Dr. Linda Spilker
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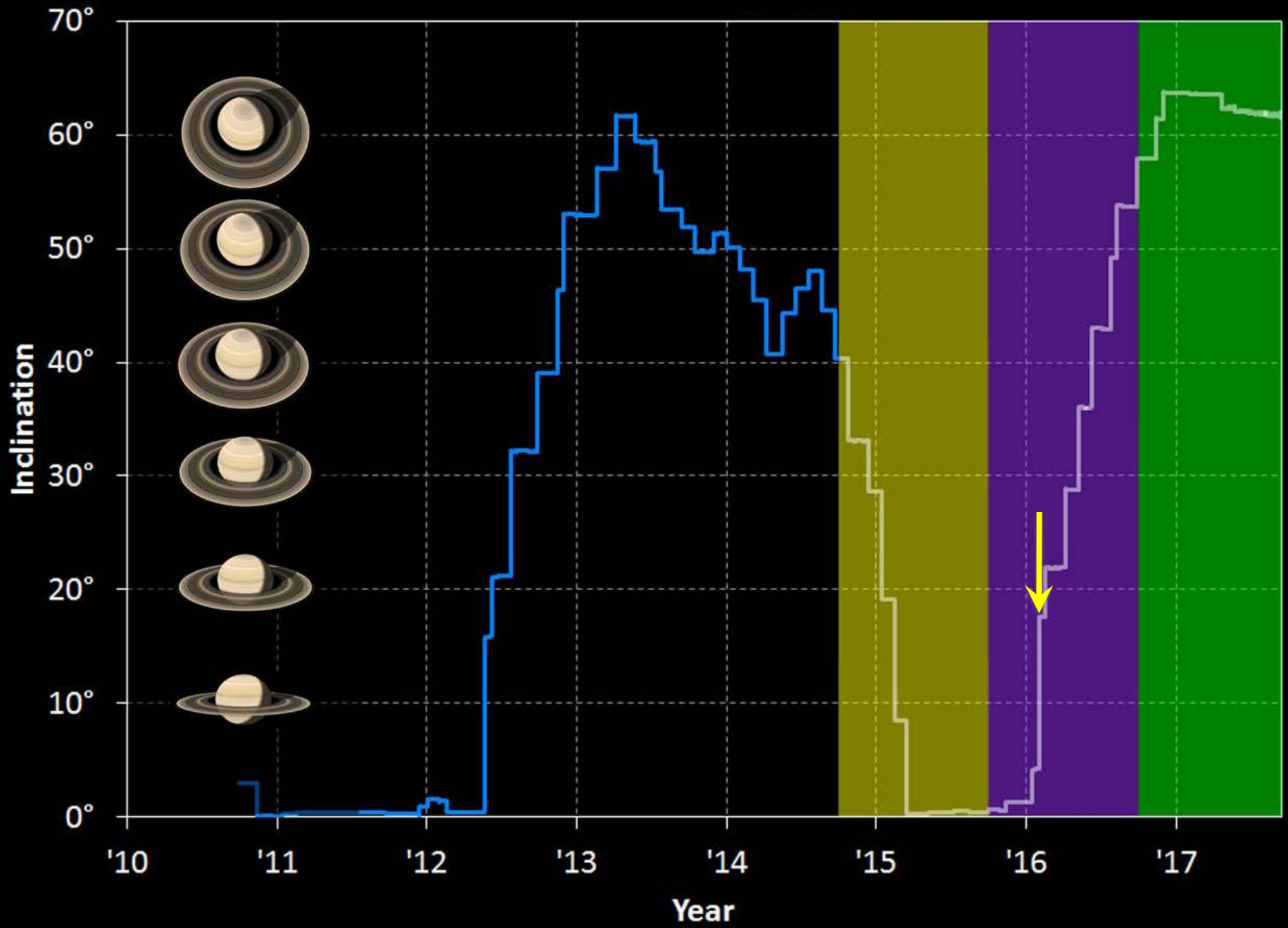
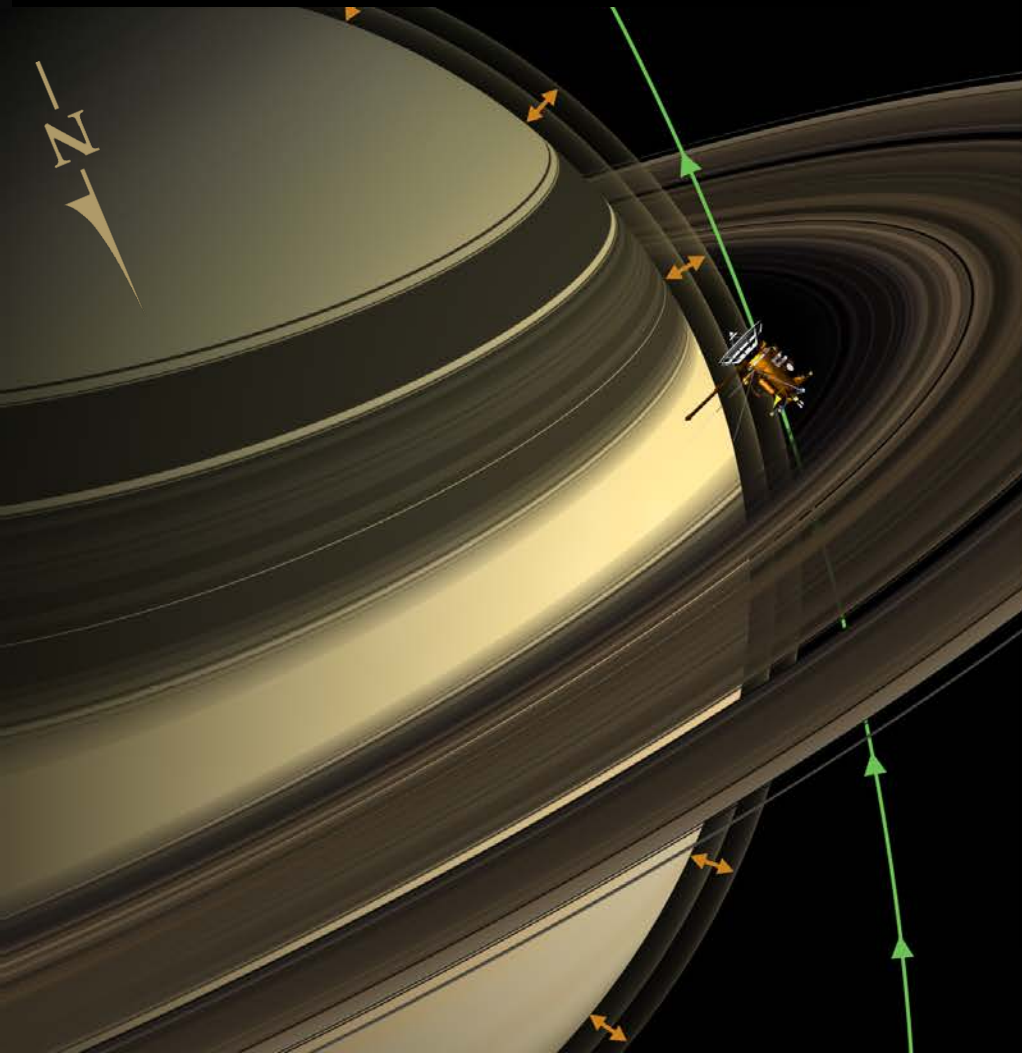
Outer Planets Assessment Group
8 February 2016

Solstice Mission Inclination Profile



Saturn’s Breathing Atmosphere

Saturn’s atmosphere has been found to “breathe” as it expands and contracts with seasonal heating and cooling.



During its last five orbits Cassini will directly sample Saturn’s upper atmosphere.

Understand why temperature of Saturn’s upper atmosphere is much hotter than can be explained.

Upper atmosphere heated by 180° F between 2005 and 2011. Outer edge expanded by 500 km.

Recent occultations show atmosphere had contracted again after 2011.

Scientists and engineers will continue to monitor atmospheric behavior as they plan the exciting Grand Finale.

”Saturn's variable thermosphere from Cassini/UVIS occultations”, T.T. Koskinen, et al., Icarus, 260, 174-179, 2015.

Seasonal Extremes at Saturn's Poles

Saturn's polar stratosphere features large warm vortices (a polar hood) during summer that changed substantially over last decade

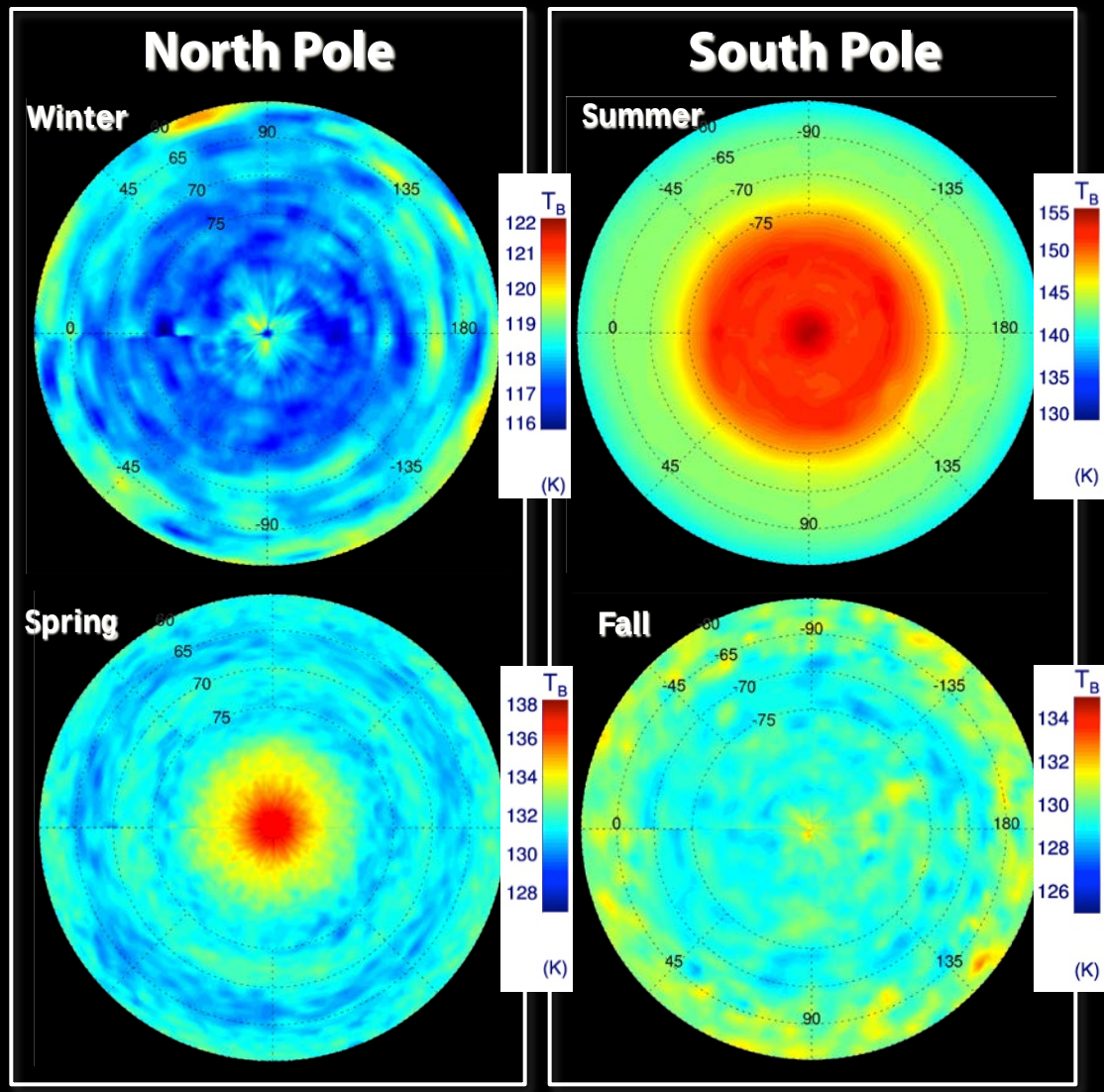
N. Pole warmed by about 20 K during spring. Cassini is still waiting for emergence of a seasonal vortex

S. Pole cooled by 35 K during its fall

Shifting temperatures depend on sunlight, and also on enormous circulation patterns

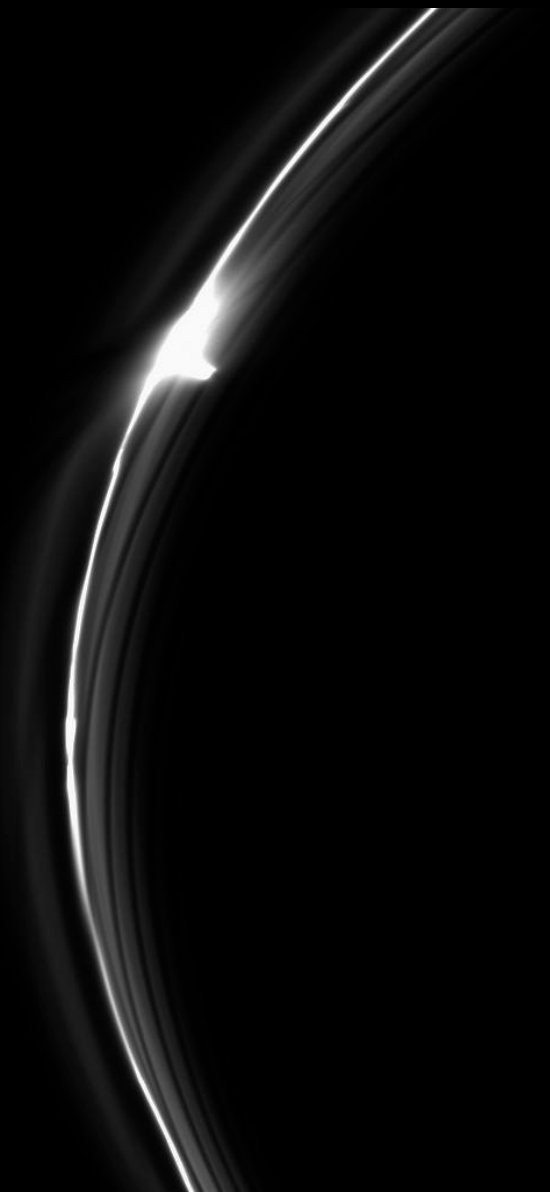
Long-term Cassini observations fill gaps in our knowledge of fundamental meteorology and chemistry of giant planet atmospheres

Stratospheric Temperature Maps of the Poles



L.N. Fletcher, et al. (2015). Seasonal evolution of Saturn's polar temperatures and composition, Icarus 250, p131–153.

Dynamic F Ring



Saturn's active F ring, sculpted by Prometheus and Pandora, is a constantly changing structure.

Features form, fade and re-appear on timescales of hours to days.

Features scientists call "gores," are to the right of the bright clump.

A "jet," appears to the left of the bright spot.

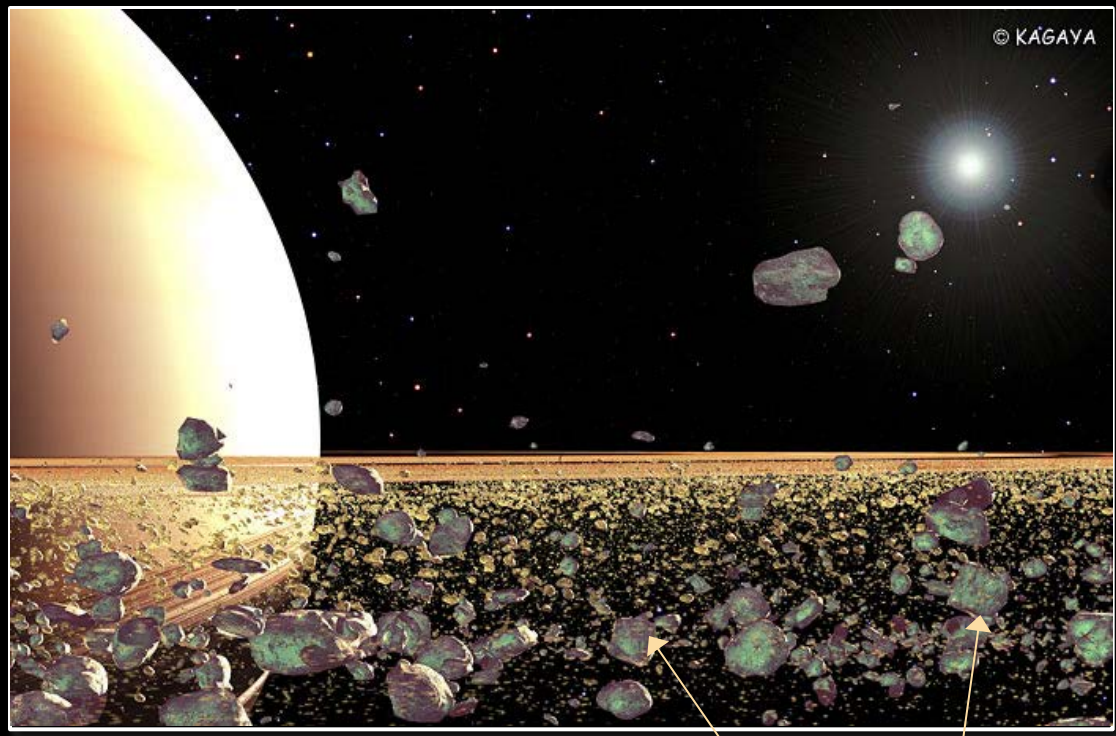
Surprisingly Young Region in Saturn's Rings

Chunks of solid ice in middle of Saturn's A ring suggest an unexpectedly young ring region

- Particles in one section of Saturn's rings are much denser than fluffy particles elsewhere

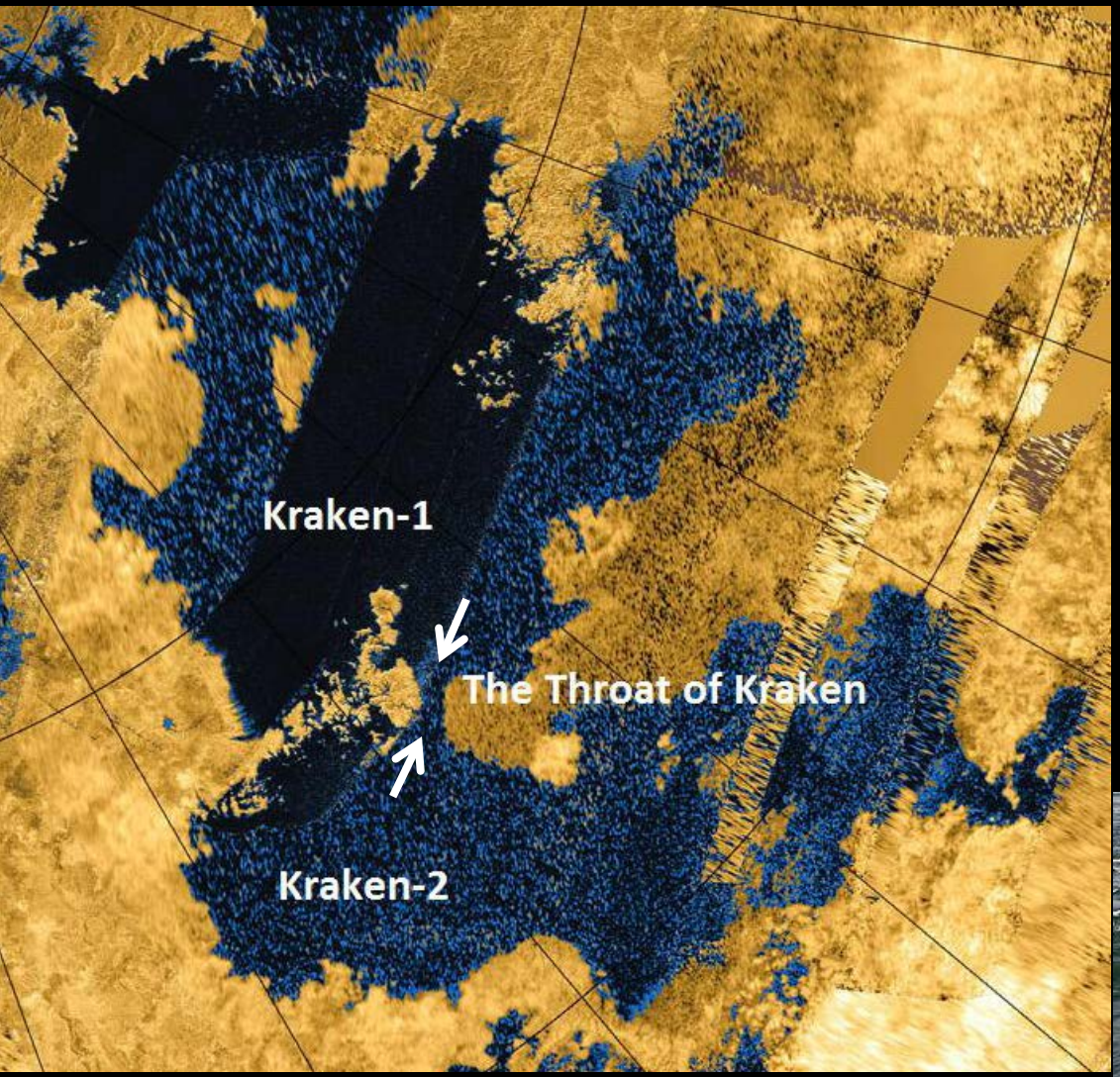
- After equinox, one section of A ring did not cool down as much as expected

- Perhaps a tiny moon broke apart only 100 million of years ago and its solid, icy fragments are now slowly spreading through rings



Morishima et al., 2015, Incomplete cooling down of Saturn's A ring at solar equinox: Implication for seasonal thermal inertia and internal structure of ring particles.

Whirlpools May Form in Titan's "Throat of Kraken" Strait



"A radar map of Titan Seas: Tidal dissipation and ocean mixing through the Throat of Kraken," R.D. Lorenz, et al., Icarus, 237, 9-15, 2014.

Whirlpools and rough seas may exist in a narrow, shallow strait that links two basins of Titan's "Sea of Kraken."

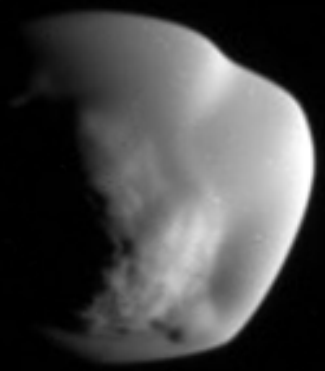
- The "Throat of Kraken," formally called "Seldon Fretum," may create turbulence similar to that in the Corryvreckan Strait off Scotland's coast.
- The Kraken strait may also limit mixing between liquid hydrocarbon basins, resulting in composition difference between the two.

Below: **Rough water in the Corryvrecken Strait results from the energetic tidal flow through the channel. Similar phenomena may occur on Titan.** *(The Corryvreckan Whirlpool - geograph-2404815-by-Walter-Baxter.jpg)*

Revealing Tiny Ring-moons

Atlas

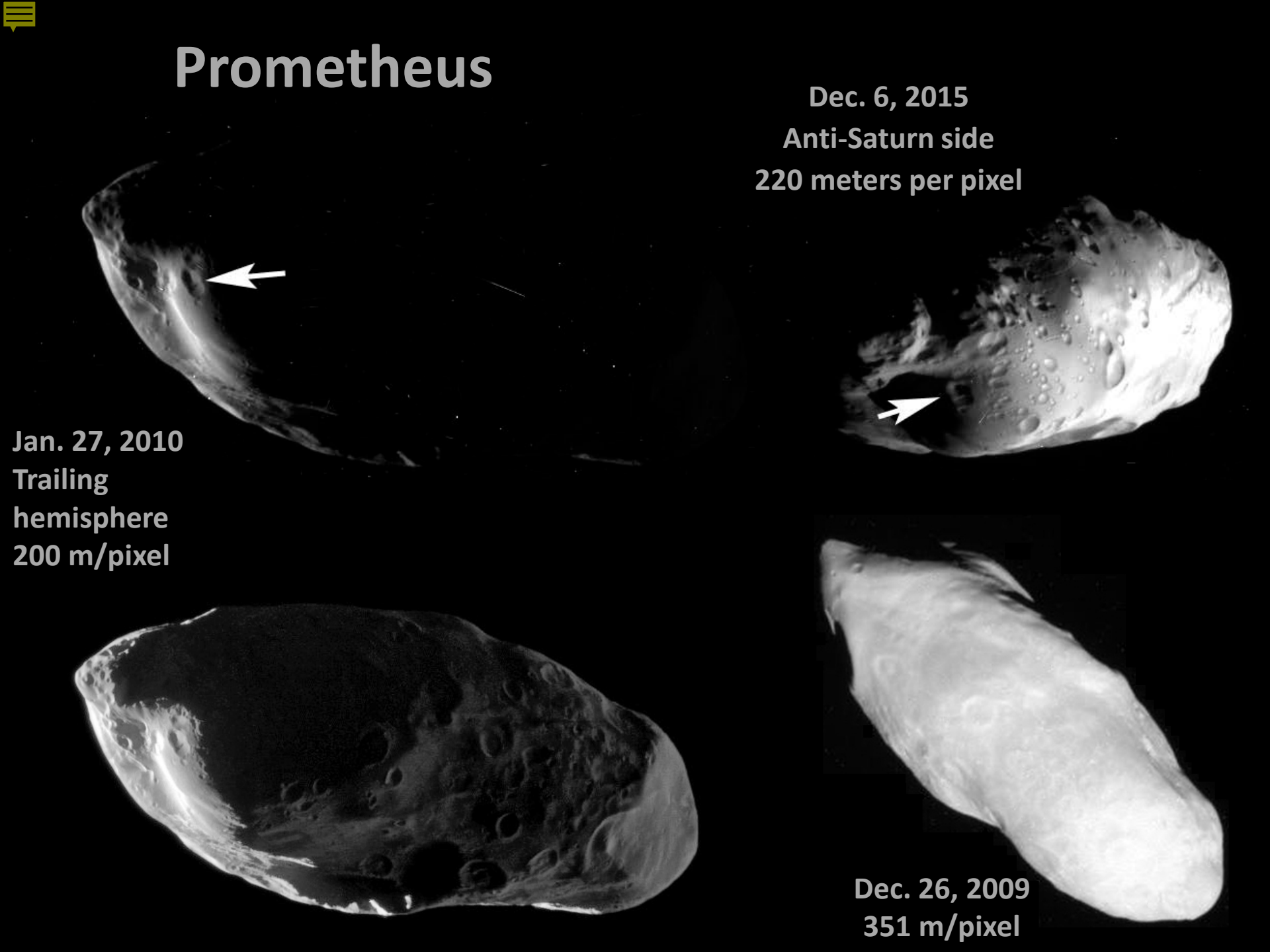
June 8, 2005
900 m/pixel



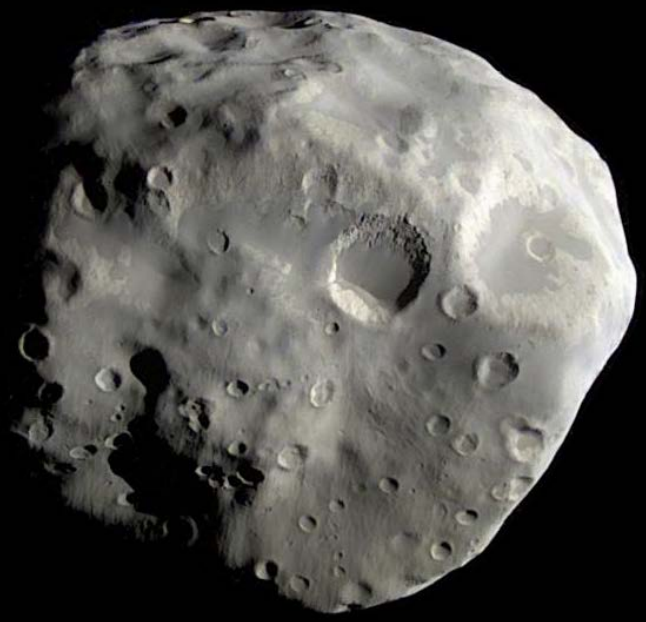
June 12, 2007
Above south pole
~1 km/pixel

Dec. 6, 2015
Anti-Saturn side
190 m/pixel

Prometheus


Dec. 6, 2015
Anti-Saturn side
220 meters per pixel
Jan. 27, 2010
Trailing
hemisphere
200 m/pixel
Dec. 26, 2009
351 m/pixel

Epimetheus

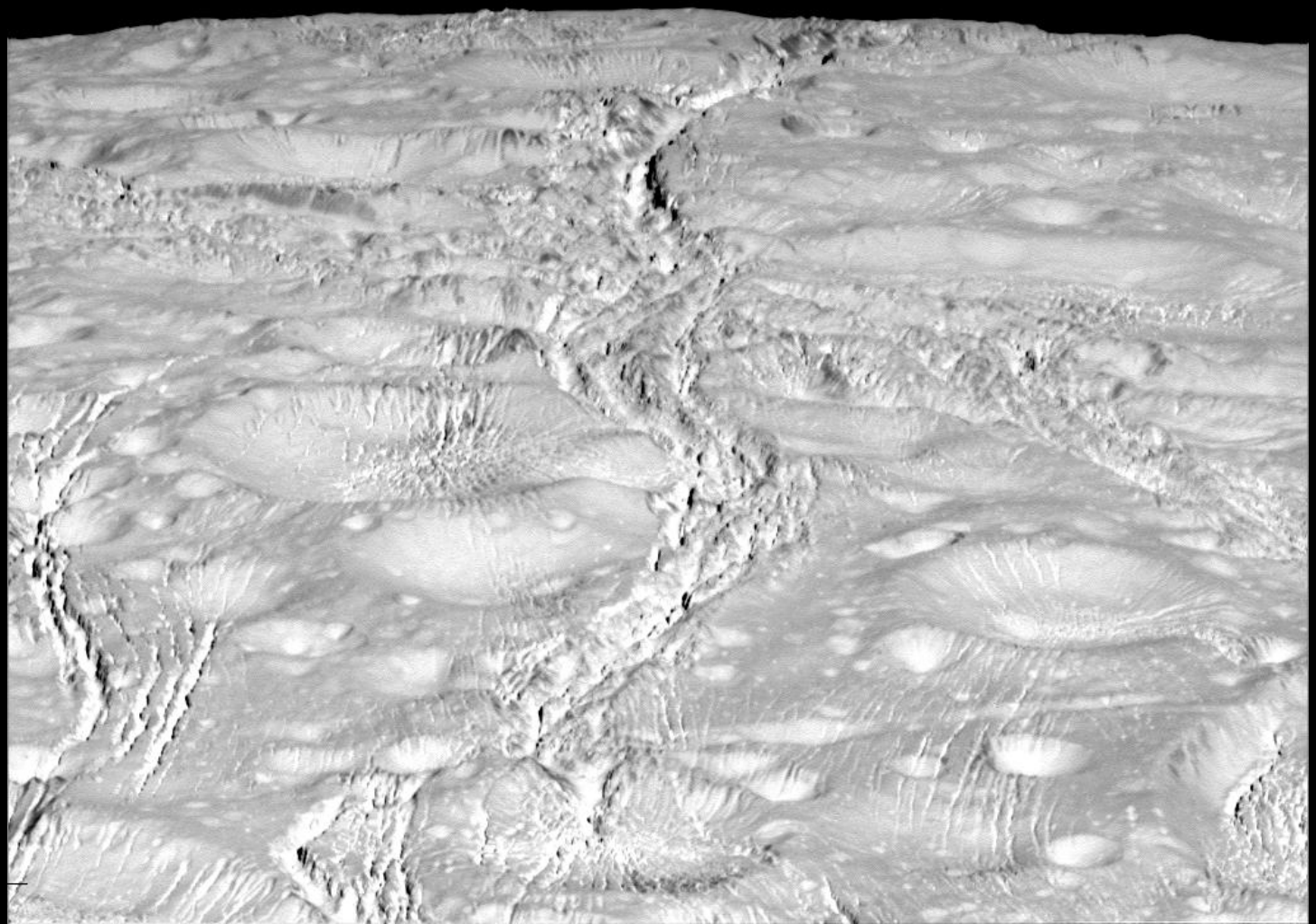


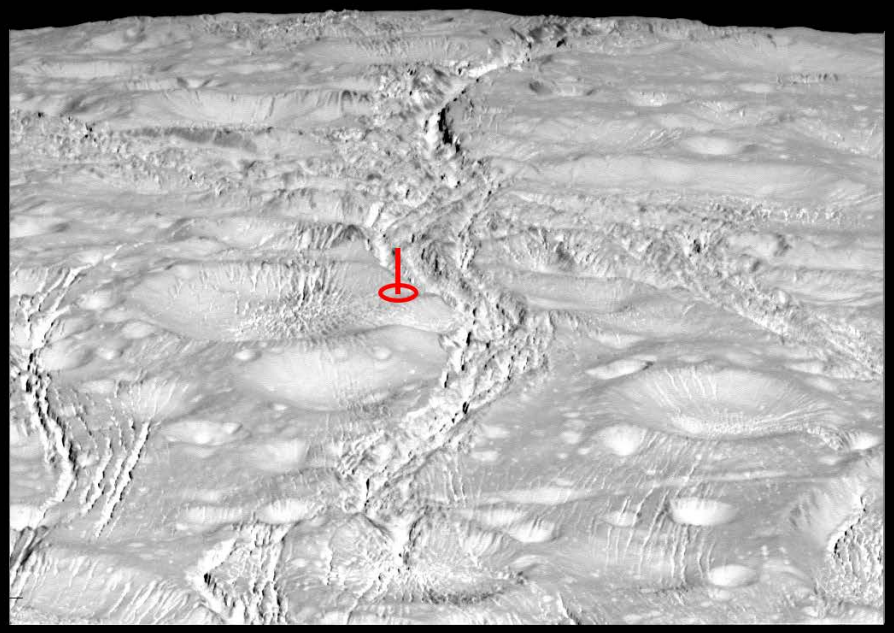
Dec. 3, 2007
South polar region
224 m/pixel

Dec. 6, 2015
Saturn-facing side
212 m/pixel

Last Enceladus Flybys

Enceladus E-20 Flyby (1839 km)





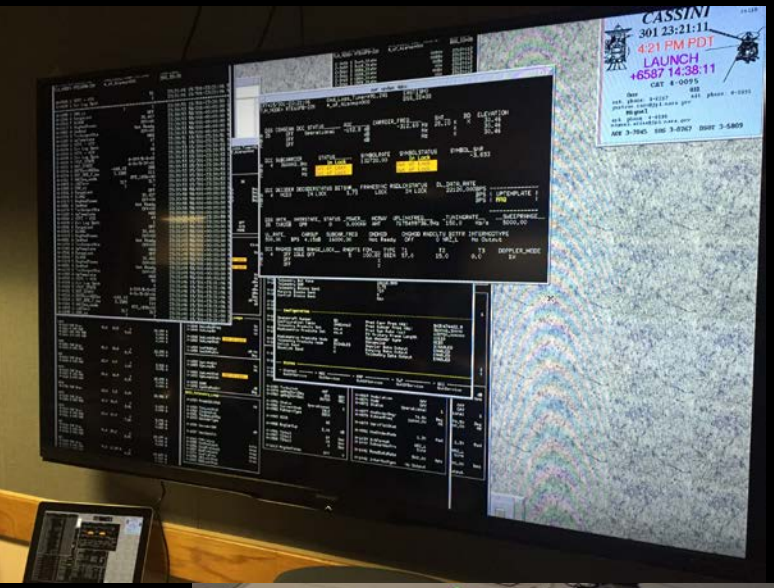
10 kilometers

North pole

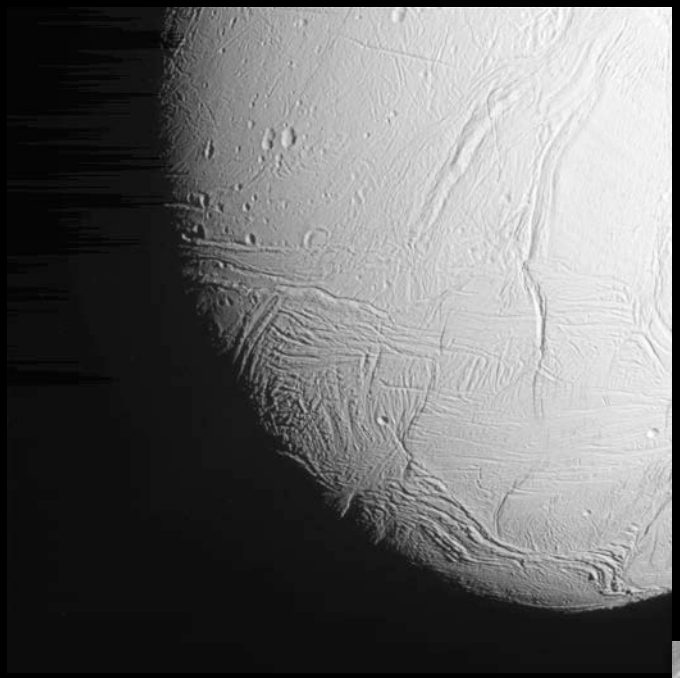
100 kilometers

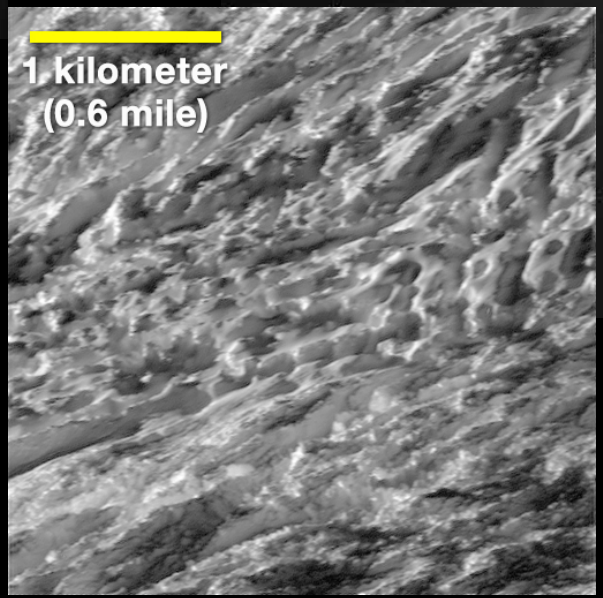

Enceladus E-21 Flyby (49 km)

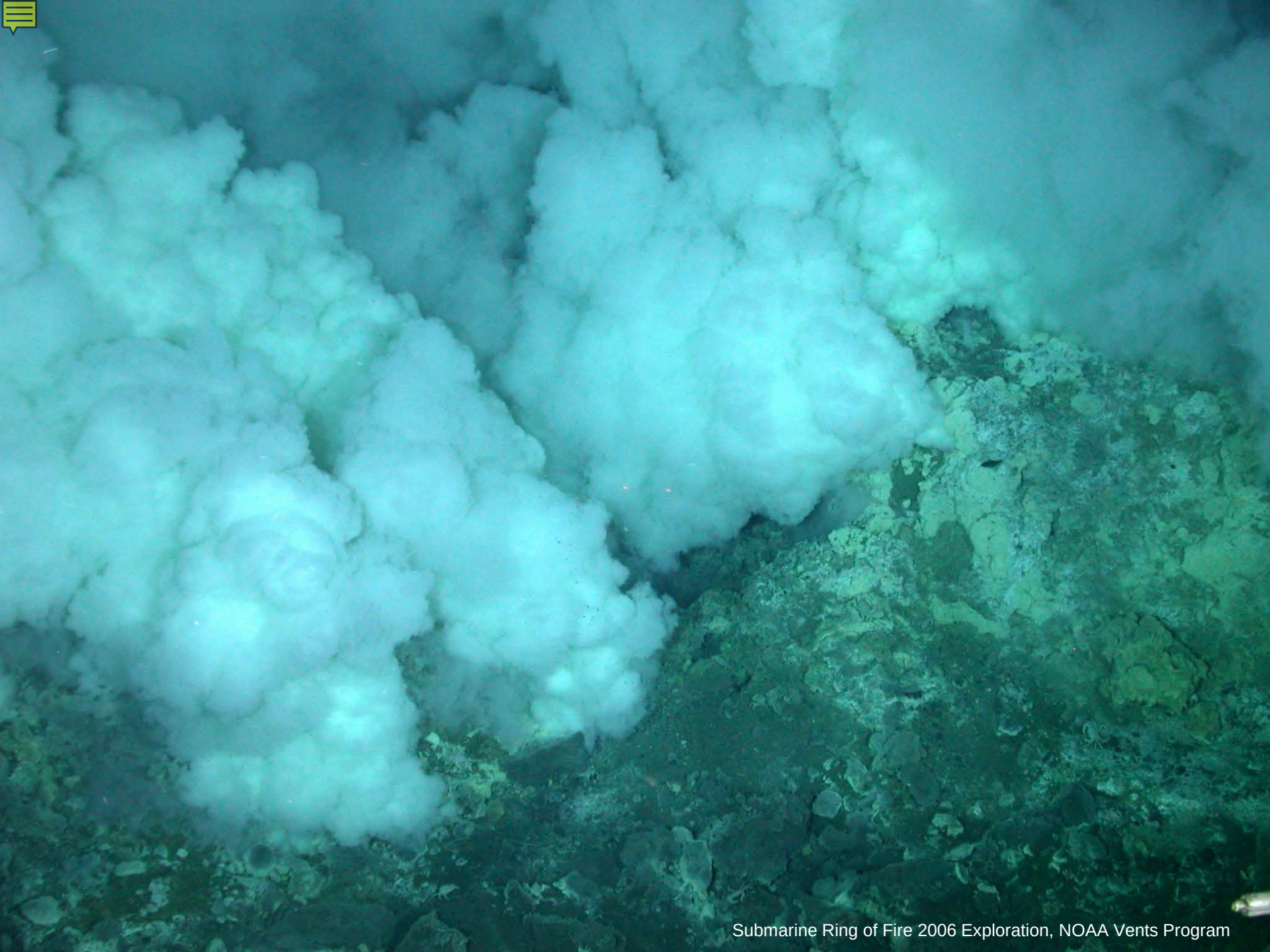
Waiting for Cassini Phone Home



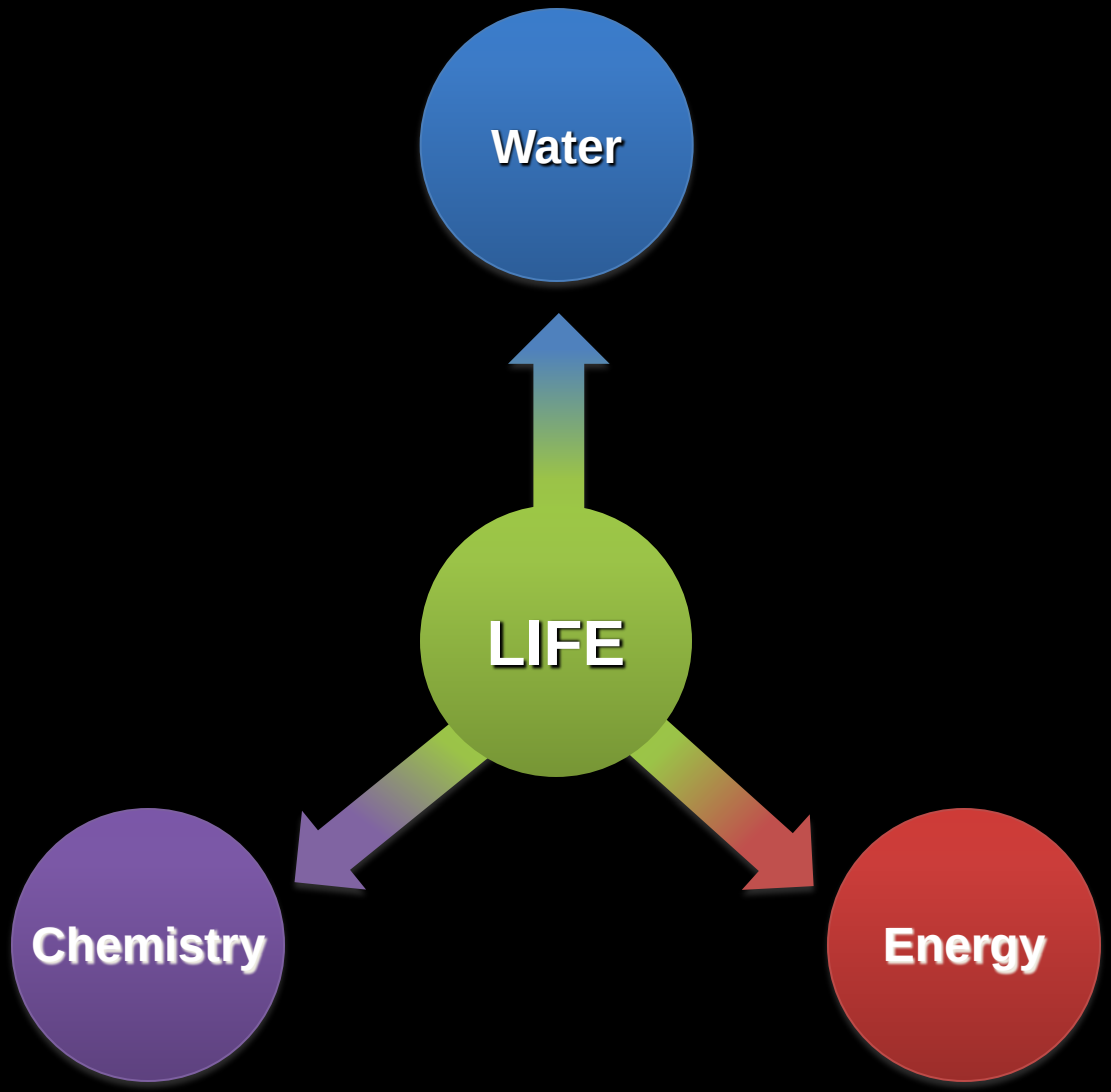
Images from E-21 Flyby



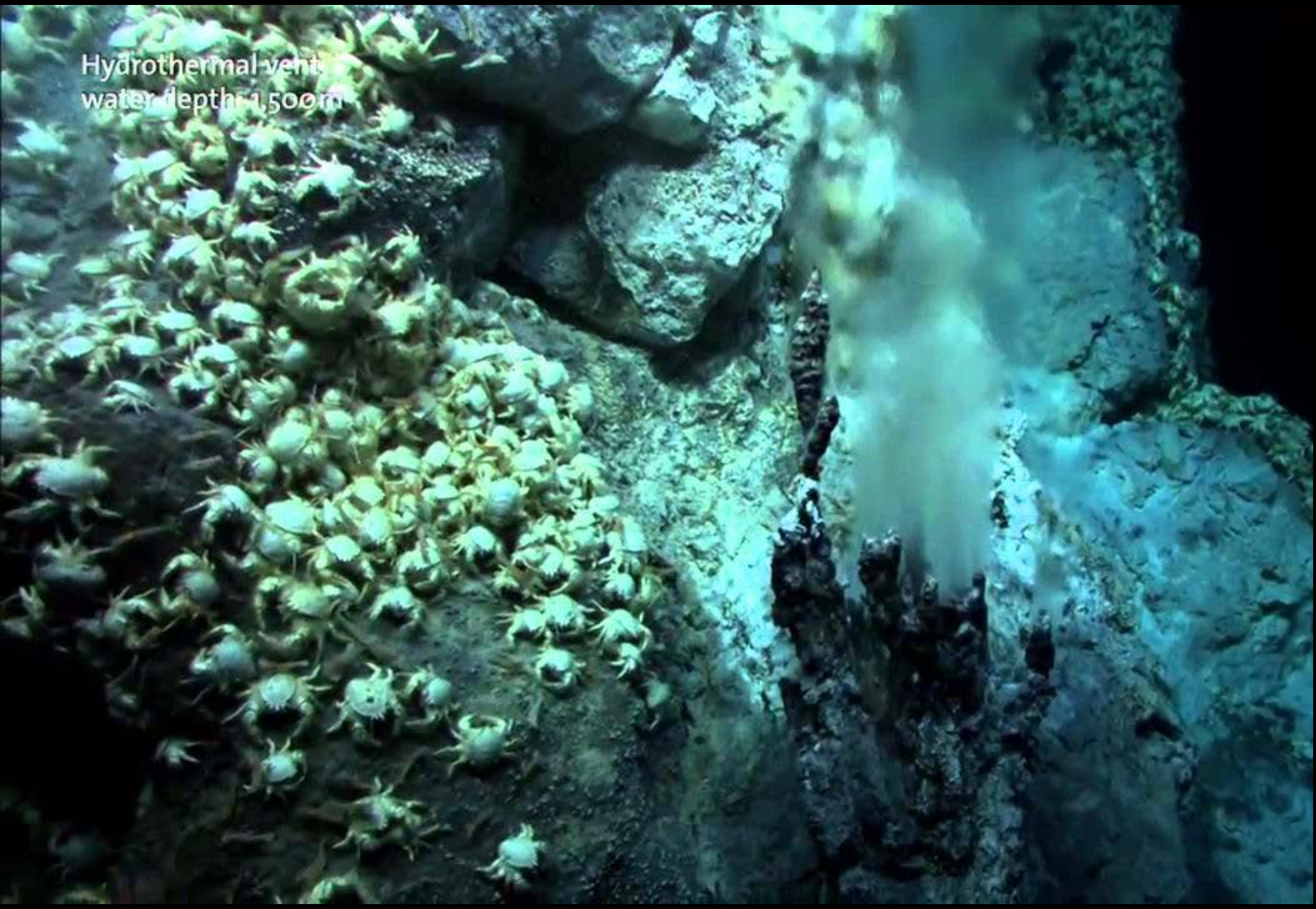




Submarine Ring of Fire 2006 Exploration, NOAA Vents Program

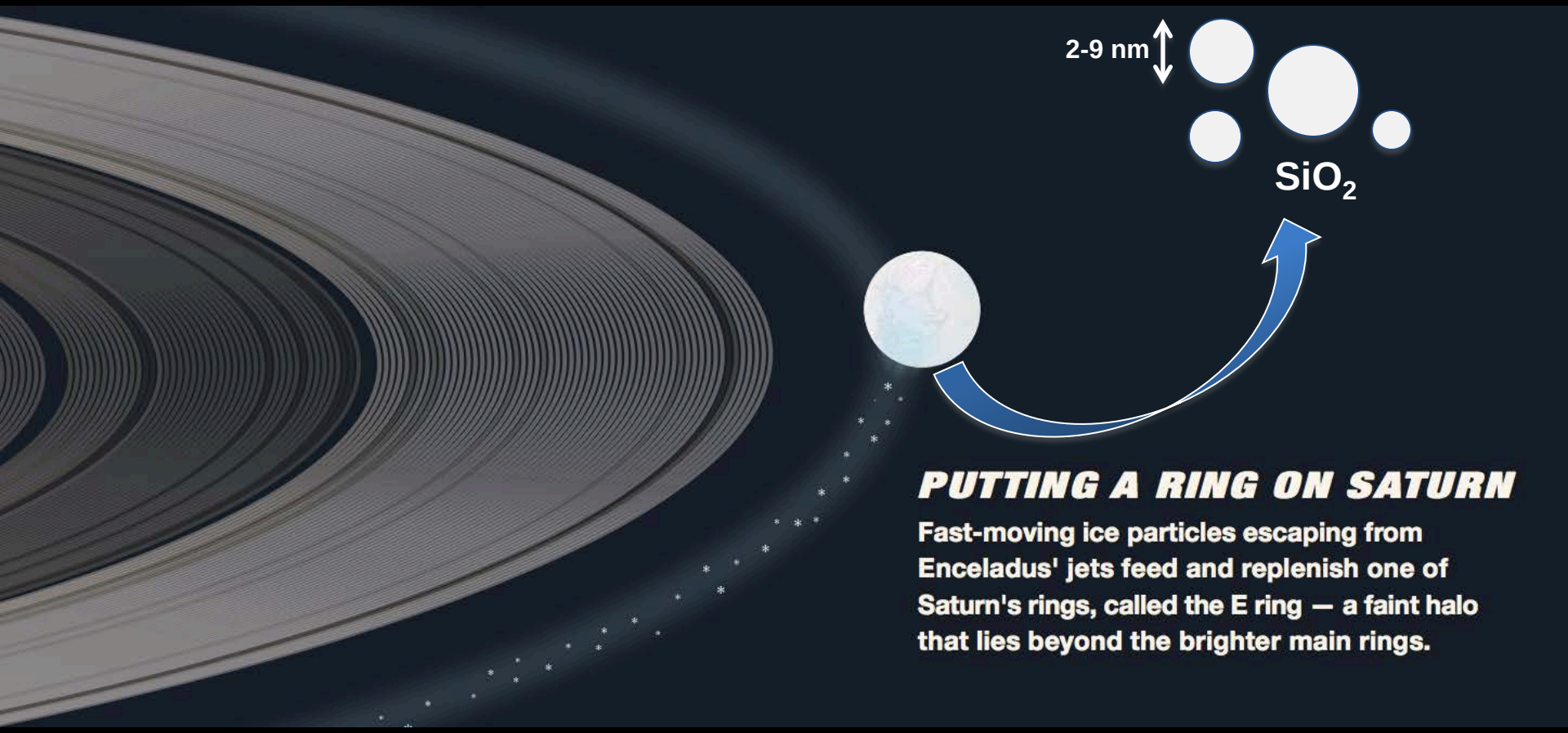

Water
LIFE
Chemistry
Energy

NOAA Okeanos Explorer Program, INDEX-SATAL 2010


Hydrothermal vent
water depth: 1,500m

Evidence for Hydrothermal Vents

1. Silica nanograins

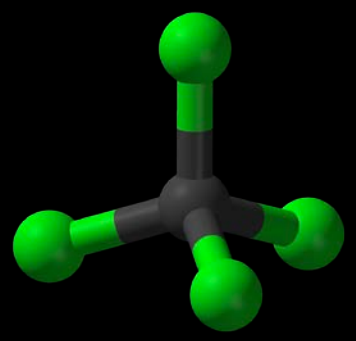


[1] Postberg et al. (2009) Nature, 459, 1098-1101; [2] Hsu et al. (2015) Nature Letters 519, 207-210.

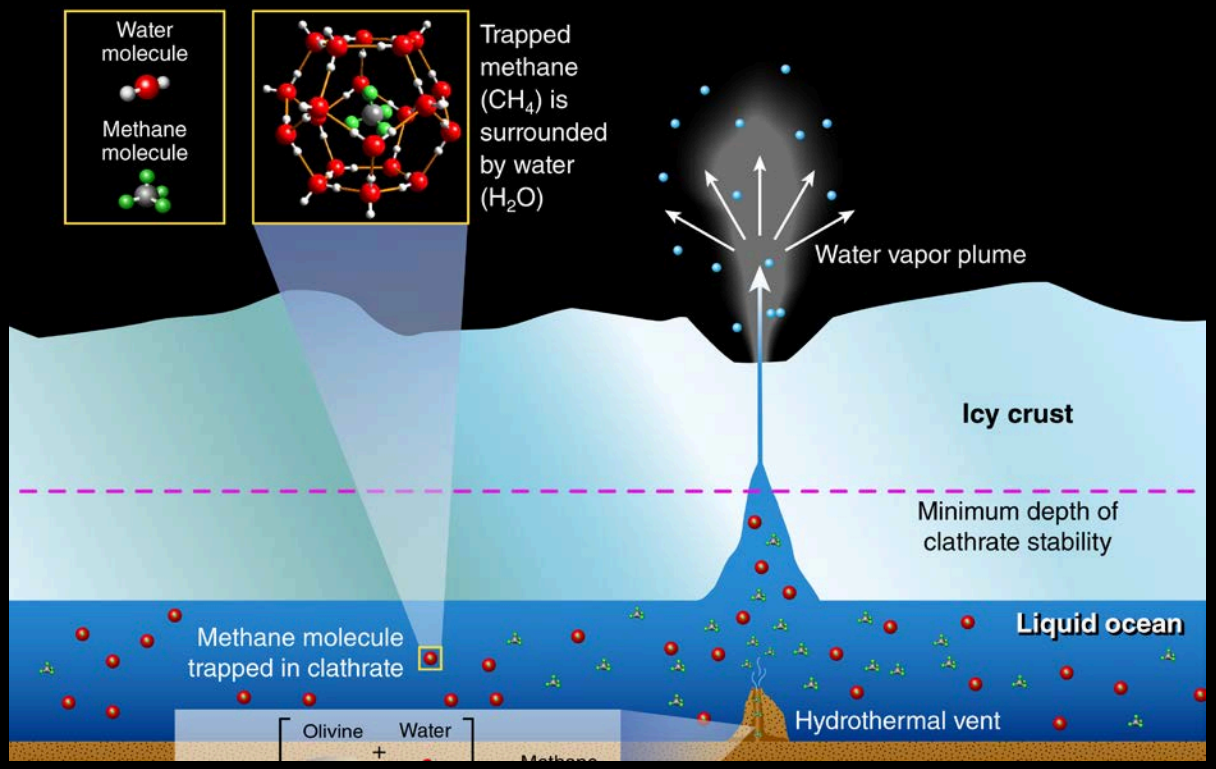
Evidence for Hydrothermal Vents

1. Silica nanograins

2. Methane



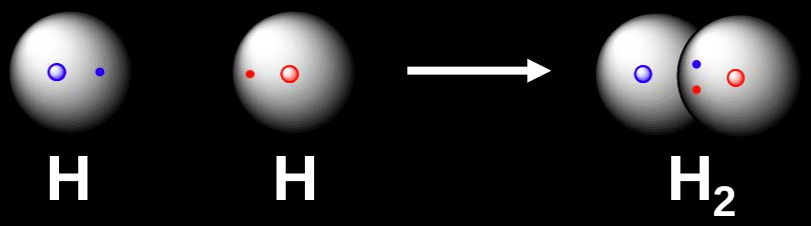
Methane (CH_4)

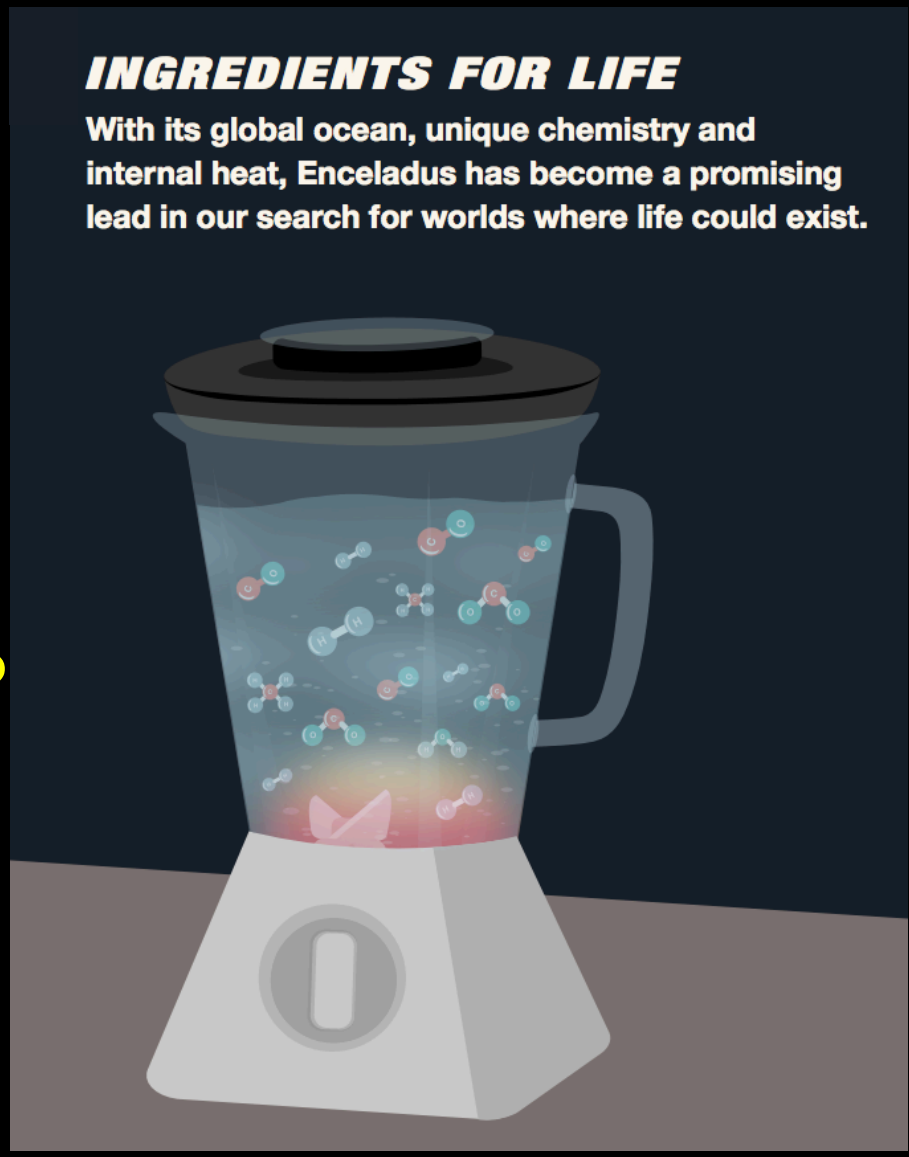


Bouquet et al. (2015) GRL, 42, 1334-1339.

Evidence for Hydrothermal Vents

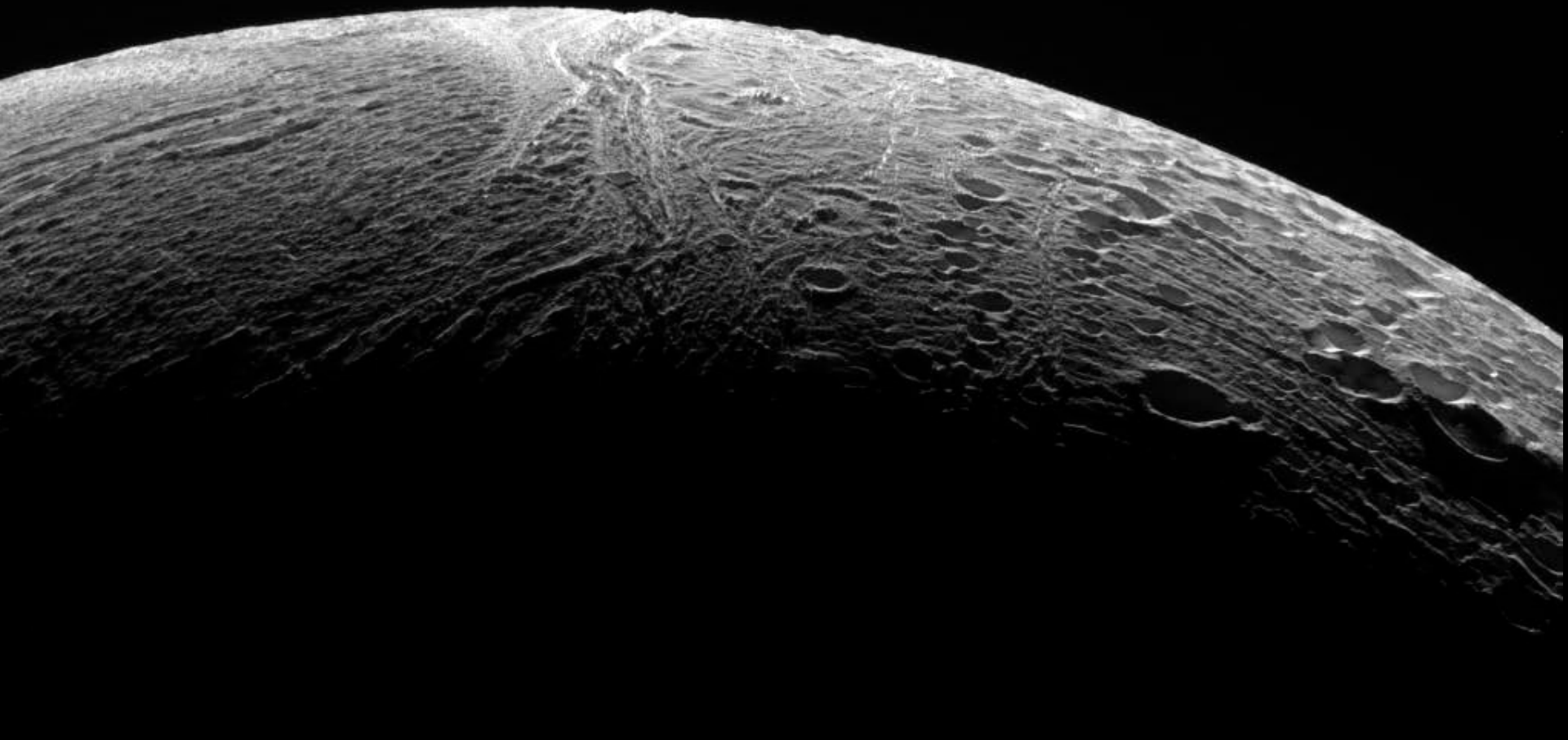
1. Silica nanograins
2. Methane
3. Molecular hydrogen?

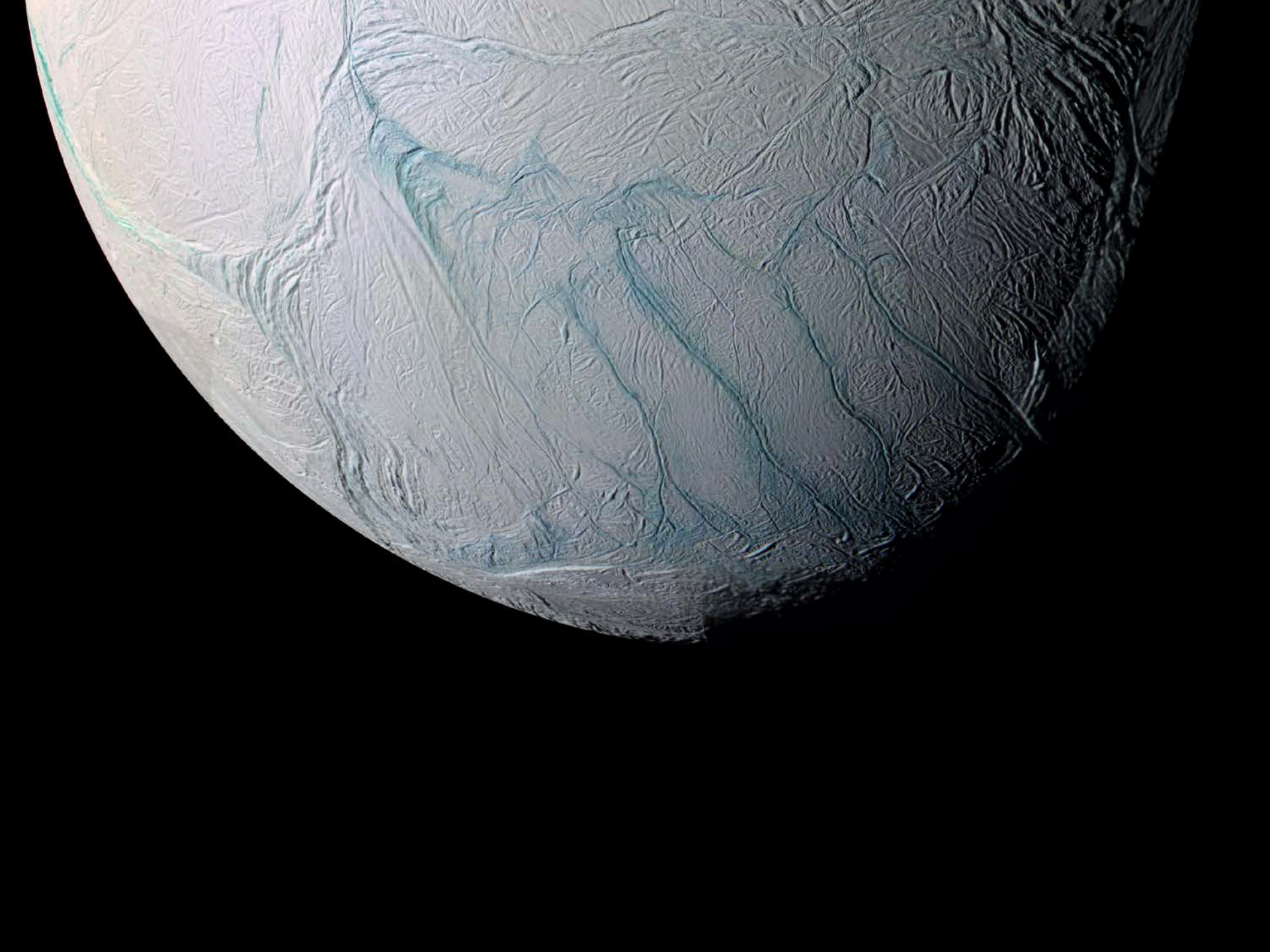


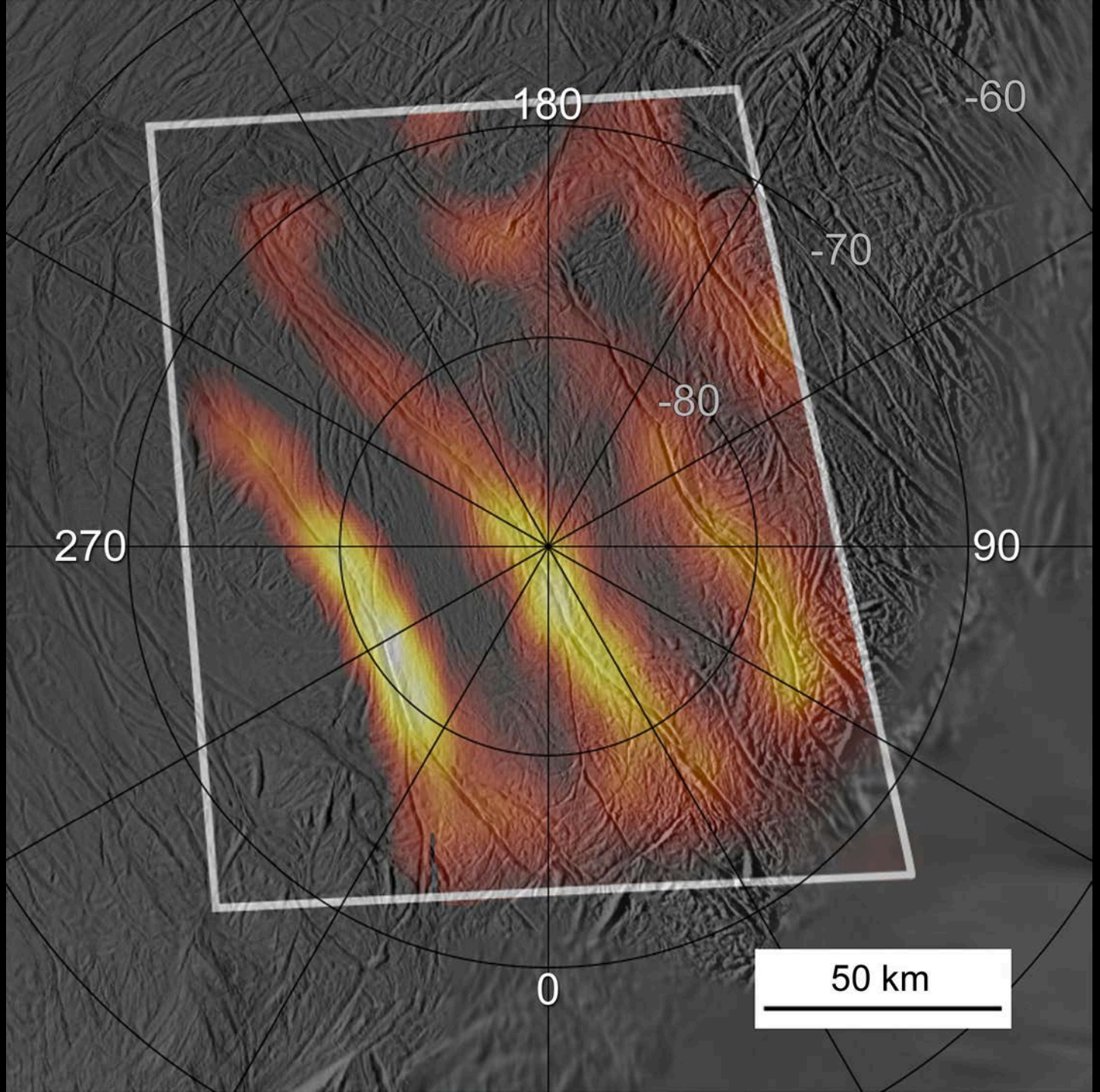


http://saturn.jpl.nasa.gov/files/enceladus_infographic_full.pdf

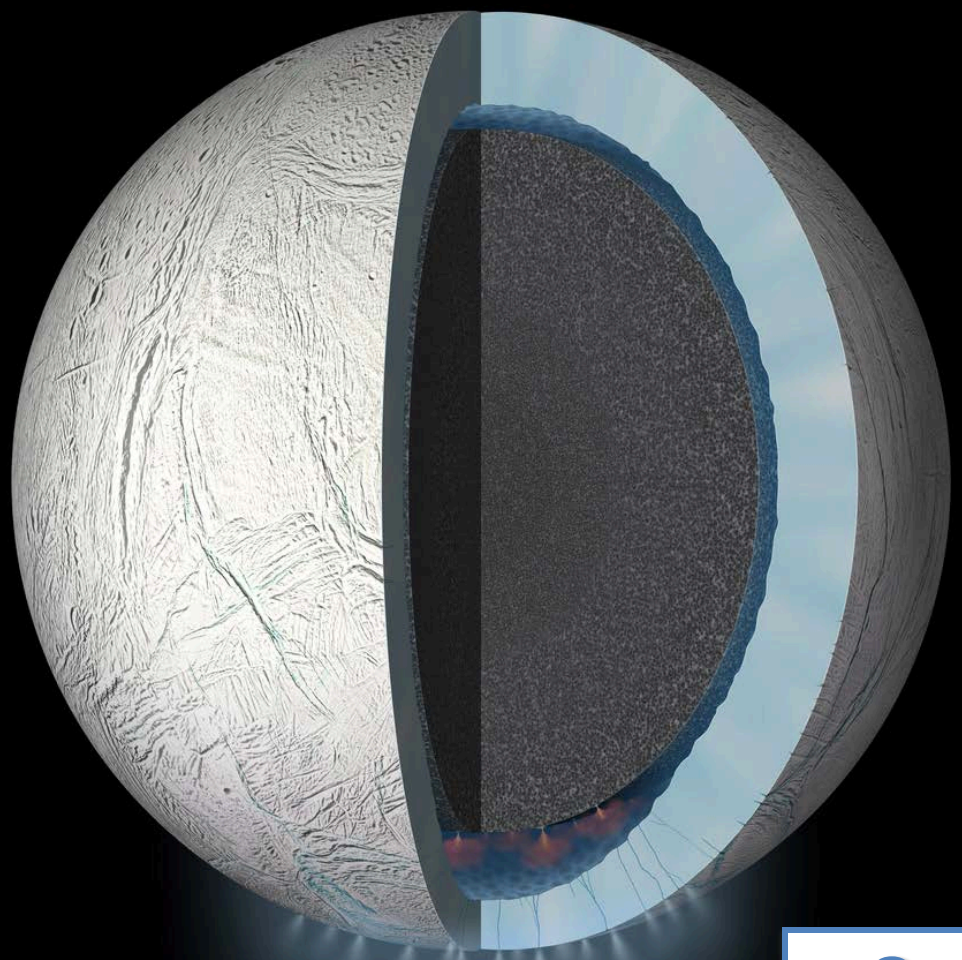
Enceladus E-22 Flyby (4999 km)






180
-60
-70
-80
270
90
0
50 km

We have learned so much . . .



- Global ocean!
- Ocean is long-lived
- Alkaline pH of ocean
- Hydrothermal vents
- Jet and Curtain-like eruptions
- Organics in plume

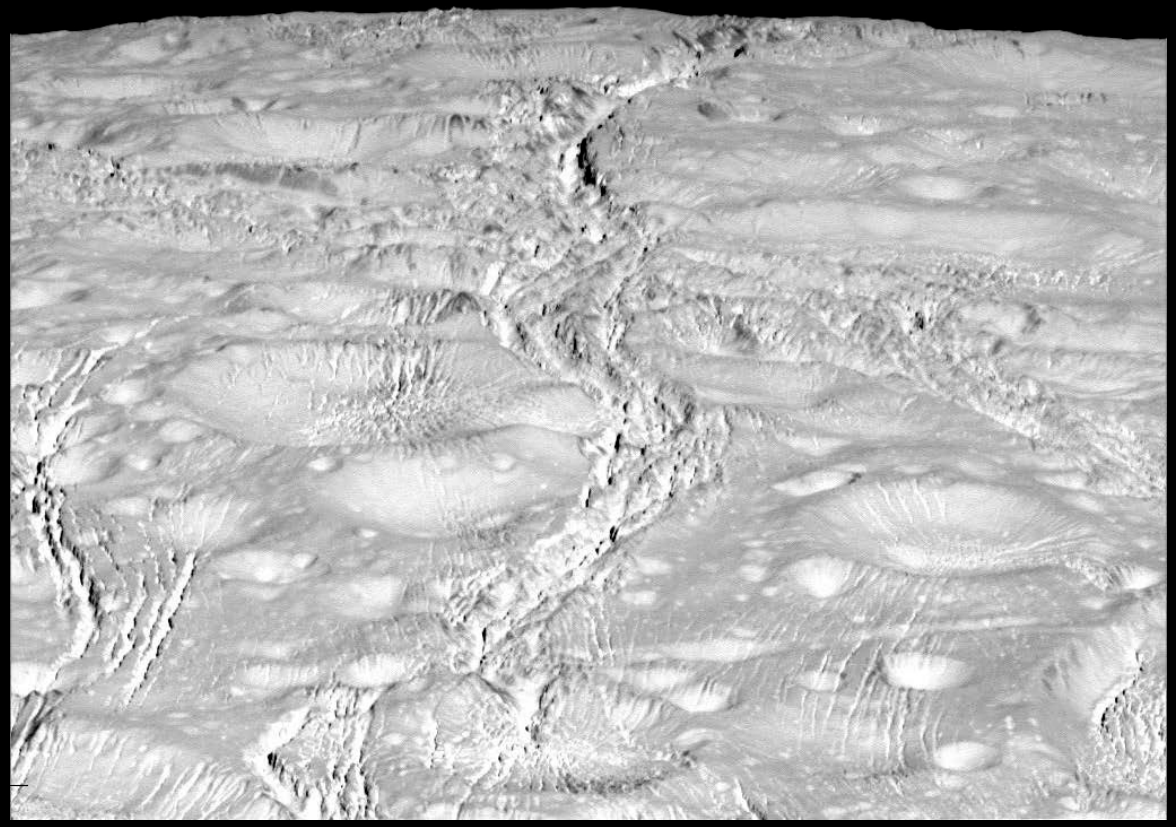
Ocean Worlds Program will enable us to go back!

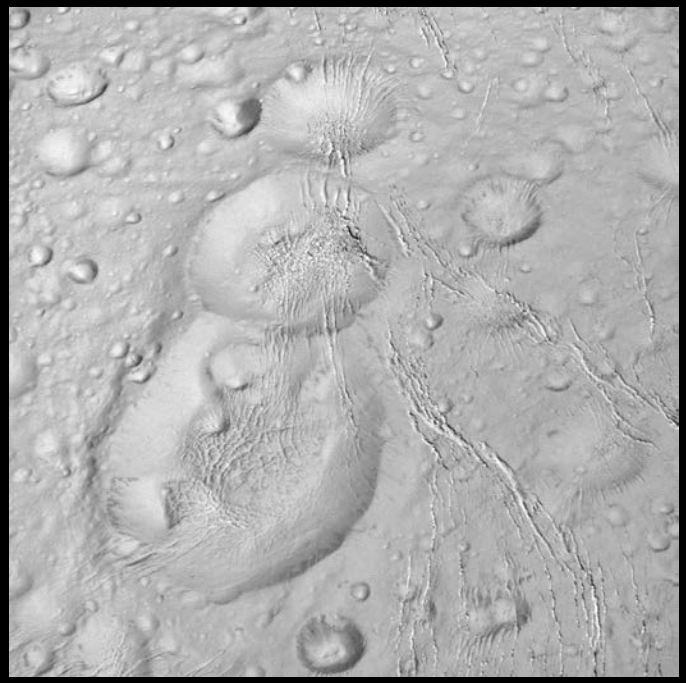
END

Revealing Enceladus' North Pole

Final views of Enceladus' north polar captured on October 14, 2015. This pole was in darkness earlier in the mission.

Scientists will look for hints of past cryovolcanic and tectonic activity on this Ocean World.

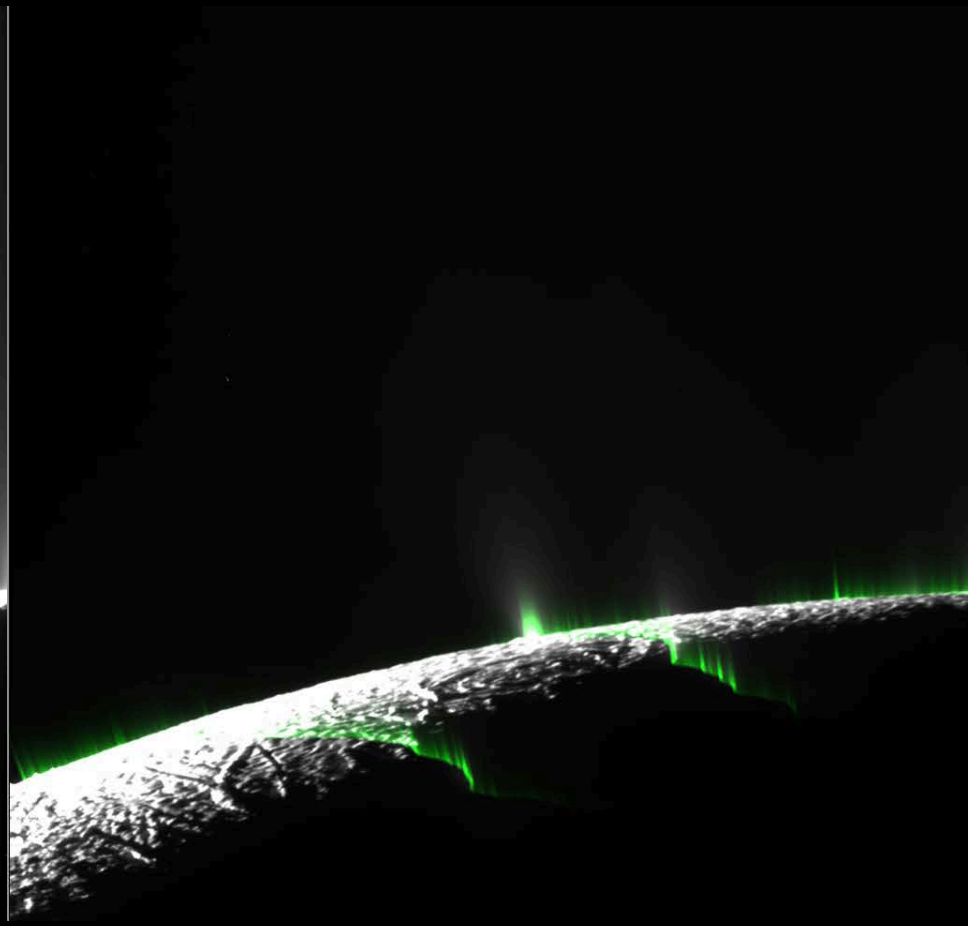




61.5 km

Cassini Image

Simulation of curtain eruption
(overlaid on Cassini image)



NASA/JPL-Caltech/SSI/PSI