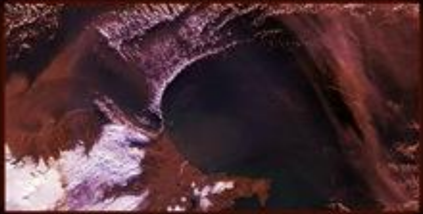
National Aeronautics and Space Administration

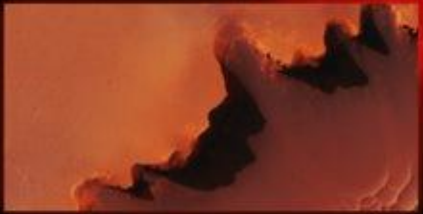
NASA Science

Weekly Highlights
December 6, 2013



EARTH SCIENCE

HELIOPHYSICS



PLANETARY SCIENCE

ASTROPHYSICS

Hubble Traces Subtle Signals of Water on Hazy Worlds

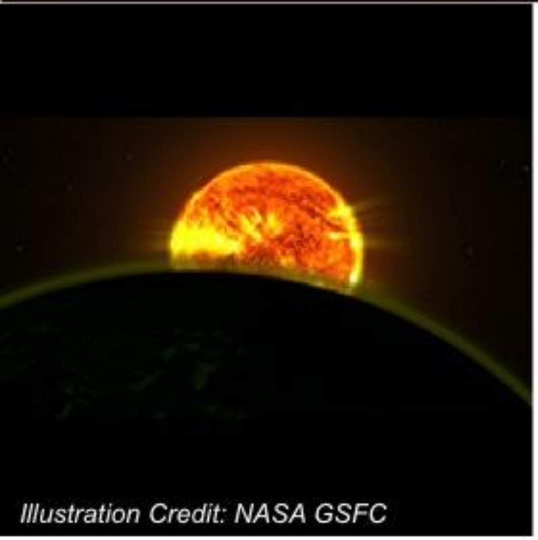
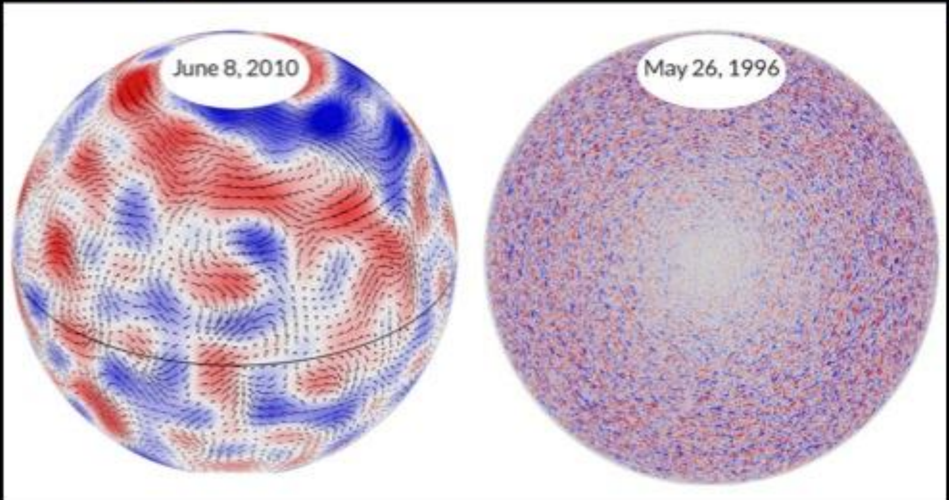


Illustration Credit: NASA GSFC

- Using NASA's Hubble Space Telescope, two teams of scientists have found faint signatures of water in the atmospheres of five distant planets.
- The presence of atmospheric water was reported previously on a few exoplanets orbiting stars beyond our solar system, but this is the first study to conclusively measure and compare the profiles and intensities of these signatures on multiple worlds.
- The five planets — WASP-17b, HD209458b, WASP-12b, WASP-19b and XO-1b — orbit nearby stars. The strengths of their water signatures varied. WASP-17b, a planet with an especially puffed-up atmosphere, and HD209458b had the strongest signals. The signatures for the other three planets, WASP-12b, WASP-19b and XO-1b, also are consistent with water.
- The scientists used Hubble's Wide Field Camera 3 to explore the details of absorption of light through the planets' atmospheres. The observations were made in a range of infrared wavelengths where the water signature, if present, would appear. The teams compared the shapes and intensities of the absorption profiles, and the consistency of the signatures gave them confidence they saw water.
- The water signals were all less pronounced than expected, and the scientists suspect this is because a layer of haze or dust blankets each of the five planets. This haze can reduce the intensity of all signals from the atmosphere in the same way fog can make colors in a photograph appear muted. At the same time, haze alters the profiles of water signals and other important molecules in a distinctive way.
- The five planets are hot Jupiters, massive worlds that orbit close to their host stars. The researchers were initially surprised that all five appeared to be hazy, but other researchers are finding evidence of haze around exoplanets.

NASA's Solar Dynamics Observatory Confirms Existence of Large-Scale Plasma Flows on the Sun



Giant, long-lived convective structures (left) move plasma on the sun's surface. Earlier observations found only much smaller plasma flows covering the sun (right). In these illustrations, blue indicates plasma flowing east to west; red indicates west to east. Credit: NASA / D. Hathaway

- Massive, long-lasting plasma flows 15 times the diameter of Earth transport heat from the sun's depths to its surface, according to a new study. The finding supports a decades-old explanation of why the sun rotates fastest at its equator.

- Rising plasma carries heat generated by nuclear fusion in the sun's interior. Once at the surface, much of the plasma's energy radiates into space; the cooler, denser plasma then sinks, driving further convection and creating circulating loops called convection cells. Some especially massive convective structures, called supergranules, can last up to 24 hours and have diameters greater than Earth's.

- In 1968, scientists theorized that even longer-lived and larger convection cells, big enough to span the entire convective zone, are necessary to maintain the fast rotation researchers had long observed around the sun's equator; without such cells, the poles should rotate faster than the equator. Since then, scientists have sought such giant cells in telescopes' observations of the sun.

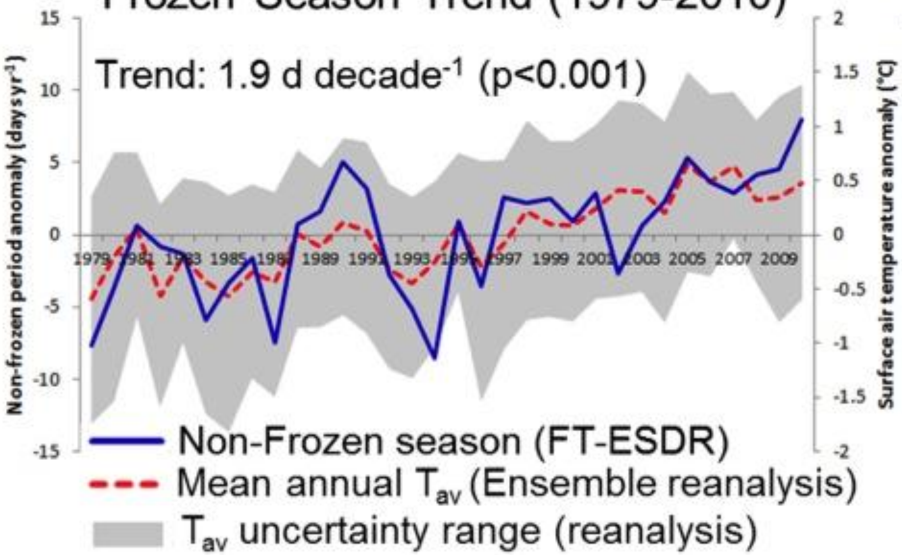
- In the new study, scientists looked for these convection cells using the Helioseismic and Magnetic Imager (HMI) instrument on NASA's Solar Dynamics Observatory (SDO). The researchers measured shifts in the wavelengths of light radiating from the sun's plasma as it flowed toward or away from Earth and used the shifts to compute plasma velocities over the solar surface. These velocities revealed the positions of supergranules, but this time, scientists were also able to use many closely timed observations to see that supergranules were pushed by even larger plasma flows. They found that many of these flows reappeared roughly once every 27 days, the time it takes for a spot on the sun to rotate and thus reappear in view from Earth. The fact that these flows could last for multiple solar rotations suggests that they are the long-lasting giant convection cells researchers have been looking for.

- The giant cells may also explain why the sun rotates faster near its equator than it does near its poles. Material moving in the direction of rotation tends also to be moving towards the equator, the new study found — helping to transport angular momentum and keeping the sun spinning more quickly around its equator. The flows ultimately help drive the 11-year solar cycle and since the flows are likely to be linked to the emergence of sunspots on the solar surface, they could play an important role in space weather events, which can impact power grids and disrupt telecommunications infrastructure on Earth.

Satellite Detection of Recent Northern Hemisphere Non-Frozen Season Trends (1979-2010)

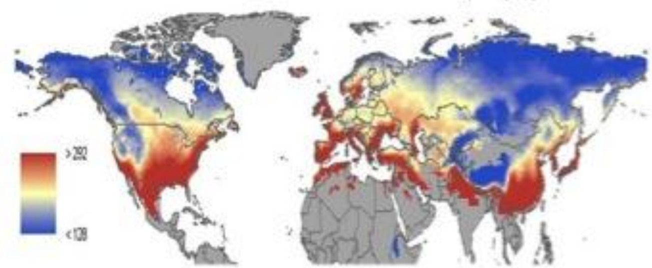
NASA funded scientists developed a 32-yr global daily freeze-thaw (FT) record from overlapping satellite microwave remote sensing data (SMMR, SSM/I sensors). The satellite microwave freeze-thaw (FT) signal provides a surrogate measure of frozen temperature constraints to water mobility and biological activity, while the non-frozen season metric bounds the potential growing season and has a major impact on vegetation phenology and productivity. The FT classification domain extends over more than 66 million km^2 and encompasses all global vegetated land areas where seasonal frozen temperatures are a significant constraint to annual productivity. Primary validation was done against in-situ temperatures from ~3700 global weather stations. The strong Northern Hemisphere (NH) trend toward earlier, longer Non-Frozen (NF) seasons (1.9 d decade^{-1}) is congruent with ~0.3˚C decadal warming trend.

Northern Hemisphere Mean Annual Non-Frozen Season Trend (1979-2010)

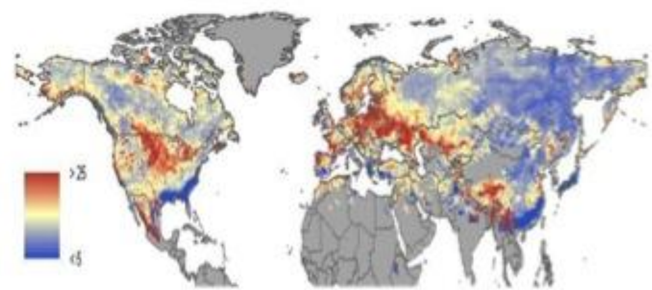


FT data served >4,800 unique users; directly contributed to >16 peer-reviewed journal publications; used or cited in >28 other peer-reviewed publications. http://nsidc.org/data/nsidc-0477.html

Mean Non-frozen Season (days)



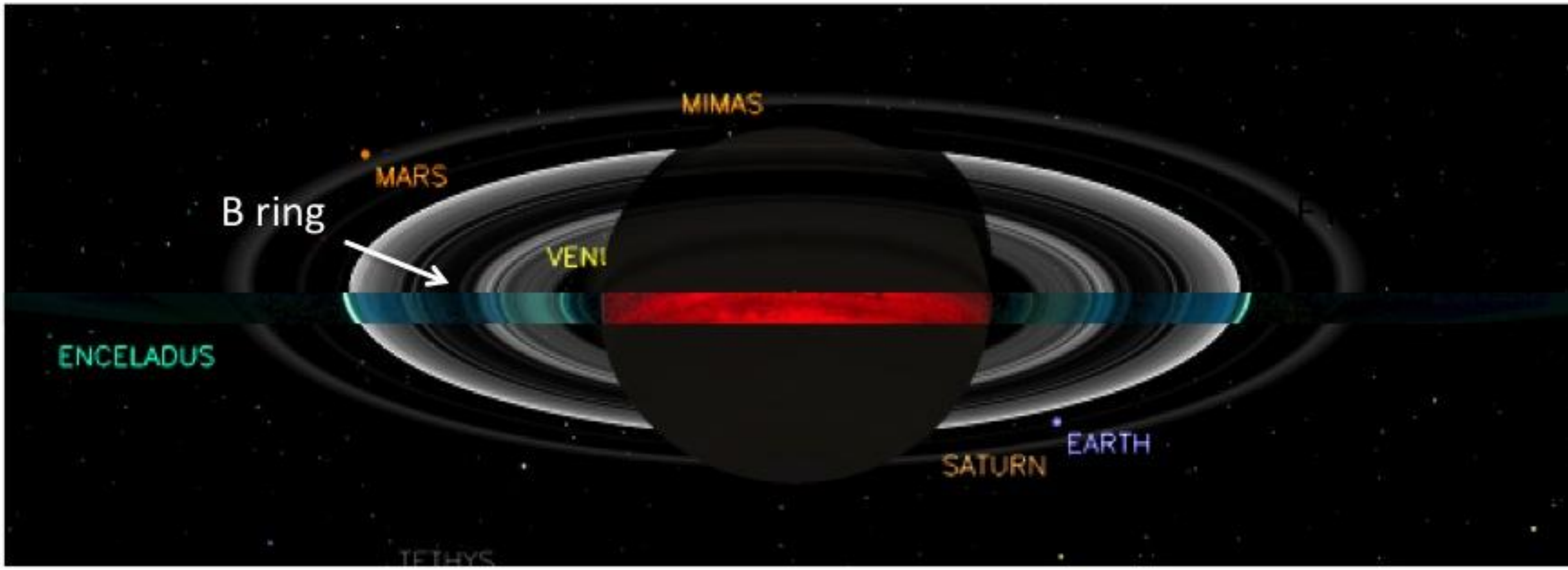
Non-frozen Season Variation (SD, days yr^{-1})



Above: The mean Northern Hemisphere non-frozen season trend defined from the satellite record is increasing, with global warming indicated by mean daily gridded surface air temperature (Tav). The satellite FT record has a mean annual spatial classification accuracy >90% relative to global weather station network observations, while the reanalysis Tav record shows relatively large uncertainty (ensemble range in grey).

An Infrared View of Saturn’s Backlit Rings

In this recent composite image of Saturn’s night side from NASA’s Cassini spacecraft, Saturn is eclipsing the Sun and features of the midsection and the main ring system stand out in the infrared.



Color enhancement highlights details of the data from the Visual & Infrared Mapping Spectrometer (VIMS) are superimposed over the backlit Saturn image. Blue highlights rings that are populated by ice particles; the F ring at the outer edge of the main rings is especially bright, whereas the normally-bright but opaque B ring is mostly dark. Red shows where heat is escaping from the planet’s warm interior.

Analysis of these images and spectra will provide scientists with improved knowledge of the sizes of ice particles in Saturn's rings. This new information will help us understand how primordial materials of our solar system condensed the bodies in our solar system billions of years ago