

**Note:** In the last issue of *FirstLight*, longtime AAC member Howard Cohen wrote an article, “Why See a Total Eclipse of the Sun.” Here Prof. Cohen introduces us to the “Great Solar Eclipse of 2009,” the longest total duration solar eclipse of the 21st Century.

## A Long Eclipse in an Exotic Land\*

*The Year 2009 brings the longest duration total solar eclipse in your lifetime.  
This eclipse also provides an excuse to visit ancient and exotic China  
during the International Year of Astronomy*

by Howard L. Cohen  
2008 February

### INTRODUCTION

**O**n 2009 July 22 a most wonderful and singular event will occur for those willing to undertake a journey to distant lands once considered by Europeans as the mysterious east — the longest duration total solar eclipse that anyone now alive can witness (6m39s in the Pacific Ocean). This is the longest in nearly twenty years and not to be exceeded until 2132.

This eclipse also comes during an auspicious time for astronomy — *The International Year of Astronomy 2009 (IYA2009)* as declared by the International Astronomical Union (IAU), endorsed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and affirmed by a United Nations General Assembly proclamation (2007 December).

**Note:** Learn more about the IYA2009 at <http://www.astronomy2009.org>.

Two other upcoming solar eclipses precede this eclipse during 2008 and 2009 but none of these have the accessibility, drama and potential to allow journeys to exotic lands as does the “Great Solar Eclipse of 2009.” These other solar eclipses include the total eclipse of 2008 August 1 with a maximum duration less than 2½ minutes and a path mostly through inhospitable arctic and Siberia regions that trails out over Mongolia and China. The next is an annular eclipse (2009 January 26) that crosses broad ocean waters of the south Indian Ocean.

### PATH OF TOTALITY

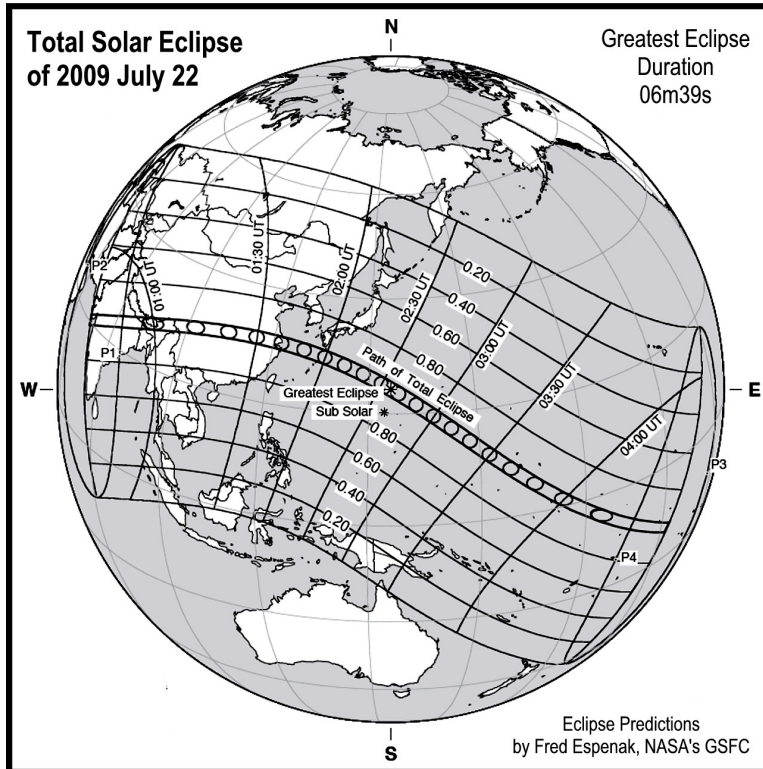
Although no part of the great 2009 eclipse will be visible from the continental United States, its eclipse path is easily accessible and provides exceptional opportunities to visit and discover the hidden secrets of the People's Republic of China.

To observe the 2009 event as a total eclipse, one must locate within a long total eclipse corridor that traverses nearly half the Earth's surface (more than 9,000 miles) but is never more than about 160 miles wide (Fig. 1). Even then, one must be near the central path line (“curve of central eclipse”) at the point of maximum duration — situated out in the wide Pacific Ocean — to achieve fullest duration. Nevertheless, one can still achieve a maximum duration of nearly six minutes in accessible regions of eastern Asia near or on the east China coast (Espenak 2008).

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In addition, a partial eclipse will also be seen over a much larger area extending north to the polar regions of Asia and south into the East Indies. None of the eclipse is visible from the United States except as a slight partial eclipse during late afternoon in the Hawaiian Islands where the Moon will obscure about 12% of the solar diameter (called the *eclipse magnitude* — the fraction of the Sun's diameter covered by the Moon at moment of greatest eclipse). Also see Fig. 1 for regions of partial eclipse.



**Figure 1. Total Eclipse of 2009 July 22.** The path of totality begins in eastern Indian and ends over 2,000 mi south of Hawaii where a slight partial eclipse occurs. Greatest eclipse is 6m39s, longest of the 20th Century. However, eclipse duration is still nearly 6 min near the central line in eastern China. Curved lines adjacent to the path of total eclipse show regions of decreasing partial eclipse with *eclipse magnitudes* from 80% to 0%. (Cred. Fred Espenak, NASA's GSFC.)

waters about 200 miles farther to the southeast, totality reaches maximum duration of not quite seven minutes. The Moon's shadow then heads into the huge expanse of the remote South Pacific Ocean where totality ends late in the day more than 2,000 miles south of the Hawaiian Islands.

With restricted access to many Pacific islands, as hallowed Iwo Jima, and the prospects of severe storms during the midst of typhoon season, China probably offers some of the best prospects for a successful eclipse trip while still having a long total eclipse duration.

Unfortunately, this longest eclipse of the 21st Century does come during summer weather that often brings cloudy skies and extreme heat and humidity. (See "The Weather" below.) Still, for veteran eclipse chasers, the prospect of standing in the Moon's shadow for more than five minutes far outweighs less than optimal weather conditions. With a careful choice of an observing location, one can still have a moderately good chance of experiencing the chilling and awesome phenomenon of totality.

The 2009 July total eclipse path first begins early morning on the west coast of the Indian subcontinent north of Bombay before crossing India's midsection. Unfortunately here, monsoon rains will likely dampen views of this extraordinary event. After moving eastward through northern Bangladesh, the path crosses the vast southeastern regions of the People's Republic of China where dramatic mountains often alternate with broad, lush green valleys. Monsoons too, oscillating frontal bands and potential smog may reduce chances of observing this eclipse. However, China still offers promising prospects of seeing this long eclipse and the opportunity to plan a trip to see the mystery of China.

After exiting the China mainland through populous Shanghai, the total eclipse path enters the Pacific Ocean south of Japan. Here the Moon's shadow moves quickly through enchanting and sometimes battle scarred tropical islands including sacred Iwo Jima more than 700 miles south of Tokyo. In

## MAXIMUM DURATION

The maximum duration of totality for a solar eclipse is about 7-1/2 minutes (nowadays 7m32s according to Belgian astronomer Jean Meeus, 2002) and this is almost never achieved — usually totality lasts only a few minutes. Almost half are approximately three minutes or less. The longest duration of the 20th Century occurred over a half century ago, 1955 June 20 (7m08s). A seven minute duration will not happen until 2150 June (7m14s) while a total eclipse with a duration near maximum is nearly two centuries in the future. According to calculations by NASA astronomer Fred Espenak (2007a), this will not happen until the remarkable 2186 July total eclipse (7m29s), the longest duration of totality in a ten millennium period from -3999 to +6000 (4000 BCE to 5999 CE)! Unfortunately, no one now alive will likely see this unbelievable eclipse. Disappointingly too, this uncommonly long duration will take place about 400 miles east of South America in the Atlantic Ocean, 500 miles north of the equator.

Currently maximum total eclipse durations are declining with the 2009 July eclipse longest of the 21st Century. Not until 2078 will total eclipse durations begin to increase when *Saros cycle 139* begins to bring eclipses of longer and longer durations. (See “The Saros” in next section.)

Thus, the total solar eclipse of 2009 gives us the longest duration of totality of the 21st century (6m39s). Since the duration varies along the path of totality, maximum duration will happen only for those near the central line at the point of greatest eclipse out in the Pacific Ocean. Nevertheless, even areas near the east China coast will still see total eclipse durations of nearly six minutes.

## THE SAROS

The 2009 July eclipse belongs to a series of now long eclipses that are members of an eclipse cycle called Saros 136 (Espenak 2007b). Eclipses occur in families. The Saros cycle is a period of about 6,585.3 days (18 years 11 days 8 hours). Two eclipses separated by one Saros cycle have similar geometry (similar duration, same time of year, etc.) although separated in longitude about one-third of Earth's rotation since the Saros cycle ends in approximately one-third of a day. The periodicity and recurrence of solar eclipses as governed by the Saros are useful for organizing eclipses into families. A typical Saros series lasts about 12 to 13 centuries and contains 70 or more eclipses. Eclipses in a given cycle typically start as partials and later become central with increasing and then decreasing durations, the longest durations occurring halfway through the period. Finally the cycle ends with partial solar eclipses more than one thousand years after the cycle first began.

Saros 136 brought us most of the long eclipses of the 20th century and will do so until late in the 21st century. Then eclipses of another cycle (Saros 139) will begin producing longer durations of totality. (The incredible 2186 eclipse of 7m29s duration belongs to this Saros.) The last long eclipse that brought more than six minutes of totality occurred 1991 June 11, the last occurring eclipse in Saros 136, and, in fact, the middle eclipse of Saros 136. Readers who witnessed totality from regions near Baja California Sur remember this spectacular event and have been patiently waiting eighteen years for the next eclipse in Saros 136!

After the 2009 July 22 eclipse, total eclipse maximum durations for Saros 136 will continue to decrease as the cycle progresses. The next eclipse in this series, for instance, occurs another eighteen years later (2027 August 2) with a maximum duration 16 seconds less than in 2009. Finally, the last total eclipse of this cycle (2496 May 13) will have a duration of 1m02s when it occurs on May 13, 2496. Saros 136 will then end with seven partial eclipses, the last in the year 2622, having produced 71 eclipses over a period of 1262.11 years since 1360.

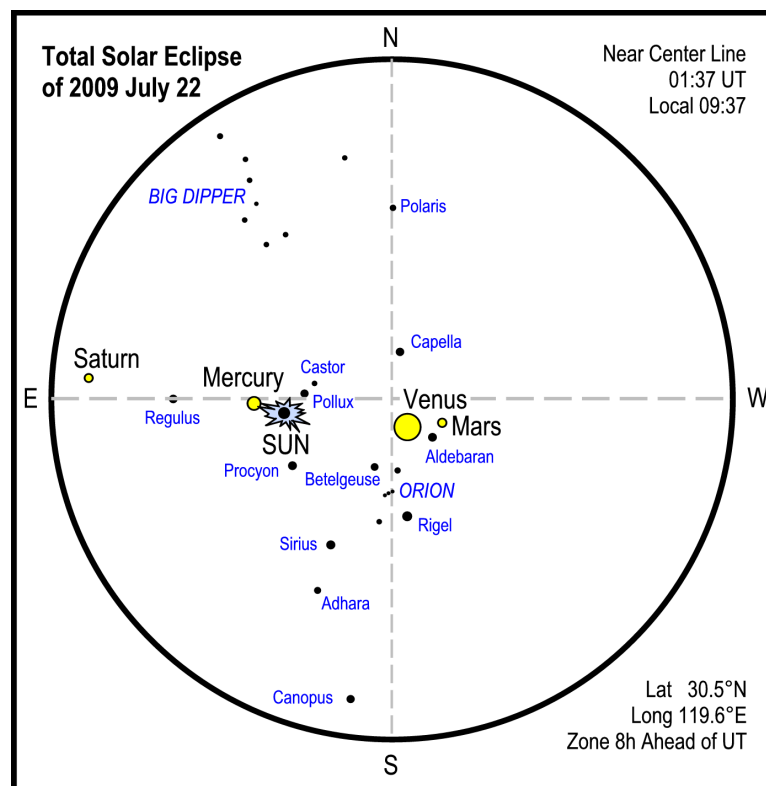
## THE WEATHER

Unlike the “Great 1991 Baja California Sur Eclipse” that came with the promise of good weather, finding viewing locations with high probabilities of success is much more daunting for the long 2009 eclipse than most others in recent memory (Anderson 2007). Much of this total eclipse path occurs during midsummer in northern latitudes in regions of subtropical climate. Like Florida, weather in China during this time can be very uncertain. Here, average cloud cover usually varies between about 50-60% over most of the total eclipse path including the Pacific Ocean. (In India conditions are much worse with average cloud cover about 65-85%.) Nevertheless, some places have reasonable weather prospects, especially on or near the Shanghai coast.

Although cloudy summer weather and smog in eastern Asia can interfere with viewing this eclipse, China offers promising locations and the opportunity to visit this still mysterious land. Still, everyone should know that this eclipse comes during the height of summer when temperatures and humidity may be overbearing and oppressive. (Floridians, however, should know how to deal with this!) Visitors will need to take proper precautions to ward off energy-sapping heat and wet air.

My wife Marian and I hope to observe this long eclipse from eastern Asia. To increase the probability of observing the eclipse, we plan to view from near the east China coast about 125 miles (200 km) southwest of Shanghai in the Zhejiang Province where weather prospects are among the best possible along the total eclipse path. Here also the duration of totality still has an impressive length of nearly six minutes. Furthermore, the total eclipse occurs during midmorning before the day’s heat builds and before summer storm clouds often form.

## THE ECLIPSE AND ECLIPSE SKY



**Figure 2. Eclipse sky during totality for the 2009 July 22 eclipse.** View is from southwest of Shanghai in eastern China at about 9:37 a.m. local time. The Sun will be in the star studded winter sky near the western edge of Cancer. *Venus*, *Mercury* and *Sirius* should be easily visible since all will have negative *stellar magnitudes*. (Drawing by author.)

In eastern China the eclipse duration remains impressively long, 5m36s at our intended observing location 20 miles (32 km) south of the center line. Here, the partial phases of the eclipse will begin at approximately 8:21 a.m. local time. Totality will follow about 72 minutes later with mid-eclipse about 9:36 a.m. and the Sun a comfortable 54 degrees above the eastern horizon (Fig. 2). After totality, the partial phases will run their course and end before lunch about 10:58 in late morning. A morning eclipse is fortunate too since convective clouds often build later in the day.

The eclipse backdrop will be the bright northern winter sky, usually hidden from view by the Sun’s glare during northern latitude summer months. Depending on sky brightness during totality, at least some bright winter stars should become visible along with a few bright planets. Brilliant *Venus* will shine nearly overhead (mag. -3.9)

along with the brightest nighttime star, *Sirius*, in the south southeast (mag. -1.4). An extra eclipse treat will be *Mercury*, since this bright planet is rarely seen due to its proximity to the Sun. In fact, Mercury will be near greatest brilliancy (mag. -1.9) and just 9 degrees below (east) of the Sun during totality.

**Note:** The use of the word *magnitude* (abbrev. *mag.*) here refers to the *stellar magnitude scale*, an astronomical scale of brightness where algebraically decreasing numbers indicate brighter objects. (When applied to solar eclipses, “magnitude” refers to the fraction of the Sun’s diameter obscured — the *eclipse magnitude*.)

## THE WAIT IS NEARLY OVER

The wait for another long eclipse is now nearly over and 2009 eclipse tours are rapidly filling. Many eclipse enthusiasts and “virgin eclipse chasers,” anxious to experience the impressive memory of a total eclipse of the Sun, will journey to China, one of the world’s most fascinating and breathtaking lands.

*“No more accessible and exciting eclipse journey will happen for many years together with the longest duration total eclipse of the century!”*

China is working hard to improve air quality and improve its infrastructure including roads and accommodations for the 2008 Olympics, an advantage for anyone touring China in 2009. A tour to China in 2009 for the “great eclipse” will not only help celebrate the *International Year of Astronomy 2009* but will also let you explore ancient and modern exotic China regardless of the eclipse. As I previously wrote (Cohen 2008), when planning your next perfect travel experience, use an eclipse as a focus for a trip that will become unforgettable and extraordinary for its own sake.

*“To witness a total eclipse of the Sun is a privilege that comes to but few people. Once seen, however, it is a phenomenon never to be forgotten.”*

– Isabel M. Lewis (1924)

If you would like to learn either more about this eclipse or more about our own exclusive tour to China for the 2009 eclipse, see <http://www.flycapers.com>. ☼

## References

- Anderson, Jay 2007, Weather and Maps for the Total Solar Eclipse 2009 July 22 (<http://home.cc.umanitoba.ca/%7Ejander/tot2009/tse09intro.htm>).
- Cohen, Howard L. 2008, *FirstLight* (Mar./Apr.), pp. 6–7, “Why See a Total Eclipse of the Sun.”
- Esenak, Fred 2007a, Ten Millennium Catalog of Long Solar Eclipses (<http://sunearth.gsfc.nasa.gov/eclipse/SEcatmax/SEcatmax.html>).
- Esenak, Fred 2007b, Saros Series 136 (<http://sunearth.gsfc.nasa.gov/eclipse/SEsaros/SEsaros136.html>).
- Esenak, Fred 2008, Total Solar Eclipse of 2009 July 22 (<http://sunearth.gsfc.nasa.gov/eclipse/SEmono/TSE2009/TSE2009.html>).
- Meeus, Jean 2002, *More Mathematical Morsels* (Willmann-Bell, Inc.: Richmond).

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