National Aeronautics and
Space Administration

2022 EXPLORE SCIENCE

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EXPLORE SCIENCE

Science and discovery unite and inspire us—and are a source of hope in difficult times. Our continued exploration of our planet and the universe around us, while facing the challenges of the pandemic, demonstrates the power of the human spirit to push beyond our limitations and transcend obstacles.

After a year of perseverance, 2022 marks a period of new beginnings, and I could not be more excited. As we embark on new missions of discovery, we aim to learn about the intriguing worlds in our solar system, the mysterious processes of the cosmos, and to better understand the nature of our interconnected home planet—the most beautiful planet we know. Robotic pioneers like Lucy are on their way to objects in our solar system yet to be visited, DART is setting off to accomplish feats yet to be attempted, and the Webb telescope seeks to open our eyes to the universe in entirely new ways. Achieving these goals is hard, but that is precisely why we do it. Our incredible teams come together to lift up humankind toward the stars. And 2022 is the year we recommit to this spirit of exploration.

This year we plan to send our first payloads to the lunar surface as part of the NASA Artemis program—and we're doing it in totally new ways, with commercial partners. We will launch NASA's first mission to Psyche, a presumed metal asteroid, a world unlike any we have explored before. We will also launch a series of Earth satellites that are part of a new unified way of observing our planet's interconnected systems. From high in the atmosphere to below the ocean's surface, these missions will provide key information to guide the Nation's efforts regarding climate change, disaster mitigation, fighting forest fires, and improving real-time agricultural processes. These investigations of our Earth System not only teach us new things but also help us protect lives and thrive on our planet.

We have a big year ahead of us, and I know our NASA Science team will excite and inspire the world as we move forward with these endeavors. After all, we are one human race, we inhabit a single planet, and we are deeply interconnected with each other. Join us as we peer into the universe and open its treasure chest of discovery and knowledge.

Thomas H. Zurbuchen

Associate Administrator
NASA Science Mission Directorate

January 2022

Return to the Veil Nebula. The Veil Nebula is the visible portion of the nearby Cygnus Loop, a supernova remnant formed roughly 10,000 years ago by the death of a massive star. The Veil Nebula's progenitor star—which was 20 times the mass of our Sun—lived fast and died young, ending its life in a cataclysmic release of energy. Despite this stellar explosion, the shock waves and debris from the supernova sculpted the Veil Nebula's delicate tracery of ionized gas, creating a scene of surprising astronomical beauty. The Veil Nebula lies around 2,100 light-years from Earth in the constellation of Cygnus (the swan), making it a relatively close neighbor in astronomical terms. Only a small portion of the nebula was captured in this image. To create the image, observations taken by Hubble's Wide Field Camera 3 instrument through five different filters were used. Post-processing methods have further enhanced details of emissions from doubly ionized oxygen (seen here in blues), ionized hydrogen, and ionized nitrogen (seen here in reds). **Image and text credit:** European Space Agency (ESA)/Hubble & NASA, Z. Levay

https://esahubble.org/images/potw2113a

Born in 1953, **Dr. Chryssa Kouveliotou**, a former senior technologist in high-energy astrophysics at NASA's Marshall Space Flight Center, is professor and department chair at George Washington University, Washington D.C. She is an expert on highly energetic transient phenomena, such as gamma-ray bursts, and led the team that first confirmed the detection of magnetars. She has received several prestigious prizes, including the Shaw Prize, Bruno Rossi Prize, Dannie Heineman Prize, and Descartes Prize. Photo credit: Chryssa Kouveliotou

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
					New Year's Day (observed date)	
2	3	4	5	6	7	8
New Moon						
9	10	11	12	13	14	15
First Quarter						
16	17	18	19	20	21	22
	Full Moon Birthday of Martin Luther King, Jr. (observed date)					
23 30	24 31	25	26	27	28	29
		Last Quarter				

December 2021

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February 2022

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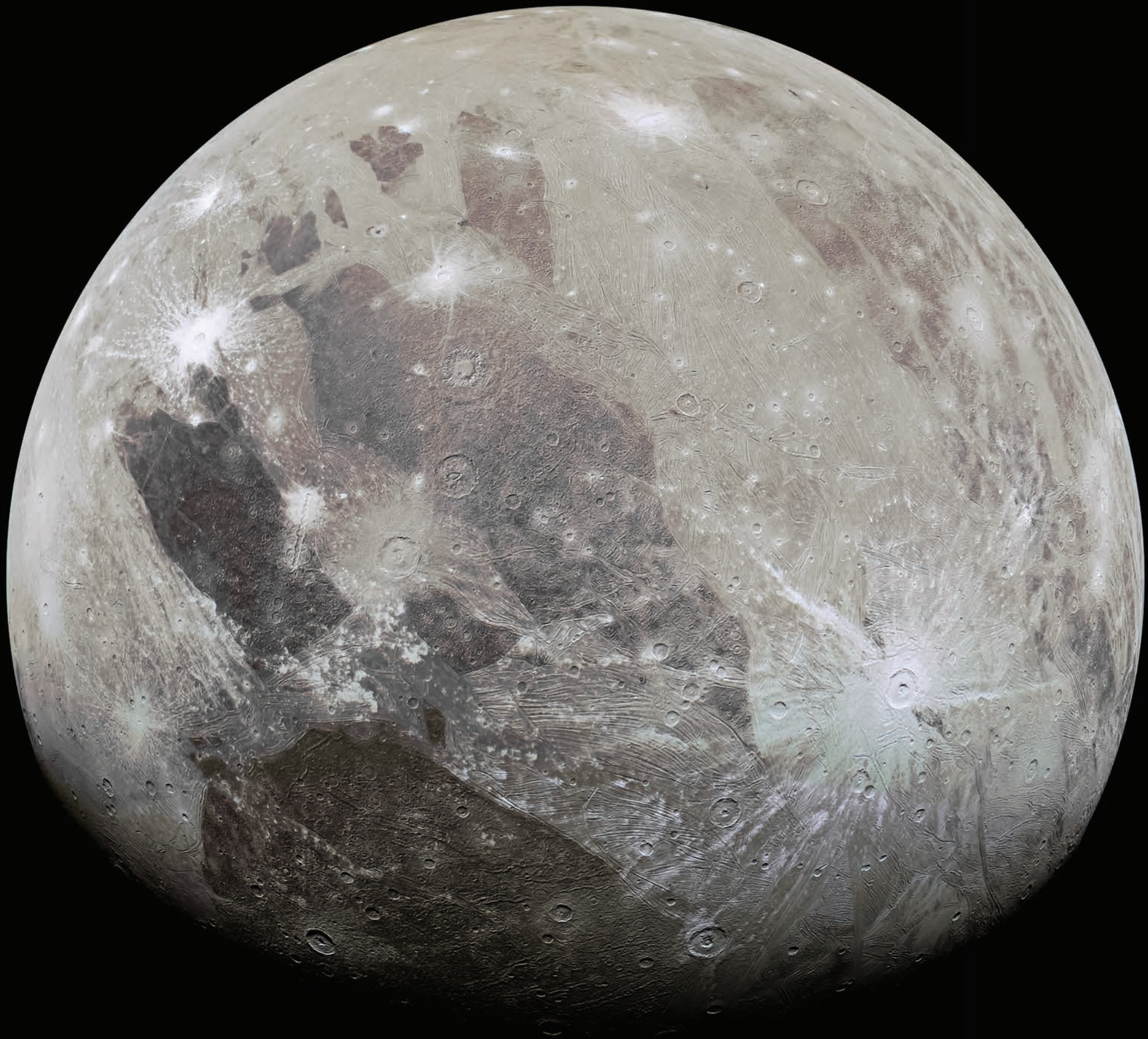
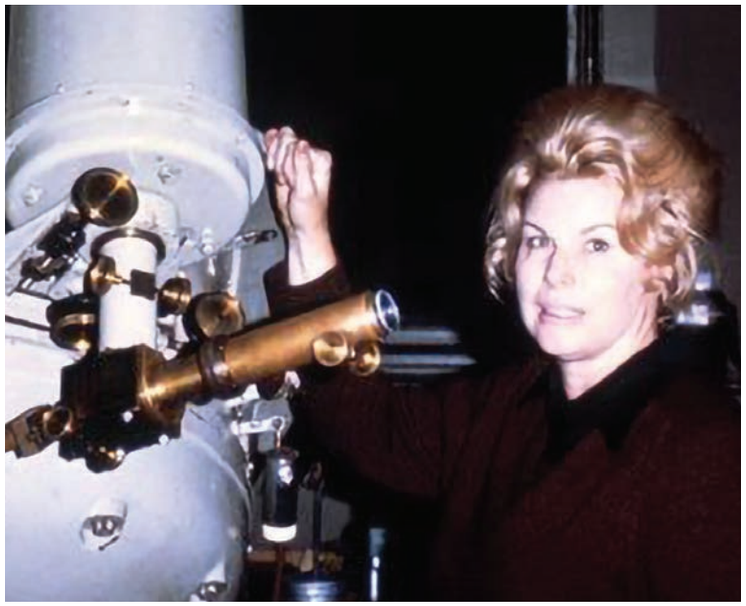


February 2022

Juno Sails by Ganymede. On June 7, 2021, the Juno spacecraft flew closer to Ganymede, Jupiter's largest moon, than any other flyby in more than two decades, offering dramatic glimpses of the icy orb. This image from JunoCam shows Ganymede's surface in remarkable detail, including craters, clearly distinct dark and bright terrain, and long structural features possibly linked to tectonic faults. The solar-powered spacecraft's encounter with the Jovian moon is expected to yield insights into its composition, ionosphere, magnetosphere, and ice shell while also providing measurements of the radiation environment that will benefit future missions to the Jovian system, which includes Jupiter and Jupiter's four largest moons—Io, Europa, Ganymede, and Callisto. **Image and text credit:** NASA/JPL-Caltech/Southwest Research Institute/Malin Space Science Systems/Kevin M. Gill

https://www.jpl.nasa.gov/news/see-the-first-images-nasas-juno-took-as-it-sailed-by-ganymede



Eleanor F. "Glo" Helin (1932–2009) was active in planetary science and astronomy for more than 40 years at the California Institute of Technology and NASA's Jet Propulsion Laboratory. In the early 1970s, she initiated the Palomar Planet-Crossing Asteroid Survey (PCAS) from Palomar Observatory, searching for large near-Earth asteroids (NEAs). This photographic program concluded after 25 years when the Near-Earth Asteroid Tracking (NEAT) project began in 1995. She remained with NEAT until her retirement in 2002, utilizing Air Force telescopes on Hāleakala Observatory, Maui, Hawaii, and expanding NEAT to include an upgraded Palomar 48-inch (1.2-meter) Oschin Schmidt telescope. Photo credit: NASA/JPL-Caltech

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 New Moon	2	3	4	5
6	7	8 First Quarter	9	10	11	12
13	14	15	16 Full Moon	17	18	19
20	21 Washington's Birthday (observed date)	22	23 Last Quarter	24	25	26
27	28					

January 2022

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30	31					

March 2022

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20	21	22	23	24	25	26
27	28	29	30	31		

March 2022

Von Kármán Vortex. This December 2020 image, captured by NASA's Terra satellite, shows clouds tracing the flow of air around, over, and downstream of three volcanic islands in Cabo Verde. This type of oscillating flow occurs when fluids or air masses pass tall, stationary objects like mid-ocean islands. The repeating patterns of swirling vortices—von Kármán vortex streets—are named for renowned mathematician and engineer Theodore von Kármán, one of the founders of the Jet Propulsion Laboratory. As a graduate student in 1912, von Kármán was the first to describe such vortices in mathematical terms. **Image and text credit:** NASA Earth Observatory image by Lauren Dauphin, using Moderate Resolution Imaging Spectroradiometer (MODIS) data from NASA Earth Observing System Data and Information System (EOSDIS)/Land, Atmosphere Near real-time Capability for EOS (LANCE) and Global Imagery Browse Services (GIBS)/Worldview; original story by Adam Voiland

https://earthobservatory.nasa.gov/images/147743/the-stability-of-von-karmans-vortices

Dr. Franco Einaudi (1937–2020) spent several years after his retirement as director of the Earth Sciences Division (ESD) at NASA's Goddard Space Flight Center (GSFC) as an "ambassador" for the agency, encouraging students from historically underserved communities to pursue careers in Earth science. A native of Turin, Italy, Einaudi came to the United States to pursue graduate and then doctoral degrees at Cornell University. This was followed by fellowships at the University of Toronto and the Cooperative Institute of Research in Environmental Sciences (CIRES) in Boulder, Colorado, and later a professorship at the Georgia Institute of Technology. He joined NASA as head of the GSFC Severe Storms Branch and later became chief of the Laboratory for Atmospheres before being named Goddard's ESD director. Einaudi, an atmospheric dynamicist, was respected worldwide for his research on gravity waves and, on two occasions, returned to Italy for visiting research and professorship positions. Einaudi was a former president of the American Meteorological Society, which recognized him for efforts to increase diversity and create opportunities for underrepresented people in science. Photo credit: Paula Ferris Einaudi

February 2022

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20	21	22	23	24	25	26
27	28					

April 2022

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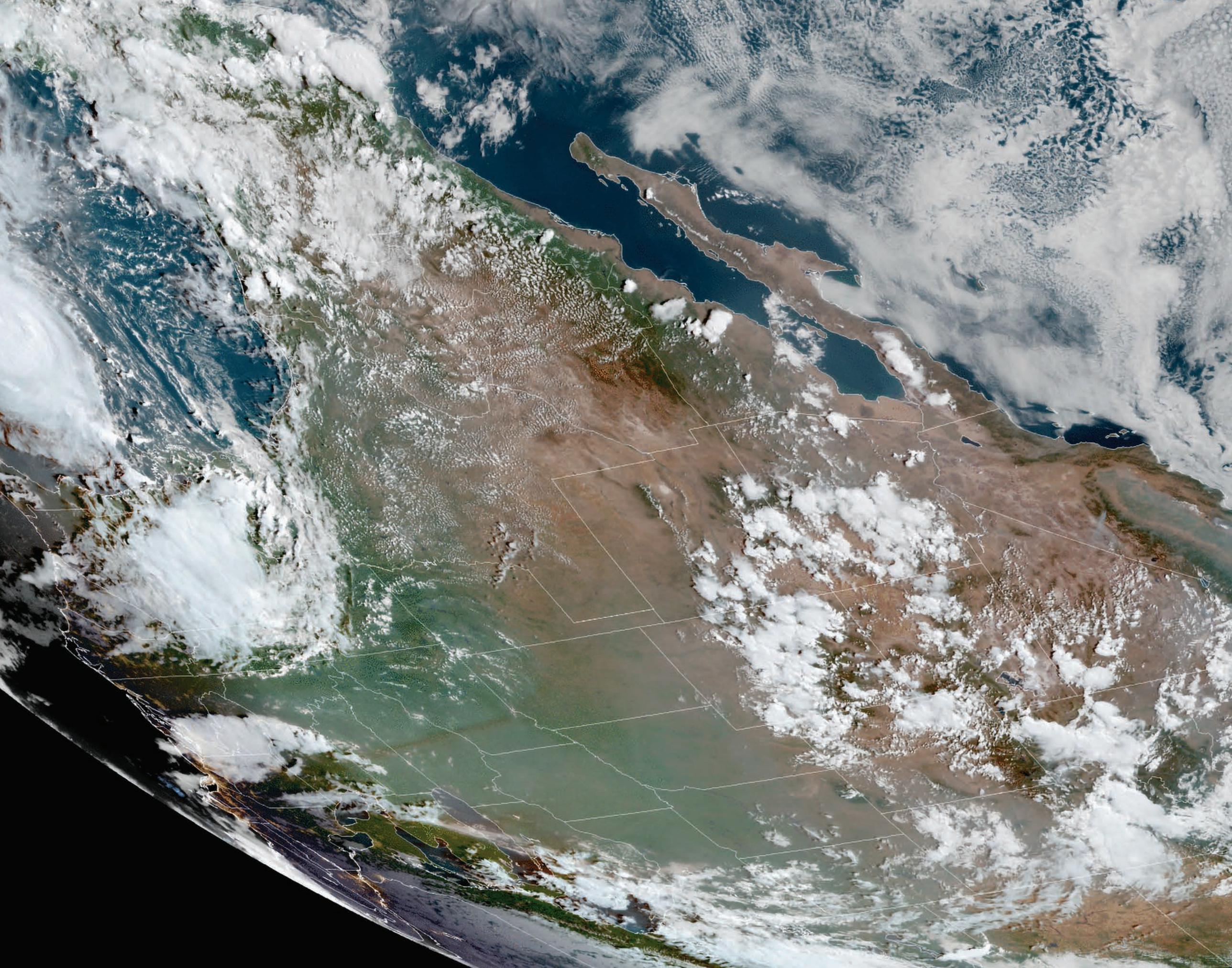
17	18	19	20	21	22	23
24	25	26	27	28	29	30

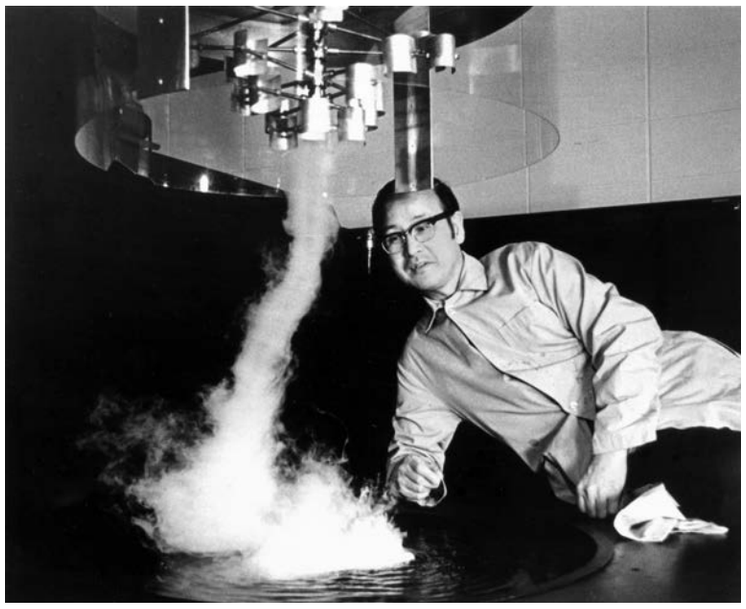
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2 New Moon	3	4	5
6	7	8	9	10 First Quarter	11	12
13 Daylight Saving Time Begins	14	15	16	17	18 Full Moon	19
20	21	22	23	24	25 Last Quarter	26
27	28	29	30	31		



April 2022

GOES West Captures Two Hurricanes and the Smoke of California Wildfires. On August 25, 2020, the National Oceanic and Atmospheric Administration (NOAA)'s Geostationary Operational Environmental Satellite (GOES) West captured this dynamic GeoColor image of North America, where wildfires ravaged the drought-plagued West and Southwest United States. The resulting hazy gray shroud of smoke spread over much of the country. Over the Gulf of Mexico, Hurricane Laura can be seen heading toward Louisiana and eastern Texas while the remnants of Hurricane Marco swirl over the Southeast. In the image, smoke can be seen filling California's Central Valley. From mid- to late August 2020, throughout this state alone, more than 650 wildfires, many sparked by lightning, burned more than 1.25 million acres (~5,058 km^2)—an area larger than the state of Rhode Island. Seven people died as a result of these fires, and more than 1,400 buildings were destroyed. **Image and text credit:** NOAA

https://www.nesdis.noaa.gov/content/goes-west-saw-eyeful-space-tuesday



Dr. Tetsuya Fujita (1920–1998) invented the scale by which the power of tornadoes is measured and discovered the phenomena of downbursts and microbursts—the result of having observed atomic-bomb blast patterns as a student in Japan during World War II. This photo shows Fujita and his tornado simulator. Photo credit: University of Chicago Photographic Archive, [apf1-09827], Hanna Holborn Gray Special Collections Research Center, University of Chicago Library

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1 New Moon	2
3	4	5	6	7	8	9 First Quarter
10	11	12	13	14	15	16 Full Moon
17	18	19	20	21	22	23 Last Quarter
24	25	26	27	28	29	30 New Moon

March 2022

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May 2022

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29	30	31				

May 2022

“Water Bears” Help Pave the Way for Prolonged Human Presence in Space. This tardigrade, *Hypsibius exemplaris*, is a new model for space biology and understanding how organisms survive in extreme environments. Tardigrades, commonly known as “water bears,” are a group of microscopic animals renowned for their ability to survive an array of extreme environmental stresses, including near complete desiccation, freezing, high temperatures, intense radiation, and even the vacuum of outer space. NASA uses tardigrades to understand how these amazing animals are able to survive extremes, what the limits of life are, and where we might find new life, both on Earth and elsewhere. As part of the Biological and Physical Science Division’s Cell-Science 04 investigation, the Boothby Lab at the University of Wyoming and scientists at NASA’s Ames Research Center study tardigrades cultured aboard the International Space Station over many generations. These experiments will allow us to understand how these extremely hardy animals cope with prolonged exposure to space environments and will help pave the way for a healthy and productive prolonged human presence in space. To create this image of *Hypsibius exemplaris*, Tagide deCarvalho used a confocal microscope and fluorescent stains to highlight the tardigrade digestive tract, including the mouthparts and stomach filled with food. This photo won the 2019 Olympus Image of the Year Global Life Science Light Microscopy Award, Americas division. The award recognizes the “very best in life science imaging worldwide,” according to Olympus. **Photo credit:** Tagide deCarvalho, University of Maryland, Baltimore County **Text credit:** NASA’s Ames Research Center, Space Biology; University of Wyoming, Thomas Boothby

https://science.nasa.gov/biological-physical/investigations/cell-science-04

Dr. Millie Hughes-Fulford (1945–2021) was a molecular biologist, medical investigator, and payload specialist at NASA. Hughes-Fulford was selected as a payload specialist by NASA in January 1983 and flew aboard STS-40 Spacelab Life Sciences (SLS 1), the first Spacelab mission dedicated to biomedical studies. Hughes-Fulford was the principal investigator on a series of spaceflight experiments, which examined bone and cancer growth regulation and the effect of spaceflight on the immune system dysregulation in astronauts. Hughes-Fulford contributed more than 120 papers and abstracts, adding a significant body of work to our understanding of bone loss and immune dysregulation in space. Photo credit: NASA

April 2022

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June 2022

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26	27	28	29	30		

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8 Mother’s Day	9 First Quarter	10	11	12	13	14
15	16 Full Moon	17	18	19	20	21
22 Last Quarter	23	24	25	26	27	28
29	30 New Moon Memorial Day	31				

June 2022

Partial Solar Eclipse. In this photo taken on June 10, 2021, a partial solar eclipse is seen as the Sun rises behind the Delaware Breakwater Lighthouse at Lewes Beach in Delaware. A solar eclipse happens when the Moon moves between the Sun and Earth, casting a shadow on Earth, fully or partially blocking the Sun's light in some areas. During a partial solar eclipse, the Sun, Moon, and Earth are not exactly lined up. The Sun will appear to have a dark shadow on only part of its surface. This partial eclipse was visible in parts of the eastern United States and northern Alaska, along with much of Canada and parts of the Caribbean, Europe, Asia, and Northern Africa. **Photo and text credit:** NASA/Aubrey Gemignani

https://www.nasa.gov/content/june-10-2021-eclipse
https://www.nasa.gov/image-feature/solar-eclipse-over-delaware

Born in 1941, **Dr. Russell Howard** has been a leader in heliophysics research, including work on developing coronagraphs that look at the Sun, and later heliospheric imagers that have launched on countless missions, including the Parker Solar Probe. He was recently awarded the 2021 George Ellery Hale prize for his contributions over half a century on his work with coronal mass ejections. Photo credit: U.S. Naval Research Laboratory/Jonathan M. Sunderman

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7 First Quarter	8	9	10	11
12	13	14 Full Moon Flag Day	15	16	17	18
19 Father's Day	20 Juneteenth National Independence Day (observed)	21 Last Quarter	22	23	24	25
26	27	28	29 New Moon	30		

May 2022

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July 2022

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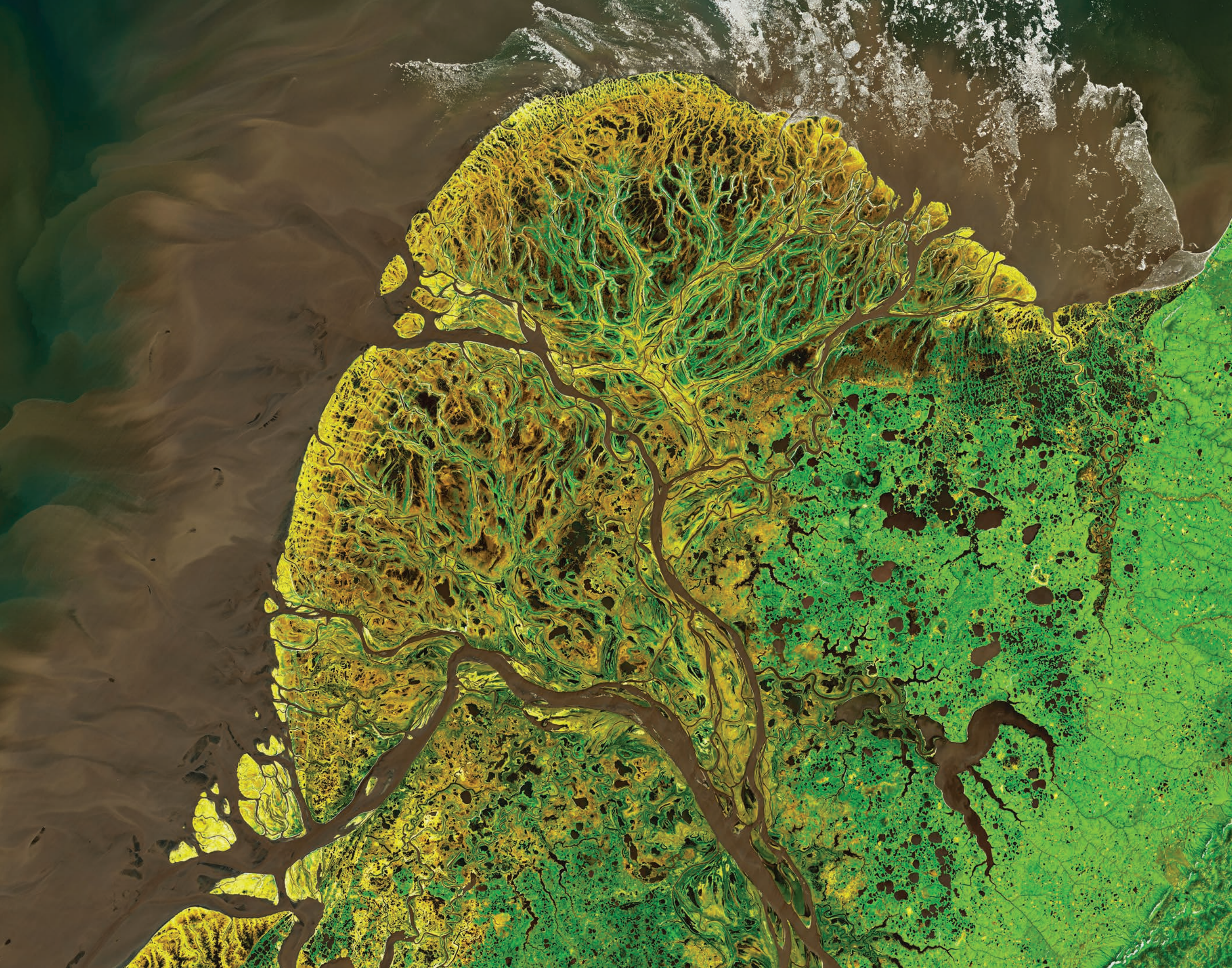
31						



July 2022

Yukon-Kuskokwim Delta. Acquired on May 29, 2021, by the NASA–U.S. Geological Survey (USGS) Landsat 8 satellite's Operational Land Imager (OLI), this composite of natural- and false-color imagery reveals fine details of the Yukon-Kuskokwim Delta along the west coast of Alaska. Scientists can use different combinations of wavelengths to make it easier to see the differences between vegetation, river water, land, and the sea. In this image, live vegetation is green and bare or dead vegetation areas are light brown. Sediment-rich rivers and ponded flood water appear dark brown. The area is brimming with fresh water in springtime due to melting snow and ice. The Bering Sea is stained brown near the coast due to sediment from glacial runoff upstream. The abundant sediment helps create natural levees along river and stream channels; the deposits help support tall willows, which provide a habitat for moose. Such landscapes in the Yukon and other Arctic river deltas are becoming more vulnerable as the land and ice of the region thaw earlier and more widely due to climate change. **Image and text credit:** NASA Earth Observatory image by Joshua Stevens, using Landsat data from USGS; original story by Kathryn Hansen.

https://earthobservatory.nasa.gov/images/148464/yukon-kuskokswim-in-colorful-transition

Born in 1927, **Virginia Norwood** was 9 years old when she received her first slide rule from her father. Adept at math and physics, Norwood ignored a high school counselor's advice to parlay those skills into becoming a librarian and instead went to the Massachusetts Institute of Technology (MIT), where she earned a degree in mathematical physics. Norwood had a distinguished career in remote sensing, patenting a radar reflector that led to the discovery of high-altitude winds and creating a transmitter that beamed Surveyor images back from the Moon. Perhaps most significantly for Earth observations, Norwood pioneered a space-based multispectral scanner, which flew on the first Landsat mission—launched in July 1972—and which continues to influence remote sensing today. Asked about being called the "Mother of Landsat," Norwood replied: "Yes. I like it, and it's apt. I created it, I birthed it, and I fought for it." Photo credit: Virginia Norwood; original story by Laura Rocchio

June 2022

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August 2022

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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4 Independence Day	5	6	7 First Quarter	8	9
10	11	12	13 Full Moon	14	15	16
17	18	19	20 Last Quarter	21	22	23
24 31	25	26	27	28 New Moon	29	30

EXPLORE SCIENCE

OPERATING & FUTURE MISSIONS

HUBBLE
WEBB
XMM-NEWTON*
XRISM*
SPHEREX
IXPE
CHANDRA
NEW HORIZONS
FERMI
NUSTAR
VOYAGER 1
VOYAGER 2
GEHRELS SWIFT
EUCLID*
TESS
ROMAN
SOLAR ORBITER*
SOLAR CRUISER
PARKER SOLAR PROBE
ARIEL*
WIND
THEMIS
MMS
TIMED
AIM
ACE
SUNRISE
GLIDE
HINODE*
GEOTAIL*
ICON
IRIS
EUVST*
GOLD
GDC
EZIE
DRAGONFLY
BEPICOLOMBO*
SDO
SET-1
PUNCH
IMAP
IBEX
SOHO*
STEREO
JUICE*
TRACERS
ENVISION*
PSYCHE
JUNO
DART
DAVINCI
EUROPA CLIPPER
LUCY
VERITAS

NEO SURVEYOR

OSIRIS-REX

MARS ODYSSEY

NEOWISE

TEMPO

GLIMR

MAIA

TROPICS

SWOT

TSIS-2

RAD-SEED

CALIPSO

OCO-2

CLOUDSAT

AURA

ESO-1, 2, 3, 4

AQUA

BION*

LIBERA

PACE

MMX*

MSR SAMPLE RETRIEVAL LANDER

MSR EARTH RETURN ORBITER*

MAVEN

CURIOSITY

MARS EXPRESS*

MRO

ROSALIND FRANKLIN*

ECOSTRESS

EMIT

PERSEVERANCE

TRACE GAS ORBITER*

GEDI

CLARREO-PF

LIS

TSIS-1

INSIGHT

OCO-3

SAGE III

ESCAPADE

APH

CELL BIO

EHD

SENTINEL-6 MICHAEL FREILICH*

RR

MICRO

BECCAL*

SENTINEL-6B*

ACME

SMAP

CAL

CYGNSS

MSRR

PREFIRE

JANUS

LMM

ZBOT-NC

GRACE-FO

SOFIE

THEMIS-ARTEMIS

NICER

VEGGIE

PEREGRINE-1~

HERMES

LANDSAT 9

FBCE

1ST NOVA-C~

LRO

LANDSAT 7, 8

AWE

BLUE GHOST~

NOAA-20*

LUNAR TRAILBLAZER

JPSS-2, 3, 4*

LEIA

DSCOVR*

GRIFFIN-1~ & VIPER

2ND NOVA-C~

GOES-T, U*

BIOEXPT-1

ICESAT-2

XL-1~

GEOCARB

SUOMI NPP*

NISAR

GPM

TERRA

EARTH SCIENCE

HELIOPHYSICS

PLANETARY SCIENCE

ASTROPHYSICS

BIOLOGICAL & PHYSICAL

Future launches in bold

* Partner-led

~ Delivery contract for NASA instrument/payloads

science.nasa.gov/missions

SEPTEMBER 2021

2022 YEAR AT A GLANCE

January

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February

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March

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June

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July

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August

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September

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October

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16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

November

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December

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25	26	27	28	29	30	31

August 2022

A Menagerie of Galaxies (ACO S 295). This Hubble Space Telescope image showcases the galaxy cluster ACO S 295, as well as a jostling crowd of background galaxies and foreground stars. Galaxies of all shapes and sizes populate this image, ranging from stately spirals to fuzzy ellipticals. As well as a range of sizes, this galactic menagerie boasts a range of orientations, with spiral galaxies such as the one at the center of this image appearing almost face on, and some edge-on spiral galaxies visible only as thin slivers of light. The cluster dominates the center of this image, both visually and physically. It is now believed that most galaxies have a black hole at their center. The huge mass of the galaxy cluster has gravitationally lensed the background galaxies, distorting and smearing their shapes. As well as providing astronomers with a natural magnifying glass with which to study distant galaxies, gravitational lensing has subtly framed the center of this image, producing a visually striking scene. **Image and text credit:** European Space Agency (ESA)/Hubble & NASA, F. Pacaud, D. Coe

https://esahubble.org/images/potw2120a

Born in 1965, **Dr. Andrea Ghez** is a Nobel Prize–winning American astrophysicist whose research focuses on the center of the Milky Way galaxy. She was elected to the National Academy of Sciences, American Philosophical Society, and Fellow of the American Physical Society. She has received several prestigious awards, including the MacArthur Fellowship, the Sackler Prize, and the Newton Lacy Pierce Prize. She has appeared in television documentaries produced by prominent networks, including an episode on the PBS show *Nova*. She is a role model to young women and was identified as a Science Hero by the My Hero Project. Photo credit: Andrea Ghez

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5 First Quarter	6
7	8	9	10	11	12 Full Moon	13
14	15	16	17	18	19 Last Quarter	20
21	22	23	24	25	26	27 New Moon
28	29	30	31			

July 2022

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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September 2022

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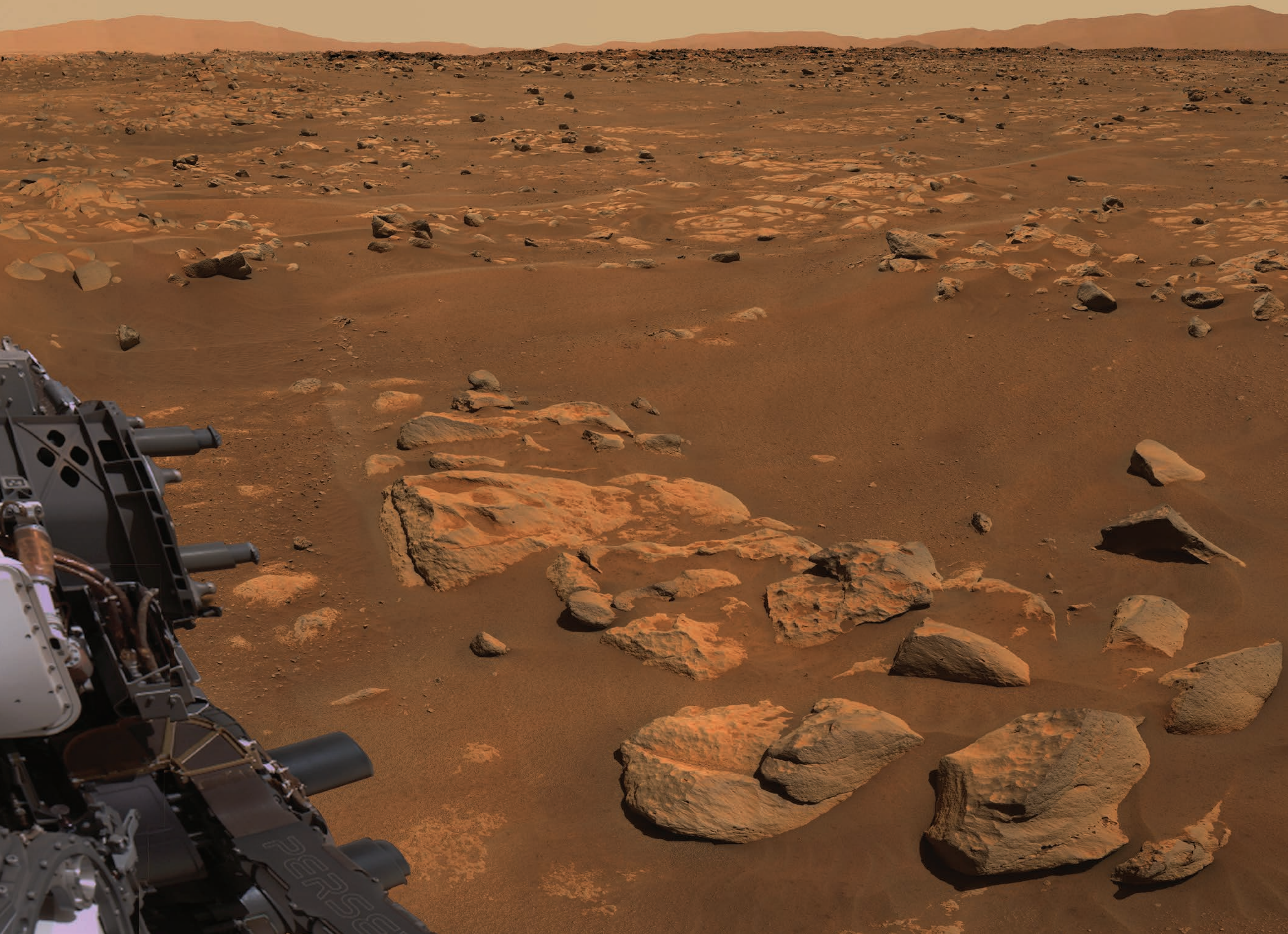
18	19	20	21	22	23	24
25	26	27	28	29	30	



September 2022

Mastcam-Z's 360-Degree View of "Van Zyl Overlook." NASA's Perseverance Mars rover used its Mastcam-Z stereo imaging system to capture a 360-degree panorama at "Van Zyl Overlook," where the rover was parked for 13 days as the Ingenuity helicopter performed its first flight. A portion of the panorama is shown above. The 2.4-billion-pixel panorama is made up of 992 individual right-eye Mastcam-Z images stitched together. The images were taken between April 15 and 26, 2021, or the 53rd and 64th Martian days, or sols, of the mission. Included in this view is the rover as seen by its navigation cameras on March 20, 2021, the 31st sol of the mission. Perseverance will characterize the planet's geology and past climate, pave the way for human exploration of the Red Planet, and be the first mission to collect and cache Martian rock and regolith (broken rock and dust). **Image and text credit:** NASA/JPL-Caltech/Arizona State University/Malin Space Science Systems

https://mars.nasa.gov/resources/25962/mastcam-zs-360-degree-view-of-van-zyl-overlook

Dr. Jakob van Zyl (1957–2020) served for 33 years at NASA's Jet Propulsion Laboratory (JPL), where he was the director for Solar System Exploration from 2016 to 2019. He was born in Namibia and was an inspiring mentor to many engineers and scientists at JPL and from his native home. His specialty was synthetic-aperture radar (SAR), and he made many contributions to the design of SAR systems such as SIR-C, SRTM, AIRSAR, TOPSAR, and GeoSAR. NASA's Ingenuity Mars Helicopter landing site was named "Van Zyl Overlook" in memory of his contributions to robotic exploration and the Ingenuity project itself. Photo credit: NASA

August 2022

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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

October 2022

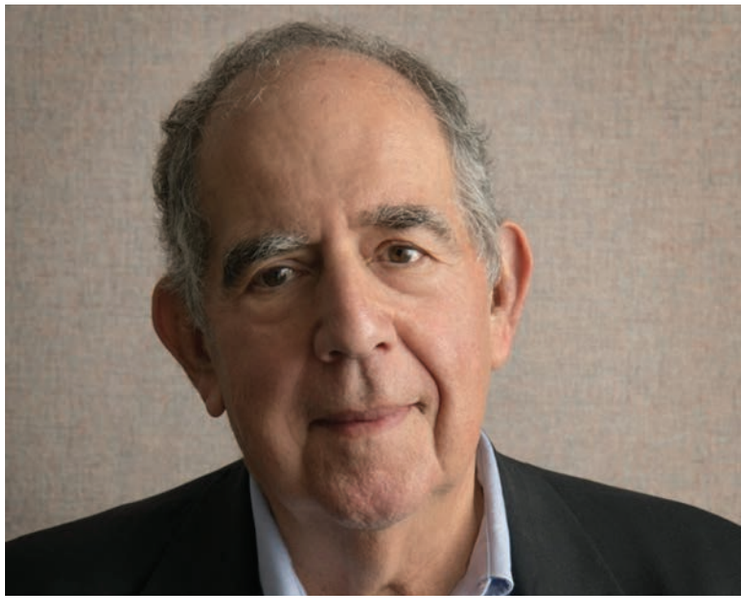
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3 First Quarter
4	5 Labor Day	6	7	8	9	10 Full Moon
11	12	13	14	15	16	17 Last Quarter Constitution Day
18	19	20	21	22	23	24
25 New Moon	26	27	28	29	30	

October 2022

Something Out There Is Watching You. Do you ever look up at the night sky and feel like someone, or something, may be looking back at you? This Halloween image from NASA's Spitzer Space Telescope may convince you that you are right! But don't expect to see these cosmic eyes without a face if you search the night sky with your own binoculars or telescope, as they are completely cloaked from view in visible light. They can only be found by telescopes that can see infrared light. Lurking in the constellation of Aquila (Latin for eagle), these celestial eyeballs are actually vast bubbles of dust and gas associated with the formation of new stars. Spitzer found that our Milky Way galaxy is full of these dusty bubbles. Contributions from nearly 80,000 citizen scientists have helped catalog 2,600 such objects. The two "eyes" shown here have the lengthy designations MWP1G043734+001170 and MWP1G043775+000606, or N89 and N90 for short. Do these star-forming bubbles give the creepy impression that they are staring back? **Image and text credit:** NASA/JPL-Caltech

http://legacy.spitzer.caltech.edu/images/6837-ssc2020-17a-Something-Out-There-Is-Watching-You



Born in 1942, **Dr. Michael Werner** is an infrared astronomer who studies star formation, the interstellar medium, exoplanets, and the central regions of the Milky Way galaxy. He was one of the leaders of the development of NASA's Spitzer Space Telescope and its project scientist from 1984 until it retired in 2020. The Royal Astronomical Society named him the George Darwin lecturer in recognition of the success of the Spitzer mission. Werner received two NASA Outstanding Leadership Medals and the NASA Distinguished Public Service Medal. Werner is both a senior research scientist and a Jet Propulsion Laboratory (JPL) Fellow. Photo credit: Michael Werner

September 2022

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4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

November 2022

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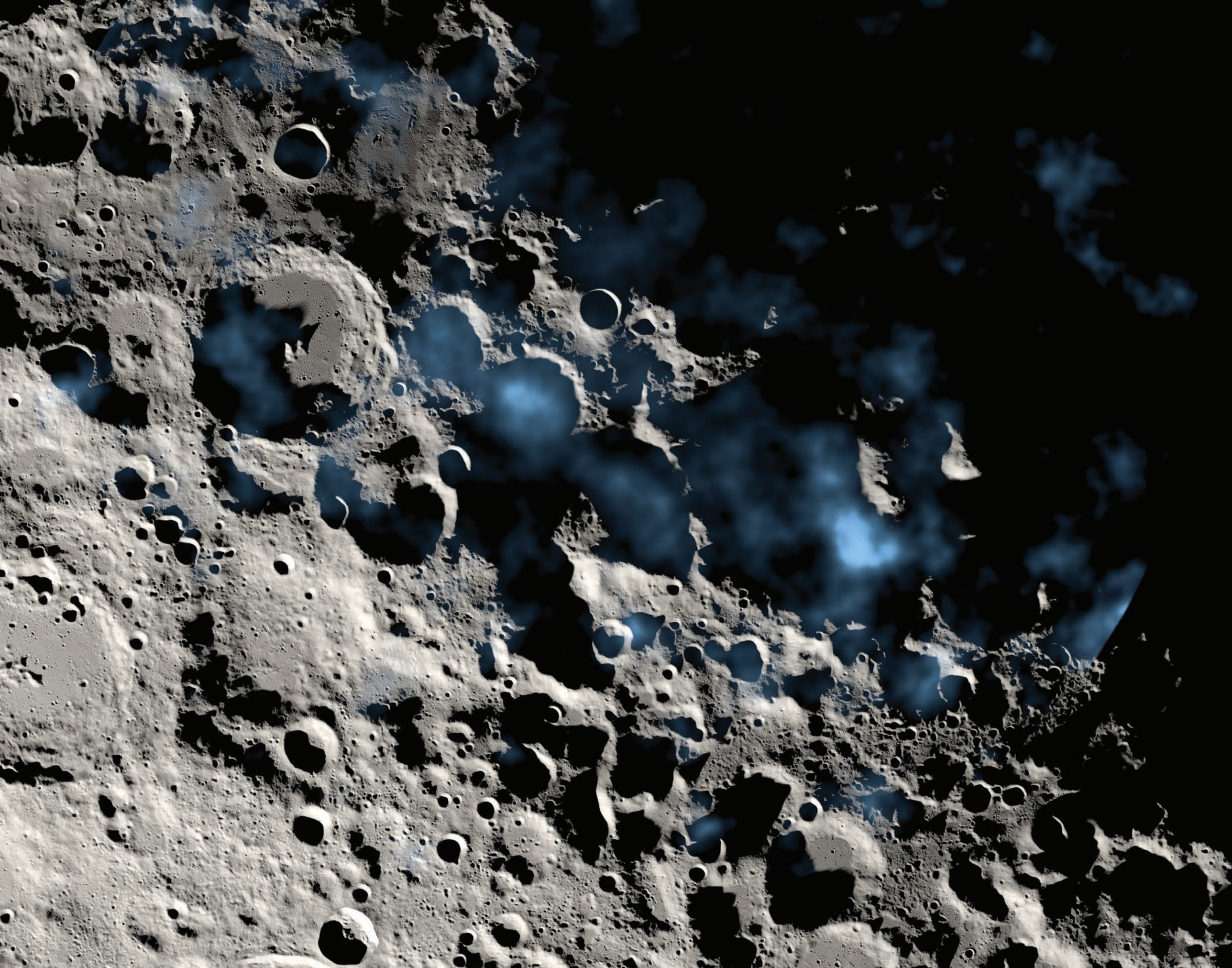
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

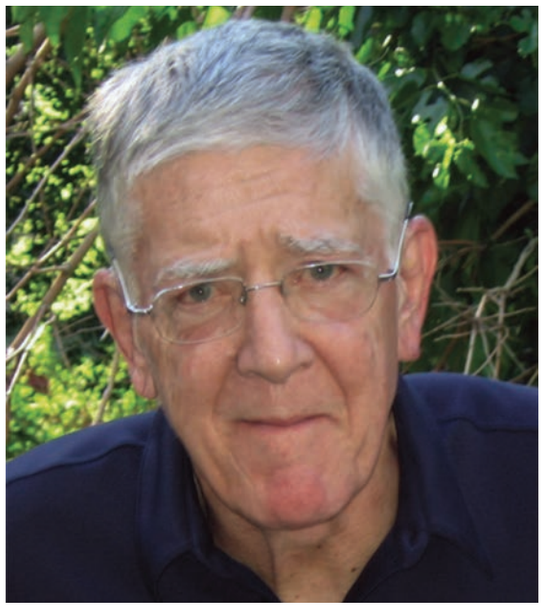
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3 First Quarter	4	5	6	7	8
9 Full Moon	10 Columbus Day	11	12	13	14	15
16	17 Last Quarter	18	19	20	21	22
23 30	24 31	25 New Moon	26	27	28	29



November 2022

Water on the Moon. Looking down on the Moon's South Pole, you notice there are areas that never see the Sun. These permanently shadowed areas have some of the coldest surfaces in our solar system, and it is believed that they harbor resources to sustain human exploration—including water ice. Under NASA's Artemis program, the agency is eager to learn all it can about the presence of water on the Moon in advance of sending the first woman and first person of color to the lunar surface in 2024 and establishing a sustainable human presence there by the end of the decade. The Lunar Exploration Neutron Detector (LEND) aboard the Lunar Reconnaissance Orbiter (LRO) has found signs of water (seen here in blues) in places that have surprised scientists, suggesting that the distribution of water is not limited to areas that are very cold and never see the Sun. Indeed, other instruments have observed the Moon and have found water in varying abundances across nearly the entire lunar surface. In advance of the next human mission to the lunar surface, NASA will send several small satellites on Artemis I, including Lunar Flashlight, Lunar IceCube, and Lunar Polar Hydrogen Mapper (LunaH-Map), that are dedicated to investigating these water ice–bearing regions from lunar orbit. NASA will also send the Volatiles Investigating Polar Exploration Rover (VIPER) to search for surface water ice near the lunar South Pole, which will help scientists understand the water's origin, how it is distributed, and if it can be harvested to sustain humans during future crewed Artemis missions. **Image credit:** Ernie Wright, NASA's Scientific Visualization Studio

https://svs.gsfc.nasa.gov/4057#31415



Dr. Roger Jay Phillips (1940–2020) attended graduate school at the University of California, Berkeley, and worked at NASA's Jet Propulsion Laboratory (JPL) as the team leader for the Apollo 17 Lunar Sounder Experiment. Following this work, he became the director of the Lunar and Planetary Institute. He then served as the director of the McDonnell Center at the Washington University in St. Louis from 1999 to 2007. His body of work deepened our understanding of geophysical topics such as plate tectonics and crustal dynamics. He studied the evolution of the massive Martian Tharsis volcanic unit, which includes Olympus Mons, and also published groundbreaking work studying the geological evolution of Venus using radar data from the Magellan mission. He was a much-loved mentor to many Ph.D. students who now carry on his legacy in planetary science. Photo credit: Jan Foster, Washington University, St. Louis

October 2022

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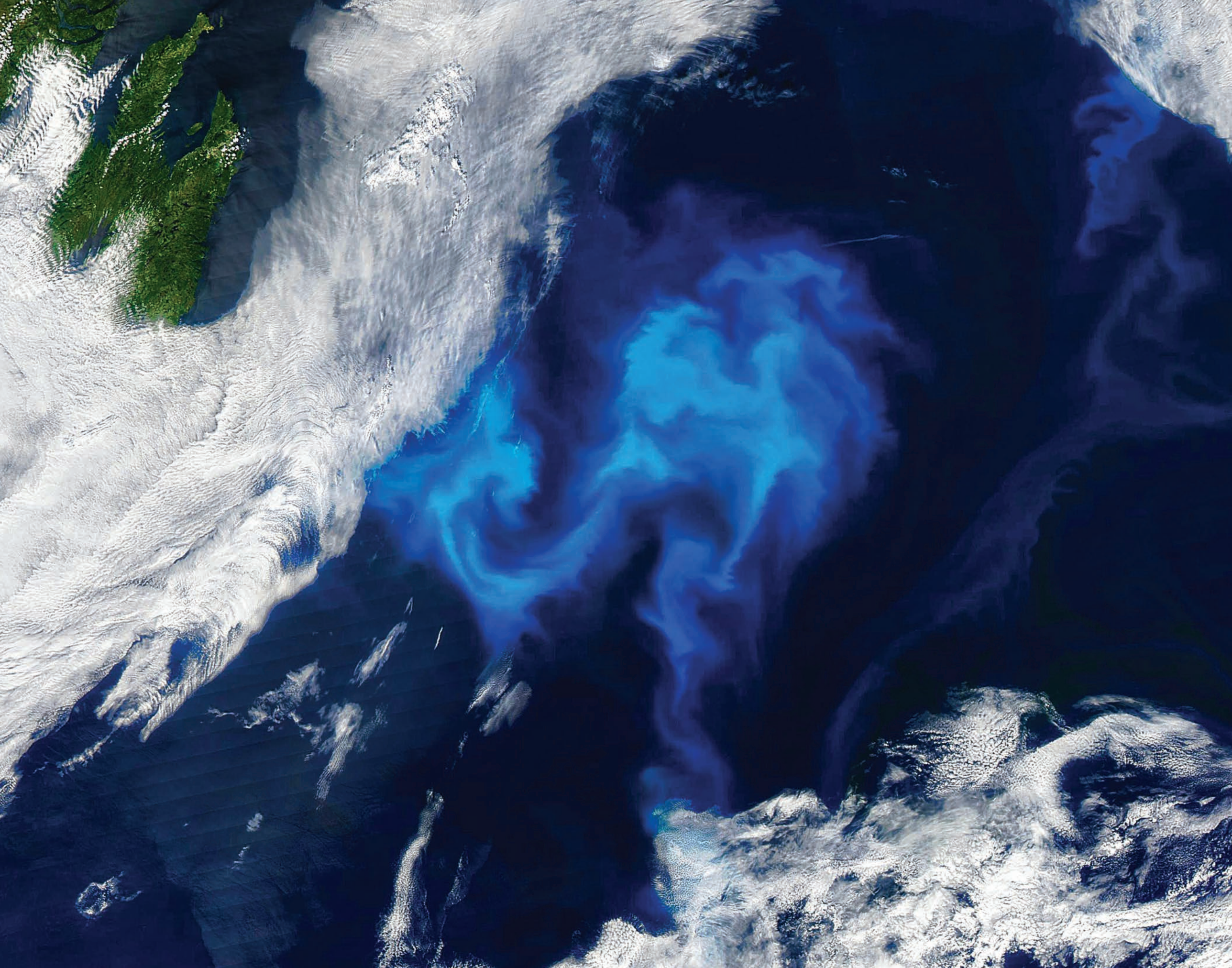
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

December 2022

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 First Quarter	2	3	4	5
6 Daylight Saving Time Ends	7	8 Full Moon Election Day	9	10	11 Veterans Day	12
13	14	15	16 Last Quarter	17	18	19
20	21	22	23 New Moon	24 Thanksgiving Day	25	26
27	28	29	30 First Quarter			



December 2022

Persistent Phytoplankton. An unusually long-lived phytoplankton bloom was observed off the coast of Newfoundland, Canada, from July through September 2020 by NASA's Terra and Aqua satellites. The bloom was dominated by coccolithophores—microscopic, floating plant-like organisms with chalky outer shells that give water a milky blue color. To get a sense of their abundance, each of the individual cells in the bloom is about 5 microns in diameter, or about 1,000 times smaller than a grain of sand. Such blooms are dependent on the right balance of sunlight, nutrients, water temperature, and salinity, making the 7-week bloom in 2020 atypical compared to the more common bloom time of 2–3 weeks. **Image and text credit:** NASA Earth Observatory image by Joshua Stevens, using Moderate Resolution Imaging Spectroradiometer (MODIS) data from NASA Earth Observing System Data and Information System (EOSDIS)/Land, Atmosphere Near real-time Capability for EOS (LANCE) and Global Imagery Browse Services (GIBS)/Worldview; original story by Michael Carlowicz

https://earthobservatory.nasa.gov/images/147299/persistent-phytoplankton

Born in 1955, **Dr. Joseph S. Francisco** was raised by his grandmother, who pushed him to get an education—and he did, graduating with honors from the University of Texas at Austin. He went on to earn a Ph.D. in chemical physics from the Massachusetts Institute of Technology (MIT), followed by the University of Cambridge and MIT for postdoctoral research, and then to the California Institute of Technology as a visiting associate. Francisco's work has contributed significantly to understanding atmospheric chemistry, including the causes of acid rain. Among his many professional affiliations, Francisco was the second African American elected president of the American Chemical Society, and he is a member of the U.S. National Academy of Sciences. Currently, he is the President's Distinguished Professor of Earth and Environmental Science and professor of chemistry at the University of Pennsylvania. Francisco has received significant recognition in the United States and internationally, including appointment to the National Medal of Science Committee for President Obama. Photo credit: Mark Simons, Senior Photographer, Purdue Marketing and Media

November 2022

S	M	T	W	T	F	S
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20	21	22	23	24	25	26
27	28	29	30			

January 2023

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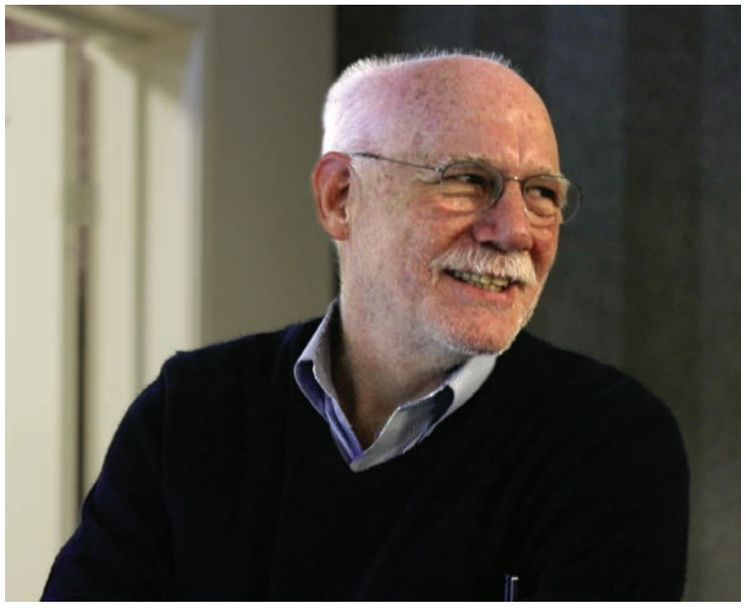
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6	7	8 Full Moon	9	10
11	12	13	14	15	16 Last Quarter	17
18	19	20	21	22	23 New Moon	24
25	26 Christmas Day (observed date)	27	28	29	30 First Quarter	31

January 2023

NASA Mission Seeks To Understand Bright Night-Shining Clouds by Creating One. Since the late 1800s, observers have searched the polar skies for elusive, high-flying clouds that shine in the darkness. These polar mesospheric clouds (PMCs) are wispy swarms of ice crystals that form in the late spring and summer over the North and South Poles. The photo above shows a time lapse of the Super Soaker sounding rocket launch in the early morning hours of January 26, 2018, from Poker Flat Research Range in Fairbanks, Alaska. Three rockets launched with the mission, two using vapor tracers to track wind movement and one releasing a water canister to seed a PMC. The green laser beam visible at the top left is the laser radar beam used to measure the artificial cloud, seen in the upper right of the photo. This cloud of trimethyl aluminum produces the harmless products of aluminum oxide, carbon dioxide, and water vapor as well as a bluish white glow that researchers can use to track upper atmospheric winds. **Photo and text credit:** NASA's Wallops Flight Facility/Poker Flat Research Range/Zayn Roohi

https://www.nasa.gov/feature/goddard/2021/nasa-mission-seeks-to-understand-bright-night-shining-clouds-by-creating-one



Born in 1953, **Dr. Robert F. Pfaff**, **Jr.** is a space scientist in the Ionosphere, Thermosphere, Mesosphere Physics Laboratory in the Heliophysics Division of NASA's Goddard Space Flight Center (GSFC). Since 1985, he has been the leader of the Electric Field Investigation Team at GSFC, providing state-of-the-art in situ experiments for use on both satellites and sounding rockets. Within NASA's sounding rocket program, Pfaff has provided electric field, magnetic field, and plasma density measurements for more than 50 sounding rocket missions. Photo credit: NASA/Joy Ng

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2 New Year's Day (observed date)	3	4	5	6 Full Moon	7
8	9	10	11	12	13	14
15 Last Quarter	16 Birthday of Martin Luther King, Jr. (observed date)	17	18	19	20	21 New Moon
22	23	24	25	26	27	28 First Quarter
29	30	31				

December 2022

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
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18	19	20	21	22	23	24
25	26	27	28	29	30	31

February 2023

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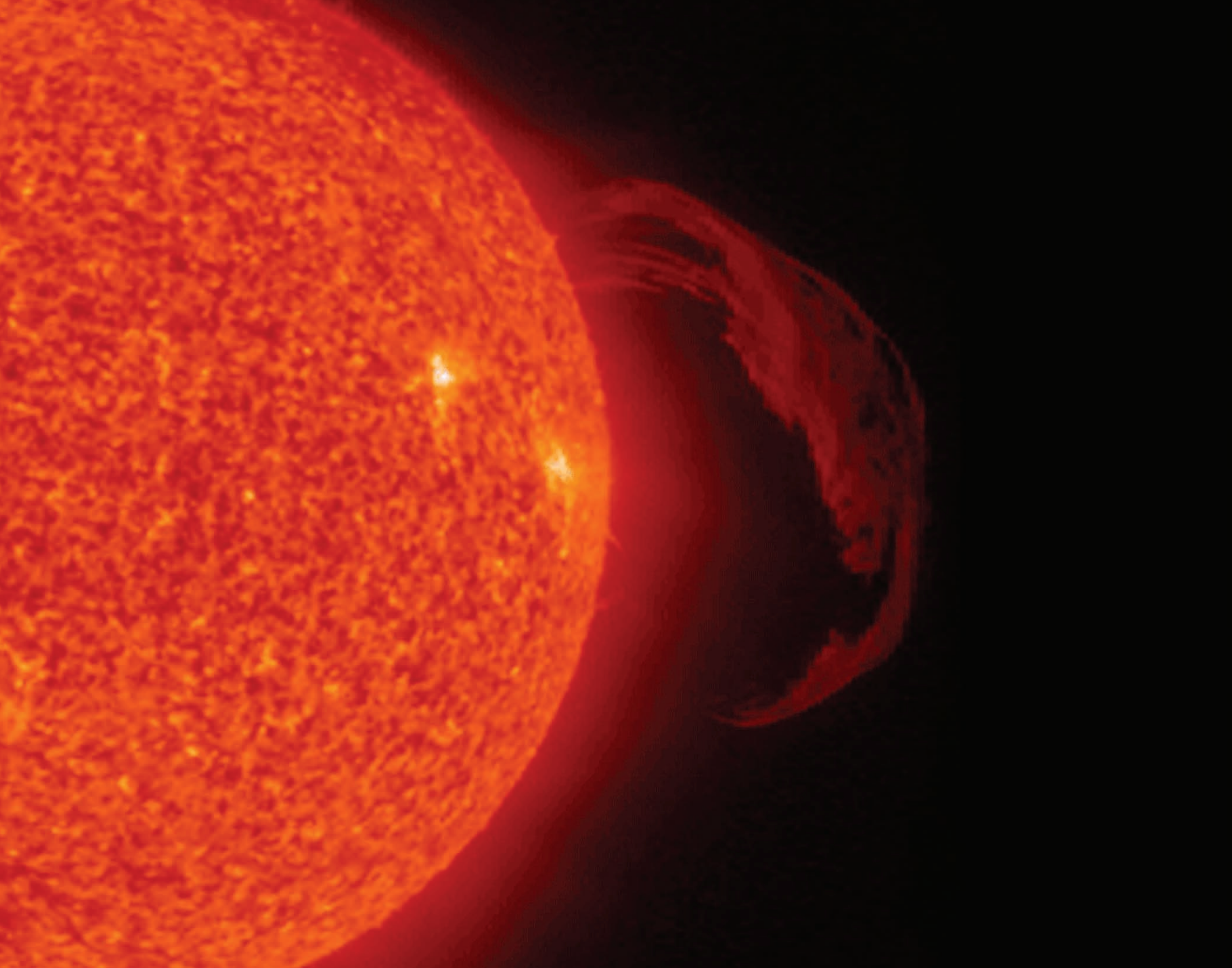
19	20	21	22	23	24	25
26	27	28				



February 2023

GOES West Views an Eruption on the Sun's Surface. The National Oceanic and Atmospheric Administration (NOAA)'s Geostationary Operational Environmental Satellite (GOES) West saw a solar prominence, a type of eruption, take place on the Sun's surface on March 30–31, 2021. This event was captured by the satellite's Solar Ultraviolet Imager (SUVI) instrument, a telescope that collects imagery of the Sun in six different wavelengths. By observing these different wavelengths, SUVI gives a more complete picture of the Sun's atmosphere. This particular image shows the 304-angstrom wavelength, which observes plasma, or ionized gas, in the Sun's atmosphere at about 90,000 degrees Fahrenheit. This event was not directed toward Earth. But when events like this travel toward Earth, NOAA's Space Weather Prediction Center uses SUVI and other data to produce space weather forecasts to predict the impact they can have. More disruptive events are far more likely to occur near solar activity maximums than during minimums. The most recent minimum occurred in December 2019, with the maximum expected around 2025. **Image and text credit:** NOAA

https://www.nesdis.noaa.gov/content/goes-west-views-solar-eruption-suns-surface

Born in 1954, **Dr. Delores Knipp** is a research professor in the Smead Aerospace Engineering Sciences Department at the University of Colorado Boulder. She studies space-atmosphere interaction regions where energy from solar and geospace storms tends to concentrate. Specifically, her research focuses on the space environment and the atmospheric and solar events that disturb it. She also studies historical space weather events to understand the impacts these events have had on society and the United States military. Searching old datasets to reveal new physical insights is her avocation. She is a retired United States Air Force Officer, former editor-in-chief of the American Geophysical Union's *Space Weather Journal*, and a Fellow of the American Meteorological Society. Photo credit: Delores Knipp

January 2023

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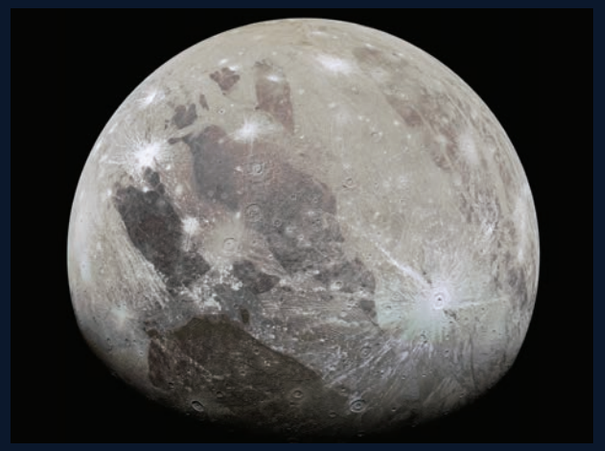
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

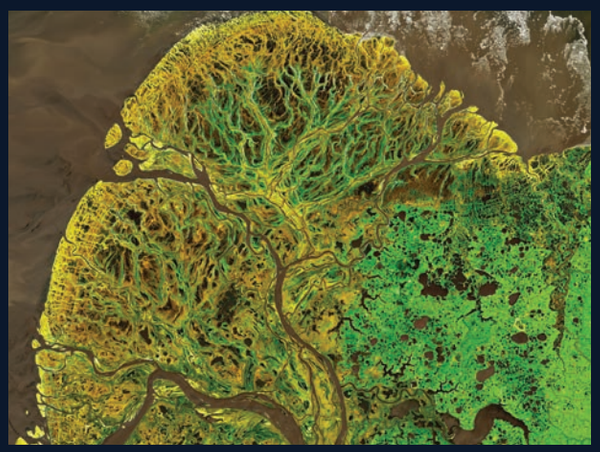
March 2023

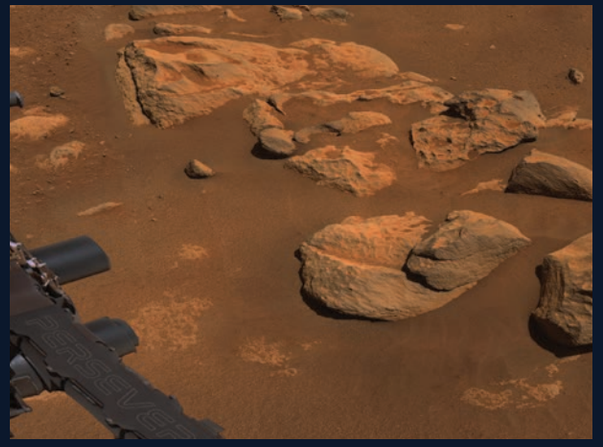
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

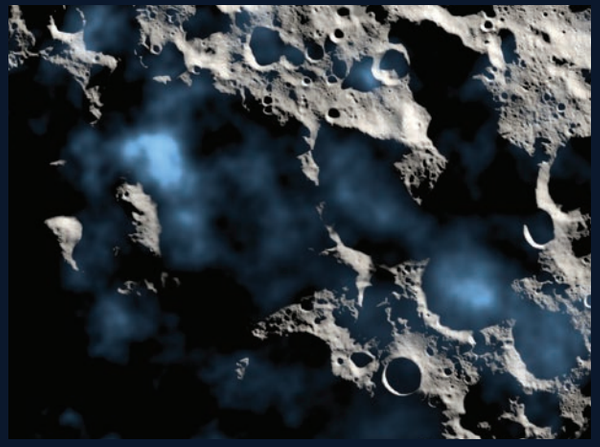
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5 Full Moon	6	7	8	9	10	11
12	13 Last Quarter	14	15	16	17	18
19	20 New Moon Washington's Birthday (observed date)	21	22	23	24	25
26	27 First Quarter	28				

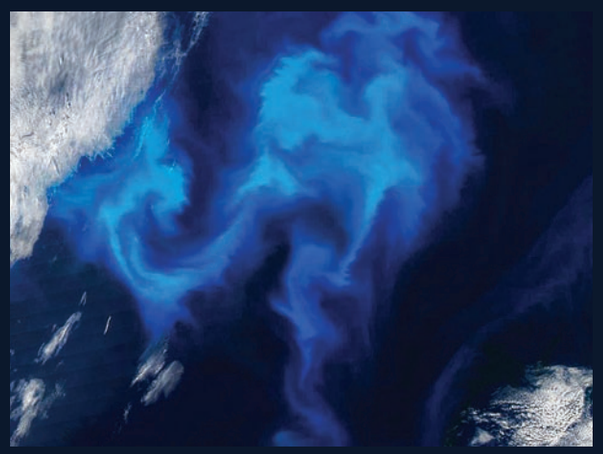
National Aeronautics and
Space Administration

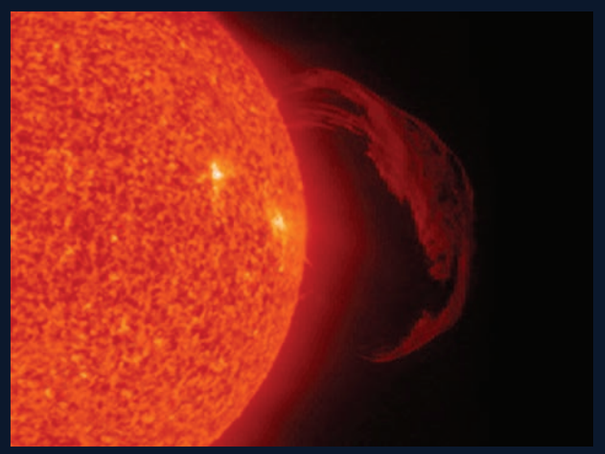












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