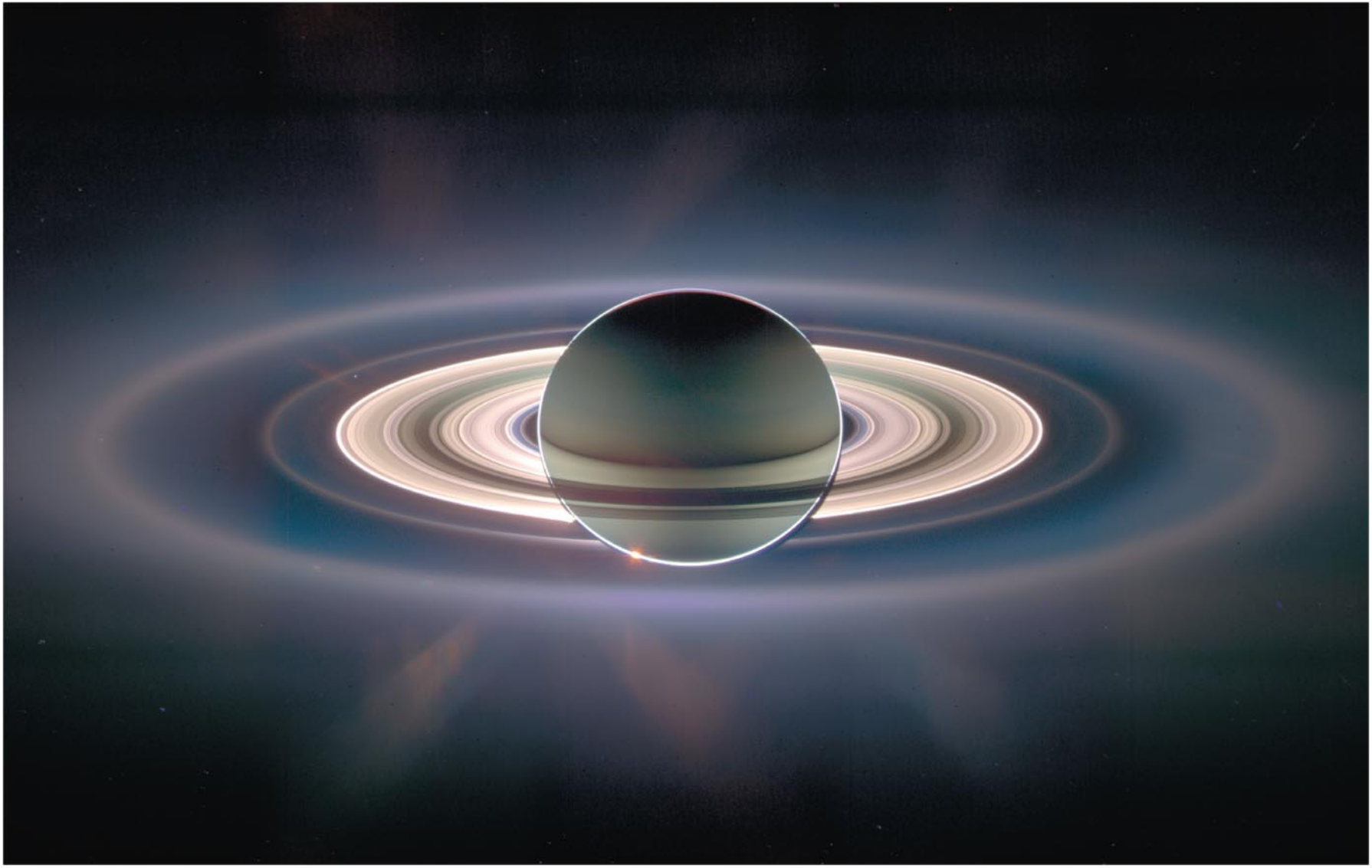
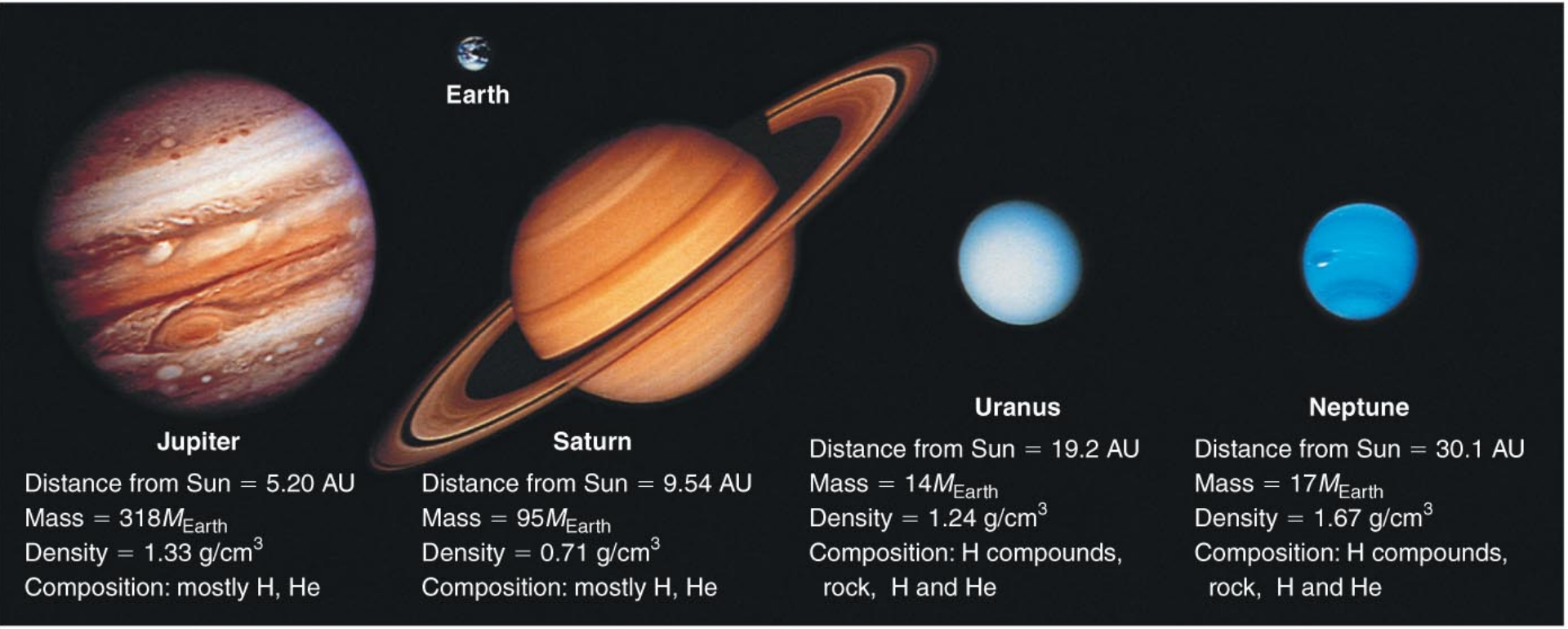
Jovian Planet Systems



11.1 A Different Kind of Planet

- Our goals for learning:
  - **Are jovian planets all alike?**
  - **What are jovian planets like on the inside?**
  - **What is the weather like on jovian planets?**
  - **Do jovian planets have magnetospheres like Earth's?**

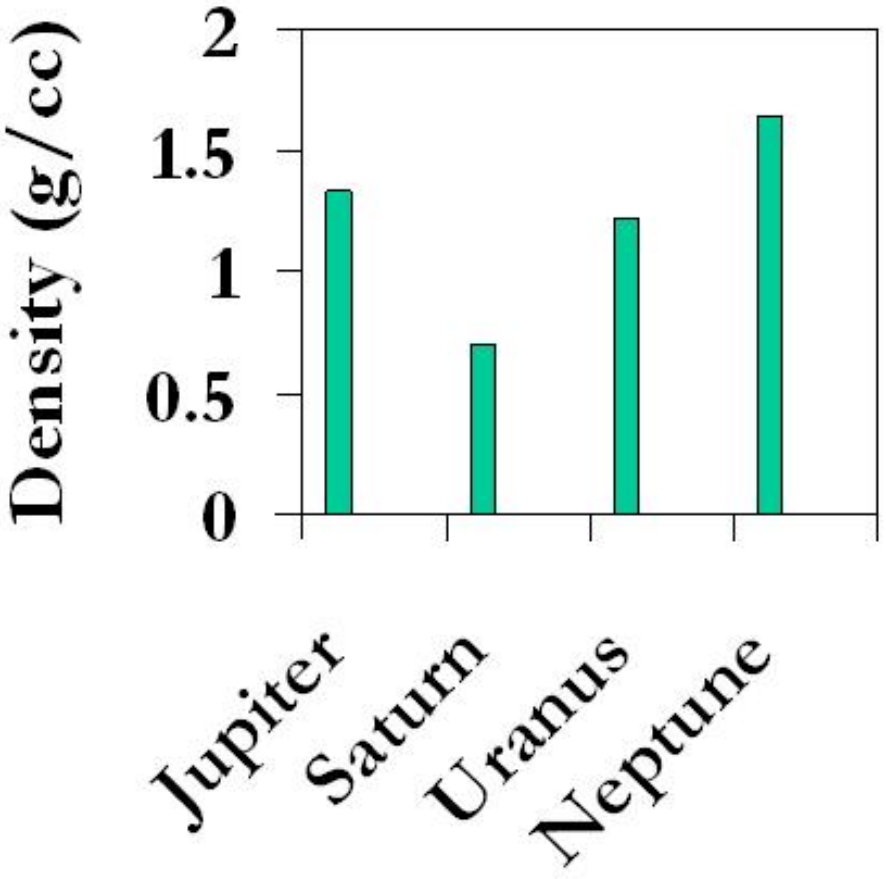
Are jovian planets all alike?



Jovian Planet Composition

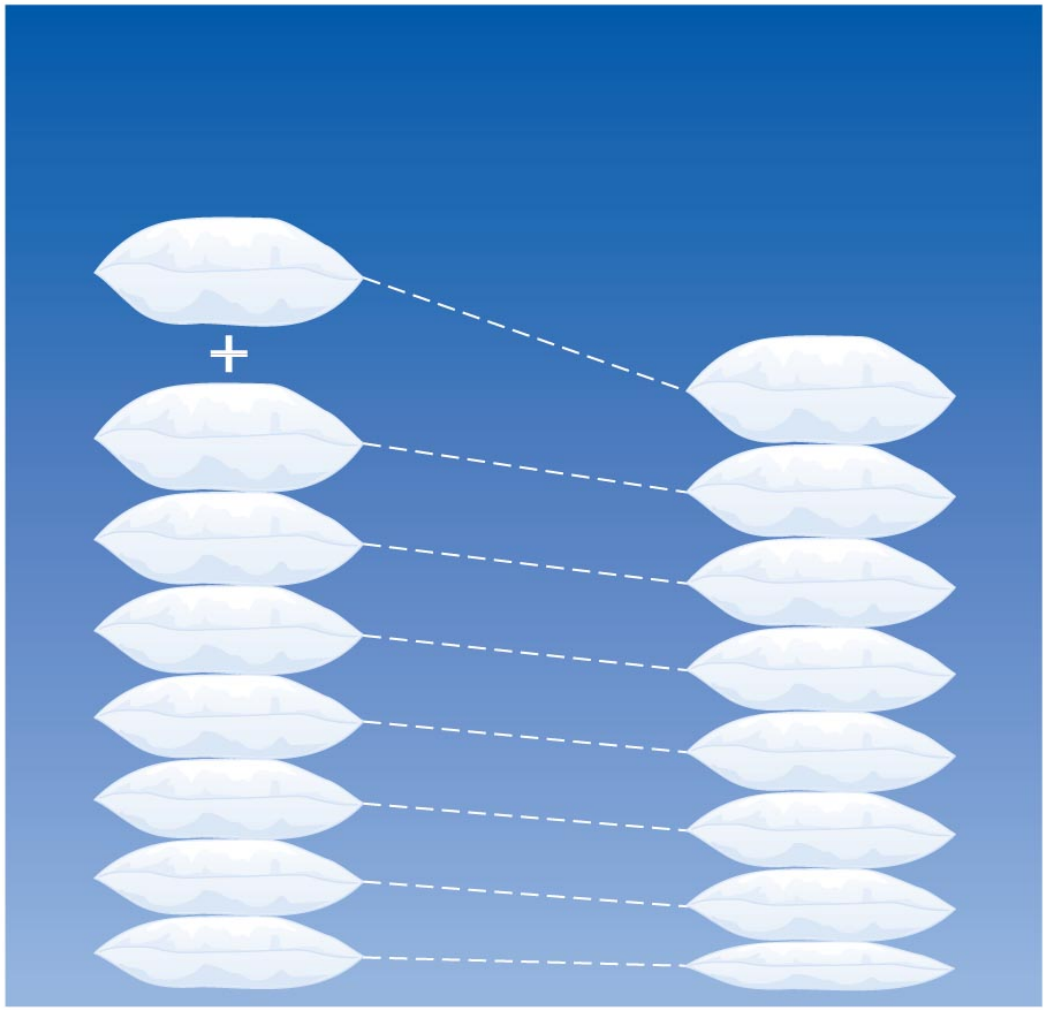
- Jupiter and Saturn
  - Mostly H and He gas
- Uranus and Neptune
  - Mostly hydrogen compounds: water (H_2O), methane (CH_4), ammonia (NH_3)
  - Some H, He, and rock

Density Differences



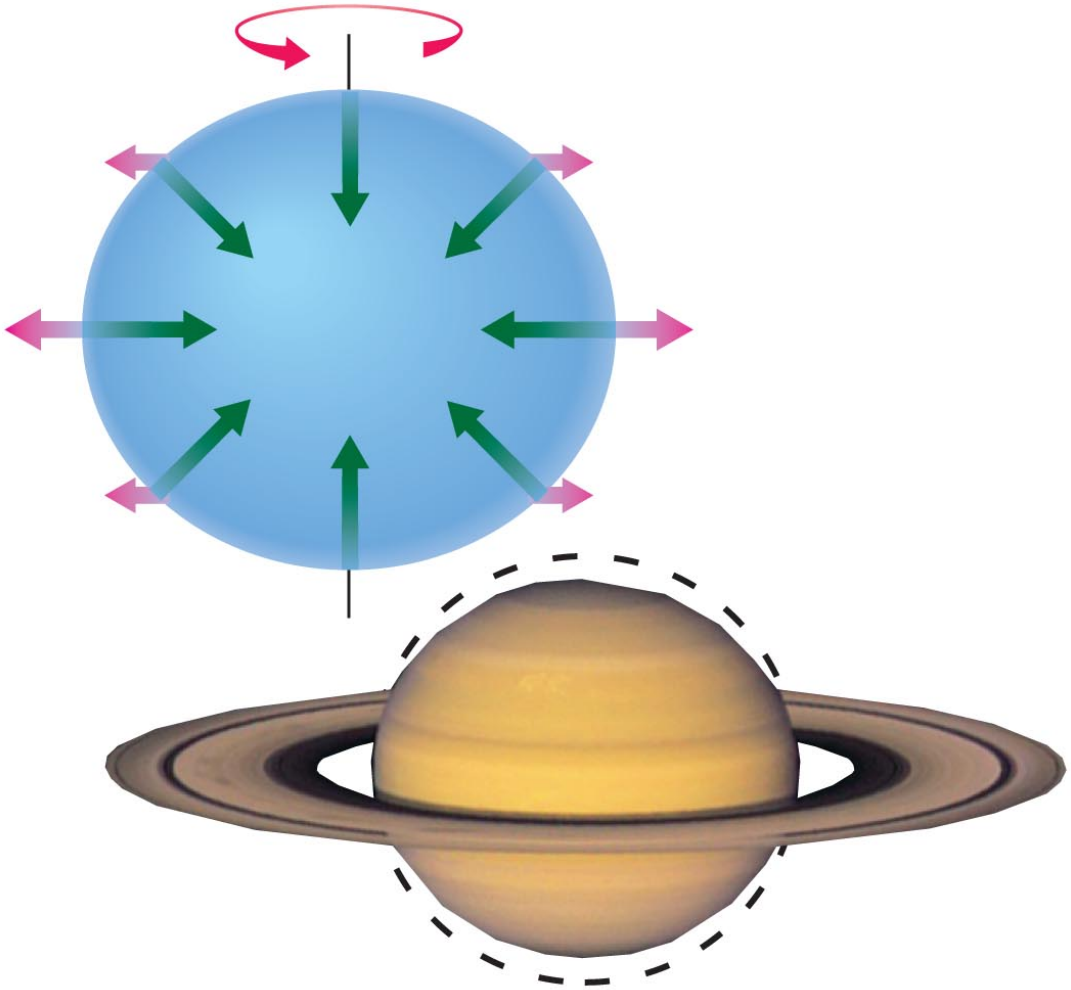
- Uranus and Neptune are denser than Saturn because they have less H/He, proportionately.
- But that explanation doesn't work for Jupiter….

Sizes of Jovian Planets



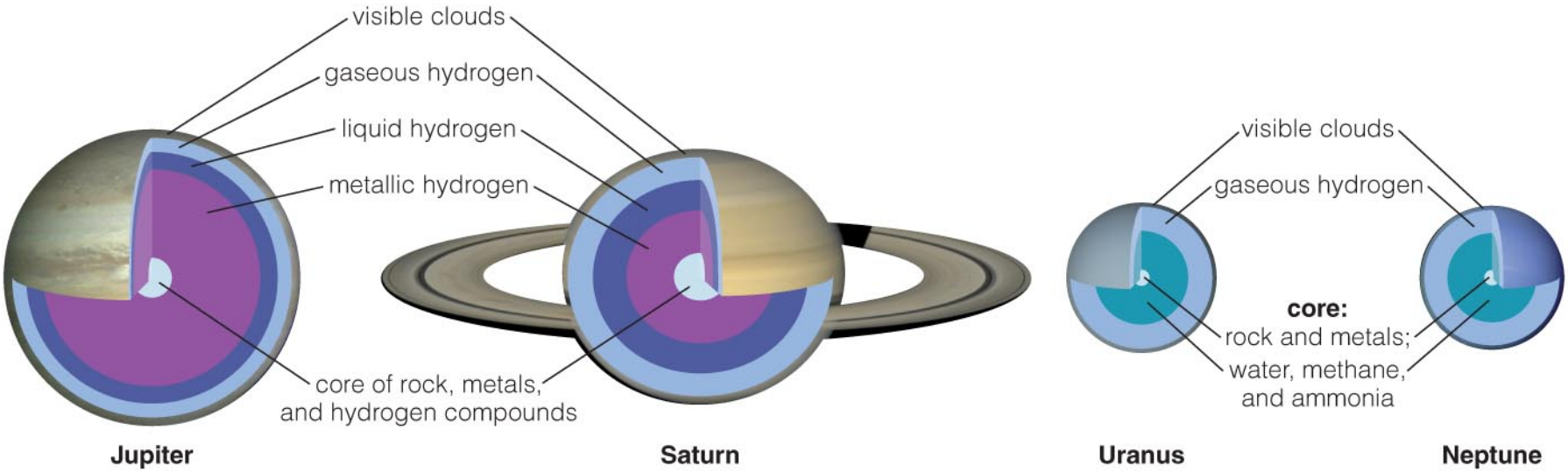
- Adding mass to a jovian planet compresses the underlying gas layers.
- Jupiter is denser than Saturn because it 3 times more massive. Gravity makes it denser.

Rotation and Shape



- Jovian planets are not quite spherical because of their rapid rotation.

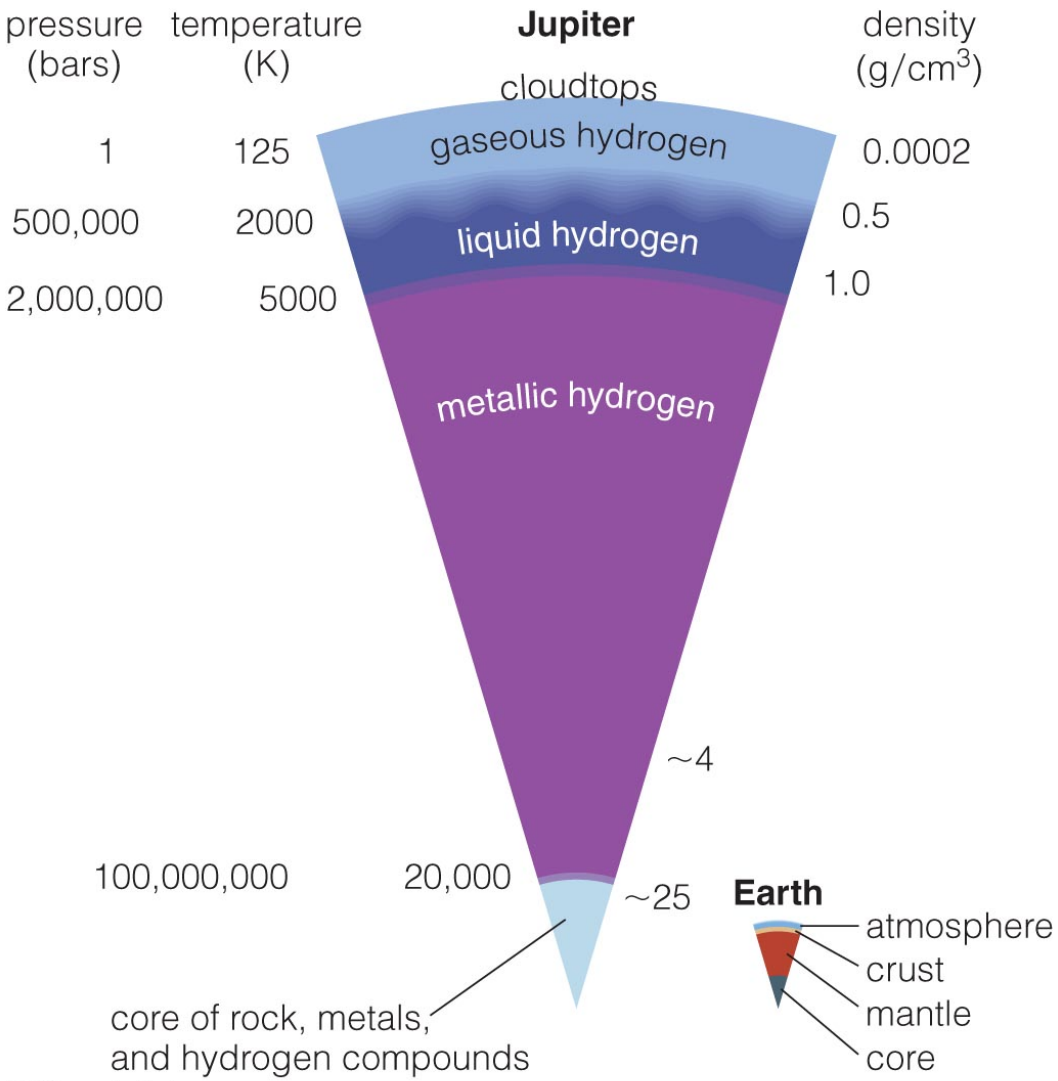
What are jovian planets like on the inside?



Interiors of Jovian Planets

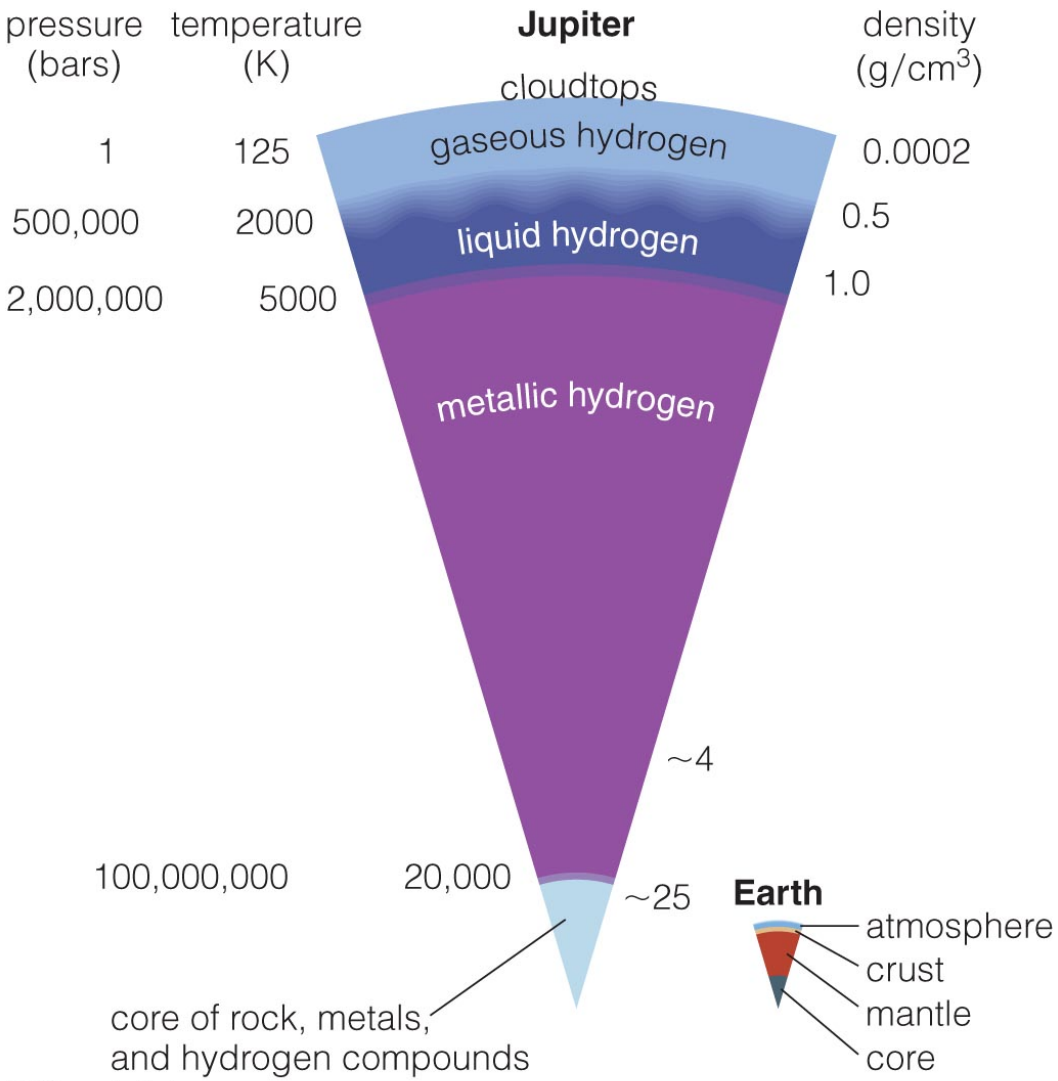
- No solid surface
- Layers under high pressure and temperatures
- Cores (~10 Earth masses) made of hydrogen compounds, metals, and rock
- The layers are different for the different planets. WHY?

Inside Jupiter



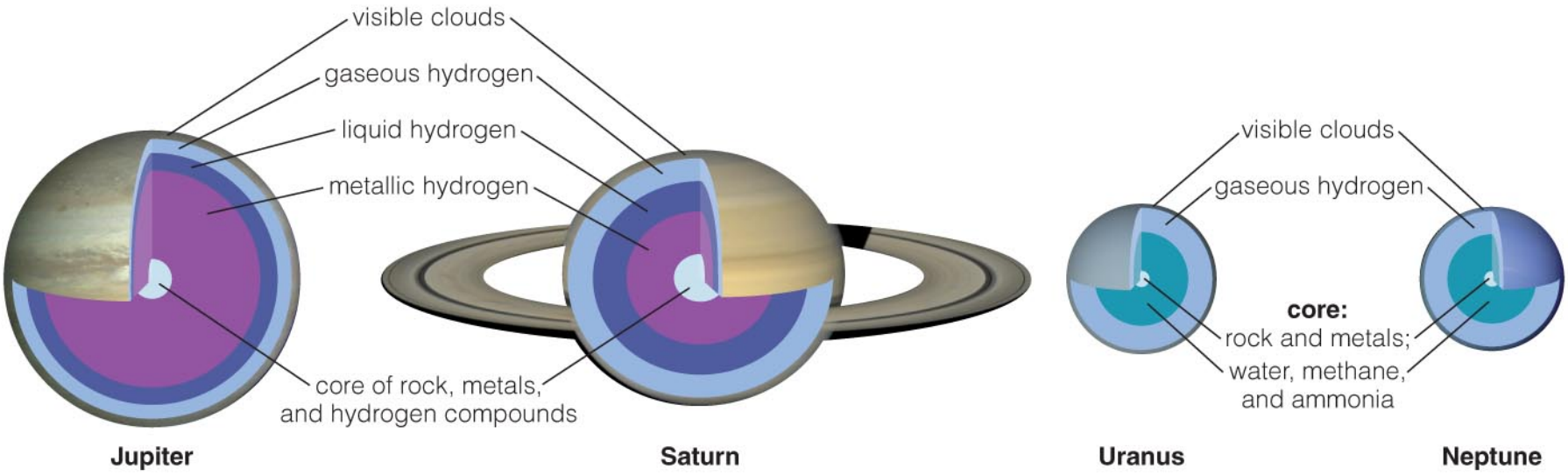
- High pressures inside Jupiter cause phase of hydrogen to change with depth.
- Hydrogen acts like a metal at great depths because its electrons move freely.

Inside Jupiter



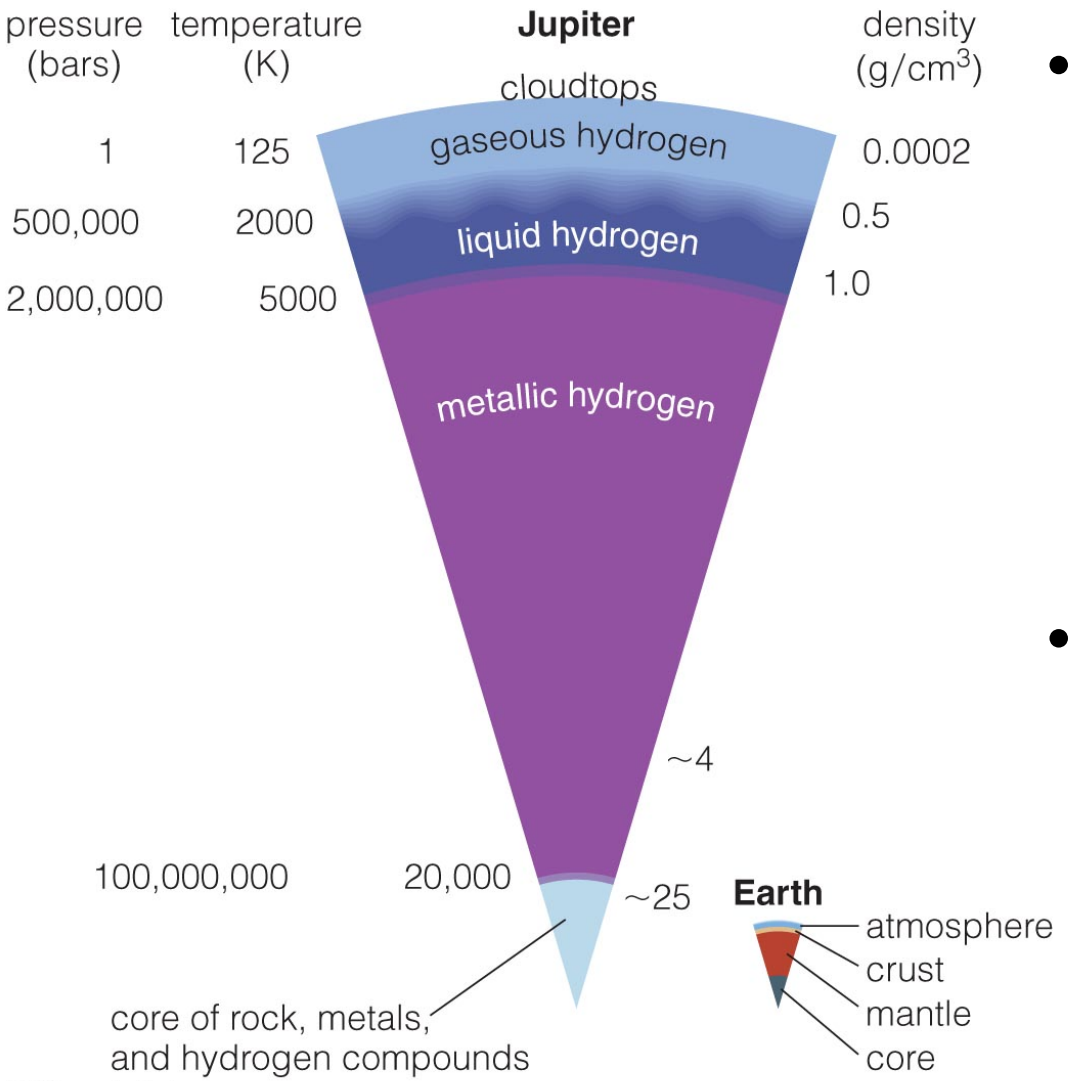
- Core is thought to be made of rock, metals, and hydrogen compounds.
- Core is about same size as Earth but 10 times as massive.

Comparing Jovian Interiors



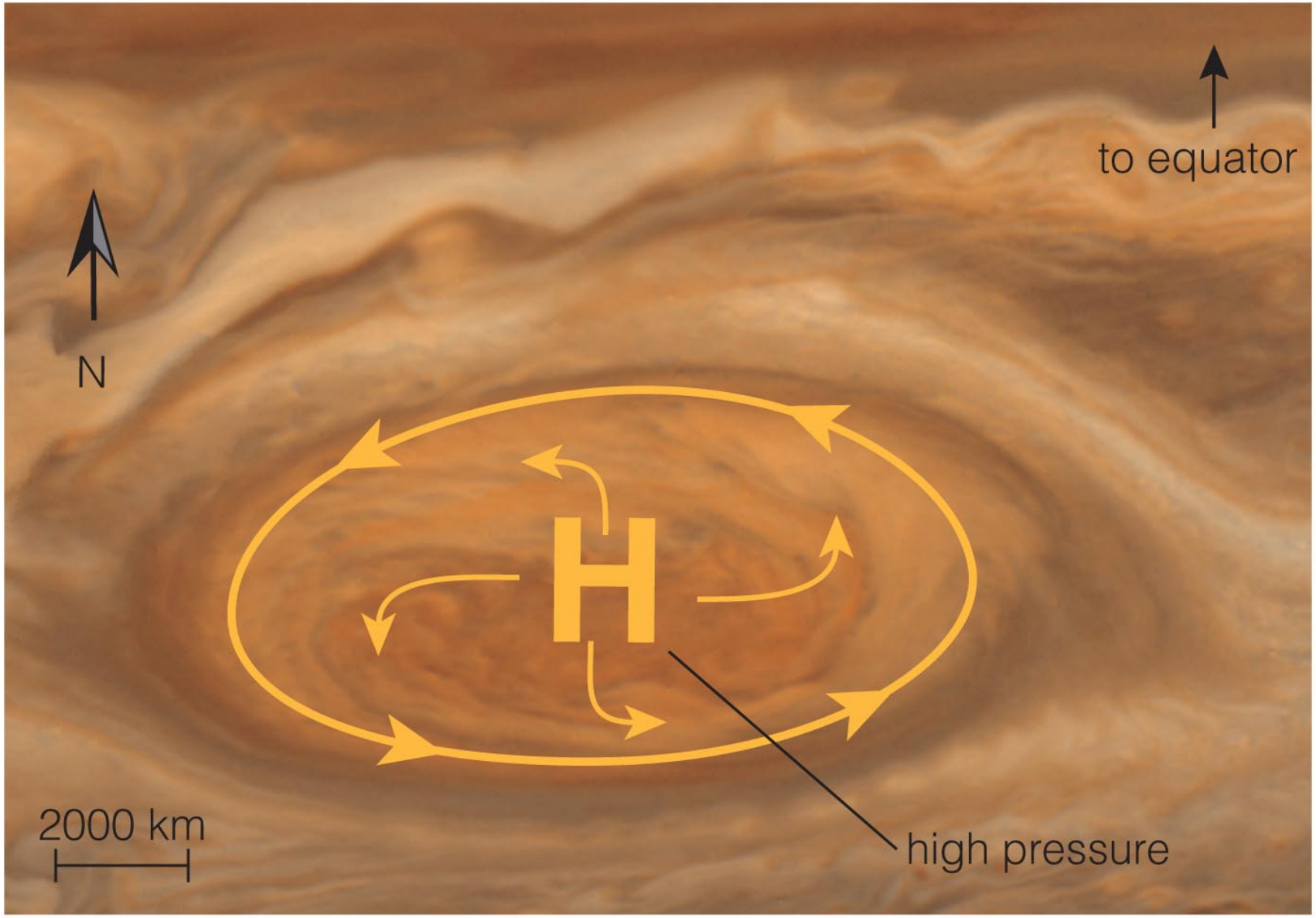
- Models suggest cores of jovian planets have similar composition.
- Lower pressures inside Uranus and Neptune mean no metallic hydrogen.

Jupiter's Internal Heat

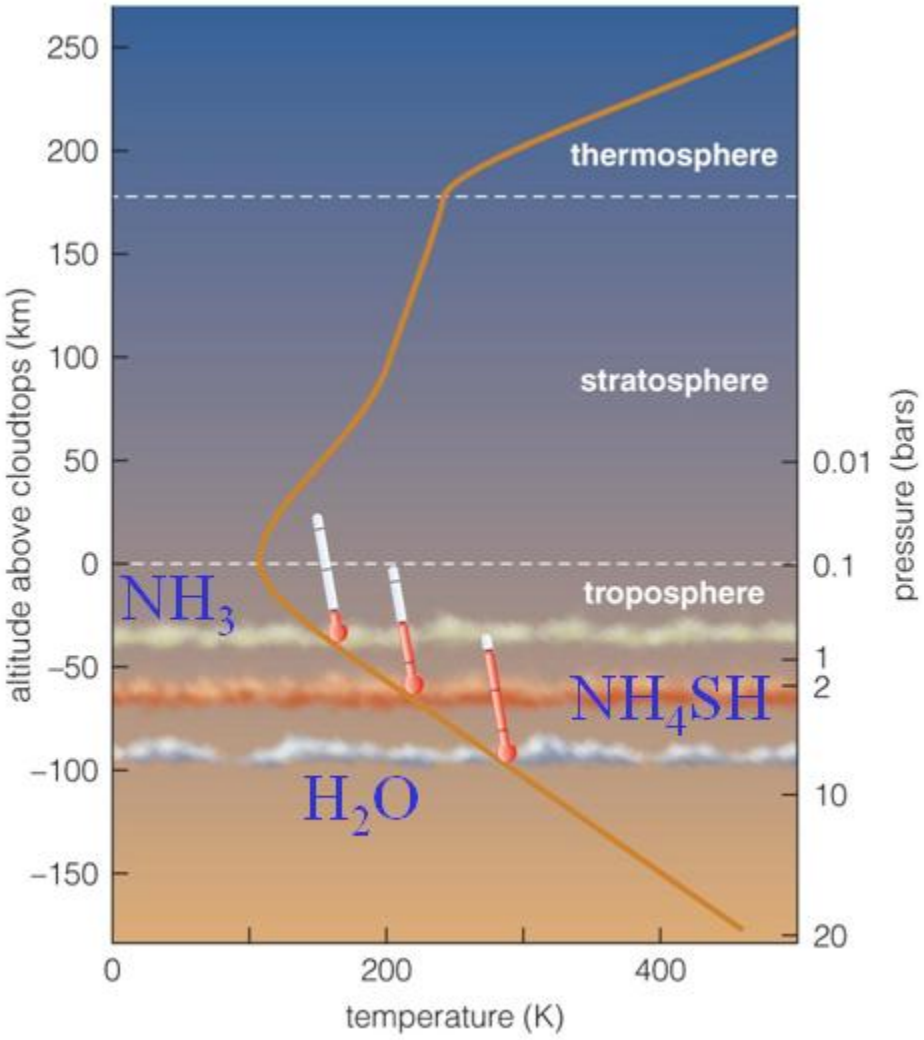


- Jupiter radiates twice as much energy as it receives from the Sun.
- Energy probably comes from slow contraction of interior (releasing potential energy).

What is the weather like on jovian planets?

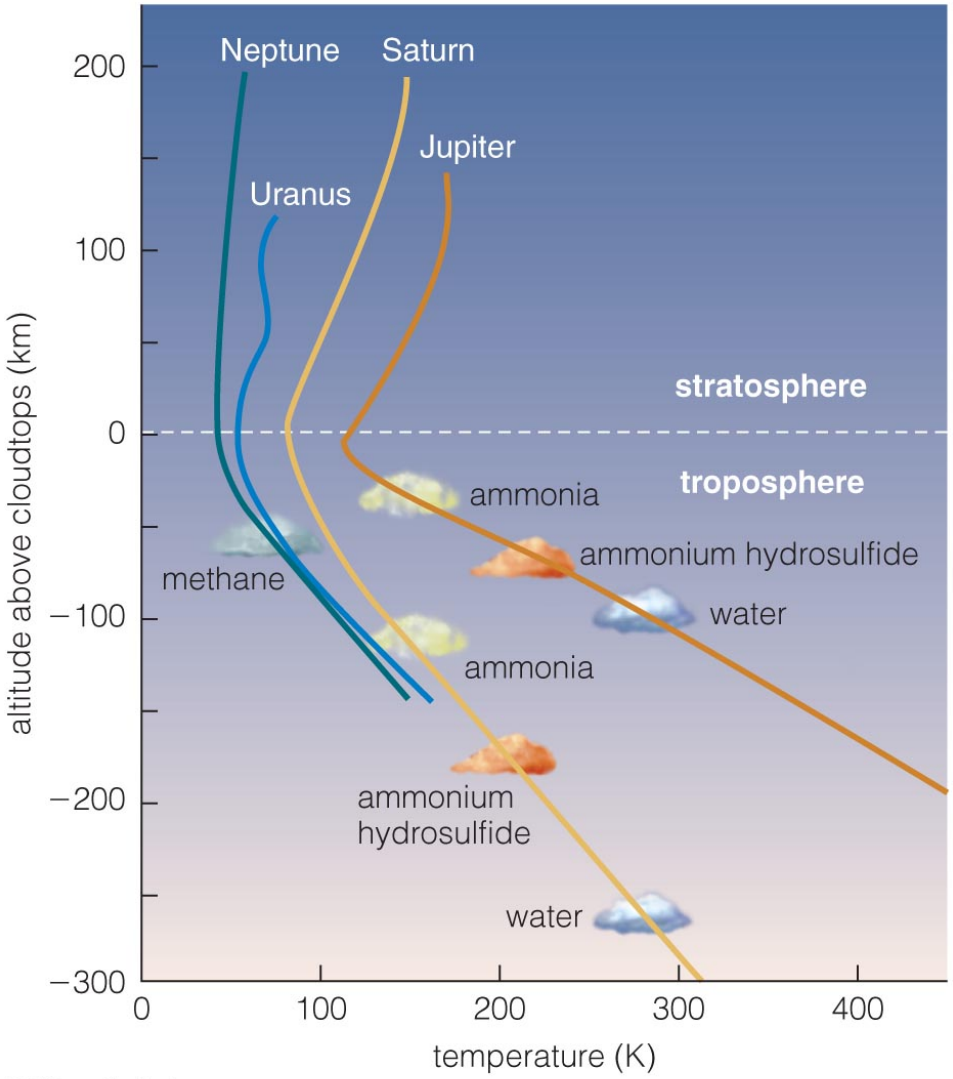


Jupiter's Atmosphere



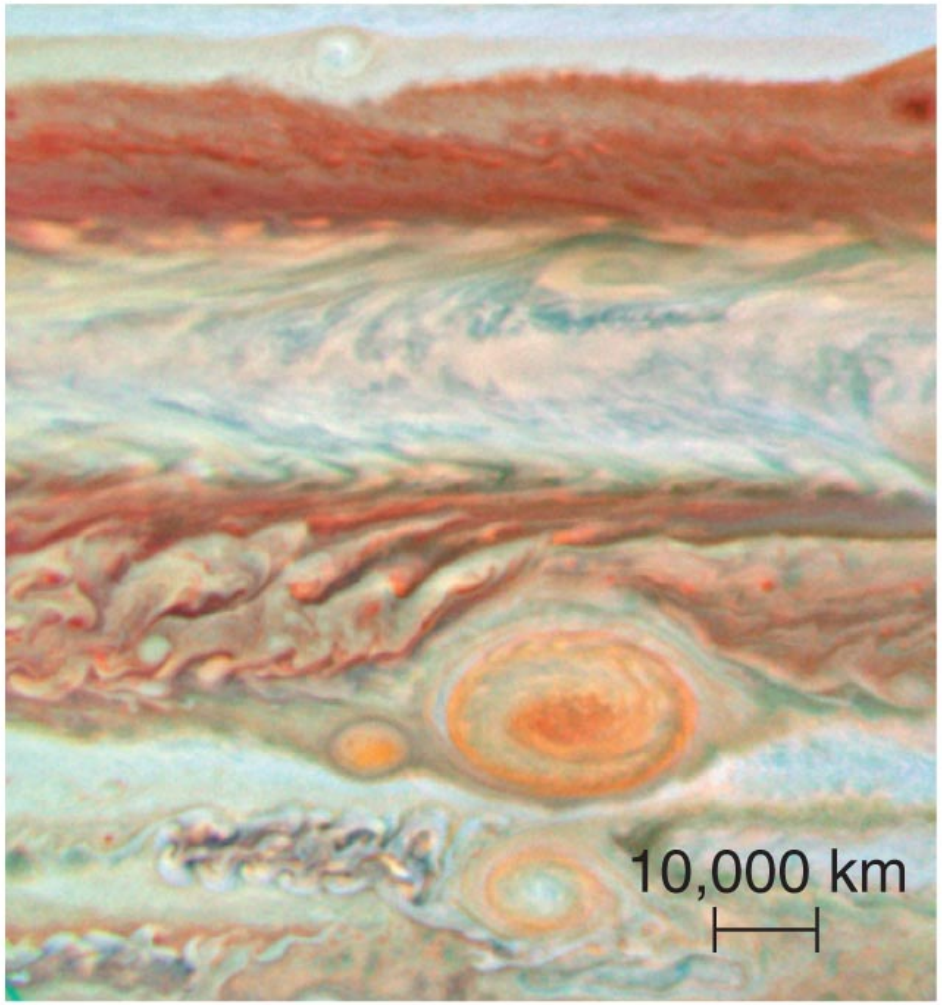
- Hydrogen compounds in Jupiter form clouds.
- Different cloud layers correspond to freezing points of different hydrogen compounds.

Jovian Planet Atmospheres



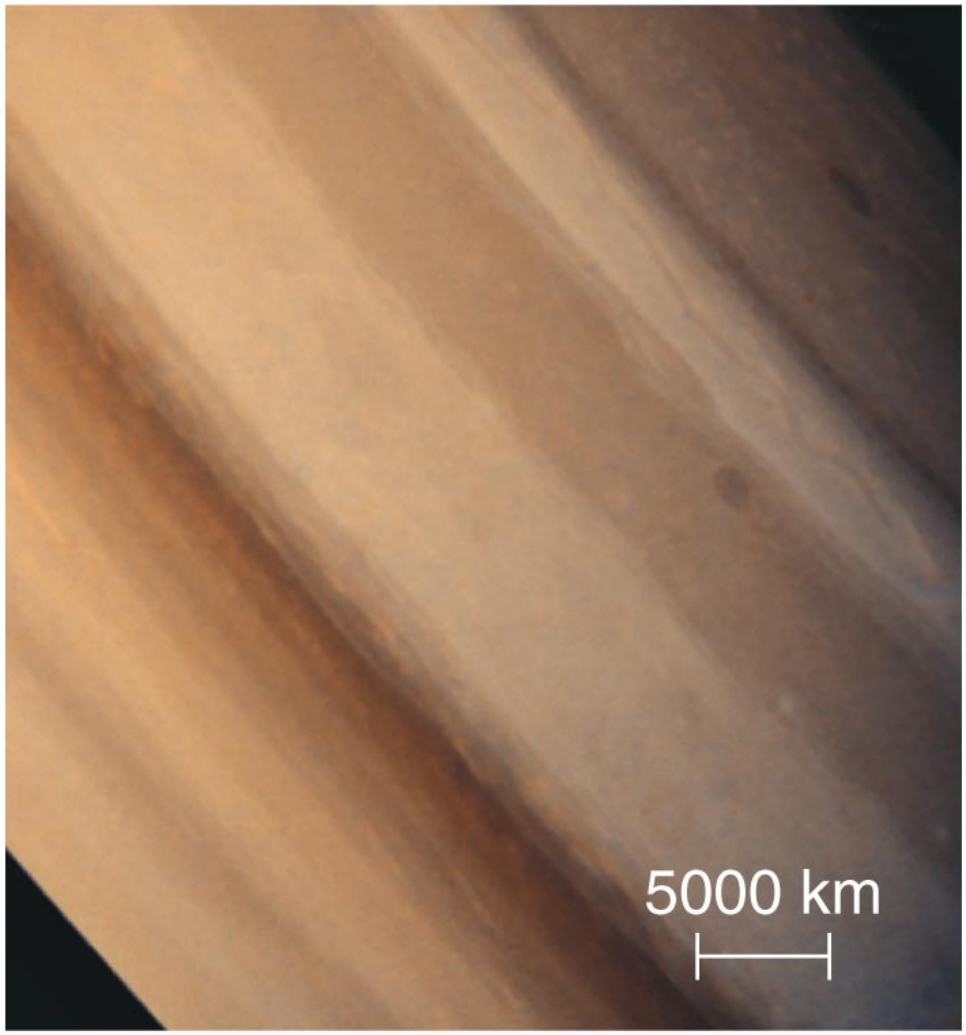
- Other jovian planets have cloud layers similar to Jupiter's.
- Different compounds make clouds of different colors.

Jupiter's Colors



- Ammonium sulfide clouds (NH_4SH) reflect red/brown.
- Ammonia, the highest, coldest layer, reflects white.

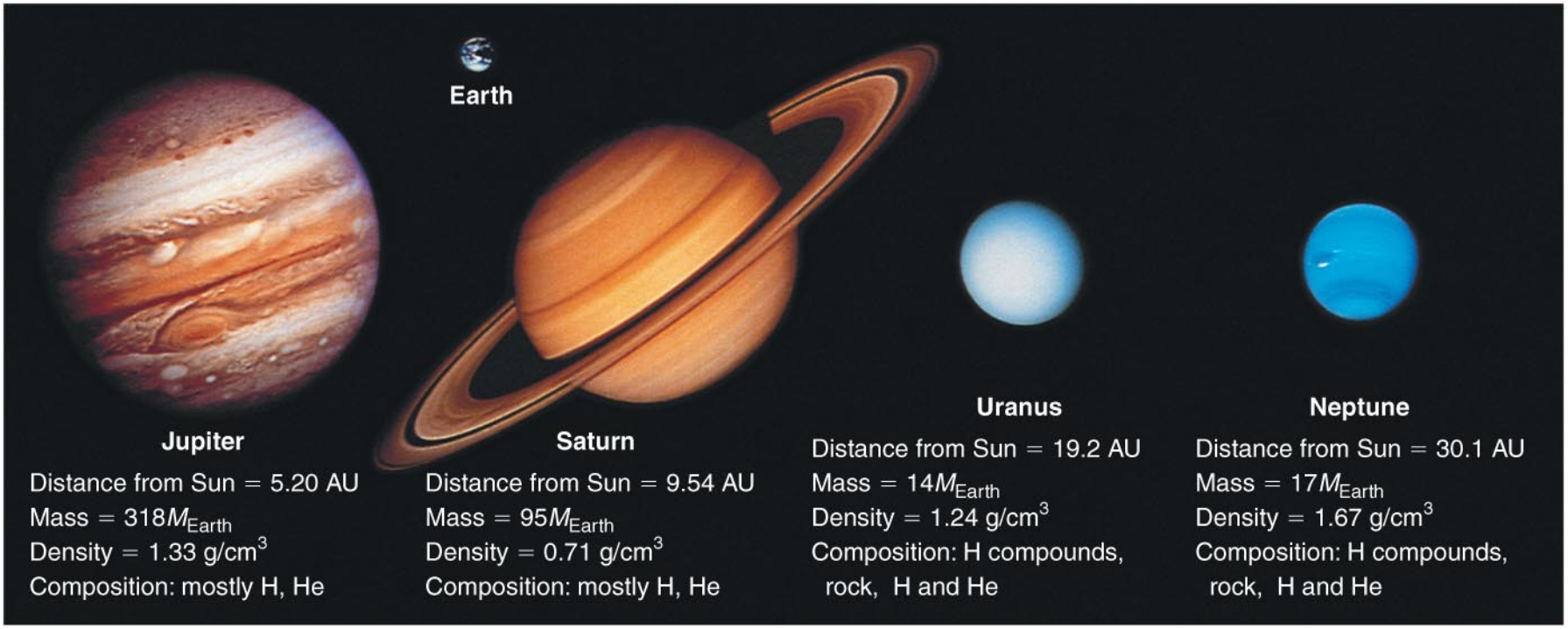
Saturn's Colors



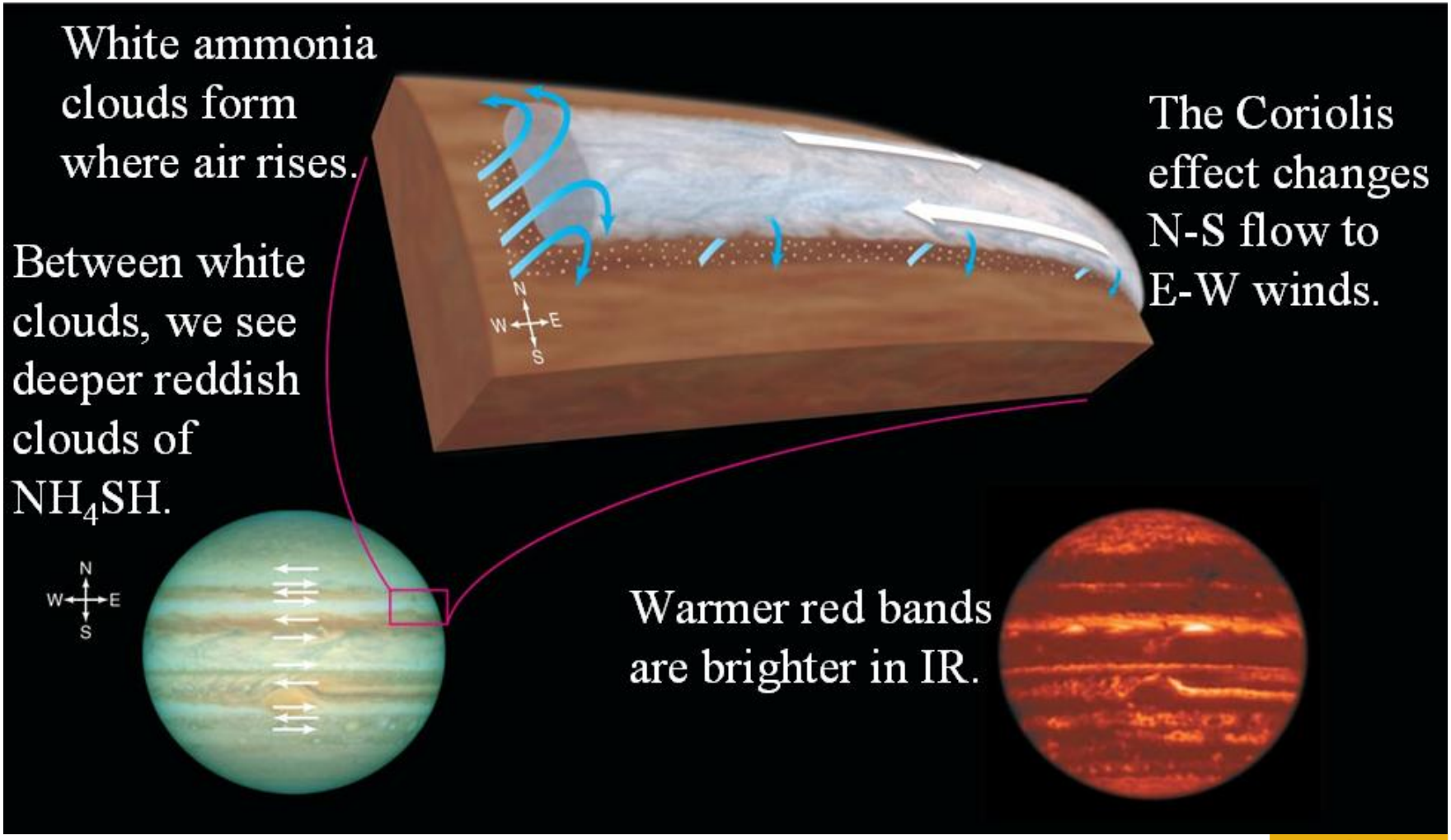
- Saturn's layers are similar, but deeper down and more subdued in color.

Methane on Uranus and Neptune

- Methane gas of Neptune and Uranus absorbs red light but transmits blue light.
- Blue light reflects off methane clouds, making those planets look blue.

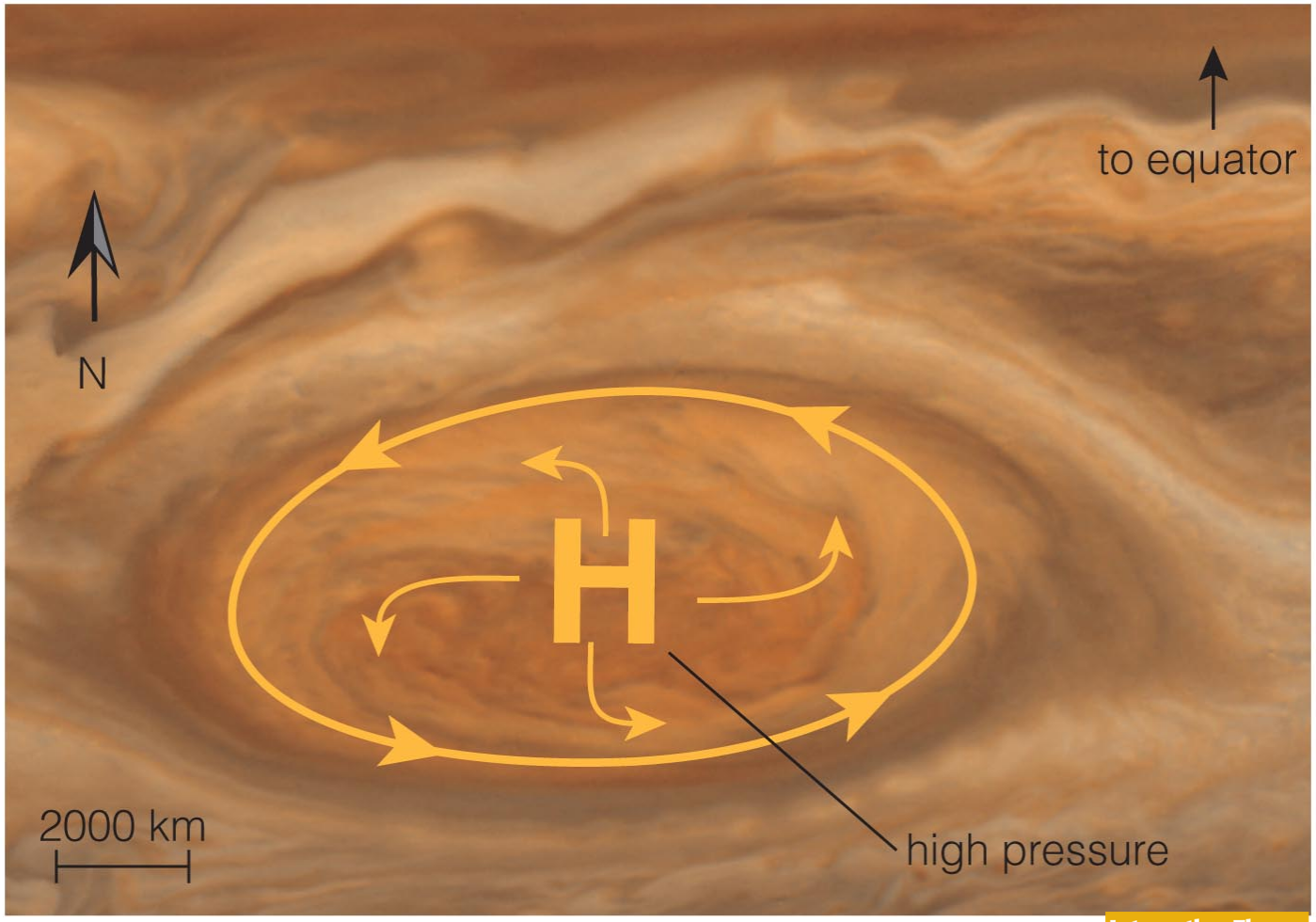


Jupiter's Bands



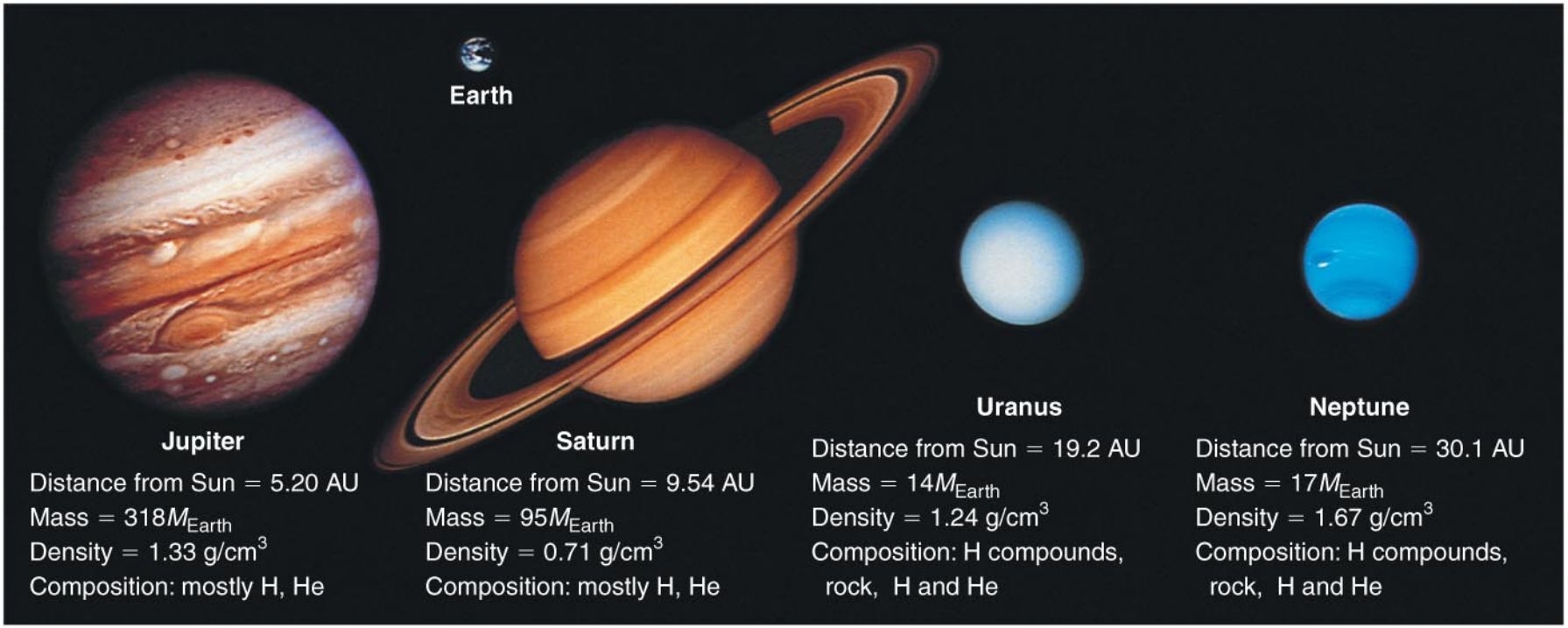
Interactive Figure

Jupiter's Great Red Spot (in motion)



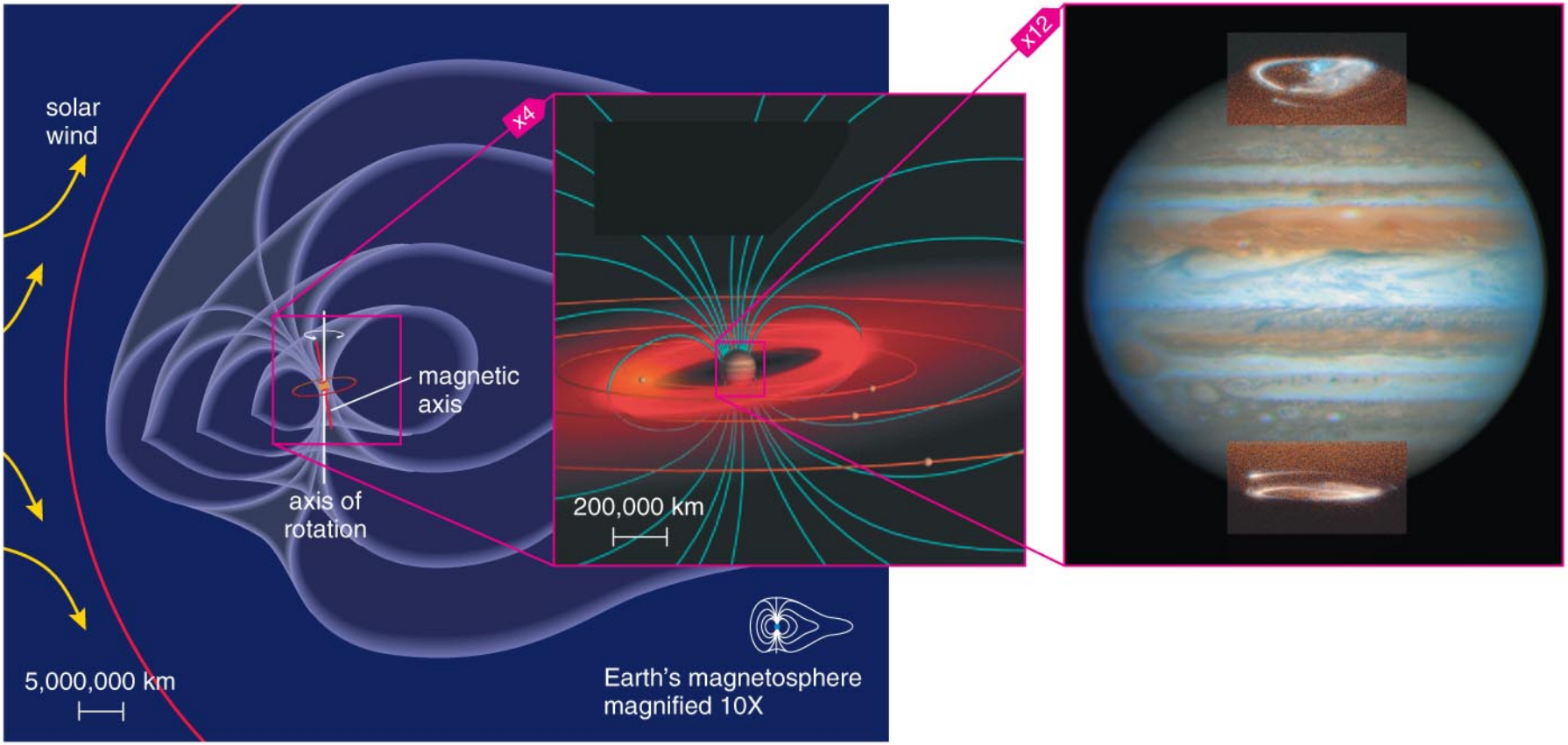
- Is a storm twice as wide as Earth
- Has existed for at least three centuries

Weather on Jovian Planets

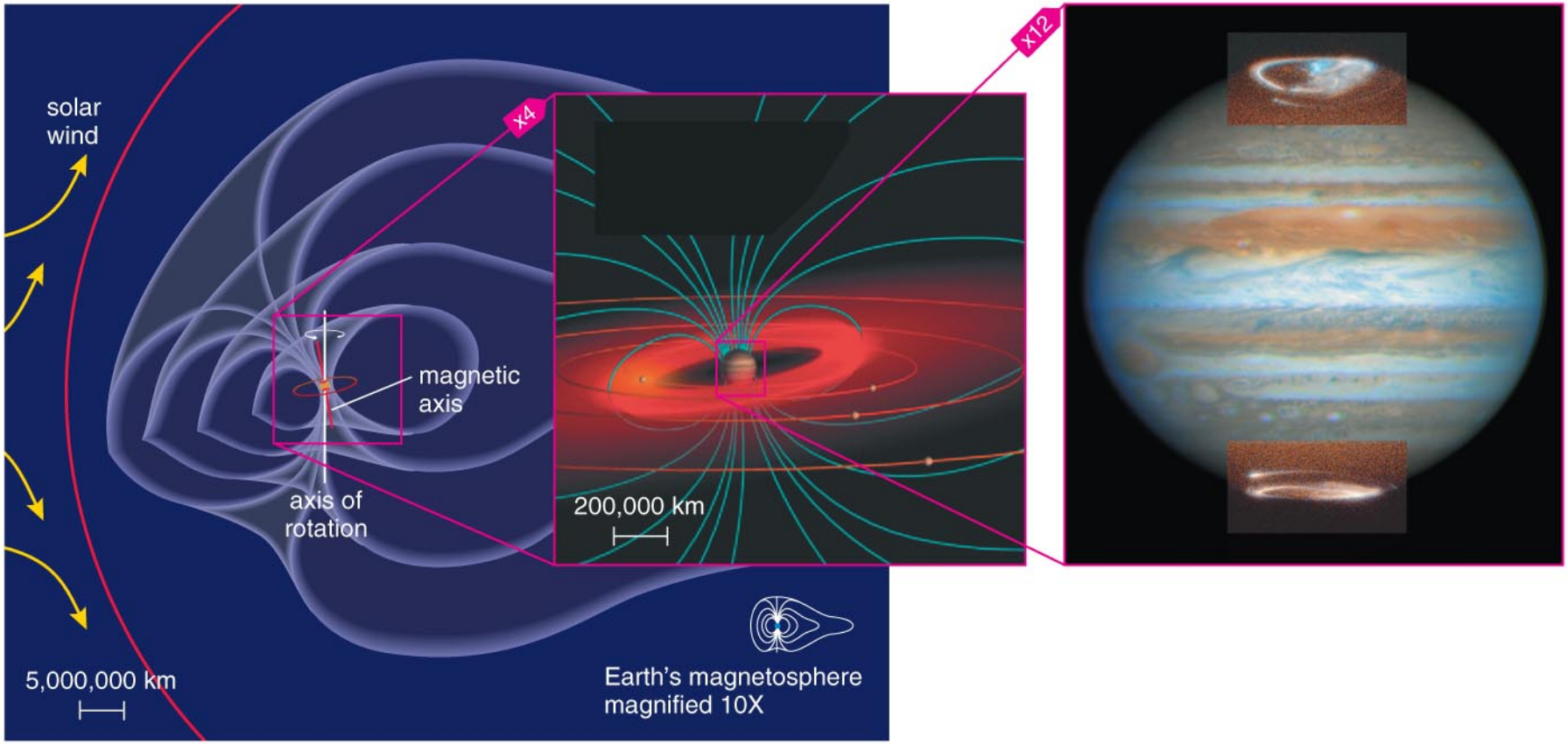


- All the jovian planets have strong winds and storms.

Do jovian planets have magnetospheres like Earth's?

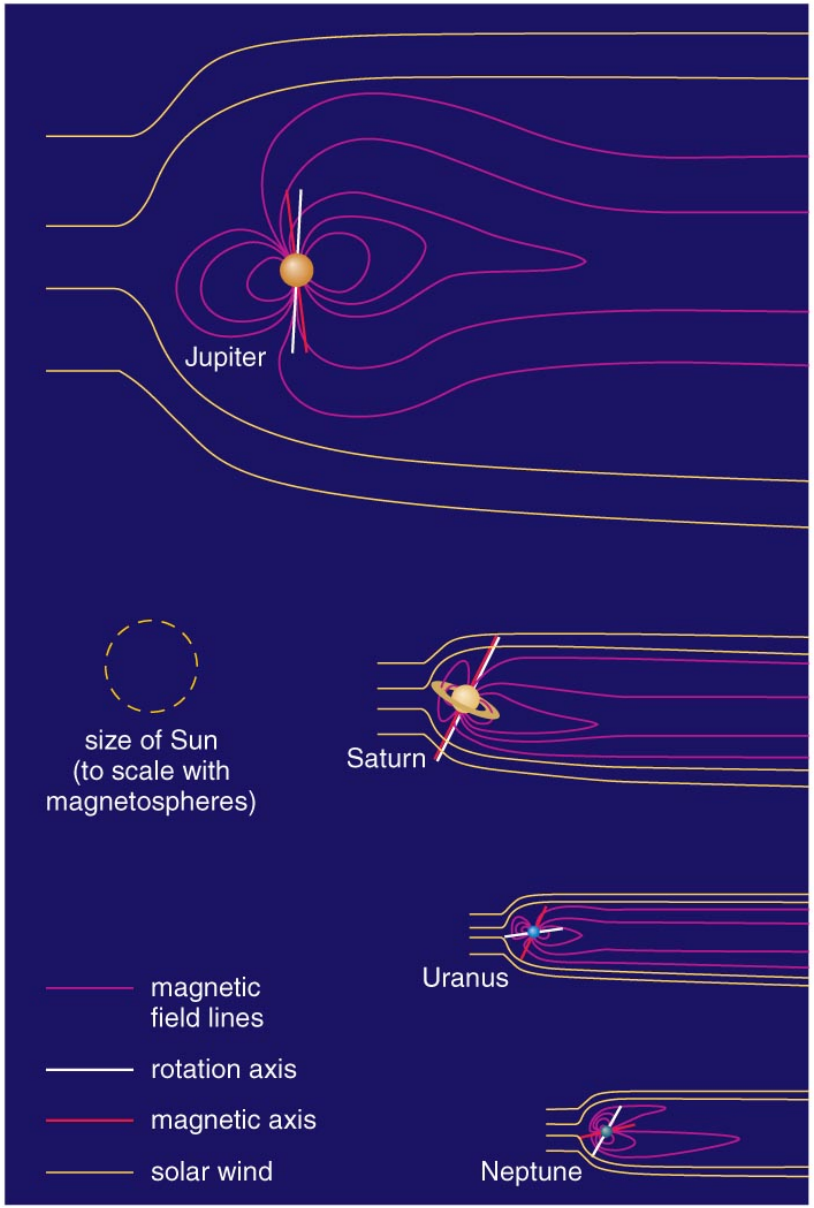


Jupiter's Magnetosphere



- Jupiter's strong magnetic field gives it an enormous magnetosphere.
- Jupiter has very strong auroras.

Other Magnetospheres



- All jovian planets have substantial magnetospheres, but Jupiter's is the largest by far.
- Why?

What have we learned?

- **Are jovian planets all alike?**
  - Jupiter and Saturn are mostly H and He gas.
  - Uranus and Neptune are mostly H compounds.
- **What are jovian planets like on the inside?**
  - Layered interiors with very high pressure and cores made of rock, metals, and hydrogen compounds
  - Very high pressure in Jupiter and Saturn can produce metallic hydrogen.

What have we learned?

- **What is the weather like on jovian planets?**
  - Multiple cloud layers determine colors of jovian planets.
  - All have strong storms and winds.
- **Do jovian planets have magnetospheres like Earth's?**
  - All have substantial magnetospheres.
  - Jupiter's is the largest by far.