

**TITAN'S GAS BEHAVIOR DURING THE SOUTH POLE FALL.** V. Cottini<sup>1,2</sup>, C. A. Nixon<sup>2</sup>, R. K. Achterberg<sup>1,2</sup>, D. E. Jennings<sup>2</sup>, N. Gorius<sup>3,2</sup> and P. G. J. Irwin<sup>4</sup>, <sup>1</sup>Department of Astronomy, University of Maryland at College Park, College Park, MD 20742, USA (valeria.cottini@nasa.gov), <sup>2</sup>Planetary Systems Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, <sup>3</sup>Department of Physics, The Catholic University of America, Washington, DC 20064, USA, <sup>4</sup>Atmospheric, Oceanic and Planetary Physics, University of Oxford, Parks Rd., Oxford, OX1 3PU, UK.

**Introduction:** Titan's southern middle atmosphere has been showing several changes since fall season started in 2009 and winter was approaching. In 2012 a large cloud was observed by Cassini in both the visible and infrared in the south pole at about 300 km [1], [2], [3] and appeared to grow rapidly. Temperatures at the south pole has become very low and condensation and gas concentration at the South Pole increased [3], [4]. The South Polar cloud shape has evolved in time and by the end of 2013 its thermal emission at  $220\text{ cm}^{-1}$  showed a collar/ring shape, centered on the atmospheric axis. Some gases as  $\text{HC}_3\text{N}$ ,  $\text{C}_4\text{H}_2$  and  $\text{C}_6\text{H}_6$  showed a ring shape as well in their emissions [5], [6].

In this work we will show the results of gas abundances retrievals in the South Pole - including some complex molecules as benzene - and their latitudinal variation changes as the cold season is evolving in time.

To retrieve the gas abundances we analyzed several Cassini Composite InfraRed Spectrometer (CIRS [7]) mid-infrared observations of the South Pole acquired during 2013-2014 and averaged in bins of latitude and emission angle, being the last one important to correctly model the atmospheric path. The data coordinates are converted in order to be centered on the atmospheric pole, which is about 4 deg shifted from Titan's south pole [8] and they refers to an altitude of 1 mbar and not to the surface. Temperature profiles are computed from the same data and latitudes from CIRS Focal Plane 4 spectra of methane. We first measure stratospheric temperatures from the same data and latitudes from the  $\nu_4$  band of methane centered around  $1300\text{ cm}^{-1}$ . We retrieve the temperature profiles applying a radiative transfer forward model combined with a non-linear optimal estimation inversion method [9]. We then retrieve the main gases abundances and track their variation with latitude using the same method.

Latitudinal changes of the main Titan's gas -  $\text{HC}_3\text{N}$ ,  $\text{C}_4\text{H}_2$ ,  $\text{C}_6\text{H}_6$ ,  $\text{C}_2\text{H}_2$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_3\text{H}_8$  and  $\text{HCN}$  - show different trends in the Southern polar regions over 2014, when winter is getting closer. We do observe a ring-shape in some of the gas abundances, with a local maximum peak around -75 deg of latitude. We do observe also an increase of abundance of most of the gases toward the south pole, as seen previously in the North during the winter. The observed increase of benzene

over the South pole is definitely evident and strong.  $\text{CO}_2$  is instead constant, as expected due to its homogeneity in the atmosphere. The ring-shape is possibly correlated with the ring-shape observed in the same maps both in the haze and in the gas thermal emissions. Ring morphology continues to evolve during 2014, decreasing and disappearing, with changes observed over month timescales (from one flyby to the next).

**References:** [1] West, R. A. et al. (2013) *BAAAS*, 45, 305.03. [2] Jennings, D. E. et al. (2012) *ApJ*, 754, L3. [3] de Kok, R. et al. (2014), *Nature*, 514, 7520, 65-67. [4] Vinatier S. et al. (2015) *Icarus*, Volume 250, p. 95-115. [5] Jennings et al. (2014) *AAS*, DPS meeting #46, #102.09. [6] Coustenis, A., et al., (2014) *AAS*, DPS meeting #46, #102.09. [7] Flasar et al. (2004) *Space Sci. Rev.*, 115, 169-297. [8] Achterberg, R. K. et al. (2008) *Icarus*, 197, 549. [9] Irwin, P.G.J. et al. (2008) *J. Quant. Spectrosc. Radiat. Trans.*, 109, 1136-1150.