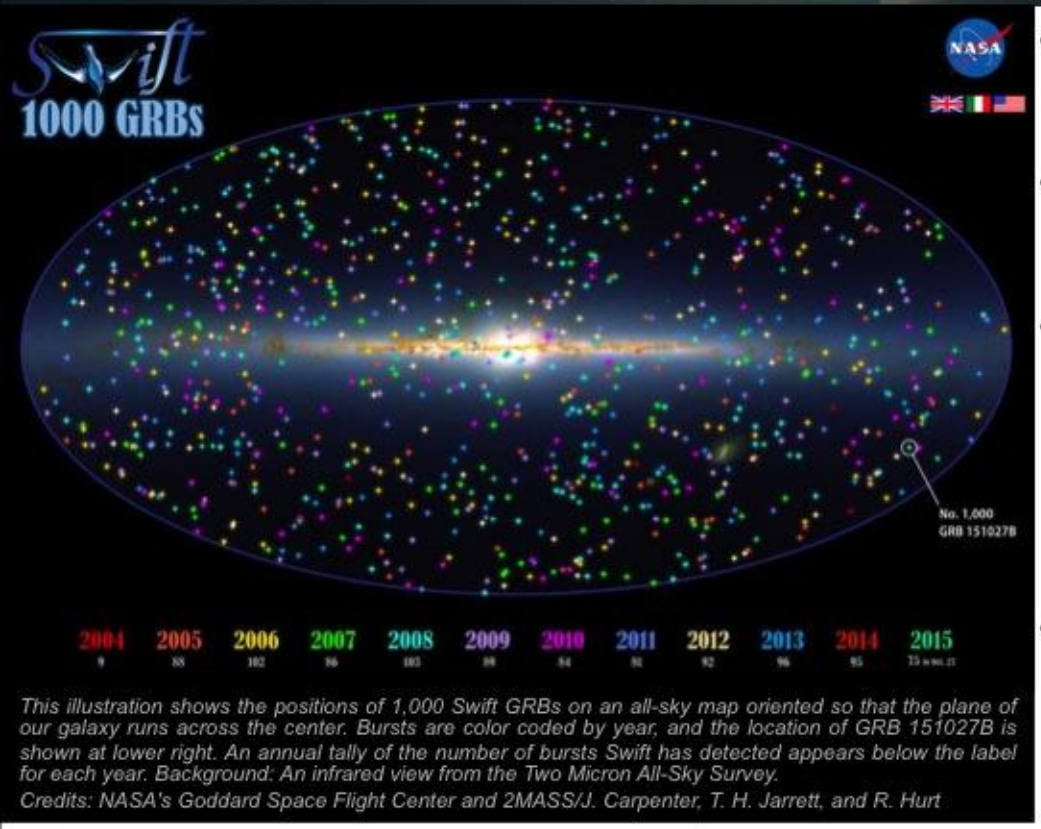
Science Mission Directorate

Weekly Highlights

November 13, 2015

NASA's Swift Spots its Thousandth Gamma-ray Burst



This illustration shows the positions of 1,000 Swift GRBs on an all-sky map oriented so that the plane of our galaxy runs across the center. Bursts are color coded by year, and the location of GRB 151027B is shown at lower right. An annual tally of the number of bursts Swift has detected appears below the label for each year. Background: An infrared view from the Two Micron All-Sky Survey.

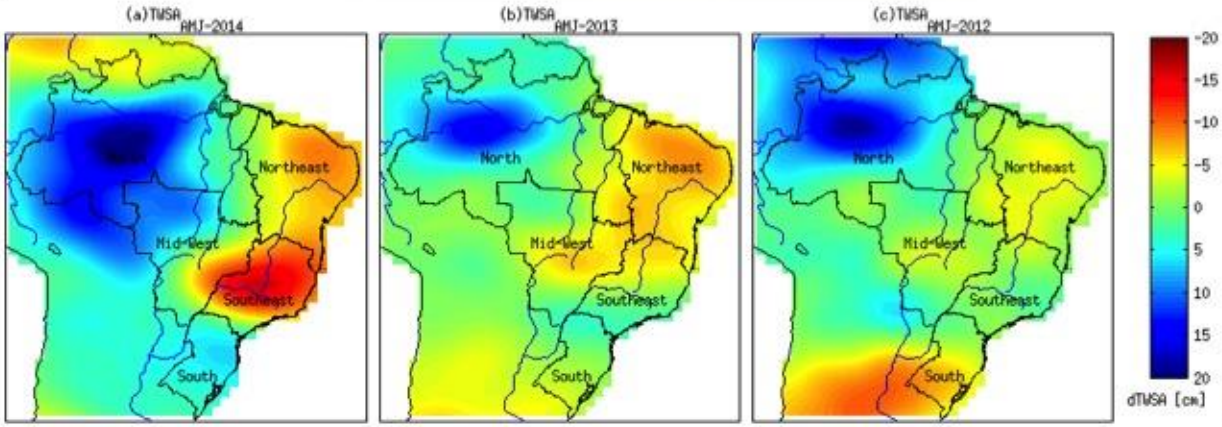
Credits: NASA's Goddard Space Flight Center and 2MASS/J. Carpenter, T. H. Jarrett, and R. Hurt

- NASA's Swift spacecraft has detected its 1,000th gamma-ray burst (GRB). GRBs are the most powerful explosions in the universe, typically associated with the collapse of a massive star and the birth of a black hole.
- A GRB is a fleeting blast of high-energy light, often lasting a minute or less, occurring somewhere in the sky every couple of days. Scientists are looking for exceptional bursts that offer the insights into the extreme physical processes at work.
- Shortly before 6:41 p.m. EDT on Oct. 27, Swift's Burst Alert Telescope detected the 1,000th GRB as a sudden pulse of gamma rays arising from a location toward the constellation Eridanus. Astronomers dubbed the event GRB 151027B, after the detection date and the fact that it was the second burst of the day. Swift automatically determined its location, broadcast the position to astronomers around the world, and turned to investigate the source with its own X-ray, ultraviolet and optical telescopes.
- Astronomers classify GRBs by their duration. Like GRB 151027B, roughly 90 percent of bursts are of the "long" variety, where the gamma-ray pulse lasts more than two seconds. They are believed to occur in a massive star whose core has run out of fuel and collapsed into a black hole. As matter falls toward the newly formed black hole, it launches jets of subatomic particle that move out through the star's outer layers at nearly the speed of light. When the particle jets reach the stellar surface, they emit gamma rays, the most energetic form of light. In many cases, the star is later seen to explode as a supernova. "Short" bursts last less than two seconds -- and sometimes just thousandths of a second. Swift observations provide strong evidence these events are caused by mergers of orbiting neutron stars or black holes.
- Once a GRB is identified, the race is on to observe its fading light with as many instruments as possible. Based on alerts from Swift, robotic observatories and human-operated telescopes turn to the blast site to measure its rapidly fading afterglow, which emits X-rays, ultraviolet, visible and infrared light, and radio waves. While optical afterglows are generally faint, they can briefly become bright enough to be seen with the unaided eye.
- Five hours after the Swift alert, the burst location became visible from the European Southern Observatory (ESO) in Paranal, Chile. There a team captured the afterglow's visible light using the Very Large Telescope's X-shooter spectrograph. The ESO observations show that light from the burst had been traveling to us for more than 12 billion years, placing it in the most distant few percent of GRBs Swift has recorded.

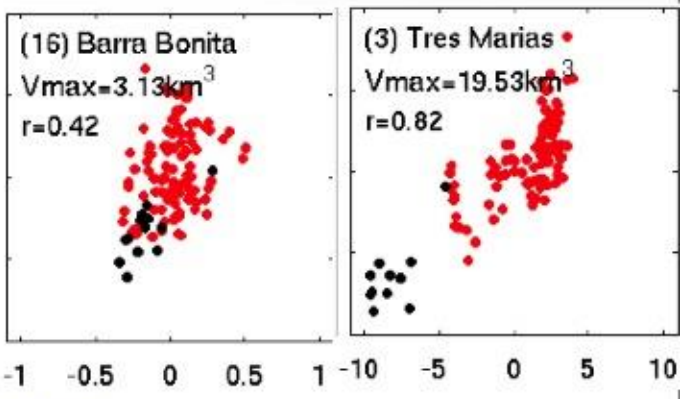
Extreme Water Deficit in Brazil Detected from Space

Getirana, A.C. | NOVEMBER 2015 | doi: 10.1175/JHM-D-15-0096.1

A NASA funded study used data derived from the Gravimetry Recovery and Climate Experiment (GRACE) mission to detect and quantify an extended major drought over Eastern Brazil, and provide estimates of impacted areas and region-specific water deficits. Two structural breakpoint detection methods were applied to time series of GRACE-based terrestrial water storage anomalies (TWSA), determining when two abrupt changes occurred. One, in particular, defines the beginning of the current drought. Using TWSA, a water loss rate of 6.1cm/year over Southeastern Brazil was detected from 2011 to 2015. Based on analysis of NASA's Global Land Data Assimilation System (GLDAS) outputs, the extreme drought was found to be mostly related to lower-than-usual precipitation rates, resulting in high soil moisture depletion and lower-than-usual rates of evapotranspiration. A reduction of 20-23% of precipitation over an extended period of three years was enough to raise serious water scarcity conditions in the country. Extreme droughts have a profound impact on society and considerably affect human safety, water supply, food production and energy generation. In Brazil, ineffective energy development and water management policies have magnified the impacts of recent severe droughts, which include massive agricultural losses, water supply restrictions and energy rationing. Spaceborne remote sensing data advance our understanding of the spatiotemporal variability of large-scale droughts, and enhance the detection and monitoring of extreme water-related events.



Above: GRACE-based terrestrial water storage anomalies (TWSA) subtracted from the 2002-2014 average during austral falls (April to June, or AMJ) in (a) 2014, (b) 2013 and (c) 2012. Black and white lines delineate Brazilian regions and states, respectively.



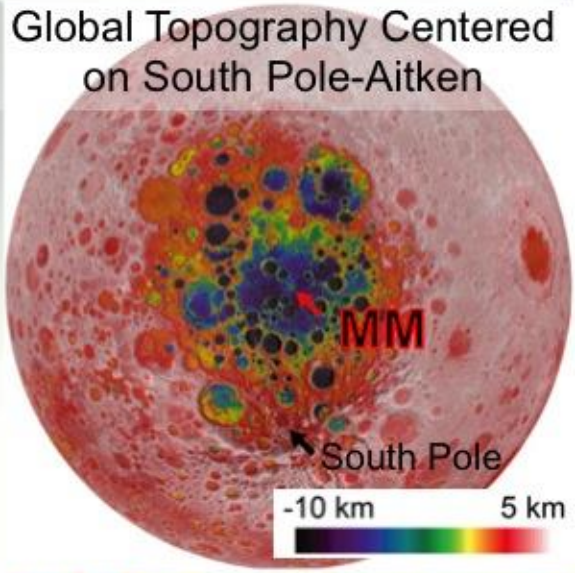
Above: Scatter plots of monthly GRACE TWSA and water storage at 2 large reservoirs located across Southeastern Brazil. *Vmax* and *r* stand for the maximum water storage capacity and correlation, respectively.

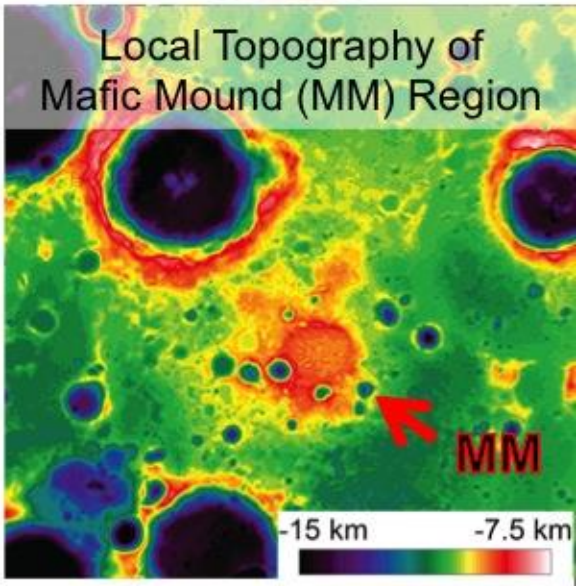
Unique Mafic Mound on the Lunar Farside

Data from sensors onboard Chandrayaan-1, LRO & GRAIL have characterized an unusual feature found in the center of the gigantic basin South Pole-Aitken on the far side of the Moon.

- The Moon's South Pole-Aitken Basin (SPA) is one of the solar system's largest impact basin with a diameter of ~2500 km (~1550 miles). This ancient basin excavated deep into the crust and upper mantle.
- Unlike most nearside basins, the SPA interior was not completely flooded by later basalts and is the deepest exposed lunar terrain.
- An unusual feature found in the center of the SPA, 75km (~46 miles) in diameter and elevated up to ~1 km (~0.6 miles) above surrounding terrain, has a distinctive mafic composition that contains Fe & Ca-rich pyroxene throughout and a small positive gravity anomaly.
- None of the common lunar processes are sufficient to explain the formation of this Mafic Mound (labeled MM in the photos at right), and new research indicates that this unique magmatic construct was formed by some combination of impact melt from the SPA impactor & melting and uplift of underlying mantle from post-impact rebound of the surface.
- This type of viscous magmatism would represent a newly recognized product of basin-forming impacts on the terrestrial planets.

Moriarty and Pieters (2015) *Geophys. Res. Letters*





GRIPS Balloon Team Arrives in Antarctica to Study Solar Flares!

The GRIPS team integrated and tested their balloon payload at NASA's Columbia Scientific Balloon Facility in Palestine, Texas, July 18-Aug. 28, 2015. After putting the finishing touches on the payload inside the hangar, the team moved GRIPS outside to test its solar panels and communications links.

GRIPS will launch on a scientific balloon from McMurdo Station in Antarctica in December 2015 to study high-energy particle radiation released from the sun in conjunction with solar flares.

Credit: NASA/GRIPS

- Members of the GRIPS balloon team began arriving at McMurdo Station in Antarctica in late October 2015. GRIPS, short for Gamma-Ray Imager/Polarimeter for Solar flares, is an instrument that studies the extremely high-energy particles released by solar flares, information that will help scientists pinpoint the processes which set off these explosive events. GRIPS will launch this December, suspended underneath a football-field-sized balloon, and will circle above the frozen Antarctic for several weeks.

- The GRIPS team will spend the month of November assembling and testing the instrument and balloon. The launch window opens on Dec. 1, 2015, but the team will have to wait for calm wind conditions to send their payload soaring to heights of nearly 25 miles. Since the sun doesn't set at all for several weeks of the Antarctic summer, GRIPS will be able to observe the sun continuously during much or all of its flight, which the team hopes will last anywhere from 14 to 55 days. The 24/7 summer sunlight also provides a constant source of energy, powering the instrument the entire time. Scientific balloons like GRIPS are a low-cost way to access Earth's upper atmosphere up to the edge of space, allowing scientists to make measurements that are impossible from the ground.

NASA Science Mission Directorate Digital Outreach Event, Atlanta, GA

The staff framed a picture of the event for the school lobby.

A real student example of the aliens they designed that could exist outside of Earth.

A design challenge the students tackled after the outreach event.

NASA Science Mission Directorate's Dr. Mamta Patel Nagaraja conducted a virtual classroom event with Dunwoody Springs Elementary in Atlanta, Georgia on September 29, 2015. Fourth graders learned about general space science using problem-based learning tools. After the outreach event, the teacher assigned the students to "become a NASA scientist" and describe life forms that could exist outside of Earth. Another challenge the students tackled was redesigning an existing toy to work properly on another planet. They discussed likely behavior of the toy on another planet, modifications needed, and how to implement those changes.

"The kids were THRILLED beyond words to 'meet' you, hear your story of experience and sharing of knowledge. They just cannot stop talking about it! Aren't we lucky to live in such a time where kids can connect with experts so they can dream big?! I think they were up all night researching some of the topics we discussed and some of the questions we left unanswered!!" - Cynthia Poundstone,
4th Grade Teacher