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Titan's Surface Temperatures in the Thermal Infrared from Cassini CIRS

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During its seventeen years at Saturn the Composite Infrared Spectrometer (CIRS) on Cassini measured brightness temperatures over all latitudes on Titan. Through a window of low atmospheric opacity at 19 microns wavelength, where radiation from the surface reaches space (Samuelson et al. 1981), CIRS mapped surface temperatures in seven periods spanning 2004 to 2017. We have previously reported latitudinal, diurnal and seasonal variation in Titan's surface temperatures during part of the Cassini mission (Jennings et al. 2016; Cottini et al. 2012). Here we present seasonal dependences of surface temperatures over the entire mission and compare them with recently upgraded general circulation model (GCM) predictions for Titan's surface (Tokano 2019). Temperatures were mapped in 10-degree latitude increments from pole-to-pole and tracked in approximately two-year periods over almost two Titan seasons: winter through spring in the north and summer through autumn in the south. Temperatures over that time were generally close to 93 K at the equator and decreased by 1-4 K toward the poles. During the course of the mission the peak temperature moved in latitude from 12 S to 25 N, closely following the subsolar latitude. The north-south temperature distribution was nearly symmetric at equinox, similar to what was seen by Voyager one Titan year earlier. At the beginning of the mission the North Pole was at a temperature of 90 K and the South Pole was at 91 K. By late in the mission the pattern had reversed, with 92 K at the North Pole and 89 K at the South Pole. As the latitude distribution shifted northward the maximum temperature decreased, from 93.8 K at the beginning of the mission to 92.7 K at the end. There appeared to be a general suppression of temperatures in the north; the temperatures at high northern latitudes were below the early prediction (Tokano 2005) by about 1 K. We suggested that depressed surface temperatures in the north might be caused by evaporation from lakes and wet ground (Jennings et al. 2016). A recent GCM study by Tokano (2019) that includes effects of topography and methane hydrology closely matches the CIRS measurements at all latitudes and seasons. The new model explains the low northern temperatures as a consequence of greater surface moisture retention in the north that persists through the year. In the south, where our data show higher temperature overall, the surface is predicted to remain dry in most seasons and areas and to become wetted at most near the southern summer solstice when no observations by Cassini took place. CIRS measurements thus support the notion of a north-south seasonal asymmetry on Titan.

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