International Meteor Organization

2009 Meteor Shower Calendar

compiled by Alastair McBeath[1]

1 Introduction

Welcome to the 2009 International Meteor Organization (IMO) Meteor Shower Calendar. Of the more active annual showers, the Quadrantids, Lyrids, η- and Southern δ-Aquariids, Orionids, Leonids and Geminids are best placed with regards the Moon, along with the occasionally stronger Ursids in December. Of greatest potential interest for what they may produce are the η-Aquariids and Orionids (which should be near their theoretical 12-year ZHR peaks in 2009, the Orionids having already produced unexpectedly strong activity in both 2006 and 2007, albeit apparently not from this cause), the moonlit Perseids, which may show an additional maximum again this year, and the Leonids, which could yield ZHRs in the 100+ category, maybe (if we are very fortunate) bordering on near-storm levels again! For radio observers, and hopeful daylight fireball enthusiasts, there is the chance of another Taurid 'swarm' return in June-July. There are minor showers to be monitored as well, and ideally, meteor observing should be carried out throughout the year to check on all the established sources, and for any new ones. We appreciate this is impractical for most people, so the Shower Calendar has been helping to highlight times when a particular effort might most usefully be employed since 1991.

The heart of the Calendar is the Working List of Visual Meteor Showers, Table 5, which had its most recent overhaul by IMO analysts in 2006, to help it remain the single most accurate listing available anywhere today for naked-eye meteor observing. Of course, for all its accuracy, it is a *Working* List, so is continually subject to further checks and corrections, based on the best data we have, so it is always as well to check the information here fully, before going out to observe (and please notify us if you find any anomalies!).

Apart from the visually-observable showers, there are many others weakly active throughout the year which only still-imaging, video, radar or telescopic observations can separate from the omnipresent background sporadics, as well as showers with radiants too near the Sun to be observed by the various optical methods, which can be detected only by forward-scatter radio or radar observations. Some of these showers are given in Table 7, the Working List of Daytime Radio Meteor Showers. The IMO's aims are to encourage, collect, analyze, and publish combined meteor data obtained from sites all over the globe, to help better our understanding of the meteor activity detectable from the Earth's surface. Thus, we encourage these more specialist forms of observing too, so all meteor workers, wherever you are and whatever methods you use to record meteors, should follow the standard IMO observing guidelines when compiling your information, and submit those data promptly to the appropriate Commission for analysis (contact details are at the end of the Calendar). Thanks to the efforts of the many IMO observers worldwide since

[1]Based on information in *IMO Monograph No. 2: Handbook for Visual Meteor Observers*, edited by Jürgen Rendtel, Rainer Arlt and Alastair McBeath, IMO, 1995, as amended by the commentaries in *WGN* **34:3** (June 2006), pp. 71–84, with subsequent corrections, plus additional material extracted from reliable data analyses produced since. Particular thanks are due to Rainer Arlt, David Asher, Jeff Brower, David Entwistle, Esko Lyytinen and Jérémie Vaubaillon for valuable discussions in respect of several events in 2009.

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 steps towards constructing a better and more complete picture of the near-Earth meteoroid flux can proceed.

Although timing predictions are included below on all the more active night-time and daytime shower maxima, as reliably as possible, it is essential to understand that in many cases, such maxima are not known more precisely than to the nearest 1° of solar longitude (even less accurately for the daytime radio showers, which have received little regular attention until quite recently). 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. The information given here may be updated after the Calendar is published, so be sure to watch for alerts on the Internet (including on IMO-News) and in WGN, the IMO's bimonthly journal. Some showers are known to show particle mass-sorting within their meteoroid streams, so the radar, radio, still-imaging, telescopic, 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.

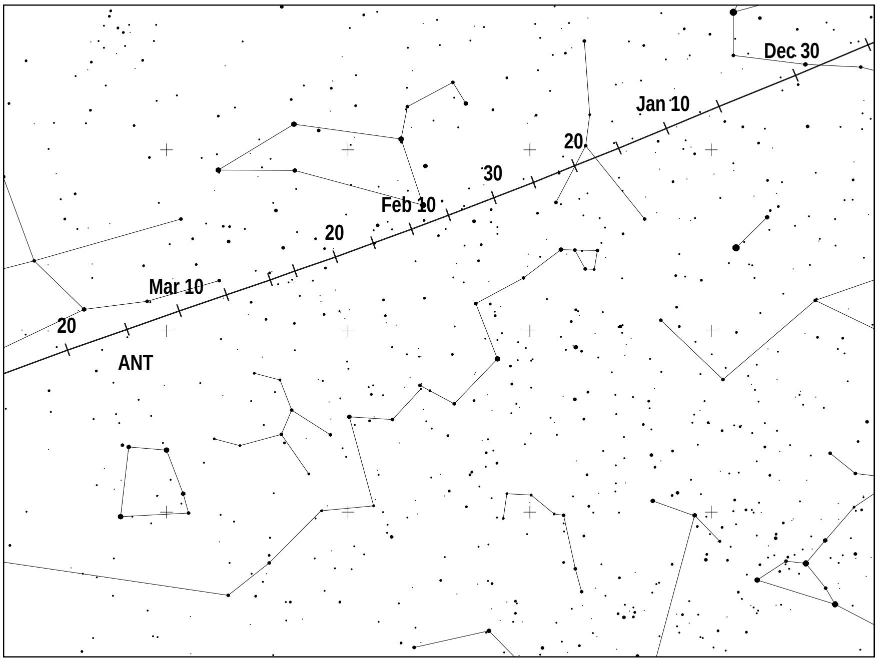
However and whenever you are able to observe, we wish you all a most successful year's work and very much look forward to receiving your data. Clear skies!

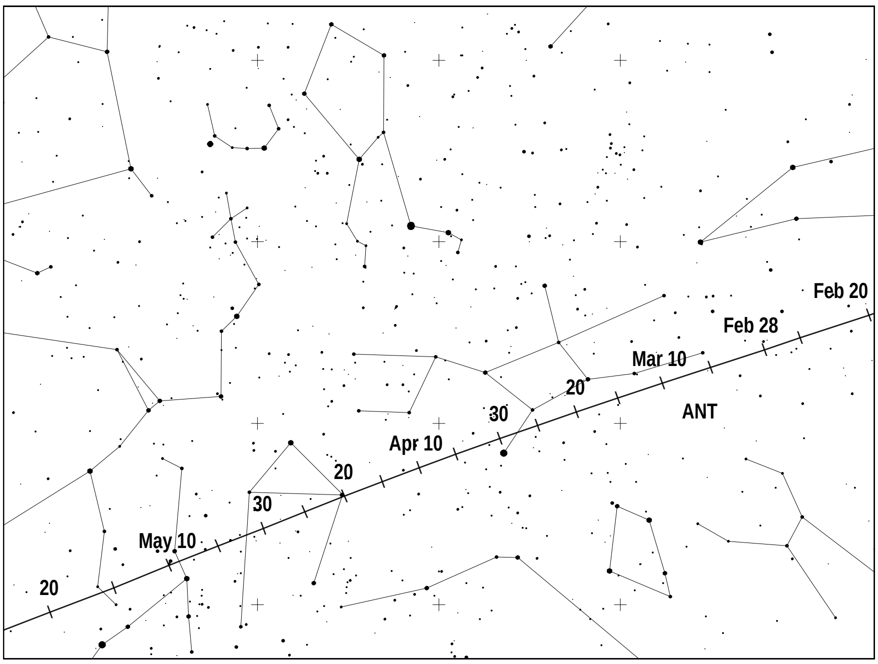
2 Antihelion Source

The Antihelion Source (ANT) is a large, roughly oval area with a size of 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, but is rather a region of sky in which a number of variably, if weakly, active minor showers have their radiants. Until 2006, attempts were made to define specific showers within this complex, but this often proved very difficult for visual observers to achieve. IMO video results from the last decade have shown why, because even instrumentally, it was impossible to usefully define distinct radiants for many of the showers here! Consequently, we currently believe it is best for observers to simply identify meteors from these showers as coming from the ANT alone. At present, we think the July-August α-Capricornids (CAP), and particularly the Southern δ-Aquariids (SDA; because their stream parameters are rather different from the average ANT orbits), should remain discretely observable visually from the ANT, so they have been retained in the Working List, but time and plenty of observations will tell, as ever. Later in the year, the strength of the twin Taurid showers (STA and NTA) means the ANT should be considered inactive while the Taurids are underway, from late September to late November. To assist observers, a set of charts showing the location for the ANT and any other nearby shower radiants is included here, to compliment 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

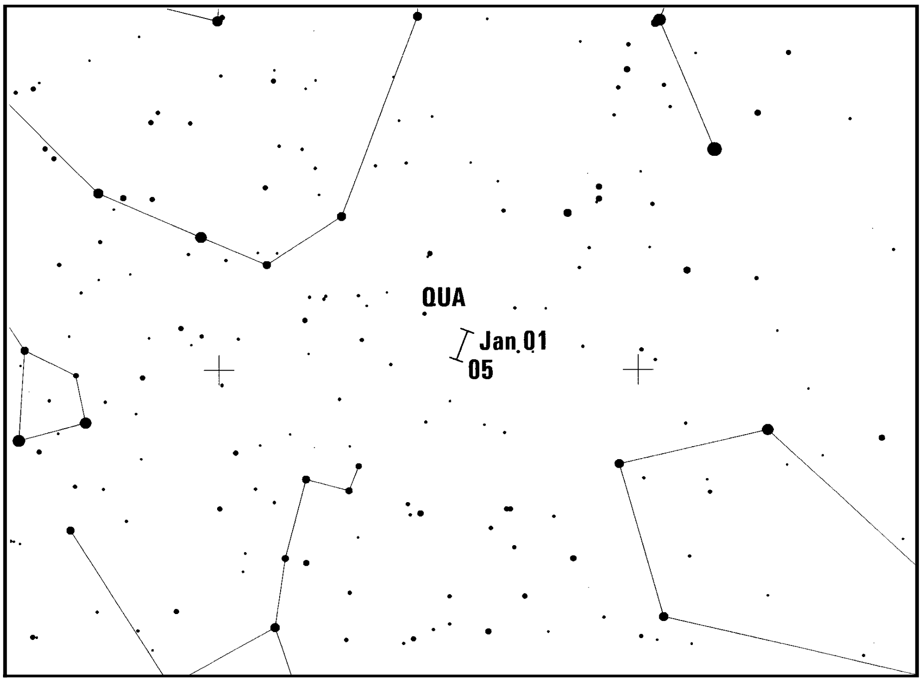
First quarter Moon favours the northern-hemisphere Quadrantids in early January, but the probable southern-hemisphere α-Centaurid peak, due around 23^{h} UT on February 7, is too close to full Moon on February 9. Mid-March brings an equally poor minor γ-Normid return for similarly southern places, likely at maximum sometime between March 10–17, perhaps most plausibly around March 13. The Antihelion Source's radiant centre starts January in south-east Gemini, and crosses Cancer during much of the month, before passing into southern Leo for most of February. It then slips through southern Virgo during March. Likely ANT ZHRs will be < 2, though IMO analyses suggest there may be an ill-defined minor peak with ZHRs ~ 2 to 3 around $\lambda_{\odot} \sim 286°–293°$ (January 6 to 13 in 2009, ruined by full Moon, if so), and ZHRs could be ~ 3 for most of March. The late January to early February spell, during which several new, swift-meteor minor showers radiating from the Coma-Leo-Virgo area have been suggested in some recent years, enjoys a new Moon for its potential core period, January 20–27. Theoretical approximate timings (rounded to the nearest hour) for the daytime radio shower maxima this quarter are: Capricornids/Sagittariids – February 1, 9^h UT; and χ-Capricornids – February 13, 10^h UT. Recent radio results suggest the Cap/Sgr maximum may variably fall sometime between February 1–4 however, while activity near the expected χ-Capricornid peak has tended to be slight and up to a day late. Both showers have radiants $< 10°–15°$ west of the Sun at maximum, so cannot be regarded as visual targets even from the southern hemisphere.





Quadrantids (QUA)

Active: January 1–5; Maximum: January 3, 12^h50^m UT ($\lambda_\odot = 283^\circ\!.16$);
ZHR = 120 (can vary $\sim$ 60–200);
Radiant: $\alpha = 230^\circ$, $\delta = +49^\circ$; Radiant drift: see Table 6;
$V_\infty = 41$ km/s; $r = 2.1$ at maximum, but variable;
TFC: $\alpha = 242^\circ$, $\delta = +75^\circ$ and $\alpha = 198^\circ$, $\delta = +40^\circ$ ($\beta > 40^\circ$ N).
IFC: before 0^h local time $\alpha = 150^\circ$, $\delta = +70^\circ$;
after 0^h local time $\alpha = 180^\circ$, $\delta = +40^\circ$ and $\alpha = 240^\circ$, $\delta = +70^\circ$ ($\beta > 40^\circ$ N).



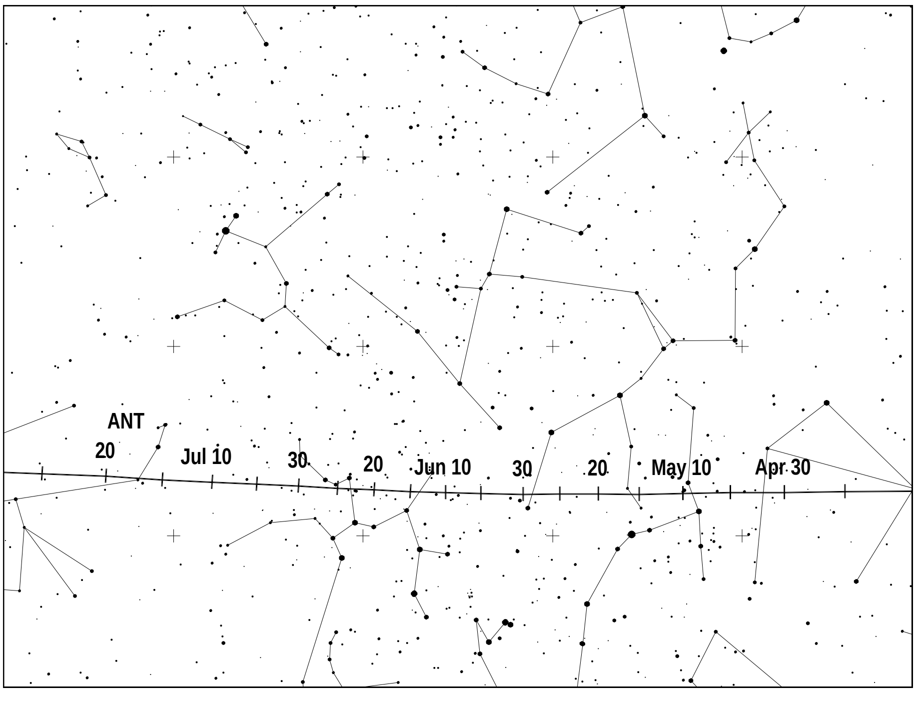
The waxing crescent Moon will set near local midnight for the maximum of the Quadrantids at northern hemisphere sites, from many of which, the shower's radiant is circumpolar, in northern Boötes. As this area attains a useful elevation only after local midnight, rising higher in the sky towards morning twilight, this is excellent news. However, the expected peak's timing falls poorly for land-based observers, except for those in the extreme western areas of North America, on islands in the North Pacific Ocean, and the extreme east of Russia. An interesting challenge is to try spotting the occasional long-pathed shower member from the southern hemisphere around dawn, but sensible Quadrantid watching cannot be carried out from such places.

The maximum timing above is based on the best-observed return of the shower ever analysed, from IMO 1992 data, confirmed by radio results in most years since 1996. The peak itself is normally short-lived, and can be easily missed in just a few hours of poor northern-winter weather, which may be why the ZHR level apparently fluctuates from year to year, but some genuine variability is probably present too. For instance, visual ZHRs in preliminary results from 2008 persisted for more than two hours at close to their best, with the maximum itself centred around three to four hours later than anticipated. An added level of complexity comes from the fact that mass-sorting of particles across the meteoroid stream may make fainter objects (radio and telescopic meteors) reach maximum up to 14 hours before the brighter (visual and photographic) ones, so observers should be alert throughout the shower. A few, but apparently not all, years since 2000 seem to have produced a, primarily radio, maximum following the main visual one by some 9–12 hours. Visual confirmation of any repeat near this time in 2009 would fall ideally for sites from Europe east to central Asia. Oddly, in 2008, there seemed to be two possible radio Quadrantid peaks, but the first was apparently about six hours *before* the visual one, during an apparent rates-plateau ahead of the main maximum in the visual data.

Past observations have suggested the QUA radiant is diffuse away from the maximum, contracting notably during the peak itself, although this may be a result of the very low activity outside the hours near maximum. Still-imaging and video observations from January 1–5 would be particularly welcomed by those investigating this topic, using the IFCs and TFCs given above, along with telescopic and visual plotting results.

4 April to June

Meteor activity picks up towards the April-May boundary, with excellently moonless shower peaks in late April from the Lyrids and π-Puppids, and even the η-Aquariids in early May survive the waxing gibbous Moon. The minor η-Lyrids will likely pass unobserved however, with their low-activity maximum on May 9 coincident with full Moon. Later in May and throughout June, most of the meteor action switches to the day sky, with six shower maxima expected during this time. Although occasional meteors from the o-Cetids and Arietids have been claimed as seen from tropical and southern hemisphere sites visually in past years, ZHRs cannot be sensibly calculated from such observations. For radio observers, the theoretical UT peaks for these showers are as follows: April Piscids – April 20, 9^{h}; δ-Piscids – April 24, 9^{h}; ε-Arietids – May 9, 8^{h}; May Arietids – May 16, 9^{h}; o-Cetids – May 20, 8^{h}; Arietids – June 7, 11^{h}; ζ-Perseids – June 9, 11^{h}; β-Taurids – June 28, 10^{h}. Signs of most of these were found in radio data from 1994–2007, though some are difficult to define individually because of their proximity to other radiants. There seems to be a modest recurring peak around April 24, perhaps due to combined rates from the first three showers listed here, for instance, while the Arietid and ζ-Perseid maxima tend to blend into one another, producing a strong radio signature for several days in early to mid June. There are indications these two June shower maxima now each occur up to a day later than indicated above.



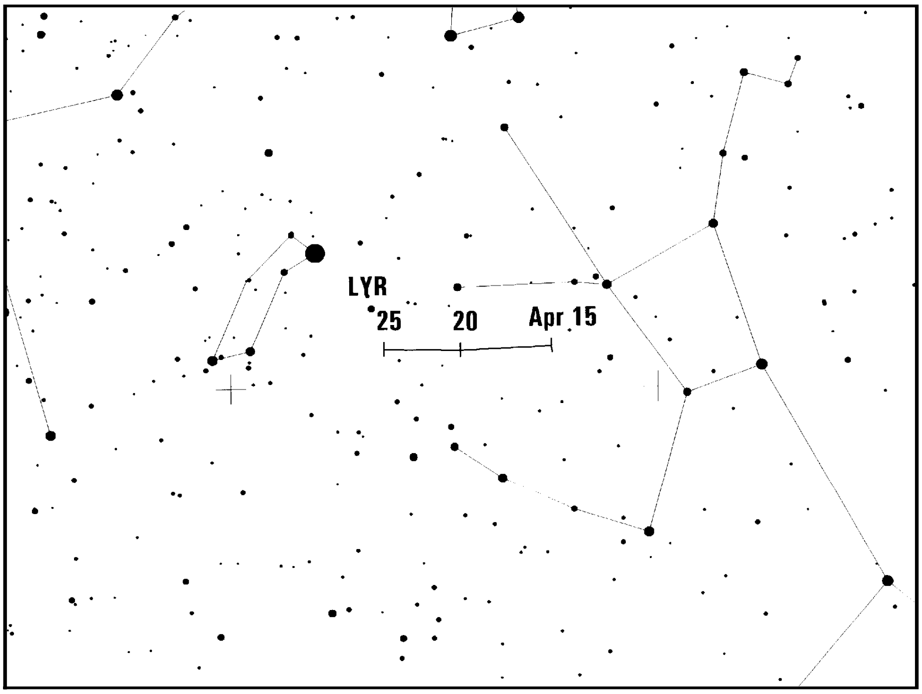
The Antihelion Source should be relatively strong, with ZHRs of 3 to 4 found in recent investigations through till mid April, and again around late April to early May, late May to early June, and late June to early July. At other times, the ZHR seems to be below ~ 2 to 3. The radiant area drifts from 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. For northern observers, circumstances for checking on any potential June Lyrids (not currently on the Working List, but possibly producing some weak activity, if at all, around June 16) are not too favourable this year, with last quarter Moon rising around midnight. Conditions are rather better for possible June Boötid hunting.

Taurid 'swarm' return: Work by David Asher has suggested the possibility of another return of the Taurid meteoroid 'swarm' during June 2009. If so, it may be detectable as an increased radio meteor flux during the ζ-Perseids or the β-Taurids, both of which are probably associated with the Taurid Complex of meteor showers, asteroids and comets. Each of the last three predicted night-time 'swarm' events during the October-November Taurids, in 1995, 1998 and 2005 produced noticeably different activity to normal. In 2005, and most impressively of the three, this included increased Taurid ZHRs and a lot of shower fireballs from late October to mid-November. Another night-time 'swarm' return was due in late 2008, still to come when this Calendar text was prepared. However, previous theoretical daytime 'swarm' returns in 1995, 1999 and 2002 have proven elusive, with nothing very remarkable found in the June-July radio results for any of those years that might be definite signs of such a return. The encounter geometry in 2009 June is expected to be similar to that in 2005 October-November, so any repeat of comparable activity may give the best chance of such a daytime-sky recovery, if it happens. The most likely time for anything to be detected is probably about 5–8 days before the β-Taurid peak, thus around June 20–23, but its potential timing and strength are unknown. There is also the chance that if an increased fireball flux takes place, there may be some daylight fireballs reported visually, though of course these cannot be deliberately watched for.

Lyrids (LYR)

Active: April 16–25; Maximum: April 22, 11^{h} UT ($\lambda_{\odot} = 32.^{\circ}32$, but may vary – see text);
ZHR = 18 (can be variable, up to 90);
Radiant: $\alpha = 271^{\circ}$, $\delta = +34^{\circ}$; Radiant drift: see Table 6;
$V_{\infty} = 49$ km/s; $r = 2.1$;
TFC: $\alpha = 262^{\circ}$, $\delta = +16^{\circ}$ and $\alpha = 282^{\circ}$, $\delta = +19^{\circ}$ ($\beta > 10^{\circ}$ S).

The $\lambda_{\odot} = 32.^{\circ}32$ timing given above is the 'ideal' maximum found in the most detailed examination of the Lyrids in modern times, published in 2001 by Audrius Dubietis and Rainer Arlt, drawing on IMO results from 1988–2000. However, the maximum time was found to be variable from year to year between $\lambda_{\odot} = 32.^{\circ}0$–$32.^{\circ}45$ (equivalent to 2009 April 22, 3^{h} to 14^{h} UT). Activity was discovered to be variable too. A peak at the ideal time produced the highest ZHRs, ~ 23, while the further the peak happened from this, the lower the ZHRs were, down to ~ 14. (The last very high maximum occurred outside the examined interval, in 1982 over the USA, when a short-lived ZHR of 90 was recorded.) The mean peak ZHR was 18 over the thirteen years examined. While generally thought of as having a short, quite sharp, maximum, this latest work revealed the shower's peak length was inconstant too. Using the interval that ZHRs were above half the maximum amount, the Full-Width-Half-Maximum time, a variation of from 14.8 hours (in 1993) to 61.7 hours (in 2000) was detected, with a mean value of 32.1 hours. The very best rates are normally achieved for just a few hours however. One other aspect of the analysis confirmed data from earlier in the 20th century, that occasionally, as their highest rates occurred, the Lyrids produced a short-lived increase in fainter meteors. Overall, the unpredictability of the shower in any given year always makes the Lyrids worth watching, since we cannot say when the next unusual return may take place.



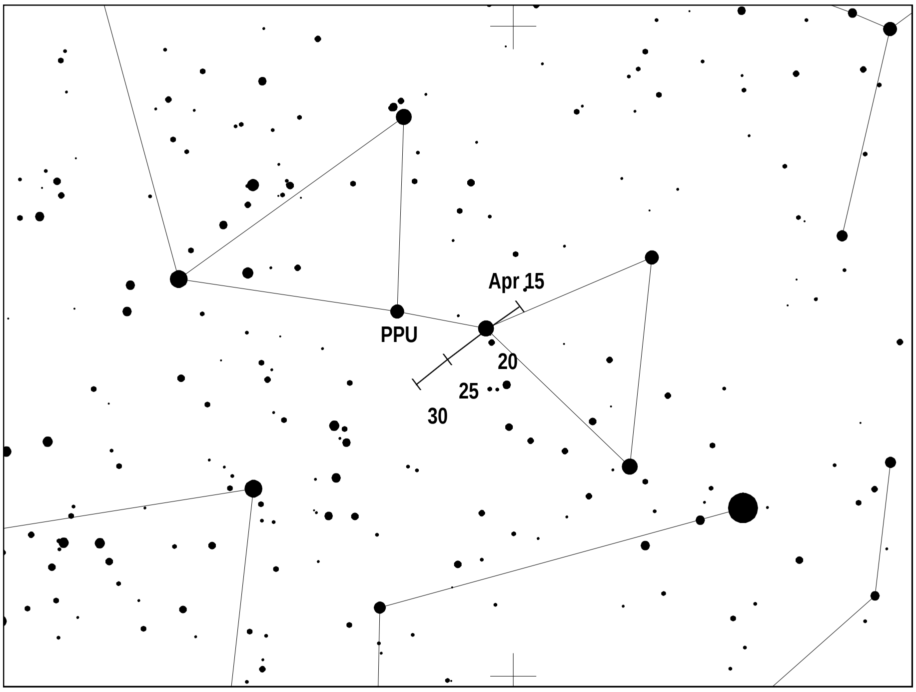
Lyrids are best viewed from the northern hemisphere, but they are visible from many sites north and south of the equator, and the shower is suitable for all forms of observation. As its radiant rises during the night, watches can be usefully carried out from about 22^h30^m local time onwards from mid-northern sites, but only from well after midnight from the mid-southern hemisphere. The waning crescent Moon will rise too late in the night in the northern hemisphere to cause any problems, and will be just a minor distraction further south on April 22. If the ideal maximum time recurs, it should be best seen from sites across the central to eastern Pacific Ocean, and the extreme west of North America, but other maximum times are perfectly possible, as noted above.

π-Puppids (PPU)

Active: April 15–28; Maximum: April 23, 16^h UT ($\lambda_\odot = 33\overset{\circ}{.}5$);
ZHR = periodic, up to around 40;
Radiant: $\alpha = 110°$, $\delta = -45°$; Radiant drift: see Table 6;
$V_\infty = 18$ km/s; $r = 2.0$;
TFC: $\alpha = 135°$, $\delta = -55°$ and $\alpha = 105°$, $\delta = -25°$ ($\beta < 20°$ N).

Activity has only been detected from this source since 1972, with notable, short-lived, shower maxima of around 40 meteors per hour in 1977 and 1982, both years when its 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, as theory predicts. Comet Grigg-Skjellerup's most recent perihelion in 2008 March produced nothing meteorically significant that April, but lunar circumstances in

2008 were poor, and faint-meteor activity (which was predicted as likely in advance) could have been missed. There were no predictions for activity in force for 2009 when this Calendar was prepared. The π-Puppids are best seen from the southern hemisphere, with useful observations mainly practical there before midnight, as the radiant is very low to setting after $1^{\rm h}$ local time. April's new Moon on the 25th creates perfect viewing circumstances this year. Covering whatever happens is important in all years, even if that is to report no obvious activity, as past datasets on the shower have typically been very patchy. So far, visual and radio data have been collected on the shower, but the slow, sometimes bright nature of the meteors makes them ideal subjects for imaging too. No telescopic or video data have been reported in any detail as yet.



η-Aquariids (ETA)

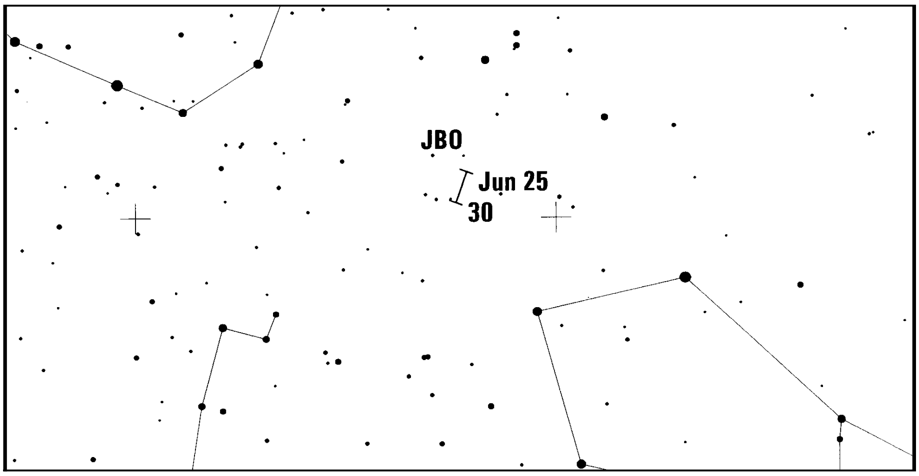
Active: April 19–May 28; Maximum: May 6, $00^{\rm h}$ UT ($\lambda_\odot = 45.^\circ5$);
ZHR = 85 (periodically variable, $\sim$ 40–85);
Radiant: $\alpha = 338^\circ$, $\delta = -01^\circ$; Radiant drift: see Table 6;
$V_\infty = 66$ km/s; $r = 2.4$;
TFC: $\alpha = 319^\circ$, $\delta = +10^\circ$ and $\alpha = 321^\circ$, $\delta = -23^\circ$ ($\beta < 20^\circ$ S).

A fine, rich shower associated with Comet 1P/Halley, like the Orionids of October, but one visible for only a few hours before dawn, essentially from tropical and southern hemisphere sites. Some useful results have come even from sites around 40° N latitude in recent years however, and occasional meteors have been reported from further north, but the shower would benefit from increased observer activity generally. The fast and often bright meteors make the wait for radiant-rise worthwhile, and many events leave glowing persistent trains after them. While the radiant is still low, η-Aquariids tend to have very long paths, which can mean observers underestimate the angular speeds of the meteors, so extra care is needed when making such reports.

A relatively broad maximum, sometimes with a variable number of submaxima, usually occurs in early May. Fresh IMO analyses in recent years, based on data collected between 1984–2001, have shown that ZHRs are generally above 30 between about May 3–10, and that the peak rates appear to be variable on a roughly 12-year timescale. The next highest rates should fall towards 2008–2010, if this Jupiter-influenced cycle is borne-out, thus ZHRs could be around their very best in 2009, according to this idea. However, activity in 2007 seemed unexpectedly weaker than normal (peak ZHRs maybe only ~ 50), which combined with the unexpectedly strong Orionid returns in October 2006 and 2007, add an extra degree of uncertainty over what may happen from the η-Aquariids this year. The waxing gibbous Moon on May 6 will set in time to still leave most of the best-visible interval viable for visual watchers well south of the equator, at least. All forms of observing can be used to study the shower, with radio work allowing activity to be followed even from many northern latitude sites throughout the daylight morning hours. The radiant culminates at about 8^{h} local time.

June Boötids (JBO)

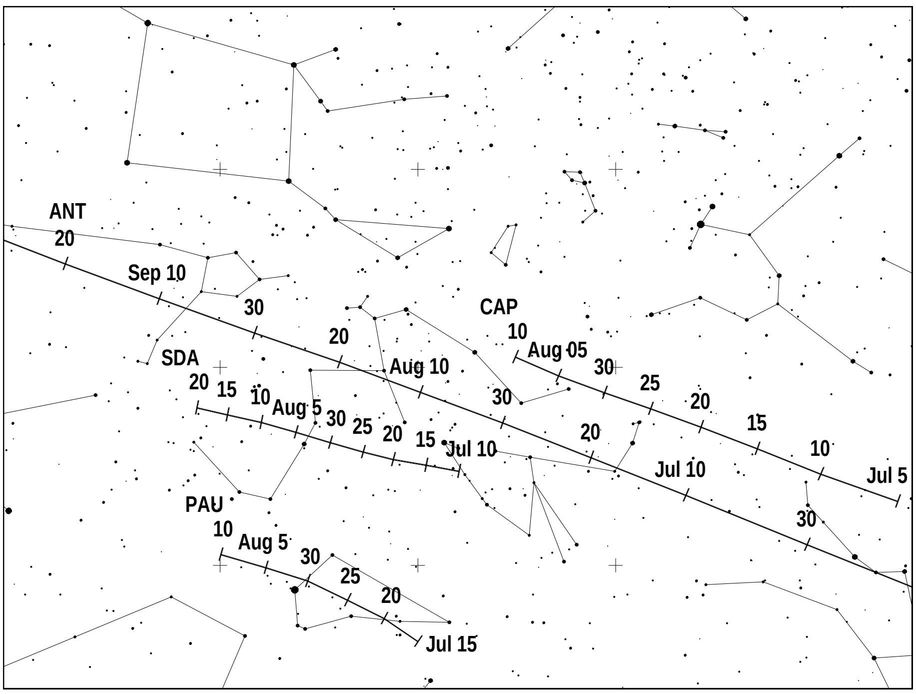
Active: June 22–July 2; Maximum: June 27, $08^{\mathrm{h}}30^{\mathrm{m}}$ UT ($\lambda_{\odot} = 95.^{\circ}7$);
ZHR = variable, 0–100+;
Radiant: $\alpha = 224^{\circ}$, $\delta = +48^{\circ}$; Radiant drift: see Table 6;
$V_{\infty} = 18$ km/s; $r = 2.2$;
TFC: $\alpha = 156^{\circ}$, $\delta = +64^{\circ}$ and $\alpha = 289^{\circ}$, $\delta = +67^{\circ}$ ($\beta = 25^{\circ}$–60° N).



This source was reinstated on the Working List after its unexpected return of 1998, when ZHRs of 50–100+ were visible for more than half a day. Another outburst of similar length, but with ZHRs of $\sim$ 20–50 was observed on 2004 June 23, a date before definite activity had previously been recorded from this shower. Consequently, the shower's start date was altered to try to ensure future activity so early is caught, and we encourage all observers to routinely monitor throughout the expected activity period, in case of fresh outbursts. Prior to 1998, only three more probable returns had been detected, in 1916, 1921 and 1927, though that in 1921 was very uncertainly recorded. With no significant reports between 1928 and 1997, it seemed likely these meteoroids no longer encountered Earth. The dynamics of the stream were poorly understood, although recent theoretical modelling has improved our comprehension. The shower's parent, Comet 7P/Pons-Winnecke, has an orbit that now lies around 0.24 astronomical units outside the Earth's at its closest approach. Its most recent perihelion passage was in 2008 September. Clearly, the 1998 and 2004 returns resulted from material shed by the comet in the past which now lies on slightly different orbits to the comet itself. Dust trails laid down at various perihelion returns during the 19th century seem to have been responsible for the last two main outbursts. There were no predictions in force for possible activity in 2009 at the time of writing, but conditions for checking are very favourable from the mid-northern latitudes where the radiant is best seen, with an early-setting waxing crescent Moon. The prolonged – in some places continuous – mid-northern twilight means the summer nights are short anyway. The radiant is usefully accessible virtually all night, and all observing techniques can be employed.

5 July to September

The Antihelion Source is the chief focus for visual attention for most of July, as its radiant area moves steadily through eastern Sagittarius, then across northern Capricornus into south-west Aquarius. Results suggest the Source may not be especially recognisable after the first few days however, as ZHRs for most of the month seem < 2, and for a time in mid-month even < 1! Activity appears to improve somewhat, with ZHRs ~ 2 to 3, by late July and through the first half of August. This level of ZHRs may make it more practical to still identify the reasonably moonless α-Capricornid maximum, despite that radiant's overlap with the Antihelion Source's. The Southern δ-Aquariids are strong enough, and the Piscis Austrinids have a radiant probably distant enough from the ANT area, that both should still be separable from it, particularly from the southern hemisphere. By the best from the major, badly moonlit, Perseids, and the almost Moon-free κ-Cygnid peak, ANT ZHRs will likely have dropped back below 2 again, as the radiant tracks on through Aquarius, and into western Pisces by the α-Aurigid maximum on the August-September boundary. The minor September Perseids lose out to the waning gibbous Moon for their likely maximum around September 9, but part of the probable very weak δ-Aurigid peak later in the month should be clear enough of the Moon to observe.



For most of September, ANT rates continue from their radiant in Pisces, albeit with ZHRs probably no better than 2–3, but remember that from September 25, Antihelion meteors are no longer to be recorded as such, as both Taurid showers take over the near-ecliptic shower baton until late November. For daylight radio observers, the interest of May-June has waned, but there remain the visually-impossible γ-Leonids (peak due near August 25, 10^h UT, albeit not found in recent radio results), and a tricky visual shower, the Sextantids. Their maximum is expected on September 27, around 10^h UT, but may possibly occur a day earlier. In 1999 a strong return was detected at $\lambda_\odot \sim 186°$, equivalent to 2009 September 29, while in 2002, the September 27 peak was not found, but one around September 29–30 was! It seems plausible that several minor maxima in early October may also be due to this radio shower. The waxing gibbous Moon creates no additional difficulties for visual observers hoping to catch some Sextantids in the pre-dawn of late September, though radiant-rise is less than an hour before sunrise in either hemisphere.

Perseids: Although the major northern hemisphere Perseids are badly affected by the last quarter Moon near their best this year, there is the possibility they may produce more than one peak again, perhaps also with somewhat increased rates. The usual maximum is due around August 12, 17^h30^m–20^h00^m UT ($\lambda_\odot = 140.^\circ0$–$140.^\circ1$), but Esko Lyytinen suggests we may encounter the 1610 Perseid trail earlier on August 12, around 9^h00^m UT ($\lambda_\odot = 139.^\circ661$). This could produce activity additional to the normal Perseid ZHRs then of a few tens, maybe up to a hundred, probably with a fairly normal magnitude distribution, or perhaps marginally brighter. He further suggests that rates overall could be enhanced above usual by the relative proximity of the annual stream's core, most likely at other times on August 12 ahead of the normal peak. The 19th century trail should pass roughly 0.003 astronomical units inside the Earth's orbit at $\lambda_\odot = 139.^\circ499$, so around 5^h UT on August 12, though it may add less than 10 to the ZHR at that point. Naturally, information to verify what takes place will be very valuable despite the Moon, so visual observers are encouraged to try to follow as much of what happens over the possible Perseid maxima as practical.

Piscis Austrinids (PAU)

Active: July 15–August 10; Maximum: July 28 ($\lambda_\odot = 125°$); ZHR = 5;
Radiant: $\alpha = 341°$, $\delta = -30°$; Radiant drift: see Table 6;
$V_\infty = 35$ km/s; $r = 3.2$;
TFC: $\alpha = 255°$ to 000°, $\delta = 00°$ to +15°, choose pairs separated by about 30° in α ($\beta < 30°$ N).

Very little information has been collected on the Piscis Austrinids in recent decades, so the details on the shower are not well confirmed, and it seems possible the ZHR may be a little optimistic. However, that impression may be due simply to the large amount of northern hemisphere summer data, and the almost complete lack of southern hemisphere winter results, on it. The shower seems to be rich in faint meteors, rather like the nearby ANT and SDA, so telescopic work is advisable to try to establish more about it. First quarter Moon for the probable maximum will set between 22^h–00^h (its setting time is progressively later for places further south).

Southern δ-Aquariids (SDA)

Active: July 12–August 19; Maximum: July 28 ($\lambda_\odot = 125°$); ZHR = 20;
Radiant: $\alpha = 339°$, $\delta = -16°$; Radiant drift: see Table 6;
$V_\infty = 41$ km/s; $r = 3.2$;
TFC: $\alpha = 255°$ to 000°, $\delta = 00°$ to +15°, choose pairs separated by about 30° in α ($\beta < 40°$ N).

Like the PAU and ANT, SDA meteors are often faint, thus are suitable targets for telescopic observing, although enough brighter members exist to make visual and imaging observations worth the effort too, primarily from more southerly sites. Radio work can pick up the SDA as well, and indeed the shower has sometimes given a surprisingly strong radio signature. Careful visual plotting is advised, to help with accurate shower association. The SDA/PAU/ANT/CAP radiants are well above the horizon for much of the night, and the SDA enjoys identical dark-sky conditions in the second half of the nights near its maximum to the PAU. Its peak may not be quite so sharp as the single date here might imply, with perhaps similar ZHRs from July 28–30. Its rates have been suspected of some variability at times too, though not in the more recent investigations.

α-Capricornids (CAP)

Active: July 3–August 15; Maximum: July 30 ($\lambda_\odot = 127°$); ZHR = 4;
Radiant: $\alpha = 307°$, $\delta = -10°$; Radiant drift: see Table 6;
$V_\infty = 23$ km/s; $r = 2.5$;
TFC: $\alpha = 255°$ to $000°$, $\delta = 00°$ to $+15°$, choose pairs separated by about 30° in α ($\beta < 40°$ N);
IFC: $\alpha = 300°$, $\delta = +10°$ ($\beta > 45°$ N),
$\alpha = 320°$, $\delta = -05°$ ($\beta = 0°$ to 45° N),
$\alpha = 300°$, $\delta = -25°$ ($\beta < 0°$).

The CAP and SDA were both definitely detected visually in former years, standing out against the much weaker other radiants supposed active in Capricornus-Aquarius then. Whether the CAP can still be detected separately from the new ANT radiant area remains to be discovered, as its radiant now partly overlaps that of the large ANT oval region. The slightly slower speed of the α-Capricornids compared to the ANT may help distinguish them from the ecliptical background. In their favour, CAP meteors are noted for being bright, at times even of fireball-class, which, combined with their low apparent velocity, can make some of these objects among the most impressive and attractive an observer could wish for. A minor enhancement of CAP ZHRs to ~ 10 was noted in 1995 by European IMO observers. More recent results suggest the maximum may continue for an extra day, so perhaps from July 30–31 this year. The waxing gibbous Moon sets somewhat later for this interval than for the PAU and SDA, even so, between roughly 23^{h}–3^{h} (again, later moonsets occur at more southerly latitudes).

κ-Cygnids (KCG)

Active: August 3–25; Maximum: August 17 ($\lambda_\odot = 145°$); ZHR = 3;
Radiant: $\alpha = 286°$, $\delta = +59°$; Radiant drift: see Table 6;
$V_\infty = 25$ km/s; $r = 3.0$;
IFC: $\alpha = 330°$, $\delta = +60°$ and $\alpha = 300°$, $\delta = +30°$ ($\beta > 20°$ N).

The waning crescent Moon creates no problems for viewing the expected κ-Cygnid peak this year from northern hemisphere sites, where the shower is chiefly accessible. Its r-value suggests telescopic and video observers may benefit from the shower's presence, but visual and photographic workers should note that occasional slow fireballs from this source have been reported too. The almost stationary radiant results from its close proximity to the ecliptic north pole in Draco. There has been some suggestion of a variation in its activity at times, perhaps coupled with a periodicity in fireball sightings, but more data are needed on a shower that is often ignored in favour of the major Perseids during August.

Aurigid Showers

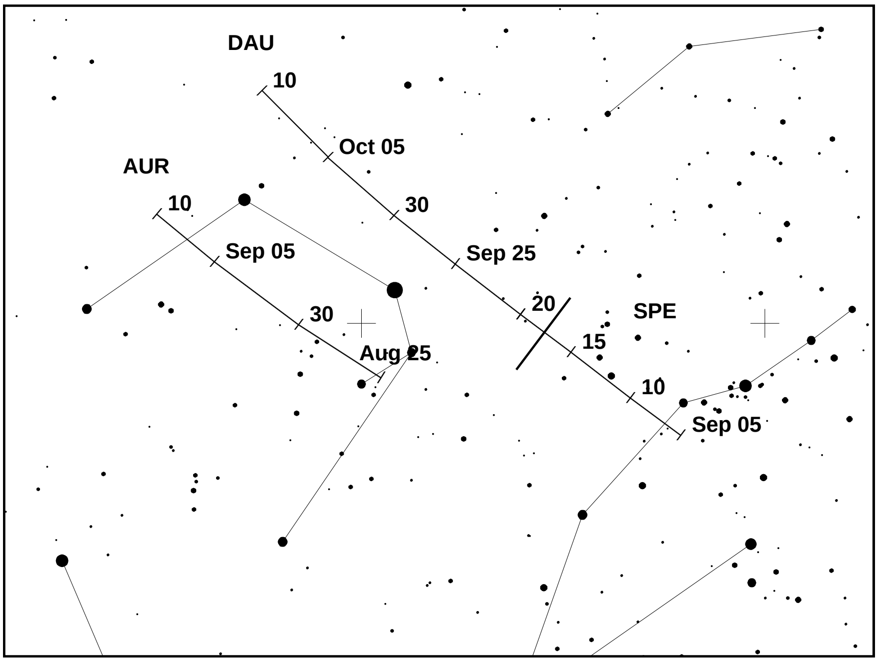
α-Aurigids (AUR)

Active: August 25–September 8; Maximum: September 1, 01^h UT ($\lambda_\odot = 158\overset{\circ}{.}6$); ZHR = 7;
Radiant: $\alpha = 84°$, $\delta = +42°$; Radiant drift: see Table 6;
$V_\infty = 66$ km/s; $r = 2.6$;
TFC: $\alpha = 052°$, $\delta = +60°$; $\alpha = 043°$, $\delta = +39°$ and $\alpha = 023°$, $\delta = +41°$ ($\beta > 10°$ S).

δ-Aurigids (DAU)

Active: September 18–October 10; Maximum: September 29 ($\lambda_\odot = 186°$), but see text;
ZHR = 3;
Radiant: $\alpha = 82°$, $\delta = +49°$; Radiant drift: see Table 6;
$V_\infty = 64$ km/s; $r = 2.9$;
TFC: As AUR.

Along with the September Perseids (SPE), these essentially northern hemisphere showers appear to be part of a series of poorly-observed sources with radiants around Aries, Perseus, Cassiopeia and Auriga, active from late August into October. IMO investigations using data collected since 1986 have suggested there are at least three showers which repeat annually, of which the AUR are the marginally stronger. Telescopic data to examine all the radiants in this region of sky – and possibly observe the telescopic β-Cassiopeids simultaneously – would be especially valuable, but still-imaging, video records and visual plotting would be welcomed too.



The AUR have produced short, unexpected outbursts at times, with EZHRs of $\sim$ 30–40 recorded in 1935, 1986 and 1994, although they have not been monitored regularly until very recently, so other events may have been missed. Only three watchers in total covered the 1986 and 1994 outbursts, for instance! While badly moonlit, the first predicted outburst happened roughly as expected in 2007, producing short-lived EZHRs of $\sim$ 130 for western North America, with many bright meteors. Radio data suggested there was a 'tail' to that event where more faint meteors continued for maybe an hour after the strongest peak, but visual observers could not confirm this, probably due to the moonlit sky. Both Aurigid radiants reach useful elevations after 23^h–0^h local time, and this year conditions are reasonably good for the AUR peak, with the waxing gibbous Moon setting between midnight and 2^h on August 31–September 1. No predictions for stronger activity had been made when this text was written, however.

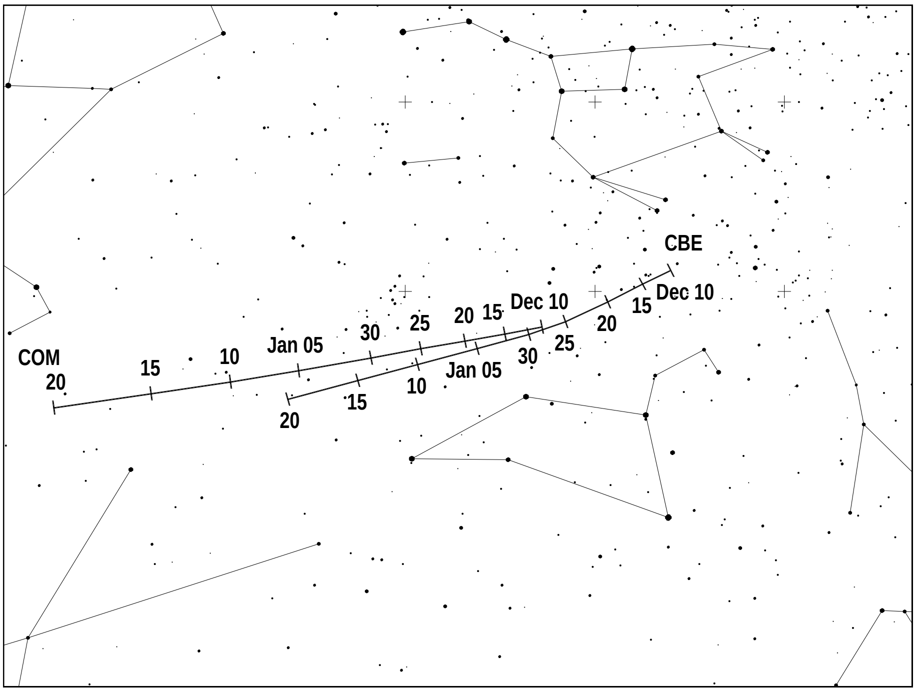
The DAU name has recently been adopted for the weaker segment of what may be a single shower, as its radiant and activity follow along directly from those of the September Perseids. At present, the showers should be treated as distinct in your observations. The DAU seem to give a weak and very ill-defined maximum between roughly $\lambda_\odot = 181°$–$191°$ (2009 September 24 to October 4). September 29 is simply the approximate middle of this peak interval, with a waxing gibbous Moon this year that will set before local midnight north of the equator. The later part of this possible maximum spell will see increasing moonlight problems as full Moon approaches on October 4.

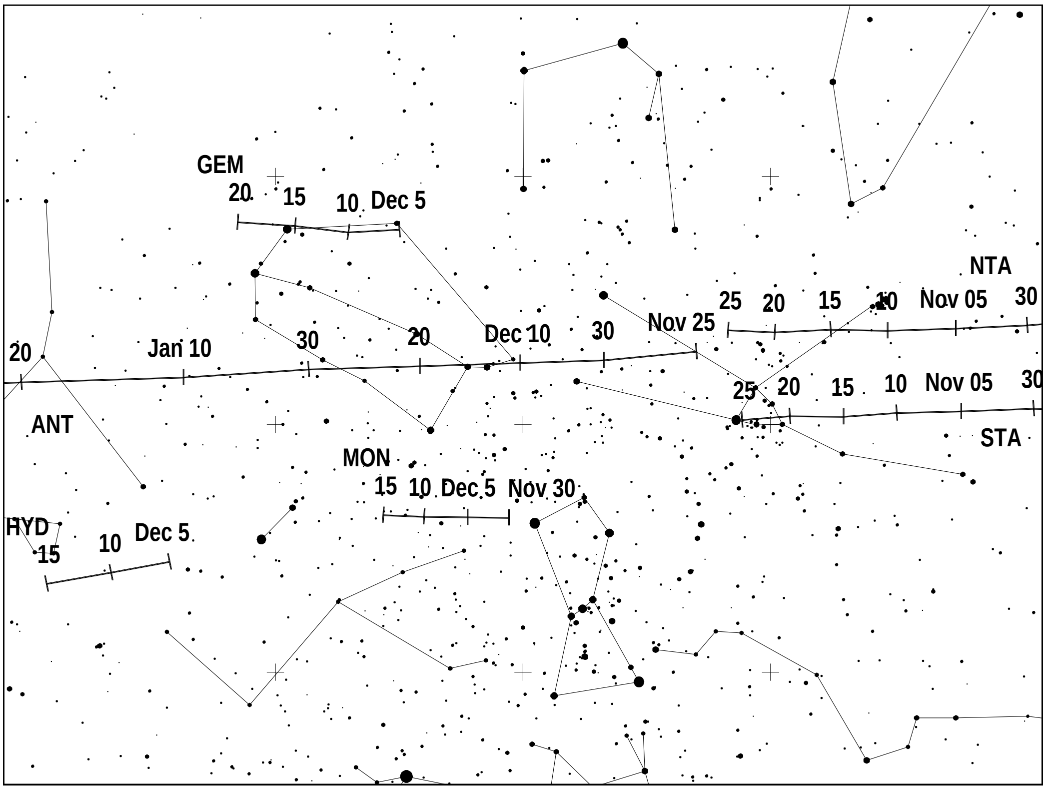
6 October to December

An excellent final quarter to the year beckons, with maxima from the all more active showers splendidly moonless. Only three less active shower peaks are lost to the bright Moon, those of the Southern Taurids, σ-Hydrids (December 12) and Coma Berenicids (probably around December 29, but see the notes below). The period near the possible Puppid-Velid early-December maximum/reference date, December 7, is also badly Moon-affected. The ANT starts the quarter effectively inactive in favour of the Taurids, but as the Taurids fade away, we should be able to again distinguish them from the sporadics as the sole ecliptical background from November 26, with a radiant centre position in eastern Taurus. During December, this centre tracks across southern Gemini, and although analyses indicate its likely ZHRs are < 2 for most of this time, some of this apparent inactivity may be due to the strength of the Geminids very close-by to the north during part of December, plus also the minor Monocerotids a little way to its south simultaneously.

October 5/6 meteors: Short-lived video outbursts were recorded in 2005 and 2006 by European observers, with activity from a north-circumpolar radiant near the 'tail' of Draco, around $\alpha \sim 165°$, $\delta \sim +78°$, on October 5/6. The 2005 event (only) was recorded very weakly by radio, but no visual results confirmed either occurrence, and no recurrence was reported in 2007. The 2008 repeat time was still to come when this was written. As the 2005/2006 events happened between $\lambda_\odot \sim 192\overset{\circ}{.}55$–$192\overset{\circ}{.}64$, this would be equivalent to 2009 October 5, 19^h20^m–21^h30^m UT, poorly timed for observing thanks to the bright Moon, full on October 4. The meteors showed an atmospheric velocity of ~ 45–50 km/s. If the active interval keeps to the same time, it would be best observed by video from Europe east across all of Asia.

Coma Berenicids (COM): As noted in the 2008 Shower Calendar, IMO single-station video data prepared just before the Calendar was printed, suggested probable COM activity was actually being detected from a radiant roughly 15° west of the position expected from data collected in past decades. It is still unclear if this is the same or a separate shower, nor is there information on whether it shows the same pattern of activity as the COM (e.g. maximum time, active dates). Although the recently-identified visual peak timing near the end of December is badly moonlit, observers at other times during this long-lasting minor shower should be aware of this possible radiant discrepancy, and report any meteors from the 'old' radiant as 'COM', but those meteors with similar shower parameters radiating from the 'new' video radiant should be given as 'CBE', to separate the two sources in your data. In critical cases, the CBE radiant should be preferred for shower association, due to its more reliably-determined location. For clarity, the radiant chart here shows both the 'old' and 'new' Coma radiants."





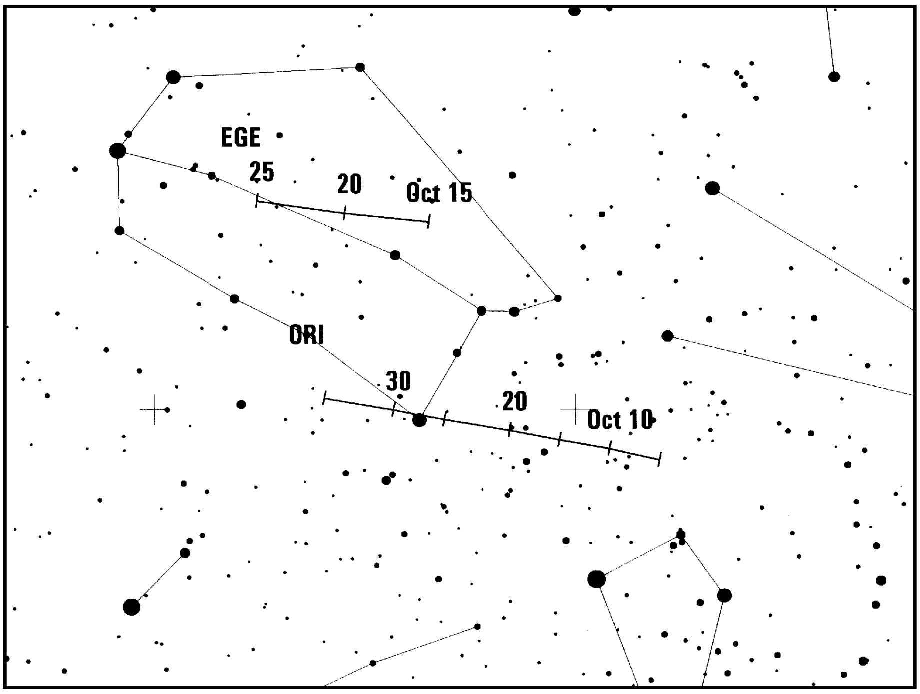
Draconids (DRA)

Active: October 6–10; Maximum: October 8, $16^{h}40^{m}$ UT ($\lambda_{\odot} = 195\overset{\circ}{.}4$,), but see text;
ZHR = periodic, up to storm levels;
Radiant: $\alpha = 262°$, $\delta = +54°$; Radiant drift: negligible;
$V_{\infty} = 20$ km/s; $r = 2.6$;
TFC: $\alpha = 290°$, $\delta = +65°$ and $\alpha = 288°$, $\delta = +39°$ ($\beta > 30°$ N).

The Draconids are primarily a periodic shower which produced spectacular, brief, meteor storms twice last century, in 1933 and 1946, and lower rates in several other years (ZHRs $\sim$ 20–500+). Most detected showers were in years when the stream's parent comet, 21P/Giacobini-Zinner, returned to perihelion, as it did last in 2005 July. Its orbital period is currently about 6.6 years. In 2005 October, a largely unexpected outburst happened near the comet's nodal crossing time, around $\lambda_\odot = 195\overset{\circ}{.}40$–$195\overset{\circ}{.}44$, probably due to material shed in 1946. Visual ZHRs were ~ 35, though radar detections suggested a much higher estimated rate, closer to ~ 150. The peak was found in radio results too, but it did not record especially strongly that way. Outlying maximum times from the recent past have spanned from $\lambda_\odot = 195\overset{\circ}{.}075$ (in 1998; EZHRs ~ 700), equivalent to 2009 October 8, 8^h45^m UT, through the nodal passage time above, to $\lambda_\odot = 195\overset{\circ}{.}63$–$195\overset{\circ}{.}76$ (a minor outburst in 1999, not a perihelion-return year; ZHRs $\sim$ 10–20), equating to 2009 October 8, 22^h15^m to October 9, 1^h30^m UT. The radiant is circumpolar from many northern hemisphere locations, but is higher in the pre-midnight and near-dawn hours of early October. For such sites, the waning gibbous moonrise allows a short dark-sky interval after dusk for observing on both dates. Draconid meteors are exceptionally slow-moving, a characteristic which helps separate genuine shower meteors from sporadics accidentally lining up with the radiant.

ε-Geminids (EGE)

Active: October 14–27; Maximum: October 18 ($\lambda_\odot = 205°$); ZHR = 2;
Radiant: $\alpha = 102°$, $\delta = +27°$; Radiant drift: see Table 6;
$V_\infty = 70$ km/s; $r = 3.0$;
TFC: $\alpha = 090°$, $\delta = +20°$ and $\alpha = 125°$, $\delta = +20°$ ($\beta > 20°$ S).



A minor shower with characteristics and activity nearly coincident with the Orionids, so great care must be taken to separate the two sources by instrumental techniques – especially video or telescopic work – or visual plotting. While it was suspected that the shower's activity had been overestimated due to misaligned Orionids, a recent video investigation by Sirko Molau did find distinct activity from this source. New Moon creates perfect observing circumstances, an ideal opportunity to obtain more data on them from either hemisphere, though northern observers have a radiant elevation advantage thanks to an area of sky that can be usefully accessed from about midnight onwards.

Orionids (ORI)

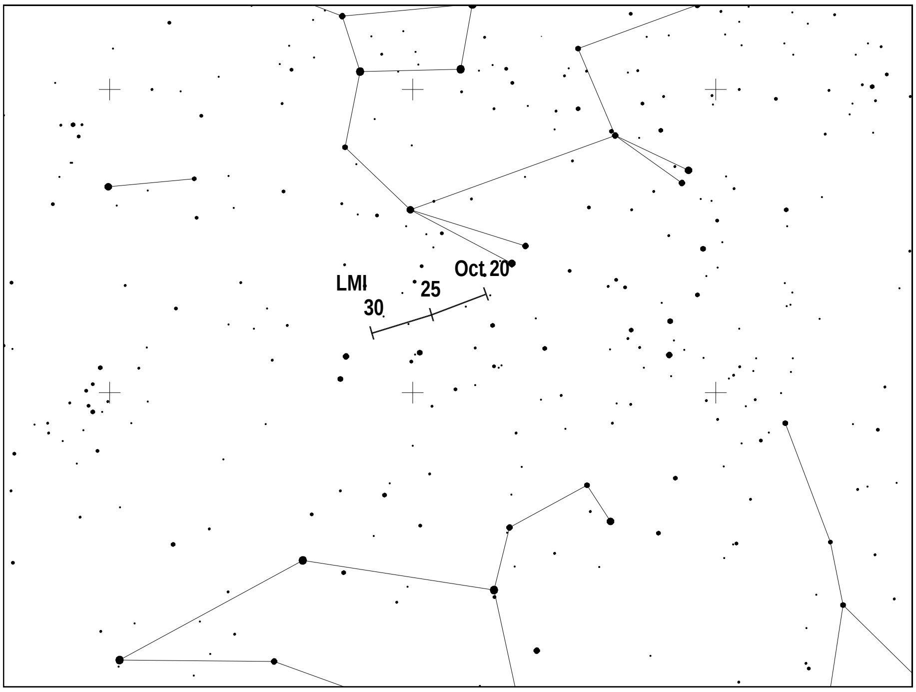
Active: October 2–November 7; Maximum: October 21 ($\lambda_\odot = 208°$); ZHR = 30;
Radiant: $\alpha = 095°$, $\delta = +16°$; Radiant drift: see Table 6;
$V_\infty = 66$ km/s; $r = 2.4$;
TFC: $\alpha = 100°$, $\delta = +39°$ and $\alpha = 075°$, $\delta = +24°$ ($\beta > 40°$ N);
or $\alpha = 080°$, $\delta = +01°$ and $\alpha = 117°$, $\delta = +01°$ ($\beta < 40°$ N).

October's new Moon also perfectly favours the Orionids at their peak in 2009. The shower's radiant, near the celestial equator, is at a useful elevation by around local midnight in either hemisphere, somewhat before in the north, so most of the world can enjoy the shower. Both 2006 and 2007 produced unexpectedly strong Orionid rates, with ZHRs better than the normal peak seen on two or three consecutive nights, at best up to 50–70. The 2006 return also produced a good number of bright Orionids. IMO analyses of the shower, most recently by Jürgen Rendtel using data from 1979–2006, have found both the peak ZHR and r parameters varied somewhat from year to year, but with maximum ZHRs usually around 20–25, and an average r of 2.4. An earlier IMO examination by Audrius Dubietis seemed to partly confirm a suspected 12-year periodicity in stronger returns found earlier in the 20th century. That would suggest better returns again in the 2008–2010 interval, thus perhaps best ZHRs should be around 30 this year. The strong 2006–07 returns seem to have had a separate resonant cause, and a further enhancement was anticipated for 2008 (still to come when this was prepared). However, this was not expected to repeat in 2009, so it will be particularly interesting to see what takes place this time. The Orionids were always noted for having several lesser maxima other than their main one, helping activity sometimes to remain roughly constant for several consecutive nights centred on this peak. In 1993 and 1998, a submaximum about as strong as the normal peak was detected on October 17/18 from Europe, for instance. All observers should be aware of these possibilities, as observing circumstances are equally favourable for covering October 17/18 beneath dark skies this time too. Several visual subradiants had been reported in the past, but recent video work suggests the radiant is far less complex; photographic, telescopic and video work to confirm this would be useful, as visual observers have clearly had problems with the shower's radiant determination before.

Leo Minorids (LMI)

Active: October 19–27; Maximum: October 23 ($\lambda_\odot = 210°$); ZHR = 2;
Radiant: $\alpha = 161°$, $\delta = +38°$; Radiant drift: See Table 6;
$V_\infty = 62$ km/s; $r = 3.0$;
TFC: $\alpha = 190°$, $\delta = +58°$ and $\alpha = 135°$, $\delta = +30°$ ($\beta > 40°$ N).

This weak minor shower has a peak ZHR apparently on or below the visual threshold. Imaging results have found signs of a radiant near the proposed position, but there is almost no reliable information on the shower's more probable active interval. Recent IMO video results analysed by Sirko Molau, searching for radiants without using known shower data, confirmed the radiant from multiple-station work, and found a maximum around $\lambda_\odot = 210°$. The radiant area can be seen only from the northern hemisphere, where it rises around midnight. The proposed maximum date has a waxing crescent Moon, which will have set long before radiant-rise, so giving the best-possible opportunity to confirm if the shower can be usefully observed visually. Telescopic, imaging or very careful visual plotting observations are advised.



Taurids

Southern Taurids (STA)

Active: September 25–November 25; Maximum: November 5 ($\lambda_\odot = 223°$); ZHR = 5;
Radiant: $\alpha = 52°$, $\delta = +15°$; Radiant drift: see Table 6;
$V_\infty = 27$ km/s; $r = 2.3$;
TFC: Choose fields on the ecliptic and $\sim 10°$ E or W of the radiants ($\beta > 40°$ S).

Northern Taurids (NTA)

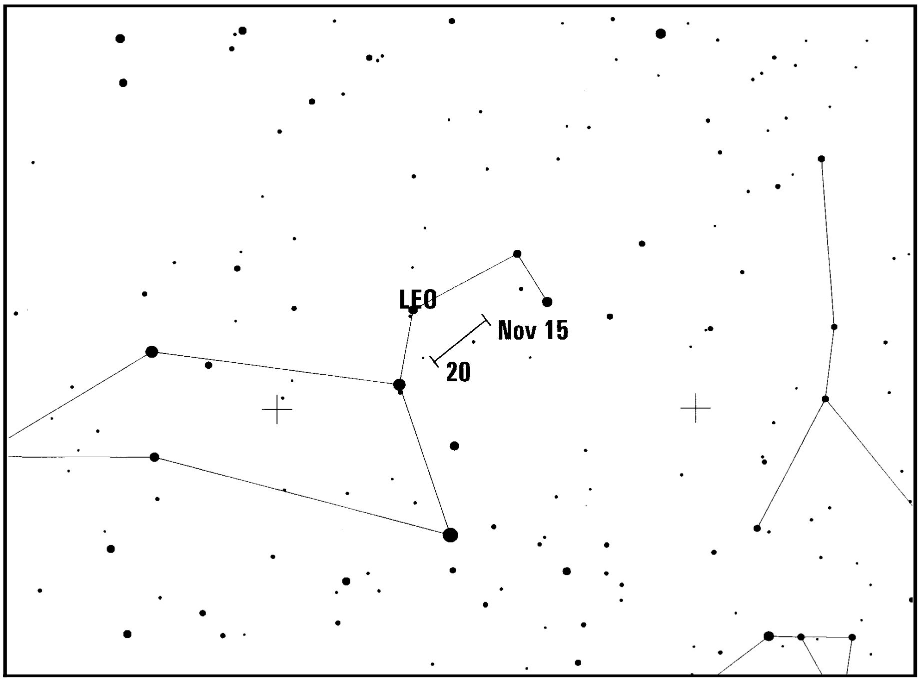
Active: September 25–November 25; Maximum: November 12 ($\lambda_\odot = 230°$); ZHR = 5;
Radiant: $\alpha = 58°$, $\delta = +22°$; Radiant drift: see Table 6;
$V_\infty = 29$ km/s; $r = 2.3$;
TFC: as Southern Taurids.

These two streams form part of the complex associated with Comet 2P/Encke. Defining their radiants is best achieved by careful visual or telescopic plotting, or imaging recordings, since they are large and diffuse. For shower association, each radiant should be considered an oval area of $\sim 20° \times 10°$, right ascension times declination, centred on the radiant position for any given date. Their activity clearly dominates the Antihelion Source area's during the northern autumn, so much so that the ANT is considered inactive while they are present. The brightness and relative slowness of many shower meteors makes them ideal targets for still-imaging, while these factors coupled with low, steady, combined Taurid rates makes them excellent subjects for newcomers to practice their plotting techniques on. The activity of both showers produces an apparently plateau-like maximum for about ten days in early November, and they have a reputation for producing some excellently bright fireballs at times, although seemingly not in every year. As remarked earlier in the April to June quarterly notes, David Asher's studies have indicated that increased Taurid fireball rates probably result from a 'swarm' of larger particles within the Taurid stream complex, which in 2005 most recently produced a lot of, occasionally very brilliant, fireballs, and enhanced combined ZHRs of $\sim$ 10–15 that persisted from about

October 29 to November 10. The anticipated 2008 'swarm' return was still to come when this Calendar was in preparation, but no prediction for a repeat was in-force for 2009, perhaps just as well, with full Moon dominating the late October to early November core period (including the STA maximum) this time. The NTA peak has only a waning crescent Moon, however. With near-ecliptic radiants, all meteoricists can observe these streams, albeit northern hemisphere observers are somewhat better-placed, as here suitable radiant zenith distances persist for much of the night, though from the southern hemisphere, a good 3–5 hours' watching around local midnight is possible with Taurus well above the horizon.

Leonids (LEO)

Active: November 10–21; Maximum: November 18, $15^{\rm h}10^{\rm m}$ UT
(nodal crossing at $\lambda_\odot = 235\overset{\circ}{.}27$), but see below; ZHR = 100+?;
Radiant: $\alpha = 152°$, $\delta = +22°$; Radiant drift: see Table 6;
$V_\infty = 71$ km/s; $r = 2.9$;
TFC: $\alpha = 140°$, $\delta = +35°$ and $\alpha = 129°$, $\delta = +06°$ ($\beta > 35°$ N); or
$\alpha = 156°$, $\delta = -03°$ and $\alpha = 129°$, $\delta = +06°$ ($\beta < 35°$ N).
IFC: $\alpha = 120°$, $\delta = +40°$ before $0^{\rm h}$ local time ($\beta > 40°$ N);
$\alpha = 120°$, $\delta = +20°$ before $4^{\rm h}$ local time and $\alpha = 160°$, $\delta = 00°$ after $4^{\rm h}$ ($\beta > 0°$ N);
$\alpha = 120°$, $\delta = +10°$ before $0^{\rm h}$ local time and $\alpha = 160°$, $\delta = -10°$ ($\beta < 0°$ N).



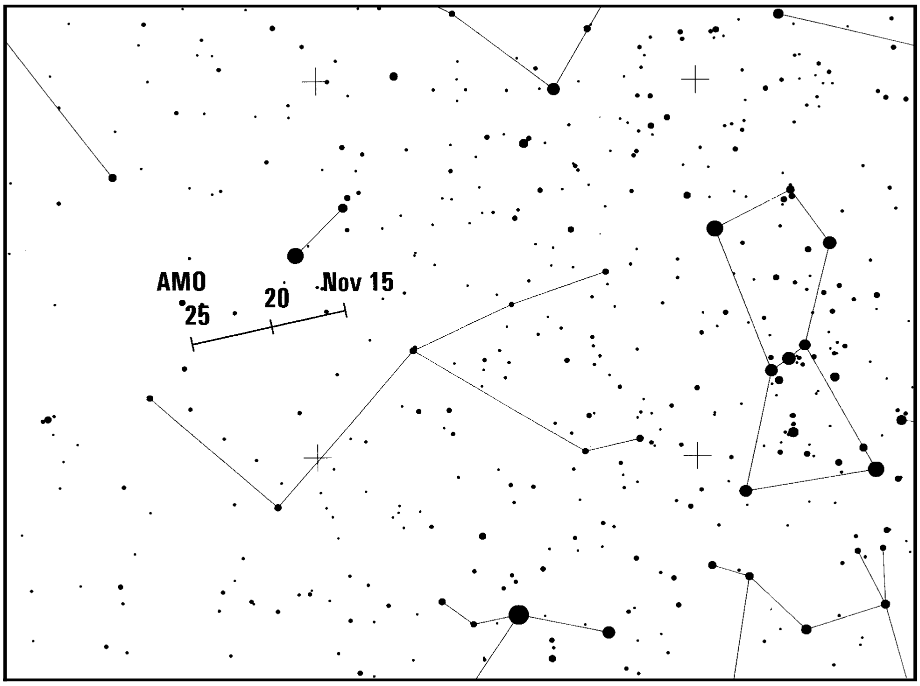
The most recent perihelion passage of the Leonids' parent comet, 55P/Tempel-Tuttle, in 1998 may be more than a decade ago now, but the shower's activity has continued to be fascinatingly variable from year to year. This year may produce another enhanced return, with ZHRs predicted to peak at 100+ according to independent theoretical work by David Asher, Esko Lyytinen & Marku Nissinen, Mikhail Maslov, and Jérémie Vaubaillon. Trails laid down by the comet in 1466 and 1533 are expected to be the chief contributors to whatever happens, with peaks on November 17, due at sometime from about $20^{\rm h}40^{\rm m}$ to $22^{\rm h}$ UT then. Esko & Marku's work suggests the 1466 trail may produce heightened rates generally, with ZHRs above 20, from about $6^{\rm h}30^{\rm m}$ UT on November 17 till $0^{\rm h}30^{\rm m}$ UT on November 18, and likely above ~ 40 from $\sim 16^{\rm h}$–$23^{\rm h}$ UT on November 17. This increased ZHR level will probably combine with that from the 1533 trail to push ZHRs up perhaps towards 120 at some stage between $21^{\rm h}$–$22^{\rm h}$ UT on the 17th. Mikhail suggested ZHRs should peak in that hour too, with ZHRs of $\sim$ 130–140, but Jérémie's modelling implied the chance of a possible meteor storm, with ZHR peaks around $21^{\rm h}44^{\rm m}$ (ZHRs $\sim$ 950+) and $21^{\rm h}51^{\rm m}$ UT ($\sim$ 600) combining to give a rate perhaps in the 1000–1500 range briefly. Other submaxima with lower rates are possible too, around November 17, $7^{\rm h}26^{\rm m}$ (ZHRs $\sim$ 200+), $9^{\rm h}$ ($\sim$ 25–30), November 18, $0^{\rm h}04^{\rm m}$ ($\sim$ 15) and $19^{\rm h}$ UT ($\sim$ 10–15, faint meteors), according to some of these same researchers. The nodal crossing time listed above is another possible peak, based on previous non-enhanced returns, though its ZHR is likely to be a more modest 10–20.

Clearly, the evening to early morning UT hours of November 17/18 are likely to be of greatest observer interest. Luckily, new Moon on November 16 ensures perfectly dark skies for covering whatever events happen (remembering that there are no guarantees in meteor work!). As the Leonid radiant rises usefully only around local midnight (or indeed afterwards south of the equator), the $21^{\rm h}$–$22^{\rm h}$ UT apparently critical interval will fall best chiefly for sites across Asia, from the extreme east of Europe eastwards to Japan and places at similar longitudes, but with the possibility of some unusual activity at almost any stage from $\sim 6^{\rm h}$–$24^{\rm h}$ UT on November 17, only European and African longitudes look set to miss out. Even here, radio coverage of the shower will be possible for part of that time. Of course, other possible maxima are not excluded (look out for updates nearer the time), and observers should be alert as often as conditions allow throughout the shower, in case something unexpected happens. All observing techniques can be usefully employed.

α-Monocerotids (AMO)

Active: November 15–25; Maximum: November 21, $15^{\rm h}25^{\rm m}$ UT ($\lambda_\odot = 239\overset{\circ}{.}32$);
ZHR = variable, usually ~ 5, but may produce outbursts to $\sim 400+$;
Radiant: $\alpha = 118°$, $\delta = +01°$; Radiant drift: see Table 6;
$V_\infty = 65$ km/s; $r = 2.4$;
TFC: $\alpha = 115°$, $\delta = +23°$ and $\alpha = 129°$, $\delta = +20°$ ($\beta > 20°$ N); or
$\alpha = 110°$, $\delta = -27°$ and $\alpha = 098°$, $\delta = +06°$ ($\beta < 20°$ N).

A late-year shower capable of producing surprises, the α-Monocerotids gave their most recent brief outburst in 1995 (the top EZHR, $\sim$ 420, lasted just five minutes; the entire outburst 30 minutes). Many observers across Europe witnessed it, and we were able to completely update the known shower parameters as a result. At the time, there was a proposed ten-year periodicity in such returns, but this passed unconfirmed when nothing unusual took place during the moonlit shower of 2005. The latest investigation by Esko Lyytinen, based on the same modelling concept that predicted the 2007 α-Aurigid outburst, suggests the main AMO trail will not cross over the Earth's orbit again until 2017 and 2020, but unfortunately, the Earth will not be near those points in November, so nothing is likely to be seen as a result. There is the possibility a weak return may happen in November 2019, ahead of the 2020 encounter, depending on how broad the trail may be. Esko suggested the next strong AMO outburst is unlikely before 2043. Despite this, observers should monitor this source closely in every year possible, in case of unanticipated events. The theoretical AMO outburst stream trail is relatively near the Earth from late 2006 to late 2009, for instance. The brevity of all past outbursts means breaks under clear skies should be kept to an absolute minimum near the predicted peak. The waxing crescent Moon causes no problems this year, because the AMO radiant is well on view from either hemisphere only after about 23^h local time, long after moonset. If correct, the peak timing would fall well for sites from the Far East and Australia, east across the Pacific Ocean to Alaskan longitudes.



Phoenicids (PHO)

Active: November 28–December 9; Maximum: December 6, 9^{h}30^m UT ($\lambda_\odot = 254\overset{\circ}{.}25$);
ZHR = variable, usually 3 or less, may reach 100;
Radiant: $\alpha = 018°$, $\delta = -53°$; Radiant drift: see Table 6;
$V_\infty = 18$ km/s; $r = 2.8$;
TFC: $\alpha = 040°$, $\delta = -39°$ and $\alpha = 065°$, $\delta = -62°$ ($\beta < 10°$ N).

Only one impressive Phoenicid return has so far been reported, that of its discovery in 1956, when the EZHR was probably ~ 100, possibly with several peaks spread over a few hours. Three other potential bursts of lower activity have been reported, but never by more than one observer, under uncertain circumstances. Reliable data is virtually nonexistent in the IMO's Visual Meteor Database, and the data stored are insufficient to compute an actual ZHR profile, but a quiet-year level of 2–3 meteors an hour is suggested at maximum. This may be a periodic shower however, and more observations of it are needed by all methods. From the southern hemisphere (only), the Phoenicid radiant culminates at dusk, remaining well on view for most of the night, and the waning gibbous Moon on December 6 allows some dark-sky evening observing through till moonrise at about 22^{h}30^m–23^h local time for mid-southern latitudes. The Phoenicids' very low velocity should make them readily distinguishable from spuriously-aligned sporadics.

Monocerotids (MON)

Active: November 27–December 17; Maximum: December 9 ($\lambda_\odot = 257°$); ZHR = 2;
Radiant: $\alpha = 100°$, $\delta = +08°$; Radiant drift: see Table 6;
$V_\infty = 42$ km/s; $r = 3.0$;
TFC: $\alpha = 088°$, $\delta = +20°$ and $\alpha = 135°$, $\delta = +48°$ ($\beta > 40°$ N); or $\alpha = 120°$, $\delta = -03°$ and $\alpha = 084°$, $\delta = +10°$ ($\beta < 40°$ N).

Only low rates are likely from this very minor source, making accurate visual plotting, telescopic or video work essential, particularly because its meteors are normally faint. The shower's details, even including the radiant position, are rather uncertain. Recent IMO data showed only weak signs of a maximum as indicated above. Telescopic results have suggested a later maximum, around $\lambda_\odot \sim 264°$, 2009 December 16, from a radiant at $\alpha = 117°$, $\delta = +20°$. Last quarter Moon rises around local midnight across the globe near the possible December 9 peak, which leaves the first half of the night for observing then, given that the radiant area is on-show virtually all night, though it culminates after moonrise this year, at about 1^h30^m local time. The December 16 peak would be still more favourable, coinciding with new Moon.

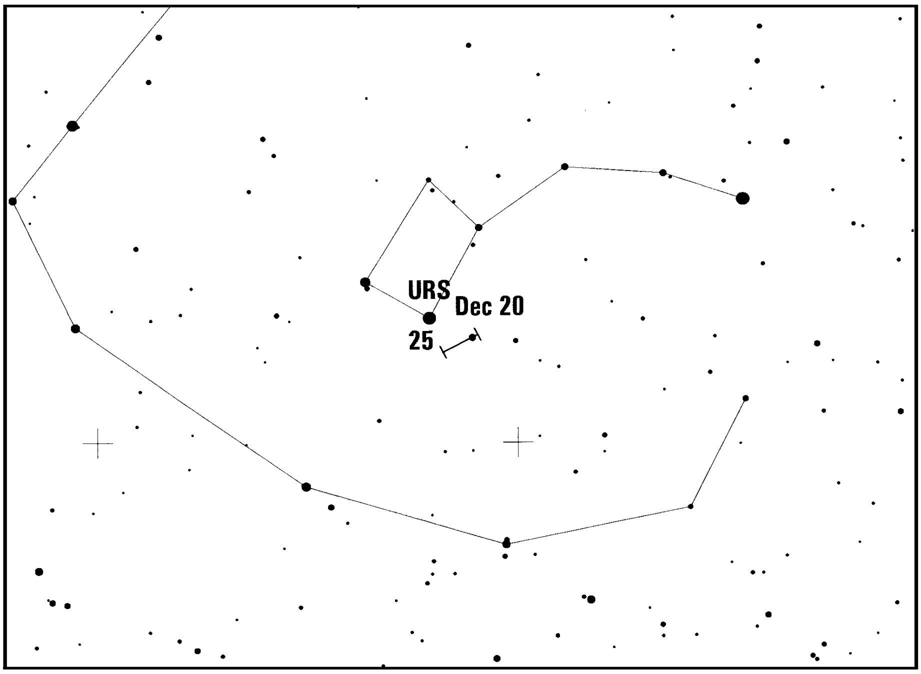
Geminids (GEM)

Active: December 7–17; Maximum: December 14, 5^h10^m UT ($\lambda_\odot = 262\overset{\circ}{.}2$) $\pm$ 2.3h;
ZHR = 120;
Radiant: $\alpha = 112°$, $\delta = +33°$; Radiant drift: see Table 6;
$V_\infty = 35$ km/s; $r = 2.6$;
TFC: $\alpha = 087°$, $\delta = +20°$ and
$\alpha = 135°$, $\delta = +49°$ before 23^h local time,
$\alpha = 087°$, $\delta = +20°$ and $\alpha = 129°$, $\delta = +20°$ after 23^h local time ($\beta > 40°$ N);
$\alpha = 120°$, $\delta = -03°$ and $\alpha = 084°$, $\delta = +10°$ ($\beta < 40°$ N).
IFC: $\alpha = 150°$, $\delta = +20°$ and $\alpha = 060°$, $\delta = +40°$ ($\beta > 20°$ N);
$\alpha = 135°$, $\delta = -05°$ and $\alpha = 080°$, $\delta = 00°$ ($\beta < 20°$ N).

One of the finest, and probably the most reliable, of the major annual showers presently observable, whose peak this year is virtually coincident with new Moon. The Geminid radiant culminates around 2^h local time, but well north of the equator it rises about sunset, and is at a usable elevation from the local evening hours onwards, while in the southern hemisphere, the radiant appears only around local midnight or so. Even from more southerly sites, this is a splendid shower of often bright, medium-speed meteors, a rewarding sight for all watchers, whatever method they employ. The peak has shown slight signs of variability in its rates and timing in recent years, with the more reliably-observed maxima during the past two decades all having occurred within 2h20m of the time given above. The main predicted timing favours places from all across the Americas eastwards to western Europe and western Africa. An earlier or later timing would extend this best-visible zone some way eastwards or westwards respectively. Some mass-sorting within the stream means the fainter telescopic meteors should be most abundant almost 1° of solar longitude (about one day) ahead of the visual maximum, with telescopic results indicating such meteors radiate from an elongated region, perhaps with three sub-centres. Further results on this topic would be useful.

Ursids (URS)

Active: December 17–26; Maximum: December 22, 13^h30^m UT ($\lambda_\odot = 270\overset{\circ}{.}7$);
ZHR = 10 (occasionally variable up to 50);
Radiant: $\alpha = 217°$, $\delta = +76°$; Radiant drift: see Table 6;
$V_\infty = 33$ km/s; $r = 3.0$;
TFC: $\alpha = 348°$, $\delta = +75°$ and $\alpha = 131°$, $\delta = +66°$ ($\beta > 40°$ N);
$\alpha = 063°$, $\delta = +84°$ and $\alpha = 156°$, $\delta = +64°$ ($\beta = 30°$ to $40°$ N).



A very poorly-observed northern hemisphere shower, but one which has produced at least two major outbursts in the past 70 years, in 1945 and 1986. Several other rate enhancements, recently in 1988, 1994, 2000, 2006 and 2007 (when EZHRs in badly moonlit skies peaked around 35, at a time about as predicted, some 20 hours after the usual maximum), have been reported as well. Other similar events could easily have been missed due to poor weather or too few observers active. All forms of observation can be used for the shower, since many of its meteors are faint, but with relatively little work carried out on the Ursids, it is impossible to be precise in making statements about it. The radio maximum in 1996 occurred around $\lambda_{\odot} = 270\overset{\circ}{.}8$, for instance, which might suggest a slightly later maximum time in 2009 of December 22, $\sim 16^{\rm h}$ UT. Models developed by Esko Lyytinen and Jérémie Vaubaillon have suggested the relative proximity of the stream's parent comet, 8P/Tuttle, last at perihelion in January 2008, seems to have been what influenced the 2006 and 2007 events. Jérémie's model further indicated that there could be another peak in 2009, around $7^{\rm h}14^{\rm m}$ UT on December 22, with ZHRs of maybe 14, which, although fairly typical for the shower overall, would be at a significantly different time to normal should they occur. The Ursid radiant is circumpolar from most northern sites (thus fails to rise for most southern ones), though it culminates after daybreak, and is highest in the sky later in the night. The waxing crescent Moon should cause few difficulties for observing whatever takes place on December 22. The $\sim 7^{\rm h}$ UT timing would be best observed from sites in North America westwards to most of the North Pacific Ocean, while the $13^{\rm h}30^{\rm m}$–$16^{\rm h}$ UT timing would be more favourable for places in Asia east to central North America.

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, all of which have notably larger radiant areas. The optimum $\alpha \times \delta$ size to be assumed for each radiant of the two Taurid showers is instead $20° \times 10°$, while that for the Antihelion Source 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.

$h\backslash D$	$V_\infty = 25$ km/s					$V_\infty = 40$ km/s					$V_\infty = 60$ km/s				
	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 Abbreviations

- α, δ: Coordinates for a shower's radiant position, usually at maximum. α 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.

- r: The population index, a term computed from each shower's meteor magnitude distribution. $r = 2.0$–2.5 is brighter than average, while r above 3.0 is fainter than average.

- $\lambda_\odot$: 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.

- V_∞: 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 with the shower radiant overhead. This figure is given in terms of meteors per hour. Where meteor activity persisted at a high level for less than an hour, or where observing circumstances were very poor, an estimated ZHR (EZHR) is used, which is less accurate than the normal ZHR.

- TFC and IFC: Suggested telescopic and still-imaging (including photographic) field centres respectively. β is the observer's latitude ('$<$' means 'south of' and '$>$' means 'north of'). *Pairs* of telescopic fields must be observed, alternating about every half hour, so that the positions of radiants can be defined. The exact choice of TFC or IFC depends on the observer's location and the elevation of the radiant. Note that the TFCs are also useful centres to use for video camera fields as well.

Table 4. Lunar phases for 2009.

New Moon	First Quarter	Full Moon	Last Quarter
	January 4	January 11	January 18
January 26	February 2	February 9	February 16
February 25	March 4	March 11	March 18
March 26	April 2	April 9	April 17
April 25	May 1	May 9	May 17
May 24	May 31	June 7	June 15
June 22	June 29	July 7	July 15
July 22	July 28	August 6	August 13
August 20	August 27	September 4	September 12
September 18	September 26	October 4	October 11
October 18	October 26	November 2	November 9
November 16	November 24	December 2	December 9
December 16	December 24	December 31	

Table 5. Working List of Visual Meteor Showers. Details in this Table were correct according to the best information available in May 2008, with maximum dates accurate only for 2009. Except for the Antihelion Source, all other showers are listed in order of their maximum solar longitude. An asterisk ('*') in the 'Shower' column indicates that source may have additional peak times, as noted in the text above. The parenthesized maximum date for the Puppids-Velids indicates a reference date for the radiant only, not necessarily a true maximum. Some showers have ZHRs that vary from year to year. The most recent reliable figure is given here, except for possibly periodic showers. These are either are noted as 'Var' = variable, where there is considerable uncertainty over the likely maximum rates, or with an asterisk to indicate the value is that suggested from theoretical considerations for the current year. For more information, contact the IMO's Visual Commission.

Shower	Activity	Maximum Date	Maximum $\lambda_\odot$	Radiant α	Radiant δ	V_∞ km/s	r	ZHR
Antihelion Source (ANT)	Nov 26–Sep 24	March–April, late May, late June	–	see Table 6		30	3.0	4
Quadrantids (QUA)	Jan 01–Jan 05	Jan 03	283°.16	230°	+49°	41	2.1	120
α-Centaurids (ACE)	Jan 28–Feb 21	Feb 07	319°.2	211°	−59°	56	2.0	5
δ-Leonids (DLE)	Feb 15–Mar 10	Feb 25	336°	168°	+16°	23	3.0	2
γ-Normids (GNO)	Feb 25–Mar 22	Mar 13	353°	239°	−50°	56	2.4	4
Lyrids (LYR)	Apr 16–Apr 25	Apr 22	32°.32	271°	+34°	49	2.1	18
π-Puppids (PPU)	Apr 15–Apr 28	Apr 23	33°.5	110°	−45°	18	2.0	Var
η-Aquariids (ETA)	Apr 19–May 28	May 06	45°.5	338°	−01°	66	2.4	85*
η-Lyrids (ELY)	May 03–May 12	May 09	48°.4	287°	+44°	44	3.0	3
June Bootids (JBO)	Jun 22–Jul 02	Jun 27	95°.7	224°	+48°	18	2.2	Var
Piscis Austrinids (PAU)	Jul 15–Aug 10	Jul 28	125°	341°	−30°	35	3.2	5
South. δ-Aquariids (SDA)	Jul 12–Aug 19	Jul 28	125°	339°	−16°	41	3.2	20
α-Capricornids (CAP)	Jul 03–Aug 15	Jul 30	127°	307°	−10°	23	2.5	4
Perseids (PER)*	Jul 17–Aug 24	Aug 12	140°.0	48°	+58°	59	2.6	100
κ-Cygnids (KCG)	Aug 03–Aug 25	Aug 17	145°	286°	+59°	25	3.0	3
α-Aurigids (AUR)	Aug 25–Sep 08	Sep 01	158°.6	84°	+42°	66	2.6	7
September Perseids (SPE)	Sep 05–Sep 17	Sep 09	166°.7	60°	+47°	64	2.9	5
δ-Aurigids (DAU)	Sep 18–Oct 10	Sep 29	186°	82°	+49°	64	2.9	3
Draconids (DRA)	Oct 06–Oct 10	Oct 08	195°.4	262°	+54°	20	2.6	Var
ε-Geminids (EGE)	Oct 14–Oct 27	Oct 18	205°	102°	+27°	70	3.0	2
Orionids (ORI)	Oct 02–Nov 07	Oct 21	208°	95°	+16°	66	2.5	30*
Leo Minorids (LMI)	Oct 19–Oct 27	Oct 23	210°	161°	+38°	62	3.0	2
Southern Taurids (STA)	Sep 25–Nov 25	Nov 05	223°	52°	+15°	27	2.3	5
Northern Taurids (NTA)	Sep 25–Nov 25	Nov 12	230°	58°	+22°	29	2.3	5
Leonids (LEO)	Nov 10–Nov 23	Nov 17	235°.27	152°	+22°	71	2.5	100+*
α-Monocerotids (AMO)	Nov 15–Nov 25	Nov 21	239°.32	117°	+01°	65	2.4	Var
Dec Phoenicids (PHO)	Nov 28–Dec 09	Dec 06	254°.25	18°	−53°	18	2.8	Var
Puppid/Velids (PUP)	Dec 01–Dec 15	(Dec 07)	(255°)	123°	−45°	40	2.9	10
Monocerotids (MON)	Nov 27–Dec 17	Dec 09	257°	100°	+08°	42	3.0	2
σ-Hydrids (HYD)	Dec 03–Dec 15	Dec 12	260°	127°	+02°	58	3.0	3
Geminids (GEM)	Dec 07–Dec 17	Dec 14	262°.2	112°	+33°	35	2.6	120
Ursids (URS)	Dec 17–Dec 26	Dec 22	270°.7	217°	+76°	33	3.0	10
Coma Berenicids, (CBE)[2]	Dec 12–Jan 23	Dec 30	278°	170°	+26°	65	3.0	5

[2]New position and date of maximum

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

Date															
Date		**ANT**		**QUA**		**CBE**									
Dec	31	112°	+21°	228°	+50°	171°	+26°								
Jan	5	117°	+20°	231°	+49°	175°	+24°								
Jan	10	122°	+19°			181°	+22°								
Jan	15	127°	+17°			185°	+19°								
Jan	20	132°	+16°			189°	+17°								
Jan	25	138°	+15°					**ACE**							
Jan	30	143°	+13°					200°	−57°						
Feb	5	149°	+11°					208°	−59°						
Feb	10	154°	+9°					214°	−60°	**DLE**					
Feb	15	159°	+7°					220°	−62°	159°	+19°				
Feb	20	164°	+5°	**GNO**				225°	−63°	164°	+18°				
Feb	28	172°	+2°	225°	-51°					171°	+15°				
Mar	5	177°	0°	230°	-50°					176°	+13°				
Mar	10	182°	−2°	235°	-50°					180°	+12°				
Mar	15	187°	−4°	240°	-50°										
Mar	20	192°	−6°	245°	-49°										
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°					332°	−3°	**ELY**					
May	05	237°	−20°					337°	−1°	283°	+44°				
May	10	242°	−21°					341°	+1°	288°	+44°				
May	15	247°	−22°					345°	+3°	293°	+45°				
May	20	252°	−22°					349°	+5°						
May	25	256°	−23°					353°	+7°						
May	30	262°	−23°												
Jun	5	267°	−23°												
Jun	10	272°	−23°												
Jun	15	276°	−23°												
Jun	20	281°	−23°	**JBO**											
Jun	25	286°	−22°	223°	+48°										
Jun	30	291°	−21°	225°	+47°	**CAP**									
Jul	5	296°	−20°			285°	−16°	**SDA**							
Jul	10	300°	−19°	**PER**		289°	−15°	325°	−19°	**PAU**					
Jul	15	305°	−18°	6°	+50°	294°	−14°	329°	−19°	330°	−34				
Jul	20	310°	−17°	11°	+52°	299°	−12°	333°	−18°	334°	−33				
Jul	25	315°	−15°	22°	+53°	303°	−11°	337°	−17°	338°	−31				
Jul	30	319°	−14°	29°	+54°	307°	−10°	340°	−16°	343°	−29	**KCG**			
Aug	5	325°	−12°	37°	+56°	313°	−8°	345°	−14°	348°	−27	283°	+58°		
Aug	10	330°	−10°	45°	+57°	318°	−6°	349°	−13°	352°	−26	284°	+58°		
Aug	15	335°	−8°	51°	+58°			352°	−12°			285°	+59°		
Aug	20	340°	−7°	57°	+58°	**AUR**		356°	−11°			286°	+59°		
Aug	25	344°	−5°	63°	+58°	76°	+42°					288°	+60°		
Aug	30	349°	−3°			82°	+42°	**SPE**				289°	+60°		
Sep	5	355°	−1°			88°	+42°	55°	+46°						
Sep	10	0°	+1°			92°	+42°	60°	+47°						
Sep	15	5°	+3°					66°	+48°	**DAU**					
Sep	20	10°	+5°	**NTA**		**STA**		71°	+48°	71°	+48°				
Sep	25	14°	+7°	19°	+11°	21°	+6°			77°	+49°				
Sep	30			22°	+12°	25°	+7°	**ORI**		83°	+49°				
Oct	5			26°	+14°	28°	+8°	85°	+14°	89°	+49°			**DRA**	
Oct	10	**EGE**		30°	+15°	32°	+9°	88°	+15°	95°	+49°			262°	+54°
Oct	15	99°	+27°	34°	+16°	36°	+11°	91°	+15°			**LMI**			
Oct	20	104°	+27°	38°	+18°	40°	+12°	94°	+16°			158°	+39°		
Oct	25	109°	+27°	43°	+19°	43°	+13°	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°			147°	+24°			**AMO**	
Nov	15			61°	+23°	60°	+16°			150°	+23°			112°	+2°
Nov	20	**ANT**		65°	+24°	64°	+16°			153°	+21°			116°	+1°
Nov	25	75°	+23°	70°	+24°	72°	+17°	**MON**		**PHO**		**PUP**		120°	0°
Nov	30	80°	+23°	**GEM**				91°	+8°	14°	−52°	120°	−45°	**HYD**	
Dec	5	85°	+23°	103°	+33°	**CBE**		96°	+8°	18°	−53°	122°	−45°	122°	+3°
Dec	10	90°	+23°	108°	+33°	153°	+34°	100°	+8°	22°	−53°	125°	−45°	126°	+2°
Dec	15	96°	+23°	113°	+33°	157°	+33°	104°	+8°	**URS**		128°	−45°	130°	+1°
Dec	20	101°	+23°	118°	+32°	161°	+30°			217°	+76°				
Dec	25	106°	+22°			166°	+28°			217°	+74°				
Dec	30	111°	+21°			170°	+26°								

Table 7. Working List of Daytime Radio Meteor Showers. An asterisk ('*') in the 'Max date' column indicates that source may have additional peak times, as noted in the text above. The 'Best Observed' columns give the approximate local mean times between which a four-element antenna at an elevation of 45° receiving a signal from a 30 kW transmitter 1000 km away should record at least 85% of any suitably positioned radio-reflecting meteor trails for the appropriate latitudes. Note that this is often heavily dependent on the compass direction in which the antenna is pointing, however, and applies only to dates near the shower's maximum. An asterisk in the 'Rate' column shows the suggested rate may not recur in all years.

Shower	Activity	Max Date	$\lambda_\odot$ 2000	Radiant α	Radiant δ	Best observed 50° N	Best observed 35° S	Rate
Cap/Sagittariids	Jan 13–Feb 04	Feb 01*	312°.5	299°	−15°	11^h–14^h	09^h–14^h	Medium*
χ-Capricornids	Jan 29–Feb 28	Feb 13*	324°.7	315°	−24°	10^h–13^h	08^h–15^h	Low*
Piscids (Apr)	Apr 08–Apr 29	Apr 20	30°.3	7°	+07°	07^h–14^h	08^h–13^h	Low
δ-Piscids	Apr 24–Apr 24	Apr 24	34°.2	11°	+12°	07^h–14^h	08^h–13^h	Low
ε-Arietids	Apr 24–May 27	May 09	48°.7	44°	+21°	08^h–15^h	10^h–14^h	Low
Arietids (May)	May 04–Jun 06	May 16	55°.5	37°	+18°	08^h–15^h	09^h–13^h	Low
o-Cetids	May 05–Jun 02	May 20	59°.3	28°	−04°	07^h–13^h	07^h–13^h	Medium*
Arietids	May 22–Jul 02	Jun 07*	76°.7	44°	+24°	06^h–14^h	08^h–12^h	High
ζ-Perseids	May 20–Jul 05	Jun 09*	78°.6	62°	+23°	07^h–15^h	09^h–13^h	High
β-Taurids	Jun 05–Jul 17	Jun 28	96°.7	86°	+19°	08^h–15^h	09^h–13^h	Medium
γ-Leonids	Aug 14–Sep 12	Aug 25	152°.2	155°	+20°	08^h–16^h	10^h–14^h	Low*
Sextantids	Sep 09–Oct 09	Sep 27*	184°.3	152°	00°	06^h–12^h	06^h–13^h	Medium*

9 Useful addresses

For more information on observing techniques, and when submitting results, please contact the appropriate IMO Commission Director:

Fireball Data Center (FIDAC): André Knöfel, Am Observatorium 2, D-15848 Lindenberg, Germany; e-mail: `aknoefel@minorplanets.de`

Photographic Commission: Vacant. Questions can be sent to e-mail: `photo@imo.net`

Radio Commission: Jean-Louis Rault, Société Astronomique de France, 16 Rue de la Valleé, 91360 Epinay sur Orge, France. e-mail: `f6agr@orange.fr`

Telescopic Commission: Malcolm Currie, 25 Collett Way, Grove, Wantage, Oxfordshire, OX12 0NT, UK; e-mail: `mjc@star.rl.ac.uk`

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

Visual Commission: Rainer Arlt, Friedenstraße 5, D-14109 Potsdam, Germany; e-mail: `rarlt@aip.de`

or contact IMO's Homepage on the World-Wide-Web at: `http://www.imo.net`

For further details on **IMO membership**, please write to: Robert Lunsford, IMO Secretary-General, 1828 Cobblecreek Street, Chula Vista, CA 91913-3917, USA; `lunro.imo.usa@cox.net`

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