

# Moons of Saturn

## Enceladus

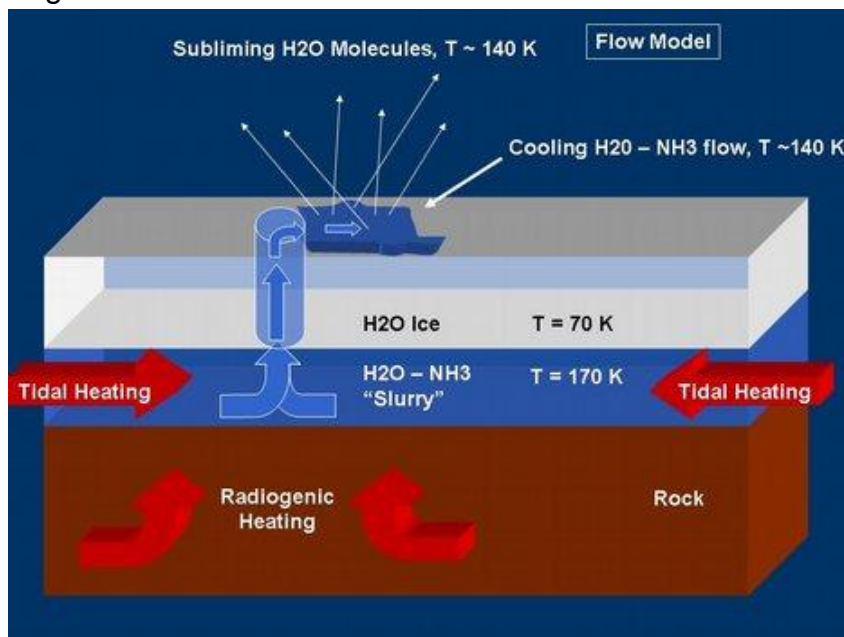
-6<sup>th</sup> largest moon of Saturn

-Voyager spacecraft passed near it in the early 1980s

-Diameter of Moon is 500km or 1/10 the size of Saturn's largest moon Titan

-Moon reflects almost all the sunlight that strikes it.

-More known about the moon with Cassini spacecraft (2005) which performed several close flybys. Probe found a water-rich plume venting from the moon's South Polar Region.



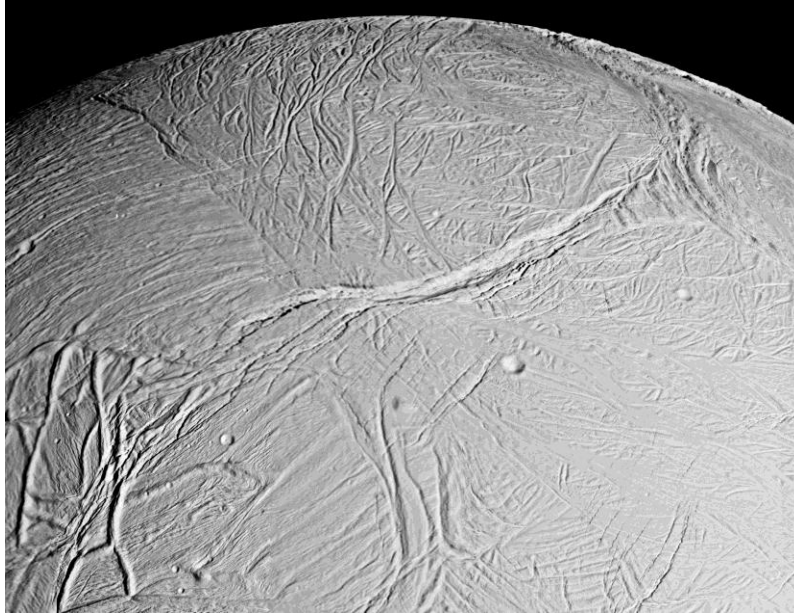
This is a model of what the water-rich plume venting might be doing on Enceladus

Image provided by <http://wn.com/MODEL>

-In the model of Enceladus water-rich plumes spraying off the surface the liquid seems to be a flow of ammonia-water-ice slurry

-The discovery by Cassini along with the presence of escaping internal heat and very few impact craters in the South Polar Region shows that Enceladus is geologically active today.

-Enceladus was thought to be too small for astrobiology significance



Close-up of Enceladus surface showing few impact craters

Image provided by <http://photojournal.jpl.nasa.gov/jpeg/PIA06191.jpg>

## Titan

- Titan is the 2<sup>nd</sup> largest moon in our solar system (Ganymede the moon of Jupiter being the first)
- Titan is slightly bigger than Mercury (Titan has a diameter of 5100km and Mercury has a diameter of about 4880km).
- Orbital Period is 15.9 days.
- if Titan orbited the sun directly it would be considered a planet.
- Titan is the only moon in the solar system with any significant atmosphere (Neptune's moon Triton has a tenuous atmosphere). Titan atmosphere contains organic chemistry.
- There is a moon orbiting around Neptune that has an atmosphere but it is not significant.
- The air is much thicker on Titan than the Earth. Most of the atmosphere is nitrogen like the Earth.
- If one was standing on the surface of Titan they would never even know that they were orbiting the huge planet of Saturn. This is due to the fact that the atmosphere is so thick, and so big.

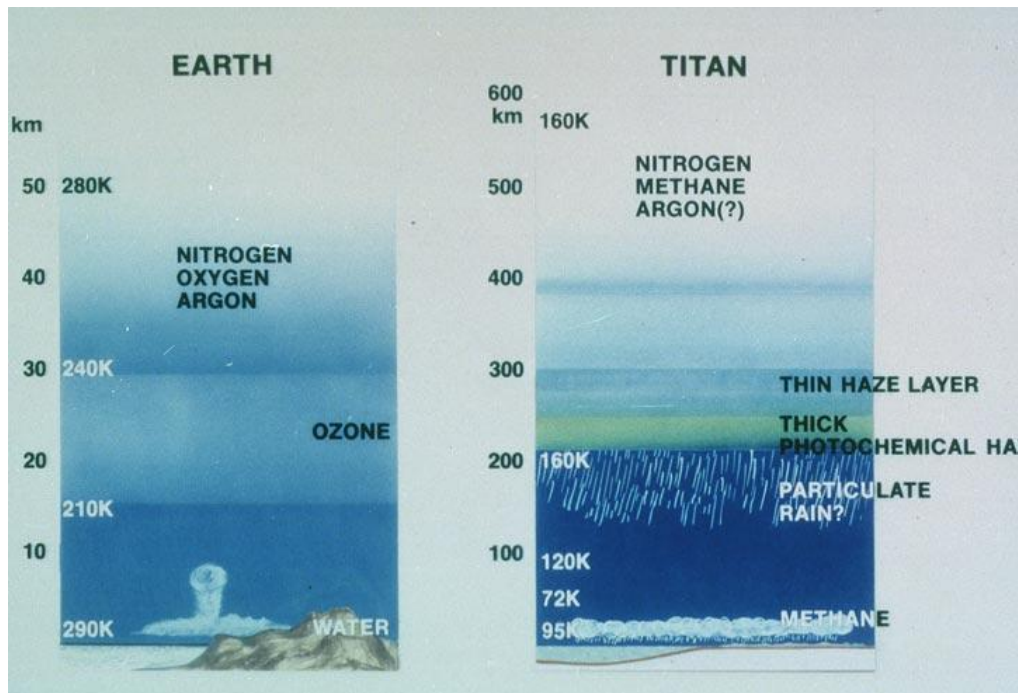


Image: <http://www.jpl.nasa.gov/media/cassini-102504/visuals.html>

-Comparison in class was an image of Earth's atmosphere being 50km thick and Titan's atmosphere to reach the same outer layer is 500-600 km thick. This is why one would never be able to see Saturn, standing on the surface you could barely see 50 feet in front of you.

-The density of Titan's atmosphere is  $1.88 \text{ g/cm}^3$ . This is about the same density of Ganymede and Callisto.

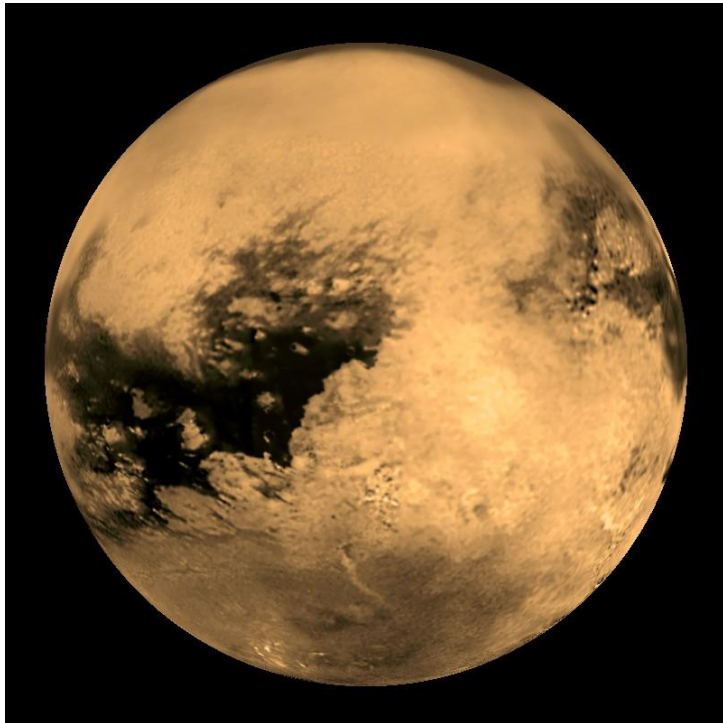
-Because of this it is thought that the interior of Titan is similar to that of Ganymede or Callisto (Ice Layer, water layer, and surface water ice under a very high pressure).



Titan size and color comparison with other major moons in the solar system

Image provided by <http://www.astronomynotes.com/solarsys/s15.htm>

- The 2<sup>nd</sup> most abundant element in Titan's atmosphere is methane
- Voyager 1 in 1980 found hydrocarbons in the upper atmosphere of Titan: C<sub>2</sub>H<sub>6</sub> (ethane), C<sub>2</sub>H<sub>2</sub> (acetylene), C<sub>3</sub>H<sub>3</sub> (propane).
- The surface gravity on Titan is substantially less than that of Mercury and Mars. The only reason that Titan has an atmosphere is because it is so cold.
- Where the Surface Temperature on Titan is 95K, Earth is 290K. drastically colder conditions, which is why you would never find water on the surface in its liquid form.
  
- Titan allows gases to spread out farther away from the surface than the Earth allows its gases.
- These gases that make up Titan's atmosphere are held down by a much lower pressure. Because of this Titan's atmosphere is much larger than ours. The atmosphere isn't held down by a high enough pressure.
- Titan's upper atmosphere is exposed to sunlight makes hydrocarbons. It has lost a lot of atmosphere through time.
  
- Titan's lower atmosphere is cold and has some methane or ethane clouds. Has not lost as much atmosphere as upper. It is shredding Hydrogen which is leaving a cloud around Saturn.
- Haze prevents viewing light on Titan's surface. This layer is about 220km up.
- Temperature of 97K
- Surface makeup: 94% N<sub>2</sub> 6% CH<sub>4</sub> and .2% H<sub>2</sub>
- If there was to be water on the surface it could only be found frozen ROCK hard.
- Possible images of cobbles on Titan's surface are thought to possibly be frozen water ice.



Website for this image: [http://sos.noaa.gov/datasets/solar\\_system/titan.html](http://sos.noaa.gov/datasets/solar_system/titan.html)

- The lighter colored spots found on the surface are thought to be pure water ice.
- The dark areas are solids areas that are thought to be made of hydrocarbons which when looked at closely resemble sand dunes found on earth.
- The areas that appear to be sand dunes are made out of sand sized particles that are made of hydrocarbon material.
- Some of these dunes are thought to be up to 60 miles high.



Image: [http://www.theregister.co.uk/2006/05/05/titan\\_dunes/](http://www.theregister.co.uk/2006/05/05/titan_dunes/)

- The dunes are thought to be up to 150 km high and hundreds of km across.
- Titan is the only object other than Earth in the solar system that has stable bodies of liquid on the surface
- The Cassini spacecraft discovered liquid hydrocarbon lakes in the polar regions of Titan
- surface features on Titan are similar to Earth in that the climate helps produce sand dunes, lakes, rivers, and seas (probably of liquid methane or ethane)

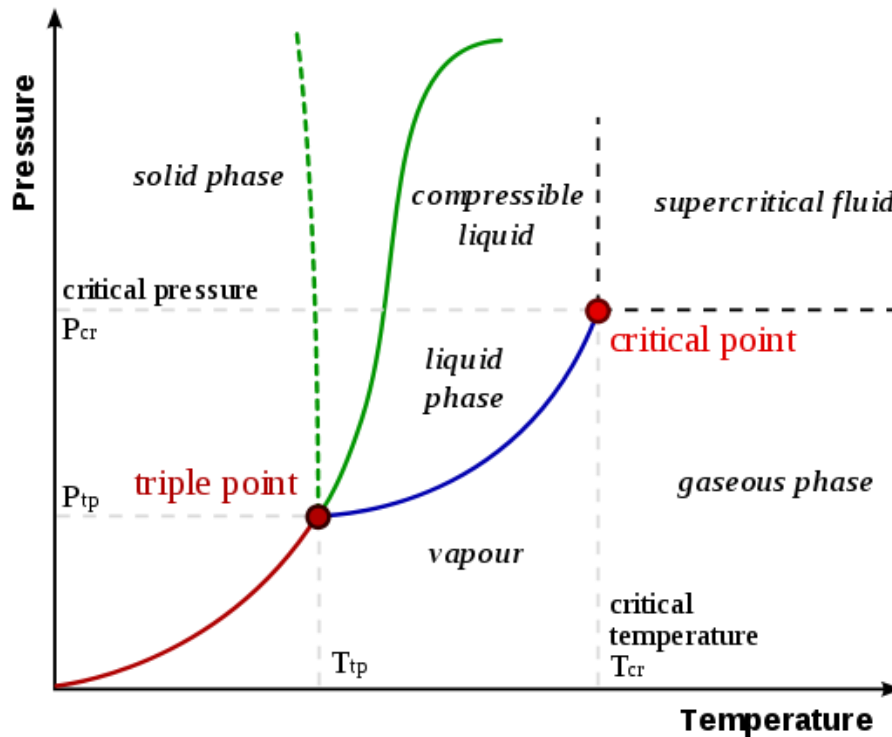


Cassini spacecraft

Image provided by [http://cassini3d.com/archives/2007/7/1/cassini\\_spacecraft/](http://cassini3d.com/archives/2007/7/1/cassini_spacecraft/)

-There is evidence of flowing liquid on the surface of Titan. It is not possible for it to have been water at any point, but it is thought that some of the features of flowing water were formed by hydrocarbon rains. Some of these features found include: channels, lakebeds, polar lakes, swamps, floodplains, seas, and lakes. The liquid it is thought that these were made from is either methane or ethane.

-Titan's Surface T.P. (triple point) is close to the T.P. of methane. Earth's T.P. is close to that of water.



The above graph shows the relationship of the pressure and temperature at which matter can coexist in a stable equilibrium

Image provided by <http://www.temperatures.com/education-training/triple-point-cells-part-one/>