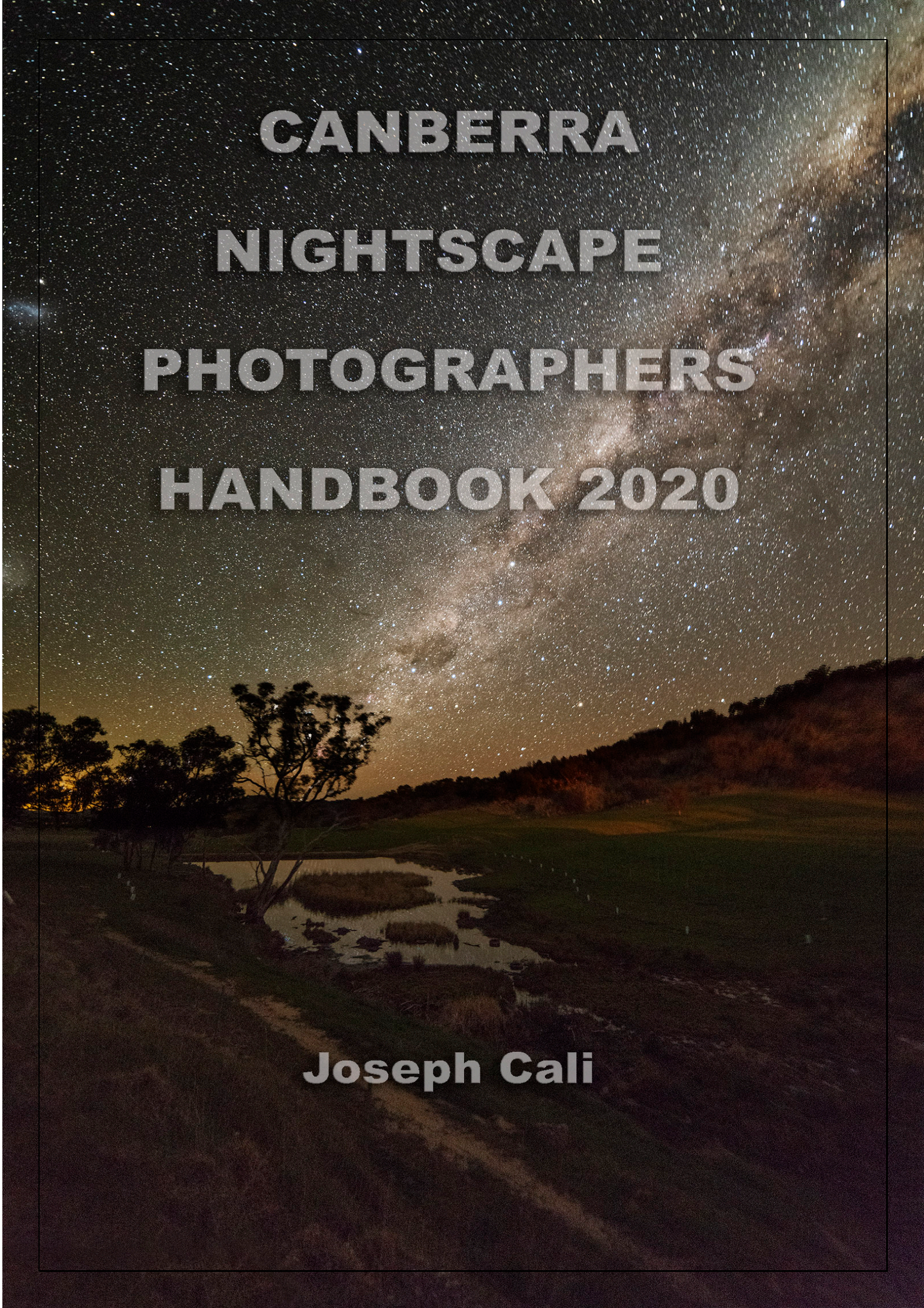
CANBERRA
NIGHTSCAPE
PHOTOGRAPHERS
HANDBOOK 2020
Joseph Cali

Shoot Planning Data for Astronomical Nightscapes

Canberra Region 2020

[149ºE, 35ºS]

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

Cover photo: Taken near Cowra on a chilly night early one September, this scene was scouted during another trip in May some four months earlier. With the Milky Way in the wrong position during May, we found other subjects then returned in September to capture this and other stunning scenes in Spring skies.

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Introduction

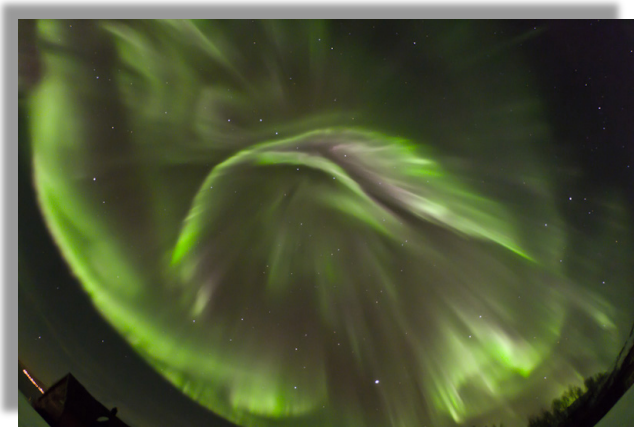
Why this handbook?

Although many smartphone apps can give you rise and set and other information for a specific day, usually the day on the app calendar, I find it useful to farm online resources to produce an annual almanac of rise/set and other useful planning information that I use for forward planning of nightscape and astronomical observing activities in the local region. I teach this approach in my nightscape photography themed workshops and events. I have produced a collection of such information each year for the past few years but shared with a few close friends. This year, I put extra time, it turned out to be a LOT of extra time, producing a pdf book for wider distribution.

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 14 total solar eclipses, many of them with my late friend, Bengt Alfredsson of Sweden. Until his sad and untimely passing in April 2019, Bengt [seen at the telescope in the photo] and I travelled all over the world chasing total eclipses, annular eclipses, aurorae, wildlife and spectacular landscapes in the Arctic, the Libyan Sahara, Zambia, Australia, China, and the Americas.

***Photos. Above left**, Bengt observing Omega Centauri through my 18" reflector. **Above 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. .*



Many of the nightscape photos used as illustrations in this document were taken on international travels with my late friend Bengt, or on Australian road trips with my long-time friend Greg Bond from Brisbane.

***Left**, a sky filling aurora lit the entire sky, and snow-covered ground beneath our feet on Kvaløya, Norway one week before the eclipse.*

ACT Public Holidays 2020

ACT PUBLIC HOLIDAYS 2020

The following public holidays will be observed in the Australian Capital Territory during 2020.

Public holiday	Date to be observed
New Year's Day	Wednesday 1 January 2020
Australia Day	Monday 27 January 2020*
Canberra Day	Monday 9 March 2020
Good Friday	Friday 10 April 2020
Easter Saturday	Saturday 11 April 2020
Easter Sunday	Sunday 12 April 2020
Easter Monday	Monday 13 April 2020
ANZAC Day	Saturday 25 April 2020
Reconciliation Day	Monday 1 June 2020
Queen's Birthday	Monday 8 June 2020
Labour Day	Monday 5 October 2020
Christmas Day	Friday 25 December 2020
Boxing Day	Saturday 26 December 2020 and Monday 28 December 2020**

Note: All public holiday dates are accurate at the time of publication.

*As 26 January (Australia Day) falls on a Sunday in 2020, the following Monday is observed as the public holiday.

**As 26 December (Boxing Day) falls on a Saturday in 2020, there is an additional public holiday on the Monday.

Information is sourced from the *Holidays Act 1958* (ACT).

(Information correct as of 7 February 2019)
Workplace Safety and Industrial Relations Division
Chief Minister, Treasury and Economic Development Directorate
Email: wsir@act.gov.au

Chief Minister, Treasury and Economic Development
GPO Box 158 Canberra ACT 2601 | phone: 132281 | www.act.gov.au

Source : https://act.gov.au

Daylight Savings Switchovers

1 hr back on Sunday April 4, @ 0200hrs EDT
1 hr forward on Sunday October 4, @ 0200hrs EST
Source : https://act.gov.au

New and full moon dates 2020

New Moons			
Year	Month	Day	UT
2019	Dec	26	5:16
2020	Jan	24	21:44
2020	Feb	23	15:34
2020	Mar	24	9:30
2020	Apr	23	2:27
2020	May	22	17:40
2020	Jun	21	6:42
2020	Jul	20	17:34
2020	Aug	19	2:42
2020	Sep	17	11:01
2020	Oct	16	19:32
2020	Nov	15	5:09
2020	Dec	14	16:19
2021	Jan	13	5:03

Full Moons			
Year	Month	Day	UT
2020	Jan	10	19:23
2020	Feb	9	7:35
2020	Mar	9	17:49
2020	Apr	8	2:36
2020	May	7	10:46
2020	Jun	5	19:13
2020	Jul	5	4:45
2020	Aug	3	16:00
2020	Sep	2	5:23
2020	Oct	1	21:07
2020	Oct	31	14:51
2020	Nov	30	9:32
2020	Dec	30	3:30

Data: https://www.fourmilab.ch/ by John Walker.

Workshops 2020

photo access

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

I have been an amateur astronomer for 42 years and teaching photography workshops at Photoaccess for the past 25 years. The following astro-photography theme workshops and field events will be offered during the first half of 2020. A similar program will be offered in the second semester. When enrolments open, courses will appear on [the Photoaccess Classes Page]

"Pinchgut Skies" – May 22-24

https://www.photoaccess.org.au/learn/classes/pinchgut-skies/

Spend a weekend shooting and enjoying under beautiful dark skies at "Retreat" a remote property 200km west of Canberra with expert astrophotographers, Joe Cali and Greg Bond and Photoaccess staff. In addition to fixed tripod nightscape photography, some tracking devices will be available ranging from entry level tracker devices to a $10000 Takahashi EM-200 high precision mounting. Joe will demonstrate set up of such devices including all important polar alignment techniques. Bring your own tracker or take turns on Joe's trackers.

Requirements: DSLR, Tripod, remote release, camping gear*, own transport.
*Location will be at shearers quarters at a private farm stay 2 hours drive from Canberra. You will need a pillow, sleeping bag or bedsheets & blankets.
Expected temperatures - night time 0-5°C, daytime 15-22°C.

Astro-Image Processing Workshops

Do you look at elegantly processed images astronomical or otherwise and wish you could do that. Tutor Joe Cali has been using Adobe Photoshop since version 2 in 1992. He began teaching photography workshops at photo access in 1995 and has taught Photoshop workshops since 2004. In this two-part series, Joe will give you a ground up introduction to Lightroom and Photoshop before moving into more specialised astro-processing techniques in the second series. You will need to have licenced installed versions of Lightroom and Photoshop running on your own computer that you can bring to class to gain full benefit. Enrolments will open soon here:- **https://www.photoaccess.org.au/learn/classes/**

Part 1 – Back to Basics. Wednesdays 6pm-9pm, May 27, June 3, 10, 17

Aimed at complete beginners, and over 4 three hour sessions, Joe will start at the basics and teach you a set of robust processing techniques essential for photographers that can be applied to astrophotographs and any other photograph. This course will cover Lightroom and Photoshop

Part 2 Specialist Techniques. Wednesdays 6pm-9pm, July 4, 11, 18, 25

This four x 3hr session will cover specialist astronomical techniques such as stacking and averaging, advanced masking and blending, noise reduction and sharpening.

One night shoots
Meet near the edge of Canberra and convoy to a dark sky [~40 mins drive]

or you can meet us there. We try to wind up by around midnight so that you are not dangerously tired driving home. Register your interest with Photoaccess and we will contact you when these events come up. Ph 02 62957810 or email **hello [at] photoaccess.org.au**

Captured by Phil Jones on the 'Murrumbidgee Midnight Madness' one-night shoot, August 2019.

Nightscapes and Star Trails

https://www.photoaccess.org.au/learn/classes/nightscapes-and-startrails/

Do you stand outside at night, look up at the stars and dream of capturing the awe-inspiring beauty of the Milky Way? If you're in possession of a DSLR camera, a tripod, warm clothes and a sense of adventure, then your dream can come true!

Semester 1

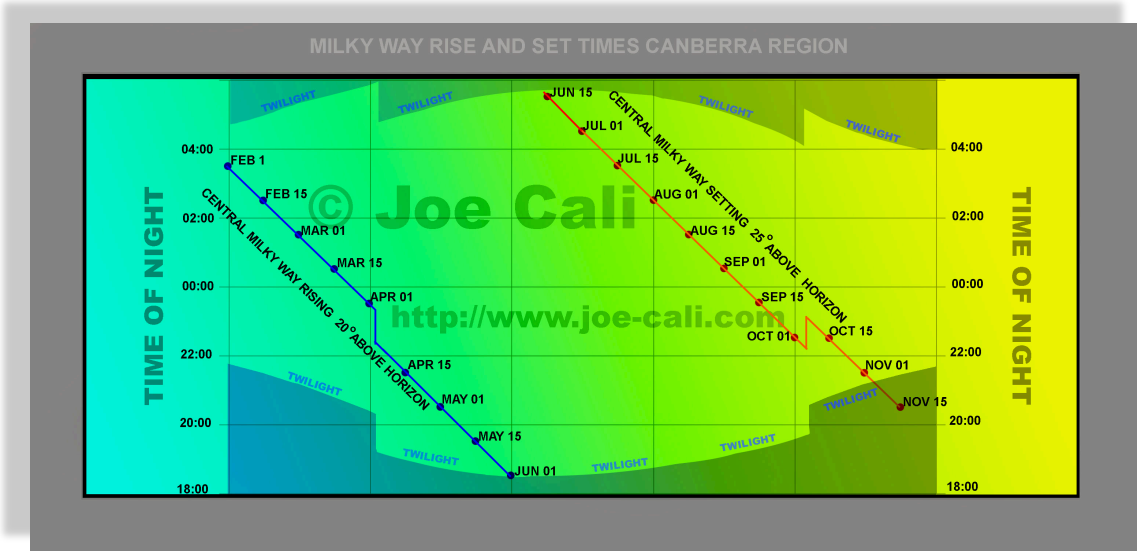
Class 1	April 1	Planning, Equipment and Field Techniques
Field trip	April 18	4 hour night shoot held at a location ~1 hours drive from Canberra
Class 3	April 29	Image review and feedback

Join experienced astrophotographer and tutor Joe Cali for this hands-on workshop focusing on creating nightscapes. Together with fellow astro-enthusiasts, you'll consider how to compose after-dark land and skyscapes, explore practical aspects of night shoots, such as forecasting clear skies and staying comfortable during long shoots, and experiment with capturing striking stills, star trails and panoramas. During long exposures, you'll no doubt also have lots of opportunity to discuss the wonder of the galaxy.

The workshop comprises two 3 hours classroom sessions at PhotoAccess and a Saturday field trip of about 6 hours (1 hour drive each way, with 3 – 4 hours field time). The field trip is scheduled for Saturday 18 April, but please note that the weather may spoil our plans and we may need to delay it. We'll be able to give you 24 hours' notice if it's re-scheduled.

For this workshop, you must have basic to intermediate photography skills, including a good working knowledge of your camera controls and any associated equipment. If you're not sure about your skill level or whether your camera equipment is suitable, please contact us in advance of booking to discuss.

When Does The Winter Milky Way Rise And Set In The 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 Antares at 20° altitude for the rising Milky Way and the Triffid nebula at 25° 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

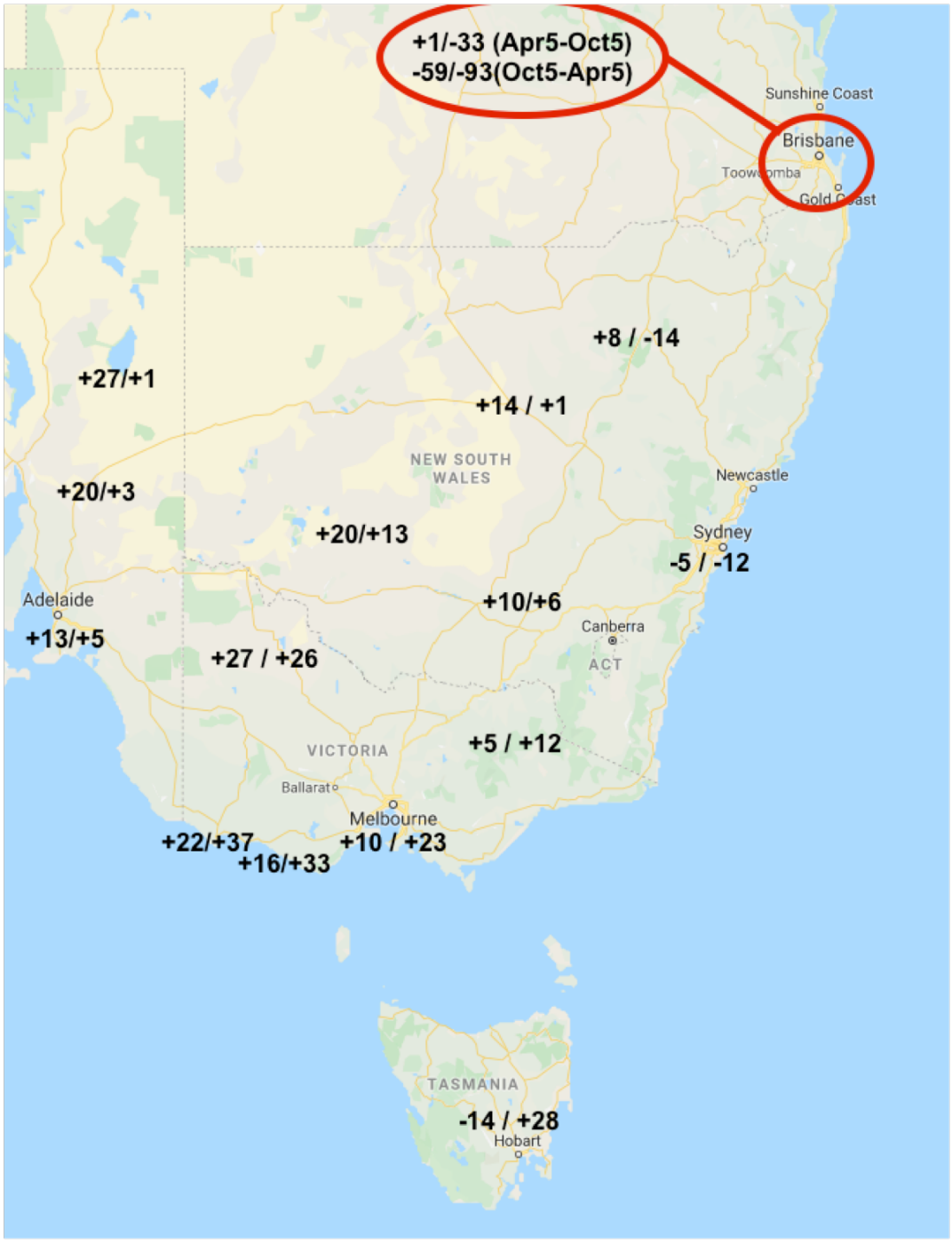
Setting – Triffid Nebula 25 ^{o} altitude

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

Milky Way Rise and Set Time Corrections for other locations

Eg Narrabri +8 / -14 =>

- Add 8 mins to MW rise & morning twilight times.
- Subtract 14 mins from MW set and evening twilight times.
- These corrections only work for the Milky Way, not for the Moon and Sun because they have declinations that vary leading to variable corrections throughout the year.



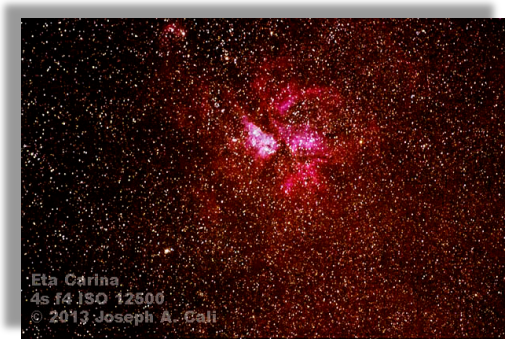
Avoiding trailed star images

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.

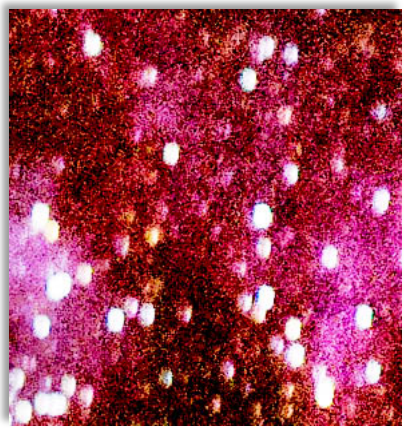
No simple "rule" can adequately calculate the maximum exposure for stars to appear stationary for all cameras, sensors and output formats. Why? Because it's a function of a number of factors –

- 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. At about the same time as I published my formula, I was contacted by Frédéric Michaud from the Société Astronòmique du Havre who had derived a different formula called the NPF rule. We compared our maths derivations and although we had approached the problem using different math methods, 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 APS 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 use 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.

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	4K TV	LAPTOP SCREEN/HD TV	FACEBOOK	600px web image
	pixel width	pixel width	pixel width	pixel width	pixel width
	4800	4000	2000	1000	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

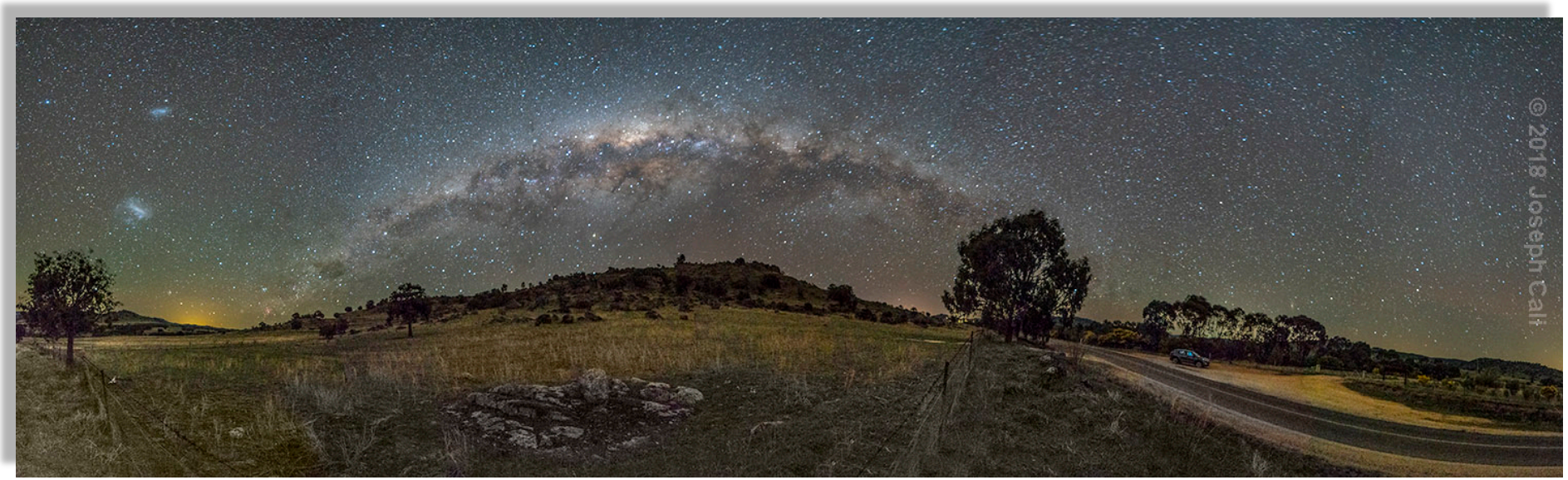
	HIGHEST RESOLUTION OUTPUT DEVICE				
	A3 PRINT	4K TV	LAPTOP SCREEN/HD TV	FACEBOOK	600px web image
	pixel width	pixel width	pixel width	pixel width	pixel width
	4800	4000	2000	1000	600
RULE FACTOR	**70**	**84**	**168**	**336**	**560**
Lens Focal length (mm)	**MAX EXPOSURE TIME (s)**	**MAX EXPOSURE TIME (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	4K TV	LAPTOP SCREEN/HD TV	FACEBOOK	600px web image
	pixel width	pixel width	pixel width	pixel width	pixel width
	4800	4000	2000	1000	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.

Above: "Forces of Nature" March 2015 *Waking at 2am, I walk 1000ft up an adjacent mountain with my late friend Bengt Alfredsson, to obtain this commanding view of Mt Bromo billowing ash and smoke, Semeru volcano steam illuminated by glowing red lava in the cone, lightning in the distance and the stunning Milky Way overhead. What more could you ask for?*

2020 ASTRONOMICAL TWILIGHT

CANBERRA

Location: E149° 00′, S35° 00′

Astronomical Twilight for 2020

Zone: 10h East of Greenwich

Astronomical Applications Dept. U. S. Naval Observatory

Washington, DC 20392-5420

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
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02	0407	2207	0447	2147	0524	2107	0553	2021	0515	1846	0534	1830	0542	1834	0531	1850	0458	1910	0414	1934	0427	2109	0359	2148
03	0408	2207	0449	2146	0526	2105	0554	2020	0516	1845	0535	1830	0542	1834	0530	1851	0457	1911	0412	1935	0426	2110	0359	2149
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15	0422	2203	0505	2130	0538	2047	0503	1904	0524	1837	0539	1830	0540	1840	0519	1858	0440	1919	0453	2047	0412	2126	0358	2201
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17	0425	2202	0508	2128	0540	2044	0505	1902	0525	1836	0540	1830	0540	1841	0517	1900	0437	1921	0450	2049	0410	2129	0358	2202
18	0426	2201	0509	2126	0541	2043	0505	1901	0526	1835	0540	1830	0539	1842	0516	1900	0435	1922	0449	2050	0409	2130	0358	2203
19	0427	2201	0510	2125	0542	2041	0506	1900	0526	1835	0541	1830	0539	1842	0515	1901	0434	1923	0447	2051	0408	2132	0359	2204
20	0429	2200	0511	2123	0542	2040	0507	1858	0527	1834	0541	1830	0538	1843	0514	1901	0432	1923	0446	2053	0407	2133	0359	2204
21	0430	2159	0513	2122	0543	2038	0508	1857	0527	1834	0541	1831	0538	1843	0513	1902	0431	1924	0444	2054	0406	2134	0359	2205
22	0432	2158	0514	2120	0544	2037	0508	1856	0528	1833	0541	1831	0537	1844	0512	1903	0429	1925	0443	2055	0405	2136	0400	2205
23	0433	2157	0515	2119	0545	2035	0509	1855	0529	1833	0541	1831	0537	1844	0510	1903	0428	1926	0441	2056	0405	2137	0400	2206
24	0434	2156	0516	2117	0546	2034	0510	1854	0529	1832	0542	1831	0536	1845	0509	1904	0426	1927	0440	2057	0404	2138	0401	2206
25	0436	2156	0517	2116	0547	2032	0510	1853	0530	1832	0542	1832	0536	1846	0508	1905	0424	1928	0439	2059	0403	2140	0402	2206
26	0437	2155	0519	2114	0548	2031	0511	1852	0530	1832	0542	1832	0535	1846	0507	1905	0423	1928	0437	2100	0402	2141	0402	2207
27	0439	2154	0520	2113	0549	2029	0512	1851	0531	1831	0542	1832	0535	1847	0506	1906	0421	1929	0436	2101	0402	2142	0403	2207
28	0440	2153	0521	2112	0549	2028	0513	1850	0531	1831	0542	1833	0534	1847	0504	1907	0420	1930	0434	2102	0401	2143	0404	2207
29	0442	2152	0522	2110	0550	2027	0513	1849	0532	1831	0542	1833	0533	1848	0503	1907	0418	1931	0433	2103	0401	2145	0405	2207
30	0443	2151			0551	2025	0514	1848	0532	1830	0542	1833	0533	1848	0502	1908	0417	1932	0431	2105	0400	2146	0405	2207
31	0444	2149			0552	2024			0533	1830			0532	1849	0500	1909			0430	2106			0406	2207

Source : https://aa.usno.navy.mil/

. SUNRISE/SET

CANBERRA — Astronomical Applications Dept. — Location: E149° 00′, S35° 00′

Rise and Set for the Sun for 2020 — U. S. Naval Observatory

Washington, DC 20392-5420 — Zone: 10h East of **Greenwich**

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
01	0553	2021	0622	2012	0651	1941	0717	1858	0640	1721	0703	1700	0713	1703	0659	1722	0623	1745	0541	1807	0602	1934	0543	2003
02	0554	2021	0623	2011	0652	1940	0718	1857	0641	1720	0704	1700	0713	1704	0658	1723	0622	1746	0539	1808	0601	1935	0543	2004
03	0554	2022	0625	2010	0653	1939	0718	1856	0642	1719	0704	1700	0713	1704	0657	1724	0621	1747	0538	1809	0600	1936	0543	2005
04	0555	2022	0626	2010	0654	1937	0719	1854	0643	1718	0705	1700	0713	1705	0656	1725	0619	1747	0536	1810	0559	1937	0543	2006
05	0556	2022	0627	2009	0655	1936	0620	1753	0644	1717	0706	1659	0712	1705	0655	1725	0618	1748	0635	1910	0558	1938	0543	2007
06	0557	2022	0628	2008	0655	1935	0621	1752	0644	1716	0706	1659	0712	1706	0654	1726	0616	1749	0634	1911	0557	1939	0543	2007
07	0558	2022	0629	2007	0656	1933	0621	1750	0645	1716	0707	1659	0712	1706	0653	1727	0615	1750	0632	1912	0556	1940	0543	2008
08	0559	2022	0630	2006	0657	1932	0622	1749	0646	1715	0707	1659	0712	1707	0652	1728	0614	1750	0631	1913	0555	1941	0543	2009
09	0559	2022	0631	2005	0658	1931	0623	1748	0647	1714	0708	1659	0712	1707	0651	1728	0612	1751	0630	1914	0554	1942	0543	2010
10	0600	2022	0632	2004	0659	1929	0624	1746	0648	1713	0708	1659	0711	1708	0650	1729	0611	1752	0628	1914	0554	1943	0543	2011
11	0601	2022	0633	2003	0700	1928	0625	1745	0648	1712	0709	1659	0711	1708	0649	1730	0609	1752	0627	1915	0553	1944	0543	2011
12	0602	2021	0634	2002	0701	1926	0625	1744	0649	1711	0709	1659	0711	1709	0648	1731	0608	1753	0625	1916	0552	1945	0544	2012
13	0603	2021	0635	2001	0701	1925	0626	1742	0650	1710	0709	1659	0710	1709	0647	1731	0606	1754	0624	1917	0551	1946	0544	2013
14	0604	2021	0636	2000	0702	1924	0627	1741	0651	1710	0710	1659	0710	1710	0646	1732	0605	1755	0623	1918	0551	1947	0544	2013
15	0605	2021	0637	1959	0703	1922	0628	1740	0651	1709	0710	1659	0710	1711	0645	1733	0604	1755	0622	1919	0550	1948	0544	2014
16	0606	2020	0638	1958	0704	1921	0629	1739	0652	1708	0710	1659	0709	1711	0643	1734	0602	1756	0620	1919	0549	1949	0545	2015
17	0607	2020	0639	1957	0705	1919	0629	1737	0653	1708	0711	1659	0709	1712	0642	1734	0601	1757	0619	1920	0549	1950	0545	2015
18	0608	2020	0640	1956	0705	1918	0630	1736	0654	1707	0711	1659	0708	1713	0641	1735	0559	1757	0618	1921	0548	1951	0545	2016
19	0609	2019	0641	1955	0706	1917	0631	1735	0654	1706	0711	1659	0708	1713	0640	1736	0558	1758	0616	1922	0548	1952	0546	2017
20	0610	2019	0642	1953	0707	1915	0632	1734	0655	1706	0712	1700	0707	1714	0639	1737	0556	1759	0615	1923	0547	1953	0546	2017
21	0611	2019	0643	1952	0708	1914	0633	1732	0656	1705	0712	1700	0706	1715	0637	1737	0555	1800	0614	1924	0547	1954	0547	2018
22	0612	2018	0644	1951	0709	1912	0633	1731	0657	1704	0712	1700	0706	1715	0636	1738	0554	1800	0613	1925	0546	1955	0547	2018
23	0613	2018	0644	1950	0710	1911	0634	1730	0657	1704	0712	1700	0705	1716	0635	1739	0552	1801	0612	1926	0546	1956	0548	2019
24	0614	2017	0645	1949	0710	1910	0635	1729	0658	1703	0712	1701	0705	1717	0634	1739	0551	1802	0610	1926	0545	1957	0548	2019
25	0615	2017	0646	1947	0711	1908	0636	1728	0659	1703	0713	1701	0704	1717	0632	1740	0549	1803	0609	1927	0545	1958	0549	2019
26	0616	2016	0647	1946	0712	1907	0637	1727	0659	1702	0713	1701	0703	1718	0631	1741	0548	1803	0608	1928	0545	1958	0549	2020
27	0617	2015	0648	1945	0713	1905	0637	1726	0700	1702	0713	1702	0703	1719	0630	1742	0546	1804	0607	1929	0544	1959	0550	2020
28	0618	2015	0649	1944	0714	1904	0638	1725	0701	1702	0713	1702	0702	1720	0629	1742	0545	1805	0606	1930	0544	2000	0551	2020
29	0619	2014	0650	1942	0714	1903	0639	1723	0701	1701	0713	1702	0701	1720	0627	1743	0544	1806	0605	1931	0544	2001	0551	2021
30	0620	2013			0715	1901	0640	1722	0702	1701	0713	1703	0700	1721	0626	1744	0542	1806	0604	1932	0543	2002	0552	2021
31	0621	2013			0716	1900			0703	1701			0659	1722	0625	1745			0603	1933			0553	2021

Source : https://aa.usno.navy.mil/

Moon 1st qtr, 16th November, 2018, 11:20 UT

Vixen VC200L f6.4

Joe Cali

Moon Rise and Moon Set

2020 MOONRISE/SET

CANBERRA

Source: Astronomical Applications Dept. U. S. Naval Observatory

Location: E149° 00', S35° 00'

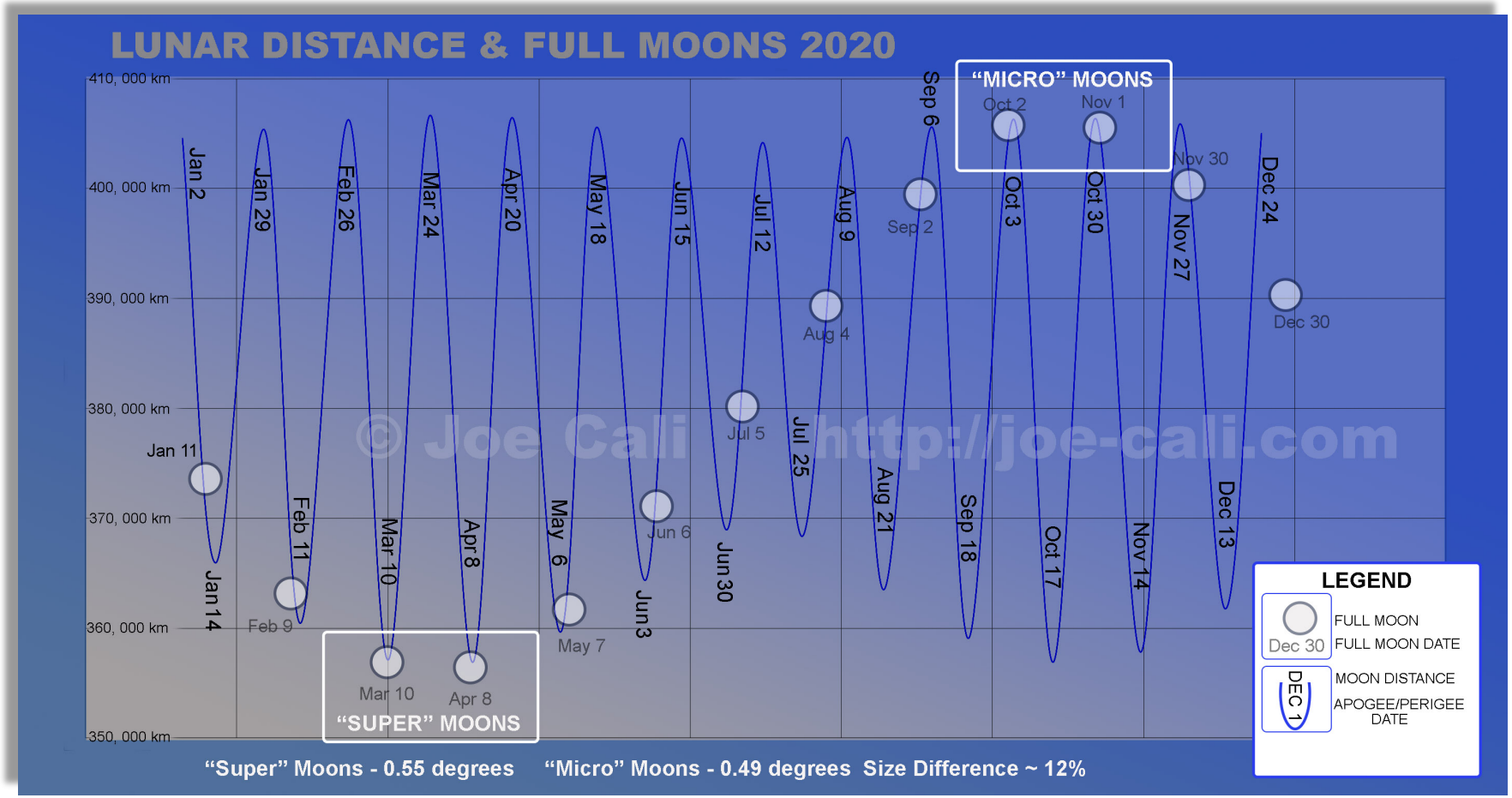
Rise and Set for the Moon for 2020

Washington, DC 20392-5420 **Time Zone: 10h East of Greenwich**

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
Day	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set	Rise	Set
	h m	h m	h m	h m	h m	h m	hh m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
01	1113		1243		1227	2317	1413		1339		1407	0122	1350	0236	1452	0453	1643	0601	1729	0535	2006	0625	2052	0607
02	1208	0024	1339	0015	1325	2354	1507	0010	1420	0009	1440	0230	1430	0345	1550	0550	1742	0634	1824	0602	2103	0655	2149	0649
03	1303	0051	1437	0045	1424		1557	0110	1458	0117	1515	0340	1515	0454	1651	0641	1839	0704	1919	0628	2201	0729	2243	0738
04	1358	0118	1537	0120	1524	0036	1643	0215	1533	0227	1553	0450	1606	0601	1753	0724	1935	0732	2015	0654	2258	0807	2332	0833
05	1454	0146	1639	0200	1622	0126	1624	0225	1608	0337	1636	0602	1703	0703	1853	0801	2031	0758	2211	0823	2353	0852		0933
06	1552	0216	1740	0247	1717	0223	1702	0336	1643	0448	1725	0712	1803	0759	1952	0834	2126	0825	2308	0854		0942	0015	1036
07	1653	0249	1838	0342	1807	0328	1738	0449	1721	0600	1819	0818	1905	0847	2048	0903	2221	0852		0929	0045	1038	0054	1141
08	1755	0326	1932	0444	1852	0438	1814	0601	1802	0713	1918	0918	2006	0928	2144	0930	2318	0921	0006	1009	0133	1140	0129	1247
09	1857	0410	2020	0553	1933	0550	1851	0714	1848	0825	2019	1010	2105	1003	2239	0957		0954	0103	1055	0215	1245	0202	1353
10	1958	0502	2103	0705	2010	0704	1930	0827	1939	0933	2120	1055	2203	1034	2334	1023	0016	1031	0158	1149	0254	1351	0234	1501
11	2054	0601	2141	0817	2046	0816	2013	0938	2035	1036	2220	1132	2259	1103		1051	0114	1114	0249	1248	0329	1500	0306	1610
12	2145	0707	2217	0929	2122	0928	2101	1047	2134	1131	2318	1205	2354	1129	0030	1122	0211	1204	0336	1353	0402	1609	0341	1722
13	2229	0816	2251	1039	2159	1040	2153	1151	2234	1219		1234		1156	0128	1157	0306	1302	0419	1501	0436	1721	0419	1835
14	2308	0926	2326	1148	2239	1149	2249	1249	2334	1259	0014	1302	0049	1223	0227	1237	0358	1406	0457	1611	0510	1834	0503	1948
15	2344	1036		1255	2322	1257	2347	1339		1334	0109	1328	0145	1252	0326	1324	0444	1514	0533	1723	0548	1948	0554	2057
16		1144	0003	1402		1401		1422	0031	1404	0203	1354	0242	1325	0424	1419	0526	1625	0607	1835	0630	2103	0653	2159
17	0018	1251	0042	1506	0010	1501	0045	1459	0128	1432	0259	1422	0341	1402	0519	1521	0604	1737	0642	1948	0718	2214	0756	2251
18	0051	1357	0126	1607	0102	1554	0143	1532	0223	1459	0356	1453	0441	1446	0609	1628	0639	1849	0718	2103	0813	2318	0901	2335
19	0126	1503	0214	1704	0157	1640	0239	1601	0317	1525	0454	1528	0541	1537	0653	1738	0714	2001	0758	2216	0913		1005	
20	0202	1608	0307	1755	0254	1721	0335	1629	0412	1552	0554	1608	0638	1635	0733	1849	0749	2113	0843	2327	1016	0014	1107	0012
21	0243	1712	0402	1840	0352	1757	0429	1655	0508	1621	0654	1655	0731	1740	0810	2000	0826	2225	0933		1119	0101	1207	0044
22	0328	1812	0500	1920	0449	1828	0524	1722	0606	1654	0753	1748	0818	1847	0844	2110	0906	2335	1029	0033	1220	0140	1304	0112
23	0418	1908	0557	1954	0545	1857	0619	1750	0705	1730	0848	1848	0900	1956	0917	2219	0952		1128	0131	1320	0214	1359	0139
24	0512	1958	0654	2026	0640	1925	0716	1820	0804	1812	0937	1952	0937	2105	0952	2328	1042	0041	1229	0221	1417	0243	1454	0204
25	0609	2042	0751	2054	0735	1951	0813	1853	0903	1900	1021	2059	1011	2213	1029		1138	0142	1330	0304	1512	0310	1550	0231
26	0708	2120	0846	2121	0829	2018	0912	1931	1000	1955	1100	2207	1044	2321	1110	0037	1236	0236	1429	0340	1607	0336	1646	0258
27	0806	2154	0940	2148	0925	2047	1010	2014	1052	2056	1136	2314	1117		1156	0144	1337	0322	1527	0411	1703	0402	1744	0329
28	0903	2224	1035	2216	1021	2117	1108	2104	1139	2200	1209		1151	0028	1247	0247	1437	0402	1623	0440	1759	0428	1843	0404
29	0958	2252	1130	2245	1118	2152	1203	2201	1221	2307	1241	0021	1229	0136	1343	0346	1535	0437	1719	0506	1856	0457	1941	0445
30	1053	2319			1217	2232	1253	2303	1259		1315	0128	1311	0244	1442	0437	1633	0507	1814	0532	1954	0530	2037	0532
31	1148	2346			1315	2317			1333	0014			1359	0350	1543	0522			1909	0558			2128	0626

Source : https://aa.usno.navy.mil/

Lunar Distance and Size, Super Moons and Micro Moons



Data: https://www.fourmilab.ch/ by John Walker. Graphic by Joe Cali

Eclipses of 2020

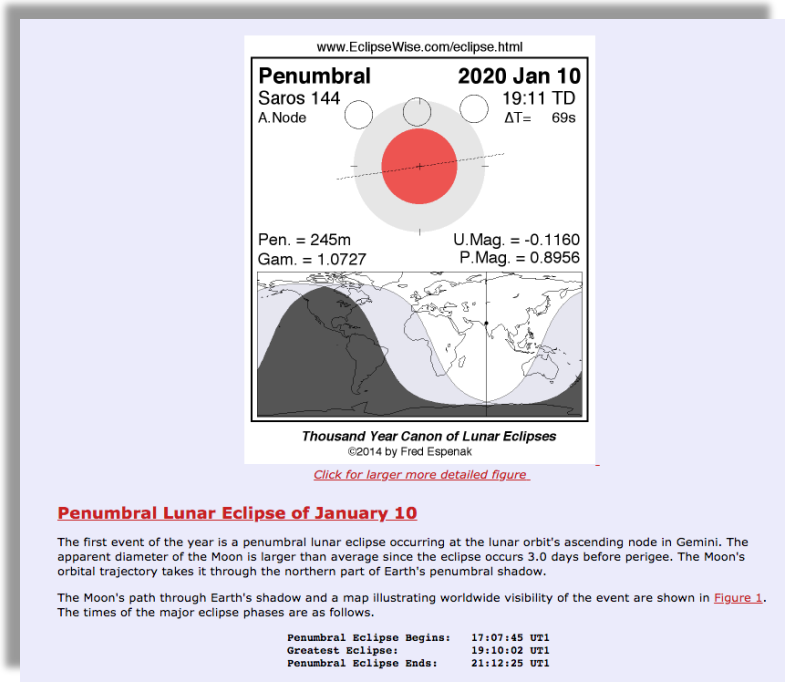
No total lunar eclipses are visible in 2020. The next total lunar eclipse visible from south east Australia occurs on May 26th, 2021. There are five eclipses that occur during 2020. An annular solar eclipse on June 21 is visible along a narrow track from the middle east across Pakistan, India, China and Taiwan. A total solar eclipse occurs across southern Chile and Argentina on December 14. Neither of these is visible from Canberra. Four penumbral lunar eclipses occur during the year. Two of these are part visible from Canberra one is fully visible.

What is a penumbral eclipse? If you were standing anywhere on the Earth-facing side of the Moon, you would see the Earth partially eclipsing the Sun. During a penumbral eclipse, the lunar surface receives less light but the Earth's umbra, the dark cone of shade cast behind the Earth never contacts the Moon and so no shadow is seen on the Moon.

Approximate Times are given in the table in Canberra local time - either Eastern Daylight Time [EDT] or Eastern Standard Time [EST] whichever applies at the time of the eclipse.

Penumbral Lunar Eclipse of 2020 Jan 10

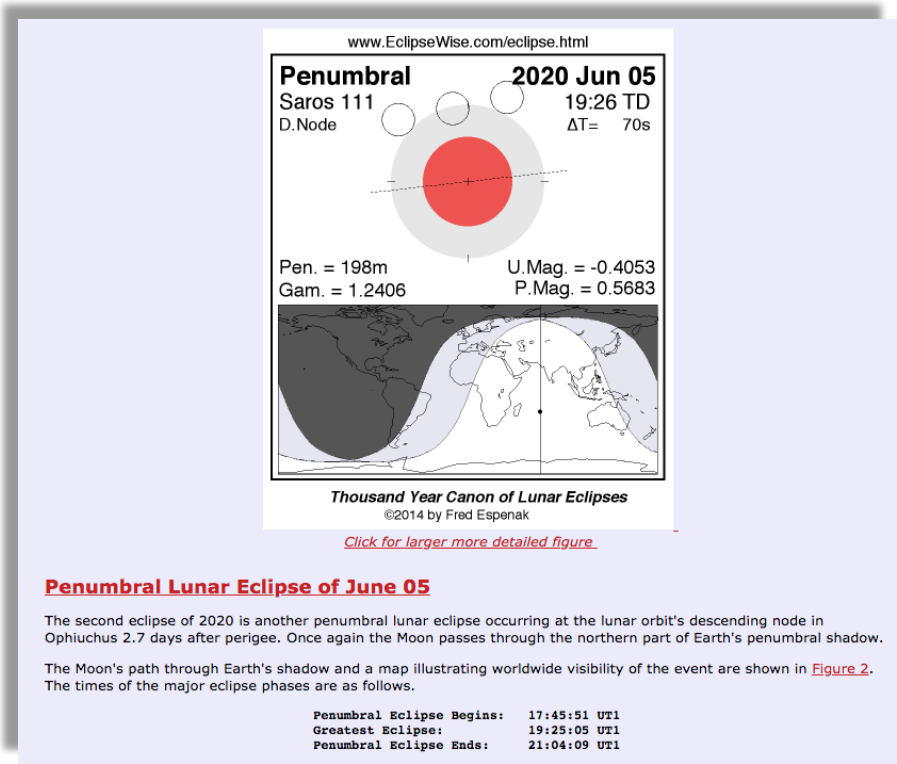
On January 10, Moonset occurs at 05:02 so hardly any of this penumbral eclipse will be visible. My recommendation is to stay in bed!



Eclipse Event	Contact	LOCAL TIME [EDT]
Penumbral Begins	P1	04:08
Greatest Eclipse	Greatest	06:11
Penumbral Ends	P4	08:13

Penumbral Lunar Eclipse of 2020 Jun 05

Moonrise is at 1636. At the start of the eclipse, at 17:45, , the Moon will be 12° above the horizon and 15° south of east. The entire event is observable from Canberra.

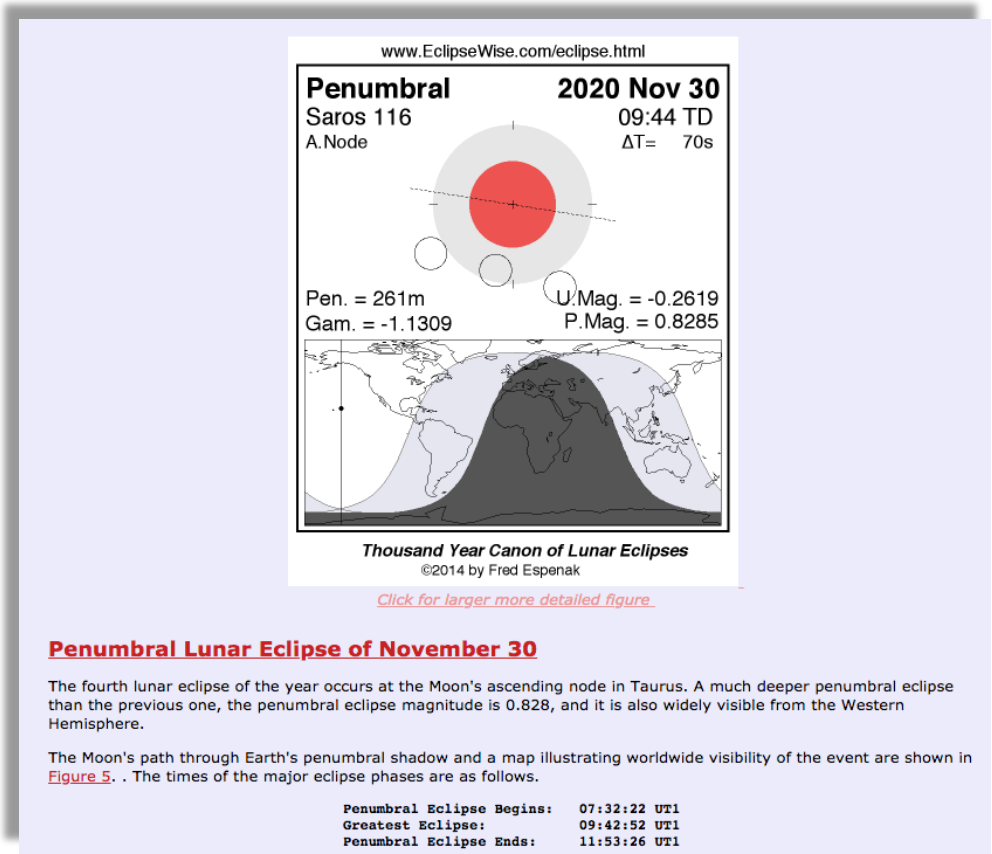


Eclipse Event	Contact	LOCAL Time [EST]
Penumbral Begins	P1	17:45:51.5
Greatest Eclipse	Greatest	19:25:04.8
Penumbral Ends	P4	21:04:08.6

Lunar Eclipse, January 31st 2018, Joe Cali

Penumbral Lunar Eclipse of 2020 Nov 30

Although this event begins at 18:32, the Moon does not rise until 19:54, the sun sets a few minutes later and astronomical twilight ends at 21:46. The eclipse will be in progress as the Moon rises. Atmospheric extinction near the horizon will make this event very difficult.



Penumbral Lunar Eclipse of November 30

The fourth lunar eclipse of the year occurs at the Moon's ascending node in Taurus. A much deeper penumbral eclipse than the previous one, the penumbral eclipse magnitude is 0.828, and it is also widely visible from the Western Hemisphere.

The Moon's path through Earth's penumbral shadow and a map illustrating worldwide visibility of the event are shown in Figure 5. . The times of the major eclipse phases are as follows.

```
Penumbral Eclipse Begins:   07:32:22 UT1
Greatest Eclipse:           09:42:52 UT1
Penumbral Eclipse Ends:     11:53:26 UT1
```

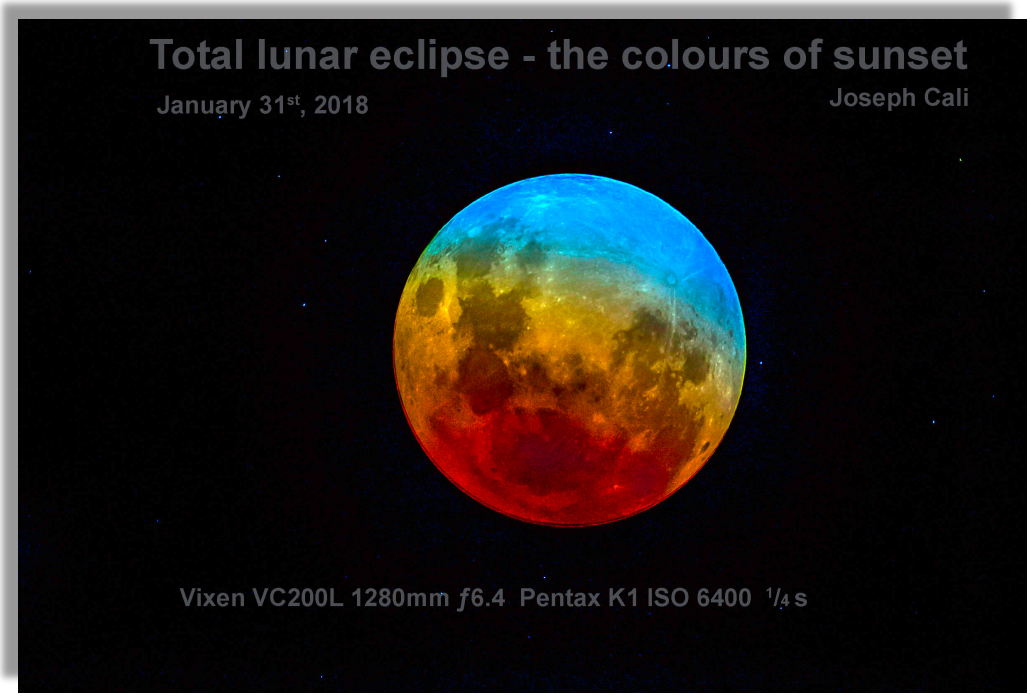
Eclipse Event	Contact	LOCAL Time [EDT]
Penumbral Begins	P1	18:32
Greatest Eclipse	Greatest	20:43
Penumbral Ends	P4	22:53

The illumination decrease of a penumbral eclipse can be recorded by taking a series of constant exposure photographs throughout the eclipse. Penumbral eclipses are mostly unnoticeable to the eye to all but the most experienced astronomical observers. A slight darkening at the nearest part of the lunar disk to the Earth's shadow may be detected by eye at mid-eclipse. Photographic technique Set your camera to ISO 200, your lens to ƒ11, camera in manual mode

shutter speed to 1/250th second. Capture at these settings without changing them during the entire duration.

Above: Wide field nightscape image of the total lunar eclipse 27th July, 2018.

Below: Total lunar eclipse 31 January, 2018. Image taken with 1300mm f6.4 telescope. Special processing has been applied to enhance the colours of sunlight refracted through the Earth's atmosphere on the lunar surface during the eclipse.



Meteor Shower Calendar

The meteor showers listed below are the easiest to observe and provide the most activity from the Canberra region. Particular attention should be noted to the time and moonlight conditions. Most showers are best seen after midnight. Some 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 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
Active from April 16th to April 25th. Peak night Apr 21-22.
Medium strength shower with decent rates for three nights around the maximum. Fireballs possible. In Canberra, the radiant is low in the sky, just 20° altitude & due north at 4:20am. Activity from this shower can be seen from the southern hemisphere, but at a lower rate.
Radiant: RA:18:04 **DEC:** +34° - **ZHR**: 18 - Velocity: 30 miles/sec (medium - 48.4km/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. I saw a display like this from Karjini National Park in 2013 just before dawn. Rates I've observed from Canberra's latitude have been disappointing by comparison to the show at Karjini. Activity is near peak for a week centred the night of maximum activity. These are swift meteors that produce a high percentage of persistent trains, but few fireballs.
Radiant: RA:22:32 **DEC:** -1° - **ZHR**: 55 - Velocity: 42 miles/sec (swift - 66.9km/sec) - Parent Object: 1P/Halley

Southern Delta Aquariids
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. These meteors produce good rates for a week centred on the night of maximum. These are usually faint meteors that lack both persistent trains and fireballs.
Radiant: RA: 22:40 **DEC:** -16.4° - **ZHR**: 16 - Velocity: 26 miles/sec (medium - 42km/sec) - Parent Object: 96P/Machholz

Alpha Capricornids
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 Canberra's latitude as anywhere else.
Radiant: RA: 20:28 **DEC:** -10.2° - **ZHR**: 5 - Velocity: 15 miles/sec (slow - 24km/sec) - Parent Object: 169P/NEAT

Perseids
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 rural locations 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 Canberra, the radiant never rises above the horizon and so we don't see much of a show.
Radiant: RA: 03:12 **DEC:** +57.6° - **ZHR**: 100 - Velocity: 37 miles/sec (swift - 60km/sec) - Parent Object: 109P/Swift-Tuttle

Orionids
Active from September 23rd to November 27th. 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 exceptional years, such as 2006-2009, the peak rates were on par with the Perseids (50-75 per hour). No accurate prediction model exists but a 12 year cycle is theorised.
Radiant: RA: 06:20 **DEC:** +15.5° - **ZHR:** 25 - Velocity: 41 miles/sec (swift - 67km/sec) - Parent Object: 1P/Halley

Southern Taurids
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 coluorful fireballs and are often responsible for an increased number of fireball reports from September through November.
Radiant: RA: 03:12 **DEC:** +12.8° - **ZHR**: 5 - Velocity: 17 miles/sec (slow - 27km/sec) - Parent Object: 2P/Encke

Northern Taurids
Active from October 19th to December 10th. Peak night Nov 10-11.
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 an notable increase in the fireball activity. There seems to be a seven year periodicity with these fireballs. 2008 was the last remarkable year. Perhaps 2015 will be the next?
Radiant: RA: 03:52 **DEC:** +22.7° - **ZHR**: 5 - Velocity: 18 miles/sec (medium - 30km/sec) - Parent Object: 2P/Encke

Leonids
Active from November 5th to November 30th. Peak night Nov 17-18.
The Leonids are best known for producing great meteor storms in the years of 1833, 1866, 1966, and 2001. I drove to western Queensland (Quilpie) in November 2001and was privileged to see a great display of bright Leonid fireballs perhap 60 per hour. These outbursts of meteor activity are best seen when the parent object, comet 55P/Tempel-Tuttle, is closest to the sun.

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://science.nasa.gov/science-news/science-at-nasa/2001/ast08nov_1

This was a seminal paper and ground-breaking prediction technique. 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, there will be no 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: 44 miles/sec (swift - 71km/sec) - Parent Object: 55P/Tempel-Tuttle

Geminids
Active from December 4th to December 16th. 2018 Peak night Dec 13-14 2018
The Geminids are usually the strongest meteor shower of the year for northern hemisphere observers. The Geminids are often bright and intensely coloured. Due to their medium-slow velocity, persistent trains are not usually seen. These meteors are also seen in the southern hemisphere, but only during the middle of the night and at a reduced rate. This year's event is around new moon.
Radiant: RA: 07:28 **DEC:** +32.2° - **ZHR**: 120 - Velocity: 22 miles/sec (medium - 35km/sec) - Parent Object: 3200 Phaethon (asteroid)

"The Leaning Shed of Back Creek"
While some photographer's go to heroic efforts to artificially colour star trails, stars already come is a wide range of colours. All you have to do is capture them as I have done in this 4 hr star trail. Hint: don't overexpose the stars.