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Evolution of Titan's stratospheric properties near the poles since the northern spring equinox

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Since 2010, we observe the appearance at Titan's south pole of several trace species for the first time, such as HC3N and C6H6, observed only at high northern latitudes before equinox. Since 2012 this situation has rapidly evolved with a strong enhancement of gases and condensates in the South pole. We will present an analysis of spectra acquired by Cassini/CIRS at high resolution from 2012 in nadir mode. We investigate here latitudes poleward of 50°S and 50°N from 2010 (after the Southern Autumnal Equinox) until 2014 (Coustenis et al. 2015). For some of the most abundant and longest-lived hydrocarbons (C2H2, C2H6 and C3H8) and CO_2, the evolution in the past 4 years at a given latitude is not very significant within error bars especially until mid-2013. In more recent dates, these molecules show a trend for increase in the south. This trend is dramatically more pronounced for the other trace species, especially in 2013-2014, and at 70°S relative to 50°S. These two regions then demonstrate that they are subject to different dynamical processes in and out of the polar vortex region. For most species, we find higher abundances at 50°N compared to 50°S, with the exception of C3H8, CO_2, C6H6 and HC3N, which arrive at similar mixing ratios after mid-2013 (Coustenis et al. 2015). While the 70°N data show generally no change with a trend rather to a small decrease for most species within 2014, the 70°S results indicate a strong enhancement in trace stratospheric gases after 2012. The 663 cm-1 HC3N and the C6H6 674 cm-1 emission bands appeared in late 2011/early 2012 in the south polar regions and have since then exhibited a dramatic increase in their abundances. At 70°S HC3N, HCN and C6H6 have increased by 3 orders of magnitude over the past 3-4 years while other molecules, including C2H4, C3H4 and C4H2, have increased less sharply (by 1-2 orders of magnitude). This is a strong indication of the rapid and sudden buildup of the gaseous inventory in the southern stratosphere during 2013-2014, as expected as the pole moves deeper into winter shadow. Subsidence gases that accumulate in the absence of ultraviolet sunlight, evidently increased quickly since 2012 and some of them may be responsible also for the reported haze decrease in the north and its appearance in the south at the same time (Jennings et al. 2015).

References: Coustenis et al. (2015), Icarus in press; Jennings et al (2015), ApJ 804, L34, 5pp.