Great American Eclipse!

A special issue of **Prime Focus** *by the* Kalamazoo Astronomical Society

Your Guide to August 21, 2017

Eclipse Overview | **Shoot the Solar Eclipse** | **Watching the Weather** | **Top 25 Eclipse Tips**

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Observations of the Great American Eclipse

by Richard S. Bell

An Introduction

On Monday, August 21, 2017 the shadow of the Moon will trace out a 70-mile-wide, 8,600-mile-long path across our planet. People within that shadow will get to experience the grandest phenomenon in all of Nature, a total solar eclipse.

Out of the 8,600-mile-long eclipse path, approximately 2,500 miles crosses our country coast-to-coast from Oregon to South Carolina. Everyone in the continental United States will be able to enjoy at least a 70% partial eclipse, but don't settle for even a 99% eclipse. You want to experience a 100% total solar eclipse! The longest duration of totality, 2 minutes and 41.6 seconds, will occur just south of Carbondale, Illinois. This just so happens to be the nearest place along the eclipse path to travel to from Kalamazoo (a driving distance of 443 miles, with an estimated travel time of 6.5 hours).

A Noteworthy Eclipse

Total solar eclipses are always greatly anticipated astronomical events, but this eclipse is noteworthy for several reasons. This is the first total solar eclipse to occur on American soil since 1991.

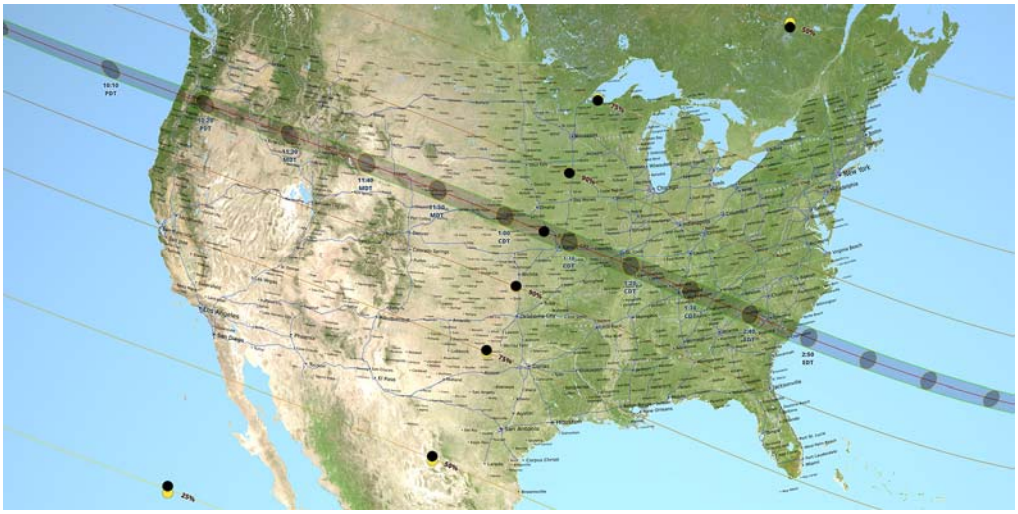
That eclipse was visible along a path tracing from the Pacific Ocean and Hawaii moving across Mexico, down through Central America and across South America ending over Brazil on July 11th of that year. It was dubbed the "eclipse of the century" since its greatest duration was 6 minutes and 53 seconds. That was the longest eclipse of the 20th century and there will not be a longer one until June 13, 2132.

The last eclipse visible from the 48 contiguous states took place on February 26, 1979. Totality's path passed through the northwestern states of Washington, Oregon, Idaho, Montana, north-central North Dakota, in addition to central Canada and Greenland. Taking place in the winter months, many observers encountered cloudy skies for that eclipse.

The August 21st eclipse is the first to cross the United States from coast to coast (or sea to shining sea) since June 8, 1918 – now over 99 years ago! That eclipse also came ashore in Oregon, but headed back out to sea in northern Florida and across Bermuda. Greatest duration for that eclipse was seen south of Alaska and lasted 2 minutes 29 seconds, shorter than this year's eclipse by ~13 seconds.

Perhaps the most remarkable fact about the 2017 eclipse is that it only makes landfall along that narrow path from Oregon to South Carolina. That's why it's referred to as the *Great American Eclipse*. The last solar eclipse to only make landfall on American soil took place on June 13, 1257 – before our nation's founding in 1776. Although, that eclipse passed over what is now the Hawaiian Islands. To find a total solar eclipse that compares to the *Great American Eclipse*, one that only made landfall in the 48 contiguous states, you have to go all the way back to July 29, 436 – 1,581 years ago.

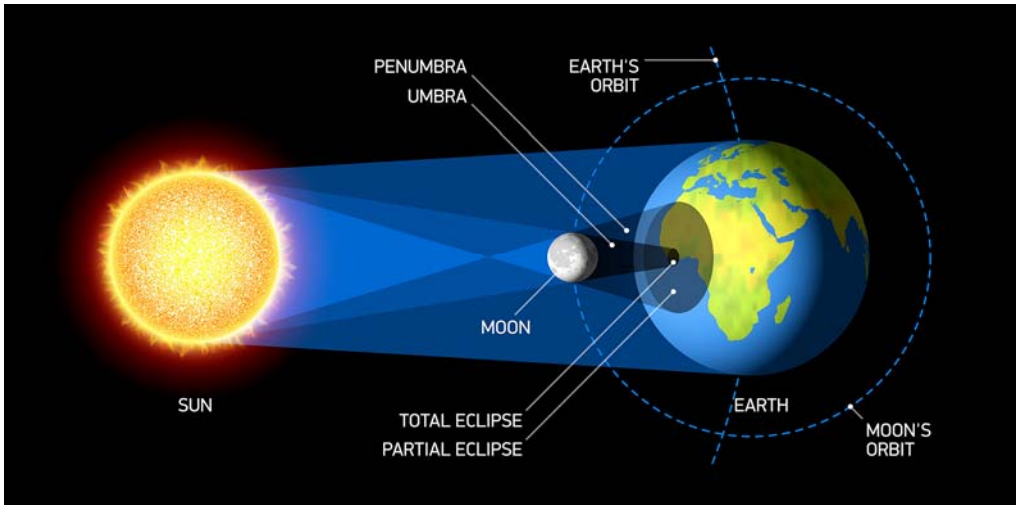
Fortunately, this eclipse occurs at



The only land mass along the 8,600-mile-long eclipse path is the continental United States. It crosses from Oregon to South Carolina. Everyone in the United States will experience at least a 70% partial eclipse.

the height of the summer vacation season and during one of the clearest months of the year.

An estimated 12.2 million Americans already reside within the path of totality and, because of the United States' excellent highway system, millions more have it within their means to drive to the path. With thousands more coming from around the world, this should be the most viewed eclipse in history...by far. You could stay home and settle for a partial eclipse, or travel to totality's path and be a part of the biggest public astronomical event of all time!



Configuration of a total solar eclipse. Astronomers refer to a three body alignment such as this as a syzygy.

Astronomy of Solar Eclipses

Solar eclipses happen because of the most amazing coincidence in the solar system. The Sun is approximately 400 times the Moon's diameter (880,000 miles ÷ 2,200 miles = 400×), but the Moon is approximately 400 times closer on average (93,000,000 miles ÷ 239,000 miles = 389×). Therefore, purely by coincidence, the Sun and the Moon appear to be about the same angular diameter in the sky! Our moon is just big enough to cover up the disk of the Sun.

This happenstance cannot be found anywhere else in the solar system. Mercury and Venus have no natural satellites, so solar eclipses are not possible from either world. The two moons of Mars, Phobos and Deimos, orbit too closely to the Martian surface so their angular diameter is insufficient to completely obscure the Sun. Moons of the outer planets, such as Jupiter and Saturn, appear far larger than the Sun does from those distant worlds. They cover up the Sun's disk and then some (plus, there's no place to stand on a gas giant)!

Quite simply, total solar eclipses happen when the Sun, Moon, and Earth are in a perfectly straight line and in that order. In astronomy, we refer to this as a syzygy.

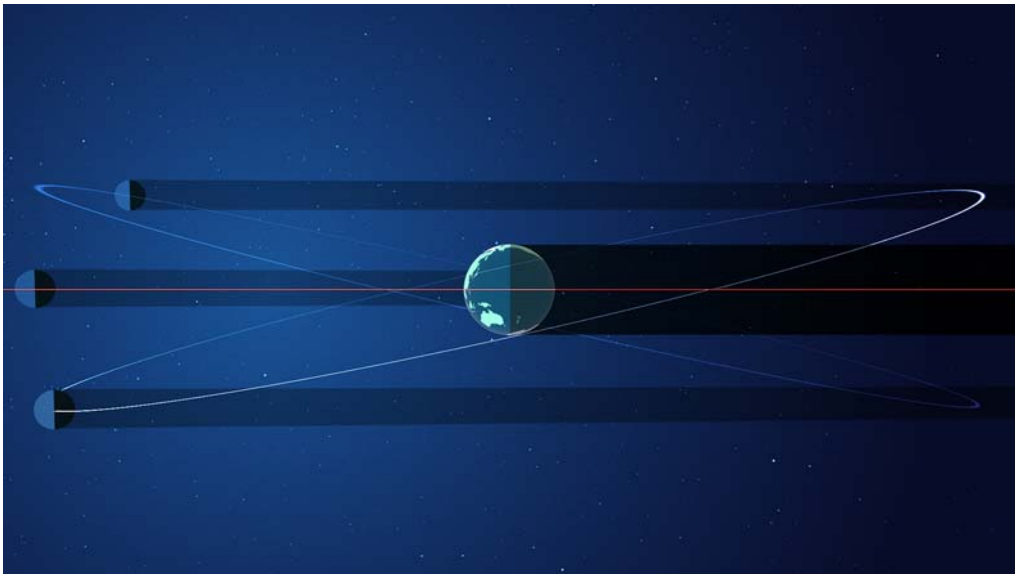
When the Moon is between the Sun and Earth, it is said to be new. During this phase, no direct sunlight can reflect off our nearest celestial neighbor's surface to Earth. Therefore, I tend to refer to New Moon as "No Moon" because it's invisible to us. Notice from your monthly calendar that we experience a New Moon at least once a month (29.53 days to be exact), so why don't people get to witness at least one solar eclipse a month?

The Moon's orbit is tilted by 5° with respect to the plane of Earth's orbit, the *ecliptic*. Solar eclipses can only take place when the Sun and Moon both meet at or near a *node*, one of two points in space where their paths appear to cross. Since the Moon and Sun don't appear as points of light, and happen to be about the same size in the sky, they don't have to line up perfectly for an eclipse to take place.

On average, eclipses occur every 18 months somewhere around the world. For a period of about 34 days, the Sun and Moon both pass close enough to a node for an eclipse to happen. This period is referred to as an *eclipse season*, a time when eclipses are likely to happen. The previous total solar eclipse took place on March 9, 2016, and the next after 2017 will happen on July 2, 2019.

When Sun, Moon, and Earth are aligned sunlight strikes the Moon and it casts a shadow that falls onto our planet. Every shadow has two distinct parts. The inner darker shadow, where no direct sunlight shines, is called the umbra. The lighter outer shadow, where some sunlight still shines, is called the penumbra. Lucky observers within the umbra will experience the full grandeur of a total solar eclipse. Those within the penumbra will only witness a partial solar eclipse.

The two types of eclipses may seem similar, but they're very different experiences. Think about it this way, a partial solar eclipse is like driving a Fiat; while a total solar eclipse is like



The Moon's orbit is tilted 5° with respect to the ecliptic, the plane of Earth's orbit around the Sun. This is why we don't experience a total solar eclipse every month. Most times, the Moon's shadow passes above or below Earth's orbital plane. We only enjoy total eclipses when the New Moon crosses the ecliptic.

driving a Ferrari. You're behind the wheel in both cases, but driving a Ferrari gives you a much more exhilarating experience!

Eclipse Safety

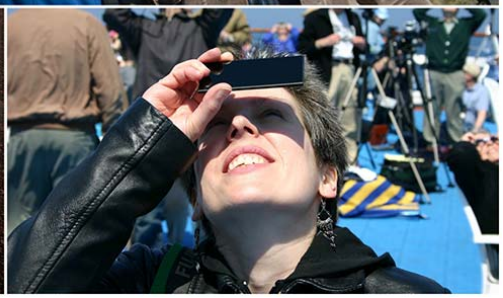
Most observing pursuits - like viewing the planets, stars or meteors on a clear night - pose no threat to your vision. This is not the case with solar eclipses, since the Sun is involved.

As you know full well, staring at the Sun for just a couple of seconds is downright painful and prolonged viewing without taking proper precautions can cause permanent damage to your vision. Fortunately, it's very simple to protect yourself and enjoy eclipses without fear of damaging your vision. There are two basic methods to safely observe the Sun: the indirect and direct method.

The absolute safest way to enjoy a solar eclipse is by not looking at the Sun at all! This is the indirect method. You can use everyday materials found around the house to project an image of a solar eclipse. When the Sun is reduced to a narrow crescent, shadows become sharper. As a result, anything that casts a shadow while letting small amounts of sunlight through will create images of the eclipse.

The most popular indirect method is to build a Pinhole Projector Box. I made one of these to safely view a partial solar eclipse in 1984. Any ordinary rectangular box will do. Place a bright white sheet on the inside of the box and cut out a small square or rectangular hole on the opposite end. Tape some aluminum foil over the hole you just cut out and then use a pin to poke a hole in the center of the aluminum foil. When the eclipse begins, turn your back to the Sun but let its light filter through the hole. An image of the Sun will be projected onto your white sheet of paper. You can safely view the eclipse, but never look at the Sun directly!

A Pinhole Projection Box.



If you have no desire to stick your head in a box during the eclipse, then you can use anything with holes in it. A colander will work just fine and create multiple crescent suns. Nature even provides a means to view an eclipse! The numerous small gaps between the leaves of trees and even holes in the leaves themselves act as small pinhole projectors.

The drawback of the pinhole projection method is that you typically don't get a very large, sharp image. It is also possible to use a pair of binoculars or a telescope for safe viewing without the use of a proper solar filter. This method is referred to as solar projection.

Unfiltered binoculars or a telescope is aimed at the Sun, and the resulting image is projected onto a screen mounted near the eyepiece. This provides a larger image of the eclipsed sun and several people can view it at the same time.

However, be sure that no passers-by, especially children, are allowed near the eyepiece of an unfiltered telescope. Viewing through an unfiltered telescope would cause excruciating pain and likely cause permanent damage to ones eyes.

A safer way to do solar projection with a telescope is to construct a Sun Funnel. A telescope eyepiece, clamped onto the narrow end of a trimmed funnel, projects an image of the Sun onto a rear projection screen mounted at the funnel's wide end. The eyepiece is safely inside the funnel, so no youngsters can peer through the telescope. (See the article on page 23 for more information on constructing a Sun Funnel.)

The most satisfying method to view the eclipse is the direct method. This means you look directly at the Sun, but with proper projection.

Eclipse Shades are the easiest, cheapest, and most satisfying way to directly observe the Sun during a solar eclipse. The lenses are made of a "black polymer" or silvery Mylar-like material that blocks 100% of ultraviolet (UV) and infrared light (IR) and 99.999% of the Sun's visible light. The black polymer shades give an orange view of the Sun, while the Mylar shades make the Sun appear bluish-white.

If Eclipse Shades are unavailable, a #14 or darker (higher number) welding glass is also suitable for solar viewing. These welding glasses also block the UV and IR light and transmit only a tiny fraction of the Sun's visible light. Typical welding glass will make the Sun appear green.

Some people like to get a close-up look at the action! Nowadays, numerous optics manufacturers produce solar filters made to fit on the ends of telescopes and binoculars.

These filters reduce the sunlight to safe levels before it enters the observing instrument. Always take care that solar filters are securely fastened so that they cannot accidentally fall off during viewing.

There are some binoculars available that are intended to only look at the Sun. This reduces the slight risk of a filter becoming damaged while in use, but these highly specialized binoculars will serve no other purpose than viewing the Sun.

Viewing the eclipse through a properly filtered telescope can be quite a thrill. The jagged edge of the Moon will stand-out in stark contrast to the Sun's smooth surface. If you're lucky, maybe you'll even see sunspots obscured by the Moon!

Eclipse Success Tips

Eclipse chasers spend months, if not years, planning every detail of their journey into the Moon's shadow. At this point you only have weeks (at best) to plan for the *Great American Eclipse*, so let's hit the highlights.

Hotels inside the path of totality have been booked solid for well over a year. In the remote chance some are still available, expect to pay many times the usual daily rate. Your best bet, if you absolutely must stay in a hotel, is to do so outside the eclipse path and then drive into the path before sunrise on Eclipse Day. For example, say you wish to view the eclipse from Carbondale. Try and see if any hotels are available in Bloomington, Springfield, or even Indianapolis.

When the Sun is reduced to a narrow crescent, shadows become sharper. Anything that can cast a shadow but still let sunlight through, like a tree, will project images of crescent suns all over the ground.

Camping is a much better option at this point. It's late July as I type this and I still hear about available campsites in southern Illinois. If regular campsites are booked near your desired eclipse viewing site, then check the website of the nearest town. Many towns along the eclipse path will likely make special campsites available during the eclipse. After all, they want you to spend money in their area!

Be sure to arrive in or near the central eclipse path about 2 days early. The *Great American Eclipse* has been predicted to trigger the largest mass migration of people in all of history! Therefore, roads leading to the eclipse path may (or probably will) be clogged with traffic jams. That's why it's best to arrive in or as close to the eclipse path as you can.

Fortunately, the eclipse does occur on a Monday. Spend the weekend hiking, biking, swimming, or visiting local museums. Many towns along the eclipse path are hosting a variety of activities to keep you entertained before Monday's epic eclipse.

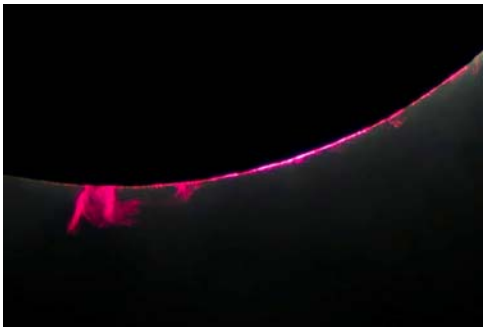
Once you arrive at or near your viewing site don't waste time checking the news or social media websites. Keep your eye on the weather forecasts! Jay Anderson's website, Eclipsophile, is an excellent resource for the typical climate along the eclipse path on August 21st.

However, we won't experience climate on Eclipse Day, we'll experience weather! Thankfully, Jay has provided an excellent article exclusively for *Prime Focus* on which weather sites to monitor as the big day approaches and how best to interpret them. It begins on page 14.

If the need does arise to travel to

Baily's Beads

Diamond Ring Effect



Prominences

an alternate location then be sure to have a GPS and eclipse path maps handy. You don't want to inadvertently travel outside the path and only observe a partial solar eclipse. Michael Zeiler, a professional cartographer, has gorgeous eclipse maps on his *Great American Eclipse* website. The August issue of *Astronomy* magazine also features full-page maps of the eclipse's path.

What to Look for on Eclipse Day

Event times along the eclipse path vary by location. For example, totality occurs on the coast of Oregon at ~10:15 am PDT and at ~2:45 pm EDT on the coast of South Carolina. Event times for your exact location can be found on Fred Espenak's Google Eclipse Map Page. Just click anywhere inside or outside the path and it gives you all the significant times of the eclipse.

Let's say circumstances keep you in Kalamazoo. Here's what you can expect to see: The partial solar eclipse begins at 12:58 pm EDT. It may take a few minutes to spot the Moon beginning to take a bite out of the Sun. More and more of the Sun will disappear behind the invisible moon until maximum eclipse at 2:23 pm. Try to at least take a 15-minute break from work around this time if possible. At this point, about 83% of the Sun's face will be obscured by the Moon. The sky will only appear slightly darker. It may be difficult to notice any change at all. As mentioned earlier, don't forget to look under a shade tree for pinhole images of the crescent sun. It'll be the highlight of the eclipse from Kalamazoo. The partial eclipse will then end at 3:45 pm.

Everything discussed above can be viewed from anywhere along the eclipse path, but the Moon keeps obscuring more and more of the Sun.

Shortly before and after totality, when the Sun appears as the narrowest of crescents, look for the most elusive feature of a total solar eclipse: shadow bands. The same atmospheric conditions that cause a star's light to twinkle at night can cause sunlight reduced to a narrow slit to ripple across the surface. It's easier to see if you throw a white sheet onto the ground.

Not every eclipse produces shadow bands, it depends on local atmospheric seeing conditions around the time of totality. Even if they do occur, most miss them because their gaze is fixed on the even greater show about to begin overhead.

Just a few seconds before and after totality, a thin slice of the Sun's visible surface may peek out from behind the Moon's rugged surface. These lights are called Baily's Beads after the British astronomer Francis Baily (1774 - 1844) who described them so well during the eclipse on May 15, 1836. They occur because the edge of the Moon is not smooth but jagged with mountain peaks.

On the brink of totality, Baily's Beads flicker out one by one until the most brilliant bead remains. This glint of light or brightening on the Moon's edge creates the dazzling "diamond ring" effect - the solar jewel. This final sparkling event signals the arrival of the Moon's shadow. Remove your Eclipse Shades once Baily's Beads becoming visible. It'll heighten the drama of the diamond ring effect and won't cause any damage to your eyesight, since they'll disappear fairly quickly. However once Baily's Beads reappear after the second diamond ring, then quickly put the shades back on.

When the brilliant disk of the Sun

This image, by Dennis DiCicco from *Sky & Telescope* magazine, shows the spectacular solar corona on display during the 2010 eclipse from Easter Island. Multiple images of varying exposures were used help give a true visual approximation of the corona's appearance during totality. However, nothing can compare to seeing it in person!

is obscured, there is a good chance of seeing prominences erupting from the Sun's surface, often in a loop configuration. Usually these red, cloud-like appendages of hydrogen that arch above the surface are tiny, but if the Sun is in an especially active phase they can be spectacular, reaching a maximum height of nearly one-third the diameter of the Sun itself.

Odds are you'll need binoculars or a telescope to spot prominences during totality. Solar activity is near minimum, so prominences will likely be small. And yes, totality is perfectly safe to view with unfiltered binoculars or a telescope. Just be conscience of when the Sun will reappear!

Just as the diamond ring effect ends, a halo of light around the Sun comes into view - the corona (the Latin word for "crown"). The corona is a tenuous layer of gas surrounding the Sun at a temperature of ~3,000,000° F. It always surrounds the Sun, but is a million times fainter than the Sun's surface. Therefore, it can only be seen with the unaided eye during totality. It is the grandest sight of a total solar eclipse.

Think of it like this: imagine you can only see the Grand Canyon for a few minutes every 18-months! That's the situation we're in during totality. The corona is a thing of astounding beauty and, by definition, quite alien. There's nothing else like it in Nature.

As totality approaches, see if you can spot the Moon's incoming shadow, the umbra itself. It glides along the surface of Earth at an average speed of approximately 1,900 miles/hour!

During totality, the sky will take on a dark blue hue. Venus will be visible about 35° to the upper right of the eclipsed sun and some of the bright stars of the winter sky might be visible in the southwestern sky. Jupiter will be difficult to spot low on the eastern horizon for observers out west, but easier the further east you are along the eclipse path. The bright star Regulus is just over a degree to the eclipsed sun's lower left, but may be difficult to spot in the glare of the corona.

Song birds may mistake totality for nightfall and go silent, thinking it's time to roost. Owls might begin to hoot and other nocturnal animals may appear. Wildlife will grow momentarily confused when the Sun quickly reasserts itself. This may be difficult to hear and observe if there are hundreds or perhaps thousands of screaming and crying people around you.

Much of the heat we receive comes from the Sun. The temperature can drop as much as 25° F around totality. As you can see, total solar eclipses are a fully immersive event. Not only can you see it, but you can hear it and feel it on your skin. It is the most surreal, alien experience you will ever have.

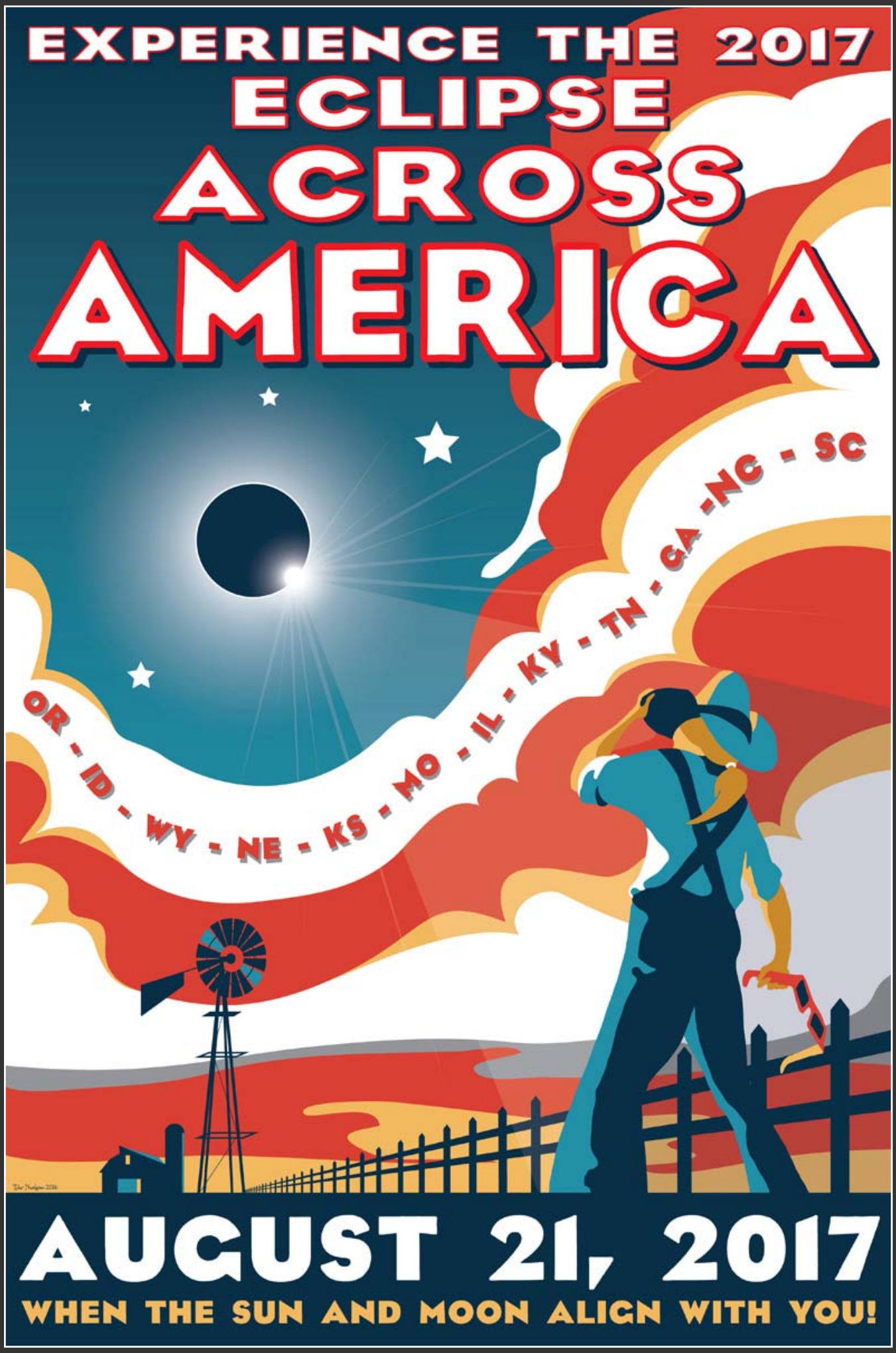
The Moon's shadow will arrive from the northwest at an average speed of 1,900 miles/hour (the exact speed depends on your location). During totality, look around the horizon for a 360° twilight effect. These are places where the Sun is still shining. The Moon will appear as a black hole in the sky surrounded by a strange aura, the corona. Planets, such as Venus, and bright stars will be visible.

Beyond 2017

The first question you'll ask yourself when the eclipse is over is when is the next one. As stated earlier, the next total solar eclipse takes place on July 2, 2019. It'll be visible across the South Pacific Ocean and Chile and Argentina in South America.

The next total solar eclipse visible from the continental United States occurs on April 8, 2024. The path of that eclipse comes ashore in North America from Mexico and then follows a path from Texas to Maine and into eastern Canada. It is total in Michigan, but only from the extreme southeast portion of the state. Carbondale, Illinois is again in the path so that's why they're referring to themselves as Eclipse City. The chances of cloudy skies are higher for the 2024 eclipse. Other total solar eclipses occur in the 48 contiguous states in 2044 and 2045. Therefore, the *Great American* Eclipse on August 21, 2017 is the best one to occur in our lifetime for decades to come. Find your way to totality, you won't regret it.

Richard Bell is a lifetime member and the current President of the Kalamazoo Astronomical Society.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AUGUST 21, 2017
WHEN THE SUN AND MOON ALIGN WITH YOU!

25 Tips to Plan for the 2017 Eclipse

by Michael E. Bakich

Follow these 25 common sense tips, and you'll be ready to rock for America's August 2017 eclipse.

This article originally appeared in the March 2016 issue of Astronomy. *Used with permission by the author.*

#1. Take eclipse day off

The point to consider is that August 21, 2017, may turn out to be the most popular vacation-day request in history. If haven't yet done so, put in your vacation request NOW!

#2. Make it a long weekend

The eclipse occurs on a Monday. Lots of related activities will occur on Saturday and Sunday in locations touched by the Moon's inner shadow. Find out what they are, where they're being held, and which you want to attend, and make a mini-vacation out of the eclipse.

#3. Watch the weather

Meteorologists study a chaotic system. Nobody now can tell you with certainty the weather a location will experience on eclipse day. So, don't get too tied up in the predictions of cloud cover you'll see for that date. Many don't distinguish between "few" (one-eighth to two-eighths of the sky covered), "scattered" (three-eighths to four-eighths), "broken" (five-eighths to seven-eighths) clouds, and overcast. One online repository of knowledge I can recommend is Canadian meteorologist Jay Anderson's Eclipsophile website (http://eclipsophile.com/) and be sure to read his article on page 14.

#4. Get involved

If your interests include celestial happenings and public service, consider volunteering with a group putting on an eclipse event. You'll learn a lot and make some new friends in the process. Don't worry if you don't know eclipses inside and out. After a year of helping prepare, you will.

#5 Attend an event

You'll enjoy the eclipse more if you hook up with like-minded people. If you don't see any special goings-on, call your local astronomy club, planetarium, or science center. Any person you talk to is sure to know of eclipse activities. Travel companies, like Astronomy's partner TravelQuest, also offer trips that will let you experience the full social impact of the eclipse.

#6. Stay flexible

Unless you're certain August 21st will be clear, don't do anything you can't undo in a short time. For example, let's say you're taking a motor home to a site. You connect it to power, extend the awnings, set up chairs, and more. But if it's cloudy six hours, three hours, or even one hour before the eclipse starts, you're going to want to move to a different location. Think of the time you would have saved if you had waited to set up. Also, the earlier you make your decision to move, the better. Just imagine what the traffic might be like on eclipse day.

#7 Concentrate on the sky

Totality will be the shortest two and a half minutes of your life. All your at-

tention should be on the Sun. Anything else is a waste. And be considerate of those around you. Please, no music.

#8. Watch for the approach of the Moon's shadow

If your viewing location is at a high elevation, or even at the top of a good-sized hill, you may see the Moon's shadow approaching along the ground from the northwest to the southeast. This sighting isn't easy because as the shadow crosses the U.S., it is moving at a minimum of Mach 1.5 (1,151 mph, 1,852 km/h) and a maximum of Mach 3.5 (2,685 mph, 4,321 km/h). Another way to spot our satellite's shadow is as it covers thin cirrus clouds if any are above your site. I hope you don't experience clouds, but if you do, you'll be surprised how fast the shadow moves.

#9. Notice it getting cooler?

Point a camera that records video at a digital thermometer and a watch, both of which you previously attached to a white piece of cardboard. Start recording video 15 or so minutes before totality and keep shooting until 15 minutes afterward. The results may surprise you.

#10 Get a filter in advance

Cardboard eclipse "glasses" with lenses of optical Mylar cost around $3. Such a device — it's not a toy — will let you safely look directly at the Sun anytime.

Another safe solar filter is #14 welder's glass, which also will cost you about $3. Wanna look cool at the eclipse? Buy goggles that will hold the welder's glass. I've even seen people wearing whole helmets. Either those or goggles serve one purpose — you won't need to hold the filter, so you can't drop it. The downside is comfort. August 21st will be warm across the U.S. and, in many locations, humid.

#11. View the 360° sunset

A couple of times during totality, take a few seconds to tear your eyes away from the sky and scan the horizon. You'll see sunset colors all around you because, in effect, those locations are where sunset (or sunrise) is happening.

#12. Pee before totality

Yes, I could have phrased this more politely, but you needed to read it. This tip, above any other on this list, could be the most important one for you. Don't wait until 10 minutes before totality to start searching for a bathroom. Too much is happening then. Make a pre-emptive strike 45 minutes prior.

#13. No filter? You can still watch the eclipse

Except during totality, we never look at the Sun. But what if you've forgotten a filter? You can still watch by making a pinhole camera. It can be as simple as two pieces of paper with a tiny hole in one of them. (Try to make the hole as round as you can, perhaps with a pin or a sharp pencil.) Line up the two pieces with the Sun so the one with the hole is closest to it. The pinhole will produce a tiny image, which you'll want to have land on the other piece of paper. Moving the two pieces farther apart will enlarge the Sun's image but will also lessen its brightness. Work out the best compromise.

#14. Bring a chair

In all likelihood, you'll be at your viewing site several hours before the eclipse starts. You don't really want to stand that whole time, do you? Are friends coming? Provide a chair for everyone.

#15. Don't forget sunscreen

Most people who go outside during the summer know this. Remember, you'll be standing around or sitting outside for hours. You may want to bring an umbrella for some welcome shade. And if you see someone who has forgotten sunscreen, please be a peach and share. This is true solar safety.

#16. Take lots of pictures

Be sure to capture images of your viewing site and the people with whom you shared this great event. If you have a camera that records video, I suggest you mount it on a tripod, position it about 25 feet (8 meters) away, aim it toward your group, and record from 15 minutes before totality to 15 minutes after. You'll document all your reactions and the darkening and brightening of your site. (Note: If your camera automatically compensates for darkness, disable that feature.)

#17. Regard totality as sacred

In the August 1980 issue of *Astronomy* magazine, author Norm Sperling contributed a "Forum" titled "Sperling's 8-second Law" in which he tries to convey how quickly totality seems to pass. I'll just quote the beginning here. "Everyone who sees a total solar eclipse remembers it forever. It overwhelms the senses, and the soul as well — the curdling doom of the onrushing umbra, the otherworldly pink prominences, and the ethereal pearly corona. And incredibly soon, totality terminates.

"Then it hits you: 'It was supposed to last a few minutes — but that couldn't have been true. It only seemed to last eight seconds!' "

#18. Bring snacks and drinks

You're probably going to get hungry — and in the summer in the U.S., you definitely will get thirsty — waiting for the eclipse to start. Unless you set up next to a convenience store, bring some light snacks and plenty to drink. Remember, even if you're attending a sponsored event, there's no guarantee water vendors won't run out. Some places will have many times the number of people they expect. Don't trust someone else with your comfort.

#19. Remember that no one will have seen totality

If you're planning an event or a family gathering related to the eclipse, consider this: Statistically, 100% of the people you encounter — to a high degree of accuracy — will never have experienced darkness at noon. You will be the expert.

#20. Invite someone with a solar telescope

If you're hosting a private shindig, make sure someone brings a telescope with a solar filter. While it's true that you don't need a scope to view the eclipse, having one there will generate buzz, and it will help Sun-watchers get the most from their experience. And you (or the scope's owner) can point out sunspots, irregularities along the Moon's edge, and more. You can even take a look at Venus.

#21. Experience totality all by yourself

The 2017 eclipse, plus the events leading up to it, will combine to be a fabulous social affair. Totality itself, however, is a time that you should mentally shed your surroundings and focus solely on the sublime celestial dance above you. You'll have time for conversations later.

#22. Schedule an after-eclipse party or meal

Regarding No. 21, once the eclipse winds down, you'll be on an emotional high for hours, and so will everyone else. There's no better time to get together with family and friends and just chat. Fun!

#23. Record your memories

Sometime shortly after the eclipse, when the event is still fresh in your mind, take some time to write, voice-record, or make a video of your memories, thoughts, and impressions. A decade from now — or, more specifically, just before the next U.S. total solar eclipse in 2024 — such a chronicle will help you relive this fantastic event. Have friends join in, too. Stick a video camera in their faces and capture 30 seconds from each of them. You'll smile each time you watch it.

#24. Don't be in a rush afterward

Traffic, or the new term I have for what we all will experience on eclipse day — gridlock — will be horrendous after the event at some locations. And the sooner you try to leave, the worse it will be. Relax. Let the part of the eclipse between third and fourth contacts play out. Many people will view this portion as "what we saw before totality, but in reverse." For this section, however, all the tension will be gone.

#25. Don't photograph it

This tip may sound strange coming from the photo editor of the best-selling astronomy magazine on Earth. But I've preached it to thousands of people whom I've led to far-flung corners of our planet to stand under the Moon's shadow. True, few of them have thanked me afterward.

But I can tell you of upward of a hundred people who have told me with trembling voices, "I wish I'd followed your advice. I spent so much time trying to center the image and get the right exposures that I hardly looked at

the eclipse at all." How sad is that?

And here's another point: No picture will capture what your eyes will reveal. Trust me, I've seen them all. Only the top 0.1% of photographers ever has come close. And you — no offense — with your off-the-shelf SLR or point-and-shoot pocket camera are not one of them.

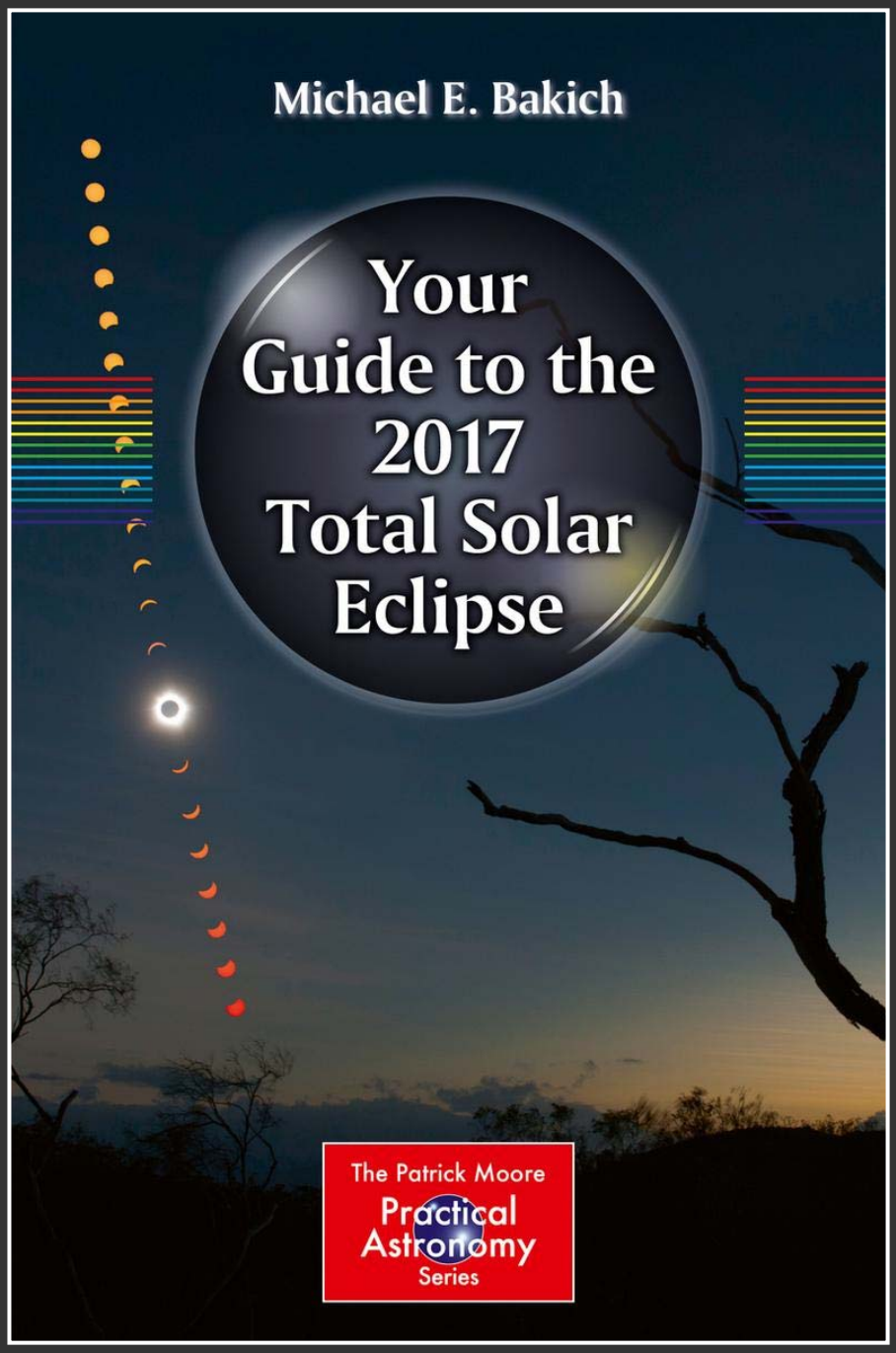
Finally, why would you even consider looking down and fiddling with a camera when you could be looking up at all that heavenly glory? This eclipse will — at maximum — last 160 seconds. That's it, friends. If your camera isn't doing what you think it should, you're going to lose valuable time adjusting it. There will be plenty of pics from imagers who have viewed a dozen of these events.

So just watch. Watch your first eclipse with your mouth agape, where your only distraction is occasionally wiping tears of joy from your eyes. I promise that you will not be disappointed.

Now, relax

Once you come up with a course of action that lets you stay flexible with some of the details, you'll feel a lot better as August 21, 2017, approaches. And the family and friends that you include surely will say, like Bill Murray's character Dr. Peter Venkman in the movie Ghostbusters, "I love this plan. I'm excited to be a part of it!"

Michael Bakich is a Senior Editor at Astronomy *magazine.*



In this book provides all the information you'll need to be ready for the total solar eclipse that will cross the United States on August 21, 2017.

In this one resource you'll find out where the eclipse will occur, how to observe it safely, what you'll experience during the eclipse, the best equipment to choose, detailed weather forecasts for locations where the Moon's shadow will fall, and much more.

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Michael Bakich is currently a Senior Editor at *Astronomy* magazine, the world's best-selling astronomy magazine. He is the author of other books such as *The Cambridge Guide to the Constellations*, *The Cambridge Planetary Handbook*, *The Cambridge Encyclopedia of Amateur Astronomy*, and *1,001 Celestial Wonders to See Before You Die*. Mr. Bakich was also the keynote speaker at the Kalamazoo Astronomical Society's award-winning "Astronomy Day" in 2014.

Chasing Eclipse Weather

The best weather websites to use in the days leading up to August 21st

by Jay Anderson

Now that August is upon us, and the eclipse looms, only three weeks away, it's time to begin thinking of weather strategies for the magical day. We have a kitbag of resources at our disposal, but until about the 12th of August or thereabouts, there is little that we can trust to point us to the right place. However, the intervening time should not be wasted, as the first half of the month can be used to "practice" and formulate an eclipse-day plan and evaluate the accuracy of some of the tools, primarily the numerical models that meteorologists use to construct the forecast.

Model Forecasts

There are many numerical models at our disposal, but at the longest range – about 10 days – only two are readily available. These are the GFS model from the National Weather Service in the U.S. and the GDPS from Environment Canada. Both of these are global models that reach out as far as 15 or 16 days into the future, but only begin to become stable about 10 days ahead.

There are many places to look at these models online, but two stand out above the others. One is spotwx.com, a Canadian web site that presents the many model outputs in the form of a graph; the other is weather.cod.edu at the College of DuPage (CoD) that uses a map format. If you want to monitor one or two places, then spotwx is your best choice. To monitor a wider area, especially if you have the capability to move a large distance in the days ahead of the eclipse, then the College site is your best bet. Figure 1 shows the output for Carbondale from spotwx; Figure 2 shows a map of cloud cover for 10 days into the future from the College site.

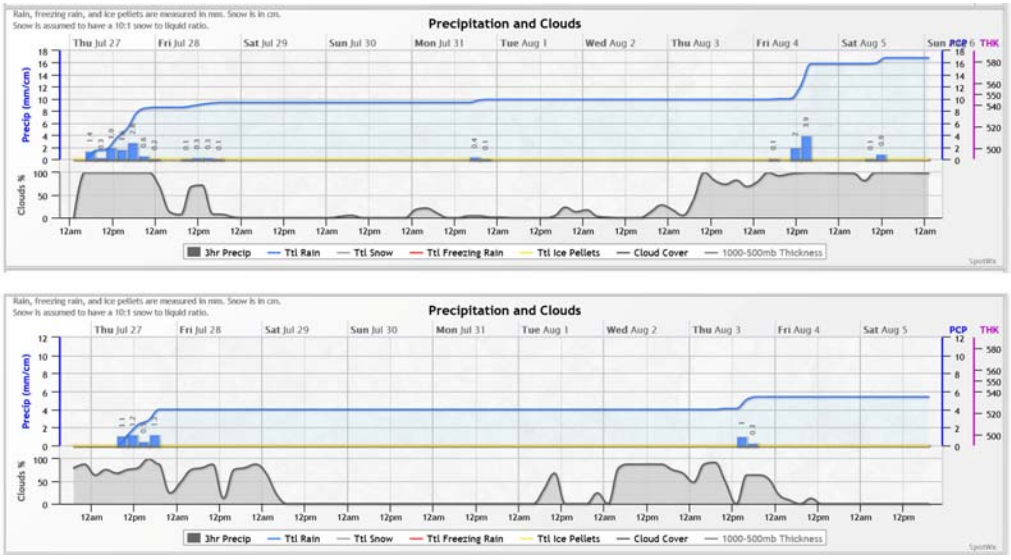


Figure 1: 10-day forecasts from the U.S. GFS (top) and Canadian GDPS models for Carbondale, IL.

Don't let the authoritative appearance of these model predictions fool you – almost certainly they are both wrong at the 10-day mark, but they can be used to develop a strategy as if they were for eclipse day. Based on the College of DuPage map, a move into Nebraska would be warranted if the cloud prediction were for eclipse day. However, the graphs from the two models at the spotwx site show that the US and Canadian models, while broadly similar, diverge at the longest range (in fact, they are at opposites) and even have small differences at the start. At this point, it is impossible to decide which one is right, but some "what-if" planning could begin.

There are two signs that the models are beginning to lock in to a consistent and more accurate forecast. The first is that an individual model maintains the same forecast over a several-day period. The second is that individual models give the same forecast, or at least nearly so. In the example shown in the cloud graphs of Figure 1, it seems it will rain on the 27th and we can be reasonably certain that the period from the 29th to the 1st will be mostly or completely sunny. If the eclipse were on the 5th, the models are not in agreement and so we have at least the hope that the Canadian model is correct. Our strategy then is to wait a day for another model run (or six hours if

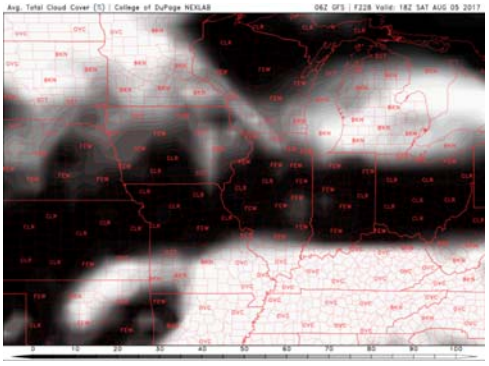


Figure 2: 10-day cloud forecast map for noon, August 5, from the GFS model

you can't stand the uncertainty), but make mental plans to move west in search of better weather if the GFS should be more accurate.

It is important not to get too excited at this point, as both forecasts will certainly change as the 10-day interval to August 5 is reduced.

As the time to the eclipse is reduced to 3 ½ days or less, new models become available – probably too many, as their disagreements may leave you even more bewildered, though the agreement between them is normally fairly close. At half a week away from the eclipse, the U.S. NAM model will become the model of choice, but the GFS and GDPS should not be ignored. The NAM uses a different mathematical approach to numerical forecasting than the longer-range models. In technical parlance, it is a non-hydrostatic model, which means it tolerates and reacts to imbalances in the atmosphere that are largely smoothed out by the GFS and GDPS. Those imbalances are important in thunderstorm forecasting, so the NAM is an important model in the late summer season when convective storms are still likely.

At 2 days out, the NAM is joined by the Canadian RDPS and HRDPS models (Figure 3), and for the most part, these will take you up to eclipse day. Spotwx.com offers two other short-range models: the 18-hour HRRR and the 21-hour RAP. These latter models are updated very frequently (hourly for the HRRR and every three hours for the RAP), but at a time this close to the eclipse, you are probably switching over to watching satellite images with declining support from the models. All of the short-range models are devoted to thunderstorm forecasting, and so the map outputs from weather.cod.edu will probably be more useful. If you are looking for sunny skies on the evening before the eclipse, you will most likely be planning to move and so a map of the path to the nearest clear skies is more useful. The RAP model available from the College does not show cloud fields, so the HRRR and the NAM will be your short-range choices.

Satellite Observations

Model calculations lead the way toward selection of a suitable eclipse-viewing site, but in the final hours, it is the satellite imagery that will give the most useful information. For an early-in-the-day eclipse, the only option is to use infrared imagery from the satellites, which provide an overnight view of the cloud cover. Once the sun rises, visible imagery can be used, though the time between sunrise and eclipse time is very short for much movement – it would be mostly for a local change in position.

Infrared images have the disadvantage of lower resolution and a tendency to show high- and mid-level cloud as being thicker than they really are. The infrared emission from the Earth depends on temperature so that cold, high-level cloud can be shown in white and light gray tones, leaving darker gray shades for warmer low cloud and the ground (Figure 5). At night, the ground may be at the same or similar temperature to the cloud and it may become difficult to distinguish the two similar-toned features. Animation of the cloud images, a feature available from the CoD site, will reveal the presence of moving clouds against the stationary backdrop, but fog will be a more difficult problem. Fog should not be a concern at eclipse time, except along the Pacific Coast, as the day will be sufficiently advanced for it to have dissipated.

Satellite images can be used to estimate the arrival of oncoming cloud, the amount of cumulus cloudiness (cellular-looking clouds such as those south of Lake Michigan in the visible image of Figure 5), and the presence of high-level cloudiness associated with larger scale weather systems. If you understand a little meteorology, the CoD satellite images can be overlain with some meteorological fields such as pressure or wind.

In Figure 5, the differences in the infrared- and visible-light images are quite pronounced. Low-level cumulus clouds are easily seen in the visible image, but blend into a much smoother medium-gray cloud level in the infrared. High-level cloud stands out as a medium-bright tone; there are many embedded thunderstorms on the right side of the image. Most of the low-level gray cloud will dissipate as the eclipse shadow approaches, but the whiter stuff will persist in spite of the lunar shadow.

Other Data Sources

Surface observations from the many

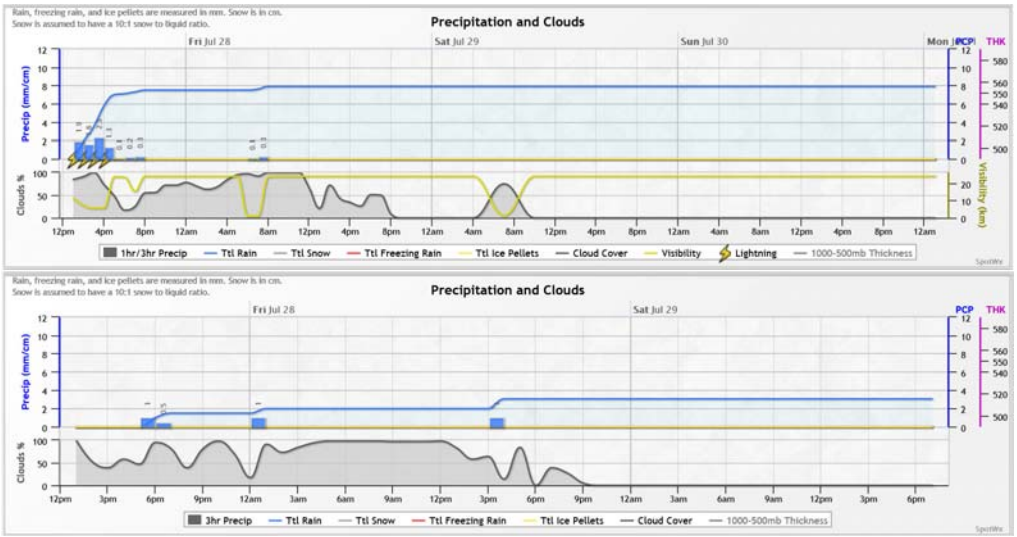


Figure 3: Short-range forecasts from the NAM model (above) and the RDPS model. In these examples, the models are largely in agreement (note that the time scales are different across the bottom), though there are still small differences to be ironed out,

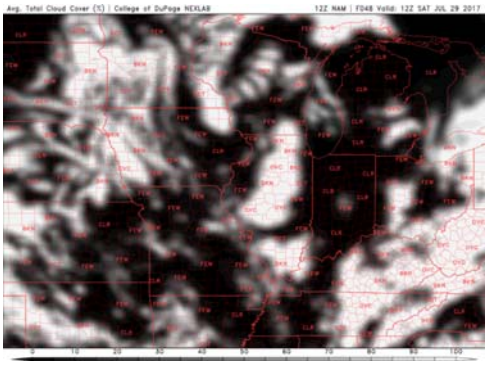


Figure 4: Example of a 48-hour cloud map from the HRRR model available at the College of DuPage site.

airport weather stations will report on cloud cover, winds, temperature, precipitation and the many other factors that go into a forecast. Unfortunately, cloud observations from U.S. ground stations take incomplete observations of cloud amount that tend to make them look much sunnier than they really are. In this era of automatic observations, weather stations use an upward pointing laser to determine cloud amount and height. Unfortunately, the laser measurements are truncated at 20,000 feet, leaving higher cloud unobserved – essentially everything at the cirrus level. You will have to fill in the details by using the infrared satellite observations, which show the cold, high cloud very well.

America is a land of private meteorology, and the airwaves and Internet will be filled with specialized forecasts for eclipse day for at least a few days in advance. Much of what I've said here could probably be ignored if you are prepared to move at short notice using media forecasts. They will be reluctant to make a commitment more than a day or two in advance, however, and so the sources here will give you a bit of a head start and allow you to evaluate the uncertainties.

Good luck on eclipse day. Keep your wits about you and enjoy the spectacle with family and friends. You will never regret the effort to stand in the shadow of the Moon.

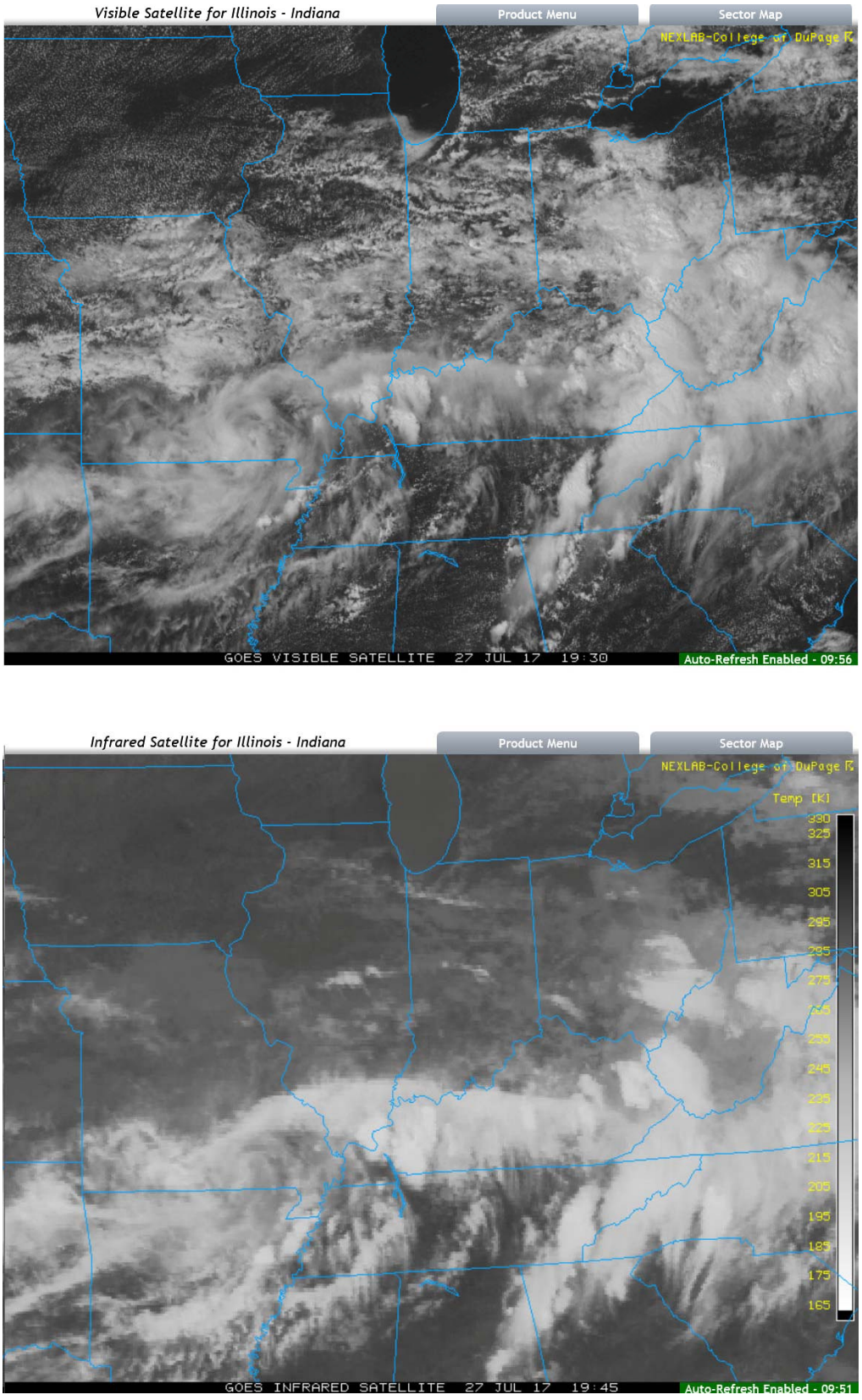


Figure 5: Examples of visible (top) and infrared satellite images from the CoD site, centered on Illinois. The site provides many other sector views covering the whole of the U.S.A.

Jay Anderson *is a Canadian meteorologist and avid eclipse chaser who, for nearly forty years, has published studies of the climate along eclipse tracks to help those who want to place themselves in the most favorable place to view the passage of the lunar shadow. Since his first eclipse in 1979, Jay has traveled the world with his wife Judy to stand under the shadow of the Moon; the eclipse on August 21st will be his 30th. He wrote this article exclusively for* Prime Focus.

National Aeronautics and Space Administration

2017 TOTAL SOLAR ECLIPSE

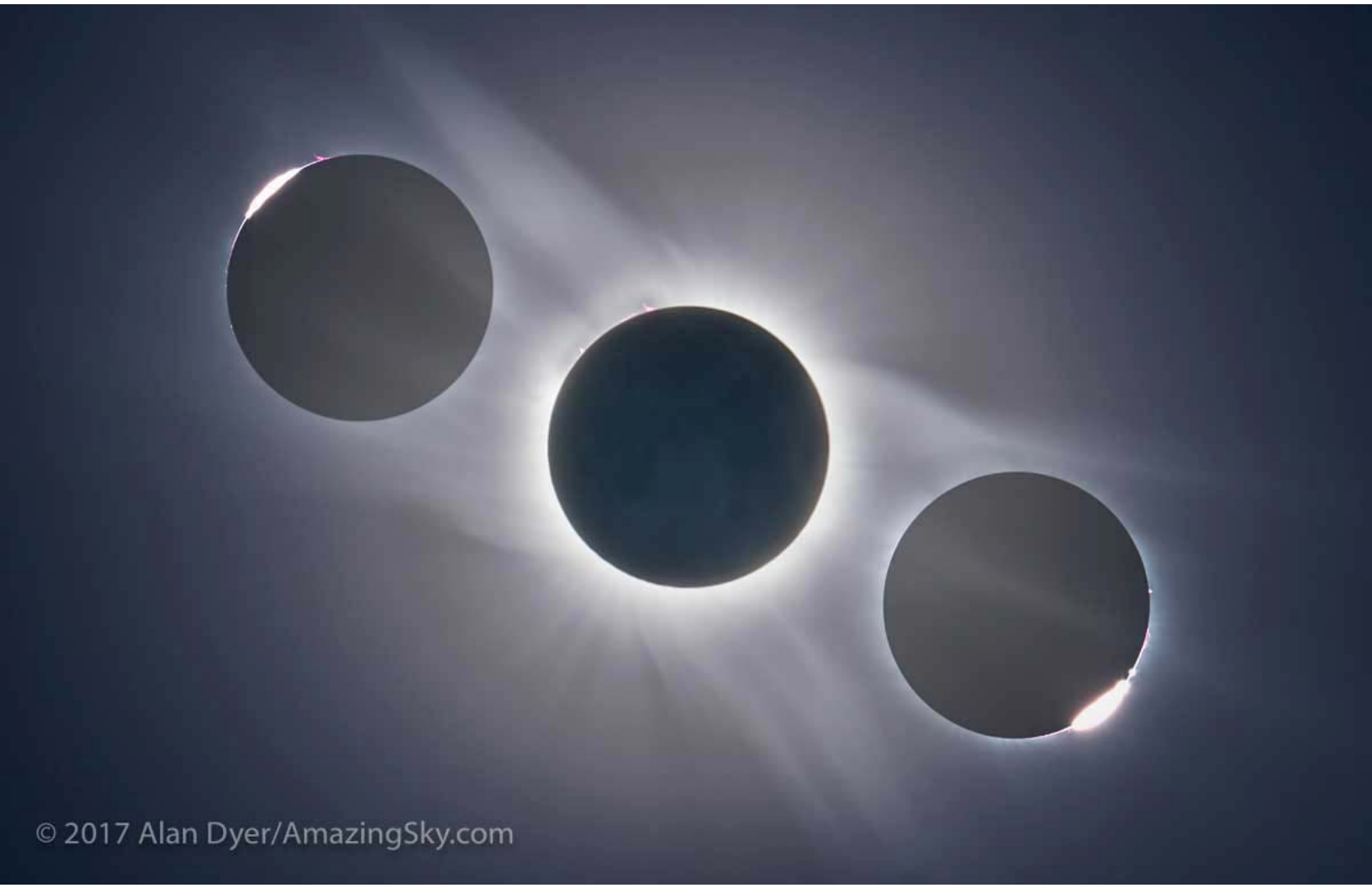
THROUGH THE EYES OF NASA

www.nasa.gov

UPDATED 6/15/2017

Shoot the Solar Eclipse

Traveling to the total eclipse of the Sun? Here's how to bring home a souvenir image, simply.



by **Alan Dyer**

The original version of this article appeared on the Canadian Nature Photographer website, a great resource for nature lovers, photographers and artists. Used with permission.

This summer an amazing natural phenomenon will sweep across the United States. On August 21st, the shadow of the Moon will touch Earth and trace a path from coast to coast, from Oregon to South Carolina.

Anyone standing in that 70-mile-wide path will see the Sun disappear for just over two minutes at midday. During the short duration of totality, the dark disk of the Moon will completely eclipse the Sun, turning the bright disk of the Sun into what looks like a black hole in the sky. In moments day will turn into deep twilight.

ECLIPSE ACROSS AMERICA

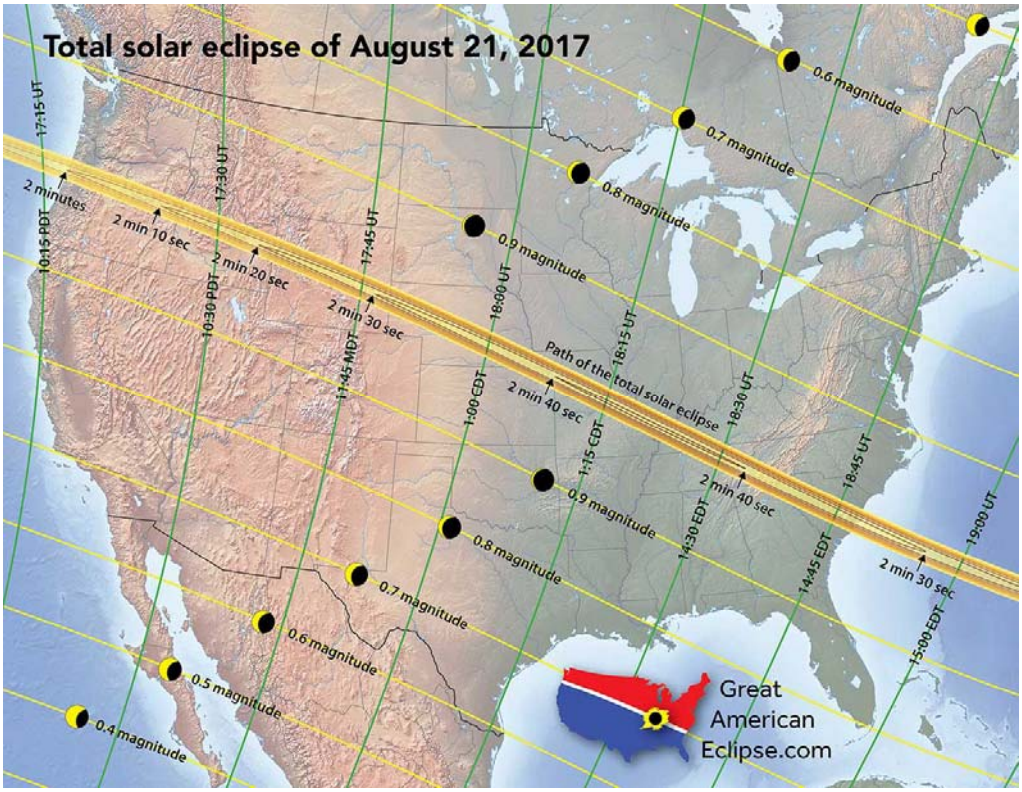
The yellow band in the image of the United Sates on page 20 indicates the narrow path of the Moon's umbral shadow and the region where you must be to witness a total solar eclipse on August 21st. The length of totality is labeled, with a maximum length of 2-minutes 40-seconds in southern Illinois. Outside the path you'll see only a partial eclipse, with the percentage indicated (0.9 = 90%). (Map courtesy www.greatamericaneclipse.com. That website has many other detailed path maps.)

To experience the total eclipse you must be within the path of totality traced by the Moon's umbral shadow. From just outside the path you'll see only 99%, or less, of the Sun covered by the Moon. That isn't 99% of the experience. Even the remaining one percent of the Sun is so bright you won't see the full range of phenomena that a total eclipse provides.

Stay at home in Michigan and the best you'll see, from southwestern portion of the state, is an 86% partial eclipse. That's good enough to make the day grow slightly dimmer, but the Sun will remain a brilliant source of light in the sky.

Traveling to the path of totality might seem a long way to go, but it's nothing compared to the effort of reaching most total eclipses, whose paths cross only remote regions of the

Wide angle photo (10 mm) of eclipse, Libya, 2006.



world. This is the first total solar eclipse in southern North America since February 26, 1979. The next is April 8, 2024.

While some total eclipses are witnessed by only a few hundred avid shadow chasers, tens of millions of people live in the path of the August 21st eclipse, while tens of millions more will travel to it.

Challenging Close-Ups

While aiming a monster telephoto lens at the Sun is the first thought of aspiring eclipse photographers, capturing a good closeup image is not without its challenges. The sky is slowing moving from east to west, requiring constant effort, and a solid but easily adjustable tripod, to keep the Sun well framed.

A safe solar filter is also essential, not for shooting totality itself, but for the partial phases, which is when you need to precisely focus the image. Then, just before totality you have to quickly remove the filter. In their excitement, many forget to do so.

During totality, shooting on Auto Exposure with a long telephoto lens will work. But capturing the full range of phenomena, from the brilliant pink prominences to the faint streamers of the outer corona, requires manually stepping through a wide range of shutter speeds. That all takes effort, and time taken away from just looking at the eclipse. Remember, you have only two and a half minutes!

Instead, may I suggest another way to shoot the eclipse. This technique produces publication quality results, yet requires little effort, and takes no time away from just looking.

WIDE-ANGLE ECLIPSE

A wide-angle lens (a 10mm on a cropped-frame Canon 20Da) captured the same 2006 total solar eclipse in a scene that takes in the Sun, twilight eclipse sky, and eclipse observers below. The image is part of a sequence taken with the camera on Auto Exposure and fired by an intervalometer for hands-off operation. This was 0.8 seconds at f/5 and ISO 100.

Simply Wide

The key is to use a DSLR or mirrorless camera that accepts interchangeable lenses. Use a lens wide enough to frame the ground below (perhaps including your eclipse group), distant scenery, and the sky and eclipsed Sun above.

PLANNING THE SCENE

A screen shot from The Photographer's Ephemeris™ (TPE) mobile app (shown below) shows the position of the Sun (the grey line) in the southeast during the eclipse from the popular destination of the Teton Valley in Wyoming. The Sun won't be over the peaks of the Grand Tetons, but opposite them.

To help you plan the scene, use photo planning software such as TPE, (http://photoephemeris.com), set to your site and to the time of totality at that site. You'll then be able to see where the eclipsed Sun will be in relation to landscape features.

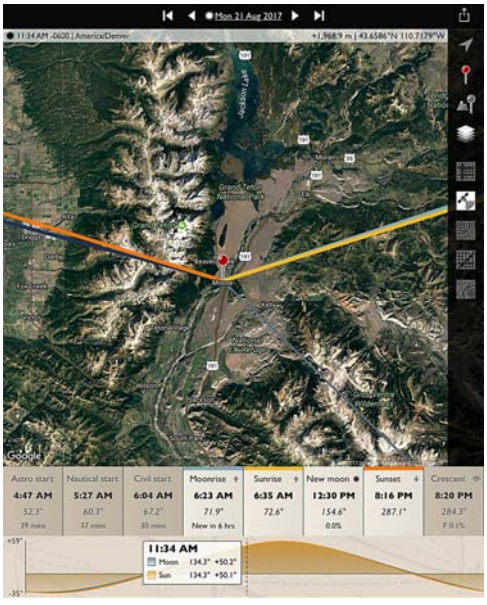
Framing a suitable scene might require moving to a location off the centre-line where totality lasts the longest. Doing so doesn't sacrifice too much precious totality time. Even halfway to the path edge you lose only 20 seconds or so, worth it to get the money shot of the eclipsed Sun over dramatic scenery.

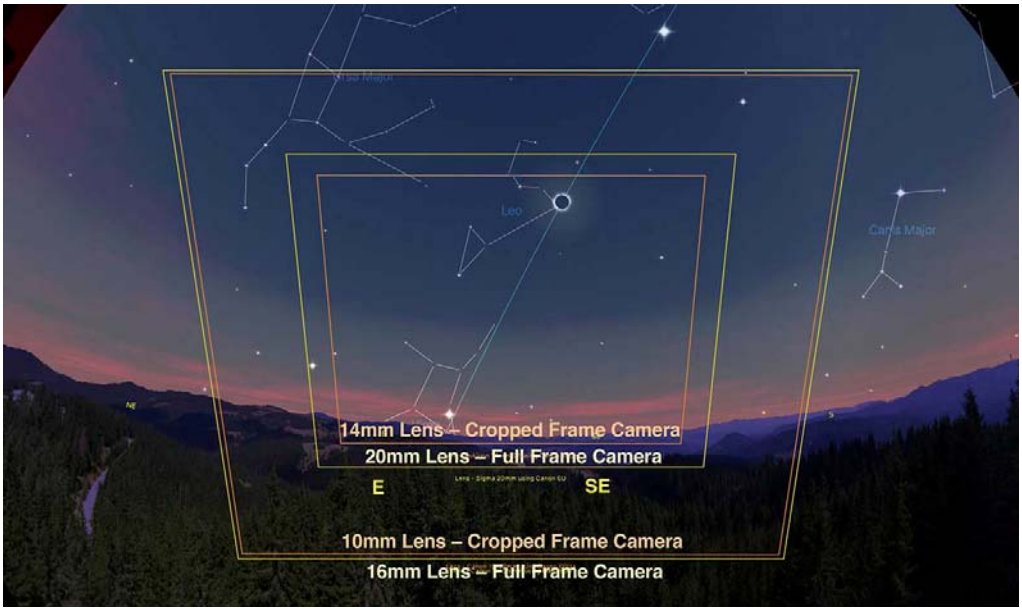
ECLIPSE FRAMING

Planetarium software, such as Starry Night™ (https://starrynight.com), can help plan the framing of the sky. The scene shown at the top of page 21 is set for eastern Idaho, and shows that wide lenses are needed to take in the high Sun of late morning, as well as the landscape below.

How wide a lens you will need depends on how far east or west you are on the eclipse path (the Sun appears higher from the eastern U.S.), and whether you frame the scene with the camera turned horizontally or vertically.

Your lens choice also depends on





whether you are shooting with a cropped-frame camera or a full-frame camera. But in general, you will need a 10mm to 24mm lens to take in the entire scene, with the eclipsed Sun over your eclipse site.

ECLIPSE AT SEA

At this eclipse in April 2005 the author was at sea in the South Pacific. The Sun was at a similar high altitude in the sky as it will be on August 21st, here requiring a 10mm lens on a cropped-frame DSLR to contain the scene shown at the bottom left. This was 1/4 second at f/4.5 and ISO 100.

What makes this method easy is that you can use Auto Exposure, on Av or "aperture priority." Set the lens to a fixed but wide aperture of f/2.8 to f/4 and the camera at a fixed ISO of 100 to 400. The camera will then alter the shutter speed as the scene darkens when totality begins, then brightens as the Sun and daylight return to normal. The shutter speeds likely won't get longer than one second, even at mid-totality when the sky is darkest.

Contrary to popular expectations, the day will not turn to full night, but to an eerie but still fairly bright twilight.

ECLIPSE FROM DOWN UNDER

In Australia in November 2012, the author used a 15mm full-frame fish-eye lens to capture the low eclipsed Sun and the shadow of the Moon, the dark blue wedge seen in the sky (center image). The camera was on aperture priority Auto Exposure and ran unattended using an intervalometer to fire the shutter every second. This was 0.3 seconds at f/2.8 and ISO 100.

To automate the camera for hands-off operation, use an outboard intervalometer, or the camera's own built-in intervalometer if it has such a function, to fire the shutter once a second. Start the sequence about three to four minutes before totality (there's no need to have a solar filter on the lens), and end it a similar time after totality.

Later in processing you can pick the best single images from the sequence, or turn the entire set into a time-lapse movie. Alternatively, you could just shoot a continuous HD or 4K movie with sound.

SHADOW PLAY

For the November 2013 total eclipse, the author was again at sea, but in the Atlantic. A camera on Auto Exposure captured the twilight and changing colors of the clouds as the lunar shadow engulfed the ship for a brief 45 seconds of totality (bottom right). This was 1/40 second at f/2.8 and ISO 800, with the ISO purposely set high to keep shutter speeds short on the rolling ship.

Either way, for stills or movies, don't use Auto Focus (AF). Set the lens and camera on Manual Focus (MF) and use Live View to focus the lens on the horizon or a distant object prior to the eclipse, then leave it. If you have Auto Focus on, the camera might fail to fire at crucial moments as it tries, unsuccessfully, to focus on what might be largely blank sky.

With only modest effort, what you'll record is the changing lighting and sky colors, and the Sun turning from a bright overexposed orb into a black hole. You might also pick up the dark edge of the lunar shadow sweeping across the sky from west to east, from right to left on your frame.

You'll get images that record the scene as your eye saw it, all without any effort during the brief moments of totality itself. While the camera fires, you can just stare up in wonder.

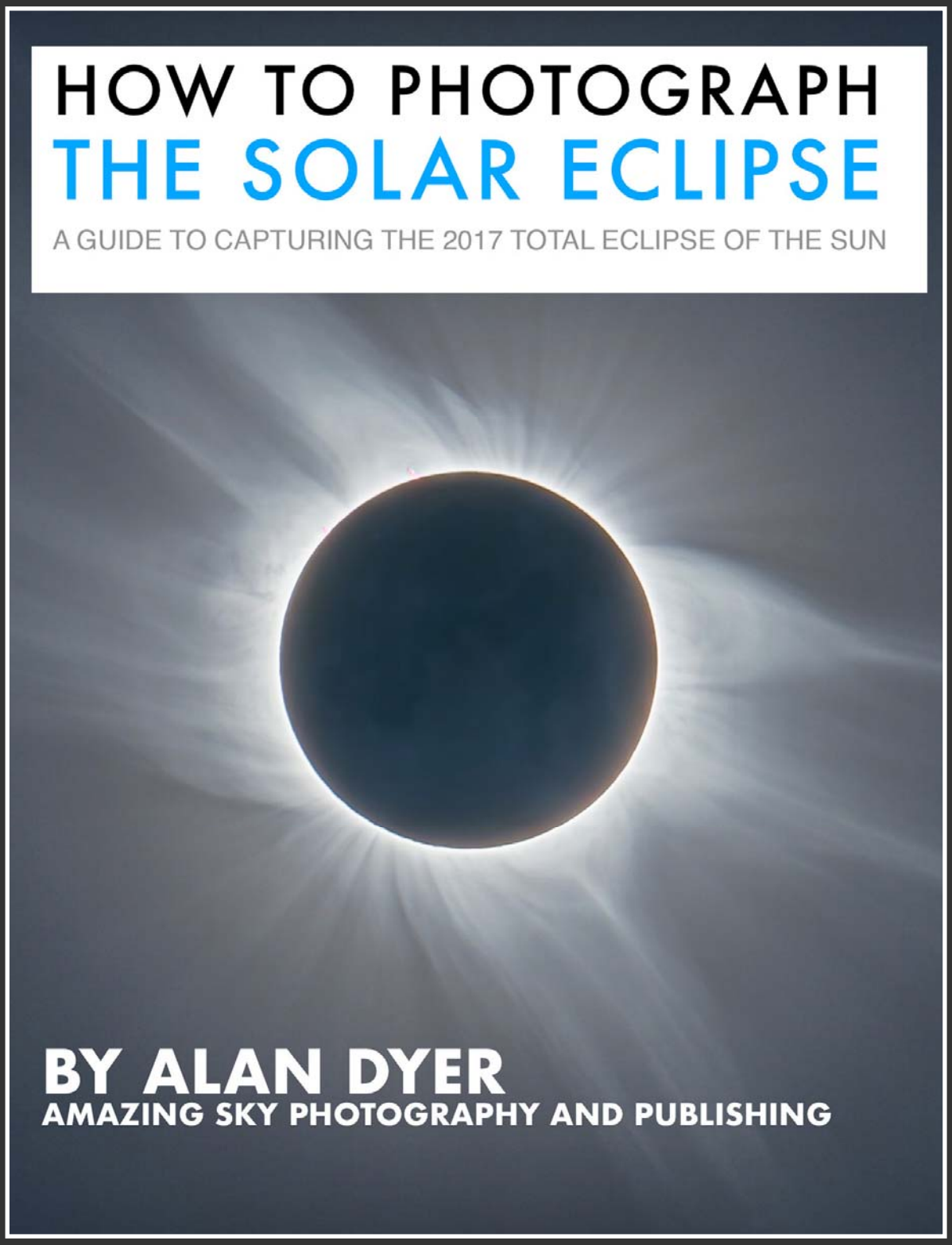
Alan Dyer is one of Canada's best-known astronomy authors and astrophotographers. His eclipse chasing adventures have taken him to every continent, chalking up 15 total solar eclipses to date. Visit Alan's website, amazingsky.com, for more examples of his day and night sky photography.

2005 Eclipse over the South Pacific (10 mm wide angle lens)

Eclipse 2012 Australia (15 mm wide angle lens)

2013 Eclipse over the Atlantic (15 mm wide angle lens)

The most comprehensive guide to photographing eclipses you'll find!



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Build a Sun Funnel

by Richard S. Bell

The biggest party of the year will take place on August 21, 2017! Millions of people will travel to the path of totality to experience the total solar eclipse. Totality is the main event, no question, but the partial phases of the eclipse are also enjoyable to observe. After all, you're watching the clockwork motion of the solar system in action.

Families and entire towns will host eclipse parties and festivals. Viewing the partial stages of the eclipse through a properly filtered telescope is enjoyable, but there's only room for one person at a time. Solar projection is the way to go with large groups of people.

Standard solar projection could be problematic if small kids are around. They may try to look through the telescope, which could be very dangerous. A safer way to do solar projection is to build a Sun Funnel!

The Sun Funnel was adapted from an existing design for a 2003 Great Lakes Planetarium Association Conference workshop by Chuck Bueter and Gene Zajac. The rear-projection screen, a key ingredient, is an idea borrowed from Bruce Hegerberg's Sun Gun. Those of you that have been in the KAS for a while know I built one of these when the *Sky & Telescope* article first came out in June 1999.

The Sun Funnel is much more portable, far cheaper, and super-easy to make. It took me about 20 minutes to put it all together.

Both Don Stilwell and I built Sun Funnels for the Transit of Venus in 2012. Hundreds of people at Warren Dunes State Park were able to safely view the transit and even snap some souvenir pictures!

A refractor works best with the Sun Funnel. Heat from the Sun could damage the secondary mirror holder of your Newtonian reflector or Schmidt-Cassegrain telescope. If you do use a Newtonian then stop down its aperture to 1 or 2 inches.

Most of the required materials are readily available. The first is a FloTool Funnel (#05034). They are available at Autozone for only $2.99 (plus tax). You'll also need a large (2.5" × 5.5") and small (13/16" × 1.5") hose clamp. The total cost of the hose clamps at the local hardware store for me was $3.58.

Da-Lite High Contrast Da-Tex rear projection screen can be purchased online from bigscreencenter.com (#95774). They sell a 12" × 12" piece of material for $15.99 plus shipping.

Begin constructing your Sun Funnel by cutting the little flat tab off the wide end of the funnel with a hacksaw. Sand off the rough edges with some course sandpaper.

Now use the hacksaw to cut 7-inches off the narrow end of the funnel and discard this piece. It's okay if your cut is slightly titled. You should have about 10-inches of the funnel left. Stand the funnel on its wide end and cut straight down the middle of the new narrow opening, making your cut about 1 to 2 inches deep. The narrow end of the funnel will now have two semicircles of plastic rather than a solid circle. This gives you some flexibility when inserting an eyepiece later.

Sand all cut surfaces with some sandpaper. You'll also want to use the sandpaper to remove the sharp little piece of plastic protruding from the side about halfway down the length of the funnel.

The eyepiece you use for projecting the Sun's image depends on the focal length of the telescope you use. Just use this equation to figure it out:

$$FL_{eyepiece}\ (mm) \approx FL_{telescope}\ (mm) \div 43$$

Make sure the eyepiece doesn't have any plastic parts. I tried using a low-quality Huygens eyepiece I had lying around, but it melted a little bit! Be sure to remove any rubber eyecup or grip your eyepiece might have.

Insert the eyepiece into the narrow end of the funnel and use the small hose clamp to secure it in place. Use the large hose clamp to attach the rear projection screen. Continuously pull down the screen material as you tighten the hose clamp, so the screen has no wrinkles. The finished product should look like the image shown to your left.

For more detailed instructions (with step-by-step images) be sure to see the article on NASA's Eclipse 2017 website.

The Sun Funnel can be used beyond the eclipse for group viewing of sunspots or transits of Mercury. Some people are very leery about viewing the Sun through a telescope. The Sun Funnel eliminates the need to worry.

KAS Members in the Shadow of the Moon

Our membership will be spread throughout the path of totality. Find out where.

OREGON

Madras:
Harold Ballen
Becky & Kalman Csia

WYOMING

Northwest of Riverton:
Richard Bell
Jean DeMott

North of Riverton:
Thomas Abraham

Casper:
Paul Asmus
Richard Dirrenberger

Glenrock:
Dave Woolf

Northeast of Cheyenne:
Charlie Bibart

NEBRASKA

Hemingford:
Roger & Molly Williams

Alliance:
Robert Wade

North Platte:
Jim Kurtz

Grand Island:
Beverly Byle
Rich Mather
Bill Nigg

Fairmont:
Kevin Jung

Lincoln:
Joe & Ellen Comiskey
Arya Jayatilaka
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St. Genevieve:
Bob & Barb Havira

South of St. Louis:
Mark Kinsey
Chris Roberts
Andy Robins

ILLINOIS

Sparta:
Matt DePriest
Cal Lamoureux
Scott Macfarlane
Jack & Ruth Price
Mike & Karen Sinclair
Greg Sirna
Don Stilwell

Carbondale:
Arthur Woodworth
Daniel Woodworth
Karen Woodworth

Marion:
Frank & Susan Severance

KENTUCKY

Paducah:
Randy & Michelle Matson

Hopkinsville:
Will Howard
Brent Sanford

Russellville:
Stephanie Stratton

TENNESEE

Clarksville:
Lydia Hoff

Nashville:
Sam Qualls

Stone River Battleground:
Richard Olsen

NORTH CAROLINA

Murphy:
Brian & Terry Swisher

Franklin:
John & Jackie Lee

Asheville:
John Miller

SOUTH CAROLINA

Pickens:
Bob & Grace Cox

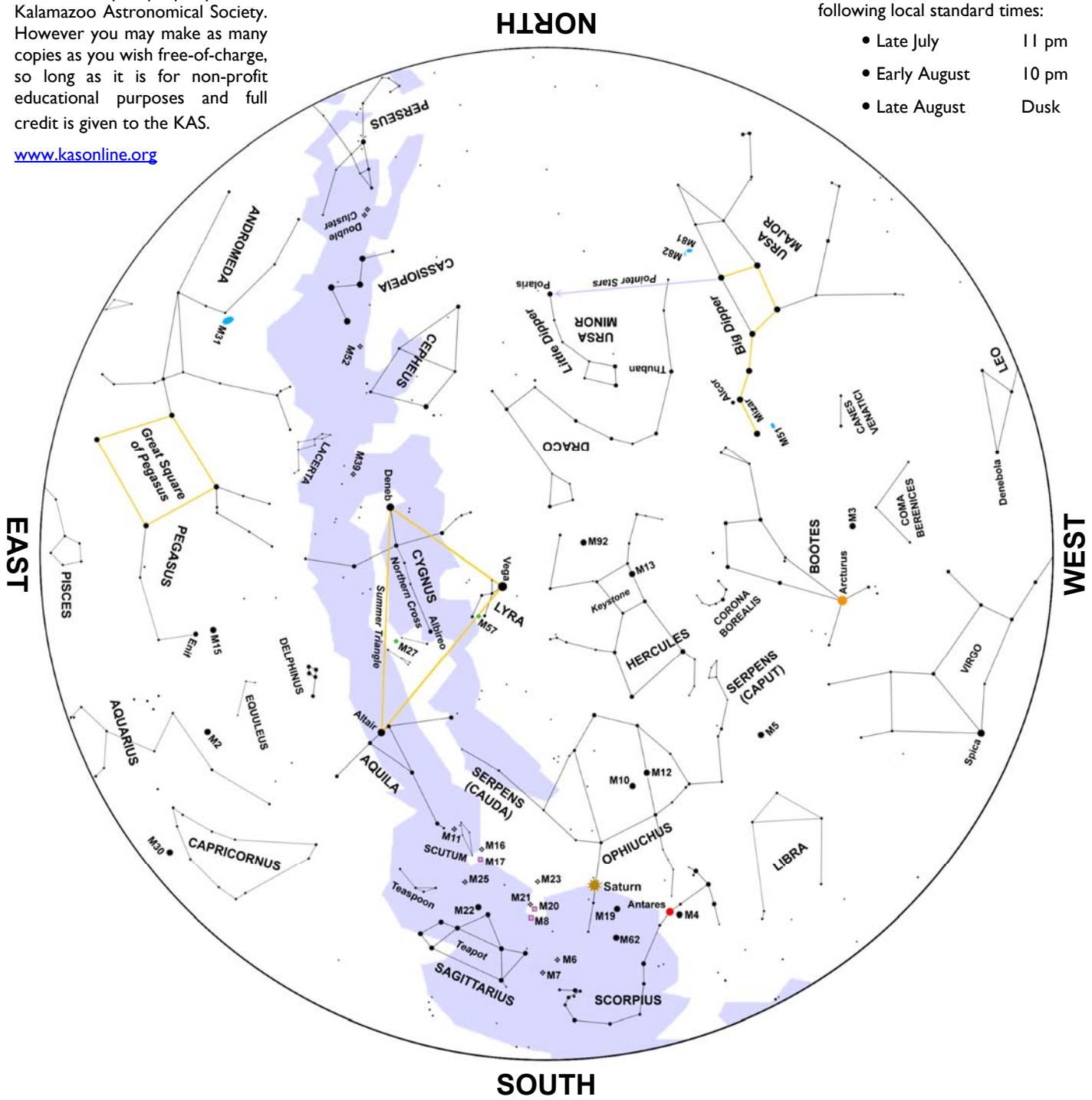
If clouds don't stay away on Eclipse Day visit this website for a HUGE list of events along the path of totality:

http://nationaleclipse.com/

August Night Sky.....

This map represents the sky at the following local standard times:

- Late July 11 pm
- Early August 10 pm
- Late August Dusk



August's highlight is - by far - the total solar eclipse that will occur along a 70-mile-wide, 2,500-mile-long path from Oregon to South Carolina. You must be within this narrow path to see phenomena such as the diamond ring effect and the stunning solar corona. The exact times of totality along the eclipse path vary, so please refer to the numerous online resources, such as NASA's Eclipse 2017 website: eclipse2017.nasa.gov.

Southwest Michigan will only experience an ~83% partial eclipse. First contact occurs at 12:58 pm EDT, with maximum coverage at 2:23 pm. When the Sun appears as a narrow crescent the sky will be slightly darker and shadows become sharper. Look under a shade tree and see if you can spot crescent suns all over the ground. The eclipse ends at 3:45 pm.

Proper projection must be utilized during the entire duration of the eclipse. Use #14 welder's glass or a pair of Eclipse Shades. Only totality is safe to view with the unaided eye.

ECLIPSE SHADES

Get ready for the Great American Eclipse on August 21, 2017!

Purchase online at kasonline.org or at any upcoming KAS event.

A minimum contribution of $3.00 per pair!

Kalamazoo Astronomical Society
c/o KAMSC
600 West Vine, Suite 400
Kalamazoo, MI 49008

STAMP

Solar Eclipse 2017
August 21, 2017