Another Look at an Enigmatic New World

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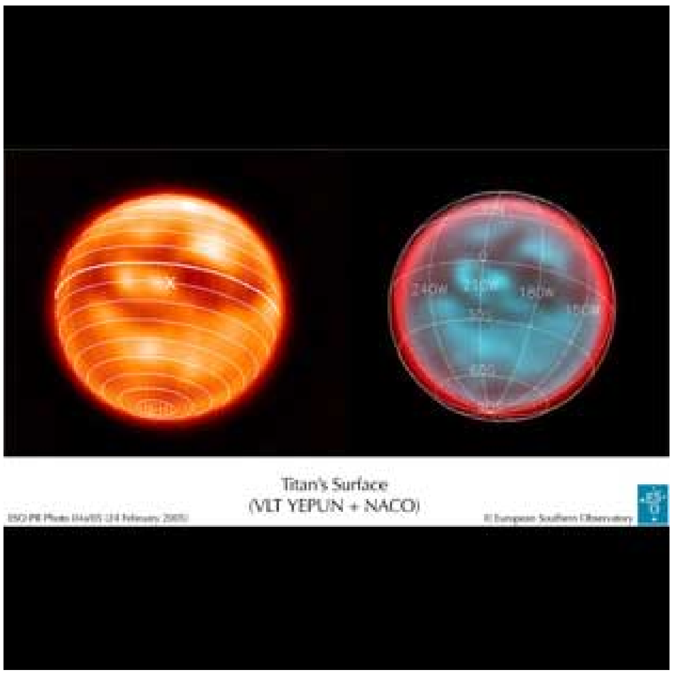

On January 14, 2005, the ESA Huygens probe arrived at Saturn's largest satellite, Titan. After a faultless descent through the dense atmosphere, it touched down on the icy surface of this strange world from where it continued to transmit precious data back to the Earth.

Several of the world's large ground-based telescopes were also active during this exciting event, observing Titan before and near the Huygens encounter, within the framework of a dedicated campaign coordinated by the members of the Huygens Project Scientist Team. Indeed, large astronomical telescopes with state-of-the art adaptive optics systems allow scientists to image Titan's disc in quite some detail. Moreover, ground-based observations are not restricted to the limited period of the fly-by of Cassini and landing of Huygens. They hence complement ideally the data gathered by this NASA/ESA mission, further optimising the overall scientific return.

A group of astronomers observed Titan with ESO's Very Large Telescope (VLT) at the Paranal Observatory (Chile) during the nights from 14 to 16 January, by means of the adaptive optics NAOS/CONICA instrument mounted on the 8.2-m Yepun telescope. The observations were carried out in several modes, resulting in a series of fine images and detailed spectra of this mysterious moon. They complement earlier VLT observations of Titan, cf. ESO Press Photos 08/04 and ESO Press Release 09/04.

The highest contrast images

The new images show Titan's atmosphere and surface at various near-infrared spectral bands. The surface of Titan's trailing side is visible in images taken through narrow-band filters at wavelengths 1.28, 1.6 and 2.0 microns. They correspond to the so-called "methane windows" which allow to peer all the way through the lower Titan atmosphere to the surface. On the other hand, Titan's atmosphere is visible through filters centred in the wings of these methane bands, e.g. at 2.12 and 2.17 microns.

Eric Gendron of the Paris Observatory in France and leader of the team, is extremely pleased: "We believe that some of these images are the highest-contrast images of Titan ever taken with any ground-based or earth-orbiting telescope."

The excellent images of Titan's surface show the location of the Huygens landing site in much detail. In particular, those centred at wavelength 1.6

micron and obtained with the Simultaneous Differential Imager (SDI) on NACO [4] provide the highest contrast and best views. This is firstly because the filters match the 1.6 micron methane window most accurately. Secondly, it is possible to get an even clearer view of the surface by subtracting accurately the simultaneously recorded images of the atmospheric haze, taken at wavelength 1.625 micron.

The images show the great complexity of Titan's trailing side, which was earlier thought to be very dark. However, it is now obvious that bright and dark regions cover the field of these images.

The best resolution achieved on the surface features is about 0.039 arcsec, corresponding to 200 km on Titan. ESO PR Photo 04c/04 illustrates the striking agreement between the NACO/SDI image taken with the VLT from the ground and the ISS/Cassini map.

The images of Titan's atmosphere at 2.12 microns show a still-bright south pole with an additional atmospheric bright feature, which may be clouds or some other meteorological phenomena. The astronomers have followed it since 2002 with NACO and notice that it seems to be fading with time. At 2.17 microns, this feature is not visible and the north-south asymmetry - also known as "Titan's smile" - is clearly in favour in the north. The two filters probe different altitude levels and the images thus provide information about the extent and evolution of the north-south asymmetry.

Probing the composition of the surface

Because the astronomers have also obtained spectroscopic data at different wavelengths, they will be able to recover useful information on the surface composition.

The Cassini/VIMS instrument explores Titan's surface in the infrared range and, being so close to this moon, it obtains spectra with a much better spatial resolution than what is possible with Earth-based telescopes. However, with NACO at the VLT, the astronomers have the advantage of observing Titan with considerably higher spectral resolution, and thus to gain more detailed spectral information about the composition, etc. The observations therefore complement each other.

Once the composition of the surface at the location of the Huygens landing is known from the detailed analysis of the in-situ measurements, it should become possible to learn the nature of the surface features elsewhere on Titan by combining the Huygens results with more extended cartography from Cassini as well as from VLT observations to come.

Notes

[1]: The team is composed of Eric Gendron, Athena Coustenis, Mathieu Hirtzig, Michel Combes, Pierre Drossart, and Alberto Negrao (LESIA, Paris-Meudon Observatory, France), Pascal Rannou (Univ. de Versailles, France), Markus Hartung (ESO), Tom Herbst (Max-Planck Institute for Astronomy, Heidelberg, Germany), Tobias Owen (IfA, Hawaii), Laird Close (University of Arizona, USA), Olivier Witasse and Jean-Pierre Lebreton (ESA/ESTEC).

[2]: Adaptive Optics (AO) systems work by means of a computer-controlled deformable mirror that counteracts the image distortion induced by atmospheric turbulence. Adaptive Optics is based on real-time optical corrections computed from image data obtained by a special camera at very high speed, many hundreds of times each second (see e.g. ESO Press Release 25/01 , ESO PR Photos 04a-c/02, ESO PR Photos 19a-c/02, ESO PR Photos 21a-c/02, ESO Press Release 17/02, and ESO Press Release 26/03 for earlier NACO images, and ESO Press Release 11/03 for MACAO-VLTI results).

[3]: Titan is tidally-locked to Saturn, and hence always presents the same face towards the planet. To image all sides of Titan (from the Earth) therefore requires observations during almost one entire orbital period, 16 days. The trailing hemisphere is the one we see when Titan moves away from us in its course around Saturn. The leading hemisphere is the one on the other side.

[4]: The Simultaneous Differential Imager is a novel optical device that provides four simultaneous high-resolution images at three wavelengths around a near-infrared atmospheric methane absorption feature. The main application of the SDI is high-contrast imaging for the search for substellar companions with methane in their atmosphere, e.g. brown dwarfs and giant exoplanets, near other stars. However, as the present photos demonstrate, it is also superbly suited for Titan imaging. (see ESO PR 09/04 and PR 02/05 for more details).