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TITLE: Seasonal changes in Titan's weather patterns and the evolution and implications of accompanying surface changes

AUTHORS (FIRST NAME, LAST NAME): Elizabeth P Turtle[1], Jason Perry[2], Alfred S. McEwen[2], John M Barbara[3], Anthony D Del Genio[3], Robert A West[4], Jason W Barnes[5], Alexander Hayes[6], Ralph D Lorenz[1], Jonathan I Lunine[6], Ellen R Stofan[7], Emily L Schaller[8], Rosaly M C Lopes[4], Trina L Ray[4]

INSTITUTIONS (ALL): 1. JHU Applied Physics Lab., Laurel, MD, United States. 2. Univ. Arizona, Tucson, AZ, United States. 3. NASA GISS, New York, NY, United States. 4. JPL, Pasadena, CA, United States.

5. Univ. Idaho, Moscow, ID, United States. 6. Cornell Univ., Ithaca, NY, United States. 7. Proxemy Research, Rectortown, VA, United States. 8. NASA Dryden, Palmdale, CA, United States.

ABSTRACT BODY: Post-equinox changes in Titan's atmospheric circulation brought clouds and extensive methane rain to Titan's low latitudes [1,2]. Observations by Cassini ISS over the ~2 years since the storm revealed most of the changes to be short-lived; only a few darkened patches persisted through Fall 2011. In an unsaturated permeable medium, infiltration rates exceed 20 mm/week [3], so persistence of surface liquids over several months suggests either a shallow impermeable layer or that the local methane table lies close to the surface. Evaporation rates greater than 1 mm/week are predicted in equatorial regions [4] and rates of 20 mm/week have been documented at Titan's poles [5], thus areas where darkening persisted must be saturated ground at the level of a methane table or have had liquid ponded to depths of 2.5-50 cm.

Several smaller areas of surface brightening were also observed, a phenomenon that is less well understood. Cassini VIMS spectra of these regions do not match those of clouds or other surface units [6, 7]. Interpretations include cleaning by runoff [2] or deposition of a fine-grained volatile solid as the result of evaporative cooling [6, 7]. In general, brightening has persisted longer than darkening, but these areas are also reverting to their original appearance, which could constrain rates of evaporation/sublimation of the bright material or re-deposition of darker hydrocarbons by aeolian transport or precipitation from the atmosphere.

Cassini and Earth-based observers monitor Titan frequently (typically at least a few times per month), but few clouds have been observed since Fall 2010, which may indicate that enough methane was removed from the atmosphere and the lapse rate stabilized sufficiently that activity will not resume until the onset of convection at mid-northern latitudes later in northern spring. A similar lapse followed a 2004 outburst of south-polar clouds [8], which also appeared to produce significant rainfall [9].

[1] Turtle et al., GRL 38, L03203, doi:10.1029/2010GL046266, 2011. [2] Turtle et al., Science 331, 10.1126/science.1201063. 2011. [3] Hayes et al., GRL 35, L09204, 2008. [4] Schneider et al., Nature 481, doi:10.1038/nature10666, 2012. [5] Hayes et al., Icarus 211, 2011. [6] Barnes et al., LPSC XXXXIII, 2012. [7] Barnes et al., in revision. [8] Schaller et al., Icarus 184, 2006. [9] Turtle et al., GRL 36, L02204, doi:10.1029/2008GL036186, 2009.

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