

**IAU WORKING GROUP ON ECLIPSES TRIENNIAL REPORT FOR  
SEPTEMBER 2018-SEPTEMBER 2021**

Inter-

Division C-E WG Solar Eclipses — **Functional**

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[\(https://www.iau.org/science/scientific\\_bodies/working\\_groups/93/\)](https://www.iau.org/science/scientific_bodies/working_groups/93/)

I report on the educational and outreach aspects of the activities of the IAU Working Group on Solar Eclipses of Divisions C (Education, Outreach, and Heritage) and E (Sun and Heliosphere) over the last triennium and with plans for the next triennium.

**CHAIR**

Jay Pasachoff (USA Chair)

**MEMBERS**

Iraida Kim (Russia)

Jagdev Singh (India)

Vojtech Rusin (Slovakia)

Yoichiro Hanaoka (Japan)

Zhongquan Qu (China)

Beatriz Garcia (Argentina)

Patricio Rojo (Chile)

Xavier Jubier (France)

Fred Espenak (US)

Jay Anderson (Canada)

Glenn Schneider (US)

Michael Gill (UK)

Michael Zeiler (USA)

Bill Kramer (USA);

associates: Michael Kentrianakis (USA)

Ralph Chou (Canada)

## THE TRIENNIAL REPORT (2019-2021)

**1. INTRODUCTION**

Web sites: [www.eclipses.info](http://www.eclipses.info), and for specific expeditions:  
[www.totalsolareclipse.net](http://www.totalsolareclipse.net).

The triennium between the September 2018 General Assembly (Vienna, to which I went following viewing a partial solar eclipse from Sweden) and the September 2021 General Assembly (delayed from Busan, South Korea with business meetings remaining on the original schedule) had total solar eclipses in Chile/Argentina on 2 July 2019 and on 14 December 2020; and annular eclipses on 26 December 2019, 21 June 2020, and 10 June 2021. It also included a partial eclipse visible from China, Russian Siberia, Korea, and Japan on 6 January 2019.

Our Working Group includes members from Russia, Japan, India, Slovakia, China, USA, UK, France, and Canada as well as newly Chile and Argentina, with additions proposed from Australia and Germany.

The Working Group on Solar Eclipses has as its task the coordination of solar eclipse efforts, particularly making liaisons with customs and other officials of countries through which the path of totality passes and providing educational information about the safe observation of eclipses for the wide areas of the Earth in which total or partial eclipses are visible. Two of our members, Espenak and Anderson, produce widely used Technical Publications with eclipse paths and detailed information, available as hard copies or online, linked through [www.eclipses.info](http://www.eclipses.info) or via <http://EclipseWise.com>, a successor to the "NASA Eclipse Site." Gill runs the Solar Eclipse Mailing List, now at [SEML@groups.io](mailto:SEML@groups.io); daily summaries are available: <https://groups.io/g/SEML>. Anderson at <http://eclipsophile.com> has cloudiness statistics and other weather-related information. Chou, a professor of optometry, is the world's expert on eye safety at eclipses. Jubier produces zoomable, clickable maps customizable for each eclipse; the forthcoming few are linked at our website at <http://eclipses.info>.

## 2. MEMBERSHIP

For the 2019 and 2020 total eclipses in Chile and Argentina, Patricio Rojo (U. Chile) and Beatriz Garcia (Pierre Auger Observatory, Argentina) were added to the Working Group. (<http://eclipses.info>). For the next triennium, September 2021-September 2024, given visibility of totality from Learmonth, Western Australia in 2023, we propose adding Terry Cuttle (public outreach, Australia) and Michael Wheatland (U. Sydney; an editor of the journal *Solar Physics*). We also propose adding Andreas Möller (Germany; who will collaborate with Bill Kramer on an archive of eclipse publications and maintain the [eclipse-chaser.com](http://eclipse-chaser.com) website). Prof. Wheatland is an IAU member; Mr. Cuttle and Mr. Möller would be associates. Also we add Costantino Sigismondi (Italy) and Kevin Reardon (US National Solar Observatory, USA).

For outreach, we are adding Robert Walsh (UK) For the three eclipses in Spain in 2025-2026-2027 (two totals and an annular), we add Mohamad Soltanolkotabi (Spain), who would be an associate.

## 3. REPORT OF ACTIVITIES

Schneider is an expert on aerial eclipse flights, and has planned a flight to the sunrise point for the 4 December 2021 totality that otherwise passes only over Antarctica and nearby ocean with low cloudiness-success probability. Kramer at <http://eclipse-chasers-com> keeps a log of statistics of individual eclipse observers, and is newly partnering with Andreas Möller for an archive of historical eclipse papers. Kentriankis was the project manager for the American Astronomical Society's 2017 eclipse efforts, <http://eclipse.aas.org>; the site now has advance notice of the 2023 and 2024 eclipse visibility across the United States. Pasachoff is a member of the newly reconstituted American Astronomical Society Task Group on Eclipses for the 2023 annular eclipse, with partial phases across all of North America, and the 2024 total solar eclipse, with totality from Mazatlán, Mexico across the US from Texas to Maine and onto the Canadian Maritimes. The task force is headed by Claire Raftery of the U.S. National Solar Observatory, with Angela Speck, now at U. Texas, and Rick Fienberg of the American Astronomical Society.

Among our successes is the distribution of material for tens of thousands of eye-protection filters. The organization Astronomers Without Borders collected millions of slightly used "eclipse glasses" (really "partial eclipse glasses") from users at the 2017

American eclipse. As an example, jmp brought 5000 of them to Mumbai and Madurai, India, for use at the 26 December 2019 annular eclipse, with further use at the 21 June 2020 annular eclipse. Some were sent to Chile for the 14 December 2020 total solar eclipse.

Because of the pandemic access was limited for international travelers for the June 21, 2020, annular eclipse, with path from Africa across the Middle East, through China, and for the December 14, 2020, total solar eclipse whose path was centered on Chile and Argentina, extending from the Pacific to the Atlantic. Though he was unable to get to either the annularity or the totality because of COVID-19 travel restrictions, Pasachoff summarized the observations of others in articles in *Astronomy Magazine*:

Pasachoff, Jay M., 2021, "Corona Light," 2020 annular eclipse images, *Astronomy Magazine*, February issue, pp. 40-45.

Pasachoff, Jay M., 2021, "The 2020 Total Eclipse," *Astronomy Magazine*, April issue, pp. 47-51.

Soon after the eclipse, NASA released the following:

Eclipse prediction -- <https://www.nasa.gov/feature/goddard/2020/scientists-use-nasa-data-predict-appearance-corona-dec-14-total-solar-eclipse>

Eclipse comet -- <https://www.nasa.gov/feature/goddard/2020/recently-discovered-comet-seen-during-2020-total-solar-eclipse-SOHO>

At the time of the 2019 eclipse, Alexander Kosonovich was in charge of IAU Symposium 354 at Copiapo, Chile; the proceedings were published by Cambridge University Press. *Solar and Stellar Magnetic Fields: Origins and Manifestations*, Copiapo, Chile, July 2019. The Proceedings appeared in September 2020:

<https://www.cambridge.org/core/journals/proceedings-of-the-international-astronomical-union/issue/88BDDA474A28E3FE79CB2BE7CE3D8854>

At the time of the 2020 total solar eclipse, Beatriz Garcia ran IAU Symposium 367, <http://sion.frm.utn.edu.ar/iaus367/>, R. M. Ros, B. García, S. Gullberg, J. Moldon & P. Rojo, Proceedings IAU Symposium No. 367, 2020, *Education and Heritage in the Era of Big Data in Astronomy: The first steps on the IAU 2020-2030 Strategic Plan*. Originally scheduled for 9-14 December 2020, San Carlos de Bariloche, Argentina, with a trip to totality at the end of the meeting, it was made virtual. Pasachoff gave an eclipse lecture. The proceedings are in press at Cambridge University Press.

#### 4. RESOURCES

Pasachoff has arranged with the editor of *The American Journal of Physics* to update, for publication in 2022 or 2023, Pasachoff, Jay M., and Andrew Fraknoi, 2017, "Resource Letter OSE-1 on Observing Solar Eclipses," *American Journal of Physics* **85**(7), 485-494, July. (<https://aapt.scitation.org/doi/pdf/10.1119/1.4985062>)

Each year, we provide "Eclipses" for the International Geophysical Calendar (International Space Environmental Service). (<http://www.spaceweather.org/ISES/info/geocal/geocal.html>)

The following new eclipse-related items appeared:

- ❖ Michael Zeiler and Michael E. Bakich, 2020, *Atlas of Solar Eclipses: 2020 to 2045* (GreatAmericanEclipse.com)

- ❖ Michael Zeiler with *Sky & Telescope*, 2020: eclipse globe, 2001-2100 (GreatAmericanEclipse.com)

The following softbound books are particularly useful for the next triennium:

- ❖ Fred Espenak, 2016, *21st Century Canon of Solar Eclipses* (Astropixels Publishing)
- ❖ Fred Espenak, 2018, *Road Atlas for the Annular Solar Eclipse of 2023* (Astropixels Publishing)
- ❖ Fred Espenak, 2017, *Road Atlas for the Total Solar Eclipse of 2024* (Astropixels Publishing)

Especially useful websites:

- ❖ IAU website linking much eclipse reference material: <http://eclipses.info>
- ❖ [NASA Eclipse Website](#) (formerly from Fred Espenak. now retired)
- ❖ EclipseWise.com from Fred Espenak, with current and past maps
- ❖ GreatAmericanEclipse.com from Michael Zeiler, with maps and materials
- ❖ Eclipse-chasers.com from Bill Kramer, with individuals' logged eclipses
- ❖ <http://xjubier.free.fr/en/> from Xavier Jubier, with current maps

Earlier eclipse-related material

- ❖ Fred Espenak, *Thousand Year Canon of Solar Eclipses 1501 to 2500*, 2014 (ISBN-10: 194 1983006); <http://www.astropixels.com/pubs/>
- ❖ Fred Espenak, [Five Millennium Canon of Solar Eclipses: -1999 to +3000](#), 2006 (NASA/TP-2006-214141);
- ❖ Jay M. Pasachoff, [The Complete Idiot's Guide to the Sun](#), Alpha Books, 2003 (ISBN-10: 1592570747).
- ❖ Leon Golub and Jay M. Pasachoff, [The Sun](#), 2017, UK: Reaktion Press; US: U. Chicago Press, 2017 ISBN:978-0-8109-7274-2.
- ❖ Leon Golub and Jay M. Pasachoff, [The Solar Corona](#), 2nd ed., Cambridge University Press, 2010 (ISBN-10: 052188201X).
- ❖ Jay M. Pasachoff and Alex Filippenko, [The Cosmos: Astronomy in the New Millennium](#), 5th ed., Cambridge University Press, 2019.
- ❖ Leon Golub and Jay M. Pasachoff, [Nearest Star: The Surprising Science of Our Sun](#), 2nd edition, Cambridge University Press, 2014 (ISBN-10: 1107672643).
- ❖ Pasachoff, Jay M., 2017, "The Great Solar Eclipse of 2017," *Scientific American*, **317**, #2, 54-61, August.
- ❖ Pasachoff, Jay M., 2017, "Heliophysics at Total Solar Eclipses," *Nature Astronomy* **1**, article number 0190 (August). <https://www.nature.com/articles/s41550-017-0190> <http://rdcu.be/uEuz>
- ❖ Pasachoff, Jay M., 2018, "Science at the Great American Eclipse," *Astronomy & Geophysics (A&G)*, 59 (August), 4.1-4.5.
- ❖ Pasachoff, Jay M., 2019, "Education and Outreach about Science at the 2017 Eclipse," in *The 2017 Total Solar Eclipse*, Astronomical Society of the Pacific Conference Series, Sanlyn Buxner, Linda Shore, and Joe Jensen, eds., pp. 331-336.
- ❖ Peticolas, Laura, Hugh Hudson, Calvin Johnson, Dan Zevin, Vivian White, Juan Carlos Martínez Oliveros, Igor Ruderman, Justin Koh, David Konerding, Mark Bender, Christopher Cable, Brian Kruse, Darlene Yan, Larisza Krista, Braxton Collier, Andrew Fraknoi, Jay M. Pasachoff, Bryan Mendez, Alex Filippenko,

Scott McIntosh, and Noelle Filippenko, 2019, "Eclipse Megamovie 2017 Successes and Potential for Future Work," in *The 2017 Total Solar Eclipse*, Astronomical Society of the Pacific Conference Series, Sanlyn Buxner, Linda Shore, and Joe Jensen, eds., pp. 337-352.

- ❖ Hudson, Hugh S., Laura Peticolas, Calvin Johnson, Vivian White, Mark Bender, Braxton Collier, Juan Camilo Guevara Gomez, Justin Koh, David Konderding, Juan Carlos Martínez Oliveros, Scott McIntosh, Brian Kruse, Brian Mendez, Jay Pasachoff, Igor Ruderman, Dan Zevin, 2018, "The Eclipse Megamovie Project," in Scott W. McIntosh, Michael Thompson, Chris G. Tzanis, eds., *Frontiers in Astronomy and Space Sciences: The Great American Eclipse of August 21, 2017 - Connecting Solar and Terrestrial Science*, *Frontiers in Astronomy and Space Sciences*. 5:37. doi: 10.3389/fspas.2018.00037.
- ❖ Pasachoff, Jay M., Christian A. Lockwood, Erin Meadors, Ross Yu, Cielo Perez, Marcos A. Peñaloza-Murillo, Daniel B. Seaton, Aris Voulgaris, Ron Dantowitz, Vojtech Rušin, Thanasis Economou, 2018, "Images and Spectra of the 2017 Total Solar Eclipse Corona from our Oregon Site," in Scott W. McIntosh, Michael Thompson, Chris G. Tzanis, eds., *Frontiers in Astronomy and Space Sciences: The Great American Eclipse of August 21, 2017 - Connecting Solar and Terrestrial Science*, *Frontiers in Astronomy and Space Sciences*. 5:37. doi: 10.3389/fspas.2018.00037.  
<https://www.frontiersin.org/articles/10.3389/fspas.2018.00037/full>
- ❖ Peñaloza-Murillo, Marcos A., and Jay M. Pasachoff, 2018, "The longest total occultation of the Sun of the 21st century at Tianhuangping (Zhejiang), China: Air-temperature observations and its theoretical analysis under adverse meteorological conditions," *J. Geophys. Res.: Atmospheres*, **123**, DOI: [10.1029/2018JD029253](https://doi.org/10.1029/2018JD029253)  
<https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2018JD029253>
- ❖ Publications by Shadia Habbal's *Solar Wind Sherpas*

Note that sometimes ESA's Solar and Heliospheric Observatory (SoHO) sees some additional partial solar eclipses, such as on Jan 13, 2021:

<https://www.nasa.gov/feature/goddard/2021/nasa-sdo-first-lunar-transit-2021-moon-sun>