AOH Newsletter

Summer 2021

News and Notes

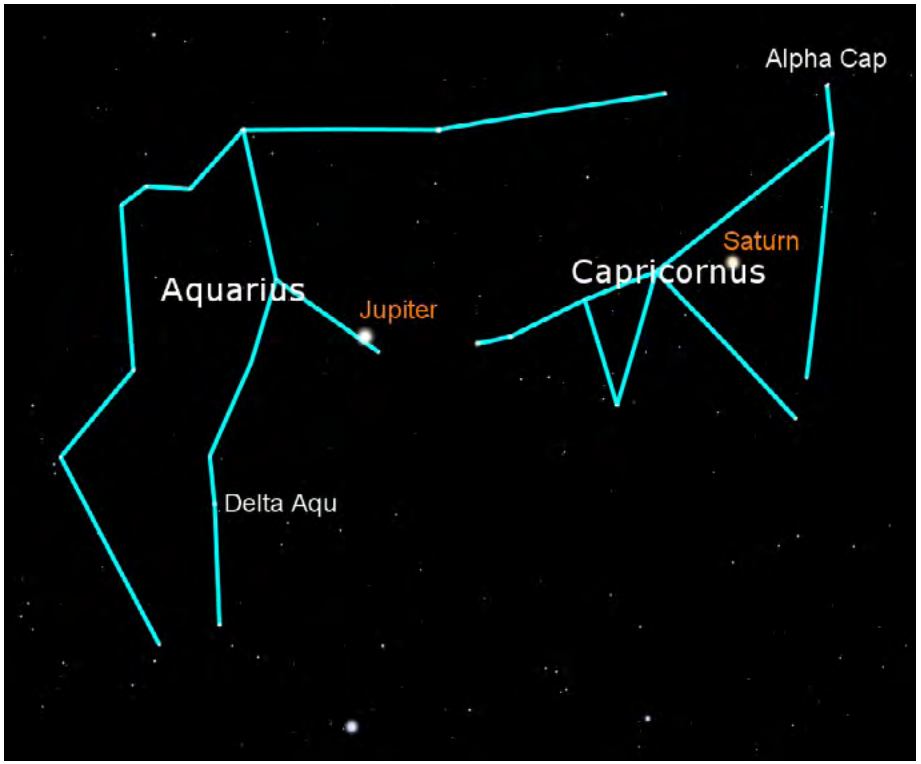
Summer is upon us, and the Astronomers of Humboldt are ready to begin some group observing sessions for AOH club members.

Check the website for up-to-date scheduling; if you go, please be respectful of those who may wish to remain socially distanced.

At this time, however, we are continuing to defer all public observing sessions and outreach programs. We'll announce on the same web page when that might change.

Meanwhile, we will continue to meet on Zoom on the weekend nearest the Full Moon. Club members will get, by email, links to the meetings. We hope to have you join us to share stories and pictures, to ask and answer questions, and to socialize, albeit remotely.

Zoom: March, April, and May

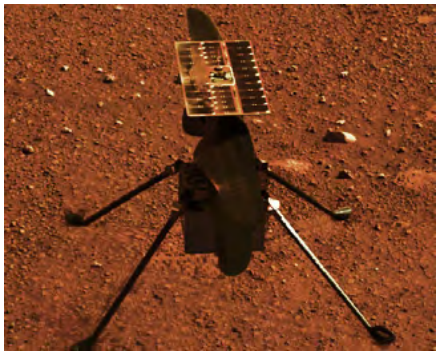


Stellarium, late July and early August

For your summer enjoyment may we suggest Jupiter and Saturn, with August oppositions in Aquarius and Capricornus, respectively, and twin meteor showers, the Delta Aquariids and Alpha Capricornids, with radiants in these same two constellations, and with maxima on the same night, July 28-29. Follow the website's Upcoming Events page for all the details.

And thanks to Grace, Susie, and Yoon for their contributions and their help with the Newsletter. —Ken

What We Did During the Pandemic



Some of us watched the first-ever powered flights from the surface of Mars. Above, left, is the helicopter Ingenuity as seen by the Perseverance MastCam (NASA photo). And one of us built our own model of Ingenuity. Above, right, is Grace Wheeler's Lego Ingenuity (GW photo). Click on it to see what it would look like on Mars.

Some of us took photos. Above, Rick Gustafson shot the Milky Way rising over Kneeland. See more at rickgustafson.com.

And here are M81 and M82, sent to us by Jack Hopkins, a local photographer who we've seen up at Kneeland a few times, whose website is hopkinsportraits.com.

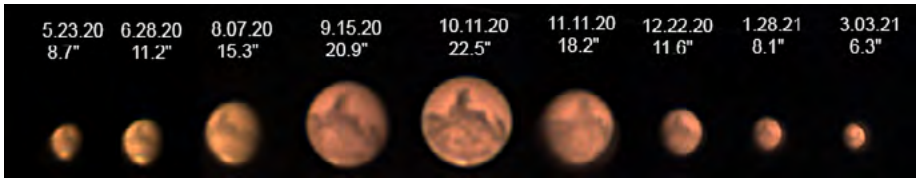
And this photo of May's "Super Blood Moon Eclipse" was posted by a friend of a friend of a friend in Hawaii. Most of us were clouded out here at home. It was a total eclipse, but very shallow: the Moon cut across the top of the Earth's shadow, so the top of the Moon stayed close to the edge of the umbra and so never got very dark.

Mars Opposition 2020

Grace Wheeler

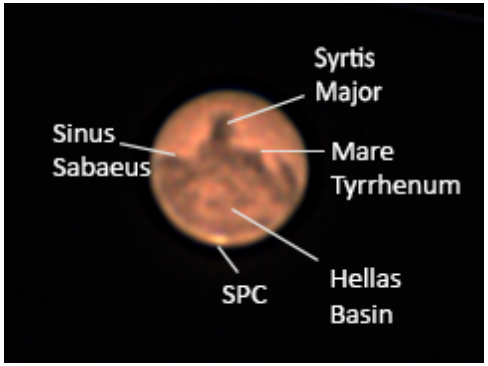
The October 10th, 2020 opposition of Mars was the last of three consecutive perihelic oppositions that started in 2016. Of the three oppositions, 2018 was the most favorable. Unfortunately, a global dust storm on Mars started about two months before opposition and obscured most of the surface of Mars during the time of close approach. For Mars observers, 2020 would the last time to view a perihelic opposition until 2033. In Humboldt, we were lucky that the rainy season was delayed and we had several clear evenings in the fall to observe Mars. An extra bonus was that Mars was transiting at a high altitude which helped minimize atmospheric distortion.

Viewing Mars through a telescope, even at opposition, can be challenging because of its small diameter. A large telescope and color filters help, but even then, albedo features can be shadowy and blurred. The availability of sensitive planetary webcams, along with stacking and processing software (Autostakkert, Registax), has made it possible to get detailed images of Mars. Examples of Mars images can be found on the ALPO Mars section website.

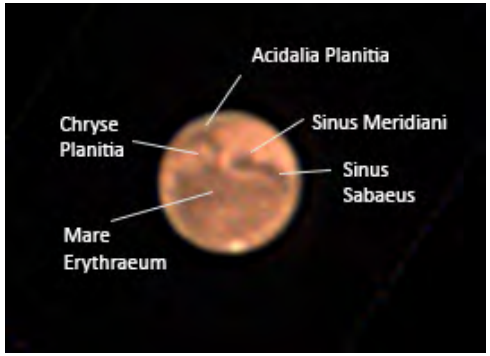


The Syrtis Major face of Mars from May 2020 to March 2021. The gibbous phase of Mars is apparent in the weeks before and after opposition. At opposition, the disk is fully illuminated and has attained its maximum apparent diameter. Also seen is the shrinking of the South Polar Cap as the Martian summer approached in September 2020.

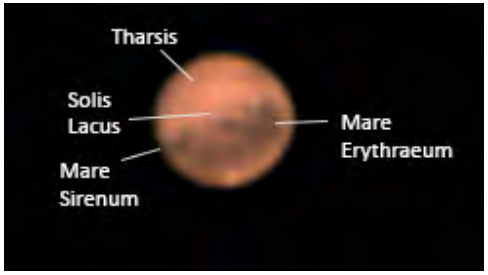
As Mars rotates on its axis from west to east, various albedo features representing geographical regions come into view. Since it is impossible to see the complete rotation of Mars in a single night, the imaging of the Martian disk must be done over several nights. Damien Peach's 2005 Mars albedo map was used to identify the major features seen on the Martian disks.



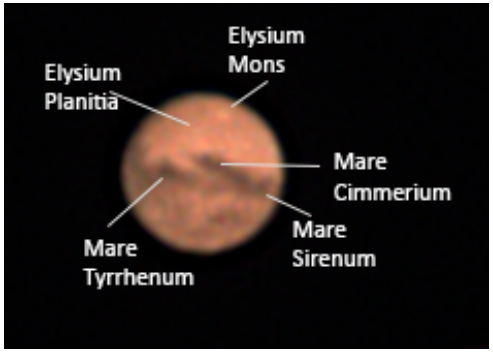
Syrtis Major is a low relief shield volcano and was one of the largest features on Mars. Jezero Crater, the landing spot for Mars rover Perseverance is located in the northeastern part of Syrtis Major. Hellas Basin is one of the largest and deepest impact craters in the solar system. SPC is the South Polar Cap. (For orientation, Sinus Sabaeus is to the west of Syrtis Major).



The dark feature known as Sinus Meridiani was observed by many of the early astronomers including Giovanni Schiaparelli. The feature is named for its role as location for Mars' prime meridian. Meridiani Planum was the landing location for Mars Rover Opportunity. Schiaparelli Crater (not labeled) is the notch located between Meridiani and Sabaeus. Acidalia Planitia is a large dark feature in the northern lowlands containing large outflow channels, few craters, and mud volcanoes. Chryse Planitia is the light-colored, low-lying area beneath Acidalia Planitia. The presence of large outflow channels suggests that the Chyrse may have experienced catastrophic flooding early in Mars' history. Chryse was explored by Viking I Lander (1976) and later Pathfinder (1997).

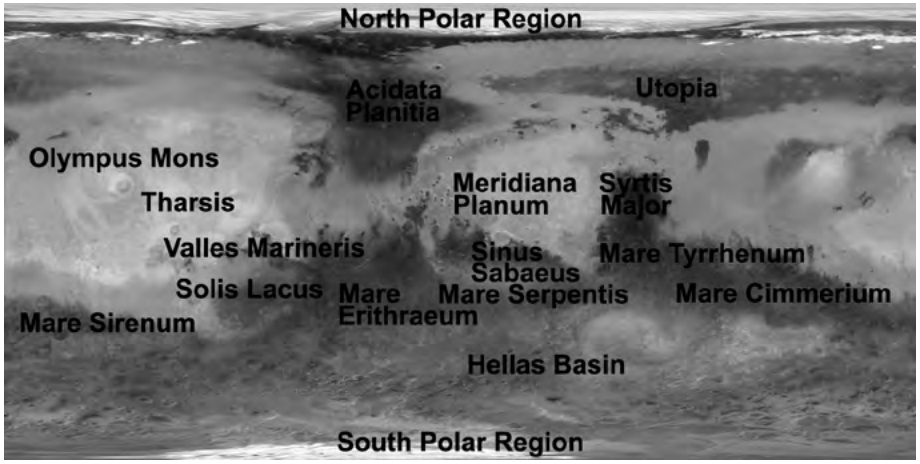


Solis Lacus (Lake of the Sun) is more commonly known as the "Eye of Mars." Solis Lacus is a high plain surrounded by mountains to the south and canyons to the north. Although it is not seen in the image, Vallis Marineris runs along the northern edge of Lacus Solis like an eyebrow. Tharsis is an expansive volcanic plateau that contains Olympus Mons (the largest volcano in the solar system) and Tharsis Montes, a chain of three other volcanoes.



Mare Sirenum, Mare Cimmerium, and Mare Tyrrenhum make up an extensive dark-colored region in the southern hemisphere of Mars. To the north lies Elysium Planitia, the second largest volcanic province on Mars. Elysium Mons, seen as the bright spot to the north, is the largest volcano of this province (and second to Olympus Mons in size). Syrtis Major lies to the west of Elysium Planitia; the eastern edge of Syrtis Major is partially visible.

Below is an albedo map of Mars that was created from surface data collected by Mars Global Surveyor. This is a geographic representation of where all of the features shown on the Martian disk images lie in relationship to each other.



Mars GLOBAL SURVEYOR TES ALBEDO MAP OF MARS (2000)
Image credit: NASA/JPL/ASU/Phil Stooke.
Modifications by GDW.

All Mars Photos in this article are by GDW.

The Dolphin

Ken Yanosko

Late in the evening in the early summer, or early in the evening in the late summer, the Dolphin appears in the east. The constellation Delphinus is one of Ptolemy of Alexandria's 48 constellations, which he cataloged in the second century, and is today one of the 88 constellations recognized by the International Astronomical Union. The dolphin pictured in Johannes Hevelius's 1690 star atlas (posthumously published) doesn't look much like a dolphin (this was before the TV series *Flipper*), but modern sky maps, like *Stellarium*, show a recognizable porpoise.

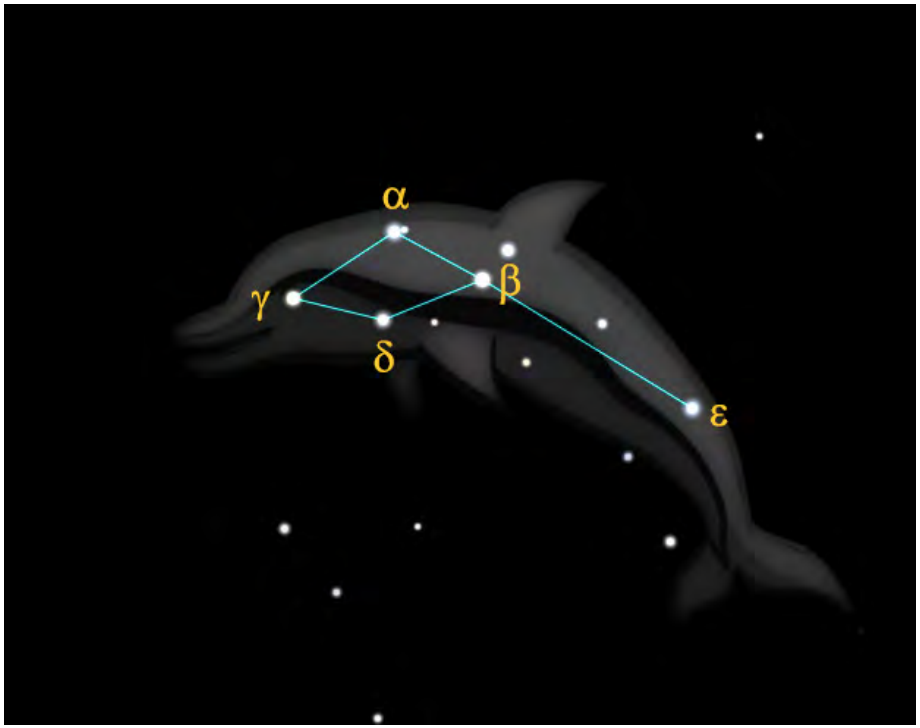
Johannes Hevelius, Firmamentum Sobiescianum*, 1690.*
From Wikimedia*, Public Domain*

There are two mythological stories from ancient Greece which explain the origin of Delphinus. The first is that the god Poseidon fell in love with a sea nymph, and sent a messenger named Delphinus to carry his proposal to the object of his affections. When Poseidon later married the girl he rewarded the messenger with a spot in the sky. The other story concerns a traveling musician who ran afoul of some thieves who threw him overboard. The god Apollo, patron of musicians, sent a dolphin to the rescue. The musician was saved and the dolphin was rewarded.

Of course, not all civilizations have seen an aquatic mammal in these stars. In the far east—China, Korea, and Japan—the Dolphin's body stars, Alpha through Delta, have been seen as a gourd; and the main star of the tail, Epsilon, was either a seed from the gourd or sometimes, with the dimmer stars surrounding it, another gourd, one which was mis-shapen and rotten. In some Pacific Islands the seafaring people didn't see a dolphin either; they saw a woodworking tool with a broad blade and a handle. And in some cultures the trapezium-shaped body is known as Job's Coffin. No one seems to know why.

Some of the stars of Delphinus have been given proper names.

The medieval Arabs named Epsilon "Deneb Aldulfin," or "Tail of the Dolphin." The IAU shortened this to "Aldulfin." The names for Alpha and Beta have a more interesting story. They first appeared in a star atlas compiled by Giuseppe Piazzi in 1814. It wasn't until 1859 that their meaning was decoded. It seems that Piazzi had an assistant named Niccolò Cacciatore. As every good cook knows, Cacciatore means "Hunter," which, as every classics scholar knows, is "Venator" in Latin. So the Latinized name "Nicolaus Venator" (reversed) got immortalized in the heavens. No one knows whether Piazzi's assistant snuck his own name into the catalog when the master wasn't looking, or whether Piazzi himself decided to honor his trusted assistant. I like to think it was the latter. (Click on the picture to see these names.)



Stellarium

There are no Messier objects in Delphinus, but there are three NGC's: globulars 6934 and 7006, and planetary 6905. And Gamma is a wide binary, described as "one of the prettier pairs in the sky." Be sure to add all these to your summer target list.

NASA's OSIRIS-REx Spacecraft Heads for Earth with Asteroid Sample

National Aeronautics and Space Administration

After nearly five years in space, NASA's Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) spacecraft is on its way back to Earth with an abundance of rocks and dust from the near-Earth asteroid Bennu.

On Monday, May 10, at 4:23 p.m. EDT the spacecraft fired its main engines full throttle for seven minutes—its most significant maneuver since it arrived at Bennu in 2018. This burn thrust the spacecraft away from the asteroid at 600 miles per hour (nearly 1,000 kilometers per hour), setting it on a 2.5-year cruise towards Earth. After releasing the sample capsule, OSIRIS-REx will have completed its primary mission. It will fire its engines to fly by Earth safely, putting it on a trajectory to circle the sun inside of Venus' orbit. After orbiting the Sun twice, the OSIRIS-REx spacecraft is due to reach Earth Sept. 24, 2023. Upon return, the capsule containing pieces of Bennu will separate from the rest of the spacecraft and enter Earth's atmosphere. The capsule will parachute to the Utah Test and Training Range in Utah's West Desert, where scientists will be waiting to retrieve it.

"OSIRIS-REx's many accomplishments demonstrated the daring and innovate way in which exploration unfolds in real time," said Thomas Zurbuchen, associate administrator for science at NASA Headquarters. "The team rose to the challenge, and now we have a primordial piece of our solar system headed back to Earth where many generations of researchers can unlock its secrets." To realize the mission's multi-year plan, a dozen navigation engineers made calculations and wrote computer code to instruct the spacecraft when and how to push itself away from Bennu. After departing from Bennu, getting the sample to Earth safely is the team's next critical goal. This includes planning future maneuvers to keep the spacecraft on course throughout its journey.

OSIRIS-REx's Touch-and-Go Sample Arm Mechanism executing touchdown maneuver on October 20, 2020. NASA photo.

"Our whole mindset has been, 'Where are we in space relative to Bennu?'" said Mike Moreau, OSIRIS-REx deputy project manager at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Now our mindset has shifted to 'Where is the spacecraft in relation to Earth?'" The navigation cameras that helped orient the spacecraft in relation to Bennu were turned off April 9, after snapping their last images of the asteroid. With Bennu in the rearview mirror, engineers are using NASA's Deep Space Network of global spacecraft communications facilities to steer the OSIRIS-REx by sending it radio signals. By measuring the frequency of the waves returned from the spacecraft transponder, engineers can tell how fast OSIRIS-REx is moving. Engineers measure how long it takes for radio signals to get from the spacecraft back to Earth in order to determine its location.

The May 10 departure date was precisely timed based on the alignment of Bennu with Earth. The goal of the return maneuver is to get the spacecraft within about 6,000 miles (approximately 10,000 kilometers) of Earth in September 2023. Although OSIRIS-REx still has plenty of fuel remaining, the team is trying to preserve as much as possible for a potential extended mission to another asteroid after returning the sample capsule to Earth. The team will investigate the feasibility of such a mission this summer.

The spacecraft's course will be determined mainly by the Sun's gravity, but engineers will need to occasionally make small course adjustments via engine burns. "We need to do regular corrections to bring the trajectory increasingly closer to Earth's atmosphere for the sample release, and to account for small errors that might have accumulated since the last burn," said Peter Antreasian, OSIRIS-REx navigation lead at KinetX Aerospace, which is based in Simi Valley, California. The team will perform course adjustments a few weeks prior to Earth re-entry in order to precisely target the location and angle for the sample capsule's release into Earth's atmosphere. Coming in too low could cause the capsule to bounce out of the atmosphere like a pebble skipping off a lake; too high and the capsule could burn up due to friction and heat from the atmosphere. If OSIRIS-REx fails to release the capsule, the team has a backup plan to divert it away from Earth and try again in 2025.

"There's a lot of emotion within the team about departure," Moreau said. "I think everyone has a great sense of accomplishment, because we faced all these daunting tasks and were able to accomplish all the objectives thrown at us. But there's also some nostalgia and disappointment that this part of the mission is coming to an end."

OSIRIS-REx exceeded many expectations. Most recently, in the midst of a global pandemic, the team flawlessly executed the most mission's critical operation, collecting more than 2 ounces (60 grams) of soil from Bennu's surface. Leading up to sample collection, a number of surprises kept the team on its toes. For example, a week after the spacecraft entered its first orbit around Bennu, on Dec. 31, 2018, the team realized that the asteroid was releasing small pieces of rock into space. "We had to scramble to verify that the small particles being ejected from the surface did not present a hazard to the spacecraft," Moreau said.

Upon arrival at the asteroid, team members also were astonished to find that Bennu is littered with boulders. "We really had this idea that we were arriving on an asteroid with open real estate," said Heather Enos, OSIRIS-REx deputy principal investigator, based at the University of Arizona, Tucson. "The reality was a big shocker." To overcome the extreme and unexpected ruggedness of Bennu's surface, engineers had to quickly develop a more accurate navigation technique to target smaller-than-expected sites for sample collection.

The OSIRIS-REx mission was instrumental in both confirming and refuting several scientific findings. Among those confirmed was a technique that used observations from Earth to predict that the minerals on the asteroid would be carbon-rich and show signs of ancient

This image, the last one taken by the spacecraft, shows crescent Bennu with its night side merging with the complete black of space as the spacecraft pushed away from Bennu.

water. One finding that proved unsuccessful was that Bennu would have a smooth surface, which scientists predicted by measuring how much heat radiated off its surface. Scientists will use the information gleaned from Bennu to refine theoretical models and improve future predictions. "This mission emphasizes why we have to do science and exploration in multiple ways—both from Earth and from up-close in space—because assumptions and models are just that," Enos said. Goddard provides overall mission management, systems engineering, and the safety and mission assurance for OSIRIS-REx. Dante Lauretta of the University of Arizona, Tucson, is the principal investigator. The university leads the science team and the mission's science observation planning and data processing. Lockheed Martin Space in Littleton, Colorado, built the spacecraft and provides flight operations. Goddard and KinetX Aerospace are responsible for navigating the OSIRIS-REx spacecraft. OSIRIS-REx is the third mission in NASA's New Frontiers Program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama, for the agency's Science Mission Directorate Washington.

For more information about OSIRIS-REx, visit: http://www.nasa.gov/osiris-rex.

Alana Johnson / Karen Fox
NASA Headquarters, Washington, DC
Rani Gran
Goddard Space Flight Center, Greenbelt, MD.

THE CONVERSATION

From iron rain on exoplanets to lightning on Jupiter: four examples of alien weather

Ian Whittaker

Artist's impression of WASP-76b
Frederik Peeters for ESO: https://www.eso.org/public/images/eso2005b/

When Oscar Wilde said "conversation about the weather is the last refuge of the unimaginative" he was unaware of some of the more extreme weather on planets and moons other than Earth.

Since the discovery of the first exoplanet in 1992, more than 4,000 planets have been discovered orbiting stars other than our own. The continuing research with exoplanets involves trying to identify their atmospheric composition, specifically to answer the question of whether life could exist there. In this search for life though, astronomers have found a huge variety of potential worlds out there.

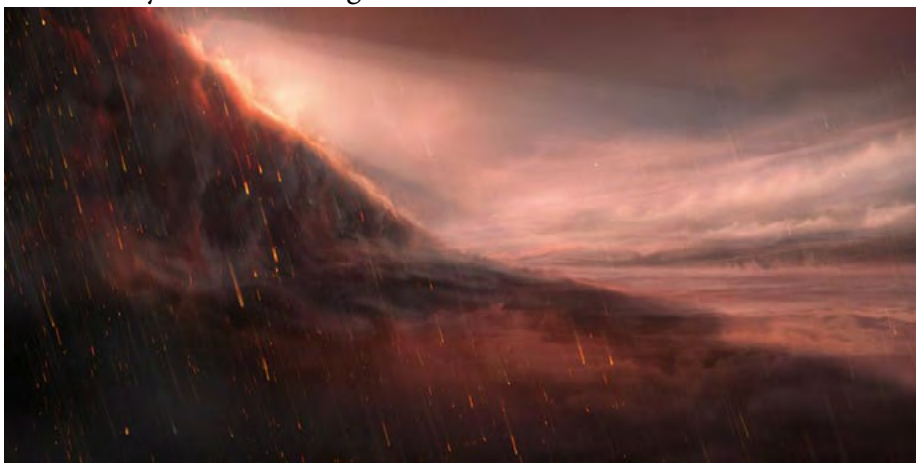
Here are four examples of bizarre weather on other astronomical bodies—to show how varied an exoplanet atmosphere could be.

1. Iron rain on WASP-76b

WASP-76 is a large, hot exoplanet discovered in 2013. The surface of this monster planet—roughly twice the size of Jupiter—is about 2,200°C (4,000°F). This means a lot of material that would be solid on Earth melts and vaporises on WASP-76b.

As described in a particularly famous 2020 study, these materials include iron. At the day side of the planet, facing towards its star, this iron is turned to a gas. It rises in the atmosphere and flows towards the night side.

When this gaseous iron reaches the night side of the planet, where the temperature is cooler, the iron then condenses back into a liquid and falls towards the surface. This is currently the only example we have of a planet with temperatures changes specific enough to allow it to literally rain iron at night.



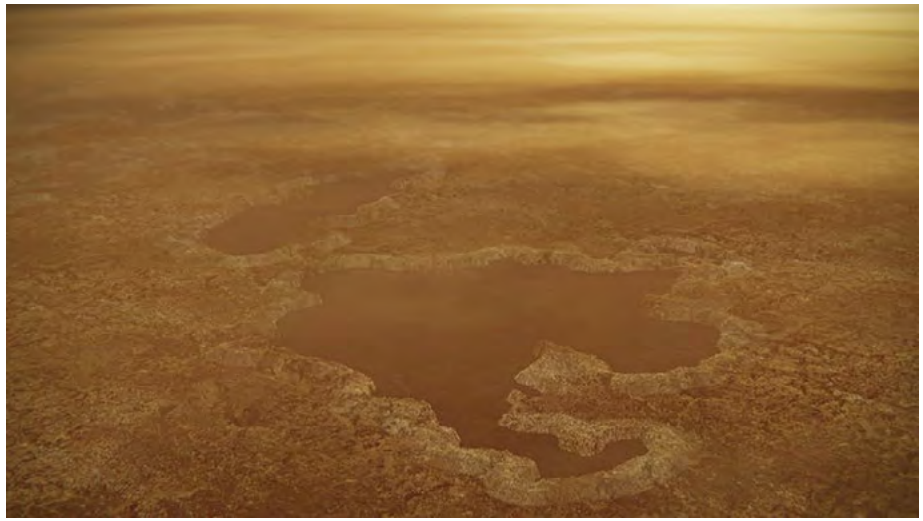
Another artist's impression of the night side of WASP-76b
ESO/ M. Kornmesser https://www.eso.org/public/images/eso2005a/

2. Methane lakes on Titan

Rather than being a planet, Titan is the largest moon of Saturn. It's particularly interesting because it has a substantial atmosphere which is rare for a moon that orbits a planet.

The moon has a surface where liquid flows, like rivers on Earth. Unlike Earth, this liquid isn't water, but a mixture of different hydrocarbons. On Earth we would use these chemicals (ethane and methane) for fuel, but on Titan it's cold enough that they stay liquid and form lakes.

It's thought ice volcanoes sporadically shoot these hydrocarbons into the atmosphere as a gas to form clouds which then condense and form rain. This precipitation is not like the standard showers we might experience on Earth—it only rains about 0.1% of the time, with drops that are bigger (estimated at around 1 cm) and fall five times slower, due to reduced gravity and increased drag.



Titan's Rimmed Lakes (Artist's Concept)
NASA/JPL-Caltech https://www.jpl.nasa.gov/images/titans-rimmed-lakes-artists-concept

3. Winds on Mars

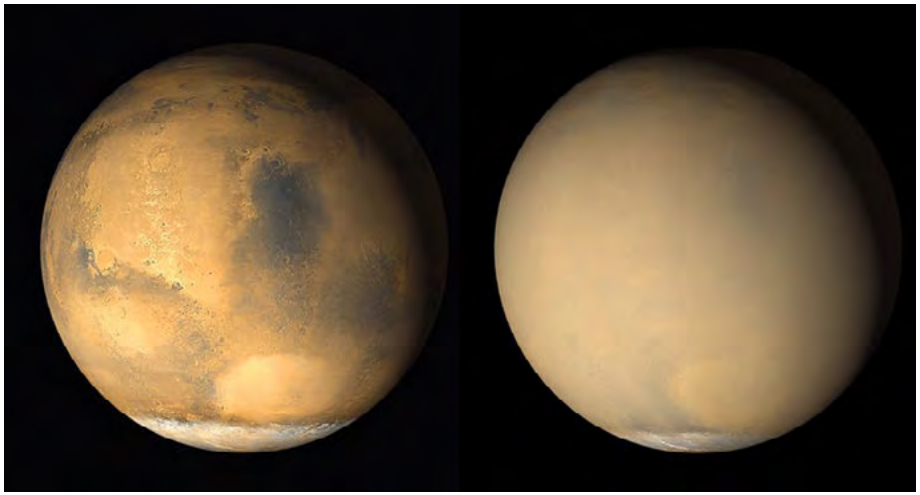
Mars has a completely different weather system to Earth, mainly because of how dry the planet is and how thin the atmosphere is. Without a significant magnetic field the atmosphere of Mars is open to the magnetic field of the Sun, which strips the upper atmosphere away. This has left a thin atmosphere, comprised mostly of carbon dioxide.

The recent first powered flight on Mars by the Nasa helicopter Ingenuity was amazing—not only for the exploration factor but because rotor blades provide so little lift in the thin atmosphere, which is roughly 2% of that on the Earth's surface. Its counter to this thin atmosphere is

a double set of large blades rotating at around 2,500 revolutions per minute, roughly equivalent to a drone rotor speed but much faster than a passenger helicopter.

While the Martian atmosphere is thin, it certainly isn't calm. Average wind speeds of 30 km/h (20 mph) are enough to move the surface material around, and early observations from the Viking lander measured wind speeds up to 110 km/h (70 mph).

The prospect of high-speed sand and dust storms may seem a major issue for exploring the planet, but the atmosphere is thin so the pressure is tiny. For example, the scene in the film The Martian where the rocket blows over simply wouldn't happen. Mars is also famous for having large-scale dust storms which obscure the view of the surface and can last for weeks at a time.



Mars before (left) and during (right) a dust storm.
NASA/JPL-Caltech/MSSS https://mars.nasa.gov/resources/21448/the-2001-great-dust-storms-hellassyrtis-major/

4. Lightning on Jupiter

In 1979, Voyager 1 flew past Jupiter and saw lightning strikes. Then in 2016, the Juno mission performed an in depth look at lightning storms on Jupiter.

On the Earth, most of the lightning is concentrated near the equator. But on Jupiter the stability of the atmosphere means most convection and turbulence occurs near the polar regions, which is where the lightning strikes mainly happen. Instead of the Earth-based lightning generation method of supercooled water droplets colliding with ice, on Jupiter, a charge builds up in snowballs of ammonia. This ammonia acts as an antifreeze for the water, keeping it liquid at much higher altitudes.

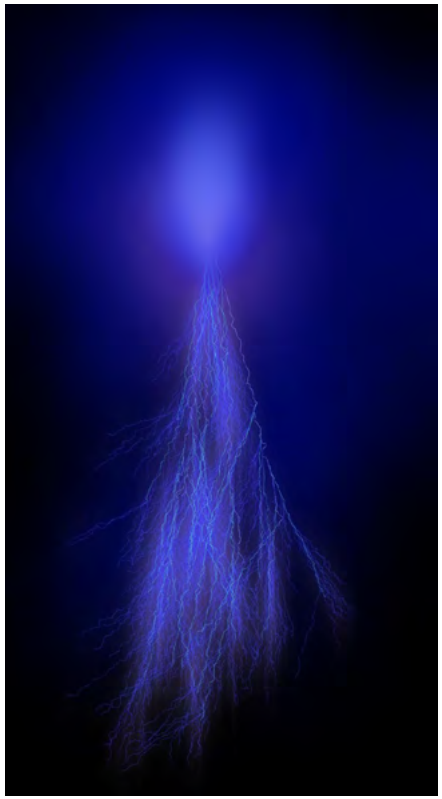
Jupiter even has less commonly known lightning called sprites and elves. Sprites are formed from lightning which rises from the clouds towards the upper atmosphere and creates a short-lived reddish glow, while elves are rings formed when the lightning strike reaching the charged part of our atmosphere (the ionosphere). These were predicted in 1921, but were not photographed on Earth until 1989, mainly due to storm clouds being in the way.

These so-called transient luminous events have now been observed on Jupiter as well, providing important information on the Jovian atmosphere as well as how these lightning formations are created and sustained.

While there are many different possibilities for weather on exoplanets, the biggest challenge is observing them in enough detail to identify what their atmosphere—if they have one—is comprised of.

The next discovery of an exoplanet weather system could be Earth-like, it could be similar to one of the examples above, or it could be something even more incredible.

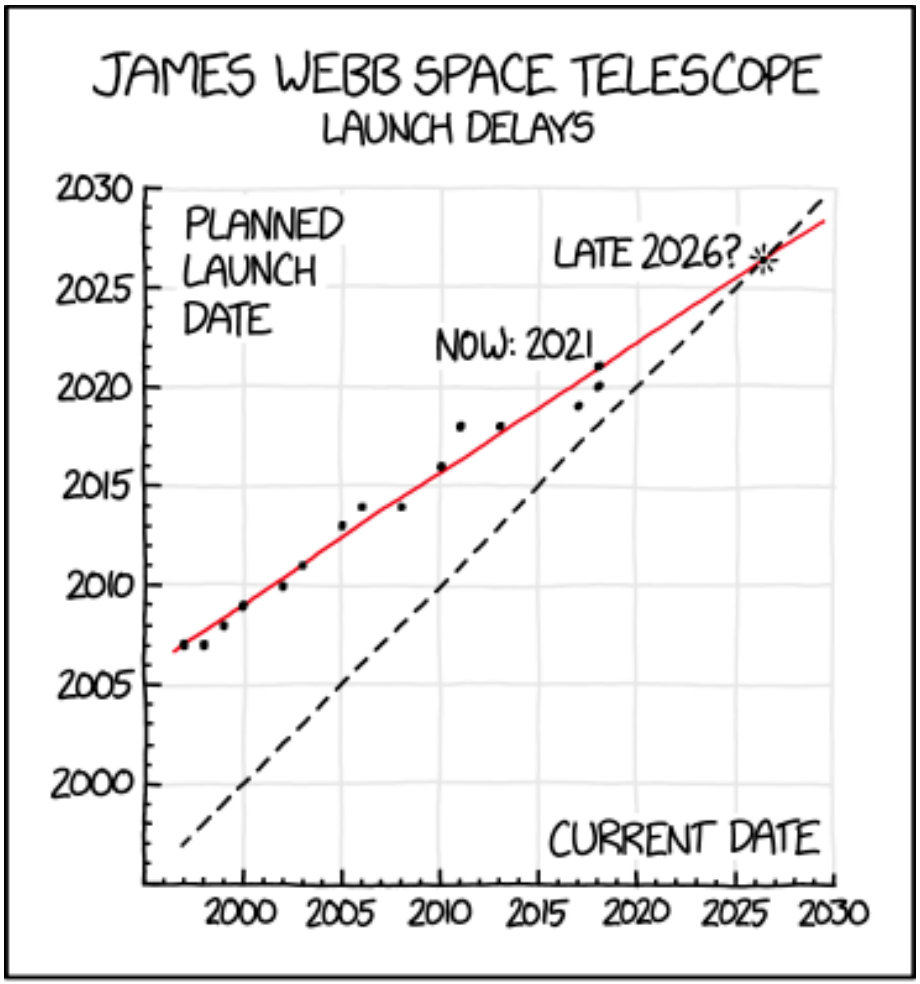
Ian Whittaker is a Senior Lecturer in Physics, Nottingham Trent University, Nottingham, UK



What a sprite could look like in Jupiter's atmosphere.
NASA/JPL-Caltech/SwRI
https://www.jpl.nasa.gov/images/jovian-sprite-illustration

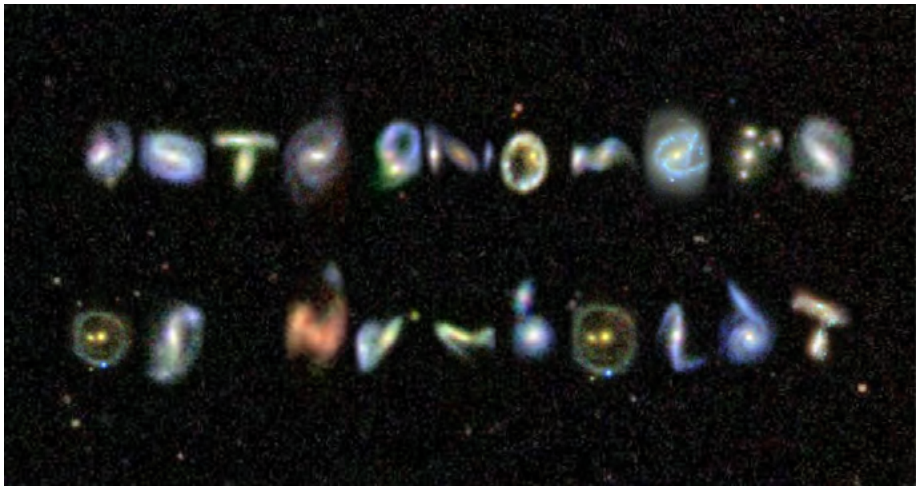
After Words

The recently-announced launch date for JWST of October 31, 2021 has just been even more recently pushed back for what NASA is saying may be "only a few weeks." The next date for launch will not be announced until later this summer or early in the fall.



Russell Munroe, XKCD, used with permission

The Galaxy Zoo, a citizen-science project for categorizing Sloan Digital Sky Survey images of galaxies, has made available an app for printing text in a "galactic font." See writing.galaxyzoo.org to print out your own name, slogan, or banner.



Heavenly Bodies

Susie Christian