National Aeronautics and
Space Administration

Science Mission Directorate

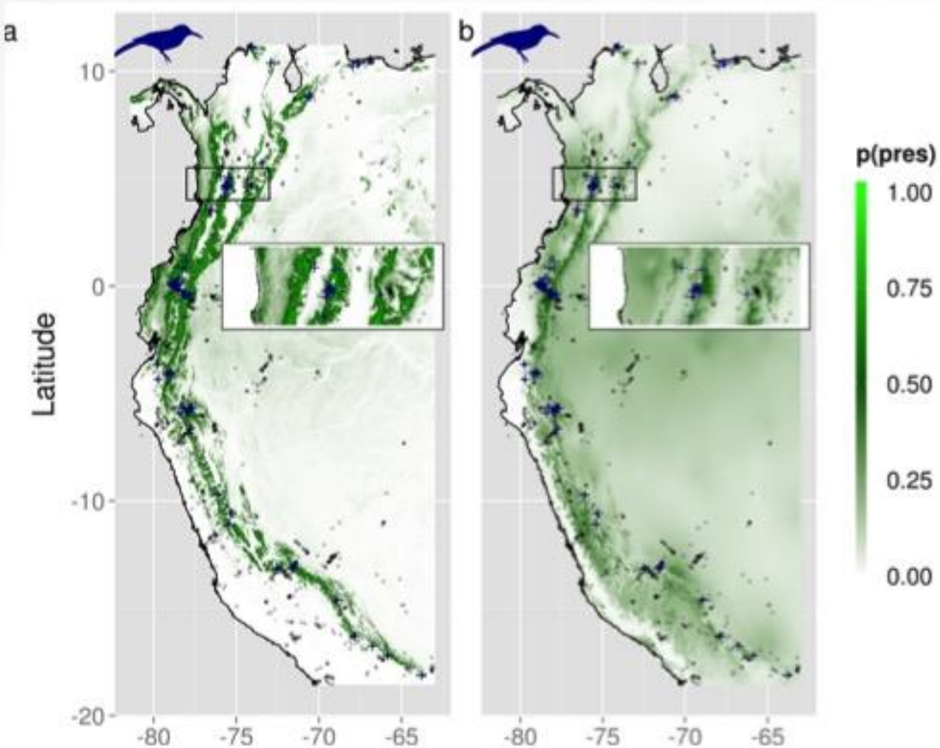
Weekly Highlights

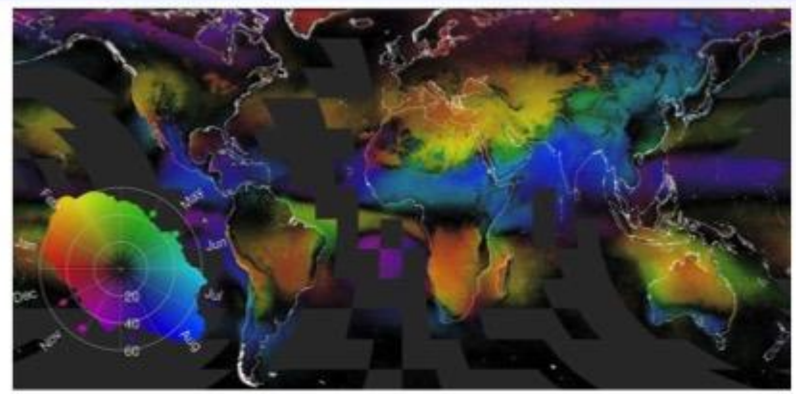
April 8, 2016

Remotely Sensed High-Resolution Global Cloud Dynamics for Predicting Ecosystem and Biodiversity Distributions

Wilson AM, Jetz W | PLoS Biology| March 2016 | doi:10.1371/journal. pbio.1002415

NASA and NSF-funded researchers developed new near global, fine-grain (~1 km) monthly cloud frequencies from 15 years of twice-daily Moderate Resolution Imaging Spectroradiometer (MODIS) satellite images that expose spatiotemporal cloud cover dynamics of previously undocumented global complexity. They demonstrated that cloud cover varies strongly in its geographic heterogeneity and that the direct, observation-based nature of cloud-derived metrics can improve predictions of habitats, ecosystem, and species distributions with reduced spatial autocorrelation compared to commonly used interpolated climate data. Cloud cover can influence numerous important ecological processes, including reproduction, growth, survival, and behavior, yet our assessment of this relevance at the appropriate scale has remained remarkably limited. Advanced spatial assessment and monitoring of biodiversity in today' s rapidly changing world is vital for managing future biological resources and a key element of several 2020 targets of the Convention on Biological Diversity and the Intergovernmental Platform on Biodiversity and Ecosystem Services.





Above: Global distribution of seasonal cloud concentration. The hue indicates the month of peak cloudiness, and the saturation and value indicate the concentration of clouds, from 0 to 100.

Left: Evaluation of predictions from species distribution models of (a,b) montane woodcreeper (Lepidocolaptes lacrymiger, blue symbols). (a) is estimated probability of presence from species distribution models fit using cloud frequency, while (b) uses interpolated precipitation. Insets in a and b show detail from boxed region. Gray points indicate locations with non-detections, while blue "+" marks indicate observed presences.

Trigger for Milky Way's Youngest Supernova Identified

Published in the March 1, 2016 edition of The Astrophysical Journal.

Credit:X-ray NASA/CXC/CfA/S.Chakraborti et al.
This Chandra image shows G1.9+0.3 where low-energy X-rays are colored red, medium-energy X-rays are green, and a higher-energy band of X-rays is blue.

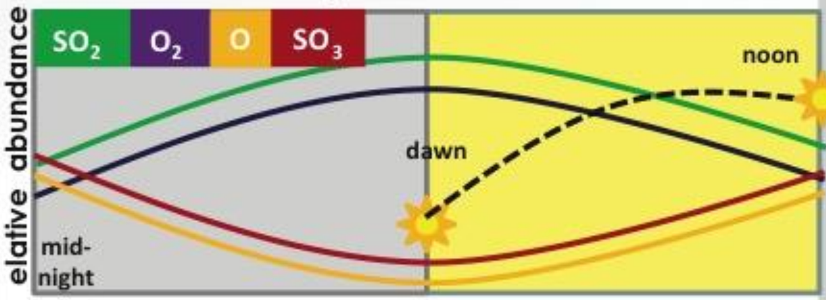
- Scientists have used data from NASA's Chandra X-ray Observatory and the NSF's Jansky Very Large Array to determine the likely trigger for the most recent supernova in the Milky Way.
- Astronomers had previously identified G1.9+0.3 as the remnant of the most recent supernova in our Galaxy. It is estimated to have occurred about 110 years ago from the vantage point of Earth, in a dusty region of the Galaxy that blocked visible light from reaching Earth.
- G1.9+0.3 belongs to the Type Ia category, an important class of supernovas exhibiting reliable patterns in their brightness that make them valuable tools for measuring the rate at which the universe is expanding. Most scientists agree that Type Ia supernovas occur when white dwarfs, the dense remnants of Sun-like stars that have run out of fuel, explode. However, there has been a debate over what triggers these white dwarf explosions. Two primary ideas are the accumulation of material onto a white dwarf from a companion star or the violent merger of two white dwarfs.
- The researchers in this latest study applied a new technique that could have implications for understanding other Type Ia supernovas. They used archival Chandra and VLA data to examine how the expanding supernova remnant G1.0+0.3 interacts with the gas and dust surrounding the explosion. The resulting radio and X-ray emission provide clues as to the cause of the explosion. In particular, an increase in X-ray and radio brightness of the supernova remnant with time is expected only if a white dwarf merger took place, according to theoretical work.
- This result implies that Type Ia supernovas are either all caused by white dwarf collisions, or are caused by a mixture of white dwarf collisions and the mechanism where the white dwarf pulls material from a companion star. It is important to identify the trigger mechanism for Type Ia supernovas because if there is more than one cause then the contribution from each can change over time, affecting their use as "standard candles" in cosmology.

Hubble Observations of Venus' Sulfur-bearing Species Reveal a Surprising Twist

Coordinated observations by Hubble and Venus Express are helping scientists study Venus' thick sulfuric acid (H_2SO_4) clouds - the "greenhouse gas" that trap heat in the atmosphere.

- The H_2SO_4 clouds depend on SO_2, without which the clouds could not form and Venus' surface temperatures would be radically different.
- To understand how SO_2 and H_2SO_4 behave and control climate, scientists sought to understand how SO_2 behaves in a single day from sunrise to sunset.

Venus' atmospheric SO_2 abundance changes relative to the time of day. Coordinated observations allowed for the *first* map of SO_2 abundance from just before sunrise to noon.



EXPECTED BEHAVIOR

On the nightside:

$SO+O \rightarrow SO_2$

$O+O \rightarrow O_2$

as free O ↓ SO_3 ↓

As the night progresses the SO_2 abundance increases, peaking just before dawn.

On the dayside:
Sunlight (=hν) splits SO_2 & O_2

$h\nu+SO_2 \rightarrow SO+O$

h +O_2 O+O

as the sun rises towards noon:

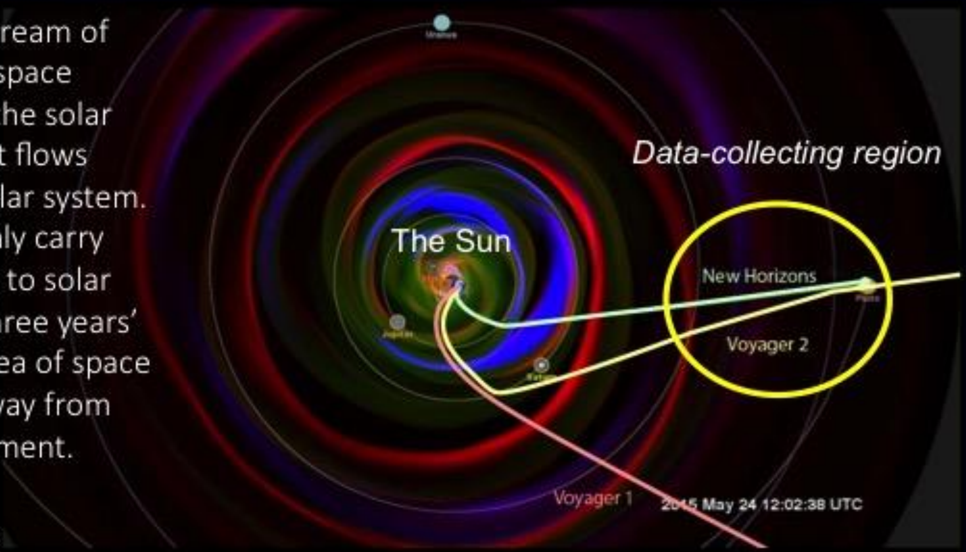
O_2 ↓ SO_2 ↓ and SO ↑

free O becomes available & SO_3 forms

- The coordinated observations confirmed some of our expectations, for example, the SO_2 abundance in the early morning was greater than SO_2 abundance at noon. However, other behaviors were the opposite of what was expected, such as the observed dayside SO abundance decreased as the SO_2 abundance decreased.
- The observed behavior suggests that we do not fully understand what controls SO_2 and SO in the atmosphere and that there is some transient process that occurs after dawn that can radically change the SO_2 density as the day progresses.
- Exploring these behaviors can lead to a new understanding of how Venus' sulfur chemistry relates to the H_2SO_4 cloud density and have the potential to reveal why Venus' climate became so divergent from Earth's.

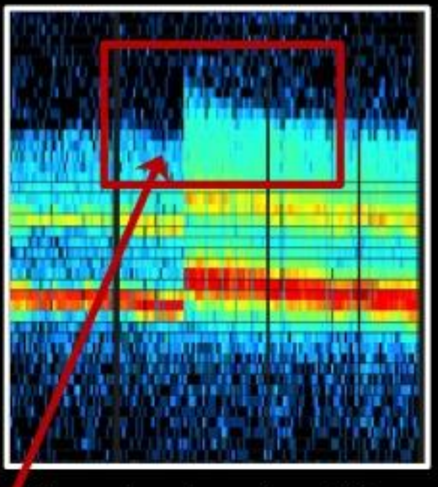
NASA's Pluto Probe Fills Critical Gap the Voyagers Left Behind

Although space looks empty, the solar wind – a thin and tenuous stream of particles and fields known as plasma – flows from the sun and fills space between the planets. Closer to home we have been able to study the solar wind quite well, but we don't know much about how it evolves as it flows outward through the heliosphere toward the outer edges of our solar system. The New Horizons mission that recently passed by Pluto doesn't only carry imagers, it also has instruments that make significant contributions to solar wind research. On its way to Pluto, the spacecraft sent back over three years' worth of continuous measurements of solar wind particles in an area of space that few spacecraft have ever visited; a region that is light-hours away from home and an almost entirely unexplored part of our space environment.



These measurements are even more valuable for two reasons:

- ✓ New Horizons solar wind measurements are taken from the approximate path the Voyager spacecraft have taken. NASA's Voyagers are much further out on their "Interstellar Mission", in the space where the solar wind meets interstellar space.
- ✓ Also, the New Horizons data reveals, for the first time, the starting seeds of a class of unusual energetic particles, called anomalous cosmic rays, that are believed to be a product of the interaction of the solar wind with winds from other stars.



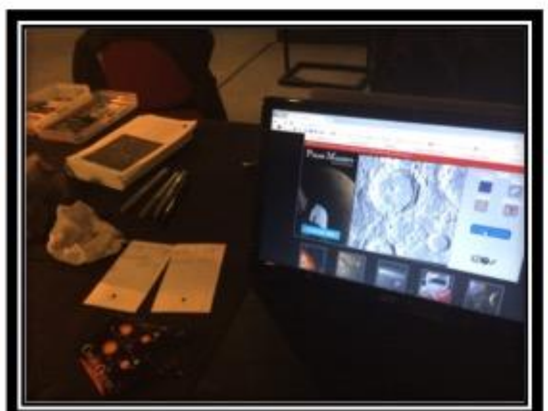
These seeds, suprathermal ions, are observed as a population with energies ever so slightly above that of the solar wind. Their effects, anomalous cosmic rays, contribute to radiation hazards for astronauts and are observed close to Earth. Anomalous cosmic rays are also being observed by the two Voyager spacecraft in the outer reaches of the solar system, but only in their final stages, leaving questions as to the acceleration mechanism. Through following the evolution of the seed population, New Horizons data will be giving us the first glimpses of their origins. These seed particles are also unaccounted for in computer models of the boundary where solar wind meets interstellar space. So new modeling with New Horizons and Voyager spacecraft observations will provide scientists with a much better understanding of the dynamics of the newly discovered heliopause region. The new study will appear in The Astrophysical Journal Supplement.

http://www.nasa.gov/feature/goddard/2016/nasa-s-new-horizons-fills-gap-in-space-environment-observations

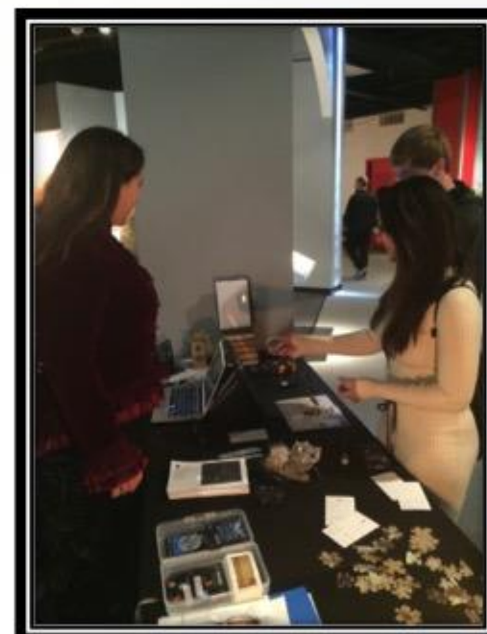
CosmoQuest at Saint Louis Science Center

- On March 4, 2016, Pamela Gay and Georgia Bracey shared CosmoQuest.org citizen science and supporting curriculum activities at the "First Fridays" event at the Saint Louis Science Center, MO
- Approximately 400 visitors (mostly family groups) stopped by the CosmoQuest table
- Information was provided about how to get involved with NASA missions through citizen science
- Hands-on activities included:
  - Marking craters on Mercury and the Moon
  - Explore light using an Einstein bulb, Galileoscope lens, color filters, and diffraction gratings
- Visitors also learned about planetary surface features by playing "Earth or Not Earth" and received NASA Science outreach materials, including CosmoQuest brochures and a variety of stickers

CosmoQuest invites attendees to science



Mapping the surface of Mercury with Messenger data and CosmoQuest.org



Pamela Gay watches as attendees use Galileoscope lens to focus light