Galactic Observer

John J. McCarthy Observatory

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"Small spiral galaxy seeking partner to expand settlement in lonely cosmos . . ."

For more information, go to page 16 inside.

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It is through their efforts that the McCarthy Observatory has established itself as a significant educational and recreational resource within the western Connecticut community.

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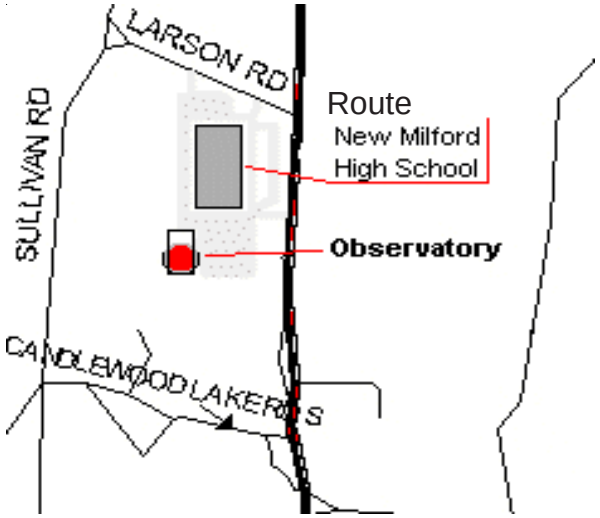


In This Issue

Earth Day 2016

Mt. Rainier
Photo: Bill Cloutier

At 14,410 feet above sea level, Mount Rainier is the fifth highest peak in the continental United States, 100 feet less in stature than the tallest, Mount Whitney in California. Thirty-five miles northeast of Mount St. Helens and seventy-five miles southeast of Seattle, the U.S. Geological Survey (USGS) considers the active volcano one of the Nation's most dangerous. A reservoir of magma, five to ten miles thick, lies beneath the mountain. The last magmatic eruption occurred 1,000 years ago and the next eruption is considered to be well overdue.

The Washington State volcano is the most glaciated peak in the continental United States with 28 named glaciers. The mountain's glacier system feeds five major rivers. Glaciers are sensitive to changes in local weather patterns (temperature and precipitation) and the global climate. The National Park Service monitors two of the largest glaciers on Mount Rainier, the Emmons and Nisqually glaciers. The Nisqually glacier has been retreating since 1983 and is now losing significant mass during the warmer , melt season. The Emmons glacier is suffering a similar fate.

"Out the Window on Your Left"

It's been almost 45 years since we left the last footprint on the dusty lunar surface. Sadly, as a nation founded on exploration and the conquest of new frontiers, we appear to have lost our will to lead as a space-faring nation. 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).

Lunar rays are bright filaments of pulverized ejecta and other debris seen radiating from relatively young craters.

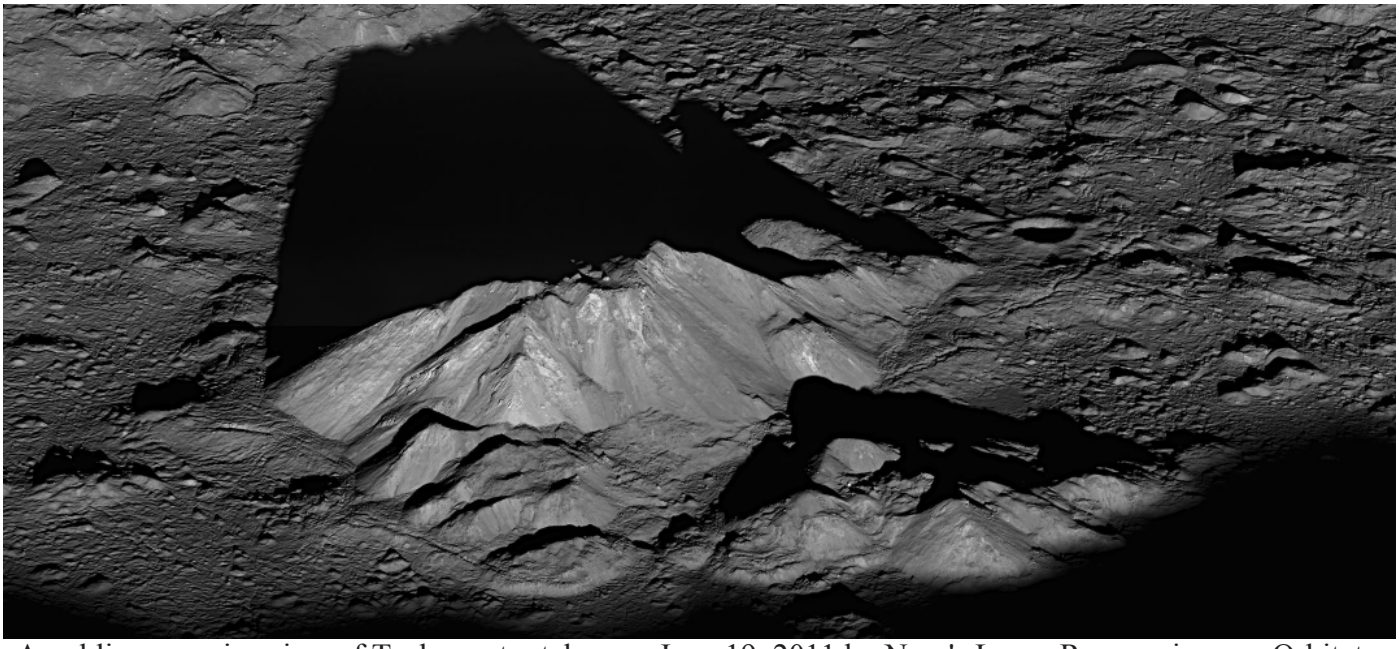
On April 2, 1968, Metro-Goldwyn-Mayer (MGM) released the now classic science fiction film "2001: A Space Odyssey." The film was based on a screenplay developed by producer Stanley Kubrick and author Arthur C. Clarke and inspired by a short story that Clarke had written in 1948 called the "Sentinel." The plot revolves around an artifact left on Moon by an alien race, the discovery of which would signal that the inhabitants of the Earth had developed the means to leave their planet.

In the movie, the artifact is buried in the crater Tycho, one of the youngest, large craters on the Moon (estimated to have formed 108 million years ago).

Tycho is one of the most recognizable lunar craters, prominently located in the southern highlands and accentuated by rays of bright ejecta that extend across the Moon's near side. The crater is approximately 51 miles (82 km) across. From rim to crater floor is about 2.92 miles (4.7 km). Typical of large, complex craters, the aftermath of the impact created large concentric terraces or benches along Tycho's interior wall and a central uplift of rock or central peak. The summit of the peak rises 1.24 miles (2 km) above the crater floor.

As can be seen in the photo above, the rays are not symmetrical, being noticeably absent to the west of the crater. The halo of bright material surrounding the crater is also asymmetrical, more than twice as wide to the east as to the west. Both characteristics are indicative of an oblique or shallow trajectory impact (less than 45°). It is likely that the impactor, 5 to 6 miles (8 to 10 km) in diameter, came in low from the west.

Clavius crater, also featured in the film, is one of the Moon's largest craters (140 miles or 225 km across). In contrast to Tycho's youth, the formation of Clavius dates back to the Nectarian period, 4 billion years ago. Five large craters arc across the floor of Clavius and the crater's rim is broken by two even larger craters – Porter and Rutherfurd. Tycho and Clavius are well placed for viewing in the days following the a First Quarter Moon.



An oblique sunrise view of Tycho crater taken on June 19, 2011 by Nasa's Lunar Reconnaissance Orbitetr (LRO). Credit: NASA Goddard/Arizona State University

Tycho Crater

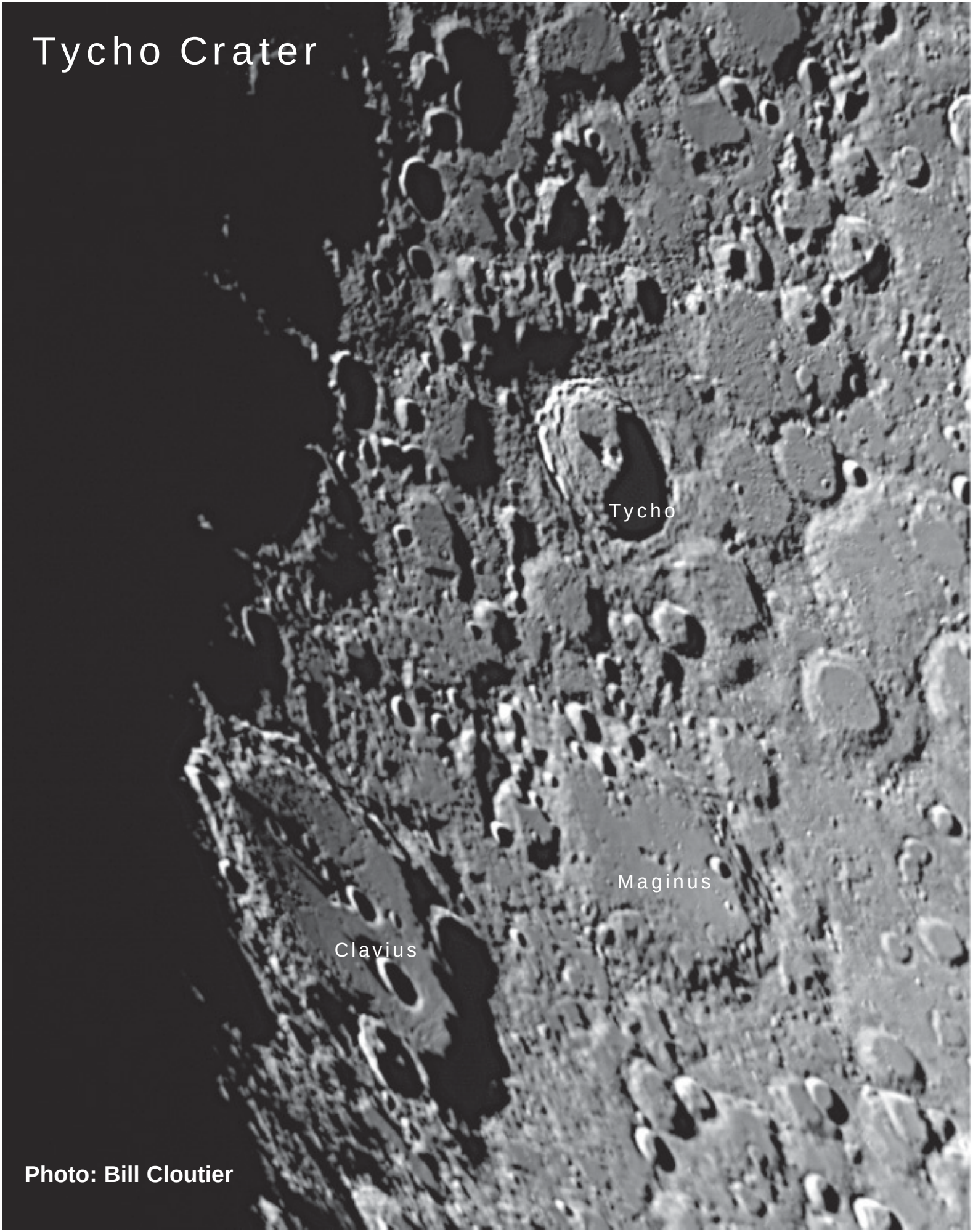


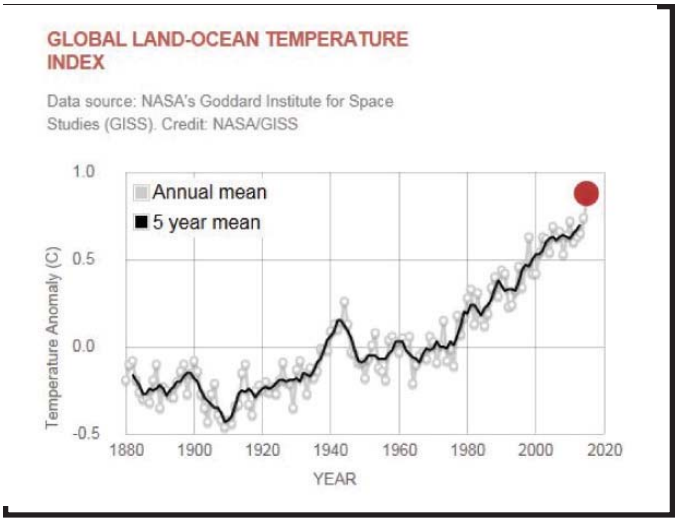
Photo: Bill Cloutier

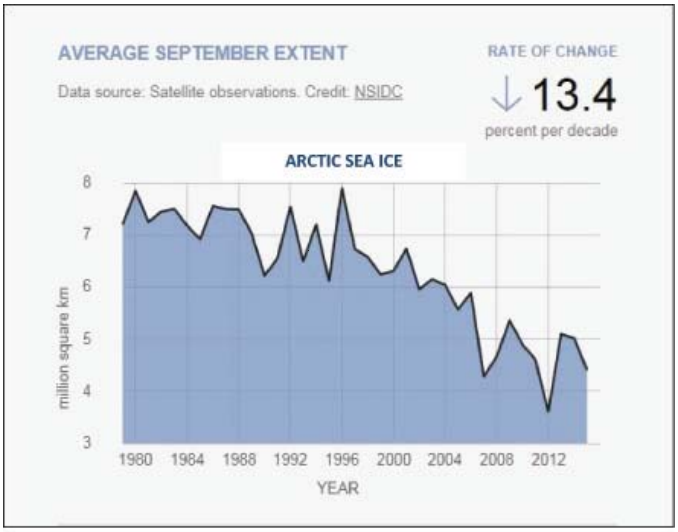
Earth Day 2016

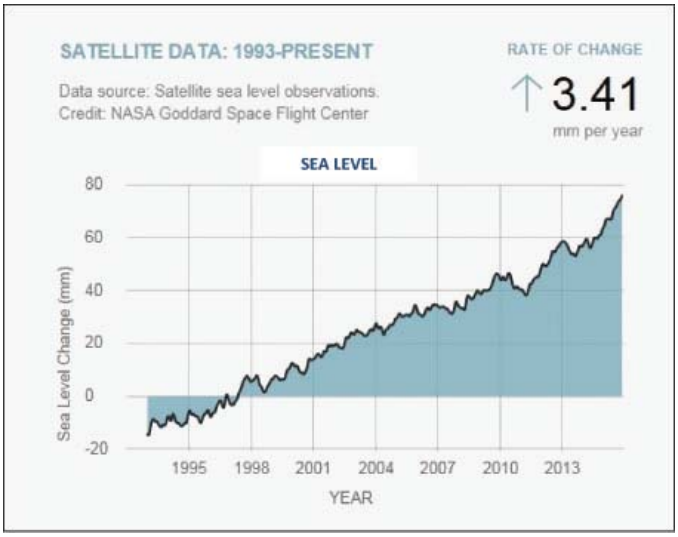
Setting aside a day to focus on spaceship Earth, its natural environment and the impact that humans have had on its fragile biosphere was the idea of U.S. Senator Gaylord Nelson after witnessing the aftermath of the 1969 Santa Barbara oil spill (a well blowout in an off-shore drilling platform that spilled 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 with the establishment of the Environmental Protection Agency and the passage of important clean air and water legislation.

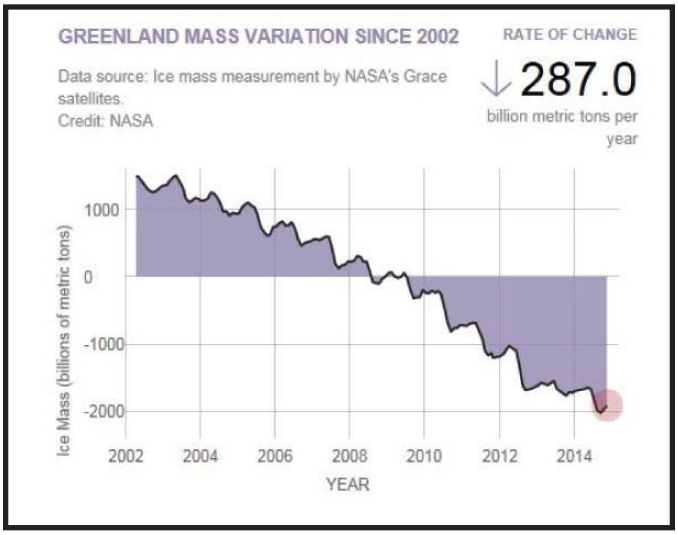
ISS Photo of Earth's Limb Credit: NASA

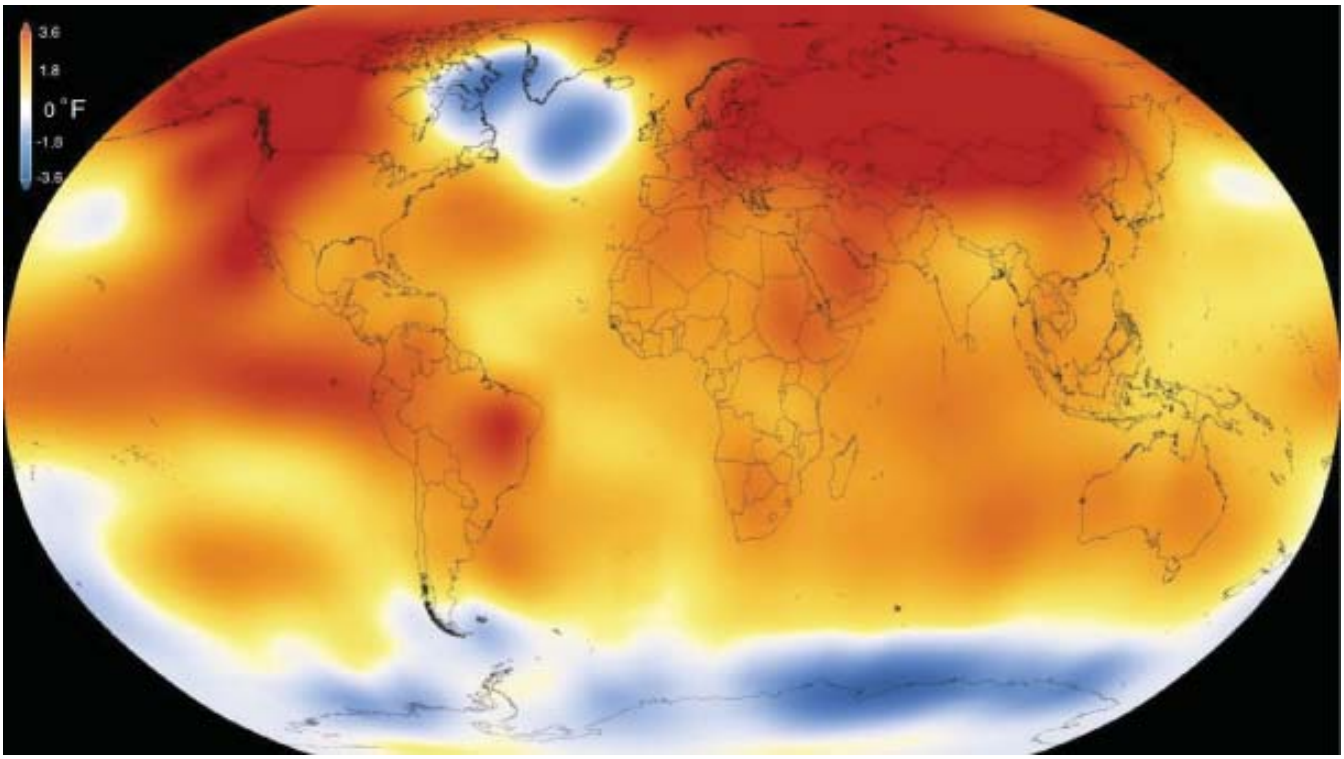
Earth Day 2016 finds the threats to the environment infinitely more challenging than an oil spill and their consequences potentially irreversible. Unlike a breached oil well, there are no quick fixes or easy answers if we do decide to address the source(s) of Earth's rapidly changing climate.











Orange colors represent temperatures that are warmer than the 1951-1980 baseline average, and blues represent temperatures cooler than the baseline.
Credits: Scientific Visualization Studio/Goddard Space Flight Center

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.

NASA monitors the Earth with a fleet of satellites, aircraft and with an array of land and sea sensors. Based upon independent analyses by NASA and the National Oceanic and Atmospheric Administration, 2015 was the warmest year on record (since record keeping began in 1880). While El Niño (warm water pooling along the central and east-central equatorial Pacific) contributed to the warmer 2015, 15 out of the 16 warmest years on record have occurred since 2001. Average global temperatures in 2015 increased by 0.23 degrees Fahrenheit (0.13 Celsius) from the 2014 values, the second highest one-year increase on record.

Potatoes for Mars (and Earth)

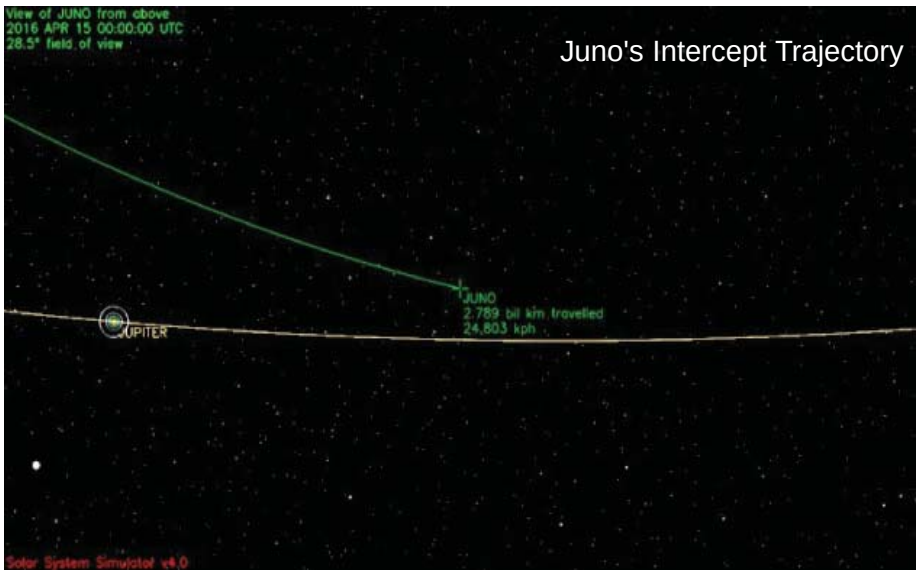
In the bestselling novel "The Martian," fictional astronaut Mark Watney is able to survive being stranded on Mars by growing potatoes in the Martian soil. Now , NASA is teaming up with Lima's International Potato Center to determine which variety of tuber is best suited for growing (and thriving) in the extreme conditions on the Red Planet. Up to one hundred varieties will be evaluated, 40 native to the Andes Mountains. The potatoes will be grown under conditions that simulate conditions on Mars, including in an atmosphere that's primarily carbon dioxide.

The Different Varieties of Potatoes Photo: AFP/Ernesto Benavides

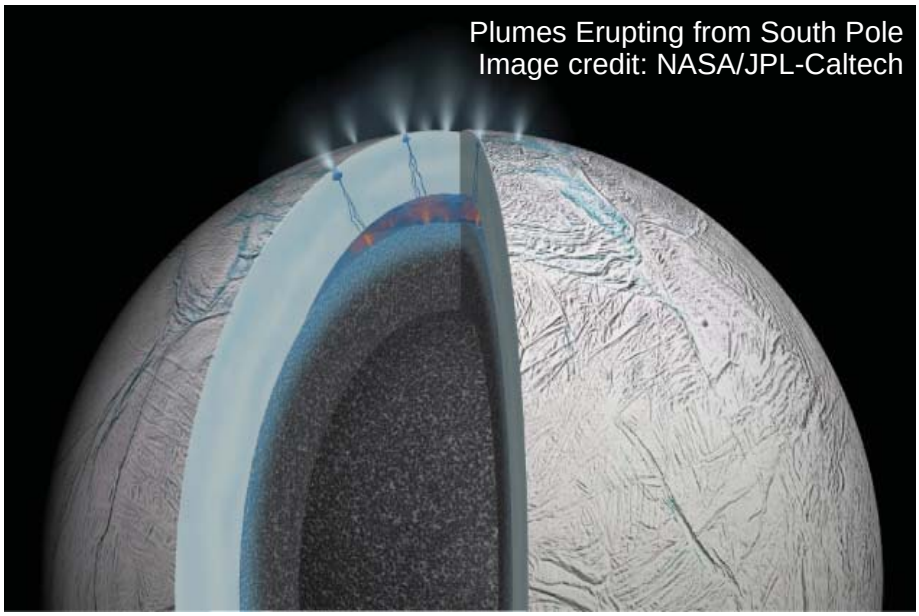
The research may provide more immediate returns on Earth. Severe droughts in underdeveloped countries have destroyed crops and threatened the livelihood of inhabitants who don' t have the means to relocate to more hospitable areas. Identifying varieties of potatoes that can grow in an arid, cold environment, and in a soil with a high salt content, could provide a low calorie, high fiber food and a good source of several vitamins, minerals and antioxidants for future colonists on Mars as well as for those on Earth dependent upon an progressively volatile climate.

Juno Update

Juno was launched in August 2011 and is scheduled to arrive at Jupiter on July 4, 2016.The diagram produced by the Jet Propulsion Laboratory's Solar System Simulator (*http://space.jpl.nasa.gov/*) for April 15th shows the position of the Juno spacecraft (in green).



Enceladus



Saturn has seven named rings, named in the order of discovery with the letters A though G. The "E" ring is furthest from the planet and is the largest ring in the solar system, extending from the orbit of Saturn's moon Mimas out toTitan. Embedded within the "E" ring is the diminutive moon Enceladus.

In the past 12 years, the Cassini spacecraft has executed 22 flybys of Enceladus, the closest on October 28th of 2015 (passing within 30 miles or 49 km over the moon' s south pole and through the icy plumes). From the encounters (and analysis of Saturn's E ring), scientists are piecing together a working model of moon' s interior. Based upon the latest research, it is likely that Enceladus has:

- a porous core that allows water to percolate through the rocky mantle
- a global ocean in contact with the rock on the ocean floor and below
- a rock/ocean interface temperature likely greater than 194°F (90°C) – heat is created by serpentinization (a chemical reaction between the mineral olivine in the rock and the seawater)
- an ocean chemistry that is alkaline with a pH as low as 8.5 based upon the formation of silica nanoparticles (and as high as 12)
- a salinity that may be comparable to the high-alkaline "soda lakes" on Earth such as Mono Lake in California
- hydrothermal activity (based upon the size of the silica grains found in the plumes and E ring). The grains continue to grow as they ascend from the sea floor to the ice/plumes above – the size of the grains suggest that this process happens relatively quickly (months to several years) so Cassini's instruments are detecting relatively new material.

The Search for Life on Mars

While NASA's 2016 Mars InSight mission was temporarily grounded, the European Space Agency (ESA) enjoyed a successful launch of their 9,550 pound (4,332 kg) ExoMars Trace Gas Orbiter (TGO) aboard a Russian Proton-M rocket. The Russian booster placed the spacecraft on an intercept trajectory for an October 19th arrival at the Red Planet. TGO is designed to detect trace atmospheric gases that could be markers for life (microbe activity) on the planet. The data collected by the TGO will be used to identify and select potential landing sites for an ESA exobiology rover on a follow-on mission in 2018. The spacecraft also carries a lander (Schiaparelli) designed to assess landing performance technology.

Launch of ESA's ExoMars Orbiter and Lander March 14, 2016

Photo credit: ESA-Stephane Corvaja

Moon Shadows

On March 9, 2016, the Moon moved between the Sun and Earth, eclipsing the Sun and casting a shadow on the Earth. The Moon's shadow raced across the Indian Ocean, moving east over the islands and open water of Indonesia and Oceania.

Located a million miles from Earth (in the direction of the Sun), the National Oceanic and Atmospheric Administration operates the DSCOVR satellite. The satellite monitors the solar wind and serves as a sentinel for solar storms. The satellite is also equipped with a four megapixel CCD camera and Cassegrain telescope pointed back towards the Earth. The camera captured images of the shadow moving across the globe every 20 minutes during the eclipse.

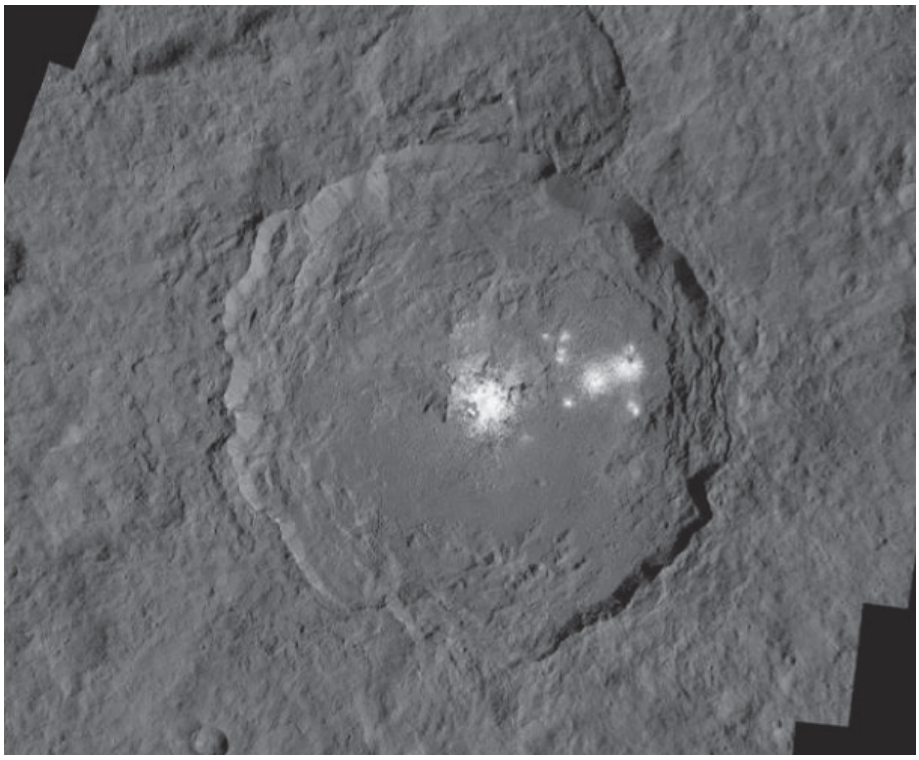
All Eyes on Ceres

The Dawn spacecraft entered orbit on March 6, 2015 and has spent the last year mapping the dwarf planet and studying its features from progressively lower orbits. In its final and lowest orbit (240 miles or 385 kilometers above the surface of Ceres), Dawn has been able to resolve the dwarf planet's "bright spots," discovered early in the mission, in much greater detail.

An animation of the eclipse , as seen from DSCOVR, is available at NASA's Earth Observatory website at: *http://earth observatory.nasa.gov/NaturalHazards/view.php?id=87675*. The NASA image (below) is courtesy of the DSCOVR EPIC team.

Occator Crater is home to one of the most prominent bright spots on Ceres. The impact crater is approximately 57 miles (92 km) across and is located just north (20°) of the dwarf planet's equator. Its floor is 2.5 miles (4 km) below the surrounding surface. Occator's central peak or dome-like structure is covered with bright deposits that appear to be salt-rich (e.g., magnesium sulfate) and consistent with material that would be left behind if a briny water ice, exposed to the warmer temperatures on the surface of the dwarf planet, were to sublimate (transition of solid ice directly to a gaseous state). Daytime surface temperatures on Ceres range from -136°F to -28°F, with the higher temperatures near the equatorial region.

Dawn is not alone in studying Ceres – the European Space Agency's Herschel Space Observatory detected water vapor around the dwarf planet in 2014. While the telescope didn't have the capability to resolve individual features, it was able to isolate the source of almost all of the water vapor to two regions.



Occator Crater on Ceres
Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

Enhanced Color of the Bright Deposits in Occator Crater
Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

Ceres has also been tar geted by the European Southern Observatory's 3.6-meter telescope at La Silla, Chile. The telescope's HARPS spectrograph has detected changes in the brightness of the spots on Ceres, not only as Ceres rotates, but over the course of a day Scientists believe that the fluctuations are related to the volatility of the bright deposits (with sunlight causing the material to sublimate). For this process to continue for any length of time, new material would continually have to be exposed to the surface.

The density of Ceres (2.09 gms/cc as compared to Earth's density of 5.52 gms/cc) suggests that water-ice comprises a significant portion of the dwarf planet's mantle. Dawn's detailed mapping surveys, combined with observations from Earth-bound and space-based telescopes, suggests that the interior of Ceres may still be active, billions of years after its formation.

Return to the "cool, green hills of Earth"

U.S. astronaut Scott Kelly and Russian cosmonauts Mikhail Kornienko returned to Earth after a 340 day stay on the International Space Station, along with fellow cosmonaut Sergey Volkov (after a six month stay). The Soyuz TMA-18M landed near the town of Zhezkazgan, Kazakhstan on Wednesday, March 2nd (local time).

While Kelly announced his retirement from NASA (effective April 1st), he will continue to participate in the post-flight medical evaluation. Lessons-learned from his year in space are expected to pave the way for other long duration flights to destinations that will, one day , include Mars.

Kelly flew in space four times, accumulating a total of 520 days in space (a record for U.S. astronauts). In his first mission, he piloted the space shuttle Discovery to the Hubble Space Telescope for a servicing mission in December 1999.

Soyuz TMA-18M Under Parachute Photo Credit: (NASA/Bill Ingalls)

More Space in Space

Tentatively scheduled for April 8th, SpaceX will launch its Dragon cargo-carrying spacecraft to the International Space Station (ISS) in a resupply mission. Stowed in the unpressurized portion of the spacecraft will be an experimental, expandable module, the Bigelow Expandable Activity Module (BEAM). Once installed, BEAM will expand to create a living and working space approximately 13 feet in length and 10.5 feet in diameter.

BEAM will be periodically visited by ISS astronauts over the two year test period to collect sensor data and to assess the condition and durability of the structure. The test period will allow NASA and Bigelow Aerospace to evaluate the structure's thermal characteristics, leak rate, radiation protection and other attributes that could determine its commercial applications for near-Earth orbit and use in supporting deep space missions.

Credit: Bigelow Aerospace, LLC

April History

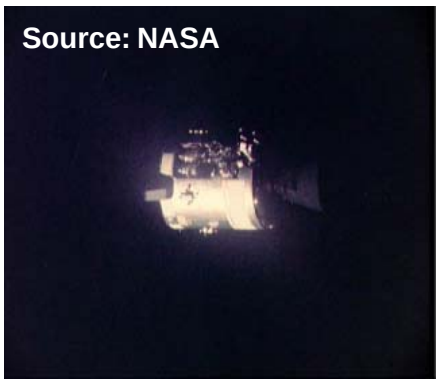
Apollo 16 wasn't the only lunar mission launched in the month of April. Two years earlier, on April 11, 1970, Apollo 13 lifted off from Cape Canaveral in what was intended to be the third manned mission to the Moon. The crew of James Lovell, Fred Haise and Jack Swigert never got their chance.

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.

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 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 View of damaged Apollo 13 Service Module from the Lunar/ Command Modules 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.



View of damaged Apollo 13 Service Module from the Lunar/ Command Modules.

The cause of the accident was eventually traced to damage the oxygen tank had sustained dur - ing its removal from Apollo 10. Due to a defective 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. 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 just before dawn on April 22nd. The dust producing the shooting stars is from *Comet Thatcher*. Expect to see 10 to 20 meteors per hour if light from a full moon doesn' t interfere. As with all meteor showers, the Lyrids are named for the constellation (Lyra) from which they appear to radiate.

Comet History

In the photo (right) *Comet Hale-Bopp* graced the evening sky on April 2, 1997, one day after perihelion (closest approach to the Sun). The comet was brighter than the brightest stars in the sky, with a dust tail that stretched almost 45 degrees across the sky. The photo shows the brighter, yellow dust tail and the dimmer, blue ion (gas) tail.

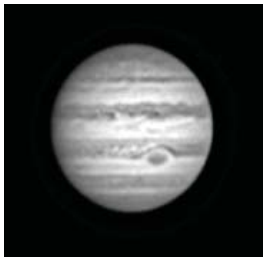
The orbital period of *Hale-Bopp* as it entered the inner solar system was 4,206 years. A close encounter with Jupiter inApril of 1996 modified its orbit, shortening its orbital period to 2,380 years as it returned to the outer solar system.

Sunrise and Sunset

Sun	Sunrise	Sunset
April 1st (EST)	06:36 am	7:19 pm
April 15th	06:13 am	7:35 pm
April 30st	05:51 am	7:51 pm

Jupiter and its Moons

Jupiter reached Opposition and its closest approach to Earth in early March. During the month of April, Jupiter is still well placed in evening sky after sunset. Jupiter will be at its highest shortly before midnight on April 1st and almost two hours earlier by month's end. As the Earth moves ahead of Jupiter on its inside orbit, Jupiter will diminish slightly in brightness and apparent size. As one of the brightest star-like objects in the night sky Jupiter can be found in the constellation Leo.



One of the more interesting and easier events to observe through a telescope is the projection of a shadow from one of Jupiter 's moons on the Jovian disk as the moon passes in front of (or transits) the planet. The photo above shows the shadow of Ganymede on the Jovian disk. On nights of good visibility the following events should be visible through a moderately-sized telescope.

Jovian Moon Transits

Date	Moon	Transit Begins	Transit Ends
6th	Io	10:32 pm	12:47 am (7th)
8th	Europa	6:55 pm	9:42 pm
15th	Io	6:55 pm	9:10 pm
15th	Europa	9:32 pm	12:19 am (16th)
22nd	Io	8:50 pm	11:04 pm
29th	Io	10:44 pm	12:58 am (30th)

Transit of Jupiter's Red Spot

The Red Spot is a large cyclone in the upper Jovian atmosphere. The rapid rotation of this gas giant (10 hours) may be responsible for the longevity of this storm, which has been observed for over 300 years. The Red Spot will cross the center line of the planetary disk on the following evenings during the hours between 8 pm to midnight local time:

Date	Transit Time	Date	Transit Time
Mar 31st	11:56 pm	17th	10:57 pm
3rd	9:25 pm	20th	8:27 pm
5th	11:03pm	22nd	10:05 pm
8th	8:33 pm	24th	11:44 pm
10th	10:11 pm	27th	9:14 pm
15th	9:19 pm	29th	10:52 pm

Astronomical and Historical Events

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)
3rd Aten Asteroid 2008 FX6 Near-Earth Flyby (0.070 AU)
3rd History: Soviet spacecraft Luna 10 becomes the first artificial satellite to orbit the Moon (1966)
4th Scheduled flyby of Saturn's largest moon *Titan* by the Cassini spacecraft
4th History: launch of Apollo 6, last test flight of the Saturn V rocket (1968)
5th Kuiper Belt Object 2014 FT71 at Opposition (46.862 AU)
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 New Moon

Astronomical and Historical Events (continued)

7th Moon at perigee (closest distance from Earth)
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 Scheduled launch of SpaceX's Dragon spacecraft from the Cape Canaveral Air Force Station, Florida, carrying supplies to the International Space Station
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 Tatel telescope toward the star Tau Ceti (1960)
9th **Second Saturday Stars - Open House at McCarthy Observatory**
9th Northeast Astronomy Forum and Telescope Show (NEAF), Rockland Community College, Sufern, NY (9th and 10th)
10th Apollo Asteroid 406952 (2009 KJ) Near-Earth Flyby (0.097 AU)
10th Atira Asteroid 2013 JX28 Closest Approach to Earth (0.733 AU)
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)
11th Apollo Asteroid 363599 (2004 FG11) Near-Earth Flyby (0.050 AU)
11th Apollo Asteroid 2009 BC11 Near-Earth Flyby (0.081 AU)
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 Kuiper Belt Object and Dwarf Planet 136108 *Haumea* at Opposition (49.764 AU)
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 First Quarter Moon
13th Comet 9P/Tempel closest approach to Earth (0.979 AU)
13th Aten Asteroid 2005 GR33 Near-Earth Flyby (0.020 AU)
13th Apollo Asteroid 11066 *Sigurd* closest approach to Earth (1.846 AU)
13th History: launch of Transit 1B, first experimental navigation satellite (1960)
14th History: Christiaan Huygens born, Dutch scientist and discoverer of Saturn's rings and largest moon *Titan* (1629)
15th Apollo Asteroid 4769 *Castalia* closest approach to Earth (0.223 AU)
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 Aten Asteroid 2100 *Ra-Shalom* closest approach to Earth (0.508 AU)
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 Mercury at its Greatest Eastern Elongation (20°) – apparent separation from the Sun in the evening sky

Astronomical and Historical Events (continued)

18th Aten Asteroid 3554 *Amun* closest approach to Earth (0.748 AU)
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)
21st Moon at apogee (furthest distance from Earth)
22nd Full Moon (Full Pink Moon)
22nd Lyrids Meteor Shower peak
22nd Earth Day
22nd History: launch of the Air Force's X-37B prototype space plane from Cape Canaveral, Florida; first orbital mission (2010)
23rd Aten Asteroid 2014 UR Near-Earth Flyby (0.079 AU)
23rd Apollo Asteroid 2016 BU13 Near-Earth Flyby (0.079 AU)
23rd Apollo Asteroid 2006 HF6 Near-Earth Flyby (0.098 AU)
24th Amor Asteroid 9950 ESA closest approach to Earth (2.368 AU)
24th History: launch of space shuttle Discovery (STS-31) and deployment of the Hubble SpaceTelescope (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 Aten Asteroid 2003 KO2 Near-Earth Flyby (0.046 AU)
26th Amor Asteroid 2202 *Pele* closest approach to Earth (2.449 AU)
26th History: flyby of Venus (gravitational assist) by the Cassini spacecraft (1998)
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 Aten Asteroid 2013 KJ6 Near-Earth Flyby (0.095 AU)
28th Kuiper Belt Object 2010 EK139 at Opposition (36.115 AU)
28th Kuiper Belt Object 2014 FC69 at Opposition (83.270 AU)
28th History: launch of the Cloudsat/Calipso cloud imaging and profiling satellites (2006)
29th Last Quarter Moon
29th Apollo Asteroid 2002 CX58 Near-Earth Flyby (0.043 AU)
30th Aten Asteroid 2008 PR9 Near-Earth Flyby (0.077 AU)

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
- **Oppositio**n: 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°)

• One astronomical unit (AU) is the distance from the Sun to the Earth or approximately 93 million miles

International Space Station and Iridium Satellites

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

Front Page

About 17 million light years from the Milky Way and its companions in the Local Group of Galaxies, lies a vast zone of empty space, dubbed the Local Void, and occupied by only one small galaxy about a third the size of our own.

Traditionally, astophysics would predict that an empty void should repel stray matter toward a nearby galaxy—but more recent theory is speculating that invisible dark energy is exerting its influence in the background.

For more information, go to *http://www.nasa.gov/image-feature/goddard/lonely-galaxy-lost-in-space*

Credit: NASA, ESA, D. Calzetti (University of Massachusetts), H. Ford (Johns Hopkins University), and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration

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Front page design and graphic calendars: Allan Ostergren

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Second Saturday Stars

FREE EVENT

Every Month at the

John J. McCarthy Observatory

Behind the New Milford High School

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April 9th

8:00 - 10:00pm

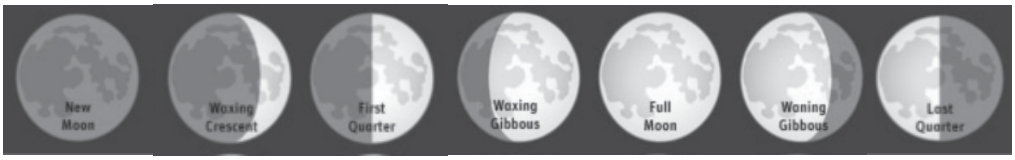
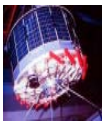
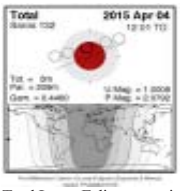
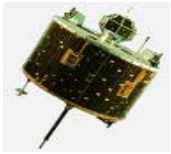
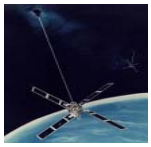
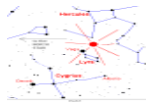
THE STATE OF OUR EARTH

Refreshments
Family Entertainment
Handicapped Accessible
ASL Interpretation Available with Prior Notice
Rain or Shine

Map

April 2016

Celestial Calendar

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Phases of the Moon  Apr 7 Apr 13 Apr 22 Apr 29					**1**  1960: First successful weather observation satellite, TIROS I (Television Infra-Red Observation Satellite), launched by NASA; operated for 78 days. (1960)	**2**  Launch of Zond 1, Soviet Venus flyby mission (1964)  Selection of the Mercury 7 astronauts (1959)  French physicists Louis Fizeau and Leon Foucault take first photo of the Sun (1845)
3  Soviet spacecraft Luna 10 first artificial satellite to orbit moon (1966)	**4** Launch of Apollo 6, last test flight of the Saturn V rocket (1968)   Total Lunar Eclipse, seen in U.S. West, before sunrise - less than 5 minutes	**5**  Launch of Pioneer 11, Jupiter and Saturn flyby mission (1973) Launch of Compton Gamma Ray Observatory (1991)   launch of the first Pegasus rocket (1990)	**6** Moon at perigee (closest distance to Earth)   Launch of Intelsat 1, first commercial communica-tions satellite (1965)	**7**  Launch of Luna 14, Soviet Moon orbiter mission (1968)	**8** Launch of unmanned Gemini I (1964)   Project OZMA, search for extraterrestrial life (1960) Discovery of Saturn's moon Telesto by Voyager 1 (1980) 	**9** NEAF NORTHEAST ASTRONOMY FORUM April 8-9 2nd Saturday Stars Open House McCarthy Observatory 
10  Japanese lunar probe Hiten impacts Moon's surface (1993)	**11** ESA spacecraft Venus Express enters orbit around Venus (2006)   Apollo 13 launch on ill-fated moon mission (1970)	**12**  Edward Maunder born. studied solar cycle and sunspots. (1851)  Shuttle, Columbia, with John Young and Robert Crippen (1981)  Yuri Gagarin first man in space on Vostok I (1961)	**13**  Launch of Transit 1B, first experimental navigation satellite (1960)	**14**  Christiaan Huygens, discoverer of Saturn's rings and moon Titan born (1629)	**15**  Leonhardt Euler, Swiss mathematician, precisely calculated the orbits of comets and other celestial bodies and contributed to the wave theory of light (1707)	**16**  Apollo 16 launch to lunar highlands (1972) Leonardo da Vinci born (1452) 
17  Closest flyby of the Sun by a spacecraft, Helios 2 (1976) Launch of Surveyor 3 Moon lander (1967) 	**18**  Albert Einstein dies in Princeton, NJ (1955)	**19**  Launch of Salyut 1 (1971) and Salyut 7 (1982), first and last Soviet space stations	**20**  Harold Graham performs 1.2-meter, 13- second free flight of a rocket pack, designed at Bell Aerosystems. (1961)	**21**  Apollo 16 on the Moon (Young, Mattingly and Duke) - fifth manned mission and first to land in the lunar highlands (1972)	**22**  Lyrids meteor shower peak launch of the Air Force's X-37B prototype space plane from Cape Canaveral, Florida; first orbital mission (2010) 	**23**  Moon at apogee (farthest from earth)  Ranger 4 Lunar probe launched - failed its mission, but became first U.S. craft to impact the Moon (1962)
24 Launch of shuttle Discovery with Hubble space telescope (1990)  Cosmonaut Valery Komarov dies on re-entry on lunar spacecraft Soyuz 1 (1967) Launch of 1st Chinese Mao 1 (*aka "the East is Red"*) satellite, (1970)	**25** The 20th Annual Great Moonbuggy Race, Huntsville, AL, at the U.S. Space & Rocket Center (April 25-27) Nikolai Semenovich Kardashev born, astrophysicist and deputy director of the Russian Space Research Institute, pioneered search for extraterrestrials (1932)	**26** Cassini spacecraft gets gravitational assist from Venus on way to Saturn 1998	**27** Karl Jansky, a Bell Labs physicist and radio engineer, announces discovery of radio transmissions from Milky Way (1932)	**28** Launch of the Air Force's X-37B prototype space plane from Cape Canaveral, first orbital mission (2010) Isaac Newton publishes *Principia*, describing gravitation and 3 laws of motion (1686)	**29** Cornelis de Jager, Dutch astronomer born; worked on predicting solar variation, to assess the Sun's impact on future climate (1921)	**30** Plinius' Eclipse, described by Pliny the Elder, Roman naturalist in Campagnia, Italy : "Then the sun was suddenly darkened and the fourteen districts of the city were struck by lightning" (59 AD)