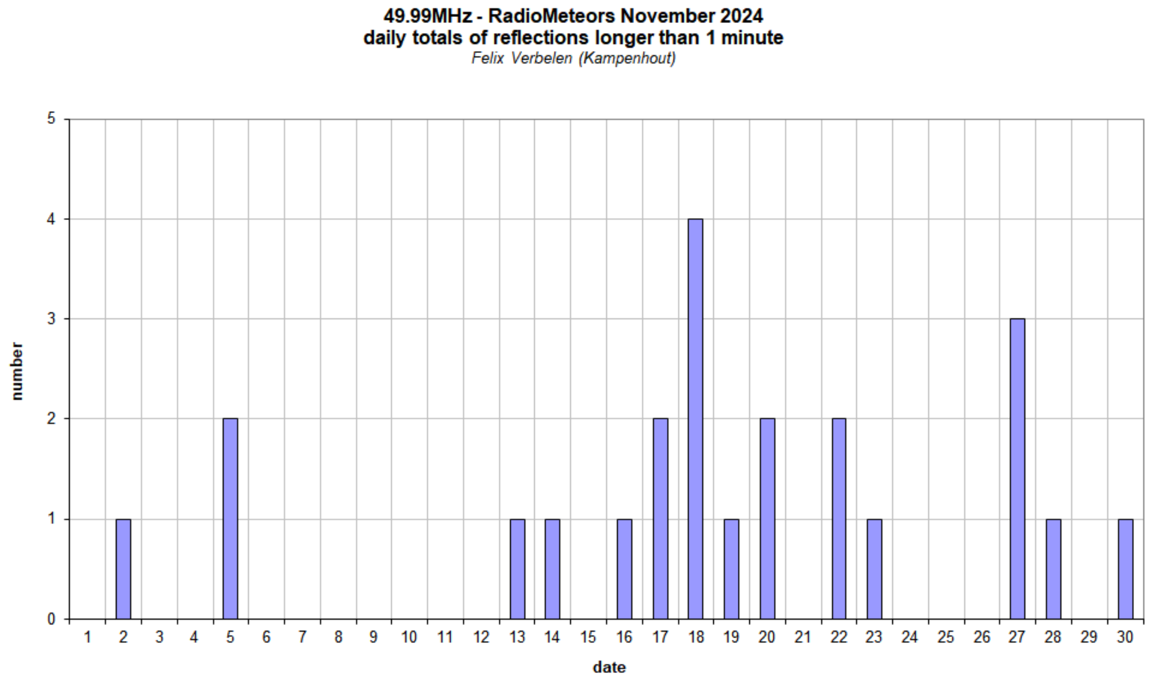
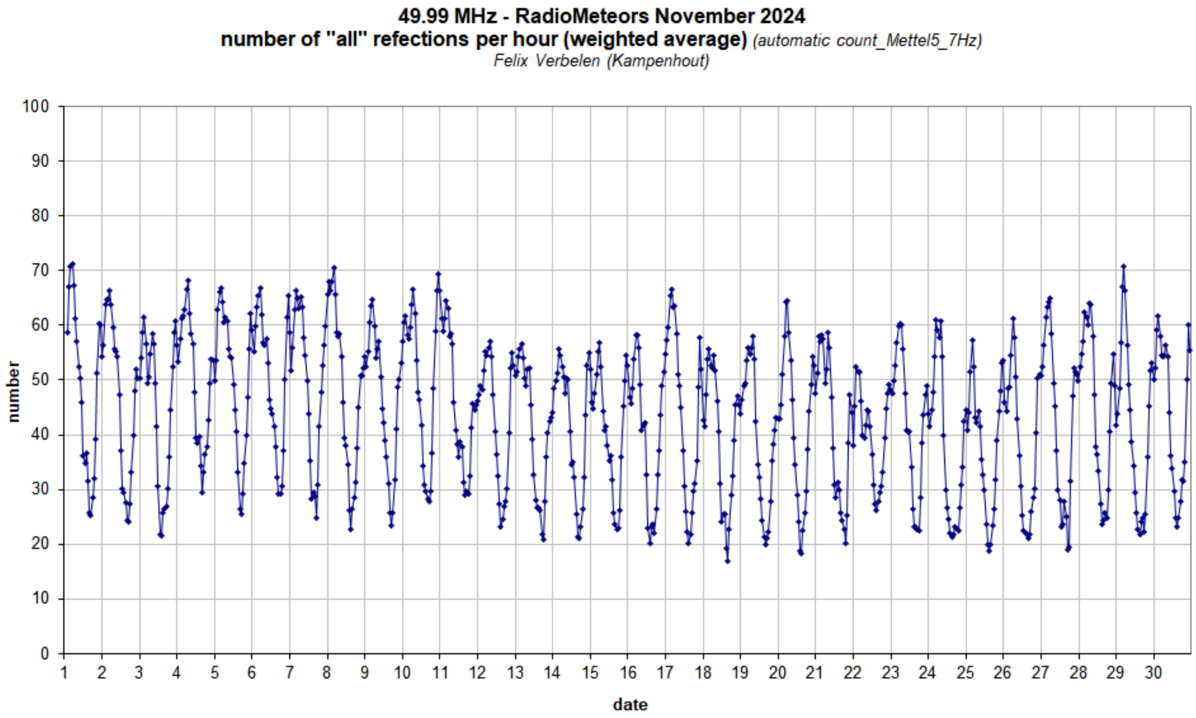


Figure 2 – The daily totals of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during November 2024.



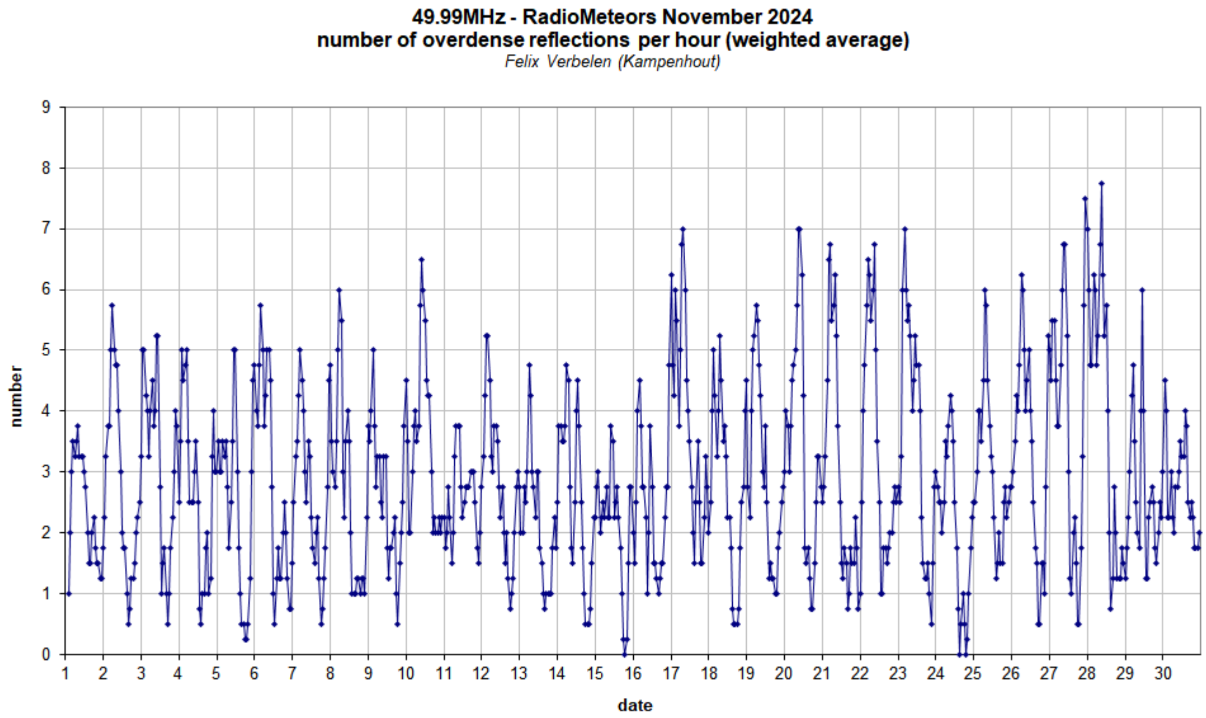
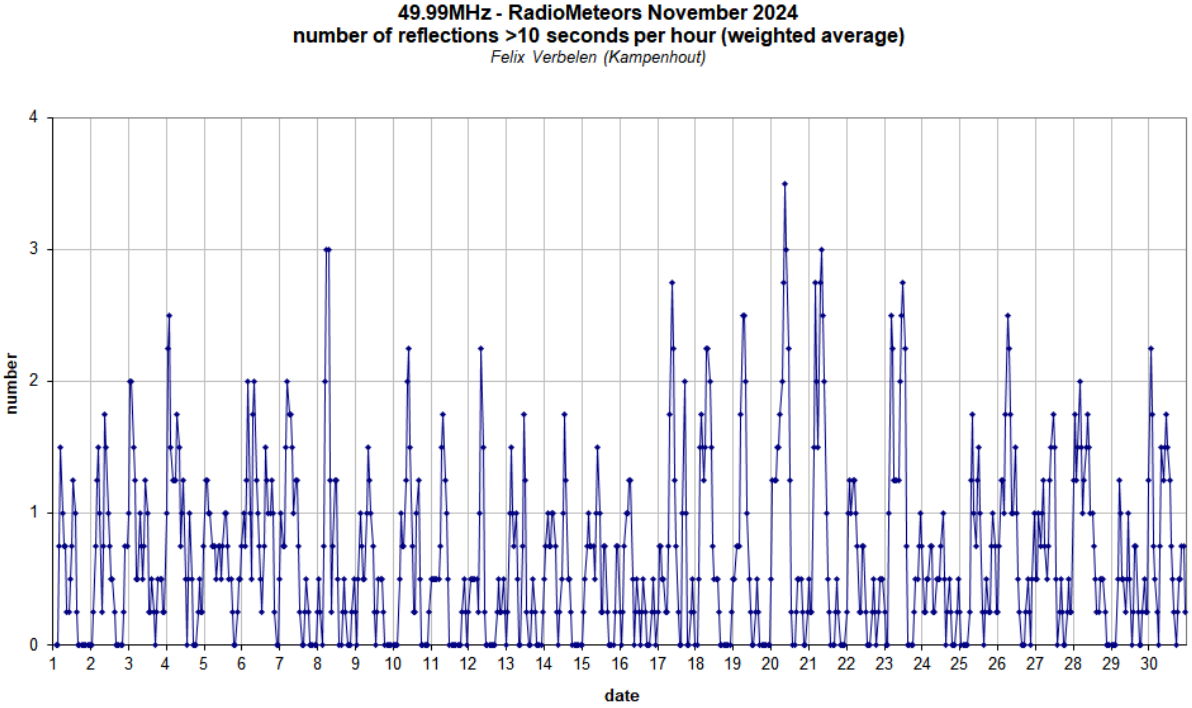


Figure 3 – The hourly numbers of “all” reflections counted automatically, and of manually counted “overdense” reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during November 2024.



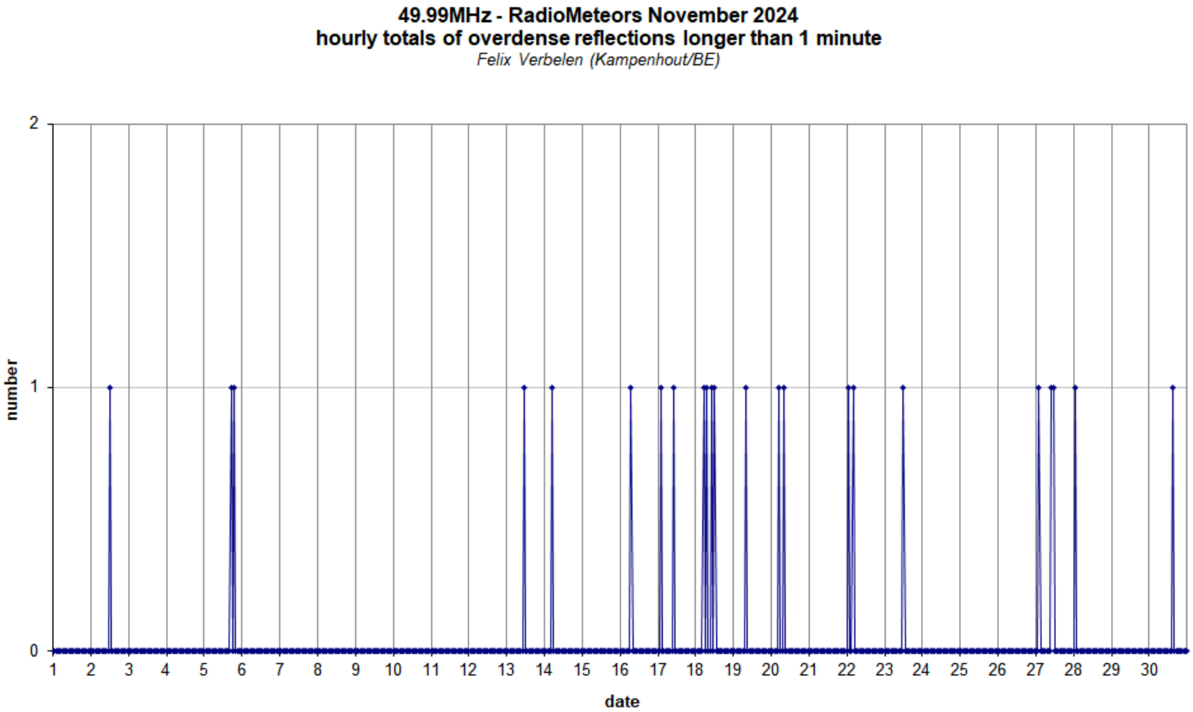


Figure 4 – The hourly numbers of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during November 2024.

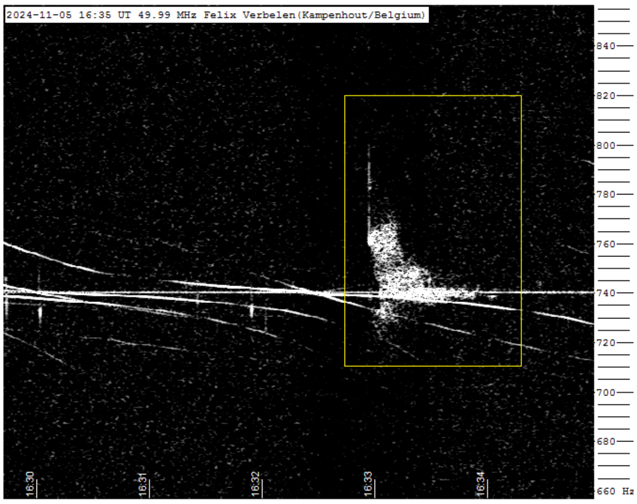


Figure 5 – Meteor echoes November 5, 16h35m UT.

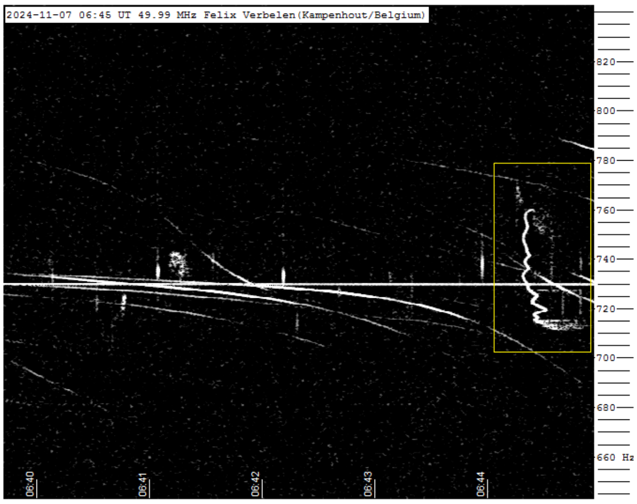


Figure 6 – Meteor echoes November 7, 06h45m UT.

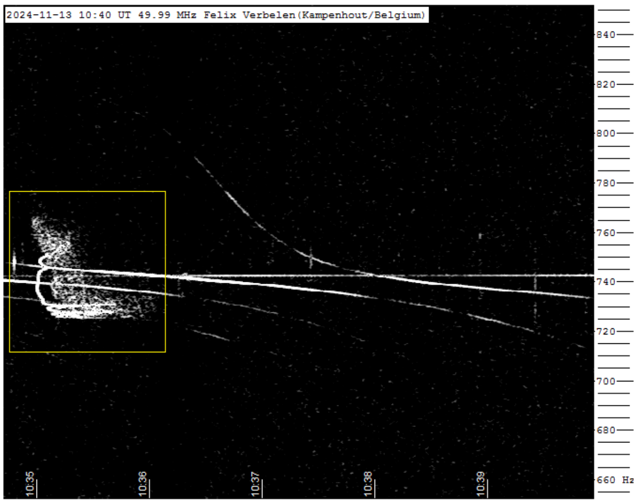


Figure 7 – Meteor echoes November 13, 10h40m UT.

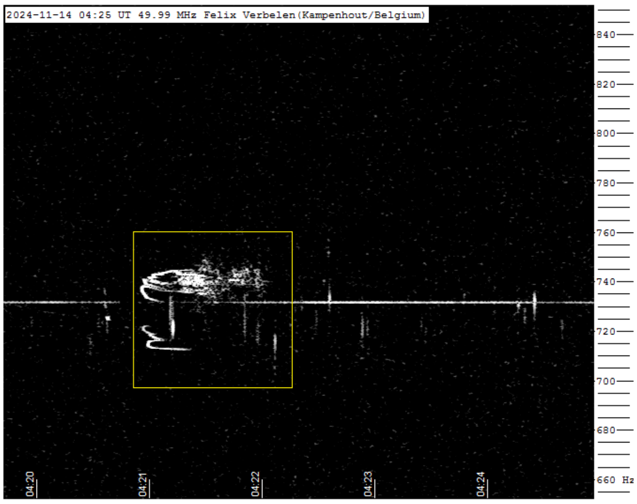


Figure 8 – Meteor echoes November 14, 04h25m UT.

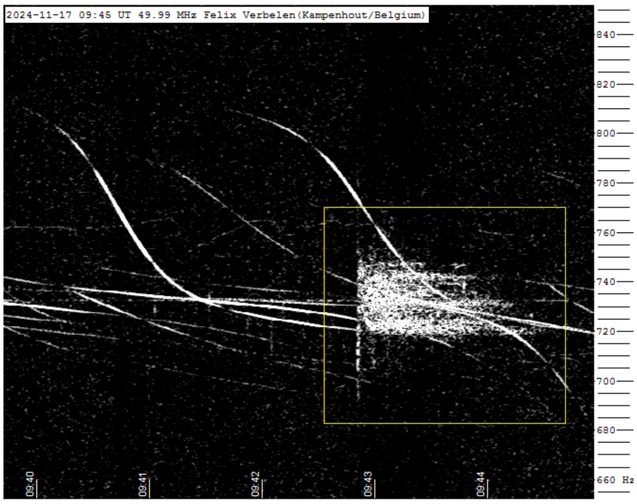


Figure 9 – Meteor echoes November 17, 09h45m UT.

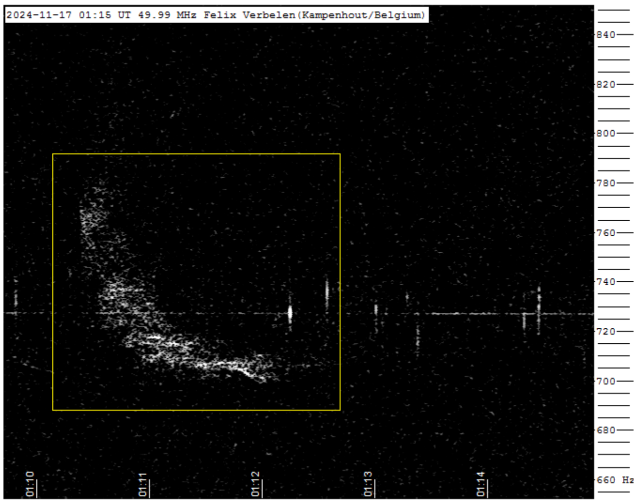


Figure 10 – Meteor echoes November 17, 01h15m UT.

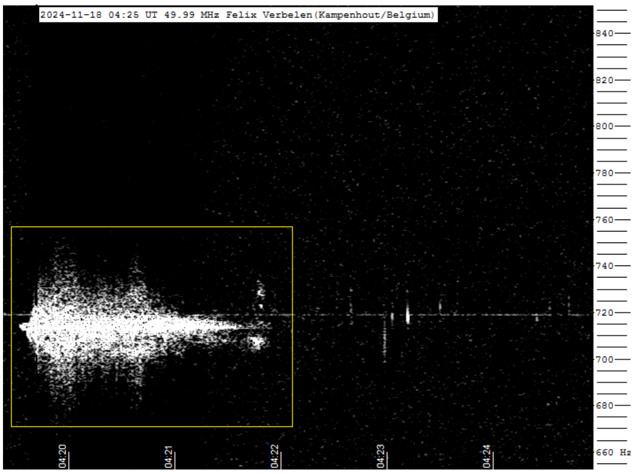


Figure 11 – Meteor echoes November 18, 04^{h}25^{m} UT.

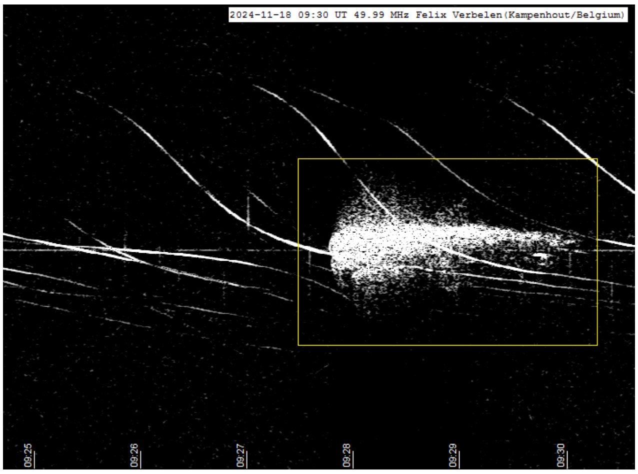


Figure 12 – Meteor echoes November 18, 09^{h}30^{m} UT.

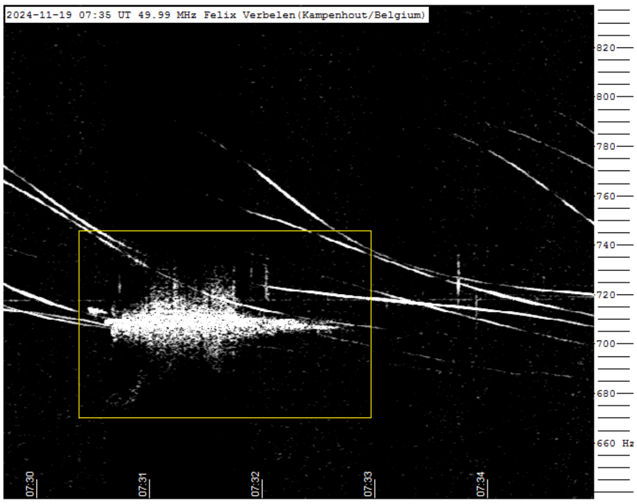


Figure 13 – Meteor echoes November 19, 07^{h}35^{m} UT.

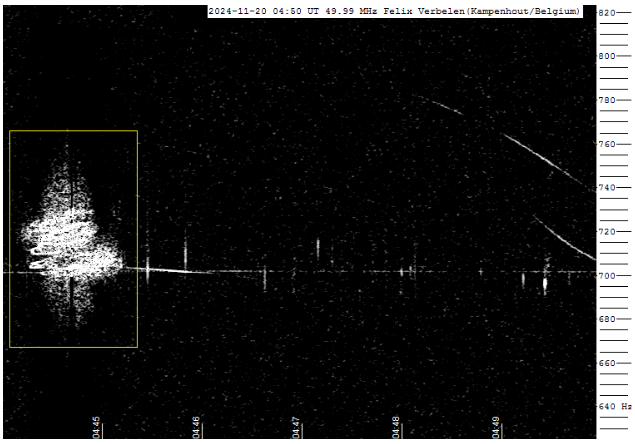


Figure 14 – Meteor echoes November 20, 04^{h}50^{m} UT.

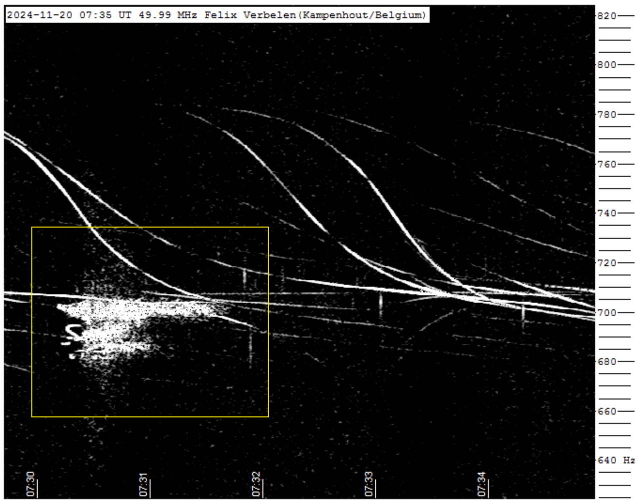


Figure 15 – Meteor echoes November 20, 07^{h}35^{m} UT.

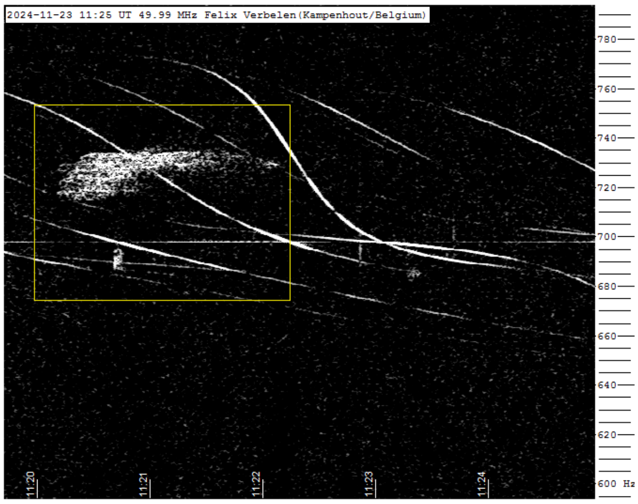


Figure 16 – Meteor echoes November 23, 11^{h}25^{m} UT.

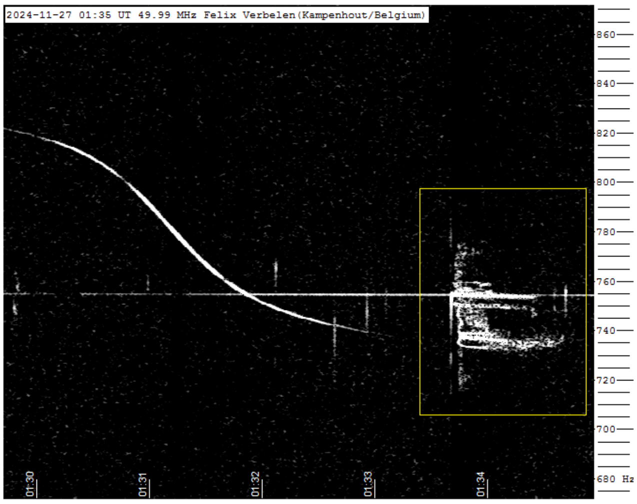


Figure 17 – Meteor echoes November 27, 01^{h}35^m UT.

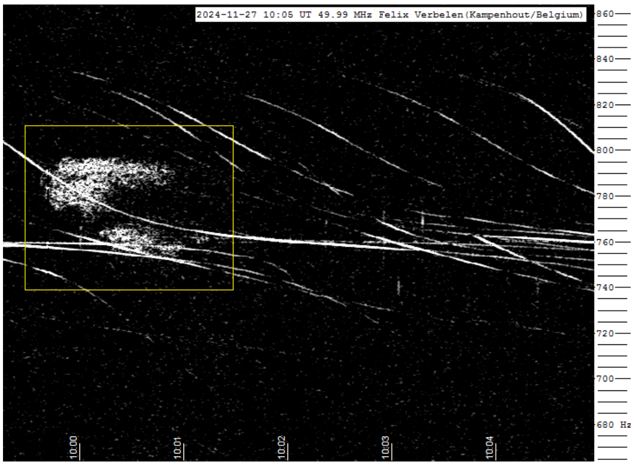


Figure 18 – Meteor echoes November 27, 10^{h}05^m UT.

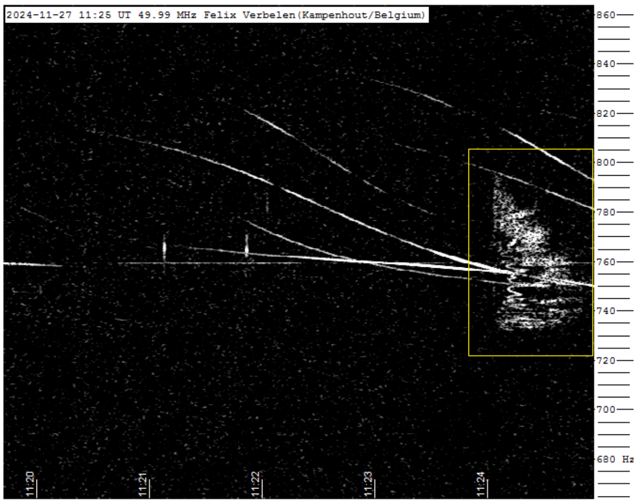


Figure 19 – Meteor echoes November 27, 11^{h}25^m UT.

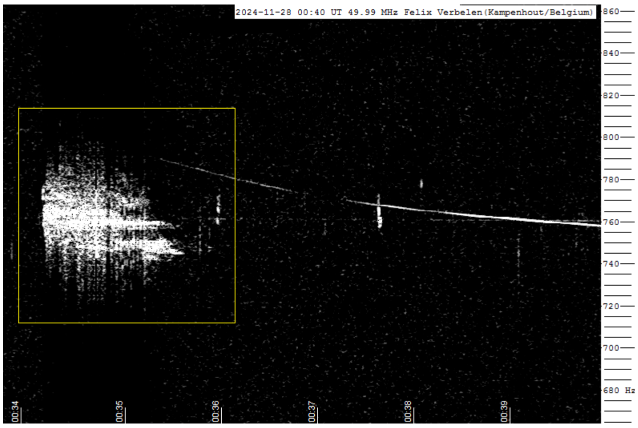


Figure 20 – Meteor echoes November 28, 00^{h}40^m UT.

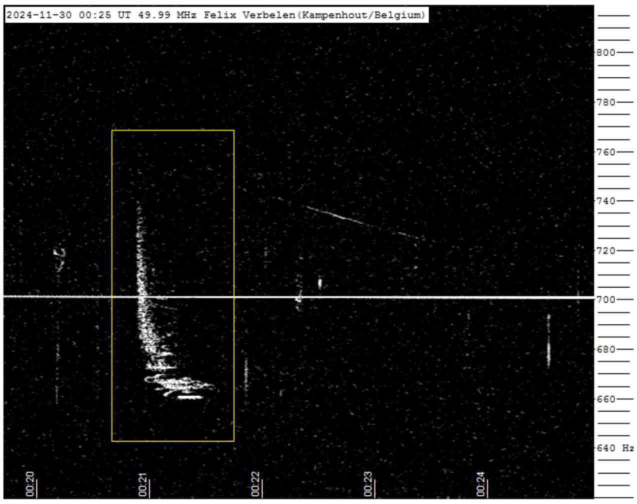


Figure 21 – Meteor echoes November 30, 00^{h}25^m UT.

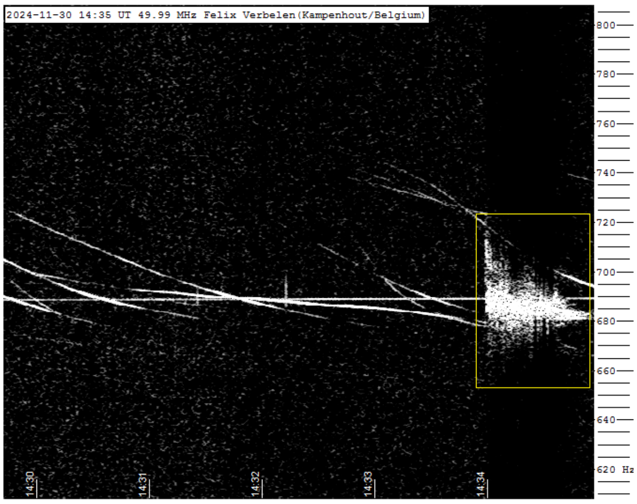


Figure 22 – Meteor echoes November 30, 14^{h}35^m UT.

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