# IAAS Monthly Astronomy Newsletter
# July 2018

The International Association for Astronomical Studies provides this newsletter as a service for interested persons worldwide.

This newsletter is published on the World Wide Web at http://www.ki0ar.com/astro.html - The Home of KI0AR - and is received nationally and internationally. A PDF formatted downloadable version of the newsletter is at http://www.ki0ar.com/current_nl.pdf.

An Open Invitation - For amateur radio operators and scanner enthusiasts, when in the Denver metro area, please join the Colorado Astronomy Net on the Rocky Mountain Radio League's W0WYX **146.94 MHz** and **449.825 MHz** repeaters. The RMRL **146.94** repeater is also linked with the WB0WDF Cripple Creek **447.400 MHz** repeater and Allstar nodes **28298**, **28299**, **29436**. We are also linked via Echolink, links are **k0jsc-r** and **canoncty** courtesy of K0JSC and K0GUR. More information on the WB0WDF repeater links, Allstar nodes and Echolinks can be found at k0jsc.com. We are also linked with Allstar nodes in Florida as well, courtesy of KA4EPS. The net meets on Tuesday nights at 7 P.M. Mountain Time (US).

Obtain your Amateur Radio (Ham) License or your General Radio Operator's License (GROL)! Visit the South Metro VE Team website for more information. The South Metro VE Team provides test sessions on the 1st Saturday of each month at our new Eagle Street Facility, The City of Centennial, 7272 South Eagle Street, Centennial, Colorado 80112-4244 at 9am.

The Colorado Astronomy Net and the IAAS are on Facebook page. Be sure to "Like" us.

Excerpts from JPL mission updates are provided as a public service as part of the JPL Solar System Ambassador / NASA Outreach program.

**Donate to the IAAS!**

Shop Smile.Amazon.com, sign up or sign in to smile.amazon.com and select the **International Association for Astronomical Studies**. 0.5% of every purchase will be donated to the group. Thank you!

# In This Newsletter...

*"Mars puts on its best show in 15 years this month. The Red Planet spans 24.3" in late July, when telescopes should show an impressive array of surface features." Astronomy Magazine, July 2018, p.36.*
*NASA/ESA/The Hubble Heritage Team (STScI/AURA)/J. Bell (ASU)/M. Wolff (SSI)*

# The Month At-A-Glance

The current month's calendar displaying the daily astronomical events.

## The Moon

### Phases:

- Last Quarter Moon occurs on the 6th.
- New Moon occurs on the 12th.
- First Quarter Moon occurs on the 19th.
- Full Moon occurs on the 27th.

- The Moon is at Perigee on the 13th, 222,097 miles from Earth.
- The Moon is at Apogee on the 27th, 252,415 miles from Earth.

### Moon/Planet Pairs:

- The Moon passes 3° south of Neptune on the 3rd.
- The Moon passes 5° south of Uranus on the 7th.
- Venus passes 1.1° north of Regulus on the 9th.
- The Moon passes 1.1° north of Aldebaran on the 10th.
- The Moon passes 2° north of Mercury on the 14th.
- The Moon passes 1.6° north of Venus on the 15th.
- The Moon passes 4° north of Jupiter on the 20th.
- The Moon passes 2° north of Saturn on the 25th
- Mercury passes 5° south of Pollux on the 25th.
- The Moon passes 7° north of Mars on the 27th.
- The Moon passes 3° south of Neptune on the 31st.

*For reference: The Full Moon subtends an angle of ~0.5°.*

# The Planets & Dwarf Planets

Planetary Reports are generated by "TheSky" software. These reports provide predicted data for the planets on the first of each month for the current year. The rise and set times for the Sun and the Moon for each day of the month  as well as meteor shower radiants are also included in the reports. These reports have been optimized for the Denver, Colorado location, however, the times will be approximate for other locations on Earth.

*(All times are local unless otherwise noted.)*

## Planetary Highlights for July

Mars reaches opposition this month and reaches its best appearance in 15 years. Venus, Jupiter and Saturn continue to shine brilliantly in the evening skies and are joined by Mercury as well. There is a partial eclipse of the Sun for observers in southeastern Australia and a total lunar eclipse for observers in Most of Europe, Asia, Africa and Australia. Pluto also reaches opposition this month. Uranus and Neptune are also well places for early morning observing.

## Mercury

Is at greatest western elongation (26°) on the 12th. Mercury is stationary on the 25th. Mercury will be visible low to the north-northwest about 30 minutes after sunset during the first half of the month. Mercury sets at 10:02 p.m. on the 1st and about 8:23 p.m. by month's end. Mercury moves from the constellation of Cancer into Leo this month shining at magnitude 0.5 on the 31st.

## Venus

Venus sets at 10:54 p.m. on the 1st and about 10:08 p.m. by month's end. Venus is headed back towards the western horizon this month. Venus is easy to spot to the west soon after sunset. Venus moves from the constellation of Leo into Virgo this month shining at magnitude -4.1.

## Earth

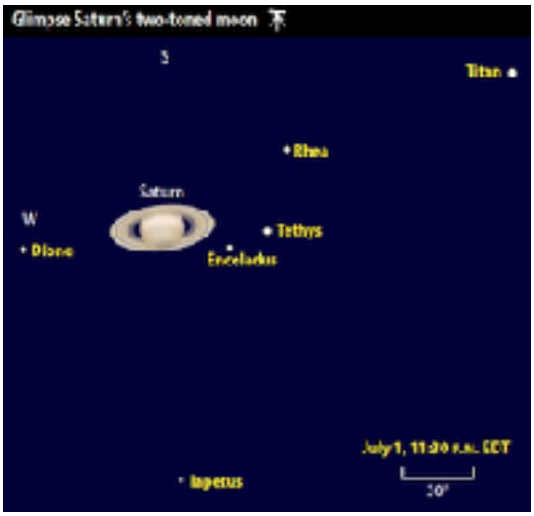
Is at aphelion (94.5 million miles from the Sun) on the 6th.

## Mars

Is at opposition on the 27th, rising as the Sun sets. Mars is closest to Earth on the 31st (35.8 million miles away). Mars is at its best viewing during this time. Hopefully, the global dust storm will have dies down enough to see some detail through a telescope. Mars rises at 10:29 p.m. on the 1st and about 8:15 p.m. by month's end. Mars is in the constellation of Capricornus shining at magnitude -2.6 on the 15th.

## Jupiter
Sets at 2:21 a.m. on the 1st and about 12:20 a.m. by month's end. Jupiter is stationary on the 10th. Jupiter can be easily spotted to the south soon after sunset. Jupiter is in the constellation of Libra shining at magnitude -2.2.

## Saturn
Rises at 8:00 p.m. on the 1st and about 5:50 p.m. by month's end. Saturn is still near its peak visibility this month and looks quite spectacular through a telescope. Saturn is in the constellation of Sagittarius shining at magnitude 0.1.

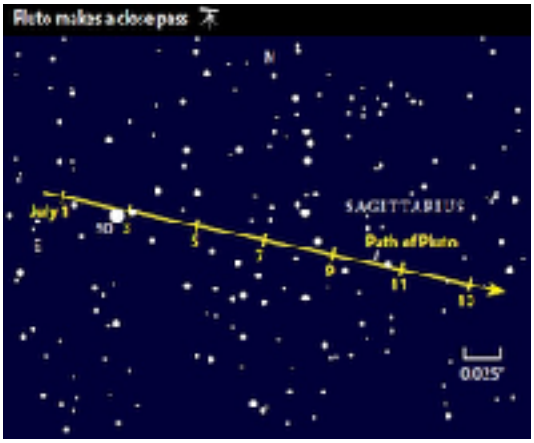



## Uranus
Rises at 1:40 a.m. on the 1st and about 11:36 p.m. by month's end. Look to the east to find Uranus about 30° above the horizon just before sunrise. Uranus is in the constellation of Aries shining at magnitude 5.8.

## Neptune
Rises 11:48 p.m. on the 1st and about 9:46 p.m. by month's end. Neptune has returned to the evening sky this month, but still the best time to observe Neptune will be late evening and early morning. Neptune is in the constellation of Aquarius shining at magnitude 7.8.

## Dwarf Planets
## Ceres
Sets at 11:56 p.m. on the 1st and about 10:21 p.m. by month's end. Ceres should be relatively easy to spot to the west this month as it continues its path through Leo. Try to spot Ceres once the skies darken after sunset. Ceres is in the constellation of Leo this month shining at magnitude 8.8.

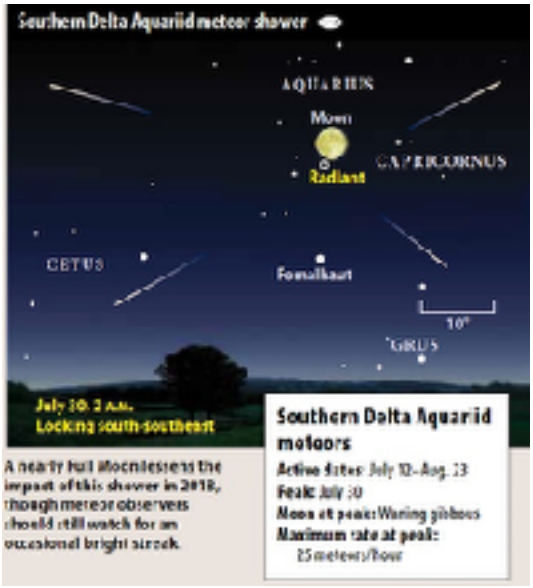
## Pluto
Is at opposition on the 12th, rising as the Sun sets. Pluto rises at 9:00 p.m. on the 1st and about 6:55 p.m. by months end. Pluto is in the constellation of Sagittarius shining at magnitude 14.2.




As always, good luck at spotting Neptune, Ceres and Pluto, a large telescope and dark skies will be needed.

# Astronomical Events

## Meteor Showers




- The Southern Delta Aquarids - This Meteor Shower has a duration of July 14 - August 18. Maximum hourly rates of 15-20 occur on July 28/29.

- The Northern Delta Aquarids extends from July 16 to September 10. Maximum occurs on August 13. The hourly rates reach a high of 10.

For more information about Meteor Showers, visit Gary Kronk's Meteor Showers Online web page at http://meteorshowersonline.com/.

Meteor Shower Radiant Report

Meteor Scatter (or Meteor burst communications) - http://en.wikipedia.org/wiki/Meteor_burst_communications - "is a radio propagation mode that exploits the ionized trails of meteors during atmospheric entry to establish brief communications paths between radio stations up to 2,250 kilometres (1,400 mi) apart." Tune your shortwave or your HF amateur radio to 54.310 MHz USB CW and see if you can hear any pings. Try other frequencies as well... 6m FT8 digital - 50.313 Mhz & 50.276 Mhz, JP-65 digital mode and the carrier frequencies of the lower vhf bands for TV channels 2, 3 & 4.

## Comets


Comet 21P/Giacobini-Zinner passes through the constellation of Cygnus into Cepheus, shining around 10th magnitude. Look for this comet during the 2nd and 3rd weeks of the month when the Moon will not interfere with viewing.

For information, orbital elements and ephemerides on observable comets visit the Observable Comets page from the Harvard-Smithsonian Center for Astrophysics. (http://cfa-www.harvard.edu/iau/Ephemerides/Comets/index.html)

For more information about Comets, visit Gary Kronk's Cometography.com web page at http://cometography.com/.

## Eclipses

- A partial Solar Eclipse occurs on the 13th across southeastern Australia.

- A total eclipse of the Moon occurs on the night of July 27/28 and is visible for most observers in the Eastern hemisphere.

  "Less than 24 hours after Mars reaches opposition, the Full Moon plunges through Earth's shadow. Observers across most of Europe, Asia, Africa, and Australia will see a total lunar eclipse, with the eclipsed Moon hanging 7° north of Mars. Totality runs from 19h30m to 21h13m UT on July 27 (before dawn on the 28th for people in eastern Asia and Australia). The 103 minutes of totality makes this the longest total lunar eclipse since 2000." Astronomy Magazine, July 2018, p. 43.

## Observational Opportunities

*(from evening to morning)*

- Enjoy Mercury,Venus, Mars, Jupiter and Saturn in the evening skies after sunset.
- Try to spot Comet 21P/Giacobini-Zinner passing through Cygnus and Cepheus.

## Asteroids

(From west to east)

- **Amphitrite** is in the constellation of Scorpius.
- **Vesta** is in the constellation of Ophiuchus.
- **Thisbe** is at opposition on the 20th in the constellation of Capricornus.


Information about the Minor Planets can be found at http://www.minorplanetobserver.com the Minor Planet Observer web site.

## Occultations

Information on various occultations can be found at http://lunar-occultations.com/iota/iotandx.htm, the International Occultation Timing Association's (IOTA) web site.

## Member Meteor Sightings

This is a new section where I will post meteor, fireball, etc sightings that have been published on the American Meteor Society's web site. I want to make this an active section of the web pages and newsletter and would like to publish the links to member sightings. If you have any published sightings, please provide me with the links and I will post them here for all to enjoy.

| Event ID | Date/Time | Location | Observer | Link |
|---|---|---|---|---|
| 3587-2015 | 2015-11-22 17:38 MST | CO | Kevin S | 3587aw |
| 3829-2015 | 2015-12-05 18:06 MST | CO | Burness A | 3829a |
| 3871-2015 | 2015-11-13 01:55 MST | CO | Charles N | 3871a |

# Subscriber Gallery

I have created a web page containing images taken and submitted by subscribers to the email newsletter, check-ins to the Colorado Astronomy Net and readers of the online newsletter and some of my own images. Any one wishing to submit their images to the gallery, please let me know. The images must be taken by the submitter and be astronomy related. Please include a description and your information so that I can give proper credit to your work. I will post the most recent submissions here.

August 21, 2017 - Total Solar Eclipse - "Bailey's Beads" and the "Diamond Ring"
Taken by: Burness Ansell, Location: Guernsey, WY - More to come. I will be creating a special Solar Eclipse page to showcase subscriber contributions.

# Planetary/Lunar Exploration Missions

(Excerpts from recent mission updates)

## JPL Latest News

**The Latest from Space**

JPL Latest News

**June 29, 2018**
**ECOSTRESS Launches to Space Station on SpaceX Mission**

Full Article & Images

"An Earth science instrument built by NASA's Jet Propulsion Laboratory in Pasadena, California, and experiments investigating cellular biology and artificial intelligence, are among the research heading to the International Space Station following Friday's launch of a NASA-contracted SpaceX Dragon spacecraft at 5:42 a.m. EDT.
...
JPL's ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) will provide a new space-based measurement of how plants respond to changes in water availability. This data can help society better manage agricultural water use."

Read the latest news and discoveries from JPL's dozens of active space missions exploring Earth, the solar system and worlds beyond.

Past, Present, Future and Proposed JPL Missions - http://www.jpl.nasa.gov/missions.

For special JPL programs and presentations in your area visit the JPL Solar System Ambassador web site at http://www2.jpl.nasa.gov/ambassador/index.html.

## Juno

**June 06, 2018**
**NASA Re-plans Juno's Jupiter Mission**

Full Article & Images

"NASA has approved an update to Juno's science operations until July 2021. This provides for an additional 41 months in orbit around Jupiter and will enable Juno to achieve its primary science objectives.  Juno is in 53-day orbits rather than 14-day orbits as initially planned because of a concern about valves on the spacecraft's fuel system. This longer orbit means that it will take more time to collect the needed science data."

NASA's JunoCam website can be visited at: https://www.missionjuno.swri.edu/junocam

More information on the Juno mission is available at: http://www.nasa.gov/juno

The public can follow the mission on Facebook and Twitter at:
http://www.facebook.com/NASAJuno
http://www.twitter.com/NASAJuno

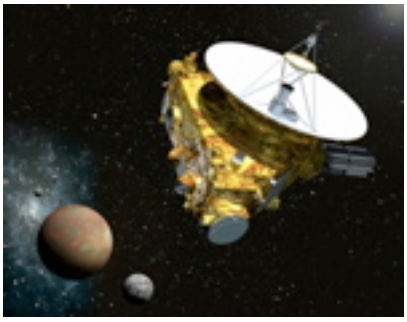
## Cassini Legacy
**June 27, 2018**
**Complex Organics Bubble up from Ocean-world Enceladus**

Full Article & Images

"Data from NASA's Cassini spacecraft reveal complex organic molecules originating from Saturn's icy moon Enceladus, strengthening the idea that this ocean world hosts conditions suitable for life. Research results show much larger, heavier molecules than ever before."

Raw images are available at http://saturn.jpl.nasa.gov/photos/raw/index.cfm.

More information about Cassini is available at the following sites:
http://saturn.jpl.nasa.gov & http://www.nasa.gov/cassini.



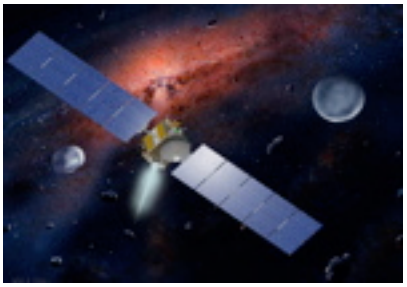
## New Horizons
**June 22, 2018**
**Charon Discovered 40 Years Ago**

Full Article & Images

"The largest of Pluto's five moons, Charon, was discovered 40 years ago today by James Christy and Robert Harrington at the U.S. Naval Observatory in Flagstaff, Arizona – only about six miles from where Pluto itself was discovered at Lowell Observatory. They weren't even looking for satellites of Pluto – Christy was trying to refine Pluto's orbit around the Sun."

**New Horizons gallery**

For more information on the New Horizons mission - the first mission to the ninth planet - visit the New Horizons home page: http://pluto.jhuapl.edu/.



## Dawn

**June 28, 2018**

**Dawn's Engines Complete Firing, Science Continues**

Full Article & Images

"Mission controllers have turned off the industrious ion engines on NASA's Dawn spacecraft for the last time and do not expect to turn them back on again, if everything goes as planned for the rest of Dawn's mission in orbit around Ceres, the largest body in the main asteroid belt. Engineers led by Dawn Project Manager Marc Rayman of NASA's Jet Propulsion Laboratory, Pasadena, California, drew this conclusion on Tuesday, June 26, after analyzing data from Dawn's last thrusting session on Thursday, June 21, and verifying plans for the rest of the mission. Mission managers expect Dawn to continue gathering science data and transmitting it to Earth for another few months."

For more information on the Dawn mission, visit the Dawn home page: http://www.nasa.gov/mission_pages/dawn/main/index.html.

## TESS

**May 18, 2018**

**NASA's New Planet Hunter Snaps Initial Test Image, Swings by Moon Toward Final Orbit**

Full Article & Images

"NASA's next planet hunter, the Transiting Exoplanet Survey Satellite (TESS), is one step closer to searching for new worlds after successfully completing a lunar flyby on May 17. The spacecraft passed about 5,000 miles from the Moon, which provided a gravity assist that helped TESS sail toward its final working orbit.

As part of camera commissioning, the science team snapped a two-second test exposure using one of the four TESS cameras. The image, centered on the southern constellation Centaurus, reveals more than 200,000 stars. The edge of the Coalsack Nebula is in the right upper corner and the bright star Beta Centauri is visible at the lower left edge. TESS is expected to cover more than 400 times as much sky as shown in this image with its four cameras during its initial two-year search for exoplanets. A science-quality image, also referred to as a "first light" image, is expected to be released in June."

For more news and information on the TESS mission, visit the Latest Tess Stories page.

# Mars Missions

## *Be A Martian*

**Mars website mobile version is here!**
**Simply type**
**http://mars.jpl.nasa.gov**
**into your mobile browser.**


**Mars on the Go! NASA Be A Martian Mobile App**
**If you want the latest news as it happens, try our Be A Martian app.**
**Download on Mobile Devices**
**Android | iPhone | Windows Phone**

### JMARS

JMARS is an acronym that stands for Java Mission-planning and Analysis for Remote Sensing. It is a geospatial information system (GIS) developed by ASU's Mars Space Flight Facility to provide mission planning and data-analysis tools to NASA's orbiters, instrument team members, students of all ages, and the general public. https://jmars.mars.asu.edu/


## Laboratory for Atmospheric and Space Physics

"The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder (CU) began in 1948, a decade before NASA.  We are the world's only research institute to have sent instruments to all eight planets and Pluto.

LASP combines all aspects of space exploration through our expertise in science, engineering, mission operations, and scientific data analysis. As part of CU, LASP also works to educate and train the next generation of space scientists, engineers and mission operators by integrating undergraduate and graduate students into working teams. Our students take their unique experiences with them into government or industry, or remain in academia to continue the cycle of exploration.

LASP is an affiliate of CU-Boulder AeroSpace Ventures, a collaboration among aerospace-related departments, institutes, centers, government labs, and industry partners."

### MAVEN

**June 14, 2018**
**NASA Encounters the Perfect Storm for Science**

Full Article & Images

"One of the thickest dust storms ever observed on Mars has been spreading for the past week and a half. The storm has caused NASA's Opportunity rover to suspend science operations, but also offers a window for four other spacecraft to learn from the swirling dust."

Visit LASP and MAVEN for more information.

## Mars Science Laboratory - Curiosity
**June 28, 2018**
**Sols 2095-2096: Over the crest**

Full Article & Images

"After a steep drive Sol 2094, Curiosity is back over the crest of Vera Rubin Ridge and enjoying the view of flatter terrain ahead. I was the SOWG Chair on this late slide sol, which means that we started planning 3.5 hours later than usual. Everything was going smoothly and we were excited to plan some potential contact science, until we found a rock under the left front wheel that might make Curiosity unstable during arm activities. So at the last minute we swapped out MAHLI and APXS activities for some additional remote sensing. We still packed a lot of science into the two-sol plan, and we'll have another opportunity to do contact science in the weekend plan."

To follow the Mars Curiosity rover and NASA on Foursquare, visit: http://www.foursquare.com/MarsCuriosity and http://www.foursquare.com/NASA


For information about NASA's partnership with Foursquare, visit: http://www.nasa.gov/connect/foursquare.html.

Mars Rover Landing - Free for the Xbox 360 (requires Kinect)

Visit the Mars Science Laboratory page at http://mars.jpl.nasa.gov/msl.

## Mars Exploration Rover Mission (Spirit and Opportunity)
**June 19, 2018**

**SPIRIT UPDATE: Spirit Remains Silent at Troy - *sols 2621-2627, May 18-24, 2011*:**

"More than 1,300 commands were radiated to Spirit as part of the recovery effort in an attempt to elicit a response from the rover. No communication has been received from Spirit since Sol 2210 (March 22, 2010). The project concluded the Spirit recovery efforts on May 25, 2011. The remaining, pre-sequenced ultra-high frequency (UHF) relay passes scheduled for Spirit on board the Odyssey orbiter will complete on June 8, 2011.

Total odometry is unchanged at 7,730.50 meters (4.80 miles)."

**OPPORTUNITY UPDATE: Opportunity Sleeps During a Planet-Encircling Dust Storm - *sols 5112 to 5120, June 11, 2018 - June 19, 2018:***

"It shows no indication of receding at this time. Since the last contact with the rover on Sol 5111 (June 10, 2018), it is likely that Opportunity has experienced a low-power fault, putting herself to sleep only to wake when the skies eventually clear. If the atmospheric opacity or the solar array dust factor has gotten worse since the last telemetry, Opportunity could also experience a mission clock fault.

A clock fault will complicate the recovery, but not prevent it. An analysis of the rover's long-term temperature trends, conservatively assuming no solar array input, indicates that the rover's electronics and batteries will stay above their flight-allowable temperatures. There is a small concern with the health of the batteries if they discharge completely. The batteries might loose some of their capacity if the cell voltages drop to near zero.

The project is listening every day for the rover during both the time of low-power fault communication windows and listening over a broader range of times under mission clock fault. Additionally, for the near term, the project is also sending a command to elicit a beep if the rover happens to be awake. The Deep Space Network (DSN) Radio Science Receiver (RSR) team is using the RSR to listen in on any DSN pass pointed at Mars that corresponds to possible wake up times for the rover.

The plan is to continue this every day while waiting for the skies to clear. The team does not expect to hear anything from Opportunity until there has been a significant reduction in the storm and the associated atmospheric opacity over the rover site.

Total odometry is 28.06 miles (45.16 kilometers)."

Landing sites link - http://marsoweb.nas.nasa.gov/landingsites/

Visit the Mars Exploration Rover page at
https://mars.nasa.gov/mer/home/.

## Mars Reconnaissance Orbiter Mission

**February 20, 2018**
**Nearly a Decade After Mars Phoenix Landed, Another Look**

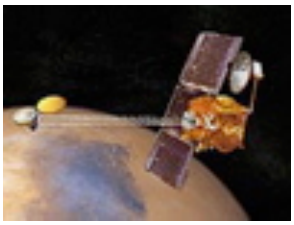
Full Article & Images

"A recent view from Mars orbit of the site where NASA's Phoenix Mars mission landed on far-northern Mars nearly a decade ago shows that dust has covered some marks of the landing.

The Phoenix lander itself, plus its back shell and parachute, are still visible in the image taken Dec. 21, 2017, by the High Resolution Imaging Science Experiment (HiRISE) camera on NASA's Mars Reconnaissance Orbiter. But an animated-blink comparison with an image from about two months after the May 25, 2008, landing shows that patches of ground that had been darkened by removal of dust during landing events have become coated with dust again."

**MARS RECONNAISSANCE ORBITER HIRISE IMAGES**

All of the HiRISE images are archived here: http://hirise.lpl.arizona.edu/.
More information about the MRO mission is available online at http://www.nasa.gov/mro.



## Mars Odyssey Orbiter

**June 13, 2018**
**NASA Encounters the Perfect Storm for Science**

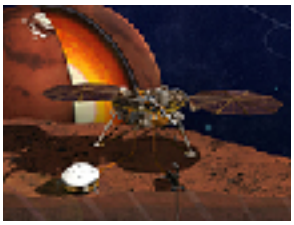
Full Article & Images

"One of the thickest dust storms ever observed on Mars has been spreading for the past week and a half. The storm has caused NASA's Opportunity rover to suspend science operations, but also offers a window for four other spacecraft to learn from the swirling dust."

**DAILY MARS ODYSSEY THEMIS IMAGES**
Thermal Emission Imaging System (THEMIS) web site: (http://themis.asu.edu/gallery)

The Odyssey data are available through a new online access system established by the Planetary Data System at: http://starbrite.jpl.nasa.gov/pds/

Visit the Mars Odyssey Mission page at http://mars.jpl.nasa.gov/odyssey/index.html.



## Journey to Mars
**InSight - Revealing the Heart of Mars**
**June 26, 2018**
**NASA Mars Mission Adds Southern California Dates**

Full Article & Images

"Looking for summer fun? Southern California families have their choice of the beach, movies, museums -- and even NASA's next mission to Mars.

Starting this week, scientists and engineers working on NASA's InSight mission will begin visiting cities in the Southern California region. InSight launched on May 5 from Vandenberg Air Force Base -- the first interplanetary launch from the West Coast. Leading up to the landing on Mars on November 26, the Mars InSight Roadshow is stopping at cities throughout quake-prone California to explain how the robotic lander will study Mars' deep interior using seismology and other geophysical measurements."

Learn more about the InSight mission at: http://www.jpl.nasa.gov/missions/insight/

## Mars Missions Status
New Mars missions are being planned to include several new rover and sample collection missions. Check out the Mars Missions web page: http://mars.jpl.nasa.gov/missions/ and the Mars Exploration page: http://marsprogram.jpl.nasa.gov/.

## Astronomy Links and Other Space News

(If you have a link you would like to recommend to our readers, please feel free to submit it.)

### Colorado Astronomy Links

### Radio Astronomy Links

### Other Astronomy Links

## Acknowledgments and References

Much of the information in this newsletter is from "Astronomy Magazine" (Kalmbach Publishing), JPL mission status reports, "Meteor Showers - A Descriptive Catalog" by Gary W. Kronk and other astronomical sources that I have stashed on my book shelves.

The author will accept any suggestions, constructive criticisms, and corrections. Please feel free to send me any new links or articles to share as well. I will try to accommodate any reasonable requests. Please feel free to send questions, comments, criticisms, or donations to the email address listed below. Enjoy!

## Subscription Information

- Email Newsletter archives -
http://ki0ar.com/pipermail/astronews_ki0ar.com/

- Full documentation of the online administration system is available at http://ki0ar.com/mailman/listinfo/astronews_ki0ar.com.

- The latest version of the newsletter is accessible from http://www.ki0ar.com/astro.html.

## Keep looking UP!

73 from KI0AR

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JPL Solar System Ambassador, Colorado
Last modified: July 01, 2018