Science at Recent Solar Eclipses

For Patrick and Joanne Poitevin's 2014 Solar Eclipse Conference

Jay M. Pasachoff
For Patrick and Joanne Poitevin’s 2014 Solar Eclipse Conference

The October 23, 2014, partial solar eclipse imaged as part of the conference from Sac Peak (Jay M. Pasachoff and Austin Shea ‘15)
1977 eclipse in the Pacific
1977 eclipse in the Pacific: the youngest viewers of eclipses:
Deborah Pasachoff, age 5 months
Eloise Pasachoff, age 2 years 7 months
Lily [Pasachoff] Kezsbom at Kids Klub, Pasadena
October 23, 2014
International Astronomical Union
Working Group on Solar Eclipses/Program Group on Public Education at Solar Eclipses

Working Group on Solar Eclipses

Reference Materials

- Eclipse Map Sites
  - 2014: October 23 Partial Eclipse in Western US/Canada, Pacific, and Siberia
    - Jubier's Clickable Map
    - Espenak's EclipseWise Page
    - Sky and Telescope Posting
  - 2015: March 20 Total Eclipse in Arctic, including Svalbard and Faroes; Partial Throughout Europe
  - 2016: March 9 Total Eclipse in Indonesia
  - 2016: September 1 Annular Eclipse in Africa
  - 2017: August 21 Total Eclipse in the U.S.
    - Jay Anderson's Weather Statistics for Future Eclipses
- Eclipse Web Sites
- Eye Safety & Solar Filters

http://www.eclipses.info/
Eclipse Web Sites

- Fred Espenak's Eclipsewise Website
- Fred Espenak's Solar Eclipses
- Fred Espenak's Lunar Eclipses
- Fred Espenak's NASA Eclipse Resources
- Xavier Jubier's Google Maps Eclipse Maps
- Xavier Jubier's Interactive maps for upcoming solar eclipses
- Xavier Jubier's Google Earth KMZ files for eclipse tracks
- Xavier Jubier's 5MCSE "Five Millennium (~1999 to +3000) Canon of Solar Eclipses"
  Using the 5MCSE link will get you to any eclipse type
- For TSE 2017 it will generate an URL such as
  Ecl=+20170821&Acc=2&Umb=1&Lmt=1&Mag=1
  &Lmt=x (x set to 1 or 0) will display or not the penumbral limits, maximum on horizon
  and rise/set curves
  &Mag=x (x set to 1 or 0) will display or not the equal magnitude curves
  &Max=x (x set to 1 or 0) will display or not the maximum eclipse curves
- Michael Zeiler: eclipse-maps.com
- Glenn Schneider's site
- The Cosmic Mirror: Daniel Fischer looks into the Universe
- Arnold Barmettler: Interactive Eclipse Maps 1900-2100
- Eclipse Chasers (Bill Kramer), with list of statistics
- Jay M. Pasachoff: Williams College Solar Eclipse Expeditions
- Miloslav Druckmüller: Eclipse Photography
- Stanford Solar Center
- Eclipse statistics and other links (Sheridan Williams)
- spaceweather.com
- Solar Monitor

http://www.eclipses.info/
image by
Jay Pasachoff
and
Dava Sobel
from the
Galápagos Legend
arranged by Jen Winter
based on images from the Galápagos Legend and the World Discoverer
From the journal Solar Physics

JAY M. PASACHOFF and SHELBY B. KIMMEL
Williams College-Hopkins Observatory, Williamstown, MA 01267-2565, U.S.A.
(e-mail: eclipse@williams.edu)

MILOSlav DRUCKMÜLLER
Institute of Mathematics, Brno University of Technology, 616 69 Brno, Czech Republic
(e-mail: druckmuller@fme.vutbr.cz)

and

VOJTECH RUŠIN and METOD SANIGA
Astronomical Institute of the Slovak Academy of Sciences, 05960 Tatranská Lomnica, Slovakia
(e-mails: vrusin@ta3.sk; msaniga@ta3.sk)

(Received 13 March 2006; accepted 11 September 2006; Published online 15 November 2006)

Abstract. The hybrid solar eclipse of April 8, 2005, provided a good opportunity to observe the
white-light solar corona, even though the eclipse lasted just 30 seconds and could be seen only from
ships in the Pacific Ocean. During the eclipse, we detected a unique ‘cloud’ of particles in the white-
composite by Miloslav Druckmüller of
40 images by the authors:
Pasachoff/Kimmel/Rusin
Our site: Tianhuangping
本队观测点：天荒坪
participants from Williams College: (2009年威廉姆斯大学科考队成员)
Jay Pasachoff
Bryce Babcock
Katie DuPré ‘10
Sara Dwyer ‘11
Caroline (Yung Hsien Ng) Tam ‘11
Rachel Wagner-Kaiser ‘10 (Keck Northeast Astron. Consortium Summer Fellow)
Adam (Jianjun) Wang
Paul Rosenthal
Charles (Huajie) Cao ‘09 (now Princeton University)

collaborators from China:

Yihua Yan, Beijing Solar Observatory
Jin Zhu, Beijing Planetarium
Lin Lan, Hangzhou High School

with assistance from the Committee for Research and Exploration of the National Geographic Society, and the Rob Spring ‘75 Fund

with assistance from the Committee for Research and Exploration of the National Geographic Society, and the Rob Spring ‘75 Fund

http://arxiv.org/pdf/0911.0325
Map by Michael Zeiler, eclipse-maps.com
A region of high magnetic activity is emerging at the circled location.
Credit: SOHO/MDI

Sunspot number: 11
What is the sunspot number?
Updated 08 July 2010

Spotless Days
Current Stretch: 0 days
2010 total: 35 days (18%)
2009 total: 260 days (71%)
Since 2004: 803 days
Typical Solar Min: 486 days
Tahai
Easter Island Eclipse Expedition
Williams College
July 11, 2010

Expedition Images: Jay M. Pasachoff, Muzhou Lu, and Craig Malamut; Cover Design: Craig Malamut
- Stronger coronal green line (Fe XIV) relative to the coronal red line (Fe X)
  - Indication that the corona is heating up again
Disk and annulus: SDO processed by Alec Engell for Leon Golub/CfA
200-mm lens equiv. (Druckmüller, Dietzel, Habbal Rusin)

CME on C2 and C3

C2/SO HO (courtesy of LASCO Consortium/NRL/NASA/ESA)

C3/SO HO (courtesy of LASCO Consortium/NRL/NASA/ESA)
November 14, 2012: Australia
<table>
<thead>
<tr>
<th>Expedition Members:</th>
<th>Sterling’s group:</th>
<th>Also:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jay Pasachoff</td>
<td>Aphonse Sterling</td>
<td>Paul Rosenthal</td>
</tr>
<tr>
<td>Naomi Pasachoff</td>
<td>(NASA MSFC)</td>
<td>Elaine Hantman</td>
</tr>
<tr>
<td>Bryce Babcock</td>
<td>Hakeem Oluseyi</td>
<td>Rob Wittenmyer ‘98 (UNSW)</td>
</tr>
<tr>
<td>Phyllis Babcock</td>
<td>(Florida Tech)</td>
<td>Gretchen Wittenmyer</td>
</tr>
<tr>
<td>Rob Lucas</td>
<td>Roderick Gray</td>
<td>Elijah Wittenmyer (age 3)</td>
</tr>
<tr>
<td>Helen Robinson</td>
<td>(Alabama A&amp;M)</td>
<td>Isaac Wittenmyer (age 9 months)</td>
</tr>
<tr>
<td>Aram Friedman</td>
<td></td>
<td>Eliana Wittenmyer (age months)</td>
</tr>
<tr>
<td>Ron Dantowitz</td>
<td></td>
<td>Edw. Ginsburg (U Mass Boston)</td>
</tr>
<tr>
<td>Nicholas Weber</td>
<td>Group from Slovakia:</td>
<td>Mike Durst</td>
</tr>
<tr>
<td>Alec Engell</td>
<td>Vojtech Rusin</td>
<td>(Columbia Basin College)</td>
</tr>
<tr>
<td>Ainslie Brennan</td>
<td></td>
<td>Bill Youngs (Eastern Wash. U)</td>
</tr>
<tr>
<td>Muzhou Lu ‘13</td>
<td>Metod Saniga</td>
<td>Dave Rust (JHUAPL)</td>
</tr>
<tr>
<td>Amy Steele ‘08</td>
<td>Metod Saniga</td>
<td>Gail Rust</td>
</tr>
<tr>
<td>Michael Kentrianakis</td>
<td>Pavel Rapavy</td>
<td>Sean Harlan Higgins</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lawrence Cram (ANU)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barbara Cram</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sharon Gray</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jeff Hall</td>
</tr>
</tbody>
</table>
Takahashi Fsq 106mm f=530
red epic 5k (“imax” camera)
coronal isophotes
Ludendorff flattening coefficient
International sunspot number $R_i$: monthly mean and 13-month smoothed number

Eclipses:
A: TSE 2006 Mar 29
B: TSE 2008 Aug. 1
C: TSE 2009 Jul. 22
D: TSE 2010 Jul. 11

Spacecraft:
SOHO
Hinode
PROBA2
TRACE
STEREO
SDO

SIDC, Royal Observatory of Belgium, modified with spacecraft
A composite of fifty 10-s SWAP images (174 Å) acquired during a 60-minute window surrounding the eclipse observation.
SWAP running-difference images
Grim spectrograph 0.6\text{\AA}/pixel
red epic 5k ("imax" camera)
November 3, 2013
Jay elephant family

Jay Pasachoff
alongside La Lopé National Park, Gabon
The Williams College Team

- Jay Pasachoff
- Allen Davis ’14
- Zophia Edwards ’05
- Marek Demianski
- Robert Lucas
- Michael Zeiler
- Polly White
- Michael Kentrianakis
- Vojtech Rusin
- Aristeidis Voulgaris

*with support from the Committee for Research and Exploration of the National Geographic Society*
Vojtech Rušin, Zophia Edwards (‘05), Jay Pasachoff, Allen Davis (‘14), Mike Kentrianakis, Aris Voulgaris, Polly White, Michael Zeiler, Marek Demianski, Rob Lucas
3 November 2013, Gabon

Williams College Eclipse Expedition; combination by Paul Gaintatzis from images by Allen Davis and Jay Pasachoff
TOTAL SOLAR ECLIPSE 2013, GABON
FLASH SPECTRUM, AFTER THIRD CONTACT 13:56:41UT
SLITLESS SPECTROGRAPH 300l/mm

TOTAL SOLAR ECLIPSE 3TH NOVEMBER 2013 GABON, MIKONGO II
FLASH SPECTRUM VISUAL SPECTROGRAPH 300l/mm 13:56:04UT

Aris Vougaris/Aristotle U. Thessaloniki; Williams College Expedition
NASA's Astronomy Picture of the Day for November 11

Inner: SWAP
Middle: ground-based
Outer: LASCO
Williams College Expedition: Jay Pasachoff, Allen Davis ‘14, Vojtech Rusin, processing by Miloslav Druckmüller
April 29, 2014, Albany, Western Australia
April 29, 2014, Albany, Western Australia
International sunspot number $R_i$: monthly mean and 13-month smoothed number.

Solar Influences Data Analysis Center, Royal Observatory of Belgium
23 October 2014

Jay Pasachoff and Austin Shea ‘15
23 October 2014

Phases of the Partial Solar Eclipse on Oct. 23, 2014


Jay Pasachoff and Austin Shea ‘15
Acknowledgments

The Williams College 2012 expeditions were supported in part by NSF grant AGS-1047726 from Solar Terrestrial Research of the Atmospheric and Geospace Sciences Division, and by the Rob Spring Fund and Science Center funds at Williams College. The JVLA is supported by the NSF. The Williams College 2013 total-eclipse expedition was supported in part by grant 9327-13 from the Committee for Research and Exploration of the National Geographic Society. ML was also supported in part by a Grant-In-Aid of Research from the National Academy of Sciences, administered by Sigma Xi, The Scientific Research Society (Grant ID: G20120315159311). VR and MS acknowledge support for 2012 from projects VEGA 2/0003/13 and NGS-3139-12 of the National Geographic Society.

We are grateful to Kazuo Shiota (Japan) for kindly providing us with some of his 2012 eclipse coronal images. We thank Alec Engell (Montana State University) for assistance on site in Australia, and Terry Cuttle (Queensland Amateur Astronomers) for help with site arrangements. We thank Aram Friedman (Ansible Technologies), Michael Kentrianakis, Amy Steele (Wesleyan U.), and Nicholas Weber (Dexter Southfield School) for collaboration on 2012 imaging.

Participating in optical observations of the annular eclipse on site at the JVLA were 8 undergraduate students, 6 of them from the just-completed Williams College junior-senior seminar on solar physics, one auditor from the seminar who was a student at neighboring Massachusetts College of Liberal Arts, and the eighth a Keck Northeast Astronomy Consortium Summer Fellow (part of our joint NSF REU program), a junior at Wesleyan. Some of their support came from the NASA Massachusetts Space Grant.
Acknowledgments

For the African eclipse of 2013, we thank Michael Zeiler (eclipse-maps.com) for his expert mapping and GPS locating ability, Polly White for measuring temperature on site and various assistance, Zophia Edwards '05 for logistic assistance, and Michael Kentrianakis for collaboration on imaging, logistics, and communications. We thank Patrice Okouma of Nommo Astronomia (Gabon) and the South African Astronomical Observatory for his organization and assistance. We thank His Excellency Michael Moussa-Adamo, Ambassador Extraordinary and Plenipotentiary of the Gabonese Republic to the United States of America and Dr. Mireille Obama Nguema E. Moore of the Gabon Embassy in Washington; Etienne Massard K. Makaga and Aboubakar Mambimba Ndjourgui of AGEOS, the Gabon Space Agency, for their logistics assistance; M. Tchemambela and Lee White of the Gabon National Parcs Agency; M. Michel Flavien Yenot of the Gabon Ministry of Communication; Dante Paradiso, Kevin K. Krapf, and colleagues of the U.S. Embassy in Libreville; Mark Sood of A Classic Tours Collection for travel assistance; and Joel Parriott, AAS Director of Public Policy, for linking us to the Embassy in DC.