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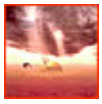
A Titanic methane source



An astounding vision of raging winds, a methane-rich atmosphere and a surface of dirty ice frozen like rock is emerging from data transmitted the billion and a half kilometres to Earth. The instruments aboard the Huygens probe, which plunged into the atmosphere of Titan the largest of Saturn's 33 moons on January 14 are painting a picture of an enigmatic atmosphere and complex surface chemistry that will keep the scientist involved in the project busy for years. Already Huygens' instruments have confirmed that the unique atmosphere of Titan resembles that of the primitive Earth while a glimpse of a terrain not unlike barren and remote regions of the Earth today provided a tantalising view of this alien world.

The Huygens probe descends through Titan's atmosphere (January 14, 2005).
(Image credit: NASA)

The Cassini-Huygens mission set out on its journey on 15th October 1997 from the Cape Canaveral launch site in Florida, getting gravitational nudges from Venus, Earth and Jupiter (December 2000) before the deeper part of its journey to Saturn which it reached in July 2004.

The mission was a collaboration between the European Space Agency (ESA), US National Aeronautics & Space Administration (NASA) and the Agenzia Spaziale Italiana (ASI) and allowed Cassini's passenger, Huygens, named for the seventeenth century Dutch physicist Christiaan Huygens who discovered Titan in 1655, to parachute into the thick atmosphere and reach the surface of Saturn's largest and most interesting moon. After safely completing the seven-year journey, Cassini released the Huygens probe in December 2004 sending it on a 22-day cruise to Titan's surface.

Building the Huygens probe
(Image credit: ESA)

Huygens carried with it six scientific instruments and these were called into action immediately the

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probe entered the Titan atmosphere providing scientists with the first direct sampling of the moon's chemistry and the first astonishing close-up views of this alien surface as it penetrated the haze that obscured the surface from the earlier Pioneer and Voyager probes sent to Saturn. "The Huygens probe has discovered a new world, Sushil Atreya of the University of Michigan and one of the vast team of scientists studying the rich data sent back by Huygens, said, And there is so much more to learn.

The Aerosol Collector and Pyrolyser (ACP).
(Image credit: Service d'Aeronomie, Centre National de la Research Scientifique, CNRS)

The Aerosol Collector and Pyrolyser (ACP) aboard Huygens collected atmospheric aerosols carried out a preparation involving evaporation, pyrolysis and gas product transfer and then an analysis with gas chromatography-mass spectrometry (GC-MS). The ACP collected two samples one from the top of the descent down to the tropopause (160-40 km) and the second sample in the cloud layer (23-17 km).

The system with its dynamic range of 10^8 could identify atmospheric constituents over a mass range from 2 to 146 atomic mass units, and revealed the chemical composition of the photochemical aerosols - in terms of hydrogen, carbon, nitrogen, and oxygen content as well as the relative concentrations of condensates in the lower stratosphere, such as C_2, H_2, H, HC_3N, HCN, and other small molecules. The relative concentrations of organic condensates within the troposphere, such as methane and ethane and non-condensable constituents, like carbon dioxide, trapped in the collected particles were also determined.

Sushil Atreya

"The GC-MS data provide strong evidence of a thick cloud or haze layer of methane in Titan's middle troposphere around 20 km above the surface," Sushil Atreya explains, "and there is a reservoir of liquid methane on the surface." Nitrogen is the most abundant gas in the Titan atmosphere, but Atreya adds that for Titan the role of water on Earth seems to be filled by methane." Heat released by Huygens warmed the surface material beneath the probe and allowed the GC-MS and possibly SSP systems to detect bursts of methane gas as it boiled off from the frozen surface, reinforcing methane's principal role in Titan's geology and atmospheric meteorology - forming clouds and precipitation that erodes and abrades the surface.

Analytical evidence of such an abundance of methane is providing important clues that might answer the perplexing question of why there is so much methane present in the first place. "The big question for Titan is how the methane gets replenished," Atreya explains, "In the absence of

recycling it would be destroyed by the Sun's ultraviolet light in 10 million years, which would in turn lead to a gradual collapse of Titan's atmosphere." The GC-MS measurements, together with supporting data from Huygens' other instruments, suggest that recycling does occur and Atreya is confident that the ongoing data analysis will provide a clear picture of Titan's hazy atmosphere in the coming months.

Some observers have speculated that because the main means of methane recycling in Earth's atmosphere is due to the organic activity of peat bogs, rice fields and ruminant animals, that perhaps Titan harbours some kind of alien life form that continuously replenishes the gas destroyed by sunlight's photo-oxidative effects. But, those hoping for ET have to face the cold facts. Titan is not a pleasant place for life it is much too cold for liquid water at -180 Celsius. A more plausible explanation may lie in vast oceans of methane that lie on or beneath the surface of Titan that are constantly feeding the atmosphere.

For more on the Cassini-Huygens Mission, read the special issue of "spectral lines" on our sister site, spectroscopyNOW.com

Related links:

- Cassini-Huygens homepage, NASA
- Cassini-Huygens homepage, ESA
- Aerosol Collector and Pyrolyser (ACP), ESA website
- Aerosol Collector and Pyrolyser (ACP), Service d'Aeronomie website
- Gas Chromatograph and Mass Spectrometer Instrument (GCMS), ESA website
- Sushil Atreya's homepage, University of Michigan, Department of Atmospheric, Oceanic and Space Sciences

Article by David Bradley

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