Space & Atmospheric Physics

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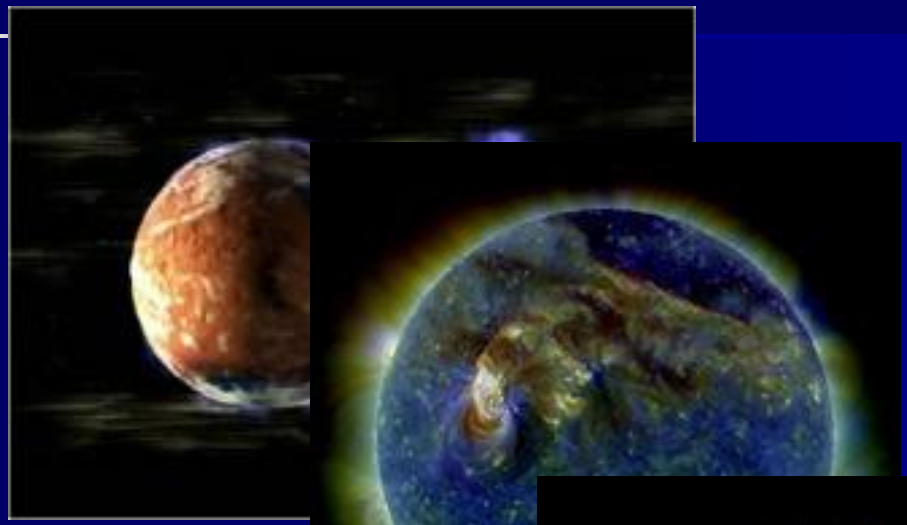
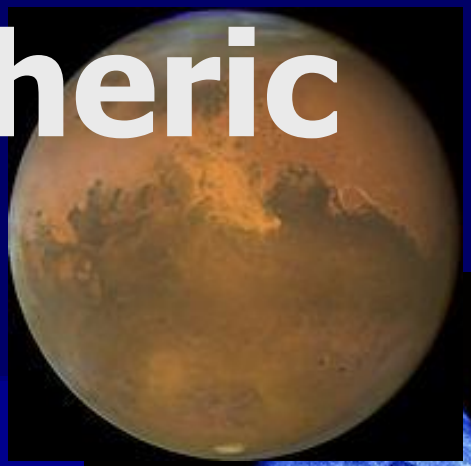
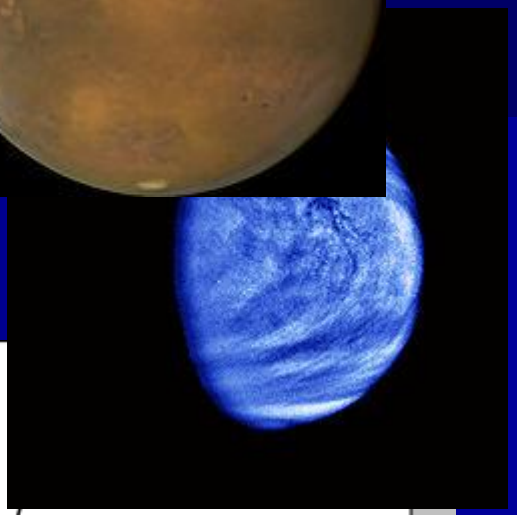
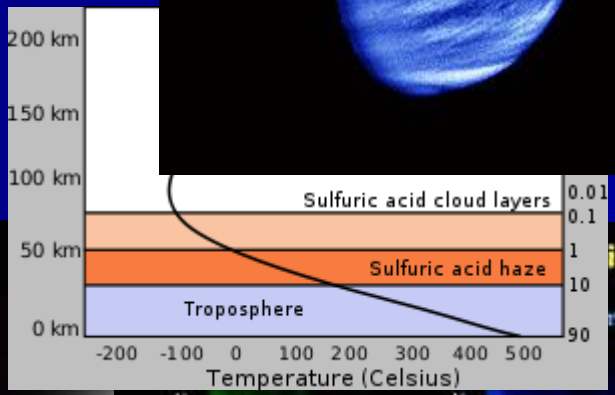
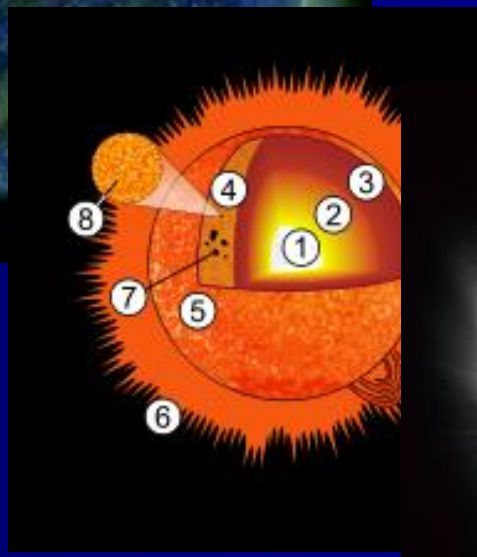
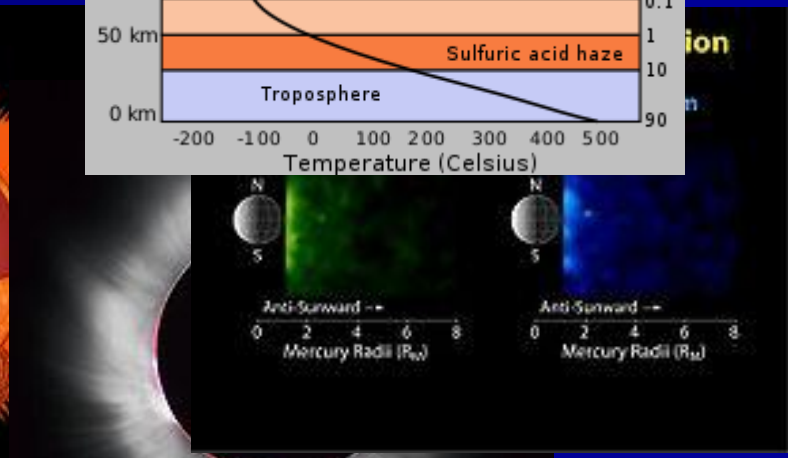












Lecture – 04 (II)

Planetary Atmospheres

Planetary Atmospheres

- Formation and Evolution of Planetary Atmospheres
- The Structure of the Terrestrial Atmosphere
- The Temperature of the Neutral Atmosphere
- The Escape of the Atmospheric Gases
- **The Atmospheres of the Planets**

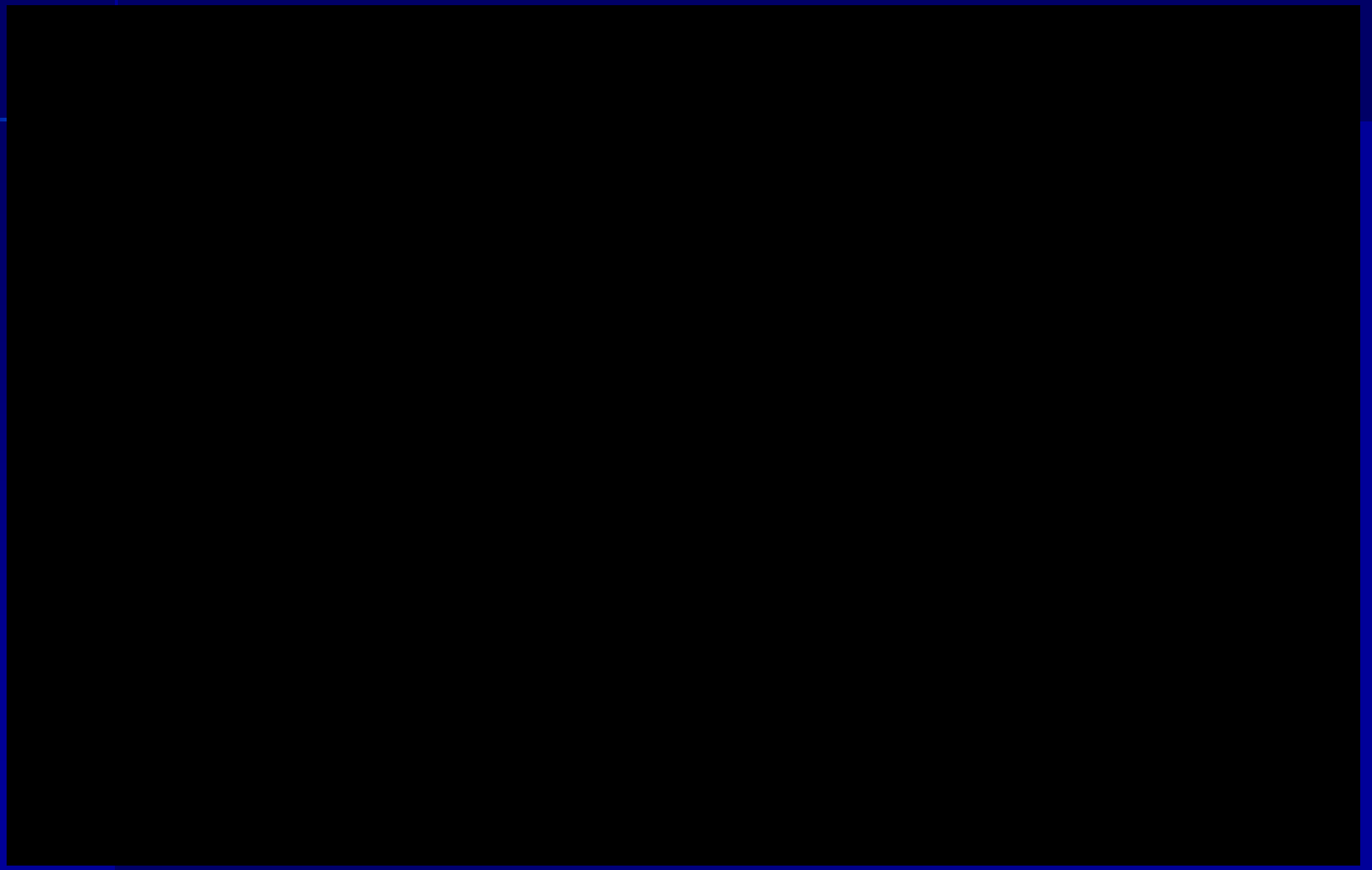
Atmosphere of Neptune

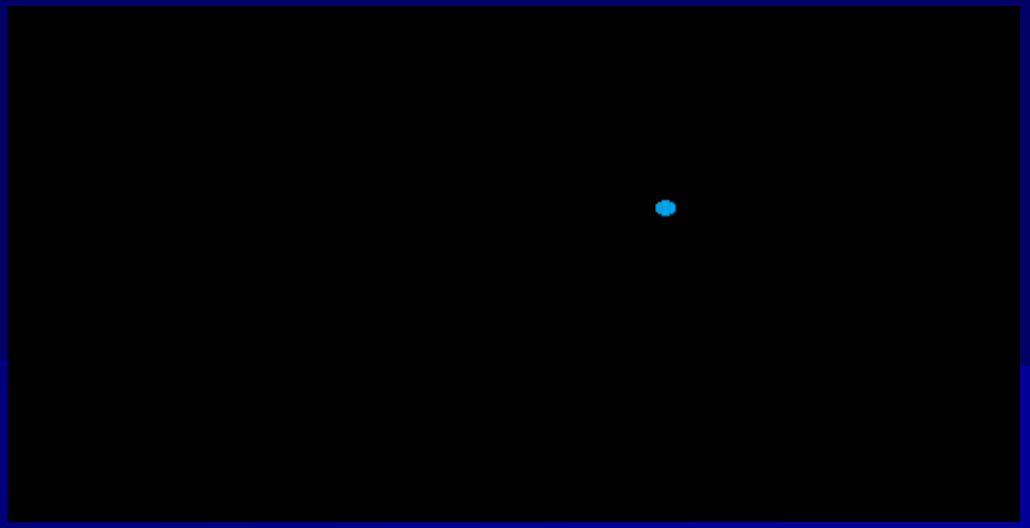
Atmosphere of Neptune

Combined color and near-infrared image of Neptune, showing bands of methane in its atmosphere, and its four moons, Proteus, Larissa, Galatea, and Despina.

Atmosphere of Neptune

What Would You See If You Fell Into Neptune?





- **Observation**
- Neptune is never visible to the naked eye, having a brightness between magnitudes +7.7 and +8.0.
- A telescope or strong binoculars will resolve Neptune as a small blue disk, similar in appearance to Uranus.
- Because of the distance of Neptune from the Earth, the angular diameter of the planet only ranges from 2.2 to 2.4 arcseconds, the smallest of the Solar System planets. Its small apparent size has made it challenging to study visually.

Atmosphere of Neptune

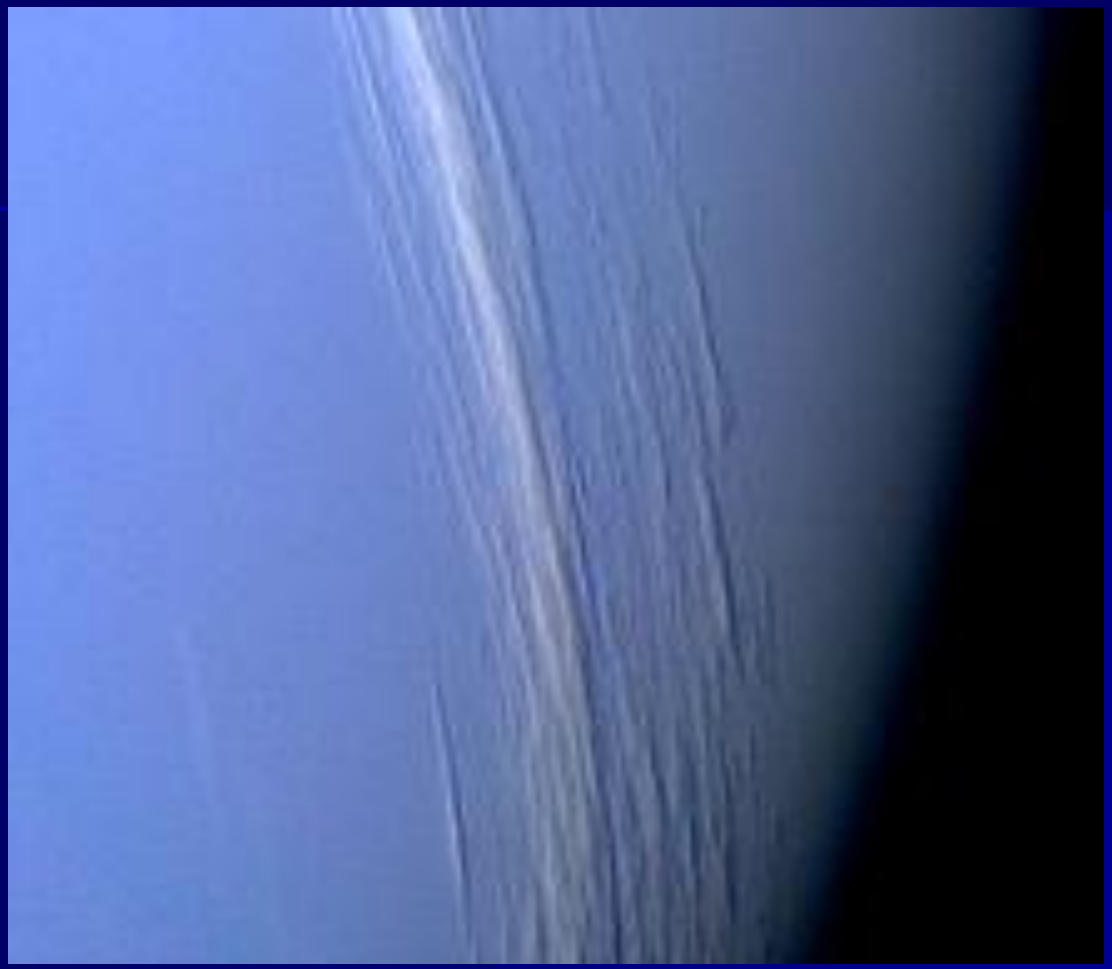
At high altitudes, Neptune's atmosphere is **80% hydrogen and 19% helium**. A trace amount of methane is also present. Prominent absorption bands of methane occur at wavelengths above 600 nm, in the red and infrared portion of the spectrum.

As with Uranus, this absorption of red light by the atmospheric methane is part of what gives Neptune its blue hue, although Neptune's vivid azure differs from Uranus's milder cyan.

Neptune's atmosphere is sub-divided into two main regions;

1. The **lower troposphere,** where temperature decreases with altitude, and the stratosphere, where temperature increases with altitude. The boundary between the two, the tropopause, occurs at a pressure of 0.1 bars (10 kPa).
2. The stratosphere then gives way to the thermosphere at a pressure lower than 10^{-5} to 10^{-4} microbars (1 to 10 Pa). The thermosphere gradually transitions to the exosphere.

Atmosphere of Neptune



Bands of high-altitude clouds cast shadows on Neptune's lower cloud deck

Atmosphere of Neptune

Models suggest that Neptune's troposphere is banded by clouds of varying compositions depending on altitude.

The upper-level clouds occur at pressures below one bar, where the temperature is suitable for methane to condense.

For pressures between one and five bars (100 and 500 kPa), clouds of ammonia and hydrogen sulfide are believed to form.

Deeper clouds of water ice should be found at pressures of about 50 bars (5.0 MPa), where the temperature reaches 0 °C. Underneath, clouds of ammonia and hydrogen sulfide may be found.

Atmosphere of Neptune

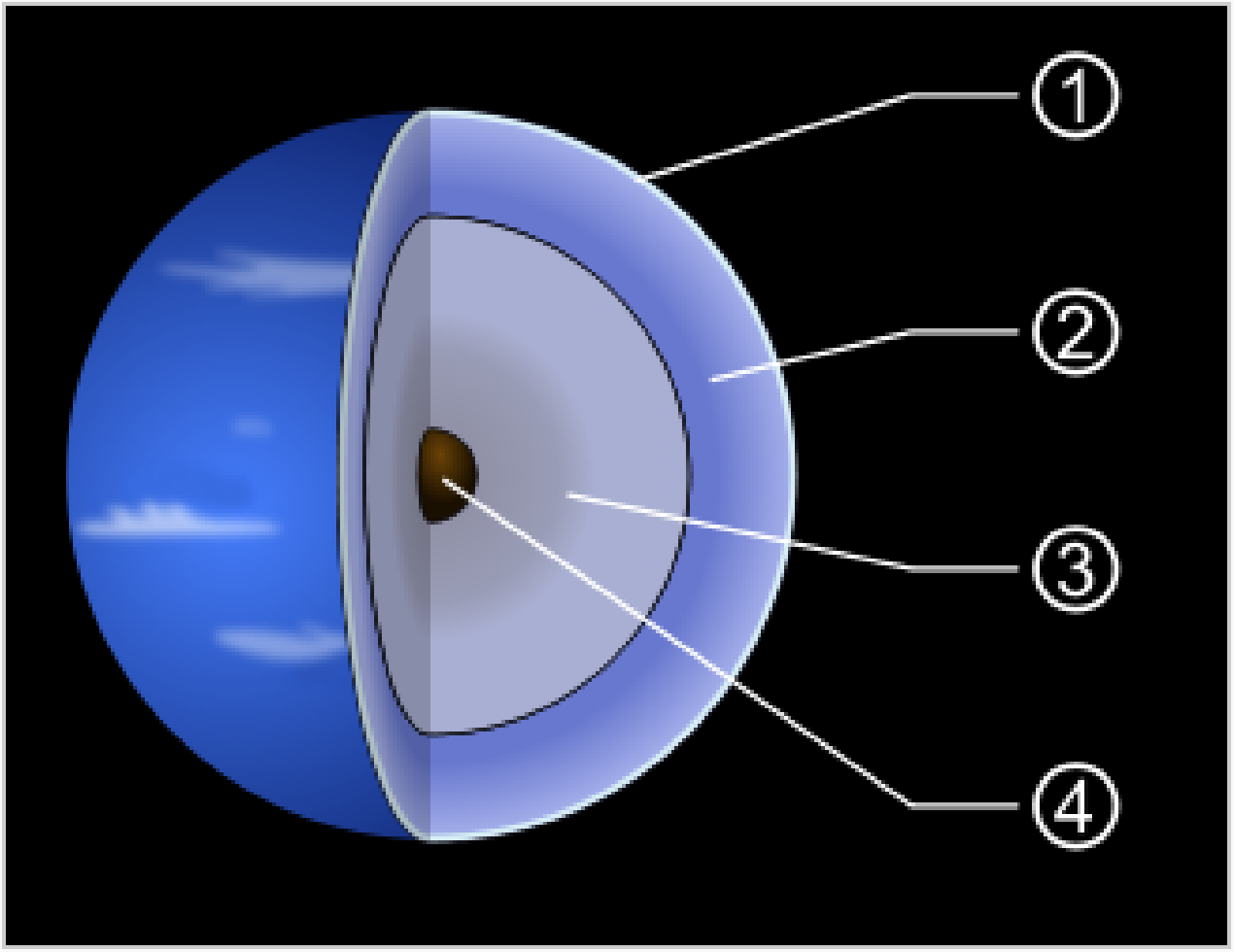
The stratosphere of Neptune is warmer than that of Uranus due to the elevated concentration of hydrocarbons.

For reasons that remain obscure, the planet's thermosphere is at an anomalously high temperature of about 750 K.

The planet is too far from the Sun for this heat to be generated by ultraviolet radiation.

One candidate for a heating mechanism is atmospheric interaction with ions in the planet's magnetic field.

Other candidates are gravity waves from the interior that dissipate in the atmosphere.



The internal structure of Neptune:

1. Upper atmosphere, top clouds
2. Atmosphere consisting of hydrogen, helium and methane gas
3. Mantle consisting of water, ammonia and methane ices
4. Core consisting of rock (silicates and nickel-iron)

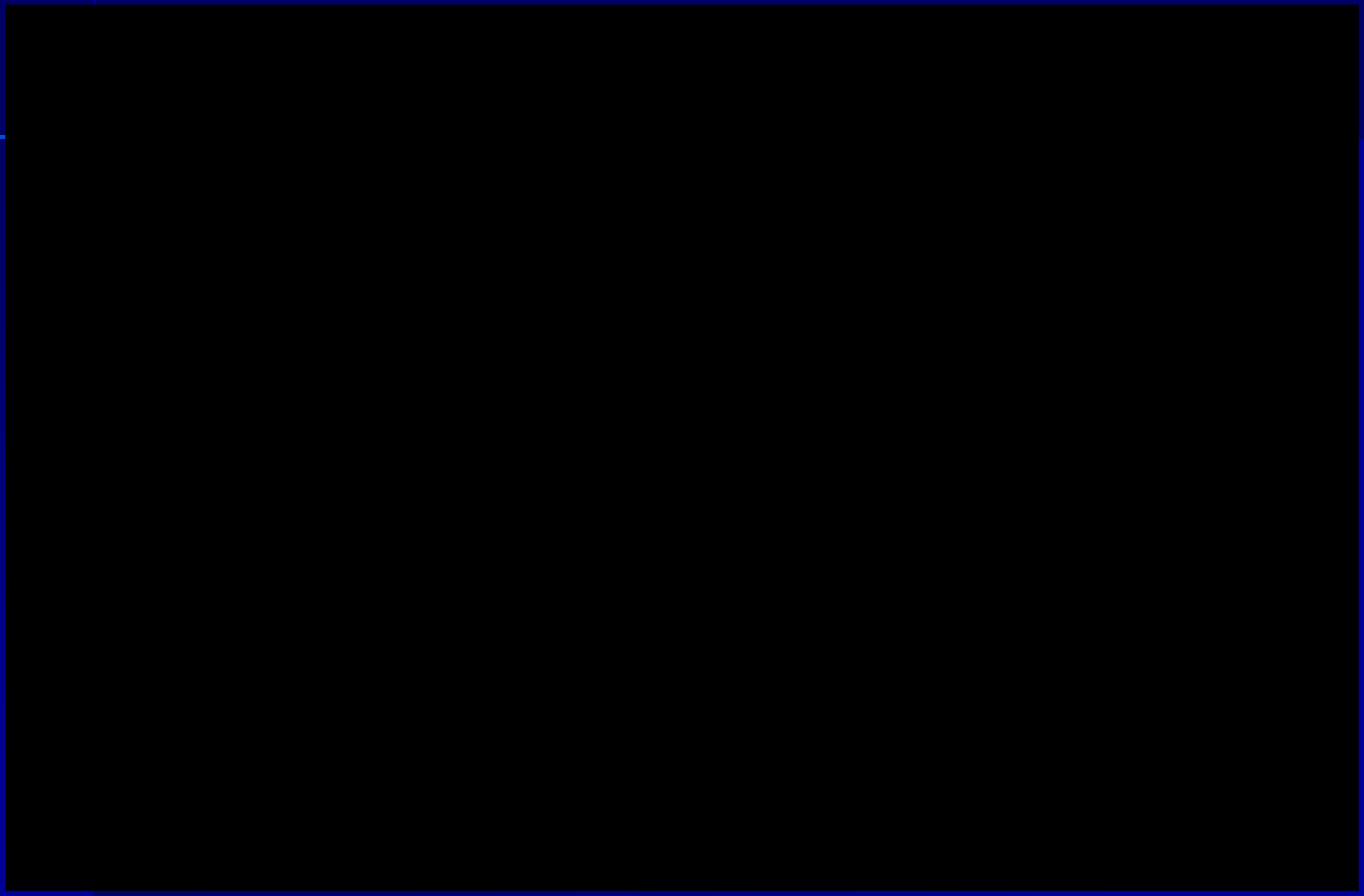
Atmosphere of Pluto

Atmosphere of Pluto

CRIRES model-based computer-generated impression of the Plutonian surface by ESO - L. Calçada, with atmospheric haze, and Charon and the Sun in the sky.

Atmosphere of Pluto

Mountains on Pluto



Atmosphere of Pluto

Pluto's atmosphere consists of a thin envelope of nitrogen, methane, and carbon monoxide gases, which are derived from the ices of these substances on its surface.

Its surface pressure ranges from 6.5 to 24 μbar.

Pluto's elongated orbit is predicted to have a major effect on its atmosphere: as Pluto moves away from the Sun, its atmosphere should gradually freeze out, and fall to the ground.

When Pluto is closer to the Sun, the temperature of Pluto's solid surface increases, causing the ices to sublimate into gas.
This creates an anti-greenhouse effect; much as sweet cools the body as it evaporates from the surface of the skin, this sublimation cools the surface of Pluto.

Pluto's temperature is about 43 K (−230 °C), 10 K colder than would otherwise be expected.

The presence of methane, a powerful greenhouse gas, in Pluto's atmosphere creates a temperature inversion, with average temperatures 36 K warmer 10 km above the surface.

Atmosphere of Pluto

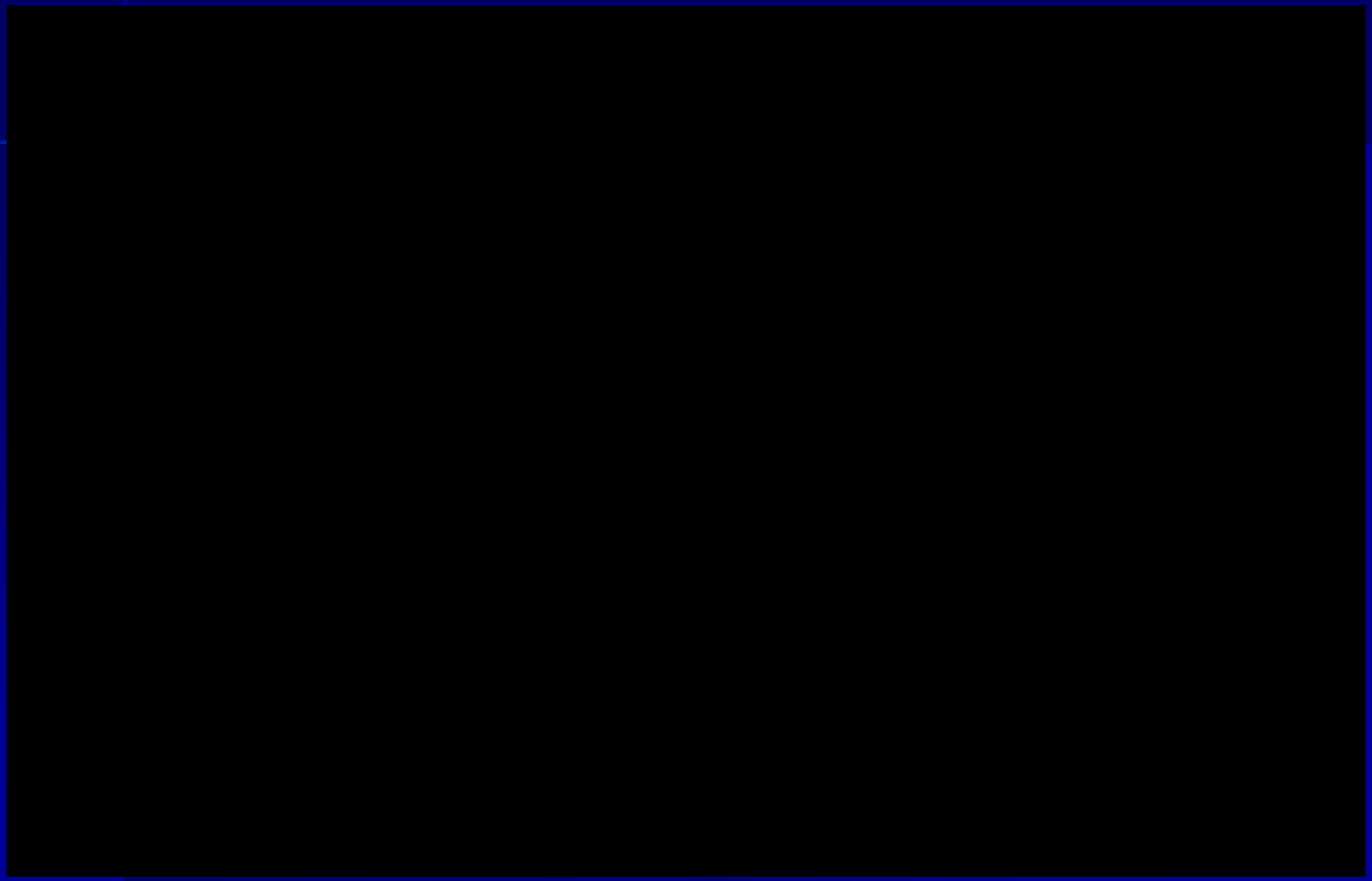
The first evidence of Pluto's atmosphere was found by the Kuiper Airborne Observatory in 1985, from observations of the occultation of a star behind Pluto. When an object with no atmosphere moves in front of a star, the star abruptly disappears; in the case of Pluto, the star dimmed out gradually. From the rate of dimming, the atmospheric pressure was determined to be 0.15 pascal, roughly 1/700,000 that of Earth.

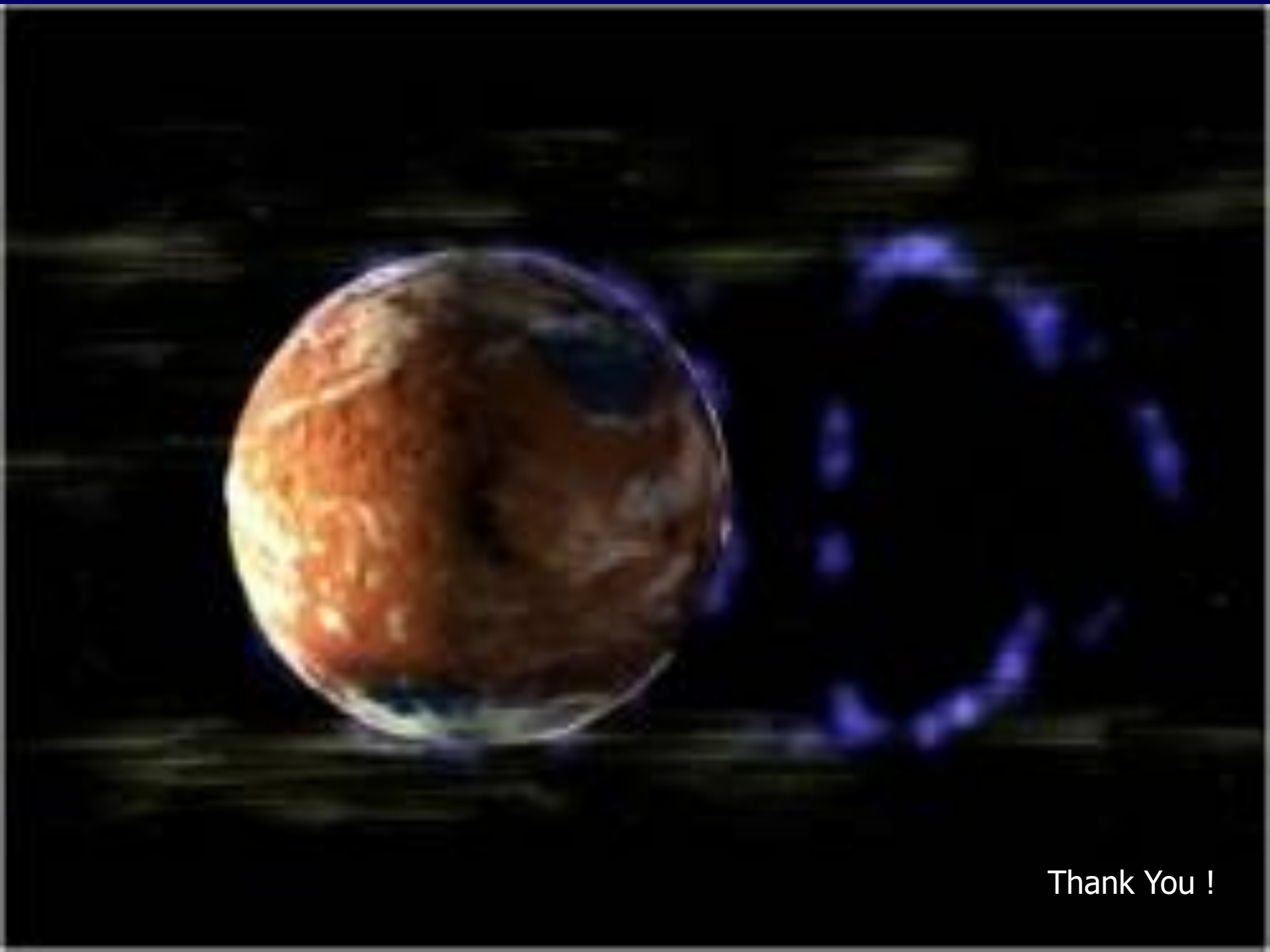
In 2002, the atmospheric pressure was estimated to be 0.3 Pascal, even though Pluto was farther from the Sun than in 1988 and thus should have been colder and had a more rarefied atmosphere.

One explanation for the discrepancy is that in 1987 the south pole of Pluto came out of shadow for the first time in 120 years, causing extra nitrogen to sublimate from the polar cap. It will take decades for the excess nitrogen to condense out of the atmosphere as it freezes onto the north pole's **now permanently dark ice cap**.

Atmosphere of Pluto

New NASA Photo Of Pluto's Atmosphere




Thank You !