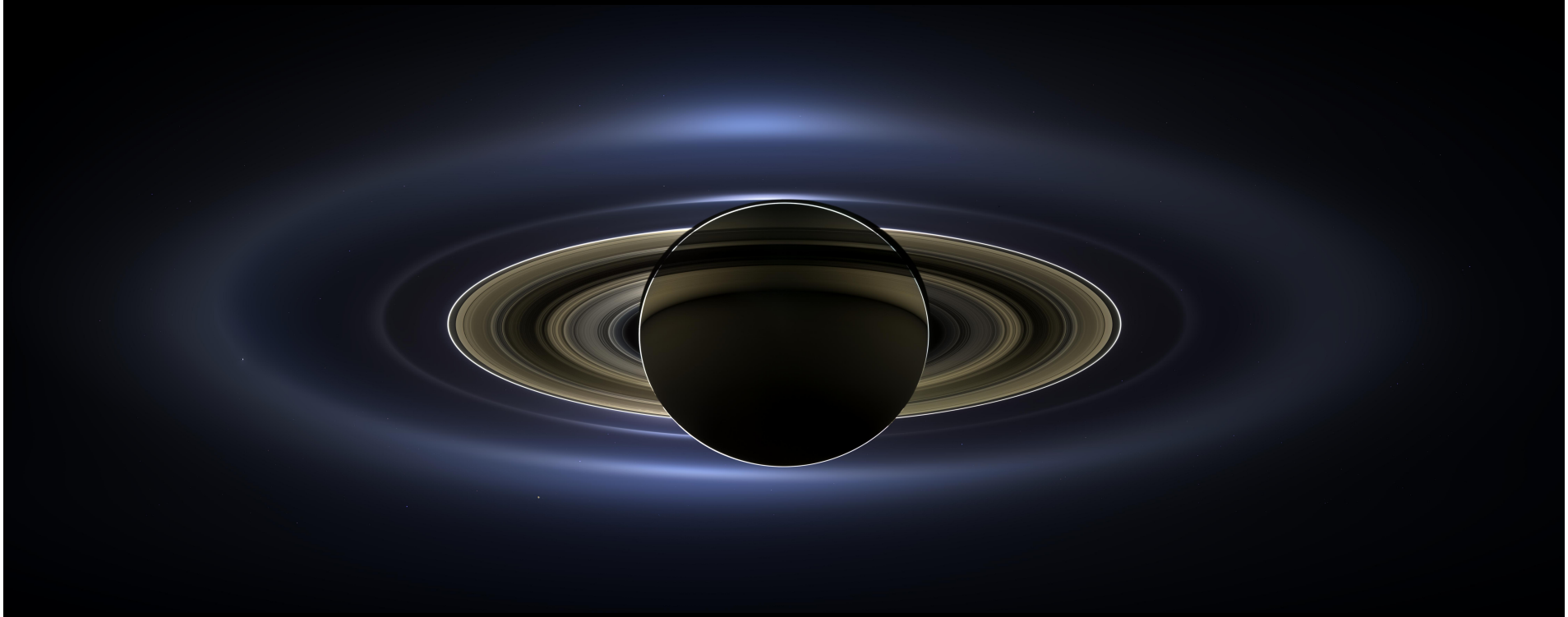
Cassini Solstice Mission

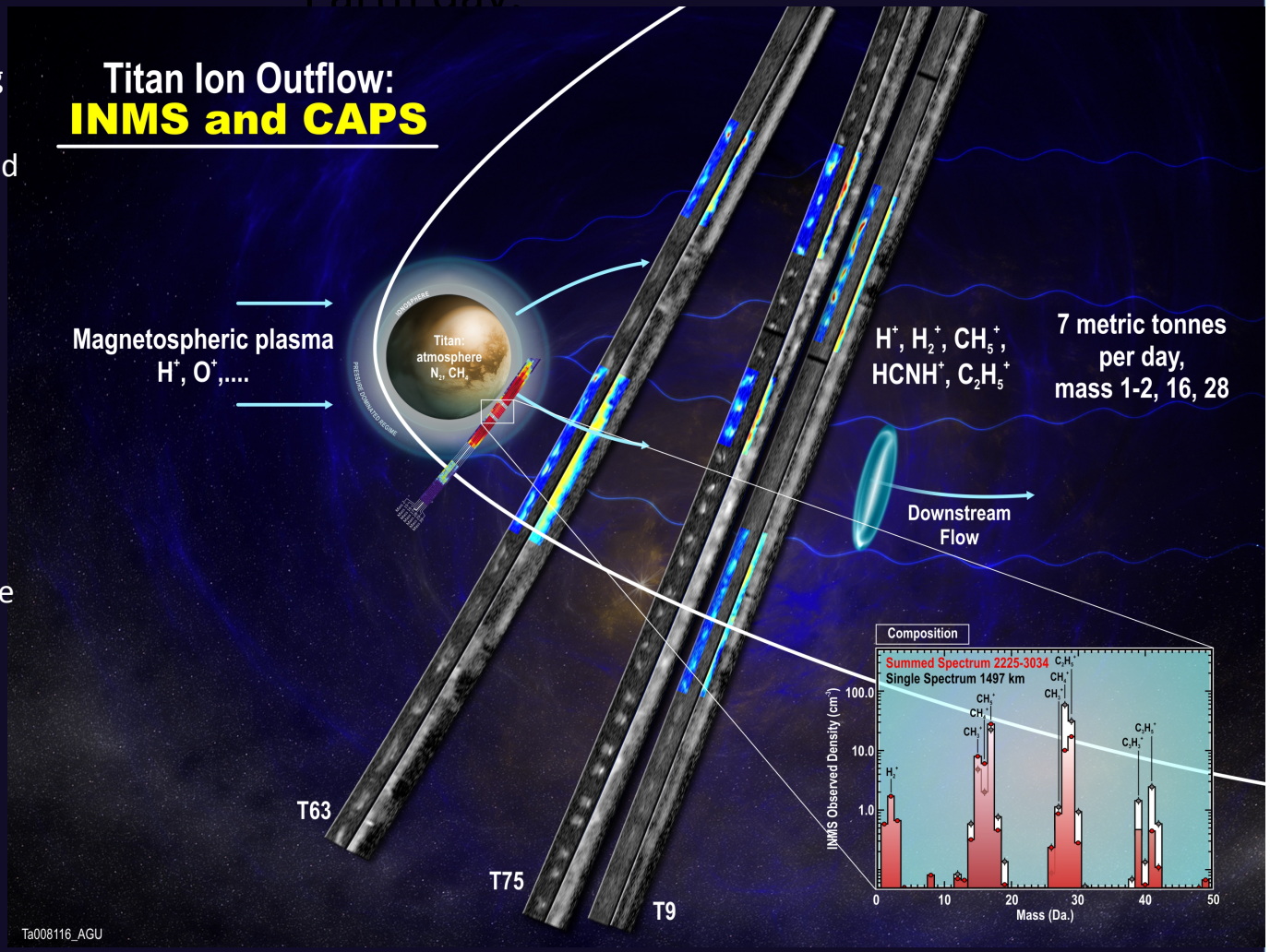
2013: The Year in Nuggets



Prebiotic Seeds Flowing Out from Titan's Ionosphere

Earth day

- Cassini observes ions escaping from Titan's ionosphere
- These ions have been observed by the Ion and Neutral Mass Spectrometer (INMS) from below Titan's exobase near 3000 km altitude
- The composition of these ions is ionospheric and contains many hydrocarbons, namely CH3+, CH4+, CH5+, HCNH+, and C2H5+
- The ions are observed near the exobase to have a speed of 0.8-1.5 km/s relative to Titan
- Further from Titan the Cassini Plasma Spectrometer (CAPS) observes ions being accelerated to the ambient flow velocity (~100 km/s) within Titan's tail
- These ions contribute about 7 tonnes of hydrocarbon materials to the Saturn system per Earth day



Meteor Strikes at Saturn

Saturn's rings regularly catch meteors

- Surface area of Saturn's rings is 100x greater than that of Earth

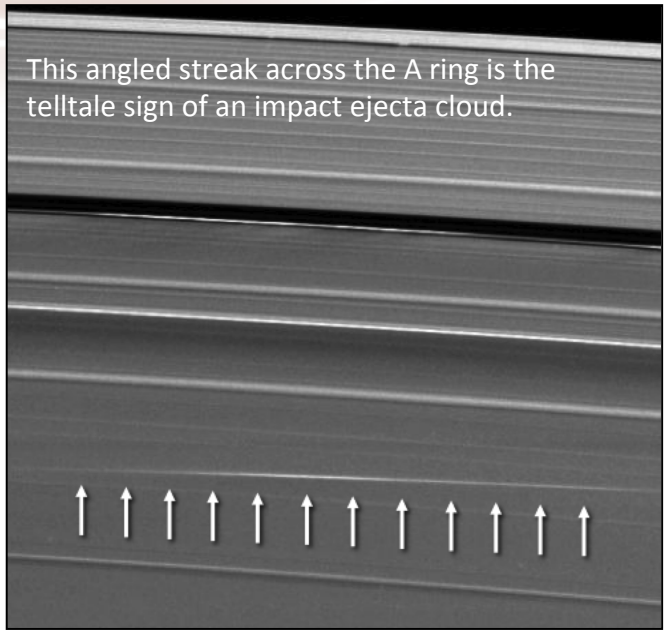
Impact seen clearly when sunlight shone edge-on to rings during 2009 equinox

- Rings dark, rising ejecta caught the sunlight

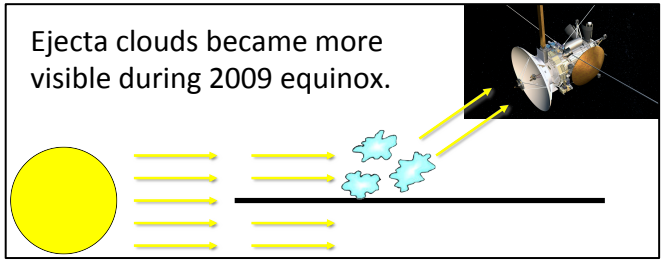
Ejecta cloud of particles shears out to an angled streak as it orbits Saturn

- Unlike on Earth or Moon, where craters and other impact-related structures are circular

Meteors likely hit rings and break up, pieces then orbit Saturn once and return to rings, creating the ejecta clouds



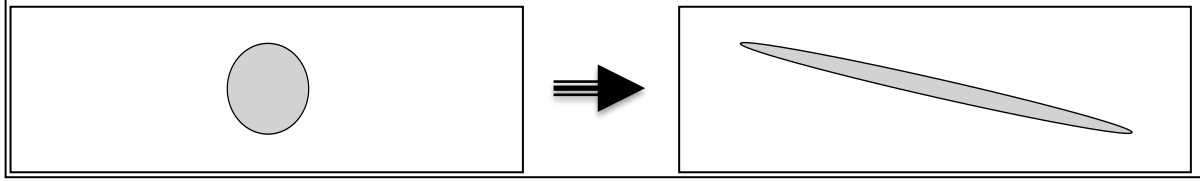
This angled streak across the A ring is the telltale sign of an impact ejecta cloud.



Ejecta clouds became more visible during 2009 equinox.

The A-ring equinox impactor was similar in size to the 2013 Chelyabinsk meteor.

An orbiting cloud shears with time, as material closer to the planet orbits at a faster rate.



The Rain Falls Mainly from the Ring Plane

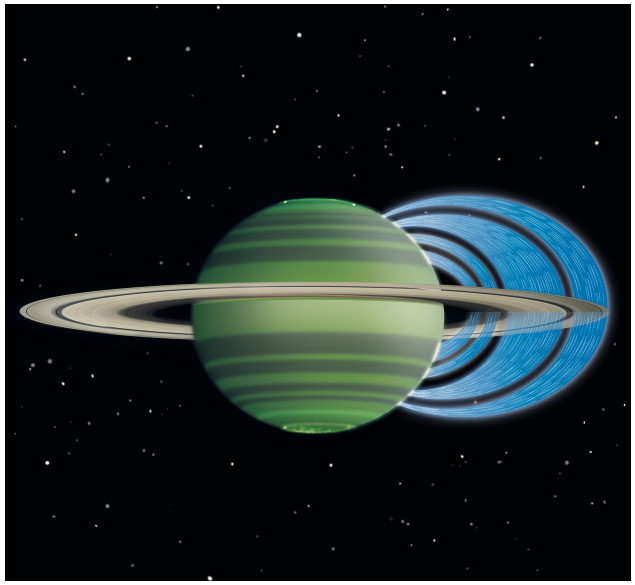
Electrically charged water particles fall from Saturn's rings onto the planet's upper atmospheric surface, quenching more than a third of what would otherwise be a planet-wide infrared glow.

- The new findings are reported* by British and NASA scientists who observed Saturn's ionosphere in infrared wavelengths from Hawaii's W.M. Keck Observatory in April 2011. Saturn's ionosphere is produced when the otherwise neutral atmosphere is exposed electrically charged particles from the sun.

- The researchers expected to see a uniform planet-wide infrared glow, as the planet is uniformly illuminated by the Sun.

- What they observed instead was a series of light and dark bands. The areas that were low in infrared emission are linked to water-dense portions of the rings. Areas with high infrared emission are linked to waterless gaps in the rings.

***J.O'Donoghue et al., "The domination of Saturn's low-latitude ionosphere by ring 'rain,' *Nature*, doi:10.1038/nature12049, April 11, 2013**



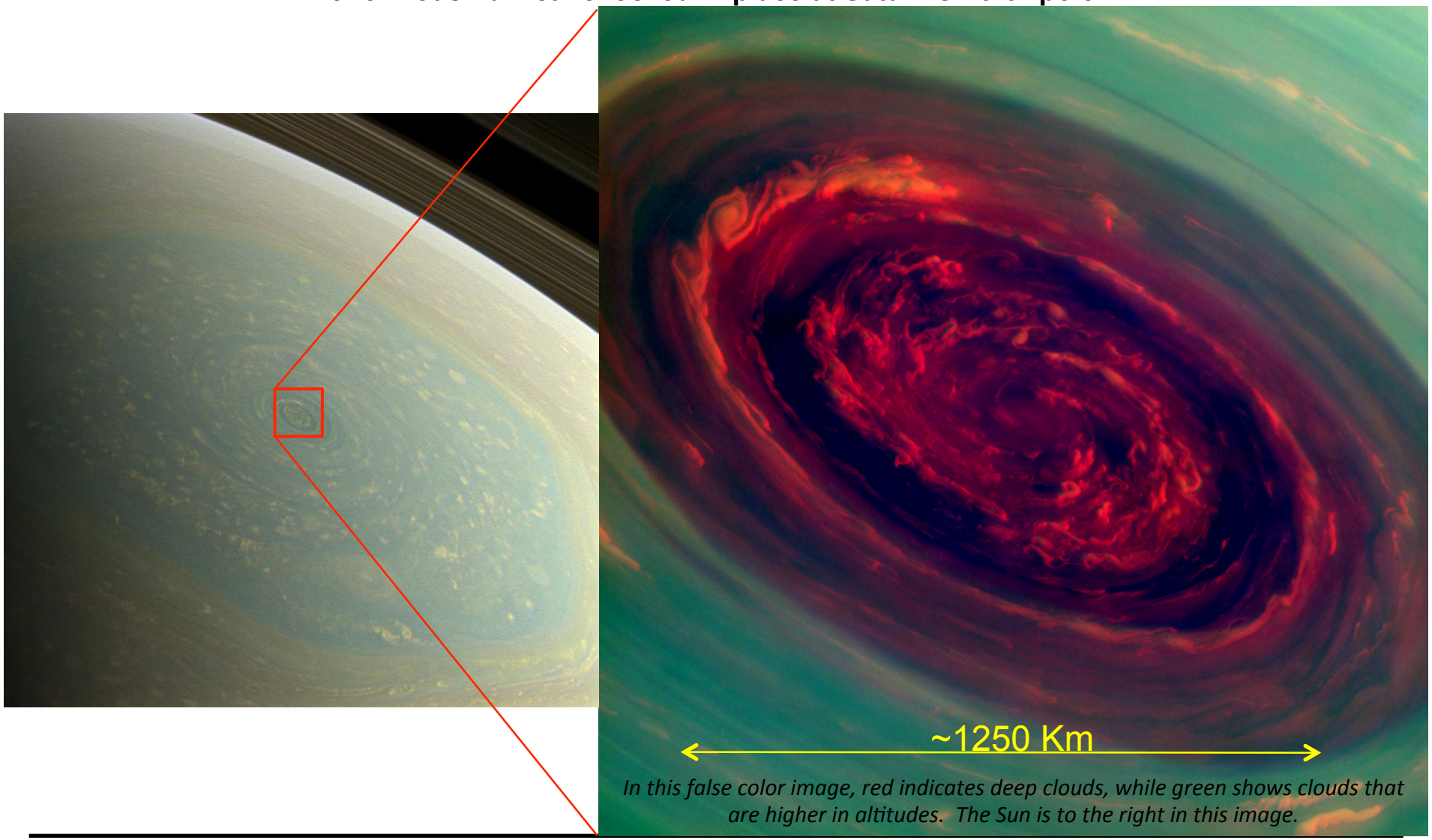
Ring Rain: ***Water particles flow into Saturn from its rings, causing a reduction in the planet's atmospheric brightness over more than a third of the planet.***

- The scientists concluded that "ring rain" flows into Saturn from its rings and extinguishes the glowing ions in the ionosphere. The process appears to be occurring across 30 to 43 per cent of the planet's upper-atmospheric surface – a much larger area than initially thought when the possibility of ring rain was first suggested in the 1980s.

- The ground-breaking results are reported by researchers at the University of Leicester, University College of London, and NASA's Jet Propulsion Laboratory.

Eye Spied: Saturn's Behemoth Polar Hurricane

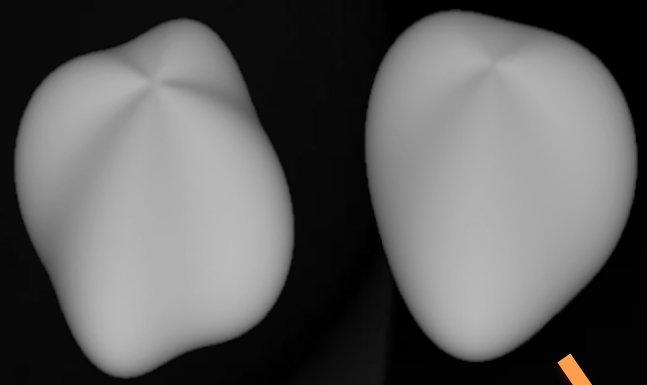
Stunning new views from NASA's Cassini spacecraft reveal the eye of an enormous hurricane locked in place at Saturn's north pole.



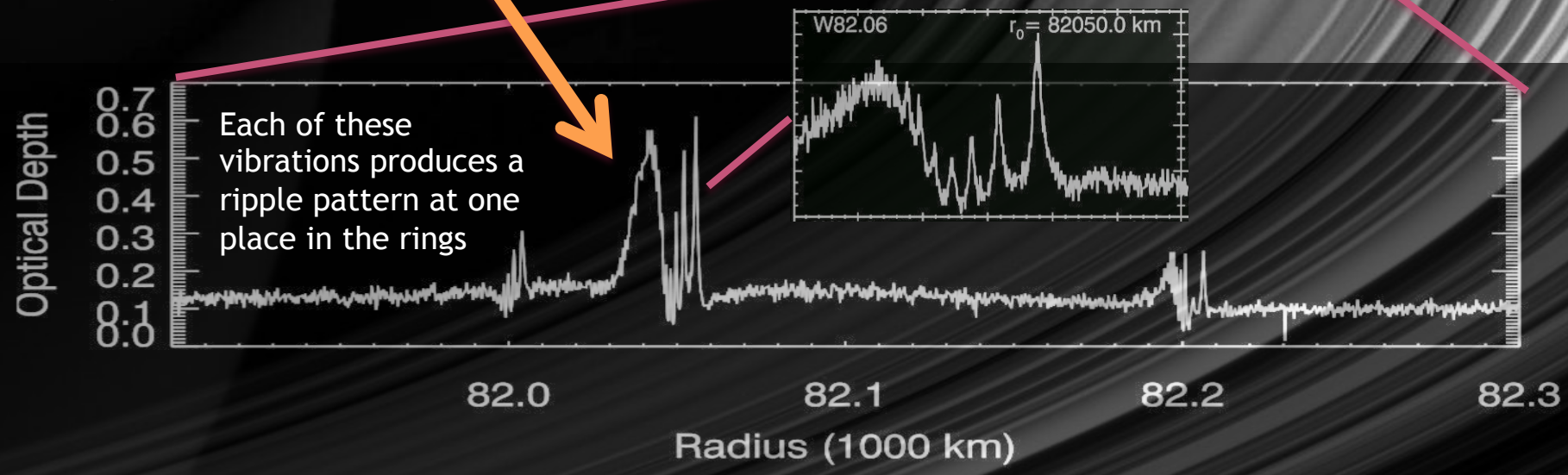
In this false color image, red indicates deep clouds, while green shows clouds that are higher in altitudes. The Sun is to the right in this image.

A Seismograph as Big as Saturn's Rings

Cassini scientists have discovered that Saturn's rings act as a seismograph that records large-scale oscillations, probably emanating from deep within the planet, that "ring" Saturn like a bell. In the same way that helioseismology tells us about activity inside the sun, "Kronoseismology" provides a completely new way to probe structure and activity in Saturn's interior.



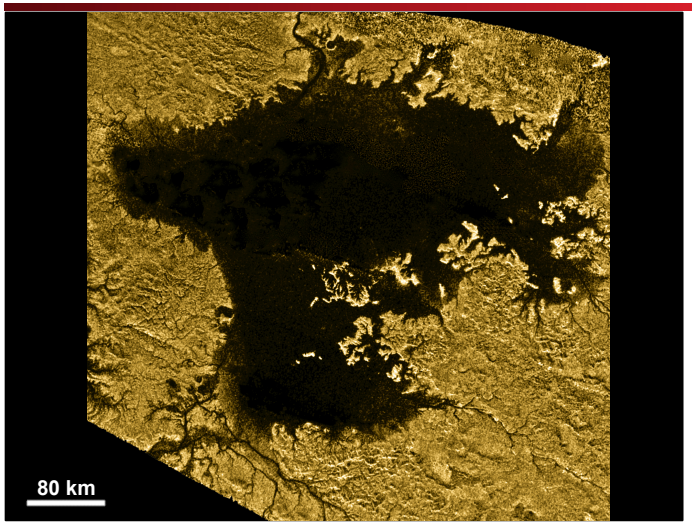
These oscillations distort Saturn's shape in distinctive ways (highly exaggerated here)



Each of these vibrations produces a ripple pattern at one place in the rings

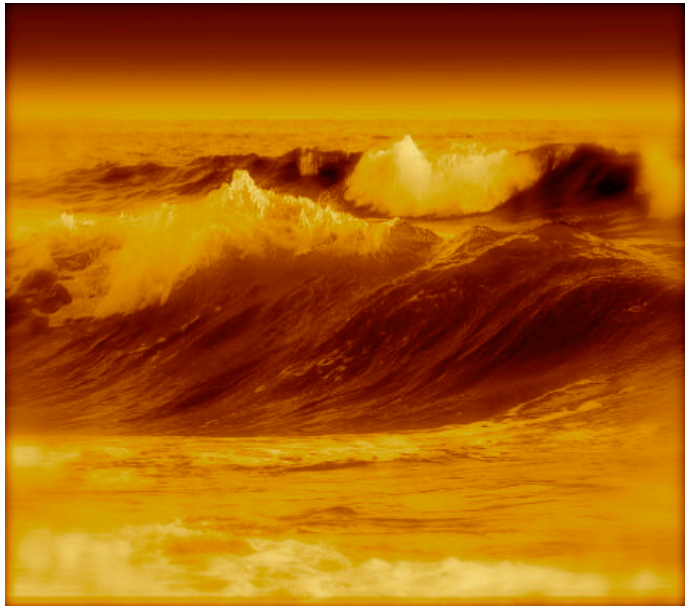
* Kronoseismology: Using Density Waves in Saturn's C Ring to Prove the Planet's Interior, M.M. Hedman and P.D. Nicholson, CRSR, Cornell University *Astrophysical Journal*

Gnarly Surf & Cyclones for Saturn's Moon Titan?



(Top) Ligeia Mare, one of the hydrocarbon seas of Titan.

(Bottom) Artists's concept of potential wild weather on Titan.

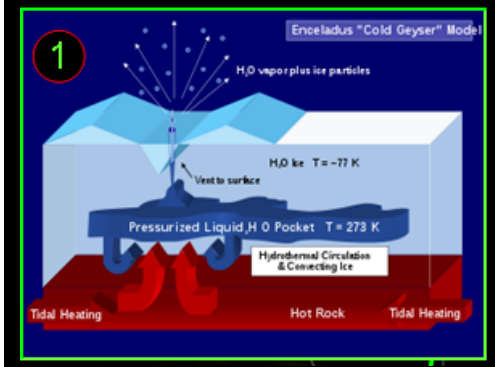


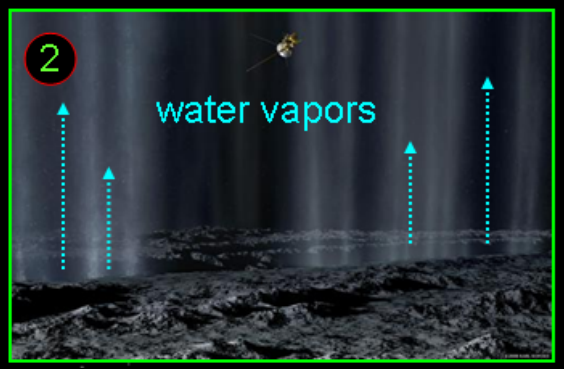
Wind-whipped waves and cyclones could occur on Saturn's moon Titan as summer arrives in the north toward the end of Cassini's mission. Two new research papers* describe the possibilities for wild weather on the only other body in the solar system besides Earth with stable liquid on its surface.

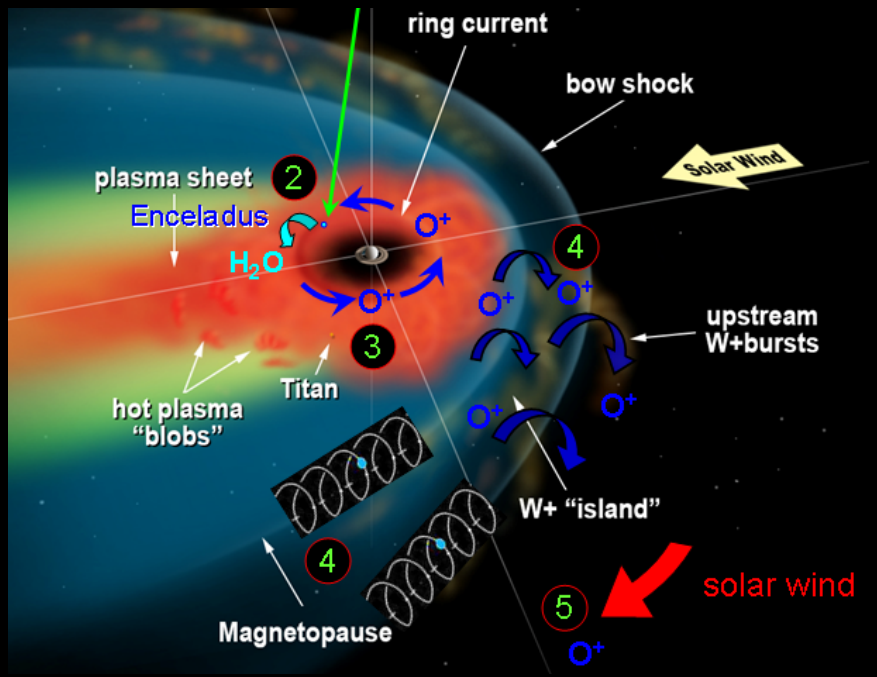
- Cassini observations of waves, or no waves, during this time will provide valuable clues about the composition of Titan's lakes and seas, and help determine the accuracy of the Global Circulation Model for Titan.
- Some of Titan's hydrocarbon lakes and seas are as large as the Great Lakes or Caspian Sea. Titan has a denser atmosphere than Earth's and less gravity. Its lakes and seas of ethane and methane have a lower surface tension than the equivalent bodies of liquid on Earth. These and other factors mean that even a light wind of one mile an hour could potentially whip up waves on Titan's lakes and seas.
- Winds are predicted to exceed the threshold for wild weather as Titan approaches summer solstice in 2017. Even tropical cyclones could also conceivably occur over Titan's polar hydrocarbon seas as summer warms the northern hemisphere.

*"Wind-Driven Capillary-Gravity Waves on Titan: Hard to Detect or Non-Existent?" A. G. Hayes et al., Icarus, in press, May 2013.
"Are tropical cyclones possible over Titan's polar seas?", , T. Tokano, *Icarus* 223 (2013) 766–774

From a subsurface ocean to outer space: The adventure of an oxygen particle from Enceladus







1 Enceladus, a small, icy moon of Saturn, possesses a sub-surface water "ocean" and tectonic activity due to tidal forces exerted by Saturn.

2 Water vapor and ice are being ejected from surface cracks at a rate of around 200 kg/s

3 Water atoms soon become ions and form a "ring current" composed primarily of protons and singly ionized oxygen ions (O^+) that nearly corotate with the planet.

4 The hottest of the heavy O^+ ions gyrate in circular orbits of enormous radii due to the very low magnetic field, Defying the physical boundaries around Saturn, the Magnetopause and the Bow Shock, they find their way upstream into the nearby solar wind where they are captured by the INCA camera of Cassini

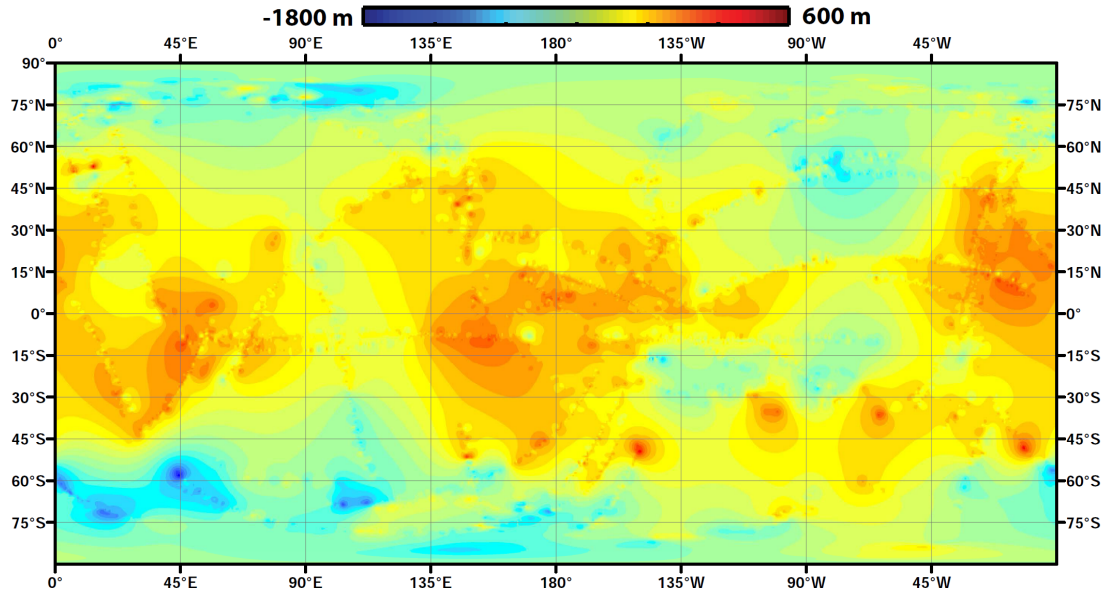
5 Once in the solar wind and free from their magnetic 'prison' the hot O+ ions become a strange 'guest' in the solar wind and eventually they get convected to its flow and travel toward the limits of our solar system.

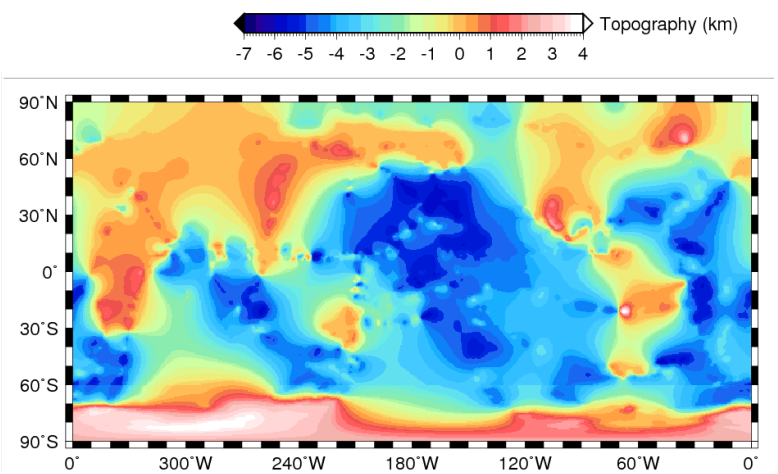
Sergis et al., Islands of hot magnetospheric W^+ in the magnetosheath of Saturn, JGR, in press

Titan's Ups and Downs Mapped

NASA's Cassini spacecraft was never expected to make large-scale topo maps of Titan, but engineers have devised a technique to exploit radar images to extract heights of the haze-shrouded surface.

The map at right is made up of 155 tracks across Titan taken since Cassini arrived at Saturn in 2004. Although these cover only part of Titan, the gaps are filled with smooth-surface estimates. The panel below shows how well we would know Earth's topography if we only had the same coverage we have for Titan - the continents and major mountain ranges are easily seen.





The new topo map of Titan shows a surface shaped by a hydrological cycle with methane rainfall: blue spots in lower left are likely basins that held former seas, while the arc of high spots lower right are mountains whose origin has not been fully explained.

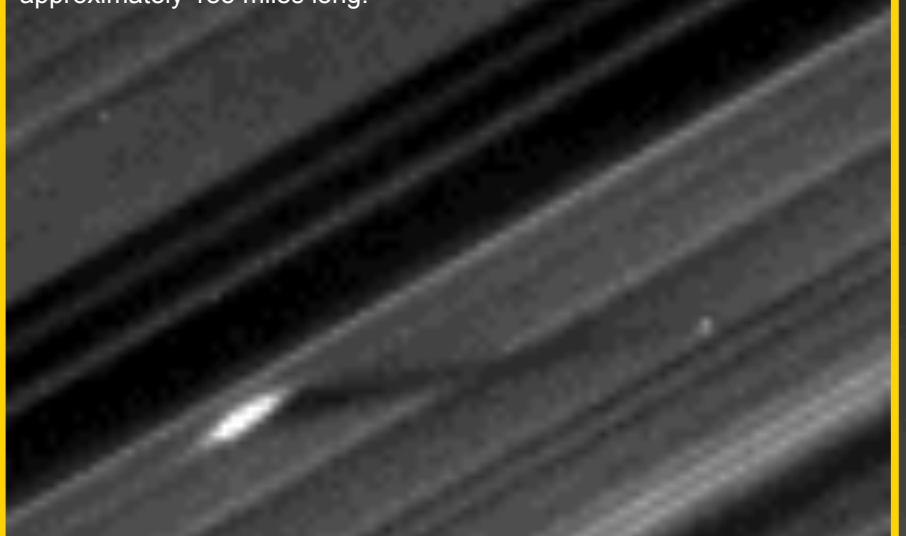
This map will be used to improve weather models for Titan and to understand the slopes driving its river networks. At Cassini's mission completion in 2017, more radar data will fill in some of the gaps in present coverage.

***"A global topographic map of Titan," Ralph D. Lorenz, Bryan W. Stiles, Oded Aharonson, Antoine Lucas, Alexander G. Hayes, Randolph L. Kirk, Howard A. Zebker, Elizabeth P. Turtle, Catherine D. Neish, Ellen R. Stofan, Jason W. Barnes, the Cassini RADAR Team, *Icarus* 225 (2013) 367–377**

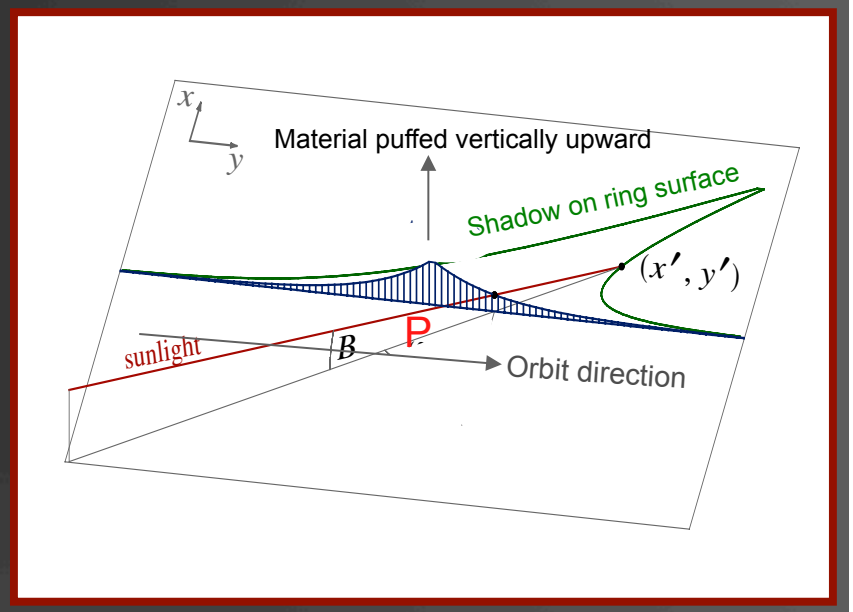
The Shadow Knows

Cassini scientists estimate small, hundred-meter-size moonlets in the millions could be embedded in Saturn's Rings. Elongated, propeller-shaped features in the rings are actually clearings in the rings created by these moonlets. Now, the geometry of the shadows cast in Saturn's rings reveals how these unseen moonlets puff up the surrounding ring particles.

The bright spot below is a cloud of particles scattered upwards by the half-mile tall moonlet, Earhart, embedded in the rings. When the sun illuminated the rings edge-on near equinox, the cloud casts a shadow approximately 185 miles long.



The moonlets scatter smaller particles into puffy clouds that are much larger than the moonlets themselves. In the case of half-mile-wide Earhart, the scattered material puffs up into an 850-foot tall, 37 mile-wide cloud that casts a low mountain-shaped shadow on the rings. The empty ring space around the moonlets (not seen here) often creates propeller-shaped clearings.



A new light-scattering model allows for gravitational scattering and collisional damping of ring particles by a "propeller" (P), predicting the shape of its shadow.

The new model explains why the puffed up, 850 foot-tall "cloud" of ring particles is much shorter along the orbit direction than the usual channel cleared out by the object and others like it.

"Vertical structures induced by embedded moonlets in Saturn's rings: the gap region," Holger Hoffmann, Frank Spahn, Martin Seiß, August 2013; Source: arXiv

Is Titan's Methane Cycle Temporary?

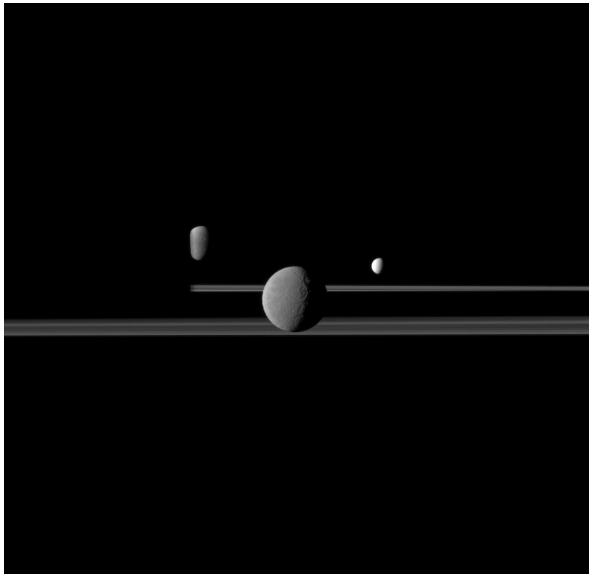
Titan's fascinating methane chemistry, its lakes, rain and hydrocarbon dunes, may be just a temporary anomaly, geologically speaking.

- A gigantic outburst of methane may have been released eons ago, possibly after a huge impact. This would have led to Titan's current global smog haze and its continent-size hydrocarbon sand dunes, according to a new model* based on data from NASA's Cassini mission.
    - A comet impact or global resurfacing by cryovolcanic activity could have caused such a release.
- The new model indicates that methane is not being replaced fast enough to sustain Titan's methane cycle. In Earth's water cycle, water continuously migrates from the surface to the atmosphere and back again. But it appears that Titan's methane rises into the atmosphere on a one-way trip to destruction.
    - Sunlight is destroying Titan's methane, and the data indicate it's not being replaced, so Titan's "methane era" may one day draw to a close.
- Over time, the destruction of methane by sunlight will reduce the overall amount of methane in Titan's environment while sand, seas and lakes derived from its destruction will continue to accumulate on the surface.

"Observations of Titan's Northern lakes at 5 microns: Implications for the organic cycle and geology," C. Sotin et al., Icarus, 2012

Cold, Old Preserve of the Solar System

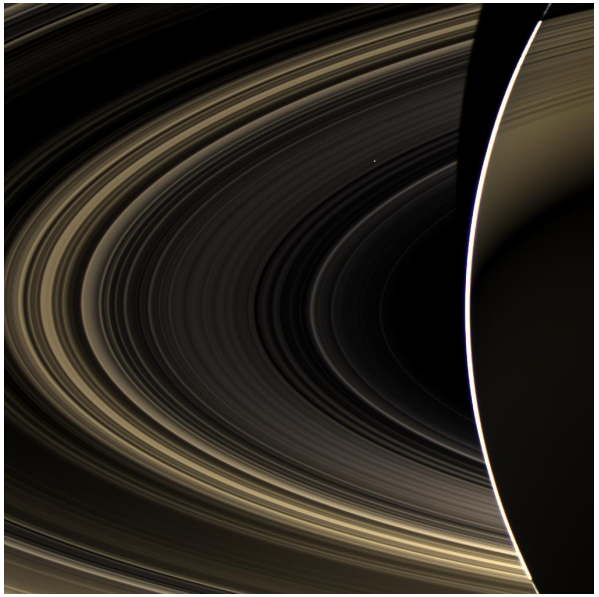
Some of Saturn's rings and moons are rusty, dusty, sunburned or polluted, but scratch their surfaces and its apparent they are artifacts that preserve the original chemistry that was present at the birth of the planets.



•Continuing study of the Saturnian system by NASA's Cassini mission is providing clues to the chemical and physical evolution of our solar system.

•New analysis* of Cassini data shows that for the most part, the differences between the surfaces of the moons and rings of Saturn are only skin deep.

•Beneath their sometimes colorful surfaces, the materials tend to be the gently worn geochemical specimens from the primordial era of our solar system when planetary bodies began to form out the cloud of material that orbited the sun after its ignition as a star. Saturn system formed in a region well beyond the "snow line" of the solar system, currently placed some 250 million miles from the sun. In this deep freeze zone, water and volatiles condense in ices and little change occurs.



•The colored patina on the ring particles and moons roughly corresponds to local pollution sources in their vicinity. For Saturn's inner ring particles and moons, water-ice spray from the geyser moon Enceladus has a whitewashing effect. Farther out, Phoebe, a moon thought to originate in the far-off Kuiper Belt, seems to be shedding reddish dust that rouges the faces of its neighboring moons.

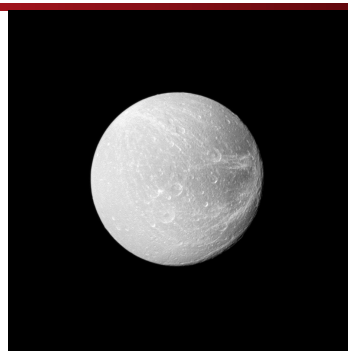
G. Filacchione et al.,"The Radial Distribution of Water Ice and Chromospheres across Saturn's System"
Astrophysical Journal and ArXiv

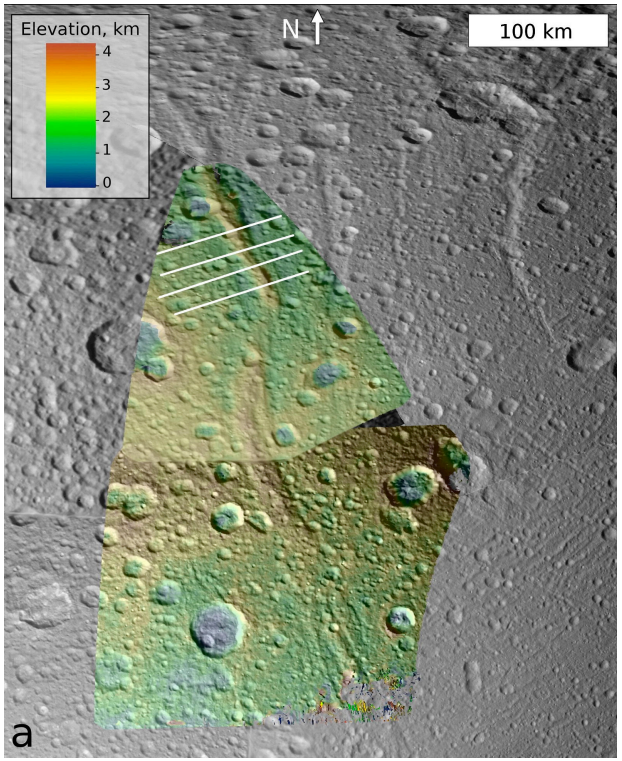
Did Saturn's Moon Dione Have an Ocean?

Evidence is mounting toward the possibility that Saturn's moon Dione had a liquid water ocean.

- Data from NASA's Cassini spacecraft show that a 500 mile-long, 4 billion year-old mountain called Janiculum Dorsa has bent the crust of Saturn's moon Dione. Scientists say the most likely explanation is that Dione had a warm subsurface ocean at the time Janiculum Dorsa formed, which allowed the icy crust to warm up enough to flex under the mountain's great weight.*
- Gravity squeezes and warms Dione. A global ocean under the crust would have decoupled Dione's core from its ice shell, causing much more heat to be generated when Dione was deformed by Saturn's gravity.
- Ten times more heat would be generated with a subsurface ocean present because the ice shell can be stretched and squeezed much easier. It is this stretching and squeezing that caused Dione's crust to bend.
- How long such an ocean might have lasted on Dione remains a mystery. Earlier, Cassini measured Dione's magnetic field and found faint evidence that a possible liquid or slushy layer could still exist beneath the crust.

Subsurface oceans on Europa and possibly on Enceladus are thought to be potential abodes for life. If Dione (lright) also once had a subsurface ocean, it may mean that possibly habitable environments are much more common than previously believed.





Above, a digital elevation model of Janiculum Dorsa on Saturn's moon Dione. The weight of this big mountain has bent Dione's crust.

*** "Flexure on Dione: Investigating Subsurface Structure and Thermal History," N.P. Hammond et al., Icarus, Volume 223, Issue 1, March 2013, Pages 418–422**

On July 19, 2013, at 5:27 pm EDT, look up and wave as NASA's Cassini spacecraft photographs Earth from Saturn.

For more information see:

http://saturn.jpl.nasa.gov/waveatsaturn

On July 19, 2013, at 2:27 pm PDT, look up and wave as NASA's Cassini spacecraft photographs Earth from Saturn.

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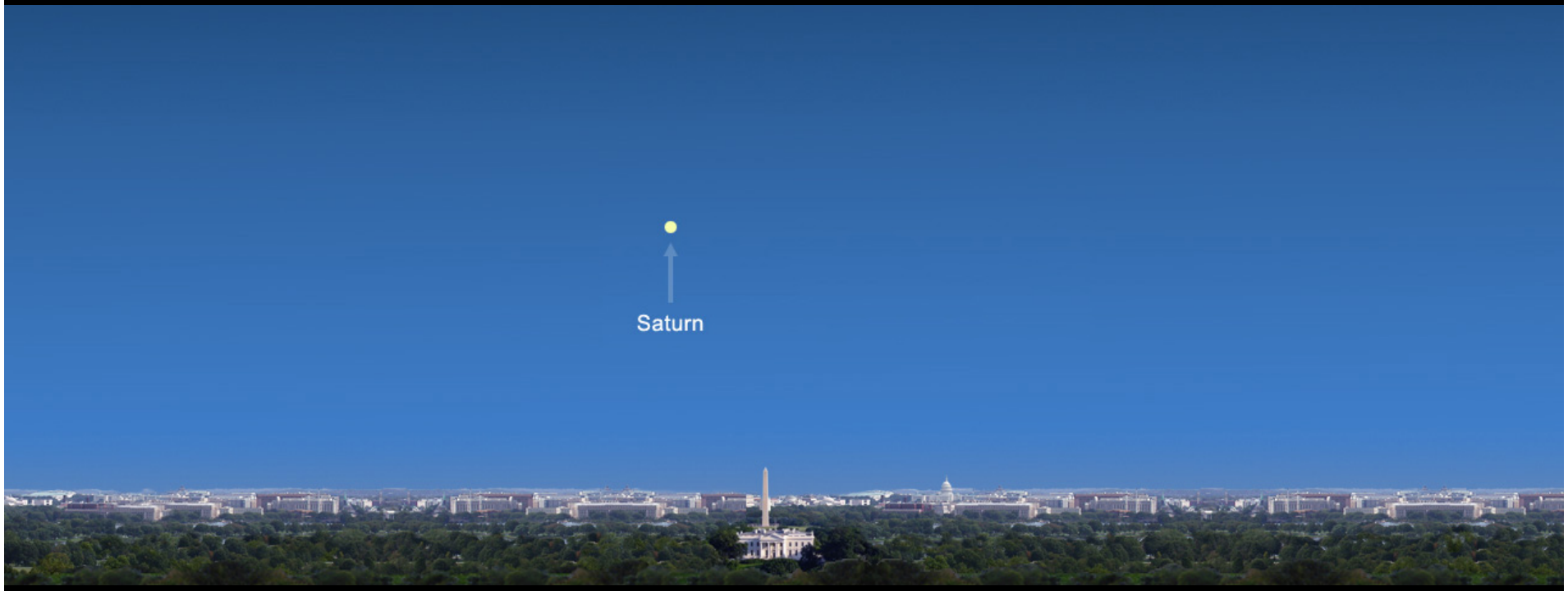
http://saturn.jpl.nasa.gov/waveatsaturn

The View from Washington



On July 19, 2013, at 5:27 pm EDT, look up and wave as NASA's Cassini spacecraft photographs Earth from Saturn.

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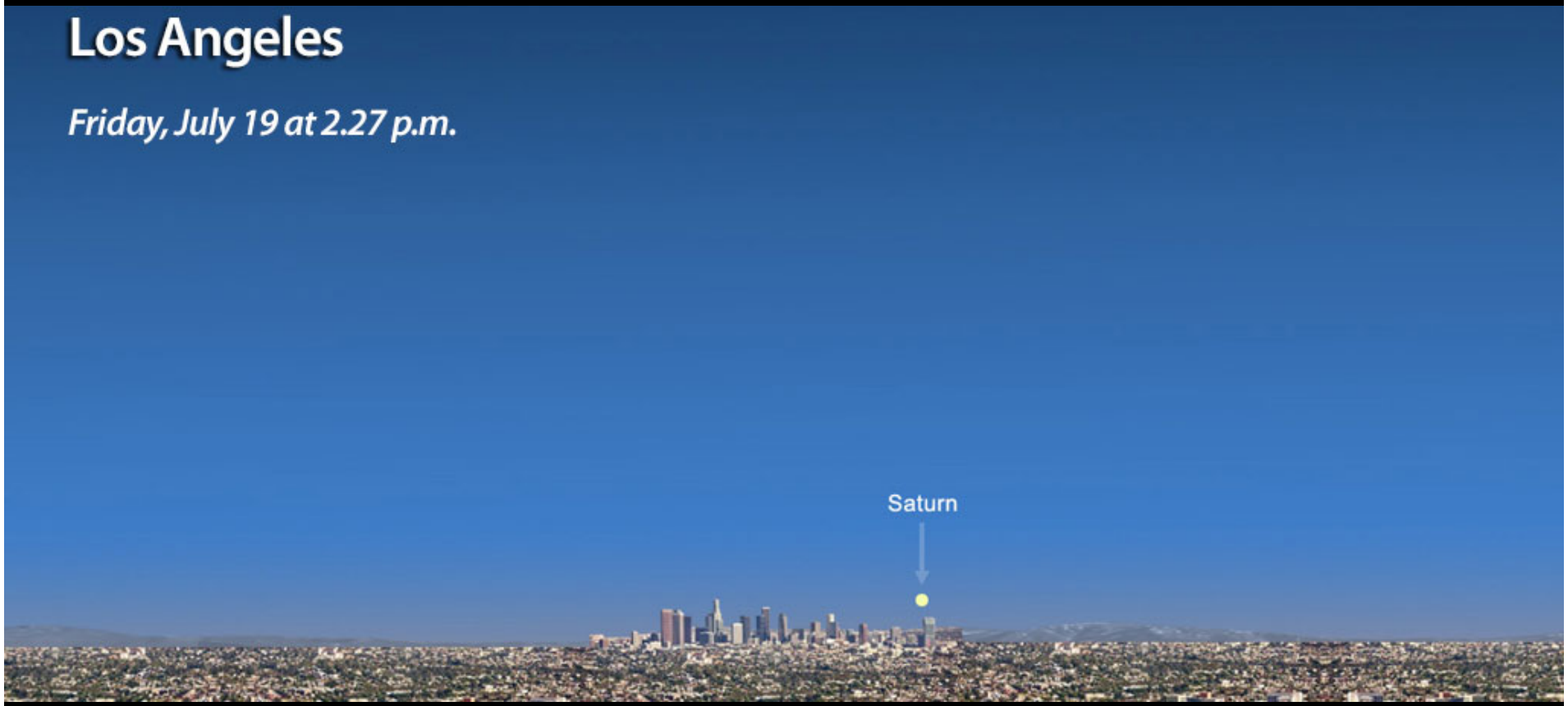
The View from Los Angeles



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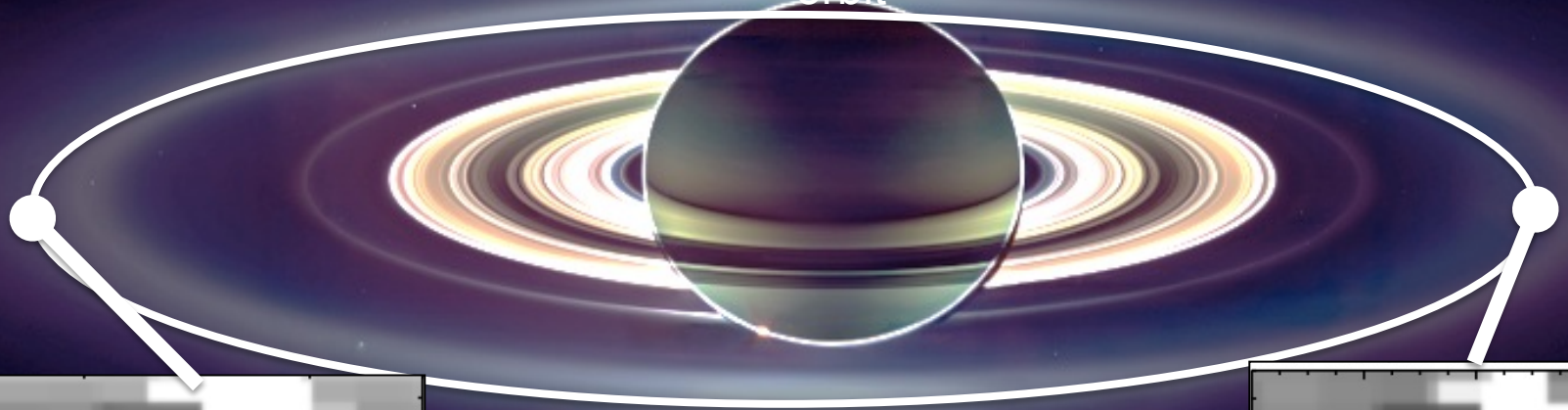
For more information see:

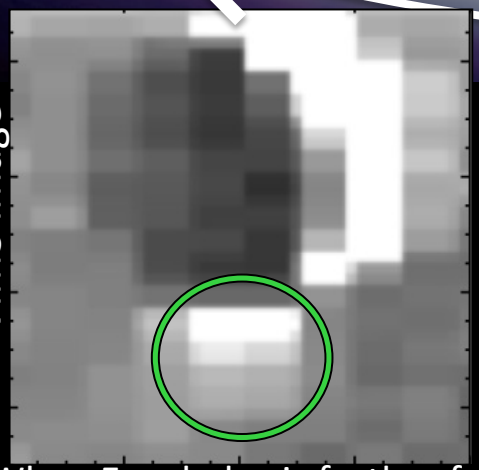
http://saturn.jpl.nasa.gov/waveatsaturn

Earth Waves at Saturn and Says “Cassini!”

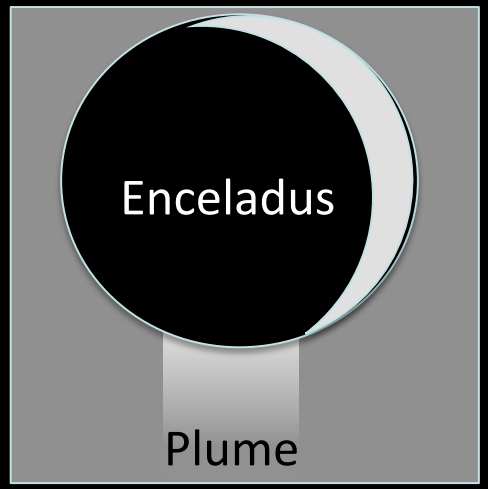
Cassini Finds Tidal Forces Controlling Enceladus' Jets

Enceladus' geological activity varies systematically as moon moves around its elliptical orbit

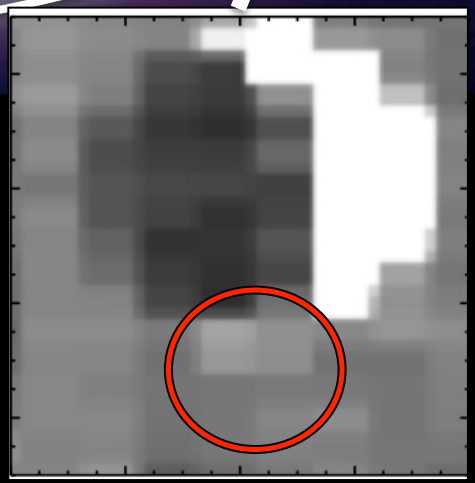




When Enceladus is further from Saturn, fissures might be pulled open and more material appears to escape from the moon



Interperative drawing

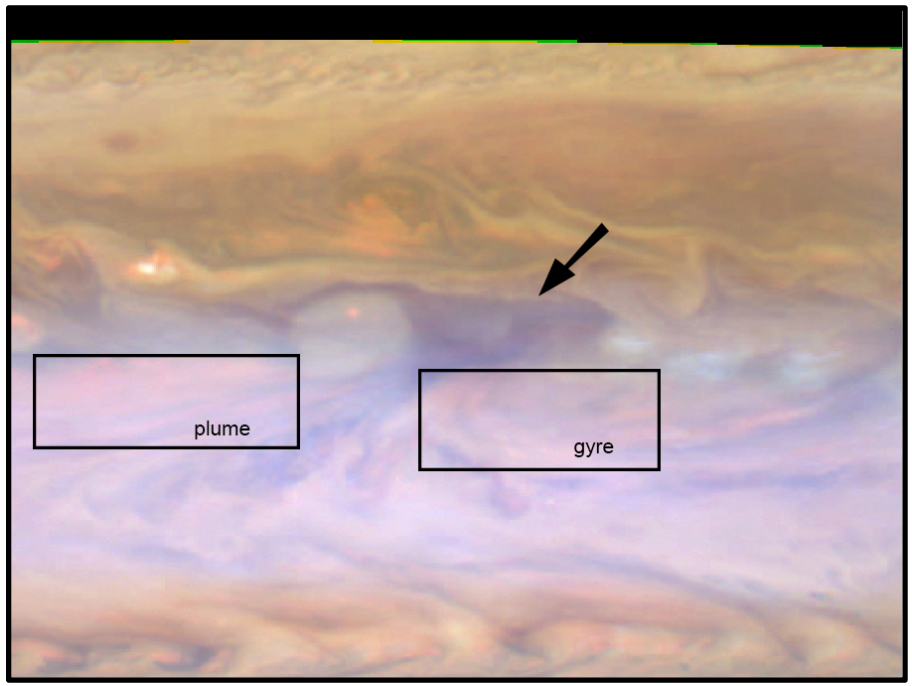


When Enceladus is closer to Saturn, fissures might be pushed shut and less material appears to escape from the moon

Hedman, et al. An observed correlation between plume activity and tidal stresses on Enceladus (Nature 2013)

“Hot Spots” Offer Windows into Jupiter

Cloudless patches called “hot spots” occasionally form in Jupiter’s cloudy atmosphere. These events provide windows on activity in normally unseen deeper layers of Jupiter's atmosphere. Why these special areas occur, and why they are only near the equator, are enduring questions.



This false-color image from Cassini is a window deep into Jupiter's atmosphere. The arrow points to the dark hot spot. The bluish clouds to the right are in the upper troposphere, or perhaps higher still, in the stratosphere. The reddish gyre under the hot spot to the right and the large reddish plume at its lower left are in the lower troposphere.

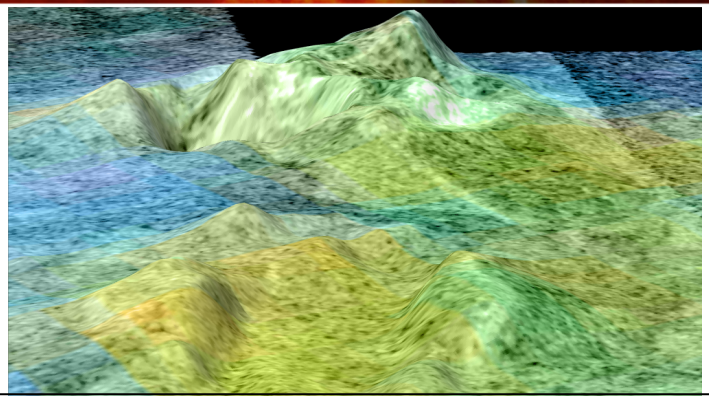
* “Meteorology of Jupiter’s equatorial hot spots and plumes from Cassini,” David S. Choi et al., *Icarus*, 2013

- Time-lapse imagery compiled during Cassini’s approach and flyby of Jupiter in 2000 enabled unique analysis of flow around a hot spot as well as its interactions with other atmospheric systems. http://saturn.jpl.nasa.gov/news/cassinifeatures/feature20130314/
- A team of scientists has published new evidence* that the hot spots are created by a Rossby wave, which on Earth plays a major role in weather (e.g. when a blast of frigid Arctic air suddenly dips down and freezes Florida's crops, a Rossby wave has nudged the polar jet stream off course.)
- The team found the Rossby wave flows in Jupiter’s atmosphere east to west as on Earth, but instead of wandering north and south, it glides up and down in altitude like a carousel horse, about 15 to 30 miles (24 to 50 kilometers) in altitude.
- Small "scooter" clouds, similar to cirrus clouds on Earth, were also tracked and helped provide what may be the first direct measurement of the true wind speed of Jupiter’s equatorial jet stream – about 300 to 450 mph (500 to 700 kph), much faster than anyone previously thought. The hot spots amble at a more leisurely pace of about 225 mph (400 kph).
- These observations help atmospheric modelers constrain properties of Jupiter's atmosphere that are difficult to observe directly.

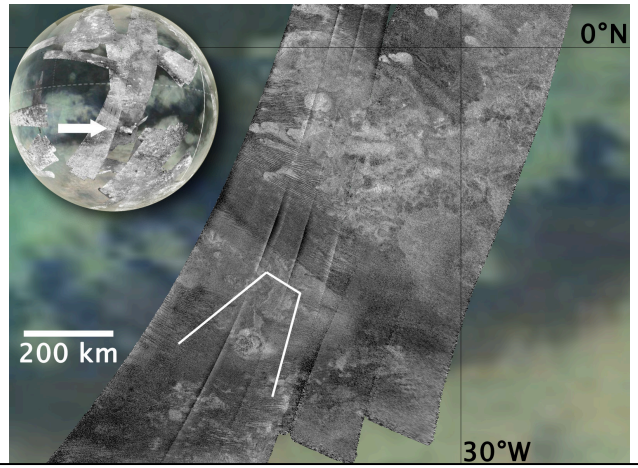
Titan's "Mount Doom"

Do slushy ice volcanoes flow on the surface of Saturn's moon Titan? New evidence* from NASA's Cassini spacecraft points to that possibility more strongly than ever.

- Titan's putative cryovolcanism has been a subject of scientific controversy, but NASA's Cassini spacecraft has found strong indications that a mountain called "Doom Mons" and nearby terrain is cryovolcanic in origin.
- A topographic model produced from Cassini data by the U.S. Geological Survey shows flow-like features characteristic of volcanic activity.
- Originally called Sotra Facula, the nearly mile-high mountain was renamed in honor of Mount Doom in J.R.R. Tolkien's fantasy fiction "The Lord of the Rings." It appears to be part of a cryovolcanic complex of volcanic cones, craters and flows, including an adjacent deep pit, Sotra Patera.
- Icy water, rather than rock, may erupt and flow on Titan. Volcano-like features on several other icy satellites, including Neptune's Triton may have formed from similar watery or slushy eruptions. The only definitive example of cryovolcanism so far is on Enceladus, where the Cassini spacecraft discovered plumes of gas and dust actively erupting from deep beneath the surface.



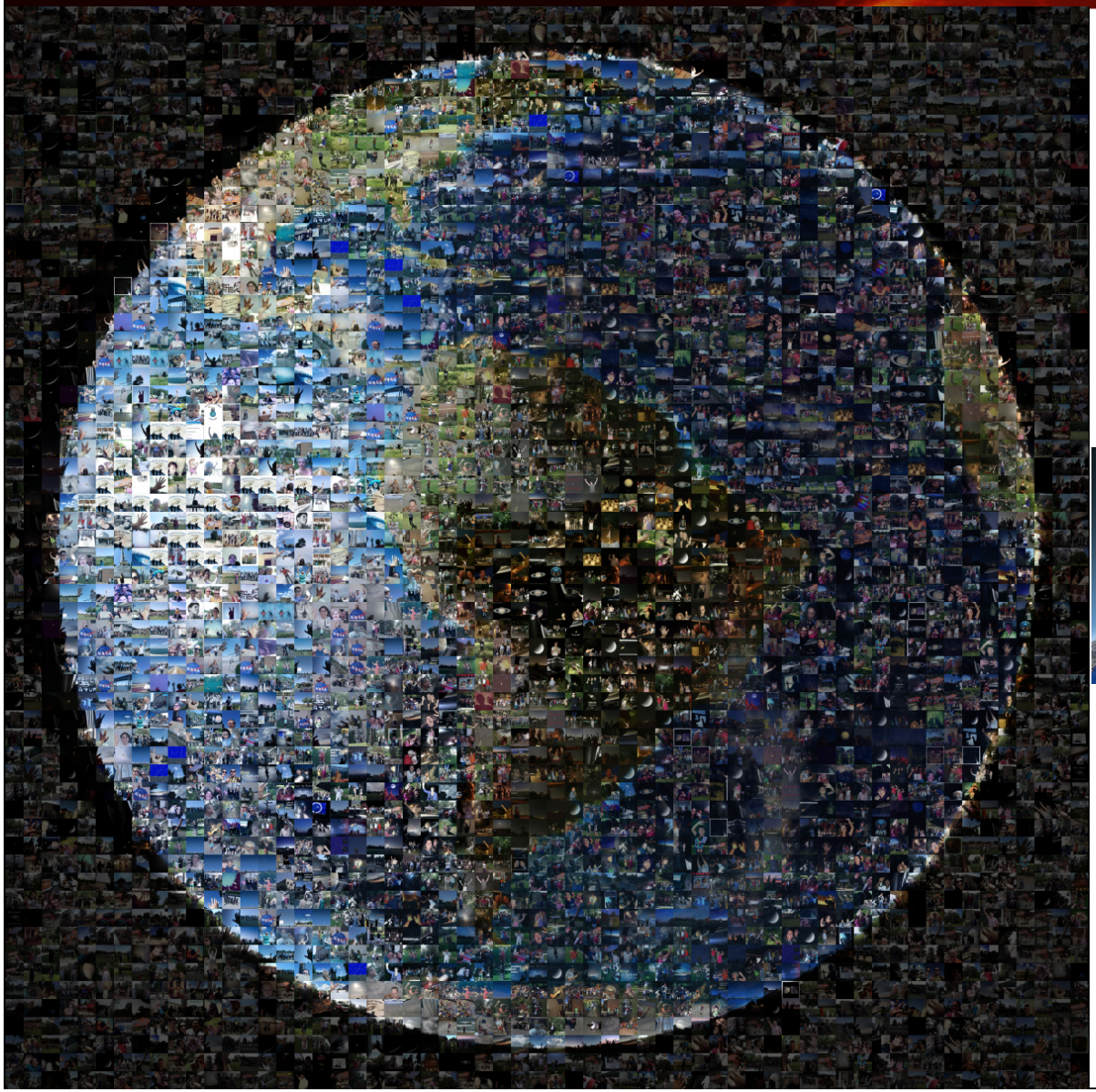
Cassini radar data and visible and infrared spectrometry were combined in this view of Doom Mons with colors showing compositional differences. Doom Mons is adjacent to the deepest depression so far found on Titan, Sotra Patera, an elongated, mile-deep pit. Green and yellow colors show areas that appear cryovolcanic in origin.



The globe with arrow shows the location of the larger map on Titan. The white lines show the approximate boundaries of the perspective view above, looking at Doom Mons and Sotra Patera from the north-northeast. At the top of the image is another mountain, Erebor Mons, also potentially of cryovolcanic origin.

*Cryovolcanism on Titan: New results from Cassini RADAR and VIMS
R. M. C. Lopes, et al., JOURNAL OF GEOPHYSICAL RESEARCH: PLANETS, VOL. 118, 416–435, doi:10.1002/jgre.20062, 2013

The Earth Waves at Saturn and Cassini



- On July 19, 2013, Cassini snapped a picture of Earth as part of a larger science campaign to map the entire Saturn and ring system.
- This was the first time that people of Earth were told in advance about their picture being taken by a spacecraft in the outer solar system.

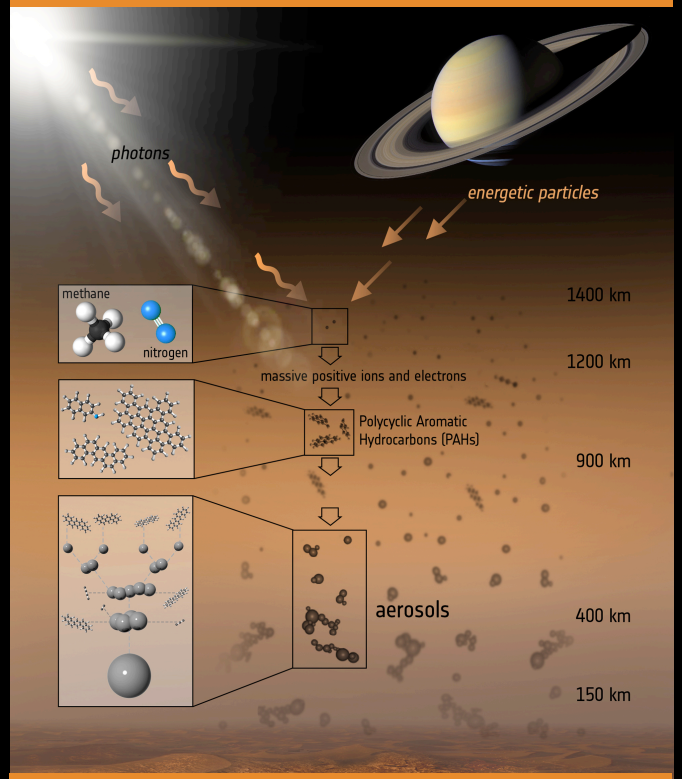
- This Earth collage is made up of more than1,400 images contributed by friends, families and groups in 30 states and 40 countries who sent in their own personal pictorial "hello" to Cassini through social media.
- http://go.nasa.gov/19JxLgF

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 layers form out of the simpler molecules high in the atmosphere.

- The presence of complex, ringed hydrocarbons, called polycyclic aromatic hydrocarbons (PAHs), explains the origin of the aerosol particles found in Titan's lowest haze layer.
- Sunlight and electrically charged particles in Saturn's magnetic environment break up nitrogen and methane molecules at about 1,000 km (600 miles) altitude above Titan. Massive positive ions and electrons form, triggering a chain of chemical reactions. A variety of hydrocarbons are produced this way and many have been detected by Cassini's instruments.
- The reactions lead to the production of carbon-based aerosols, large aggregates of atoms and molecules that are found well below 500 km (300 miles) altitude in Titan's haze.
- 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.

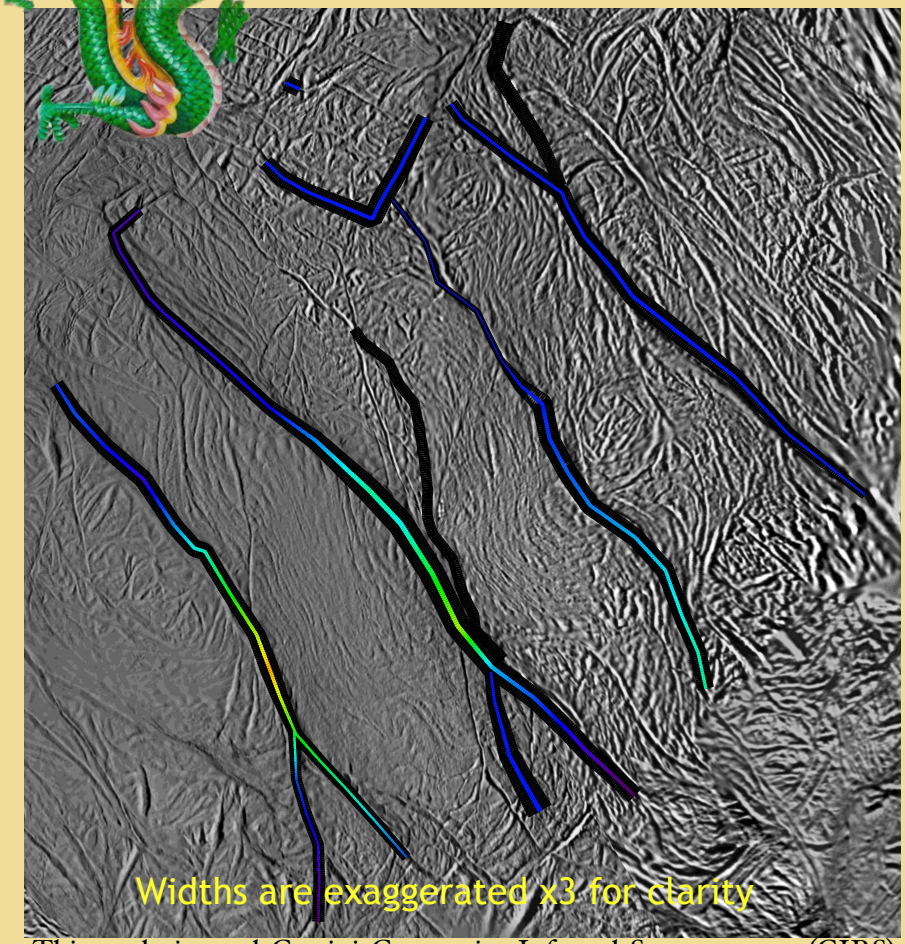


PAHs are thought to have played a role in the formation of life on Earth. Their role in Titan's complex atmospheric chemistry is one reason why Titan is of interest to astrobiologists.

*Large Abundances of Polycyclic Aromatic Hydrocarbons in Titan's Upper Atmospshere," , M. López-Puertas *et al.,* The Astrophysical Journal, Vol. 770, Number 2. 2013 *ApJ* 770 132
* "An unidentified emission in Titan's upper atmosphere," B. M. Dinelli **et al., 29 APR 2013,** Geophysical Research Letters

SLOUCHING TIGER – HIDDEN DRAGON

A NEW ESTIMATE OF HEAT FLOW FROM ENCELADUS' TIGER STRIPES.



This analysis used Cassini Composite Infrared Spectrometer (CIRS) data taken in 2008/2010 and a new model of the tiger stripes.

C.J.A. Howett, J.R Spencer, A. Verbiscer, T. A. Hurford, M. Segura and D. C. Spencer, 2013. **Enceladus Heat Flow from High Spatial Resolution Thermal Emission Observations.** European Planetary Science Congress 2013 (EPSC2013-840)

For the first time, both the emission temperatures and widths of Enceladus' tiger stripes have been systematically mapped:

- The stripes are calculated to vary in temperature from about 78°to 170° K (-319° to -163° °F), across widths from 100 m to 1.8 km (110 yards to 1.1 miles).
- The new results provide a preliminary estimate of Enceladus' heat flow from the tiger stripes, which equals about 5 gigawatts.

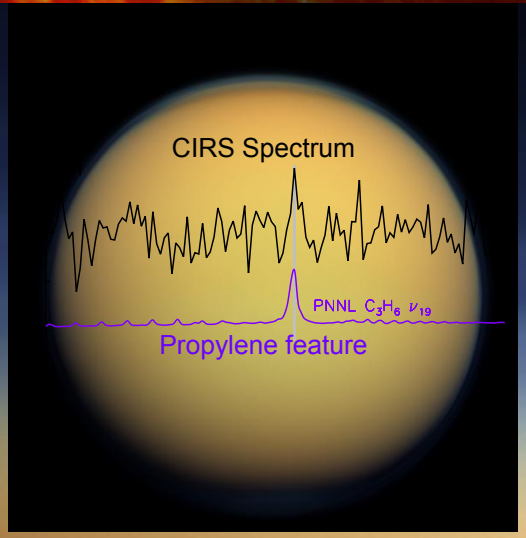
Accurate knowledge of Enceladus' heat flow is important because it provides a fundamental constraint on tidal energy generation and transport in Enceladus, and explains the likelihood of a subsurface ocean.

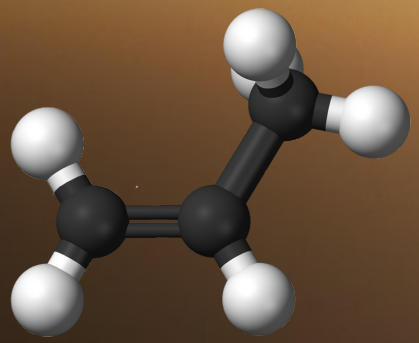
The new estimate of the tiger stripes' heat flow is a small fraction of previous heat flow estimates (about 16 gigawatts) for entire South Pole region. (Howett *et al.*, 2011).

- Was this heat flow previously overestimated, or is additional heat escaping elsewhere? The investigation continues.

Discovery of propylene in Titan's upper atmosphere with Cassini CIRS

- Cassini's Composite Infrared Spectrometer (CIRS) Team detected a new molecule, propylene (propene), in Titan's upper atmosphere.
- First definitive identification of propylene gas in a planetary atmosphere outside Earth.
- Propylene is an important raw material for our chemical industry used to make polypropylene, a durable plastic that is molded into food storage containers.

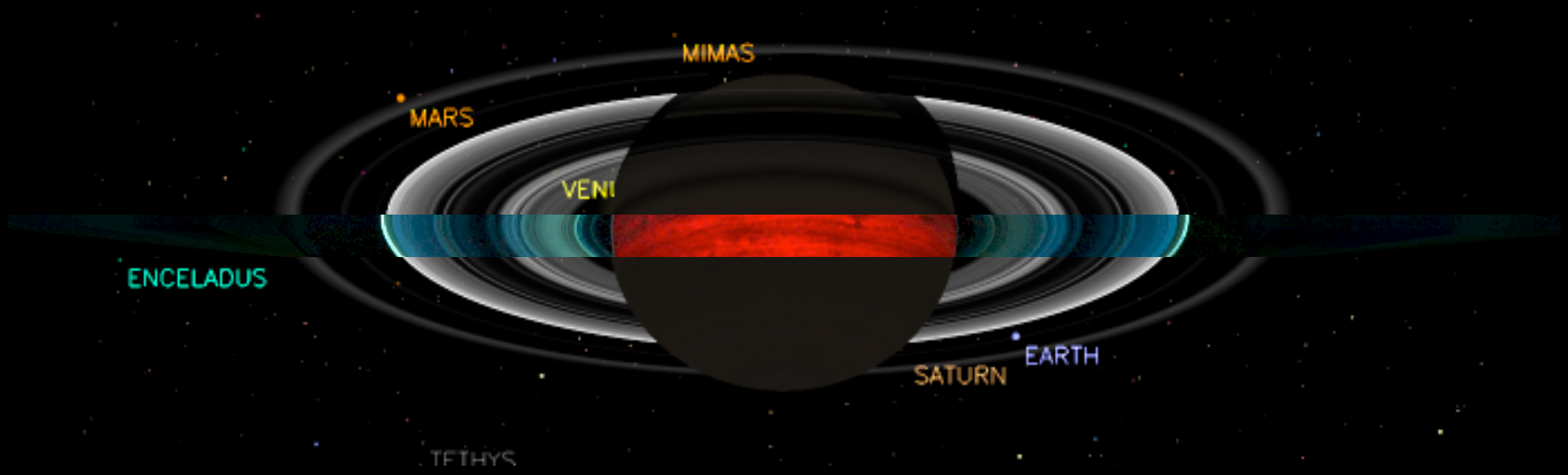




Detection of Propene [Propylene] in Titan's Stratosphere
C. Nixon, D. Jennings, B. Bézard, S. Vinatier, N. Teanby, K. Sung, T. Ansty, P. Irwin, N. Gorius, V. Cottini, A. Coustenis, F. M. Flasar. Astroph.J.Lett. 776, 2013

An Infrared View of Saturn’s Backlit Rings

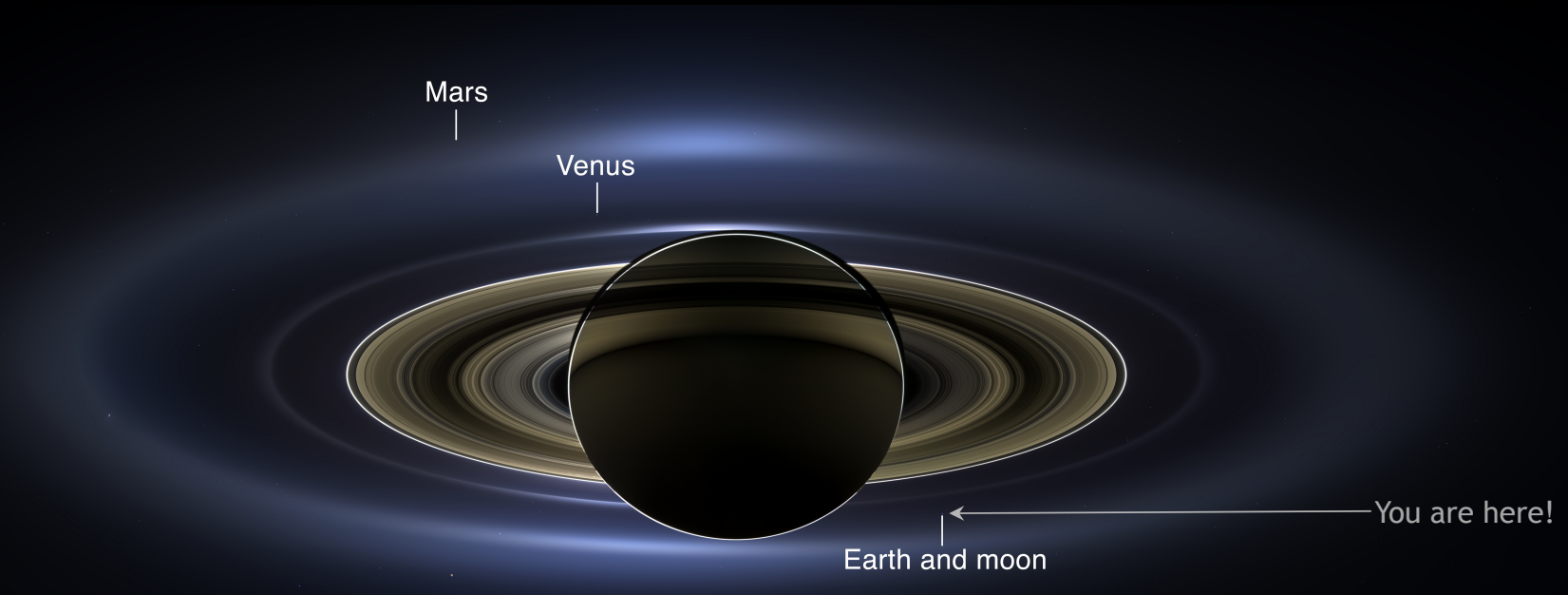
Viewed from Saturn’s night side when the Sun was eclipsed by Saturn, subtle features of Saturn’s midriff and the main ring system stand out in this recent infrared image from NASA’s Cassini spacecraft. Details are highlighted through color enhancement of the data from the Visual & Infrared Mapping Spectrometer (VIMS) and are superimposed over a simulated image.



Blue highlights rings that are populated by ice particles. The F ring at the outer edge of the main rings is especially bright. 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 into our home planet Earth and other bodies of the solar system billions of years ago.

In Saturn's Shadow



http://go.nasa.gov/17qTDwD

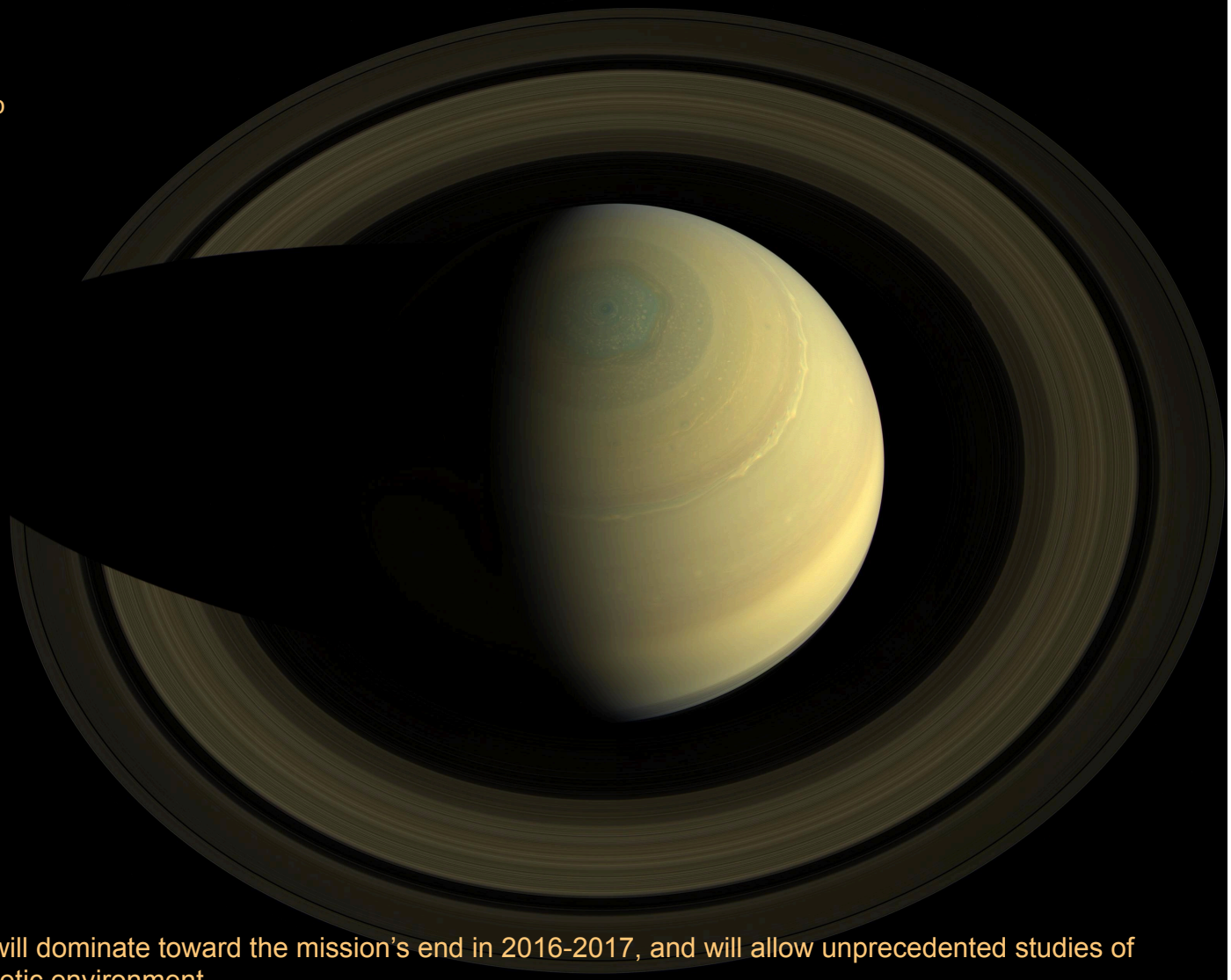
40 Countries “Wave” Back!

http://go.nasa.gov/17qTDwD

On Top of the (Ringed) World

This natural-color view of Saturn was made possible by a rare, near-polar orbit Oct. 10, 2013 that allowed NASA's Cassini spacecraft to look down upon the sunlit northern hemisphere.

When Cassini arrived in 2004, Saturn's wintry northern hemisphere sported a bluish hue. Nine years later, the now-summery northern hemisphere has taken on golden tones. At the pole, the mysterious hexagon weather pattern remains bluish.



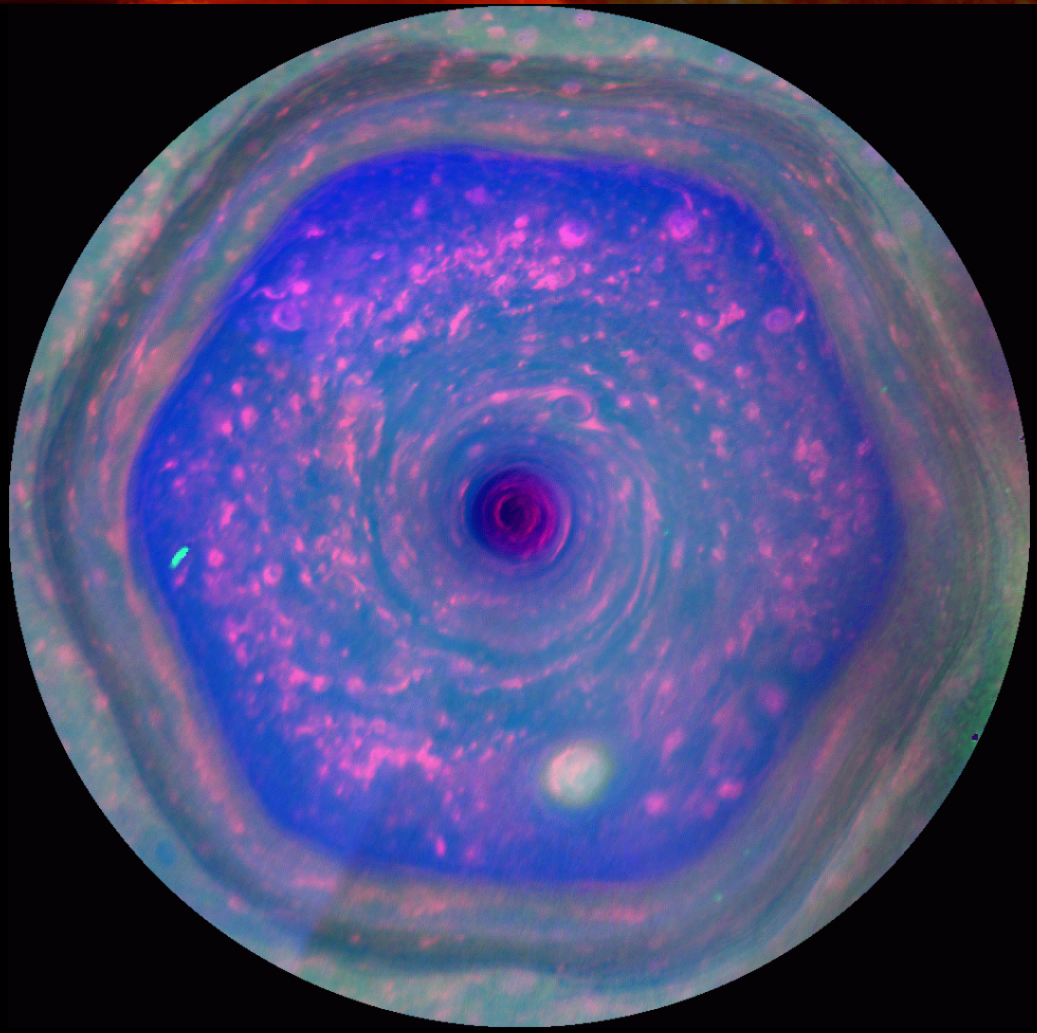
Similar, highly-inclined orbits will dominate toward the mission's end in 2016-2017, and will allow unprecedented studies of Saturn' poles, rings and magnetic environment.

Cassini Delivers the Best-Yet Views of Saturn's Hexagon

Ten hours of Cassini observations comprise a new movie showing Saturn's hexagon -- a wavy jet stream of 200 mile-per-hour winds (about 350 kilometers per hour) and is about 20,000 miles (30,000 kilometers) across.

False-color rendering of the images allowed scientists to distinguish differences among the types of particles suspended in the atmosphere. They found small haze particles dominate inside the hexagon and larger particles outside its borders. The hexagonal jet stream acts as a barrier, which results in a structure akin to Earth's Antarctic ozone hole.

This ultra-stable jet stream has been in the same configuration for decades, possibly centuries. Comparisons with Earth's famously unstable jet stream may yield new understanding of the mechanisms that govern the paths of jet streams, with important implications for weather prediction on Earth.



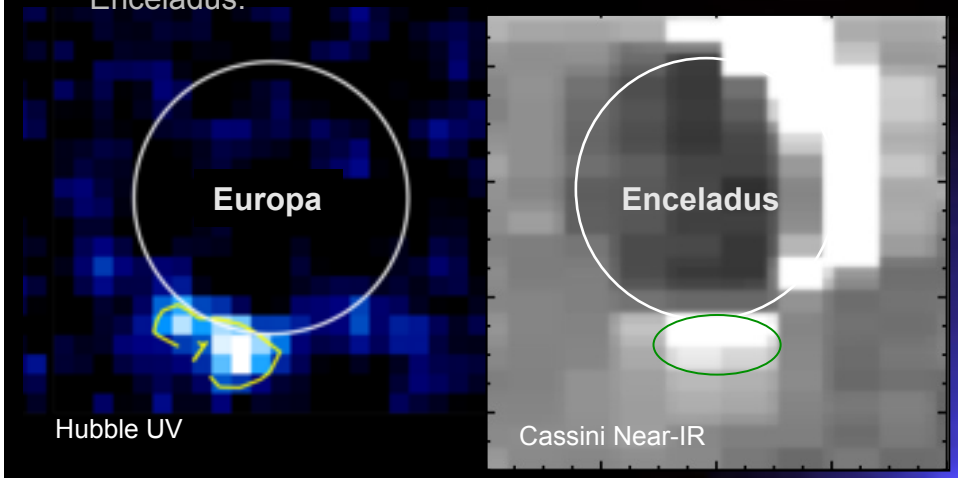
The hexagon movies are online at: http://go.usa.gov/Wtrk

"Updates on Saturn's Northern High-Latitude Cloud Morphology and the Aftermath of the 2010 Giant Storm from Cassini ISS", K.M. Sayanagi, S. Ewald, U. Dyudina, A.P. Ingersoll. Presented at the American Geophysical Union Fall Meeting, Dec. 9-13, 2013.

Enceladus Aids in Detection of a Water Plume at Europa

Cassini spacecraft studies of the watery, slightly salty and organic-rich plume shooting from Saturn's moon Enceladus provided crucial clues aiding the NASA Hubble Telescope discovery of strikingly similar phenomena at Jupiter's ocean moon, Europa.

- The new finding of water vapor above Europa's south polar region provides the first strong evidence for a water plume erupting off that moon's surface. Earlier findings already pointed to the existence of an ocean located under Europa's icy crust.
- Europa's ocean has long been considered a key locale in the outer solar system to search for life. If a plume originates from Europa's ocean, it could potentially provide future robotic explorers, such as Europa Clipper, with a means to directly sample this sought-after ocean water in the same way that Cassini has repeatedly flown through and sampled the jets from Enceladus.



The subtle spectral signature of what appears to be a plume at Europa (yellow outline) in the Hubble ultraviolet data is reminiscent of near-infrared data (green outline) that led to Cassini's discovery that Enceladus is most active at its farthest point from Saturn.

Cassini is set to make three more flybys of Enceladus, including one through the jets (see image below) in late 2015 just 30 miles above the surface. In 2016, a special stellar occultation of the jets when they are most active will provide more data on the plume's chemistry and volume. Cassini data may facilitate future Europa plume studies.