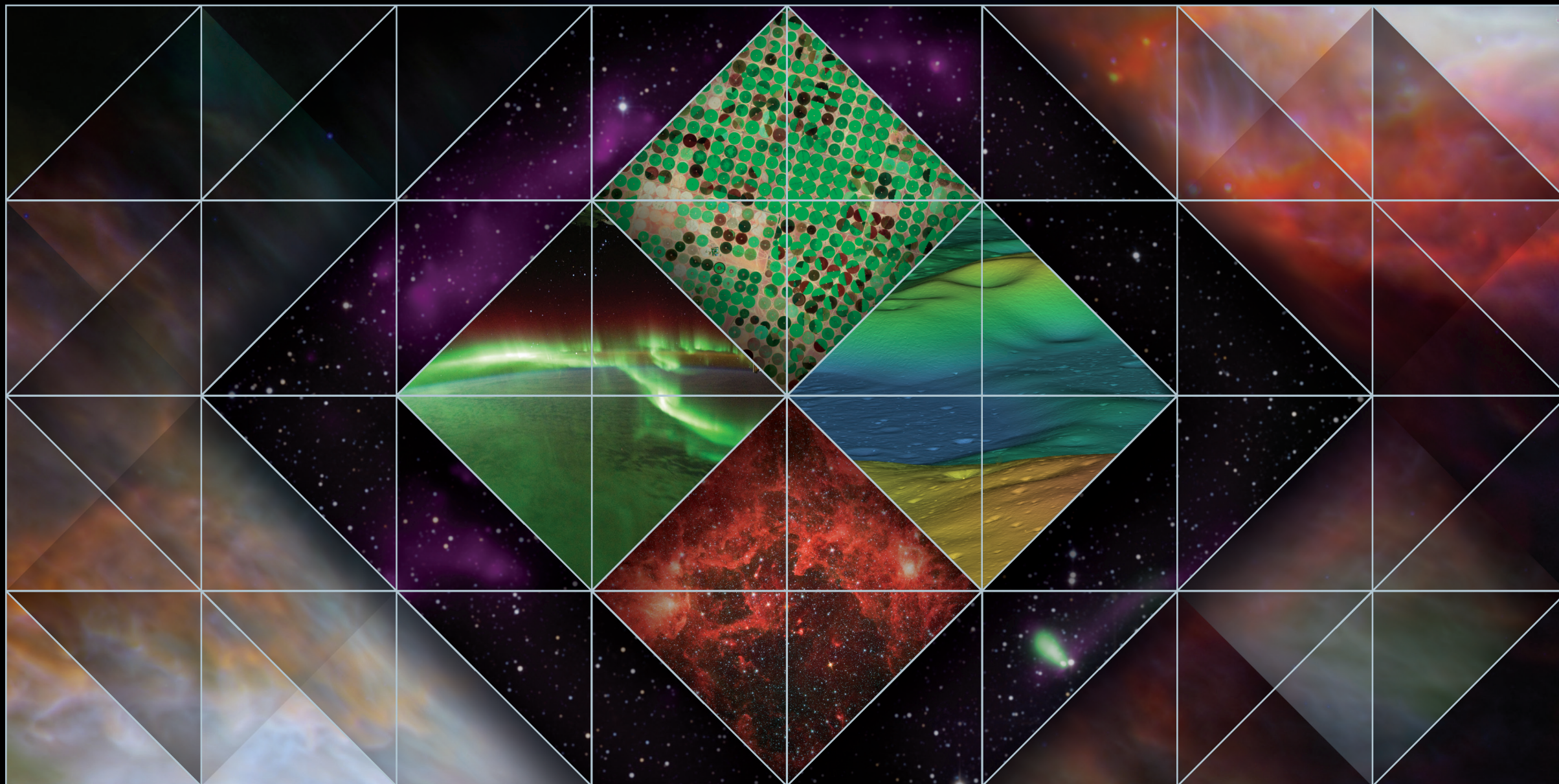
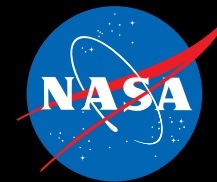


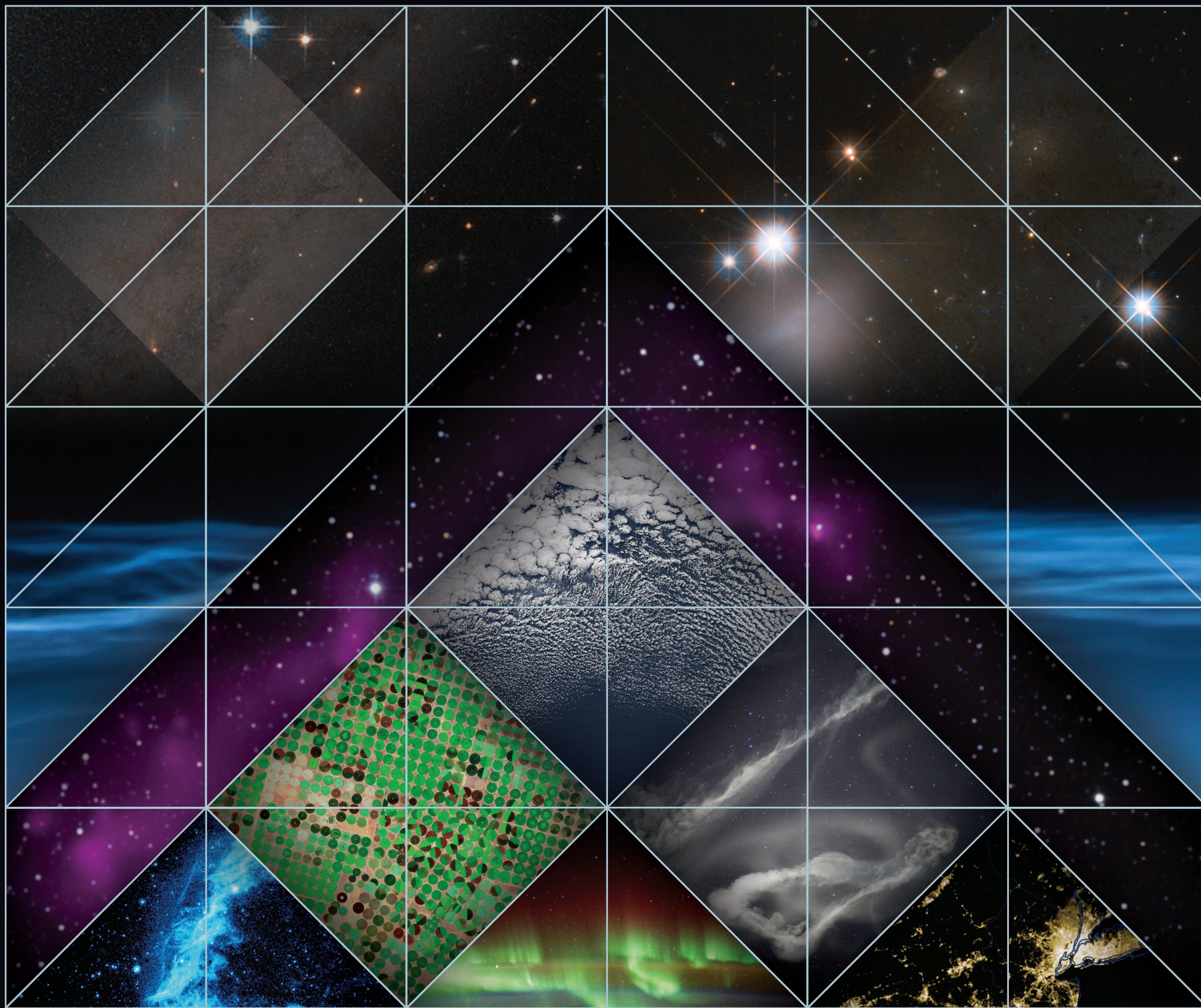
# NASA Science

National Aeronautics and  
Space Administration

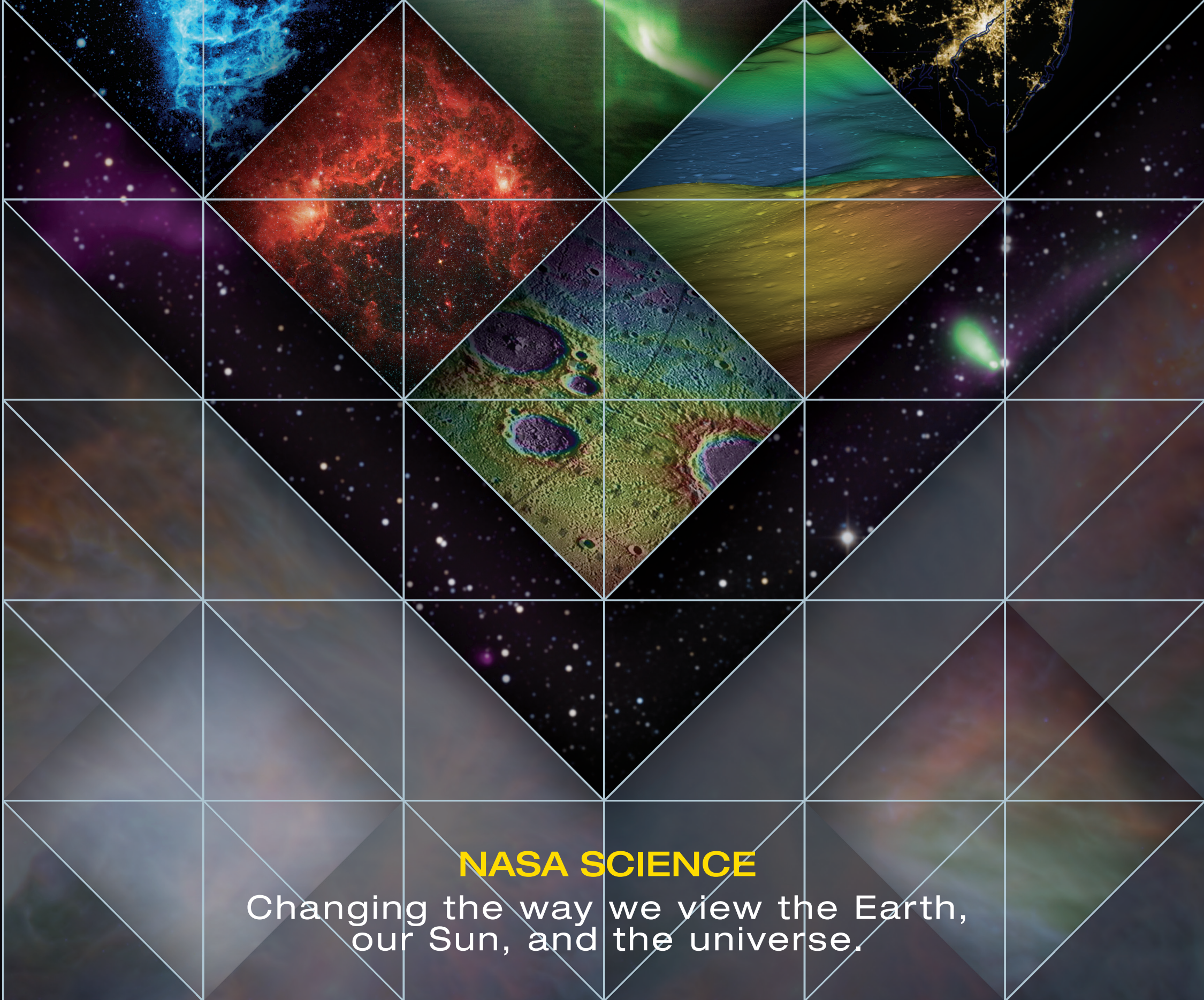


# 2013





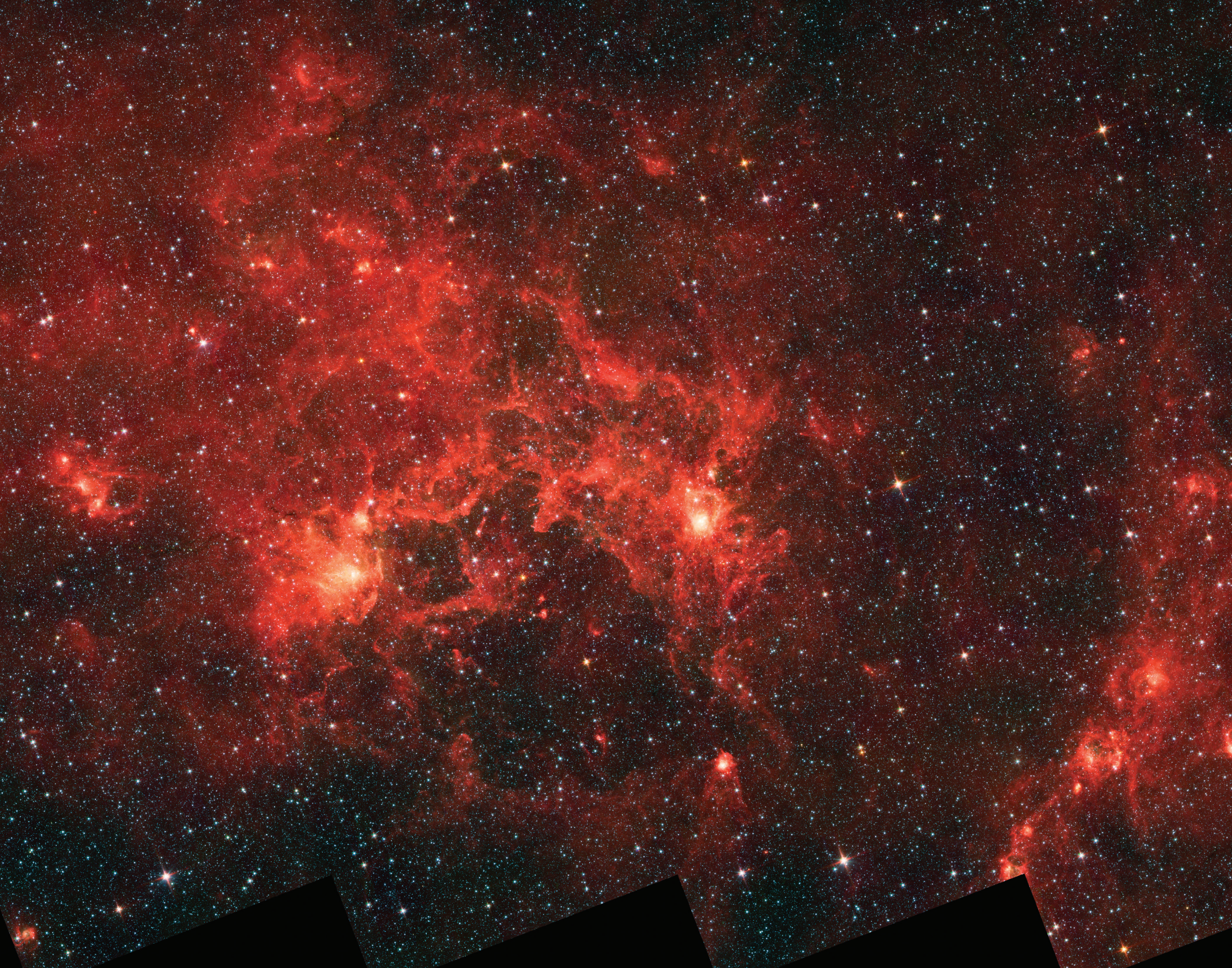




**NASA SCIENCE**

Changing the way we view the Earth,  
our Sun, and the universe.







Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5 ●
6	7	8 New Year's Day	9	10	11 ●	12
13	14	15	16	17	18 ●	19
20	21 Inauguration Day Martin Luther King, Jr. Day	22	23	24	25	26
27 ●	28	29	30	31		

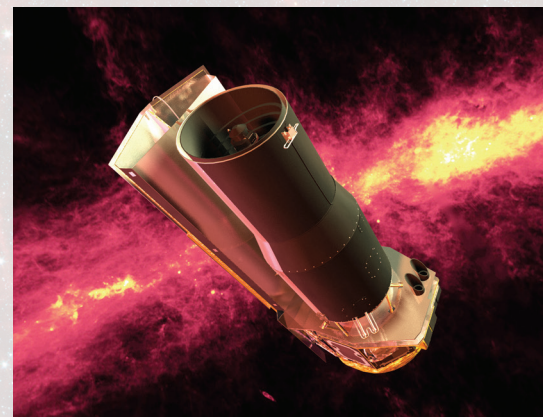
## Massive Deep Space Dragonfish

Lurking in the depths of our oceans, Deep Sea Dragonfish are known for their fang-like teeth, large mouths, and bulging eyes. The nebula pictured here is located approximately 30,000 light years from Earth in the Crux constellation—and is nicknamed the "Dragonfish." This turbulent region, jam-packed with stars, is home to some of the most luminous *massive stars* in our galaxy—the *Milky Way*.

The massive stars—with a mass eight times greater than that of the Sun—have blown a bubble in the gas and dust that make up the radiant nebula, carving out a shell of more than 100 light-years across (seen in the lower, central part of the image). This shell forms the fish's "toothy maw," and the two bright spots make up its beady "eyes."

The unseen central cluster of massive stars is heating up the surrounding cloud of gas and dust more than other star clusters, which suggests that this might be the largest massive star cluster in our galaxy. The heat, or infrared light, was detected by the Infrared Array Camera on NASA's Spitzer Space Telescope. The bright spots along the shell, including the eyes, are possible smaller regions of newly formed stars, triggered by the compression of the gas and dust by winds from the massive stars.

Image and Partial Text Credit: NASA/Jet Propulsion Laboratory-Caltech/University of Toronto



Artist's rendering of the Spitzer Space Telescope.  
Credit: NASA/JPL-Caltech

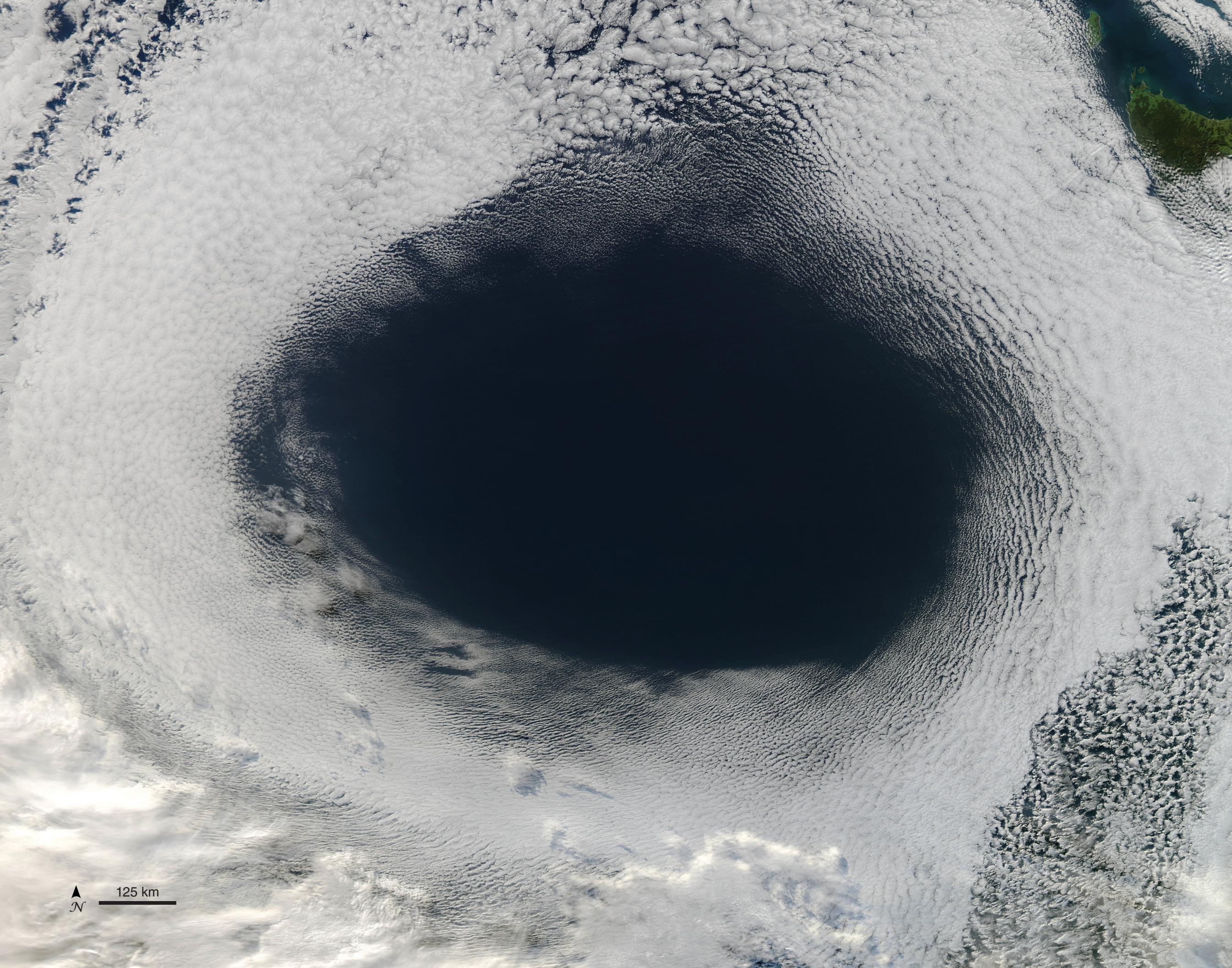
### DECEMBER 2012

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### FEBRUARY 2013

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125 km

N





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

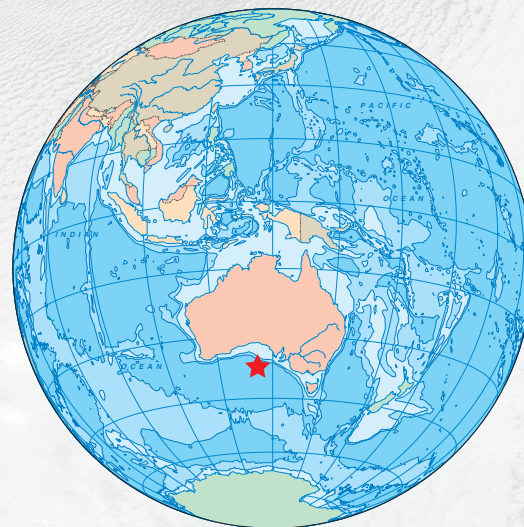
## Australian Skies Say High

At any given time, looking down from space, areas of white clouds can be seen blanketing different parts of Earth's surface. On June 5, 2012, the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Aqua satellite acquired this view of a hole in marine stratocumulus clouds over the Great Australian Bight at 3:00 PM local time.

Images like this "say" something about the atmospheric conditions present at the particular time. This cloud hole, with a diameter that stretched as far as 620 miles (1000 kilometers) across, was caused by sinking air associated with an area of high pressure. Globally, the average sea-level pressure is about 1013 millibars, but at the center of this high, the pressure topped 1040 millibars. Stormy weather in this area is the norm during Southern Hemisphere winter, so finding such a large "eye" through the clouds is unusual, and provides a rare opportunity to observe the sea surface below.

In general, winds blow outward and away from areas of high pressure, with a resulting downward air flow in the center. The sinking air warms, increasing its rate of evaporation and making it difficult to sustain clouds. In contrast, winds blow into areas of low pressure, sending air upward, and generating clouds and stormy weather. While low-pressure systems often produce circular cyclonic storms and clouds, high-pressure systems (which are sometimes called anticyclones) can yield large circular areas of clear skies like this.

Image and Partial Text Credit: NASA Earth Observatory



### JANUARY 2013

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### MARCH 2013

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Daylight Saving Time Begins						
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<del>24</del>	25	26	27 	28	29	30
31						

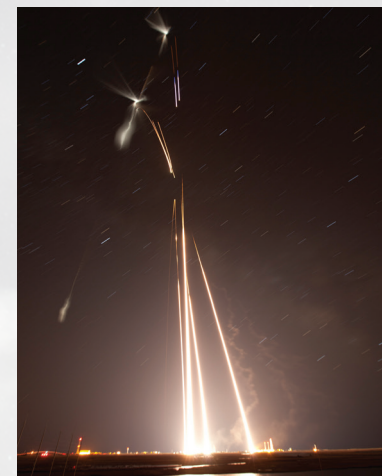
## Probing the Edge of Our Atmosphere

Near the edge of our atmosphere, some 60 miles (97 kilometers) above the Earth's surface, winds travel upwards of 200-300 miles per hour (322-483 kilometers per hour) through a region that has been described as an ultra-high-altitude jet stream. Found at much higher altitudes than the meandering polar and subtropical jet streams that are more commonly studied by meteorologists, scientists know very little about this mysterious region simply because it is so far away.

On March 27, 2012, starting at 4:58 AM EDT (09:58 UTC), NASA launched five sounding rockets in just over five minutes to probe the fast-moving jet. Launched from NASA's Wallops Flight Facility in Virginia, each rocket released a chemical tracer that glows when it reacts with oxygen, creating the luminous contrails pictured above in an otherwise black and starry sky. The shapes of these smoky ropes provide clues about the region's wind speed, direction, and turbulence, which allow scientists to better understand what drives these winds.

The results from the mission—called the Anomalous Transport Rocket Experiment (ATREX)—will help scientists better model the electromagnetic regions of space that can damage satellites and disrupt communications systems. The experiment will also help explain how the effects of atmospheric disturbances in one part of the globe can be transported to other parts of the globe in a mere day or two.

Image and Partial Text Credit: NASA/Goddard Space Flight Center



Five suborbital sounding rockets were launched from Wallops Flight Facility in Virginia to study the upper-level jet stream. Credit: NASA/Wallops

### FEBRUARY 2013

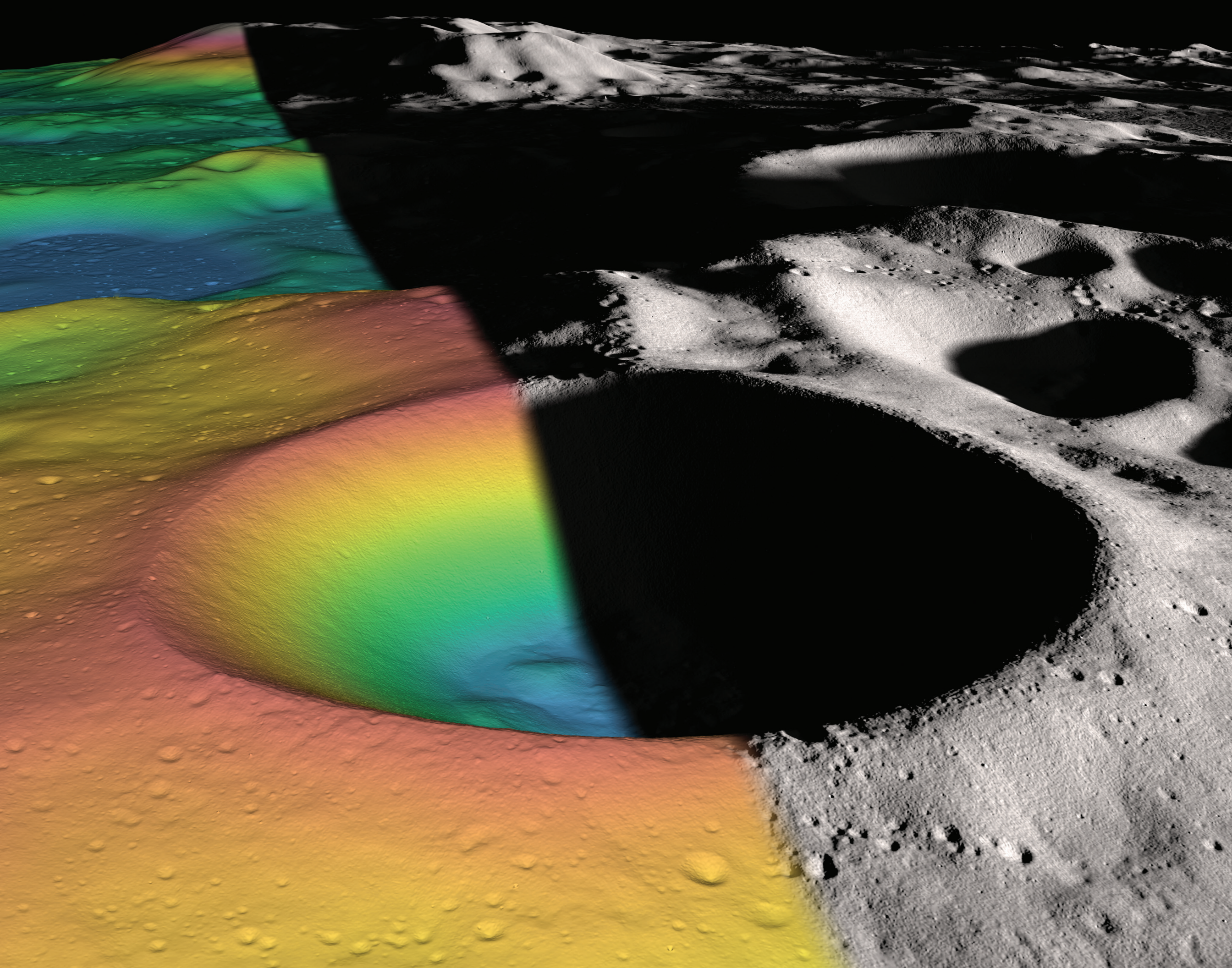
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### APRIL 2013

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28	29	30				









Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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14	15	16	17	18 ●	19	20
21	22	23	24	25 ●	26	27
28	29	30				

## Untouched Crater on the Moon

If NASA is to, one day, return humans to the Moon, one of the big questions to answer will be: *Where is the best place to land?* Shackleton Crater, located at the Moon's South Pole, has long been viewed as a prime location for a self-sustaining lunar outpost for two reasons: sunlight and the possibility of water. The crater is situated such that its rim receives almost constant illumination from the Sun (80-90% of the time), while the interior is enshrouded in perpetual shadow and is extremely cold.

Recent findings from NASA's Lunar Reconnaissance Orbiter (LRO) have enhanced Shackleton's attractiveness as a potential settlement site. Using laser light from LRO's laser altimeter, researchers found the crater's floor to be brighter than those of other nearby craters, which is consistent with the presence of small amounts of ice. The results indicate that as much as 22% of the crater floor may be composed of ice.

In addition to the possible evidence of ice, the crater has remained relatively untouched since its formation more than three billion years ago. The image above shows elevation [left] and shaded relief [right] of Shackleton. The colors on the "elevation" side indicate a gradual decrease in height from the crater's rim (red) to its core (blue). The crater is 2 miles (~3.2 kilometers) deep and more than 12 miles (~19 kilometers) wide. The high sides cast a dark shadow (black) on the crater's interior, as shown on the "shaded relief" side. The image was constructed using a digital elevation model that employed over 5 million elevation measurements from the Lunar Orbiter Laser Altimeter (LOLA) onboard LRO.

Image and Partial Text Credit: NASA/Zuber, M.T. et al./Nature 2012



Artist's illustration of the Lunar Reconnaissance Orbiter circling the moon. Credit: NASA

MARCH 2013						
S	M	T	W	T	F	S
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MAY 2013						
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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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12	13	14	15	16	17	18 
Mother's Day 19	20	21	22	23	24	25 
26	27	28	29	30	31 	
	Memorial Day					

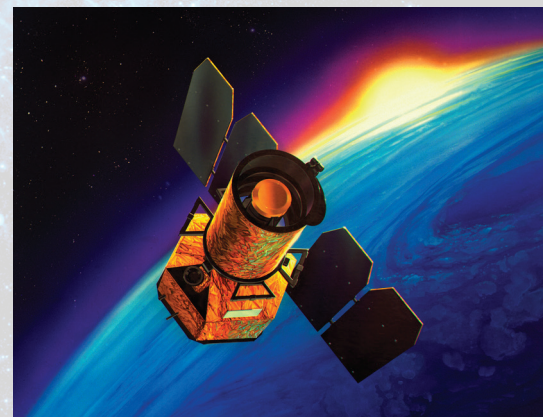
## Brilliant Evidence of Stellar Explosion

Thousands of years ago, a massive stellar explosion, or *supernova*, sent a tremendous shockwave hurtling through the surrounding interstellar medium heating the threads of gas and dust that formed the luminous Cygnus Loop nebula.

The nebula lies about 1500 light-years away from Earth and is a supernova remnant left over from a colossal explosion that occurred between 5000 to 8000 years ago. The initial flash would have been bright enough to be seen clearly from Earth with the naked eye. The Cygnus Loop extends over three times the size of the full moon in the night sky and it is still spreading outward. The nebula is next to the "Swan" constellation, or Cygnus, tucked beneath one of its "wings."

Parts of the nebula can actually be seen in visible light, but for unprecedented views like this, scientists use ultraviolet space telescopes capable of detecting various wavelengths outside the visible range. Wispy tendrils of the hot dust and gas glow brilliantly in this ultraviolet image, taken by NASA's Galaxy Evolution Explorer.

Image and Partial Text Credit: NASA/Jet Propulsion Laboratory-Caltech



Artist's illustration of the Galaxy Evolution Explorer.  
Credit: NASA/Jet Propulsion Laboratory-Caltech

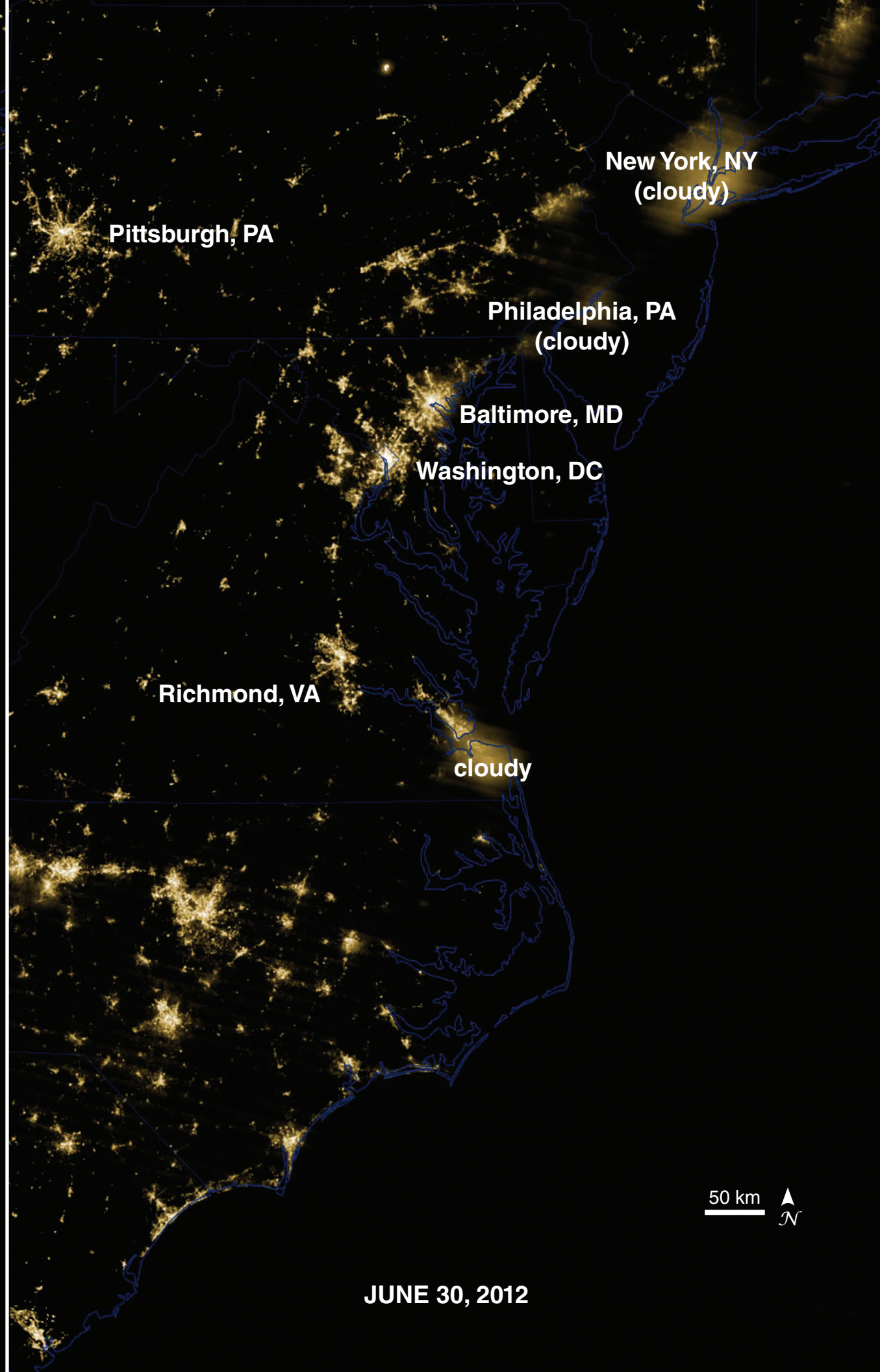
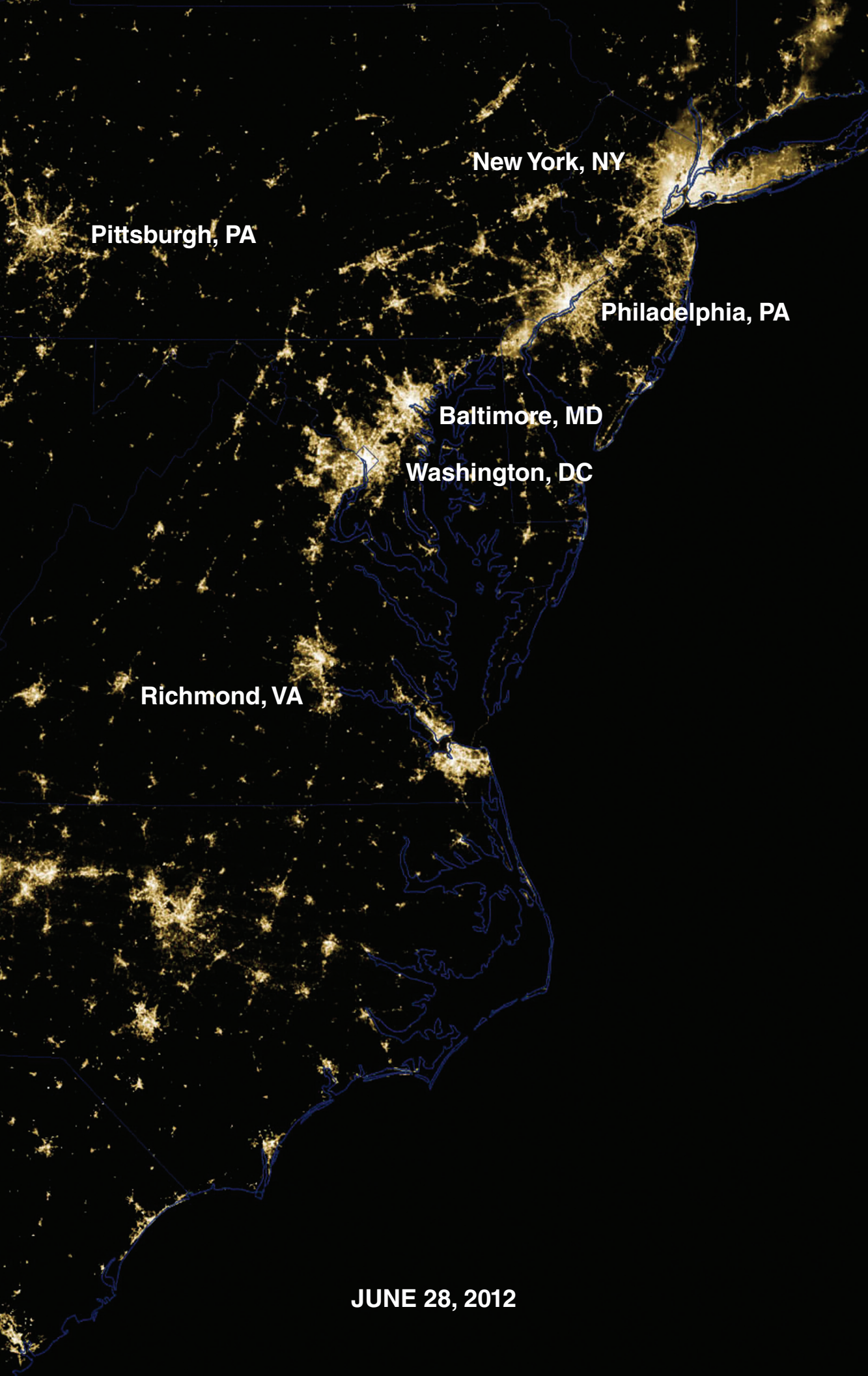
## APRIL 2013

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28	29	30				

## JUNE 2013

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23 30	24	25	26	27	28	29







Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
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16	17	18	19	20	21	22
Father's Day					Flag Day	
<del>23</del>	24	25	26	27	28	29
30						

## Fast-moving Storms Leave Millions In the Dark

On June 29, 2012, an intense, long-lived line of thunderstorms, traveling eastward at nearly 60 miles per hour (~97 kilometers per hour), trekked across the Midwest to the Mid-Atlantic region. Known as derechos, storms like these are notorious for their destructive straight-line winds and great distances traveled—the term *derecho* comes from the Spanish word for “straight.” The derecho killed more than 20 people, caused millions of dollars in property damage, and left some 4.3 million households without power for days. Most of the damage was the result of trees falling on buildings, homes, vehicles, and power lines, caused by the near-hurricane-force winds.

These images were taken with the day/night band of the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (Suomi NPP) satellite before (June 28) and after (June 30) the storms. Comparisons between the images show the extensive power outages over Washington, DC, and Baltimore, MD. Of particular interest is the loss of light to the north and west of Washington, DC, along the 270 and 66 interstate highways and Maryland route 267. Fallen trees on power lines caused most of the outages. Clouds obscure the lights of Philadelphia, PA, and other areas north and east of Baltimore in the “after” image.

Suomi NPP—NASA’s newest Earth-observing satellite—was launched from Vandenberg Air Force Base on October 28, 2011, and is the result of a partnership between NASA, the National Oceanic and Atmospheric Administration, and the Department of Defense.

Image and Partial Text Credit: NASA Earth Observatory



MAY 2013						
S	M	T	W	T	F	S
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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	

JULY 2013						
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8 ●	9	10	11 Independence Day	12	13
14	15	16 ●	17	18	19	20
21	22 ●	23	24	25	26	27
28	29 ●	30	31			

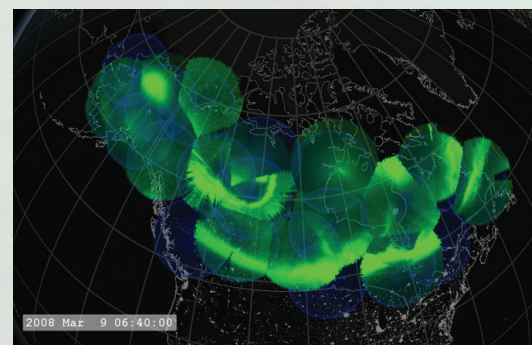
## Astronaut View of the Not-So-Southern Lights

On September 17, 2011, astronauts aboard the International Space Station (ISS) were afforded this breathtaking view of electric green lights dancing atop the night sky. At the poles, this awe-inspiring view of the *aurora australis* (a.k.a. the Southern Lights) would have been just another dazzling light show for the astronauts onboard, but what made this scene unique was that this aurora appeared near the southern Indian Ocean—outside the normal siting-range for these southern dancers.

Days before the sighting, on September 14, 2011, a sudden burst of energy from the Sun's surface sent enormous amounts of solar matter spewing towards the Earth. These massive ejections of solar matter and electromagnetic radiation are called *coronal mass ejections*, or CMEs. As solar particles from CMEs move into the Earth's magnetic field, or *magnetosphere*, they travel around to its night (dark) side along magnetic field lines, oriented north-south around the Earth. When these field lines reconnect at the north and south magnetic poles, in an area known as the *magnetotail*, energy is released and the particles collide with the Earth's upper atmosphere near the poles, and sometimes even lower latitudes. As the particles bombard oxygen and nitrogen, the atoms release a photon of light that we see as the beautiful colors of the aurora.

A digital camera onboard the ISS, orbiting some 230 miles (~370 kilometers) above the Earth's surface, captured this image. Solar panels and other sections of the ISS can be seen in the photograph.

Image and Partial Text Credit: Image Science and Analysis Laboratory, NASA/Johnson Space Center. "The Gateway to Astronaut Photography of Earth."

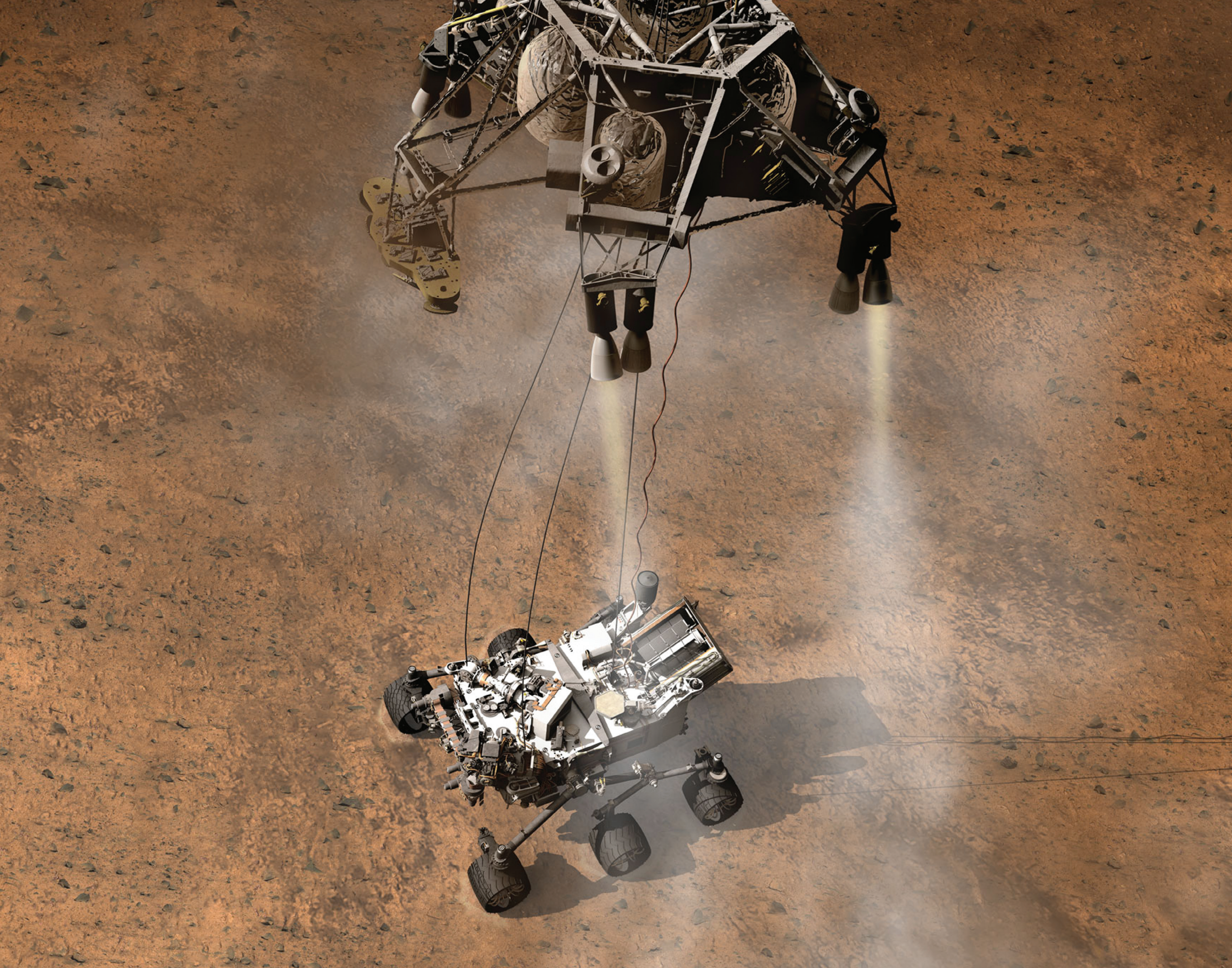


A collection of ground-based All-Sky Imagers (ASI) are an important component of NASA's Timed History of Events and Macroscale Interactions during Substorms (THEMIS) mission in understanding the interaction of the magnetosphere and aurora. This image highlights Canada and Alaska, in contrast to the main image highlighting the Southern Hemisphere. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio

JUNE 2013						
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AUGUST 2013						
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25	26	27	28	29	30	31







Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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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	31

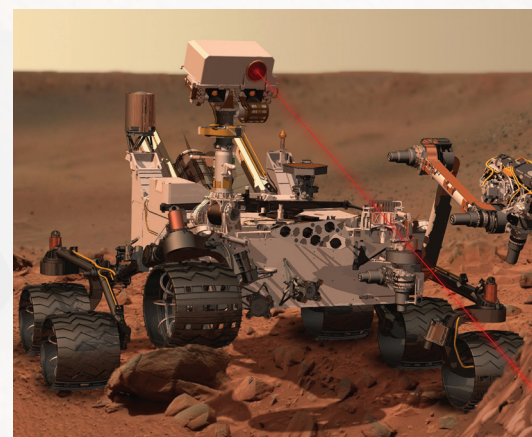
## Curiosity Lands Safely on Mars

On August 6, 2012, at 6:31 UTC (1:31 AM EDT), NASA's *Curiosity* rover—the hardest mission in the history of robotic planetary exploration—landed gracefully on Mars near the foot of a mountain inside Gale Crater. Almost everything about this mission is new and bold. The entry, descent, and landing (EDL) phase of the mission—dubbed the *seven minutes of terror*—began when the spacecraft reached the top of the Martian atmosphere traveling 13,000 miles per hour (~21,000 kilometers per hour), and ended seven minutes later with the rover landing safely on the surface of Mars amidst cheers of jubilation from mission control at the NASA Jet Propulsion Laboratory (JPL).

The artist's illustration pictured above shows the *touchdown* stage of the landing—the last of six synched transformations that had to unfold perfectly. In the image, the spacecraft has detected the touchdown, and pyrotechnic cutters have just severed the connections (cables) between the rover and the spacecraft's descent stage. The rocket-powered descent stage (top of image) is about to fly away as its work is complete.

Over the next two years, the rover will slowly work its way up the rugged slopes of Mount Sharp, which rise about 3.4 miles (5.5 kilometers) above the crater's floor, to study the layers of strata that make up the mountain. These rock layers are understood to be the surviving remnants of a series of deposits that occurred in the aftermath of a huge impact that created Gale Crater nearly three billion years ago. *Curiosity* will use its ten instruments to investigate whether this area of Mars has ever offered conditions favorable for life, or still does.

Image and Partial Text Credit: NASA/Jet Propulsion Laboratory-Caltech



This artist's concept depicts *Curiosity* as it uses its Chemistry and Camera (ChemCam) instrument to investigate Mars. Image Credit: NASA/Jet Propulsion Laboratory-Caltech

## JULY 2013

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28	29	30	31			

## SEPTEMBER 2013

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29	30					







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

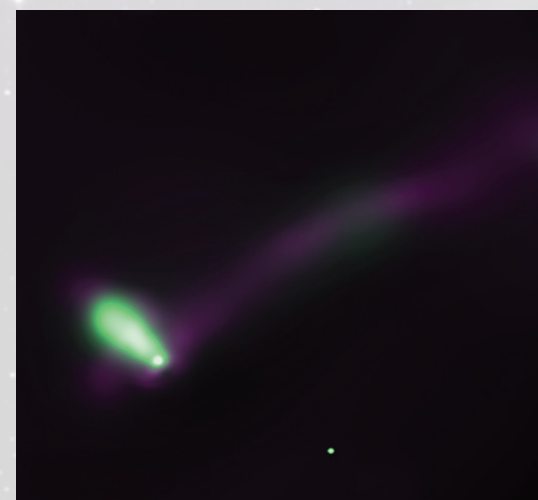
## Record-breaking Speed Detected In Space

Researchers using three different telescopes—NASA's Chandra X-ray Observatory and the European Space Agency's XMM-Newton in space, and the Parkes radio telescope in Australia—may have found the fastest moving pulsar ever seen.

The evidence for this potentially record-breaking speed comes, in part, from the features highlighted in this composite image. The large area of diffuse X-rays (purple) was produced when a *massive star* exploded as a *supernova*, known as MSH 11-61A. Near the bottom right of the image, well outside the boundary of the supernova remnant, Chandra reveals a comet-shaped X-ray source named IGR J11014. The source appears green in the image and has a long trailing tail. It is likely a rapidly spinning, super-dense star known as a *pulsar* that was ejected during the explosion. The bright star nearby is likely a foreground star unrelated to the supernova remnant.

Astronomers estimate that the age of the supernova remnant MSH 11-61A is approximately 15,000 years and that it lies at a distance of about 30,000 light years from Earth. Combining these values with the distance that IGR J11014 (the pulsar) appears to have traveled from the center of the supernova remnant, astronomers estimate that it is moving at a speed between 5.4 million and 6.5 million miles per hour.

Image and partial text credit: NASA/CXC/UC Berkeley/J. Tomsick *et al.* and ESA/XMM-Newton; DSS, 2MASS/UMass/IPAC-Caltech/NASA/NSF



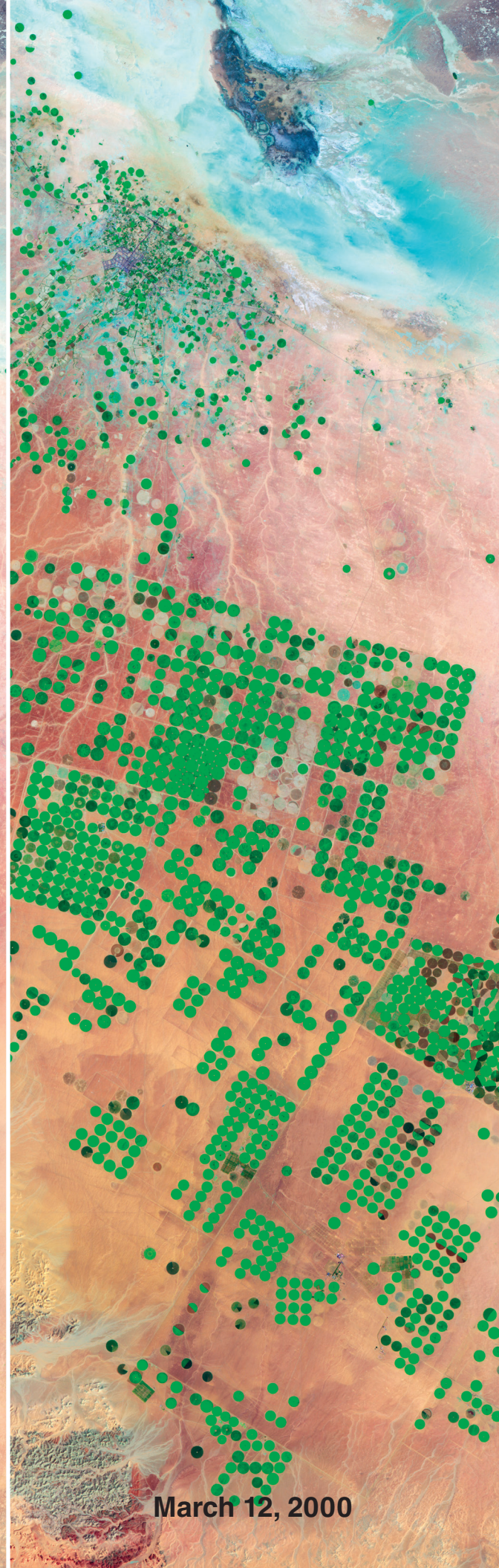
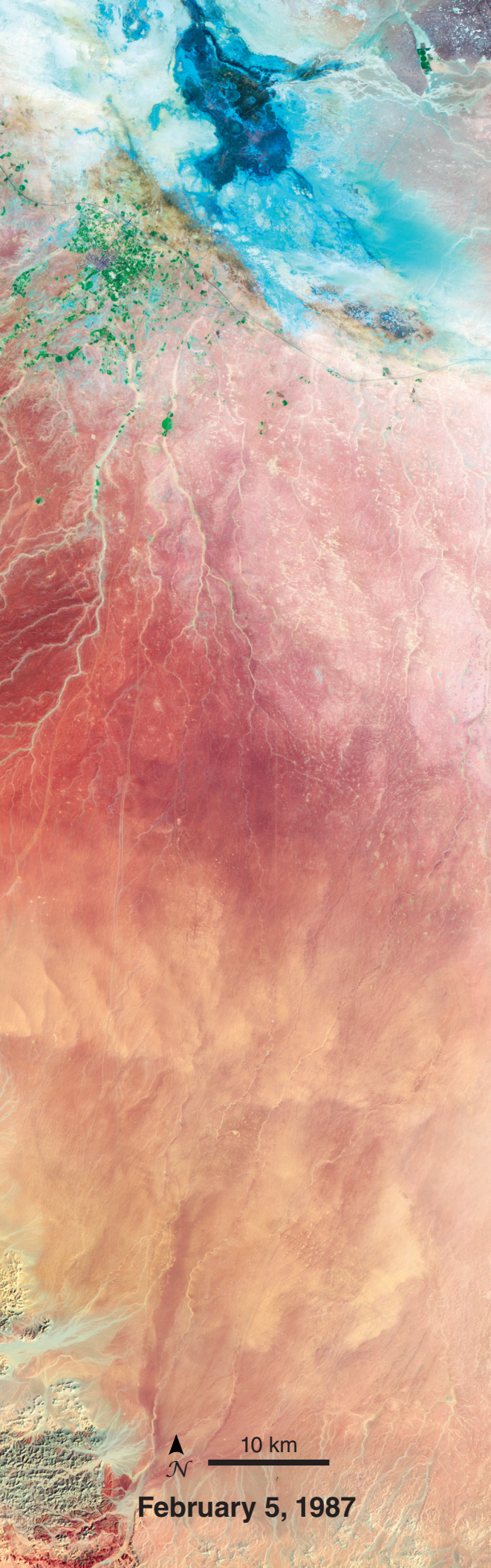
X-ray view of IGR J11014 from Chandra (green) and XMM-Newton (purple).

AUGUST 2013						
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OCTOBER 2013						
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20	21	22	23	24	25	26
27	28	29	30	31		











Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
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6	7	8	9	10	11 ●	12
13	14 Columbus Day	15	16	17	18 ●	19
20	21	22	23	24	25	26 ●
27	28	29	30 Halloween	31		

## Saudi Arabians Tap Ancient Reserves

Saudi Arabia is known for its rich reserves of oil, but in recent decades this desert place has been drilling for an even more precious resource—water. To facilitate irrigation to areas that, on average, receive just ~4 to 8 inches (100 to 200 millimeters) of rainfall a year, engineers and farmers have drilled beneath the desert sands, through as much as a kilometer of sedimentary rock, to tap ancient reserves of water that date back to the last Ice Age. They are using the underground water source to grow wheat, fruits, and vegetables. Although no one knows how much water lies beneath the desert—estimates range from ~60 to 210 cubic miles (252 to 870 cubic kilometers)—hydrologists believe it will only be economical to pump it for about 50 years.

Irrigation slowly transforms the desert landscape, as is evident in this series of Landsat false-color images of the Wadi As-Sirhan Basin in northwestern Saudi Arabia, from 1987, 1991, 2000, and 2012, respectively. The agricultural fields in the images are about 0.62 miles (one kilometer) across and use center-pivot irrigation (also called circle irrigation). The color of each crop circle tells us something—new vegetation appears bright green while dry vegetation or uncultivated fields appear rust colored. Dry, barren surfaces (mostly desert) are pink and yellow.

Since 1972, at least one Landsat satellite has operated at all times, providing the longest uninterrupted satellite record of Earth's surface. This record has allowed researchers to observe patterns of land use from space and document how the land surface is changing with time. NASA and the U.S. Geological Survey jointly manage the Landsat program.

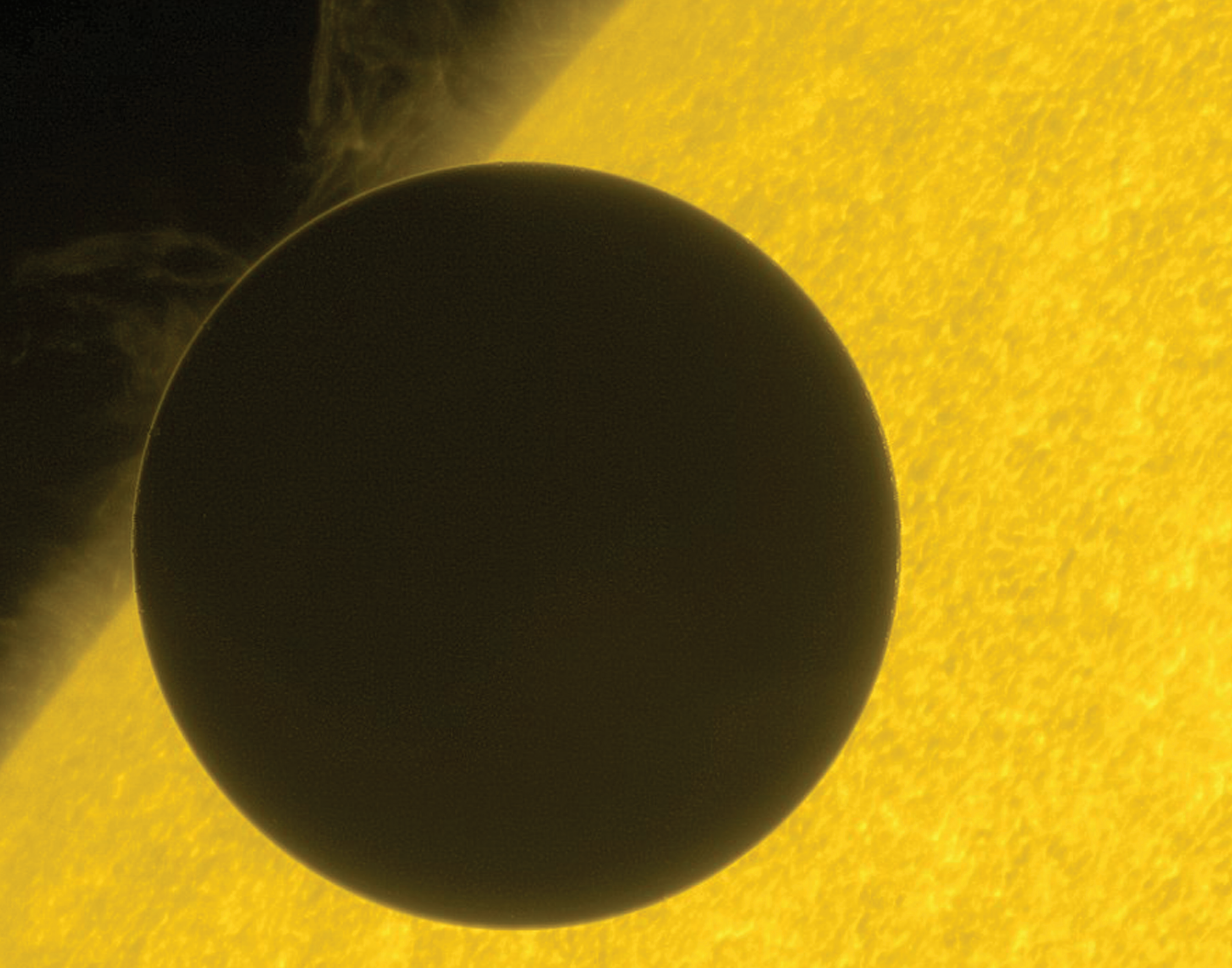
Image and Partial Text Credit: NASA Earth Observatory



SEPTEMBER 2013						
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					

NOVEMBER 2013						
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







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

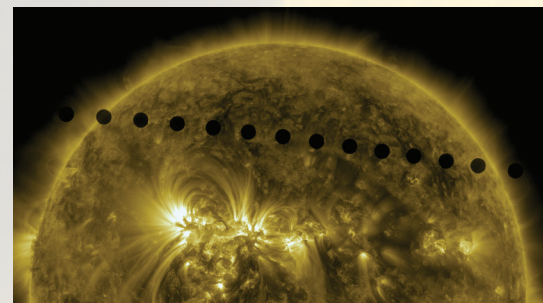
## Rare Transit of Venus

On occasion, celestial bodies appear to pass in front of other celestial bodies when viewed from the vantage point of yet another celestial body. This celestial “passing” is called a *transit*. On June 5–6, 2012, people around the world got a rare opportunity to watch Venus pass directly in front of the Sun, called a *transit of Venus*. Unfortunately if you missed this one, you’ll have to wait over a century for another, because it won’t happen again until December 2117.

During a transit of Venus—when viewed from the vantage point of Earth—Venus appears as a tiny dark disc moving across the surface of the Sun (images above and to the right). A young English astronomer named Jeremiah Horrocks was the first to observe this rare phenomenon in 1639. These historical measurements were used to calculate the very first scientific estimates of the size of our Solar System. Today, scientists use a combination of measurements from various satellites and telescopes to witness the events—one instrument being the Solar Optical Telescope onboard the Hinode spacecraft that captured this stunning image. In the ongoing quest to discover new planets, scientists search for evidence of transits across distant stars outside of our Solar System.

Hinode is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) to study the connections of the Sun’s surface magnetism, primarily in and around sunspots. NASA’s Marshall Space Flight Center in Huntsville, Alabama, manages Hinode science operations. The Lockheed Martin Corporation in Palo Alto, California, is the lead U.S. investigator for the Solar Optical Telescope.

Image and Partial Text Credit: NASA/JAXA/Lockheed Martin



This image composite—built from 171 images collected by NASA’s Solar Dynamics Observatory (SDO)—shows the transit of Venus on June 5–6, 2012. Credit: NASA/Goddard Space Flight Center/SDO

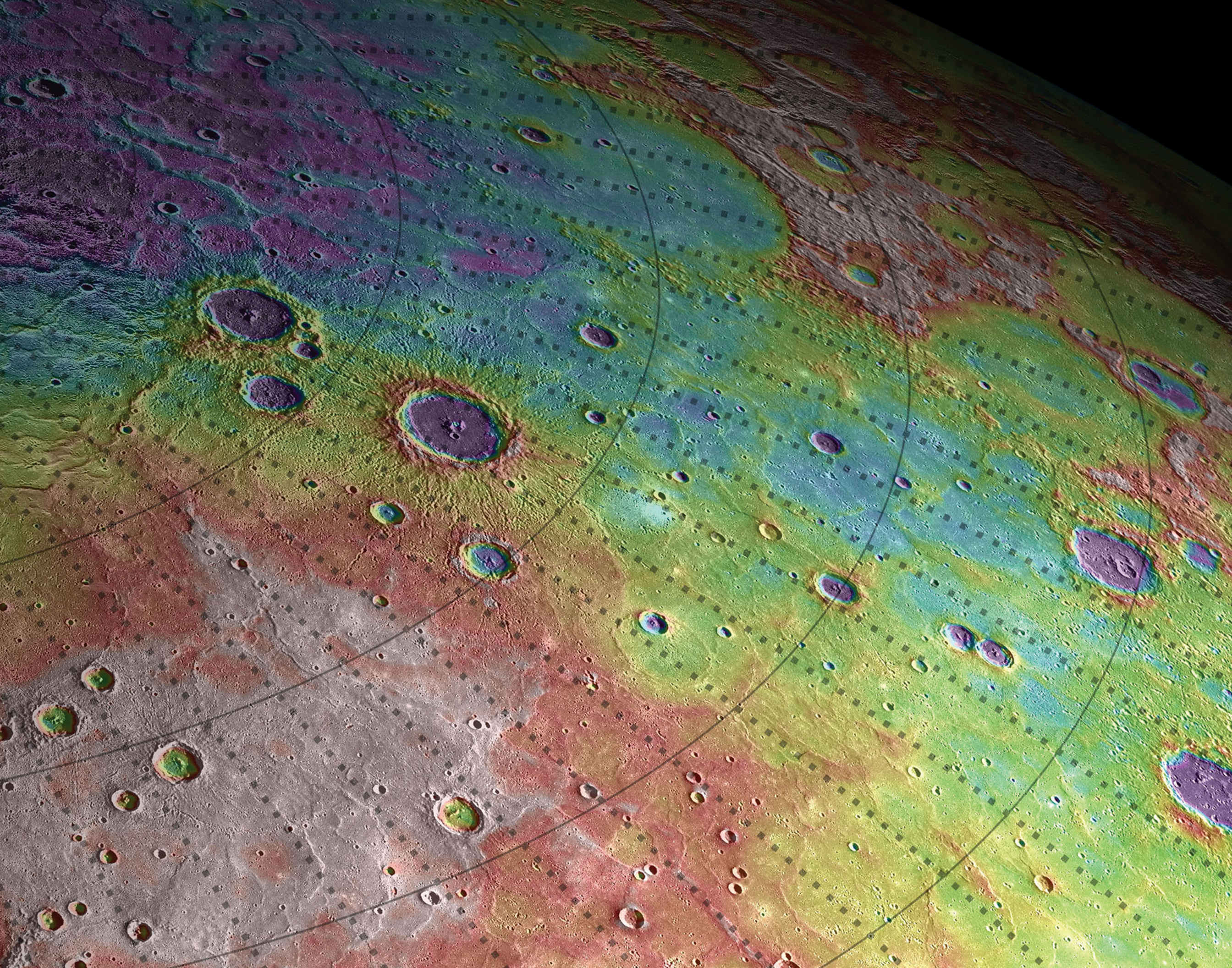
## OCTOBER 2013

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

## DECEMBER 2013

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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	9 ●	10	11	12	13	14
15	16	17 ●	18	19	20	21
22	23	24	25 ●	26	27	28
29	30	31	Christmas Day			

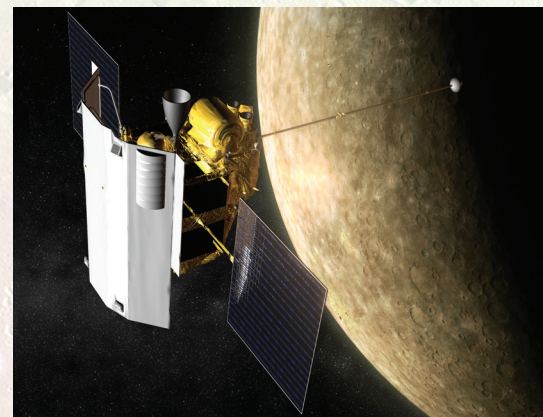
## Highs and Lows on Mercury

Celestial bodies often display the scars of ancient catastrophic collisions with one another. Impact craters for example, dot the surface of asteroids, non-gaseous planets, and most moons, leaving evidence of their violent encounters with comets, asteroids, and meteorites. On planets like Mercury, where there is a very thin atmosphere, little or no weather, and minimal geological activity, impact craters are well preserved.

This image mosaic of Goethe Basin, located in Mercury's northern region, was created using topographic data from the Mercury Laser Altimeter onboard the MESSENGER spacecraft. The colors show changes in elevation and help reveal a variety of different features on the land surface. Shades of purple indicate low areas, extending as much as a kilometer deeper than the highest regions, shown in shades of light pink.

Deep impact craters (purple) are easy to discern while it can be much harder to distinguish shallower *ghost craters*—so named because the craters have been filled by volcanic lava that flooded the surface, burying the craters and leaving just an outline of the crater's rim. Many of the ghost craters contain *graben*, smaller extensional troughs, and are outlined by *wrinkle ridges*. Wrinkle ridges also mark the outer boundary of the basin. After the volcanic floods, additional cosmic bodies impacted the surface, creating the various size craters in this scene. Data from MESSENGER's seven instruments will continue to help scientists unravel the mysteries of Mercury and its geologic history.

Image and Partial Text Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington/Brown University.



Artist's illustration of the MESSENGER spacecraft in orbit near Mercury. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

## NOVEMBER 2013

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## JANUARY 2014

S	M	T	W	T	F	S
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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	



