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Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Founded in 1947

Volume 56, Number 4, Autumn 2014

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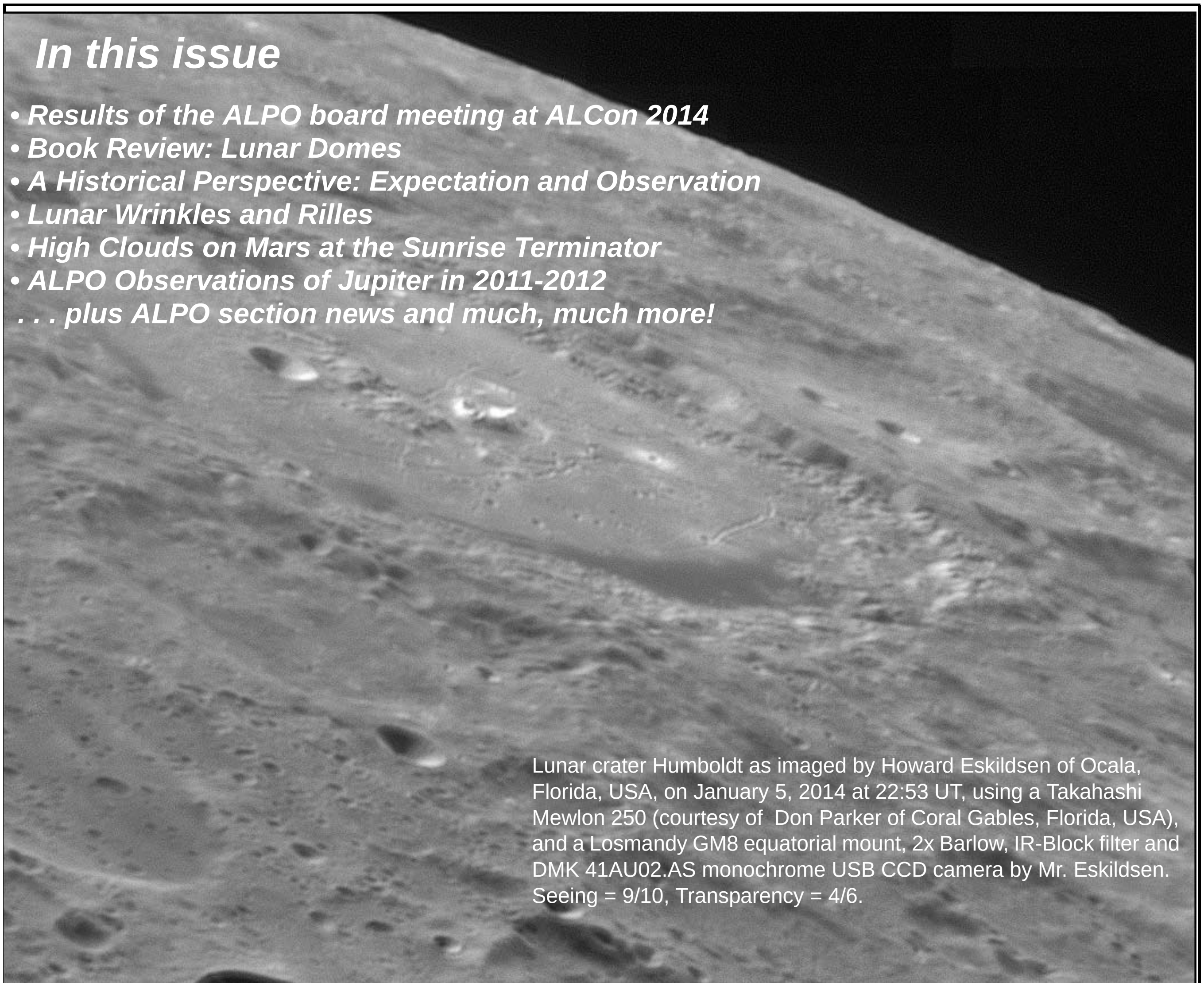

In this issue

Lunar crater Humboldt as imaged by Howard Eskildsen of Ocala, Florida, USA, on January 5, 2014 at 22:53 UT, using a Takahashi Mewlon 250 (courtesy of Don Parker of Coral Gables, Florida, USA), and a Losmandy GM8 equatorial mount, 2x Barlow, IR-Block filter and DMK 41AU02.AS monochrome USB CCD camera by Mr. Eskildsen. Seeing = 9/10, Transparency = 4/6.

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 56, No.4, Autumn 2014
This issue published in September 2014 for distribution in both portable document format (pdf) and also hardcopy format.

This publication is the official journal of the Association of Lunar & Planetary Observers (ALPO).

The purpose of this journal is to share observation reports, opinions, and other news from ALPO members with other members and the professional astronomical community.

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Visit the ALPO online at:
http://www.alpo-astronomy.org

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Point of View
A Most Convenient Eclipse

By Michael D. Reynolds, associate director, ALPO Eclipse Section coordinator

In a few short years, we in the United States will be treated to one of nature's most-spectacular phenomena: a total solar eclipse.

The eclipse occurs on Monday, August 21, 2017, and the path of totality races from the state of Oregon through the Midwest into the South, exiting the United States in Charleston, South Carolina. I actually think it should be declared a national holiday. But I doubt that any politician from either side of the aisle would take my proposal seriously. And that is a shame. But that does not mean that we as Solar System ambassadors should ignore this opportunity to spread the word about our passion and love of the Universe, especially all things Solar System.

First: everyone – and I mean everyone – should make plans to travel to see totality. I know of friends from Mexico, Canada and South America that are already planning their eclipse trips. Three years out, you say? Isn't that just crazy?? No… that is how excited both passionate eclipse chasers and eclipse neophytes are about this opportunity who realize the path of totality is in their nearby neighborhood.

Those of us who chase total solar eclipses for those brief seconds or minutes under the shadow –for me, 18 total solar eclipses at this point – know why we do it. I try to describe totality to audiences, my college astronomy classes, even fellow professional and amateur astronomers. Yet words and even photographs do not even come close. You must EXPERIENCE totality! You MUST put yourself under the shadow.

We will also have a great opportunity to share about the ALPO and what we are about. We all see the greying of astronomy, especially amateurs. Here's our golden opportunity to use an event that I guarantee will draw a lot of attention nationally. Mark my words: every local and national news organization will hype this up; unlike comets that occasionally do not perform like we desire, this total solar eclipse WILL occur!

See, I often hear from many that chasing eclipses is too expensive; it is only for the well-to-do amongst us. So what will be your excuse in 2017? Do not settle for a partial solar eclipse. If you are alive, you better be in the path of totality. Because the show will go on, with or without you!

Inside the ALPO
Member, section and activity news

News of General Interest

ALPO 2015 Conference News

All ALPO members are urged to try and attend the Astronomical League convention (ALCon 2015) to be held in Las Cruces, New Mexico, home of our ALPO founder, Walter Haas.

Details will be published in JALPO57-1, due for release in mid-December.

Meteorite Impact in Nicaragua?

From online news reports

Astronomers and others are studying what may be a new meteor crater near Managua that could have resulted from a breakaway piece of Near Earth Asteroid 2014 RC on September 6.

The crater measures 39 feet (12 meters) wide by 18 feet (5.5 meters) deep and lies on a remote section of Managua's international airport.

We hope to have more details in JALPO57-1 (Winter 2015).

The suspected meteorite landed in a wooded area near the international airport and an air force base. Source: AP/BBC News

For details on all of the above, visit the ALPO home page online at www.alpo-astronomy.org

ALPO Interest Section Reports

ALPO Online Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

Follow us on Twitter, become our friend on FaceBook or join us on MySpace.

To all section coordinators: If you need an ID for your section's blog, contact Larry Owens at larry.owens@alpo-astronomy.org

Computing Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

Important links:

- To subscribe to the ALPOCS yahoo e-mail list, http://groups.yahoo.com/group/alpocs/
- To post messages (either on the site or via your e-mail program), alpocs@yahoogroups.com
- To unsubscribe to the ALPOCS yahoo e-mail list, alpocs-unsubscribe@yahoogroups.com
- Visit the ALPO Computing Section online at www.alpo-astronomy.org/computing

Lunar & Planetary Training Program

Tim Robertson, section coordinator
cometman@cometman.net

Those interested in this VERY worthwhile program (or even those who wish to brush up on their skills) should contact Tim Robertson at the following addresses:

Timothy J. Robertson
ALPO Training Program
195 Tierra Rejada #148
Simi Valley, California 93065

Send e-mail to: cometman@cometman.net

Please be sure to include a self-addressed stamped envelope with all correspondence.

For information on the ALPO Lunar & Planetary Training Program, go to: www.cometman.net/alpo/

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ALPO Observing Section Reports

Mercury / Venus Transit Section

John Westfall, section coordinator
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Visit the ALPO Mercury/Venus Transit Section online at *www.alpo-astronomy.org/transit*

Meteors Section

Robert Lundsford, section coordinator
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Visit the ALPO Meteors Section online at *www.alpo-astronomy.org/meteorblog/* Be sure to click on the link to viewing meteors, meteor shower calendar and references.

Meteorites Section

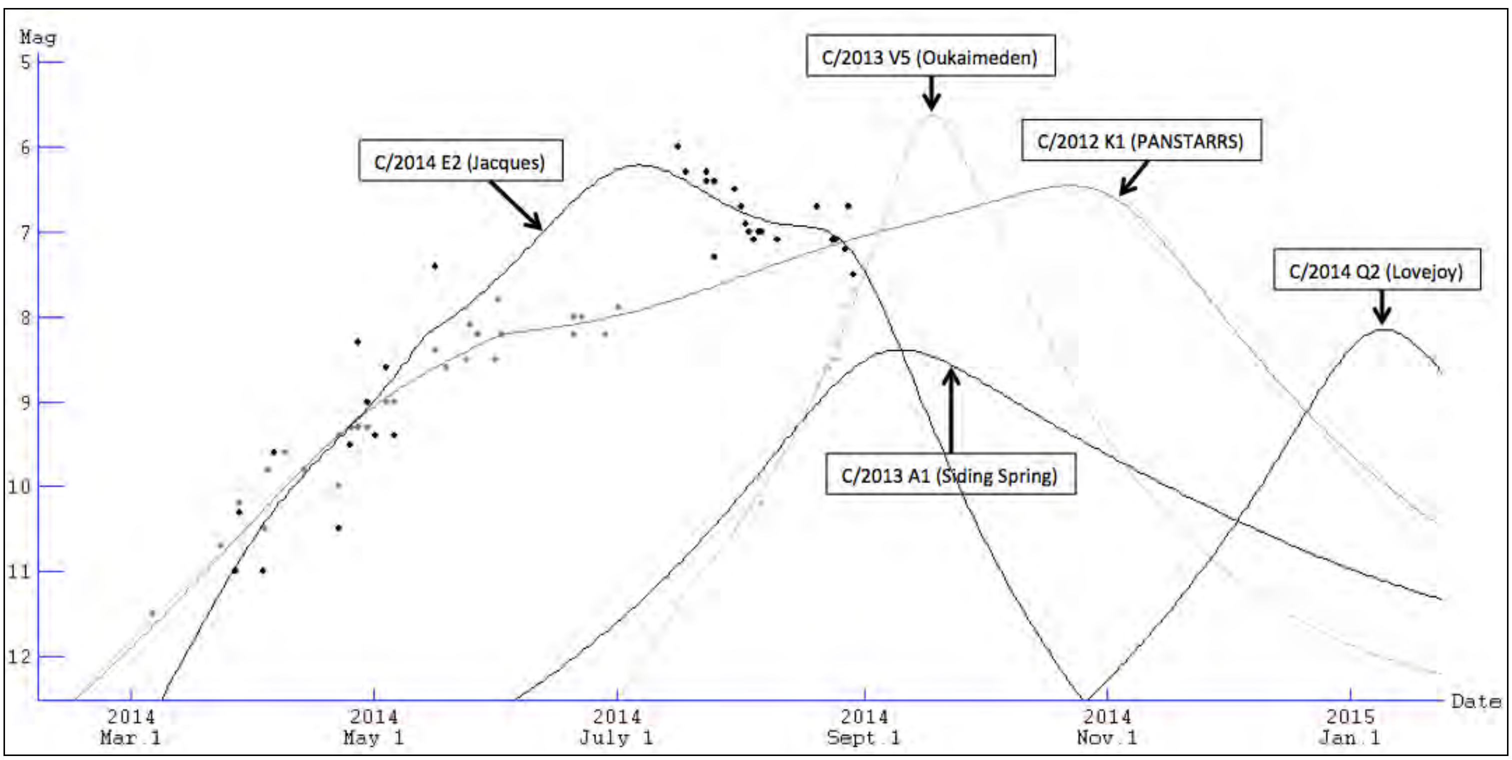
Report by Dolores H. Hill, section coordinator
dhill@lpl.arizona.edu

Visit the ALPO Meteorite Section online at *www.alpo-astronomy.org/meteorite/*

Comets Section

Report by Carl Hergenrother, acting section coordinator
chergen@lpl.arizona.edu

The ALPO Comets Section experienced a high level of activity over the summer of 2014. It helped that Comet C/2014 E2 (Jacques) was a nice 6-7th magnitude comet during July and August. Also Comets C/2012 K1 (PANSTARRS), C/2013 UQ4 (Catalina) and C/2013 V5 (Oukaimeden) were bright enough for small telescope and CCD observations. I'd like to thank the following observers who submitted visual magnitude observations, CCD images or drawings to the Section this summer: Salvador Aguirre, Denis Bucyznski, Jean-Francois Coliac, Carl Hergenrother, Manos Kardasis, Gianluca Masi, Frank Melillo, Gary Nowak, John Sabia and Willian Souza. Special thanks goes to former Comet Section Coordinator and current Assistant Coordinator Gary Kronk who has digitized much of the Section's archive of past observations. Many of these observations have been placed on the Section website. The Comet Section Image Gallery now contains over 800 images of 125 different comets going back to Comet Ikeya-Seki in 1965.



Past and predicted magnitudes for Comets C/2012 K1 (PANSTARRS), C/2013 A1 (Siding Spring), C/2013 V5 (Oukaimeden), C/2014 E2 (Jacques) and C/2014 Q2 (Lovejoy). The lightcurves for C/2012 K1, C/2013 V5 and C/2014 E2 are based on visual and CCD magnitudes measurements submitted to the ALPO Comet Section. Plot produced with Seiichi Yoshida's "Comets for Windows" program.

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- C/2014 Q2 (Lovejoy) - Last winter, the comet of the season was C/2013 R1 (Lovejoy). Well, Terry Lovejoy of Australia has done it again and discovered yet another bright comet that should be visible in small telescopes this winter.

- C/2014 Q2 (Lovejoy) was first seen on 2014 August 17 at 14th magnitude and may brighten to 7-8th magnitude by the end of December. It reaches perihelion on 2015 January 30 at 1.30 AU from the Sun. Prior to perihelion the comet will approach to within 0.48 AU of Earth in early January. It will be located deep in the southern sky until late December.

- C/2014 E2 (Jacques) - So far the best comet of 2014, Comet Jacques is in full retreat from the Sun and Earth this Winter. By October the comet should be 10th magnitude and fading rapidly in the evening sky. As of the end of August, we have received 35 magnitude estimates and 47 images/drawings of this comet.

- C/2013 V5 (Oukaimeden) - As of late August, Comet Oukaimeden has brightened to 7-8th magnitude as it approaches a September 28 perihelion at 0.63 AU from the Sun. The comet may brighten to 5th-6th magnitude. It will only be visible from the Southern Hemisphere until late in December when it may have faded well beyond 10th magnitude. An intrinsically faint, dynamically new comet, there is a good chance the comet may disintegrate before you read this Section Report.

- C/2013 A1 (Siding Spring) - For Earth-based observers, C/2013 A1 (Siding Spring) may be the least impressive of the comets listed in this report. But for Mars-based observers, it will be one for the ages. On October 19, the comet will pass within ~132,000 km or just 1/3rd the Earth-Moon distance. Though little dust is now predicted to impact Mars (early estimates called for a meteor 'hurricane' with ZHRs of many 10s of thousands),

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the comet will be a negative magnitude object in the Martian sky and will be close enough for the armada of Mars spacecraft to study it in detail. Here on Earth, Siding Spring is an evening object low in the southwestern sky at 9-10th magnitude. By November it will be too close to the Sun for observation.

- C/2012 K1 (PANSTARRS) - A nice comet between March and June, C/2012 K1 has been too close to the Sun since early July for ground-based observation. Having passed perihelion on August 27 at 1.05 AU from the Sun, the comet is now moving away from the Sun and becoming better placed for observation. A morning object, PANSTARRS will only be observable by northern observers in early to mid-October. Southern observers will be able to follow it throughout the winter as it fades from ~6th to 9th magnitude.

As always, the ALPO Comets Section thanks those who have sent observations during 2013 and we solicit new images, drawings and magnitude estimates during the rest of this year.

The ALPO Comet Section solicits all observations of comets, including drawings, magnitude estimates, images and spectra. Drawings and images of current and past comets are being archived in the ALPO Comet Section image gallery at *http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=4491*

Please send all observations and images to Carl Hergenrother at the e-mail address shown at the beginning of this section report.

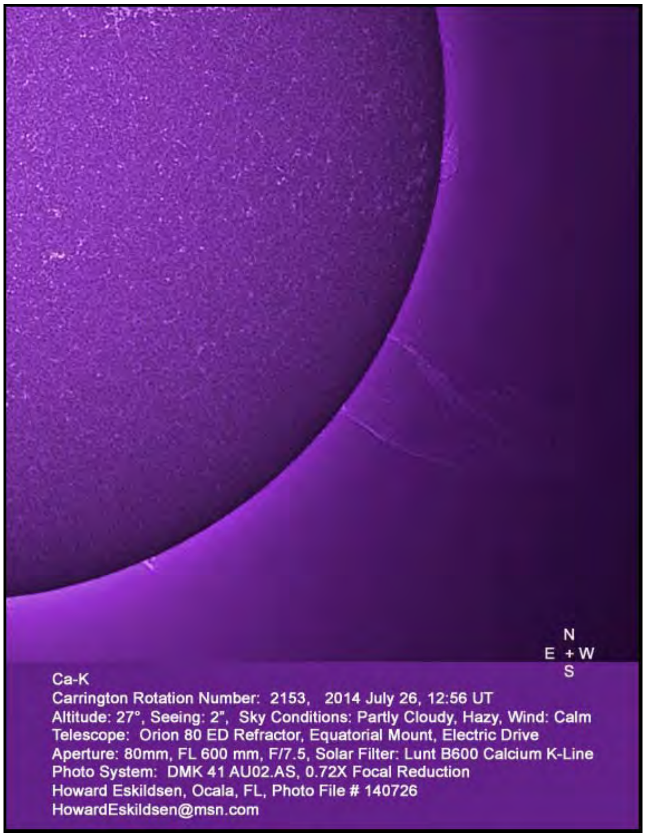
Visit the ALPO Comets Section online at *www.alpo-astronomy.org/comet*

Solar Section

Report by Kim Hay, section coordinator
kim.hay@alpo-astronomy.org

The Sun has certainly been very interesting through the summer months. From July 15 to 17, the Sun was almost void of groups and spots. Many observers did not see anything, but there were small traces of activity on the western edge. Over the next month the Sun then ramped up with groups mainly showing up in its southern hemisphere, and producing many C-class flares.

Solar images by Brad Timerson (at left) and Howard Eskildsen (at right).



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On August 15, the Sun had a large "Grand Canyon" filament, which measured 250,000 km from end-to-end and which ejected a coronal mass ejection (CME) towards Earth. (See the video at www.spaceweather.com)

Now we are looking forward to seeing what will happen the rest of the year, since we are currently in the 2nd peak of Solar Cycle 24 and in CR2153.

Below are some images by two of our ALPO observers, Brad Timerson of Newark, NY, USA, and Howard Eskildsen of Ocala, Florida, USA.

Brad has only just recently started solar observing and taking images. Howard is a prolific imager and also has an article in the September 2014 issue of *Sky & Telescope* on "The Violet Sun".

The ALPO Solar Section has an e-mail list that contains many members with lots of experience and information of different observing techniques and equipment. If you would like to join the Yahoo Solar ALPO list, please go to https://groups.yahoo.com/neo/groups/SolarAlpo

There are currently 322 members.

If you would like to send your sketches, or images of your observations and have them archived in the Carrington Rotation periods, please send them as either jpg or gif file types, no larger than 250 mb in size to me at the e-mail address at the beginning of this report. Please include all information on your image, including the CR number.

We are always looking for members to submit an article to the JALPO on solar imaging and solar phenomena. Please send to myself (kim.hay@alpo-astronomy.org) or to Ken Poshedly (ken.poshedly@alpo-astronomy.org)

For information on solar observing – including the various observing forms and information on completing them – go to www.alpo-astronomy.org/solar

Mercury Section

Report by Frank J. Melillo, section coordinator
frankj12@aol.com

The ALPO Mercury Section received far fewer observations during 2014 than previously. The apparition report will be written up for the year and published along with one new observer who has contributed to this section.

John Boudreau, with his outstanding work on Mercury, had only one good image during 2014 so far. On July 12, he captured Mercury with his new 14" K-D telescope. He had tried on other days, but the seeing conditions didn't allow him to capture any surface details. Let's hope that the remainder of this year will be better for him.

August 3 marked 10 years since the MESSENGER spacecraft was launched from Cape Canaveral, Florida. So far, it has taken 225,858 images of Mercury and its surface while orbiting 3,308 times! The spacecraft is now in a second extended mission which is scheduled to conclude in March 2015. It has been in orbit at least three Earth-years and 14 Mercury-years!

On July 22, I tried, but failed, to find Mercury during the favorable morning apparition during the daylight. At first, I spotted Venus, which was nearby Mercury. After observing Venus for some time, I then tried to find Mercury by determining how many degrees it was away from Venus.

Once I got the coordination, I slewed to the area where Mercury should have been. Unfortunately, time was running out as the sunlight reached over the telescope and the sky was getting hazier due to the summer heating.

John Boudreau with his 4.5" f18 Dall-Kirkham Cassegrain (with optical tube assembly by John and optics by Robert F. Royce). This is primarily a planetary scope intended for imaging. John's primary ALPO interests including Mercury and Venus, plus some imaging of Uranus and Neptune. I plan to be more involved with Jupiter this coming apparition.

As I always said, you should take this opportunity in daylight when Mercury and Venus are near each other.

More about the observations will be featured in upcoming issues of this Journal.

Visit the ALPO Mercury Section online at www.alpo-astronomy.org/mercury

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Venus Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Venus rises barely a half hour before sunrise by October 1 and must be tracked into daylight for worthwhile views so the effects of atmospheric dispersion do not seriously affect seeing conditions.

The 2014 Western (Morning) Apparition will end as Venus enters Superior Conjunction with the Sun on October 25. Venus has been progressing through its waxing phases as it shrinks in angular diameter from a crescent to a gibbous and finally a fully-illuminated disk at Superior Conjunction.

A Table of Geocentric Phenomena in Universal Time (UT) is included with this report for the convenience of observers for the 2014 Western (Morning) Apparition, as well as for the upcoming 2014-15 Eastern (Evening) Apparition for planning purposes

The ALPO Venus Section has so far received about 100 drawings and images of Venus as the apparition has progressed, with more expected before the end of the period.

But observers are alerted that images are still needed by the Venus Express (VEX) mission which started systematically monitoring Venus at UV, visible (IL) and IR wavelengths back in May 2006.

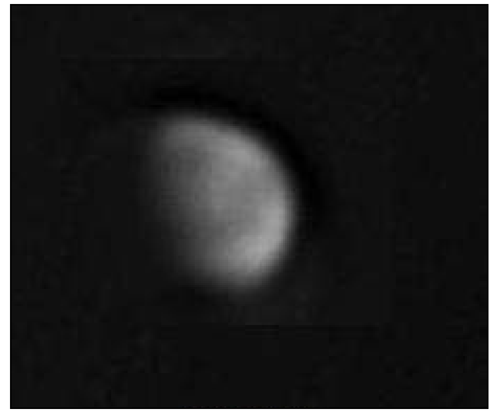
This Professional-Amateur (Pro-Am) effort is ongoing at least until the end of 2014, so observers should continue to send images to both the ALPO Venus Section and the VEX website at:

http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=38833&fbodylongid=1856.

Regular Venus program activities (including drawings of Venus in integrated light and with color filters of known transmission) are also valuable throughout the period that VEX is observing the planet.

The observation programs carried out by the ALPO Venus Saturn Section are listed on the Venus page of the ALPO website at http://www.alpo-astronomy.org/venus as well as in considerable detail in the author's ALPO Venus Handbook, which is available from the ALPO Venus Section. Observers are urged to carry out digital imaging of Venus at the same time that others are imaging or making visual drawings of the planet (i.e., simultaneous observations).

Although regular imaging of Venus in both UV, IR and other wavelengths is extremely important and highly encouraged, far too many experienced observers have neglected making visual numerical relative intensity estimates and reporting visual or color filter impressions of features seen or suspected in the atmosphere of the planet (for instance, categorization of dusky atmospheric markings, visibility of cusp caps and cusp bands, measurement of cusp extensions, monitoring for the Schröter phase effect near the date of predicted dichotomy, and looking for terminator irregularities).



H.G. Lindberg of Skulttuna, Sweden submitted this 365nm UV image of Venus captured on June 10, 2014, at 06:33UT using a 25.4 cm (10.0 in.) Newtonian in fair seeing (numerical values for seeing and transparency with not provided). Amorphous and banded dusky markings are seen on the disk of Venus in this image. The apparent diameter of Venus is 13.3", phase (k) 0.799 (79.9% illuminated), and visual magnitude 4.0. South is at top of image.

Geocentric Phenomena of the Current 2014 Western (Morning) Apparition of Venus in Universal Time (UT)

Inferior Conjunction		Jan 11 (angular diameter = 63.1 arc-seconds)
Greatest Illuminated Extent		Feb 15 (m_v = –4.9)
Greatest Elongation West	2014	Mar 22 (Venus will be 47° west of the Sun)
Predicted Dichotomy		Mar 23.73 (exactly half-phase predicted)
Superior Conjunction		Oct 25^d (angular diameter = 9.7 arc-seconds)

Geocentric Phenomena of the Upcoming 2014-15 Eastern (Evening) Apparition of Venus in Universal Time (UT)

Superior Conjunction	2014	Oct 25 (angular diameter = 9.7 arc-seconds)
Greatest Elongation East		Jun 06 (Venus will be 45.4º East of the Sun)
Predicted Dichotomy	2015	Jun 06.38 (exactly half-phase predicted)
Greatest Illuminated Extent		Jul 12 (m_v = -4.5)
Inferior Conjunction		Aug 15 (angular diameter = 63.1 arc-seconds)

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Lunar Calendar for Fourth Quarter 2014 (All Times UT)

Oct	01	19:33	First Quarter
	06	09:41	Moon Perigee: 362500 km
	08	10:51	Full Moon
	08	10:55	Total Lunar Eclipse
	08	17:44	Moon Descending Node
	12	09:58	Moon-Aldebaran: 1.4° S
	13	13:34	Moon North Dec.: 18.5° N
	15	19:12	Last Quarter
	18	06:05	Moon Apogee: 404900 km
	23	00:46	Moon Ascending Node
	23	21:45	Partial Solar Eclipse
	23	21:57	New Moon
	25	16:04	Moon-Saturn: 1.1° S
	28	01:03	Moon South Dec.: 18.5° S
	31	02:48	First Quarter
Nov	03	00:21	Moon Perigee: 367900 km
	05	03:13	Moon Descending Node
	06	22:23	Full Moon
	08	19:41	Moon-Aldebaran: 1.5° S
	09	23:12	Moon North Dec.: 18.6° N
	14	15:16	Last Quarter
	15	01:56	Moon Apogee: 404300 km
	19	08:18	Moon Ascending Node
	19	16:01	Moon-Spica: 2.8° S
	22	12:32	New Moon
	24	08:17	Moon South Dec.: 18.6° S
	27	23:11	Moon Perigee: 369800 km
	29	10:06	First Quarter
Dec	02	08:32	Moon Descending Node
	06	04:35	Moon-Aldebaran: 1.5° S
	06	12:27	Full Moon
	07	09:06	Moon North Dec.: 18.7° N
	12	23:02	Moon Apogee: 404600 km
	14	12:51	Last Quarter
	16	13:27	Moon Ascending Node
	19	20:55	Moon-Saturn: 1.6° S
	21	18:25	Moon South Dec.: 18.7° S
	22	01:36	New Moon
	24	16:43	Moon Perigee: 364800 km
	28	18:31	First Quarter
	29	09:27	Moon Descending Node

Table courtesy of William Dembowski and NASA's SkyCalc Sky Events Calendar

Routine use of the standard ALPO Venus observing forms will help observers know what needs to be reported in addition to supporting information such as telescope aperture and type, UT date and time, magnifications and filters used, seeing and transparency conditions, etc.

The ALPO Venus Section urges interested readers worldwide to join us in our projects and challenges ahead.

Individuals interested in participating in the programs of the ALPO Venus Section are encouraged to visit the ALPO Venus Section online *http://www.alpo-astronomy.org/venusblog/*

Lunar Section

Lunar Topographical Studies / Selected Areas Program

Report by Wayne Bailey, program coordinator

wayne.bailey@alpo-astronomy.org

The ALPO Lunar Topographical Studies Section (ALPO LTSS) received a total of 82 new observations from 11 observers during the April-June quarter. Five contributed articles were published in addition to numerous commentaries on images submitted.

The *Focus-On* series continued with an article on Mare Vaporum. Upcoming *Focus-On* subjects include Banded Craters, the Altai Scarp and ghost craters.

All electronic submissions should now be sent to Acting Assistant Coordinator Jerry Hubbell at *jerry.hubbell@alpo-astronomy.org* or myself at *wayne.bailey@alpo-astronomy.org*.

Hard copy submissions should continue to be mailed to me at the address provided in the ALPO Resources section of this Journal.

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Visit the following online web sites for more info:

- ALPO Lunar Topographical Studies Program *moon.scopesandscapes.com/alpo-topo*
- ALPO Lunar Selected Areas Program *moon.scopesandscapes.com/alpo-sap.html*
- The Lunar Observer (current issue) *moon.scopesandscapes.com/tlo.pdf*
- The Lunar Observer (back issues) *moon.scopesandscapes.com/tlo_back.html*
- Banded Craters Program: *moon.scopesandscapes.com/alpo-bcp.html*
- The Lunar Discussion Group: *tech.groups.yahoo.com/group/Moon-ALPO/*
- The Moon-Wiki: *the-moon.wikispaces.com/Introduction*
- Chandrayaan-1 M3: *pds-imaging.jpl.nasa.gov/portal/chandrayaan-1_mission.html*
- LADEE: *www.nasa.gov/mission_pages/ladee/main*
- LROC: *lroc.sese.asu.edu/EPO/LROC/lroc.php*
- GRAIL: *http://www.nasa.gov/mission_pages/grail/main/*

Lunar Meteoritic Impacts

Brian Cudnik, program coordinator
cudnik@sbcglobal.net

Please visit the ALPO Lunar Meteoritic Impact Search site online at *www.alpo-astronomy.org/lunar/lunimpacts.htm*.

Lunar Transient Phenomena

Report by Dr. Anthony Cook, program coordinator
tony.cook@alpo-astronomy.org

Dates and UTs, on which to see features under similar illumination conditions to past LTPs, can be found at *http://users.aber.ac.uk/atc/tlp/tlp.htm*. If you think that you see a LTP, please follow through the rigorous checklist also on that web site before contacting me.

Twitter LTP alerts are available on: *http://twitter.com/lunarnaut*.

Finally, please visit the ALPO Lunar Transient Phenomena site online at *http://users.aber.ac.uk/atc/alpo/ltp.htm*

Mars Section

Report by Roger Venable, section coordinator
rjvmd@hughes.net

The largest dust storm detected during this apparition began on July 1 and was captured on serial images by Clyde Foster of South Africa. Clyde is a new imager of Mars, and was quickly rewarded by this jackpot. A July 2 image (not shown) by Xavier Dupont of France also displays the storm, but less favorably. Paul Abel of England drew the dust storm as a yellow cloud on July 5.

The images by both Messrs. Foster and Abel are on the following page.

As of October 1, Mars is in the evening sky, elongated 64 degrees from the Sun. Its southern latitude makes it low in the sky for observers in the Northern Hemisphere but high for their counterparts south of the Equator. However, its diameter subtends only 6 arc seconds, so its observation is challenging.

Join us in the Mars observers group on Yahoo at *groups.yahoo.com/neo/groups/marsobservers/info*

Note that this is a new web address, as Yahoo has changed its group addresses. If you type into your browser the previous Mars observers group address, you will be automatically redirected to this new one.

Visit the ALPO Mars Section online and explore the Mars Section's recent observations: *www.alpo-astronomy.org/mars*

Minor Planets Section

Frederick Pilcher, section coordinator
pilcher35@gmail.com

First, please note my new e-mail address and delete any previous one you may have for me.

Second, some highlights published in the *Minor Planet Bulletin*, Volume 41, No. 3, 2014 July - September are hereby presented. These represent the recent achievements of the ALPO Minor Planets Section.

Brian Warner found evidence for a satellite of 5175 Ables, with a small amplitude 10.44-hour variation, interpreted as the rotation period of the satellite, superimposed upon a larger amplitude 2.7976 hour variation caused by rotation of the primary. No occultation/transit/eclipse events were observed; the line-of-sight was not close to the orbital plane.

For the previously known binaries 3309 Brorfelde and (35107) 1991 VH, occultation/ transit/eclipse events were observed again, improving our knowledge of the satellite orbit.

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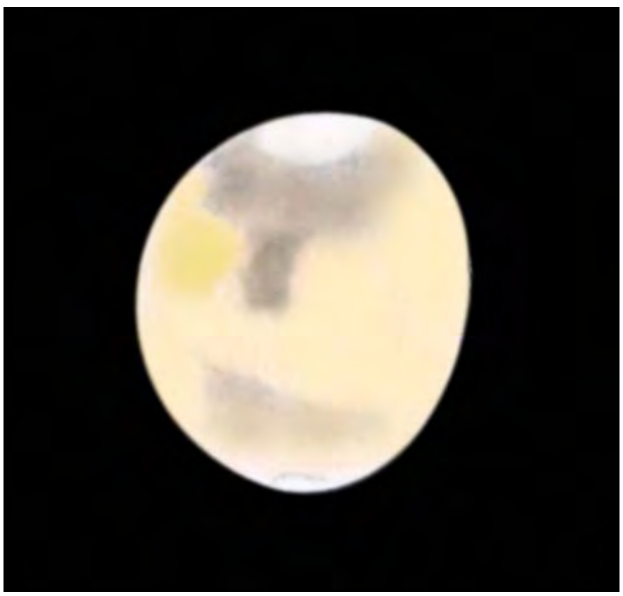
Lightcurves with derived rotation periods are published for 156 other asteroids, the largest number ever published in a single issue of the *Minor Planet Bulletin*. The ALPO Minor Planets Section is thriving!

These lightcurves are of asteroids numbered 18, 110, 121, 155, 163, 199, 208, 227, 234, 236, 317, 323, 428, 434, 473, 487, 495, 502, 520, 525, 616, 620, 670, 684, 702, 772, 822, 852, 855, 1019, 1025, 1044, 1181, 1219, 1246, 1294, 1299, 1321, 1360, 1374, 1384, 1600, 1626, 1656, 1943, 2161, 2381, 2713, 2770, 2812, 2834, 3062, 3101, 3266, 3496, 3573, 3800, 3992, 4055, 4067, 4440, 4464, 4490, 4511, 4716, 4954, 5253, 5380, 5450, 5707, 5871, 5871, 6107, 6493, 6516, 6517, 6652, 7446, 7454, 7966, 8866, 8958, 9165, 10465, 11958, 12920, 13026, 13578, 14255, 15374, 15964, 16009, 16135, 16562, 17590, 19682, 20561, 20744, 21107, 21688, 22412, 25916, 26022, 28461, 34726, 36439, 40267, 44600, 48601, 49667, 52317, 53435, 53530, 54063, 55532, 68031, 69142, 69406, 85118, 85990, 86039, 86217, 87073, 98889, 113781, 118337, 120279, 138127, 143409, 243566, 275677, 277570, 294739, 306695, 326317, 357622, 377097, 1995 CR, 2006 DP14, 2009 CT, 2009 QF31, 2011 BT15, 2012 AU10, 2013 PD21, 2013 WT44, 2013 XF22, 2013 YZ13, 2013 YZ37, 2014 AY28, 2014 BR8, 2014 BR57, 2014 CR, 2014 CG13, 2014 CU13, 2014 DX110, 2014 EM, 2014 EL45.



(At left) Drawing of Mars by Paul Abel of Leicester, U.K., on July 5, 2014, at 21:30 UT (observed from 21:16 to 22:14 UT), with the apparent disc diameter only 9.2 arc seconds. The central meridian is 309 degrees west longitude. The dust storm in Libya and Isidis is depicted as a yellow area to the east (left) of the dark central area known as Syrtis Major. The white area at the top is not the polar cap, but rather Hellas, a depression that is filled with clouds, as it usually is at this season of the Martian year. The small North Polar Cap is depicted at the bottom. Paul used the Leicester Observatory's corrected Dall-Kirkham reflector of 508 mm aperture, and W58 and W80A filters in addition to integrated light, at 278 magnifications. Seeing 2 to 3 on the ALPO's 0 to 10 scale.

(Below) A sequence of images of Mars showing the evolution of the dust storm in Libya, taken by Clyde Foster from Centurion, South Africa. From left to right, 2014 June 30 at 16:18 UT with CM 281 degrees; July 1 at 17:20 UT with CM 287; July 2 at 17:56 UT with CM 286; and July 3 at 17:13 UT with CM 266. 6-30 1618, cm 281. L_S was 154 to 155, which is late northern summer on Mars. All were made with a Schmidt-Cassegrain telescope of 355mm aperture, at f/33, using a ZWO ASI120MC digital color camera.

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Note that some of these provide secure period determinations and some only tentative ones. Some are of asteroids with no previous lightcurve photometry, while others are of asteroids with previous period determinations which may be consistent or inconsistent with the earlier values. The latter are of more value than the unitiated may realize.

Observations of asteroids at multiple oppositions widely spaced around the sky are necessary to find axes of rotation and highly accurate sidereal periods.

The *Minor Planet Bulletin* is a refereed publication and that it is available online at *http://www.minorplanet.info/mpbdownloads.html*.

Annual voluntary contributions of $5 or more in support of the publication are welcome.

Please visit the ALPO Minor Planets Section online at *http://www.alpo-astronomy.org/minor*

Jupiter Section

Report by Ed Grafton, acting section coordinator
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The 2014 opposition of Jupiter was favorable for northern hemisphere observers, with Jupiter reaching 22 degrees declination and a diameter of 47 arc seconds. Jupiter reached solar conjunction July 24, 2014. At its greatest distance from Earth, Jupiter was 6.28 AU with an apparent diameter of less than 31 arc seconds.

Jupiter's Great Red Spot has been seen to be gradually shrinking over the last two hundred years. In 2014, data compiled by J. Rogers (BAA) showed the GRS had a longitudinal diameter of 13.6 degrees. With the recently higher image resolutions obtained by amateurs, the period of GRS rotation can be measured when high contrast variations exist within the red spot. Measurements in 2014 showed a circulation period of 3.6 days, continuing the trend over the last few years of faster rotation.

An interesting configuration of white oval cyclonic storms occurred this opposition in an alignment that resembled the cartoon character Mickey Mouse. Manos Kardasis captured this configuration in a high resolution methane band image on December 20, 2013 at 889 nanometers and Damian Peach in visible light on February 25, 2014.

http://www.egrafton.com/manos_peach_mm.jpg

Richard Schmude has recently been observing the brighter planets in the near infrared using J and H filters. The J and H filters are sensitive to light with wavelengths of 1.25 and 1.65 micrometers, respectively. Richard has found that the brightness of Venus is consistent with the light being reflected off of the cooler layers of its atmosphere.

This is not the case for Mercury, however. It is very bright in the H filter. The albedo of Mars levels off in the J and H filter range. Jupiter is dimmer in the J and H filters than in visible light. Saturn's rings have a big impact on that planet's brightness.

Visit the ALPO Jupiter Section online at *http://www.alpo-astronomy.org/jupiter*

Galilean Satellite Eclipse Timing Program

Report by John Westfall, program coordinator
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By the time you read this, a new Jupiter apparition will have begun (and it is, of course, a good time to send in your satellite eclipse timings for the 2013-14 Apparition).

Jupiter as imaged by Damian Peach. See text for details.

In 2014-15, Jupiter remains well north of the celestial equator throughout the apparition, favoring observers in the Earth's northern hemisphere. The 2014-2015 Jupiter Apparition is notable in that it includes a season of satellite mutual events - eclipses and occultations of the satellites by each other.

Mutual-event seasons take place every six years when the Earth and Sun cross the planet's equator and thus the planes of the orbits of its Galilean satellites. The coming mutual-event season contains almost 500 predicted events - 270 mutual occultations and 207 mutual eclipses. Their schedule corresponds remarkably well with the Jupiter apparition itself:

- 2014 Jul 24 – Jupiter in conjunction with the Sun
- 2014 Aug 18 – First mutual event predicted (Ganymede eclipses Callisto)
- 2014 Nov 07 – Earth crosses Jupiter's equator (from north to south)*
- 2015 Feb 04 – Sun crosses Jupiter's equator (from north to south)

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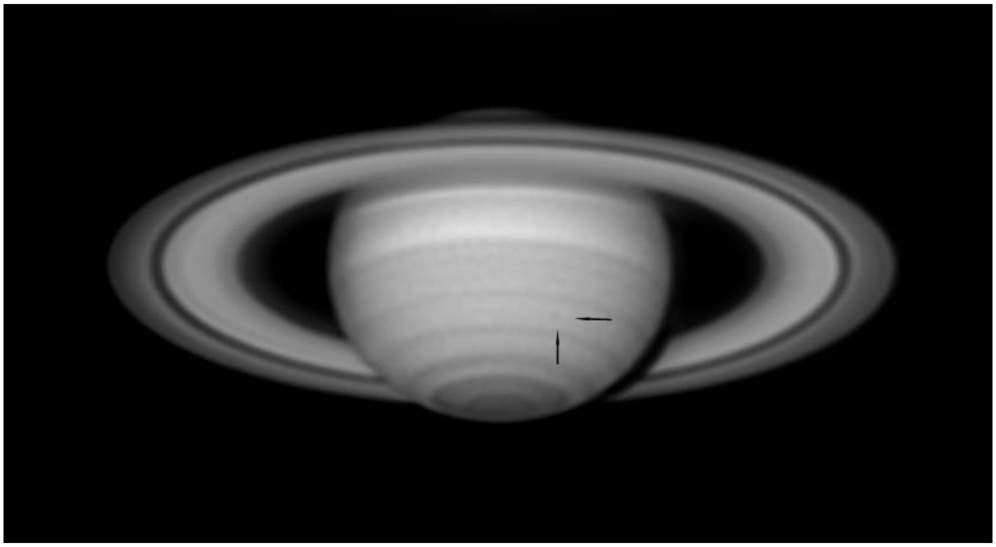
- 2015 Feb 06 – Jupiter in opposition to the Sun
- 2015 Apr 10 – Earth crosses Jupiter's equator (from south to north)*
- 2015 May 03 – Earth crosses Jupiter's equator (from north to south)*
- 2015 Aug 13 – Last mutual event predicted (Io occults Europa)
- 2015 Aug 26 – Jupiter in conjunction with the Sun

(*The last time the Earth crossed Jupiter's equator three times was during the 1919-20 Apparition.)

Satellite mutual events take many forms – eclipses versus occultations – but they also include total, partial and annular versions of both. You can simply view them, draw them, or take sequential photographs or videos of them. This program coordinator will be happy to receive these forms of observation (as well as your timings of the "normal" eclipses of the four satellites by Jupiter itself).

Furthermore, if you conduct sequential photometry of mutual events, your resulting "light curve" can provide the accurate mid-time, duration and "depth" (light drop) of the event, with potential scientific value in terms of refining the satellites' orbits.

You can find out more about observing these phenomena, obtain a schedule of events, and even learn how to participate in the "PHEMU15" event-photometry campaign (all this in English), at the website of the Institut de Méchanique Céleste et de Calcul des Éphémérides (IMCCE): www.imcce.fr/phemu. (Note that all photometric observations should be submitted to the IMCCE.)



This image of Saturn was taken on July 26, 2014 at 09:17 UT by Trevor Barry observing from Broken Hill, Australia, using a 40.6 cm (16.0 in.) custom Newtonian at red wavelengths showing an extremely small recurring NTrZ dark spot [arrows point to the location of the dark spot in the image]. Numerous belts and zones are seen on the globe of Saturn, including the hexagonal North polar hexagon and the major ring components. Cassini's division (A0 or B10) clearly runs all the way around the circumference of the rings (except where the globe blocks our view of the rings), plus Encke's "complex" (A5), Keeler's (A8) gap, and other "intensity minima" at the ring ansae are noticeable. The dark shadow of the globe on the rings is situated toward the West (right) in this image, and note that it has shifted from the East (left) side of the globe right since opposition on May 10. The shadow of the rings on the globe is also apparent just South of the outermost edge of Ring A. Seeing = 7.5 and transparency was not specified. The apparent diameter of Saturn's globe was 17.2" with a ring tilt of +21.1°. CMI = 121.2°, CMII = 248.4°, CMIII = 246.3°. South is at the top of the image.

Contact John Westfall via e-mail at johnwestfall@comcast.net or via postal mail at 5061 Carbondale Way, Antioch, CA 94531 USA to obtain an observer's kit, also available on the Jupiter Section page of the ALPO website.

Saturn Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Saturn passed through opposition back on May 10 and is slowly progressing toward conjunction with the Sun on November 18. Therefore, readers will want to catch views of the planet as early as possible before Saturn descends too low in the western sky where atmospheric turbulence causes poor seeing conditions.

The rings are currently tilted about +21 degrees towards Earth, which means that the northern hemisphere of the globe and north face of the rings remain visible to best advantage.

The accompanying table on the following page of geocentric phenomena for the 2013-14 apparition is presented here for the convenience of readers who wish to plan their Saturn observing activities.

As this report goes to press, observers have already submitted well over 500 images and drawings of Saturn. Although there have been no reports of significant atmospheric outbursts as in 2010-11,

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Geocentric Phenomena for the 2013-14 Apparition of Saturn in Universal Time (UT)	
Conjunction	2013 Nov 6^{d}
Opposition	2014 May 10^{d}
Conjunction	2014 Nov 18^{d}
Opposition Data:	
Equatorial Diameter Globe	18.6 arc-seconds
Polar Diameter Globe	16.6 arc-seconds
Major Axis of Rings	42.2 arc-seconds
Minor Axis of Rings	15.5 arc-seconds
Visual Magnitude (m_v)	+0.1 m_v (in Libra)
B =	+21.6°
Declination	-15.4°

observers have reported a brightening along the EZn, a few observers with larger apertures have captured images of at least one recurring small dark spot in the NTrZ and more transient dark features in the far north and near the periphery of the NPR. As conjunction approaches on November 18, it will be interesting to see if the aforementioned features persist along with any other discrete phenomena within the zones and belts of the planet's northern hemisphere. Consequently, observers are urged to continue to keep Saturn under careful scrutiny until the end of the current observing season.

The observation programs conducted by the ALPO Saturn Section are listed on the ALPO Saturn Section web page at *www.alpo-astronomy.org/saturn* as well as in considerable detail in the author's book, *Saturn and How to Observe It*, available from Springer, Amazon.com, etc., or by writing to the ALPO Saturn Section for further information.

Observers are urged to carry out digital imaging of Saturn at the same time that others are imaging or visually watching Saturn (i.e., simultaneous observations). Although regular imaging of Saturn is extremely important and highly encouraged, far too many experienced observers have neglected making visual numerical relative intensity estimates, which are badly needed for a continuing comparative analysis of belt, zone, and ring component brightness variations over time. So this type of visual work is strongly encouraged before or after imaging the planet.

The ALPO Saturn Section appreciates the dedicated work by so many observers who regularly submit their reports and images. *Cassini* mission scientists, as well as other professional specialists, are continuing to request drawings, digital images, and supporting data from amateur observers around the globe in an active Pro-Am cooperative effort.

Information on ALPO Saturn programs, including observing forms and instructions, can be found on the Saturn pages on the official ALPO Website at *www.alpo-astronomy.org/saturn*

All are invited to also subscribe to the Saturn e-mail discussion group at *Saturn-ALPO@yahoogroups.com*

Remote Planets Section

Report by Richard W. Schmude, Jr., section coordinator
schmude@gordonstate.edu

This coordinator submitted the 2013-2014 remote planets report to Ken Poshedly on July 30, 2014. The highlights of this report were the red/near infrared images of Uranus and Neptune and the B and V brightness measurements made by Jim Fox. This coordinator has also electronically distributed finder charts for Uranus and Neptune. Please let me know if you want a finder chart for these planets.

Uranus will reach opposition in early October and will be visible for most of the night during mid-fall. The northern hemisphere of the planet will face the Earth. With Neptune having reached opposition in late August, it will be visible during the early and late evening during October and November. Neptune's southern hemisphere will face the Earth.

To all remote planet observers, please keep up the good work!

Finally, a reminder that the book *Uranus, Neptune and Pluto and How to Observe Them*, which was authored by this coordinator, is available from Springer at *www.springer.com/astronomy/popular+astronomy/book/978-0-387-76601-0* or elsewhere (such as *www.amazon.ca/Uranus-Neptune-Pluto-Observe-Them/dp/0387766014*) to order a copy.

Visit the ALPO Remote Planets Section online at *www.alpoastronomy.org/remote*.

Feature Story:

ALPO Board Meeting Minutes, July 12, 2014, San Antonio, Texas

Minutes provided by Matt Will, ALPO Secretary / Treasurer
matt.will@alpo-astronomy.org

Call to Order

On Saturday, July 12, 2014, at 9:12 a.m. CDT (Central Daylight Time), ALPO Executive Director and Board Chairman Ken Poshedly called the ALPO Board to order in the Ballroom C of the Hilton San Antonio Airport Hotel in San Antonio, Texas. The ALPO Board meeting was held during the 2014 AL/ALPO San Antonio Conference (ALCon 2014).

Board Members Present

ALPO Board members Ken Poshedly (executive director and chairman), Julius L. Benton, Jr., Michael D. Reynolds (associate executive director), Richard W. Schmude, Jr., John E. Westfall, and Matthew L. Will (secretary and treasurer) were present in San Antonio. Board members Donald C. Parker, Sanjay Limaye, and Walter H. Haas (founder and director emeritus of the ALPO) could not attend this year's conference. A teleconference phone line was provided for these Board members not attending the meeting in person. Don Parker called into the teleconference line at the beginning of the meeting and Sanjay Limaye called in later on but could not participate in the entire meeting. Walter Haas was not available to call into the meeting. ALPO Lunar Section Coordinator Wayne Bailey and ALPO member Jim Fox were also in attendance at this meeting.

Issue One: Approval of the Board Meeting Minutes of 2013

(Introduced by Matthew Will)

Board meeting minutes for our 2013 ALPO Board meeting were approved by all the Board members present.

Issue Two: Location for the ALPO to Convene in 2015

(Introduced by Ken Poshedly and Matthew Will)

Earlier in the year, the ALPO Board voted to meet with the Astronomical League in Las Cruces for our 2015 annual meeting. A meeting site for the ALPO in 2016 was open to discussion. The possibility of a meeting in 2016 hosted by the Pisga Astronomical Research Institute (PARI) in Rosman, North Carolina, was considered. PARI is an educational and research organization dedicated to astronomical studies. The organization occupies the former property of the NASA and later DOD tracking station near Rosman which was acquired by the organization's founder Robert Cline. PARI has many fascinating astronomical features such as a museum and library, optical and radio telescopes, good meeting facilities, dormitories, and space for setting up telescopes under excellent dark skies. The ALPO would be meeting on its own using the facilities at PARI and managing the income and expenses for conducting this conference. While PARI offers a unique setting for an annual meeting and is well equipped to handle a group our size, 40 to 80 attendees, the location is remote and could prove costly for members to attend, thus costly for the ALPO if lower attendance were to create a shortfall. It was generally agreed by the ALPO Board that a meeting at PARI would be too financially burdensome under the current circumstances. The Board would be open to an annual meeting at the PARI site in the future if it should become viable for the ALPO.

The ALPO has had some positive feedback for a future meeting with the Society for Astronomical Sciences (SAS). SAS is known to many ALPO members as a research group with Pro-Am collaborations in a wide number of fields that include variable stars, asteroids, and planetary studies. They meet in California every year and are now shifting toward meetings in hotels, in easy-to-travel locations as opposed to meeting at remote locations like Big Bear Lake, California. SAS meets in even numbered years with AAVSO, so only an odd numbered year would only be open to the ALPO for a join meeting with them. The Astronomical League will be meeting in the Washington, DC area in 2016. Since there doesn't seem to be support for having any other group or organization hosting us in 2016, the ALPO Board agreed that Washington, DC would be a good location considering that we have not met in the east since 2009. John Westfall made a motion that the ALPO meet for its annual meeting with the Astronomical League in Washington, DC in 2016. Richard Schmude seconded. The vote from the ALPO Board was 7 voting yes and 0 voting no. The motion carried.

The ALPO Board was open to suggestions for a meeting site in 2017. The Astronomical League is meeting in Casper, Wyoming and will schedule their annual meeting immediately before the 2017 total solar eclipse of August 21st. This is a bit later than the ALPO usually meets. Also, ALPO members may have other plans for the eclipse. While the ALPO Board would not preclude the possibility of meeting with the League in 2017, the ALPO Board might be inclined to consider other meeting options. The Society for Astronomical Sciences might be open to a 2017 meeting. It would be the first time since 2004 that we have met in California. Contact will be made with SAS to propose a joint meeting with them in 2017. The Royal Astronomical Society of Canada is also an option for future annual meetings that the ALPO Board will be happy to consider.

Issue Three: Review of ALPO Finances and Endowment

(Introduced by Matthew Will).

ALPO Secretary and Treasurer, Matthew Will reported to the ALPO Board the ALPO's finances for the preceding year in the annual report submitted to the Board last February. A supplemental report was submitted in June covering the first half of 2014.

The ALPO finished the Year 2013 in the black with a surplus of $1937.05. This comes after a rather dramatic deficit of $1,962.58 in 2012. The surplus was due to increased renewals, more new members joining, lower than anticipated administrative expenses and a deferral of publishing expenses that will be paid during 2014. It's anticipated that 2014 will produce a deficit with these added expenses which will necessitate the membership dues increase that was voted by the ALPO Board at last year's annual meeting. For a fuller explanation of general expenses and Journal production cost, see last year's minutes. The ALPO Springfield account's balance was $5,652.25 as of June 15, 2014.

Originally, the dues increase was scheduled for January 1, 2015. Since releases of the Journal are occurring a few weeks in advance of the normal publication dates, it is likely that the Winter 2015 issue will be released on or about the second week of December 2014. Having a dues increase a few weeks later, on January 1st, is likely to cause some confusion as members will be in the process of renewing. It would be better to have the dues increase as close to the date of the release of a new issue of the Journal as possible. Therefore, Matthew Will recommended deferring the dues increase until March 1, 2015, a week or two before the release of the spring issue of the Journal. Mike Reynolds made a motion to push back the date for the increase to March 1, 2015. Richard Schmude seconded the motion. The vote from the ALPO Board was 7 voting yes and 0 voting no. The motion carried.

Below is the table for dues increase to begin March 1, 2015.

Table of Proposed Dues Increases (2015)

Type of Membership	Old Rates	New Rates
One-Year Paper Domestic	$33.00	$39.00
Two-Year Paper Domestic	$60.00	$72.00
One-Year Paper International	$40.00	$46.00
Two-Year Paper International	$74.00	$86.00
One-Year Digital	$12.00	$14.00
Two-Year Digital	$20.00	$24.00
Sustaining Member	$65.00	$75.00
Sponsor	$130.00	$150.00

The ALPO Endowment continues to grow. The purpose of the ALPO Endowment is to eventually provide funding for an ALPO central office. Since June of last year, the Endowment increased its value by $2,510.29 to a total of $32,171.32. The increase was due chiefly to contributions from higher level ALPO memberships and some donations.

Surprisingly, the ALPO membership has grown over the last year, from 358 members to 381 with the release of the last issue of the Journal. Renewals are up and new members seem to be joining at a steady rate. The reason for this may be due to the practice instituted beginning June of last year of sending out first renewal notices in the postal mail, enclosed in a number 10 envelope, separate from the Journal mailings. Response to this policy has been positive for it gives the member an additional opportunity to renew in addition to responding to the blow sheet renewal forms that are tucked into the Journal issue that is mailed out.

Board member Sanjay Limaye suggested that the ALPO might consider advertising in Sky & Telescope to increase ALPO membership. In the past, the cost of advertising in Sky & Telescope has been prohibitive, but Matt Will was willing to look into it again. Sanjay also suggested that press releases to mainstream publication such as USA Today, Wall Street Journal, Associated Press, etc., might engender a special notoriety that would make others in the astronomical community think seriously about belonging to our organization. Ken noted that the ALPO and the Astronomical League have had an unofficial reciprocating ad policy. A recent ad in the League's publication promoting ALPO membership didn't seem to bump our new member numbers much from what we might expect considering the size of the Astronomical League's membership, which is around 16,000 members.

Matt Will and Ken Poshedly will proceed with finishing production of a brochure intended to solicit advertisements from astronomical related businesses and corporate sponsorships. Hopefully, this revenue stream will help to stabilize finances and grow our endowment.

Issue Four: Membership Workgroup Status

(Introduced by Matthew Will).

The ALPO Membership Workgroup was formed to explore and find new and dynamic ways for promoting and stabilizing ALPO membership. The workgroup currently is composed of thirteen members that represent a diverse sampling of person with educational, public relations, administrative expertise as well as talents and skill in digital communications.The workgroup has proposed up to 16 different projects to work on, though the energies of the workgroup will be confined to a few initially. Several members have committed to working on these projects. Matt Will, the workgroup's chair will coordinate with the workgroup to perform a membership survey, the first since 1998. The chair wishes to thank all that are participating in the workgroup. Others are welcome to join the workgroup and offer suggestions and projects to work on.

Issue Five: Review of Current Staff Status

(Introduced by Ken Poshedly and Matthew Will)

Executive Director Ken Poshedly has made a number of appointments in the last year that are defined by our own standing rules as acting staff members. The ALPO Board votes to confer permanent status on acting staff usually after two years or more in that position or until the Board feels that an acting staff member is meeting the needs for that position. Other acting staff have been in their positions for more than a year but not for the full two years. So, there were no changes in staff status. Also, all ALPO staff were found to be in good standing with their ALPO memberships with no expirations reported.

The disposition and definition of scientific advisors attached to ALPO observing sections and the ALPO Board was debated at this meeting. Ken Poshedly expressed the viewpoint that scientific advisors seem to be less inclined to participate in peer review or providing other support to the ALPO. Matthew Will pointed out that our guidelines and standing rules documents for ALPO Board and Staff do not define the position of scientific advisor beyond a consulting capacity to the section under their presently assumed roles. While scientific advisors in the past have provided valuable support to the various sections to which they are attached, they can also serve to provide greater support the ALPO in other capacities. At the Board level, a professional astronomer sitting on the Board might be asked to help ALPO staff network with other professionals in need of ALPO observational data. Don Parker and Richard Schmude said that ALPO observational data is continually being used to supplement professional studies. John Westfall suggested that reviewing publications such as Icarus in subject areas that the ALPO covers might prove to be a fertile ground for future recruitment of scientific advisors at the staff and Board levels.

To address Ken's concerns, Matthew Will volunteered to draft language in both the guidelines and standing rules to further define the scientific advisor's role both at the staff and Board levels.

Issue Six: Publications Staff and Peer Review

(Introduced by Ken Poshedly)

The issue of the continued role of the scientific editor positions in the Publications Section and peer review for the Journal was discussed by the ALPO Board. Ken Poshedly related to the Board his experiences in employing the current scientific editors for peer review efforts. While some scientific editors took peer review efforts seriously, checking for scientific content and accuracy as well as grammar, others would not go beyond checking the readability of submitted scientific papers. Rigorous peer review in the Journal insures that the content of all articles and papers are true and accurate. Anything less cast doubt on authenticity and reliability of data and statements made in the Journal. The credibility of good peer review is reflected in the choice of reviewers. While the ALPO still has some worthy reviewers, the credibility of any publication is strengthened when it seeks out peer reviewers from outside the publication that can give an unbiased appraisal of the work being reviewed. The ALPO should be adapting its peer review process toward inviting outside reviewers to study and appraise submissions for publication. Ken had noted that he has already begun this process with outside reviewers from local universities in Georgia. In light of this recent change in policy regarding peer review for papers published in the Journal, there seems to be little need to officially maintaining a roster of scientific editors for this purpose. Ken Poshedly made a motion to retire the position of scientific editor from the Publications Section. John Westfall seconded the motion. The motion carried by a vote of 7 to 0 from the ALPO Board. The ALPO Board wishes to thank scientific editors Klaus Brasch, Richard Jakiel, Roger Venable, and John Westfall for their participation in reviewing ALPO articles and papers for the Journal, over the many years.

Issue Seven: Mars Section Apparition Reports

(Introduced by Ken Poshedly and Matthew Will)

It has come to the attention of the ALPO Board that the Mars Section has not had an apparition report published in the Journal since the apparition report of 2003 appeared in issue Vol. 46, No. 3. The ALPO Board appreciates the turnover in Mars Section staff in recent years and its commitment of the newer staff members in reporting recent findings of Mars phenomena in the ALPO section report pages in the Journal and at annual meetings. As a major section that defines apparitions as distinct periods for evaluation of observational data, the Board's concern is to see that apparition reports can still be accomplished in a methodically manner. Ken Poshedly in his capacity as Executive Director has agreed to engage in a dialogue with the Mars Section to see what steps need to be made to make this happen.

Issue Eight: Website Issues

(Introduced by Ken Poshedly and Matthew Will)

Ken Poshedly stated that it's time for ALPO coordinators to review their section web pages and discard old or outdated information that has no archival value or relevance. Also, some coordinators should consider refreshing and updating these pages that don't have timely information or observations. Updated material indicates to others that the section is still active, which of course, the impression we want to project on these pages.

Issue Nine: Observer's and Service Awards

(Introduced by Ken Poshedly)

The ALPO has two awards to honor persons providing outstanding work for our programs. The Walter H. Haas Observer's Award is bestowed annually to an amateur astronomer for excellence in observational Solar System astronomy. This award is named after our founder and director emeritus, and was established in 1985. The selection of this award is conducted by a committee convened by its committee chairman, Don Parker. The composition of the committee changes from year to year so that the responsibility of selection is shared by a wider group of well-qualified members of the ALPO, while allowing others that vote one year to be considered for the award in another year when not serving on the committee. The Award itself consists of an engraved plaque. The awardee also receives a two-year complimentary membership in the ALPO. This year's recipient is Paul Maxson. Paul's interest in imaging the sun and planets started in the mid 1970's. The late Chick Capen mentored Paul in planetary photography and persuaded him to become an ALPO member in 1976, Paul has served as an ALPO staff member for the Solar Section in the 1980's and 1990's, eventually guiding that section as a lead coordinator from July 1993 to October 1996. Paul has done outstanding work in imaging the Solar System over the many years contributing his work to many ALPO observing sections that includes requests for his images in assisting with professional research and outreach. Congratulations Paul!

The Peggy Haas Service Award was established to recognize a member of the ALPO for outstanding service to our organization. This award was named after our founder's late wife for her past support of the ALPO in many meaningful and indispensable ways, from assisting her husband with the Journal to performing such functions the ALPO's Librarian for its book-lending service from 1966 to 1985. The award was inaugurated in 1997. The current executive director solely selects the recipient for this award. The Peggy Haas Award can recognize an ALPO officer, board member, volunteer staff member, or non-staff member who has contributed outstanding service in some way to the organization, in a capacity excluding observational skills (observational skills are recognized by the Walter H. Haas Award). Considered not to be an annual award, presentation will occur when appropriate and not at any specific time interval. The Award itself consists of an engraved plaque. The awardee also receives a lifetime membership in the ALPO. No awardee was selected at the time of our annual meeting.

Adjournment

Without any new business to conduct, the meeting adjourned at 11:16 AM CDT on July 12, 2014.

Book Review

Lunar Domes: Properties and Formation Processes

Review by Robert Garfinkle, FRAS
ALPO Book Review Editor
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Lunar Domes: Properties and Formation Processes by Raffaello Lena, Christian Wöhler, James Phillips, and Maria Teresa Chiocchetta, (Springer Praxis Publishing), 2013. 174 pages, index, 145 half-tone images, 10 color images, 247 x 175 cm. Price $89.95 (e-book $69.95) (hardback; ISBN 978-88-470-2636-0; e-book, ISBN 978-88-470-2637-7).

Back in the 1960s, members of the lunar sections of the Association of Lunar and Planetary Observers (ALPO) and the British Astronomical Association (BAA) joined forces to try to catalogue lunar domes. Varying observational skill levels of the observers, poor quality lunar maps, and differing optical equipment hampered these early compliers. The early catalogues contained many errors in dome location coordinates, descriptions, and the listing of features that were non-existent or non-domes. The compliers in some cases listed the same dome at different orthographic coordinates. At the time of the commencement of the cataloguing, the only detailed lunar map was the Hugh Percy Wilkins (1896–1960) 300-inch map, but that map had systematic errors in the placement of its coordinate lines. Fifty years later, that problem has been removed with our modern lunar maps.

Lunar Domes uses modern high-tech lunar spacecraft imaging and electronic maps from relatively recent missions to the Moon along with Earth-based CCD images to assist in locating domes and calculating dome's selenographic coordinates. Software programs not available to the early cataloguers are also employed to discover a dome's type, geological properties, chemical makeup, slope angles, and dimensions. How to accomplish this data mining is explained in detail throughout the book. The authors are all experienced lunar dome observers and this expertise shows throughout the book.

The book is divided into two main parts. The first part covers the morphometry, geophysical modeling and lunar dome formation processes. The second half of the book covers how to observe lunar domes. The book is divided into nine chapters and two appendices. The book also includes a list of further references and the bibliography of references used by the authors to create this book. Before one begins to search the lunar surface for lunar domes, it is probably best to have a good understanding of just what you are looking for.

The first chapter gives in easy to understand language a description of eight different types of lunar domes and their general creative processes. They describe the difference between effusive and intrusive domes, volcanic cones, and lunar pyroclastic deposits. Covered are also descriptions of domes located in the maria and highlands and those domes that are bisected by a rille.

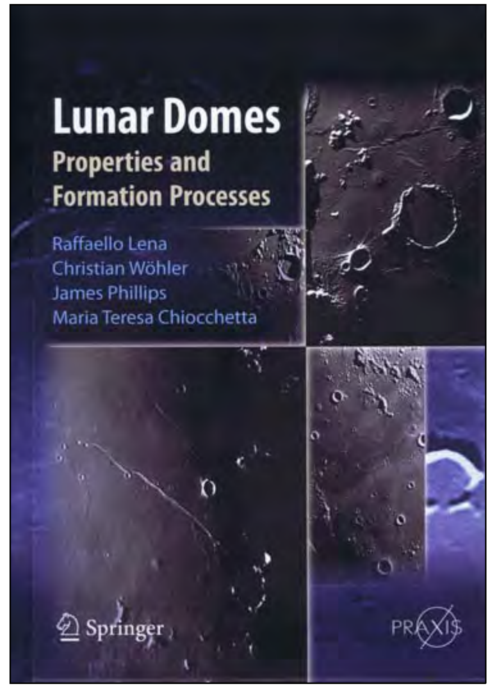
Chapter 2 teaches you how to observe lunar domes and determine their morphometric properties. The authors show you how to use CCD imaging and software in making these measurements.

Chapter 3 is how to use the reflectance spectra data from lunar orbiting spacecraft to determine the spectral properties of domes. With this information one can see the difference in the chemical makeup of the surface layer of a dome. Not all domes are made from the same type of lava. Some are high in titanium oxide (TiO_2) and others are of low TiO_2 basalts.

Not all lunar domes are the result of lava flowing out of a vent crater and building up layers of materials to form the gentling sloping domes. Some domes are the result of magma pushing up the top layers of the surface, but not breaking through to the surface. These can be either dikes or laccoliths. These intrusive domes are further explained in chapter 4.

Once you have collected data on a dome, the dome needs to be put into some scheme of classification so it can be compared to like features. That is covered in chapter 5.

Part II of the books is where you will begin to search for and observe lunar domes. The authors selected the domes near Birt, Menelaus, and the bisected dome near Gassendi for detailed study in this chapter. Other domes receive this in-depth coverage in the following chapters.



Chapter 7 is divided into 2 sections. The first covers effusive domes located on the eastern half of the lunar disk (from 0° to 90° east selenographic longitude). The second half of this chapter covers the effusive domes on the other half of the lunar disk. The authors take the time to thoroughly discuss typical domes. The chapters also contain tables of data about the domes covered.

One thing that I feel is missing is a glossary of terms and acronyms introduced in the book. This would make it easier for a reader to understand such things and not have to go back and try to find in the text where the term or acronym was first used or explained. The list of references is extensive with many current articles listed. Overall, I highly recommend this book to both professional and amateurs lunar observers who love to hunt for, observe, and understand all there is to discover and learn about lunar domes.

***Robert A. Garfinkle, FRAS,** is an independent scholar of the history of astronomy and author of two astronomy books. He is also our JALPO book review editor. Book reviews appropriate for the ALPO are welcome for publication in this journal. Please send your reviews to the ALPO Book Review Editor, Bob Garfinkle at ragarf@earthlink.net.*

Feature Story:

Expectation and Observation

By Thomas Dobbins, coordinator, ALPO Historical Section
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Online readers may left-click their mouse on an author's e-mail addresses in blue text to contact the author of this article.

Likewise, left-click on the various hyperlinks in the References section at the end of this paper for online sources of further information.

Discussion

Even as the 20th century drew to a close, visual observers of the planets continued to make unexpected discoveries. Two sterling examples were the work of Stephen James O'Meara [Figure 1].

In 1976 O'Meara reported the presence of dusky radial "spokes" in Saturn's B-Ring, delicate, ephemeral features that had been independently recorded in 1887 by Thomas Gwyn Elger in England and Charles-Émile Stuyvaert in Belgium [Reference 1]. Five years later O'Meara determined an accurate rotation period for features in the temperate latitudes of distant Uranus [Reference 2].

These remarkable feats of visual acuity, both accomplished using a surprisingly modest telescope (the 9-inch Clark refractor of the Harvard-Smithsonian Center for Astrophysics), were initially greeted with skepticism and even derision. The credibility of visual observers had been irreparably damaged early in the 20th century by the bitter debate that raged for decades over the presence of canals on Mars [Figure 2]. In a 1967 address to the Arizona Academy of Sciences, Gerard Kuiper (1905-1973), the leading American planetary scientist of his generation, complained bitterly about the lingering effects of the Martian canal controversy. He attributed the longevity of the myth to a perverse rating system that emerged among the amateur community of Mars observers during the 1920s:

Figure 1: Steven James O'Meara, renowned for his remarkably keen eyesight and prowess as a visual observer.

> *The careful observers with better telescopes who continued to denounce the canals as optical illusions were castigated. This controversy brought disrepute to planetary science and weakened its status in universities. To this day the effects have not been overcome and affect even the NASA programs adversely through inadequate academic scientific support.*
>
> *Before leaving the subject of the Martian canals it is instructive to see how the cult was perpetuated in the semi-professional literature for decades. For many years W. H. Pickering, the brother of the famous Harvard astronomer E. C. Pickering, collected amateur observations of Martian canals and published the results in 44 reports in Popular Astronomy. The amateur observers were "rated" by the number of canals they had noted. Thus, there was a premium on reporting many canals [Reference 3].*

The notion that under good atmospheric conditions any observer worth his salt who was equipped with a decent telescope should be able to see canals persisted well into the 1960s [Reference 4]. The Cave Optical Company's 1962 catalog enticed prospective customers with the claim that "Mars is seen in a wealth of very fine maria and canal detail" through the firm's 10-inch Astrola reflectors. Readers of the 1964 Optical Craftsmen catalog were assured that "much of the subtle canal network of Mars can be observed at favorable oppositions" through an 8-inch Connoisseur Series telescopes.

A cautionary tale of the interplay of expectation and observation from the annals of military history is worth recounting in any discussion of the phenomenon called "expectancy bias" by cognitive psychologists. Fifteen months before the outbreak of World War Two in Europe an experimental fighter plane known as the Heinkel He-100 captured the first absolute air speed record for Germany. Plagued by engine overheating, a fragile cooling system, and a rash of landing gear failures, the promising design was rejected by the German Air Ministry in favor of the Messerschmitt Bf-109, which would serve as the Luftwaffe's principal single-engine fighter throughout the coming war. The twelve He-100 prototypes were relegated to the defense of the Heinkel factory at Rostock on the Baltic coast. Manned by factory test pilots, they would never fire a shot in anger [Reference 5].

In the spring of 1940 Josef Goebbels' Propaganda Ministry decided to put the dozen idle He-100s to good use. Re-christened the Heinkel He-113, the aircraft were painted and re-painted with the insignia of several fictitious squadrons and staged on a variety of German airfields [Figure 3]. Heinkel workers posed as Luftwaffe pilots and ground crew in a series of photographs that appeared in German newspapers and magazines to accompany announcements that a sleek new fighter of unrivalled performance was beginning to enter Luftwaffe service.

The ruse was a resounding success. The alarmed British military intelligence services warned pilots and anti-aircraft gunners that they would soon be encountering the He-113. Within a month Royal Air Force pilots began to report dogfights with He-113s over the English Channel. Some pilots even contrasted the He-113's appearance and performance with those of the Messerschmitt Bf-109, the aircraft they had actually encountered [Reference 6].

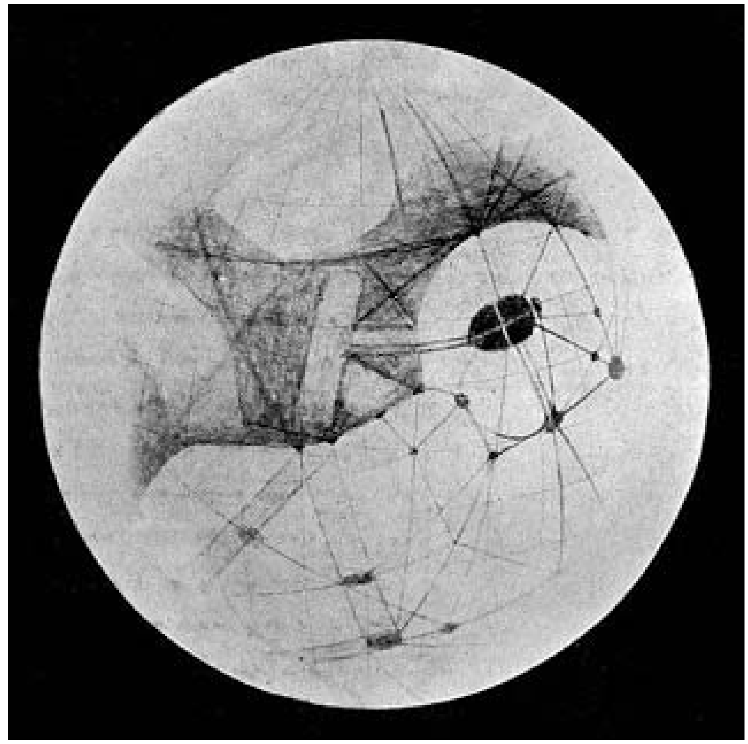

Figure 2: Percival Lowell's depiction of an intricate network of gossamer-thin, rectilinear Martian canals, the subject of a decades-long debate.

Pilots, anti-aircraft gunners, and aircraft spotters received extensive training in aircraft recognition. The ability to rapidly and accurately identify both friendly and enemy aircraft was literally a matter of life and death. Posters and flash cards featuring aircraft silhouettes were widely employed to foster the ability to recognize aircraft at a glance [Figure 4].

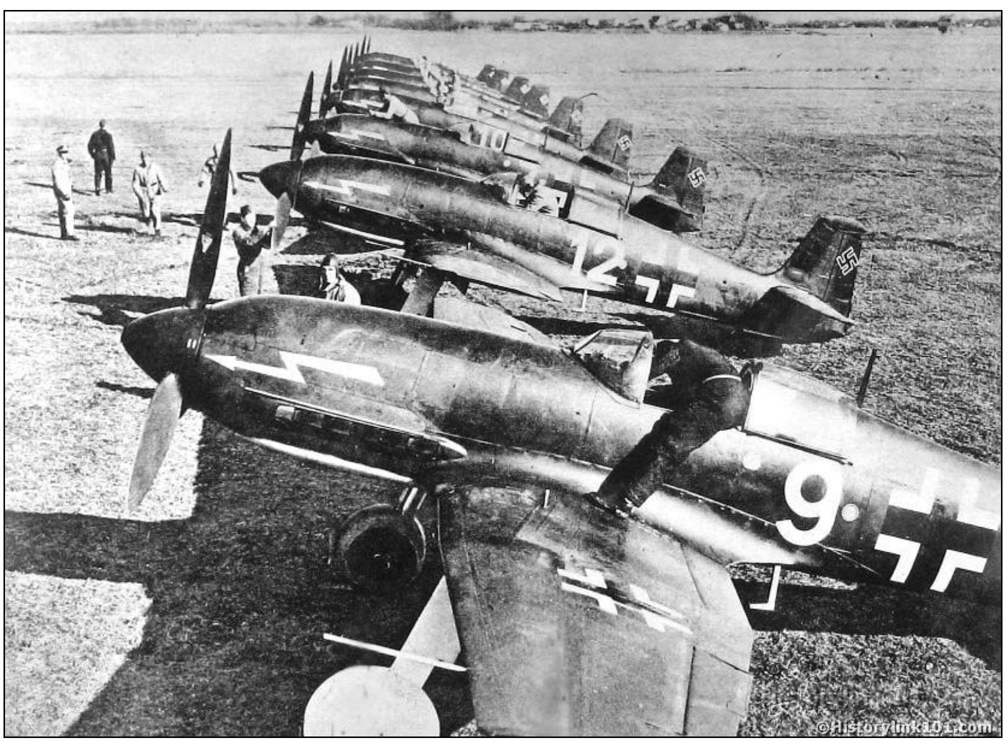

Figure 3: One of the photographs of the Heinkel He-100 prototypes used in the clever German deception operation.

Although the He-113 bore a superficial resemblance to the Bf-109, it differed in a number of aspects that should never have eluded a trained eye, notably a prominent radiator located under the middle of the fuselage, a comparatively large rudder, inverted gull wings, a retractable tail wheel, and inward-retracting wide-track undercarriage that were completely enclosed in flight. Despite these salient differences with the Bf-109, sporadic reports of encounters with He-113s continued for years. It was only after the war that the British realized the extent to which they had been hoodwinked. More than a twinge of embarrassment may account for the fact that the Air Ministry's files on the He-113 were only declassified in 1972.

How were such highly trained observers repeatedly deceived? The answer is really quite simple – they "saw" what they were told to expect to see, just like the host of observers who "saw" a network of canals on Mars. The same interplay of expectation and observation has no doubt contributed to the controversial reports of the ashen light of Venus [Reference 7] and transient lunar phenomena [Reference 8]. The story of the He-113 is worth recalling if only momentarily whenever we look through a telescope.

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2. Thomas Dobbins, "A Last Hurrah at Uranus" *Sky & Telescope*, September 2012, p. 54.

3. Kuiper's address appeared as Appendix C in the Condon Report, the informal name of the University of Colorado's UFO study. See Edward V. Condon, Scientific Study of Unidentified Flying Objects (New York: E.P. Dutton) 1969. pp. 1309-1315; ; *http://www.avia-it.com/act/biblioteca/libri/PDF_Libri_By_Archive.org/AVIATION/Final%20report%20of%20the%20Scientific%20study%20of%20Unidentified%20Flying%20Objects%20-%20Condon%20E..pdf*

4. Thomas Dobbins and William Sheehan "The Canals of Mars Revisited" *Sky & Telescope*, June 2003, p. 28.

5. Hans-Peter Dabrowski, Heinkel He-100, World Record and Propaganda Aircraft (Altglen, Pennsylvania: Schiffer Publishing) 1991; *http://www.amazon.com/Heinkel-He-100-Propaganda-Aircraft/dp/088740345X*

6. Leonard James, Hitler's Forgotten Secret Weapon: The Incredible Story of the Heinkel He-113 Super Fighter in the Battle of Britain (United Kingdom: Bretwalda Books) 2012; *http://www.amazon.co.uk/Hitlers-Forgotten-Secret-Weapon-Bbritain/dp/1907791531*

7. For an up-to-date overview of the ashen light phenomenon with cogent reasons for skepticism, see William Sheehan, Klaus Brasch, Dale Cruikshank, Richard Baum, "The Ashen Light of Venus: The Oldest Unsolved Solar System Mystery" *Journal of the British Astronomical Association*, 124,4, 2014, 209-215; *http://www.britastro.org/journal_item/5631*

8. For a skeptical polemic about TLPs, see Thomas Dobbins and William Sheehan "Transient Lunacy" *Selenology Today*, Issue 34, 2014, 4-33; *http://www.lunar-captures.com//Selenology_Today/selenologytoday34.pdf*

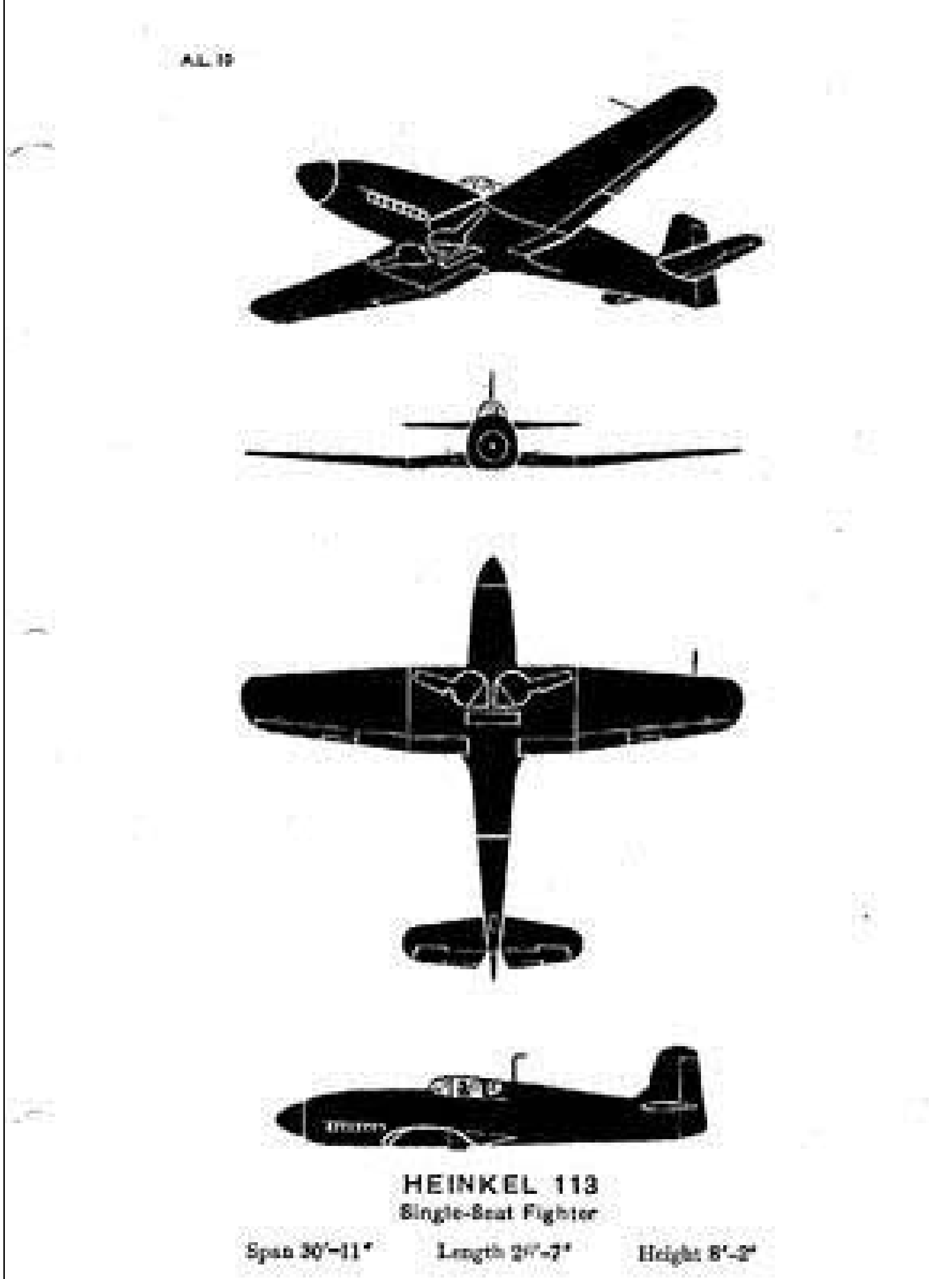

Figure 4: The British Air Ministry issued this recognition poster of the Heinkel He-113 in 1940.

Feature Story:
Wrinkles and Rilles

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Introduction

High relief features attract the most attention from most lunar observers. Craters and mountains near the terminator provide spectacular (sometimes rapidly changing) views. However, there's a range of less obvious structures whose common feature is that they are low-relief, narrow, elongated features that, in most cases, are only visible under low-angle illumination. Hence, they are best observed, but often overlooked, among the high-relief, commonly observed, features along the terminator. Because they are narrow features, and low-angle illumination is always from the east or west, there's an observational bias in favor of north-south-oriented features. These features are labeled with the names of "dorsum", "rima" or "rupes". However, within each of these categories, several different geologic mechanisms are involved.

Wrinkle Ridges or Dorsa

These are positive relief features, basically long, narrow ridges, often winding and with fairly gentle slopes. The slope is often steeper on one side than the other. At times the character changes along the ridge, with the steep side seemingly randomly changing from one side to the other along the length of the ridge, which gives a twisted appearance. The slope angle is fairly small, on the order of 10-20 degrees, so they are only obvious at low Sun angles, near the terminator. Typical height above the surroundings is around 100 meters.

They are commonly found around the edges of maria, although they also occur on the floors of flooded craters and at the boundaries of lava flows. Similar appearing roughly circular features, usually referred to as "ghost craters", mark the location of buried crater rims.

Figure 1 is an example of dorsa that are concentric with the edge of a mare. The usual explanation for these is that as the mare basin filled, the added weight caused the basin floor, and therefore the mare surface, to sink. The resulting tilting and stretching caused the material near the mare edge to crack and/or slide inwards. Cracking produces rilles that will be discussed later. Sliding compresses the rock, which bends to form the ridges. It also is possible that cracking and shifting of the surface material could form fault scarps (instead of rilles) that are covered by later lava flows, forming ridges similar to the formation of ghost craters. Figures 2 and 3 show what is probably the best known example of a wrinkle ridge concentric to the mare rim, the Serpentine Ridge in Mare Serenitatis (Dorsum Smirnov and Dorsum Lister). These ridges run north-south, so are ideally oriented to create shadows and extend from near Posidonius almost to Plinius. Figure 4 shows an example of ridges that seem to trace a buried inner ring of the Mare Imbrium basin. Dorsum Grabau arcs from the southwest to just west of Montes Spitzbergen, then an un-named low, broad ridge continues on toward Kirch.F. Just northwest of Kirch F, another un-named ridge continues on, passing just west of Mons Pico β. There also seems to be an un-named ghost

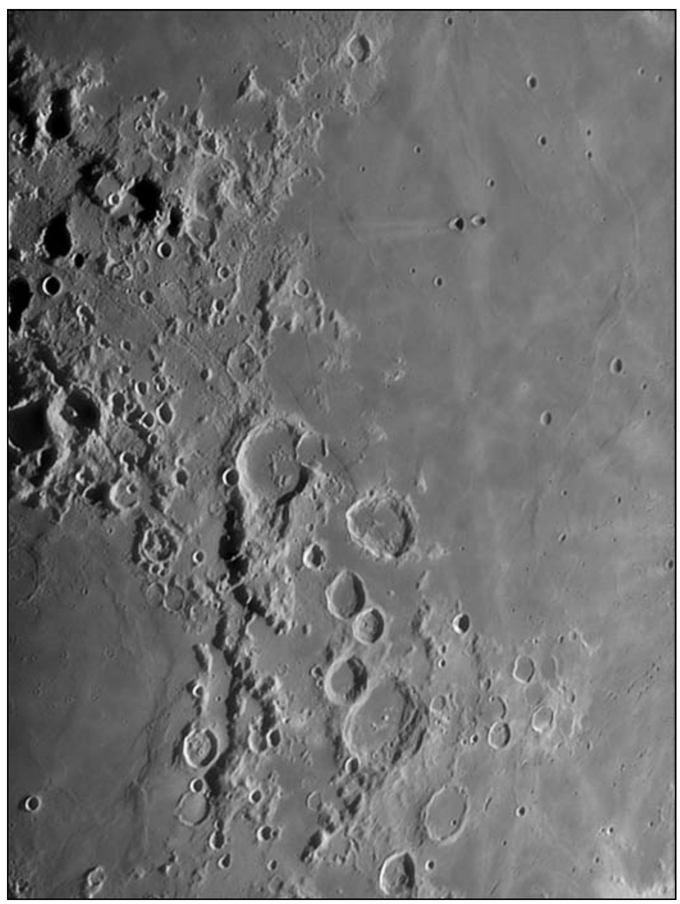

Figure 1. Mare Crisium. Rik Hill, Tucson, AZ USA. Oct. 03, 2012 06:45 UT. Seeing 7/10. TEC 8" Mak-Cass, f/20. 656.3nm filter, DMK21AU04.

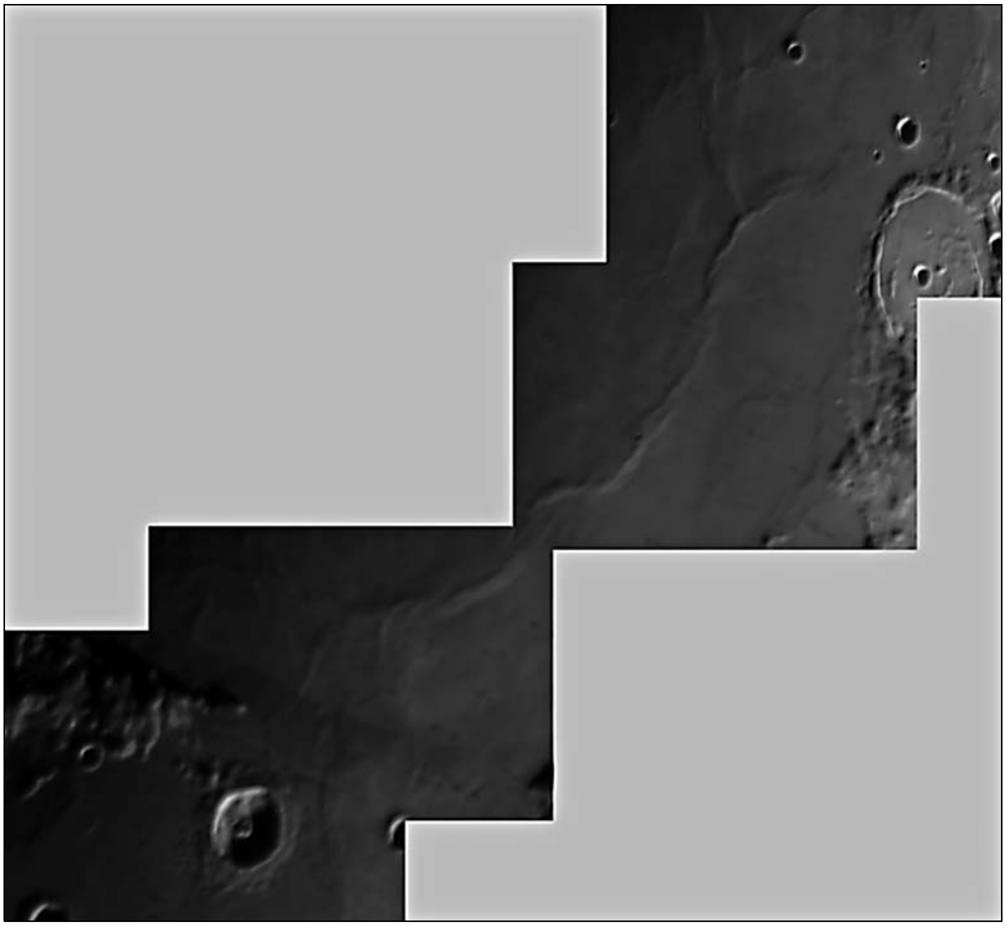

Figure 2. Serpentine Ridge. Marnix Praet. Stekene, Belgium. Meade 10" SCT, 2.5x Barlow. DMK21AU618.

crater south of Plato, with Mons Pico on its rim.

The north-south ridge that divides the crater Alphonsus is shown in Figure 5. This ridge includes the central peak and is accompanied through part of its length by a parallel rille to its west. It's difficult for me to visualize the source of compressional forces that could form this ridge, since the usual subsistence explanation should produce radially symmetric compression, not bi-lateral symmetry. There are also numerous rilles on the crater floor, but this is the only ridge. It also has an irregular, braided appearance. I wonder if it marks the location of a buried fault, or series of vents, that were a source of the magma that flooded Alphonsus. A different pattern of ridges appears in Grimaldi, more reminiscent of the mare marginal ridges.

Between Mons Piton and Aristillus, there's a ridge that looks like it could be the leading edge of a lava flow out of Mare Serenitatis (Figure 6).

Close examination of the images presented here, or your own observations, also show examples of ridges that deviate from the general descriptions given above. Examples are ridges that are perpendicular, rather than parallel to a mare rim, ridges located near the center of a mare, and tangled masses of ridges (the group of ridges northwest of Euclides is a good example of the latter).

Another class of features that sometimes appears similar to dorsa are “rupes” (scarps or cliffs). They differ from dorsa in that they only slope in one direction; one side is displaced vertically from the other. Rupes Altai (the Altai Scarp) is a well-known example of a cliff-like structure which forms part of the western outer rim of the Nectaris basin. Rupes are examples of geologic faults. There are several examples of faults with smoother structures however. The best known is Rupes Recta, the straight wall in Mare Nubium between Birt and Thebit (Figure 7). Lesser known is Rupes Cauchy in Mare Tranquilitatis (Figure 8). These look like straight versions of wrinkle ridges, but on closer examination it will be noted that since they only have one sloping face, they will either appear bright or dark, depending on whether the face is illuminated or shadowed. Dorsa, in comparison, will have both light and dark sides, since one side will be shadowed while the other is illuminated.

Rilles or Rimae

These are long, narrow, negative relief features. Like dorsa, there is more than one mechanism of formation involved. Some are nearly straight or smoothly curved. Others are sinuous, meandering back and forth like a terrestrial stream bed. And still others appear to have ragged edges or are discontinuous, as though formed by connecting small craters or pits.

Arcuate (bow-shaped or curved) rilles are found near the boundaries of mare surfaces (figures 9, 10 & 11, also see figures 7 & 8), where they apparently formed as the basalt filling the mare basin caused the basin floor to sink under its weight, bending and stretching the surface near the edge. When the rock breaks under this tension, the edges separate, thereby forming a rille. When parallel sets of cracks form, the blocks between them can shift downward, forming a graben, which also appears as a rille.

Rilles are also commonly found on the floors of flat-bottomed, flooded craters (Figure 9). Gassendi and Hevelius are examples of floor-fractured craters. Here, the rilles are formed by magma intrusion beneath the flooded crater floor causing the floor to stretch into a shallow dome.

Sinuous (meandering) rilles are formed by fluid lava flowing downslope and eroding the pre-existing surface, either by mechanical or thermal erosion. The result is similar to stream channels on the Earth but with a significant difference. Terrestrial stream channels start out small and grow as they collect more water from a larger area, either from direct run-off or merging of tributary streams. Lava channels start out large at their

sources, but narrow as the lava solidifies. One of the best, and most visible, examples is Schröter's Valley near Aristarchus (Figure 12), which starts at the Cobra Head and winds down the Aristarchus Plateau to terminate in Oceanus Procellarum. It was probably a significant source of the lava that filled northern Procellarum. The valley itself is several kilometers wide, but spacecraft have shown a narrow rille running the length of its floor, similar to terrestrial streams that have eroded large valleys.

Another form of rille is created when a lava flow is deep and slow enough that the surface cools and solidifies, allowing the fluid lava below to drain away forming lava tubes. When the roof of the tube collapses or is punctured, the resulting channel is also a rille. Rima Hyginus (figures 13, 14 & 15) is a good example of this type of rille. The rille extending north from Hyginus has sections that appear to be a continuous string of overlapping collapse pits, and the southern portion has several sections where the roof appears to be intact. This is a good area to find rilles, with the Rimae Triesnecker, Hyginus and Ariadaeus all within a relatively small area, each showing different characteristics.

The dorsa and rimae are visually two different types of features. But within these classifications, there are examples that are formed by several different processes that result in superficially similar objects. They are somewhat difficult to observe since lighting is critical, but they are abundant on the Moon, so some can be found whenever you chose to look.

Additional Reading

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Figure 3. Dorsum Smirnov. Colin Ebdon, Colchester, Essex, England. July 18, 1999 20:15-1:00 UT. Seeing AIII deteriorating, transparency moderate - good. Colongitude 336.8-337.1º. 10", f/6.5 Newtonian, 183x & 236x.

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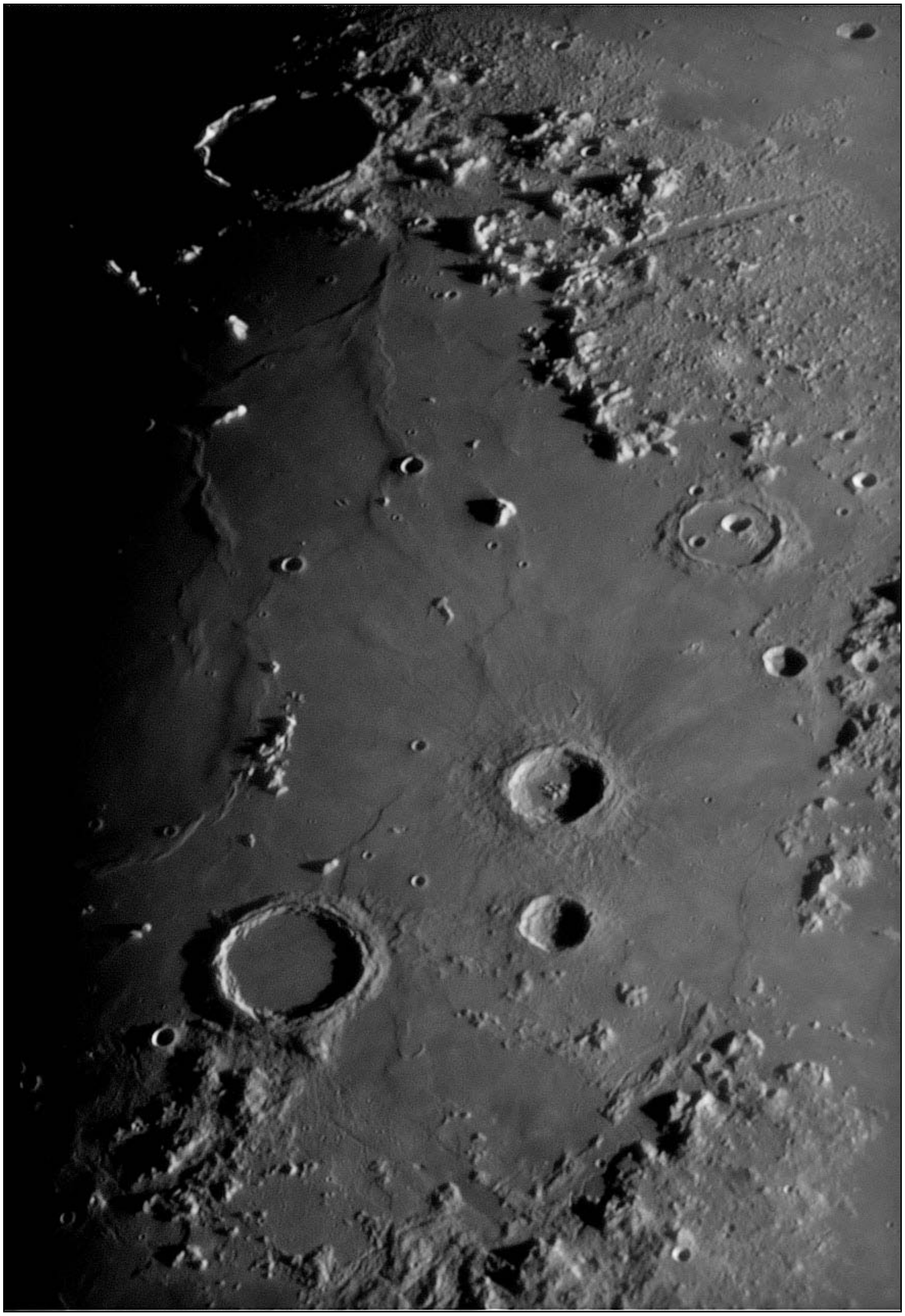

Figure 4. Archimedes-Plato. Howard Eskildsen, Ocala, FL USA. Nov. 22, 2012 01:51 UT. Seeing 6/10, transparency 5/6. 6" f/8 Refractor, 2x barlow, IR & V-block filters, DMK 41AU02.AS.

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Figure 5. Alphonsus. Howard Eskildsen, Ocala, FL USA. Nov. 22, 2012 01:26 UT. Seeing 6/10, transparency 5/6. 6” f/8 Refractor, 2x barlow, IR & V-block filters, DMK 41AU02.AS.

Figure 6. CASSINI-– Ed Crandall – Lewisville, North Carolina USA. October 23, 2012 00:07 UT. 110 mm, f/6.5 APO, 3x barlow, Toucam.

Figure 7. Rupes Recta. Fykatas Stergios. Vienna, Austria. March 2, 2012 23:12 UT. Seeing 6/10. LX90 8”, 2x barlow, Alccd5.

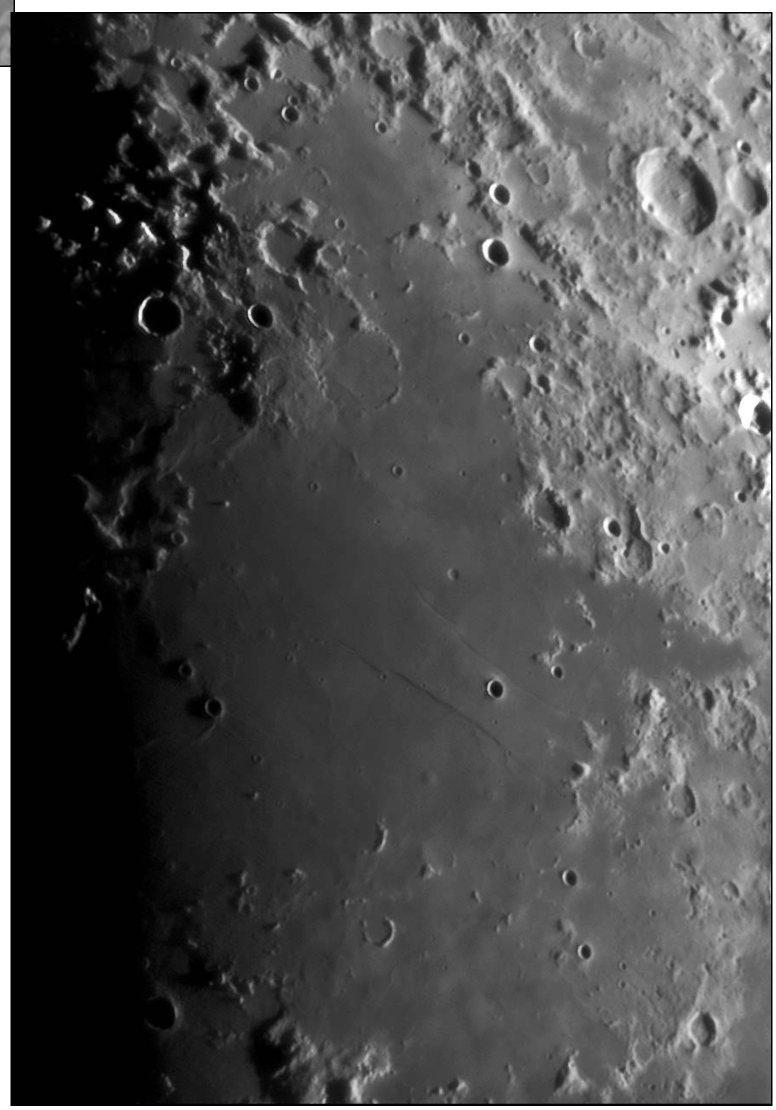

Figure 8. Rupes Cauchy. Howard Eskildsen, Ocala, FL USA. Jan. 17, 2013 00:26 UT. Seeing 6/10, transparency 5/6. 6” f/8 Refractor, 2x barlow, IR & V-block filters, DMK41AU02.AS.

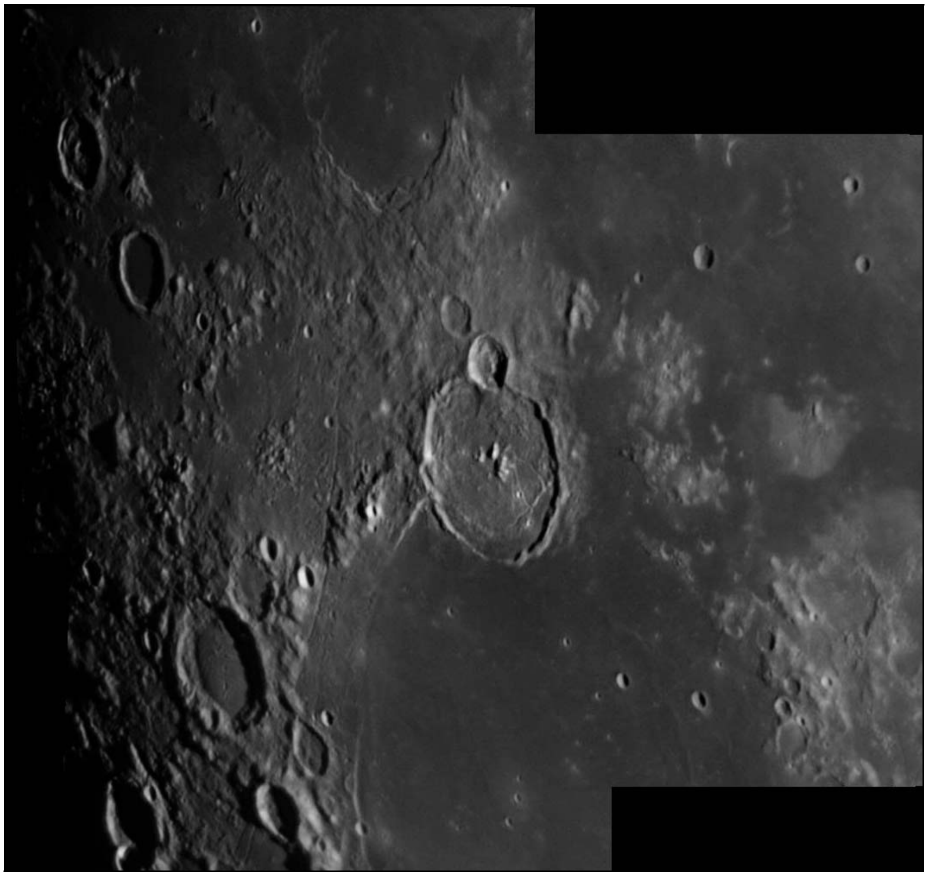

Figure 9a. Gassendi & Mare Humorum. Rik Hill, Tucson, AZ USA. TEC 8” Mak-Cass, f/20. 656.3nm filter, DMK21AU04. a: Oct. 27, 2012 04:09 UT.

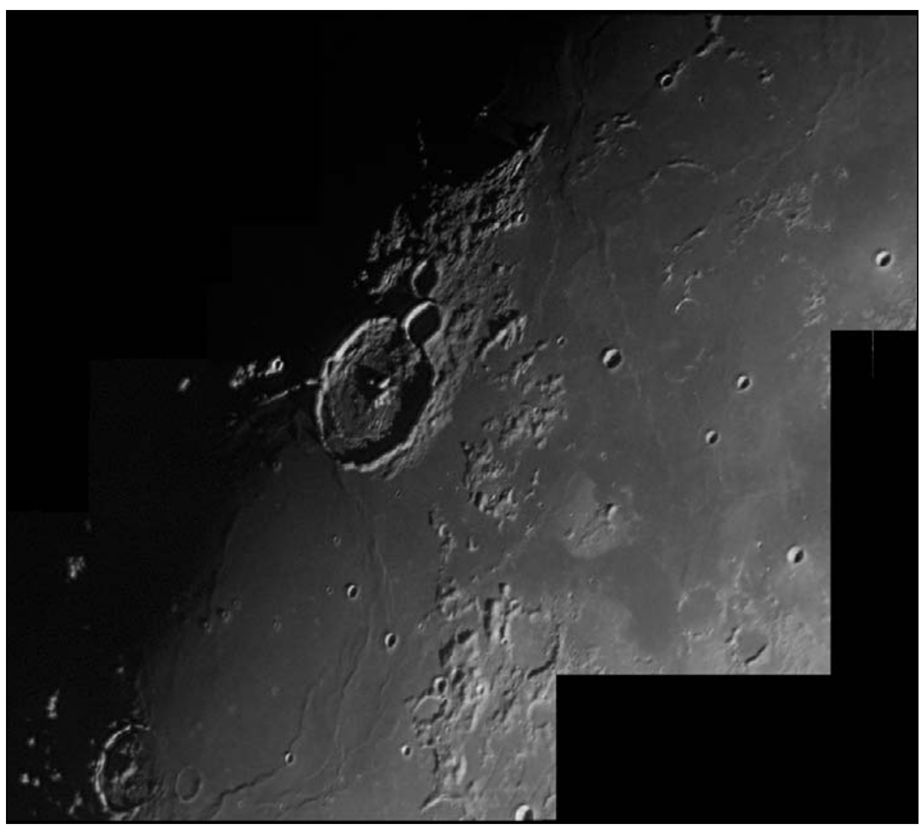

Figure 9b. Seeing 7/10. b: Oct. 26, 2012 03:47 UT. Seeing 8/10.

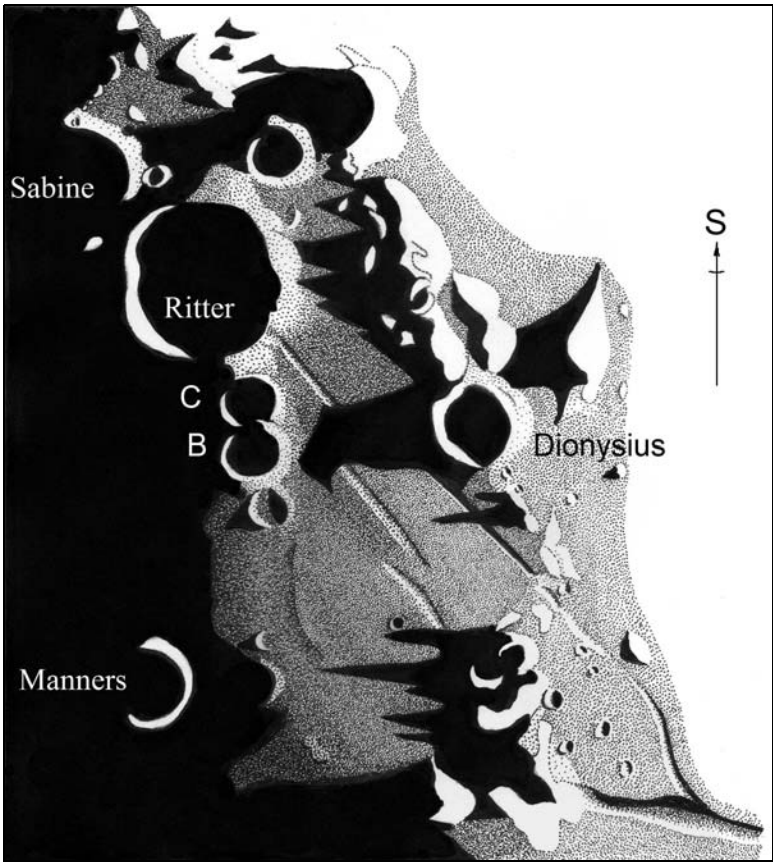

Figure 10. Dorsum Smirnov. Colin Ebdon, Colchester, Essex, England. July 18, 1999 20:15-1:00 UT. Seeing AIII deteriorating, transparency moderate - good. Colongitude 336.8-337.1º. 10", f/6.5 Newtonian, 183x & 236x.

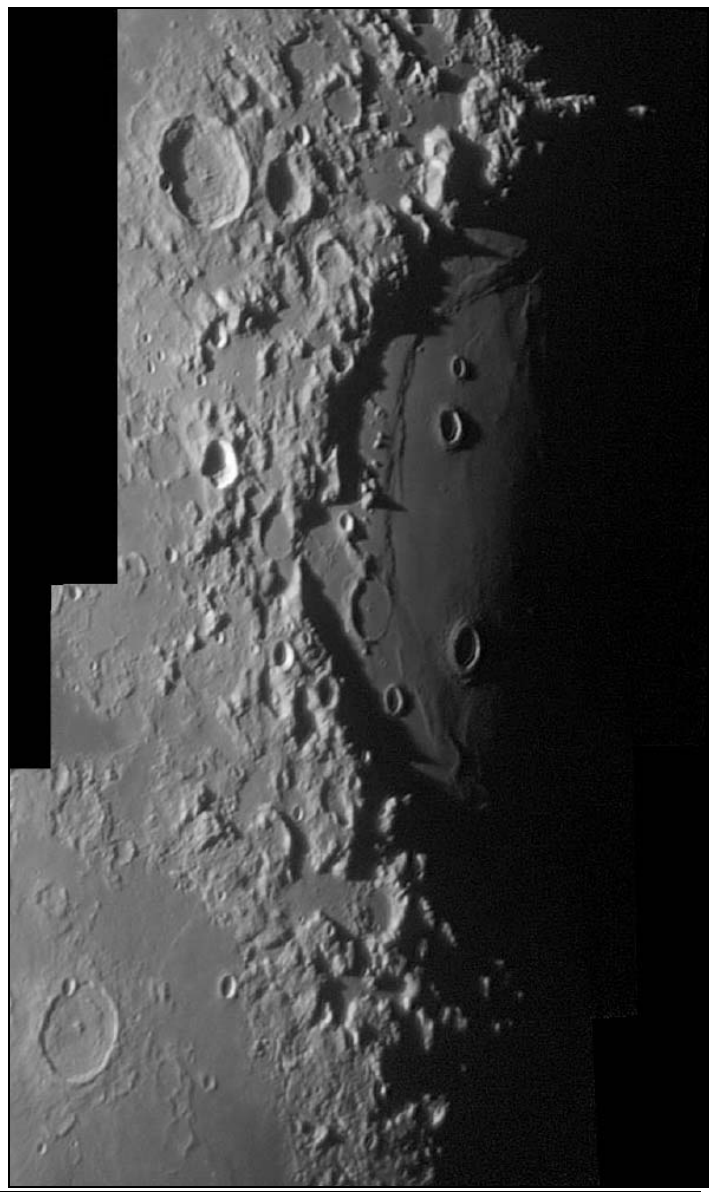

Figure 11. Goclenius. Howard Eskildsen, Ocala, FL USA. Jan. 17, 2013 00:23 UT. Seeing 6/10, transparency 5/6. 6” f/8 Refractor, 2x barlow, IR & V-block filters, DMK 41AU02.AS.

Figure 12. Aristarchus. Maurice Collins-Palmerston North, New Zealand. February 23, 2013 08:57 UT. WO FLT-110, Refractor f/21.

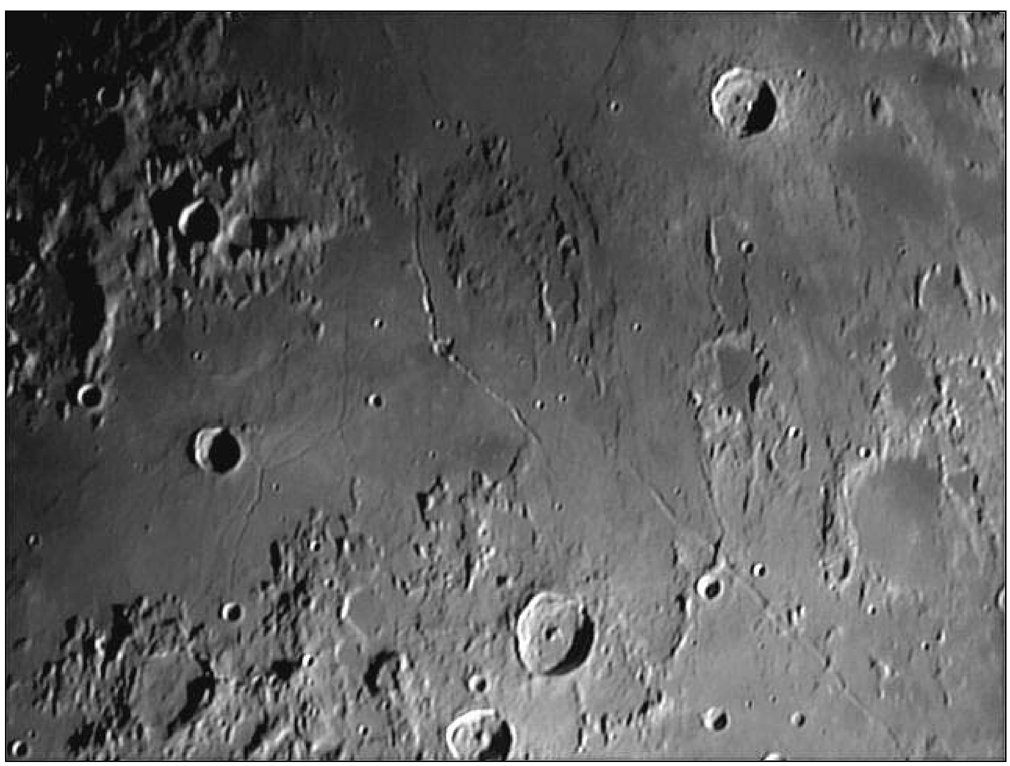

Figure 13. Rima Hyginus. Ed Crandall – Lewisville, North Carolina, USA. October 23, 2012 00:03 UT. 110 mm f/6.5 APO, 3x barlow, ToUcam.

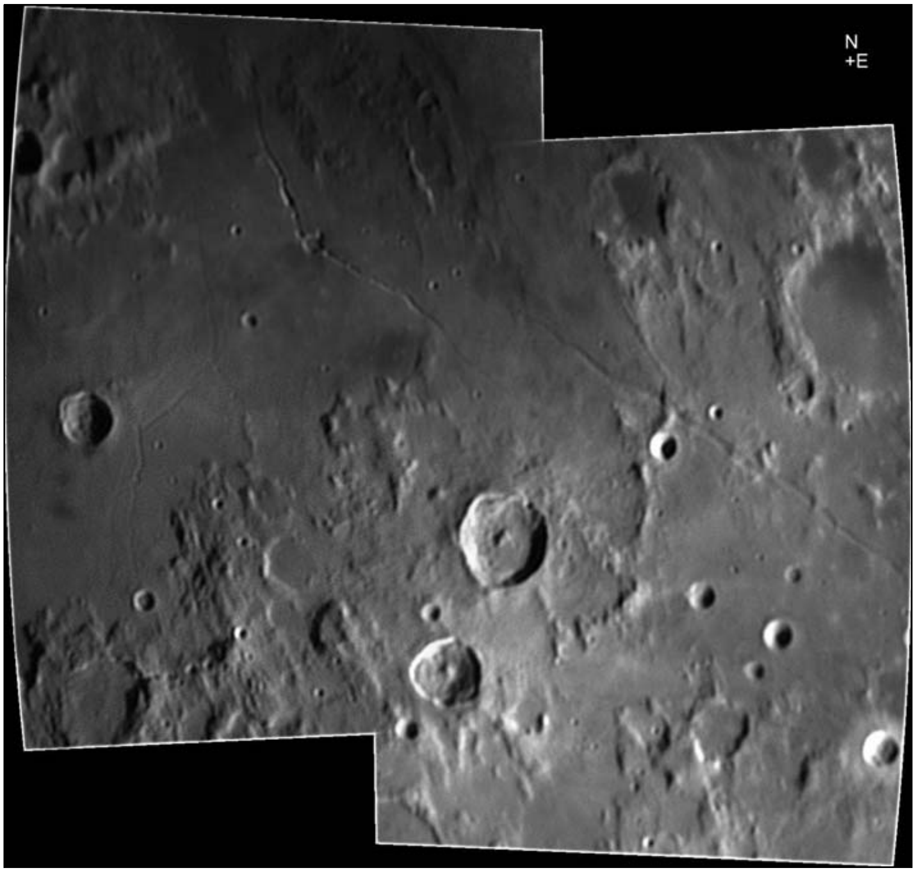

Figure 14. Rima Hyginus. Michael Sweetman. Tucson, AZ USA. January 20, 2013 06:44 UT. Seeing 3-4/10 Transparency 3/6. 6" MAK, f/24, 742 nm filter DMK21.

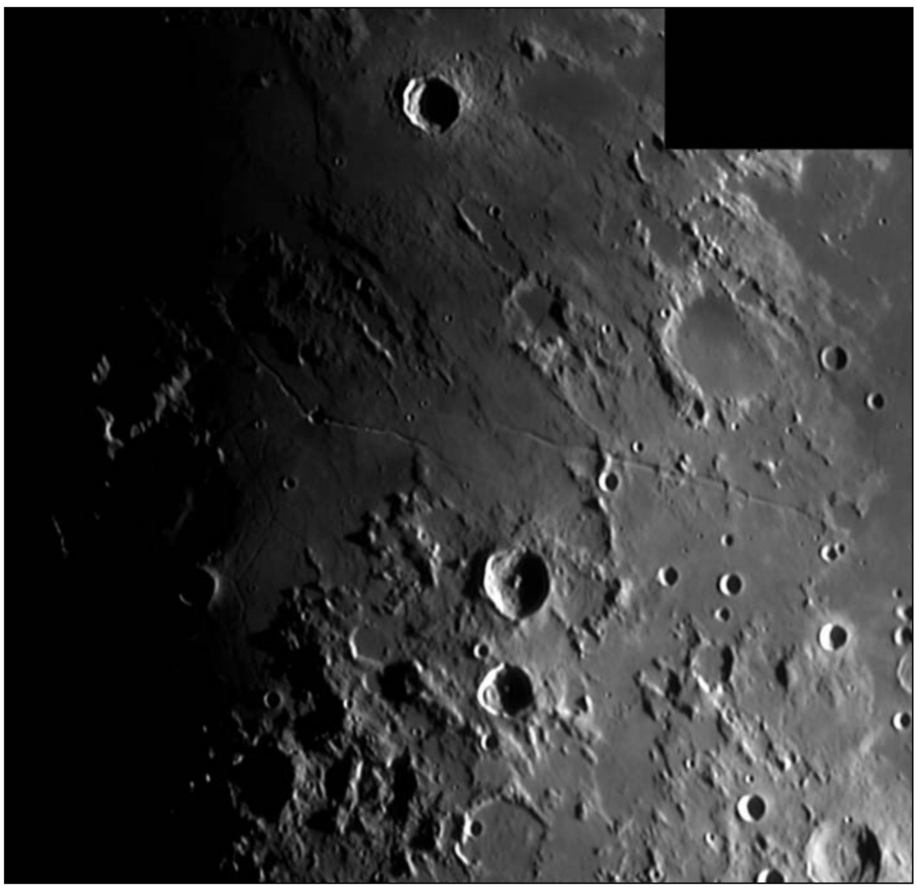

Figure 15. Rima Hyginus. Alexander Vandenbohede. Brugge, Belgium. Feb. 17, 2013 19:30 UT. 20cm f/15 refractor, webcam.

Feature Story

High Clouds at the Sunrise Terminator of Mars – Revisited

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Abstract

On March 19, 2012, at areocentric Ls 85, a cloud that was very high in Mars atmosphere and visible beyond the sunrise terminator was discovered by Wayne Jaeschke. It was imaged by him and subsequently by others on many nights. The cloud at the time of discovery was centered at about 45° south latitude and about 197° west longitude, and though most images of it found it to be near this location, a few documented it or similar high terminator clouds at quite different locations. Images of the cloud are presented here. Comparable clouds have been detected in the past, and they were at areocentric longitudes of the Sun and areographic locations different from this one. Certain images of the cloud are measurable, and the measurements show that the cloud was in the Martian mesosphere. Mesospheric clouds are routinely detected by spacecraft orbiting Mars, but in recent years have seldom been detected by Earth-based observers. Review is made of Minami's proposal that the cloud was an aurora. The present authors suggest that the composition and cause of the clouds are uncertain, but prominent possibilities include condensation of CO_2 in the Martian night, and water ice clouds related to atmospheric gravity waves.

Online Features

Left-click your mouse on: the author's e-mail address in blue text to contact any of the authors of this article.

Likewise, left-click on the various hyperlinks in the References section at the end of this paper for online sources of further information.

Note that colors or gradations of color in figures 1, 2, 3 and 8 cannot be displayed in the hardcopy (black-and-white) version of this paper.

Conventions Used in This Paper

In this paper, the planetographic longitude convention, with increasing longitude toward planetary west, is used exclusively. This is the convention that ALPO Mercury and Mars observers have long used, and it differs from the planetocentric longitude system, in which longitude increases to the east. Planetary east is defined as the direction toward which the planet rotates, just as it is with Earth. In the case of Mars, planetary east is approximately opposite to celestial east.

South is presented as up and planetary east (celestial west) to the left in all the images in this article.

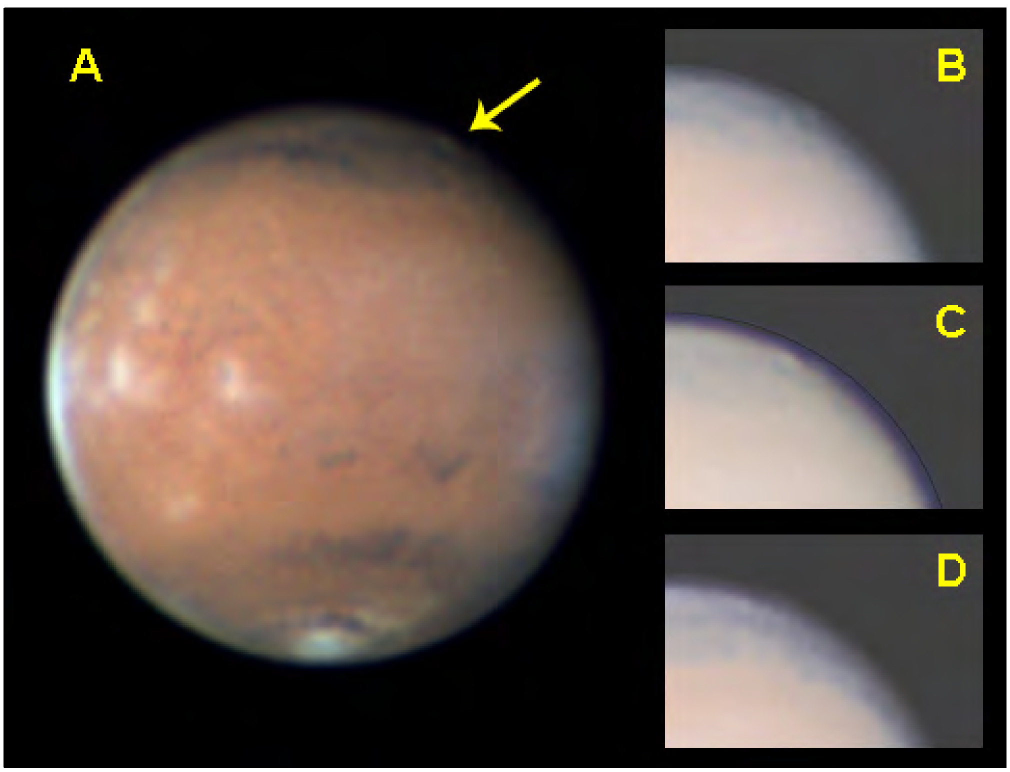

Figure 1. Mars images taken March 19, 2012, by Wayne Jaeschke. In this and all other images in this article, south is up, and planetary east (celestial west) is to the left. Panel A is a full disc image made at 02:56 UT, with central meridian (CM) of 158° west longitude. The arrow indicates the location along the terminator of the cloud feature discussed in this article. Panels B, C and D are sections of Wayne's three RGB composite images taken that night, brightened in order to show the feature along the terminator. Panel B was taken 43 minutes before panel A, CM = 147°; panel C is a section of the image of panel A; panel D was taken 51 minutes after panel A, CM = 170°. Schmidt-Cassegrain telescope of 356 mm aperture and Flea3 camera, using Astrodon filters. Composites of red, green, and blue images.

The Discovery

In the 2012 apparition of Mars, the March 3 opposition was shortly after the aphelion of February 15 and shortly before the northern winter solstice of March 30. Further information about that apparition has been detailed in this journal (Beish and Venable, 2011). The cloud detections presented in this article were made from March 12 to April 25, that is, shortly after opposition and near the time of northern winter solstice. The terminator visible after opposition is the sunrise terminator. The disc was still 98.81% illuminated as seen from Earth at the time of the first detection of the cloud on March 19.

Wayne Jaeschke is an observer in Pennsylvania, USA. On 19 March UT, 2012, he made three images of Mars, spaced 43 and 51 minutes apart. These showed a peculiar brightening along the southern part of the sunrise terminator. In Figure 1, the middle one of the three images is shown in panel A, displaying Jaeschke's excellent imaging skill, as much detail is depicted. The insets are from each of the three images of that night, and are enhanced to reveal the peculiarities along the southwest part of the terminator. After processing these images, he planned to observe on the next night (March 20, UT), to better characterize this feature. On the 20 he succeeded in making a series of nine

Table 1. Times, Circumstances, Observers, Locations and Colors of Imaged, Sunrise-Terminator Clouds

yyyy-mm-dd†	hh:mm†	CM‡	L_S‡	Figure	Cloud Lat. Range*	Cloud Long. Range*	Color Notes**
2012-03-12	23:05	154	83	3 (A)	-46.0 to -53.0	201	B = G > R
2012-03-14	23:28	142	83	3 (B)	-43.5 to -48.5	197	G > R = B
2012-03-15	00:10	152	83	3 (C)	-45.5 to -52.0	199	
2012-03-17	01:11	149	84	3 (D)	-43.5 to -50.0	197	
2012-03-19	02:31	151	85	3 (E)	-43.5 to -47.5	196	G > R = B
2012-03-19	02:56	157	85	1	-43.0 to -48.0	191 to 200	
2012-03-19	03:30	160	85	3 (F)	-49 to -53	205	
2012-03-20	00:02	106	86	3 (G)	-41 to -46	147 to 163	B > G > R
2012-03-20	02:34	144	86	2	-38.5 to -46.5	187 to 195	G > B > R > IR
2012-03-20	02:37	144	86	3 (H)	-38.0 to -45.0	194	
2012-03-20	03:27	156	86	3 (I)	-43.5 to -52.0	198	B > G > R
2012-03-21	02:58	142	86	4 (A)	-30.5 to -47.5	192	
2012-03-21	03:23	146	86	4 (B)	-33.0 to -47.5	192	B > G > R
2012-03-21	03:33	149	86	5	-33.5 to -47.0	189 to 202	
2012-03-22	04:06	148	87	4 (C)	-37.5 to -47.5	195	G > R = B
2012-03-22	04:12	150	87	4 (D)	-40.5 to -49.0	195	
2012-03-23	04:50	150	87	4 (E)	-43.0 to -48.0	192	R = G > B
2012-03-23	05:34	160	87	4 (F)	-42.5 to -51.0	202	B = G > R
2012-03-23	05:39	161	87	4 (G)	-46 to -52	202	
2012-03-27	02:20	078	89	4 (H)	-43.5 to -47.5	118	B = G > R
2012-03-28	02:34	073	89	4 (I)	-46.0 to -51.5	111	
2012-03-31	04:42	077	91	4 (J)	-44.5 to -47.5	113	
2012-04-06	02:39	354	93	4 (K)	+8.5 to 18.5	063	B > G > R > UV
2012-04-09	17:31	184	95	4 (L)	-30 to -51	221	B > G > R
2012-04-12	17:55	162	96	4 (M)	-38.0 to -51.0	194	B > G > R
2012-04-13	20:03	185	97	4 (N)	-39.0 to -53.5	215	G > B
2012-04-25	02:39	180	102	4 (O)	-40.5 to -52.0	206	B > G > R

† All dates and times are UT.

‡ CM is central meridian; L_S is areocentric longitude of the Sun.

* Measured at the terminator, not in the illumination defect, using the WinJUPOS measuring engine, by Venable. Latitude is rounded to nearest half degree. Longitude is rounded to 1 degree, and has a range only in cases of multiple images by the observer that day.

** Color is roughly judged, where possible, by comparing brightness in monochrome images taken with color filters. Processing, including edge sharpening in all images, together with camera variables, prevents quantitative measurement of color.

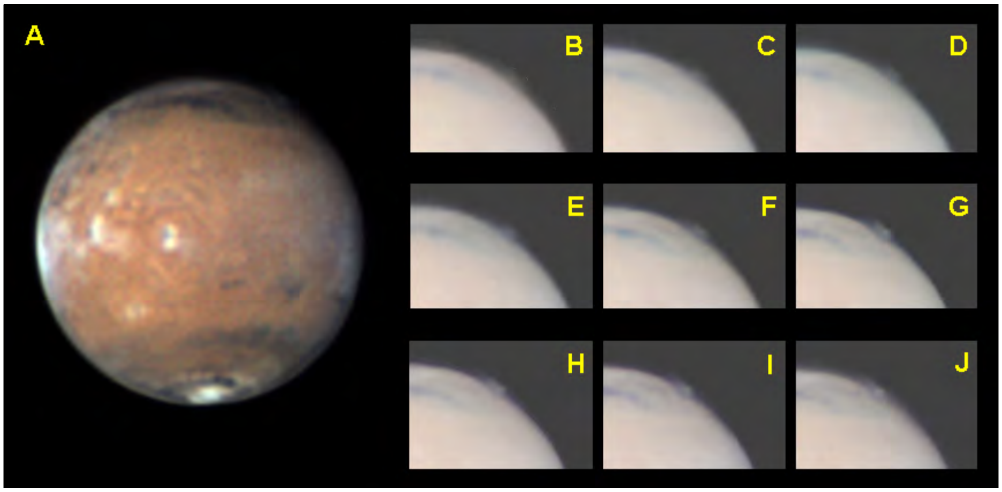

Figure 2. Images by Wayne Jaeschke taken on March 20, 2012. Panel A is a red, green, and blue composite image made at 02:52 UT, with CM = 148°. Panels B through J are green light images that have been brightened to bring out the terminator cloud. Panel B, 02:02 UT with CM 136°; C, 02:11 UT with CM 138°; D, 02:15 UT with CM 139°; E, 02:19 UT with CM 140°; F, 02:23 UT with CM 141°; G, 02:34 UT with CM 144°; H, 02:40 UT with CM 145°; I, 02:46 UT with CM 146°; J, taken from panel A. Imaging instruments were as described for Figure 1.

images at intervals of four to 11 minutes, spanning the expected time at which the feature would appear. Figure 2 shows one of these March 20 images, and enhanced insets from all nine. Note that in panel F and subsequent images, the cloud appears to be slightly separated from the terminator by a dark line. The visual effect of the series of nine images is that the cloud appears to come into view as the planet rotates, and then begins to disappear against the bright planetary surface with further rotation. Wayne made an animation of this series, which shows this effect dramatically but cannot be presented in this printed format.

Other Observations of the Clouds in 2012

On March 20, Jaeschke called attention to his finding and posted an animation of his green-light images on the ALPO Mars observers' message list. The report prompted widespread excitement and speculation as to the nature of the feature. Responding to this announcement, amateur observers worldwide made efforts to image the cloud, and reviewed their own recent images for the possibility of overlooked images of it. Most were not able to image the cloud, largely by reason of unfavorable presenting longitudes of Mars at the times of their observations. Nevertheless, a number of observers had success. Most of the successes are presented in figures 3 and 4 and listed in Table 1. Note that a number of observers were able to find the feature on images that they had made before March 21, while successful observations of the cloud continued until it was last imaged on April 25. A number of other observers made images that may or may not show a trace of the cloud, however these images are not presented here.

When imaged, the cloud was faint, so that clear depictions of it for this article required an unusual amount of brightening of many of the images. Unfortunately, this enhancement has detracted from the original beauty of most of the images in figures 3 and 4.

Jim Phillips of South Carolina, USA, made a series of images on March 21 that, like the series by Jaeschke the day before, show the cloud rotating around the unseen limb of the planet as the planet rotates. See Figure 5.

There were no visual sightings of the cloud, despite the fact that several experienced observers made drawings of the planet during this time. This may be related to the faintness of the clouds, as noted above.

The areocentric longitude of the Sun (Ls) of these clouds ranged from 83° on March 12 to 102° on April 25, 2012, which is late northern spring and early northern summer, with a concentration of successful observations centered on March 21, at Ls 86°.

The authors are thankful for the work of the many dedicated observers who endeavored to image Mars during this critical time period.

Table 2. Results of Cloudtop Height Measurements of Three Images

Imager	yyyy-mm-dd-hhmm	Phase Angle	% Illum. Defect	Cloudtop Lat. at Nearby Limb	Illum. Defect at Cloud Lat.	Skyplane Distance	Cloudtop Height
Jaeschke	2012-03-20-0234	13.3	1.335	-43.8	80 km	188 km	108 km*
Phillips	2012-03-21-0340	14.1	1.495	-44.1	89 km	193 km	104 km*
Miyazaki	2003-11-08-1141	39.5	11.43	-37.5	554 km	285 km	26 km**

*Actual **Minimum

Latitude and Longitude of the 2012 Clouds

Each of the images showing the cloud was imported into the WinJUPOS measuring engine (Hahn, 2014). This software tool facilitates the measurement of the areographic latitudinal and longitudinal ranges of the cloud. Measurements of latitude and longitude were made at the terminator, not in the illumination defect. The results of these measurements are presented in Table 1.

The table shows that 26 of the 27 images of the cloud show it to be entirely included in the latitude range of −30° to −53.5°, the "minus" sign indicating south latitude. Of these 26, the mean latitude of the latitudinal center of the cloud was −45.0° with a standard deviation of 3.3°. The mean expanse in latitude from the northernmost extent to the southernmost extent of the cloud was 9.3°, with a standard deviation of 4.6°.

Twenty of the 27 observations show the longitude of the terminator adjacent to the cloud to be in the range of 187° to 206° west longitude. The mean longitude for these 20 observations was 197° west. In four of the observations, serial images showed the persistence of the cloud over longitudes ranges of 8° to 16°. It is possible that the cloud on March 20 extended more than 50° in areocentric longitude, as detections over that wide a range were made on that night. See Table 1.

A few observations detected clouds that were distinctly outside these ranges of latitude and longitude. The only one that deviated in latitude was Donald Parker's observation made on April 6, 2012. This observation shows that these very high sunrise terminator clouds can occur at tropical northern latitudes. Seven observations (including Parker's on the 6 of April) were of clouds outside the longitude range of the majority. Pellier's observation on March 20 is interesting in that it was the same night that independent observations by Jaeschke, Meier, and Walker detected a cloud about 40° further west in longitude. The April nine observation by Abgarian, Morozov and Goryachko, and the April 13 observation by Peach, show a cloud at longitudes further west than the majority.

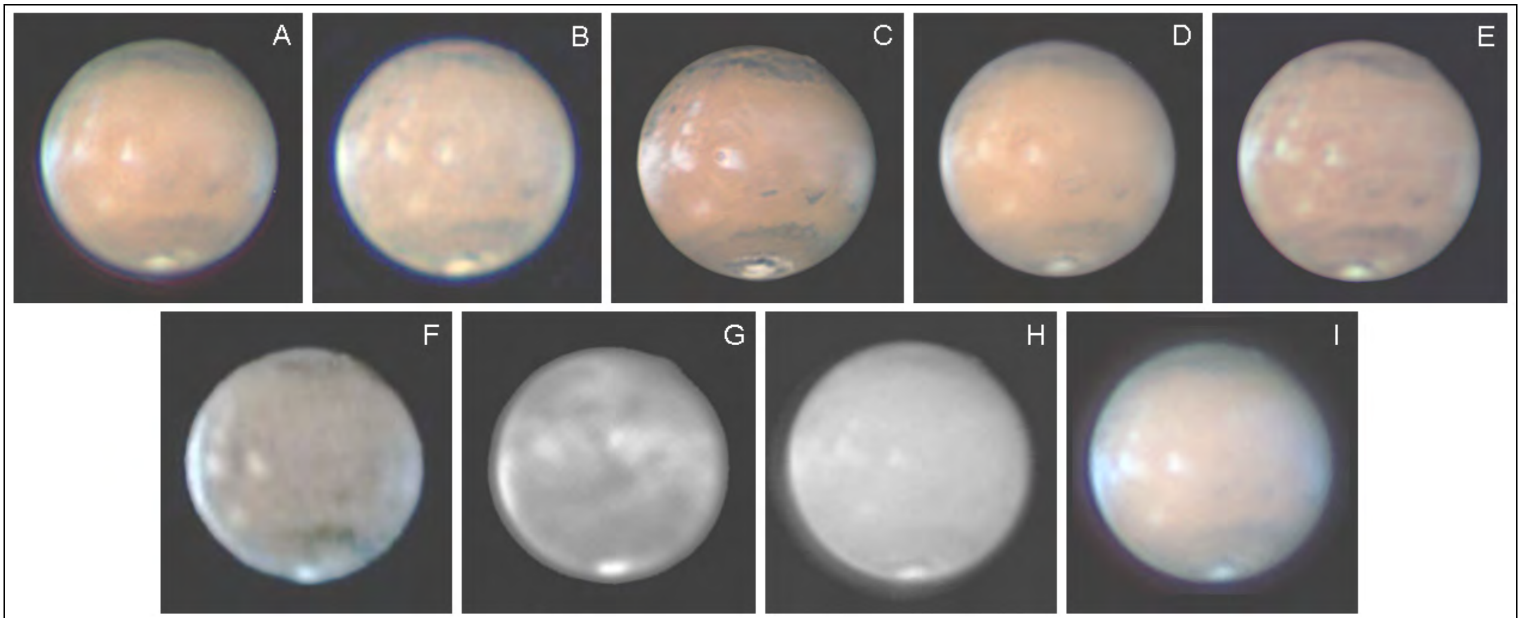

Figure 3. Images of the terminator cloud that were found by retrospective review of images after Jaeschke's March 20, 2012, announcement of the finding of a terminator projection. All were made by stacking many brief exposures by "lucky imaging." These images are all brightened here so as to bring out the faint, abnormal feature in the upper right part of the terminator. This brightening washes out the color and contrast in the rest of the image. (A) By Mark Delcroix of Toumefeuille, France, on March 12, 2012, at 23:06 UT. Newtonian telescope of 318 mm aperture and Basler acA640 camera, using Astronomik RGB filters. (B) By Jean-Jacques Poupeau of Pecqueuse, France, on March 14, 2012, at 23:28 UT. Windowed Cassegrain telescope of 350 mm aperture and Skynyx 2-0 camera, using RGB filters. (C) By Damian Peach of Selsey, West Sussex, England, on March 15, 2012, at 00:10 UT. Schmidt-Cassegrain telescope of 356 mm aperture and RGB filters. (D) By Wayne Jaeschke of West Chester, Pennsylvania, USA, on March 17, 2012, at 01:11 UT. Schmidt-Cassegrain telescope of 356 mm aperture and Flea3 camera, using Astrodon filters. (E) Efrain Morales Rivera of Aguadilla, Puerto Rico, on March 19, 2012, at 02:31 UT. Schmidt-Cassegrain ACF telescope of 200 mm aperture and Flea3 camera, using Astronomik LRGB filters. (F) By Frank Melillo of Holtsville, New York, USA, on March 19, 2012, at 03:30 UT. Schmidt-Cassegrain telescope of 200 mm aperture and ToUcam Pro II color camera. (G) By Christophe Pellier of Nantes, France, on March 20, 2012, at 00:02 UT. Gregorian telescope of 250 mm aperture and PLA-Mx camera, using blue filter (part of a series of RGB images). (H) By Rolf Meier of Ottawa, Canada, on March 20, 2012, at 02:37 UT. Schmidt-Cassegrain telescope of 356 mm aperture and Skynyx 2-0 camera, using a green filter (part of an RGB image). (I) By Gary Walker of Macon, Georgia, USA, on March 20, 2012, at 03:27 UT. Refracting telescope of 200 mm aperture and Flea3 camera, using Astronomik RGB filters. Seeing 4, transparency 4.

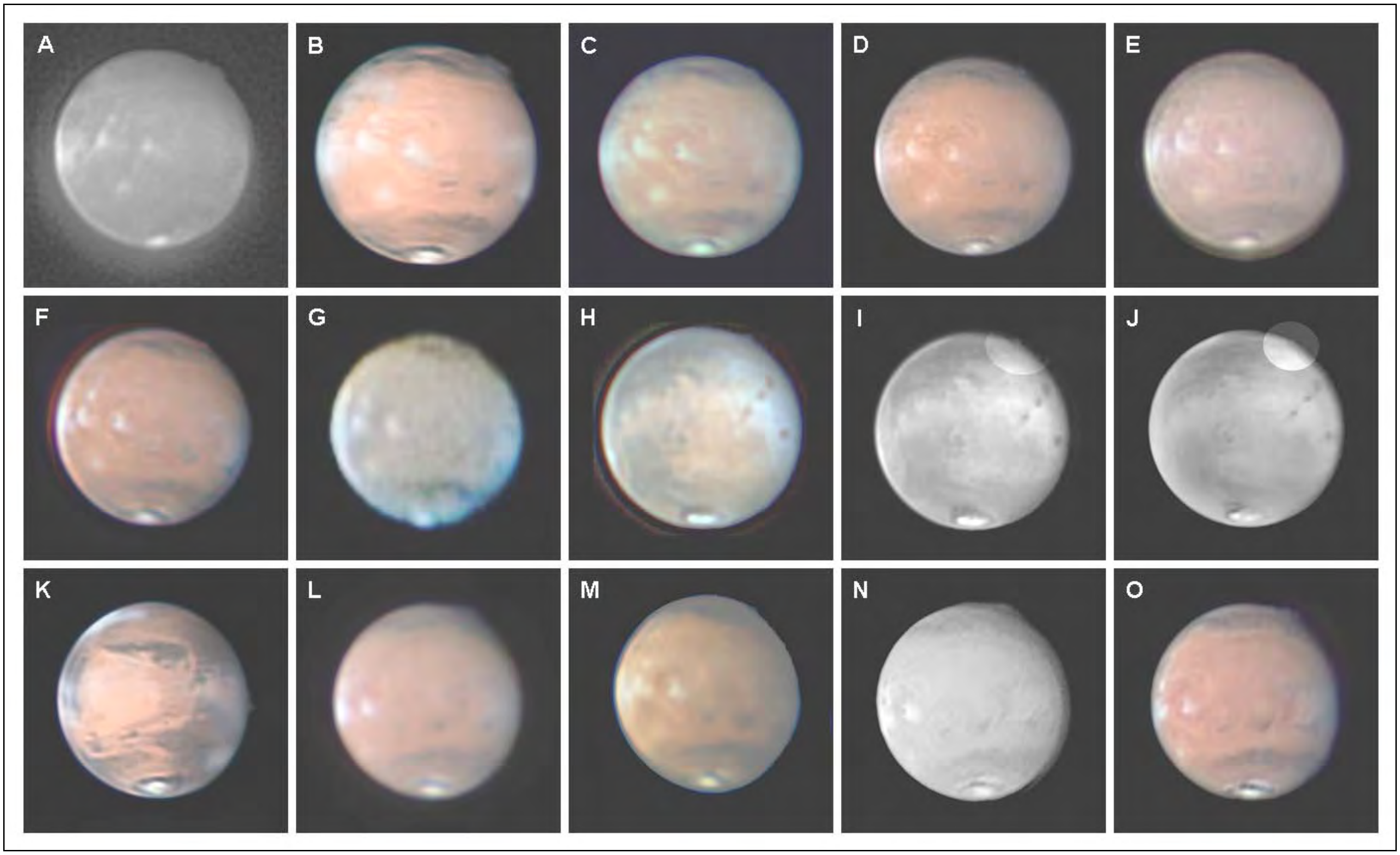

Figure 4. Images of the terminator cloud that were taken after Jaeschke's March 20, 2012, announcement of the finding of a terminator projection. All were made by stacking many brief exposures by "lucky imaging." These images are all brightened here so as to bring out the faint, abnormal feature in the upper right part of the terminator. This brightening washes out the color and contrast in the rest of the image. (A) By James Willinghan of Elkridge, Maryland, USA, on March 21, 2012, at 02:58 UT. Schmidt-Cassegrain telescope of 304 mm aperture and monochrome digital camera, using Astronomik green filter (part of a RGB series). (B) By Donald Parker of Coral Gables, Florida, USA, on March 21, 2012, at 03:22 UT. Schmidt-Cassegrain telescope of 356 mm aperture and DMK 21AU618.AS camera, using Astrodon RGB filters. (C) By Efrain Morales Rivera of Aguafilla, Puerto Rico, on March 22, 2012, at 04:06 UT. Schmidt-Cassegrain telescope of 304 mm aperture and Flea3 camera, using Astronomik LRGB filters. (D) By Wayne Jaeschke of West Chester, Pennsylvania, USA, on March 22, 2012, at 04:12 UT. Schmidt-Cassegrain telescope of 356 mm aperture and Flea3 camera, using Astrodon RGB filters. (E) By James Willinghan of Elkridge, Maryland, USA, on March 23, 2012, at 04:50 UT. Schmidt-Cassegrain telescope of 304 mm aperture and monochrome digital camera, using Astronomik RGB filters. (F) By Paul Maxson of Sun City West, Arizona, USA, on March 23, 2012, at 05:34 UT. Schmidt-Cassegrain telescope of 356 mm aperture and monochrome camera, using RGB filters. (G) By Frank Melillo of Holtsville, New York, USA, on March 23, 2012, at 05:39 UT. Schmidt-Cassegrain telescope of 250 mm aperture and ToUcam Pro II color camera. (H) By Gary Walker of Macon, Georgia, on March 27, 2012, at 02:20 UT. Refracting telescope of 200 mm aperture and Flea3 camera, using Astronomik RGB filters. (I) By Wayne Jaeschke of West Chester, Pennsylvania, USA, on March 28, 2012, at 02:34 UT. Schmidt-Cassegrain telescope of 356 mm aperture and Flea3 camera, using Astrodon RGB filters. (J) By Wayne Jaeschke of West Chester, Pennsylvania, USA, on March 31, 2012, at 04:42 UT. Schmidt-Cassegrain telescope of 356 mm aperture and Flea3 camera, using Astrodon RGB filters. (K) By Donald Parker of Coral Gables, Florida, USA, on April 6, 2012, at 02:39 UT. Schmidt-Cassegrain telescope of 356 mm aperture and DMK 21AU618.AS camera, using Astrodon RGB filters. (L) By Mikhail Abgarian, Konstantin Morozov, and Yuri Gorachko, of Minsk, Belarus, on April 9, 2012, at 17:31 UT. Maksutov telescope of 230 mm aperture and Basler acA640-100gm camera, using Astronomik RGB filters. (M) By Manos Kardasis of Athens, Greece, on April 12, 2012, at 17:55 UT. Schmidt-Cassegrain telescope of 280 mm aperture and DMK21 monochrome camera, using Astronomik RGB filters. (N) By Damian Peach of Selsey, West Sussex, England, on April 13, 2012, at 20:03 UT. Schmidt-Cassegrain telescope of 356 mm aperture, green filter (part of an RGB series). (O) By William Flanagan of Houston, Texas, USA, on April 25, 2012, at 02:39 UT. Schmidt-Cassegrain corrected telescope of 356 mm aperture and Flea3 camera, using Astrodon LRGB filters.

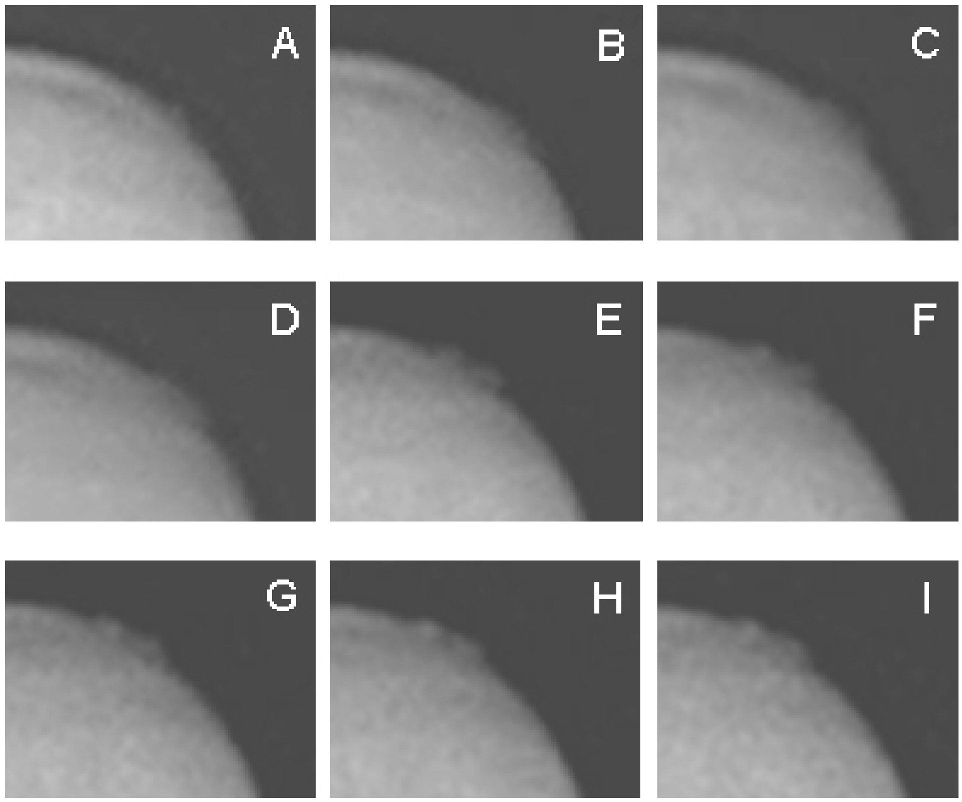

Figure 5. A sequence of images taken by Jim Phillips of South Carolina, USA, on March 21, 2012. All are made with a blue filter, using a refractor telescope of 200 mm aperture. Note that, as with Jaeschke's sequence of images taken the previous night (Figure 2), the cloud appears to rotate around the unseen limb and terminator as the planet rotates. (A) At 02:40 UT. (B) At 02:52 UT. (C) At 02:56 UT. (D) At 03:00 UT. (E) At 03:17 UT. (F) At 03:33 UT. (G) At 03:40 UT. (H) At 03:45 UT. (I) At 03:50 UT. Seeing described as "good".

The three detections of the cloud from the 28 to the 31 of March all showed it to be at a longitude of about 114° on those dates, which is about 80° eastward of the majority of detections. Parker's April 6 observation showed a cloud unique in longitude and well as latitude. See Table 1.

The Color of the 2012 Clouds

Sixteen of the observations were subjectively valuable regarding color, because red, green, and blue component images were made. The brightness of the clouds and the planet cannot be accurately measured from these images, because color is affected by the variables of camera sensitivity and observer preferences in capturing, color mixing, and contrast enhancement. However, a subjective idea of the relative brightnesses of the clouds can be derived by looking at the images. One of the authors (RV) made judgments of the relative brightness of the cloud in each of the component images by comparing the cloud's brightness to that of the rest of the planet in the same color-filtered image. The 'color notes' in Table 1 are the outcome of this judgment.

In seven of the 16 observations, the cloud appeared brightest in blue light compared to the rest of the planet, while in four, it appeared brightest in green. In no case did it appear brightest in red. In three cases, blue light was tied for brightest, while in four cases, green was tied, and in one case, red was tied for brightest. See figures 6 and 7.

In summary, the clouds appeared to be more bluish than reddish. However, the dominance of blue light reflection may be less pronounced than we usually see with the water-ice clouds of Mars, which are consistently relatively bright in blue light as compared to green, and are poorly visualized in red light.

Previous Detections of Similar Clouds

Masatsugu Minami, director of the Mars Section of the Oriental Astronomy Association, immediately pointed out that these very high clouds at the sunrise terminator appear to be much the same as those observed in 2003. Minami observed them well, visually, from Fukui prefecture, Japan, on November 4 and 7 of that year, and Masami Murakami of Kanagawa prefecture, Japan, also glimpsed it on the latter date. Isao Miyazaki, of Okinawa, Japan, was able both to see the cloud and to image it on November 8, 2003 (Minami, 2003). The latitude of −40° to −50° of these clouds was essentially the same as those detected in 2012, but the longitude of the terminator of 260° to 280° west is unlike that of any of the 2012 detections. Also, the Ls of the 2003 observations was about 294° (southern summer), which is very different from the Ls of the 2012 detections. Sections of the images of Miyasaki's November 8 series are displayed in Figure 8.

After a discussion of the visibility of the mountain peaks of Earth's Moon when they are slightly beyond the terminator, Percival Lowell stated that the first terminator projection ever seen on Mars was detected at the Lick Observatory by a visitor, in 1888 (Lowell, 1906, pp99-100).

During the perihelic apparition of 1894, Andrew Ellicott Douglas, working at the Lowell Observatory, described and measured many terminator projections, and also many terminator depressions and "special forms" irregularities. Most of these were faint. However, some were so easily seen, notably by himself, Percival Lowell, and William Pickering, as well as by a few visitors to the observatory, that he described them as “almost obtrusive.” Douglas made filar micrometer measurements and descriptions of them, and tabulated 487 such observations. Like the images of the 2012 terminator clouds, many of his measurements showed only small projections, but a few were nearly an arc second in distance from the terminator in the sky plane. He and Pickering drew many of them. He discussed hypotheses about their nature at length (Douglas, 1898).

It is important to note that Douglas found them at a diversity of northern and southern latitudes and at all longitudes. He made a map of the terminator positions associated with his sightings. His data on the terminator projections, but not including the depressions and special forms, is here adapted as Figure 9. Of these 109 terminator projections, 99 were before opposition on the sunset terminator, and 10 were after opposition on the sunrise terminator.

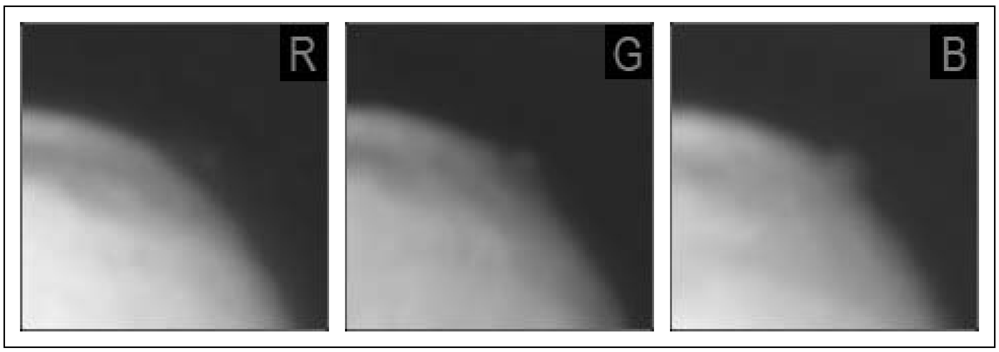

Figure 6. Images of the high terminator cloud by Mikhail Abgarian, Konstantin Morozov, and Yuri Goryachko of Minsk, Belarus. R is the red image, G is the green image, and B is the blue image, each made by “lucky imaging” as part of an RGB series on April 9, 2012, centered on 17:39 UT. Note that the cloud is easiest to see in the blue light image, which is different from the images in Figure 7. Maksutov-Cassegrain telescope of 230 mm aperture and Basler acA640-100gm camera, using Astronomik filters. Seeing 5/10, transparency 5/5.

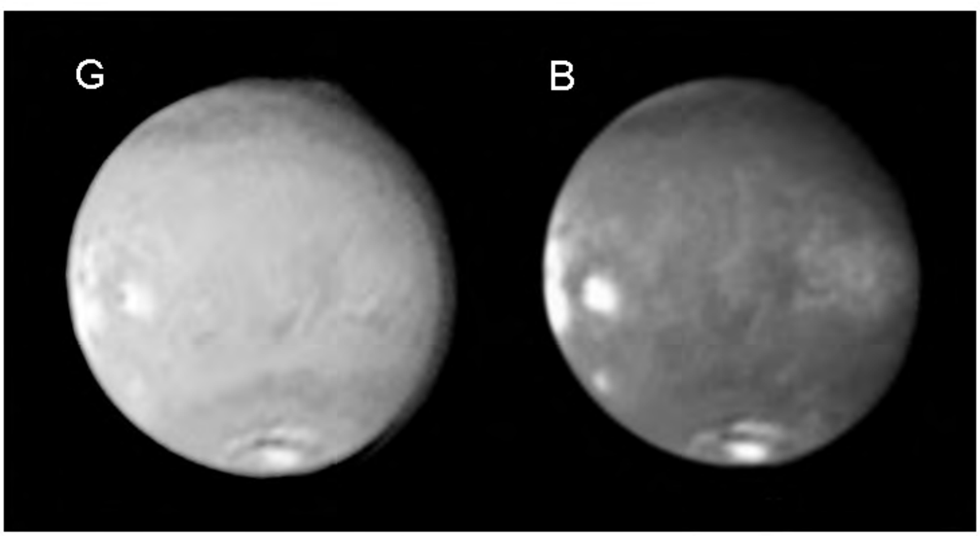

Figure 7. Images of Mars by Damian Peach of West Sussex, England, on April 13, 2012. Both are by “lucky imaging”, the one on the left being green-filtered, taken at 20:03 UT, while that on the right is blue-filtered at 20:23. Note that the high terminator cloud appears brighter in green light than it does in blue, which is different from the RGB series in Figure 6. However, it is possible that the cloud changed in brightness during the 20-minute interval between the green and blue images here. Schmidt-Cassegrain telescope of 356 mm aperture.

His discussion includes a mention of some observations of them from Lick Observatory in 1890 by Keeler, Holden, and Schaeberle; in 1892 from Lick by Perrotin and Campbell as well as by Keeler, Holden, and Schaeberle; in 1894 from Arequipa, Peru, by Pickering and himself; and also in 1894 by Schaeberle at Lick, by Javelle in Nice, France, by Williams in Brighton, England, and by Flammarion and Antoniadi in Juvisy, France. Douglas also mentions a description of a terminator projection by Cassini in 1666, but dismisses it, “for his telescope was not equal to such an observation” (Douglas, 1898).

Vesto Slipher detected a sunrise terminator projection on May 25, 1903, and observed it with Percival Lowell. Lowell noted that by the next night it had changed latitude and longitude, moving a distance of “390 miles.” He calculated its height at 17 miles using his own filar micrometer measurements, and at 14 miles using the measurements by Slipher (Lowell, 1903). These measurements should be interpreted as a minimum height of the top of the cloud, as will be discussed below. Figure 10 is a copy of Lowell’s drawing of the cloud he sighted. As depicted, the cloud spans a latitude range of +17° to +26°, and the terminator next to it was at longitude 39° west. As with other historical examples of high terminator clouds, this is a cloud location distinctly different from that of the 2012 clouds.

It is interesting to note that Lowell described the May 1903 cloud as distinctively yellowish. This observation appears to correspond with the 2012 images that show the cloud to be brightest in green light rather than in blue light in a significant fraction of the observations.

Masatsugu Minami and Masami Murakami have found two descriptions of terminator projections by Eugène Antoniadi. One of these was on 16 March 1929, the other on 14 April 1933 (Minami and Murakami, 2012).

Christophe Pellier has compiled a group of images from the Hubble Archives that show terminator projections or clouds visible beyond the limb. Some of these were brought to his attention by Reiichi Konnaï. One is of a sunrise terminator cloud on May 17, 1997, which was imaged in only one spectral series of seven wavelengths, from 336 nm to 1042 nm. These show the cloud to be brightest in blue light. Another is of a sunset terminator

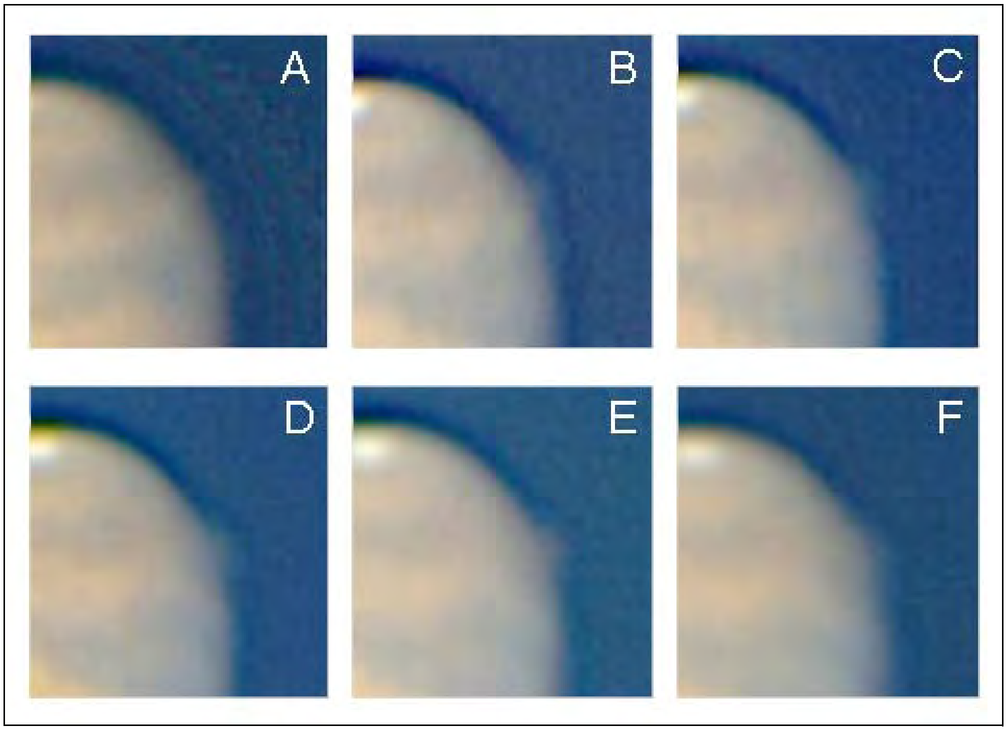

Figure 8. Mars images taken November 8, 2003, by Isao Miyazaki. The images are brightened by Miyazaki in order to show the feature along the terminator, as reported in 2003. Panel A was at 09:34 UT with CM = 168°. Panel B was at 11:05 UT with CM = 190°. Panel C was at 11:23 UT with CM = 195°. Panel D was at 11:41 UT with CM = 199°. Panel E was at 12:00 UT with CM = 204°. Panel F was at 12:21 UT with CM = 209°. Each image was made from a stack of about 900 frames taken with a ToUcam Pro color digital camera, through a Newtonian telescope of 40 cm aperture.

cloud imaged on March 3, 1999, that was documented by a sequence of images that display its evolution. In addition, Pellier includes three HST images of high *limb* clouds that appear disconnected from the *limb*, during opposition periods of 1995, 1997 and 1999. Each of these is evidently brightest in blue light (Pellier, 2012).

Reiichi Konnaï has found an image by the Mars Express Visual Monitoring Camera that shows a sunrise terminator projection of cloud on May 6, 2012, at 00:45 UT. This image is the first image made upon turning on the camera after a months-long outage (Konnaï, 2012). One of us (Venable) has estimated the location of this cloud at approximately latitude +48° and longitude 129° west.

The Viking Orbiters both imaged very high clouds in their approach images (Figure 11). These craft continued to image very high clouds, not only at the terminator and limb, but also over the sunlit surface of Hellas. Some of the Hellas daytime clouds were sufficiently optically dense to cast shadows. The heights of these daytime clouds were calculated by triangulation of the sun angle, viewing angle, and the positions of the clouds and their shadows, and were found to be at 50 km. These clouds have been assumed to be made of CO_2 (Briggs, Klaasen, *et al*, 1977). These authors state, "Very high altitude clouds are a common feature of the middle latitudes in the winter hemisphere."

Very high altitude clouds in the mesosphere of Mars are routinely detected by remote sensing with instruments aboard orbiting spacecraft, and they are a subject of active current research. There are elements of dust, water ice, and CO_2 ice, and their movements and seasonal associations are partly sorted out. The findings have been helpful to researchers working on global climate models of the planet. See, for example, Vincendon, Pilorget, *et al*, 2011; Benson, Heavens, *et al*, 2010; Clancy, Wolff, *et al*, 2004; and McCleese, Heavens, *et al*, 2010.

Measuring the Heights of the Clouds of 2012 and 2003

Due to the geometry of our perspective on the planet, and to the temporal length of the series of images by Jaeschke on March 20 (Figure 2) and Phillips on March 21 (Figure 5), it is possible to measure the actual height of the top of the cloud in their images. The principle of this is explained in Figure 12. Actual heights can be calculated only at small phase angles, in which the cloudtop extends beyond the unseen limb of the planet. Estimates of the heights of the bottoms of the clouds cannot be measured, as the cloud bottoms cannot be identified in the images.

With the 2003 sequence of images by Miyazaki, a height can be calculated, but it is a minimum possible height of the top of the cloud, not an actual height, as the larger phase angle did not allow the cloudtop to project beyond the unseen limb of the planet. This method is explained in Figure 13. Note that the cloud heights calculated by Douglas (Douglas, 1898) and Lowell (Lowell, 1903) use the method of Figure 13, and so represent a minimum height of the cloudtop, not an actual height.

Table 2 gives the heights so measured, using the WinJUPOS measuring engine (Hahn, 2014). In the table, the percent illumination defect is the percentage of the planet's disc that is not illuminated as seen from Earth. The cloudtop latitude is measured at the nearby limb, not at the terminator, and this is different from the measurements of Table 1. The illumination defect at the limb latitude of the cloud is a calculated value, while the skyplane distance from the terminator to the greatest extent of the cloud is measured on the images.

It is important to note that the actual heights of the tops of the clouds in Jaeschke's and Phillips's images are essentially the same, at 108 and 104 km respectively. This is a great height, and is in the upper mesosphere. Miyazaki's cloudtop minimum height of 26 km places it at least as high as the lower mesosphere, and of course it could be as high as the 2012 clouds.

The computing process represented by figures 12 and 13 is simplified in the explanatory captions. Measurements utilized diffraction effects at the edges of the images.

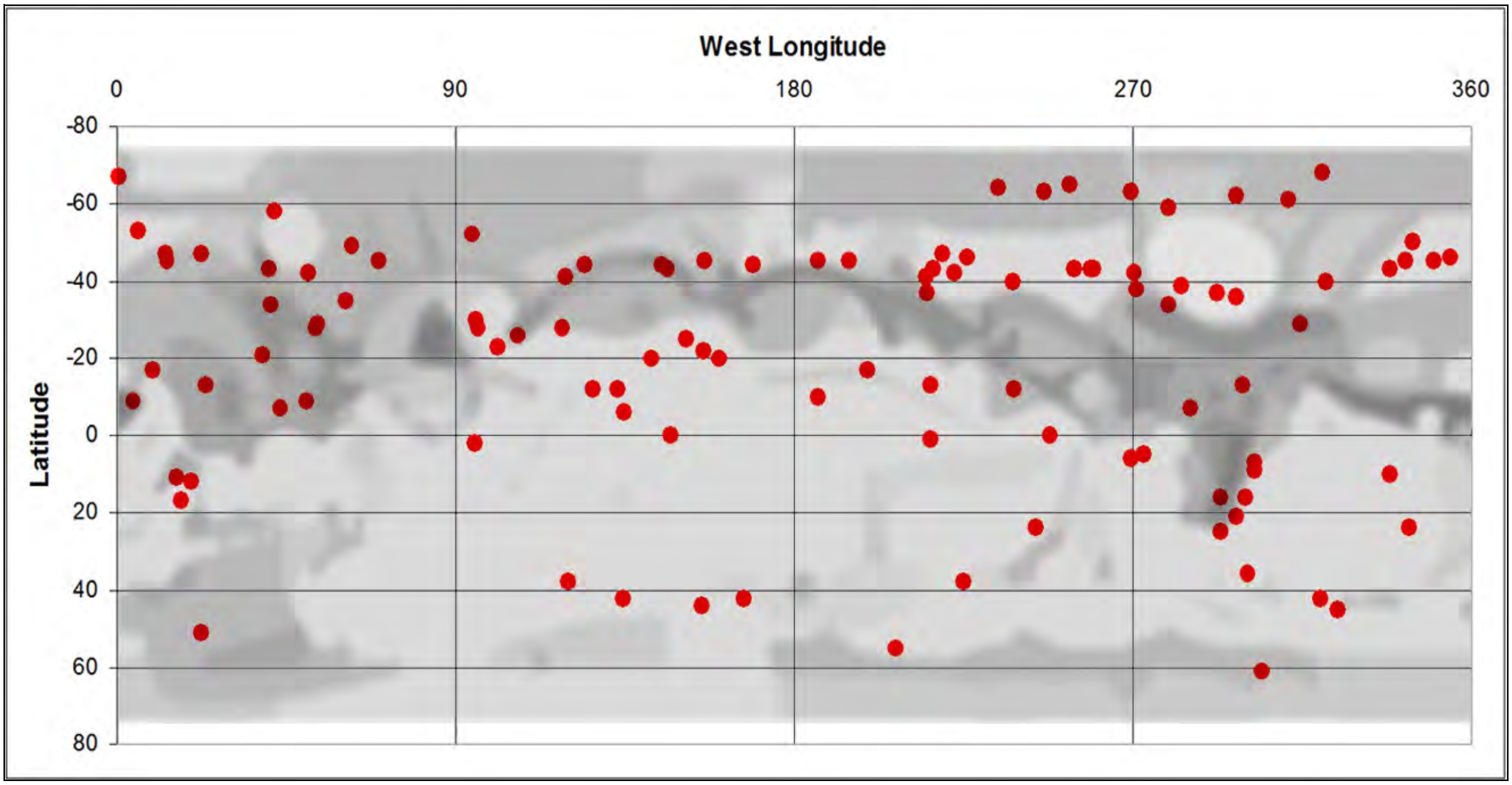

Figure 9. The positions of all 109 terminator projections measured by Douglas in 1894. Multiple observations of the same feature are considered as one. Each dot is centered at the mean of the southernmost and northernmost extent of a feature in latitude, and the mean of the easternmost and westernmost position of the terminator at that latitude during the length of the observation. The longitudinal positions he recorded were the calculated locations of the terminator, not the illumination defect or limb, at the latitude of the feature. He measured the latitude along the terminator, using an imaginary line perpendicular to the terminator and extending through the feature (Douglas, 1898). Compiled by Venable. Background map by Venable.

Readers with further interest in these computations or measurements should contact author Venable directly.

Discussion

Quality of the Images

Many of the 2012 high cloud images were of excellent resolution. For example, Jaeschke's best image, shown in panel A of Figure 2, shows detail such as the line separating the cloud from the planet, and the bifid nature of Euxinus Lacus, that indicate effective resolution of about 0.2 arc seconds. The quality of amateur images of planets has continued to increase during the last few apparitions of Mars. The images of these clouds cannot be criticized on the basis of image quality.

Color of the Clouds

The images by Parker and Kardasis show that it is visible in red, green, and blue light, while some imagers presented only their green color component images because the cloud was most evident in that color, rather than in blue. Visibility in red is unusual for a thin, water-ice cloud, suggesting that the composition of the cloud is unusual. Note that Lowell described the May 1903 cloud as yellow in color. Nevertheless, some of the clouds, such as those found in Hubble images, are brightest in blue light. This inconsistency in the estimation of color may be related to the small sample size and the lack of careful controls for color assessment in many of the images. Nevertheless, it raises the possibility that there may be compositional differences among these high clouds.

During the planet encircling dust storm of 2001, measurements of the optical depth of dust using limb images by the Mars Orbiting Camera aboard the Mars Global Surveyor spacecraft, detected dust at altitudes as high as 70 km in the equatorial regions, but not at temperate latitudes (Clancy, Wolf, *et al*, 2003). Similar detections of very high, mesospheric dust were made in the planet encircling dust storms of 1971 and 1977 using Mariner and Viking cameras. A larger data set obtained with the Mars Climate Sounder aboard the Mars Reconnaissance Orbiter reveals a maximum dust density at or below a height of 25 km in the absence of planet encircling dust storms (McCleese, Heavens, *et al*, 2010). No planet-encircling dust storm was present during the 2003 and 2012 Earth-based observations discussed in the present article. Thus, though dust can ascend high into the Martian mesosphere, it is unlikely to have been present there so as to give rise to the 2003 or 2012 observations. This leaves unexplained those observations of yellow or green color of the clouds.

We are missing them in our images

Because amateur imagers have seldom detected clouds that are seen as extensions beyond the terminator of Mars, they are considered rare. But they are not rare. The observations of many of them by Douglas in a single apparition, and his citing of other observers who had noted similar projections, demonstrate that these projections can frequently be detected if one is looking for them. The regularity of their occurrence is shown by the detection of such a cloud in the very first image obtained after restarting the orbiting Mars Express Visual Monitoring Camera, and by their presence in the approach images of both Viking orbiters. It is highly unlikely that rare occurrences would show up so frequently by chance in these particular images by spacecraft. The notion that we don't look for faint terminator extensions and thus miss them was brought up by Minami in 2003 (Minami, 2003).

The nine images in Figure 3 are evidence that we are missing terminator projections as we process our images. These nine were detected either retrospectively on previously processed images, or by reprocessing after the alert was published that such a cloud feature might be detected. Enhancement of the edges of the planet's image is needed to bring them out, a procedure to which most imagers seldom give attention. Many imagers blacken the background of an image to enhance its visual appeal, and in doing this a high threshold for black may mask faint terminator projections. A relatively new image processing technique involving lengthier imaging sequences and "derotation" using the WinJUPOS software, though excellent for revealing planetary detail, promises to further obscure subtle limb and terminator irregularities.

The Mountain Hypothesis

Douglas, together with the other classical observers he cites, was especially interested in terminator irregularities, both projections and depressions, because he hoped to establish the positions of mountains that might produce either type of irregularity due to the slope of the surface (rather than due to clouds). Thus, these observations were an effort to map the planet. He abandoned this pursuit for three reasons. First, the mapping of the surface locations of the irregularities showed no consistent geographical locations (see Figure 9). Second, he found that the two maximum heights of such mountains, according to his measures, would have to be 126 and 161 km, respectively. Third, in no case was a projection immediately preceded by a depression, such as a mountain should cause. He concluded that the projections were due to clouds, not mountains, albeit clouds higher than are present on Earth (Douglas, 1898). Notice that Figure 9 shows that the projections had no clustering around the Tharsis or Elysium volcanos, which are the highest mountains in the Solar System.

The Aurora Hypothesis

The November 4 through November 8, 2003, clouds occurred at the time of an unusually powerful series of solar flares and coronal mass ejections (CMEs). There was an X17 flare on October 28, an X10 flare on Oct 29, and an X28 (estimated) flare on November 4. The first of these is the fourth most powerful flare ever recorded, and the last of these is the most powerful flare ever recorded on the Sun. The CMEs from these flares were very fast moving and very large, and impacted the Earth 19 hours after ejection, and therefore must have struck Mars about 27 hours after ejection. The first two were aimed nearly directly at the two planets, while the last and largest had somewhat less effect on Earth-based communications because it was pointed 90° away from our direction. The October 28 flare's interfering effect on communications lasted about 72 hours, while the November 4 flare's effects were weaker and lasted about 48 hours on Earth (Plunkett, 2006).

In view of the temporal correspondence between those radiation outbursts and the detection of the November 2003 terminator clouds, Minami has suggested that the high clouds are auroras (Minami, 2003; Minami and Murakami, 2012). However, the correspondence is not precise. The magnetometer aboard the Mars Global Surveyor detected changes in the weak magnetic fields of Mars, caused by the October 28 CME, from October 30 to

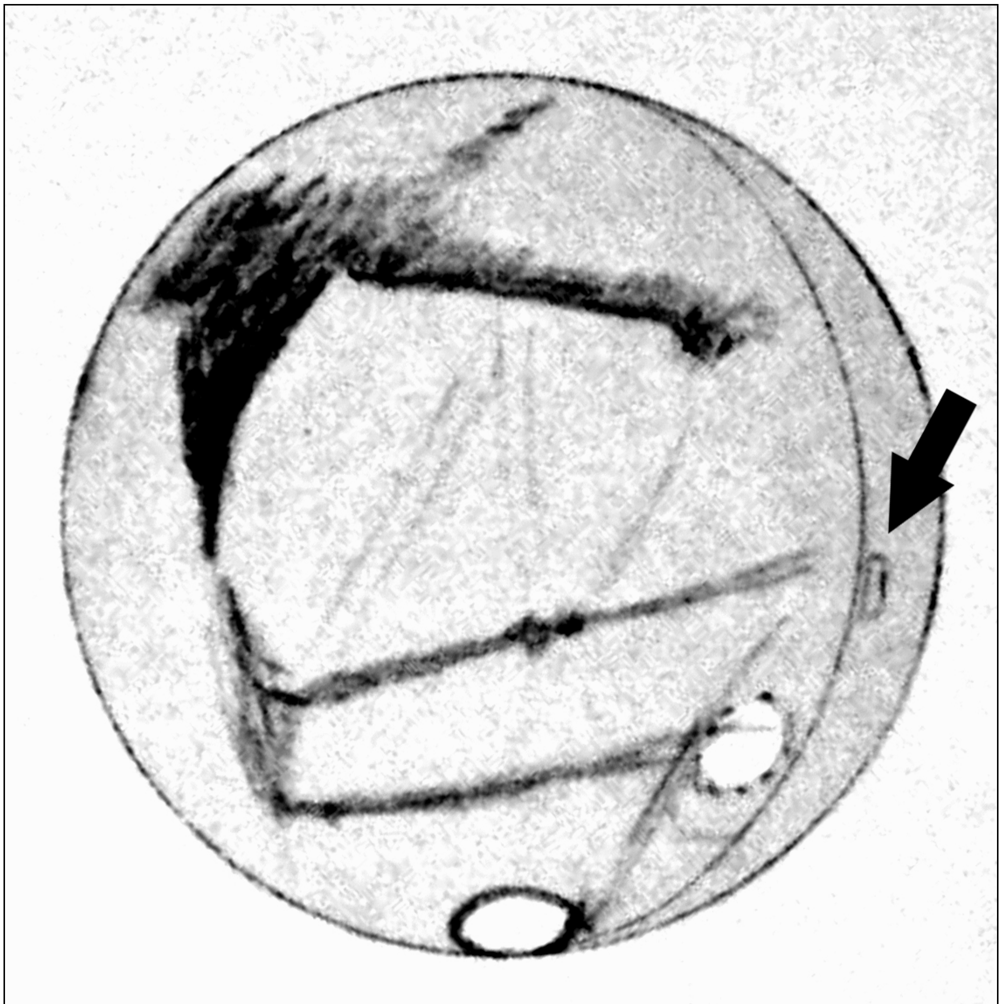

Figure 10. Lowell's terminator projection of May 25 and 26, 1903. Drawing by Lowell, arrow added here for clarity. Adapted from Lowell, 1906, p. 101.

November 1, lasting 43 hours (Crider, Espley, *et al*, 2005). Note that this ended three days before the cloud was first seen on November 4. Likewise, its effects on communications on Earth ended on November 1. The November 4 CME could not have arrived at Mars in time to cause Minami's November 4 observation of the high cloud, and its effects should have essentially ended on Mars on November 7, two days after it arrived at Mars, and before the November 8 cloud sightings and image by Miyazaki. Minami's aurora hypothesis appeared quite insightful when first presented, and one can see its rationale, but it has problems beyond the imperfect correspondence of the cloud detections to the known magnetic effects of the CME at Mars.

First, the clouds are in the mesosphere of Mars, not the thermosphere where an aurora would be. Second, auroras are not detectable in images that are optimally exposed to show directly sunlit surface features such as the present images do. They are seen only in night-side images taken from Earth orbit, or in very narrow passband images taken of the outer planets. Third, the strength of the narrow zones of remnant crustal magnetism on Mars is about 0.1% of the strength of Earth's magnetic field, with the strongest zones having typical peak values around 60 nanoteslas on Mars compared to 60 microteslas on Earth – so that auroral effects on Mars must be extremely weak. However, a few very small areas of peak intensity up to 1,000 nanoteslas have been detected (see Mitchell, Lillis, *et al*, 2005). Fourth, the 2012 detections of the clouds were at times when only weak CMEs were occurring, with some M-class flares around the time of Delcroix's March 12 detection but no strong CMEs later in the month when the majority of detections occurred (Cdaw Data Center, 2012). Fifth, Miyazaki's 2003 images that provoked the aurora hypothesis speak of clouds, not auroras, in two respects: They are located in contact with the terminator, where very high clouds would be sunlit; and they are not present at the unseen limb, where the long optical path through an aurora would make it appear brightest.

In view of these problems with the aurora hypothesis, together with the known occurrence of mesospheric clouds on Mars, the aurora hypothesis can be considered to be a relatively poor match to the phenomenon.

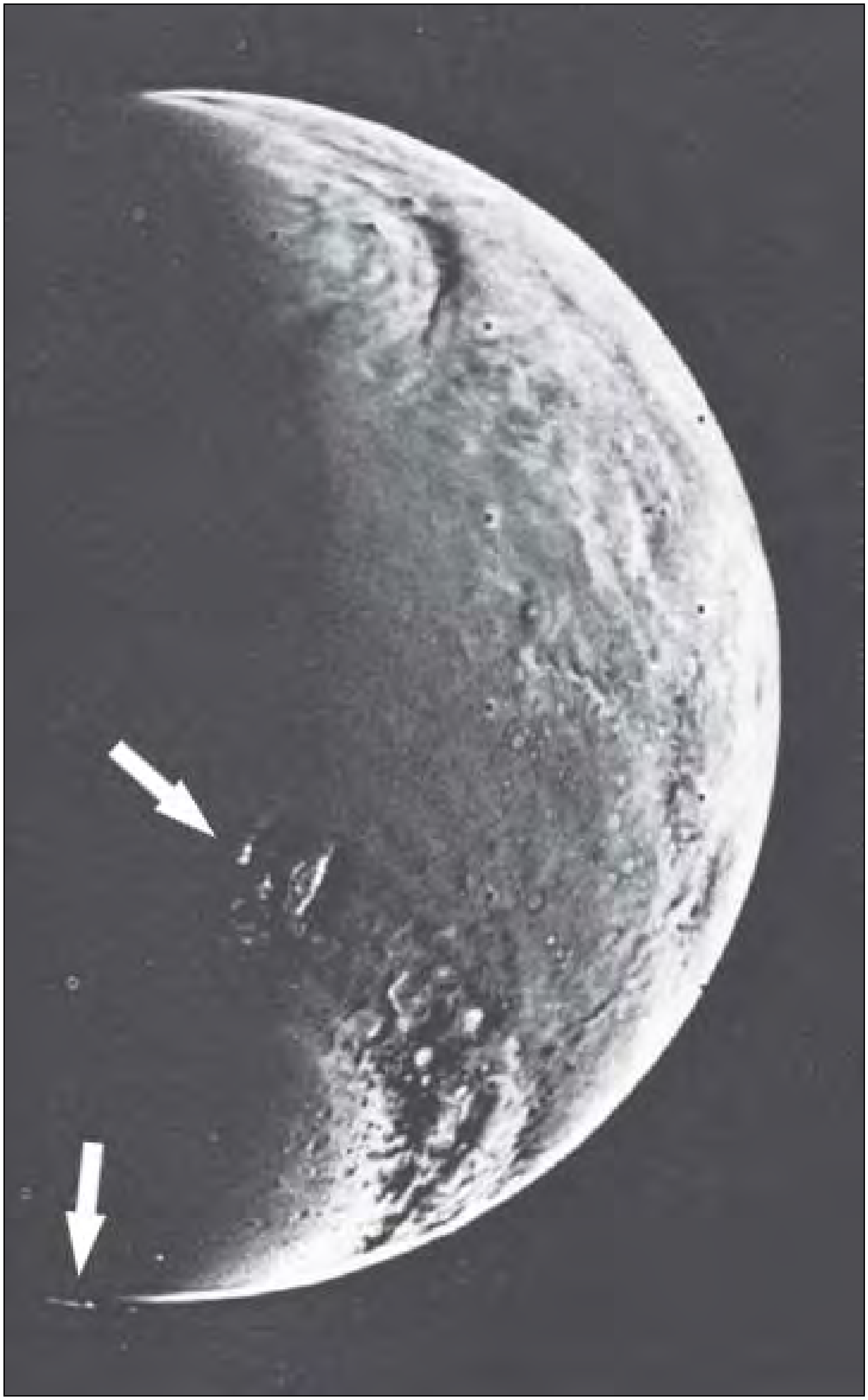

Figure 11. Approach image from Viking Orbiter 2 in 1976 showing a sunrise terminator cloud that is at least 30 km in altitude in the Electris region (upper arrow), and a limb cloud at a height of 50 km (lower arrow), as estimated by Briggs, Klaasen, et al. Similar clouds of great height were imaged in the approach images from the Viking Orbiter 1 (Briggs, Klaasen, *et al*, 1977).

The Cloud Hypothesis

The occurrence of CO_2 ice clouds in the mesosphere of Mars has been suspected ever since the Viking orbiter images showed optically dense, daytime clouds over Hellas at a height of 50 km (Briggs, Klaasen, *et al*, 1977). This notion gained support by the finding that the upper mesosphere has a nighttime temperature below the condensation point of CO_2 (Figure 14).

A brief, further discussion of Figure 14 is in order. The layers of the atmosphere are often considered to be defined by their temperature gradients. The troposphere has decreasing temperature with height, and only its very top is shown on the graph in Figure 14. Its upper border is marked by the temperature inflection at the very bottom of the temperature line, at about 10 km (Pathfinder) to 13 km (Viking) altitude, where the temperature begins rising with increasing altitude. Above the troposphere, this region of increasing temperature with increasing altitude is commonly thought of as the stratosphere, so called because it is relatively stable due to the temperature inversion. At about 17 km, the temperature gradient reverses, and begins to fall with increasing altitude. The 17 km inflection marks the top of the stratosphere and the bottom of the mesosphere. Above the mesosphere is the thermosphere, beginning at about 120 km altitude and characterized by rapidly rising temperatures with increasing altitude due to the effect of high energy solar UV radiation.

It is reasonable to suppose that very high clouds visible beyond the sunrise terminator, rotating into view as the planet rotates, may be CO_2 ice clouds that formed in the cold Martian night. Indeed, the steeper decline in temperature with increasing altitude that is present between 70 and 80 km in the Martian night (Figure 14) may cause an instability that would be associated with convective cloud formation. Against this idea is the notion that the temperature of the upper mesosphere is governed primarily by radiative phenomena. Furthermore, observations using the OMEGA and CRISM instruments aboard the Mars Express orbiter show that both CO_2 and H_2O clouds do occur at altitudes from 60 to 80 km, but have a cirrus, nonconvective form (Vincendon, Pilorget, *et al*, 2011). Other observations emphasize that such clouds occur mostly in certain seasons and over certain surface areas, and suggest that mesospheric gravity waves induced by turbulence in the lower atmosphere may cause the formation of the high clouds (Spiga, González-Galindo, *et al*, 2013).

The composition of the clouds is not fully solved, but studies indicate that they are a

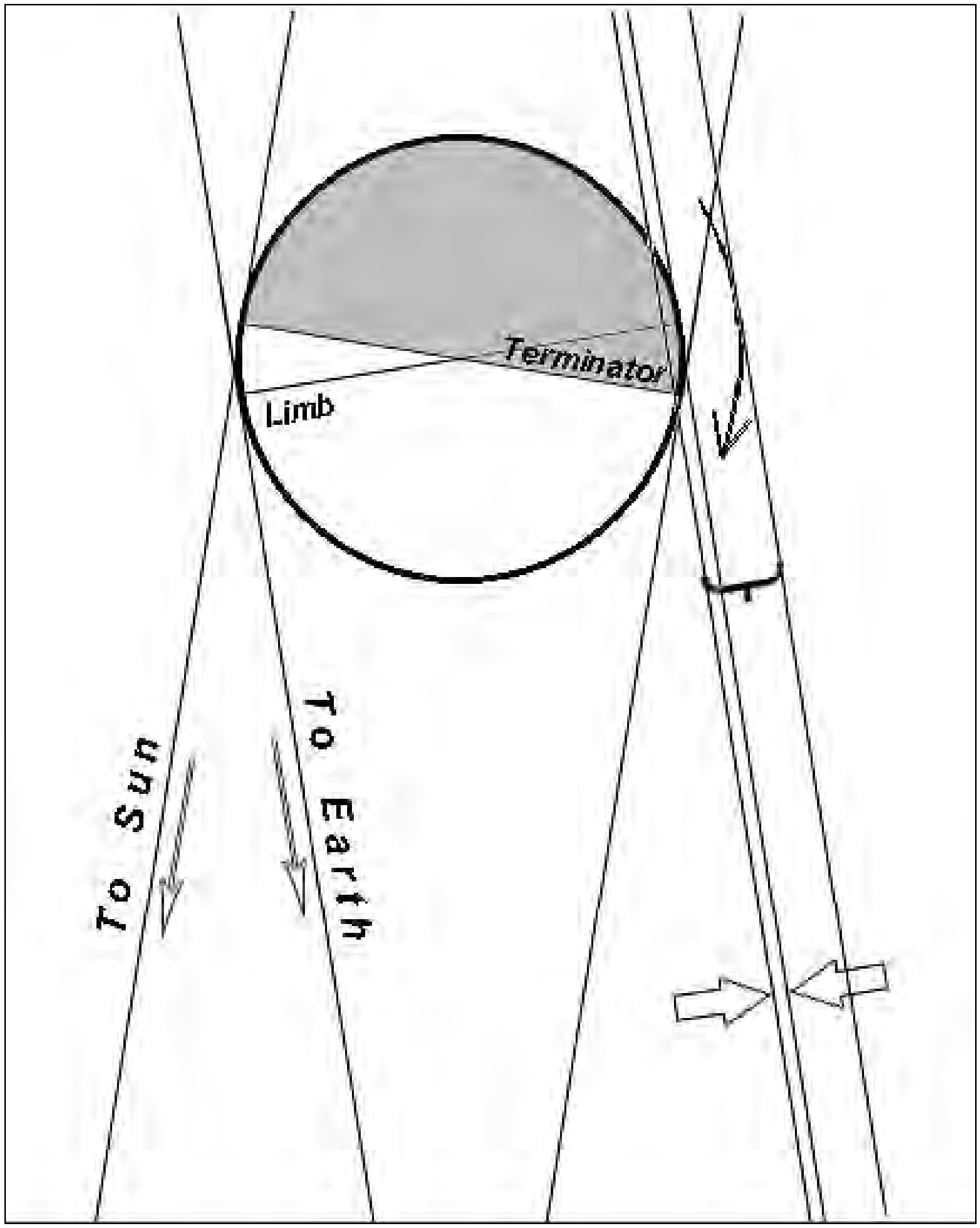

Figure 12. How a temporally long series of images enables the measurement of the height of the top of a cloud. This diagram is simplified, for clarity. Note the directions to Sun and Earth, and note also that the phase angle is small. The perspective on the sunlit planet as seen from Earth leaves a part of the disk unseen, called the “illumination defect.” The width of this illumination defect is designated by the distance between the two arrows at the bottom right. The curved arrow to the right of the planet indicates the path of the top of the cloud as it rotates around the unseen limb and the terminator as the planet rotates. The bracket below that arrow spans the distance, measured in the plane of the sky, between the terminator and the point of maximum extent of the cloudtop beyond the terminator. To compute the height of the cloudtop above the surface, one must choose from the sequence of images that image in which the cloudtop appears to be farthest from the terminator. Then, the height of the cloudtop above the planet’s surface is equal to the width of the bracket minus the width of the illumination defect. In making the actual computation, one must calculate the width of the illumination defect at the unseen limb at the latitude at which the cloud is seen.

common feature of the Martian mesosphere. It is our recent ground-based detections of them that are unusual.

The Bottom Line

Amateur observers should be looking for these clouds, understanding that they are among the more fascinating features of the Martian atmosphere. It is likely that if one is sensitive to the possibility that they may be detected, many more detections of them will be made. Although one might think that the long optical path through the terminator clouds made them especially visible shortly after the 2012 opposition, it is impressive that the 2003 observations were at a time of nearly maximal phase angle, as were some of the observations by Douglas. Thus, observers should be looking for them all the time. It would be valuable if a number of detections of them could be compiled, so as to document the Ls, the latitudes and the longitudes at which they are most often seen. That this can be done both visually and by imaging has been demonstrated by past observations. Imagers are urged to regularly inspect the terminator areas of their images with enhanced brightness, and to do so before employing the WinJUPOS derotation technique.

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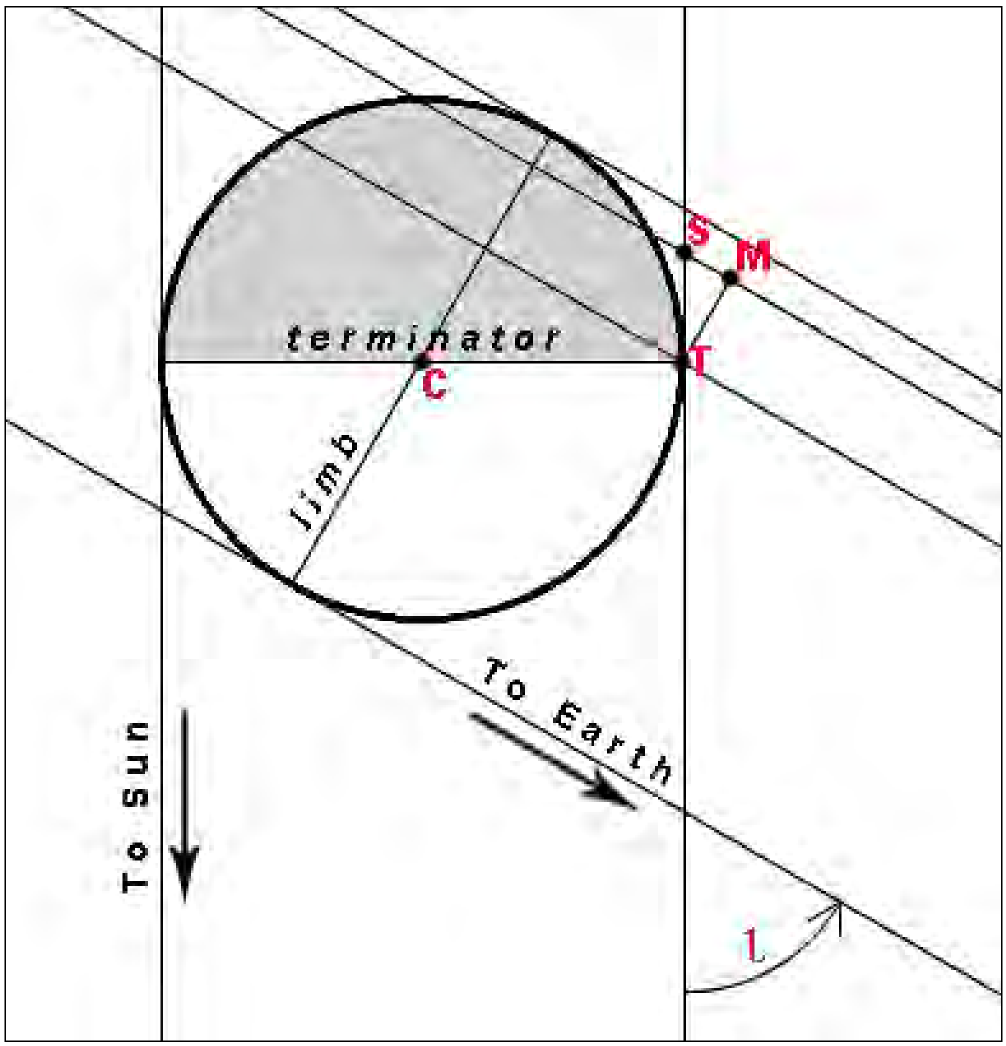

Figure 13. How to measure the minimum height of a cloudtop. This diagram is simplified for clarity. Note the directions to Sun and Earth, and the phase angle ι. The cloudtop projects beyond the terminator at point T by the distance TM, as seen from Earth. The actual location of the cloudtop could be anywhere along the line from Earth that passes through point M. Point S is the closest point to the planet surface at which the cloudtop could be seen, because closer points along the line through S and M are not illuminated by the Sun. Since the distance TM is measured, and the angle TSM is equal to the phase angle, the distance TS is equal to TM times the cosecant of the phase angle. Once TS is thus known, and since the radius of the planet CT is known, the distance CS is calculated by the Pythagorean theorem. The minimum cloud height is then CS minus the radius CT.

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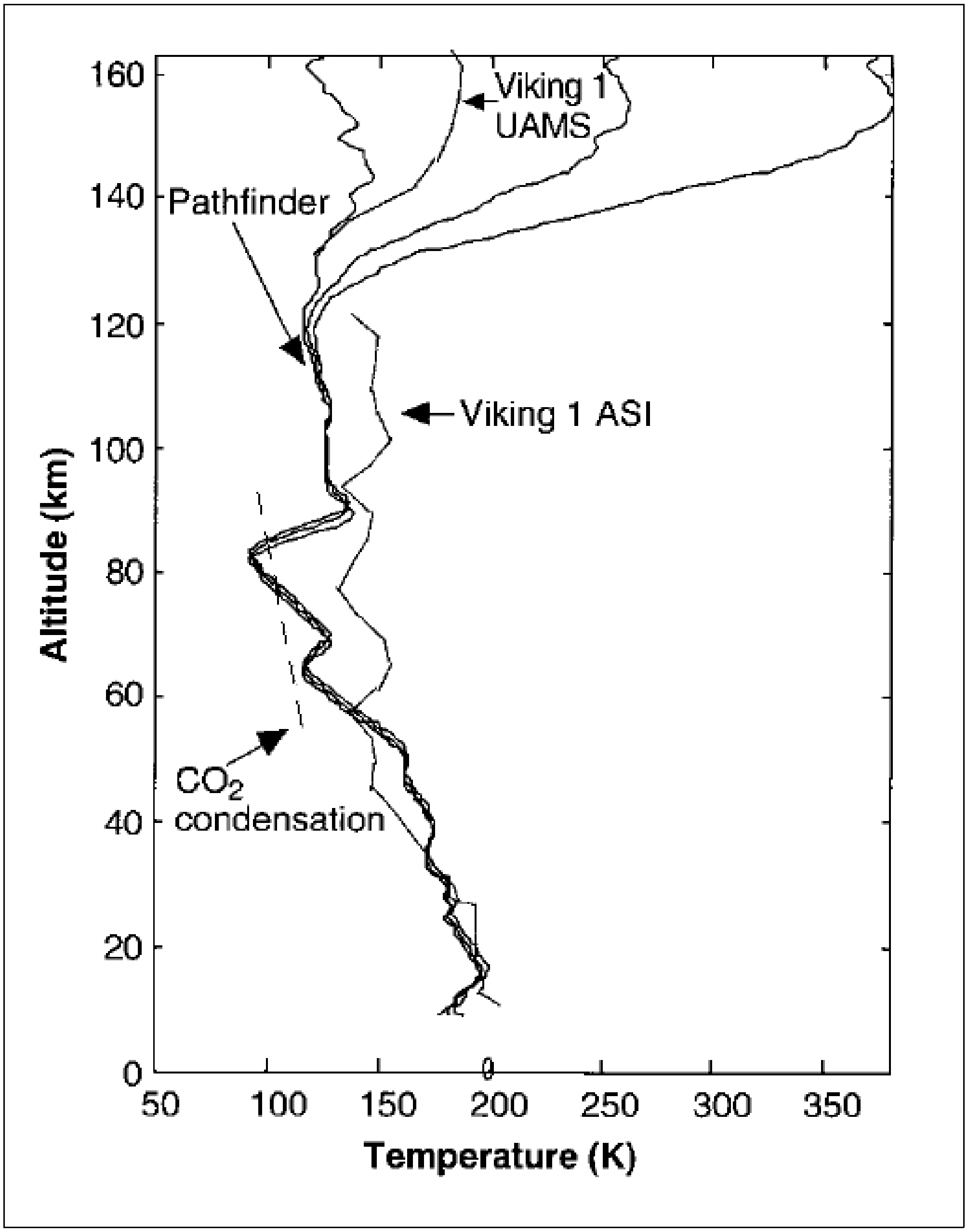

Figure 14. The atmospheric temperature profile as measured by the Mars Pathfinder Lander at night (03:00 local solar time) and by the Viking 1 Lander during daytime (16:15 local solar time). Pathfinder used an accelerometer to measure density during descent, and the density data was converted to temperature data. The Viking data is in two forms, as density data from the Upper Atmosphere Mass Spectrometer (UAMS) above about 130 km, and as deceleration (density) data from the Atmospheric Structure Instrument below about 120 km. The pathfinder data is shown as three lines – the mean calculated value, and values 2 standard deviations above and below the calculated value. From Schofield, Barnes, *et al*, 1997.

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Feature Story:

ALPO Observations of Jupiter During the 2011-2012 Apparition

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This paper includes Jupiter images submitted by a number of observers.

Abstract

In almost all cases, drift rates are consistent with historical values. The SPR is darker than the NPR in ultraviolet light. The North Equatorial Belt is very thin in early 2012 in both visible and methane-band light. The width change of the NEB occurred simultaneously in both visible and methane band wavelengths. The SEB fade in 2009-2010 did not have this characteristic. This leads me to believe the process responsible for the changing NEB width is different from the one responsible for the SEB fade. Jupiter is 0.03 stellar magnitudes brighter than what is predicted from a recently published V filter model of that planet's brightness (Mallama and Schmude, 2012).

Introduction

Belt, zone and current names and their abbreviations are listed in Table 1. Abbreviations are used in this report.

Professional astronomers published several important Jupiter reports during late 2011 and early 2012. For example, Pérez-Hoyos et al (2012) report the 2009-2010 fade of Jupiter's SEB (SEB fade) started deep in the atmosphere and worked its way upwards. They also report the reflectivity of the SEB did not change simultaneously over the 255 to 953 nm wavelength range. Fletcher et al (2011) conclude the SEB faded at about the same time the temperature and aerosol opacity changed. They show Jupiter's atmosphere became more opaque in mid-infrared wavelengths between May 2008 and July 2010. This change preceded the SEB fade. This group also points out that the turbulence usually following the GRS "became quiescent" in mid-2009. They suggest this turbulence shuts down before an SEB fade. In a third report, Pilcher et al (2012) report Jupiter's moon Himalia (Jupiter VI) has a rotational period of 7.7819 ± 0.0005 hours. They also report its brightness changes 0.20 magnitudes during rotation. In a final study, Mallama and Schmude (2012) summarize brightness measurements of Jupiter made in the Johnson U, B, V, R and I system between 1963 and 2011. They report a model that predicts the brightness and color of Jupiter for different solar phase angles. This group also reports how large-scale changes, like the fading of the SEB, affect Jupiter's brightness.

Amateur astronomers have also contributed to our knowledge of Jupiter. This report summarizes results based on an analysis of ultraviolet, visible-light and methane-band images. It also includes the writer's brightness measurements.

The characteristics of Jupiter for the 2011-2012 apparition are listed in Table 2. Listed in Table 3 are those who submitted observations, images or measurements of Jupiter to the writer, to the ALPO Jupiter group or to either of these two websites:

http://alpo-j.asahikawa-med.ac.jp/Latest/Jupiter2008Apparition.htm

http://www.arksky.org

This paper follows certain conventions. The planetographic (or zenographic) latitude is always used. Latitudes are measured using either the software package WinJUPOS or the procedure outlined in Peek (1981, 49). West refers to the direction of increasing longitude. Longitude is designated with the Greek letter l, and a subscript Roman numeral which is the longitude system. For example, II = 54° means the system I longitude equals 54° W. The three longitude systems are described in (Rogers, 1995, 11; 2006, 334). All dates and times are in Universal Time (UT). Unless stated otherwise, all data are based on visible light images. All methane band images were made in light with a wavelength near 0.89 mm. Currents, except where noted, are named in accordance with Rogers (1990, 88). In all cases the drift rate, except where noted, is for the center of the feature. Feature names contain a letter and a number. Names are assigned based on the description in Schmude (2010, 31). All features are renamed every apparition except for the GRS and Oval BA. Therefore, feature B1 is probably not the same as B1 in the previous apparition.

Disk Appearance

Figures 1 and 2 show Jupiter's appearance in visible light. Figure 3 shows the appearance in methane band light with a wavelength near 0.89

All Readers

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- The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Observing Scales

Standard ALPO Scale of Intensity:
- 0.0 = Completely black
- 10.0 = Very brightest features
- Intermediate values are assigned along the scale to account for observed intensity of features

ALPO Scale of Seeing Conditions:
- 0 = Worst
- 10 = Perfect

Scale of Transparency Conditions:
- Magnitude of the faintest star visible near Jupiter when allowing for moonlight and twilight

Table 1: Names and Abbreviations of Belts and Zones on Jupiter

Belt and Zone Name	Abbreviation	Current Name	Abbreviation
South Polar Region	SPR	South Polar Current	SPC
South Polar Belt	SPB	South South South South Temperate Current	S^4TC
South Temperate Zone	STZ	South South South Temperate Current	S^3TC
South Tropical Zone	STrZ	South South South Temperate Current Jetstream	S^3TC jetstream
South Equatorial Belt	SEB	South South Temperate Current	SSTC
Equatorial Zone	EZ	South Temperate Current	STC
Equatorial Band	EB	South Tropical Current	STrC
North Equatorial Belt	NEB	North Equatorial Current	NEC
North Tropical Zone	NTrZ	North Temperate Current	NTC
North Temperate Belt	NTB	North North Temperate Current Jetstream	NNTC jetstream
North Temperate Zone	NTZ	North North Temperate Current	NNTC
North North Temperate Belt	NNTB	North North North Temperate Current	N^3TC
North Polar Region	NPR	North North North North Temperate Current	N^4TC
Great Red Spot	GRS	North Polar Current	NPC

micrometers. Figures 4 and 5 show the longitudes of Jupiter's features for different dates in 2011-2012.

Adamoli, Budine, Cudnik, Plante, Sweetman and the writer report over 800 light intensity estimates of Jupiter's belts, zones and oval storms. These estimates cover the time period between May 27, 2011 and April 8, 2012. The average light intensities based on the ALPO scale (10 = white and 0 = black) are: SPR (6.0), STrZ (8.0), SEB (3.7), EZs (8.8), EB (7.1), EZn (8.7) NEB (3.2), NTrZ (8.5), NTB (5.7), NTZ (7.1), NNTB (5.8), NNTZ (7.3), GRS (6.3), Oval BA (8.5) and NPR (5.8). One notable change during the last year is the SEB darkened 2.7 intensity units.

Adamoli's intensity estimates are converted to the ALPO scale using the same procedure as in Schmude (2012a).

Table 4 lists the latitudes of five belts on Jupiter based on measurements of color images. Belt latitudes are based on measurements made with the software package WinJUPOS. The biggest changes are the narrow SPB, NEB and NTB, and the wider SEB.

Table 5 lists the latitudes of a few features on Jupiter based on measurements of methane band images. The biggest change is the faint SEB. This may be the result of the SEB fade which occurred in 2010.

Measurement of white, red and brown oval features on Jupiter

The selected oval sizes are summarized in Table 6. The sizes are based on measurements made with WinJUPOS. The north, south, east and west coordinates (degrees of longitude and planetographic latitude) of each feature defines the dimensions in degrees. The conversion from degrees of latitude and longitude to kilometers is more complicated than for a sphere; this conversion is described in the next few paragraphs.

Jupiter is an oblate spheroid. Therefore, latitude is defined as either planetographic or planetocentric. The planetographic latitudes are first converted to planetocentric latitudes. This simplifies the calculations.

The conversion of the east-west dimension from degrees of longitude to kilometers is described first. The goal is to find the circumference of a circle perpendicular to Jupiter's axis with a radius of segment L – K. This will allow us to convert degrees of longitude to kilometers. See Figure 6A. Jupiter's equator lies along the X axis and the north and south poles lie along the Y axis. The planetocentric latitude is angle

Table 2: Characteristics of the 2011 - 2012 Apparition of Jupiter[a]

First conjunction date	2011 Apr 11
Opposition date	2011 Oct 29
Second conjunction date	2012 May 13
Brightness at opposition (stellar magnitude)	-2.9
Equatorial angular diameter at opposition	49.7 arc-seconds
Right Ascension at opposition	2h 14m
Declination at opposition	+11° 53’
Planetocentric latitude of the Earth at opposition	+3.8°
Planetocentric latitude of the Sun at opposition	+3.5°

[a]Data are from the Astronomical Almanac (2010 and 2011)

Table 3. to the 2011-2012 Jupiter Apparition Report[a, b]

Name; location (type of observation)	Name; location (type of observation)	Name; location (type of observation)	Name; location (type of observation)
P. Abel, UK (D, DN, TT)	M. Frassati, Italy (D)	A. Maniero, Italy (I)	K. Sasaki, Japan (I)
M. Adachi, Japan (D, DN)	F. Gabriele, Italy (I)	P. Maxson, USA (I)	Y. Sato, Japan (I)
G. Adamoli, Italy (D, DN, Re)	C. Galdies, Malta (I)	A. Medugno, Italy (I)	R. Schmude, Jr.; USA (D, DN, PP)
T. Akutsu; Philippines (I)	F. Gale, USA (D)	F. Melillo, USA (I)	I. Sharp, UK (I)
L. Albero, Spain (I)	A. Garbelini, Jr., Brazil (I)	J. Melka, USA (I)	M. Smrekar, Slovenia (I)
P. Amodio, Italy (I)	C. Gargiulo, Italy (I)	J.-C. Meriaux, USA (I)	M. Sparrenberger, Brazil (I)
K. Ando; Japan (I)	S. Ghomizadeh, Iran (I)	T. Mishina, Japan (I)	S. Spinoso, Italy (I)
G. Angelo, Italy (I)	C. Go, Philippines (I)	A. Mistretta, Italy (I)	G. Stelmack, Canada (I)
K. Aoki, Japan (I)	Y. Goryachko, Belarus (I)	M. Mobberley, UK (I)	J. D. Strikis, Greece (I)
C. Ashcraft, USA (I)	F. Goujon, France (I)	S. Mogami, Japan (I)	M. Sugimoto, Japan (I)
J. Atanackov, Slovenia (I)	E. Grafton, USA (I)	M. Mole, Slovenia (I)	J. Sussenbach, The Netherlands (I)
T. Barry, Australia (I)	F. Graham, USA (D)	E. Morales, USA (I)	T. Suzuki, Japan (I)
G. Basti, Italy (I)	D. Gray, UK (D)	O. Moreno, Spain (I)	M. Sweetman, USA (D, DN)
J. Beltran, Spain (I)	P. Grego, UK (D)	T. Murata, Japan (D)	R. Taggart, USA (I)
A. Berdejo, Spain (I)	M. Guidi, Italy (I)	M. Naitou, Japan (I)	I. Takimoto, Japan (I)
B. Berente, Hungary (I)	T. Haeberle, USA (D)	K. Nakai, Japan (I)	C. Tanaka, Japan (I)
G. Bianchi, Italy (I)	T. Hansen, Germany (I)	H. Nakanishi (I)	G. Tarsoudis, Greece (I)
A. Bianconi, Italy (I)	T. Hasebe, Japan (I)	Y. Nakano, Japan (I)	A. Tasselli, UK (I)
D. Bleser, USA (I)	A. Hatanaka, Japan (I)	D. Niechoy, Germany (D, I)	R. Tatum, USA (I)
G. Bleser, USA (I)	T. Hayashi, Japan (I)	T. Nonoguchi, Japan (D)	M. Teodorescu, Romania (I)
F. Borges, Brazil (I)	R. Hill, USA (I)	P. Oberc, Slovenia (I)	K. Tokujiro, Japan (I)
J. Boudreau, USA (I)	R. Hillebrecht, Germany (DN)	A. Obukhov, Russia (I)	Y. Tomita, Japan (I)
P. Breisch, Germany (I)	M. Hood, USA (I)	T. Olivetti, Italy (I)	H. Torsten (I)
P. Budine, USA (D)	C. Hsuan-Hsiao, Taiwan (I)	J. Ortega, Spain (I)	C. Triana, Columbia (I)
K. Buecke, Germany (I)	J. Hubbell (I)	S. Ota, Japan (I)	A. Trivsano, Italy (I)
M. Caimmi, Italy (I)	T. Ikemura, Japan (I)	L. Owens, USA (I)	D. Tyler, UK (I)
L. Campos, Portugal (I)	T. Ishibashi, Japan (I)	H. Oyamada, Japan (I)	F. Ucha, Spain (I)
P. Casquinha; Portugal (I)	M. Jacquesson, France (I)	K. Ozaki, Japan (I)	T. Usude, Japan (I)
J. Castella, Spain (I)	W. Jaeschke, USA (I)	D. Parker, USA (I)	M. Vedovato, Italy (I)
C. Cellini, Italy (I)	R. Jakiel, USA (I)	T. Parker, USA (I)	G. Van Hauwermeiren, Belgium (I)
D. Chang; Hong Kong, China (I)	D. Kananovich, Estonia (I)	D. Peach, UK (I)	A. Vidal, Spain (I)
R. Chavez, USA (I)	S. Kanno, Japan (I)	C. Pellier, France (I)	C. Viladrich, France (I)
G. Chester; USA (I)	H. Karasawa, Japan (I)	O. Pettenpaul, Germany (I)	G. Walker, USA (I)
A. Coffelt, USA (I)	M. Kardasis, Greece (I)	J. Phillips, USA (I)	S. Walker, USA (I)
B. Colville, Canada (I)	A. Kazemoto, Japan (I)	M. Phillips, USA (I)	J. Warell, Sweden (I)
B. Combs, USA (I)	B. Kendrick, USA (I)	G. Pizarro, Spain (I)	J. Warren, USA (I)
G. Crist, USA (I)	S. Kidd, UK (I)	P. Plante, USA (D)	A. Wesley, Australia (I)
B. Cudnik, USA (D, DN, TT)	B. Kingsley, UK (I)	J. Poupeau, France (I)	R. Wheeler, USA (I)
I. Dalpasso, Italy (I)	W. Kivits, The Netherlands (I)	J. Pryal, USA (DN)	F. Willems, USA (I)
J.-L. Dauvergne, France (I)	D. Köhn, Germany (I)	E. Punzo, Italy (I)	J. Willinghan, USA (I)
P. De Gregorio, Italy (I)	M. Koishikawa, Japan (I)	D. Put, The Netherlands (I)	T. Wilson, USA (I)
V. da Silva, Jr., Brazil (I)	J. Kos, Slovenia (I)	K. Quin, USA (I)	F. Winterer, Germany (I)
M. Delcroix, France (I)	S. Kowollik, Germany (I)	T. Ramakers, USA (O)	T. Winterer, Germany (I)
K. Dimitrios, Greece (I)	E. Kraaikamp The Netherlands (I)	J. Rogers, UK (Re)	B. Worsley, USA (I)
X. Dupont, France (I)	T. Kumamori, Japan (I)	P. Rosen, Sweden (I)	M. Yamada, Japan (I)
R. Duran, Spain (I)	A. Lasala, Spain (I)	M. Rosolina (D, DN)	A. Yamazaki, Japan (I)
P. Edwards, UK (I)	P. Lawrence, UK (I)	C. Roussell, Canada (D, DN, TT)	S. Yoneyama, Japan (I)
H. Einaga, Japan (I)	P. Lazzarotti, Italy (I)	J. Rozakis, Greece (I)	T. Yoshida, Japan (I)
T. Enomoto, Japan (I)	D. Llewellyn, USA (I)	T. Saitou, Japan (I)	K. Yunoki, Japan (I)
I. Esquivel, Mexico (I)	O. Lopez, Spain (I)	S. Saltamonti, Italy (I)	C. Zannelli, Italy (I)
I. Falcon, Spain (I)	R. Lunsford, USA (I)	A. Sanchez, Spain (I)	F. Zanotti, Italy (I)
C. Fattinnanzi, Italy (I)	P. Masuri, Italy (I)	O. Sánchez, Spain (I)	L. Zielke, Denmark (I)
A. Filothodoros, Poland (I)	P. Malinski, Poland (I)	J. Sanchez; Spain (I)	

[a] Type of observation: D = drawing, DN = descriptive notes, I = image, PP = photoelectric photometry, R = radio studies, Re-Interim report, TT = transit times, and O = other.
[b] All people who submitted images to http://www.arksky.org in the ALPO Jupiter archive and in the ALPO Japan.
Latest website in the Jupiter archive are acknowledged in this table.

ECK = angle B. If one places the origin at point C, the X component of point K gives us the length between points L and K. The X component of point K is computed from the intercept of the ellipse and line CK. The equations are:

$$\frac{X^2}{R_E^2} + \frac{Y^2}{R_P^2} = 1 \qquad \text{ellipse equation (1)}$$

$$Y = \mathrm{TAN}(B)\,X \quad \textit{or} \quad Y = \mathrm{TAN}(\text{angle ECK})\,X \qquad \text{line CK equation (2)}$$

In equation 1, R_E and R_P are the lengths of the semimajor and semiminor axes, respectively. This equation defines Jupiter. Equation 2 defines the planetocentric latitude. One then rearranges these equations in terms of Y, sets them equal to one another, solves for X and derives:

$$\text{X component of point K} = R = (1/[(\mathrm{TAN}^2(B)) + (R_P^2/R_E^2)])^{0.5} \qquad (3)$$

With the X component of point K, which equals R, one may compute the circumference of the circle of interest. Afterwards, one converts degrees of longitude to kilometers as:

$$\text{East-west length in km} = E \times (2 \times R \times \pi)/360° \qquad (4)$$

In this equation, E is the east-west length of the oval in degrees of longitude at a planetocentric latitude B; R is defined in equation 3 and p = 3.1415926.

The computation of the north-south length in kilometers is more difficult. Before considering an ellipse I computed the circumference of a circle as a check on the reliability of the method.

I choose to carry out calculations in the following way. The first step is to compute the point where equations 5 and 6 intersect. This is done for B = 0°, 10°, 20°, 30° … up to 90°. See Figure 6B. The distances between adjacent points are computed and the distances are added. The sum is multiplied by 4.00 to yield the circumference. This procedure is repeated with 1°, 0.1° and 0.01° increments of B. My results are listed in Table 7. As can be seen, the difference in the measured and actual circumference drops as the increment is reduced. The difference of the computed and theoretical circumference is negligible for the 0.1° and 0.01° increment values.

$$X^2 + Y^2 = 1.000 \qquad \textit{equation for a circle with radius = 1.000} \qquad (5)$$

$$Y = \mathrm{TAN}(B)\,X \qquad \textit{equation for line CK; see Figure 6C} \qquad (6)$$

A similar procedure is carried out for an ellipse. Essentially I compute the intercept of equations 1 and 2 (where R_E = 71,541 km and R_P = 66,896 km). The value of B starts at 0° and rises in 10° increments. As before, the distances between adjacent points are computed. See Figure 6D. The distances are added up and this sum is multiplied by 4.00 to yield the circumference. This procedure is repeated with increments of 1°, 0.1° and 0.01° for B. The resulting circumferences are listed in Table 7.

The computed circumferences for 1°, 0.1° and 0.01° increments are nearly equal. This along with the results for the circle leads me to believe the computed ellipse circumference, when B is allowed to vary every 0.01°, is very close to the actual value. Furthermore, this leads me to believe the length of any fraction of an ellipse may be computed from the sum of the lengths of the small segments which lie along the arc. The north-south dimension of an oval is computed from the sum of the small segments over the range of latitudes. For example, if an oval extends from 39.5° S to 42.0° S, the sum of the 250 small segments between these latitudes is added up. This is believed to be within 10^{-4} % of the actual dimension.

The aspect and area for each oval is calculated from the dimensions in kilometers. The aspect is the quotient of the north-south and east-west lengths. The area is computed from:

$$\text{Area} = \text{north-south length} \times \text{east-west length} \times \pi/4.00 \qquad (7)$$

Equation 7 is strictly valid for ovals having an elliptical shape. Figure 6E shows two outlines of the GRS. The dashed one is based on measurements made from an October 10, 2011 image using WinJUPOS. The solid outline is computed from the equation for an ellipse with the measured semimajor and semiminor axes of the GRS. The close resemblance of the two outlines is evidence the elliptical shape is a good

Table 4: Planetographic Latitudes of Belts on Jupiter (based on images made in visible wavelengths, October 2011)

Feature	South Edge	North Edge
South Polar Belt	65.9° S ± 0.5°	61.4° S ± 0.5°
South Equatorial Belt	24.5° S ± 0.4°	7.3° S ± 0.1°
North Equatorial Belt	8.3° N ± 0.2°	16.7° N ± 0.3°
North Temperate Belt	28.1° N ± 0.5°	31.0° N ± 0.5°
North North Temperate Belt	36.8° N ± 0.5°	39.8° N ± 0.5°

Table 5: Planetographic Latitudes of Belts on Jupiter (based on methane-band images made at a wavelength of 0.889 µm, October 2011)

Feature	South Ege	North Ege
South Polar Cap	—	64.9° S ± 0.5°
South Equatorial Belt	19.5° S ± 1.0°	10.9° S ± 0.5°
North Equatorial Belt	10.0° N ± 0.5°	17.0° N ± 0.5°
North Temperate Belt	22.7° N ± 0.5°	27.3° N ± 1.0°
North Polar Cap	72.4° N ± 1.5°	—

Table 6: Dimensions of White, Red and Dark Oval Features on Jupiter (2011-2012)

Feature	Length (degrees)		Length (km)		Aspect	Area (10^6 km^2)
	N-S	E-W	N-S	E-W		
A5	1.86 ± 0.11	2.79 ± 0.11	2200	1800	1.20	3.2
A6	1.94 ± 0.10	2.90 ± 0.12	2300	1900	1.22	3.5
A7	2.90 ± 0.25	5.46 ± 0.48	3500	3600	0.97	9.8
A8	1.51 ± 0.13	2.48 ± 0.20	1800	1600	1.11	2.3
A1	1.97 ± 0.20	3.35 ± 0.23	2400	2700	0.88	5.1
A2	2.40 ± 0.15	3.72 ± 0.16	2900	3100	0.94	7.1
A12	1.76 ± 0.12	2.93 ± 0.27	2200	2700	0.79	4.6
A13	1.57 ± 0.11	2.27 ± 0.19	1800	2100	0.88	3.0
B1	2.06 ± 0.07	3.43 ± 0.11	2500	3300	0.76	6.6
B2	1.89 ± 0.09	2.96 ± 0.11	2300	2900	0.81	5.2
B3	2.48 ± 0.09	3.75 ± 0.11	3000	3600	0.83	8.7
B4	2.03 ± 0.07	3.05 ± 0.10	2500	3000	0.84	5.8
B5	2.38 ± 0.10	3.89 ± 0.15	2900	3800	0.77	8.6
B6	2.36 ± 0.07	3.83 ± 0.10	2900	3700	0.78	8.4
B7	2.76 ± 0.07	4.50 ± 0.11	3400	4400	0.77	11.6
B8	1.34 ± 0.12	2.18 ± 0.23	1600	2100	0.78	2.7
B9	1.80 ± 0.09	2.49 ± 0.10	2200	2400	0.91	4.2
B10	1.92 ± 0.08	3.06 ± 0.09	2400	3000	0.80	5.5
Oval BA	5.56 ± 0.16	8.39 ± 0.21	6800	9000	0.76	48.2
C3	1.27 ± 0.04	1.81 ± 0.06	1600	1900	0.82	2.4
C4	1.27 ± 0.04	2.03 ± 0.07	1600	2200	0.73	2.7
GRS	8.72 ± 0.10	15.2 ± 0.1	10,800	17,700	0.61	151
N2	2.02 ± 0.07	2.98 ± 0.15	2500	3600	0.70	7.1
N3	1.48 ± 0.05	2.12 ± 0.09	1900	2600	0.72	3.7
N4	3.30 ± 0.09	10.9 ± 0.2	4100	13,200	0.31	43
N5	2.79 ± 0.07	6.96 ± 0.13	3500	8400	0.41	23
N6	3.18 ± 0.08	8.68 ± 0.15	3900	10,500	0.38	32
N7	1.99 ± 0.06	3.30 ± 0.10	2500	4000	0.62	7.8
N1	3.15 ± 0.11	4.82 ± 0.20	3900	5700	0.69	17.5
G1	3.88 ± 0.21	7.89 ± 0.17	4700	7600	0.62	28.4
G2	1.94 ± 0.06	3.09 ± 0.11	2400	3000	0.80	5.6
G3	2.25 ± 0.14	4.06 ± 0.25	2800	3900	0.70	8.5
G4	2.65 ± 0.23	4.24 ± 0.37	3300	4100	0.80	10.4
I8	1.62 ± 0.09	2.08 ± 0.17	2000	1900	1.07	2.9
I5	1.94 ± 0.07	2.80 ± 0.10	2400	2300	1.02	4.3
I6	2.37 ± 0.06	3.40 ± 0.12	2900	2700	1.07	6.0
I4	1.57 ± 0.20	2.78 ± 0.21	1900	1800	1.04	2.7
I2	2.93 ± 0.16	4.78 ± 0.17	3500	2900	1.22	7.9
I3	2.20 ± 0.22	3.95 ± 0.27	2600	2400	1.09	5.0
I1	3.13 ± 0.16	9.35 ± 0.47	3700	3400	1.07	9.9

Table 7. Computed Circumference of a Circle (see note) 2011-12

Increment (degrees)	Circle			Ellipse
	Computed circumference	True circumference	Percent Error	Computed circumference
10	6.275213	6.2831853	0.12688	434,475.7 km
1	6.283106	6.2831853	0.001262	435,029.5 km
0.1	6.283184	6.2831853	0.000021	435,035 km
0.01	6.283185	6.2831853	0.000005	435,035.1 km

Note: In this table, the radius is 1.000 and the ellipse has semimajor and semiminor axes of 71, 541 km and 66,897 km. In both cases, the increment was changed by 10°, 1°, 0.1° and 0.01°. As the increment decreases, the calculation of the circumferences approaches the actual circumference.

approximation to the size and shape of the GRS and presumably other ovals on Jupiter. It is believed equation (7) is a valid approximation to within ±10%.

The oval characteristics in Table 6 are believed to be more accurate than those in previous reports (Schmude, 2003, pp. 41-62); (Schmude, 2007, pp. 25-50); (Schmude, 2008a, pp. 30-49); (Schmude, 2009a, pp. 24-39); (Schmude, 2009b, pp. 29-45) and (Schmude, 2010, pp. 29-44) for two reasons. The first is the conversion from degrees of longitude and latitude to kilometers is more accurate for the Table 6 results. The second reason for the greater accuracy of the Table 6 results is most values are based on averages of 15 measurements or more instead of around 4 as in the earlier studies.

Region I: Great Red Spot

The general appearance of the GRS is shown in Figures 1K, 2A – 2C, 2K and 2L. Cudnik reports a salmon color for the GRS on August 21, 2011. Abel usually draws the GRS as having a non-uniform orange color (November 13, 17, 27, January 12, February 1). Adachi notes it has a red color at high magnification on November 3. Gray draws the GRS as an orange-brown oval in a color drawing on November 1. Adachi notes that it has a prominent southern arch on September 11. Budine also draws this dark arch on February 9, 2012. See Figure 1K. Niechoy, however, does not draw a dark southern arch around the GRS on November 28, 2011. See Figure 1I. The southern arch of the GRS may have changed. Note it is darker in Figures 2A, 2C and 2I than in Figure 2B. This arch changed in methane band light. See Figures 3A, 3B and 3E.

The dimensions of the GRS are summarized in Table 6. Its east-west length is 15.2° ± 0.1°. This is lower than the corresponding values of 17°, 16° and 16° for 2003 – 2006 as shown in Figure 2 of Rogers (2008). The north-south dimension of the GRS is 9.6° (planetographic latitude) in 2011-2012. This is smaller than the 10.3° reported in (Rogers, 2008) for 2006. The smaller size of the GRS in 2011-2012 is consistent with Rogers' conclusion of a shrinking GRS.

Jim Melka points out a small dark spot within the GRS on his November 3, 2011 image. It appears on visible light images between November 1 and 4. Figures 7A – 7C show the projection. Measurements are consistent with it making one trip around the GRS in 6.46 days. The circumference of the GRS is needed to compute the speed in meters per second. A procedure like the one illustrated in Figure 6D yields a GRS circumference of 45,400 km. The average speed of the projection is 7028 km per day or 81 ± 8 meters per second. An estimated uncertainty of 10% is included.

The average longitude of the GRS between October 14 and November 13 is 171.2° W. This is 14.2° farther west than in September 2010.

Region II: South Polar Region to the South Tropical Zone

The two Polar Regions are not equally dark. On a few occasions, the SPR is drawn darker than the NPR. For example, Abel (January 12 and 14), Murata (September 28) and the writer February 18 notes the SPR is darker than the NPR. See also Figures 1B, 1E, 1H and 1K. Strangely though, the NPR has a lower average light intensity (5.8) than the SPR (6.0).

The NPR and SPR may also have different colors. Abel draws the SPR as grayish brown and the NPR as grayish on February 1. Ultraviolet images show the SPR is darker than the NPR. See Figure 7D – 7F. Ultraviolet images made on December 11, 2010 (T. Akutsu); August 29, 2009 (D. Parker); August 4, 2008 (K. Yunoki); July 24, 2007 (K. Yunoki) and June 2, 2006 (C. Pellier) all show the SPR as being darker than the NPR.

The South Polar Belt (SPB) is faint. One reason why it is faint is Jupiter's southern hemisphere is tipped away from the Earth. One of Adachi's drawings shows a faint southern SPB on September 11. It is visible in Figure 2C.

Drift rates for different currents between 60° S and 16° S are summarized in Table 8. The drift rates are like those in the previous apparition. Two exceptions are the SSSTC and the STBN Jetstream following the GRS. The average drift rate of the STBN Jetstream is -91°/30 days which is more negative than the corresponding value of -75°/30 days in the previous apparition. The two spots (A1 and A2) in the S^3TC are believed to be the same feature but with different drift rates.

Region III: South Equatorial Belt

The SEB underwent three changes. First of all it grew wider. Figure 8 shows the positions and widths of the SEB during the 2011-2012 apparition. The southern edge is 3° farther south than in September 2010. The average latitudes of the northern and southern borders between 1940 and 1990 are 7.0° S and 20.7° S (Rogers, 1995, p. 167). Therefore, the southern border is farther south than the corresponding average between 1940 and 1990. A second change is its range of colors. For

Table 8: Planetographic Latitudes and Drift Rates of Features South of the EZ (2011-2012)

Feature (Descr.)	Number of Points	Planetographic Latitude	Drift Rate Deg./30 Days System II	Feature (Descr.)	Number of Points	Planetographic Latitude	Drift Rate Deg./30 Days System II
South Polar Current at 60° S							
A5 (wo)	24	59.8° S	-18	A6 (wo)	19	59.8° S	-13
A7 (wo)	35	59.8° S	-13	A8 (wo)	33	59.2° S	-11
Average		*59.6*	*-14*				
South South South Temperate Current							
A1 (wo)	21	51.1° S	-25	A2 (wo)	23	50.1° S	-3
Average		*50.6° S*	*-14*				
South South South Temperate Current Jetstream							
A10 (wo)	9	43.2° S	-84	A11 (wo)	25	43.7° S	-94
A12 (wo)	44	43.5° S	-95	A13 (wo)	48	43.1° S	-89
Average		*43°.4° S*	*-91*				
South South Temperate Current							
B1 (wo)	42	40.8° S	-28	B2 (wo)	39	40.8° S	-27
B3 (wo)	44	40.6° S	-27	B4 (wo)	42	40.9° S	-27
B5 (wo)	31	40.9° S	-29	B6 (wo)	36	40.9° S	-28
B7 (wo)	43	40.7° S	-28	B8 (wo)	8	40.7° S	-33
B9 (wo)	28	41.0° S	-27	B10 (wo)	39	41.2° S	-30
Average		*40.9° S*	*-28*				
South Temperate Current							
C1 (ds)	8	34.6° S	-16	C2 (ds)	31	34.8° S	-15
BA (ro)	37	33.0° S	-13	C3 (wo)	28	33.7° S	-13
C4 (wo)	24	33.4° S	-13				
Average		*33.9° S*	*-14*				
South Temperate Belt North Jetstream, following the GRS							
C5 (ds)	11	26.7° S	-97	C6 (ds)	15	25.6° S	-80
C7 (ds)	13	26.9° S	-96	C8 (ds)	14	26.8° S	-94
C9 (ds)	14	27.6° S	-98	C10 (ds)	14	28.5° S	-83
C11 (ds)	12	28.4° S	-91	C12 (ds)	12	28.3° S	-88
C13 (ds)	17	27.2° S	-97	C14 (ds)	16	27.9° S	-87
Average		*27.4° S*	*-91*				
South Tropical Current							
GRS (ro)	47	22.0° S	1				
South Equatorial Belt Current							
D1	45	16.3° S	5	D2	19	16.6° S	10
Average		*16.5 ° S*	*7*				

Note: descr. = description: wo = white oval, ds = dark spot, b = barge, f = festoon, ro = red oval.

example, Abel records shades of gray, orange, brown and white in the SEB on November 27. Several shades are also shown in his September 22-23, November 27 and January 12 drawings. Color images also show shades of gray and orange in the SEB. A third SEB change is the development of bright white spots following the GRS. This stopped in 2009 before the SEB fade but started back up in the current apparition.

The SEB did not fade simultaneously in visible and methane band light. In visible wavelengths, it began fading in late 2009 and became nearly as bright as the STrZ during the first 10 months of 2010. It then started to reappear in November 2010 and was dark by early 2011. In methane band light, the SEB behaved differently. It had its normal dark appearance in 2010 but was nearly as bright as the STrZ in June 2011. Since then the SEB has started to return to its normal dark appearance. Therefore, methane band images show the SEB becoming faint about 1.5 years after it became faint in visible wavelengths.

The longitudes of two brownish barges (D1 and D2) in the SEB are plotted in Figure 5. The average drift rate of these features is 7°/30 days. This is close to similar features in 2009-2010 (Schmude, 2011b, p. 37).

Region IV: Equatorial Zone

Several drew the EZ as white or nearly white having bluish-gray streaks in it. These streaks may be festoons, isolated spots or fragments of the Equatorial Band (EB). Plante draws a nearly continuous and narrow EB on November 2. See Figure 1G. On the other hand, Adachi draws a wide EB on September 9. Budine draws many small grayish streaks and festoons in the EZ. See Figure 1H and 1K. The EZ is the brightest area on Jupiter with mean intensities of 8.8 and 8.7 for the southern and northern portions, respectively.

Color images generally show a bright EZ containing many smaller bluish-gray spots. In a few cases, these spots appear to form two dark cloud bands within the EZ. See Figure 2I.

The northern third of the EZ is almost always brighter than the remaining portion in methane band light. See Figure 3A – 3F. On a few occasions, two dark linear belts are in the EZ. See Figures 3D and 3E.

Region V: North Equatorial Belt

The NEB is usually a brownish-red belt. For example, Abel draws it in different shades of red and brown on November 27. On the same date, he draws the barges as brown ovals. The barges are generally drawn within the NEB during the first half of the apparition. See Figures 1A – 1F. Afterwards, the NEB grew thin and the barges are drawn separated from the NEB. See Figure 1K.

The middle graphs in Figure 8 show the positions and widths of the NEB. These are based on visible light images. The NEB is very narrow in early 2012 – 14 months after December 2010. The sequence of events for a thinning event is: 1) portions of the northern third of the NEB grow progressively fainter and 2) these portions blend in with the NTrZ resulting in a thinner belt. Figures 2A, 2B and 2C show the progression of a portion of the NEB near III = 180° W growing fainter with time. By March 2012, this belt is only 5° wide. This is less than half its average width between 1913 and 1990 (Rogers, 1995, p. 113). More recently, the writer analyzed its width between 1995 and 2011. The width in March 2012 was much lower than at any time between 1995 and 2011 (Schmude 2012b).

What triggered the changes in the NEB? One possibility is its rifts. See Figures 2A and 2F. These are nearly parallel with Jupiter's equator.

The bottom two frames in Figure 8 show the NEB position and width in methane band light (wavelength = 0.89 mm). Measurements are made in a similar way as in visible light. Like the situation in visible light, the NEB started becoming thinner in late 2011. Most of this change came from the southward shift of the northern border. Essentially the width changes nearly simultaneously in visible and methane band wavelengths. This is not the case for the fading SEB in 2009-2010. Based on this behavior, it is concluded the process responsible for the changing NEB width is different from the one which caused the SEB to fade in 2009-2010.

The drift rates of six NEB barges (N2 – N7) are shown in Figure 5. The average barge drift rate is -7°/30 days. This is close to the corresponding value in the previous apparition. Lengths and other characteristics for these barges are in Table 6.

Region VI: North Tropical Zone to the North Polar Region

The NTB and NNTB are visible in several drawings. See Figures 1B, 1E, 1F, 1J and 1K. In many cases, only part of the NNTB is drawn. This is probably because it has an uneven intensity. Some portions are darker than others in visible light. Dark sections of the NNTB are shown in Figures 2F, 2I and 2J. Abel draws the NTB and NNTB as brownish-orange belts. Adachi notes the NNTB has an orange color on November 26.

One final note is the bright oval at 74° N. It has a drift rate of 10°/30 days and a shape like other features north of 45° N. The writer has not measured the drift rate of a feature this far north before.

The longitudes of features in different currents north of the NEB are shown in Figure 5 and drift rates are summarized in Table 9. These are like those in the previous apparition (Schmude, 2012a).

Wind Speeds

Table 10 summarizes wind speeds. These are with respect to the system III longitude and represent how fast large features are moving. They are computed in the same way as in Rogers (1995, 392). Uncertainties are computed in the same way as in Schmude (2003, 50).

Photoelectric Photometry

The writer used an SSP-3 solid state photometer along with a Maksutov telescope and filters transformed to the Johnson V, R and I system to make all brightness measurements. The telescope was stooped down to an aperture of 0.007 m for the Jupiter measurements but the full aperture was used for the comparison star measurements. Experimental measurements show the reduction in aperture caused a 5.053 magnitude change in measured brightness. This factor was used in determining all Jupiter brightness values. More information on the equipment and method may be found elsewhere (Optec inc, 1997), (Schmude, 1992, p. 20), (Schmude, 2008, pp. 156-168).

Table 9: Planetographic Latitudes and Drift Rates of Features North of the EZ (2011-2012)

Feature (Descr.)	Number of Points	Planetographic Latitude	Drift Rate Deg./30 Days System Ii	Feature (Descr.)	Number of Points	Planetographic Latitude	Drift Rate Deg./30 Days System Ii
North Tropical Current, barges							
N2 (b)	33	15.2° N	-7	N3 (b)	35	15.2° N	-7
N4 (b)	42	15.6° N	-8	N5 (b)	47	15.6° N	-5
N6 (b)	44	15.7° N	-6	N7 (b)	42	15.3° N	-10
Average		*15.4 ° N*	*-7*				
North Tropical Current, oval							
N1 (wo)	28	20.4° N	-11				
North Temperate Current B							
F1 (ds)	27	27.9° N	-51	F2 (ds)	27	28.3° N	-51
F3 (ds)	27	28.4° N	-54				
Average		*28.2 ° N*	*-52*				
North North Temperate Current B							
H1 (ds)	33	35.6° N	-82	H2 (ds)	34	35.7° N	-84
H3 (ds)	15	36.0° N	-87	H4 (ds)	32	35.4° N	-75
H5 (ds)	37	36.4° N	-86	H6 (ds)	35	36.1° N	-90
H7 (ds)	13	35.9° N	-87	H8 (ds)	31	35.7° N	-87
H9 (ds)	35	36.3° N	-92	H10 (ds)	30	35.7° N	-80
H11 (ds)	31	35.0° N	-83	H12 (ds)	31	35.1° N	-84
H13 (ds)	22	34.2° N	-80				
Average		*35.6° N*	*-84*				
North North Temperate Current							
G1 (wo)	7	41.3° N	-9	G2 (wo)	35	41.0° N	3
G3 (wo)	35	41.4° N	-6	G4 (wo)	12	41.7° N	-9
Average		*41.4° N*	*-6*				
North North North Temperate Current							
I8 (wo)	30	45.9° N	-18	I9 (ds)	17	44.4° N	-25
Average		*45.2° N*	*-22*				
North North North North Temperate Current							
I5 (wo)	24	50.7° N	5	I6 (wo)	32	52.8° N	7
Average		*51.8° N*	*6*				
North Polar Current at 60° N							
I4 (wo)	5	60.3° N	17				
North Polar Current at 63° N							
I2 (wo)	7	62.9° N	-4	I3 (wo)	11	62.1° N	-5
Average		*62.5° N*	*-5*				
North Polar Current at 74° N							
I1 (wo)	5	74.0° N	10				

The brightness measurements are listed in Table 11. These are corrected for atmospheric extinction and color transformation. On October 6 and March 17, the comparison star is Alpha-Aries. On all other dates, Epsilon Taurus is the comparison star. Comparison star magnitudes are from Iriarte et al (1965).

Mallama and Schmude (2012) published a paper on Jupiter brightness measurements made between 1963 and 2011. Equations were derived based on these measurements. Jupiter was 0.03 magnitudes brighter in 2011-2012 than what is predicted for the V filter equation. This may be caused by the NEB becoming narrow during the current apparition.

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Table 10: Average Drift Rates, Rotation Periods and Wind Speeds[a] for Several Currents on Jupiter (2011-2012 Apparition)

Current	Feature(s)	Drift Rate (degrees/30 days)			Rotation Rate	Wind Speed (m/s)
		Sys. I	Sys. II	Sys. III		
SPC at 60° S	A5 – A8	215	-14	-6	9h 55m 22s	1.5 ± 0.4
SSSTC	A1, A2	215	-14	-6	9h 55m 21s	2.0
SSSTC – Jetstream	A10 – A13	138	-91	-83	9h 53m 37s	29.8 ± 0.8
SSTC	B1 – B10	201	-28	-20	9h 55m 02s	7.5 ± 0.3
STC	C1 – C4, Oval BA	215	-14	-6	9h 55m 22s	1.8 ± 0.2
STBN – Jetstream	C5 – C14	138	-91	-83	9h 53m 37s	35.8 0.8
STrC	GRS	230	1	9	9h 55m 42s	-4.1 ± 1[a]
SEB barges	D1, D2	236	7	15	9h 55m 50s	-7.0 ± 1[a]
NTrC – Barges	N2 – N7	222	-7	1	9h 55m 31s	-0.4 ± 0.5
NTrC – White Oval	N1	218	-11	-3	9h 55m 26s	0.9 ± 2[a]
NTC-B	F1 – F3	177	-52	-44	9h 54m 29s	19.0 ± 0.3
NNTC – Jetstream	H1 – H13	145	-84	-76	9h 53m 46s	30.5 ± 0.5
NNTC	G1 – G4	223	-6	2	9h 55m 33s	-0.9 ± 0.9
NNNTC	I8, I9	207	-22	-14	9h 55m 11s	4.8 ± 0.9
N4TC	I5, I6	235	6	`14	9h 55m 49s	-4.4 0.2
NPC at 60° N	I4	246	17	25	9h 56m 04s	-6.2 ± 2[a]
NPC at 63° N	I2, I3	224	-5	3	9h 55m 34s	-0.8 ± 0.1
NPC at 74° N	I1	239	10	18	9h 55m 55s	-2.6 ± 2[a]
Note: [a] Estimated uncertainty						

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Table 11: Photometric Magnitude Measurements of Jupiter for the 2011-2012 Apparition

Date (2011-12)	Filter	α (deg.)	Measured Magnitude	$X(1,\alpha)$
Sept. 2.420	V	10.3	-2.69	-9.37
Sept. 10.420	V	9.3	-2.74	-9.37
Oct. 1.402	V	5.9	-2.83	-9.36
Oct. 3.402	V	5.6	-2.89	-9.41
Oct. 6.406	V	5.0	-2.92	-9.43
Oct. 8.400	V	4.6	-2.88	-9.39
Oct. 28.184	V	0.36	-2.94	-9.42
Nov. 24.191	R	5.6	-3.33	-9.86
Nov. 24.212	R	5.6	-3.29	-9.82
Nov. 25.189	V	5.8	-2.87	-9.41
Nov. 25.205	V	5.8	-2.89	-9.43
Dec. 3.181	I	7.2	-3.18	-9.76
Dec. 3.200	V	7.2	-2.81	-9.39
Dec. 18.156	V	9.4	-2.73	-9.41
Dec. 24.138	V	10	-2.69	-9.40
Jan. 15.051	V	11.3	-2.48	-9.35
Mar. 17.040	V	7.9	-2.11	-9.37

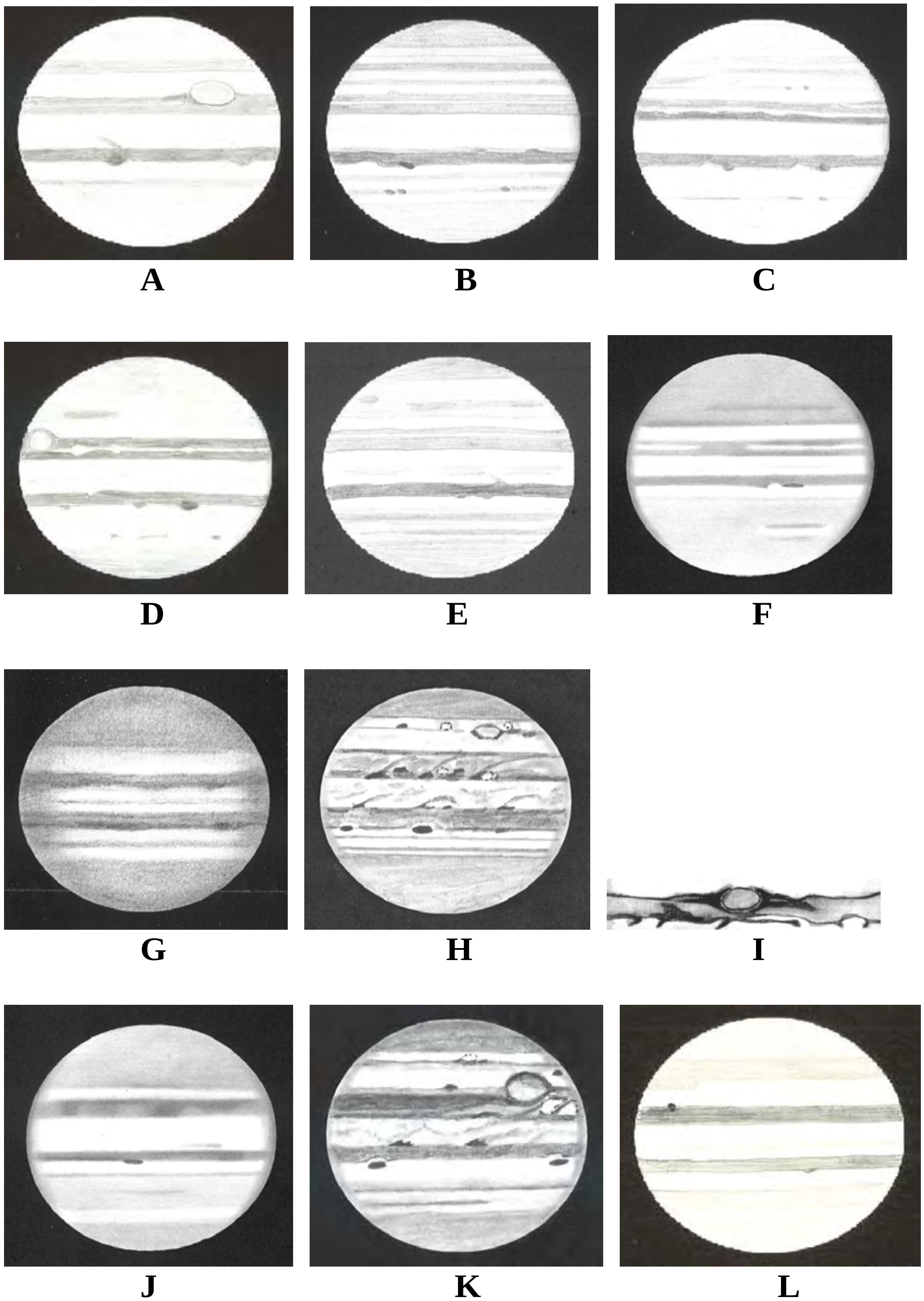


Figure 1. Drawings of Jupiter made during the 2011-2012 apparition. In figures 1-3, M is a Maksutov, RL is a reflector, RR is a refractor and SC is a Schmidt-Cassegrain telescope. A: June 3, 2011 (11:00 UT) B. Cudnik, 0.20 m SC, II = 312°W, III=144°W. B: July 10, 2011 (10:55 UT) B. Cudnik, 0.36 m SC, II = 26°W, III=296°W. C: July 24, 2011 (12:05 UT) B. Cudnik, 0.36 m SC, II = 119°W, III=282°W. D: July 31, 2011 (11:05 UT) B. Cudnik, 0.20 m SC, II = 108°W, III=217°W. E: September 20, 2011 (11:20 UT) B. Cudnik, 0.20 m SC, II = 252°W, III=333°W. F: Nov. 1, 2011 (9:48 UT) M. Sweetman, 0.10 m RR, II = 354°W, III=114°W. G: Nov. 2, 2011 (3:00 UT) P. Plante, 0.64 m RL, II = 263°W, III=18°W. H: Nov. 13, 2011 (3:45 UT) P. Budine, 0.13 m RL, II = 229°W, III=259°W. I: Nov. 28, 2011 (18:50 UT) D. Niechoy, 0.20m telescope, II = 270°W, III=181°W. J: Dec. 27, 2011 (6:25 UT) M. Sweetman, 0.10 m RR, II = 74°W, III=129°W. K: Feb. 9, 2012 (23:15 UT) P. Budine, 0.15 m M, II = 71°W, III=144°W. L: April 8, 2012 (1:15 UT) B. Cudnik, 0.20 m SC, II = 288°W, III=277°W.

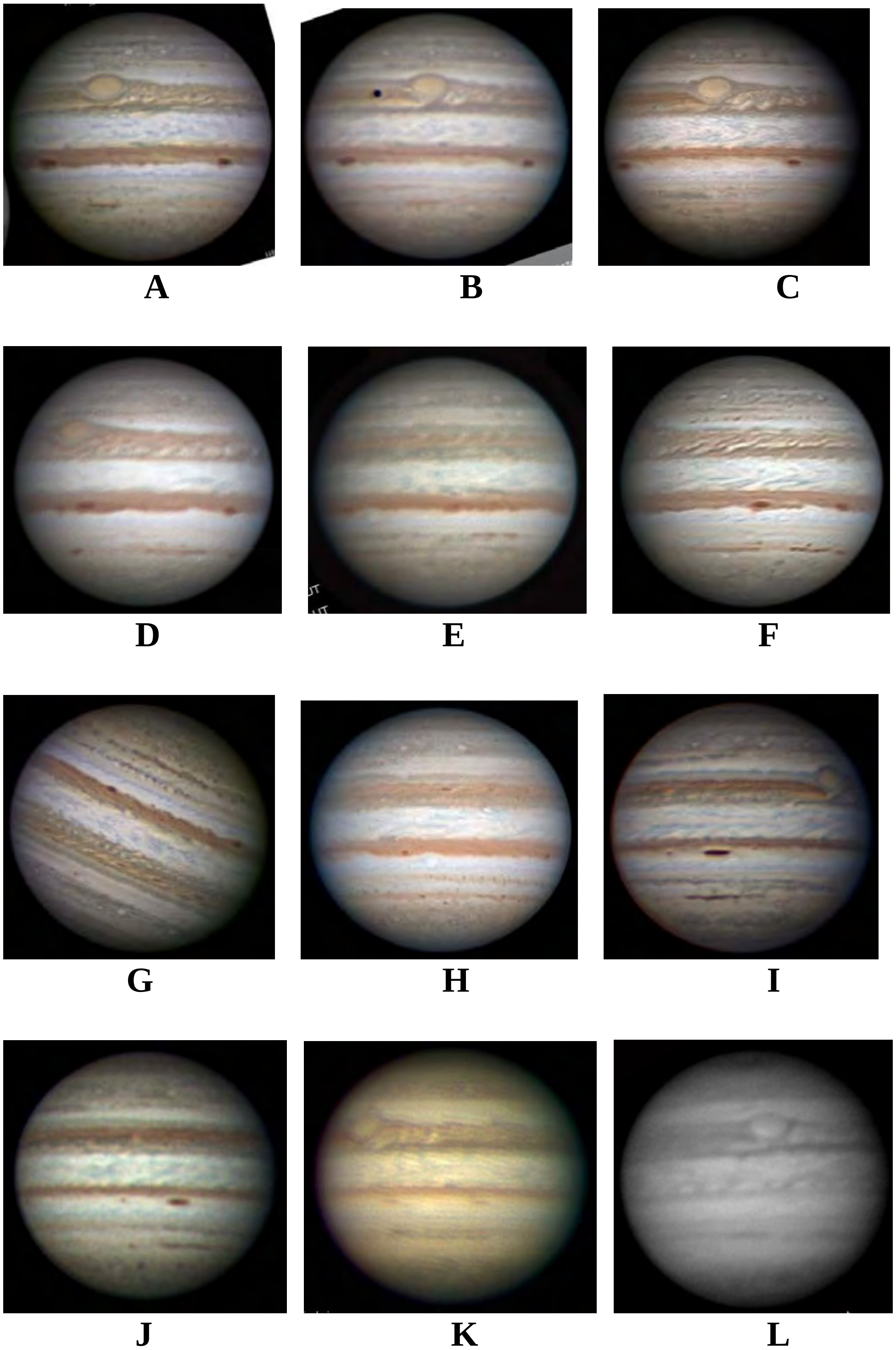
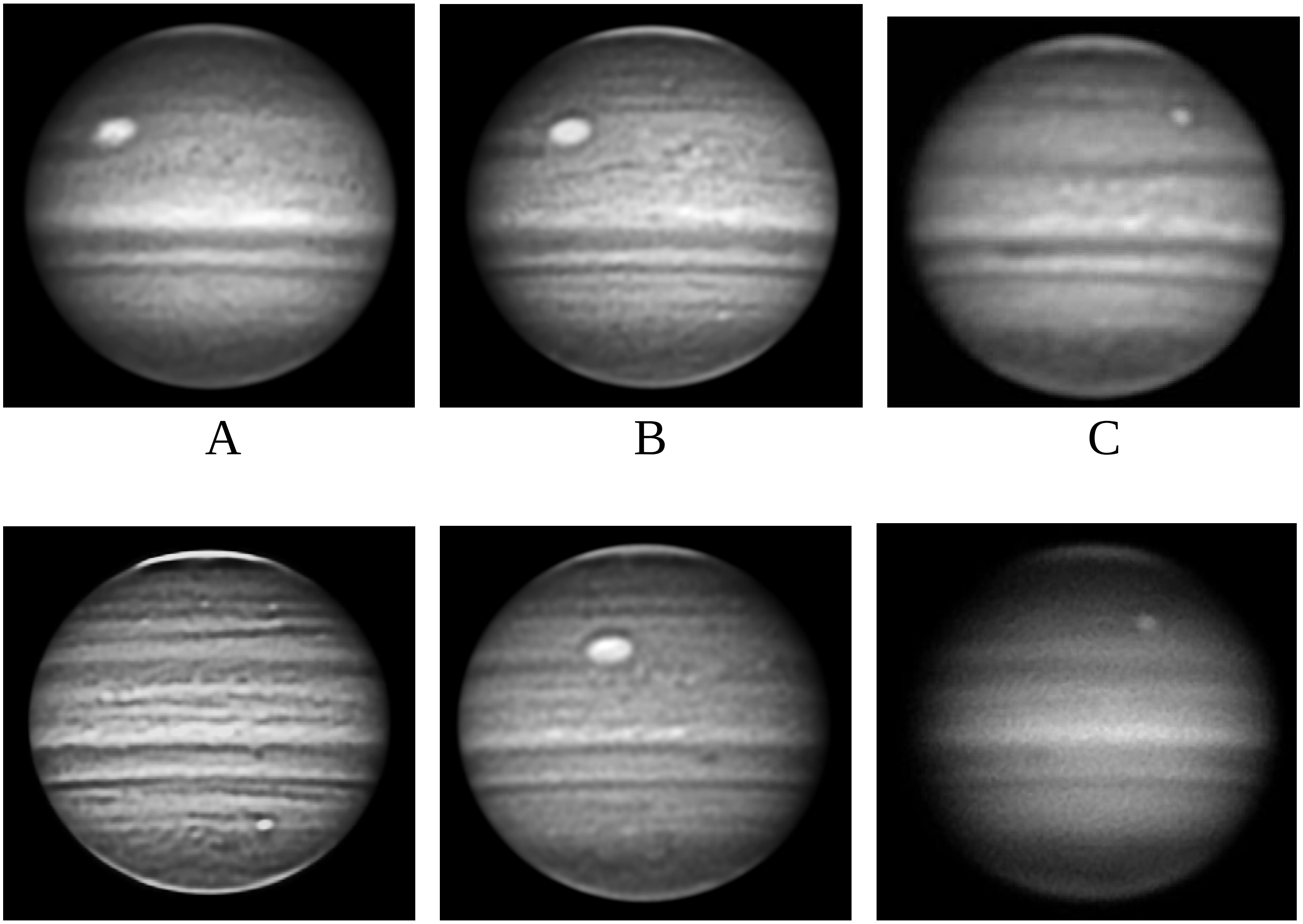


Figure 2. Images of Jupiter made during the 2011-2012 apparition. A: September 14, 2011 (2:21:14 UT) D. Peach, II = 56°W, III=185°W. B: October 17, 2011 (14:06 UT) T. Barry, 0.41 m RL, II = 301°W, III=174°W. C: Dec. 14, 2011 (12:05 UT) C. Go, II = 30°W, III=181°W. D: June 18, 2011 (9:57:13 UT) D. Parker, 0.41 m RL, II = 120°W, III=198°W. E: July 21, 2011 (8:29 UT) S. Walker, 0.32 m RL, II =234°W, III=60°W. F: August 10, 2011 (9:36:46 UT) D. Parker, 0.41 m RL, II = 193°W, III=226°W. G: September 18, 2011 (1:42:30 UT) D. Peach, II = 304°W, III=43°W. H: Oct. 4, 2011 (23:35:50 UT) C. Fattinnanzi, 0.36 m RL, II = 33°W, III=3°W. I: Jan. 3, 2012 (17:08:10 UT) M. Kardasis, 0.28 m SC, II = 131°W, III=128°W. J: Feb. 10, 2012 (17:44.4 UT) M. Jacquesson, 0.20 m SC, II = 27°W, III=94°W. K: March 18, 2012 (17:02 UT) M. Kardasis, II =75°W, III=220°W. L: April 1, 2012 (17:20 UT) D. Tyler, 0.36 m SC, II = 132°W, III=171°W.



A B C D E F

Figure 3. Methane band images of Jupiter made at a wavelength of 0.89 micrometers. A: June 18, 2011 (9:53:19 UT) D. Parker, 0.41 m RL, II = 117°W, III=195°W. B: July 12, 2011 (9:43:16 UT) D. Parker, 0.41 m RL, II = 298°W, III=193°W. C: September 29, 2011 (2:29 UT) C. Pellier, II = 271°W, III=285°W. D: November 24, 2011 (1:37:04 UT) D. Parker, 0.41 m RL, II = 89°W, III=36°W. E: January 9, 2012 (23:38:19 UT) D. Parker, 0.41 m RL, II = 236°W, III=185°W. F: March 8, 2012 (10:18 UT) C. Go, II = 52°W, III=275°W.

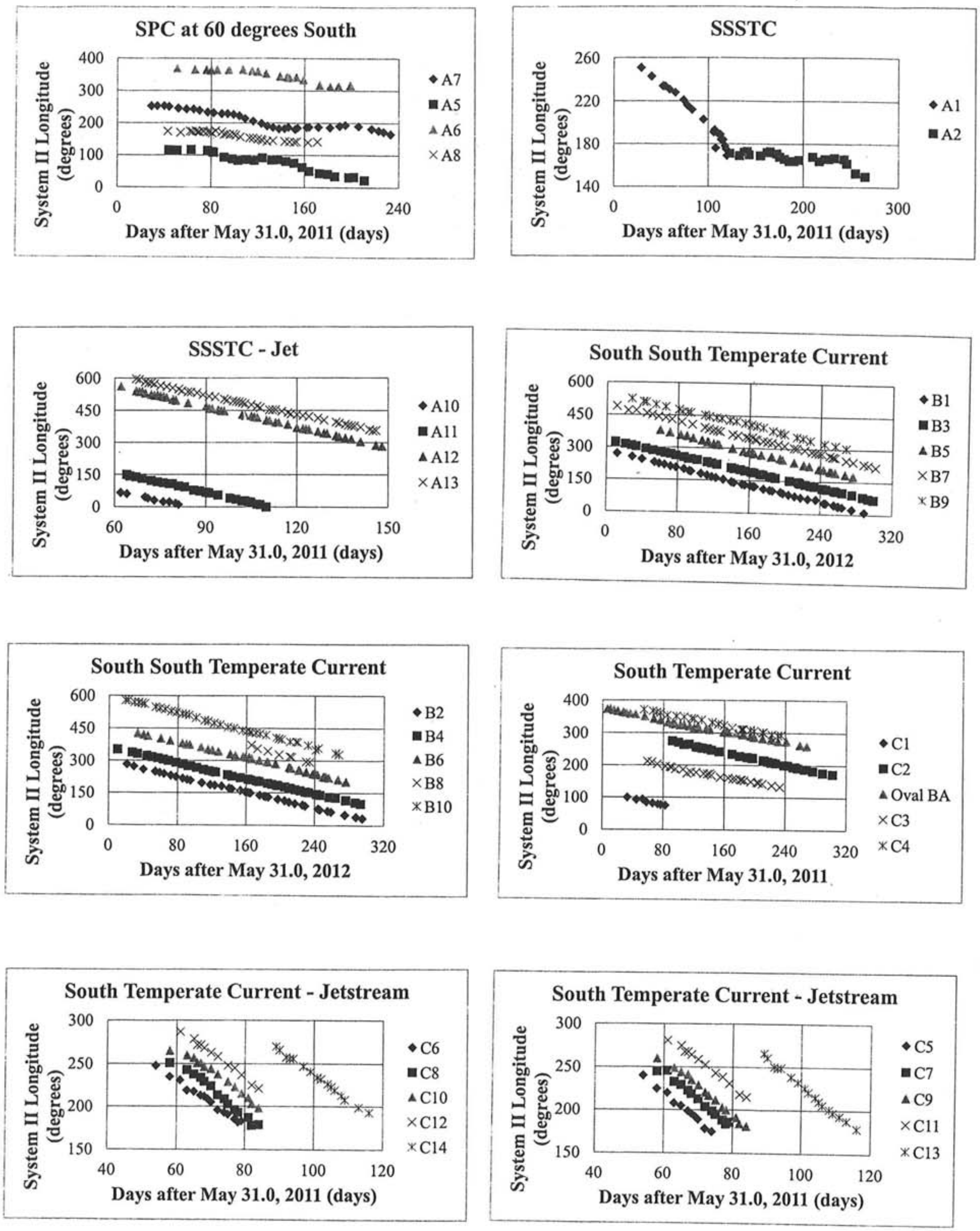


Figure 4. Graphs showing the system II longitude of various features in Jupiter's southern hemisphere versus the number of days after May 31.0, 2011.

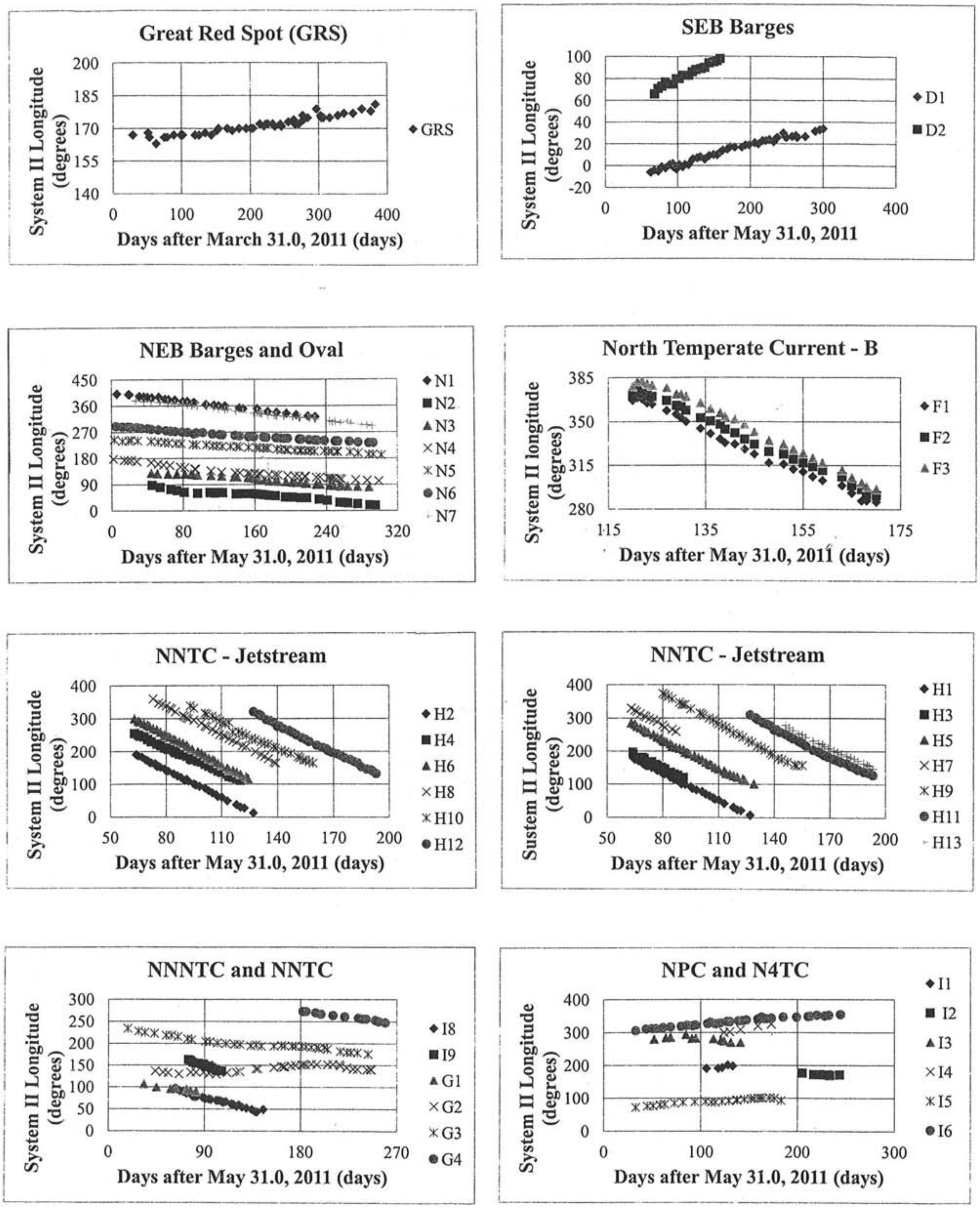


Figure 5. Graphs showing the system II longitude of the GRS and various features in Jupiter's northern hemisphere versus the number of days after May 31.0, 2011 (or March 31.0, 2011 for the GRS).

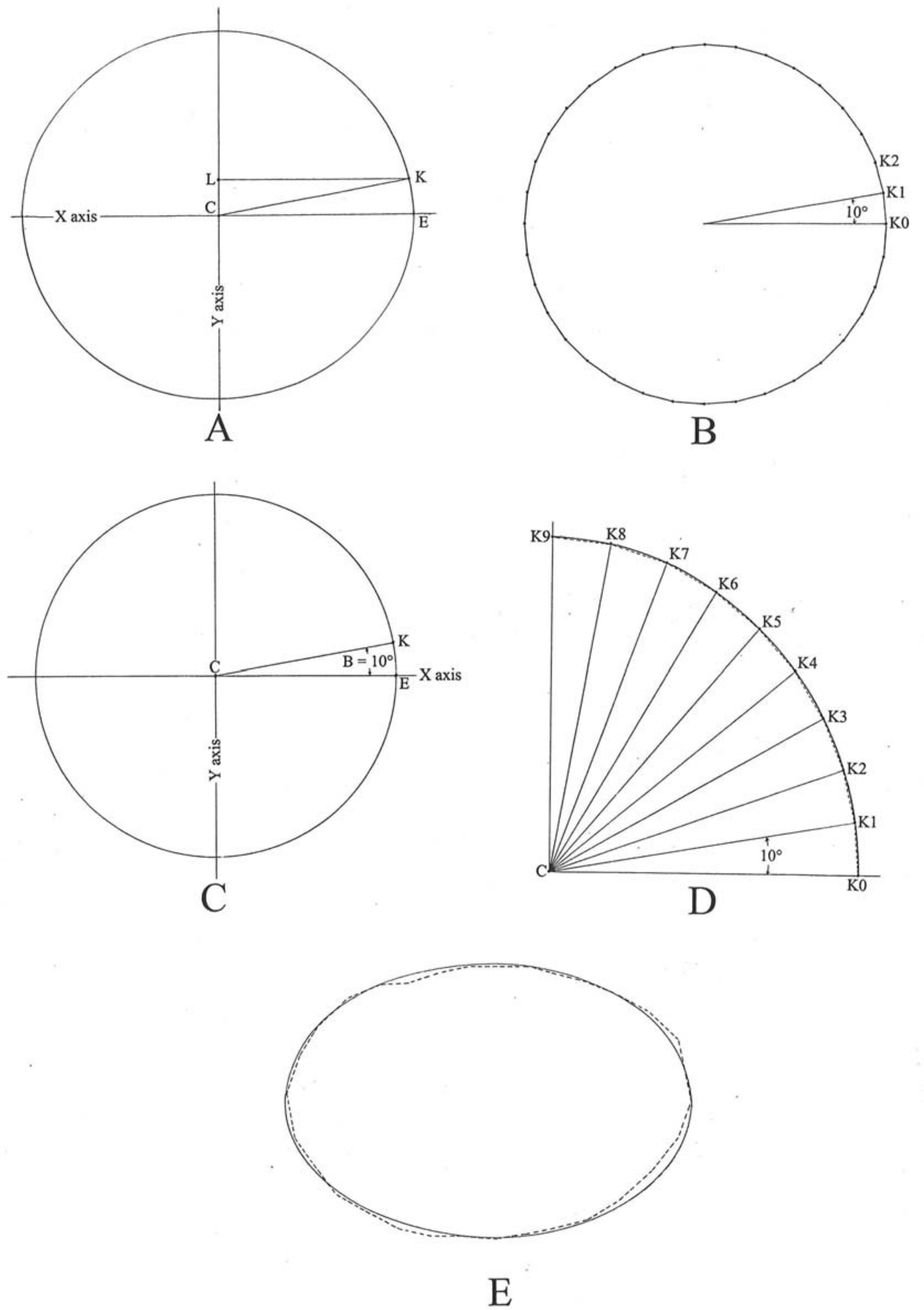


Figure 6. This figure illustrates how the sized of oval features were computed. A: Side view of Jupiter with its south pole at top and north pole at bottom. Jupiter's equator lies along the X axis. Segment LK is the radius of a circle perpendicular to the Y axis and is at the planetocentric latitude of the feature of interest. B: The circumference of a circle is determined iteratively by determining the X and Y coordinatoes of points K0, K1, K2, etc. and then measuring the length of the 36 segments starting with segment K0-K1. The sum of the lengths is very close to the theoretical circumference of the circle. See Table 7. C: Segment CK is illustrated intersecting the circle at point K. The angle was changed by 10 here. D: a 90° portion of an ellipse. The length of arc K0-K9 was computed by measuring the lengths of the nine segments starting with segment K0-K1.

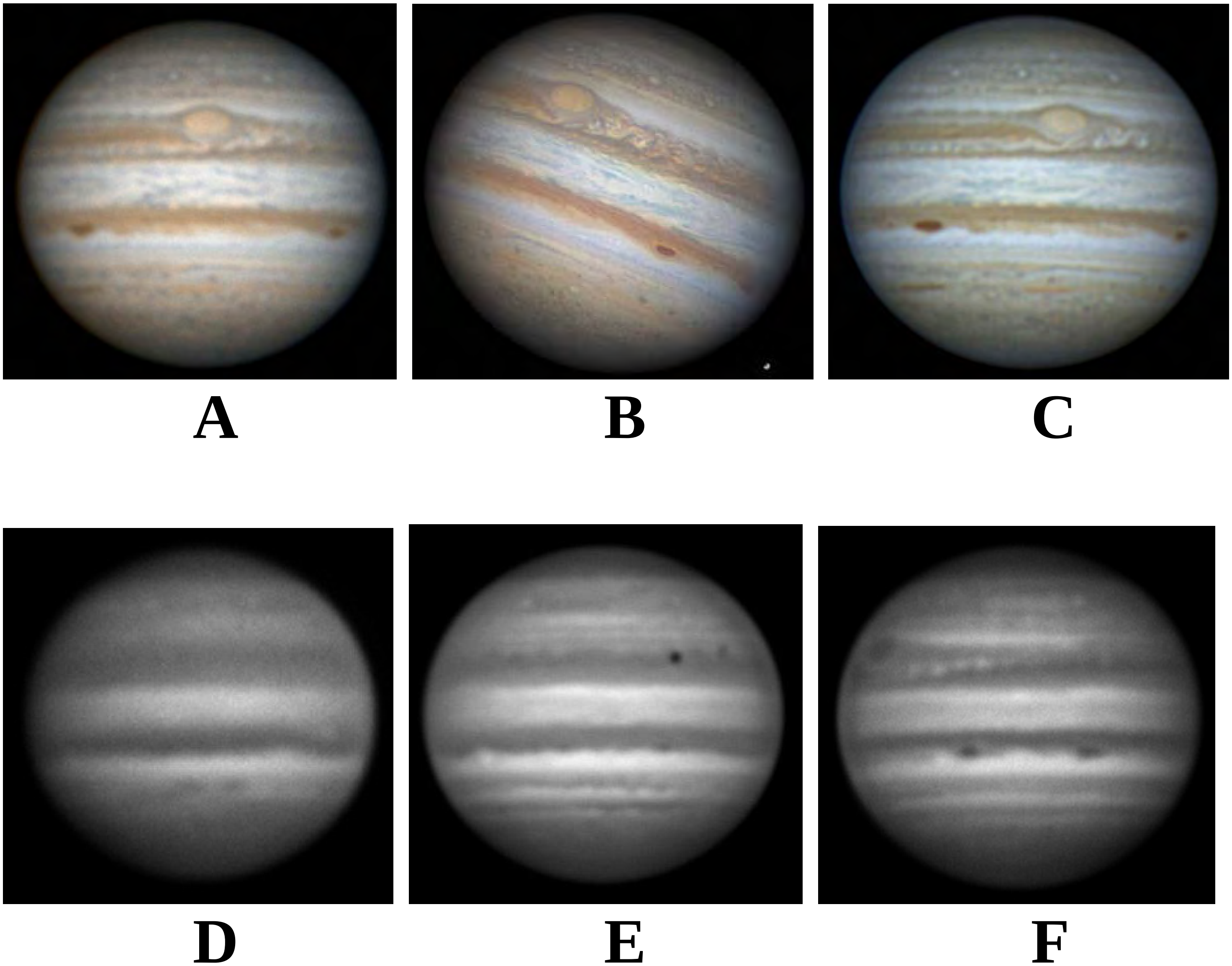


Figure 7. This figure illustrates the projection in the GRS (A through C) and ultraviolet images (D through F). **A**: November 1 (21:15 UT) M. Mobberley. **B**: November 3 (3:45.2 UT) W. Jaeschke. **C**: November 3 (12:42 UT) T. Suzuki. **D**: July 11 (20:37:27 UT) T. Akutsu, ultraviolet filter, λ_I = 180° W, λ_{II} = 79° W. **E**: October 15 (18:39:07 UT) T. Akutsu, ultraviolet filter, λ_I = 76° W, λ_{II} = 323° W. **F**: December 12 (11:40:52 UT) T. Akutsu, ultraviolet filter, λ_I = 60° W, λ_{II} = 227° W.

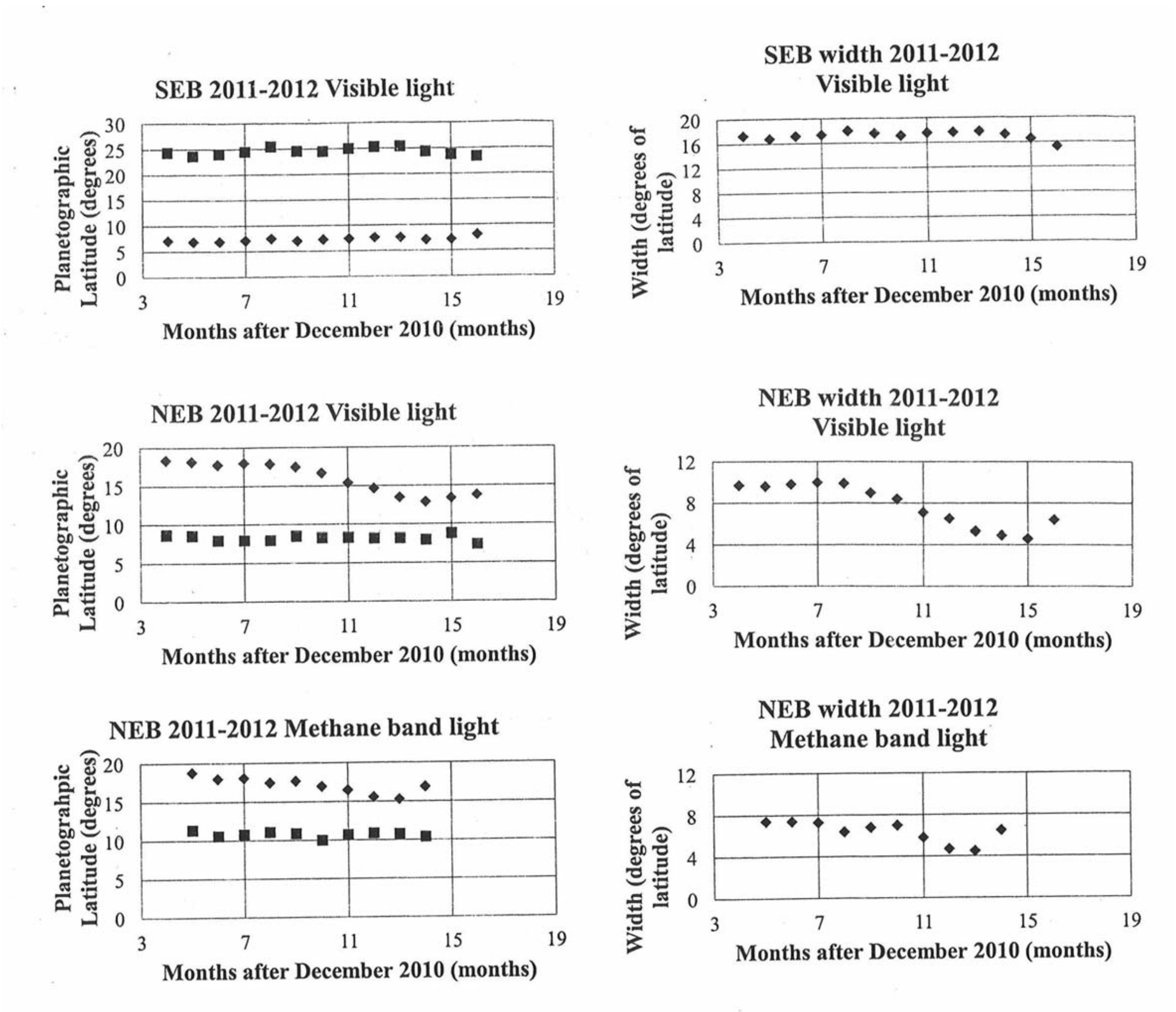
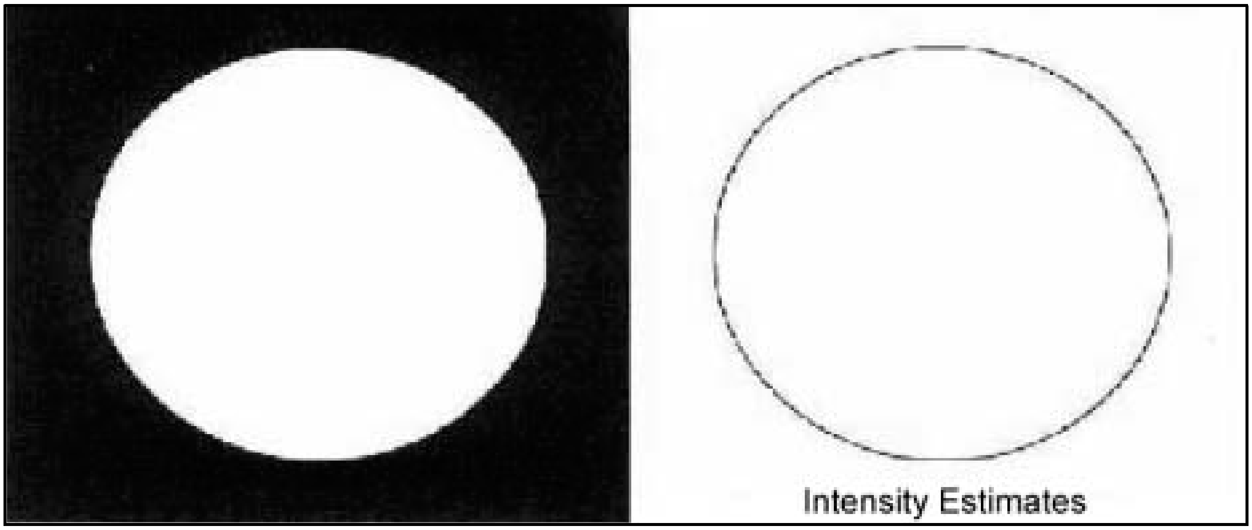


Figure 8. The top two graphs show the positions and widths of the SEB. Both graphs are based on measurements of visible light images. The middle two graphs show the positions and widths of the NEB. These graphs are also based on measurements of visible light images. The bottom two graphs show the positions and widths of the NEB based on measurements of methane band images.

ALPO Jupiter Section Observation Form No. _____



Date (UT): ______________________________________ Name: ______________________________________

Time (UT): _____________________________________ Address: ______________________________________

CM I _____ CM II ____ CM III _______ ____

Begin (UT): _____________ End (UT) ____________ City, State, ZIP: _______________________________

Telescope: f/ ___ Size: __________ (in./cm.; RL/RR/SC) ____

Magnification: _______x ________x ________x Observing Site: _______________________________

Filters: __________________________________(W / S) ____

Trnasparency (1 - 5): ____ (Clear / Hazy / Int. Clouds) E-mail: ______________________________________

Seeing (1 - 10): _________ Antoniadi (I - V): _________

No.	Time (UT)	S I (°)	S II (°)	S III (°)	Remarks

<u>Notes</u>

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ALPO Galilean Satellite Eclipse Visual Timing Report Form

Describe your time source(s) and estimated accuracy	Observer Name: Apparition: 20_____-20_____ (conjunction to conjunction)

Event Type (a)	Predicted UT		Observed UT Time (9d)	Telescope Data (e)			Sky Conditions (0-2 scale) (f)			Notes (g)
	Date (b)	Time (c)		Type	Aperture (cm)	Mag.	Seeing	Transparency	Field Brightness	

(a) 1 = Io, 2 = Europa, 3 = Ganymede, 4 = Callisto; D = Disappearance, R = Reappearance
(b) Month and Day
(c) *Predicted* UT to 1 minute
(d) *Observed* UT to 1 second; corrected to watch error if applicable; indicate in "Notes" if Observed UT date differs from Predicted UT date
(e) R = Refractor, N = Newtonian Reflector, C = Cassegrain Reflector, X = Compound/Catadioptric System; indicate in "Notes" if other type.
(f) These conditions, including field brightness (due to moonlight, twilight, etc.), should be described as they apply to the actual field of view, rather than to general sky conditions. Use whole numbers only, as follows:

- 0 = Condition not perceptible; no effect on timing accuracy
- 1 = Condition perceptible; possible minor effect on timing accuracy
- 2 = Condition serious; definite effect on timing accuracy

(g) Include here such factors as wind, drifting cloud(s), satellite near Jupiter's limb, moonlight interference, etc.

At the end of the apparition, return this form to:

John E. Westfall, ALPO Assistant Jupiter Coordinator, P.O. Box 2447, Antioch, CA 94531-2447 USA
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http://www.zone-vx.com/alpo-smartimpact.html

The Lunar Observer

http://moon.scopesandscapes.com/tlo.pdf

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- **Monograph No. 2**. *Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994. 52* pages. File size approx. 6.0 mb.
- **Monograph No. 3**. *H.P. Wilkins 300-inch Moon Map.* 3rd Edition (1951). Available as one comprehensive file (approx. 48 megabytes) or five section files (Part 1, 11.6 megabytes; Part 2, 11.7 megabytes; Part 3, 10.2 megabytes; Part 4, 7.8 megabytes; Part 5, 6.5 mb)
- **Monograph No. 4.** *Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.127* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere. File size approx. 2.6 mb.
- **Monograph No. *5.*** *Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir; 1877-1878.* By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Hard copy $10 for the United States, Canada, and Mexico; $15 elsewhere. File size approx. 2.6 mb.
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Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.76 pages. Hard copy $12 for the United States, Canada, and Mexico; $16 elsewhere.File size approx. 2.6 mb.

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- **Lunar (Jamieson):** *Lunar Observer's Tool Kit*, price $50, is a computer program designed to aid lunar observers at all levels to plan, make, and record their observations. This popular program was first written in 1985 for the Commodore 64 and ported to DOS around 1990. Those familiar with the old DOS version will find most of the same tools in this new Windows version, plus many new ones. A complete list of these tools includes Dome Table View and Maintenance, Dome Observation Scheduling, Archiving Your Dome Observations, Lunar Feature Table View and Maintenance, Schedule General Lunar Observations, Lunar Heights and Depths, Solar Altitude and Azimuth, Lunar Ephemeris, Lunar Longitude and Latitude to Xi and Eta, Lunar Xi and Eta to Longitude and Latitude, Lunar Atlas Referencing, JALPO and Selenology Bibliography, Minimum System Requirements, Lunar and Planetary Links, and Lunar Observer's ToolKit Help and Library. Some of the program's options include predicting when a lunar feature will be illuminated in a certain way, what features from a collection of features will be under a given range of illumination, physical ephemeris information, mountain height computation, coordinate conversion, and browsing of the software's included database of over 6,000 lunar features. Contact harry@persoftware.com

- **Venus (Benton):** Introductory information for observing Venus, including observing forms, can be downloaded for free as pdf files at http://www.alpo-astronomy.org/venus. The *ALPO Venus Handbook* with observing forms included is available as the *ALPO Venus Kit* for $17.50 U.S., and may be obtained by sending a check or money order made payable to "Julius L. Benton" for delivery in approximately 7 to 10 days for U.S. mailings. The *ALPO Venus Handbook* may also be obtained for $10 as a pdf file by contacting the ALPO Venus Section. All foreign orders should include $5 additional for postage and handling; p/h is included in price for domestic orders. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO Venus section. Observers should make copies using high-quality paper.

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- **Minor Planets (Derald D. Nye):** *The Minor Planet Bulletin*. Published quarterly; free at http://www.minorplanetobserver.com/mpb/default.htm. Paper copies available only to libraries and special institutions at $24 per year via regular mail in the U.S., Mexico and Canada, and $34 per year elsewhere (airmail only). Send check or money order payable to "Minor Planet Bulletin", c/o Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 8564I-2309.

- **Jupiter:** *(1) Jupiter Observer's Handbook*, $15 from the Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail leaguesales@astroleague.org. (2) *Jupite*r, the ALPO section newsletter, available online only via the ALPO website at *http://mysite.verizon.net/macdouc/alpo/jovenews.htm;* (3) *ALPO_Jupiter*, the ALPO Jupiter Section e-mail network; to join, send a blank e-mail to ALPO_Jupiter-subscribe@yahoogroups.com (4) *Timing the Eclipses of Jupiter's Galilean Satellites* free at http://www.alpo-astronomy.org/jupiter/GaliInstr.pdf, report form online at http://www.alpo-astronomy.org/jupiter/GaliForm.pdf; send SASE to John Westfall for observing kit and report form via regular mail. (5) *Jupiter Observer's Startup Ki*t, $3 from Richard Schmude, Jupiter Section Coordinator.

- **Saturn (Benton):** Introductory information for observing Saturn, including observing forms and ephemerides, can be downloaded for free as pdf files at http://www.alpo-astronomy.org/saturn; or if printed material is preferred, the *ALPO Saturn Kit* (introductory brochure and a set of observing forms) is available for $10 U.S. by sending a check or money order made payable to "Julius L. Benton" for delivery in approximately 7 to 10 days for U.S. mailings. The former *ALPO Saturn Handbook* was replaced in 2006 by *Saturn and How to Observe It* (by J. Benton); it can be obtained from book sellers such as Amazon.com. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO Saturn

ALPO Resources

People, publications, etc., to help our members

Section.

- **Meteors:** (1) *The ALPO Guide to Watching Meteors* (pamphlet). $4 per copy (includes postage & handling); send check or money order to Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail *leaguesales@astroleague.org*. (2) *The ALPO Meteors Section Newsletter*, free (except postage), published quarterly (March, June, September, and December). Send check or money order for first class postage to cover desired number of issues to Robert D. Lunsford, 1828 Cobblecreek St., Chula Vista, CA 91913-3917.

Other ALPO Publications

Checks must be in U.S. funds, payable to an American bank with bank routing number.

- ***An Introductory Bibliography for Solar System Observers.*** **No charge.** Four-page list of books and magazines about Solar System objects and how to observe them. The current edition was updated in October 1998. Send self-addressed stamped envelope with request to current ALPO Membership Secretary (Matt Will).

- ***ALPO Membership Directory.*** Provided only to ALPO board and staff members. Contact current ALPO membership secretary/treasurer (Matt Will).

Back Issues of The Strolling Astronomer

- Download JALPO43-1 thru the latest current issue as a pdf file from the ALPO website at *http://www.alpo-astronomy.org/djalpo* (free; most recent issues are password-protected, contact ALPO membership secretary Matt Will for password info).

  Many of the hard-copy back issues listed below are almost out of stock and there is no guarantee of availability. Issues will be sold on a first-come, first-served basis. Back issues are $4 each, and $5 for the current issue. We can arrange discounts on orders of more than $30. Order directly from Secretary/Treasurer “Matthew Will” (see address under “Board of Directors,”):

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The Association of Lunar & Planetary Observers (ALPO) was founded by Walter H. Haas in 1947, and incorporated in 1990, as a medium for advancing and conducting astronomical work by both professional and amateur astronomers who share an interest in Solar System observations. We welcome and provide services for all individuals interested in lunar and planetary astronomy. For the novice observer, the ALPO is a place to learn and to enhance observational techniques. For the advanced amateur astronomer, it is a place where one's work will count and be used for future research purposes. For the professional astronomer, it is a resource where group studies or systematic observing patrols add to the advancement of astronomy.

Our Association is an international group of students that study the Sun, Moon, planets, asteroids, meteors, meteorites and comets. Our goals are to stimulate, coordinate, and generally promote the study of these bodies using methods and instruments that are available within the communities of both amateur and professional astronomers. We hold a conference each summer, usually in conjunction with other astronomical groups.

We have “sections” for the observation of all the types of bodies found in our Solar System. Section coordinators collect and study submitted observations, correspond with observers, encourage beginners, and contribute reports to our quarterly Journal at appropriate intervals. Each section coordinator can supply observing forms and other instructional material to assist in your telescopic work. You are encouraged to correspond with the coordinators in whose projects you are interested. Coordinators can be contacted either via e-mail (available on our website) or at their postal mail addresses listed in our Journal. Members and all interested persons are encouraged to visit our website at *http://www.alpo-astronomy.org*. Our activities are on a volunteer basis, and each member can do as much or as little as he or she wishes. Of course, the ALPO gains in stature and in importance in proportion to how much and also how well each member contributes through his or her participation.

Our work is coordinated by means of our periodical, *The Strolling Astronomer*, also called the *Journal of the Assn. of Lunar & Planetary Observers*, which is published seasonally. Membership dues include a subscription to our Journal. Two versions of our ALPO are distributed — a hardcopy (paper) version and an online (digital) version in “portable document format” (pdf) at considerably reduced cost.

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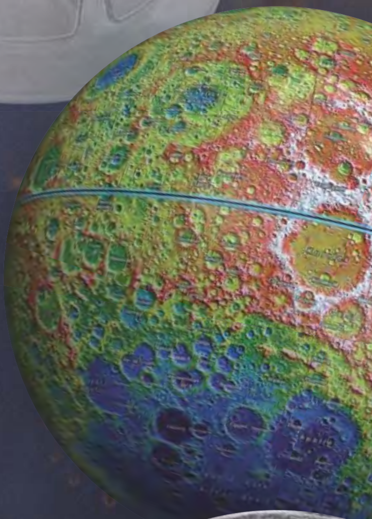

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