



**Skylight Astronomical Society**

# Probes to the Outer Solar System Past, Present and Future

*Spotlight on: Juno*

**Terry P. Riopka, President of Skylight Astronomical Society - 2018**

# Probes to the Outer Solar System Past and Present

Launch  
Date

1972 Pioneer 10

1973 Pioneer 11

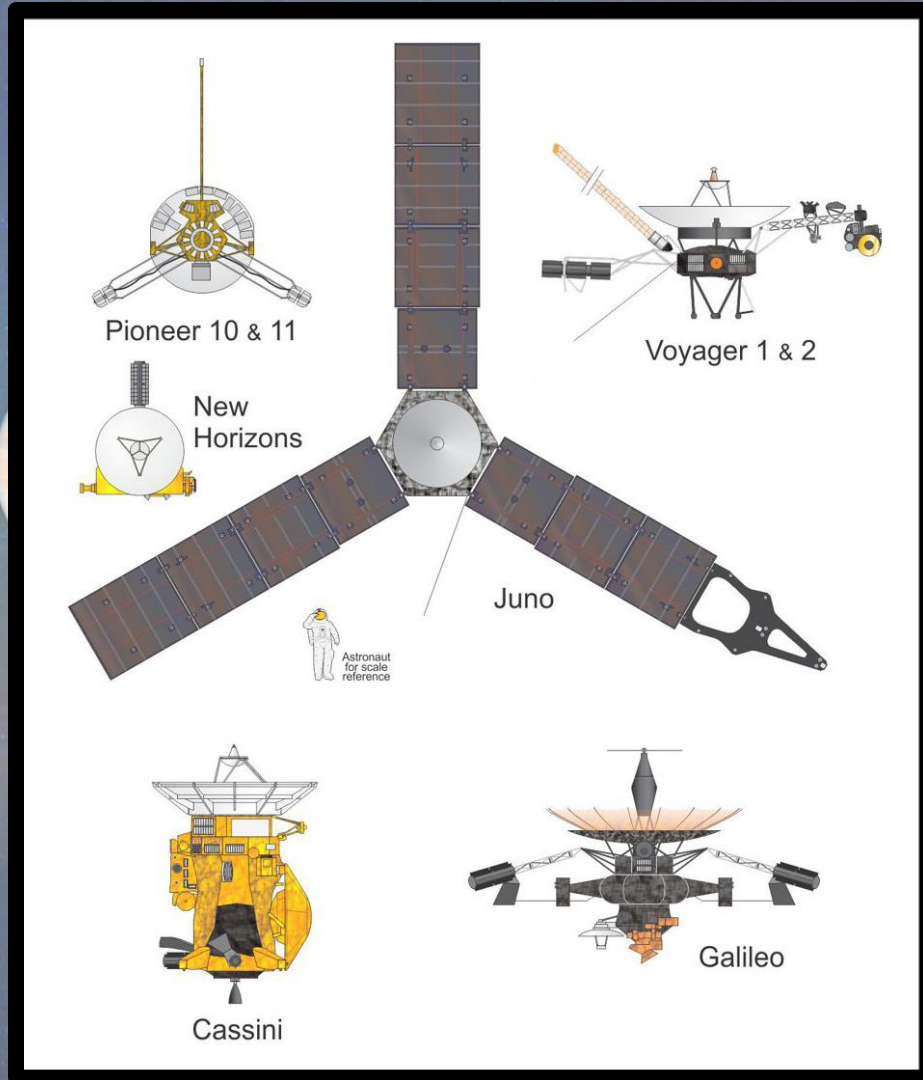
1977 Voyager 2  
Voyager 1

1989 Galileo

1997 Cassini-Huygens

2006 New Horizons

2011 Juno



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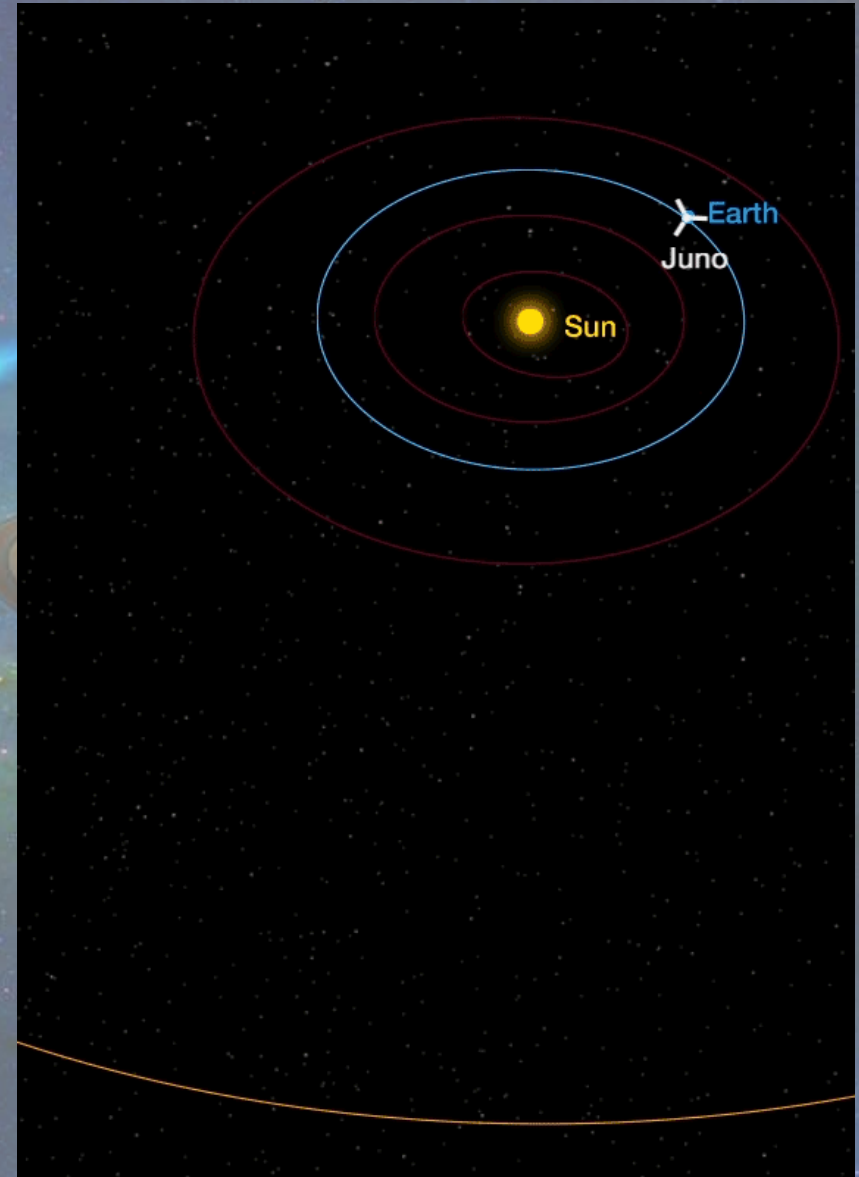
# Juno Launch



- Launched on Atlas V rocket August 5, 2011
- New Frontiers 2 spacecraft
- Entered Jupiter polar orbit on July 5, 2016

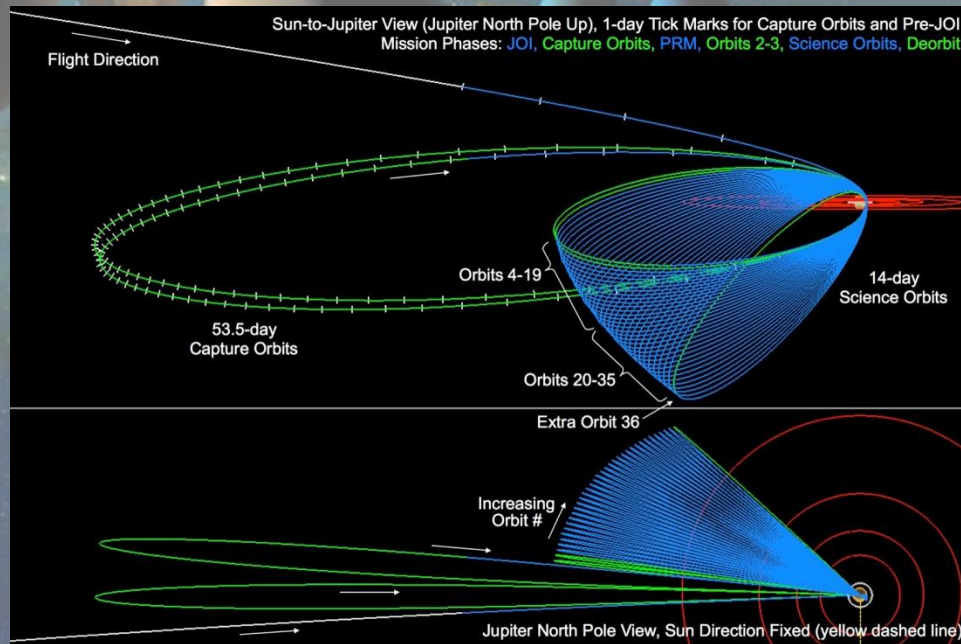
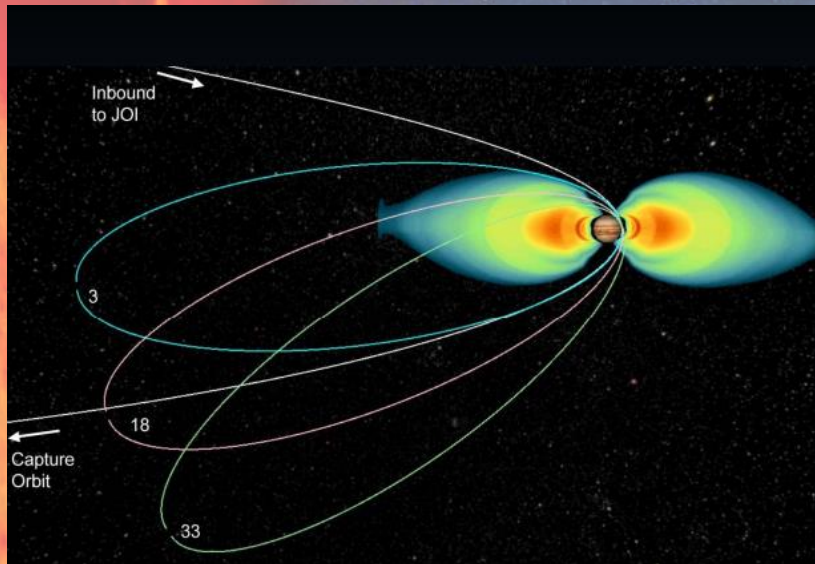


- largest solar array wings ever deployed on a planetary probe
- will remain in sunlight continuously from launch through the end of the mission



# Juno Orbit Insertion

- Arrived at 130,000 mph, decelerated by 1200 mph to enter orbit
- Planned eccentricity-reducing burn cancelled due to problem with main engine helium valves
- Was supposed to execute 37 14-day science orbits in 20 months
- Altered to do 12 53-day science orbits ending July 2018
- Mission may be extended to 34 orbits



• *Juno* will actually receive much lower levels of radiation in its polar orbit than the *Galileo* orbiter received in its equatorial orbit.

• At end of the mission, will perform a 22-day controlled deorbit and disintegrate into Jupiter's atmosphere

# Juno Mission

The primary science objectives of the mission are as follows:

## **Origin**

Determine the abundance of water and place an upper limit on the mass of Jupiter's possible solid core to decide which theory of the planet's origin is correct

## **Interior**

Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational and magnetic fields

## **Atmosphere**

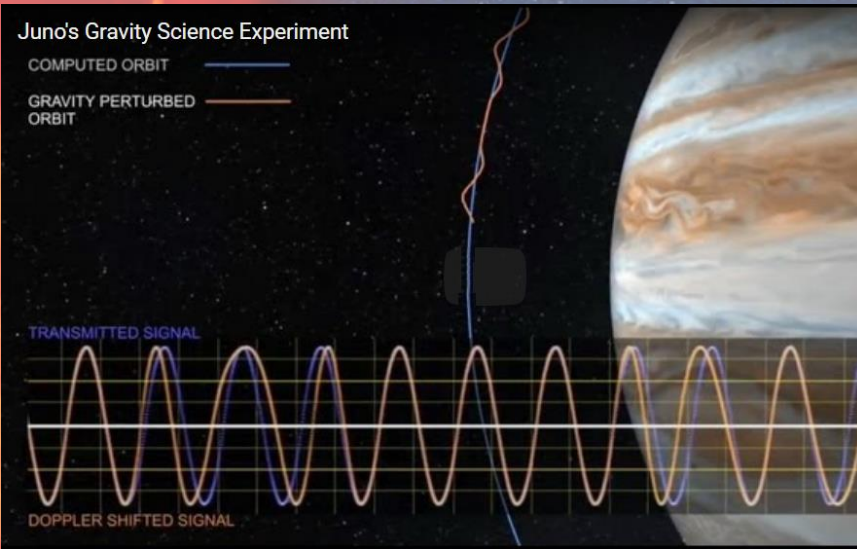
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes.

## **Magnetosphere**

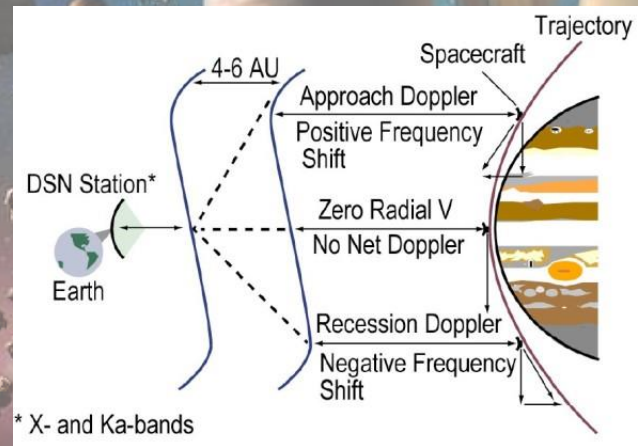
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras

Did a massive planetary core form first and capture all that gas gravitationally, or did an unstable region collapse inside the nebula, triggering the planet's formation?

# Gravity Science Instrument



- Local variations in gravity can act on the spacecraft in orbit and cause it to speed up or slow down



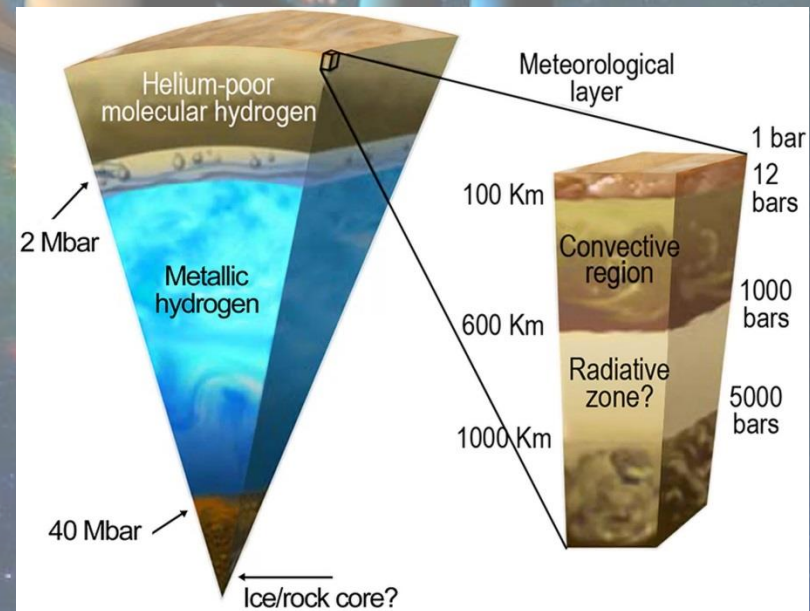
To measure these tiny shifts, Juno's telecommunication system is equipped with a radio transponder that detects signals sent from NASA's Deep Space Network on Earth and immediately sends a signal in return

- changes in spacecraft motion can be detected using the Doppler Shift in the X and Ka band transponders used by the radio sub-system.

# Juno Discoveries

- Jupiter's magnetic field is nearly two times stronger than scientists had predicted.
- estimate Jupiter's core to contain a 7–25 Earth mass of heavy elements.
- The Juno Microwave Radiometer, which probed hundreds of kilometers beneath the surface, found a remarkable level of organization — including a strange band of ammonia sitting right above the equator that extends deep into the planet

- another interesting find was that Jupiter's gravity field varies with depth, which indicated that material is flowing as far down as 3,000 km (1,864 mi).
- results show that Jupiter's magnetic field might actually be generated higher up, in the shallower layer of molecular hydrogen more consistent with a fuzzy core, which may be much larger than anybody had anticipated
- core may even be partially dissolved

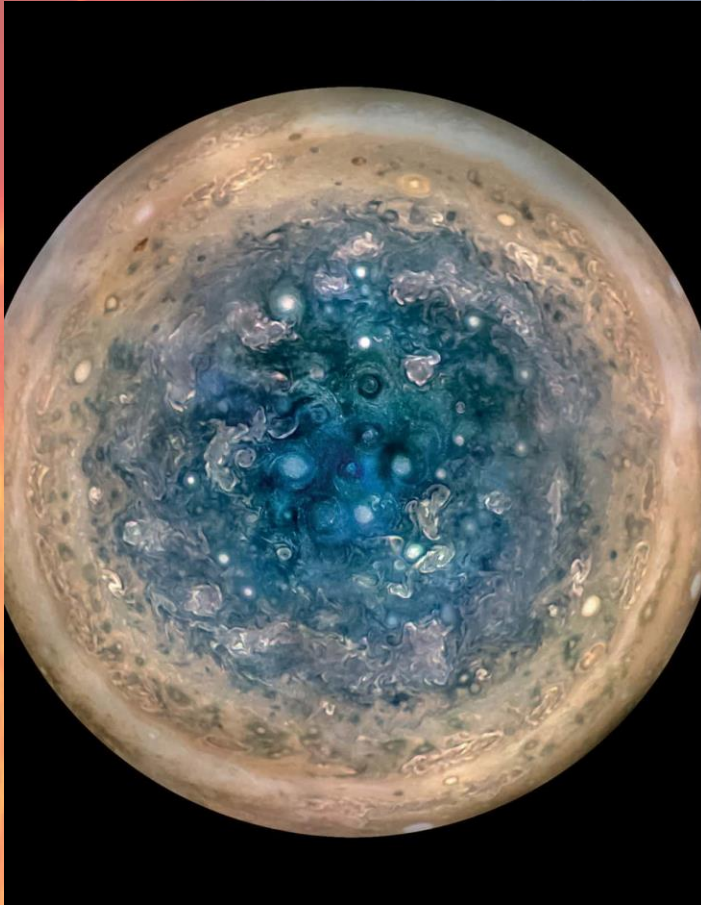


# Juno – Jupiter North Polar Region



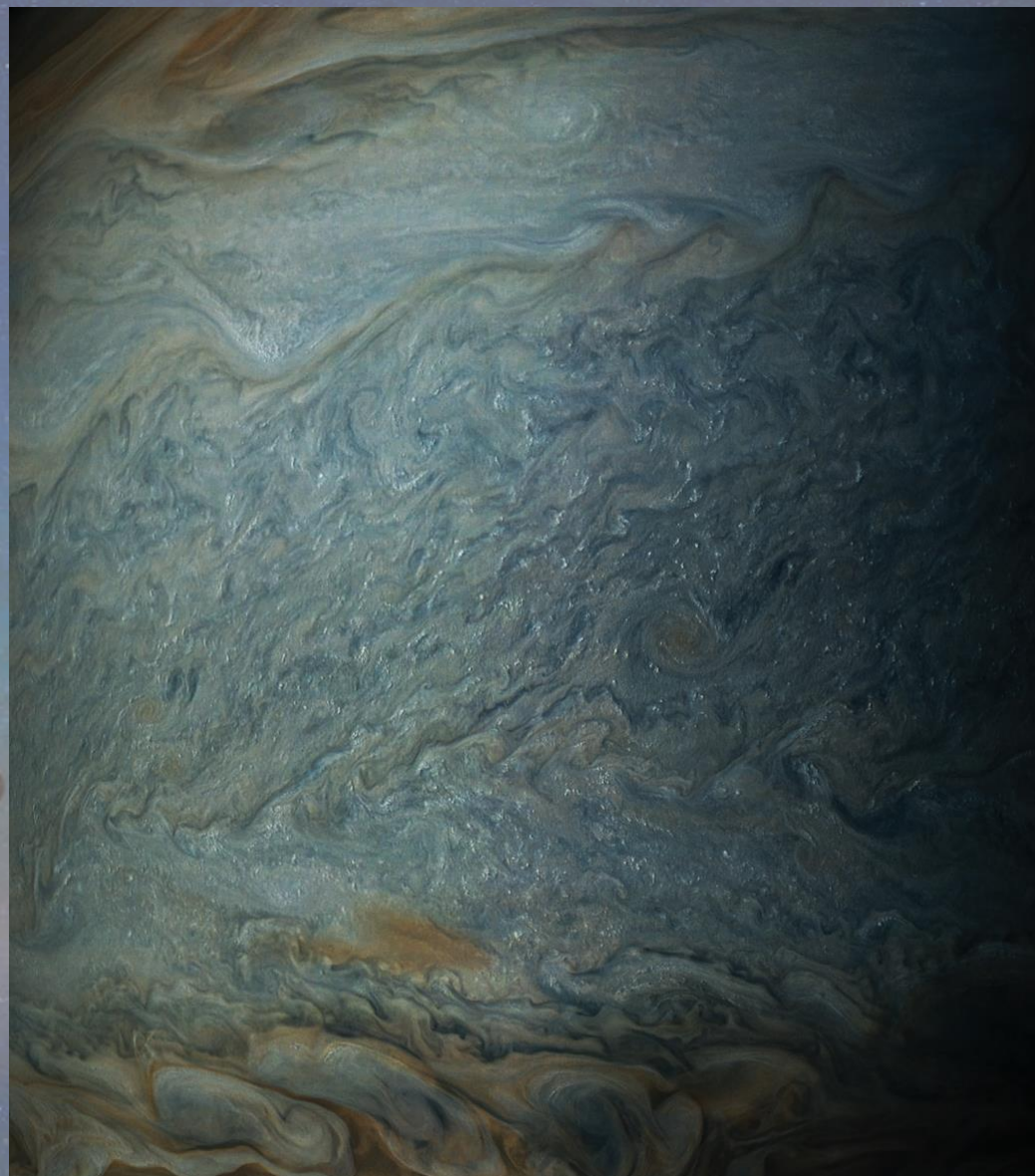
- Unclear what, exactly, drives these polar cyclones, some of which are up to 870 miles (1,400 km) wide
- Are they stable over long periods?

# Juno – Jupiter South Polar Region

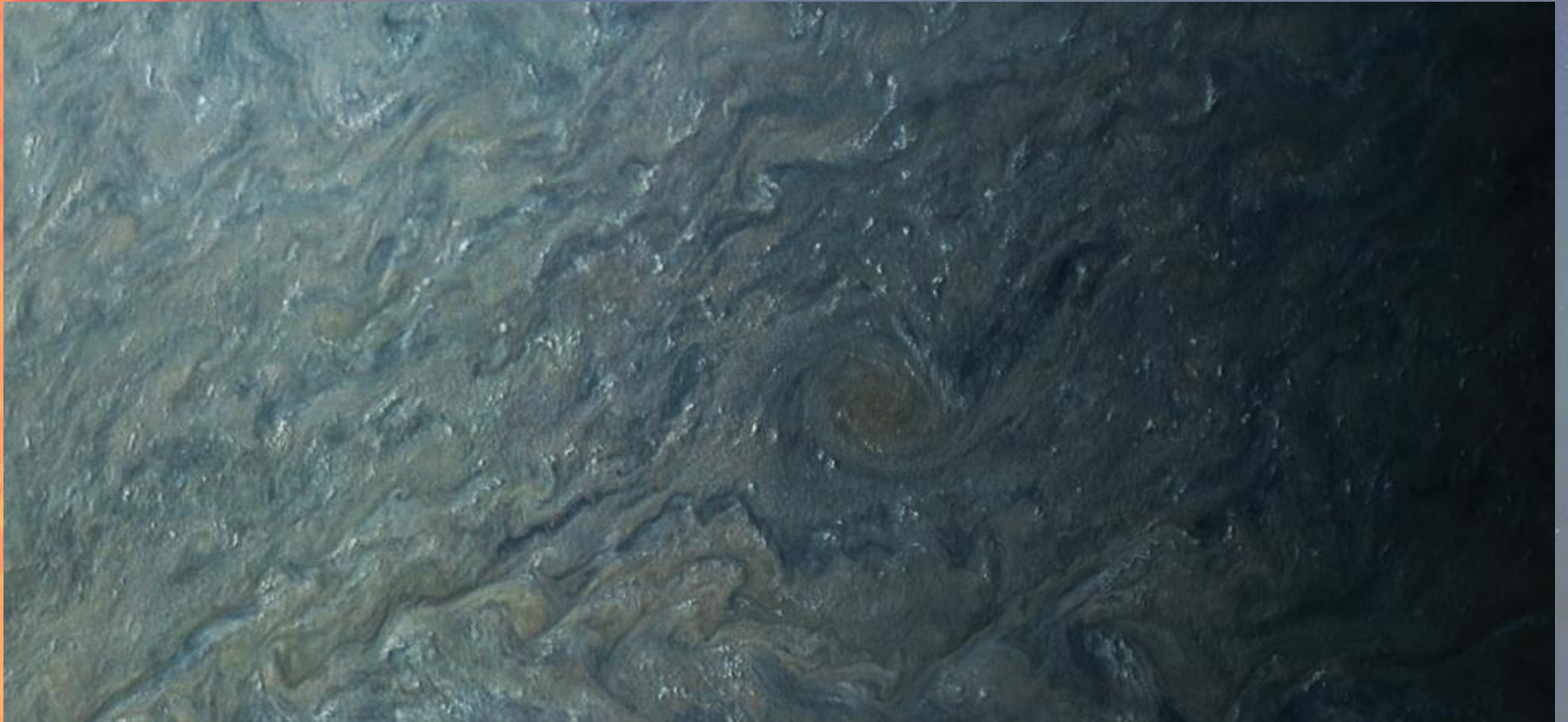


- In total, Juno spotted eight cyclonic storms around the north pole and five around the south pole.
- Scientists were especially surprised to see these, since computer modelling suggests that such small storms would not be stable around the poles due to the planet's swirling polar winds.

# Juno Discoveries

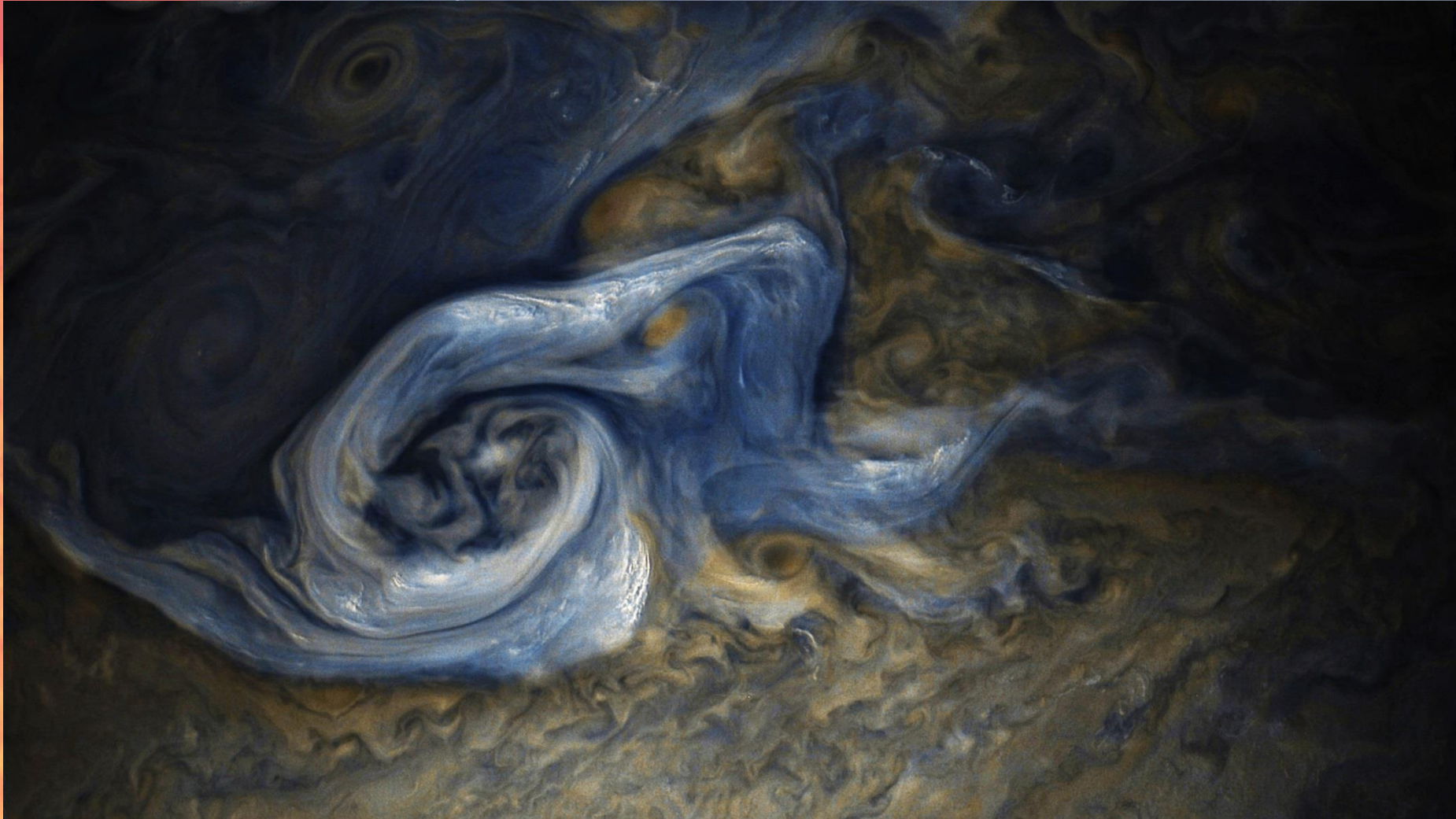


# Juno Discoveries



Cloud structures raised above surroundings

# Juno Discoveries



North Polar Region - Clouds with ammonia crystals

# Probes to the Outer Solar System

End

Thank you!

