International Meteor Organization

2025 Meteor Shower Calendar

edited by Jürgen Rendtel [1]

1 Introduction

Welcome to the thirty-fifth edition of the International Meteor Organization (IMO) Meteor Shower Calendar. Its main goal is to draw the attention of observers to both regularly returning meteor showers and to events which may be possible according to model calculations. Additional peaks and/or enhanced rates found by observations, and observational evidence of no rate or density enhancement at predicted moments are of scinetific interest. Rate and timing data may help to improve our knowledge about meteoroid streams. We hope the Calendar continues to be a useful tool to plan your meteor observing activities.

Video meteor camera networks are collecting data throughout the year. Nevertheless, visual observations comprise an important data sample for many showers, and the well established analysing procedures allow us to derive reliable flux density data. Because visual observers are more affected by moonlit skies than video cameras, we consider the moonlight circumstances when describing the visibility of meteor showers. For the three strongest annual shower peaks in 2025, we find an almost moonlight-free Quadrantid peak, the Perseid peak is shortly after Full Moon, while the waning crescent Moon will little affect observations of the Geminid maximum. Favourable conditions allow near-maximum observations of the η-Aquariids, the Southern δ-Aquariids, the Aurigids, the Orionids, the Leonids and the Ursids. Cirumstances are poor for the April Lyrids, the September ε-Perseids and the October Draconids. Note, that 2025 is another Taurid "swarm year" with possibly enhanced Taurid activity in early November (see page 13).

The heart of the Calendar is the Working List of Visual Meteor Showers (Table 5, page 25) which is continuously updated so that it is the single most accurate listing available anywhere today for visual meteor observing. Nevertheless, it is a **Working** List which is subject to further modifications, based on the best data we had at the time the Calendar was written. Observers should always check for later changes noted in the IMO's journal *WGN* or on the IMO website. Vice versa, we are always interested to receive information whenever you find any anomalies! In the Calendar we refer to the shower designation as listed by the IAU's Meteor Data Center, which has 110 "established showers" (2024 June 12).

[1]Based on information in the *Meteor Observers Workbook 2014*, edited by Jürgen Rendtel (referred to as 'WB' in the Calendar), and "A Comprehensive List of Meteor Showers Obtained from 10 Years of Observations with the IMO Video Meteor Network" by Sirko Molau and Jürgen Rendtel (referred to as 'VID' in the Calendar), as amended by subsequent discussions and additional material extracted from data analyses produced since. I particularly thank Mikhail Maslov and Jérémie Vaubaillon for new information and comments in respect of events in 2025 (see also the *References* in section 8). Masahiro Koseki added important data about several showers. Hiroshi Ogawa provided useful information concerning daytime showers detectable by radio forward scatter observations. Information about the SDA and CAP activity in late July base on comments by Koen Miskotte. Last but not least thanks to Tim Cooper, Robert Lunsford, Mikhail Maslov, and Alastair McBeath for carefully checking the contents. This Calendar version 3.1-24 includes information provided by Mikiya Sato on 2024 June 26 (pages 5, 15 and 17).

Interesting encounters are listed in Table 6a (page 27). Since there is always a possibility of completely unexpected events, ideally meteor observing should be performed throughout the year. This way we can improve the data for established meteoroid streams covering their entire activity periods. Combining data obtained with different techniques improve the reliability of derived quantities and is helpful for calibrating purposes.

Video meteor observations allow us to detect weak sources. An increasing number of confirmed radiants provides us with more possibilities to establish relations between meteoroid streams and their parent objects. Some of the sources may produce only single events but no annual recurring showers, such as, for example, the June Boötids or the τ-Herculids.

Observing techniques which allow the collection of useful shower data include visual, video and still-imaging along with radar and radio forward scatter methods. Visual and video data allow rate and flux density calculations as well as determination of the particle size distribution in terms of the population index r or the mass index s. Multi-station camera setups provide us with orbital data, essential for meteoroid-stream investigations. Showers with radiants too near the Sun for observing by the various optical methods can be detected by forward-scatter radio or back-scatter radar observations. The list of daytime showers (Table 7) has been updated referring to IAU-established showers including comments on their detectability provided by Hiroshi Ogawa.

The IMO's aims are to encourage, collect, analyze, and publish combined meteor data obtained from sites all over the globe, to improve our understanding of the meteor activity detectable from the Earth's surface. For best effects, it is recommended that all observers should follow the standard IMO observing guidelines when compiling information, and submit those data promptly to the appropriate Commission for analysis (contact details are at the end of the Calendar). Many analyses try to combine data obtained by more than one method, extending the ranges and coverage but also to calibrate results from different techniques. Thanks to the efforts of the many IMO observers worldwide since 1988 that have done this, we have been able to achieve as much as we have to date, including keeping the shower listings vibrant. This is not a matter for complacency however, since it is solely by the continued support of many people across the planet that our attempts to construct a better and more complete picture of the near-Earth meteoroid flux can proceed.

Timing predictions are included below on all the more active night-time and daytime shower maxima as reliably as possible. However, it is essential to understand that in many cases, such maxima are not known more precisely than to the nearest degree of solar longitude. In addition, variations in individual showers from year to year mean past returns are only a guide as to when even major shower peaks can be expected. As noted already, the information given here may be updated and added-to after the Calendar has been published. Some showers are known to show particle mass-sorting within their meteoroid streams, so the radar, radio, still-imaging, video and visual meteor maxima may occur at different times from one another, and not necessarily just in those showers. The majority of data available are for visual shower maxima, so this must be borne in mind when employing other observing techniques.

Whenever you are able to observe, we wish you all a most successful year's work and very much look forward to receiving your data, whose input is possible via the online form on the IMO's website `www.imo.net`. Clear skies!

2 Antihelion Source

The Antihelion Source (ANT) is a large, roughly oval area of about 30° in right ascension and 15° in declination, centred about 12° east of the solar opposition point on the ecliptic, hence its name. It is not a true shower at all (and therefore has no IAU shower number), but is rather a region of sky in which a number of variably, if weakly, active minor showers have their radiants. IMO video results have shown that even instrumentally, it was impossible to define distinct and constantly observable radiants for many of the showers here! Thus we recommend observers simply to identify meteors from these showers as coming from the ANT alone.

Apart from this, we have been able to retain the α-Capricornids and particularly the Southern δ-Aquariids in July to August as apparently distinguishable showers separate from the ANT. Later in the year, the Taurid showers dominate the activity from the Antihelion region meaning the ANT should be considered inactive while the Taurids are underway, from late September into December. To assist observers, a set of charts showing the location for the ANT and any other nearby shower radiants is included here, to complement the numerical positions of Table 6, while comments on the ANT's location and likely activity are given in the quarterly summary notes.

3 January to March

The year starts with the **Quadrantid (010 QUA)** peak for the northern hemisphere observers on January 3 close to 15^{h} UT.

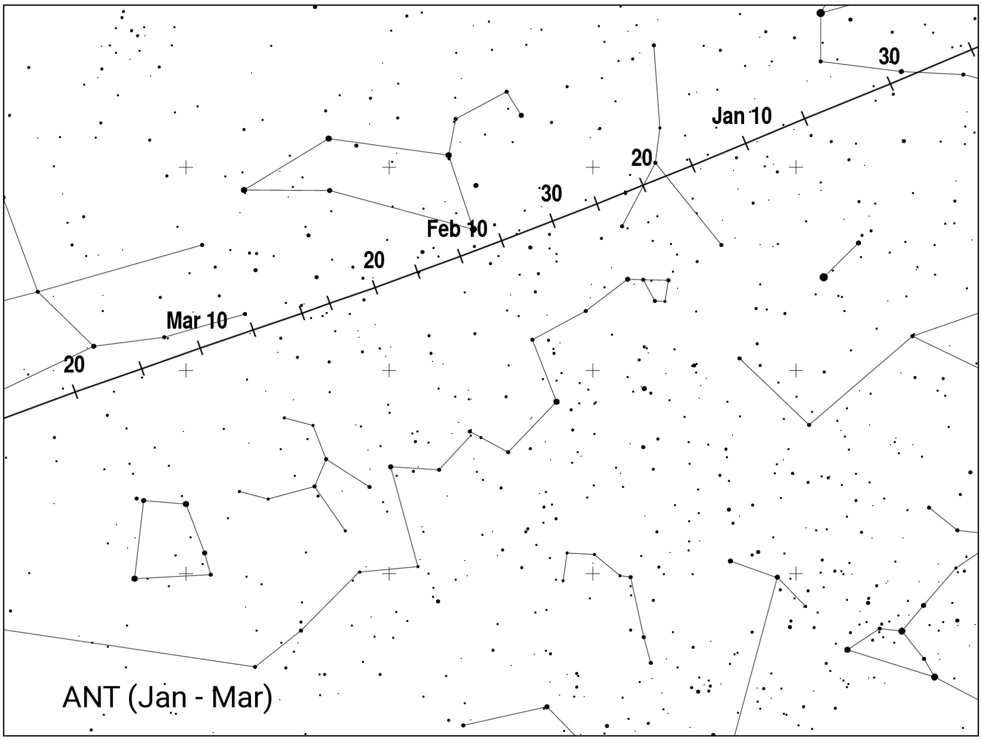
On 2015 January 10 at $02^{\mathrm{h}}50^{\mathrm{m}}$ UT, radar and video data showed an outburst of the **κ-Cancrids (793 KCA**; radiant at $\alpha = 138°$, $\delta = +9°$) at $\lambda_{\odot} = 289.^{\circ}315$. Activity from this source was also found in the 2016 data of the IMO Video Network and data of the SonotaCo network find the shower annually over the past decade around January 10. There are hints that the KCA event of 2015 may have been an enhancement of the o-Leonids (515 OLE). Both are in the working list of the IAU MDC and require more data. The outburst position of the 2015 activity is reached on 2025 January 9 near 16^{h} UT. At this time, the radiant of the Antihelion source centre is located at $\alpha = 122°$, $\delta = +19°$, which is roughly 20° northeast of the KCA radiant; KCA meteors ($V_{\infty} = 47$ km/s) are faster than those from the ANT ($V_{\infty} = 30$ km/s).

The **ι-Centaurids (919 ICN)** – not in our working list – appear to be active annually, albeit with fairly low rates, but in 2024 showed enhanced activity between January 21–26 (Cooper, 2024). The shower of fast meteors ($V_{\infty} = 64$km/s) with a radiant at $\alpha = 199°, \delta = -39°$ could benefit from dedicated visual observation.

The **Comae Berenicids (020 COM)** can be traced until early February. Around January 18 we find weak activity of the **γ-Ursae Minorids (404 GUM)** – this year badly affected by bright moonlight. The **α-Centaurids (102 ACE)** reach their maximum around February 8 and perhaps later – see the ACE description on page 5.

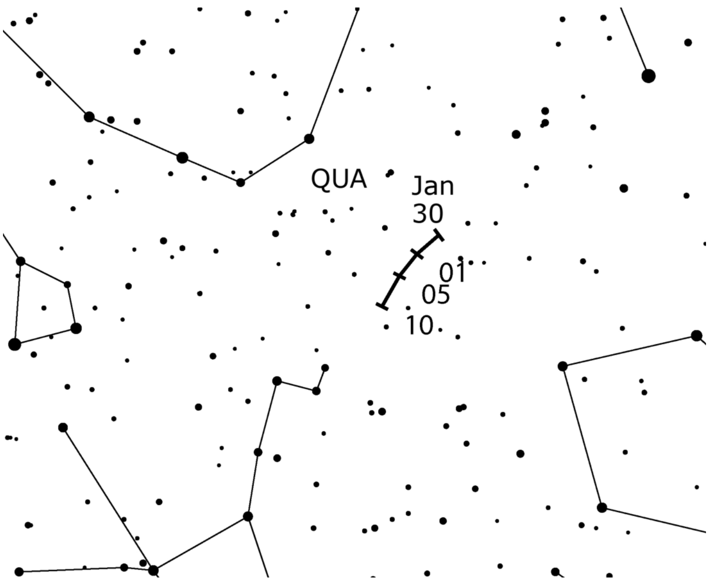
The **ANT's** radiant centre is in south-east Gemini in early January, and crosses Cancer during much of the month, before passing into southern Leo for most of February. It then shifts through southern Virgo during March – see the chart shown on the next page.

Probable ZHRs will be of the order of 2 to 3 during most of the time. Video meteor flux density data indicate a slight increase in March around $\lambda_{\odot} \approx 355°$ (corresponding to 2025 March 15).



Quadrantids (010 QUA)

Active: December 28–January 12; Maximum: January 3, $15^{\mathrm{h}}00^{\mathrm{m}}$ UT ($\lambda_\odot = 283.^\circ15$),
ZHR = 80 (can vary $\approx 60-200$);
Radiant: $\alpha = 230^\circ$, $\delta = +49^\circ$; Radiant drift: see Table 6;
$V_\infty = 41$ km/s; $r = 2.1$ at maximum, 2.5 elsewhere.

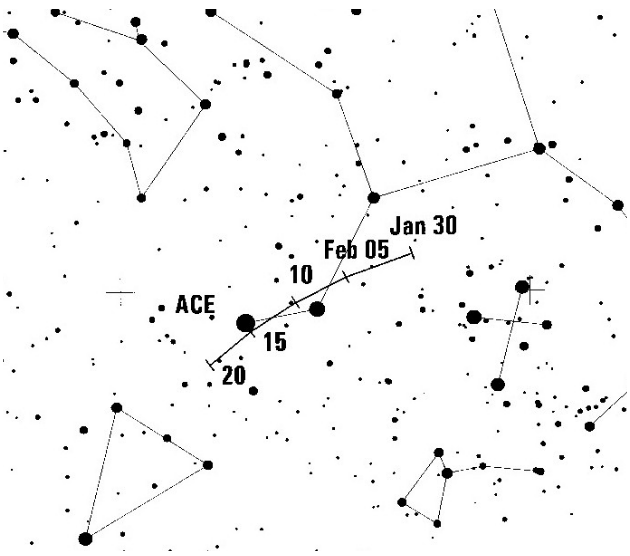


In 2022 and 2023, the highest visual QUA rates were in the lower range of the values given above but at the same position as usual. Maximum rates of the 2024 return were at the average level. Video meteor data of 2020–2022 indicated a peak time a few hours ahead of the reference time, but the peaks in 2023 and 2024 occurred at the known $283.^\circ15$ again. In the years 2020–2022, the radio forward scatter data show a maximum which is wider than the usually quoted 4 hours. Modelling the stream is difficult so that all data may help checking the current model parameters. This year the conditions are perfect concerning the moonlight effects.

It is well known that the QUA activity extends until about January 12 and even a few days after the actual peak, bright fireballs have been observed. Another 5–7 days after the peak can still be used for undisturbed optical observations.

α-Centaurids (102 ACE)

Active: January 31–February 20; Maximum: February 8 ($\lambda_\odot = 319.°4$);
ZHR variable, usually ≈ 6;
Radiant: $\alpha = 211°$, $\delta = -58°$; Radiant drift: see Table 6; $V_\infty = 58$ km/s; $r = 2.0$.



The α-Centaurids are mainly known from their appearances in 1974 and 1980 when bursts of only a few hours' duration apparently yielded ZHRs close to 20–30. The average peak ZHR between 1988–2007 was merely 6 though (WB, p. 18), albeit coverage has frequently been extremely patchy. Significant activity was reported on 2015 February 14 (airborne observation) although there was no confirmation of an outburst predicted for 2015 February 8. An outburst during 2021 February 13–15 associated with the γ-Crucids (1047 GCR) might have been a return of the ACE. Visual observation during the late part of the activity after the assumed maximum will be difficult due to increasing moonlight interference. Since further data is needed to obtain information about the stream which is not clearly detectable recently by visual and video observations, observers may concentrate on the first week of February. The shower's radiant is nearly circumpolar for much of the sub-equatorial inhabited Earth, and is at a useful elevation from late evening onwards.

4 April to June

In this period the meteor rates increase significantly, but much of the total meteor activity in late April into May remains unobservable for optical methods as it is caused by daytime showers with their radiants located less than about 30° distant from the Sun.

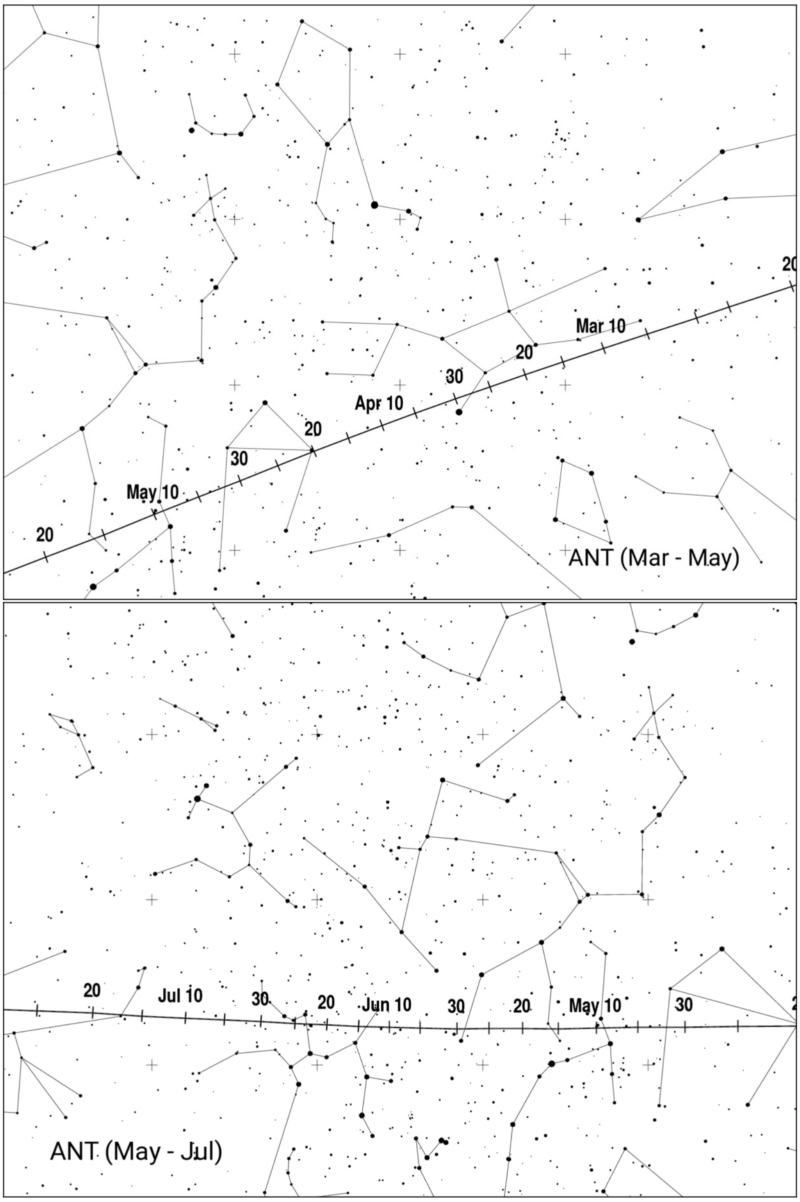
Sato's calculations yield a return of the **April α-Capricornids (752 AAC)** on April 7 at 13^h35^m UT ($\lambda_\odot = 17.°637$) from a radiant at $\alpha = 304°, \delta = -13°$. This shower of fast meteors ($V_\infty = 69$ km/s) was detected in 2014 (SonotaCo, et al., 2014) and a new approach to the dust trail is expected in 2025.

The waning Moon partly affects observations of the maximum of the **April Lyrids (006 LYR)** while the conditions are fine for the **π-Puppid (137 PPU)** maximum on April 23.

Observations of the maximum of the **η-Aquariids (031 ETA)** can be observed essentially under moon-free conditions as the waxing Moon leaves the morning hours unaffected. This is not the case for the minor **η-Lyrids (145 ELY)** with activity around May 10 – two days before Full Moon. The **June Boötids (170 JBO)** reach their potential maximum between June 23 and 28.

According to analyses of visual and video IMO data, the **ANT** should produce ZHRs of the order of 4–5 with insignificant variations. The radiant area drifts from south-east Virgo through

Libra in April, then across the northern part of Scorpius to southern Ophiuchus in May, and on into Sagittarius for much of June (charts on the next page).



Daytime showers: In the second half of May and throughout June, most of the meteor action switches to sources with their radiants in the daylight sky (see also Table 7 at page 27). Here we give the data of the IAU MDC and recent findings (Ogawa, 2022; 2023) and some brief comments.

Shower	Maximum $\lambda_\odot$ (Date) IAU MDC	Ogawa
April Piscids (144 APS)	26.°0 (Apr 16)	32.°6 (Apr 22)
N. ω-Cetids (152 NOC)	47.°8 (May 08)	52.°0 (May 12)
S. ω-Cetids (153 OCE)	48.°6 (May 09)	48.°8 (May 09)
S. May Arietids (156 SMA)	52.°7 (May 13)	
Arietids (171 ARI)	76.°7 (Jun 07)	77.°8 (Jun 08)
ζ-Perseids (172 ZPE)	78.°6 (Jun 09)	83.°5 (Jun 14)
β-Taurids (173 BTA)	96.°7 (Jun 28)	

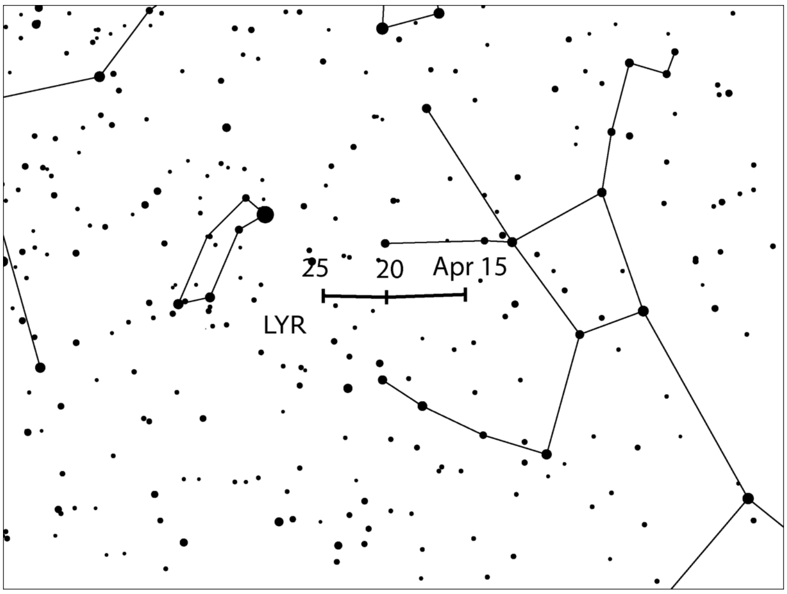
For the **April Piscids (144 APS)**, Ogawa (2022) finds an activity which seems to be of similar strength to the radio Ursids of December in the period $\lambda_\odot = 30^\circ\!.5 - 34^\circ\!.5$ and a maximum at $\lambda_\odot = 32^\circ\!.6$. This differs significantly from the values in the IAU MDC database: maximum at $\lambda_\odot = 26°$ (April 16) or even earlier. This early date is before the start date found by Ogawa (2022) and requires observations. Later in May there are three showers: 152 NOC, 153 OCE, 156 SMA, with radiants relatively close to one another and overlapping activity periods. Therefore it is probably not possible to separate the activity of these showers in radio forward scatter observations. We may perhaps identify a broad activity profile around $\lambda_\odot = 50°$ (2025 May 10/11). The **Arietids (171 ARI)** is the strongest of the daytime showers, but again we find an overlap, now with the **ζ-Perseids (172 ZPE)** between 73°and 88°. The actual duration of the shower(s) is not well known.

April Lyrids (006 LYR)

Active: April 14–30; Maximum: April 22, 13^h30^m UT ($\lambda_\odot = 32^\circ\!.32$, but may vary – see text);
ZHR = 18 (can be variable, up to 90);
Radiant: $\alpha = 271°$, $\delta = +34°$; Radiant drift: see Table 6;
$V_\infty = 49$ km/s; $r = 2.1$.

The $\lambda_\odot = 32^\circ\!.32$ (2025 April 22, 13^h30^m UT) timing given here refers to the ideal maximum position found in *IMO* results from 1988–2000. However, the maximum time was variable from year to year. The recent maxima have been found between $\lambda_\odot = 32^\circ\!.2$–$32^\circ\!.5$ (equivalent to 2025 April 22, 10^h30^m to 18^h00^m UT). Usually, the peak activity at the ideal time produced higher ZHRs, ≈ 23. The further the peak happened from this, the lower the ZHRs were, down to ≈ 14 – a relation which needs to be confirmed. Further, the shower's peak length varied. A ZHR of more than half of the peak value was found on average for 32.1 hours, but this duration varied between 14.8 and 61.7 hours. The best rates are normally achieved for just a few hours. The analysis also confirmed that occasionally, as their highest rates occurred, the Lyrids produced a brief increase in fainter meteors. In 1982 a short-lived ZHR of 90 was recorded.

For 2025 there are no predictions for any activity increase from theoretical modelling of this shower associated with the long-period comet C/1861 G1 (Thatcher).

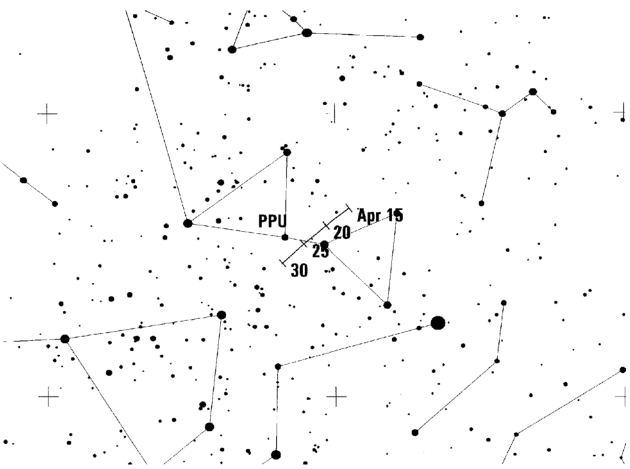


Lyrid meteors are best viewed from the northern hemisphere, but are visible from many sites north and south of the equator. As the radiant rises during the night, watches can be carried out usefully after about 22^h30^m local time from mid-northern sites, but only well after midnight from the mid-southern hemisphere. The waning crescent moon in Capricornus should not disturb too much (last quarter on April 21).

π-Puppids (137 PPU)

Active: April 15–28; Maximum: April 23, 19^h UT ($\lambda_\odot = 33.^\circ5$);
ZHR variable, in most years ≈ 5, but up to around 40;
Radiant: $\alpha = 110^\circ$, $\delta = -45^\circ$; Radiant drift: see Table 6;
$V_\infty = 18$ km/s; $r = 2.0$.

The shower was discovered in 1972; later notable, short-lived, activity with rates around 40 meteors per hour was reported in 1977 and 1982. In both years, the parent comet, 26P/Grigg-Skjellerup was at perihelion. Before 1982, little activity had been seen at other times, but in 1983, a ZHR of ≈ 13 was reported, perhaps suggesting material has begun to spread further along the comet's orbit. The comet passed its perihelion last on 2023 December 25.



Not unexpectedly, nothing meteorically significant happened in the years around the recent perihelion passages. When this Calendar was prepared, no predictions for any 2025 π-Puppid meteor activity had been issued.

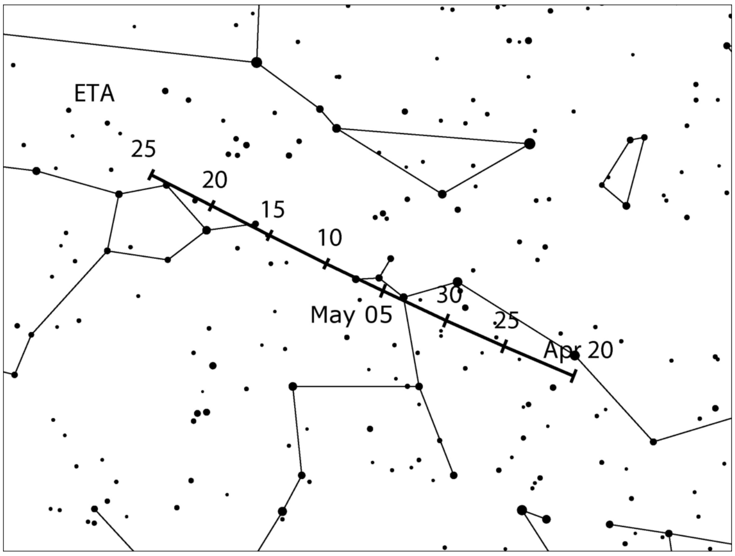
The π-Puppids are best-seen from the southern hemisphere, with useful observations mainly practical before midnight, as the radiant is very low to setting after 01^h local time. The last quarter Moon (April 21) leaves the first half of the night undisturbed for optical observations this year. Covering whatever transpires is important, even if that is to report no obvious activity. The IMO data over the past 19 years have only records of 2018, 2019 and 2020 which confirm low, but detectable rates.

η-Aquariids (031 ETA)

Active: April 19–May 28; Maximum: May 6, 03^h UT ($\lambda_\odot = 45.^\circ5$); ZHR = 50 (var., 40–85);
Radiant: $\alpha = 338^\circ$, $\delta = -1^\circ$; Radiant drift: see Table 6;
$V_\infty = 66$ km/s; $r = 2.4$.

This stream is associated with Comet 1P/Halley, like the Orionids of October. Shower meteors are only visible in the hours before dawn essentially from tropical and southern hemisphere sites. The shower is one of the best for southern observers. Useful results may be obtained from places up to about 40° N latitude. The radiant culminates near 8^h local time. In most years, a substantial amount of optical ETA-data is collected worldwide. However, due to the relatively short observing window between radiant rise and morning twilight for each site, it remains difficult to obtain a continuous profile.

This year the moonlight interference increases after the maximum period (Full Moon on May 12). IMO analyses of visual data collected since 1984 have shown that ZHRs are generally above 30 in the period May 3–10. An often claimed variability of the peak rates associated with Jupiter's orbital period close to 12 years has not been confirmed in a recent study (Egal et al., 2020) using optical and radar data. The preliminary data of the 2024 return shows slightly enhanced rates at a rather late position on May 8.

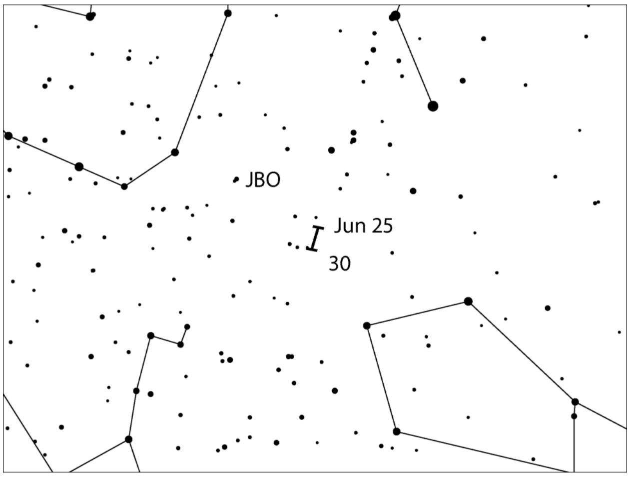


Recent peak ZHRs were:

2008	2009	2017	2018	2019	2020	2021	2022	2023	2024
≈ 85	≈ 70	75	60	50	50	45	42	40	45 (preliminary)

June-Boötids (170 JBO)

Active: June 22–July 2; Maximum: June 27, 11^h UT ($\lambda_\odot = 95.°7$), but see text;
ZHR = variable, 0–100+;
Radiant: $\alpha = 224°$, $\delta = +48°$; Radiant drift: see Table 6; $V_\infty = 18$ km/s; $r = 2.2$.



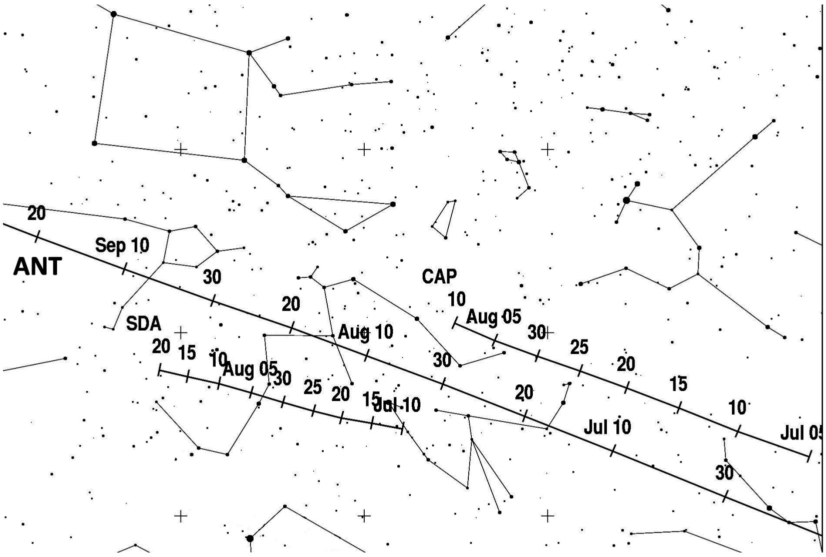
This shower is known for its unexpected return of 1998 (ZHR 50 − 100+ for more than half a day). Another outburst of similar length (ZHR ≈ 20−50) was observed on 2004 June 23. The return predicted in 2010 yielded a poorly established ZHR < 10 on June 23–24. Prior to 1998, only three more probable returns had been detected, in 1916, 1921 and 1927 (however, with different reliability).

The orbit of the parent comet 7P/Pons-Winnecke (orbital period about 6.3 years, last perihelion passage on 2021 May 27) currently lies around 0.23 astronomical units outside the Earth's at its closest approach.

The 1998 and 2004 events resulted from meteoroids ejected from the comet in the past when the comet was still in a different orbit. For the 2025 return, there are no predictions of peculiar activity published. Nevertheless, we encourage all observers to monitor throughout the proposed period, in case of any activity. From mid-northerly latitudes the radiant is observable almost all night, but the prolonged – in some places continuous – twilight overnight keeps the useable time short. VID suggested some June-Boötids may be visible in most years around June 20 – 25 but with activity largely negligible except near $\lambda_\odot = 92°$ (2025 June 23, 14^h UT), radiating from $\alpha = 216°$, $\delta = +38°$ which is about ten degrees south of the radiant found in 1998 and 2004.

5 July to September

The **ANT** is the chief focus for visual attention in the first half of July, as its radiant area moves steadily through eastern Sagittarius, then across northern Capricornus into southwest Aquarius (see chart below). ZHRs for most of the month should be $\approx$ 2 to 3. From around September 20, the **Southern Taurids (002 STA)** effectively take over the near-ecliptic activity from the ANT through to December (see chart on page 13).



The low activity of the **July Pegasids (175 JPE)** around July 10 coincides with the Full Moon period. After mid-July the large ANT radiant area overlaps that of the minor **α-Capricornids (001 CAP)** into August, but the lower apparent velocity of the CAP allows observers to separate the two. The stronger and faster **Southern δ-Aquariids (005 SDA)** should be distinguishable from the ANT as well. The highest rates of CAP and SDA are due on July 30/31.

On 2016 July 28 at $00^{\rm h}07^{\rm m}$ UT ($\lambda_\odot = 125\overset{\circ}{.}132$) the **July γ-Draconids (184 GDR)** produced an outburst detected by radar and video observations. The same position is reached again on 2025 July 28 near $07^{\rm h}$ UT – worth checking although there was no extra activity observed in 2017 – 2023. SonotaCo net observations indicate that the GDR is an annual shower with a sharp but variable maximum from year to year (Koseki, 2020). The radiant is at $\alpha = 280°$, $\delta = +51°$, and the meteors have low speed ($V_\infty = 27$ km/s).

The **η-Eridanids (191 ERI)** are effectively visible only in the first days of August before the Full Moon on August 9.

The **Perseid (007 PER)** maximum on August 12 occurs shortly after the Full Moon. At the time of the maximum the gibbous moon will be in Pisces, badly affecting the visible rates as it gains height together with the radiant. Vaubaillon mentions that there may be activity from the 1079 dust trail which is disrupted into at least two parts. The Earth will approach one of these at $\lambda_\odot = 139\overset{\circ}{.}736$ (2025 August 12, $13^{\rm h}15^{\rm m}$UT) with possible significant rates from a radiant at $\alpha = 46\overset{\circ}{.}0, \delta = +57\overset{\circ}{.}6$. Minor contributions from other old trails may add somewhat. Further, Jenniskens (2006) lists a filament encounter after $\lambda_\odot = 139\overset{\circ}{.}38$ (i.e. August 12 well after $04^{\rm h}$ UT) with a ZHR ≤ 50.

The maximum period of the **κ-Cygnids (012 KCG)** around August 16 is moon-free.

Circumstances are good for observations of the **Aurigid (206 AUR)** maximum in the night August 31 – September 1. The **September ε-Perseids (208 SPE)** reach their maximum on September 9/10, just about two days after the Full Moon. The parent object is not known; there are some ideas about a long period object and in 2016 a meteor cluster was observed.

The **ε-Eridanids (209 EER)** – not to be mixed up with the η-Eridanids (191 ERI) – seem to be related to comet C/1841 L1 Klinkerfues. If so, Vaubaillon finds weak activity from the 1216 trail (6 revolutions) on 2025 September 12, $20^{h}43^{m}$ UT ($\lambda_{\odot} = 169.^{\circ}983$). The radiant at $\alpha = 52°, \delta = -15°$ rises only well after midnight so that optical observations are affected by the waning Moon in Taurus.

For **radio observers**, daytime activity decreases (see remarks to Table 7 on page 27). We may detect the **κ-Leonids (212 KLE)** at $\lambda_{\odot} = 183°$ (September 25) as another established daytime shower. The **Daytime Sextantid (221 DSX)** maximum follows at $\lambda_{\odot} = 188°$ (October 1). Very few meteors of this shower may also be detected by optical methods.

Southern δ-Aquariids (005 SDA)

Active: July 12–August 23; Maximum: July 31 ($\lambda_{\odot} = 128°$); ZHR = 25;
Radiant: $\alpha = 340°$, $\delta = -16°$; Radiant drift: see Table 6; $V_{\infty} = 41$ km/s; $r = 2.5$ (see text).

The shower is one of the most active annual sources in the southern hemisphere. The ZHR of the SDA is around 25 for about two days; the ZHR exceeds 20 between $\lambda_{\odot} = 124°$ and 129°. During the maximum there are numerous bright SDA meteors visible, causing $r \approx 2.5$ around the maximum and $r \approx 3.1$ away from the peak period. Rare outbursts with a ZHR of about 40 were reported by Australian observers on 1977 July 28/29 and from Crete on 2003 July 28/29 – both before the maximum date found in recent years (e.g., Koseki, 2021) and given here. The activity level and variations of the shower need to be monitored. First quarter Moon on August 1 leaves most of the night undisturbed until after the maximum.

The radiant is shown in the chart on page 10. At mid-northern latitudes only a small portion of the shower meteors is visible, but conditions significantly improve towards southern latitudes.

α-Capricornids (001 CAP)

Active: July 3–August 15; Maximum: July 31 ($\lambda_{\odot} = 128°$); ZHR = 5;
Radiant: $\alpha = 307°$, $\delta = -10°$; Radiant drift: see Table 6; $V_{\infty} = 23$ km/s; $r = 2.5$.

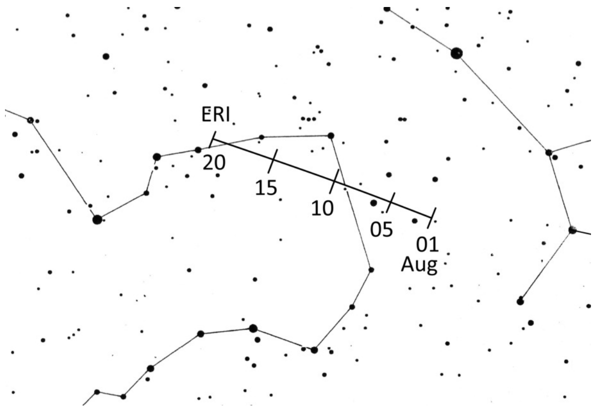
Although the radiant of the CAP (see chart on page 10) partly overlaps that of the large ANT region, the low CAP velocity should allow to distinguish between the two sources. Frequently, bright and at times fireball-class shower meteors are seen. Minor rate enhancements have been reported at a few occasions in the past, although the highest observed ZHR of ≈ 10 dates back to 1995. Recent results suggest the maximum date of July 30/31.

η-Eridanids (191 ERI)

Active: July 31–August 19; Maximum: August 07, $\lambda_{\odot} = 135°$; ZHR = 3;
Radiant: $\alpha = 41°$, $\delta = -11°$; Radiant drift: see Table 6; $V_{\infty} = 64$ km/s; $r = 3.0$.

The η-Eridanids (191 ERI) included in our working list recently may be associated with comet C/1852 K1 (Chacornac). The activity period given here has been adapted from Koseki (2021; pp. 140–141).

It seems that the activity continues long after its maximum which needs observational data. However, this will be difficult after about August 7 due to increasing moonlight interference. The radiant of these fast meteors in the northwestern part of Eridanus is best observed after midnight, preferably from southern locations.



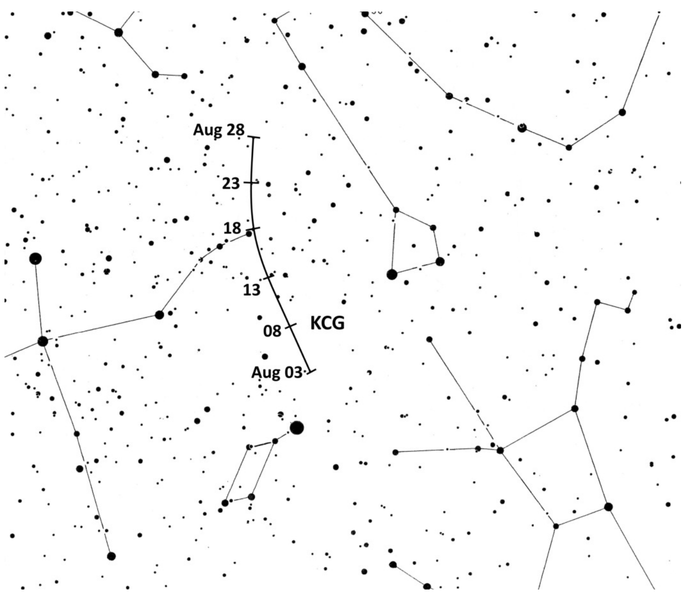
κ-Cygnids (012 KCG)

Active: August 3–28; Maximum: August 16 ($\lambda_\odot = 144°$); ZHR = 3;
Radiant: $\alpha = 288°$, $\delta = +54°$; Radiant drift: see Table 6; $V_\infty = 23$ km/s; $r = 3.0$.

Enhanced κ-Cygnid activity was observed in 2007, 2014 and 2021 supporting an assumed 7-year period of the stream. This indicates that we do not expect enhanced rates in 2025. Apart from the periodic peaks, a recent analysis indicates a general ZHR level increase in the recent years after an apparent dip in the period 1990–2005.

An average flux density profile for the period 2012–2018 from video data shows a clear maximum at 144° and detectable activity between August 2 and September 3.

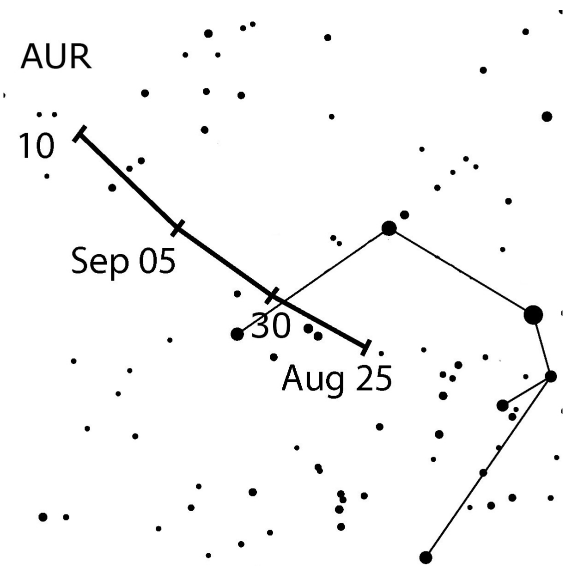
Research by Koseki (2014) has shown a complex radiant structure extending into Draco and Lyra. The isolated radiant position and the low velocity of the meteoroids should be used to associate KCG meteors to the complex assuming a slightly larger radiant area. The shower is best-observed from northern hemisphere sites, from where the radiant is easily available all night. Visual observations are not suitable to distinguish between the subradiants identified with other techniques, but provide the total activity from radiants in the mentioned area.



Aurigids (206 AUR)

Active: August 28–September 5; Maximum: September 01, 03^h UT ($\lambda_\odot = 158.6°$) – see text;
ZHR = 10; Radiant: $\alpha = 91°$, $\delta = +39°$; Radiant drift: see Table 6; $V_\infty = 66$ km/s; $r = 2.5$.

This northern-hemisphere shower has produced outbursts with peak ZHRs of ≈ 30–50 recorded in 1935, 1986, 1994 and 2019. Observations of the first *predicted* outburst in 2007 confirmed the calculated values widely and was characterised by many bright meteors. The peak ZHR of ≈ 130 lasted only for about 20 minutes.



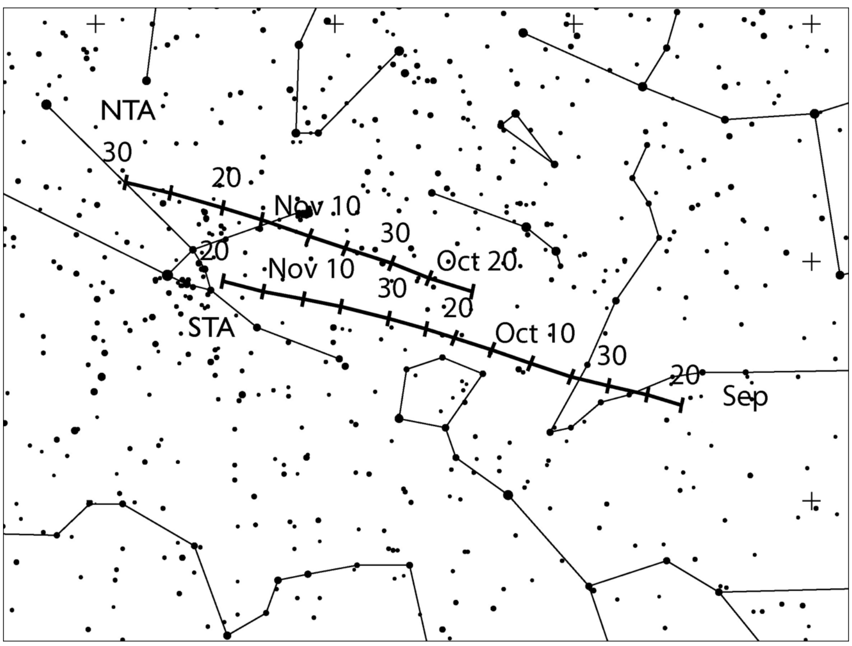
Slightly enhanced rates were also observed in 2021. According to calculations of Sato (2023) the assumed one-revolution dust trail was last in the vicinity of the Earth on 2022 September 01 at 01^{h} UT ($\lambda_{\odot} = 158\overset{\circ}{.}289$), but not close enough for detectable extra activity. For 2025 there is no exceptional activity expected.

The Aurigid radiant reaches a useful elevation only after $\approx 01^{\mathrm{h}}$ local time – this year with no moonlight interference.

6 October to December

The maxima of the **Orionids (008 ORI)** and **Leonids (013 LEO)** are free of moonlight; the major **Geminid (004 GEM)** maximum is only little affected and the **Ursids (015 URS)** can be observed in dark skies.

The two **Taurid** branches reach their highest rates around November 05 (Southern Taurids, 002 STA) and November 12 (Northern Taurids, 017 NTA), respectively, between Full Moon and last quarter Moon. The **ANT** activity resumes only around December 10, as the Northern Taurids fade away. The radiant centre tracks from Taurus across southern Gemini during later December. The typical ZHR level is about 2. Here we want to draw your attention to the possibility of enhanced rates of brighter Taurids: 2025 will be another "Taurid swarm" year. Larger meteoroids in the vicinity of the 7:2 orbital period resonance with Jupiter usually cause bright meteors and fireballs in such swarm years about a week around November 3. The previous "swarm" in 2022 was observed under poor circumstances (near Full Moon) mainly by video cameras. The flux density observed in the first decade of November in 2022 was about twice as high as in 2023.



Several minor showers are active in the last quarter of the year. The maximum of the **October Camelopardalids (281 OCT)** occurs on October 5 in moonlit skies. The **October Draconids (009 DRA)** reach their maximum on October 8 just after Full Moon. The very weak **δ-Aurigids (224 DAU**, maximum October 11) are also effectively invisible due to moonlight. Later, the **ε-Geminids (023 EGE**, maximum October 18) and the **Leonis Minorids (022 LMI)** occur in dark skies. This is also the case for the **α-Monocerotids (246 AMO)** – with no peculiar activity expected in 2025. The **November Orionids (250 NOO)** can be nicely observed.

In the past years, there were several activity signs from the **Andromedids (018 AND)** on 2021 November 28 and 2018 December 02. There is nothing predicted for the 2025 return, but observers might want to check for slow AND meteors. Recent analyses indicate that weak AND activity is observable annually. The radiant drifts significantly northwards in declination from end November to early December (Shiba, 2022). The very late part is listed as 446 DPC (December φ-Cassiopeids; activity observed in 2011):

$\lambda_\odot$	Date	α	δ	Shower
230°	Nov 12	22°	+32°	AND
240°	Nov 22	24°	+41°	AND
250°	Dec 01	23°	+50°	AND
255°	Dec 06	20°	+55°	DPC

Conditions are poor for the early December southern showers. The **Phoenicids (254 PHO**; maximum December 1) and the complex **Puppid-Velids (301 PUP**; maximum December 7), both are more active with a waxing Moon. Later, the **Monocerotids (019 MON**, maximum December 9) and the **σ-Hydrids (016 HYD**, maximum December 9) have a gibbous waning Moon in the morning sky.

There was a hint at possible **meteors from comet 46P/Wirtanen** in the 2023 Calendar. Vaubaillion's calculations reveal that there might be another chance to observe activity from a 7-revolutions trail of this shower, tentatively called **λ-Sculptorids** on 2025 December 12, roughly between 10^h and 22^hUT. The radiant of these extremely slow meteors ($V_\infty = 10$km/s) is at $\alpha = 8°, \delta = -38°$.

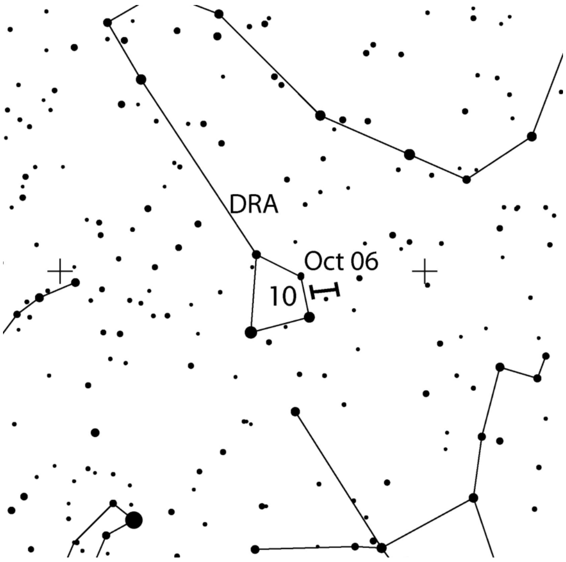
The maximum of the weak and long-lasting **Comae Berenicids (020 COM)** around December 16 occurs close to the New Moon. There are several showers with similar radiants and also orbital elements to the COM and previously listed **December Leonis Minorids (032 DLM)**. An activity period of over 70 degrees appears too long for a meteor shower having such a high inclination orbit. Due to the complex situation (especially for the visual observer – see Rendtel, 2023) we suggest to summarise all meteors from the (extended) COM/DLM-region under "COM" for the entire activity period.

At the end of the year, the first **Quadrantids (010 QUA)** can be seen.

Draconids (009 DRA)

Active: October 6–10; Maximum: October 8, 19^h UT ($\lambda_\odot = 195.4°$); ZHR = 5 (?);
Radiant: $\alpha = 263°$, $\delta = +56°$; Radiant drift: negligible; $V_\infty = 21$ km/s; $r = 2.6$.

Although the observing conditions for the Draconids (also called October Draconids) are very poor – the gibbous Moon less than 2 days after full is in Aries – we give some details here. The radiant is north-circumpolar for latitudes north of about 45°N. Draconid meteors are exceptionally slow-moving.



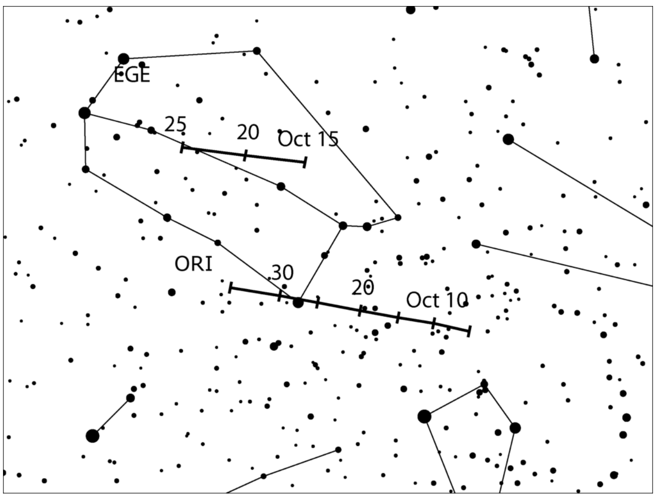
The shower produced spectacular meteor storms in 1933 and 1946, and enhanced but lower rates in several other years (ZHRs ≈ 20–500+). Recent outbursts happened in 2011 (ZHR ≈ 300; predicted) and in 2012 (unexpected). The 2018 return yielded a ZHR of about 150 persisting for about 4 hours.

For the 2025 return we expect an encounter with the 2012 dust trail on October 8. Calculated peak times are:
$\lambda_\odot = 195.^\circ 269$ (15^h52^mUT; Jenniskens, 2006).
$\lambda_\odot = 195.^\circ 238$ (15^h07^mUT; Maslov, 2024).
$\lambda_\odot = 195.^\circ 257$ (15^h34^mUT; Sato, 2024).
Estimated prospects for the activity level: *Jenniskens 2006 (Table 6d)* gives ZHR ≤ 50. *Maslov* calculated that the number density is about 8 times higher than of a 1-revolution Leonid trail. However, the Earth crosses this unperturbed trail at the end dominated by small meteoroids (high ejection velocities required). So there may be a very short outburst with a ZHR of 100–150 from a radiant which is essentially identical to the position given above. *Sato* also emphasizes that the trail is dominated by small meteoroids and therefore may be limited to radar observations. The time of the closest approach favours observing sites roughly east of 40°E in the northern hemisphere.

The parent comet 21P/Giacobini-Zinner will reach its next perihelion on 2025 March 25. Therefore we advise observers to pay attention to a period about 24 hours around the given time as there may be meteors from older dust trails which produce no significant rates alone but perhaps add to the general rate.

ε-Geminids (023 EGE)

Active: October 14–27; Maximum: October 18 ($\lambda_\odot = 205°$); ZHR = 3;
Radiant: $\alpha = 102°$, $\delta = +27°$; Radiant drift: see Table 6;
$V_\infty = 70$ km/s; $r = 3.0$.



A weak minor shower with characteristics and activity nearly coincident with the Orionids, so great care must be taken to separate meteors of the two sources. The waxing moon is not an issue. Northern observers have a radiant elevation advantage and can observe from about local midnight onwards. There is some uncertainty about the shower's parameters. Both visual and video data indicate that the maximum may be later than listed; at least it is not well defined with ZHRs of about 3 for more than one day.

Orionids (008 ORI)

Active: October 2–November 7; Maximum: October 21 ($\lambda_{\odot} = 208°$); ZHR = 20+;
Radiant: $\alpha = 95°$, $\delta = +16°$; Radiant drift: see Table 6;
$V_{\infty} = 66$ km/s; $r = 2.5$.

The shower's radiant (see chart above in the EGE section) is at a useful elevation from local midnight or so in either hemisphere, somewhat before in the north. New Moon on October 21 is perfect for all optical observations.

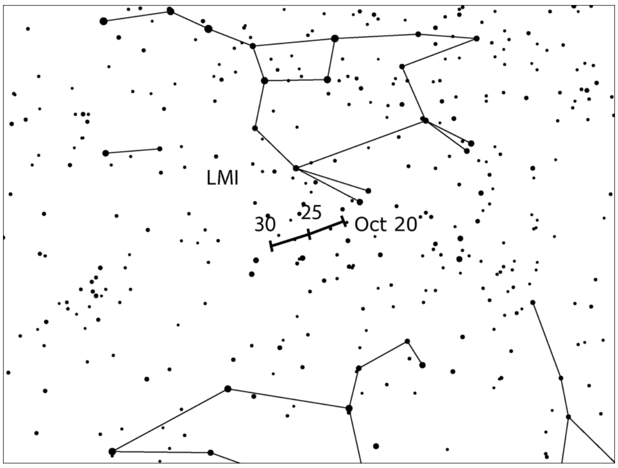
Each return from 2006 to 2009 produced unexpectedly strong ZHRs of around 40–70 on two or three consecutive dates. An earlier IMO analysis of the shower, using data from 1984–2001, found both the peak ZHR and r parameters varied somewhat from year to year, with the highest mean ZHR ranging from $\approx$ 14–31 during the examined interval.

A suspected 12-year periodicity in stronger returns claimed earlier in the 20th century is not detectable from visual data but seems to occur in CMOR radar data since 2002 (Egal et al., 2020). Higher activity due to the suspected cycle was mentioned for the period between 2020–2022 in the previous calendars. The average maximum Orionid ZHRs in the years 2012–2020 was in the range of 20–30. The available data do not allow us to draw a conclusion about the periodicity question.

The Orionids may also provide several lesser maxima and sometimes the activity may be similar for several consecutive nights centred on the main peak. In 1993 and 1998, a submaximum about as strong as the normal peak was detected on October 17/18 from Europe.

Leonis Minorids (022 LMI)

Active: October 19–27; Maximum: October 24 ($\lambda_{\odot} = 211°$); ZHR = 2;
Radiant: $\alpha = 162°$, $\delta = +37°$; Radiant drift: see Table 6;
$V_{\infty} = 62$ km/s; $r = 3.0$.



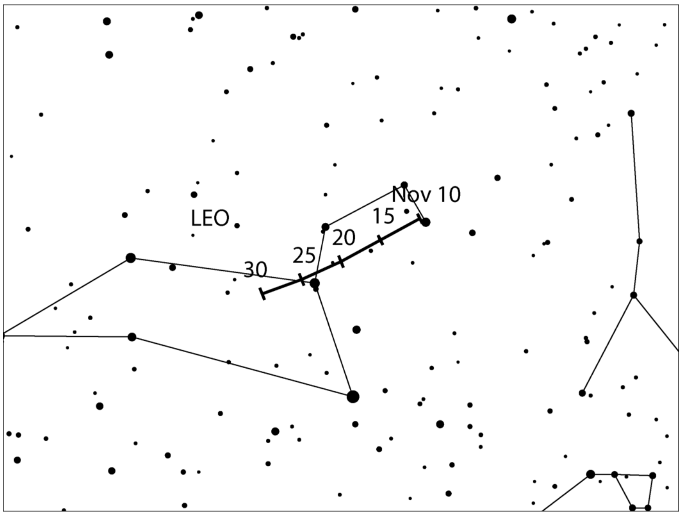
This shower was first found in photographic orbital data and comet C/1739 K1 (Zanotti) is suggested as parent object. The activity was established from video data over the past years, and a reasonable sample of visual data has been collected as well.

Visual data from 2017–2021 yield a maximum ZHR of the order of 5 around October 24 or perhaps slightly earlier. The radiant area can be seen solely from the northern hemisphere, where it rises around midnight. The given maximum date is close to the New Moon providing good conditions to observe the entire activity period.

Leonids (013 LEO)

Active: November 6–30; Maximum: November 17, 18^h UT (nodal crossing at $\lambda_\odot = 235.^\circ27$), but see text; ZHR $\approx$ 15
Radiant: $\alpha = 152^\circ$, $\delta = +22^\circ$; Radiant drift: see Table 6;
$V_\infty = 71$ km/s; $r = 2.5$.

The parent comet of this shower, 55P/Tempel-Tuttle, has passed its aphelion; the next perihelion is due on 2031 May 20. The meteoroids we observe now are ahead of the comet. The knowledge of the dust ejection mechanisms and trail evolution allowed us to predict and verify variable activity in numerous years until recently.



The ("regular") nodal Leonid maximum at $\lambda_\odot = 235.^\circ27$ should occur on 2025 November 17 shortly before 18^h UT. Maslov (2007) gives 2025 November 17, 10^h UT (i.e. $\lambda_\odot = 234.^\circ95$) with an expected ZHR of about 10–15.

Additionally, *Maslov* calculated extra activity from the 1699 dust trail to occur on November 17 close to 19^h and 22^h30^m UT. The activity level is difficult to estimate. The particles come close to the Earth but have been ejected from the comet at relatively high negative (backwards) ejection velocities.

Smaller meteoroids are expected to be blown away by solar radiation pressure in such a trail. This suggests only a rather small increase of the ZHR but the meteor brightnesses should be higher than the average level.

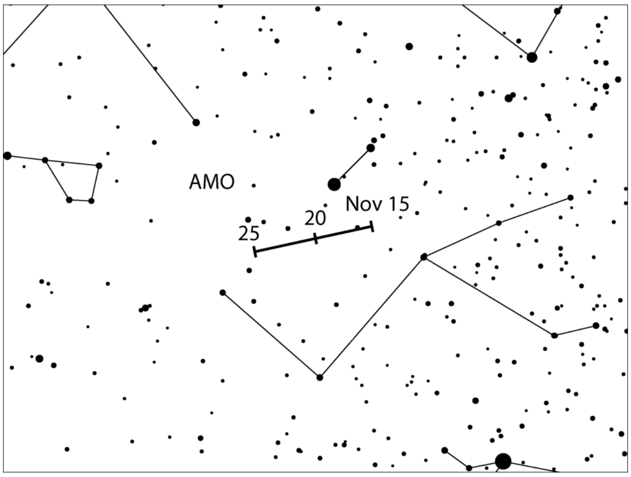
Calculations by *Sato* confirm the Earth's approach to two segments of the 1699 trail at 19^h18^m and 22^h40^m UT. Sato expects that the second peak may have a detectable activity. There is litte experience with dust returning prior to the parent comet.

Another quite old trail from 1167 is mentioned by Vaubaillon. This split trail comes close to the Earth already on November 9, around 22^hUT. It is worth monitoring the activity although there is no idea about the rate. This also holds for the 1633 trail. Here the minimum distance is even larger, but observers should be alert to monitor the activity on November 15, around 03^hUT.

Here are the 2025 encounter times in chronological order:
Nov 09, 22^hUT (1167 dust trail)
Nov 15, 03^hUT (1633 dust trail)
Nov 17, 10^hUT (nodal maximum at $\lambda_\odot = 234.^\circ95$)
Nov 17, 18^hUT (nodal maximum at $\lambda_\odot = 235.^\circ27$)
Nov 17, 19^hUT (1699 dust trail at $\lambda_\odot = 235.^\circ341$)
Nov 17, 22^h40^mUT (1699 dust trail at $\lambda_\odot = 235.^\circ482$)

α-Monocerotids (246 AMO)

Active: November 15–25; Maximum: November 21, 23^h30^m UT ($\lambda_\odot = 239.^\circ32$);
ZHR = variable, usually ≤ 5, see text;
Radiant: $\alpha = 117^\circ$, $\delta = +01^\circ$; Radiant drift: see Table 6; $V_\infty = 65$ km/s; $r = 2.4$.

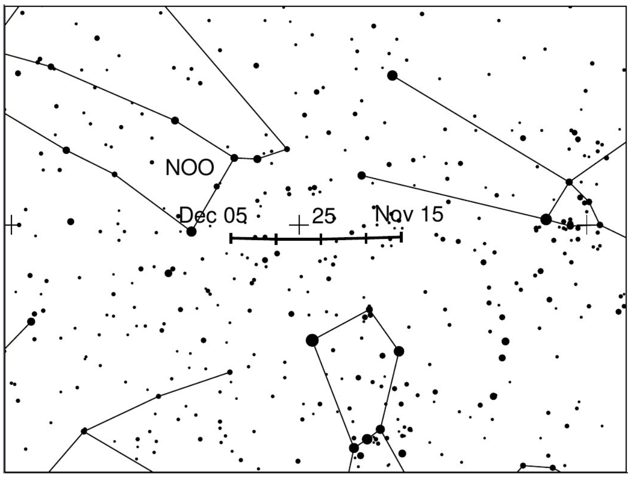


The most recent α-Monocerotid outbursts have been observed in 1995 (ZHR ≈ 420) and 2019 (ZHR ≈ 120). In both cases, the peak lasted for just five minutes, the entire outbursts 30 minutes. The next strong AMO outburst is unlikely before 2043. Despite all this, observers are advised to monitor the AMO annually to complete our knowledge about this stream. New Moon on November 20 provides us with favourable observing conditions. The radiant reaches suitable elevation above the horizon from about local midnight.

November Orionids (250 NOO)

Active: November 14–December 6; Maximum: November 28 ($\lambda_\odot = 246^\circ$); ZHR = 3;
Radiant: $\alpha = 91^\circ$, $\delta = +16^\circ$; Radiant drift: see Table 6;
$V_\infty = 41$ km/s; $r = 3.0$

Detailed analysis of video data revealed that there are two consecutive, very similar showers whose activity intervals partially overlap each other: the November Orionids (250 NOO), followed by the Monocerotids (019 MON). In the last days of November the NOO shower is the strongest source in the sky.

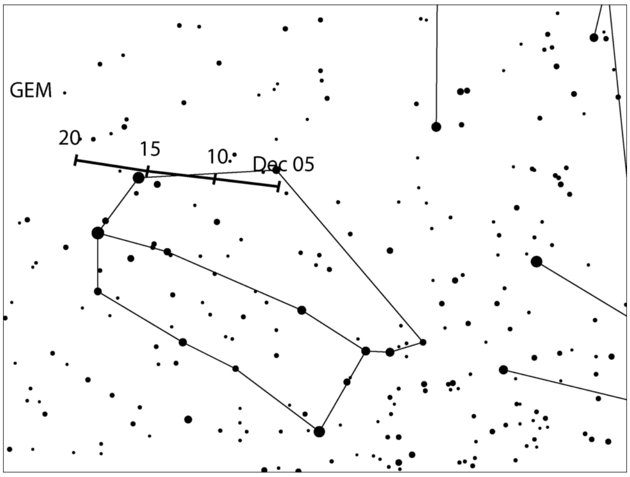


The radiant is located in northern Orion, about 8° north of α Ori. This location is close to the Northern Taurids, but far enough east to distinguish meteors from the two sources. Additionally, the faster velocity of the November Orionids should help distinguish these meteors from the slower Taurids.

The radiant culminates near 2^h local time, but is above the horizon for most of the night. First quarter Moon on November 28 leaves the better suited morning hours for optical observations under dark skies.

Geminids (004 GEM)

Active: December 4–17; Maximum: December 14, 08^h UT ($\lambda_\odot = 262^\circ\!.2$); ZHR = 150;
Radiant: $\alpha = 112^\circ$, $\delta = +33^\circ$; Radiant drift: see Table 6;
$V_\infty = 35$ km/s; $r = 2.6$.



The best and most reliable of the major annual showers presently observable reaches its broad moon-free maximum on December 14 centred at 08^h UT. The shower is known for bright meteors and fireballs.

Well north of the equator, the radiant rises about sunset, reaching a usable elevation already from the local evening hours onwards. Observing locations at middle and northern latitudes are best suited. In the southern hemisphere, the radiant appears only around local midnight or so. It culminates near 02^h local time.

The peak has shown little variability in its timing in recent years, with the more reliably-reported maxima during the past two decades (WB, p. 66) all having occurred within $\lambda_\odot = 261^\circ\!.5$ to $262^\circ\!.4$, that is 2025 December 13, 15^h to December 14, 12^h UT.

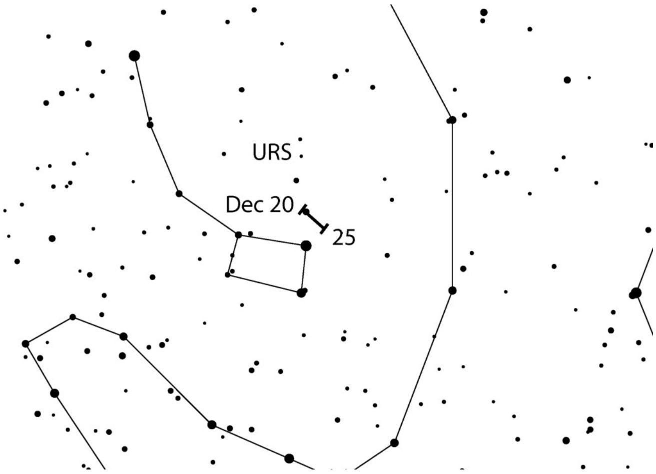
The Geminids are known for their broad maximum, producing ZHR of 100 and more over roughly 10–12 hours. During most returns a mass sorting was observed: there is a larger portion of bright Geminids towards the end of the immediate maximum period. Since the Geminids are on a short-period orbit, relatively rapid changes may happen. So all observations of each return may help to follow and understand the evolution of this unique stream. Around the maximum observers should report their rate and magnitude data for short intervals (no longer than 15 minutes).

Ursids (015 URS)

Active: December 17–26; Maximum: December 22, 10^h UT ($\lambda_\odot = 270^\circ\!.7$) and see text;
ZHR = 10 (occasionally variable up to 50);
Radiant: $\alpha = 217^\circ$, $\delta = +76^\circ$; Radiant drift: see Table 6;
$V_\infty = 33$ km/s; $r = 2.8$.

This poorly-observed northern hemisphere shower has produced at least two major outbursts (in 1945 and 1986). Further events could have been missed due to weather conditions. The maximum is rather narrow and seems to fluctuate from year to year. Several lesser rate enhancements have been reported from 2006 to 2008, in 2011, 2014, 2015, 2017 and 2020 (visual and video data). The parent comet 8P/Tuttle has an orbital period of 13.6 years. It passed its perihelion last on 2021 August 27. In the past, many Ursid peaks occurred when the comet was close to its *aphelion,* indicating that predictions are difficult.

For the 2025 return, Jenniskens (2006, Table 5b) lists a filament encounter on December 22, $05^h 39^m$ UT ($\lambda_\odot = 270.^\circ 26$). The ZHR of 25 listed in Jenniskens is similar to the values indicated by him for the 2021—24 returns, although no such enhancements were reported by observers in 2021–23. Vaubaillon finds the densest section of the stream in the vicinity of the Earth on December 22 around 10^h UT at the average position with no pronounced peak.



The Ursid radiant is circumpolar from most northern sites, so fails to rise for most southern ones. The radiant is highest in the sky towards the morning and is essentially moon-free in 2025.

7 Radiant sizes and meteor plotting for visual observers

by Rainer Arlt

If you are not observing during a major-shower maximum, it is essential to associate meteors with their radiants correctly, since the total number of meteors will be small for each source. Meteor plotting allows shower association by more objective criteria after your observation than the simple imaginary back-prolongation of paths under the sky. With meteors plotted on gnomonic maps, you can trace them back to their radiants by extending their straight line paths. If a radiant lies on another chart, you should find common stars on an adjacent chart to extend this back-prolongation correctly.

How large a radiant should be assumed for shower association? The real physical radiant size is very small, but visual plotting errors cause many true shower meteors to miss this real radiant area. Thus we have to assume a larger effective radiant to allow for these errors. Unfortunately, as we enlarge the radiant, so more and more sporadic meteors will appear to line up accidentally with this region. Hence we have to apply an optimum radiant diameter to compensate for the plotting errors loss, but which will not then be swamped by sporadic meteor pollution. Table 1 gives this optimum diameter as a function of the distance of the meteor from the radiant.

Table 1. Optimum radiant diameters to be assumed for shower association of minor-shower meteors as a function of the radiant distance D of the meteor.

D	optimum diameter
15°	14°
30°	17°
50°	20°
70°	23°

Note that this radiant diameter criterion applies to all shower radiants *except* those of the Southern and Northern Taurids, and the Antihelion Source. The optimum $\alpha \times \delta$ size to be assumed for the STA and NTA is instead $20° \times 10°$, while that for the ANT is still larger, at $30° \times 15°$.

Path-direction is not the only criterion for shower association. The angular velocity of the meteor should match the expected speed of the given shower meteors according to their geocentric velocities. Angular velocity estimates should be made in degrees per second (°/s). To do this, make the meteors you see move for one second in your imagination at the speed you saw them. The path length of this imaginary meteor is the angular velocity in °/s. Note that typical speeds are in the range 3°/s to 25°/s. Typical errors for such estimates are given in Table 2.

Table 2. Error limits for the angular velocity.

angular velocity [°/s]	5	10	15	20	30
permitted error [°/s]	3	5	6	7	8

If you find a meteor in your plots which passes the radiant within the diameter given by Table 1, check its angular velocity. Table 3 gives the angular speeds for a few geocentric velocities, which can then be looked up in Table 5 for each shower.

Table 3. Angular velocities as a function of the radiant distance of the meteor (D) and the elevation of the meteor above the horizon (h) for three different geocentric velocities (V_∞). All velocities are in °/s.

	$V_\infty = 25$ km/s					$V_\infty = 40$ km/s					$V_\infty = 60$ km/s				
$h\backslash D$	10°	20°	40°	60°	90°	10°	20°	40°	60°	90°	10°	20°	40°	60°	90°
10°	0.4	0.9	1.6	2.2	2.5	0.7	1.4	2.6	3.5	4.0	0.9	1.8	3.7	4.6	5.3
20°	0.9	1.7	3.2	4.3	4.9	1.4	2.7	5.0	6.8	7.9	1.8	3.5	6.7	9.0	10
40°	1.6	3.2	5.9	8.0	9.3	2.6	5.0	9.5	13	15	3.7	6.7	13	17	20
60°	2.2	4.3	8.0	11	13	3.5	6.8	13	17	20	4.6	9.0	17	23	26
90°	2.5	4.9	9.3	13	14	4.0	7.9	15	20	23	5.3	10	20	26	30

8 References and Abbreviations

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Abbreviations:

$\boldsymbol{\alpha}$, $\boldsymbol{\delta}$: Coordinates for a shower's radiant position, usually at maximum. $\boldsymbol{\alpha}$ is right ascension, δ is declination. Radiants drift across the sky each day due to the Earth's own orbital motion around the Sun, and this must be allowed for using the details in Table 6 for nights away from the listed shower maxima.

$\boldsymbol{r}$: The population index, a term computed from each shower's meteor magnitude distribution. $r = 2.0 - 2.5$ implies a larger fraction of brighter meteors than average, while r above 3.0 is richer in fainter meteors than average.

$\boldsymbol{\lambda_\odot}$: Solar longitude, a precise measure of the Earth's position on its orbit which is not dependent on the vagaries of the calendar. All $\lambda_\odot$ are given for the equinox 2000.0.

$\boldsymbol{V_\infty}$: Pre-atmospheric or apparent meteoric velocity, given in km/s. Velocities range from about 11 km/s (very slow) to 72 km/s (very fast). 40 km/s is roughly medium speed.

ZHR: Zenithal Hourly Rate, a calculated maximum number of meteors an ideal observer would see in perfectly clear skies (reference limiting magnitude +6.5) with the shower radiant overhead. This figure is given in terms of meteors per hour.

9 Tables: lunar and shower data

Table 4. Lunar phases for 2025.

New Moon	First Quarter	Full Moon	Last Quarter
	January 6	January 13	January 21
January 29	February 5	February 12	February 20
February 28	March 6	March 14	March 22
March 29	April 5	April 13	April 21
April 27	May 4	May 12	May 20
May 27	June 3	June 11	June 18
June 25	July 2	July 10	July 18
July 24	August 1	August 9	August 16
August 23	August 31	September 7	September 14
September 21	September 30	October 7	October 13
October 21	October 29	November 5	November 12
November 20	November 28	December 5	December 11
December 20	December 27		

Table 5. Working List of Visual Meteor Showers. Details in this Table were correct according to the best information available in June 2024, with maximum dates accurate only for 2025. The parenthesized maximum date for the Puppids-Velids indicates a reference date for the radiant only, not necessarily a true maximum. The given ZHR is based on recent oberved returns. Possibly periodic showers are noted as 'Var' = variable. For more information check the updates published e.g. in the IMO Journal *WGN*.

Shower	Activity	Maximum Date	Maximum $\lambda_\odot$	Radiant α	Radiant δ	V_∞ km/s	r	ZHR
Antihelion Source (ANT)	Dec 10–Sep 20 –	March–April, late May, late June		see Table 6		30	3.0	4
Quadrantids (010 QUA)	Dec 28–Jan 12	Jan 03	283°.15	230°	+49°	41	2.1	80
γ-Ursae Minorids (404 GUM)	Jan 10–Jan 22	Jan 18	298°	228°	+67°	31	3.0	3
α-Centaurids (102 ACE)	Jan 31–Feb 20	Feb 08	319°.4	211°	−58°	58	2.0	6
April Lyrids (006 LYR)	Apr 14–Apr 30	Apr 22	32°.32	271°	+34°	49	2.1	18
π-Puppids (137 PPU)	Apr 15–Apr 28	Apr 23	33°.5	110°	−45°	18	2.0	Var
η-Aquariids (031 ETA)	Apr 19–May 28	May 06	45°.5	338°	−01°	66	2.4	50
η-Lyrids (145 ELY)	May 03–May 14	May 10	50°.0	291°	+43°	43	3.0	3
Dayt. Arietids (171 ARI)	May 14–Jun 24	Jun 07	76°.7	43°	+24°	38	2.8	30
June Bootids (170 JBO)	Jun 22–Jul 02	Jun 27	95°.7	224°	+48°	18	2.2	Var
July Pegasids (175 JPE)	Jul 04–Jul 14	Jul 10	108°.0	347°	+11°	63	3.0	3
July γ-Draconids (184 GDR)	Jul 25–Jul 31	Jul 28	125°.13	280°	+51°	27	3.0	5
S. δ-Aquariids (005 SDA)	Jul 12–Aug 23	Jul 31	128°	340°	−16°	41	2.5	25
α-Capricornids (001 CAP)	Jul 03–Aug 15	Jul 31	128°	307°	−10°	23	2.5	5
η-Eridanids (191 ERI)	Jul 31–Aug 19	Aug 07	135°	41°	−11°	64	3.0	3
Perseids (007 PER)	Jul 17–Aug 24	Aug 12	140°.0	48°	+58°	59	2.2	100
κ-Cygnids (012 KCG)	Aug 03–Aug 28	Aug 16	144°	286°	+59°	23	3.0	3
Aurigids (206 AUR)	Aug 28–Sep 05	Sep 01	158°.6	91°	+39°	66	2.5	6
Sep. ε-Perseids (208 SPE)	Sep 05–Sep 21	Sep 09	166°.7	48°	+40°	64	3.0	8
Dayt. Sextantids (221 DSX)	Sep 09–Oct 09	Sep 27	184°.3	156°	−02°	32	2.5	5
Oct. Camelopard. (281 OCT)	Oct 05–Oct 06	Oct 05	192°.58	164°	+79°	47	2.5	5
Draconids (009 DRA)	Oct 06–Oct 10	Oct 08	195°.4	262°	+54°	20	2.6	5
δ-Aurigids (224 DAU)	Oct 10–Oct 18	Oct 11	198°	84°	+44°	64	3.0	2
ε-Geminids (023 EGE)	Oct 14–Oct 27	Oct 18	205°	102°	+27°	70	3.0	3
Orionids (008 ORI)	Oct 02–Nov 07	Oct 21	208°	95°	+16°	66	2.5	20
Leonis Minorids (022 LMI)	Oct 19–Oct 27	Oct 24	211°	162°	+37°	62	3.0	2
S. Taurids (002 STA)	Sep 20–Nov 20	Nov 05	223°	52°	+15°	27	2.3	7
N. Taurids (017 NTA)	Oct 20–Dec 10	Nov 12	230°	58°	+22°	29	2.3	5
Leonids (013 LEO)	Nov 06–Nov 30	Nov 17	235°.27	152°	+22°	71	2.5	10
α-Monocerotids (246 AMO)	Nov 15–Nov 25	Nov 21	239°.32	117°	+01°	65	2.4	Var
Nov. Orionids (250 NOO)	Nov 13–Dec 06	Nov 28	246°	91°	+16°	44	3.0	3
Phoenicids (254 PHO)	Dec 01–Dec 05	Dec 01	249°.5	08°	−27°	15	2.8	Var
Puppid-Velids (301 PUP)	Dec 01–Dec 15	(Dec 07)	(255°)	123°	−45°	44	2.9	10
Monocerotids (019 MON)	Dec 05–Dec 20	Dec 09	257°	100°	+08°	41	3.0	3
σ-Hydrids (016 HYD)	Dec 03–Dec 20	Dec 09	257°	125°	+02°	58	3.0	7
Geminids (004 GEM)	Dec 04–Dec 20	Dec 14	262°.2	112°	+33°	35	2.6	150
Comae Berenicids (020 COM)	Dec 05–Feb 04	Dec 16	264°	158°	+30°	64	3.0	3
Ursids (015 URS)	Dec 17–Dec 26	Dec 22	270°.7	217°	+76°	33	2.8	10

Table 6 (next page). **Radiant positions during the year in α and δ.**

Date							
Date	**ANT**	**QUA**	**COM**				
Jan 0	112° +21°	228° +50°	172° +25°				
Jan 5	117° +20°	231° +49°	176° +23°		**GUM**		
Jan 10	122° +19°	234° +48°	180° +21°		220° +71°		
Jan 15	127° +17°		185° +19°		224° +69°		
Jan 20	132° +16°		189° +17°		228° +67°		
Jan 25	138° +15°		193° +15°	**ACE**	232° +65°		
Jan 30	143° +13°		198° +12°	199° −56°			
Feb 5	149° +11°		203° +10°	206° −58°			
Feb 10	154° +9°			213° −59°			
Feb 15	159° +7°			219° −61°			
Feb 20	164° +5°			224° −62°			
Feb 28	172° +2°						
Mar 5	177° 0°						
Mar 10	182° −2°						
Mar 15	187° −4°						
Mar 20	192° −6°						
Mar 25	197° −7°						
Mar 30	202° −9°						
Apr 5	208° −11°						
Apr 10	213° −13°	**LYR**	**PPU**				
Apr 15	218° −15°	263° +34°	106° −44°	**ETA**			
Apr 20	222° −16°	269° +34°	109° −45°	323° −7°			
Apr 25	227° −18°	274° +34°	111° −45°	328° −5°			
Apr 30	232° −19°	279° +34°		332° −3°	**ELY**		
May 05	237° −20°			337° −1°	286° +43°		
May 10	242° −21°			341° +1°	291° +43°		
May 15	247° −22°			345° +3°	296° +44°		
May 20	252° −22°			349° +5°			
May 25	256° −23°			353° +7°			
May 30	262° −23°	**ARI**					
Jun 5	267° −23°	42° +24°					
Jun 10	272° −23°	47° +24°					
Jun 15	276° −23°						
Jun 20	281° −23°	**JBO**					
Jun 25	286° −22°	223° +48°					
Jun 30	291° −21°	225° +47°	**CAP**			**JPE**	
Jul 5	296° −20°		285° −16°	**SDA**		343° +10°	
Jul 10	300° −19°	**PER**	289° −15°	325° −19°		347° +11°	
Jul 15	305° −18°	6° +50°	294° −14°	329° −19°		351° +12°	
Jul 20	310° −17°	11° +52°	299° −12°	333° −18°		356° +13°	**GDR**
Jul 25	315° −15°	22° +53°	303° −11°	337° −17°			277° +51°
Jul 30	319° −14°	29° +54°	307° −10°	340° −16°	**ERI**	**KCG**	282° +51°
Aug 5	325° −12°	37° +56°	313° −8°	345° −14°	39° −14°	281° +45°	
Aug 10	330° −10°	45° +57°	318° −6°	349° −13°	44° −12°	284° +49°	
Aug 15	335° −8°	51° +58°		352° −12°	48° −10°	287° +53°	
Aug 20	340° −7°	57° +58°	**AUR**	356° −11°	52° −9°	289° +56°	
Aug 25	344° −5°	63° +58°	85° +40°			291° +59°	
Aug 30	349° −3°		90° +39°	**SPE**		293° +62°	
Sep 5	355° −1°		96° +39°	43° +40°			
Sep 10	0° +1°		102° +39°	48° +40°			
Sep 15	5° +2°	**STA**		53° +40°			
Sep 20		18° +5°	**DSX**	59° +41°			
Sep 25		21° +6°	147° −2°				
Sep 30		25° +7°	152° −2°	**ORI**		**OCT**	
Oct 5		28° +8°		85° +14°	**DAU**	164° +79°	**DRA**
Oct 10		32° +9°	**EGE**	88° +15°	82° +45°		262° +54°
Oct 15	**NTA**	36° +11°	99° +27°	91° +15°	87° +43°	**LMI**	
Oct 20	38° +18°	40° +12°	104° +27°	94° +16°	92° +41°	158° +39°	
Oct 25	43° +19°	43° +13°	109° +27°	98° +16°		163° +37°	
Oct 30	47° +20°	47° +14°		101° +16°		168° +35°	
Nov 5	52° +21°	52° +15°		105° +17°	**LEO**		
Nov 10	56° +22°	56° +15°	**NOO**		147° +24°		**AMO**
Nov 15	61° +23°	60° +16°	81° +16°		150° +23°		112° +2°
Nov 20	65° +24°	64° +16°	84° +16°		153° +21°		116° +1°
Nov 25	70° +24°		88° +16°	**PHO**	156° +20°	**PUP**	120° 0°
Nov 30	74° +24°	**GEM**	92° +16°	7° −27°	159° +19°	130° −44°	91° +8°
Dec 5	85° +23°	103° +33°	149° +37°	10° −27°	122° +3°	132° −44°	98° +9°
Dec 10	90° +23°	108° +33°	153° +35°	13° −28°	126° +2°	135° −44°	101° +8°
Dec 15	96° +23°	113° +33°	157° +33°		130° +1°	138° −44°	105° +7°
Dec 20	101° +23°	118° +32°	161° +31°		134° 0°	217° +76°	108° +7°
Dec 25	106° +22°		166° +28°		**HYD**	217° +74°	**MON**
Dec 30	111° +21°	226° +50°	170° +26°			**URS**	
	ANT	**QUA**	**COM**				

Table 6a. Dates and radiant positions (in α and δ) for the sources of possible or additional activity described in the text.

Shower	Activity Date	$\lambda_\odot$ 2000.0	Radiant α	Radiant δ	Details see page
κ-Cancrids (793 KCA)	Jan 09	289°.315	138°	+9°	3
April α-Capricornids (752 AAC)	Apr 07	17°.637	304°	−13°	5
July γ-Draconids (184 GDR)	Jul 28	125°.132	280°	+51°	10
Perseids (007 PER)	Aug 12	139°.736	46°	+58°	10
	Aug 12	139°.38	48°	+58°	10
ε-Eridanids (209 EER)	Sep 12	169°.983	52°	−15°	11
October Draconids (009 DRA)	Oct 08	195°.257	263°	+56°	15
Leonids (013 LEO)	Nov 09	227°.40			17
	Nov 15	232°.64			17
	Nov 17	235°.341	154°	+22°	17
	Nov 17	235°.482	154°	+22°	17
Ursids (015 URS)	Dec 22	270°.26	218°	+76°	19

Table 7. Working List of Daytime Radio Meteor Showers. According to the naming rules, all shower names have the prefix ‘Daytime’ which is omitted in our Table. We only included showers which are listed as “established” in the IAU MDC database and are strong enough for forward scatter observations ($W_{\mathrm{Cmax}} > 500$ in Brown et al., 2010). For recent activity data compiled here see Ogawa (2022; 2023). See also the Table of northern summer daytime showers on page 6. In most cases, the start and end of the activity period are uncertain and the given values are tentative. For the 144 APS we refer to the values provided by Ogawa (2022) and described on page 6.

Shower	Activity	Max Date	$\lambda_\odot$ 2000.0	Radiant α	Radiant δ
April Piscids (144 APS)	Apr 20 – Apr 25	Apr 22	32°.6	5°	+5°
N. ω-Cetids (152 NOC)	May 01 – May 17	May 06	45°.5	9°	+17°
S. ω-Cetids (153 OCE)	May 01 – May 17	May 06	45°.5	20°	−6°
S. May Arietids (156 SMA)	May 01 – May 17	May 07	47°.1	28°	+8°
Arietids (171 ARI)	May 25 – Jun 20	Jun 07	77°.0	43°	+24°
ζ-Perseids (172 ZPE)	May 30 – Jun 20	Jun 09	78°.6	67°	+23°
β-Taurids (173 BTA)	Jun 15 – Jul 05	Jun 25	94°	82°	+20°
κ-Leonids (212 KLE)	Sep 20 – Sep 30	Sep 25	183°	162°	+15°
Sextantids (221 DSX)	Sep 15 – Oct 05	Oct 01	188°	156°	2°

10 Useful addresses

On the IMO's website http://www.imo.net you find online forms to submit visual reports and reports of fireball sightings. It is also possible to submit reports of visual observation sessions for other observers. You can also access all reports in the database, both of visual data and fireball reports.
Visual reports: http://www.imo.net → Observations → Add a visual observation session
Fireball reports: http://www.imo.net → Observations → Report a fireball

For more information on observing techniques, to see the latest results from well-observed major meteor showers and unusual shower outbursts, or when you wish to submit your results, please use the IMO's website, www.imo.net as your first stop. The web page also allows to access the data for own analyses. Questions can be mailed to the appropriate address (note the word "meteor" **must** feature in your message's "subject" line to pass the anti-spam filters):

For especially bright meteors: fireball@imo.net
For meteor still imaging: photo@imo.net
For forward-scatter radio observing: radio@imo.net
For meteor moving-imaging: video@imo.net
For visual observing: visual@imo.net

The IMO has Commssions for various fields, about which you may enquire with the respective director:

Photographic Commission: William Ward, 84 Woodwynd, Kilwinning, KA13 7DJ, Scotland, U.K.; e-mail: bill_meteor@yahoo.com

Radio Commission: Christian Steyaert, Kruisven 66, 2400 Mol, Belgium; e-mail: steyaert@vvs.be

Video Commission Sirko Molau, Abenstalstraße 13b, 84072 Seysdorf, Germany; e-mail: sirko@molau.de

Visual Commission: Jürgen Rendtel, Eschenweg 16, 14476 Potsdam, Germany; e-mail: jrendtel@web.de

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Those unable to access the Internet may write for information to Robert Lunsford, IMO Secretary-General, 14884 Quail Valley Way, El Cajon, CA 92021-2227, USA. When using ordinary mail, please try to enclose return postage, either in the form of stamps (same country *only*) or as an International Reply Coupon (I.R.C. – available from main postal outlets). Thank you!

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