Celebrating the 2017 Great American Eclipse: Lessons Learned from the Path of Totality
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What the American Astronomical Society Learned from the "Great American Eclipse"

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Abstract. The American Astronomical Society formed the AAS Solar Eclipse Task Force to function as a think tank, coordinating body, and communication gateway to the vast resources available about the 21 August 2017 "Great American Eclipse." The task force secured funding that was used mainly for three purposes: (1) to build a website that contained basic information about solar eclipses, safe viewing practices, and eclipse imaging and video, along with resources for educators and the media; (2) to solicit, receive, evaluate, and fund proposals for mini-grants to support eclipse-related education and public outreach to under-represented groups; and (3) to organize a series of multidisciplinary workshops to prepare communities for the eclipse and to facilitate collaboration between astronomers, meteorologists, school administrators, and transportation and emergency-management professionals. Our safety messaging won the endorsement of several medical societies. In the weeks immediately preceding the eclipse, the marketplace was flooded by counterfeit eclipse glasses and solar viewers, forcing a last-minute change in our communication strategy. Here we review the task force's activities, take stock of what went right and what went wrong, and consider how to better prepare the public for future solar eclipses.

1. Introduction

On 21 August 2017 a total eclipse of the Sun crossed the United States of America from coast to coast but touched no other country. Millions of people in a 100-kilometer-wide, 4,000-km-long path got a rare chance to see the solar corona and experience "darkness at midday." Outside the path of totality, all of North America experienced a partial eclipse. As the first total solar eclipse to touch the U.S. mainland since 1979 and the first to span the continent since 1918, the "Great American Eclipse" presented a great opportunity to excite people about science and connect them to the cosmos. Yet it also presented a great challenge: more than 300 million residents and visitors needed to learn how to view the eclipse safely.

2. AAS Solar Eclipse Task Force

To address this opportunity and challenge, the American Astronomical Society established the AAS Solar Eclipse Task Force to function as a think tank, coordinating body, and communication gateway to the vast resources available about the 2017 eclipse and solar eclipses more generally.

The task force secured funding from the AAS Council (now the Board of Trustees), the National Science Foundation (NSF), and NASA totaling about USD $500,000.

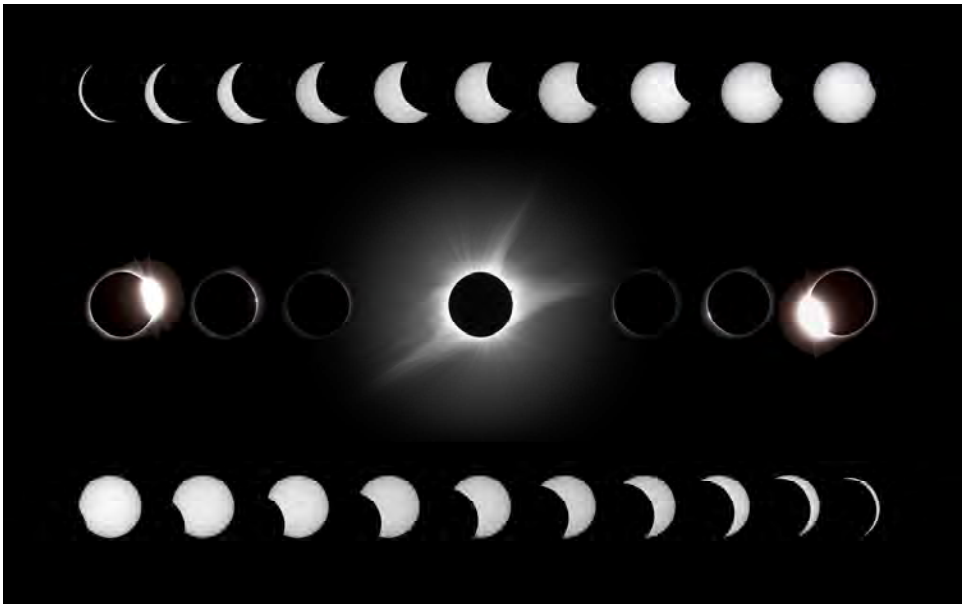

Figure 1. The solar eclipse of August 21, 2017, as seen from Madras, Oregon. The top row shows the partial phases before totality, which lasted about 11/4 hours. The middle row shows the two minutes of totality from the first diamond ring to the second. The bottom row shows the partial phases after totality, which again lasted about 11/4 hours. Each row should be read from right to left, matching the approximate direction the Moon moved across the Sun (with celestial north up). This sequence was obtained with a DSLR camera attached to a small refractor on an equatorial tracking mount. During the partial phases before and after totality, the telescope was covered by a safe solar filter. No filter was used during totality, which is about as bright as the full Moon and just as safe to look at without protection. Credit: Rick Fienberg / TravelQuest International.

These resources were used mainly for three purposes: (1) to build a website (`https://eclipse.aas.org`) containing basic information about solar eclipses, safe viewing practices, and eclipse imaging and video, along with resources for educators and the media and a searchable map of eclipse-related events and activities, with links to other authoritative websites with more detailed information; (2) to solicit, receive, evaluate, and fund proposals for mini-grants to support eclipse-related education and public outreach to under-represented groups both inside and outside the path of totality; and (3) to organize a series of multidisciplinary workshops across the country to prepare communities for the eclipse and to facilitate collaborations between astronomers, meteorologists, school administrators, and transportation and emergency-management professionals.

One of our first activities was to send two eclipse astronomers by car along the entire path of totality over several weeks to alert cities and towns to what was coming, a la Paul Revere and William Dawes. They talked with government officials, public-safety officials, tourist bureaus, and local businesses. Most communities had not yet heard of the 2017 eclipse and were grateful to be given advance warning to prepare for the event and the likely influx of visitors.

3. Mini-Grants Program

The goal of our mini-grants program was to provide small grants in support of programs designed to engage in eclipse outreach activities with under-represented groups, including women/girls, ethnic minorities, and people with physical and/or mental disabilities who often do not imagine themselves in science careers. We received 100 qualified proposals totaling USD $368,000 (plus 52 unqualified proposals)—similar to the over-subscription rate for professional telescopes.

A total of 31 projects, distributed among 21 states both within and outside the path of totality, were selected to receive mini-grants averaging about USD $3,000 each. Obviously, with more funding, we could have awarded many more such grants.

Figure 2. Attendees at eclipse events sponsored by recipients of AAS mini-grants were asked to describe their experience in a tweet. This "word cloud" was generated from the resulting descriptions, with word size weighted by frequency of occurrence. Credit: Jake Noel-Storr.

Our evaluation found that members of the public attended events with no particular interest in learning anything—they just wanted to have fun and see the eclipse—but many left wanting to learn more about eclipses (Fig. 2).

4. "Get Thee to Totality!"

One of our main goals was to encourage people to get into the path of totality. Some 12 million Americans live within the path, and two-thirds of the U.S. population lives within 500 miles (800 km)—a comfortable day's drive—from it (Zeiler, 2017). The difference between a total eclipse and a partial eclipse, we said repeatedly, is literally the difference between night and day. Yet a study done for NASA by the University of Michigan (Miller, 2017) suggests that whereas about half the U.S. population viewed the eclipse directly, only 6% (1 in 16) traveled to see it, and many of these people traveled not into the path of totality but to a place where the partial eclipse was simply deeper than at home. Somehow a key part of our message wasn't heard clearly and/or didn't reach as many people as we had hoped to reach.

One clue to the nature of the problem appears in the Michigan study, which says, "Approximately 20 million adults traveled from their home area to another area to be able to watch the solar eclipse, usually seeking a higher degree of totality." Something got lost in translation here, because "a higher degree of totality" is as meaningless and/or misleading as "a higher degree of virginity." We should have been more careful to emphasize that even a 99% eclipse is still partial, and that in the minute it takes for the Moon to cover the last 1% of the Sun's bright face, it gets about 5,000 times darker. In other words, instead of getting 99% of the experience of totality with a 99% eclipse, you get barely 0.02%—and that's considering only the change in daylight, not the visibility (or lack thereof) of the solar corona, chromosphere, prominences, horizon colors, and other effects.

Also, too many people described the 2017 eclipse as a "once in a lifetime" opportunity but then went on to say that "the next one in the U.S. is in 2024." Obviously we all could have done a better job explaining what was unique (or at least special) about this one.

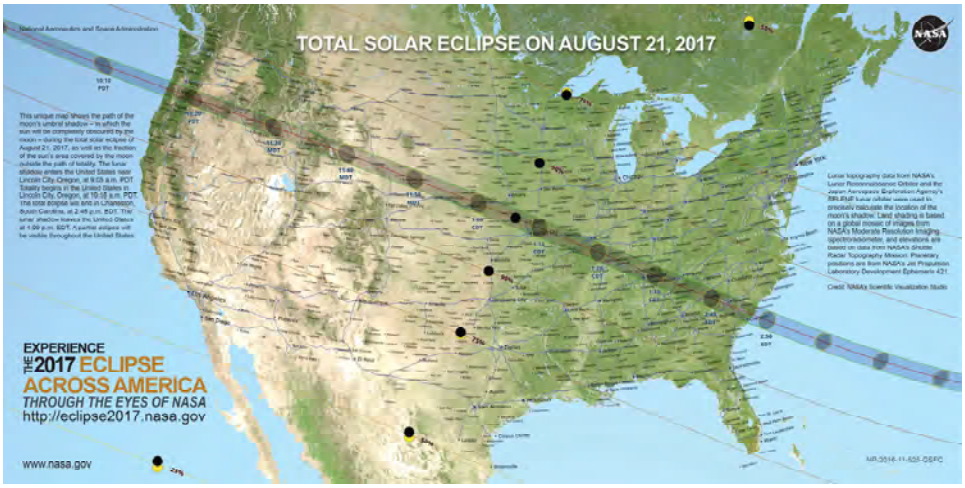

Figure 3. Millions of copies of this map of the August 21, 2017, solar eclipse were downloaded from the NASA Eclipse 2017 website. Taken literally, it shows that outside the path of totality you see the Sun partially blocked by the Moon, whereas inside the path you see...nothing? A few months before the eclipse, NASA replaced this version with a new one showing a thin ring of white around the lunar silhouette inside the path, but even that version barely hints at the spectacular appearance of the totally eclipsed Sun in the sky. Credit: NASA.

Another clue as to why more people didn't travel into the path of totality comes from looking back at the maps that were distributed widely before the eclipse. Some represent the partial eclipse outside the path of the lunar umbra with crescent Suns but either have no graphics along the path[1] or show totality as little more than a black disk [2] (Fig. 3). Nowhere do they indicate that only along the path can you see one of the most awesome and dramatic sights in all of nature: the solar corona.

[1] https://www.greatamericaneclipse.com/nation/

[2] https://eclipse2017.nasa.gov/sites/default/files/nasa_eclipse_map.jpg

Another area where I think we could have done better is partnering with corporate America to increase awareness of, and interest in, the eclipse. In the U.S., Coca Cola is "the official soft drink of Major League Baseball," and at every baseball game, you see Coke's logo everywhere. If we had planned better, perhaps Corona beer would have been the official beer of the eclipse, and Eclipse gum and mints would have been the official gum and mints of the eclipse. This would have exposed people to the impending event in nearly every liquor and grocery store in the country.

5. Eclipse Eye Safety

Aside from promoting awareness of the eclipse, the AAS Solar Eclipse Task Force focused on developing and disseminating eclipse safety information and working to ensure the widespread distribution of safe solar-viewing glasses and filters. We wanted to avoid a problem we'd seen in other countries at other eclipses, where astronomers encourage people to observe the event but doctors and other experts warn people to stay inside to avoid eye injury.

The AAS and NASA jointly developed safety messaging that won the endorsement of the American Academy of Ophthalmology, the American Academy of Optometry, the American Optometric Association, and the Canadian Association of Optometrists, to whom we reached out directly. We based our message on the ISO 12312-2 international safety standard for solar viewers (International Organization for Standardization, 2015), which was adopted in 2015. Our basic message was simple: Except during totality, look at the Sun only through viewers that are certified to meet the ISO 12312-2 standard. We put more detailed instructions on a 1-page flyer that was available for free download and reposting on other websites, in both English and Spanish. In the week leading up to the eclipse, we got more traffic on our safety pages than on all other AAS websites, combined, over the last 20 years!

In retrospect, we didn't work hard enough to find all the professional societies of eye doctors, for example, we overlooked the Macula Society and the American Society of Retina Specialists, both of whom (we found out later) had reached out to their members with information about the eclipse and calls to report any injuries among their eclipse-watching patients. We should have tried harder to reach primary-care physicians, too, since more people visit their regular doctor each year than visit an eye specialist. Sadly, the American Medical Association refused to endorse our safety messaging—not because they found any fault with it, but because their leadership (as of 2016-2017) felt it was easier to refuse to endorse *anything* than to have to deal with all the requests they receive to endorse various products and services.

With support from the Moore Foundation, Google, the Research Corporation, and NASA, we distributed about 2.1 million eclipse glasses (and an extensive booklet of eclipse information and outreach suggestions) to 7,100 public libraries throughout the U.S. that otherwise couldn't have afforded to acquire them (Dusenbery, 2018). We also linked these libraries with local experts to help execute their eclipse-related programs. In this way we harnessed a huge amount of energy and enthusiasm among professional and amateur astronomers and effectively channeled it into doing outreach in their communities.

6. The Amazon Problem

In the weeks immediately preceding the eclipse, it became clear that the marketplace was being flooded by fake or counterfeit eclipse glasses and solar viewers, most of them apparently imported from China and sold on Amazon.com. They claimed to meet the ISO 12312-2 standard, but there was no evidence backing that up. Some vendors posted official-looking documents that turned out to be falsified copies of legitimate vendors' ISO certificates or that demonstrated compliance with other, irrelevant standards, such as those for ordinary sunglasses! By the time we convinced Amazon to properly vet their sellers and promote only genuinely safe eclipse viewers, the damage was done: the public was confused about whether *any* solar filters from *any* source were truly safe.

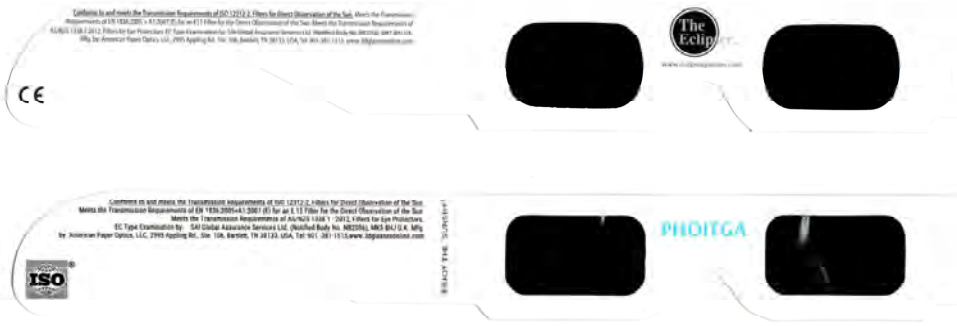

Figure 4. The cardboard eclipse glasses at top are manufactured by American Paper Optics and certified to be compliant with the ISO 12312-2 international safety standard. The glasses at bottom, purchased at a country store in New Hampshire, are counterfeit. There are numerous typographical errors in the printed text, most notably "ENJOY THE SUNSHY" (presumably meant to be "sunshine"), and the shape of the cutouts for the solar filters is wrong. The counterfeits produce a comfortably bright image of the Sun, but whether they block potentially harmful ultraviolet and infrared solar radiation remains unknown, as they have not been properly tested. Credit: Rick Fienberg.

This development led to us make a last-minute change in our communication strategy. We compiled an online list of manufacturers and authorized dealers selling genuinely ISO-compliant viewers—which we verified by examining their documentation and confirming that it came from a properly accredited testing laboratory. Then we informed the public via our website and a widely picked-up press release (Fienberg, 2017) that they should buy their eclipse viewers only from one of the vendors on our list.

This "Amazon problem" created havoc in another area where we focused a lot of effort: schools. In many districts administrators cancelled schools' eclipse-viewing plans just days before the eclipse. Most such cancellations were enacted against teachers' wishes, but some teachers themselves chose to keep students indoors, fearing they would look at the Sun without protection or through potentially unsafe eclipse glasses—and fearing lawsuits from concerned parents. Teachers who did view the eclipse with their classes said it was one of the most memorable events of their careers, whether or not they were in the path of totality. And, thankfully, we received no reports from teachers of any eye injuries to themselves or their students.

How prevalent were eclipse-related eye injuries more generally? The American Society of Retina Specialists asked its 2,000 members for reports and received news of only 25 injuries, which they described as "a likely testament to excellent media coverage of the event." Among the Macula Society's 400 members, only 10 reported treating eclipse-related eye injuries. The American Optometric Association received only 13 reports of injuries from its 4,500 members, suggesting that "the vast majority of people got the safety message." Still, if what we heard from schools is any guide, there's bad news in this good news: After hearing about the problems with eclipse glasses/viewers sold on Amazon.com, many people presumably opted not to watch the eclipse at all, because they were concerned that their viewers might be unsafe.

7. Conclusions

It should be much easier to prepare the U.S. for the annular and total solar eclipses that will occur just six months apart in late 2023 and early 2024, respectively. Reasons include these: (1) The last total solar eclipse in the U.S. will be a recent memory, not a distant one; (2) Huge numbers of Americans who didn't travel to totality know someone who did and now regret their choice; (3) Amazon has pledged to do a better job of vetting sellers of eclipse viewers to ensure compliance with ISO 12312-2; (4) The fact that eye injuries were so rare in 2017 will reassure people that eclipse viewing is safe; (5) The communities along the path in 2017 had a positive experience and will share their stories with communities along the path in 2023 and, especially, 2024; and (6) A significant fraction of the millions of Americans who experienced totality in 2017 will want to do so again in 2024 and to make sure their family and friends do too.

The "Great American Eclipse" of 2017 was a great success and a great learning experience for eclipse-related event organizers. Building on that experience, we hope to make the total solar eclipse in the U.S. on 8 April 2024 even greater!

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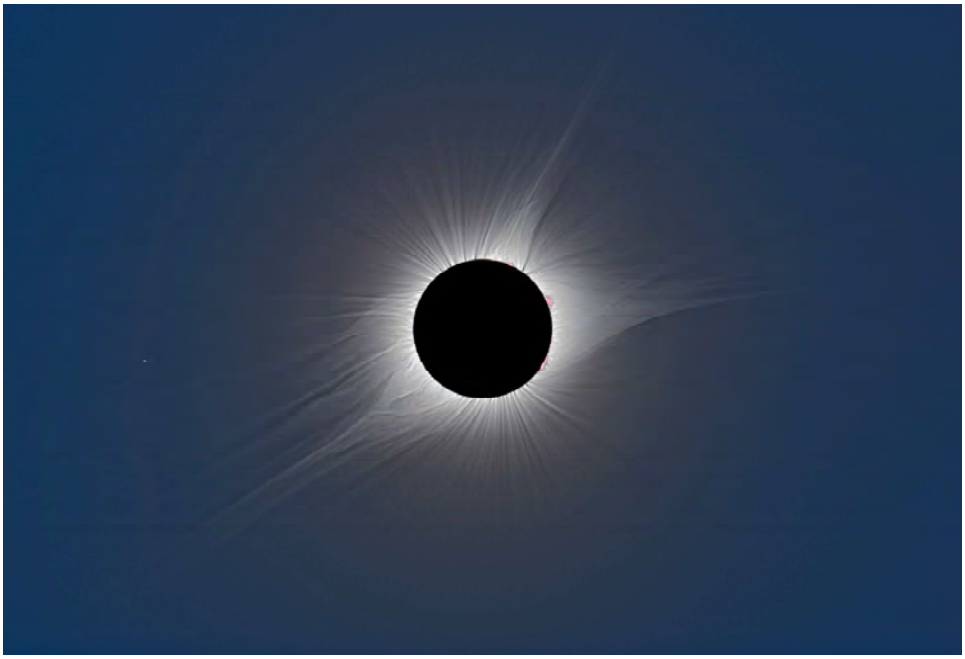

Figure 5. The total phase of the August 21, 2017, solar eclipse as captured from Madras, Oregon, using the same equipment as in Figure 1, but without a solar filter. This is a composite of about a dozen short, medium, and long exposures, as no single exposure can capture the huge range of brightness exhibited by the solar corona. The star to the left (east) of the eclipsed Sun is Regulus, the brightest star in the constellation Leo. Much fainter Nu (ν) Leonis is visible at upper right. Sean Walker of *Sky & Telescope* magazine assisted with image processing. Credit: Rick Fienberg / TravelQuest International.

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