Galactic Observer

John J. McCarthy Observatory

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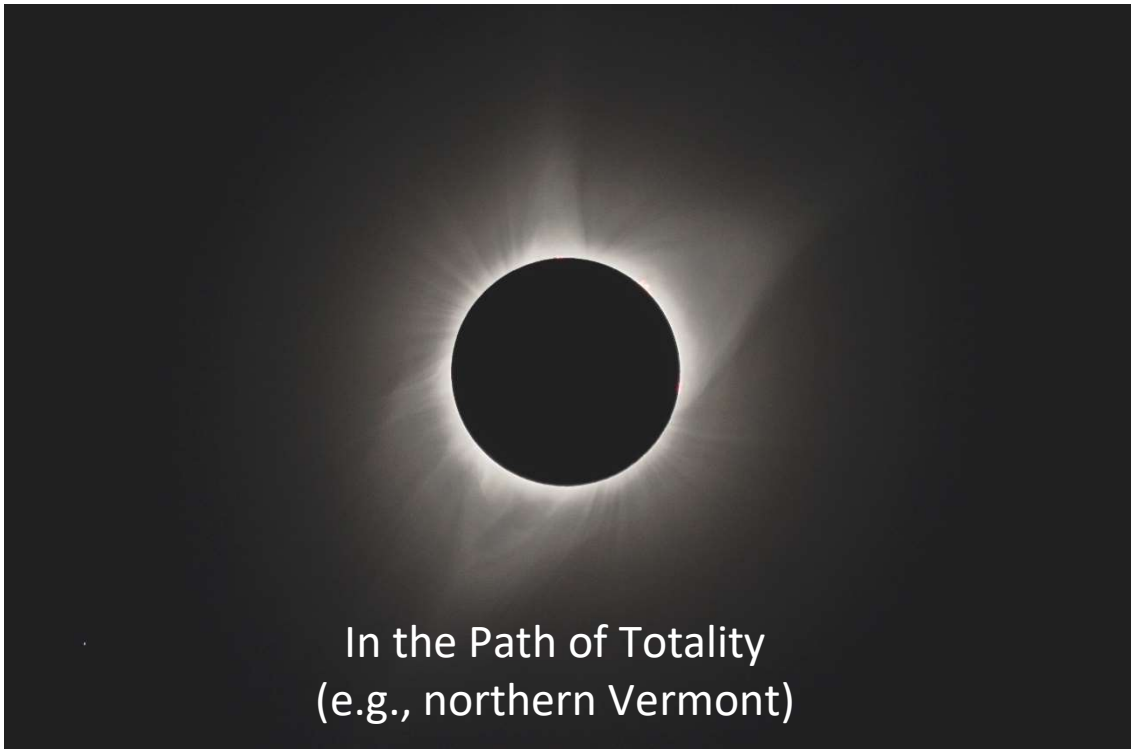
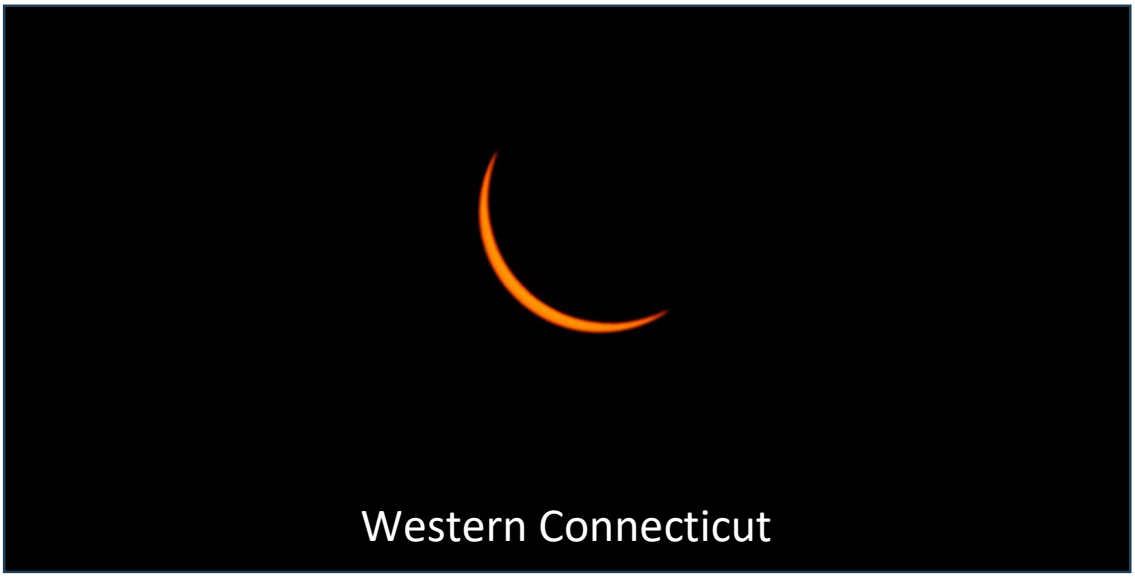
Sun Safety

On April 8th a Total Solar Eclipse will be visible along a narrow track stretching from Texas to Maine. More than 30 million people live within the path of totality and millions more are expected to travel to view it. However, when the Sun is partially covered by the Moon, the use of protective eyewear is essential to avoid serious injury (retina burns and/or blindness). Have fun, but be safe!

Photo: Bill Cloutier

April Astronomy Calendar and Space Exploration Almanac



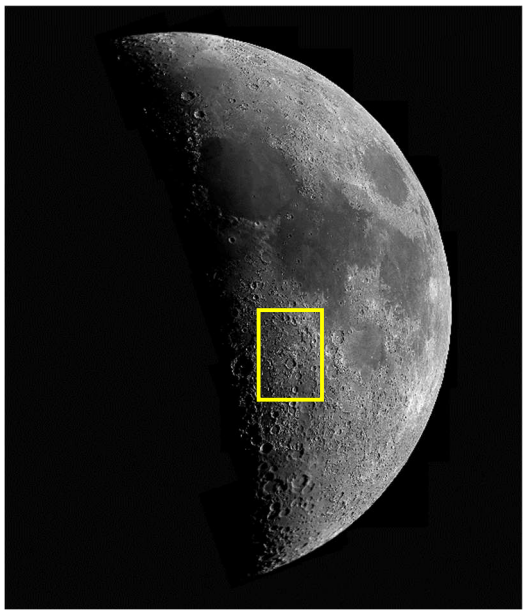


A total eclipse of the Sun is only visible within the narrow track along which the Moon's shadow traverses the Earth as the planet rotates. On April 8th, the centerline of totality passes through upper New York State (including the cities of Buffalo, Rochester and Watertown) before crossing into northern Vermont (Burlington) and Maine (Baxter State Park). Western Connecticut will experience a partial eclipse with a maximum of about 92% of the Sun obscured. Photos: Bill Cloutier

In This Issue

"Out the Window on Your Left"

It's been more than 51 years since Gene Cernan left the last bootprint on the Moon's surface. As a nation founded on exploration and the conquest of new frontiers, today's commitment to return to the Moon has been as fleeting as the funding. But what if the average citizen had the means to visit our only natural satellite; what would they see out the window of their spacecraft as they entered orbit around the Moon? This column may provide some thoughts to ponder when planning your visit (if only in your imagination).



Central lunar highlands and location of the Apollo 16 landing

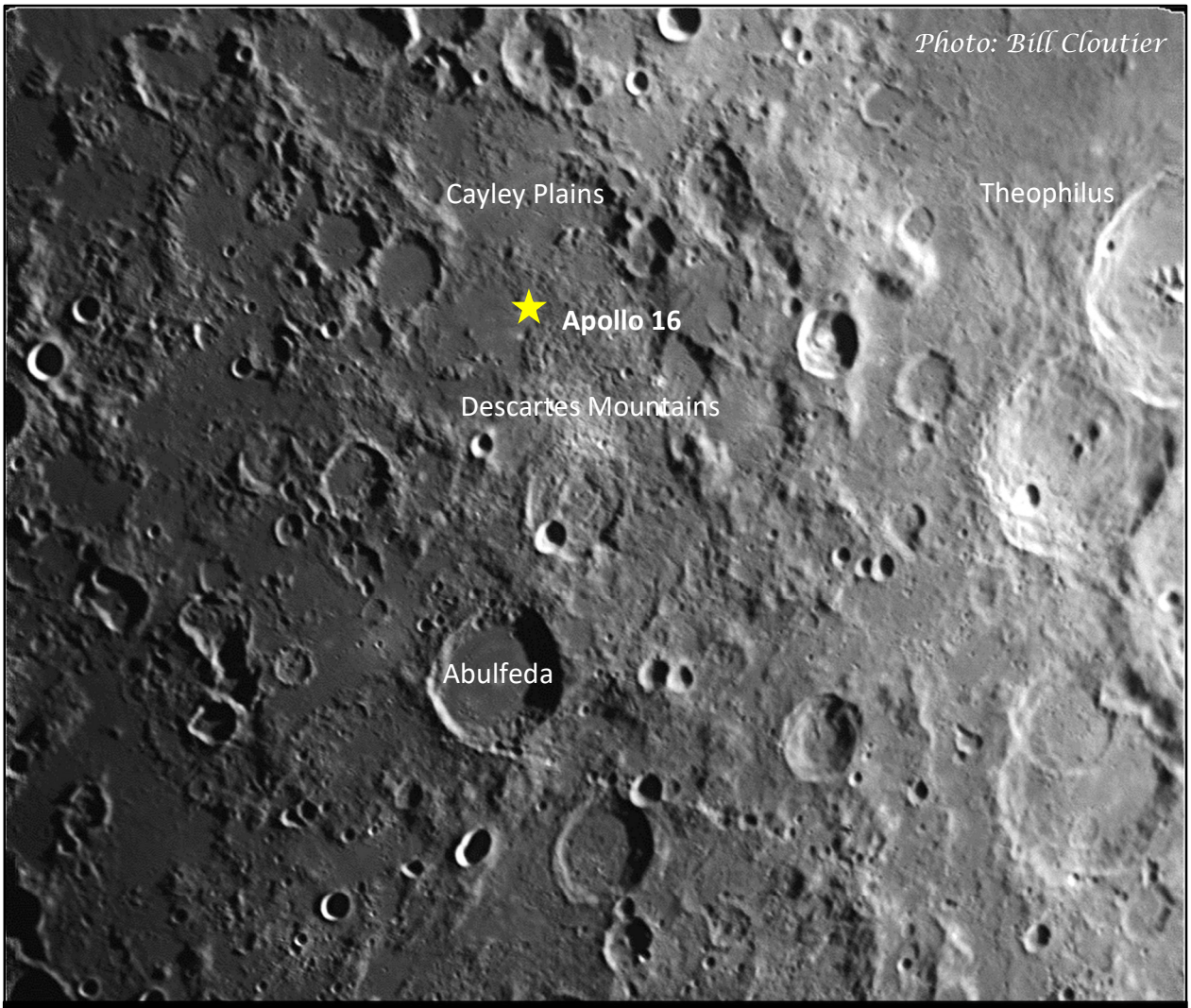
On April 20, 1972, Commander John Young set the Apollo 16 lunar module (named Orion) down between two geologic units – the Cayley Plains and the Descartes Mountains, in the central lunar highlands. Apollo 16 was the second J-type mission, characterized by larger scientific payloads, extended surface times, and longer excursions with the lunar rover. During their stay, John Young put the battery-powered rover through its paces in a "Grand Prix" exercise - consisting of a series of S-turns, hairpin turns and hard stops.

Young and Charlie Duke spent over 20 hours on the surface, collecting approximately 212 pounds (96 kg) of rock and soil samples. Although geologists had expected the region to be covered by volcanic material, almost all of the rock samples collected by the astronauts turned out to be breccias (broken fragments of rock that have been cemented together into a matrix). The samples also contained bits of anorthosite (including two of the largest returned by the Apollo missions). Anorthosite crystallized in the magma ocean that covered the Moon shortly after its accretion almost 4.5 billion years ago, forming the bulk of the early lunar crust.

The breccias that covered the landing area likely came from the nearby impact basins. While Nectaris is the closest large impact basin (less than 125 miles or 200 km from the landing site), the samples also included what is believed to be material from the much further but larger Imbrium basin, 620 miles or 1,000 km away. The samples allowed scientists to date the Nectaris impact basin-forming event at 3.92 billion years ago. Bits of basalt, that formed 3.79 billion years ago and that were interspersed with the breccias, likely originated from the mare that overlies the Nectaris impact basin. The basalt was likely ejected by a mare impact, for example, the one that created the 60-mile-diameter (100 km) crater, lying 150 miles (250 km) to the east of the landing site.

Apollo 16 also released a small satellite into lunar orbit from the service module. It was intended to complement a similar satellite released by Apollo 15 eight months earlier. However, unlike the Apollo 15 satellite, which maintained a stable orbit, the orbit of the Apollo 16 satellite decayed rapidly, crashing into the lunar surface after just 35 days. It was later determined that the inclination of the Apollo 16 satellite's orbit was unstable due to mass concentrations (or mascons) hidden beneath the lunar surface.

Descartes Highlands



John Young putting the Apollo 16 electrical-powered rover through its paces
Credit: Charlie Duke and NASA

Solar Eclipse 2024

On April 8th, residents of North America will be treated to a total solar eclipse as the Moon passes directly between the Sun and the Earth. Within a narrow track (approximately 115 miles or 185 km wide) from Texas to Maine, the Moon will completely cover the Sun for up to 4 minutes and 27 seconds (a phase called "Totality"). The longest duration will be in Texas with totality in Maine almost a minute less.

Outside that path, the Moon will only cover a fraction of the Sun (Partial Eclipse) – its coverage will depend upon your distance from the track's centerline. If you are planning to travel to view Totality, state maps and historical forecasts can be found at https://eclipsophile.com/2024tse/. It is only when the Sun is completely covered by the Moon that its ghostly atmosphere, the corona, is visible to Earth-bound observers.

If you are staying in the western Connecticut area, approximately 92% of the Moon will be covered or obscured at mid-eclipse.

Start of the Partial Eclipse in Western Connecticut (EDT):	2:12 pm
Maximum Eclipse (92% Obscuration):	3:27 pm
End of Partial Eclipse in Western Connecticut:	4:37 pm

Solar eclipses occur when the New Moon passes in front of the Sun in its orbit around the Earth. Eclipses only occur every six months or so, as the Moon's orbit is inclined about 5° from the plane of the Earth's orbit around the Sun. Because of the inclination, the New Moon passes either above or below the Sun in Earth's sky during most monthly orbits.

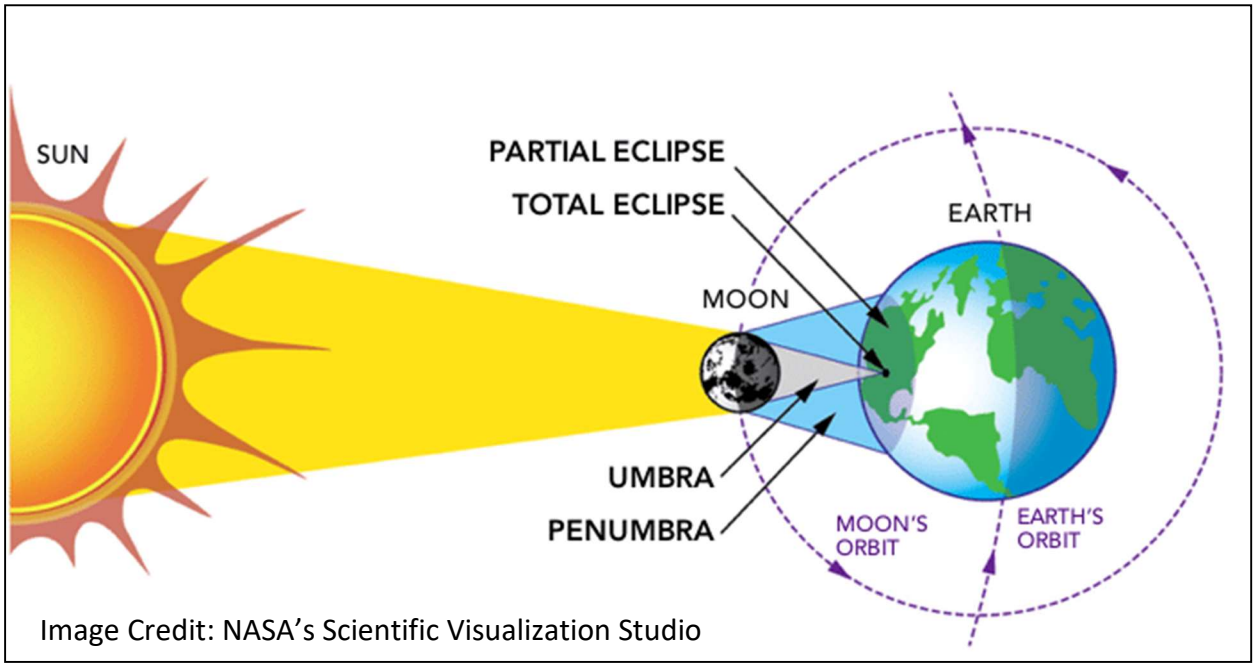
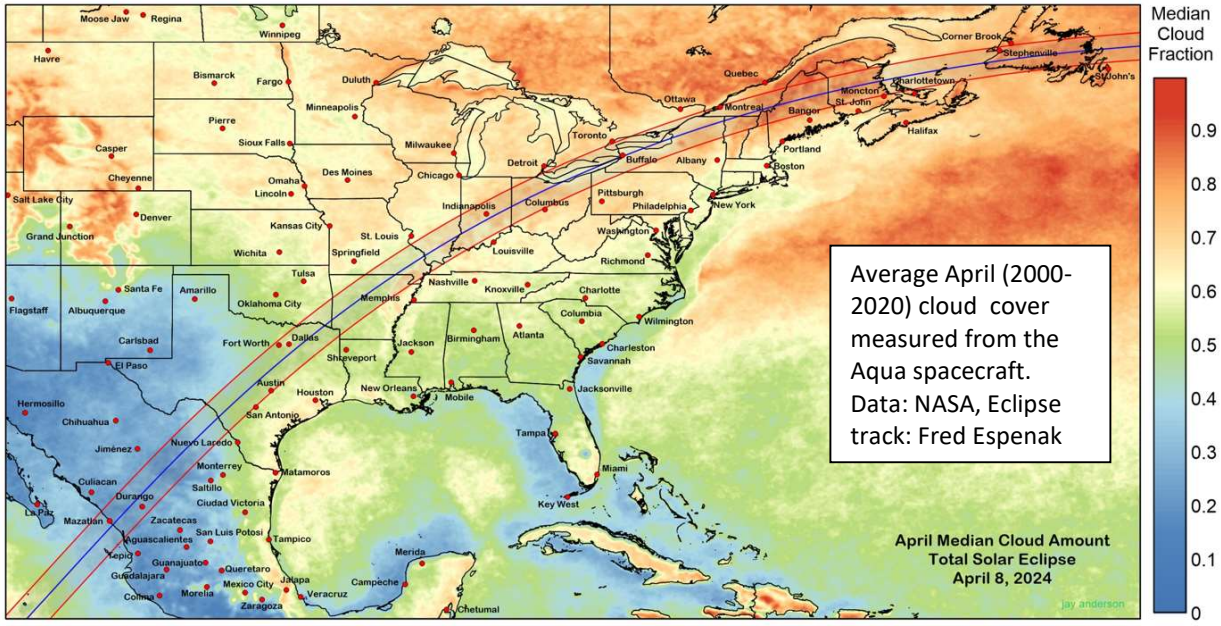


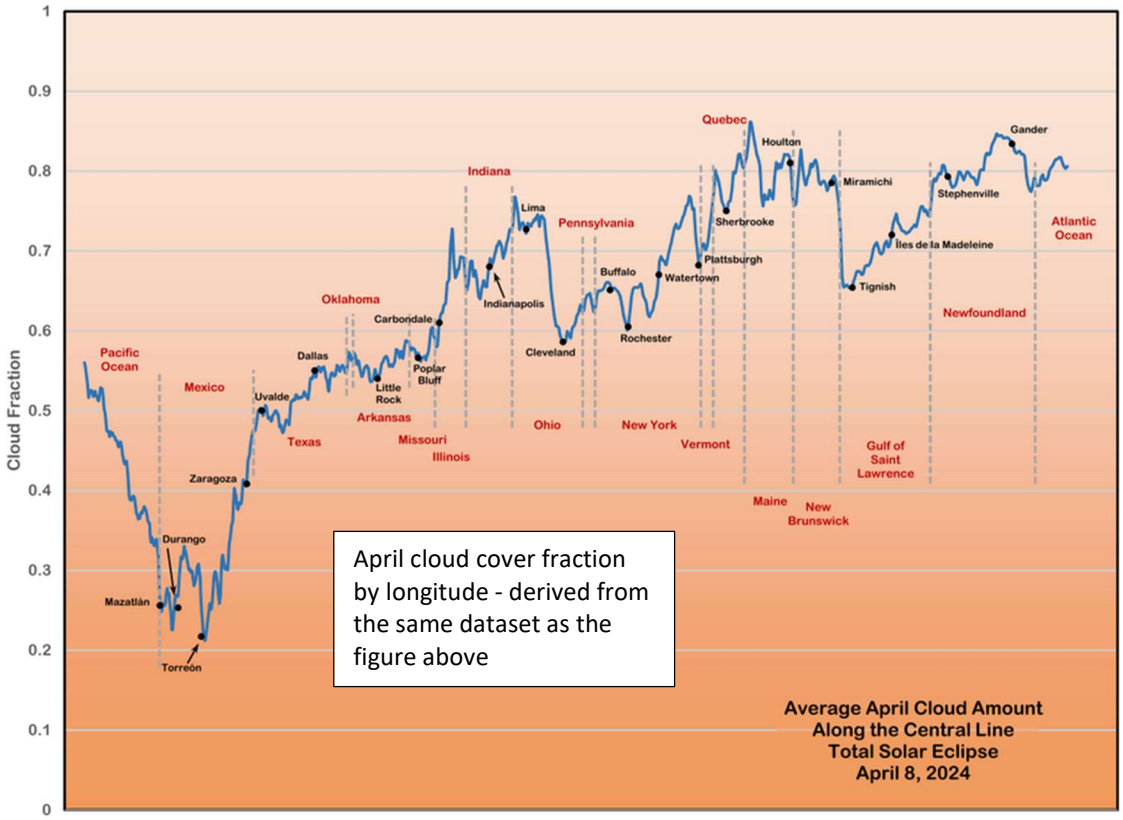
Image Credit: NASA's Scientific Visualization Studio

Since a fully eclipsed Sun is only visible along a narrow path, it may be a hundred years or more before such an occurrence is visible from the exact same location again. The next opportunities to experience a total solar eclipse over the United States will be in 2044 (in North Dakota and Montana) and in 2045 (as it crosses from California to Florida).

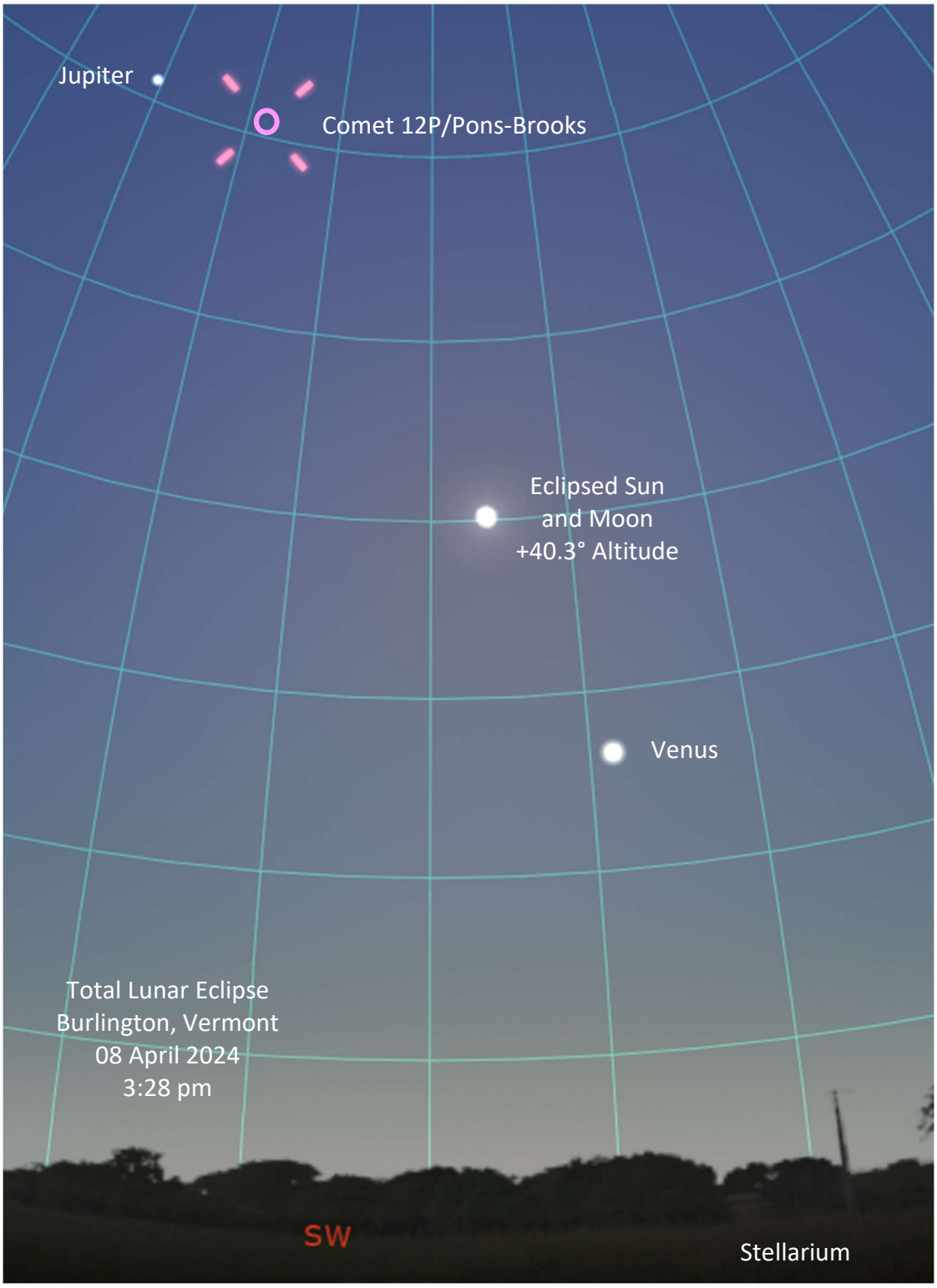
Weather Outlook for April 8th

Viewing totality (those three to four minutes when the Moon completely covers the Sun) will require the observer to be in the right location and a bit of luck with the weather. Totality begins on the Mexican coast, with the Moon's umbra crossing into Texas around 1:27 pm CDT. The eclipse track will pass through parts of 15 U.S. states before exiting Maine at 3:35 p.m. EDT. Statistically, there is a greater chance of cloudy skies for the northeastern half of the United States, with the best weather prospects in the south.



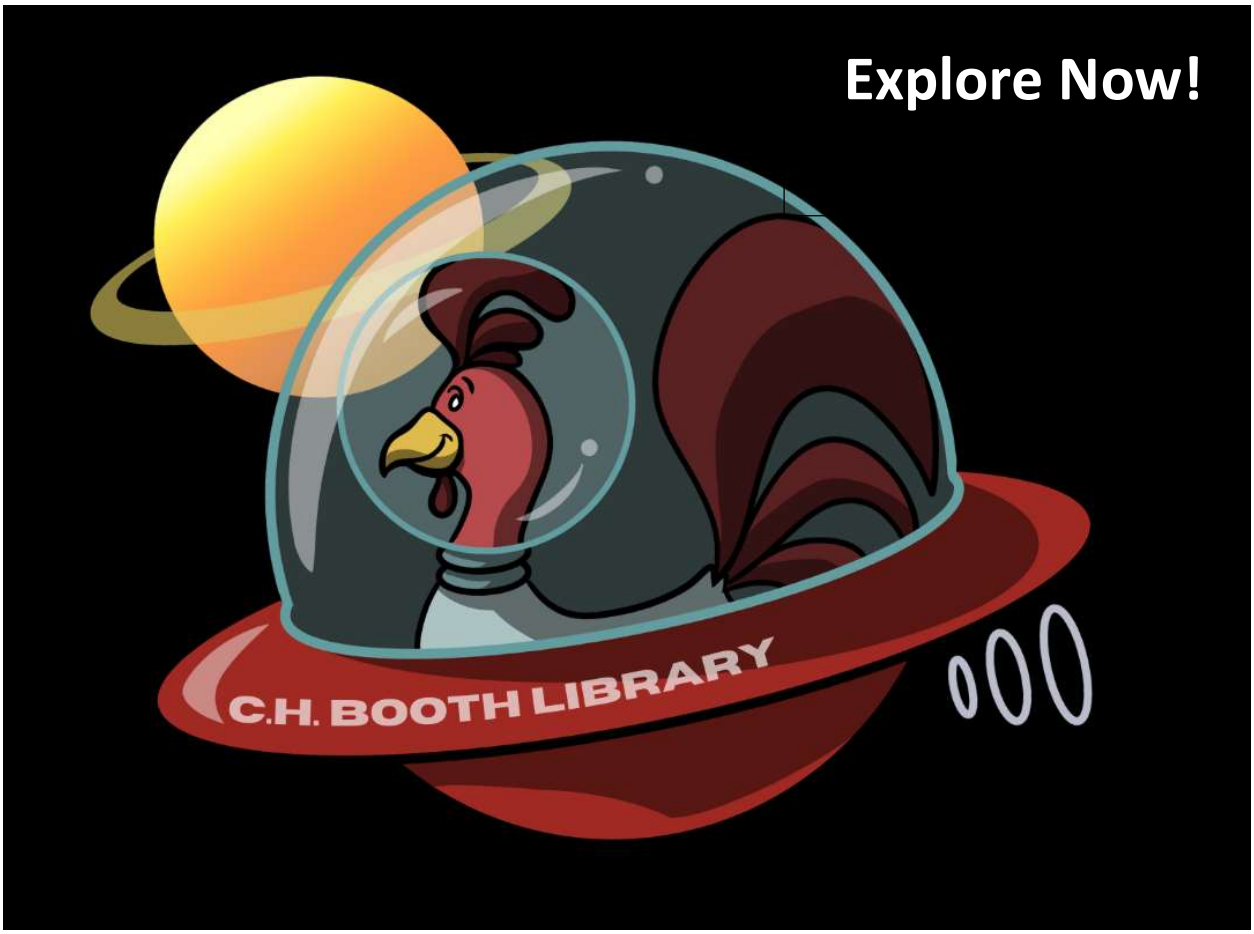


Solar Eclipse Comet?

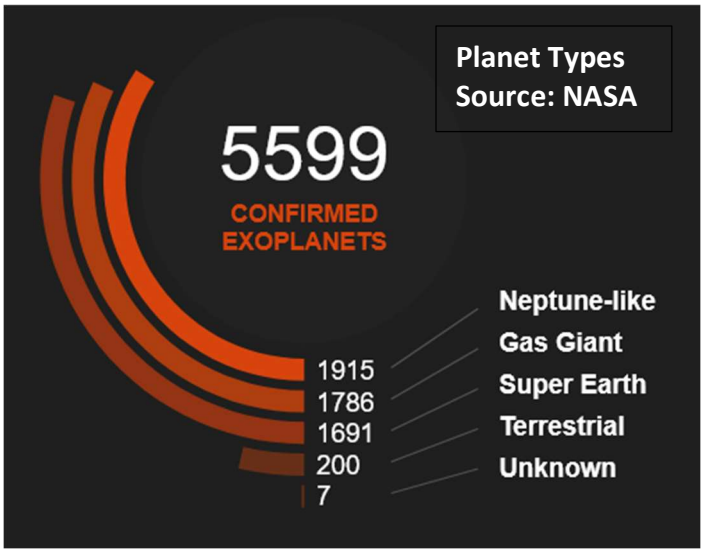


Comet Pons-Brooks visits the inner solar system every 71 years. It will be closest to the Sun (perihelion) on April 21st when it is predicted to brighten to 4.5 magnitude, near the limit of visibility. If it undergoes further brightening, it might be visible near the planet Jupiter during totality.

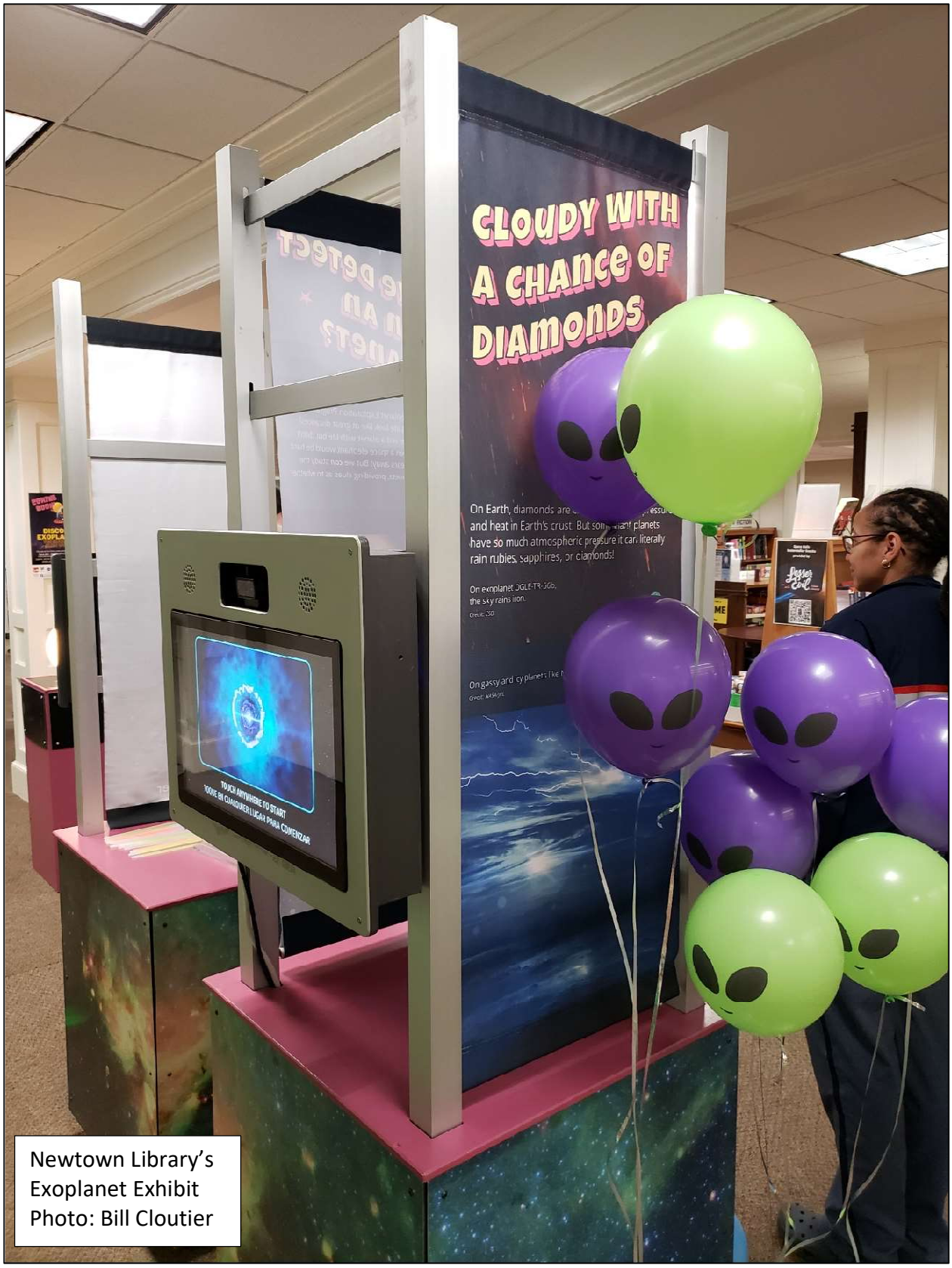
Local Exoplanet Exhibit



The C.H. Booth Library in Newtown is hosting NASA's traveling exhibition *Discover Exoplanets: The Search for Alien Worlds* through the month of May. The library is one of only ten libraries in the country selected to host the exhibit and the only site in the Northeast and Tristate area. The exhibit, in partnership with NASA's Space Science Institute, is a free, hands-on, multimedia experience that brings the excitement of exoplanets (planets orbiting other stars in our galaxy) to patrons and visitors to the library through a series of interactive exhibits and fun activities.



It was only 30 years ago when the first exoplanet was discovered. Since then, thanks to an exponential leap in technology, the count of confirmed exoplanets now approaches 5,600, as astronomers continue to find smaller and more Earth-like worlds, including those with potentially habitable biospheres.



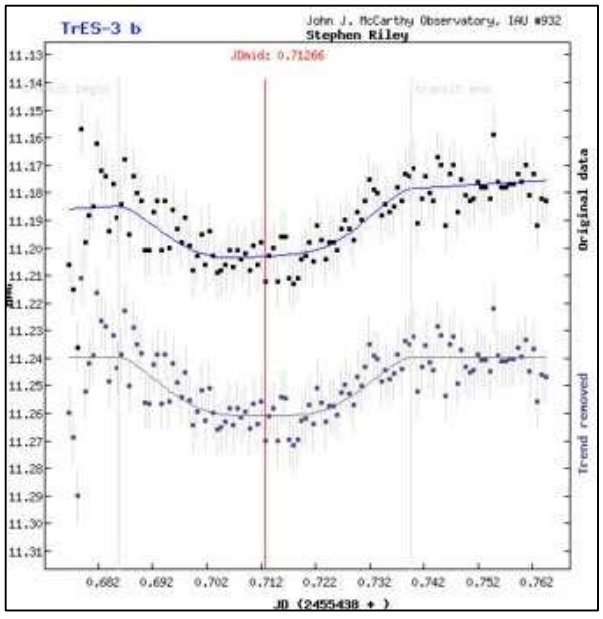
Newtown Library's Exoplanet Exhibit
Photo: Bill Cloutier

Joining the Exoplanet Hunt

McCarthy Observatory's next generation telescope is a PlaneWave CDK17, a 17-inch (0.43 m) f/6.8 Corrected Dall-Kirkham Astrograph

The McCarthy Observatory's new telescope, with its precision tracking ability and state-of-the-art imaging equipment, will allow students to detect small changes in the light from distant stars that harbor planets (exoplanets), as those planets pass in front of, and block, a small fraction of the light from their host stars.

The size and length of a planet's passage or transit can tell astronomers a great deal about the planet that's causing the dip in brightness. With contributions from observatories like the McCarthy Observatory, astronomers can make the best the use of larger telescopes for follow-up observations, use the data to discover new exoplanets in an extrasolar system, monitor stellar variability and/or confirm the existence of newly discovered exoplanets.



Made in Space

After an almost six month delay, Varda Space Industries' (Varda) pioneering drug manufacturing experiment returned to Earth, landing on the Utah Test and Training Range near Salt Lake City on February 21st. The experiment had been launched the previous June on a SpaceX rideshare mission but its homecoming had been prevented by the FAA and Air Force officials over safety concerns in regard to the capsule's hypersonic reentry.

Drug Manufacturing Unit
Image Credit: Varda Space

The in-space manufacturing capsule, called Winnebago-1, is the world's first space manufacturing mission conducted outside of the International Space Station. For this flight, Varda's automated mini-lab grew crystals of ritonavir, a drug commonly used to treat HIV.

According to Varda, processing in a microgravity environment benefits from the lack of convection and sedimentation. This results in the formation of more ordered crystals and smaller, more uniform units to improve drug delivery. The crystals were delivered to Improved Pharma, a pharmaceutical company based in Indiana, for evaluation at which time the company will determine its next steps for commercializing orbital drug processing and microgravity manufacturing.

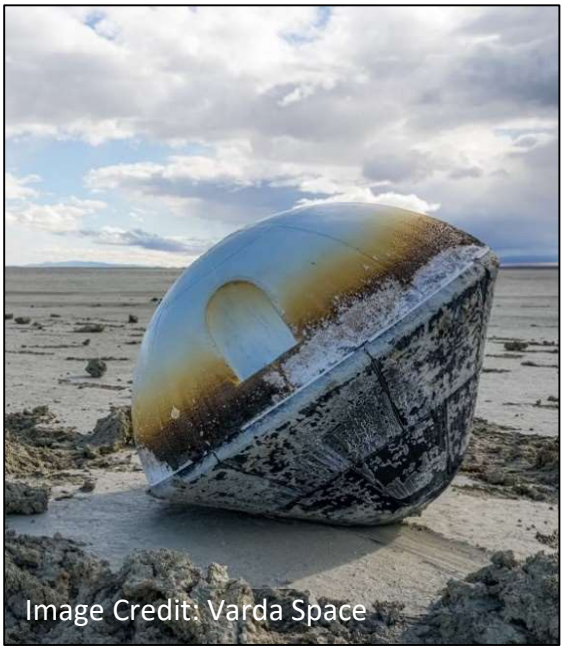


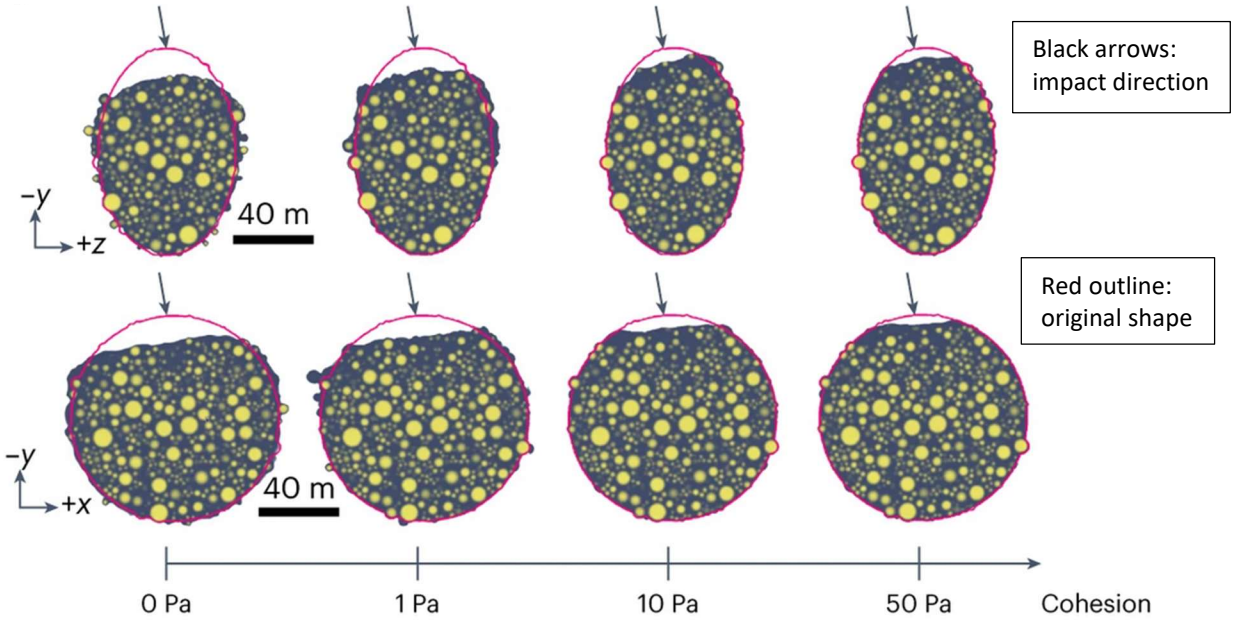
Image Credit: Varda Space

Rocket Lab provided the host satellite for the mission. The satellite bus provided electricity, communications, propulsion, and attitude control over the mission duration, as well as positioning for Varda's capsule to return to Earth. The company's next mission could fly as soon as mid-2024.

What Really Happened to Dimorphos?

On the evening of September 26, 2022, NASA's Double Asteroid Redirection Test (DART) spacecraft collided with Dimorphos, a moon of the asteroid Didymos. The collision was a planned demonstration, designed to assess the effectiveness of a kinetic impact in changing the path or deflecting an asteroid from its pre-impact trajectory.

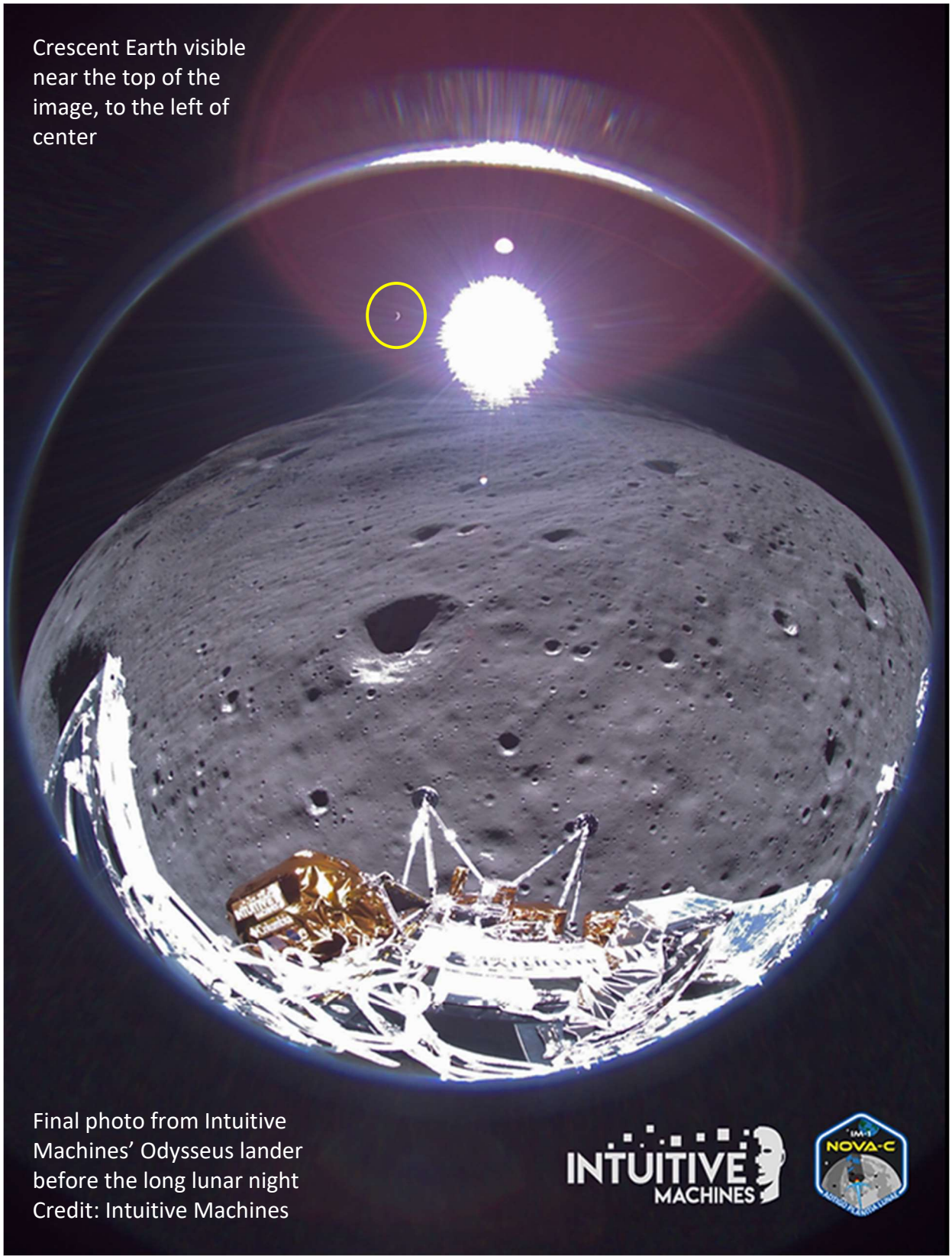
Dimorphos is a small rocky body approximately 525 feet or 160 meters wide. Pre-impact, it orbited the larger, near-Earth asteroid Didymos (2,560 feet or 780 meters) once every 11 hours and 55 minutes. Post-collision analysis of NASA's kinetic impact test indicates that the small moon's orbit was changed by about 4% as a result of the collision with DART, with Dimorphos moving slightly closer to the larger member of the binary pair, Didymos. Observations by multiple observatories in the southern hemisphere and planetary radar facilities in California and West Virginia confirmed that Dimorphos' pre-impact orbital period was also shortened by about 32 minutes. This was the first time humanity has demonstrated an asteroid deflection technology and successfully altered the trajectory of a celestial object. The European Space Agency's HERA mission will launch to Dimorphos in 2024. The spacecraft will rendezvous with the two asteroids in 2026 to conduct detailed surveys and characterize the impact site on the moon. However new research suggests that instead of a crater, HERA might find that the DART impact caused a global deformation and resurfacing of little moon.



Deformation of Dimorphos as a function of asteroid's internal structural strength
Credit: Raducan, S.D., Jutzi, M., Cheng, A.F. et al. Physical properties of asteroid Dimorphos as derived from the DART impact. Nat Astron (2024).

DART impacted Dimorphos at 14,760 mph (23,760 kph) about 50 feet (15 meters) from asteroid center. The impact ejected at least 2.2 million pounds (1 million kg) from, what is now believed to be, a world comprised of a loose mixture of dust, stones, and boulders, similar to other asteroids that have been visited such as (162173) Ryugu and (101955) Bennu. Researchers running multiple simulations have concluded that due to the asteroid's low cohesive strength, instead of producing a crater, the impact likely reshaped the entire moon.

Goodnight Moon



Starship – Third Flight

On March 14th, SpaceX conducted its third test flight of its new Starship vehicle. The revolutionary rocket soared into orbit after separating from its heavy booster over the Gulf of Mexico. After coasting 145 miles (234 km) above the Earth, Starship, engulfed in a glowing plasma field, was lost upon reentry over the Indian Ocean. Photos: SpaceX

SpaceX's Starship during the coast phase.
Photo: SpaceX

34 Years of Discovery

The first of NASA's "Great Observatories," the Hubble Space Telescope was launched on April 24, 1990. After a calamitous start, with an aberration in the figure of its primary mirror that affected the clarity of the telescope's early images, five astronaut servicing missions not only corrected the initial flaw, but continued to upgrade the orbiting observatory with the latest technology. Today the telescope is a far superior instrument than when launched 34 years ago.

The fifth and final space shuttle servicing mission was in May 2009. Today, almost fifteen years later, all four of its instruments (Advanced Camera for Surveys, Cosmic Origins Spectrograph, Space Telescope Imaging Spectrograph, and Wide Field Camera 3) are operational, as well as the Fine Guidance Sensors which can be used for precision astrometry. Three of the six gyroscopes, used to detect the telescope's rate and direction of motion and installed in 2009, remain operational, although one has showed signs of impending failure. In 2021, NASA switched operations over to a backup computer, otherwise the observatory remains in "good health."

Earth Day 2024

Setting aside a day to focus on spaceship Earth, its natural environment and the impact that humans have had on its fragile biosphere, was the idea of U.S. Senator Gaylord Nelson after witnessing the aftermath of the 1969 Santa Barbara oil spill (a well blowout in an off-shore drilling platform that spilled an estimated 80,000 to 100,000 barrels along the southern California coastline). In the first Earth Day, on April 22, 1970, 20 million Americans participated in country-wide events. The public awakening was credited for the establishment of the Environmental Protection Agency and the passage of important clean air and water legislation.

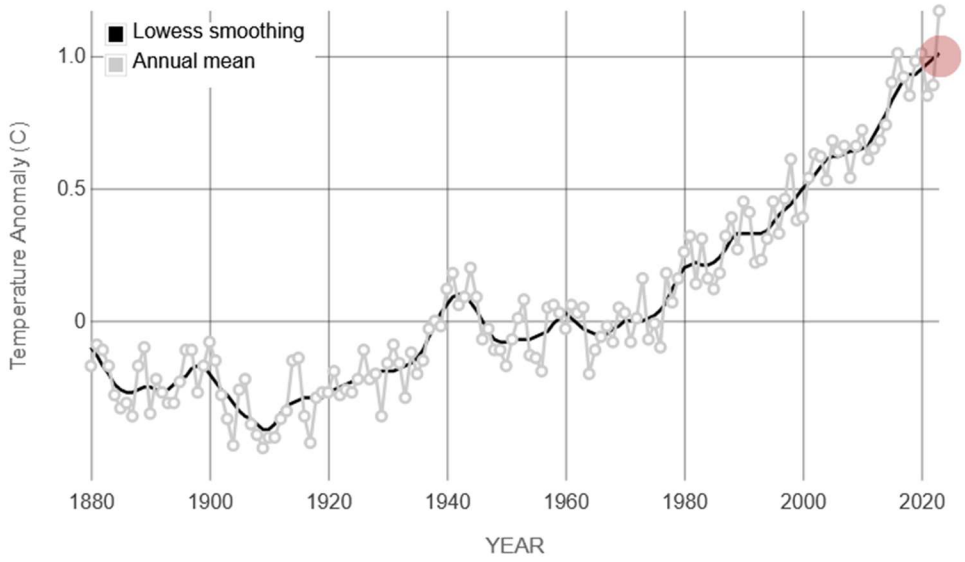
ISS Photo of Earth's Limb
Credit: NASA

Sunset image of the Earth's limb taken from the International Space Station showing several layers of the Earth's atmosphere (the Earth's atmosphere has several distinct layers). The majority (75% by mass and 99% of the water vapor) of the atmosphere (troposphere), highlighted in yellows and oranges, extends 5 to 10 miles above the surface (wider at the equator). Above the troposphere (pink and white region) is the stratosphere which extends to an altitude of 31 miles. Overlying layers - the mesosphere, thermosphere and exosphere become progressively thinner as the Earth's atmosphere transitions to the vacuum of space.

Earth Day 2024 finds the threats to the environment infinitely more challenging than an oil spill and their consequences potentially irreversible. Unlike a breached oil well, there are no quick fixes or easy answers if we do decide to address the source(s) of Earth's rapidly changing climate. Earth's health report is presented in the following graphs. It's not that the climate is changing - change is inevitable in such a complex, dynamic system over eons - it's the rate of change over such a short period of time that should be reawakening public consciousness.

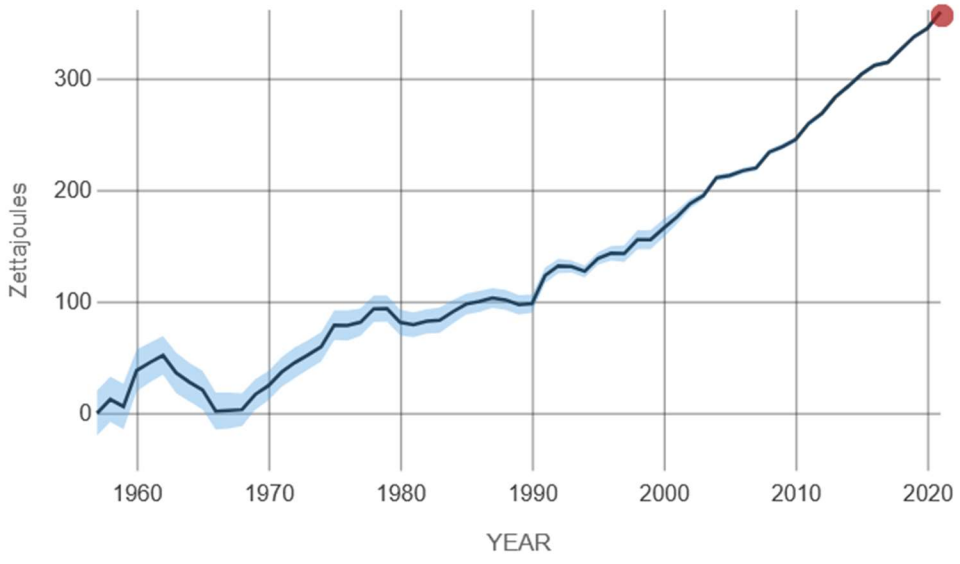
GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS).
Credit: NASA/GISS



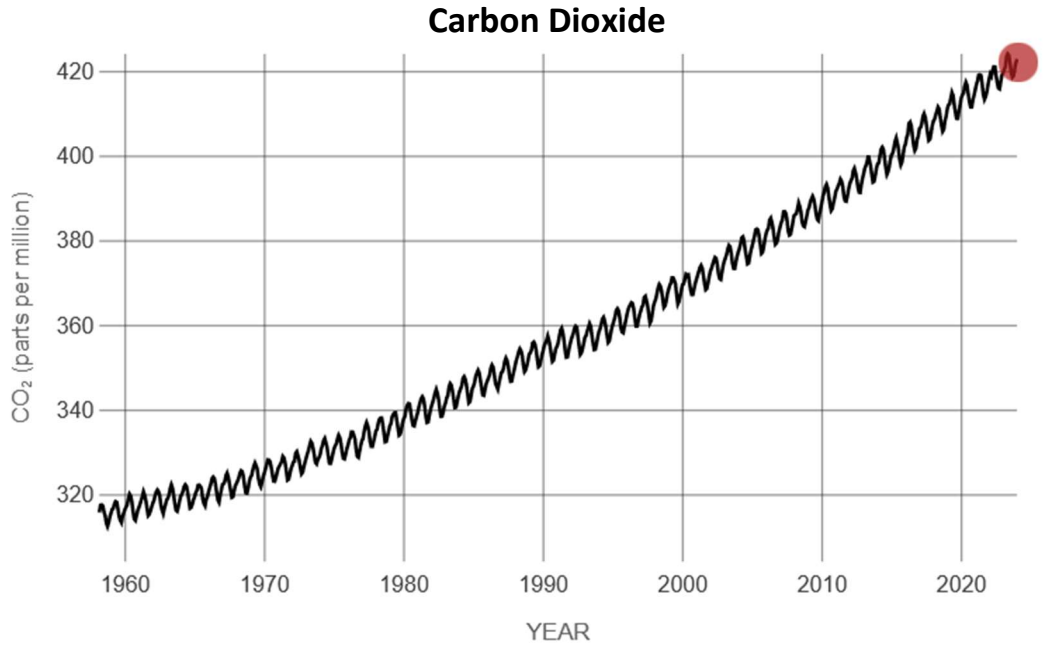
OCEAN HEAT CONTENT CHANGES SINCE 1955 (NOAA)

Data source: Observations from various ocean measurement devices, including conductivity-temperature-depth instruments (CTDs), Argo profiling floats, and eXpendable BathyThermographs (XBTs). Credit: NOAA/NCEI World Ocean Database



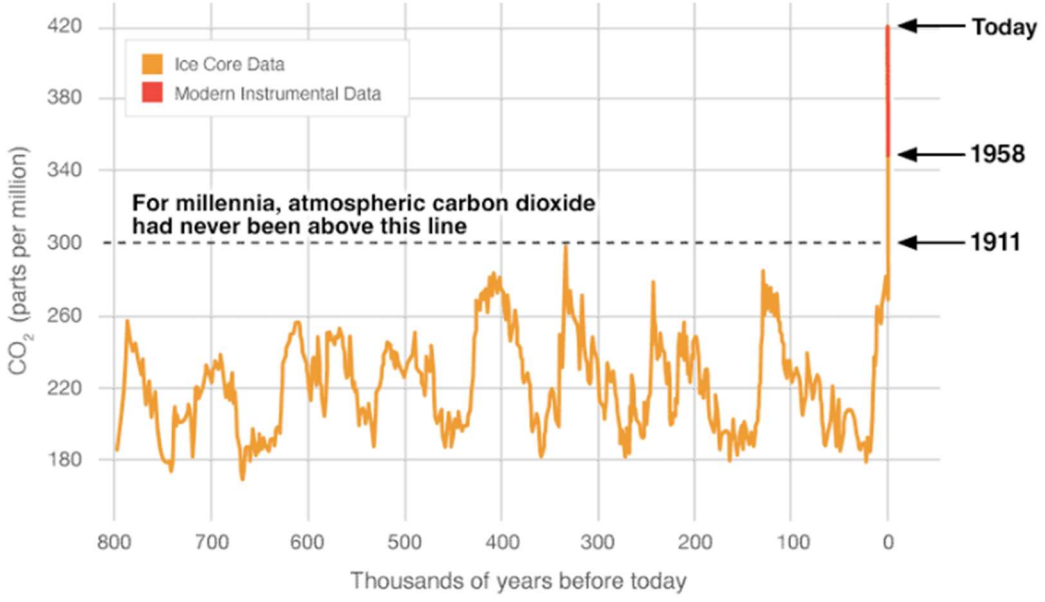
DIRECT MEASUREMENTS: 1958-PRESENT

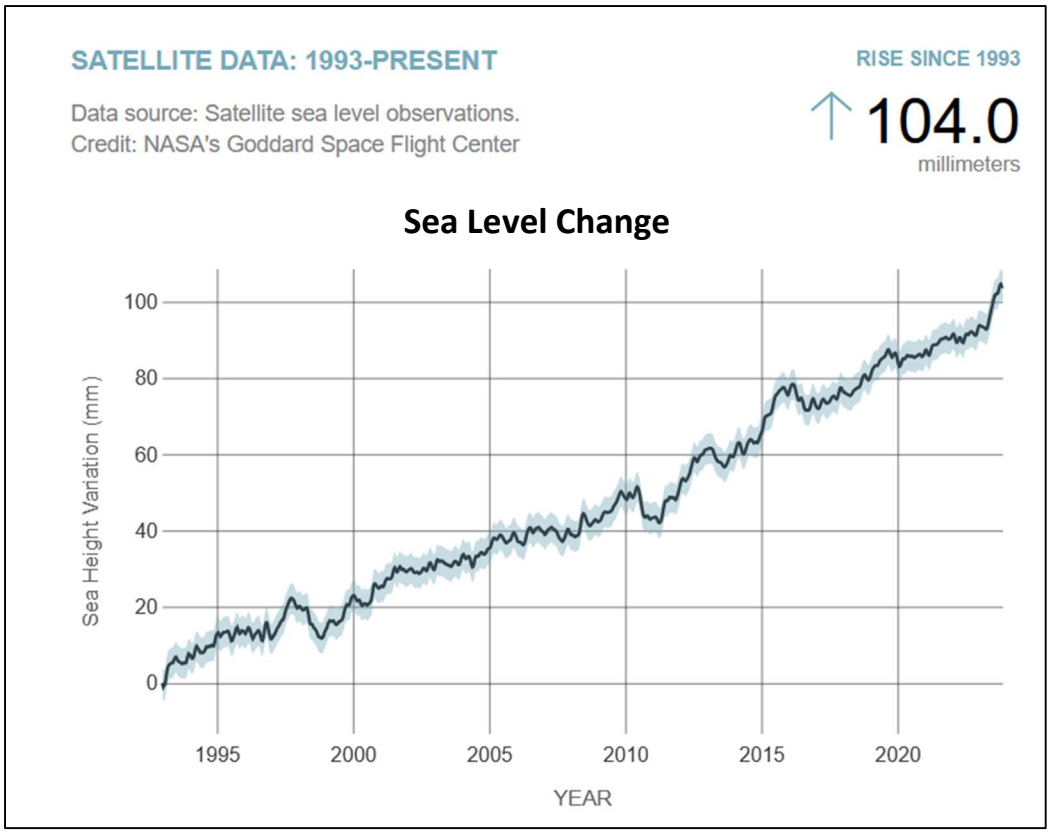
Data source: NOAA, measured at the Mauna Loa Observatory

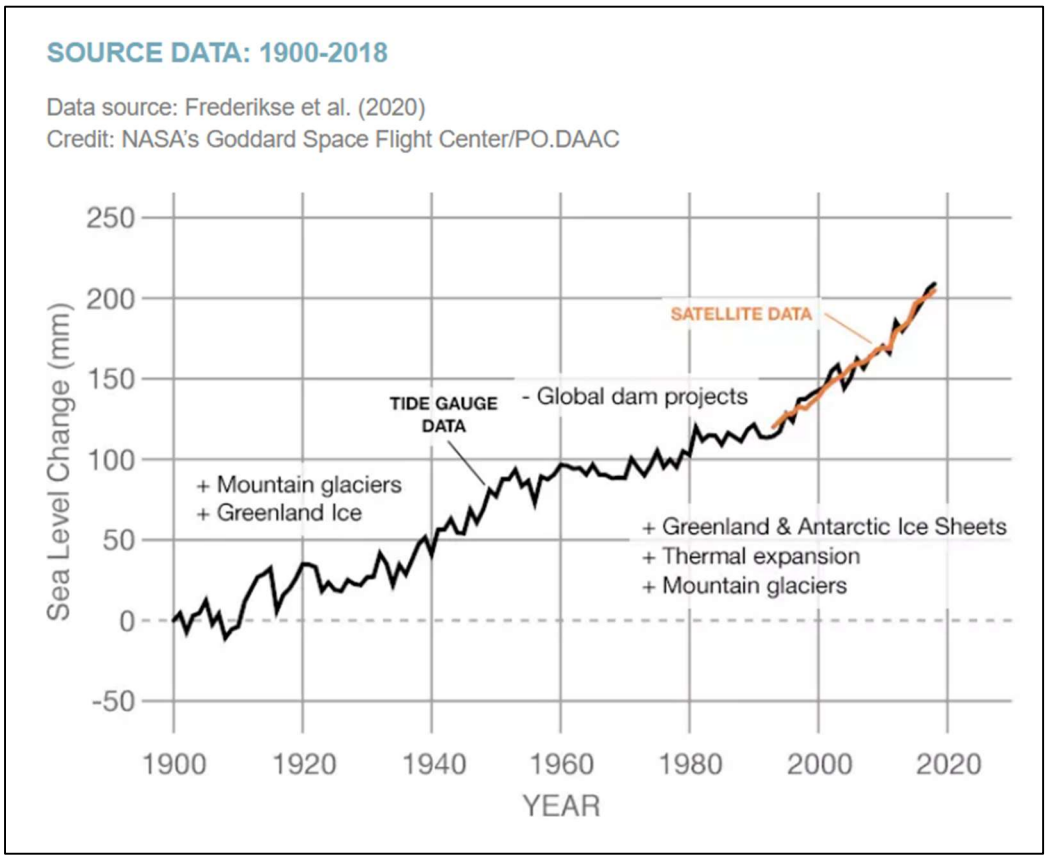


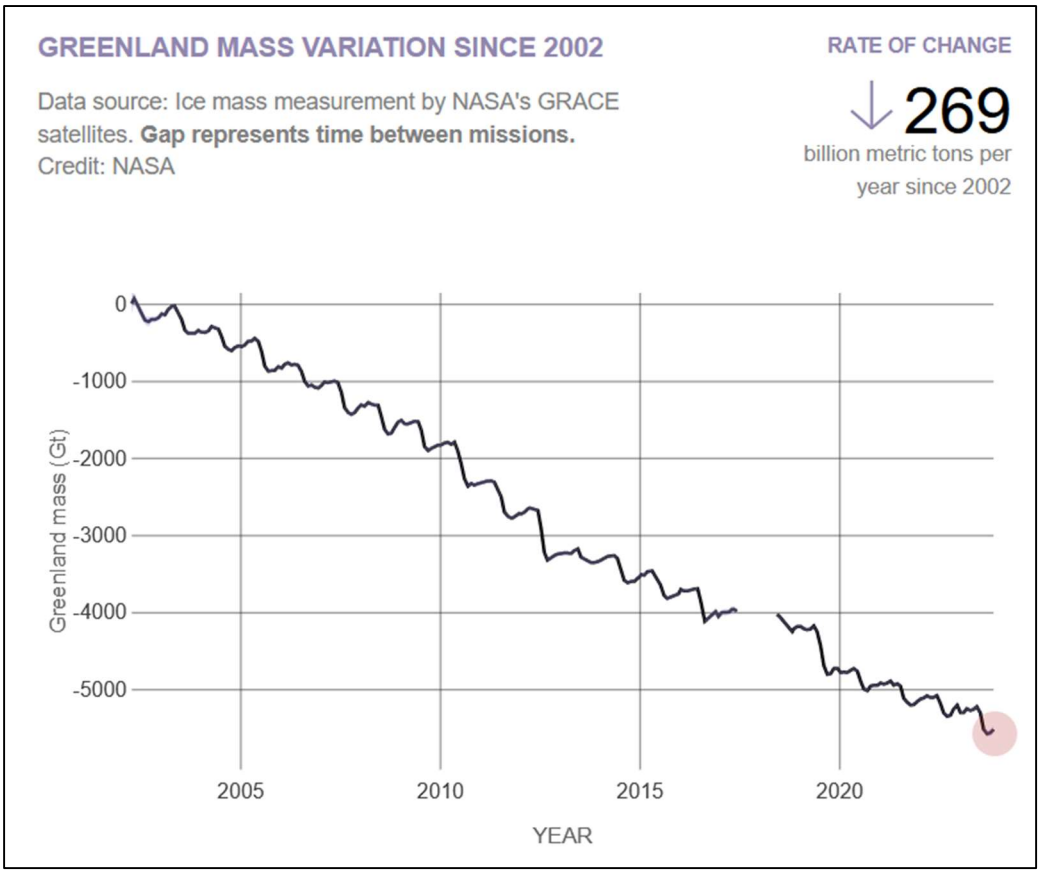
PROXY (INDIRECT) MEASUREMENTS

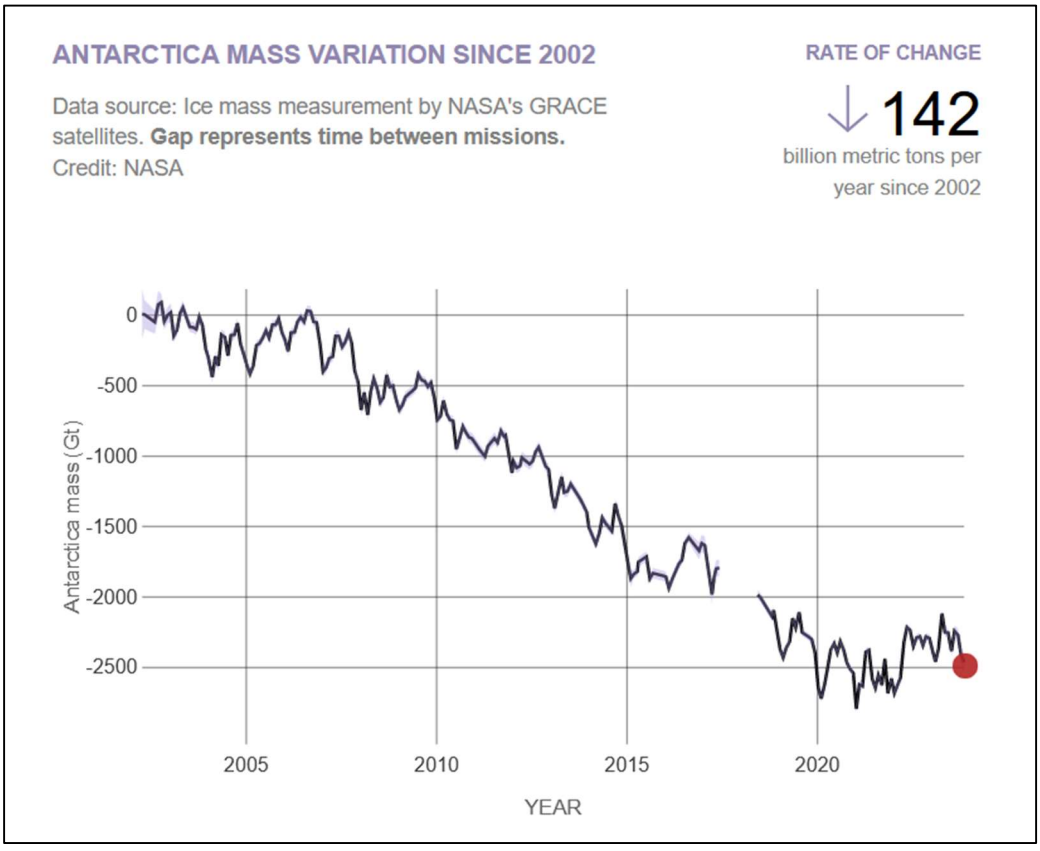
Data source: Reconstruction from ice cores.
Credit: NOAA

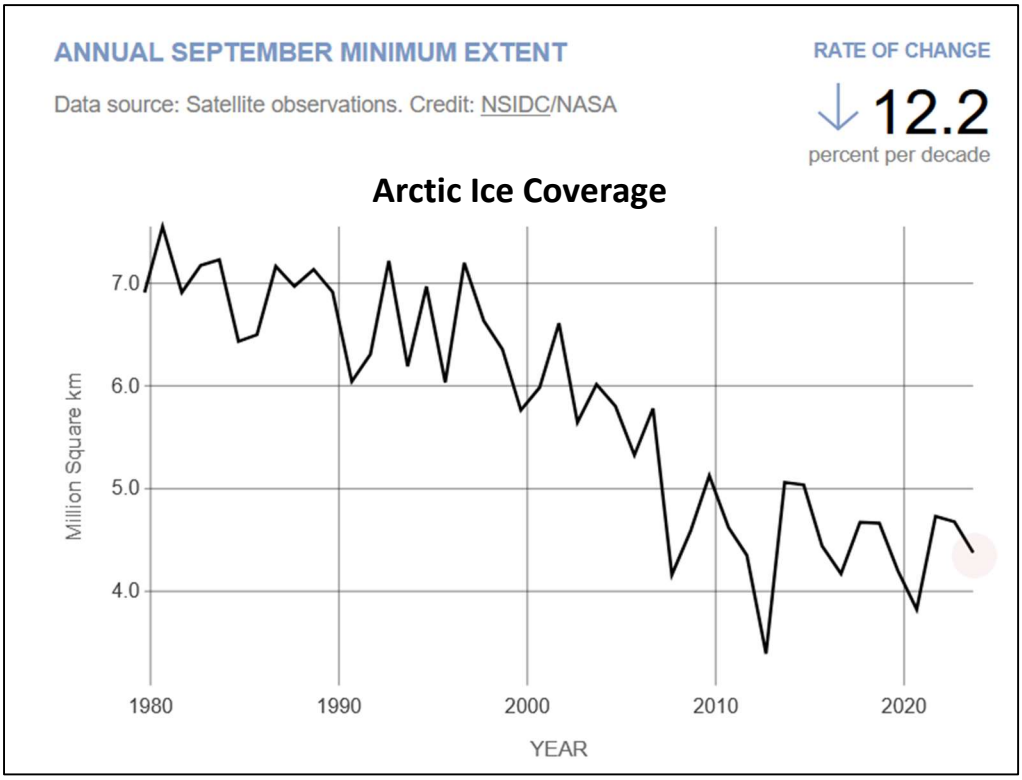



SATELLITE DATA: 1993-PRESENT
Data source: Satellite sea level observations.
Credit: NASA's Goddard Space Flight Center
RISE SINCE 1993
104.0
millimeters
Sea Level Change
Sea Height Variation (mm)
100
80
60
40
20
0
1995
2000
2005
2010
2015
2020
YEAR


SOURCE DATA: 1900-2018
Data source: Frederikse et al. (2020)
Credit: NASA's Goddard Space Flight Center/PO.DAAC
Sea Level Change (mm)
250
200
150
100
50
0
-50
1900
1920
1940
1960
1980
2000
2020
YEAR
SATELLITE DATA
TIDE GAUGE DATA
- Global dam projects
+ Mountain glaciers
+ Greenland Ice
+ Greenland & Antarctic Ice Sheets
+ Thermal expansion
+ Mountain glaciers


GREENLAND MASS VARIATION SINCE 2002
Data source: Ice mass measurement by NASA's GRACE satellites. Gap represents time between missions.
Credit: NASA
RATE OF CHANGE
269
billion metric tons per year since 2002
0
-1000
-2000
-3000
-4000
-5000
Greenland mass (Gt)
2005
2010
2015
2020
YEAR


ANTARCTICA MASS VARIATION SINCE 2002
Data source: Ice mass measurement by NASA's GRACE satellites. Gap represents time between missions.
Credit: NASA
RATE OF CHANGE
142
billion metric tons per year since 2002
0
-500
-1000
-1500
-2000
-2500
Antarctica mass (Gt)
2005
2010
2015
2020
YEAR



2023 - Warmest Year on Record

The Earth's average surface temperature in 2023 was the warmest on record since global records began in 1850, according to an analysis done by the National Oceanic and Atmospheric Administration (NOAA). Global temperatures for 2023 were 2.12°F (or 1.118°C) above the 20th-century average of 57.0°F (13.9°C). The 10-warmest years on record have all occurred since 2014. Warming is attributed to human activities, including the emission of greenhouse gases, such as carbon dioxide and methane.

The Earth's oceans have absorbed much of the excess heat and carbon dioxide (warmer water also expands, contributing to rising sea levels). The annual global ocean heat content (OHC) for 2023 for the upper 2000 meters was a record high, surpassing the previous record set in 2022. The five highest OHC vales have all occurred in the last five years (2019–2023).

Carbon dioxide and water combine to form carbonic acid, which has increased the ocean's acidity by about 30% since the beginning of the Industrial Revolution. Between 7.2 and 10.8 billion metric tons of carbon dioxide are taken up by the oceans every year, impacting many ocean species (particularly those with shells and skeletons) and weakening coral reefs.

Cold water is more dense than warm water. This difference in density is responsible for ocean's currents (along with the global winds) and, to some degree, its level (the process is known as thermohaline circulation). Ocean currents regulate the Earth's temperature, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the equator. Without currents, land temperatures would be more extreme and some areas, that currently benefit from the moderation, would not be habitable. The warming of the oceans reduces the temperature differential between the hot and cold regions and the energy available to drive

circulation and upwelling (sinking cold water replaced by rising warm water). The Gulf Stream, which moves billion of tons of water up the east coast of North America every second, is becoming weaker and moving slower than it has in thousands of years.

The ice sheets covering Greenland and Antarctica have also decreased in mass. Satellite observations by NASA's Gravity Recovery and Climate Experiment (GRACE) and GRACE Follow-On satellites have documented an average of 270 billion metric tons of ice lost each year between 2002 and 2023 for the Greenland ice sheet, while Antarctica lost ice at a rate of about 150 billion metric tons per year over the same period.

Global sea level rose about 8 inches (20 centimeters) in the last century - recorded by tidal gauges and, more recently, by satellites. The rate of increase has nearly doubled over the past two decades. A hotter planet is likely contributing to long-term climate changes (desertification and coastal flooding) and fueling extreme weather events that will impact our quality of life.

In 2018, NASA launched two missions that will provide decision makers (and the public) the latest information on the effects of climate change. The Gravity Recovery and Climate Experiment Follow-On mission (GRACE-FO), in partnership with the German Research Centre for Geosciences, continues the work of predecessor missions and is a significant improvement in the accuracy in tracking the movement of water (for example, from glaciers and ice sheets to the ocean). NASA also launched the Ice, Cloud, and Land Elevation Satellite-2, or ICESat-2, a mission that provides precise elevation measurements on the Earth's ice sheets, glaciers and sea ice. In November 2020, Sentinel-6 was launched, the latest in a series of satellites (starting with TOPEX-Poseidon and the Jason series) that have been monitoring global mean sea level since 1992.

In December 2022, the Surface Water & Ocean Topography (SWOT) satellite joined the Earth-monitoring fleet. Jointly developed by NASA and Centre National D'Etudes Spatiales, with contributions from the Canadian Space Agency and United Kingdom Space Agency, SWOT will measure the height of water in freshwater bodies and the ocean on more than 90% of Earth's surface.

Local

Most of the contiguous U.S. experienced above-average temperatures during 2023. New Hampshire and Massachusetts each ranked 2023 warmest on record while Maine, Vermont, Connecticut each ranked the year second warmest.

Bradley International Airport recorded an average temperature of 53.6°, which is just shy of the 53.7° recorded in 2012 — the hottest year the station has seen since its first recorded year in 1949. The station also recorded 64.91 inches of precipitation, 17 inches above the annual average of 47.05. July was the wettest on record with nearly 14" of rain in the Hartford area.

As one of the wettest years (3rd wettest since 1905), the Connecticut River swelled to its highest summer levels in 50 years.

The year was also noteworthy for both wild weather and extremes. Three tornadoes touched down in 2023 (in Roxbury, Scotland and Killingly). In one of the warmest years, the coldest temperatures in the past 5 years occurred in February with sub-zero temperatures.

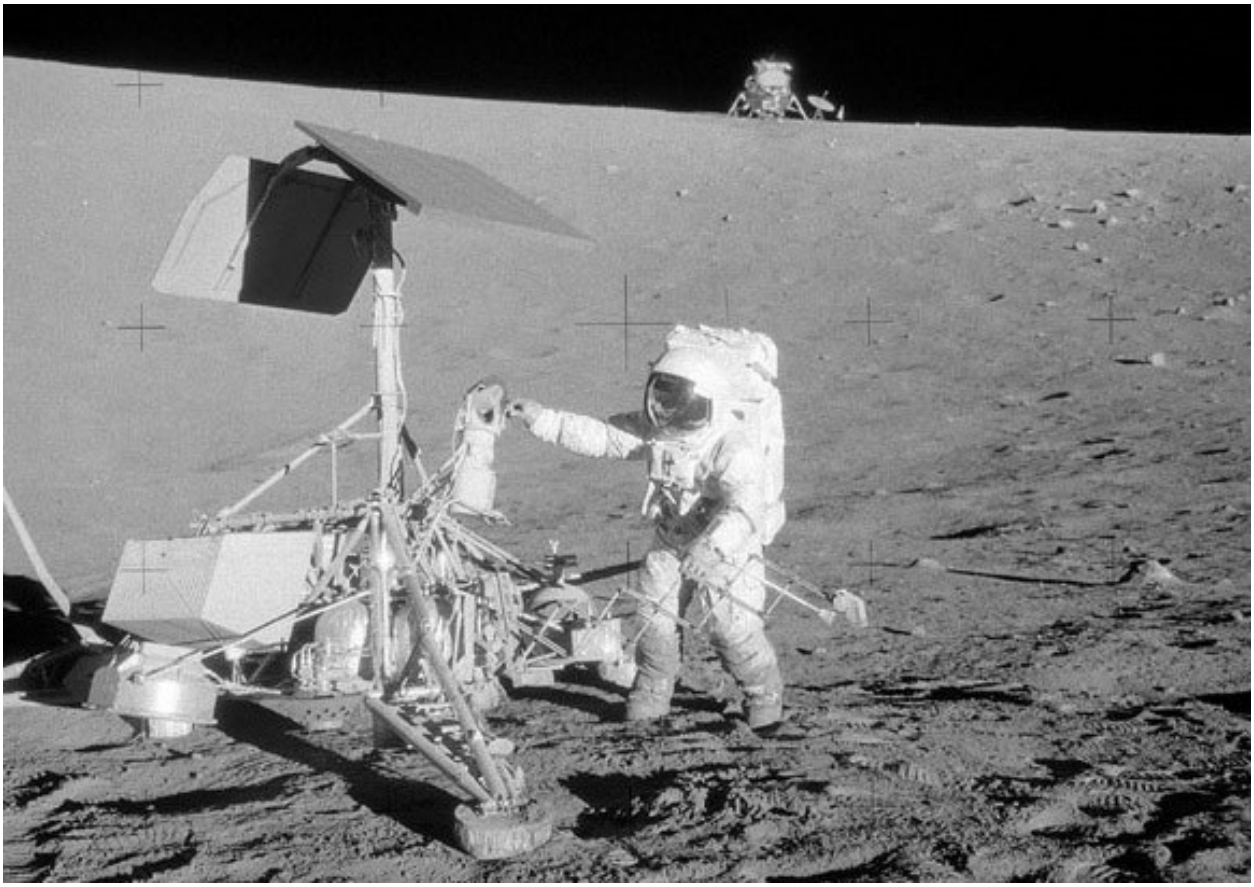
Home World

The Surveyor 3 spacecraft was launched on April 17, 1967, and was the second of the Surveyor series to successfully soft-land on the moon. The robotic spacecraft landed three days later inside an eroded crater in Oceanus Procellarum (Ocean of Storms), 230 miles (370 km) south of the crater Copernicus. The robotic lander returned 6,000 photographs of its surroundings including the first photo of Earth taken from the lunar surface. Surveyor 3 also provided data on the lunar soil, including its ability to support the weight of the Apollo lunar landing module, soil reflectivity and thermal properties.

Surveyor 3 photo of Earth

Credit: NASA

The Apollo 12 astronauts removed several parts from the Surveyor 3 spacecraft during their mission to Oceanus Procellarum. Its camera is now on display in the Smithsonian National Air and Space Museum in Washington, D.C.



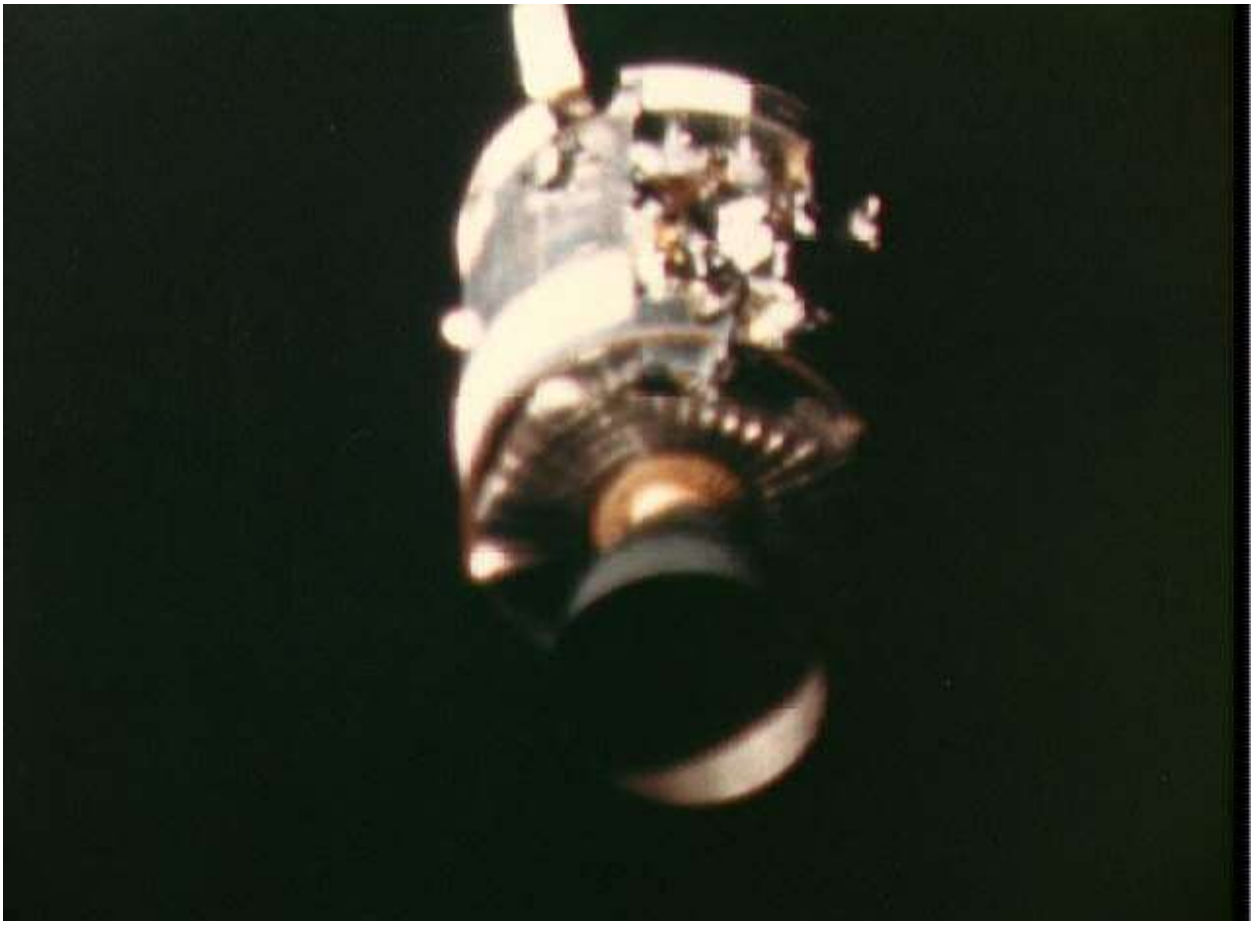
Apollo 12 astronaut Pete Conrad examines Surveyor 3's camera on November 20, 1969 before it was removed for its return to Earth

Image Credit: NASA/Apollo 12 astronaut Alan Bean

April History

Apollo 16 wasn't the only lunar mission launched in the month of April. Two years earlier, on April 11, 1970, Apollo 13 lifted off from Cape Canaveral in what was intended to be the third manned mission to the Moon. The crew of James Lovell, Fred Haise and Jack Swigert never got their chance.

Two days later and almost 200,000 miles from Earth, the No. 2 oxygen tank exploded, cracking the feed pipe to the No. 1 oxygen tank and crippling the fuel cells providing the electrical power to the Command Module. The next four days would become the greatest human drama in space history.



Damaged Apollo 13 Service Module photographed after the Command Module separation

Photo: NASA

With failing power and a cloud of debris surrounding the space craft, the three astronauts shut down the Command Module and moved into the Lunar Module (LM). The LM was designed to support two astronauts for a maximum of 45 hours. The LM now needed to support the three astronauts for 75 to 100 hours for a safe return to Earth. To conserve supplies, almost all the spacecraft's systems were turned off. The temperature dropped to just above freezing, water condensed on all the internal surfaces and instruments, and the level of carbon monoxide increased to life-threatening levels. Fluids and gases being expelled from the crippled Command Module

acted like small rockets, continually pushing the spacecraft off course. The debris cloud prevented anything more than rudimentary navigation. The astronauts became dehydrated (fuel cells also provide water) and the conditions inside the spacecraft became increasingly unsanitary when the crew, through a misunderstanding, began to accumulate human waste inside the spacecraft (instead of discharging it).

Only through the ingenuity of the engineers back in mission control, the backup crew and hundreds of contractors involved in the assembly and operation of the spacecraft, was the crew returned safely to Earth. The crew and the spacecraft reentered the Earth's atmosphere not knowing whether the heat shield had been damaged in the explosion or whether the parachutes would still deploy after four days of extreme cold. While Houston lost contact with the spacecraft for a minute longer than expected, Apollo 13 splashed down right on target.

The cause of the accident was eventually traced to damage the No. 2 oxygen tank had sustained during its removal from Apollo 10. With a damaged drain, internal heaters were used to empty the tank. Unfortunately, the pad power supply was not compatible with the spacecraft's power systems. The higher voltage melted the insulation leaving bare metal exposed to the pure oxygen environment inside the tank. When Jack Swigert turned on the tank fan, the contents exploded. The story of Apollo 13 is detailed in astronaut Jim Lovell's book "Lost Moon," former Flight Director Gene Kranz's book "Failure is Not an Option," and recreated in the Ron Howard/Tom Hanks film "Apollo 13."

April Showers

The Lyrid meteor shower is expected to peak around April 22nd. The dust producing the shooting stars is from *Comet Thatcher*. Expect to see 10 to 20 meteors per hour and dark skies being only two days past a New Moon. As with all meteor showers, the Lyrids are named for the constellation (Lyra) from which they appear to radiate.

Sunrise and Sunset (New Milford, CT)

Date	Sunrise	Sunset
April 1st (EDT)	06:35 am	7:19 pm
April 15th	06:12 am	7:34 pm
April 30th	05:51 am	7:51 pm

Astronomical and Historical Events

1st Last Quarter Moon
1st History: Comet *Hale-Bopp* reaches perihelion – closest approach to Sun (0.914 AU) (1997)
1st History: launch of the first weather satellite, Tiros 1 (1960)
2nd History: U.S. release of the movie "2001 A Space Odyssey" (1968)
2nd History: launch of Zond 1, Soviet Venus flyby mission (1964)
2nd History: selection of the Mercury 7 astronauts (1959)
2nd History: French physicists Louis Fizeau and Leon Foucault take first photo of the Sun (1845)

Astronomical and Historical Events (continued)

3rd Closest approach of Aten class asteroid and Near-Earth Object 2023 GC2
3rd History: Soviet spacecraft Luna 10 becomes the first artificial satellite to orbit the Moon (1966)
4th History: launch of Apollo 6, last test flight of the Saturn V rocket (1968)
5th History: launch of the Compton Gamma Ray Observatory (1991)
5th History: launch of the first Pegasus rocket (1990)
5th History: launch of Pioneer 11, Jupiter and Saturn flyby mission (1973)
6th History: launch of Intelsat 1, first commercial communications satellite (1965)
7th Moon at perigee (closest distance from Earth)
7th History: launch of the Mars Odyssey orbiter (2001)
7th History: first spacewalk from the space shuttle (Story Musgrave, Don Peterson, STS-6) (1983)
7th History: launch of Luna 14, Soviet Moon orbiter mission designed to test radio transmission stability, measure the lunar gravity field, solar wind and cosmic rays (1968)
8th New Moon
8th Closest approach of Apollo class asteroid and Near-Earth Object 2005 FG
8th Closest approach of Apollo class asteroid, Near-Earth Object and Potentially Hazardous Asteroid 2020 BP13
8th History: launch of the Bigelow Expandable Activity Module (2016) aboard a SpaceX Dragon cargo vehicle - module was installed on the International Space Station for a two-year long demonstration of the expandable habitat
8th History: discovery of Saturn moon's *Telesto* by the Voyager 1 spacecraft (1980)
8th History: meteorite hits house in Wethersfield, Connecticut (1971)
8th History: launch of the unmanned Gemini 1 (1964)
8th History: Project Ozma, the search for extraterrestrial intelligence, begins as Frank D. Drake, an astronomer at the National Radio Astronomy Observatory in Green Bank, West Virginia, turns the 85-foot Howard Tate telescope toward the star Tau Ceti (1960)
10th History: Japanese lunar probe Hiten impacts Moon; first non-U.S./Soviet lunar probe, also first to visit the Lagrangian Points L4 and L5 during its three-year mission (1993)
10th History: discovery of asteroid *216 Kleopatra* by Johann Palisa (1880)
11th History: ESA spacecraft Venus Express enters orbit around the planet Venus (2006)
11th History: launch of Apollo 13 with astronauts James Lovell, Fred Haise and Jack Swigert; mission aborted when oxygen tank explodes and cripples the Command Module (1970)
12th History: launch of the first space shuttle (Columbia) with astronauts John Young and Robert Crippen (1981)
12th History: launch of Vostok 1 with cosmonaut Yuri Gagarin, first person to orbit the Earth (1961)
12th History: Edward Maunder born; studied solar cycle and sunspots. Analyzed period between 1645 and 1715 when almost no sunspots where recorded - known as the "Maunder minimum" or "Little Ice Age" because of the severe winters (1851)
12th History: discovery of Asteroid 10 *Hygiea* by Annibale de Gasparis (1849)
13th **Second Saturday Stars - Open House at McCarthy Observatory**
13th Closest approach of Aten class asteroid and Near-Earth Object 2021 GQ5
13th History: launch of Transit 1B, first experimental navigation satellite (1960)
14th Closest approach of Aten class asteroid and Near-Earth Object 2023 FN13
14th Closest approach of Apollo class asteroid and Near-Earth Object 2022 UO1

Astronomical and Historical Events (continued)

14th History: launch of the European Space Agency's Jupiter Icy Moons Explorer mission, or JUICE, aboard an Ariane 5 rocket from Kourou, French Guiana (2023)
14th History: Christiaan Huygens born, Dutch scientist and discoverer of Saturn's rings and largest moon *Titan* (1629)
15th First Quarter Moon
15th Closest approach of Apollo class asteroid, Near-Earth Object and Potentially Hazardous Asteroid 517681 (2015 DE198)
15th Closest approach of Apollo class asteroid, Near-Earth Object and Potentially Hazardous Asteroid 439437 (2013 NK4)
16th History: launch of Apollo 16 with astronauts John Young, Ken Mattingly and Charles Duke, the only mission to the lunar highlands (1972)
16th History: Leonardo Da Vinci born, first to correctly explain Earthshine (1452)
17th History: closest flyby of the Sun by a spacecraft, Helios 2 (1976)
17th History: launch of Surveyor 3, Moon lander, first to experience a lunar eclipse from the Moon's surface during which the temperature fell 250° F; Apollo 12 would later land near Surveyor 3 in 1969, retrieving pieces of the lander for return to Earth and analysis of the effects of the harsh lunar environment (1967)
18th Closest approach of Aten class asteroid and Near-Earth Object 2023 HU3
18th History: launch of the Transiting Exoplanet Survey Satellite (TESS) by a SpaceX Falcon 9 rocket from the Cape Canaveral Air Force Station, Florida (2018)
19th Moon at apogee (furthest distance from Earth)
19th Closest approach of Aten class asteroid and Near-Earth Object 2021 JW2
19th Closest approach of Apollo class asteroid and Near-Earth Object 2017 SA2
19th History: launch of the last Soviet Salyut space station, Salyut 7 (1982)
19th History: launch of the first space station, Soviet Salyut space station, Salyut 1 (1971)
22nd Lyrids Meteor Shower peak
22nd Earth Day
22nd History: Cassini's final close flyby of Saturn's moon Titan, initiating the 22 Grand Finale orbits between the planet and its rings and the end of mission in September (2017)
22nd History: launch of the Air Force's X-37B prototype space plane from Cape Canaveral, Florida; first orbital mission (2010)
23rd Full Moon (Full Pink Moon)
24th History: launch of space shuttle Discovery (STS-31) and deployment of the Hubble Space Telescope (1990)
24th History: launch of Mao 1, first Chinese satellite (1970)
24th History: cosmonaut Vladimir Komarov dies during re-entry of a prototype Soviet lunar spacecraft (Soyuz 1) when parachute lines become entangled (1967)
25th Closest approach of Apollo class asteroid and Near-Earth Object 2021 VH2
26th History: first flight of the modified Boeing 747 with its 98.4-inch (2.5 meter) diameter infrared telescope – the Stratospheric Observatory for Infrared Astronomy (SOFIA) (2007)
26th History: Venus flyby (gravitation assist) by the Cassini spacecraft (1998)
26th History: Ranger 4 impacts Moon (1962) - while the mission didn't return any scientific data due to an onboard computer failure, Ranger 4 become the first U.S. spacecraft to reach another celestial body when it crashed on the far side of the Moon

Astronomical and Historical Events (continued)

26th History: launch of Sputnik 14 (Cosmos 4), first successful Soviet reconnaissance satellite – designed to study upper layers of atmosphere and monitor U.S. nuclear tests (1962)
26th History: discovery of Asteroid 9 *Metis* by Andrew Graham (1848)
28th History: launch of the Cloudsat/Calipso cloud imaging and profiling satellites (2006)
30th Closest approach of Amor class asteroid and Near-Earth Object 2021 GD3
30th Closest approach of Apollo class asteroid, Near-Earth Object and Potentially Hazardous Asteroid 2022 TN1
30th History: Surveyor 3 lander takes the first picture of Earth from the Moon's surface (1967)

Commonly Used Terms

- Apollo: a group of near-Earth asteroids whose orbits also cross Earth's orbit; Apollo asteroids spend most of their time outside Earth orbit.
- Aten: a group of near-Earth asteroids whose orbits also cross Earth's orbit, but unlike Apollos, Atens spend most of their time inside Earth orbit.
- Atira: a group of near-Earth asteroids whose orbits are entirely within Earth's orbit
- Centaur: icy planetesimals with characteristics of both asteroids and comets
- Kuiper Belt: region of the solar system beyond the orbit of Neptune (30 AUs to 50 AUs) with a vast population of small bodies orbiting the Sun
- Opposition: celestial bodies on opposite sides of the sky, typically as viewed from Earth
- Plutino: an asteroid-sized body that orbits the Sun in a 2:3 resonance with Neptune
- Trojan: asteroids orbiting in the 4th and 5th Lagrange points (leading and trailing) of major planets in the Solar System

References on Distances

- the apparent width of the Moon (and Sun) is approximately one-half a degree (½°), less than the width of your little finger at arm's length which covers approximately one degree (1°); three fingers span approximately five degrees (5°)
- 1 astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station and Starlink Satellites

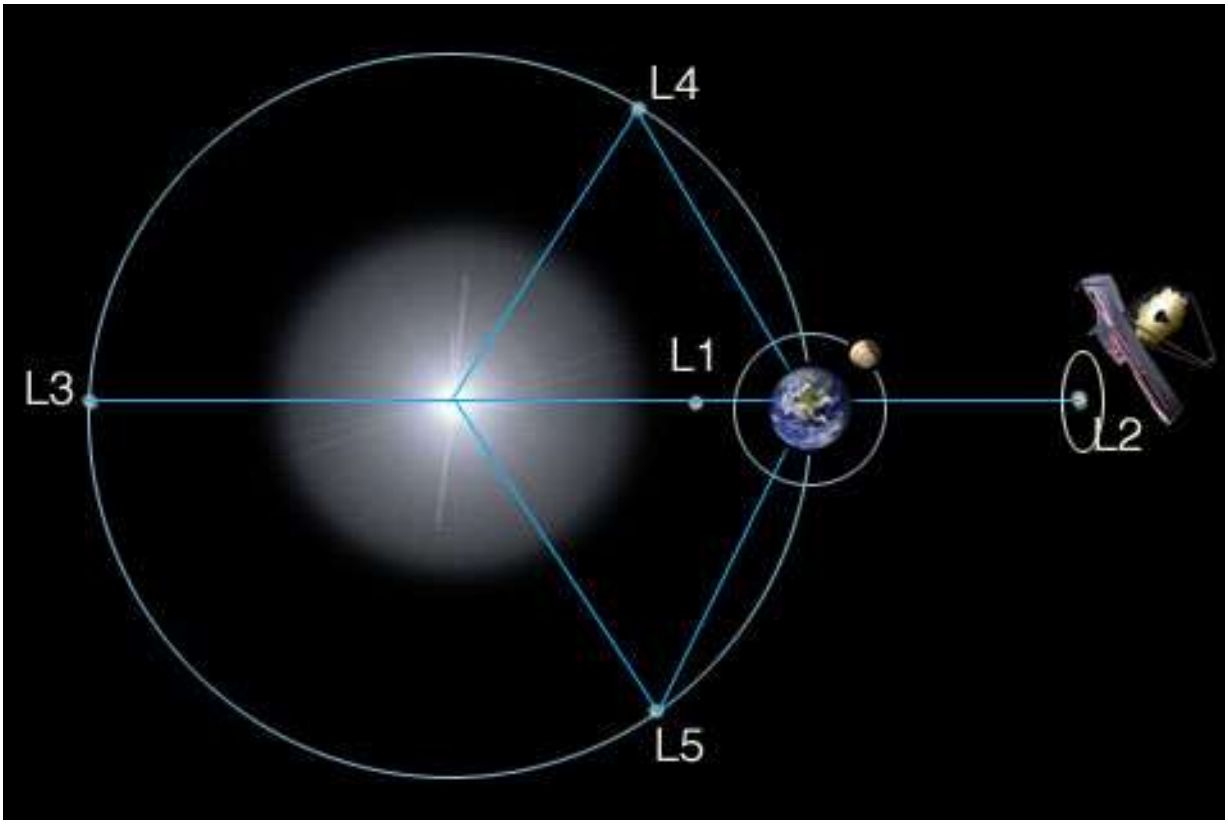
Visit www.heavens-above.com for the times of visibility and detailed star charts for viewing the International Space Station and bright satellites.

Solar Activity

For the latest on what's happening on the Sun and the current forecast for flares and aurora, check out www.spaceweather.com

Lagrange Points

Five locations discovered by mathematician Joseph Lagrange where the gravitational forces of the Sun and Earth (or other large body) and the orbital motion of the spacecraft are balanced, allowing the spacecraft to hover or orbit around the point with minimal expenditure of energy. The L2 point (location of the Euclide and James Webb telescope) is situated 1.5 million kilometers beyond the Earth (as viewed from the Sun).



James Webb Space Telescope

https://webb.nasa.gov/index.html

Euclid Space Telescope

https://www.esa.int/Science_Exploration/Space_Science/Euclid

NASA's Global Climate Change Resource

Vital Signs of the Planet: https://climate.nasa.gov/

Mars – Mission Websites

- Mars 2020 (Perseverance rover): https://mars.nasa.gov/mars2020/
- Mars Science Laboratory (Curiosity rover): https://mars.nasa.gov/msl/home/
- Mars Atmosphere and Volatile EvolutioN (MAVEN): https://science.nasa.gov/mission/maven/

Solar Eclipse Resources

- 2024 Path - http://xjubier.free.fr/en/site_pages/solar_eclipses/TSE_2024_GoogleMapFull.html
- Weather Probabilities - https://eclipsophile.com/2024tse/
- Eclipse Glasses - https://www.rainbowsymphony.com/

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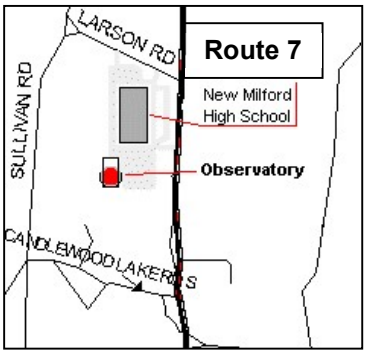

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