CHARACTERIZING TITAN'S HAZE WITH A BALLOON-BORNE SPECTROPOLARIMETER

N. SILVESTRI*, D. M. STAM, J. M. SMIT AND J. H. H. RIETJENS

SRON Netherlands Insitute for Space Research
n.silvestri@sron.nl, d.m.stam@sron.nl, j.m.smit@sron.nl, j.h.h.rietjens@sron.nl

ABSTRACT

Saturn's moon Titan is covered by several haze layers. Information on the number density, the composition, size, and shape of the haze particles as functions of the altitude is key to understanding the atmosphere's complex hydrocarbon cycle. For a spacecraft instrument, the highest haze layers hamper the view on lower layers. Instead, a balloon floating through Titan's thick atmosphere, as proposed in the Tandem/Titan Saturn System Mission to ESA, appears to be the ideal in-situ element for the desired science goals. The haze particles can be studied by a balloon instrument that measures scattered sunlight that has been transmitted through the haze. In particular the degree of (linear) polarization of this light is known to be very sensitive to the properties of the scattering particles [1]. The DISR instrument on the Huygens probe also had polarimetric capabilities for studying Titan's atmosphere [2].

We will present SPEX (Spectropolarimeter for Planetary EXploration) as payload for a Titan balloon. SPEX measures the flux F and degree of polarization P of scattered sunlight from 350 to 800 nm, with 2 (F) to 20 nm (P) spectral resolution. SPEX uses birefringent crystals to modulate the flux spectrum with P [3]. The main advantages of this novel technique are that F and P are measured simultaneously, and without moving parts. SPEX has originally been designed as Mars orbiter payload, with 7 fixed nadir and 2 fixed limb-viewing apertures. We will illustrate SPEX' capabilities as balloon payload with numerically simulated SPEX observations, choosing appropriate viewing angles. We calculate [4] the scattered sunlight in Titan's atmosphere below the main haze layers, modeling the haze particles as aggregates [5], and using the haze vertical profile described by [6]. Our simulations cover the whole spectral range of SPEX.

Our simulations show that no major adaptations are required when using SPEX as designed for Mars on a Titan balloon. An improvement on the science return could be obtained by increasing the spectral resolution of the polarization modulation. This would increase the retrieved resolution of P across the methane absorption bands. The polarization across absorption bands holds information on the spatial distribution of haze particles. This spectral resolution increase can easily be achieved by increasing the thickness of the birefringent crystals in the SPEX pre-optics system.

1. Hansen, and Travis, Space Sci. Rev., **16**, 527-610, 1974
2. Tomasko, et al., Space Sci. Rev., **104**, 469-551, 2002
3. Snik, Karalidi, and Keller, Appl. Opt., **48**, 1337-1346, 2009
4. De Haan, Hovenier, and Bosma, Astron. Astrophys., **183**, 371-391, 1987
5. Skorov, Keller, and Rodin, Planet. Space Sci., **56**, 660-668, 2008
6. Tomasko et al., Planet. Space Sci., **56**, 669-707, 2008

· For more information on SPEX, see: www.sron.nl/spexinstrument