The Astonomy & Nightscape Photographer's Handbook

2026

SE NSW

E VIC

Edition

Joseph Cali

Above: *The great Aurora of May 11, 2024, now called the" Gannon event," was a spectacular bright aurora observed all over the world in to tropical latitudes in both hemispheres. Eastern Australia was covered in thick cloud. Joe Cali travelled to Hay in central south NSW to get a whole night of clear skies. The solar maximum continues into 2026 so stay tuned for more auroral displays. Below: Silo art at Weethalle painted by Heesco Khosnaran, with Milky Way behind. Pentax K5, ISO 3200, 20s, Pentax 12mmED f4*

Front cover: *The comet C/2023 A3 (Tsuchinshan-ATLAS) put on quite a show in late September and October 2024. The front cover image is a tracked and stacked image with a Pentax K1 DSLR ISO 800 17 exposures of 30s with a Rokinon 135mm ED f2 lens.*

Astrophotography and Astronomical Nightscape Handbook SE NSW/E VIC Region Edition 2026

Compiled & Edited by Joe Cali
https://joe-cali.com

Above: *"The Zodiacal Light," single image captured at Cooper Creek Camp on the Birdsville Track just near the inflow to Kati Thanda. Pentax K1 DSLR with Samyang 14mm f2.8 lens. ISO 1600, 50s. Camera uses its own image stabiliser to track the stars.*

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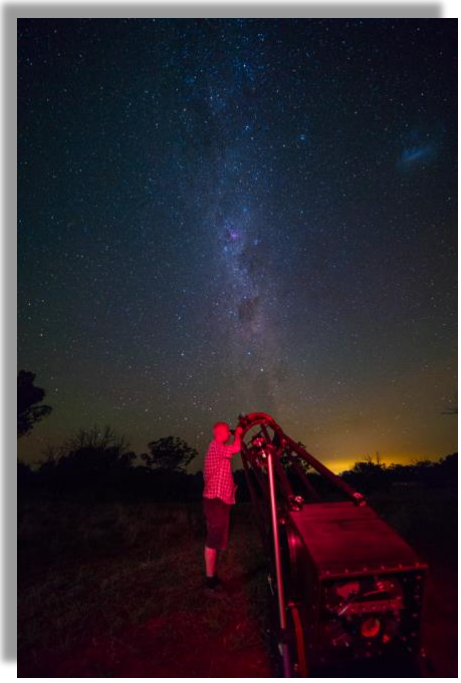
Introduction

Why this handbook?

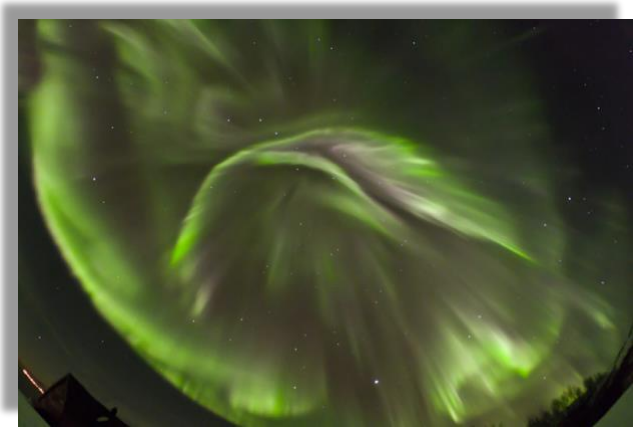
Many smartphone apps can give you rise and set and other information for a specific day, usually the current day, I find it annoying to scroll forward to future dates. I farm online resources to produce an annual almanac of rise/set and other useful planning information that I use for forward planning of my nightscape workshops and astronomical observing activities in the local region. I use it for planning workshops and for deep sky observing weekends I host for friends a few times per year. I have produced a collection of such information each year for many years but only shared with a few close friends. It's genesis lies in small bespoke handbooks I used to produce for eclipse chases with my late friend, Bengt Alfredsson of Sweden. Rise and set tables switch from standard to daylight savings time on the appropriate dates. Times are calculated for Canberra, centroid of the wide target area. You may think, but, but, but, I live in Sydney. Well, you should be doing your observing from the clear dark skies out west rather than whining about all the cloud on the coast. Failing that, subtract about 10 mins from the tabulated times for Canberra. I have to add 2 mins for Young. **My sincere thanks to Glenn Hughes of Sydney for proof reading the draft.**

About me



I have been an avid observer of all things astronomical and a keen photographer since the 1970's. I built my first telescope when I was 15, and my last scope ....well, I guess I haven't built or even planned it yet.

I really enjoy the meditative solitude of spending a whole night alone under the stars watching the Earth revolving. However, I equally love sharing it with close friends or introducing new people to the joys of the night sky. I have observed 15 total solar eclipses, many of them with my late friend, Bengt Alfredsson of Sweden seen in the photo above viewing through my 18 inch telescope on his last visit to Australia in 2018 a year before his death.



***Photos. Top left**, Bengt Alfredsson observing Omega Centauri through my 18" reflector. **Top right,** In March 2015, we observed a total solar eclipse from Svalbard, only 800km from the north pole at a chilly 22^{o}C below zero.*
***Above left:** A sky filling aurora lit the entire sky, and snow-covered ground beneath us on Kvaløya, Norway just one week before the 2015 total solar eclipse on Svalbard.*

Joseph Cali

Public Holidays NSW

Holiday	DATE
New Year's Day	Thursday 1 January 2026
Australia Day	Monday 26 January 2026
Good Friday	Friday 3 April 2026
Easter Saturday	Saturday 4 April 2026
Easter Sunday	Sunday 5 April 2026
Easter Monday	Monday 6 April 2026
Anzac Day	Saturday 25 April 2026
King's Birthday	Monday 8 June 2026
Bank Holiday	Monday 3 August 2026
Labour Day	Monday 5 October 2026
Christmas Day	Friday 25 December 2026
Boxing Day	Saturday 26 December 2026
Additional Day	Monday 28 December 2026

ACT PUBLIC HOLIDAYS 2026

The following public holidays will be observed in the Australian Capital Territory during 2026.

Public holiday	Date to be observed
New Year's Day	Thursday 1 January 2026
Australia Day	Monday 26 January 2026
Canberra Day	Monday 9 March 2026
Good Friday	Friday 3 April 2026
Easter Saturday – the day after Good Friday	Saturday 4 April 2026
Easter Sunday	Sunday 5 April 2026
Easter Monday	Monday 6 April 2026
ANZAC Day	Saturday 25 April 2026
Reconciliation Day	Monday 1 June 2026*
King's Birthday	Monday 8 June 2026
Labour Day	Monday 5 October 2026
Christmas Day	Friday 25 December 2026
Boxing Day	Saturday 26 and Monday 28 December 2026**

* /** Additional days compensate for weekend holiday

Daylight Savings Switchovers ACT/NSW/VIC/TAS

ENDS: Sunday, April 5 when clocks are moved back an hour at 3:00 am

BEGINS: Sunday, October 4 when clocks are moved forward an hour at 2:00 am

Moon Phases 2026

Moon Calendar 2026 with all the **moon phases** of the year. Check here all the moon phases of every month of 2026 in *Australia*.

2026 Moon Perigee and Apogee Distances (micromoons and super moons)

Perigee			Apogee		
Jan 1	21:45	360347 km F−1d12h	Jan 13	20:49	405436 km N−4d23h
Jan 29	21:54	365877 km F−3d 0h	Feb 10	16:54	404576 km N−6d19h
Feb 24	23:20	370131 km F−6d12h	Mar 10	13:44	404384 km F+7d 2h
Mar 22	11:41	366856 km N+3d10h	Apr 7	8:33	404973 km F+5d 6h
Apr 19	6:58	361630 km N+1d19h	May 4	22:32	405841 km F+3d 5h
May 17	13:49	358073 km N+ 17h	Jun 1	4:34	406368 km + F+ 19h
Jun 14	23:19	357195 km N− 3h	Jun 28	7:12	406266 km + F−1d16h
Jul 13	7:51	359110 km N−1d 1h	Jul 25	16:46	405548 km F−3d21h
Aug 10	11:20	363287 km N−2d 6h	Aug 22	8:22	404642 km F−5d19h
Sep 6	20:27	368254 km N−4d 7h	Sep 19	3:02	404216 km F−7d13h
Oct 1	20:42	369336 km F+5d 3h	Oct 16	22:57	404638 km N+6d 7h
Oct 28	18:02	364410 km F+2d13h	Nov 13	17:51	405618 km N+4d10h
Nov 25	20:59	359346 km F+1d 6h	Dec 11	6:47	406420 km −− N+2d 5h
Dec 24	8:31	356649 km ++ F+ 7h			

Full moon larger diameter: Jan 1, Nov 25, Dec 24
Full moons small diameter: Jun 1, Jun 28

Moon Phases 2026 (UT)

New	Full
2025 Dec 20 1:44	2026 Jan 3 10:04
2026 Jan 18 19:53	2026 Feb 1 22:11
2026 Feb 17 12:03	2026 Mar 3 11:39
2026 Mar 19 1:26	2026 Apr 2 2:13
2026 Apr 17 11:54	2026 May 1 17:25
2026 May 16 20:03	2026 May 31 8:47
2026 Jun 15 2:56	2026 Jun 29 23:58
2026 Jul 14 9:45	2026 Jul 29 14:37
2026 Aug 12 17:38	2026 Aug 28 4:20
2026 Sep 11 3:27	2026 Sep 26 16:50
2026 Oct 10 15:50	2026 Oct 26 4:13
2026 Nov 9 7:03	2026 Nov 24 14:55
2026 Dec 9 0:53	2026 Dec 24 1:30
2027 Jan 7 20:25	

SOURCE: FOURMILAB Lunar apogee and perigee calculator
https://www.fourmilab.ch/earthview/pacalc.html

WORKSHOPS

Joe Cali - Mirador de la Crucetita, Argentina, 2019 Photo: Terry Cuttle.

Field trip image by Min Lush; Pentax K5 12mm f4

I am now running my **"Nightscape & Star Trails"** workshop twice a year as a combination of 3 x 90 min zoom sessions, prior to a field night of 3-6 hours at a very dark sky location, followed by a zoom session to review and discuss results and processing techniques. There is not enough time to include instruction in processing techniques however, all participants are given password access to a range of my online astrophotography image processing tutorials using Lightroom and Photoshop and I will demonstrate processing of selected images during the review session, a recording of this session and all other sessions is available.

I may be offering a total lunar eclipse photography workshop in Canberra or the Central West on the evening of March 3rd, 2026.

Because this publication is prepared well in advance of 2026, no workshops are currently scheduled to run out of the Photoaccess Art Centre in 2026 but they will be advertised on the Photoaccess booking page when scheduled. I usually aim to commence these courses in mid-March and mid August. Check the workshops page in Feb for the lunar eclipse workshop, March and early August for the nightscape workshops.
https://www.photoaccess.org.au/workshops/classes/

2026 Sky Event Almanac

Australian Eastern Standard Time

January - June

Date	AEST (h:m)	Even
Jan 02	07:43	Moon at Perigee: 360348 km
03	20:03	FULL MOON
04	03	Earth at Perihelion: 0.98330 AU
04	08	Quadrantid Meteor Shower
04	08:01	Jupiter 3.7°S of Moon
04	13:28	Pollux 3.0°N of Moon
06	21	Mercury at Aphelion
07	02	Venus at Superior Conjunction
07	02:20	Regulus 0.5°S of Moon
07	21:22	Moon at Descending Node
09	20	Mars in Conjunction with Sun
10	18	Jupiter at Opposition
11	01:48	LAST QUARTER MOON
11	09:50	Spica 1.6°N of Moon
14	06:48	Moon at Apogee: 405437 km
15	05:28	Antares 0.6°N of Moon
19	05:52	NEW MOON
22	02	Mercury at Superior Conjunction
22	10:03	Moon at Ascending Node
23	06	Venus at Aphelion
23	22:31	Saturn 4.3°S of Moon
26	14:47	FIRST QUARTER MOON
28	07:07	Pleiades 1.1°S of Moon
30	07:53	Moon at Perigee: 365878 km
31	12:31	Jupiter 3.8°S of Moon
31	23:45	Pollux 3.0°N of Moon
Feb 02	08:09	FULL MOON
03	12:48	Regulus 0.4°S of Moon
04	05:18	Moon at Descending Node
07	18:26	Spica 1.8°N of Moon
09	22:43	LAST QUARTER MOON
11	02:52	Moon at Apogee: 404577 km
11	13:19	Antares 0.7°N of Moon
17	22:01	NEW MOON
17	22:12	Annular Solar Eclipse; mag=0.963
18	16:19	Moon at Ascending Node
19	09:03	Mercury 0.1°N of Moon: Occn.
19	21	Mercury at Perihelion
20	04	Mercury at Greatest Elong: 18.1°E
20	09:54	Saturn 4.6°S of Moon
24	12:43	Pleiades 1.2°S of Moon
24	22:28	FIRST QUARTER MOON
25	09:18	Moon at Perigee: 370132 km
27	16:26	Jupiter 4.0°S of Moon
28	07:34	Pollux 3.0°N of Moon
Mar 02	22:00	Regulus 0.4°S of Moon
03	14:35	Moon at Descending Node
03	21:34	Total Lunar Eclipse; mag=1.151
03	21:38	FULL MOON
07	03:24	Spica 1.8°N of Moon
07	21	Mercury at Inferior Conjunction
10	21:32	Antares 0.7°N of Moon
10	23:43	Moon at Apogee: 404385 km
11	19:39	LAST QUARTER MOON
16	05	Mercury 3.4°N of Mars
18	00:07	Mercury 2.0°N of Moon
18	01:22	Moon at Ascending Node
18	07:51	Mars 1.5°S of Moon
19	11:23	NEW MOON
20	22:39	Venus 4.6°S of Moon
21	00:46	Vernal Equinox
22	20	Neptune in Conjunction with Sun
22	21:40	Moon at Perigee: 366858 km
23	18:32	Pleiades 1.1°S of Moon
25	18	Saturn in Conjunction with Sun
26	05:18	FIRST QUARTER MOON
26	17	Mars at Perihelion: 1.38126 AU
26	22:13	Jupiter 3.9°S of Moon
27	13:18	Pollux 3.0°N of Moon
30	05:00	Regulus 0.4°S of Moon
30	21:34	Moon at Descending Node
Apr 02	12:12	FULL MOON
03	11:32	Spica 1.8°N of Moon
04	09	Mercury at Greatest Elong: 27.8°W
07	05:21	Antares 0.6°N of Moon
07	18:32	Moon at Apogee: 404974 km
10	14:52	LAST QUARTER MOON
14	09:43	Moon at Ascending Node
16	10:45	Mars 3.7°S of Moon
17	21:52	NEW MOON
19	16:57	Moon at Perigee: 361631 km
19	18:49	Venus 4.8°S of Moon
20	02:28	Pleiades 1.0°S of Moon
20	05	Mars 1.2°N of Saturn
20	20	Mercury 0.5°S of Saturn
21	08	Mercury 1.7°S of Mars
23	05	Lyrid Meteor Shower
23	08:06	Jupiter 3.6°S of Moon
23	18:59	Pollux 3.2°N of Moon

July - December

Date	AEST (h:m)	Even
Jul 01	20	Mercury at Aphelion
04	17:51	Moon at Ascending Node
07	04	Earth at Aphelion: 1.01664 AU
08	05:29	LAST QUARTER MOON
10	00:36	Venus 0.9°N of Regulus
11	08:54	Pleiades 1.1°S of Moon
13	11	Mercury at Inferior Conjunction
13	17:50	Moon at Perigee: 359111 km
14	19:43	NEW MOON
17	10:07	Regulus 0.5°N of Moon
17	10:27	Moon at Descending Node
18	02:31	Venus 2.0°N of Moon
21	13:21	Spica 2.4°N of Moon
21	21:06	FIRST QUARTER MOON
25	07:00	Antares 0.6°N of Moon
26	02:45	Moon at Apogee: 405549 km
28	20	Delta-Aquarid Meteor Shower
29	22	Jupiter in Conjunction with Sun
30	00:36	FULL MOON
31	21:54	Moon at Ascending Node
Aug 02	18	Mercury at Greatest Elong: 19.5°W
06	12:21	LAST QUARTER MOON
07	16:23	Pleiades 1.2°S of Moon
09	15:31	Mars 4.4°S of Moon
10	21:18	Moon at Perigee: 363288 km
11	08:38	Pollux 3.6°N of Moon
11	22:48	Mercury 2.1°S of Moon
13	03:37	NEW MOON
13	03:46	Total Solar Eclipse; mag=1.039
13	12	Perseid Meteor Shower
13	19:56	Moon at Descending Node
14	19	Mercury at Perihelion
15	16	Venus at Greatest Elong: 45.9°E
16	18:47	Venus 2.1°N of Moon
17	21:49	Spica 2.4°N of Moon
20	12:46	FIRST QUARTER MOON
21	14:18	Antares 0.6°N of Moon
22	18:20	Moon at Apogee: 404644 km
28	03	Mercury at Superior Conjunction
28	04:47	Moon at Ascending Node
28	14:13	Partial Lunar Eclipse; mag=0.930
28	14:18	FULL MOON
Sep 01	23:24	Venus 1.2°S of Spica
03	22:03	Pleiades 1.2°S of Moon
04	17:51	LAST QUARTER MOON
07	04:24	Mars 3.0°S of Moon
07	06:26	Moon at Perigee: 368255 km
07	16:32	Pollux 3.6°N of Moon
09	04:13	Jupiter 0.8°S of Moon: Occn.
10	05:17	Moon at Descending Node
10	05:36	Regulus 0.5°N of Moon
11	13:27	NEW MOON
14	06:53	Spica 2.4°N of Moon
14	21:10	Venus 0.5°S of Moon: Occn.
17	22:18	Antares 0.6°N of Moon
19	06:44	FIRST QUARTER MOON
19	13:00	Moon at Apogee: 404217 km
23	10:06	Autumnal Equinox
24	12:40	Moon at Ascending Node
26	10	Neptune at Opposition
26	11:49	Mercury 0.8°N of Spica
27	02:49	FULL MOON
Oct 01	03:39	Pleiades 1.1°S of Moon
02	06:41	Moon at Perigee: 369338 km
03	23:25	LAST QUARTER MOON
04	22	Saturn at Opposition
04	22:27	Pollux 3.8°N of Moon
05	15:30	Mars 1.2°S of Moon: Occn.
06	20:18	Jupiter 0.2°S of Moon: Occn.
07	11:19	Moon at Descending Node
07	12:57	Regulus 0.6°N of Moon
11	01:50	NEW MOON
12	12:30	Venus 3.1°S of Moon
12	20	Mercury at Greatest Elong: 25.2°E
13	06:08	Mercury 2.1°N of Moon
15	06:25	Antares 0.4°N of Moon
17	08:56	Moon at Apogee: 404639 km
19	02:13	FIRST QUARTER MOON
21	18:53	Moon at Ascending Node
22	04	Orionid Meteor Shower
24	13	Venus at Inferior Conjunction
26	14:12	FULL MOON
28	11:11	Pleiades 1.0°S of Moon
29	04:01	Moon at Perigee: 364411 km
Nov 01	04:00	Pollux 4.0°N of Moon
02	06:28	LAST QUARTER MOON
03	00:23	Mars 1.1°N of Moon: Occn.
03	09:11	Jupiter 0.5°N of Moon: Occn.

2026 Sky Event Almanac

Australian Eastern Standard Time

January - June

	24	12:32	FIRST QUARTER MOON
	24	14:17	Venus 3.4°S of Pleiades
	26	10:37	Regulus 0.2°S of Moon
	27	00:36	Moon at Descending Node
	30	18:17	Spica 1.8°N of Moon
May	02	03:23	FULL MOON
	04	12:20	Antares 0.5°N of Moon
	05	08:30	Moon at Apogee: 405843 km
	05	18	Eta-Aquarid Meteor Shower
	10	07:10	LAST QUARTER MOON
	11	14:36	Moon at Ascending Node
	15	00	Mercury at Superior Conjunction
	15	14	Venus at Perihelion
	17	06:01	NEW MOON
	17	23:48	Moon at Perigee: 358074 km
	18	20	Mercury at Perihelion
	19	11:50	Venus 2.9°S of Moon
	20	22:39	Jupiter 3.1°S of Moon
	21	02:30	Pollux 3.4°N of Moon
	23	02	Uranus in Conjunction with Sun
	23	16:41	Regulus 0.0°N of Moon
	23	21:11	FIRST QUARTER MOON
	24	01:26	Moon at Descending Node
	28	00:09	Spica 1.9°N of Moon
	31	18:32	Antares 0.4°N of Moon
	31	18:45	FULL MOON
Jun	01	14:32	Moon at Apogee: 406369 km
	07	16:19	Moon at Ascending Node
	08	02:17	Venus 4.6°S of Pollux
	08	20:00	LAST QUARTER MOON
	10	06	Venus 1.6°N of Jupiter
	13	23:15	Pleiades 1.0°S of Moon
	15	09:18	Moon at Perigee: 357196 km
	15	12:54	NEW MOON
	16	06	Mercury at Greatest Elong: 24.5°E
	17	05:32	Mercury 2.6°S of Moon
	17	12:08	Pollux 3.6°N of Moon
	17	16:54	Jupiter 2.5°S of Moon
	18	06:21	Venus 0.3°S of Moon: Occn.
	20	00:31	Regulus 0.3°N of Moon
	20	03:57	Moon at Descending Node
	21	18:25	Summer Solstice
	22	07:55	FIRST QUARTER MOON
	24	06:11	Spica 2.2°N of Moon
	25	22	Mercury 3.8°S of Jupiter
	28	00:32	Antares 0.5°N of Moon
	28	17:11	Moon at Apogee: 406267 km
	29	04:32	Mars 4.3°S of Pleiades
	30	09:57	FULL MOON

July - December

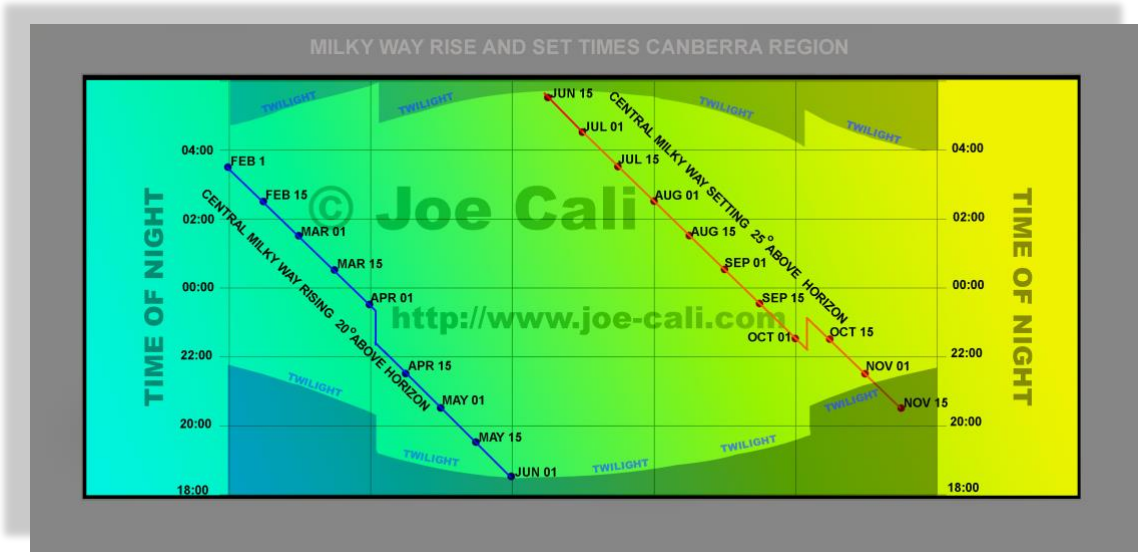
	03	13:02	Moon at Descending Node
	03	18:40	Regulus 0.8°N of Moon
	05	00	Mercury at Inferior Conjunction
	06	05	S Taurid Meteor Shower
	07	21:31	Venus 1.1°N of Moon: Occn.
	07	22:40	Spica 2.4°N of Moon
	09	17:02	NEW MOON
	10	19	Mercury at Perihelion
	10	23:49	Venus 0.1°S of Spica
	11	13:58	Antares 0.3°N of Moon
	13	04	N Taurid Meteor Shower
	14	03:50	Moon at Apogee: 405619 km
	16	14	Mars 1.2°N of Jupiter
	17	21:48	FIRST QUARTER MOON
	17	21:49	Moon at Ascending Node
	18	10	Leonid Meteor Shower
	21	09	Mercury at Greatest Elong: 19.6°W
	24	21:18	Pleiades 0.9°S of Moon
	25	00:53	FULL MOON
	25	17:47	Mars 1.6°N of Regulus
	26	06:58	Moon at Perigee: 359348 km
	26	09	Uranus at Opposition
	28	11:27	Pollux 4.2°N of Moon
	30	13:34	Moon at Descending Node
	30	19:18	Jupiter 1.2°N of Moon: Occn.
Dec	01	00:35	Regulus 1.1°N of Moon
	01	05:32	Mars 3.3°N of Moon
	01	16:09	LAST QUARTER MOON
	05	04:36	Spica 2.5°N of Moon
	09	10:52	NEW MOON
	11	16:46	Moon at Apogee: 406421 km
	13	01:35	Jupiter 1.3°N of Regulus
	14	23:04	Moon at Ascending Node
	14	23	Geminid Meteor Shower
	17	15:43	FIRST QUARTER MOON
	22	06:50	Winter Solstice
	22	08:37	Pleiades 1.0°S of Moon
	23	08	Ursid Meteor Shower
	24	11:28	FULL MOON
	24	18	Mercury at Aphelion
	24	18:30	Moon at Perigee: 356650 km
	25	21:41	Pollux 4.4°N of Moon
	26	07	Venus at Perihelion
	27	17:55	Moon at Descending Node
	28	03:32	Jupiter 1.5°N of Moon
	28	08:44	Regulus 1.4°N of Moon
	31	04:59	LAST QUARTER MOON

Terms Used in Sky Event Almanac

Perihelion - instant when a planet is closest to the Sun
Aphelion - instant when a planet is furthest from the Sun
Perigee - instant when the Moon is closest to Earth
Apogee - instant when the Moon is furthest from Earth
Inferior Conjunction - instant when a planet (Mercury or Venus) passes between Earth and the Sun
Superior Conjunction-instant when a planet (Mercury or Venus) passes on the opposite side of the Sun from Earth
Greatest Elongation - the maximum angular separation between the Sun and the planet (Mercury or Venus) as seen from Earth
- during eastern elongation (E), the planet appears as an evening star;
- during western elongation (W), the planet appears as a morning star
Opposition - instant when a planet appears opposite the Sun as seen from Earth
Conjunction - instant when a planet appears closest the Sun as seen from Earth
Occultation - the Moon occults or eclipses a star or planet
Ascending Node - point where the Moon crosses from the southern to northern portion of its orbit
Descending Node - point where the Moon crosses from the northern to the southern portion of its orbit
Aldebaran - bright star in the constellation Taurus
Pollux - bright star in the constellation Gemini
Regulus - bright star in the constellation Leo
Spica - bright star in the constellation Virgo
Antares - bright star in the constellation Scorpius
Pleiades - bright star cluster in the constellation Taurus

Source: Fred Espenak / https://astropixels.com/almanac/almanac21/almanac2026aest.html

Milky Way Rise & Set – Canberra region



This rise and set graphic plots the time when the Milky Way centre is above the horizon at a "good" or "minimum" photographic altitude. I use the star Antares, at 20º altitude, for the rising Milky Way and the Trifid nebula at 25º for the setting Milky Way. These are somewhat arbitrary but values that I've found, by trial and error, work well for me. At lower altitudes, the muck in the atmosphere causes too much extinction. The discontinuity in the plots represents the shifts between eastern daylight savings time [EDT] and eastern standard time [EST] in autumn and spring respectively.

Rising – Antares 20 º altitude

Setting – Triffid Nebula 25 º altitude

While a rising or setting Milky Way can be photographed at higher or lower altitudes. I find these to be good workable limits.

Joe Cali Pentax K1, Samyang 14mm f2.8; *"Old Deserted House, Foggy Night"*

Avoiding trailed star images

Reading about nightscape photography, you will have no doubt have come across someone claiming they have the perfect rule for pinpoint stars. One person will claim the "700 rule," another the "600, 500, 400, 300, 250 rule. I have read many such articles and posts. In almost every case the author does not understand the basics of astro-mechanics and the translation of moving stars onto a flat image plane when capturing nightscapes.

No simple "rule" can adequately calculate the maximum exposure for stars to appear stationary for all cameras, sensors, and output formats. Why? Because it's a function of several factors.

- Sensor size
- Pixel size in the sensor
- Lens focal length
- Declination (stellar latitude) of the stars
- Final display output format/size

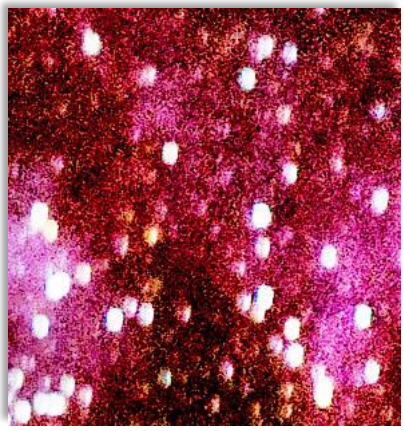
In 2013, I derived a formula that took all of these factors into account.

Tmax = 14 x N x P ÷ [FL x cos(d)]

N - Number of pixels of trailing
P - Pixel size in microns
FL - Focal Length in mm
d - Declination in degrees

At about the same time as I published my formula, I was contacted by Frédéric Michaud from the Société Astronòmique du Havre who, at about the same time, had derived a different formula now called the NPF rule. We compared our maths derivations and although we had approached the problem differently, and our formulae look very different, when we compared our results, we found our two formulae to be quite consistent and any small differences had no practical effect on the image appearance.

To test the method at the extreme I shot the above image of Eta Carinae nebula using an APSc camera, ISO12800, a 300mm f4 lens and a 4s exposure. The recommendation in the table is 2s for a 600px output image and when I blow this up to 100%, I can see oval shaped stars with trails twice as long as they are wide, perfectly consistent with the formula result.



Recently I re-examined the maths derivation and discovered a simplification based on using sensor dimension, lens focal length and final output size only. Other parameters are used but cancel out. You will note that as you make your desired output format smaller, you can afford to have more pixels of movement on the camera sensor and consequently, longer allowable exposure times. If you want to express this as a "600 rule" type of formula, the blue line indicates the number for the rule for various formats. You can see that it varies greatly with output format.

These techniques allow remarkable work to be produced with little more than a camera, tripod, and remote release. There comes a point where, if you want to do very large prints or show work on large format 4K TV screens, you probably will need to move to using a tracking device else the exposures will be so short, the images will be very noisy.

Don't get too tied up in knots about capturing pinpoint images. If in pursuit of pinpoint stars, the exposures are so short that the captured image is full of noise then what's the point. Given the choice of a little trailing with good signal and no trailing with a lot of noise, I'll accept a little trailing any "night."

FULL FRAME CAMERA SENSOR

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	105	126	252	504	840
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	26	32	63	126	210
8	13	16	32	63	105
10	11	13	25	50	84
12	9	11	21	42	70
14	8	9	18	36	60
16	7	8	16	32	53
18	6	7	14	28	47
20	5	6	13	25	42
24	4	5	11	21	35
28	3.8	5	9	18	30
35	3.0	3.6	7	14	24
40	2.6	3.2	6	13	21
45	2.3	2.8	6	11	19
50	2.1	2.5	5	10	17
60	1.8	2.1	4	8	14
70	1.5	1.8	3.6	7	12
80	1.3	1.6	3.2	6	11
90	1.2	1.4	2.8	6	9
100	1.1	1.3	2.5	5	8
120	0.9	1.1	2.1	4	7
135	0.8	0.9	1.9	3.7	6
150	0.7	0.8	1.7	3.4	6
200	0.5	0.6	1.3	2.5	4
300	0.4	0.4	0.8	1.7	2.8

APS Camera Sensor

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	70	84	168	336	560
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	18	21	42	84	140
8	9	11	21	42	70
10	7	8	17	34	56
12	6	7	14	28	47
14	5	6	12	24	40
16	4	5	11	21	35
18	4	5	9	19	31
20	4	4	8	17	28
24	2.9	4	7	14	23
28	2.5	3.0	6	12	20
35	2.0	2.4	5	10	16
40	1.8	2.1	4	8	14
45	1.6	1.9	4	7	12
50	1.4	1.7	3.4	7	11
60	1.2	1.4	2.8	6	9
70	1.0	1.2	2.4	5	8
80	0.9	1.1	2.1	4	7
90	0.8	0.9	1.9	4	6
100	0.7	0.8	1.7	3.4	6
120	0.6	0.7	1.4	2.8	5
135	0.5	0.6	1.2	2.5	4
150	0.5	0.6	1.1	2.2	3.7
200	0.4	0.4	0.8	1.7	2.8
300	0.2	0.3	0.6	1.1	1.9

MICRO 4/3 SENSOR (OLYMPUS)

	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT pixel width 4800	4K TV pixel width 4000	LAPTOP SCREEN/HD TV pixel width 2000	FACEBOOK pixel width 1000	600px web image pixel width 600
RULE FACTOR	50	61	121	242	404
Lens Focal length (mm)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)	MAX EXPOSURE TIME (s)
4	13	15	30	61	101
8	6	8	15	30	50
10	5	6	12	24	40
12	4	5	10	20	34
14	4	4	9	17	29
16	3.2	4	8	15	25
18	2.8	3.4	7	13	22
20	2.5	3.0	6	12	20
24	2.1	2.5	5	10	17
28	1.8	2.2	4	9	14
35	1.4	1.7	3.5	7	12
40	1.3	1.5	3.0	6	10
45	1.1	1.3	2.7	5	9
50	1.0	1.2	2.4	5	8
60	0.8	1.0	2.0	4	7
70	0.7	0.9	1.7	3.5	6
80	0.6	0.8	1.5	3.0	5
90	0.6	0.7	1.3	2.7	4
100	0.5	0.6	1.2	2.4	4
120	0.4	0.5	1.0	2.0	3.4
135	0.4	0.4	0.9	1.8	3.0
150	0.3	0.4	0.8	1.6	2.7
200	0.3	0.3	0.6	1.2	2.0
300	0.2	0.2	0.4	0.8	1.3

How to use it?

These tables use overall sensor size, final display size and lens focal length. While pixel size is important, it drops out when exposure times are calculated on final display scale. There are three tables on this page. Choose the table (full-frame, APS C, Micro 4/3rds) that corresponds to your DSLR or mirrorless camera sensor. Choose the row corresponding to the lens focal length and the column that is closest to your desired output. This is the maximum exposure time in seconds corresponding to a star movement of 1 pixel on your final output.

"Under the Milky Way tonight" © Joe Cali 2018

Panorama Stitching

When shooting panoramas, the final image ends up much bigger than the sensor's native pixel dimension. For example, my camera full frame sensor is 7400px wide. When using a 14mm lens for a 2000 pixel display the recommendation is 18s. If I produce a 21000 pixel wide pano like this one, approximately 3 times wider than my sensor, I can increase the exposure time for each panel to one minute as in the panorama example above. Trailing is visible in each individual panel when examined in detail. Once the image is stitched and down-sized for display, these short trails disappear.

When shooting star trails and time sequences, long exposures can be quite practical. In the star trail image on page 26, just after the meteor shower section, I did shoot many short 40s exposures. My original intention was to capture a time-lapse. Shooting short, point star images gives you the option of producing a star trail or a time lapse from an imaging session. When capturing for star trails only, I set my shutter speed to 2 minutes leaving me less images to composite and better signal to noise in the captured sub-exposures.

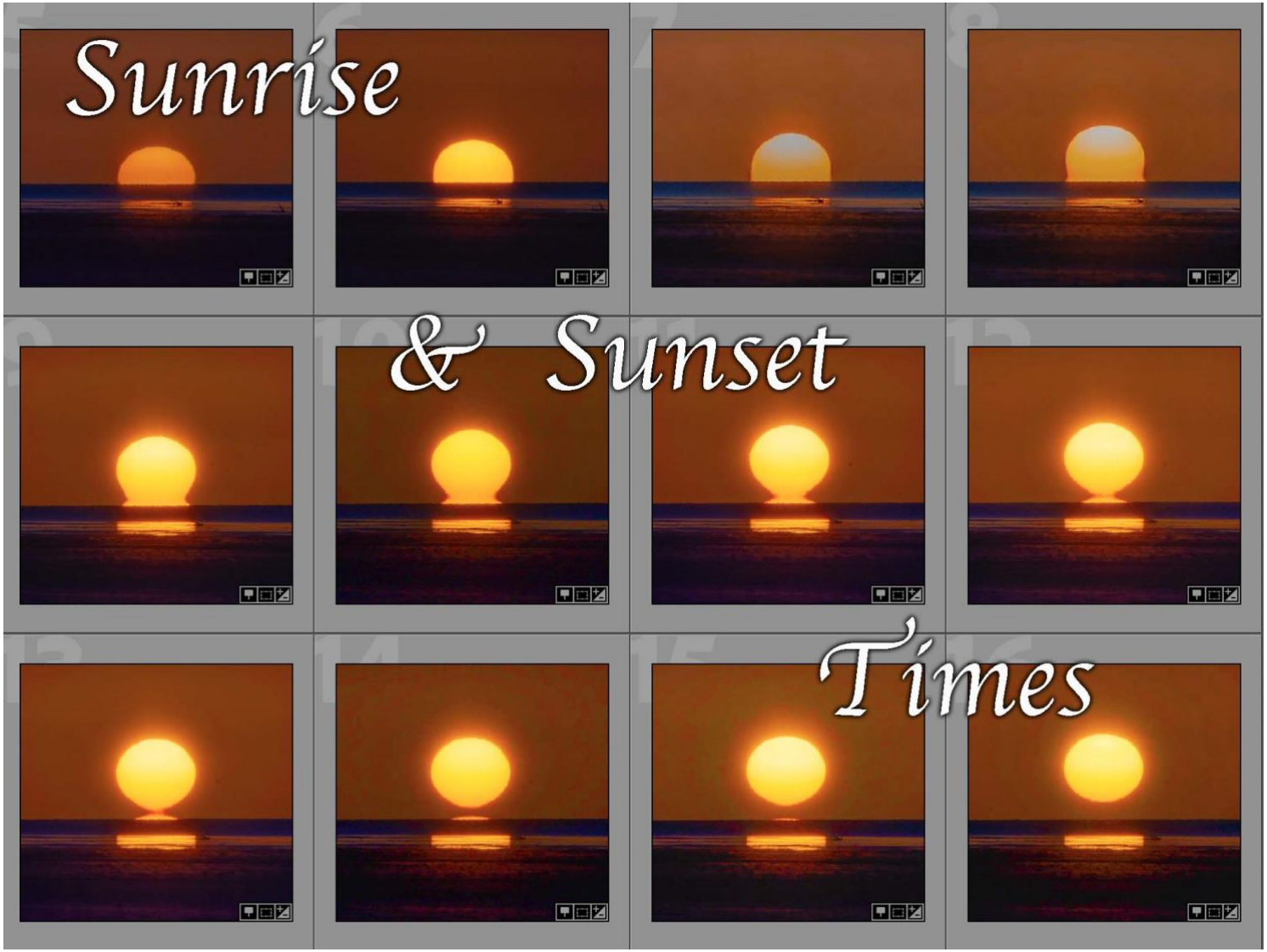


Photo: Sunrise at Kati Thanda Lake Eyre – Joe Cali

Sunrise and twilight are calculated for Canberra. For Sydney: subtract ~10 mins. Young add 2 mins.

Times Of Sunrise And Sunset

Criteria

Latitude	Longitude
35° 18' S	149° 8' E

Results

Times Of Sunrise And Sunset												
	Jan		Feb		Mar		Apr		May		Jun	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	05:52	20:21	06:21	20:12	06:50	19:41	07:16	18:58	06:41	17:21	07:04	16:59
2	05:52	20:21	06:22	20:11	06:51	19:40	07:17	18:57	06:41	17:20	07:04	16:59
3	05:53	20:22	06:23	20:10	06:52	19:38	07:18	18:55	06:42	17:19	07:05	16:59
4	05:54	20:22	06:25	20:10	06:53	19:37	07:19	18:54	06:43	17:18	07:05	16:58
5	05:55	20:22	06:26	20:09	06:54	19:36	06:20	18:52	06:44	17:17	07:06	16:58
6	05:56	20:22	06:27	20:08	06:55	19:34	06:20	17:51	06:45	17:16	07:06	16:58
7	05:56	20:22	06:28	20:07	06:56	19:33	06:21	17:50	06:45	17:15	07:07	16:58
8	05:57	20:22	06:29	20:06	06:56	19:32	06:22	17:48	06:46	17:14	07:07	16:58
9	05:58	20:22	06:30	20:05	06:57	19:30	06:23	17:47	06:47	17:13	07:08	16:58
10	05:59	20:22	06:31	20:04	06:58	19:29	06:24	17:46	06:48	17:12	07:08	16:58
11	06:00	20:22	06:32	20:03	06:59	19:28	06:25	17:44	06:49	17:11	07:09	16:57
12	06:01	20:21	06:33	20:02	07:00	19:26	06:25	17:43	06:49	17:10	07:09	16:57
13	06:02	20:21	06:34	20:01	07:01	19:25	06:26	17:42	06:50	17:10	07:10	16:57
14	06:03	20:21	06:35	20:00	07:02	19:23	06:27	17:41	06:51	17:09	07:10	16:58
15	06:04	20:21	06:36	19:59	07:02	19:22	06:28	17:39	06:52	17:08	07:10	16:58
16	06:05	20:21	06:37	19:58	07:03	19:21	06:29	17:38	06:52	17:07	07:11	16:58
17	06:06	20:20	06:38	19:57	07:04	19:19	06:29	17:37	06:53	17:07	07:11	16:58
18	06:07	20:20	06:39	19:56	07:05	19:18	06:30	17:35	06:54	17:06	07:11	16:58
19	06:08	20:20	06:40	19:55	07:06	19:16	06:31	17:34	06:55	17:05	07:12	16:58
20	06:09	20:19	06:41	19:53	07:07	19:15	06:32	17:33	06:55	17:05	07:12	16:58
21	06:10	20:19	06:42	19:52	07:07	19:14	06:33	17:32	06:56	17:04	07:12	16:58
22	06:11	20:18	06:43	19:51	07:08	19:12	06:33	17:31	06:57	17:03	07:12	16:59
23	06:12	20:18	06:44	19:50	07:09	19:11	06:34	17:29	06:58	17:03	07:13	16:59
24	06:13	20:17	06:45	19:49	07:10	19:09	06:35	17:28	06:58	17:02	07:13	16:59
25	06:14	20:17	06:46	19:47	07:11	19:08	06:36	17:27	06:59	17:02	07:13	17:00
26	06:15	20:16	06:46	19:46	07:11	19:06	06:37	17:26	07:00	17:01	07:13	17:00
27	06:16	20:15	06:47	19:45	07:12	19:05	06:37	17:25	07:00	17:01	07:13	17:00
28	06:17	20:15	06:48	19:44	07:13	19:04	06:38	17:24	07:01	17:01	07:13	17:01
29	06:18	20:14	06:49	19:42	07:14	19:02	06:39	17:23	07:02	17:00	07:13	17:01
30	06:19	20:13			07:15	19:01	06:40	17:22	07:02	17:00	07:13	17:01
31	06:20	20:13			07:16	18:59			07:03	16:59		

Times Of Sunrise And Sunset												
	Jul		Aug		Sep		Oct		Nov		Dec	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	07:13	17:02	06:58	17:21	06:23	17:44	05:40	18:07	06:00	19:34	05:42	20:03
2	07:13	17:02	06:57	17:22	06:21	17:45	05:38	18:07	05:59	19:35	05:42	20:04
3	07:13	17:03	06:57	17:23	06:20	17:46	05:37	18:08	05:58	19:35	05:42	20:05
4	07:13	17:03	06:56	17:24	06:18	17:47	06:35	18:09	05:57	19:36	05:41	20:06
5	07:13	17:04	06:55	17:24	06:17	17:47	06:34	19:10	05:56	19:37	05:41	20:06
6	07:12	17:04	06:54	17:25	06:16	17:48	06:33	19:11	05:56	19:38	05:41	20:07
7	07:12	17:05	06:53	17:26	06:14	17:49	06:31	19:11	05:55	19:39	05:41	20:08
8	07:12	17:05	06:52	17:27	06:13	17:49	06:30	19:12	05:54	19:40	05:42	20:09
9	07:12	17:06	06:51	17:27	06:11	17:50	06:28	19:13	05:53	19:41	05:42	20:10
10	07:11	17:06	06:50	17:28	06:10	17:51	06:27	19:14	05:52	19:42	05:42	20:11
11	07:11	17:07	06:49	17:29	06:09	17:52	06:26	19:15	05:51	19:43	05:42	20:11
12	07:11	17:08	06:47	17:30	06:07	17:52	06:24	19:15	05:51	19:44	05:42	20:12
13	07:10	17:08	06:46	17:30	06:06	17:53	06:23	19:16	05:50	19:45	05:42	20:13
14	07:10	17:09	06:45	17:31	06:04	17:54	06:22	19:17	05:49	19:46	05:43	20:13
15	07:10	17:09	06:44	17:32	06:03	17:55	06:20	19:18	05:48	19:47	05:43	20:14
16	07:09	17:10	06:43	17:33	06:01	17:55	06:19	19:19	05:48	19:48	05:43	20:15
17	07:09	17:11	06:42	17:33	06:00	17:56	06:18	19:20	05:47	19:49	05:44	20:15
18	07:08	17:11	06:41	17:34	05:58	17:57	06:16	19:21	05:47	19:50	05:44	20:16
19	07:08	17:12	06:39	17:35	05:57	17:58	06:15	19:21	05:46	19:51	05:44	20:17
20	07:07	17:13	06:38	17:35	05:55	17:58	06:14	19:22	05:46	19:52	05:45	20:17
21	07:06	17:13	06:37	17:36	05:54	17:59	06:13	19:23	05:45	19:53	05:45	20:18
22	07:06	17:14	06:36	17:37	05:53	18:00	06:11	19:24	05:45	19:54	05:46	20:18
23	07:05	17:15	06:34	17:38	05:51	18:01	06:10	19:25	05:44	19:55	05:46	20:19
24	07:05	17:15	06:33	17:38	05:50	18:01	06:09	19:26	05:44	19:56	05:47	20:19
25	07:04	17:16	06:32	17:39	05:48	18:02	06:08	19:27	05:43	19:57	05:47	20:19
26	07:03	17:17	06:31	17:40	05:47	18:03	06:07	19:28	05:43	19:58	05:48	20:20
27	07:02	17:18	06:29	17:41	05:45	18:04	06:06	19:29	05:43	19:59	05:49	20:20
28	07:02	17:18	06:28	17:41	05:44	18:04	06:05	19:30	05:42	20:00	05:49	20:20
29	07:01	17:19	06:27	17:42	05:42	18:05	06:03	19:31	05:42	20:01	05:50	20:21
30	07:00	17:20	06:25	17:43	05:41	18:06	06:02	19:32	05:42	20:02	05:51	20:21
31	06:59	17:21	06:24	17:44			06:01	19:33			05:51	20:21

Photo: Dawn Twilight Kati Thanda Lake Eyre. © Joe Cali

Sunrise and twilight are calculated for Canberra. For Sydney: subtract ~10 mins. Young add 2 mins.

Times Of Astronomical Twilight

Criteria

Latitude	Longitude
35° 18' S	149° 8' E

Results

Times Of Astronomical Twilight												
	Jan		Feb		Mar		Apr		May		Jun	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	04:05	22:08	04:44	21:49	05:22	21:09	05:52	20:22	05:14	18:47	05:34	18:29
2	04:06	22:08	04:46	21:48	05:23	21:07	05:53	20:21	05:15	18:46	05:34	18:29
3	04:06	22:08	04:47	21:47	05:25	21:06	05:54	20:20	05:16	18:45	05:35	18:29
4	04:07	22:08	04:49	21:46	05:26	21:04	05:54	20:18	05:16	18:44	05:35	18:29
5	04:09	22:08	04:50	21:44	05:27	21:03	04:55	20:17	05:17	18:43	05:35	18:29
6	04:10	22:08	04:51	21:43	05:28	21:01	04:56	19:15	05:18	18:42	05:36	18:28
7	04:11	22:08	04:53	21:42	05:29	21:00	04:57	19:14	05:18	18:42	05:36	18:28
8	04:12	22:07	04:54	21:41	05:30	20:58	04:58	19:13	05:19	18:41	05:37	18:28
9	04:13	22:07	04:56	21:39	05:31	20:57	04:59	19:12	05:20	18:40	05:37	18:28
10	04:14	22:07	04:57	21:38	05:32	20:55	04:59	19:10	05:20	18:39	05:38	18:28
11	04:15	22:06	04:58	21:37	05:33	20:54	05:00	19:09	05:21	18:39	05:38	18:28
12	04:17	22:06	05:00	21:35	05:34	20:52	05:01	19:08	05:22	18:38	05:38	18:28
13	04:18	22:05	05:01	21:34	05:35	20:50	05:02	19:06	05:22	18:37	05:39	18:28
14	04:19	22:05	05:02	21:32	05:36	20:49	05:02	19:05	05:23	18:37	05:39	18:29
15	04:21	22:04	05:04	21:31	05:37	20:47	05:03	19:04	05:24	18:36	05:39	18:29
16	04:22	22:04	05:05	21:30	05:38	20:46	05:04	19:03	05:24	18:35	05:40	18:29
17	04:23	22:03	05:06	21:28	05:39	20:44	05:04	19:02	05:25	18:35	05:40	18:29
18	04:25	22:02	05:08	21:27	05:40	20:43	05:05	19:00	05:26	18:34	05:40	18:29
19	04:26	22:02	05:09	21:25	05:41	20:41	05:06	18:59	05:26	18:34	05:41	18:29
20	04:27	22:01	05:10	21:24	05:42	20:40	05:07	18:58	05:27	18:33	05:41	18:29
21	04:29	22:00	05:11	21:22	05:43	20:38	05:07	18:57	05:27	18:33	05:41	18:30
22	04:30	21:59	05:13	21:21	05:43	20:37	05:08	18:56	05:28	18:32	05:41	18:30
23	04:31	21:58	05:14	21:19	05:44	20:35	05:09	18:55	05:29	18:32	05:41	18:30
24	04:33	21:57	05:15	21:18	05:45	20:34	05:10	18:54	05:29	18:32	05:42	18:30
25	04:34	21:56	05:16	21:16	05:46	20:32	05:10	18:53	05:30	18:31	05:42	18:31
26	04:36	21:55	05:18	21:15	05:47	20:31	05:11	18:52	05:30	18:31	05:42	18:31
27	04:37	21:54	05:19	21:13	05:48	20:29	05:12	18:51	05:31	18:30	05:42	18:31
28	04:39	21:53	05:20	21:12	05:49	20:28	05:12	18:50	05:31	18:30	05:42	18:32
29	04:40	21:52	05:21	21:10	05:50	20:27	05:13	18:49	05:32	18:30	05:42	18:32
30	04:41	21:51			05:50	20:25	05:14	18:48	05:32	18:30	05:42	18:32
31	04:43	21:50			05:51	20:24			05:33	18:29		

Times Of Astronomical Twilight												
	Jul		Aug		Sep		Oct		Nov		Dec	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	05:42	18:33	05:31	18:49	04:58	19:09	04:14	19:33	04:27	21:07	03:57	21:47
2	05:42	18:33	05:30	18:49	04:57	19:09	04:12	19:34	04:25	21:09	03:57	21:49
3	05:42	18:33	05:29	18:50	04:55	19:10	04:11	19:34	04:24	21:10	03:56	21:50
4	05:42	18:34	05:29	18:51	04:54	19:11	05:09	19:35	04:23	21:11	03:56	21:51
5	05:42	18:34	05:28	18:51	04:53	19:12	05:07	20:36	04:21	21:13	03:56	21:52
6	05:42	18:35	05:27	18:52	04:51	19:12	05:06	20:37	04:20	21:14	03:56	21:53
7	05:42	18:35	05:26	18:52	04:50	19:13	05:04	20:38	04:19	21:15	03:55	21:54
8	05:42	18:36	05:25	18:53	04:49	19:14	05:03	20:39	04:18	21:17	03:55	21:55
9	05:41	18:36	05:24	18:54	04:47	19:14	05:01	20:40	04:16	21:18	03:55	21:56
10	05:41	18:37	05:23	18:54	04:46	19:15	04:59	20:41	04:15	21:19	03:55	21:57
11	05:41	18:37	05:22	18:55	04:44	19:16	04:58	20:42	04:14	21:21	03:55	21:58
12	05:41	18:37	05:21	18:56	04:43	19:17	04:56	20:43	04:13	21:22	03:55	21:59
13	05:41	18:38	05:20	18:56	04:41	19:17	04:55	20:44	04:12	21:24	03:55	22:00
14	05:40	18:39	05:19	18:57	04:40	19:18	04:53	20:46	04:11	21:25	03:55	22:01
15	05:40	18:39	05:18	18:57	04:38	19:19	04:52	20:47	04:10	21:26	03:55	22:02
16	05:40	18:40	05:17	18:58	04:37	19:20	04:50	20:48	04:09	21:28	03:56	22:02
17	05:39	18:40	05:16	18:59	04:35	19:21	04:49	20:49	04:08	21:29	03:56	22:03
18	05:39	18:41	05:15	18:59	04:34	19:21	04:47	20:50	04:07	21:30	03:56	22:04
19	05:38	18:41	05:14	19:00	04:32	19:22	04:45	20:51	04:06	21:32	03:56	22:04
20	05:38	18:42	05:13	19:01	04:31	19:23	04:44	20:52	04:05	21:33	03:57	22:05
21	05:38	18:42	05:12	19:01	04:29	19:24	04:42	20:53	04:04	21:35	03:57	22:05
22	05:37	18:43	05:11	19:02	04:28	19:25	04:41	20:55	04:03	21:36	03:58	22:06
23	05:37	18:43	05:09	19:03	04:26	19:26	04:39	20:56	04:02	21:37	03:58	22:06
24	05:36	18:44	05:08	19:03	04:25	19:26	04:38	20:57	04:02	21:39	03:59	22:07
25	05:35	18:45	05:07	19:04	04:23	19:27	04:37	20:58	04:01	21:40	04:00	22:07
26	05:35	18:45	05:06	19:05	04:22	19:28	04:35	21:00	04:00	21:41	04:00	22:07
27	05:34	18:46	05:05	19:05	04:20	19:29	04:34	21:01	03:59	21:42	04:01	22:08
28	05:34	18:46	05:03	19:06	04:18	19:30	04:32	21:02	03:59	21:44	04:02	22:08
29	05:33	18:47	05:02	19:07	04:17	19:31	04:31	21:03	03:58	21:45	04:03	22:08
30	05:32	18:48	05:01	19:07	04:15	19:32	04:29	21:05	03:58	21:46	04:03	22:08
31	05:32	18:48	04:59	19:08			04:28	21:06			04:04	22:08

Extreme atmospheric distortion at sunrise from the shores of Kati Thanda (Lake Eyre). The lowest point on the lake is 15m below mean sea level. Layers of different density air above the lake surface result in extreme flattening and distortion of the Sun's image.


Rise and Set of the Moon

Times Of Moonrise And Moonset

	Jan		Feb		Mar		Apr		May		Jun	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	18:22	02:56	19:57	05:00	18:30	03:55	18:23	06:08	16:44	06:00	17:17	07:51
2	19:33	03:52	20:33	06:14	19:02	05:06	18:47	07:09	17:15	07:01	18:09	08:44
3	20:35	04:58	21:04	07:25	19:30	06:13	19:14	08:09	17:51	08:02	19:06	09:31
4	21:25	06:11	21:31	08:32	19:56	07:18	19:42	09:10	18:32	09:01	20:05	10:12
5	22:05	07:26	21:56	09:36	20:21	08:21	19:15	09:11	19:20	09:57	21:06	10:47
6	22:38	08:39	22:20	10:37	20:46	09:22	19:53	10:12	20:14	10:48	22:07	11:17
7	23:06	09:47	22:46	11:37	21:13	10:23	20:36	11:10	21:12	11:33	23:08	11:45
8	23:31	10:51	23:13	12:37	21:43	11:23	21:26	12:05	22:12	12:12		12:11
9	23:55	11:52	23:44	13:37	22:16	12:24	22:22	12:54	23:14	12:46	00:09	12:36
10		12:52		14:37	22:56	13:23	23:22	13:37		13:16	01:12	13:02
11	00:19	13:50	00:20	15:35	23:43	14:21		14:15	00:16	13:43	02:19	13:32
12	00:45	14:49	01:03	16:31		15:14	00:24	14:47	01:19	14:10	03:30	14:06
13	01:14	15:48	01:52	17:22	00:36	16:01	01:27	15:17	02:23	14:36	04:45	14:48
14	01:46	16:48	02:48	18:08	01:34	16:42	02:32	15:44	03:30	15:04	06:02	15:40
15	02:25	17:46	03:49	18:47	02:36	17:18	03:37	16:11	04:40	15:37	07:17	16:44
16	03:10	18:40	04:53	19:21	03:41	17:50	04:44	16:39	05:55	16:15	08:23	17:56
17	04:02	19:29	05:58	19:51	04:46	18:19	05:53	17:09	07:13	17:02	09:18	19:13
18	05:01	20:12	07:03	20:19	05:51	18:46	07:06	17:44	08:30	18:00	10:02	20:28
19	06:03	20:49	08:08	20:45	06:57	19:12	08:23	18:25	09:40	19:07	10:37	21:38
20	07:07	21:21	09:14	21:12	08:05	19:41	09:39	19:16	10:40	20:21	11:07	22:45
21	08:11	21:50	10:21	21:40	09:15	20:12	10:52	20:17	11:28	21:34	11:34	23:47
22	09:15	22:16	11:30	22:12	10:28	20:48	11:56	21:25	12:07	22:45	11:59	
23	10:18	22:42	12:41	22:49	11:43	21:32	12:49	22:36	12:38	23:52	12:23	00:48
24	11:23	23:08	13:54	23:34	12:56	22:25	13:32	23:47	13:06		12:50	01:48
25	12:29	23:37	15:05		14:04	23:26	14:06		13:31	00:55	13:18	02:48
26	13:38		16:10	00:29	15:03		14:36	00:54	13:55	01:55	13:51	03:48
27	14:50	00:10	17:06	01:33	15:51	00:34	15:02	01:59	14:20	02:55	14:29	04:47
28	16:04	00:50	17:52	02:43	16:31	01:44	15:27	03:00	14:47	03:54	15:13	05:45
29	17:14	01:39			17:04	02:54	15:51	04:01	15:16	04:54	16:04	06:40
30	18:19	02:38			17:32	04:01	16:16	05:00	15:51	05:54	16:59	07:29
31	19:13	03:46			17:58	05:06			16:30	06:54		

Times calculated for Canberra. For Sydney: subtract ~10 mins. Young add 2 mins.

Times Of Moonrise And Moonset

	Jul		Aug		Sep		Oct		Nov		Dec	
	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
1	17:59	08:11	19:56	08:18	22:04	08:07	23:27	08:02	01:16	11:12	01:05	12:31
2	19:00	08:48	20:57	08:44	23:14	08:39		08:56	01:58	12:23	01:33	13:36
3	20:01	09:20	21:59	09:08		09:18	00:33	09:59	02:33	13:32	02:00	14:38
4	21:01	09:48	23:04	09:35	00:26	10:04	01:30	12:08	03:03	14:38	02:25	15:39
5	22:02	10:14		10:04	01:35	11:01	03:18	13:20	03:30	15:42	02:52	16:41
6	23:03	10:39	00:12	10:38	02:39	12:06	03:57	14:31	03:56	16:44	03:21	17:42
7		11:04	01:23	11:19	03:34	13:18	04:31	15:40	04:22	17:46	03:54	18:43
8	00:06	11:31	02:36	12:09	04:20	14:32	05:00	16:46	04:49	18:48	04:32	19:42
9	01:13	12:02	03:45	13:10	04:58	15:44	05:27	17:50	05:19	19:50	05:15	20:38
10	02:24	12:39	04:48	14:21	05:30	16:53	05:53	18:54	05:54	20:51	06:05	21:28
11	03:38	13:25	05:41	15:36	05:58	18:00	06:19	19:57	06:34	21:50	06:59	22:11
12	04:52	14:22	06:25	16:52	06:25	19:05	06:48	21:00	07:19	22:44	07:57	22:49
13	06:02	15:30	07:01	18:04	06:52	20:09	07:20	22:02	08:11	23:32	08:56	23:21
14	07:02	16:45	07:32	19:13	07:19	21:12	07:56	23:03	09:07		09:55	23:49
15	07:52	18:02	07:59	20:19	07:49	22:15	08:38		10:05	00:13	10:54	
16	08:32	19:17	08:26	21:23	08:22	23:16	09:26	00:00	11:04	00:49	11:52	00:15
17	09:05	20:27	08:52	22:26	09:00		10:19	00:52	12:04	01:20	12:52	00:40
18	09:34	21:33	09:20	23:28	09:44	00:16	11:16	01:37	13:04	01:48	13:53	01:04
19	10:00	22:36	09:50		10:34	01:11	12:16	02:17	14:04	02:14	14:57	01:31
20	10:25	23:38	10:25	00:29	11:29	02:00	13:16	02:51	15:05	02:39	16:06	02:00
21	10:52		11:05	01:29	12:28	02:43	14:17	03:21	16:10	03:05	17:18	02:35
22	11:20	00:39	11:51	02:26	13:29	03:20	15:18	03:48	17:18	03:33	18:33	03:17
23	11:51	01:40	12:43	03:19	14:31	03:53	16:21	04:14	18:31	04:06	19:46	04:11
24	12:27	02:40	13:40	04:06	15:33	04:22	17:25	04:40	19:47	04:45	20:50	05:16
25	13:09	03:38	14:41	04:47	16:35	04:49	18:32	05:07	21:02	05:34	21:44	06:30
26	13:58	04:34	15:43	05:23	17:39	05:15	19:44	05:38	22:10	06:33	22:28	07:48
27	14:52	05:25	16:45	05:54	18:44	05:41	20:58	06:13	23:08	07:42	23:04	09:04
28	15:51	06:10	17:47	06:22	19:52	06:09	22:12	06:56	23:55	08:57	23:34	10:16
29	16:52	06:49	18:49	06:47	21:03	06:40	23:23	07:48		10:11		11:25
30	17:53	07:22	19:52	07:13	22:16	07:18		08:50	00:33	11:23	00:02	12:29
31	18:55	07:52	20:57	07:39			00:25	10:00			00:28	13:32

Times calculated for Canberra. For Sydney: subtract ~10 mins. Young add 2 mins.

Eclipses of 2026

Total lunar eclipse on March 3rd, 2026.

Only one eclipse is visible from East Australia in 2026. A total lunar eclipse commences soon after moonrise on Wednesday March 3rd, 2026. Moonrise occurs at 19:09 AEDT and the penumbral eclipse begins at 19:44 AEDT almost 1 hr before astronomical twilight (20:38 AEDT). Civilised hours for the discerning astronomer who needs their beauty sleep.

Lunar Eclipse Contacts

Eclipse Event	Contact	Time (AEDT)
Moonrise/Sunset	-	19:09/19:18
Penumbral Begins	P1	19:43:57.6
Civil Twilight		19:42
Nautical Twilight		20:09
Astronomical Twilight		20:38
Partial Begins	U1	20:49:36.6
Total Begins	U2	22:03:54.4
Greatest Eclipse	Greatest	22:33:40.0
Total Ends	U3	23:02:52.6
Partial Ends	U4	00:17:25.9
Penumbral Ends	P4	01:23:18.6

Contact times courtesy the late Fred Espenak/ https://EclipseWise.com

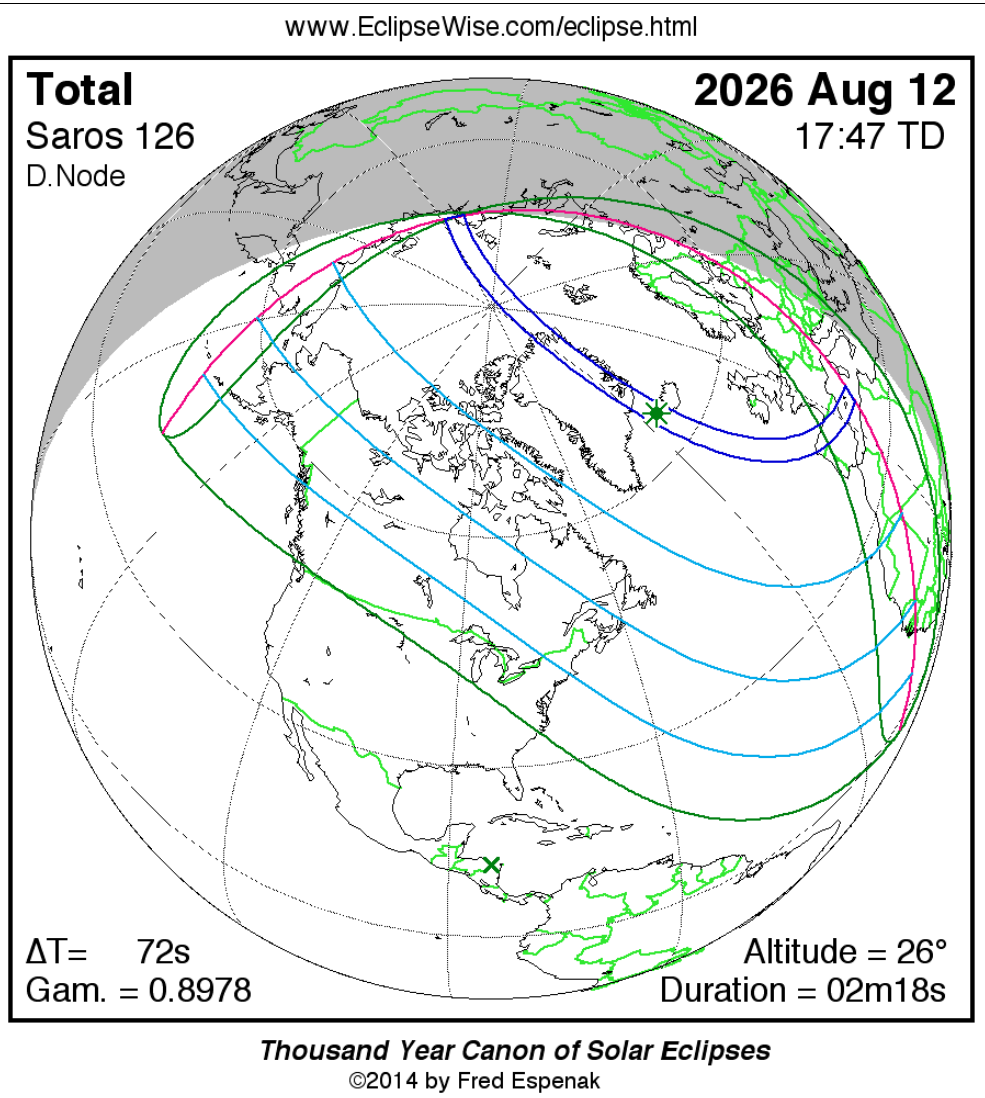
Solar Eclipses 2026

Two solar eclipses occur in 2026. An annular eclipse is visible from Antarctica on February 17th. The path of annularity will be difficult and expensive to access. Very small obscuration partial eclipses are visible from South Africa, Patagonia, and Tierra Del Fuego.

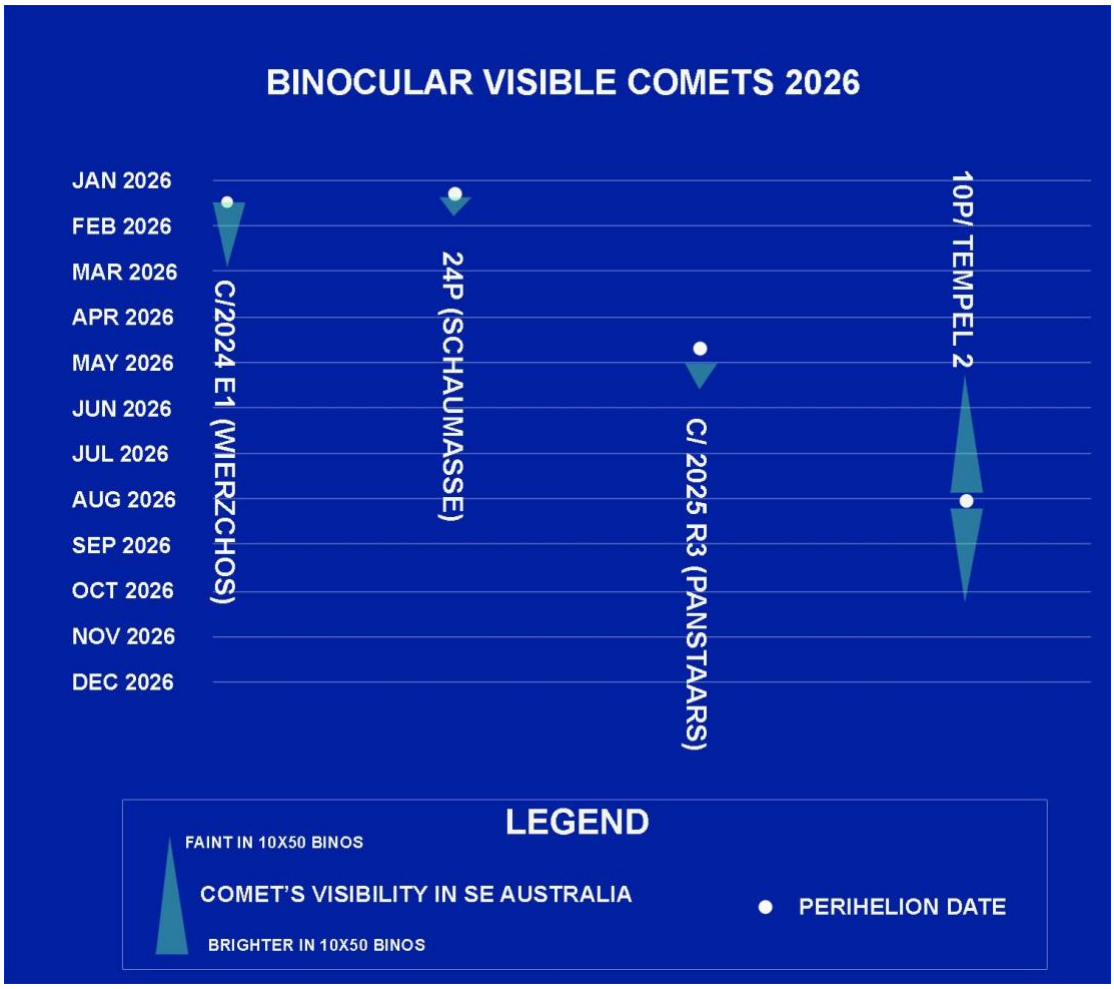
A total solar eclipse is visible on August 12th from Greenland, Iceland, and northern Spain. Weather around the Arctic Circle is mostly 80-90% cloudy. Weather prospects in Central Northern Spain are much better.

Eclipse circumstances and maps
http://www.EclipseWise.com/eclipse.html

Weather prospects
https://eclipsophile.com/tse2026/



Comets 2026

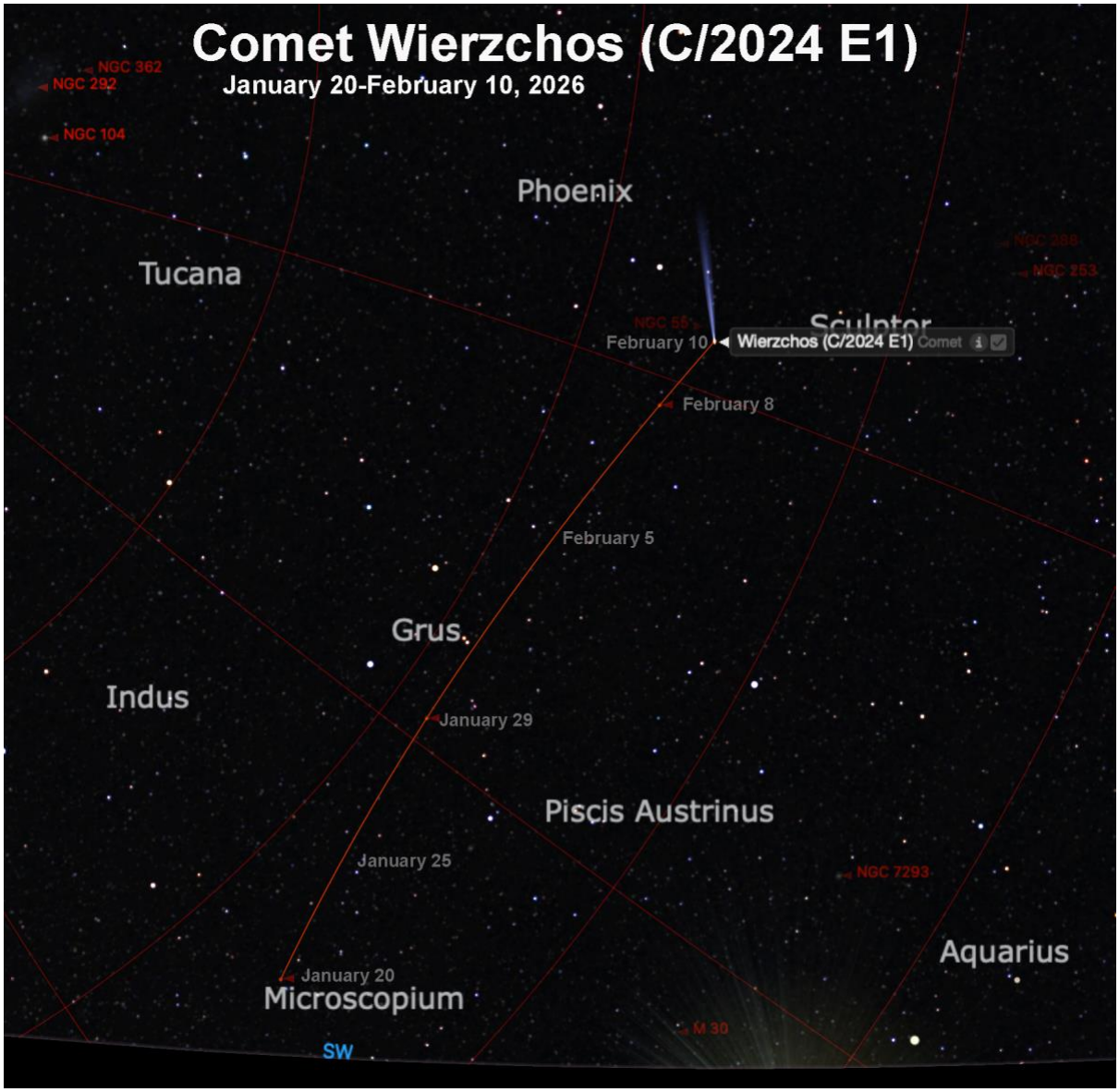


Source Seichi Yoshida's web site comet data.

No really bright naked eye comets have been discovered or are predicted at time of writing (October 2025). Two moderately bright binocular comets, one with marginal naked eye visibility are predicted at time of writing.

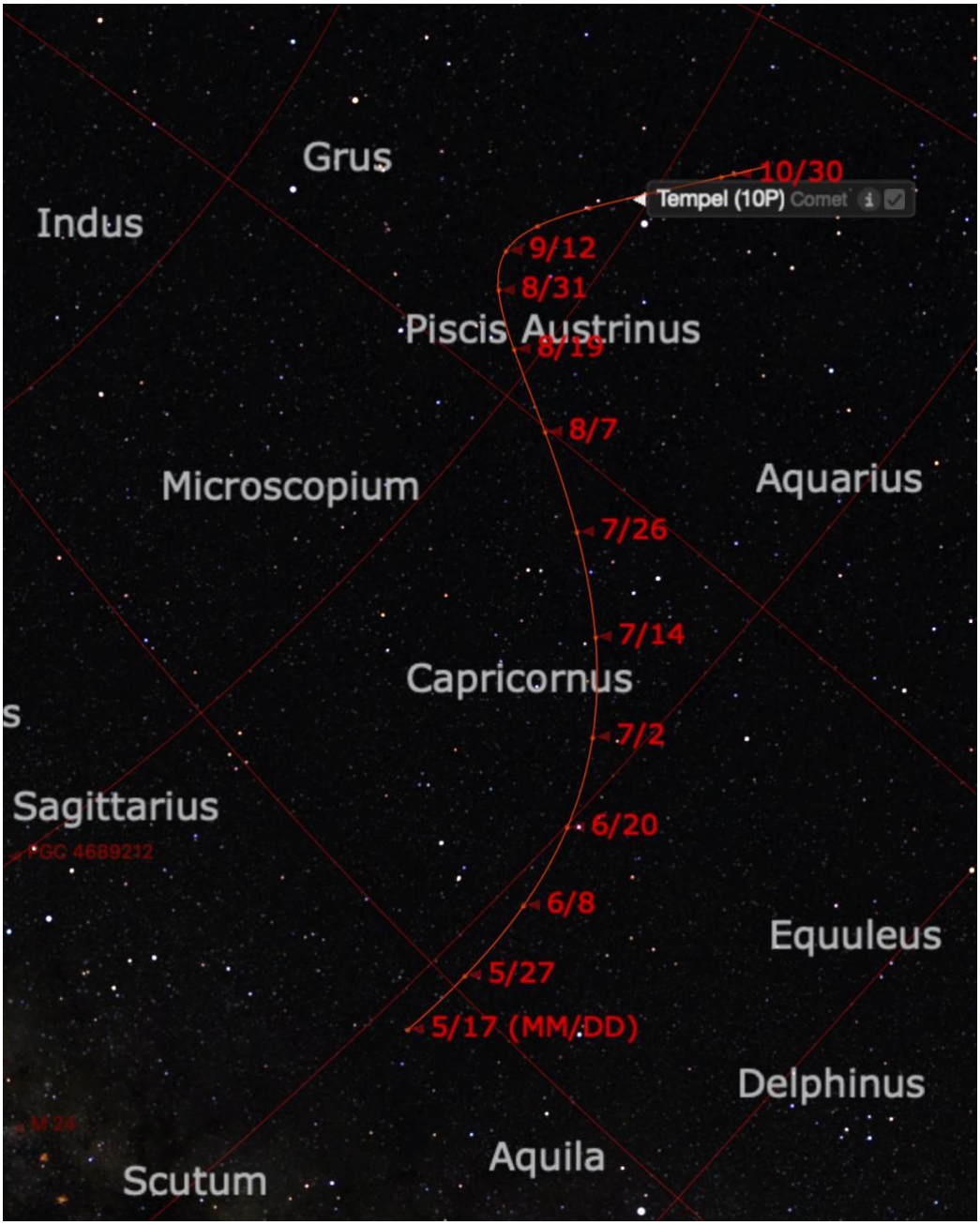
C/2024 E1 (Wierzchos)
Discovery Date March 3, 2024
Magnitude 5.5 (Mid Jan-Feb, 2026)
Discoverer Kacper W. Wierzchos (Mt. Lemmon Survey)

This comet is predicted to rise to magnitude 5.5 from mid-January to mid-February, 2026 peaking in early February. On Feb 5th, the comet's coma will be within 1^{o} of the Grus Quartet. The comet will be visible in our south-eastern sky near the star α Indi. Mag 5.5 spread across a comet is not naked eye but can provide a good binocular view.



10P/Tempel 2

Periodic Comet 10P/Tempel 2 will reach perihelion on August 2 and a maximum magnitude of about 7. It is also visible in the area around Piscis Austrinus. Best observed around August 10 without Moon interference in the constellation of Piscis Austrinus approximately midway between Fomalhaut and M30. It will be visible above magnitude 10 over an extended period from May to October meandering across a long path from Aquila to Sculptor.


Grus
Indus
10/30
Tempel (10P) Comet
9/12
8/31
Piscis Austrinus
8/19
8/7
Microscopium
Aquarius
7/26
7/14
Capricornus
7/2
Sagittarius
6/20
6/8
Equuleus
5/27
5/17 (MM/DD)
Delphinus
Aquila
Scutum

Meteor Shower Calendar

The meteor showers listed below are the easiest to observe and provide the most activity from eastern Australia. Particular attention should be noted to the time and moonlight conditions. **Most showers are best seen after midnight when the part of the night sky you are observing is heading towards the oncoming meteors. Early evening, the night sky is trailing the Earth's motion.** Most are not even visible until after midnight. Showers that peak with the moon's phase greater than one half illuminated (first quarter to last quarter) will be affected by moonlight and difficult to observe. While the date and time of night-time each shower is best seen remains much the same year after year, the moonlight conditions change considerably from one year to the next.

Lyrids LYR

Active from April 16th to April 25th. Peak night Apr 21-22.

1. Medium strength shower in the north hemisphere as the radiant is essentially overhead with decent rates for three nights around the maximum. Fireballs possible. From Australia, the radiant is low in the sky, just 20^{o} altitude & due north at 4:20am in NSW, 27^{o} in SEQ. Activity from this shower can be seen from the southern hemisphere, but at a much lower rate, 3-5 per hr. Even though these are called the Lyrids, the radiant is in Hercules not far from Vega.

Radiant: RA:18:04 **DEC:** +34° - **ZHR**: 18 - Velocity: 48km/sec - Parent Object: C/1861 G1 (Thatcher)

Eta Aquariids

Active from April 19th to May 26th. Peak night May 6-7

Great shower when viewed from northern Australia where they can produce rates of 40-60 per hour in exceptional years. I saw a display like this from Karjini National Park in 2013 just before dawn on a couple of mornings. Activity is near peak for a week centred on May 6-7. Some decent albeit lower-level activity can usually be seen from anywhere in Australia.

Radiant: RA:22:32 **DEC:** -1° - **ZHR**: 55 - Velocity: fast 66.9km/sec - Parent Object: 1P/Halley

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Southern Delta Aquariids [SDA]

Active from July 21st to August 23rd. Peak night Jul 29-30

The Delta Aquariids, like the Eta Aquarids are best observed from northern Australia, but still worth it from NSW. Visible as soon as it is dark and all night so viewer friendly. These meteors also produce numbers for a week centred July 29-30. These are usually faint meteors , mostly mag 3 or 4 but some at 1 or 2 that lack both persistent trains and fireballs.

Radiant: RA: 22:40 **DEC:** -16.4° - **ZHR**: 16 - Velocity: medium - 42km/sec - Parent Object: 96P/Machholz

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Alpha Capricornids [CAP]
Active from July 11th to August 10th. Peak night Jul 26-27
The Alpha Capricornids are not very active with peak rates of five shower members per hour. The shower can produce bright fireballs and are seen as well from eastern Australian latitudes as anywhere else. Anywhere in Oz or NSW. Catch them while going for the SDA
Radiant: RA: 20:28 **DEC:** -10.2° - **ZHR**: 5 - Velocity: slow - 24km/sec - Parent Object: 169P/NEAT

Perseids [PER]
Active from July 13th to August 26th. Peak night Aug 11-12
The Perseids are the most popular meteor shower internationally as they peak on warm August nights as seen from the northern hemisphere. The Perseids are active from July 13 to August 26. They reach a strong maximum on August 12 or 13, depending on the year. Normal rates seen from dark-sky locations in the northern hemisphere range from 50-75 shower members per hour at maximum. They are well worth a look if you are in the northern hemisphere or even far north Australia but from Brisbane, the radiant barely rises and never rises from SE NSW and so we don't see much of a show though some meteors are always visible from dark skies.
Radiant: RA: 03:12 **DEC:** +57.6° - **ZHR**: 100(nth hemisphere) - Velocity: swift - 60km/sec - Parent Object: 109P/Swift-Tuttle

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Orionids [ORI]
Active from Oct 2nd to Nov 7th. Peak night Oct 21-22
The Orionids are a medium strength shower that sometimes reaches high strength activity. In a normal year the Orionids produce 20-25 shower members at maximum in the northern hemisphere. In exceptional years, such as 2006-2009, the peak rates were on par with the Perseids (50-75 per hour). No accurate prediction model exists. Southern hemisphere rates are a bit lower.
Radiant: RA: 06:20 **DEC:** +15.5° - **ZHR:** 25 - Velocity: swift - 67km/sec - Parent Object: 1P/Halley

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Southern Taurids [STA]
Active from September 23rd to November 19th. Peak night Oct 28-29
The Southern Taurids are a long-lasting shower with several minor peaks in October and November. The shower is active for two months but rarely produces more than five shower members per hour, even at maximum activity. The Taurids (both branches) are most notable for colourful fireballs and are often responsible for an increased number of fireball reports from September through November. The shower is active for nearly two months so organise pre-dawn observing activities anytime from new Moons until a few days before full Moons. Peak night on Nov 5th.

Radiant: RA: 03:12 **DEC:** +12.8° - **ZHR**: 5 - Velocity: slow - 27km/sec - Parent Object: 2P/Encke

Northern Taurids [NTA]

Active from October 19th to December 10th. Peak night Nov 12-13.
This shower is much like the Southern Taurids, just active a bit later in the year. When the two showers are active simultaneously in late October and early November, there is sometimes a notable increase in the fireball activity. You might see 2 or 3 per hour - bright orange and slow. There seems to be a seven-year periodicity with these fireballs. 2008 was the last remarkable year so 2029 is a possible peak year. The shower is active for nearly two months so organise pre-dawn observing activities anytime from new Moons until a few days before full Moons.

Radiant: RA: 03:52 **DEC:** +22.7° - **ZHR**: 5 - Velocity: medium - 30km/sec - Parent Object: 2P/Encke

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Leonids [LEO]

Active from November 5th to November 30th. Peak is Nov 18 after 1:00 AM. The Leonids are best known for producing great meteor storms in the years of 1833, 1866, 1966, 1999 and 2001.

In the late 1990's, Asher and McNaught modelled the orbits of clusters of material reduced from observations of earlier outbursts. They published predictions of high activity, predicting both time and geographic location for high activity showers during the 1999-2001 peak.

- https://www.theguardian.com/science/2000/nov/16/technology
- https://articles.adsabs.harvard.edu//full/2000JIMO...28..138A/0000138.000.html

This was a seminal paper and ground-breaking prediction technique. I drove to western Queensland (near Quilpie) in November 2001 using these predictions and was privileged to see a great display of bright Leonid fireballs perhaps 60 per hour. These outbursts of meteor activity are best seen when the parent object, comet 55P/Tempel-Tuttle, is closest to the Sun.

Unfortunately, it appears that the Earth will not encounter any dense clouds of debris again until 2099. Therefore, when the comet returns in 2031 and 2064(the 33 year cycle years), there will be no extreme ZHR meteor storms, but perhaps several good displays of Leonid activity when rates are in excess of 100 per hour. The best we can hope for now until the year 2030 is peaks of around 15 shower members per hour and perhaps an occasional weak outburst when the Earth passes near a debris trail. The Leonids are often bright meteors with a high percentage of persistent trains.

Radiant: RA: 10:08 **DEC:** +21.6° - **ZHR**: 15 - Velocity: 70km/sec
Parent Object: 55P/Tempel-Tuttle

Geminids [GEM]
Active from December 4th to December 16th. Peak time is the mornings of Dec 13-14-15 after midnight.

The Geminids are usually the strongest meteor shower of the year for northern and southern hemisphere observers. The Geminids are often bright and intensely coloured pale green. Due to their medium velocity, persistent trains of vapour can sometimes be seen. These meteors are also seen in the southern hemisphere, but at a reduced rate
Radiant: RA: 07:28 **DEC:** +32.2° - **ZHR**: 120 - Velocity: medium - 35km/sec - Parent Object: 3200 Phaethon (asteroid)

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