International Meteor Organization

2027 Meteor Shower Calendar

edited by Jürgen Rendtel [1]

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1 Introduction

Welcome to the thirty-seventh 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 scientific 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 2027, we find the Quadrantid peak shortly before New Moon, a waxing Moon for the Perseid peak and Full Moon for the Geminids. Favourable conditions allow us to observe the main η-Aquariid activity and the maximum periods of the Southern δ-Aquariids, the Aurigids, the Ursids. The September ε-Perseids have a waxing gibbous Moon, but observations of them are of interest also this year. The October Draconids have a similar problem with the waxing gibbous Moon, while the Orionids and Leonids are troubled by the waning gibbous to last quarter Moon instead. The April Lyrid maximum shortly after Full Moon has the worst conditions.

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 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 113 "established showers" (2026 July 3).

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[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 as well as publications which are listed in the *References* in section 8. Masahiro Koseki helped with important data concerning the SLY and COM activities. I particularly thank Mikhail Maslov, Mikiya Sato and Jérémie Vaubaillon for new information and comments in respect of events in 2027. Hiroshi Ogawa and Chris Steyaert evaluated information concerning daytime showers detectable by radio forward scatter observations. Last but not least thanks to Alastair McBeath, Tim Cooper, Robert Lunsford, Mikhail Maslov, Ina Rendtel, Chris Steyaert, Cis Verbeeck and Thomas Weiland for carefully checking the contents.

Interesting potential 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 improves 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, the τ-Herculids or the α-Monocerotids.

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[2]), 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 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

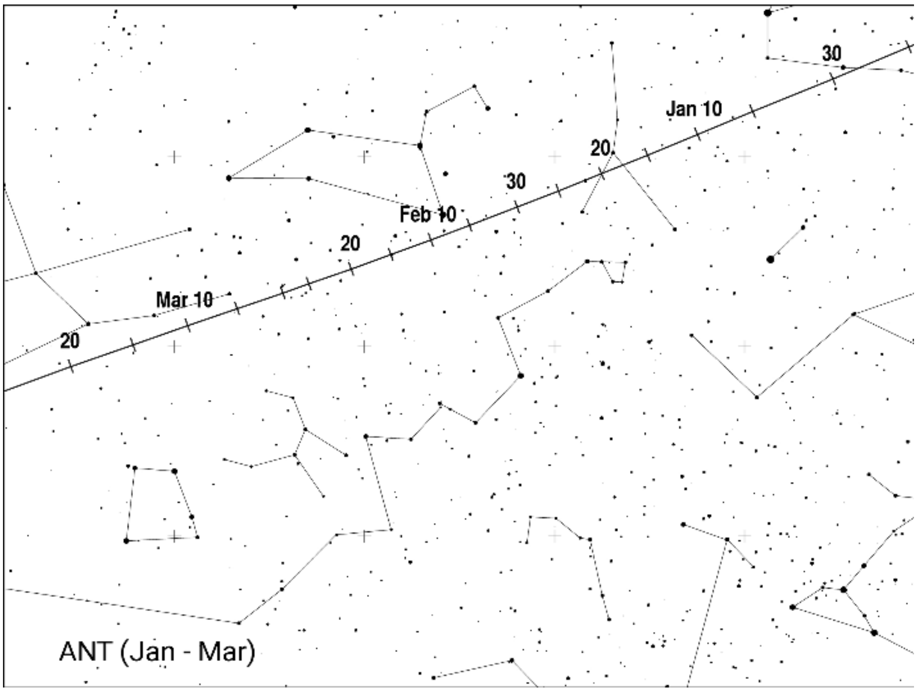
The first of the large annual showers, the **Quadrantids (010 QUA)**, peak on January 4 shortly after 03^{h} UT. Some meteors of the **Comae Berenicids (020 COM)** can be observed until end January. The weak activity of the **γ-Ursae Minorids (404 GUM)** around January 18 is badly affected by a waxing gibbous moon this year.

The **ι-Centaurids (919 ICN)** – not in our working list – appears to be active annually, albeit with fairly low rates. In 2024 Tim Cooper from South Africa reported enhanced activity between January 21–26. The shower of fast meteors ($V_\infty = 64$km/s) with a radiant at $\alpha = 199°, \delta = -39°$ could benefit from regular observations, although the bright Moon this time will cause problems for visual observers. The **α-Centaurids (102 ACE)** reach their maximum around February 8 or perhaps later – see the ACE description on page 5.

Meteoroids released from comet **252P/LINEAR** are expected to come close to the Earth in 2027. The first possible activity enhancement caused by trails from 1963 and 1968 is calculated for March 31, 14–16^{h} UT (Maslov, 2026b). The density should be very low. The radiant is at $\alpha = 76°, \delta = -12°$ (about 4° southwest of β Orionis). The second expected encounter is more interesting. It is caused by the 1984 dust trail (Maslov, 2026b; Vaubaillon, 2026). The predicted time is April 2, $02^{\mathrm{h}}55^{\mathrm{m}}$UT (Maslov) or April 01, $19^{\mathrm{h}}39^{\mathrm{m}}$UT (Vaubaillon). Considering the high spatial number density and the minimum distance of the trail, Maslov estimates a ZHR of about 10–20. Vaubaillon comments that the sub-trail the Earth will intersect looks quite perturbed and kind of chaotic so that an encounter may happen in a span of 1–2 days (i.e. March 31 to April 2). This means that all periods with the radiant above the horizon should be used to check for activity.

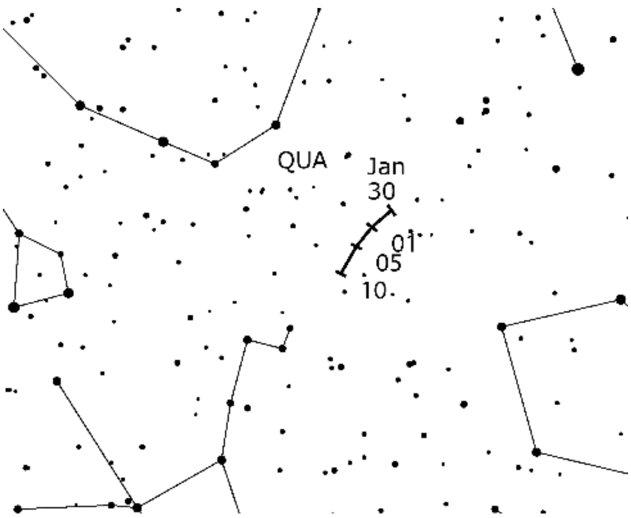
In early January, the **ANT's** radiant centre is in south-east Gemini, and crosses Cancer during much of the month, before passing into southern Leo for most of February. It then shifts through southern Virgo during March – see chart on page 4. The ZHR may be expected to be of the order of 2 to 3 during most of the time. Video meteor flux density data as well as some visual data indicate a slight increase in March around $\lambda_\odot \approx 355°$ (corresponding to 2027 March 15/16).

[2] There is an entry in the IAU Meteor Shower DataBase: 1079 ANT = August ν-Taurids. In our Calendar we use ANT for the Antihelion meteors only; the 1079 ANT do not cause visually detectable activity.



Quadrantids (010 QUA)

Active: December 28–January 12; Maximum: January 4, $03^{h}25^{m}$ UT ($\lambda_{\odot} = 283\overset{\circ}{.}15$), ZHR = 80 (can vary $\approx 60 - 200$); Radiant: $\alpha = 230°$, $\delta = +49°$; Radiant drift: see Table 6; $V_{\infty} = 41$ km/s; $r = 2.1$ at maximum, 2.5 elsewhere.

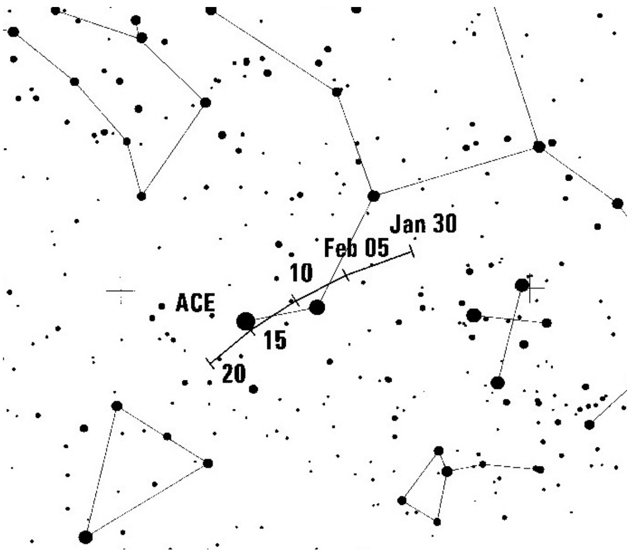


Observations yielded variable peak rates for the recent returns: in 2022, 2023 and 2025 the highest visual ZHR was in the lower range of the values given above; in 2024 and 2026 (with moonlight) close to the previously known average. Gaps in the temporal coverage lead to an uncertainty of about $0\overset{\circ}{.}1$ (i.e. about 2.5 hours) for the peak timing. Checking different data sets, we may conclude that the peak is to be expected near the $283\overset{\circ}{.}15$ reference position. Video meteor data of 2020–2022 indicated a peak time slightly ahead of the reference time. 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 further observational data may help checking the current model parameters. Vaubaillon emphasizes that the stream is slightly shifted towards the Sun in 2027 which might cause enhanced activity. Conditions are perfect concerning the moonlight.

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 ($\lambda_\odot = 319\overset{\circ}{.}4$);
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. Activity was reported on 2015 February 14, 03^h50^m–04^h10^m UT (photographic airborne observation; Legg, 2015) 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 α-Centaurids.

New Moon on February 6 provides good conditions for visual observations in 2027.

Further data is needed to obtain information about the stream which is not clearly detectable recently by visual and video observations. 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° away of the Sun's position.

In 2027, the minor planet **2009 CR$_2$** comes relatively close to the Earth on April 20, 21^h08^mUT. The stream is somewhat elongated and it may well be that the spatial density does not allow the detection of activity (Vaubaillon, 2026). The radiant of the very slow meteors (V_∞=15.4 km/s) is at $\alpha = 198°$, $\delta = 62°$, which is about 7° north of the bright star ζ Ursae Majoris. Checking for possible activity signs is of general interest for this case. Unfortunately, the expected time coincides with the full moon.

Comet **P/2009 WX$_{51}$ (Catalina)** was a very faint and low activity object in a near-Earth orbit with a minimum orbit intersection distance (MOID) to the Earth's orbit of 0.0094 AU in 2009. The comet was not recovered in its subsequent perihelia (2015, 2020 and 2026 (yet)). Despite the weak activity, the comet is of peculiar interest because of its orbit with a MOID < 0.02 AU in the entire period from 1988 to 2042. The following computations of Maslov (2026a) are based on the single observed return in 2009. They show three encounters of the Earth with dust ejected in 1955 and 1966 on 2027 April 21. These are at:
15:40 UT (1955 trail, 0.00030 AU),
20:29 UT (1966 trail, 0.00009 AU), and
21:46 UT (1966 trail, 0.00058 AU).

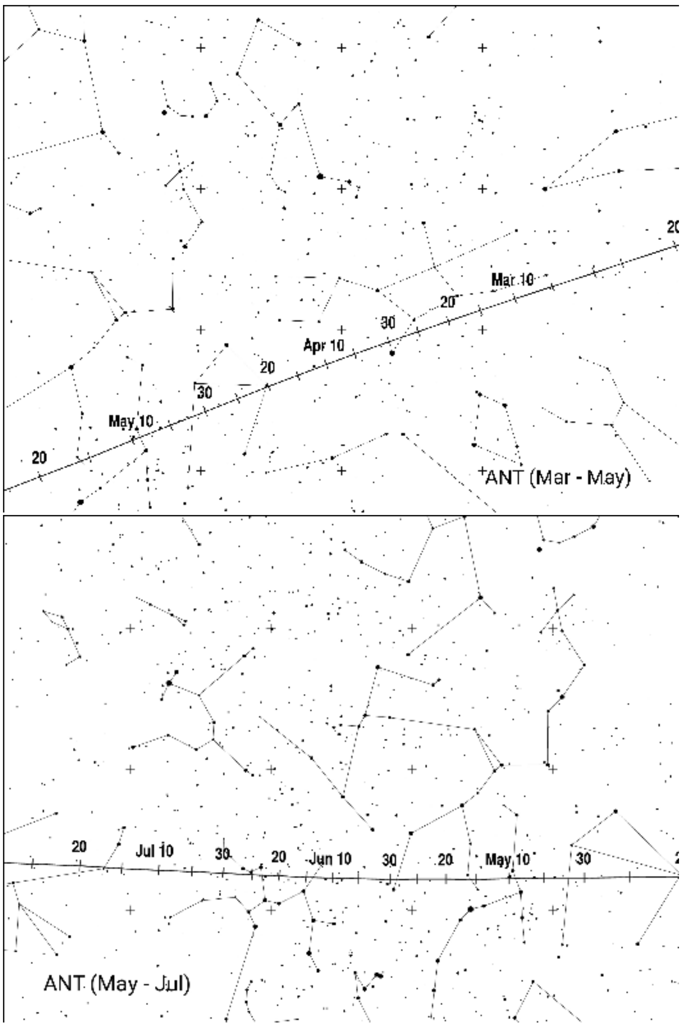
For an active comet, the parameters (low ejection velocity of 20 – 27 m/s) would indicate a meteor storm, but here we may expect a few tens per hour only. The radiant at $\alpha = 38°$, $\delta = +35°$ in Triangulum is only about 26° east of the Sun – so it is basically a daytime shower. There is a small region in Asia (1st peak) and western Europe (2nd peak) with twilight conditions *and* low radiant altitude. Chances for radio and radar observations are much better.

The maximum of the **April Lyrids (006 LYR)** at 32°.32 is expected on April 23, 01^h40^mUT – just three days after the Full Moon. During the peak night, the moon is located in Libra/Scorpius and causes bright skies just when the radiant is gaining height. The disturbance is less for the southern **π-Puppid (137 PPU)** maximum on April 24 as their radiant is only above the horizon in the evening hours.

Conditions are favourable for the observation of the maximum period of the **η-Aquariids (031 ETA)** and are still fine for the minor **η-Lyrids (145 ELY)** with activity around May 11.

On June 11 at 21^h55^mUT ($\lambda_\odot = 80°.378$) Jenniskens (2006, Table 3) mentions a possible display of the **γ-Delphinids (065 GDE)** from a radiant at $\alpha = 312°$, $\delta = +17°$. The IAU MDC data base has the radiant of the fast meteors ($V_\infty = 65$ km/s) at $\alpha = 338°$, $\delta = +20°$ and has the shower as an annual one between $\lambda_\odot = 75° - 82°$, i.e. June 6 – 13. The assumed dust used for the modelling was already close to the Earth on 2013 June 11, but no activity was reported. In 2027, the minimum distance of 0.00010 AU is half of the 2013 value.

Recent video data indicate that the maximum of the weak **June Boötids (170 JBO)** may be expected on June 22 – three days after Full Moon, from a radiant at $\alpha = 221°$, $\delta = +48°$ which is different from the position found during the events in 1998 and 2004.



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 page 6).

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 on page 27). Here we give the data of the IAU MDC and recent findings (Ogawa, 2023) and some brief comments.

Shower	Maximum $\lambda_\odot$ (Date) IAU MDC	Ogawa
April Piscids (144 APS)	$26\overset{\circ}{.}0$ (Apr 16)	$32\overset{\circ}{.}6$ (Apr 23)
N. ω-Cetids (152 NOC)	$47\overset{\circ}{.}8$ (May 09)	$52\overset{\circ}{.}0$ (May 13)
S. ω-Cetids (153 OCE)	$48\overset{\circ}{.}6$ (May 09)	$48\overset{\circ}{.}8$ (May 10)
S. May Arietids (156 SMA)	$52\overset{\circ}{.}7$ (May 14)	
Arietids (171 ARI)	$76\overset{\circ}{.}7$ (Jun 08)	$77\overset{\circ}{.}8$ (Jun 09)
ζ-Perseids (172 ZPE)	$78\overset{\circ}{.}6$ (Jun 10)	$83\overset{\circ}{.}5$ (Jun 15)
β-Taurids (173 BTA)	$96\overset{\circ}{.}7$ (Jun 29)	

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 $\lambda_\odot = 30\overset{\circ}{.}5 - 34\overset{\circ}{.}5$ and a maximum at $\lambda_\odot = 32\overset{\circ}{.}6$. 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. In May, there are three showers, 152 NOC, 153 OCE and 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 $\lambda_\odot = 50°$ (2026 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.

η-Aquariids (031 ETA)

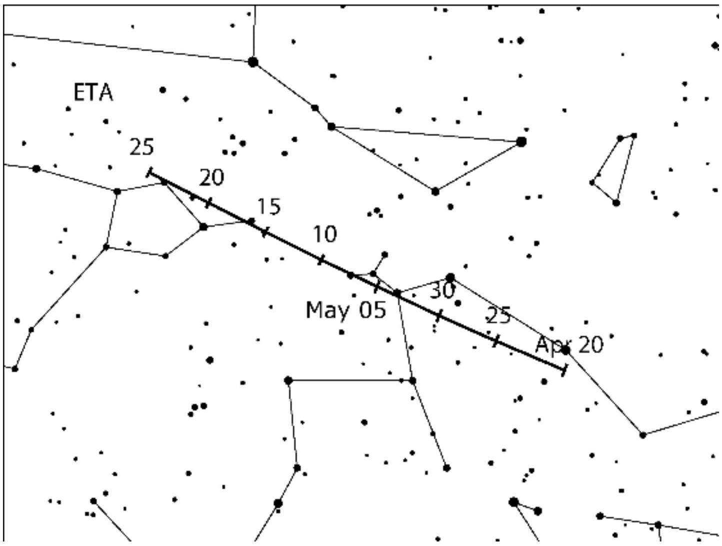
Active: April 19–May 28; Maximum: May 6, 09^h UT ($\lambda_\odot = 45\overset{\circ}{.}5$); ZHR = 50 (var., 40–80+);
Radiant: $\alpha = 338°$, $\delta = -1°$; Radiant drift: see Table 6;
$V_\infty = 66$ km/s; $r = 2.4$.

Meteors from this source are only visible in the hours shortly before dawn, as the radiant culminates near 8^h local time. Useful results may be obtained from places south of about 40° N latitude. In many previous years, a substantial amount of optical ETA data has been collected worldwide. This year, the maximum period and its subsequent activity decline can be well observed without moonlight interference.

IMO analyses of visual data collected since 1984 have shown that ZHRs are generally above 30 between May 3 and 10. A periodicity in the peak ZHR has not been found in data over the past decades. However, the derived ZHR since 2008 (when resonant meteoroids caused high rates) has continuously decreased. The last six years yielded a ZHR level of roughly 40. So it is important to continue the series using visual data as well as other methods.

Recent peak ZHRs were:

2008	≈ 85
2009	≈ 70
2011	65
2017	75
2018	60
2019	50
2020	50
2021	45
2022	42
2023	40
2024	45
2025	45
2026	35 (preliminary)

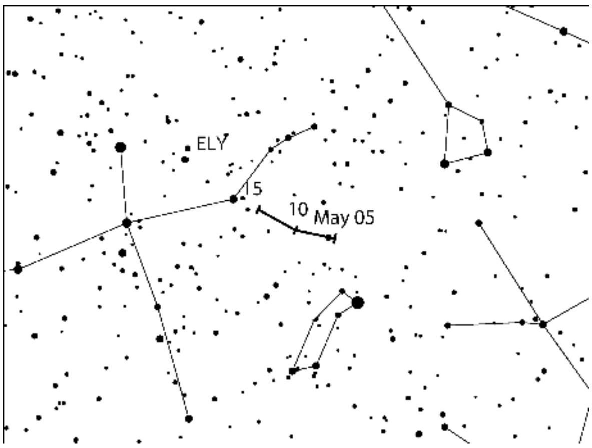


η-Lyrids (145 ELY)

Active: May 5–14; Maximum: May 11 ($\lambda_\odot = 50°$); ZHR = 3;
Radiant: $\alpha = 291°$, $\delta = +43°$; Radiant drift: see Table 6; $V_\infty = 43$ km/s; $r = 3.0$.

This weak shower is associated with Comet C/1983 H1 IRAS-Araki-Alcock. Most of the observational data on the shower has come from video results which define the radiant and the maximum position reliably.

Visual data obtained between 2007 and 2021 yield an average peak ZHR of 3–4 between $\lambda_\odot = 49°$ and 50°. Care needs to be taken to separate any potential η-Lyrids from the sporadics. The radiant area is usefully on-view all night from the northern hemisphere (primarily). The maximum occurs with a slim waxing crescent Moon, so visual observing circumstances this year are near-perfect.



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 on page 10). ZHRs for most of the month should be ≈ 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 16).

Some weak **July Pegasid (175 JPE)** activity is possible around July 10. 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 CAP and SDA rates are expected end-July with no moonlight interference.

On 2016 July 28 at 00^h07^m UT ($\lambda_\odot = 125.^\circ132$) the **July γ-Draconids (184 GDR)** produced an outburst detected by radar and video observations. The same position is reached in 2027 on July 28 near 21^h UT. Although no extra activity was observed in 2017 – 2025, it may be worth checking because SonotaCo Network observations indicate that the GDR is an annual shower with a sharp but variable maximum from year to year (Koseki, 2020). The radiant of the slow meteors ($V_\infty = 27$ km/s) is at $\alpha = 280°$, $\delta = +51°$.

The **η-Eridanids (191 ERI)** are expected to reach a weak maximum around August 8. The next maximum is that of the **Perseids (007 PER)** on August 13, followed by the **κ-Cygnid (012 KCG)** activity. Full Moon on August 17 causes poor observation conditions for the central KCG activity.

The **Aurigid (206 AUR)** maximum occurs on September 1 with a new Moon. Conditions are still good to record the maximum of the **September ε-Perseids (208 SPE)** on September 9/10.

Activity from the region Auriga-Lynx should be recorded as **September Lyncids (081 SLY)** between mid September and mid October.

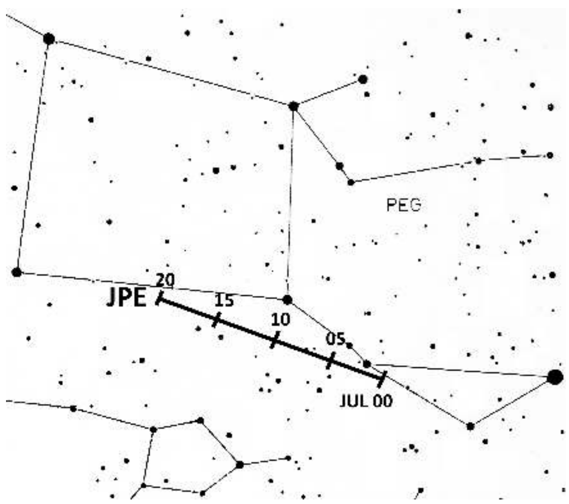
For **radio observers**, the daytime activity decreases markedly after June (see Table 7 on page 27), leaving just the **κ-Leonid** peak (212 KLE) at $\lambda_\odot = 183°$ (September 26) and the **Daytime Sextantids (221 DSX**; maximum around $\lambda_\odot = 188°$, October 1). A very few meteors of this latter shower may also be detected by optical methods.

July Pegasids (175 JPE)

Active: July 1–20, Maximum: July 10, $\lambda_\odot = 108°$; ZHR = 3;
Radiant: $\alpha = 347°$, $\delta = 11°$; Radiant drift: see Table 6; $V_\infty = 63$ km/s; $r = 3.0$.

Meteors of this essentially northern shower have been observed repeatedly, and the shower was described in the 1995 edition of the IMO's Meteor Observer Handbook. Recent video meteor data (VID as well as Koseki, 2021) suggest an activity period which may extend well over the end given here, perhaps to end-July or into early August.

The rates remain low all the time, but occasionally bright shower meteors have been recorded visually, photographically and by video cameras. All studies quoted in the IAU MDC database agree on the maximum date.

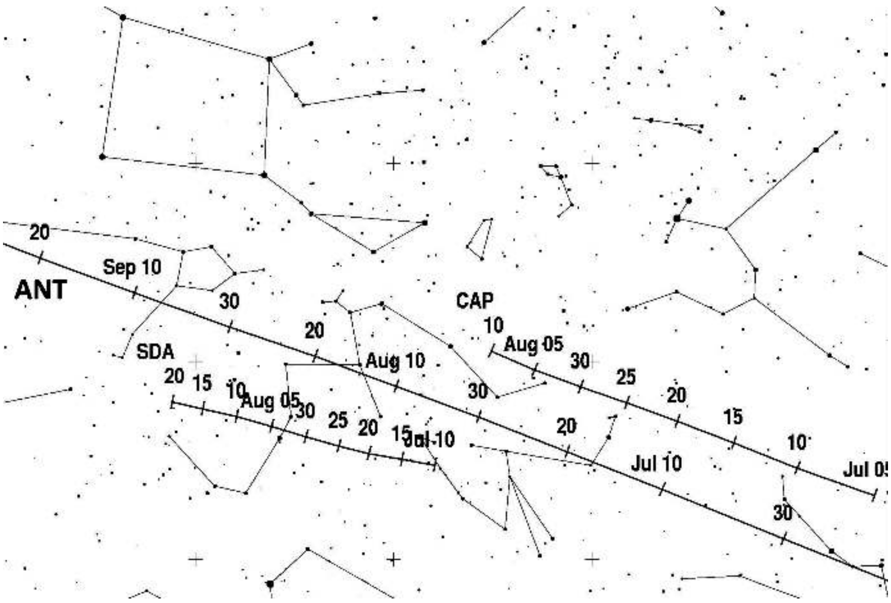


The radiant is above the horizon all night for observers at mid-northern latitudes, with conditions best after local midnight. Meteors of this shower appear fast. The Moon reaches its first quarter on July 10 so that the post-midnight period is not affected.

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 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. Some recent results suggest the maximum date of July 30/31.



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).

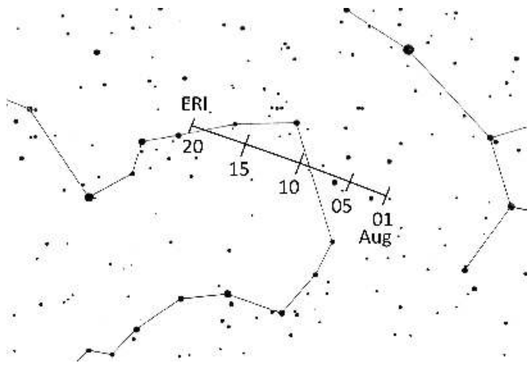
The shower is one of the most active annual sources in the southern hemisphere. The ZHR of the SDA is around 25 for about two days; the ZHR exceeds 20 between $\lambda_\odot = 124°$ and 129°. During the maximum there are numerous bright SDA meteors visible, causing $r \approx 2.5$ around the maximum 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. The activity level and variations of the shower need to be monitored.

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.

η-Eridanids (191 ERI)

Active: July 31–August 19; Maximum: August 08, $\lambda_\odot = 135°$; 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).

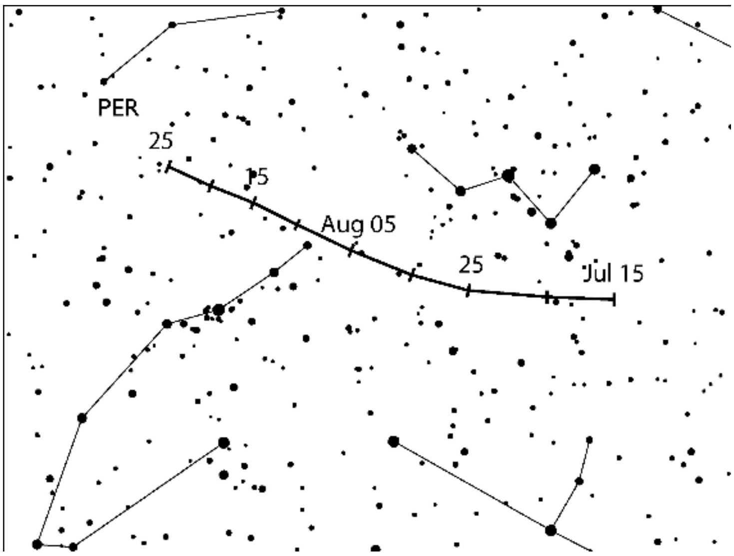


It seems that the activity continues long after its maximum which requires observational confirmation. The radiant of these fast meteors in the northwestern part of Eridanus is best observed after midnight, preferably from southern locations. The period around the tentative maximum can be used for observations with no moonlight interference.

Perseids (007 PER)

Active: July 17–August 24; Maximum: August 13, 08^h to 10^h UT (node at $\lambda_\odot = 140\overset{\circ}{.}0 - 140\overset{\circ}{.}1$); ZHR = 110+ (details about timing and rates see text);
Radiant: $\alpha = 48°$, $\delta = +58°$; Radiant drift: see Table 6; $V_\infty = 59$ km/s; $r = 2.2$.

Previous IMO observations (see WB pp. 32–36) found the timing of the mean or 'traditional' broad maximum varied between $\lambda_\odot \approx 139\overset{\circ}{.}8$ to $140\overset{\circ}{.}3$, equivalent to 2027 August 13, 03^h – 16^h UT. The orbital period of the parent comet 109P/Swift-Tuttle is about 130 years. The Perseids produced strong activity from a primary maximum throughout the 1990s. Enhanced activity was last observed in 2016 due to passages through separated dust trails.



High activity about 0.7 to 1.5 days after the main peak has been reported during the returns in 2018, 2020 and 2021. Nothing similar was observed in 2022—2025.

In 2027 the Earth passes through the part of the Perseid meteoroid stream which was shifted closer to the Earth's orbit by gravitational perturbations of Jupiter. Maslov finds that the shift is about 0.006 AU which may raise the activity level by 10–20 percent (ZHR 110–120). The shift will further increase to the 2028 return, with a good chance of causing substantially higher rates then.

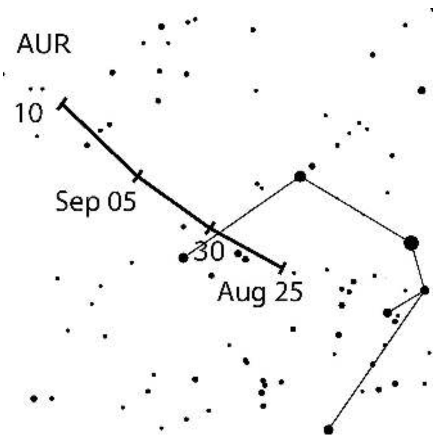
Maslov also notes that on 2027 August 13 at 02^h UT some rarified fragments of the 1479 trail could produce some addition to the background activity. Vaubaillon summarizes that the overall position of the last dozen trails is located 0.015 AU from the Earth and corresponds to 2027 August 13, 02^h16^m UT. This might be different from the usually observed shower because the entire stream includes very old trails (23 revolutions) not necessarily taken into account by the simulation.

Jenniskens' (2006) Table 5c lists two dust trail encounters for the 2027 return. The first on August 12, $19^{\mathrm{h}}18^{\mathrm{m}}$ UT is probably weak (ZHR $\approx$ 20); the second on August 12, $23^{\mathrm{h}}46^{\mathrm{m}}$ UT may be stronger (ZHR listed as 280). Further, Table 5d of Jenniskens (2006) gives an encounter with a filament of 109P on August 13, 07^{h} UT (ZHR 50).

Since the dust trail and filament meteoroid size distributions may be different from the background stream, it is advised to report rate and magnitude data for intervals of 30 minutes or less. The Moon lies midway between first quarter and full on August 12 and 13, so the moon-free period will be quite short for the expected maxima, depending on the observers' latitude. Mid-northern latitude sites are best for Perseid observing, as from here, the radiant has reached a reasonable elevation from 22^{h}–23^{h} local time onwards. Regrettably, the shower cannot be properly viewed from most of the southern hemisphere, or from latitudes north of about 60°N.

Aurigids (206 AUR)

Active: August 28–September 5; Maximum: September 01, $15^{\mathrm{h}}30^{\mathrm{m}}$ UT ($\lambda_\odot = 158.^\circ6$); ZHR = 6; 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 $\approx$ 30–50 recorded in 1935, 1986, 1994 and 2019. Slightly enhanced rates were also observed in 2021. Observations of the first *predicted* outburst in 2007 confirmed the calculated values widely and was characterised by many bright meteors. The peak ZHR of $\approx$ 130 lasted only for about 20 minutes. For the 2027 return we do not have indications of activity peculiarities. The Aurigid radiant reaches a useful elevation only after $\approx 01^{\mathrm{h}}$ local time – this year with no moonlight interference.

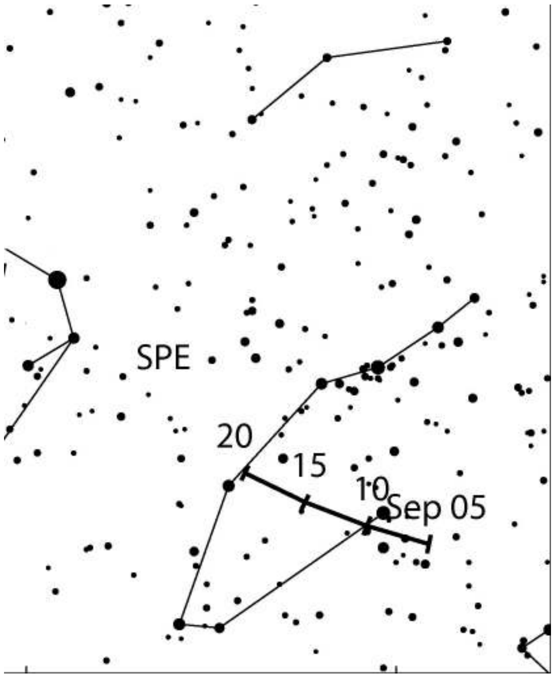
September ε-Perseids (208 SPE)

Active: September 5–21; Maximum: September 10, 00^{h} UT ($\lambda_\odot = 166.^\circ7$), ZHR = 8; Radiant: $\alpha = 48°$, $\delta = +40°$; Radiant drift: see Table 6; $V_\infty = 64$ km/s; $r = 2.5$.

This shower produced high rates on 2008 September 9, between roughly $\lambda_\odot = 166.^\circ894$–$166.^\circ921$, and another bright-meteor event with a very sharp peak at $\lambda_\odot = 167.^\circ188$ in 2013, but no subsequent unambiguous increases. Generally, the shower is rich in bright meteors.

For the 2026 return (still to come at the time of writing this text) Sato and Vaubaillon ran model calculations which indicate a weak chance of a rate enhancement (see the 2026 Meteor Shower Calendar, p. 13). The shower is of peculiar interest because a bright meteor cluster was observed and there are hints at higher rates in 2040. As the expectations are based on model assumptions, a continuous observational record of the activity may help to improve the parameters of the currently unknown parent object.

The waxing gibbous Moon leaves the morning hours dark to record data of the maximum of this primarily northern-hemisphere shower. The radiant area is well on-view all night from about 22^{h}–23^{h} local time for mid-northern locations.

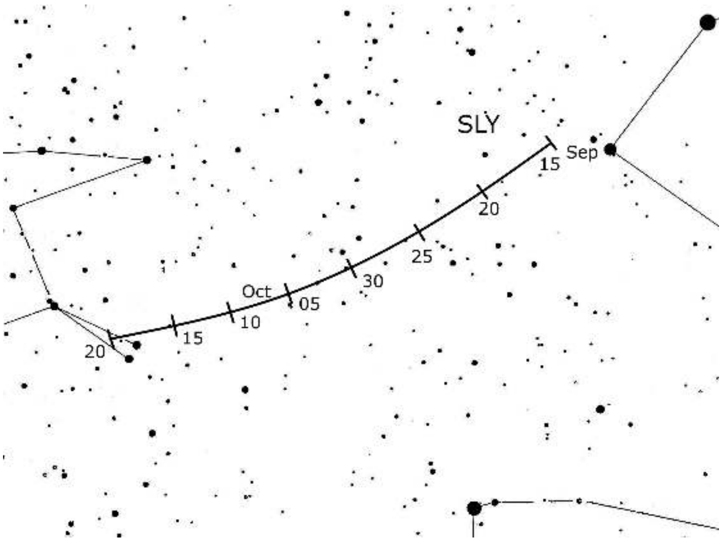


September Lyncids (081 SLY)

Active: September 10–October 8; Maximum: September 13 ($\lambda_{\odot} = 170°$); ZHR $\approx 3-4$;
Radiant: $\alpha = 113°$, $\delta = +56°$; Radiant drift: see Table 6; $V_{\infty} = 60$ km/s; $r = 3.0$.

There is easily detectable activity from the Lynx region after mid-September well into October. On 2023 September 25 close to $00^{\mathrm{h}}30^{\mathrm{m}}$ UT a short burst was observed. It was suggested that it could be associated with either the September Lyncids (081 SLY) or the β-Aurigids (210 BAU).

However, there is some confusion about the radiants and activity periods of some far northern showers not too far from the apex in this time. Perhaps there are activities of at least two sources grouped together. The first maximum occurs at $\lambda_{\odot} = 170°$ (September 13) and a weaker one at $\lambda_{\odot} = 192°$ (October 5). Further, the radiant centres are separated by about 15° in right ascension. The respective entries are also found in the entry for the 081 SLY in the IAU database.



Due to these difficulties, we suggest that visual observers summarise the activity from this complex under the label **September Lyncids (081 SLY)** applying the parameters given here and considering a radiant size of about 10°. The activity start is set to the end of the SPE period and may last until mid-October. We will need to evaluate the situation with more data, and perhaps adjust the parameters in future years.

6 October to December

The maximum of the **Orionids (008 ORI)** is due on October 22. Usually, the maximum is rather broad, about a day or so. At the maximum time, the bright waning Moon is located in Gemini and thus illuminates the sky when the radiant is above the horizon.

On October 23/24 the Earth may encounter a number of trails of comet **15P/Finlay** (Maslov, 2026a). Five of them may produce activity with ZHRs up to several dozen. The expected rates are very approximate only, and will be likely several times lower than they were in 2021 recorded as **Arids (1130 ARD)** from a slightly different radiant in Ara (see Jenniskens, 2023; p. 757). The calculated radiant in 2027 (Maslov, 2026a) of the very slow meteors ($V_\infty = 16$km/s) is close to $\alpha = 256°, \delta = -38°$, i.e. about 3° east of the 3rd magnitude star μ Scorpii. The details for the trails are:

Ejection year	$\lambda_\odot$	Encounter 2027 Oct	Possible ZHR
1960	209.068	23, 02:27 UT	several dozen
1947	209.405	23, 10:09 UT	5–10
1953	209.612	23, 15:34 UT	several dozen
1947	209.959	23, 23:56 UT	several dozen
1967	210.183	24, 05:20 UT	5–10

The best locations for observations of this evening shower are at various longitudes in the southern hemisphere. Possible activity of the 1130 ARD is also mentioned by Jenniskens (2023) for 2027 October 23, 22^h24^m UT (and later years).

About a month later, the **Leonid (013 LEO)** nodal maximum is expected on November 18 again with the gibbous moon in Gemini. Because of some possible peculiarities, we add a detailed shower description below (pages 17–18).

The two **Taurid** branches reach their highest rates around November 6 (Southern Taurids, 002 STA) and November 13 (Northern Taurids, 017 NTA) respectively, roughly between first quarter and full 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.

In the night of the **Geminid (004 GEM)** maximum on December 14 (centred around 20^h UT), the full moon is close to its northernmost position on the ecliptic and thus severely disturbs visual observations.

The **Ursids (015 URS)** reach their maximum on December 23, 4^hUT. There are no indications for enhanced rates or filament crossings.

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

Several minor showers are active in the last quarter of the year. The maximum of the **October Camelopardalids (281 OCT)** occurs on October 6, followed by the **October Draconids (009 DRA)** on October 9 near 07^h UT. The latter is badly affected by the waxing Moon, which is most problematic before local midnight, when the DRA radiant is higher in the sky. Later, the **ε-Geminids (023 EGE**, maximum October 19) and the **Leonis Minorids (022 LMI**, maximum on October 25) suffers waning moonlight in the post-midnight hours. Similarly, the **α-Monocerotids (246 AMO)** maximum occurs when the moon reaches its last quarter phase. There are no predictions of enhanced rates for the maximum on 2027 November 22. Conditions are good to observe the maximum of the **November Orionids (250 NOO)** on November 28.

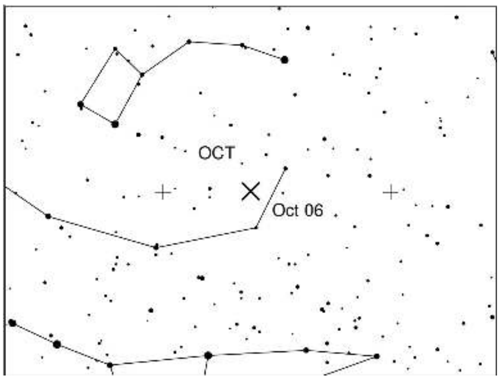
The weak periodic **Phoenicids (254 PHO)** reach their probable maximum position around December 2. The maximum of the complex **Puppid-Velids (301 PUP)** follows around December 7. The later maxima on December 9 of the **Monocerotids (019 MON)** and the **σ-Hydrids (016 HYD)** are affected by moonlight (first quarter on December 6).

The maximum of the weak and long-lasting **Comae Berenicids (020 COM)** is due around or shortly before December 23. There are several showers with similar radiants and also orbital elements to the COM. We suggest to summarise all meteors from the (extended) COM/DLM-region under "COM" for the entire activity period as described on page 20.

October Camelopardalids (281 OCT)

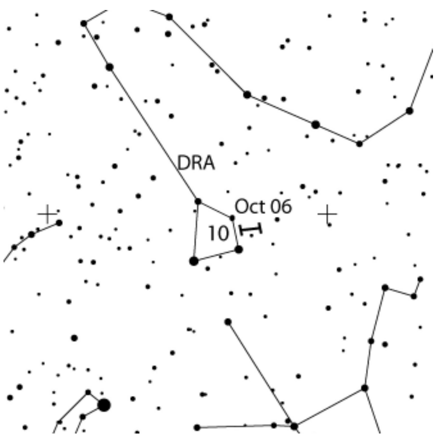
Active: October 5–6; Maximum: October 6, 11^{h}UT ($\lambda_{\odot} = 192^{\circ}\!.58$); ZHR = 5(?)
Radiant: $\alpha = 164°$, $\delta = 79°$; Radiant drift: negligible; $V_{\infty} = 47$ km/s; $r = 2.5$ (uncertain)

Activity from this north-circumpolar radiant was recorded annually since 2005, with a peak at $\lambda_{\odot} = 192^{\circ}\!.58$. By assuming a long-period parent object, and using the well-documented 2005 outburst as its reference point, Esko Lyytinen calculated that there might be detectable visual activity near $\lambda_{\odot} = 192^{\circ}\!.529$ in 2018 and 2019. In both years, some activity was indeed recorded, with a slightly higher rate on 2018 October 6, 00^{h}30^{m}UT$\pm$ 1.3^{h} ($192^{\circ}\!.45 \pm 0^{\circ}\!.05$; ZHR $\approx$ 5). Surprises are possible because the stream is either a long-period one with an atypically wide 1-revolution trail, or we are still to encounter the densest part of the trail. However, for 2027 no specific activity prediction has been issued.



Draconids (009 DRA)

Active: October 6–10; Maximum: October 9, 07^{h} UT ($\lambda_{\odot} = 195^{\circ}\!.4$); ZHR = 5 (?);
Radiant: $\alpha = 263°$, $\delta = +56°$; Radiant drift: negligible; $V_{\infty} = 20$ km/s; $r = 2.6$.



The waxing moon (first quarter on October 7) affects evening observations when the radiant is highest in the sky. 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 $\approx$ 20–500+). Recent outbursts happened in 2011 (ZHR $\approx$ 300; predicted) and in 2012 (rich in faint radar meteors; unexpected). The 2018 return yielded a ZHR of about 150 persisting for about 4 hours. For the 2027 return there are no predictions of enhanced rates.

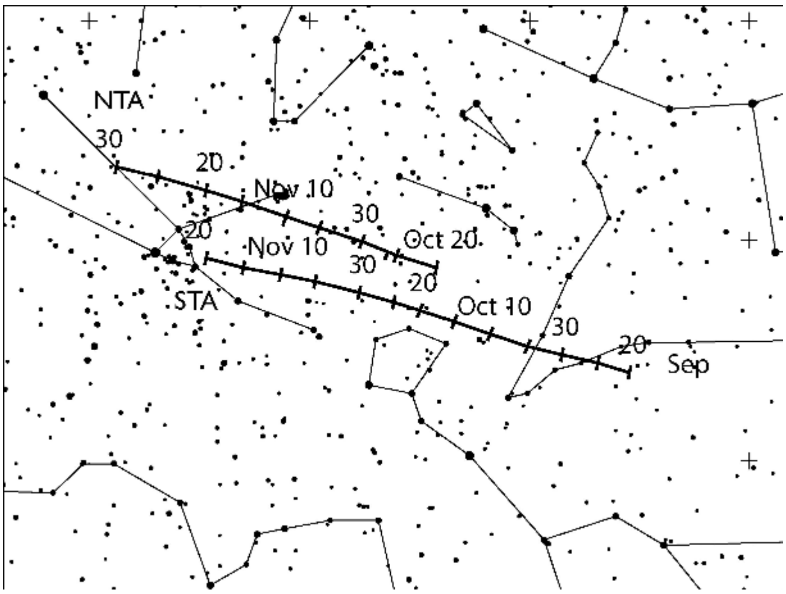
The parent comet 21P/Giacobini-Zinner passed its perihelion on 2025 March 25. Like in 2026, we advise observers to pay attention to a period about 24 hours around the given nodal crossing time – not to expect significant rates but to record the background activity.

Southern Taurids (002 STA)

Active: September 20–November 20; Maximum: November 06 ($\lambda_{\odot} = 223°$); ZHR = 5–10;
Radiant: $\alpha = 52°$, $\delta = +15°$; Radiant drift: see Table 6; $V_{\infty} = 27$ km/s; $r = 2.3$.

This stream, with its Northern counterpart, forms part of the complex associated with Comet 2P/Encke. Observers find a superposition of activities. For shower association, assume the radiant to be an oval area, about 20° in α by 10° in δ, centred on the radiant position for any given date. Its near-ecliptic radiant makes the shower a target for observers at all latitudes, albeit those in the northern hemisphere are somewhat better-placed, as here suitable radiant zenith distances persist for much of the night.

Overall Taurid rates dominate the activity from the Antihelion Source during the northern autumn, so much so that the ANT is considered inactive while either branch of the Taurids is present. The brightness and relative slowness of many Taurid meteors makes excellent subjects for newcomers to practice their visual plotting techniques. The main maximum (ZHR 5–10) of the STA is found around November 06, but there is an early maximum (ZHR near 5) around October 13 – a date which often was listed as the actual STA maximum. There are several components contributing to the STA activity.



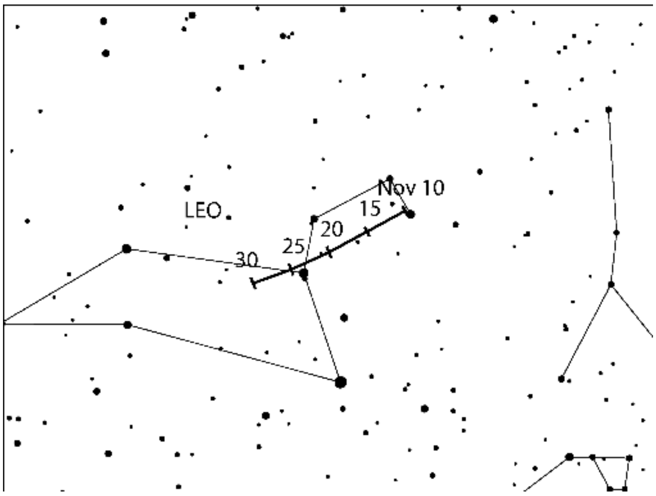
Northern Taurids (017 NTA)

Active: October 20–December 10; Maximum: November 13 ($\lambda_{\odot} = 230°$); ZHR = 5;
Radiant: $\alpha = 58°$, $\delta = +22°$; Radiant drift: see Table 6; $V_{\infty} = 29$ km/s; $r = 2.3$.

The large, oval radiant region to be used for shower association, the shower's excellent visibility overnight, and its dominance over the ANT during September to December are essentially the same as discussed in the STA section above. As previous results had suggested seemingly plateau-like maximum rates persisted for roughly ten days in early to mid November, the NTA peak may not be so sharp as its single maximum date might imply.

Leonids (013 LEO)

Active: November 6–30; Maximum: November 18, 06^{h} UT (nodal crossing at $\lambda_{\odot} = 235\overset{\circ}{.}27$), ZHR ≈ 15, notes about time and ZHR see text
Radiant: $\alpha = 152°$, $\delta = +22°$; Radiant drift: see Table 6; $V_{\infty} = 71$ km/s; $r = 2.5$.



The regular nodal Leonid maximum at $\lambda_{\odot} = 235\overset{\circ}{.}27$ should occur on 2027 November 18 at 06^{h} UT. Maslov (2007) describes that a strong Leonid background maximum is to be expected. Due to the proximity of the parent comet 55P/Tempel-Tuttle, the activity may rise to a ZHR of $40 - 50$ on November 17, 22^{h} UT. (The next perihelion of the Leonids' parent comet, 55P/Tempel-Tuttle, is due on 2031 May 20. Hence, the meteoroids we observe now are ahead of the comet.)

Further, an outburst of brighter meteors with a ZHR of about 50 from the old 1167 trail is possible on November 20 at $04^{\mathrm{h}}18^{\mathrm{m}}$UT (Maslov, 2007). The low ejection velocity (5.6 m/s) necessary to move the meteoroids to the Earth's orbit indicates that there is a large fraction of bright meteors. Vaubaillon (2026) also hints at the encounter with the 1167 trail, calculated to occur on November 20, $04^{\mathrm{h}}25^{\mathrm{m}}$UT. Vaubaillon emphasizes that it is a very old trail and hence the encounter details are really uncertain. But if it happens, it might be a nice display since this part of the trail looks quite dense. By November 20 the moon has moved into Cancer but is only a bit less disturbing than on November 18.

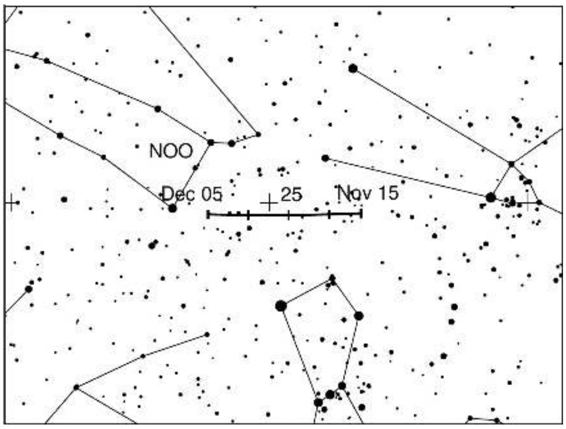
Sato (2026) identified several dust trails which approach the Earth in 2027 between November 18 and 20. These trails consist of meteoroids ejected opposite to the comet's orbital motion so that they have slightly shorter orbital periods than the comet and thus reach the Earth's orbit before the comet. The ejection velocities which are necessary to bring the meteoroids close to the Earth's orbit are of the order of 5 m/s. This is considerably smaller than for similar trails in the previous years – suggesting that the 2027 trails may contain relatively larger meteoroids. However, the dust trail number density is low and the trails are very old. The estimated ZHR may be of the order of a few tens. The three identified trails are:

Ejection year	Encounter 2027 (UT)	Solar Long. (2000.0)
1533	Nov 18 $20^{\mathrm{h}}02^{\mathrm{m}}$	$235\overset{\circ}{.}860$
1567	Nov 19 $12^{\mathrm{h}}23^{\mathrm{m}}$	$236\overset{\circ}{.}547$
1600	Nov 20 $10^{\mathrm{h}}10^{\mathrm{m}}$	$237\overset{\circ}{.}463$

So, in chronological order we find these possibly active periods for the 2027 Leonid return:
Nov 17, 22^{h} UT ZHR 40–50 (nodal meteoroids, Maslov 2007)
Nov 18, 06^{h} UT ZHR ? (nodal crossing at $\lambda_{\odot} = 235\overset{\circ}{.}27$)
Nov 18, 20^{h} UT ZHR 20+(?) (1533 trail, Sato 2026)
Nov 19, 12^{h} UT ZHR 20+(?) (1567 trail, Sato 2026)
Nov 20, 04^{h} UT ZHR 40–50 (1167 trail, Maslov 2007; Vaubaillon 2026)
Nov 20, 10^{h} UT ZHR 20+(?) (1600 trail, Sato 2026)

November Orionids (250 NOO)

Active: November 13–December 6; Maximum: November 28 ($\lambda_\odot = 246°$); ZHR = 3;
Radiant: $\alpha = 91°$, $\delta = +16°$; Radiant drift: see Table 6; $V_\infty = 43$ km/s; $r = 3.0$

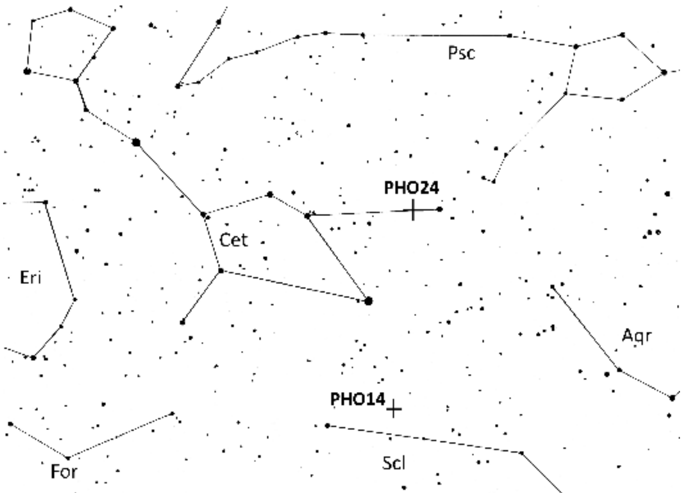


Detailed analysis of video data revealed that there are two consecutive, very similar showers whose activity intervals partially overlap each other: the November Orionids (250 NOO), followed by the Monocerotids (019 MON). In the last days of November the NOO shower is the strongest source in the sky.

The radiant is located in northern Orion, about 8° north of α Orionis. This location is close to the Northern Taurid radiant. This should be 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. New Moon on November 28 creates perfect conditions for optical observations under dark skies.

Phoenicids (254 PHO)

Active: Around December 1 (see text); ZHR = unknown;
Radiant: $\alpha = 8°$, $\delta = -27°$ (further details in the text); $V_\infty = 15$ km/s; $r = 2.8$ (?).



The Phoenicids were discovered in 1956 when the ZHR probably reached ≈ 100 from $\alpha = 16°, \delta = -45°$, possibly with several peaks spread over a few hours. Later, there was no clear activity sign until 2014 December 1. This activity was predicted by Sato and Watanabe and indeed occurred at the calculated time. From this return we take the radiant position (labelled in our chart as "PHO14"). This is about 7° southwest of the star β Ceti and far north of the radiant found in 1956.

The stream is associated with 289P/Blanpain (probably = 2003 WY_{25}). The orbit of the comet is subject to Jupiter perturbations. For 2024 three possible approaches to dust trails released in 1861 and 1866 had been calculated with low rates of mainly faint meteors. No significant activity was observed at the expected activity dates and from the radiant for the possible 2024 encounters. Particularly, the radiants were very different from the tabulated values (see the position labelled "PHO24" for comparison). The shower name is retained. For 2027 there is no expectation of activity, but we recommend to monitor possible meteors from this source, starting about 10 days before the given date. *If* any activity is recorded, observers should mention not only the numbers but also the radiant position. PHO meteors are extremely (!) slow.

Andromedids (018 AND)

Active: November 12–December 10 (uncertain); Maximum 2027: December 6 ($\lambda_\odot = 254°$); ZHR = 5+(?); Radiant: $\alpha = 25°$, $\delta = +51°$; Radiant drift: see Table below; $V_\infty = 18$ km/s; $r = 3.0(?)$

In the past years, there were activity signs from the Andromedids (018 AND) on 2021 November 28 and 2018 December 02. Wiegert et al. (2013, Table 5) found that in 2027 there may be a display caused by dust from 1649 similar to the occurrence in 2018. The radiant is calculated as $\alpha = 25°$, $\delta = +51°$ which is just northwest of the star φ Cassiopeiae and about 7° southeast of the position given in the Table below. The maximum should occur at $\lambda_\odot = 254°$, i.e. on December 6.

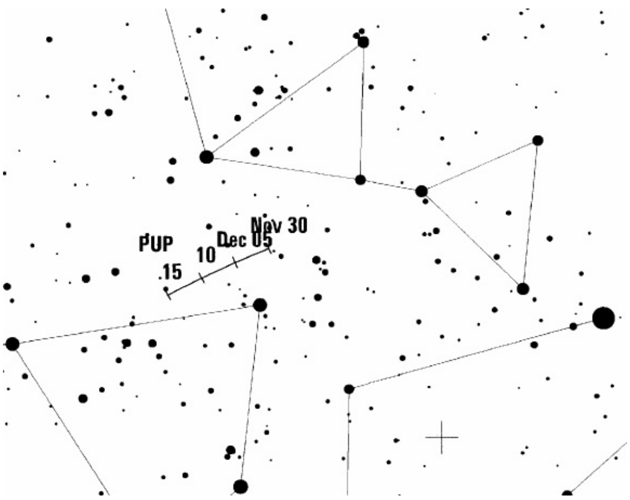
Recent analyses indicate an annual weak Andromedid activity. The radiant drifts significantly northwards in declination from end November to early December (Shiba, 2022). The very late part is listed as 446 DPC (December φ-Cassiopeids; activity observed in 2011). We recommend that visual observers report all meteors fitting the radiant area and *in particular the very low velocity (18 km/s)* given in the short list below as 'AND', keeping in mind that the predicted radiant for 2027 is slightly southeast of the tabulated reference position.

$\lambda_\odot$	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

Puppid-Velids (301 PUP)

Active: December 1–15(?); Maximum: December ≈ 7 ($\lambda_\odot \approx 255°$); ZHR ≈ 10; Radiant: $\alpha = 123°$, $\delta = -45°$; Radiant drift: see Table 6; $V_\infty = 44$ km/s; $r = 2.9$.

"Puppid-Velids" is the traditional designation for a system of poorly-studied showers (see, e.g. Jenniskens 2006, p. 517). It is visible chiefly from locations south of the equator.



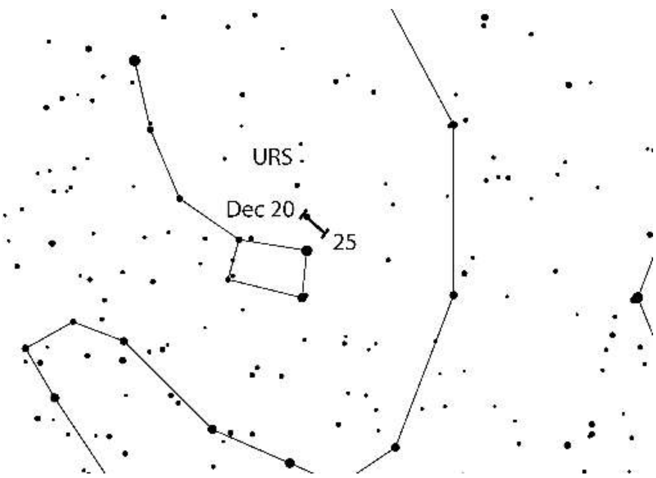
The designation 301 PUP which we use here represents an "average" radiant position which is close to that of the 746 EVE (e-Velids). The radiants summarised as PUP are tightly clustered so that visual observing cannot separate them. The activity is not well established, though slightly higher rates seem to occur in early to mid December and perhaps around December 20 again (then being close to a radiant which is given as 784 KVE (κ-Velids) in the IAU database. There are more weak showers listed in the database, extending activity possibly into January – close to the detection threshold and thus not listed here.

All this has "working" status and needs further investigation. First quarter moon on December 6 allows monitoring the shower mainly during the first period of its activity. The radiant area is on-view all night from tropical and southern locations, highest towards dawn. Visual observers should consider an extended radiant size of about 10° in diameter. Occasional bright fireballs, notably around the suggested maximum, have been reported.

Ursids (015 URS)

Active: December 17–26; Maximum: December 23, 04^h UT ($\lambda_\odot = 270.^\circ 7$);
ZHR = 10 (occasionally variable up to 50);
Radiant: $\alpha = 217°$, $\delta = +76°$; 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).



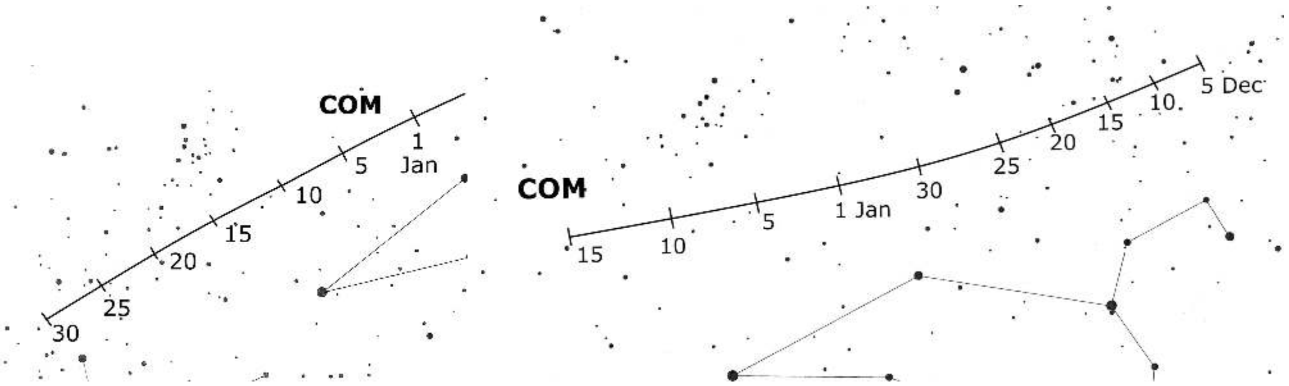
The parent comet 8P/Tuttle has an orbital period of 13.6 years. It passed its perihelion last on 2021 August 27. Many of the observed Ursid peaks occurred when the comet was close to its *aphelion,* indicating that predictions are difficult. For the 2027 return there are no dust trail or filament encounters predicted. So the ZHR should be close to the average values of about 10.

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 moon-free in 2027.

Comae Berenicids (020 COM)

Active: December 4–January 30; Maximum: December 23 ($\lambda_\odot = 271°$); ZHR = $2 - 3$;
Radiant: $\alpha = 164°$, $\delta = +29°$; Radiant drift: see Table 6;
$V_\infty = 65$ km/s; $r = 3.0$.

For many years, we listed two meteor showers in our working list: the Comae Berenicids (020 COM) and the December Leonis Minorids (032 DLM) between early December to early February. The data, however, was not consistent as there are more radiants in the IAU database with similar showers (Rendtel & Molau, 2022). For the visual observer it is not possible to distinguish between these showers. Therefore, we recommend to summarise activity associated with radiants in the region north of Leo as Comae Berenicids (COM). We consider $\lambda_\odot = 271°$ (December 23) as the reference date.



Visual data of December 2019, 2020 and 2021 show no significant rate variation, but a trend to slightly higher ZHRs around December 20–23 similar to the video data. At this time, the (mean) radiant position is at $\alpha = 164°$, $\delta = +29°$. This is less than 3° south of the star ξ Ursae Majoris. Nevertheless, we keep the designation COM.

Video meteor activity data and visual ZHR data suggest that the COM activity is most obvious between December 17 and 29 ($\lambda_\odot = 265 - 277°$). Overall, meteors from this region are detectable from December 4 ($\lambda_\odot = 251°$) until January 31 ($\lambda_\odot = 311°$).

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 $20^\circ \times 10^\circ$, while that for the ANT is still larger, at $30^\circ \times 15^\circ$. In a few cases, we add information about radiant extensions in the shower descriptions.

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

References:

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Abbreviations and symbols:

$\boldsymbol{\alpha}$, $\boldsymbol{\delta}$: 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 2027.

New Moon	First Quarter	Full Moon	Last Quarter
January 7	January 14	January 22	January 29
February 6	February 14	February 20	February 28
March 8	March 15	March 22	March 30
April 6	April 13	April 20	April 28
May 6	May 13	May 20	May 28
June 4	June 11	June 19	June 27
July 4	July 10	July 18	July 26
August 2	August 9	August 17	August 25
August 31	September 7	September 15	September 23
September 30	October 7	October 15	October 22
October 29	November 6	November 14	November 21
November 28	December 6	December 13	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 2026, with maximum dates accurate only for 2027. 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 observed 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 04	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 23	32°.32	271°	+34°	49	2.1	18
π-Puppids (137 PPU)	Apr 15–Apr 28	Apr 24	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 05–May 14	May 11	50°.0	291°	+43°	43	3.0	3
Dayt. Arietids (171 ARI)	May 14–Jun 24	Jun 08	76°.7	43°	+24°	38	2.8	30
June Bootids (170 JBO)	Jun 22–Jul 02	Jun 22	90°.3	221°	+48°	18	2.2	Var
July Pegasids (175 JPE)	Jul 01–Jul 20	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
α-Capricornids (001 CAP)	Jul 03–Aug 15	Jul 31	128°	307°	−10°	23	2.5	5
S. δ-Aquariids (005 SDA)	Jul 12–Aug 23	Jul 31	128°	340°	−16°	41	2.5	25
η-Eridanids (191 ERI)	Jul 31–Aug 19	Aug 08	135°	41°	−11°	64	3.0	3
Perseids (007 PER)	Jul 17–Aug 24	Aug 13	140°.0	48°	+58°	59	2.2	110+
κ-Cygnids (012 KCG)	Aug 03–Aug 28	Aug 17	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 10	166°.7	48°	+40°	64	2.5	8
Sep. Lyncids (081 SLY)	Sep 10–Oct 08	Sep 13	170°	113°	+56°	60	3.0	3
Dayt. Sextantids (221 DSX)	Sep 20–Oct 06	Oct 01	188°	156°	−02°	32	2.5	5
Oct. Camelopard. (281 OCT)	Oct 05–Oct 06	Oct 06	192°.58	164°	+79°	47	2.5	5
Draconids (009 DRA)	Oct 06–Oct 10	Oct 09	195°.4	263°	+56°	20	2.6	5
ε-Geminids (023 EGE)	Oct 14–Oct 27	Oct 19	205°	102°	+27°	70	3.0	3
Orionids (008 ORI)	Oct 02–Nov 07	Oct 22	208°	95°	+16°	66	2.5	20
Leonis Minorids (022 LMI)	Oct 19–Oct 27	Oct 25	211°	162°	+37°	62	3.0	2
S. Taurids (002 STA)	Sep 20–Nov 20	Nov 06	223°	52°	+15°	27	2.3	7
N. Taurids (017 NTA)	Oct 20–Dec 10	Nov 13	230°	58°	+22°	29	2.3	5
Leonids (013 LEO)	Nov 06–Nov 30	Nov 18	235°.27	152°	+22°	71	2.5	15+
α-Monocerotids (246 AMO)	Nov 15–Nov 25	Nov 22	239°.32	117°	+01°	65	2.4	Var
Nov. Orionids (250 NOO)	Nov 14–Dec 06	Nov 28	246°	91°	+16°	43	3.0	3
Phoenicids (254 PHO)	Nov 20–Dec 05	Dec 02	249°.5	08°	−27°	15	2.8	Var
Andromedids (018 AND)	Nov 12–Dec 10	Dec 06	254°	25°	+51°	18	3.0	5
Puppid-Velids (301 PUP)	Dec 01–Dec 15	(Dec 07)	(255°)	123°	−45°	44	2.9	10
Monocerotids (019 MON)	Dec 01–Dec 19	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
Ursids (015 URS)	Dec 17–Dec 26	Dec 23	270°.7	217°	+76°	33	2.8	10
Comae Berenicids (020 COM)	Dec 04–Jan 30	Dec 23	271°	164°	+29°	65	3.0	3

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

Date		ANT		QUA		COM								
Jan	0	112°	+21°	228°	+50°	172°	+25°							
Jan	5	117°	+20°	231°	+49°	176°	+24°			**GUM**				
Jan	10	122°	+19°	234°	+48°	180°	+23°			220°	+71°			
Jan	15	127°	+17°			185°	+21°			224°	+69°			
Jan	20	132°	+16°			189°	+19°			228°	+67°			
Jan	25	138°	+15°			194°	+17°	**ACE**		232°	+65°			
Jan	30	143°	+13°			198°	+16°	199°	−56°					
Feb	5	149°	+11°					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°	221°	+48°									
Jun	30	291°	−21°	222°	+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°	**SLY**					
Sep	20			18°	+5°	**DSX**		59°	+41°	120°	+48°				
Sep	25			21°	+6°	152°	−2°			127°	+47°				
Sep	30			25°	+7°	156°	−2°	**ORI**		133°	+46°	**OCT**			
Oct	5			28°	+8°	160°	−2°	85°	+14°	140°	+45°	164°	+79°	**DRA**	
Oct	10			32°	+9°	**EGE**		88°	+15°	147°	+44°			263°	+56°
Oct	15	**NTA**		36°	+11°	99°	+27°	91°	+15°			**LMI**			
Oct	20	38°	+18°	40°	+12°	104°	+27°	94°	+16°			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°	119°	−45°	91°	+8°
Dec	5	85°	+23°	103°	+33°	148°	+35°	10°	−27°	122°	+3°	122°	−45°	98°	+9°
Dec	10	90°	+23°	108°	+33°	152°	+34°	13°	−28°	126°	+2°	125°	−45°	101°	+8°
Dec	15	96°	+23°	113°	+33°	157°	+32°			130°	+1°	128°	−45°	105°	+7°
Dec	20	101°	+23°	118°	+32°	161°	+30°			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	δ	Details see page
ι-Centaurids (919 ICN)	Jan 21–26		199°	−39°	3
252P/LINEAR	Apr 01–02		76°	−12°	3
P/2009 WX_{51}	Apr 21		38°	+35°	5
2009 CR_2	Apr 20		198°	+62°	5
γ-Delphinids (065 GDE)	Jun 11	80.°378	312°	+17°	6
July γ-Draconids (184 GDR)	Jul 28	125.°132	280°	+51°	9
Perseids (007 PER) trails & filament	Aug 12–13				12
Arids (1130 ARD) / 15P/Finlay	Oct 23	209.°1–210.°2	256°	−38°	14
Leonids (013 LEO) trails	Nov 18–20				17
Andromedids (018 AND)	Dec 06	254°	25°	+51°	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). See also the Table of northern summer daytime showers on page 7. 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 7.

Shower	Activity	Max Date	$\lambda_\odot$ 2000.0	Radiant α	δ
April Piscids (144 APS)	Apr 20 – Apr 25	Apr 23	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 08	47.°1	28°	+8°
Arietids (171 ARI)	May 25 – Jun 20	Jun 08	77.°0	43°	+24°
ζ-Perseids (172 ZPE)	May 30 – Jun 20	Jun 10	78.°6	67°	+23°
β-Taurids (173 BTA)	Jun 15 – Jul 05	Jun 26	94°	82°	+20°
κ-Leonids (212 KLE)	Sep 20 – Sep 30	Sep 26	183°	162°	+15°
Sextantids (221 DSX)	Sep 20 – Oct 06	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 access to the data for your 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 Commissions for various fields, about which you may enquire with the respective director:

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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: observations@rmob.org

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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