

# In Depth: Titan's turbulence surprises scientists

November 30 2005

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Strong turbulence in the upper atmosphere, a second ionospheric layer and possible lightning were among the surprises found by the Huygens Atmospheric Structure Instrument (HASI) during the descent to Titan's surface.

*Above: Huygens probe descending through Titan's atmosphere.*

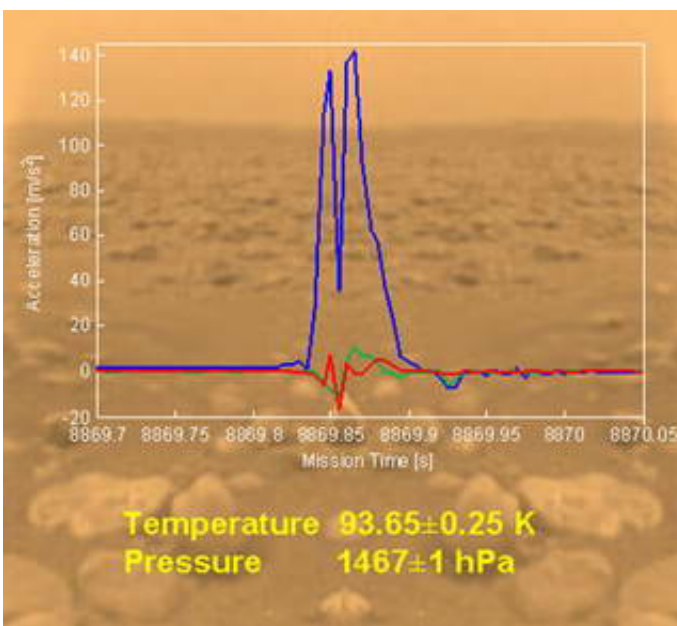
HASI provided measurements from an altitude of 1400 km down to the surface of the physical characteristics of the atmosphere and surface, such as temperature and density profiles, electrical conductivity, and surface structure. The Huygens SSP made measurements just above and

on the surface of Titan.

High-altitude atmospheric structure had been inferred from earlier solar occultation measurements by Voyager, but the middle atmosphere (200–600 km) was not well determined, although telescopic observations indicated a complex vertical structure.

Very little was known about the surface of Titan because it is hidden by a thick 'haze' - initial speculation was that the surface was covered by a deep hydrocarbon ocean, but infrared and radar measurements showed definite albedo contrasts —possibly consistent with lakes, but not with a global ocean.

Earlier observations showed that the surface pressure on Titan was comparable to that on Earth, and that methane formed a plausible counterpart to terrestrial water for cloud and rain formation. There was also speculation on the possibility of lightning occurring in Titan's atmosphere that could affect the chemical composition of the atmosphere.



*The HASI instrument's accelerometers recorded the signature of the probe impact. Credits: ESA /ASI/UPD/OU (background: ESA/NASA/UofA)*

HASI found that in the upper part of the atmosphere, the temperature and density were both higher than expected. The temperature structure shows strong wave-like variations of 10-20 K about a mean of about 170 K. This, together with other evidence, indicates that Titan's atmosphere has many different layers.

Models of Titan's ionosphere predicted that galactic cosmic rays would produce an ionospheric layer with a maximum concentration of electrons between 70 and 90 km altitude. HASI also surprised the Huygens team by finding a second lower ionospheric layer, between 140 km and 40 km, with electrical conductivity peaking near 60 km.

HASI may also have seen the signature of lightning. Several electrical field impulse events were observed during the descent, caused by possible lightning activity in the spherical waveguide formed by the surface of Titan and the inner boundary of its ionosphere.

The vertical resolution of the temperature measurement was sufficient to resolve the structure of the planetary boundary layer. This boundary layer had a thickness of about 300 m at the place and time of landing. The surface temperature was accurately measured at  $93.65 \pm 0.25$  K and the pressure  $1467 \pm 1$  hPa (very close to measurements made earlier by Voyager, about 95K and 1400 hPa).

Source: ESA

Citation: In Depth: Titan's turbulence surprises scientists (2005, November 30) retrieved 10 April 2024 from <https://phys.org/news/2005-11-depth-titan-turbulence-scientists.html>

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