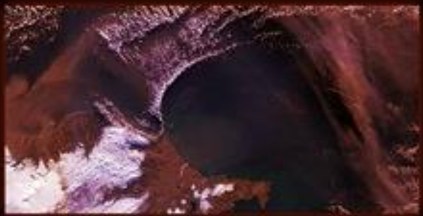
National Aeronautics and Space Administration

NASA Science

Weekly Highlights
November 1, 2013



EARTH SCIENCE

HELIOPHYSICS

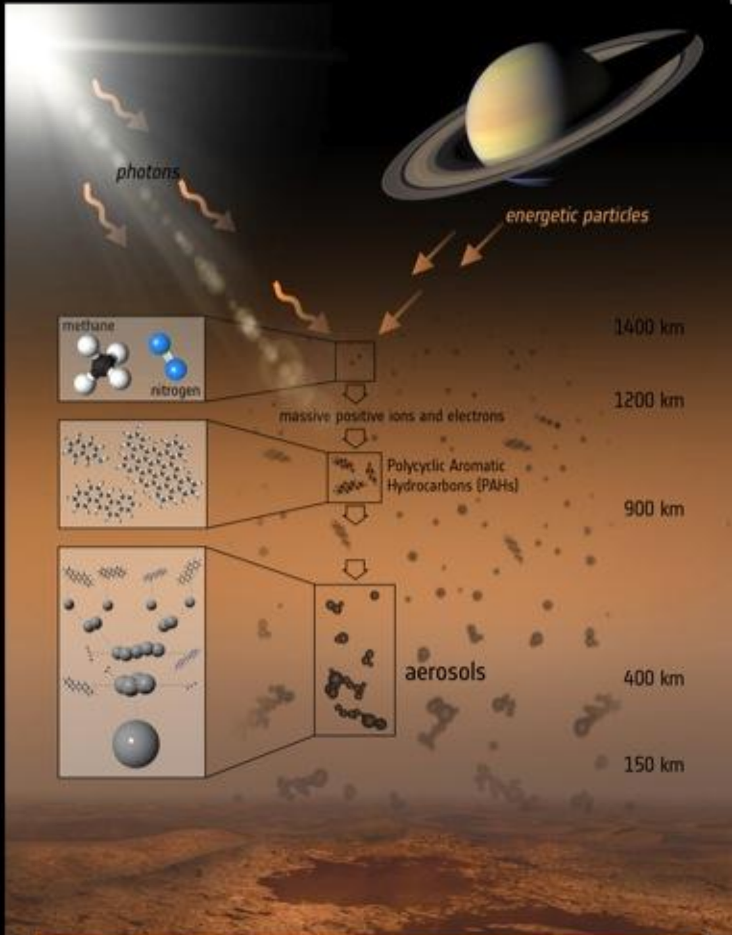
PLANETARY SCIENCE

ASTROPHYSICS

Cassini Finds Titan's Smog Begins with Chemical Reactions High in the Atmosphere

New analysis of Cassini data sheds light on how the heavy, complex hydrocarbon aerosols that make up Titan's haze form out of the simple molecules higher in the atmosphere.

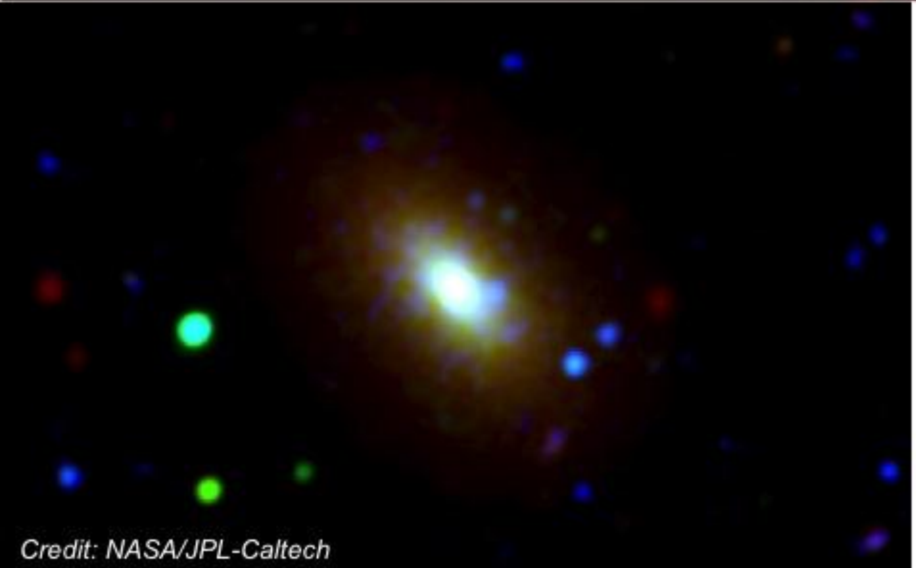
- Titan's haze is made up of distinct layers defined by their organic composition as determined by emission data collected by the Visual-Infrared Mapping Spectrometer (VIMS) on Cassini, but the chemical and physical mechanisms responsible for these layers has not yet been confirmed by empirical data.
- Analysis of recent measurements have provided evidence in support of a model which describes cascading processes:
  - At the top of Titan's atmosphere, above 1,000 km (600 miles), sunlight and electrically charged particles in Saturn's magnetic environment break up nitrogen and methane molecules. Massive positive ions and electrons form, triggering a chain of chemical reactions that lead to the formation of complex, ringed hydrocarbons, called polycyclic aromatic hydrocarbons (PAHs).
  - In turn, these PAHs form the neutral counterparts of the aerosol particles, large aggregates of atoms and molecules that are found well below 500 km (300 miles) altitude in Titan's haze.
- PAHs are thought to have played a role in the formation of life on Earth. Their role in Titan's complex atmospheric chemistry is one reason why Titan is of interest to astrobiologists.
- How these aerosols vary with seasonal change on Saturn will be one focus of Cassini's mission through 2017.



Complex hydrocarbon particles have been found to aggregate into larger particles that create the layers of Titan's atmospheric haze.

M. López-Puertas *et al.*, The Astrophysical Journal, Vol. 770, Number 2. 2013 *ApJ* 770 132
B. M. Dinelli **et al., 29 APR 2013,** Geophysical Research Letters

Galaxy Growth Examined Like Rings of a Tree



Credit: NASA/JPL-Caltech

In this image of a galaxy called NGC 3377, infrared light from WISE is colored red, and ultraviolet light from GALEX is green and blue. The center of the galaxy appears white, where all three wavelengths of light are present and add up. The outside of the galaxy is mostly ultraviolet light, and thus contains more blue and green. The dots in the picture are stars located in the foreground.

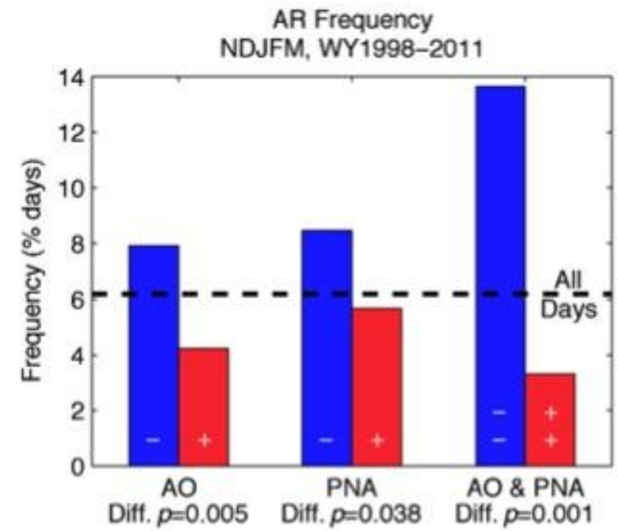
NGC 3377 is located 31 million light-years away in the constellation Leo. It is an older galaxy, having already exhausted its stellar fuel supply. The outer regions, while containing more young stars than the core, are bright in ultraviolet light due to a small population of older, extremely hot stars

- Astronomers can read the rings in a galaxy's disk to unravel its past. Using data from NASA's Wide-field Infrared Survey Explorer (WISE) and Galaxy Evolution Explorer (GALEX), scientists have acquired more evidence for the "inside-out" theory of galaxy growth, showing that bursts of star formation in central regions were followed one to two billion years later by star birth in the outer fringes.
- The discovery may also solve a mystery of elderly galaxies. The galaxies in the study, known as "red and dead" for their red color and lack of new star births, have a surprising amount of ultraviolet light emanating from the outer regions. Often, ultraviolet light is generated by hot, young stars, but these galaxies were considered too old to host such a young population.
- The solution to the puzzle is likely hot, old stars. Astronomers used a new multi-wavelength approach to show that the unexplained ultraviolet light appears to be coming from a late phase in the lives of older stars, when they blow off their outer layers and heat up.
- GALEX and WISE turned out to be the ideal duo for the study. GALEX was sensitive to the ultraviolet light, whereas WISE sees the infrared light coming from older stars. Both telescopes have large fields of view, allowing them to easily capture images of entire galaxies. GALEX is no longer operating, but WISE was recently reactivated to hunt asteroids, a project called NEOWISE.

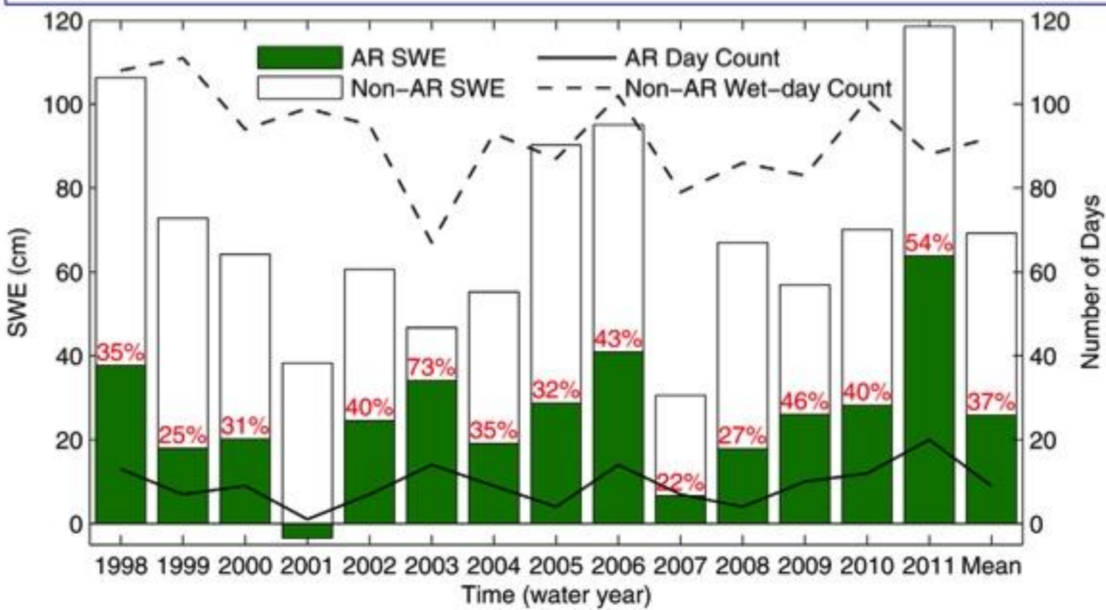
The 2010/2011 Snow Season In California's Sierra Nevada: Role Of Atmospheric Rivers And Modes Of Large-scale Variability

Guan, B., N. P. Molotch, D. E. Waliser, E. J. Fetzer, and P. J. Neiman (2013), Water Resour. Res., 49, doi:10.1002/wrcr.20537

NASA funded researchers examined the anomalously snowy winter season of 2010/2011 in the Sierra Nevada, which was analyzed in terms of snow water equivalent (SWE) anomalies and the role of atmospheric rivers (ARs). ARs are narrow channels of enhanced water vapor transport in the atmosphere. They are responsible for over 90% of the water vapor transport between the tropics and extratropics while occupying less than 10% of the circumference of the earth surface. The study suggests that the massive Sierra Nevada snowpack during the 2010/2011 winter season is primarily related to anomalously high frequency of ARs favored by the negative phases of the Arctic Oscillation (AO) and the Pacific-North American (PNA) teleconnection pattern. A secondary contribution is from increased snow accumulation during these ARs favored by colder air temperatures associated with AO, PNA, and La Niña. The results highlight the importance of understanding the relationship between AR activity and the large-scale ocean-atmosphere variability for better prediction and management of water resources/floods in California and other western states.

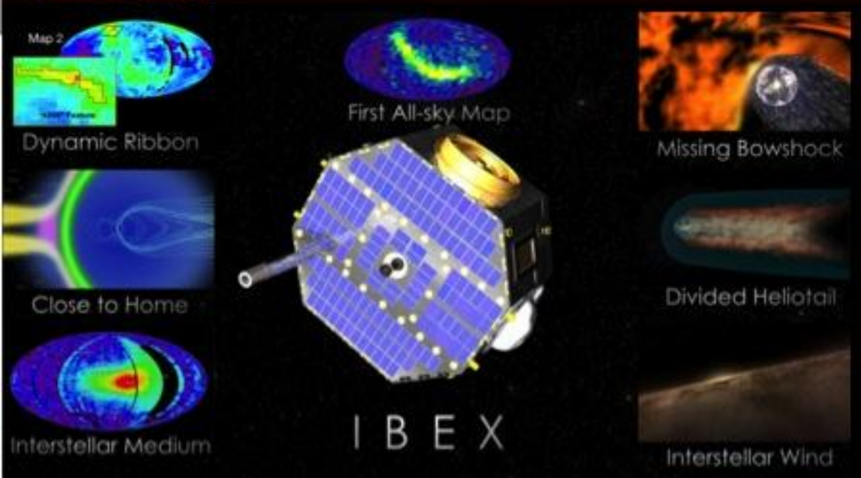


Above: AR frequency (percent days) in California over negative (blue) and positive (red) phases of AO and PNA during the winter months (November–March) of WY1998–2011. The statistical significance (p value) of the difference between the blue and red bars in each set is indicated.



Left: Snow sensor estimates of SWE (cm) over the Sierra Nevada associated with ARs compared to the total seasonal (November–March) accumulation (bars). Percentage contribution of ARs to the seasonal snow accumulation is indicated (red numerals). Also shown is the number of AR dates (solid line) and non-AR wet dates (dashed line) each season. The multiyear mean is shown with the rightmost bar. AR percentage contribution is not shown for WY2001 when the season's sole AR occurred late in the cool season and reduced the SWE.

NASA's IBEX Celebrates 5 Years of Discoveries



Above: IBEX discoveries made during its first five years of operations. Credit: NASA.

- Launched on Oct. 19, 2008, the Interstellar Boundary Explorer, or IBEX, spacecraft, is unique to NASA's Heliophysics fleet: it images the outer boundary of the heliosphere, a boundary at the furthest edges of the solar system, far past the planets, some 8 million miles away.

- There, the constant stream of solar particles flowing off the sun, the solar wind, pushes up against the interstellar material flowing in from the local galactic neighborhood. IBEX is also different because it creates images from particles instead of light. Scientists create maps from the observed neutral atoms. Over the course of six months and many orbits around Earth, it can image the entire sky in ENAs.

- During its first five years, IBEX has made many discoveries:

- Mapping the Boundaries: In its first year, IBEX scientists created the first-ever all-sky map of the heliosphere's boundary, where the influence of the solar wind diminishes and interacts with the interstellar medium. The most startling finding was that the map was not uniform or symmetrical, but showed a bright ribbon of energetic neutral atoms snaking through it. IBEX then showed that the heliosphere's boundaries changed more rapidly than expected, with variations as short as six months.

- ENAs Near Earth: Because IBEX is orbiting Earth, it also can look back toward Earth's neutral-atom environment and so has provided the first ENA images of the magnetosphere from the outside. Nearby, IBEX scanned the moon, as well showing the moon creates a backscattered, neutral solar wind with about 10 percent of the impinging solar-wind protons becoming ENAs.

- The Heliosphere: Looking Ahead and Looking Behind: Measurements by IBEX announced in 2012 showed the influence of the heliosphere on the local interstellar medium is different than expected. IBEX data suggested that there is no bow shock preceding the heliosphere's movement through space. IBEX has also provided the first observations of the heliotail.

- Into the Galaxy: IBEX has also supplied information about the local galactic environment. It made the first direct measurements of neutral hydrogen, oxygen, and neon coming into the heliosphere from the interstellar medium. Measurements showed the composition of the current galactic neighborhood is different than that of the sun and the solar system. IBEX also found that the speed of the galactic wind registered around 52 thousand miles per hour. By comparing this wind to results from other missions over the last 40 years, observations showed the direction of the wind has changed about 7 degrees in the last four decades.

NASA Solar Dynamics Observatory “Sunday Experiment”

The SDO E/PO team hosted the “Sunday Experiment” on September 15th a the GSFC Visitor Center. Over 300 people attended the public event, which featured hands-on science activities, solar viewing, and scientist lectures. Participants learned about SDO science and space weather, and built electromagnets, explored the Sun’s magnetic field with magnaprobes, and experimented with UV beads.