

# Satellites of the Outer Planets

11/20/2009

# Opening Discussion

- <http://www.youtube.com/watch?v=a5Tne92jfxo>
- Have you seen anything interesting in the news?
- <http://www.nytimes.com/2009/11/19/science/earth/1>
- What did we talk about last class?

## Medium and Large Moons of the Jovian Planets

### Jupiter



### Saturn



### Uranus



### Neptune



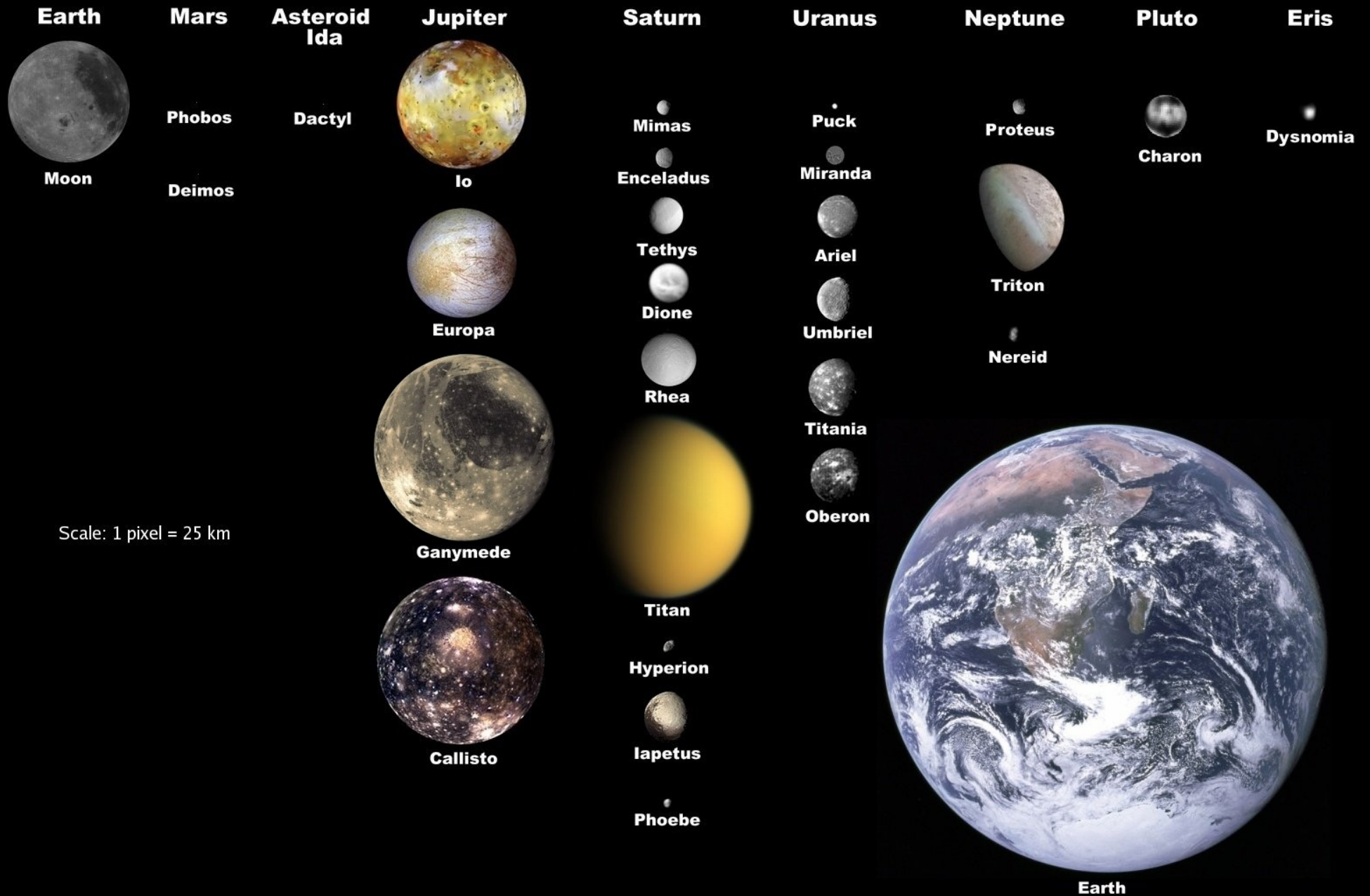
### Other objects for comparison



# Jovian Satellite Systems

- Unlike the terrestrial planets, the Jovian planets all have numerous moons. Some of those moons are quite large relative to the terrestrial planets, but none are that large relative to their planets.
- Each of the larger moons has as much complexity as a terrestrial planet. Many of them appear to have more geological complexity than the Moon, Mercury, or even Mars.

# Selected Moons of the Solar System, with Earth for Scale

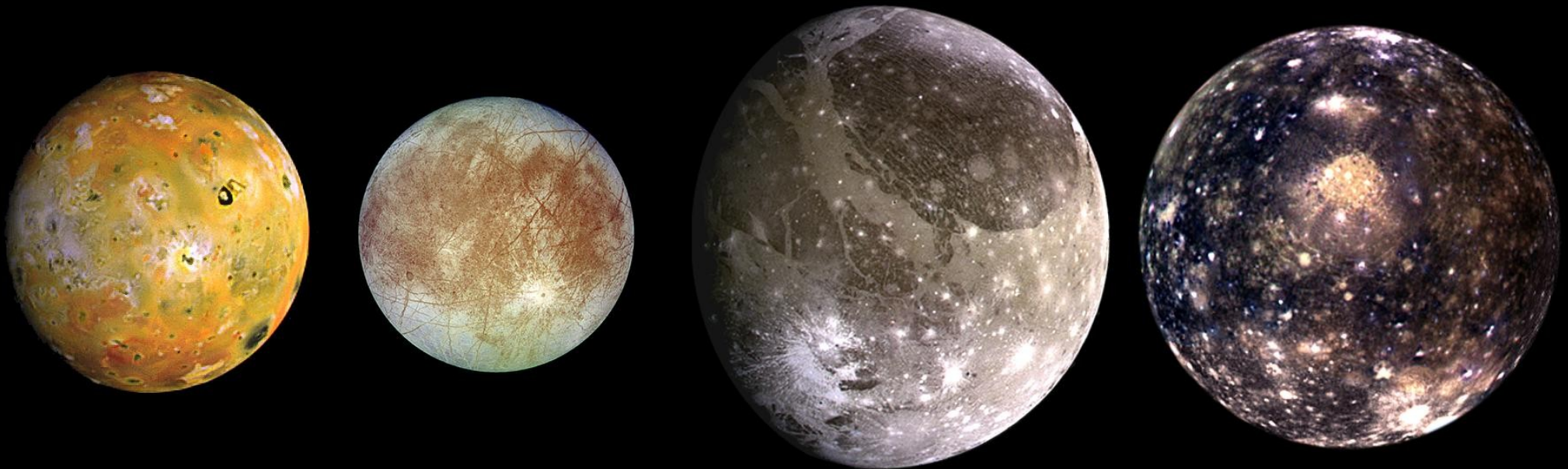


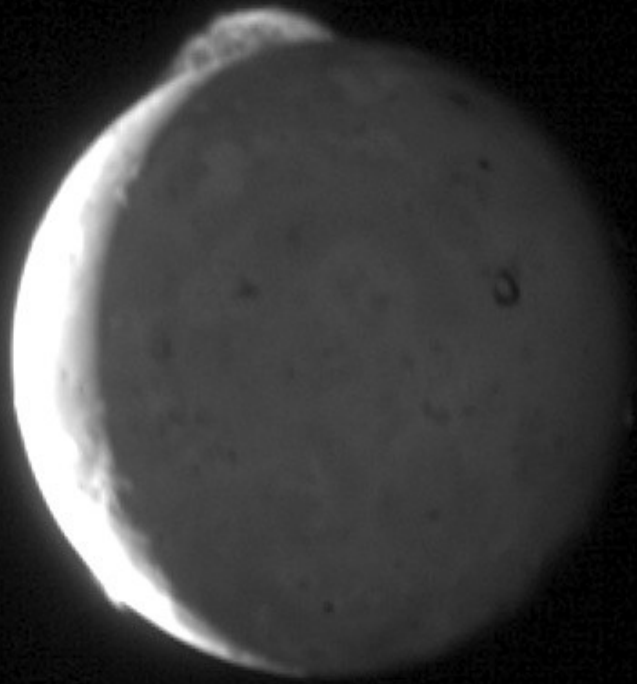
# Ice Geology

- Given the relatively small sizes of the moons of the Jovian planets, one might suspect them to all be cold, inactive worlds. In general this is not the case.
- A big part of why these moons have active geology is that they contain a lot of ices. These ices include water ice, ammonia ice, and methane ice.
- Ices flow and melt at much lower temperatures than rocks so you can have significant geology without as much heat as would be required on a terrestrial body.

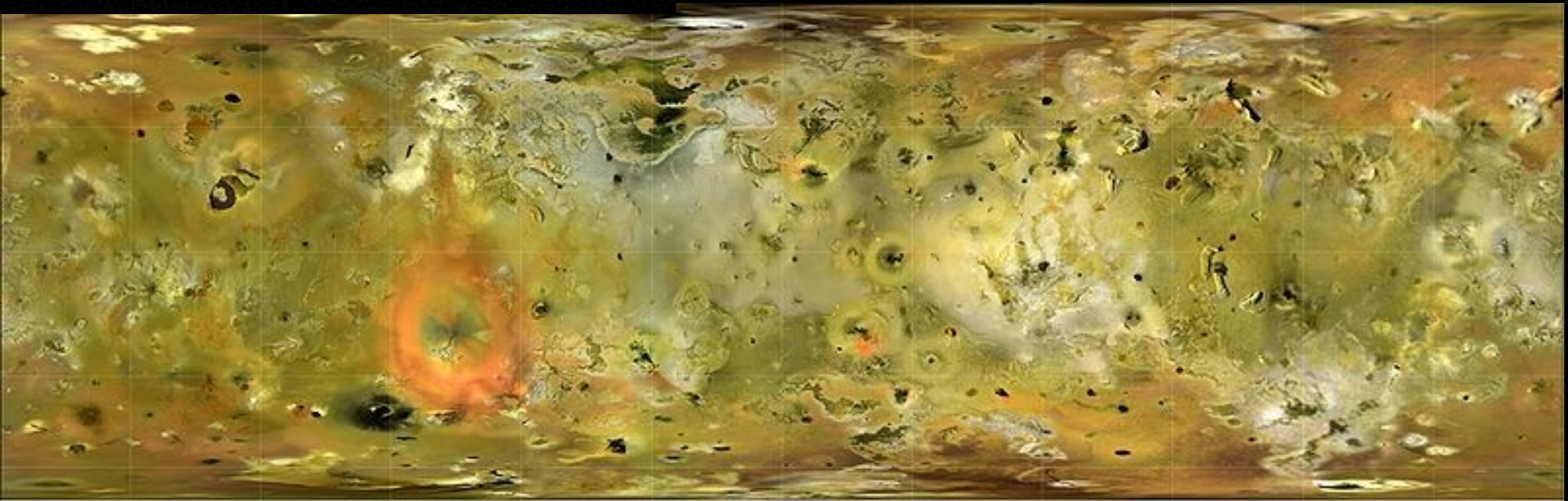
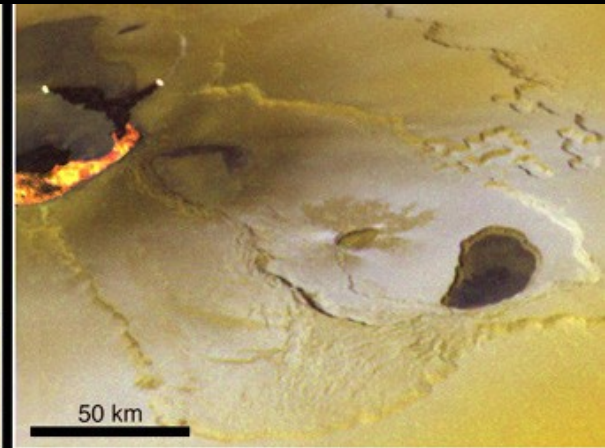
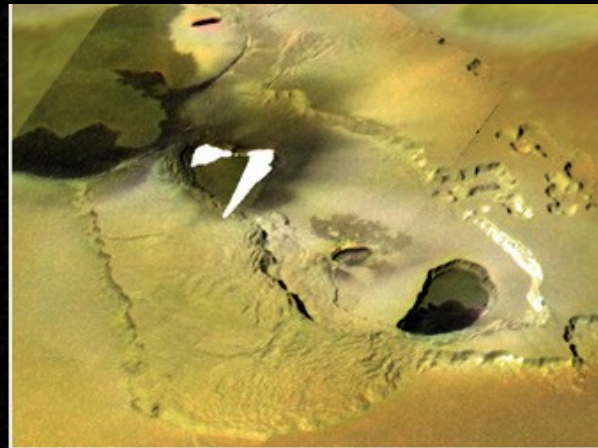
# Galilean Satellites

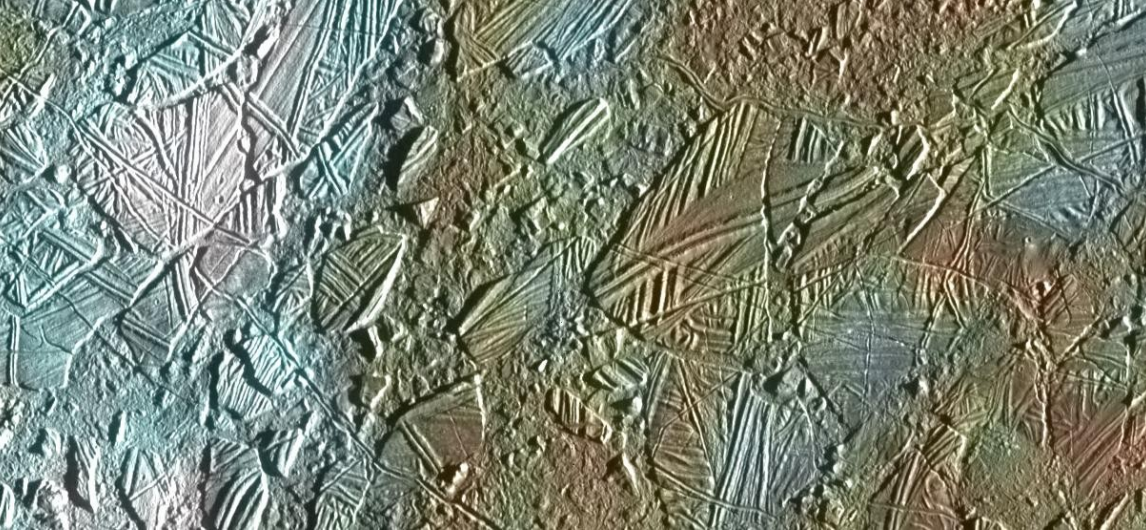
- Jupiter has four large moons all seen by Galileo. They are Io, Europa, Ganymede, and Callisto.
- The surfaces are very different. The inner three are trapped in resonance that provides tidal heating.



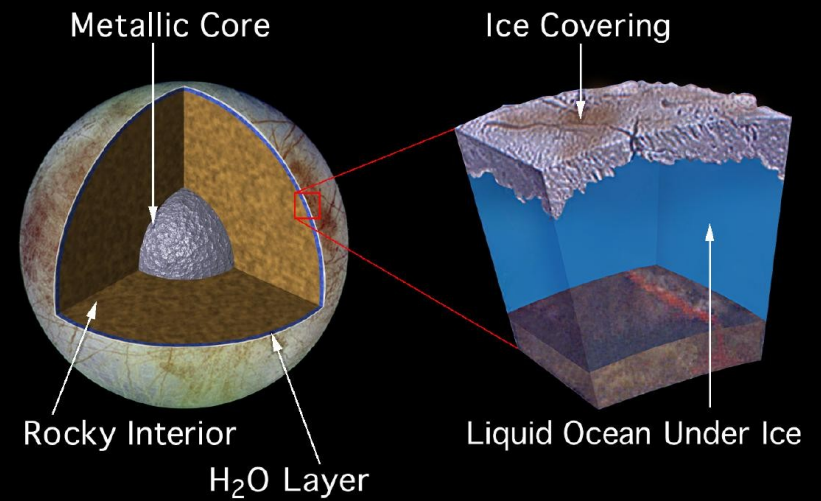
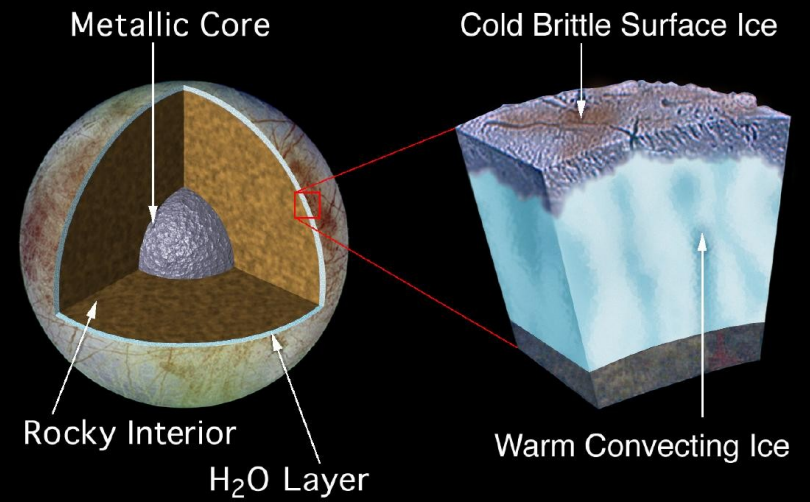
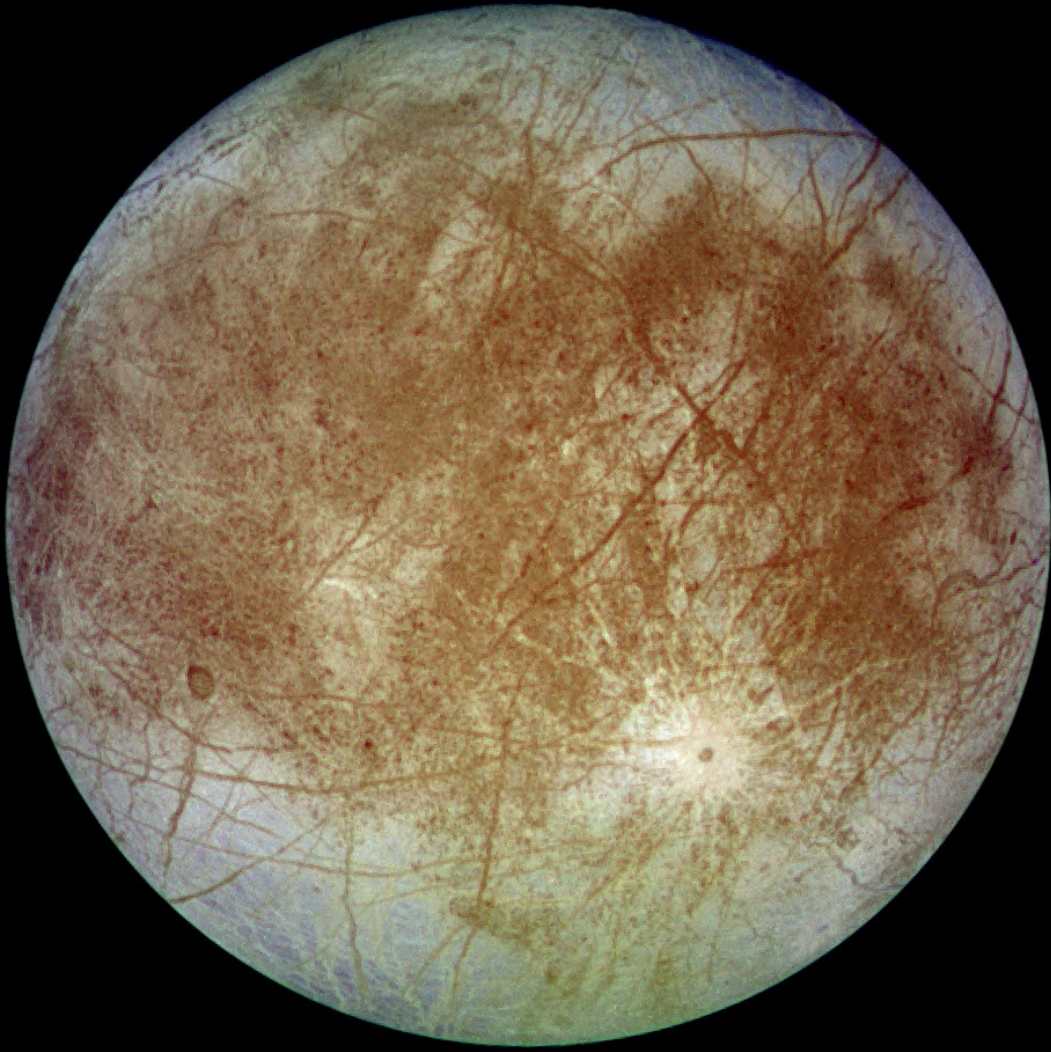


Io



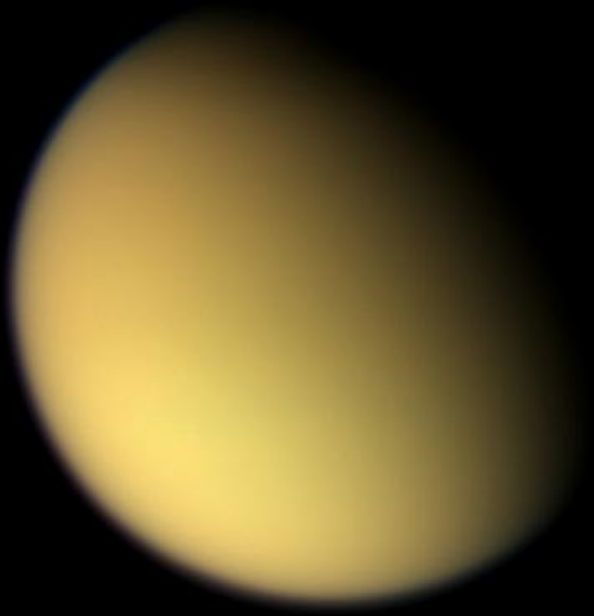


# Europa



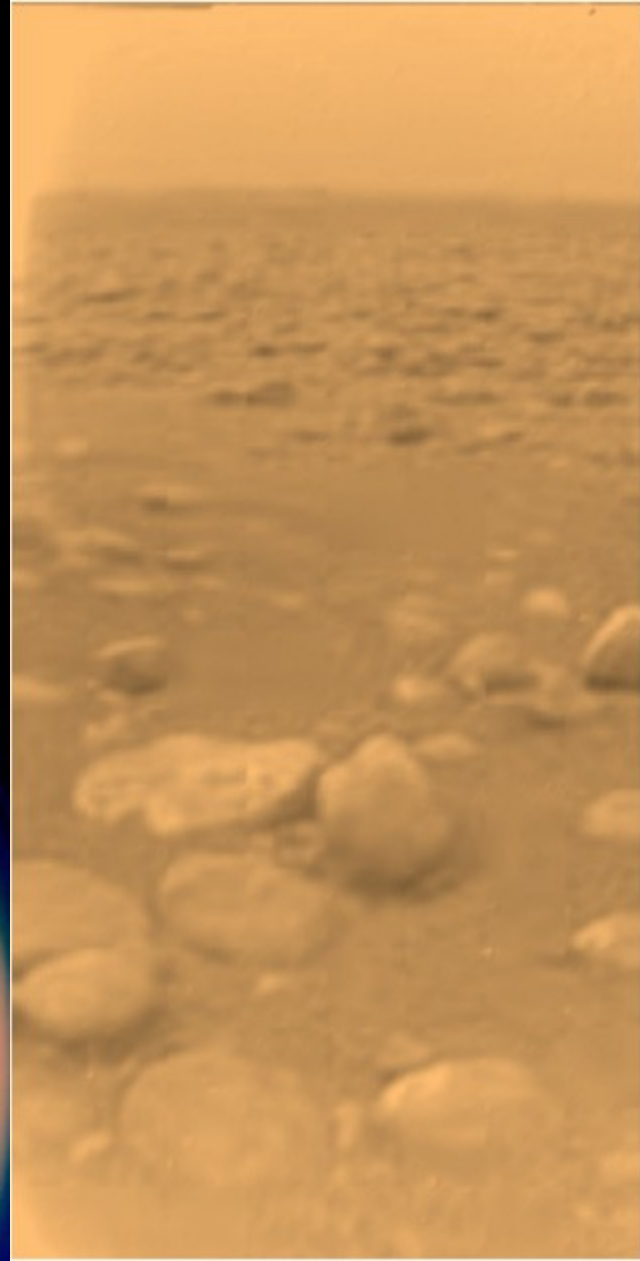
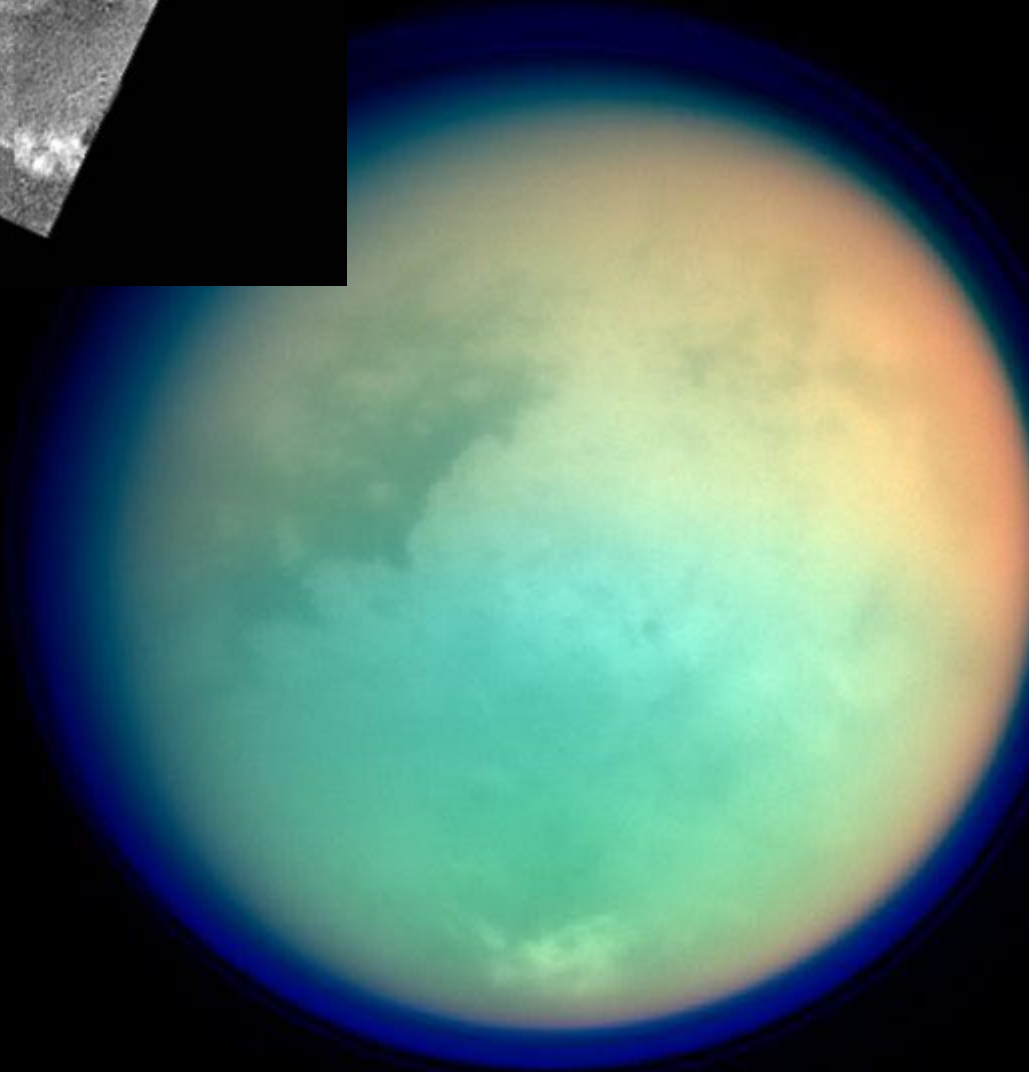
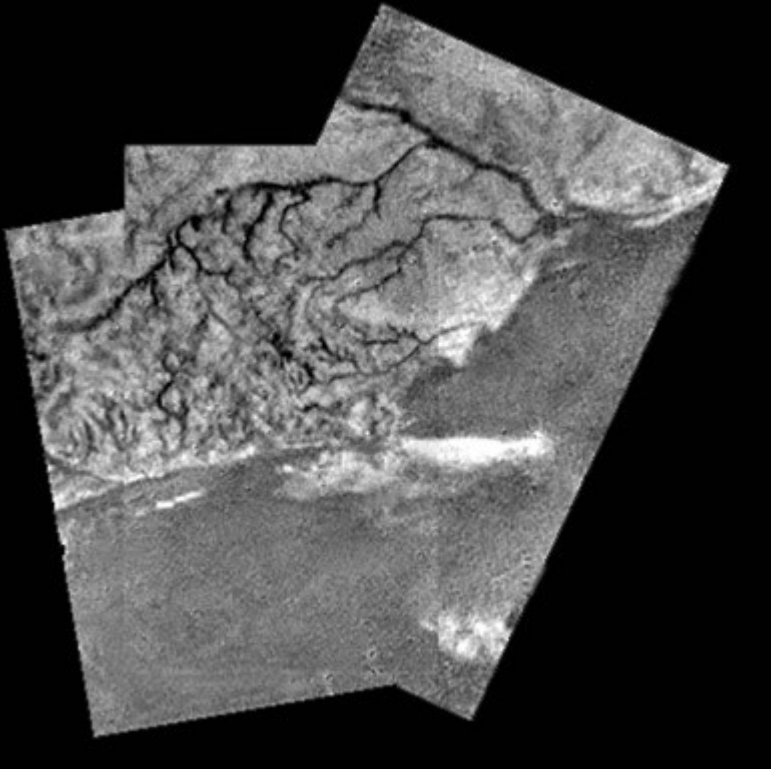


# Titan

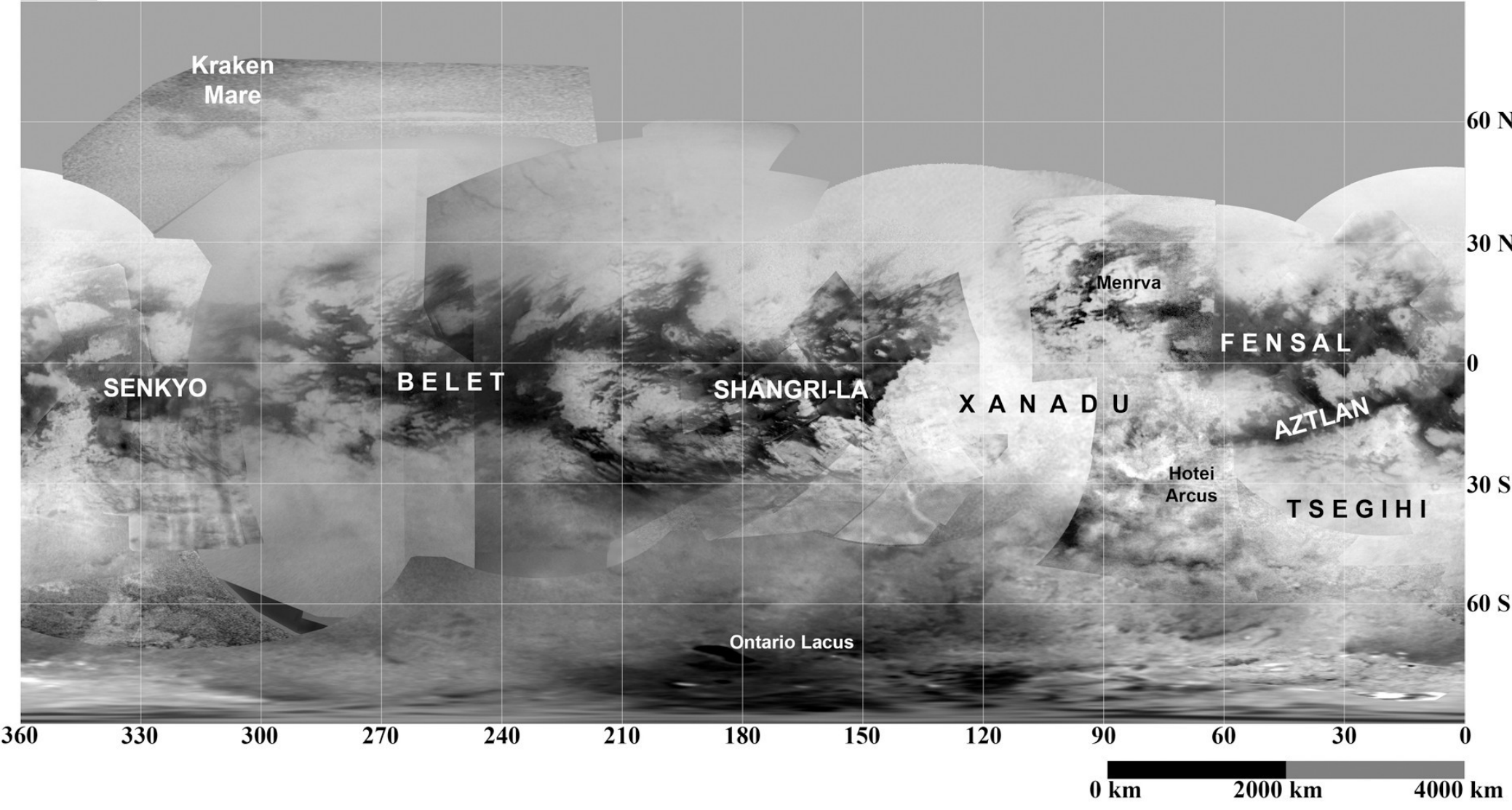


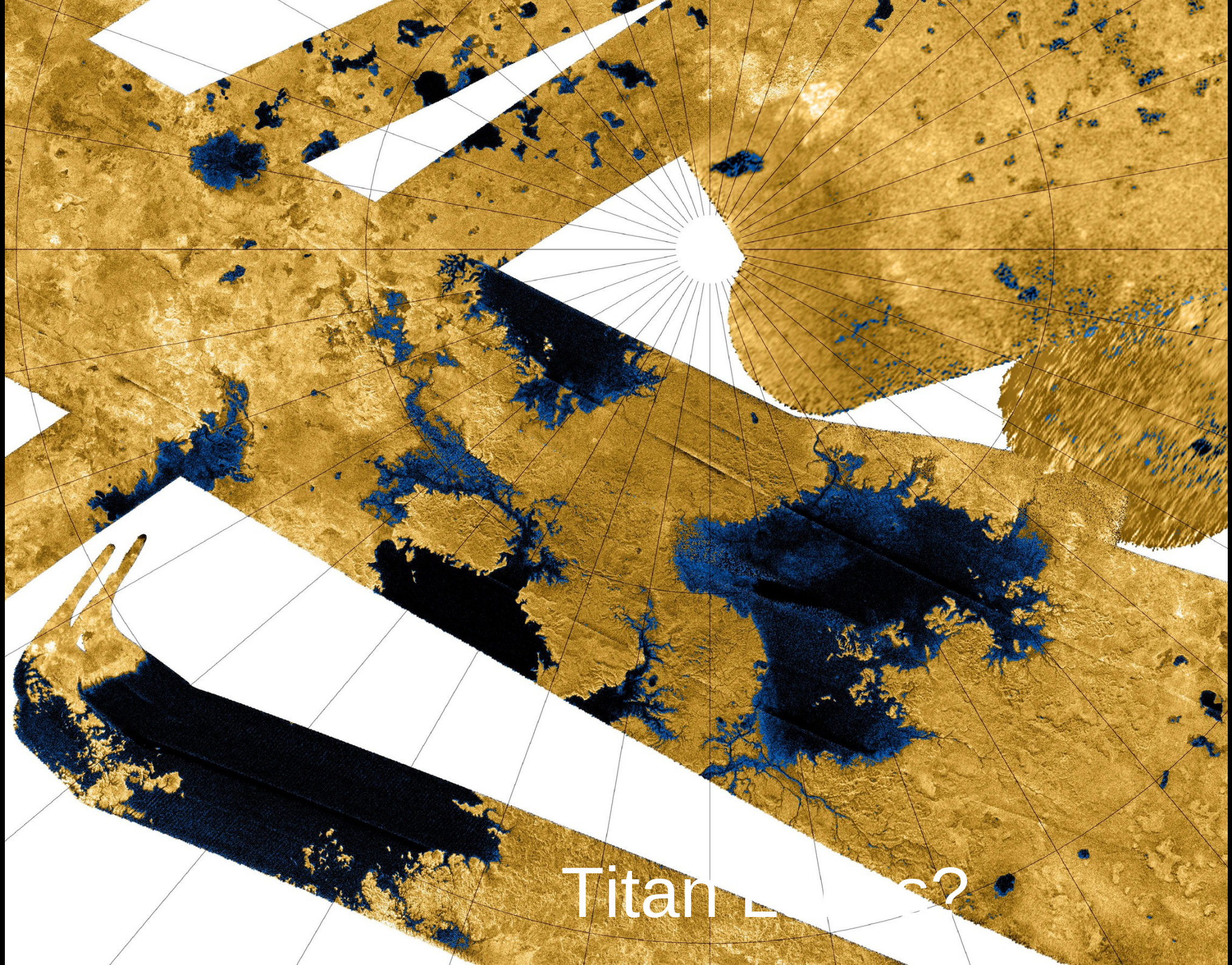
- Titan is the only moon in our Solar System with a thick atmosphere. It has a surface pressure of 1.5 bars. The atmosphere is 90% nitrogen. As such, Titan has the most Earth-like atmosphere in the Solar System.
- The temperature however is frigid (-180 C) and the other components of the atmosphere are mostly methane and ethane.
- Titan's surface is obscured by an organic haze.

# Titan Surface



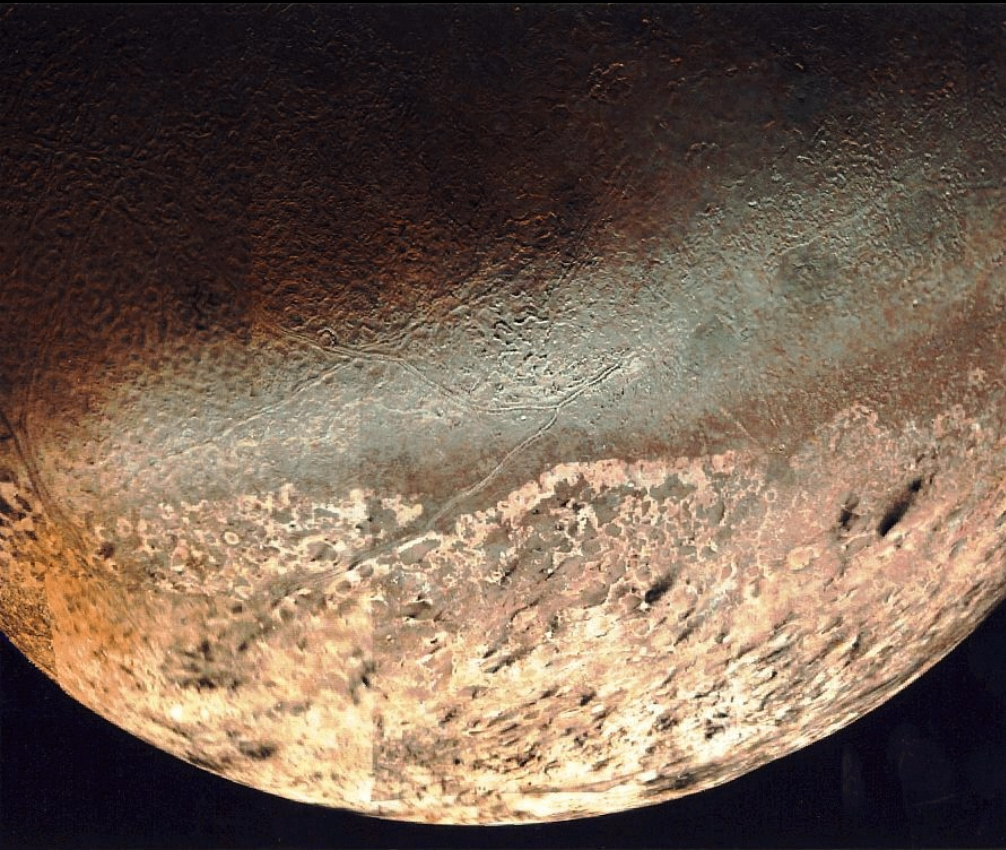
# Titan Map





Titan L<sub>1</sub> c2

# Triton



- Neptune's largest moon is a true oddball. Triton is the only large moon in the Solar System with a retrograde orbit. This implies that Triton was captured and did not form in orbit around Neptune.
- Triton has the coldest surface temperatures of the moons and planets (colder than Pluto), yet its surface shows signs of geologic activity and it even has a thin atmosphere that produces features on the surface.

# Medium Sized Moons

- Saturn, Uranus, and Neptune all have moons between 300 km and 1500 km in diameter. The geological variety of these moons is shocking given their small size.
- This link has a list of all known natural satellites.
- [http://en.wikipedia.org/wiki/List\\_of\\_natural\\_satellites](http://en.wikipedia.org/wiki/List_of_natural_satellites)

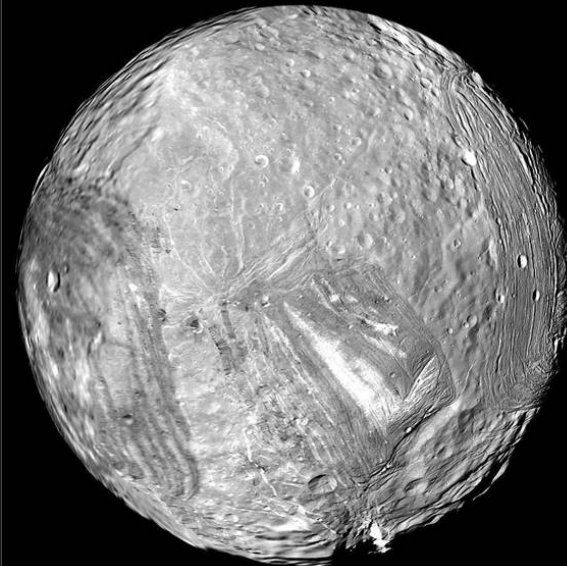
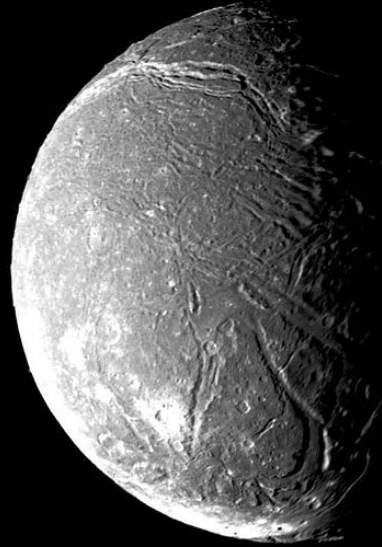
# Medium Moons of Saturn

- Mimas,  
Enceladus,  
Tethys, Dione,  
Rhea, Iapetus



# Medium Moons of Uranus

- Ariel
- Umbriel
- Titania
- Oberon
- Miranda





# Medium Moons of Neptune

- Nereid
- Proteus



# Minute Essay

- What do you find most surprising about the large and medium sized Jovian moons?