

Warning: it is very dangerous to look directly toward the Sun whenever any part of it is visible, especially through binoculars or telescopes. SERIOUS EYE DAMAGE MAY RESULT. A safe method of indirectly observing the Sun's disc appears [below](#).

It **is** safe - and spectacular - to watch the eclipse during the brief period called **totality**, while the Moon is **completely** covering the Sun - that is the excitement of this event! However, you **must be sure** that you are watching at the correct time.

General Information

A total eclipse of the Sun, in which the Sun is completely covered by the Moon, was visible from a narrow path across South Australia for up to 33 seconds between 7:40 pm and 7:42 pm (South Australian Summer Time) on the evening of 2002 December 4. This was the first time in over 26 years that such an event will have been seen from Australia.

The exact moment of commencement of totality and its duration depended on the observer's exact location. Along the path, the greatest duration from Australia was at the Ceduna end; across the path, the greatest duration is at the path's centre (i.e. along the centre line ([Table 1](#))).

The path of totality actually began in the Atlantic Ocean just west of Africa, where the Moon's shadow first reached the Earth at 05:50 Universal Time (UT, or GMT). It then crossed southern Africa and the Indian Ocean, and reached Australia at Ceduna in South Australia at 09:10 UT (7:40 pm or 19:40 local summer time). The shadow then continued in a north easterly direction, passing just north west of Woomera, and included Wirraminna and Lyndhurst.

Details of the shadow's path across Australia- See the full sized maps at the end of this document.



To see totality, it was **essential** to be within the narrow path. The rest of Australia – outside the narrow path of totality – witnessed a **partial** eclipse only. The path's width decreased from 36 kilometres at Ceduna to only 27 kilometres at its end. As mentioned above, totality was shorter nearer the path's edges, where its duration drops off to zero. It was advisable, therefore, to be well within the path.

At most, the duration of totality from a particular place along the centre line in Australia was only 33 seconds, which occurs as the path enters Australia at Ceduna. This duration reduced to 22 seconds at the very end of the path, at sunset in the far south west of Queensland. The Moon's shadow crossed Australia for only two minutes; after this, it left the Earth.

How Solar Eclipses Occur

A solar eclipse occurs when the Moon, in its orbit around the Earth, blocks all or part of the Sun's disc as seen from the Earth's surface (see figure 1). Only by observing from within the cone-shaped **umbra** of the Moon's shadow can we see the Sun's disc completely obscured;

from within the lighter **penumbra**, at least part of the Sun remains visible and we witness only a partial eclipse.

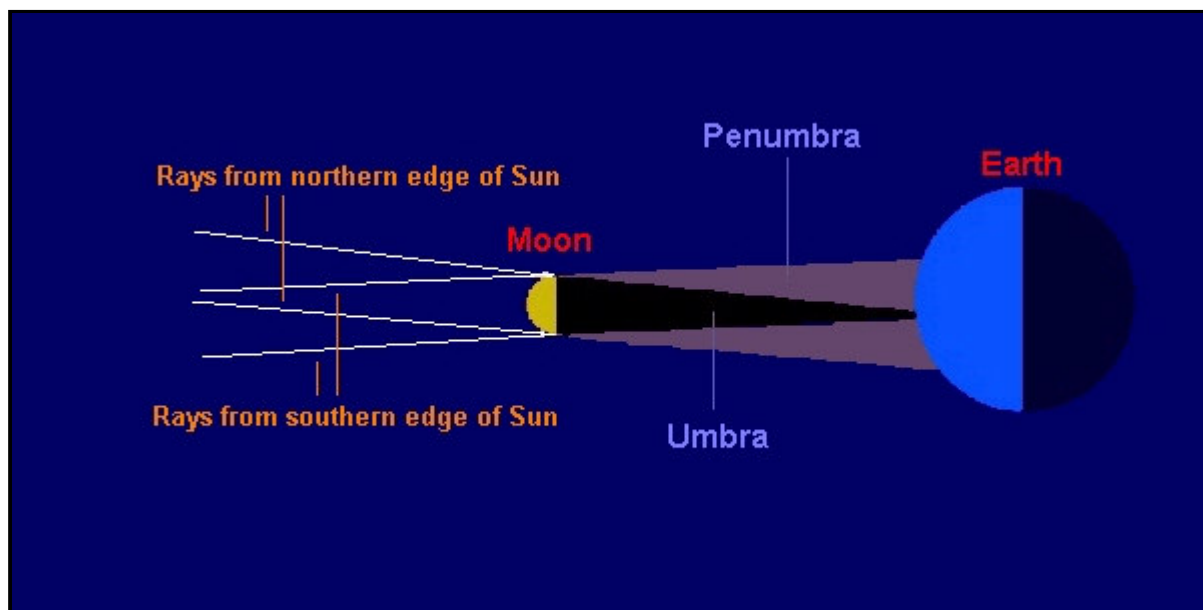


Figure 1 - How a solar eclipse occurs.

Although a solar eclipse of some kind occurs at least twice each year, in only some of these events does the Moon completely cover the Sun: sometimes, the umbra misses the Earth altogether, passing 'above' or 'below' our planet. Even when the umbra does intersect the Earth, we are very close to its end, where the diameter of the shadow is very small. So, as the Moon's shadow moves from west to east across the Earth's surface (due to the orbital motion of the Moon), it traces out a quite narrow path – at most about 270km wide. In such events, although a large part of the Earth's surface witnesses a partial eclipse, only those people lucky enough to be within the path of totality will see the brief spectacle of the Moon completely covering the Sun. Sometimes, the Earth's surface is actually beyond the end of the cone, and we witness an **annular** eclipse. In these events, a ring of Sun appears to surround the Moon at mid-eclipse, and so from nowhere is the Sun completely covered. Such an eclipse was seen from Australia in February 1999.

The Rarity of Solar Eclipses

Total solar eclipses occur, on average, about 75 times per century - so, in the long term, the average interval between them is about 1.3 years. However, from a particular place, such an event is quite rare because the path of totality is so narrow, and most people wishing to see one must travel – sometimes long distances – so that they are within the path. **Partial** solar eclipses can be seen from a large area of the Earth's surface; from a particular place, they are relatively common, occurring every few years. From any one particular location on Earth, total solar eclipses are seen, on average, once about every 375 years; however, they are slightly more common in the northern than in the southern hemisphere. Over an entire country, they are seen more often, depending on the size of the country. [Table 2](#) lists all total solar eclipses visible from Australia during the 20th and 21st centuries.

The Spectacle of a Total Solar Eclipse

A total solar eclipse has often been said to be the most spectacular sight that the eye can behold. However, totality itself lasts for at most a few precious minutes: in the case of the 2002 eclipse, it was well under one minute!

Such an event as a whole begins, from a given place, about an hour earlier, when the Moon just begins to cover the Sun, appearing to take a 'bite' out of its disc (but see the section entitled '[How to Watch the Partial Phases Safely](#)'). About twenty



minutes before totality, it becomes obvious that the light level is decreasing. In the last minute or two, the light appears to drop ever more rapidly.

Totality begins as the last direct rays of sunlight are cut off. The land is illuminated by a light resembling an eerie twilight. **Only now is it safe to gaze sunward.** The Moon appears in silhouette as an inky black disc. Surrounding the Moon, we can see the Sun's **corona** - its hot outer atmosphere, which extends a long way into space. Streamers, related to the Sun's complex magnetism, may be visible in the corona. Around the sky, we can glimpse some of the brightest stars. Contrary to popular belief, a total solar eclipse does not 'turn day into night'. However, it will still be quite dull - too dull, for example, to easily read such things as camera settings.

Then, suddenly, the opposite edge of the Sun pops into view and totality is over. It is then no longer safe to look at the eclipse. As the Moon gradually uncovers the Sun, there are still the remaining partial stages, but the highlight is always the brief period of totality. It is an unforgettable moment.

What could we expect to see?

Although total solar eclipses are spectacular events, the 2002 eclipse from Australia was far from ideal for Australian observers.

Firstly, the length of totality was be short: at most 33 seconds, from Ceduna (the maximum possible duration of a total solar eclipse is seven and a half minutes, although this rarely happens).

Secondly, the Sun was quite low in the sky as seen from Australia, increasing the chance of cloud blocking the view. From Ceduna, where it was at its highest, the Sun was only nine degrees above the horizon during totality - about half a hand span held at arm's length. It was even lower for observers farther north east along the path; at the path's end, totality will occur as the Sun was setting.

From Ceduna, the entire event commenced at 6:40pm local time (08:10 UT), when the Moon first began to cover the Sun. Totality occurred an hour later, and lasted from 7:40:10 to 7:40:43 pm local time (09:10:10 UT to 09:10:43 UT). Eclipse times for other locations both within and just outside the path are shown in [Table 3](#) , and for major Australian cities in [Table 4](#).

During the brief period of totality, it is safe to look at the eclipse, as no part of the Sun's disc is exposed (but see the [section on safety](#), below). The thing to watch for during totality is the Sun's **corona**, but the Sun's low altitude during this event will mean that the Earth's atmosphere will absorb some of its light, making the corona appear less bright than usual. You may also see some tiny pink spots of light at the edge of the disc - these are called **prominences**, and are regions of relatively dense gas which can sometimes appear as loops, or as if they were 'tongues of flame' (which they are not!).

With such a short length of totality, it is unlikely that anyone wanted to spend much time looking elsewhere around the sky. However, there was one object that may be noticed without much trouble near the Sun: the planet Mercury. It was located about 11 degrees above the Sun and a little to the right, looking like a moderately bright star. Farther afield, some bright stars may have been visible. Two hand spans (at arm's length) to the left of the Sun, and a little higher, was Alpha Centauri, the third brightest star in the night sky and one of the two 'pointers' to the Southern Cross. The other pointer was just to its left and a little lower. Acrux, the brightest star in the Cross, was a little lower still, and about two-thirds of a handspan to the left of Alpha Centauri. Almost exactly overhead was the star Fomalhaut,

while Achernar was quite high in the south eastern sky. Canopus will be directly below Achernar, but only 13 degrees above the horizon.

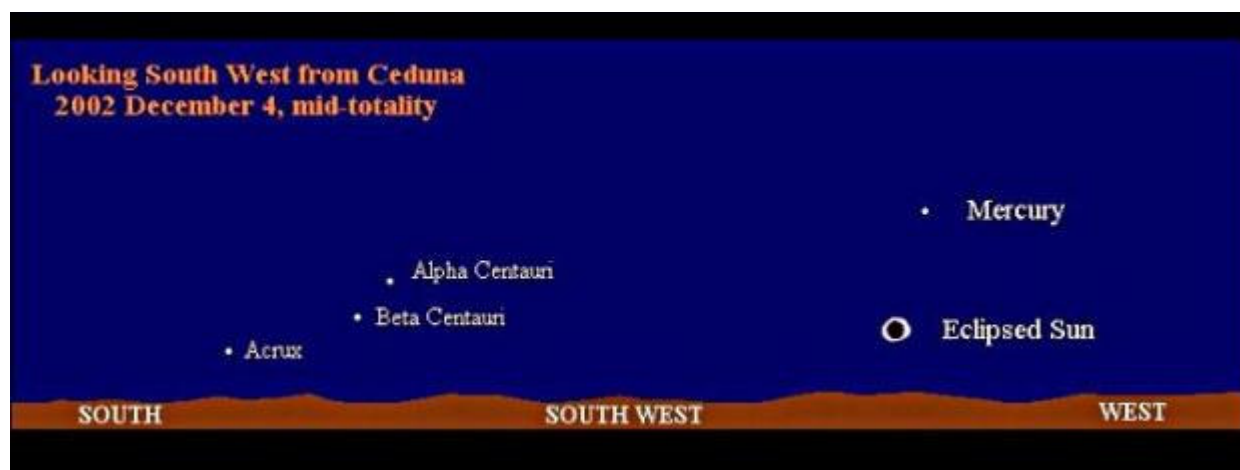


Figure 3 - The sky during totality.

After only 33 seconds - and even less, farther inland from Ceduna - a brilliant point of light suddenly appeared at the lower left edge of the Sun. This was the opposite edge of the Sun's disc reappearing.

Totality was over. At that moment (and at the corresponding moment just before the beginning of totality), that point of light, together with the Sun's corona just visible around the Moon's silhouette, appeared like a diamond ring. But you mustn't admire it for long: after this instant, you **must** look away. Totality was followed by another period of partial eclipse, as the Moon gradually uncovers the Sun. The light brightened rapidly. However, from much of Australia, sunset intervened before the end of the event. From Ceduna, for example, the Sun set at 8:29 pm, with the Sun still 14% eclipsed.

Getting to the Eclipse

Total solar eclipses are popular events! If you are planning to travel to the path of totality for any eclipse, it is highly advisable to make all necessary travel bookings as soon as possible. This particularly applies to accommodation: most establishments are usually booked out very early.

One option in 2002 was to join a tour. Typically, several organisations run tours to total solar eclipse sites. For the 2002 eclipse, The Powerhouse Museum in Sydney organised a tour to Woomera (with travel to the path of totality on eclipse day), and the Sutherland Astronomical Society (Sutherland, NSW) and the Australian Museum in Sydney both organised a tour to Ceduna.

It is likely that there will be several other tour options in for other eclipses. In this regard, it would be wise to contact local astronomical clubs and societies, museums and planetariums.

Weather Prospects

There was a good chance of clear skies on eclipse evening. Records from the Australian Bureau of Meteorology show that, for December, Ceduna experiences an average of 9.2 clear days and 11.6 partly cloudy days. While these figures do not seem particularly encouraging, the Bureau advises that the clouds tend to clear more toward the latter part of the day. Inland, the situation is rather better: Woomera's December records show an average of 14.8 clear days and 7.9 partly cloudy days. Indeed, the general advice for a typical December day was to observe from some distance inland.

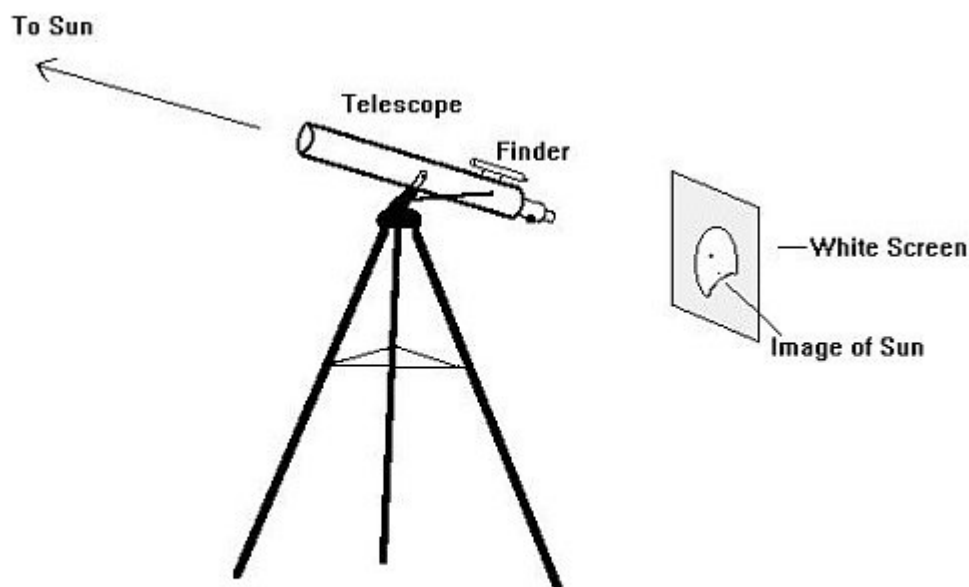
However, according to the Australian Meteorological Office at Ceduna, this is not the case if

the region contains thundery clouds at the time. They advised that under these circumstances, observers would do well to be nearer the coast - at Ceduna itself.

It must be remembered that, farther inland, the Sun's altitude is lower at totality. Putting all of this together, the best choice of location would appear to be a short distance inland along the path. However, it is a good idea to be ready to move quickly if it becomes obvious that the weather is likely to be better elsewhere!

How to Watch the Partial Phases Safely

As mentioned above, it is safe to watch the eclipse during the few seconds of totality, but DO NOT attempt to observe the partial phases of the eclipse directly. It is possible to indirectly watch this part of the eclipse using a small telescope to project an image, as shown in figure 2. With your back to the Sun, aim a telescope to the Sun and focus the Sun's image onto a white screen held about 20cm behind the eyepiece. DO NOT LOOK THROUGH THE TELESCOPE, OR ITS LITTLE FINDERSCOPE! Using this method, never leave the telescope unattended, and ensure that children are supervised at all times. Viewing the projected image is quite safe, but looking through the telescope will cause almost instant blindness.



How to use a telescope to project an image of the Sun.
NEVER look through the telescope or its finder!

Figure 4

Instead of a telescope, you can use a large piece of card with a hole about 2mm across punched in it; the card is held about a metre in front of the white screen. This is - for obvious reasons - called the 'pinhole method'. With your back to the Sun, hold the card to that the Sun's light passes through the hole and onto the screen. The image of the Sun will be a little 'fuzzy', but the shape of the eclipsed Sun will be clearly visible. You may also notice that there are images of the eclipsed Sun all over the ground under leafy trees, where the gaps between the leaves form little 'pinholes' of their own!

Photographing the Eclipse

Unless you have considerable expertise in solar photography, we do not recommend that you attempt to photograph the partial phases directly.

A safe, simple way to photograph the partial phases is to take pictures of the projected

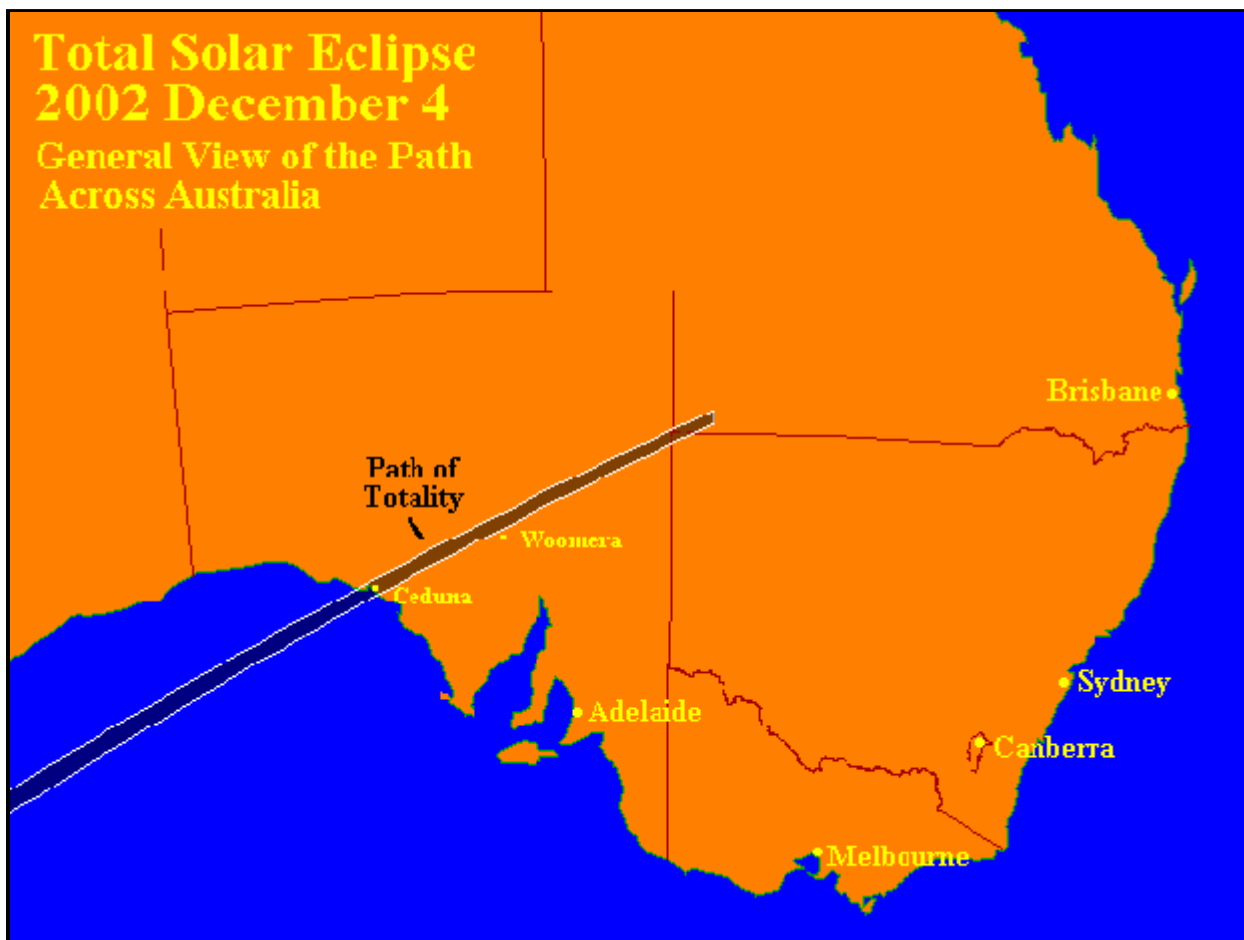
image, using your camera's meter as an exposure guide. The recommended methods of producing this image are explained in the preceding section.

It is possible to directly photograph the partial phases, but you **must** have an appropriate dark filter for your camera. If you intend to look through the camera, the filter must be specifically designed for use with the Sun. Without a filter, it is impossible to photograph the partial phases directly, and attempting to do so is dangerous. We strongly urge you to contact the author, your local planetarium or an astronomical society for advice on equipment and methods.

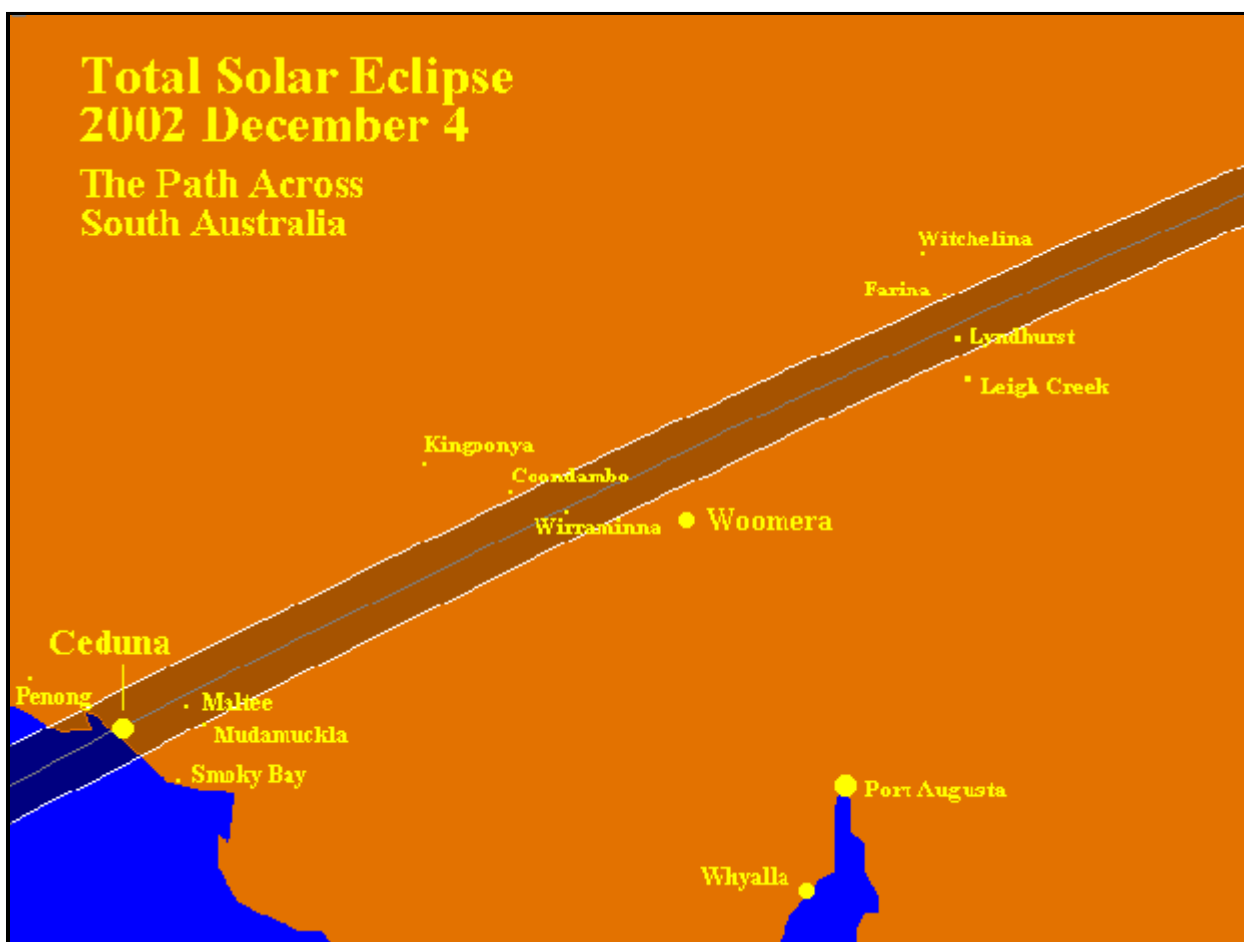
Photography during totality is a quite different matter. You will be aiming the camera directly toward the eclipsed Sun, and **no filter is used**. Make sure your camera flash does not fire - switch it off. It will not help, and will serve only to annoy others enjoying the spectacle! It is strongly recommended that you use a tripod, and a lens of at least 200mm focal length. The exposures you will need to make depend on the subject of interest. Quite short exposures will show the prominences, whereas progressively longer exposures will reveal more and more of the corona. Taking into account the low altitude of the Sun at Ceduna, using 100 ISO (100 ASA) film and a lens set at f/8, an appropriate exposure is about 1/500 second for the prominences, and from 1/30 second up to two seconds for the corona (longer exposures show progressively more of the corona). It is a good idea to 'bracket' your exposures - if you have time, take several pictures using different exposures. Different f/numbers will mean using different exposure times. For example, if you are using f/5.6 you can halve the above times, but using f/11 the exposures must be doubled. If you are farther inland along the path, you will need to expose for longer: at the very end of the path, your exposures will be about four times (i.e. two stops) greater than at Ceduna.

Time, however, is the big problem. For the 2002 eclipse it was short - very, very short. You simply did not have time to take all of the pictures you would have liked to. Many people attempt to do too much during totality, and miss the excitement of the spectacle! There are plenty of pictures in books and magazines available after the event, so you could consider not taking pictures at all - sound advice if you have never witnessed such an event before.

Details of the shadow's path across Australia



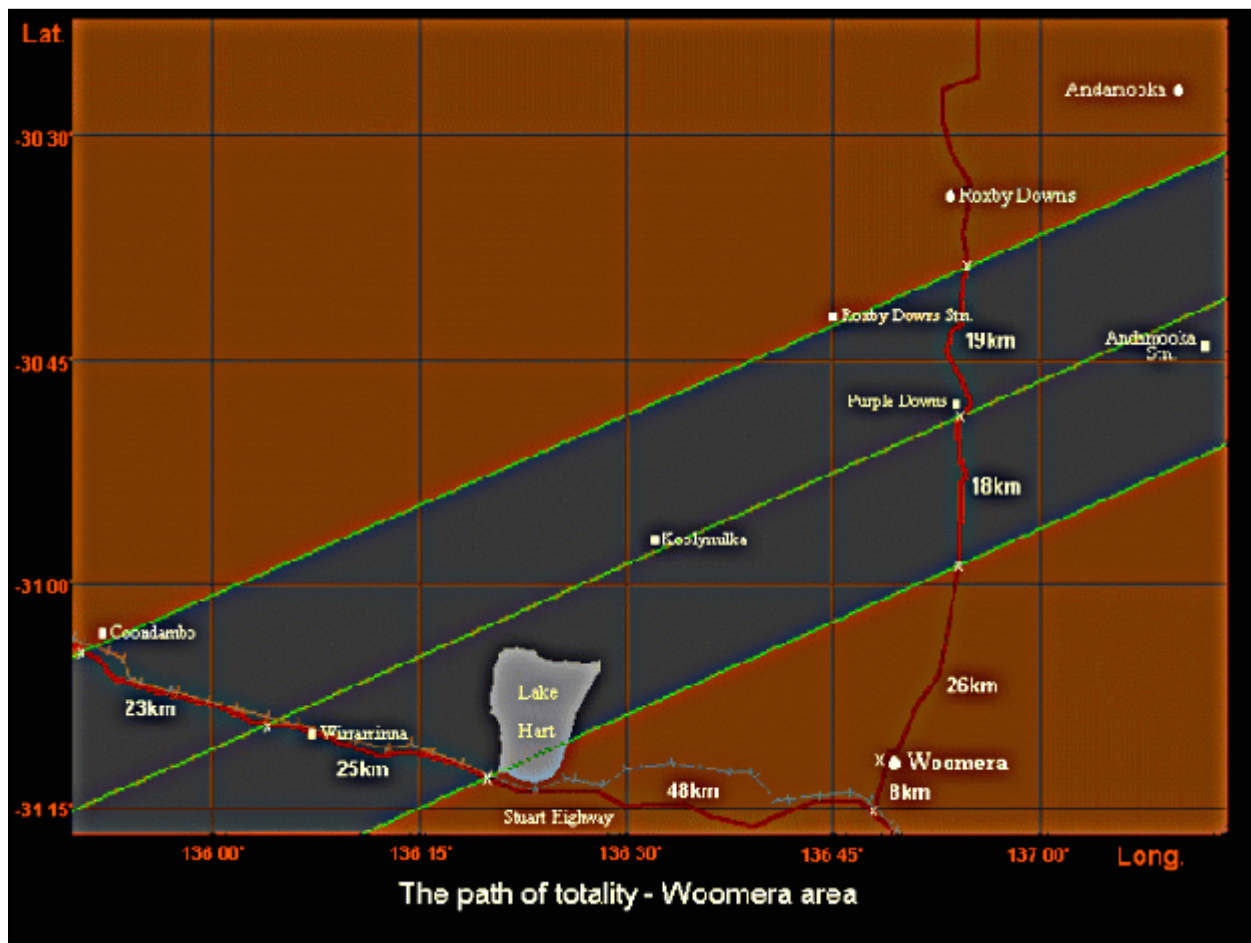
SE Australia



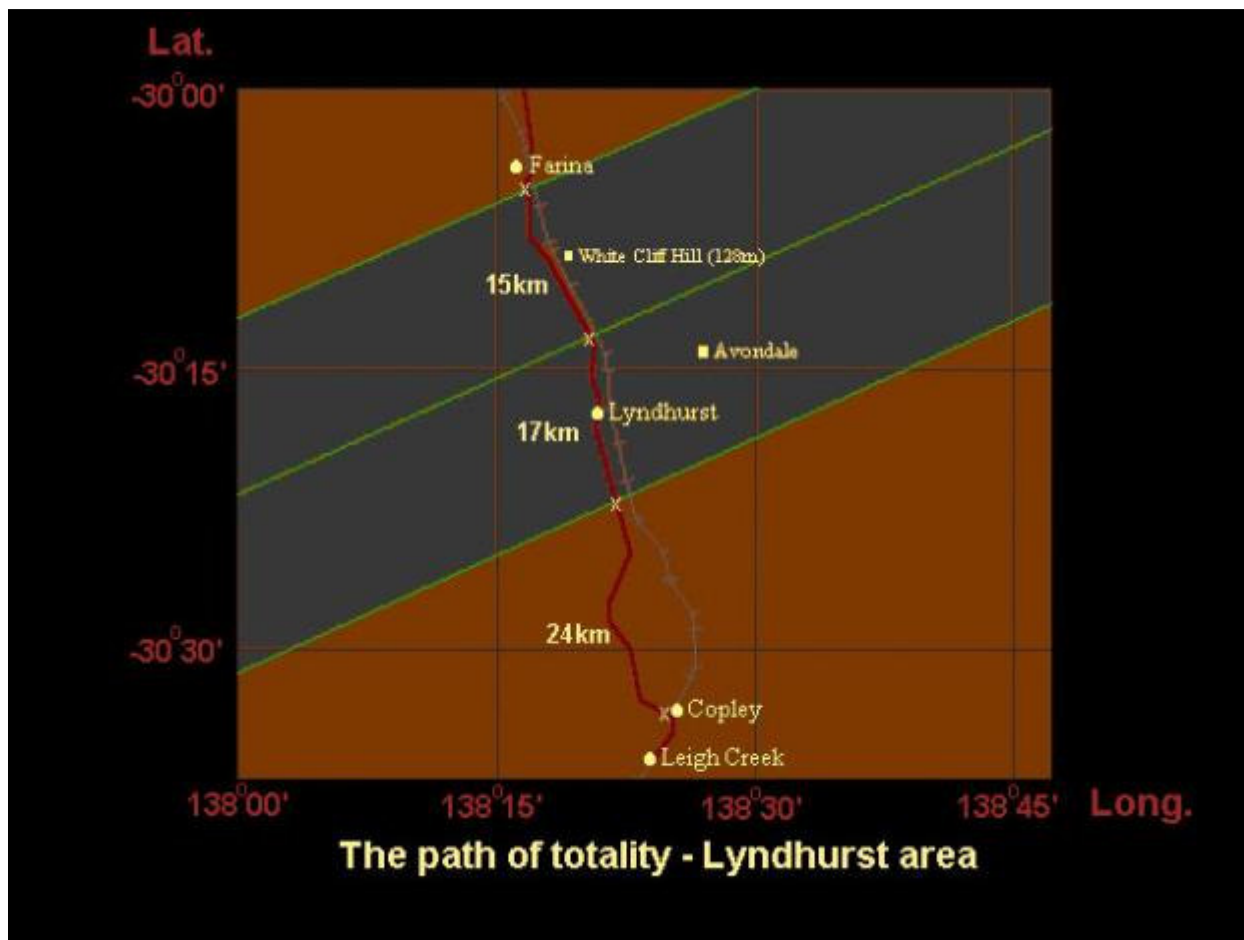
Ceduna to Lyndhurst



Around Ceduna



Around Woomera



Around Lyndhurst

For more information about future solar eclipses, see the [IAU Homepage for the Working Group](#)

[p on Solar Eclipses](#)

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