Science Mission Directorate

Weekly Highlights

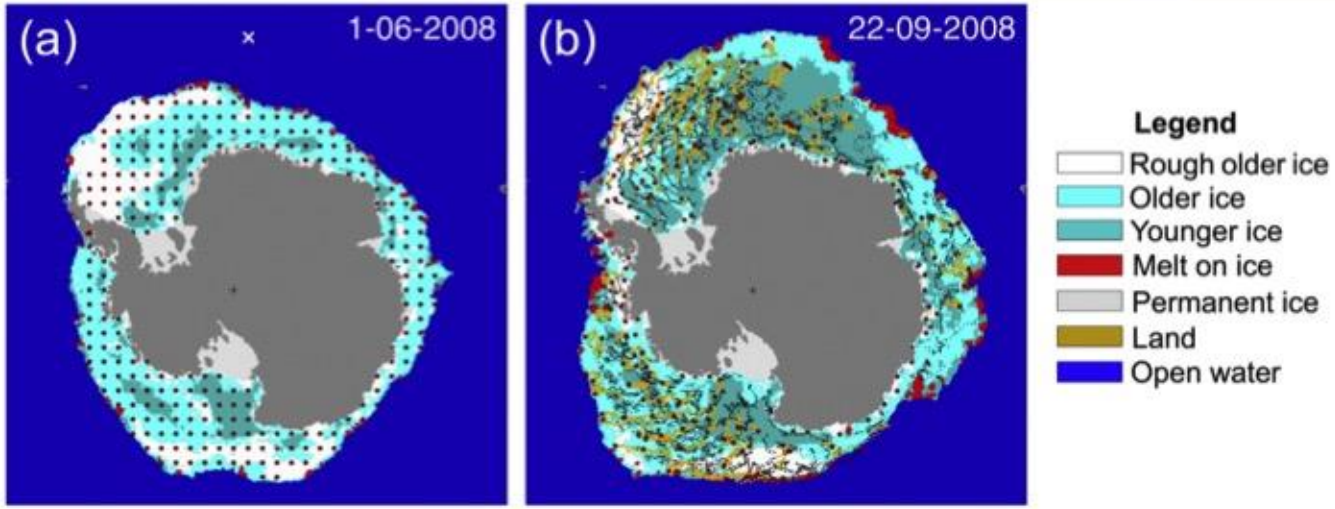
June 10, 2016

Geophysical Constraints on the Antarctic Sea Ice Cover

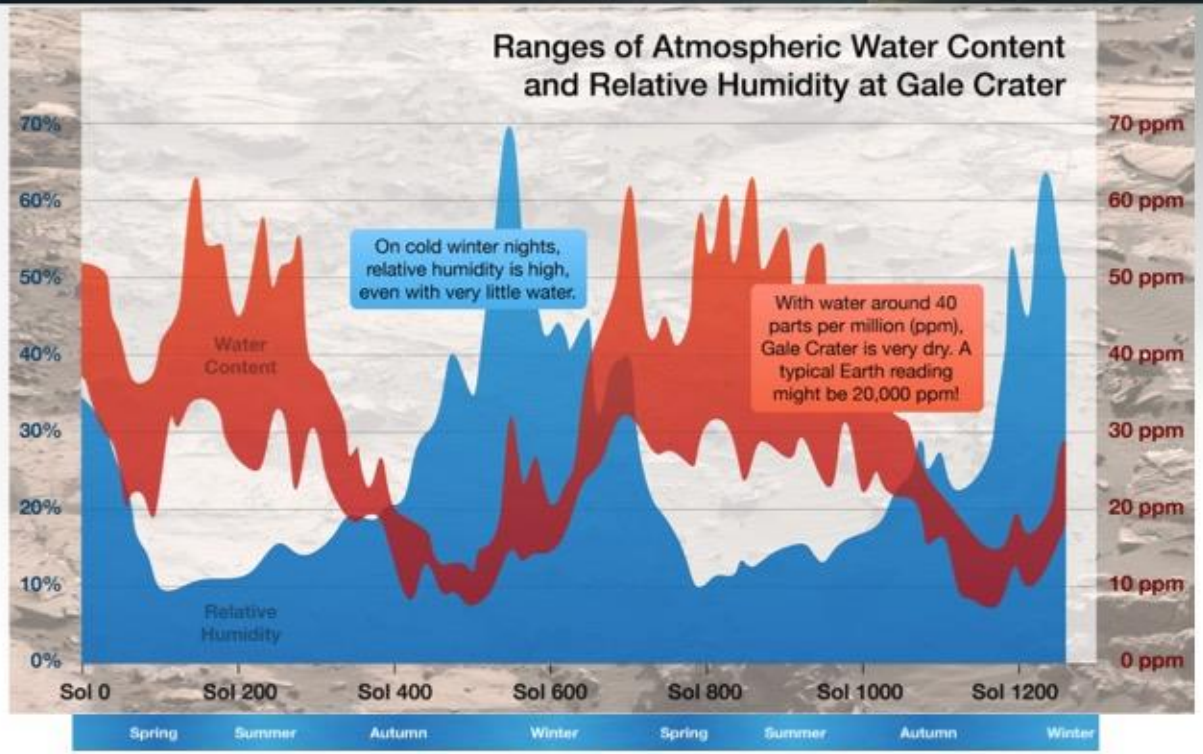
S.V. Nghiem, I.G. Rigor c, P. Clemente-Colón d, G. Neumanna, P.P. Li, Remote Sensing of Environment, Volume 181 (2016) Pages 281–292, http://dx.doi.org/10.1016/j.rse.2016.04.005

NASA JPL scientists investigated the contrast between the slight increase of Antarctic sea ice and the drastic reduction of Arctic sea ice since the 1970s, which has been considered a conundrum. Sea ice trajectory tracking with satellite scatterometer data in 2008 shows that ice around Antarctica is pushed offshore by winds influenced by the continental topography. The ice trajectories reveal that sea ice, grown earlier in the ice season, drifts northward away from the Antarctic continent forming a circumpolar frontal ice zone (FIZ) behind the ice edge. The FIZ thereby consists of sea ice that becomes rougher due to a longer exposure to wind and wave actions, and thicker over time by more ice growth and greater snow accumulation. In the Antarctic circumpolar sea ice zone adjacent to the sea ice edge, satellite data in 1999–2009 exhibit a band of strong radar backscatter, which is consistent with the signature of older, thicker, and rougher sea ice with more snow in the FIZ. This sea ice band, as wide as 1000 km, serves as a 'Great Shield,' encapsulating and protecting younger and thinner ice in the internal ice pack. In the young and thin ice region behind the FIZ, ice can grow rapidly as winds continue opening interior areas thereby creating effective "ice factories." During the ice growth season, the FIZ advances until reaching lower-latitude warm waters at a boundary determined by the southern Antarctic Circumpolar Current front that is constrained by seafloor features. These persistent topographical and bathymetric geological factors help sustain the Antarctic sea ice cover. As such, the behavior of Antarctic sea ice is not a paradox as some have suggested, but instead is consistent with the geophysical characteristics in the southern polar region that starkly contrast to those in the Arctic.

Right: Tracking of trajectories of sea ice parcels over different synoptic sea ice classes. The left panel (a) represents the initial set of points in a 2° grid. The right panel (b) shows the trajectories of the sea ice parcels at the end of the tracking on the equinox of 22 September 2008. Red dots are the current positions with the orange
trails indicating the drift of the tracks.



Two Mars Years of Meteorology



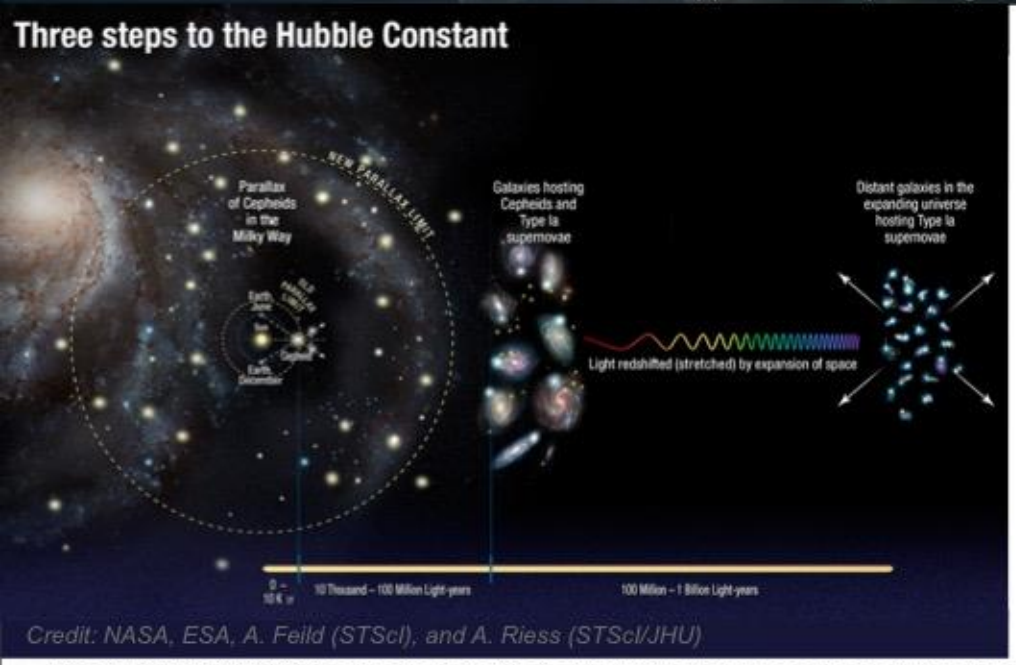
For two full Mars years, the Rover Environmental Monitoring Station (REMS) instrument on the Curiosity rover has collected data on humidity and absolute water vapor.

- REMS, provided by the Spanish Centro de Astrobiologia (CAB), makes daily measurements of a series of atmospheric conditions via two small booms mounted on the rover's mast (see below).

- Measurements of relative humidity values reach ~70% at 1.6 meters (5.25 ft) above the surface, and even though there is very little water in the atmosphere, this means that near the ground where temperatures are colder, the humidity is potentially saturating.
- Importantly, even with this high relative humidity, after measurements through both winters, no frost or seasonal hydration of the soil has been detected.

Hubble Finds Universe is Expanding Faster than Expected

The results will appear in an upcoming issue of The Astrophysical Journal.



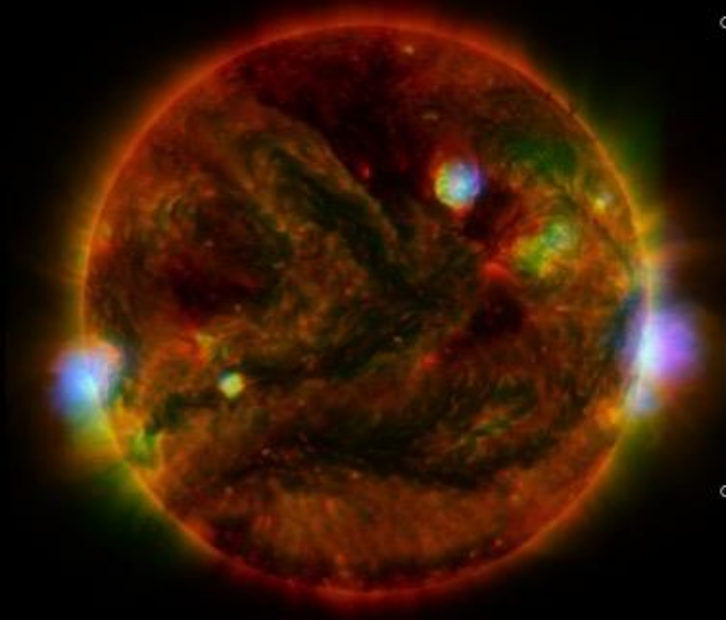
Credit: NASA, ESA, A. Feild (STScI), and A. Riess (STScI/JHU)

- Astronomers using NASA's Hubble Space Telescope have discovered that the universe is expanding 5 percent to 9 percent faster than expected. Scientists made the discovery by refining the universe's current expansion rate to unprecedented accuracy, reducing the uncertainty to only 2.4 percent.
- The astronomers looked for galaxies containing both Cepheid stars and Type Ia supernovae. Cepheid stars pulsate at rates that correspond to their true brightness, which can be compared with their apparent brightness as seen from Earth to accurately determine their distance. Type Ia supernovae are exploding stars that flare with the same brightness and are brilliant enough to be seen from relatively longer distances.
- By measuring about 2,400 Cepheid stars in 19 galaxies and comparing the observed brightness of both types of stars, scientists accurately measured their true brightness and calculated distances to roughly 300 Type Ia supernovae in far-flung galaxies. The team compared those distances with the expansion of space as measured by the stretching of light from receding galaxies. The team used these two values to calculate how fast the universe expands with time, or the Hubble constant.
- The improved Hubble constant value is 73.2 kilometers per second per megaparsec. (A megaparsec equals 3.26 million light-years.) The new value means the distance between cosmic objects will double in another 9.8 billion years.
- This refined calibration presents a puzzle, however, because it does not match the expansion rate predicted for the universe from its trajectory seen shortly after the big bang. Measurements of the afterglow from the big bang by NASA's Wilkinson Microwave Anisotropy Probe (WMAP) and ESA's Planck satellite mission yield predictions for the Hubble constant that are 5 percent and 9 percent, respectively, smaller.
- There are a few possible explanations for the universe's excessive speed. One possibility is that dark energy, already known to be accelerating the universe, may be shoving galaxies away from each other with even greater — or growing — strength.
- Another idea is that the cosmos contained a new subatomic particle in its early history that traveled close to the speed of light. Such speedy particles are collectively referred to as "dark radiation" and include previously known particles like neutrinos. More energy from additional dark radiation could be throwing off the best efforts to predict today's expansion rate from its post-big bang trajectory.
- The boost in acceleration could also mean that dark matter possesses some weird, unexpected characteristics. Dark matter is the backbone of the universe upon which galaxies built themselves up into the large-scale structures seen today.
- And finally, the speedier universe may be telling astronomers that Einstein's theory of gravity is incomplete.
- The Hubble observations were made with the Wide Field Camera 3 (WFC3), and were conducted by the Supernova H0 for the Equation of State (SH0ES) team, which works to refine the accuracy of the Hubble constant. The SH0ES team has reduced the uncertainty in the Hubble constant value by 76 percent since beginning its quest in 2005. The SH0ES Team is still using Hubble to reduce the uncertainty in the Hubble constant even more, with a goal to reach an accuracy of 1 percent.

Astrophysics NuSTAR Mission is Helping to Solve an Age-old Solar Physics Mystery

Grefenstette, B. et al. (2016) THE FIRST FOCUSED HARD X-RAY IMAGES OF THE SUN WITH NUSTAR. The Astrophysical Journal. To Be Published Soon.

The NASA Astrophysics Small Explorer mission, NuSTAR launched in June of 2012, is the first orbiting telescope that can focus light in the high energy X-ray band. This makes it capable of capturing previously elusive and mysterious events on the Sun's corona. Since its launch, NuSTAR, the Nuclear Spectroscopic Telescope Array mission, has spent most of its time investigating the mysteries of black holes, supernovae, and other high-energy objects in space. But NuSTAR data are making waves in solar physics as well in research partially funded by the Heliophysics R&A program. A paper soon to be published by Grefenstette et al., presents the first NuSTAR images of high energy x-rays coming from the sun and connecting these data to one of the biggest mysteries we have about how our home star operates, "the coronal heating problem."



Flaring, active regions of our sun are highlighted in this new image combining high-energy X-rays from NuSTAR (shown in blue), low-energy X-rays from Hinode (shown in green), and extreme ultraviolet light from SDO (shown in yellow and red). Captured April 29, 2015, the NuSTAR image is a mosaic made from combining smaller images. Credits: NuSTAR

- Nanoflares may help us better understand the "coronal heating problem. With NuSTAR's high-energy view, it has the potential to capture nanoflares -- smaller versions of the sun's giant flares that erupt with charged particles and high-energy radiation. The sun's atmosphere, or its corona is, on average, 1.8 million˚ F while the surface of the sun is relatively cooler at 10,800˚ F. It is like a flame coming out of an ice cube. One would think that the extreme heat in the corona could be due to the massive amounts of plasma and radiation being produced by frequent coronal mass ejections and solar flares erupting from its surface. However, research has shown that even when the surface of the sun is quiet, the atmosphere still blazes. It has been hypothesized that nanoflares, although smaller than solar flares, may be one of the sources of this intense heat. It has been challenging to detect these nanoflares with the instruments aboard current solar optics missions because they aren't sensitive enough to detect the high radiation produced by nanoflares during less active periods on the Sun's surface. NuSTAR has observed high energy photons from the Sun using is hard X-ray instruments, and scientists are working to plug this data into the coronal heating problem mystery to help solve this decades-old puzzle.
- Because NuSTAR was designed to study extremely faint astrophysics objects, it is uniquely capable of observing the faintest X-ray emission from the sun and complements the existing solar observatories, which are equipped to capture much brighter flares. SDO (the Solar Dynamics Observatory) and Hinode can produce images of microflares, which are not as faint as nanoflares and tend to happen along-side coronal mass ejection events, while RHESSI has the ability to observe the largest flares. NuSTAR is not only able to observe these less bright, highly radiative flares but can capture data during less active, quiet times on the sun's surface. We know more about how large plasma and radiation events on the sun's surface affect its atmosphere – to capture data on how the atmosphere stays heated during quieter times with less activity is crucial to better understanding why the "coronal heating problem" exists.

What happens on the sun, affects what happens here on Earth – we are a part of an interconnected system. And, how we research the different processes and phenomena in space is also a part of an interconnected system – a collaborative effort that encourages sharing the use of instruments and information across scientific disciplines. Although NuSTAR is primarily an Astrophysics mission, its data on the sun is helping to transform one of solar physics' biggest mysteries into something we are beginning to understand. One small step for Astrophysics and one giant leap for Heliophysics – either way, we are all walking together.

“Views of Our Planets” and “Pluto-Explored!” at the 2016 World Stamp Show

- On, May 31, 2016, the United States Postal Service dedicated the “Views of Our Planets” and the “Pluto – Explored!” Commemorative Forever® Stamps during a First-Day-of- Issue Ceremony
- The event took place during the World Stamp Show NY2016 at the Jacob K. Javits Convention Center to a packed audience
- NASA Chief Scientist, Ellen Stofan, Planetary Science Director, James Green, New Horizons Principal Investigator, Alan Stern, and Manager, Alice Bowman provided attendees a firsthand account how the stamp images were achieved and the background story of a 1991 US Postage Stamp, the New Horizons Mission, and the Pluto-Explored! stamps

Crowds stood in line to get NASA autographs for hours in the equivalent of three-city-blocks line.

USPS/Antonio Alcalá © 2016 USPS

- The pane of 16 Forever-Stamps showcases some of the more visually compelling historic images of the planets obtained during the last 50 years of NASA space exploration
- Stamps feature Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune
- The souvenir sheet of four New Horizons stamps features two new stamps appearing twice --the first stamp is an artist’s rendering of NASA’s New Horizons while the second stamp shows an enhanced color image of Pluto taken by New Horizons near its closest approach to the planet