Science Mission Directorate

Weekly Highlights

November 18, 2016

2015-16 ANSMET Meteorites

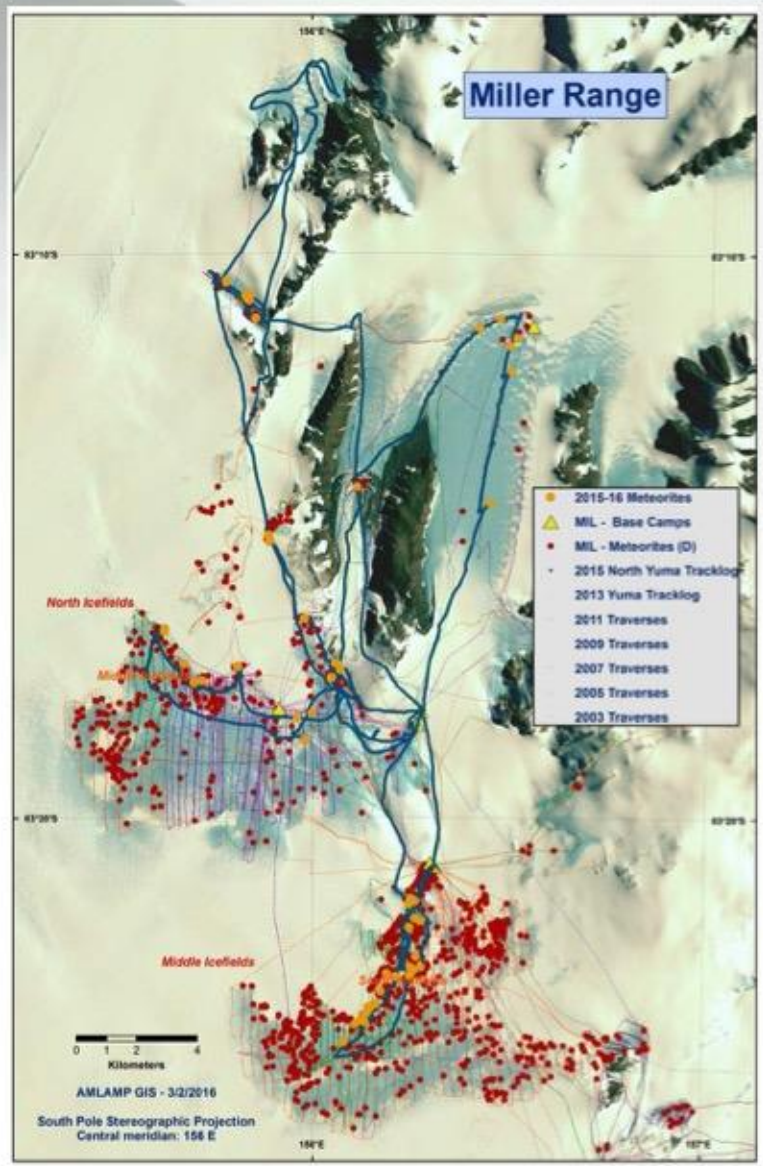
The Antarctic Search for Meteorites (ANSMET) project, funded by the Near Earth Object Observations Program, has recovered over 21,000 meteorites from Antarctica on annual expeditions since 1976.

- For the 2015-16 field season, the ANSMET team returned to the Miller Range in the Transantarctic Mountains, on the edge of the south polar ice cap. Previous visits to this area showed it to be a rich location for meteorites with over 2900 specimens recovered over many visits to date, including lunar, martian and other rare types.
- Despite several days of sustained 40 mph winds during this most recent 40-day field camp, the ANSMET team collected another 569 meteorites for the U.S. national collection.
- At the end of the season, the meteorites were shipped in their frozen state from Antarctica to the curation facilities at Johnson Space Center where they were classified into chemical groups. Some of these newest finds already have been distributed to the scientific community for detailed analyses.

Karner et al., 79th Ann. MetSoc Mtg, Abst #6551

The image on the left shows a eucrite being measured and photgraphed in the field as part of the collection process. Eucrites are a group of meteorites blasted off the surface of asteroid (4) Vesta, the first rendezvous target of NASA's Dawn mission.

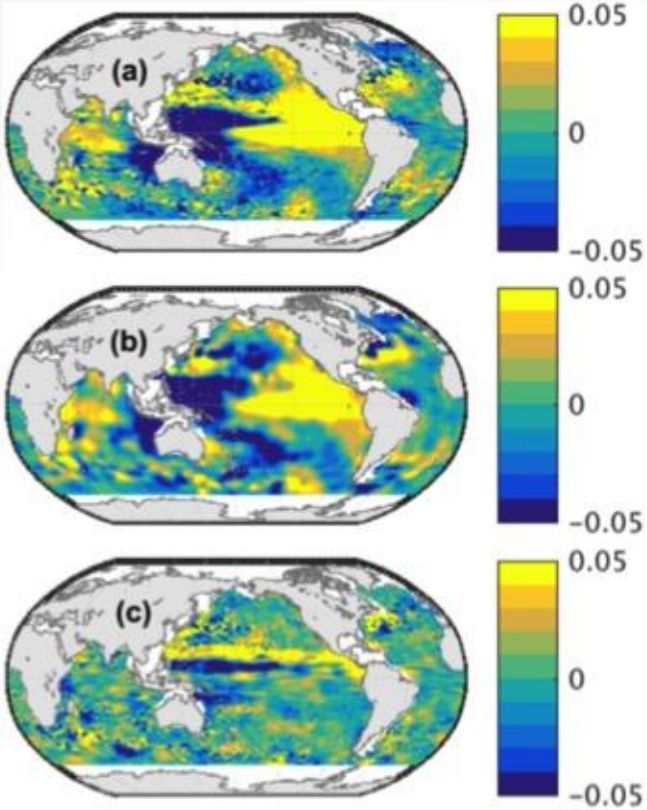
On the right, a satellite image of the northern Miller Range is overlain with field traverse lines and locations of the meteorites found in the area.

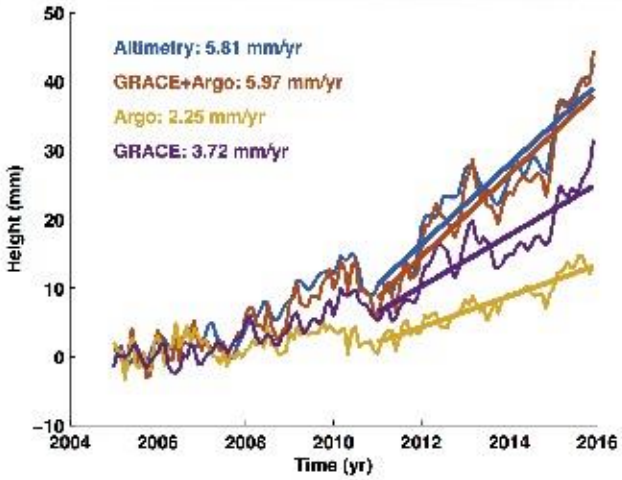


El Niño, La Niña, and the Global Sea Level Budget

Piecuch, C. G., & Quinn, K. J.| Ocean Science| November 2016 | doi: 10.5194/os-12-1165-2016

NASA-funded scientists diagnosed the nature of the global-mean sea level (GMSL) balance in relation to the El Niño–Southern Oscillation (ENSO) observationally, using data from Argo pro-filing floats, satellite gravimetry data from NASA's Gravity Recovery and Climate Experiment (GRACE), and radar altimetry during 2005–2015. Previous studies have shown that nonseasonal variations in GMSL are significantly correlated with ENSO. In the current study, the researchers demonstrated that steric (density) and barystatic (mass) effects make comparable contributions to the GMSL budget during ENSO, in contrast to previous interpretations based largely on hydrological models, which emphasized the barystatic component. The steric contributions reflect ocean heat storage across various depths in the Pacific Ocean. Distributions of ocean heat storage in the Pacific arise from a mix of diabatic exchanges at the sea surface and adiabatic redistributions within the ocean interior.





Above: Non-seasonal time series of altimetric GMSL, GRACE ocean mass, Argo steric height, and GRACE plus Argo over 2005–2015.

Sea level is an informative index of climate and serious concern for coastal communities. The study's results have implications for understanding the surface warming slowdown and demonstrate the usefulness of the Global Ocean Observing System for constraining Earth's hydrological cycle and radiation imbalance.

Left: (a) Spatial pattern of non-seasonal anomalous Argo steric sea level from the Scripps Institution of Oceanography (SIO) gridded dataset (Jul–Dec 2015); (b) As in (a) but based on the International Pacific Research Center (IPRC) gridded dataset; (c) Spatial pattern of the difference between SIO and IPRC datasets (data sets are monthly Argo in situ temperature and salinity grids from SIO and IPRC).

NASA Space Telescopes Pinpoint Elusive Brown Dwarf

Published in the November 7, 2016 issue of The Astrophysical Journal

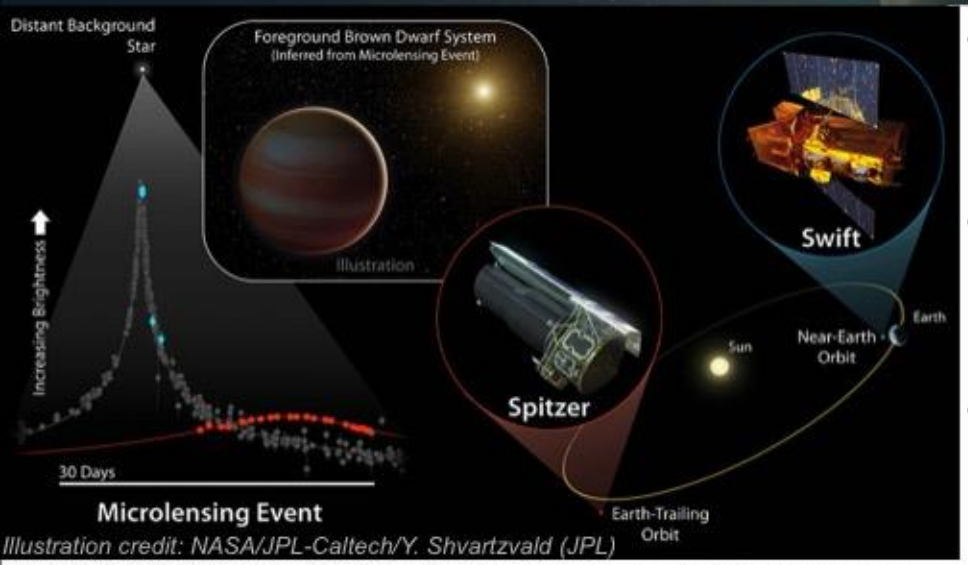


Illustration credit: NASA/JPL-Caltech/Y. Shvartzvald (JPL)

- NASA's Spitzer and Swift space telescopes joined forces to observe a microlensing event which revealed a brown dwarf. Brown dwarfs are thought to be the missing link between planets and stars. Their centers are not hot or dense enough to generate energy through nuclear fusion.
- Scientists have found that, for stars roughly the mass of our sun, less than 1 percent have a brown dwarf orbiting within 3 AU. This phenomenon is called the "brown dwarf desert." The newly discovered brown dwarf, OGLE-2015-BLG-1319, may inhabit this desert.
- Spitzer and Swift observed the microlensing event after being tipped off by ground-based microlensing surveys. In a microlensing event, a background source star serves as a flashlight for the observer. When a massive object passes in front of the background star along the line of sight, the background star brightens because the foreground object deflects and focuses the light from the background source star. Depending on the mass and alignment of the intervening object, the background star can briefly appear thousands of times brighter.
- One way to understand better the properties of the lensing system is to observe the microlensing event from more than one vantage point. By having multiple telescopes record the brightening of the background star, scientists can take advantage of "parallax," the apparent difference in position of an object as seen from two points in space. When you hold your thumb in front of your nose and close your left eye, then open it and close your right eye, your thumb seems to move in space -- but it stays put with two eyes open. In the context of microlensing, observing the same event from two or more widely separated locations will result in different magnification patterns.
- Spitzer observed the binary system containing the brown dwarf in July 2015. While Spitzer is over 1 AU away from Earth in an Earth-trailing orbit around the sun, Swift is in a low Earth orbit encircling our planet. Swift also saw the binary system in late June 2015 through microlensing, representing the first time this telescope had observed a microlensing event. But Swift is not far enough away from ground-based telescopes to get a significantly different view of this particular event, so no parallax was measured.
- By combining data from these space-based and ground-based telescopes, researchers determined that the newly discovered brown dwarf is between 30 and 65 Jupiter masses. They also found that the brown dwarf orbits a K dwarf, a type of star that tends to have about half the mass of the sun. Researchers found two possible distances between the brown dwarf and its host star, based on available data: 0.25 AU and 45 AU. The 0.25 AU distance would put this system in the brown dwarf desert.

THEMIS Observations are Providing New Insight into Electron Acceleration at Earth's Foreshock

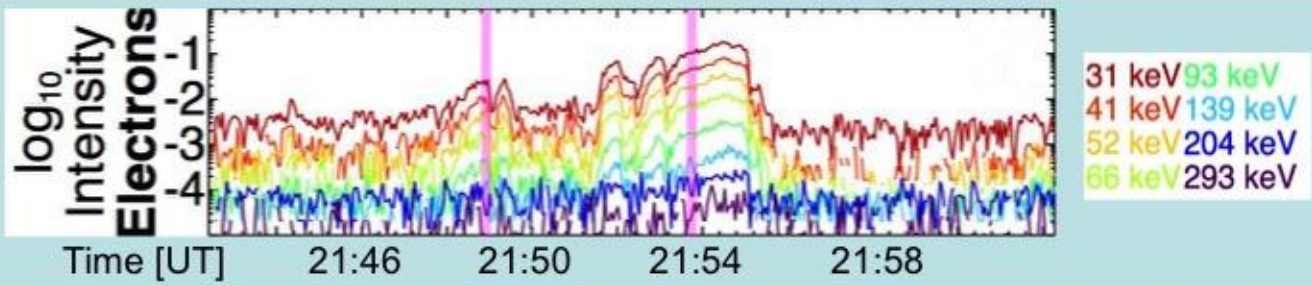
L. B. Wilson, III, D. G. Sibeck, D. L. Turner, A. Osmane, D. Caprioli, and V. Angelopoulos (2016). RELATIVISTIC ELECTRONS PRODUCED BY FORESHOCK DISTURBANCES OBSERVED UPSTREAM OF EARTH'S BOW SHOCK. Physical Review Letters; 117, 215101. DOI: https://doi.org/10.1103/PhysRevLett.117.215101

The Heliophysics THEMIS mission has observed something scientists didn't think could happen in near-Earth space. Upstream of where the solar wind meets Earth's magnetosphere, the foreshock, THEMIS observed relativistic electrons that were not accelerated by solar or magnetospheric events; Heliophysics STEREO and Wind data helped verify that the particles were instead accelerated locally in the collisionless plasma of the foreshock.

Typically, a particle streaming toward Earth first encounters a boundary region known as the bow shock, which forms a protective barrier between the solar wind – the continuous and varying stream of charged particles flowing from the sun – and Earth. The electric and magnetic fields in the bow shock decelerate and heat the particles, causing most to be deflected away from Earth. However, some are reflected back towards the sun forming the region permeated by these electrons and ions that we call the foreshock.

Relativistic particles have been observed in the foreshock region for over forty years, but until now, we hadn't seen high-energy electrons originate in this area of near-Earth space. These electrons only stay at such high energies over a very short time scale. Before THEMIS, missions were not able to observe the distribution of energetic electron fluxes as quickly as needed to observe an event like this. THEMIS is able to capture observations on a shorter timescale (~3s), making it capable of observing such short-duration enhancements.

This is a figure from the paper showing THEMIS data from 19 August 2008 of an example foreshock disturbance with electron enhancement. The line colors represent different high energy spectrums, labeled on the right. The electron enhancement studied on this date can be seen near the 21:54 time stamp.



These new results were published in the *Physical Review Letters* on 14 November 2016. Scientists aren't sure what accelerates these electrons to such high energies; we know of no shock acceleration mechanism that can energize the electrons in the foreshock up to such high, relativistic energies. This discovery could provide a new paradigm for electron acceleration in plasma near Earth and beyond. This research has broad implications as particle acceleration in collisionless plasmas happens all over the universe. Understanding how electrons interact with small-scale electromagnetic fluctuations to become highly energized advances our knowledge of how energy is transformed throughout the universe. Thanks to THEMIS we now know more about how energy is transferred close to home, in an area we didn't think high-velocity particles could originate.

"Engineering Time" at the Catawba Science Center in Hickory, NC

- On Saturday, September 10, 2016, the Catawba Science Center in Hickory, NC, ran an "Engineering Time" focused on planets and exoplanets, a topic chosen based on patron requests
- These events engage families in activities run by local engineers and scientists
- The NASA Goddard Astrophysics Education Team assisted with activity selection and provided long-distance professional development
- There were three primary stations featuring activities from NASA's Afterschool Universe and Family Science Night programs:
  - Building a clay scale model of the Solar System
  - Building spectroscopes using spectroscopy to identify elements
  - Building a model that represents the radial velocity method of exoplanet detection
- During the two hour event, approximately 100 people attended including 35 children built and took home functional spectroscopes
- Surveys given to participants as they left the event revealed that 100% of respondents enjoyed the program and 40% were more interested in science, technology, and math after the event
- Catawba Science Center serves 7 rural counties of western North Carolina
- In an effort to reach underrepresented audiences, CSC has established the “Portal To Science” program in which families that qualify for Medicaid or WIC only pay $1 admission
- Four “Portal To Science” families attended the event