National Aeronautics and
Space Administration

Science Mission Directorate

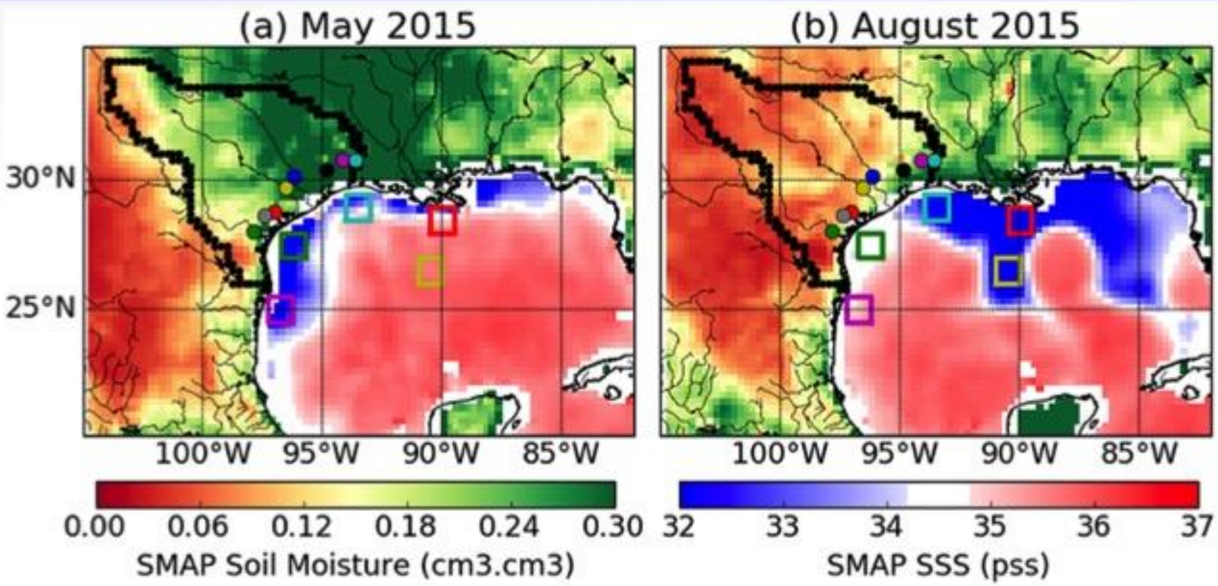
Weekly Highlights

December 2, 2016

SMAP Observes Flooding From Land to Sea: The Texas Event Of 2015

S. Fournier, J. T. Reager, T. Lee, J. Vazquez-Cuervo, C. H. David, and M. M. Gierach *| Geophysical Research Letters, 43 | November 2016 | doi: 10.1002/2016GL070821*

NASA JPL scientists studied the May 2015 severe flooding in Texas. While floods can have damaging impacts on both land and sea, most studies tend to focus on only one side of the land/sea continuum. The study presents the first two-sided analysis. The investigation benefited from simultaneous measurements of land surface soil moisture and sea surface salinity from NASA's recent Soil Moisture Active Passive (SMAP) mission and ESA's Soil Moisture and Ocean Salinity (SMOS), as well as ancillary data including water storage measurements from NASA's Gravity Recovery and Climate Experiment (GRACE) and ocean color measurements from the Moderate Resolution Imaging Spectroradiometer (MODIS). They reported the comprehensive chronology of the flooding: above average rainfall preceding the flood caused soils to saturate; record rainfall then generated record river discharge; and subsequently, an unusual freshwater plume associated with anomalous ocean currents formed in the north central Gulf of Mexico. Together with the Mississippi River plume, a rare "horseshoe" pattern was created that may have significant biogeochemical implications. Such integrated land/sea analysis of flood evolution can improve impact assessments of future extreme flooding events.



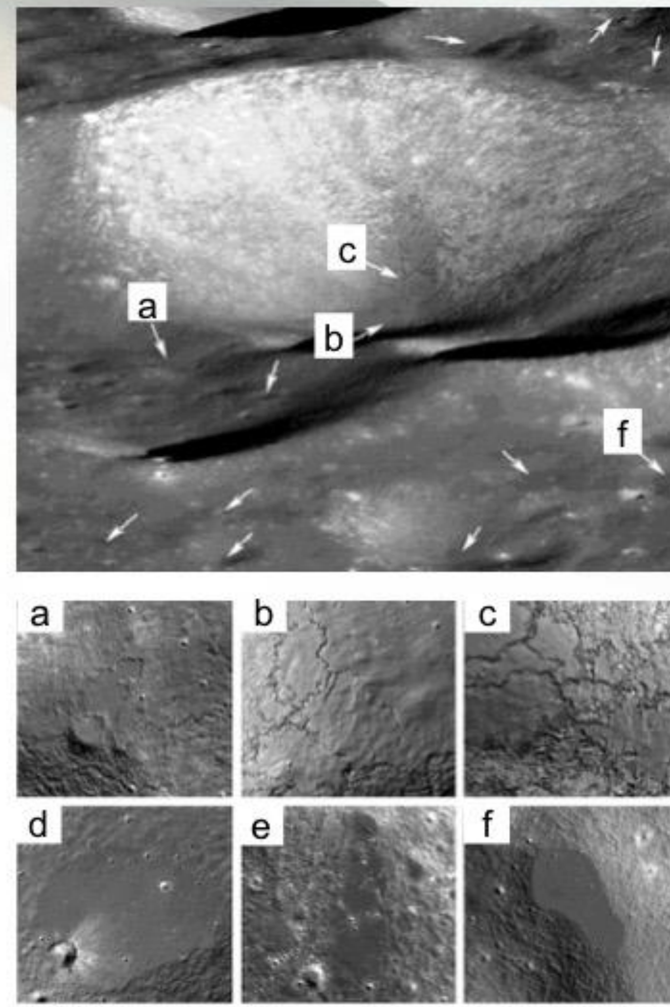
Above: Monthly maps of (a) May and (b) August 2015 SMAP soil moisture inland and sea surface salinity (SSS). The black line delimits the Texas Gulf Coast Hydrologic Region. The colored dots correspond to the gauge for each major Texas river. The colored squares delimit five different boxes used to compute the averaged SSS.

Floods are among the most common and significant types of natural hazards in terms of impacts on environment, society, and economy. Inland flooding claims 176 lives and 2.7 billions of dollars in property losses in an average year in the United States. Additionally, floods can have detrimental impact on ocean ecosystems due to the significant perturbation of salinity and the terrestrial matter intrusion that can threaten marine life. Multi-variate satellite observations (e.g., SMAP, GPM/TRMM, JASON-2 and GRACE) are essential to provide integrated assessment of land/sea impacts associated with flooding.

Unusual Distribution of Impact Melt on the Lunar Farside: A Not So Nearby Source?

A deposit of about 8 cubic kilometers (almost 2 cubic miles) of once-molten rock observed by the Lunar Reconnaissance Orbiter Camera (LROC) appears to have been spread across about 7,700 square kilometers (~3000 square miles, more than twice the size of Rhode Island) of the lunar far side.

- The material consists of smooth, flat deposits called “ponds” on the floors of many craters and in other low spots, as well as a veneer across the majority of the region.
- Recent research examined four potential ways that these ponds may have formed: basin ejecta, pyroclastic volcanism, effusive volcanism, and ballistically emplaced impact-melt. The observed morphology – in a broad area with material that behaved as a fluid – is not consistent with the first three methods, suggesting that the most likely source is impact melt thrown from a large crater. Possible source craters, based on minimum required size (>20 km diameter) appropriate age, are at least 250 km away, with one (Tycho) exactly antipodal.
- This discovery places important constraints on our knowledge of the distribution of impact melt relative to the parent crater and how far such melt can travel.



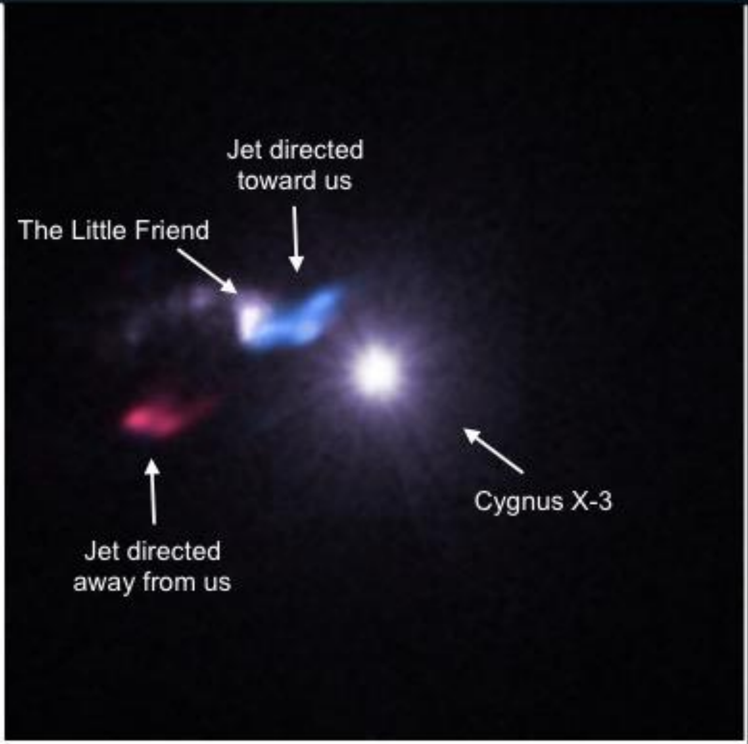
Top: West-to-east oblique view showing broad range of smooth material. Lettered arrows correspond to panels shown at left.

Robinson et al., (2015) An exceptional grouping of lunar highland smooth plains: Geography, morphology, and possible origins, *Icarus*, v.273, 121-134

Cyg X-3's Little Friend

Published in the The Astrophysical Journal Letters.

- A snapshot of the life cycle of stars has been captured where a stellar nursery is reflecting X-rays from a source powered by an object at the endpoint of its evolution. This discovery provides a new way to study how stars form.
- This composite image shows X-rays from NASA's Chandra X-ray Observatory (white) and radio data from the Smithsonian's Submillimeter Array (red and blue). The X-ray data reveal a bright X-ray source to the right known as Cygnus X-3, a system containing either a black hole or neutron star (a.k.a. a compact source) left behind after the death of a massive star. Within that bright source, the compact object is pulling material away from a massive companion star. Astronomers call such systems "X-ray binaries."
- In 2003, astronomers presented results using Chandra's high-resolution vision in X-rays to identify a mysterious source of X-ray emission located very close to Cygnus X-3 on the sky (smaller white object to the upper left). The separation of these two sources is equivalent to the width of a penny about 800 feet away. A decade later, astronomers reported the new source is a cloud of gas and dust. In astronomical terms, this cloud is rather small - about 0.7 light years in diameter.



Credit: X-ray: NASA/CXC/SAO/M.McCollough et al, Radio: ASIAA/SAO/SMA

- Astronomers realized that this nearby cloud was acting as a mirror, reflecting some of the X-rays generated by Cygnus X-3 towards Earth. They nicknamed this object the "Little Friend" due to its close proximity to Cygnus X-3 on the sky and because it also demonstrated the same 4.8-hour variability in X-rays seen in the X-ray binary.
- To determine the nature of the Little Friend, more information was needed. The researchers used the Submillimeter Array (SMA), a series of eight radio dishes atop Mauna Kea in Hawaii, to discover the presence of molecules of carbon monoxide. This is an important clue that helped confirm previous suggestions that the Little Friend is a Bok globule, small, dense, very cold clouds where stars can form. The SMA data also reveal the presence of a jet or outflow within the Little Friend, an indication that a star has started to form inside. The blue portion shows a jet moving towards us and the red portion shows a jet moving away from us.

Heliophysics Van Allen Probes Mission Reveals Key Mechanism for Precipitation of 'Killer Electrons' into our Atmosphere

Shprits, Y. Y. et al (2016). Wave-induced loss of ultra-relativistic electrons in the Van Allen radiation belts. Nat. Commun. 7:12883 doi: 10.1038/ncomms12883

During a unique geomagnetic storm in January 2013, the NASA Heliophysics Van Allen Probes mission provided new measurements of "killer electrons," also known as ultra-relativistic electrons. Ultra-relativistic electrons (highly energetic electrons traveling at the speed of light) are the most dangerous electrons to spacecraft and astronauts orbiting Earth; scientists have been trying to understand how they behave for over half a century. These new Van Allen measurements are helping us understand how these particles are lost from the doughnut-shaped Van Allen Radiation Belts that surround Earth and give us insight into how they precipitate into our atmosphere. Studying both ultra-relativistic electron loss and acceleration is important in understanding the dynamic nature of the radiation belts themselves and how electron loss from the belts affects Earth. While early Van Allen Probes measurements have helped us understand acceleration mechanisms, how these particles are lost has remained a mystery.

Since James Van Allen first discovered space radiation, we have been trying to understand what causes changes in Earth's radiation belts, such as electron loss. We know that the dipole nature of Earth's magnetic field allows for the trapping of highly energetic particles like ultra-relativistic electrons into the radiation belts. We don't know by which mechanisms these trapped particles escape because different loss mechanisms are intensified during a storm making it hard to differentiate between them in the data.

The data needed to analyze killer electrons occurs in the high-energy spectrum > 3MeV. We haven't had an opportunity to capture such high-energy particle measurements during an electron loss event until a particularly unique geomagnetic storm that occurred in January 2013. An abundance of high-energy electrons were posited into the radiation belts from an earlier geomagnetic storm in October of 2012; elevated fluxes of these October 2012 electrons allowed for high-energy measurements to be taken using the Relativistic Electron-Proton Telescope (REPT) on Van Allen. REPT measured how the particles were distributed in regards to their energy, direction of velocity and distance from the Earth.

In analyzing the data, an international team of scientists concluded that Electromagnetic Ion Cyclotron (EMIC) waves scattered the ultra-relativistic electrons into our atmosphere. Modeling results also support their conclusions. A paper with these results was published in *Nature Communications* in September 2016.

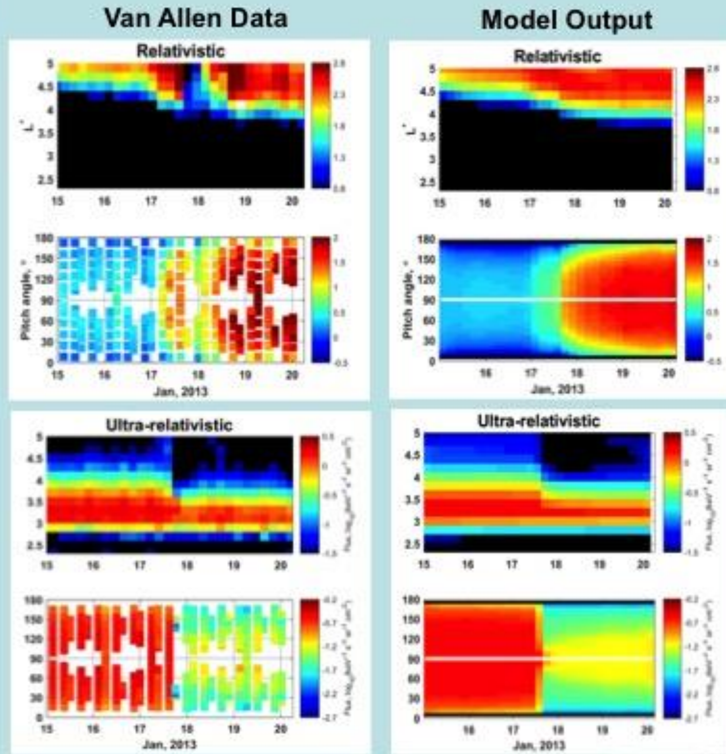


Figure 1. Van Allen Probes Observations of radial profiles of electron fluxes and angular distributions of electrons during the January 17, 2013 storm, alongside model output produced with EMIC wave input. The model used the Versatile Electron Radiation Belt code with EMIC waves showing a remarkable correspondence with the Van Allen Probes observations while also reproducing the evolution of radial profiles, energy and pitch angle distributions consistent with the data recorded during the storm. These findings resolve a number fundamental scientific questions related to how particles interact with plasma waves and how electrons are lost from the belts.

NASA Langley Leads Interagency Training for STEM Role Models

NASA Headquarters, Washington D.C.
October 13-14, 2016

***Above: Inter-Agency Role Model Training**, Participants collaborating and developing Training Implementation Plans*

***Above: Jessica Taylor**, Reviewing with the participants the research about women and girls in STEM*

***Above: NASA Role Model Training**, Participants applying role model strategies to real-work scenarios*

- NASA Langley's Science Directorate Trainers, Jessica Taylor and Sarah McCrea, were invited by NASA's White House Liaison to lead two training sessions for STEM Role Models at NASA Headquarters
- On Thursday, October 13, 2016, Taylor and McCrea led a session to effectively prepare colleagues to serve as confident role models
- Thirty-five STEM professionals from across 14 federal agencies attended and developed their own training plans
- Attendees were selected by responding to a call from the White House Council for Women and Girls in STEM Working Group
- On Friday, October 14, 2016, Taylor and McCrea led an internal training session for 30 NASA employees from Goddard Space Flight Center (GSFC), Headquarters, and Marshall Space Flight Center (MSFC)
- The training was developed by NASA Langley with content heavily influenced by PBS SciGirls and additional references including: TechBridge, American Association for University Women, and various National Academies publications

***Above: NASA Administrator Charlie Bolden and Sarah McCrea**, Administrator Supported Interagency training with Afternoon Key Note*