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When and where does it rain on Titan?

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Abstract

We study the temporal and spatial evolution of rain-wetted surface on the north pole of Titan to aid our understanding of seasonality of the methane cycle and its evolution through time. These observations would also enable us to explore the reasons GCM (General Circulation Model) predictions of northern summers differ from the observed rainfall/storm activity. Here, we report wet-sidewalk effect indicating fresh rainfall or near surface fog/cloud activity in at least three other observations of Titan's North Pole (apart from the first detection made in the T120 flyby [1]).

1. Introduction

Titan is the only place besides the Earth known to host a hydrological cycle. An axis tilt of 26°, similar to Earth, also causes seasons on this planet-like moon. As summer approached Titan's northern hemisphere (2009) the expected increase in storm and rain activity were not detected, whereas big cloud systems and storms [2, 3] were observed on Titan's South Pole during the southern summers. The contrast of storm and cloud activity in the two hemispheres over the summer, not forecasted by Titan's Global Circulation Models (GCMs), indicates a delay in the northern summer and is not consistent with current Titan weather models. We recently reported a bright feature in the Cassini VIMS (Visual and Infrared Mapping Spectrometer) [4] T120 observation (June 07, 2017) of Titan. The feature is a broad-specular reflection, similar to a wetted side walk after a rainfall event [4]. This reflection off of Titan's surface marks the detection of a potential rainfall event on the North Pole (using the wet-sidewalk effect) and heralds the arrival of northern summer on Titan. In this work, we conduct a temporal and spatial survey of the subsequent Cassini flybys (T121–T126) just before the end of the Cassini mission to systematically search for other potential rainfall events using the wet-sidewalk effect on the north pole of Titan. With the same purpose, we also look at previous flybys to identify any missed rainfall events.

2. Data and Methods

We go through the Cassini VIMS dataset (T100 onward) to detect any wet-sidewalk glints. We generate orthographic images of the Cassini flybys to observe any anomalously bright regions in the VIMS color composite (R: 5µm, G: 2µm, B: 1.3 µm). As a first identifier, the wet-sidewalk reflections look bright in this color scheme. Another color composite using a different wavelength combination (R: 5µm, G: 2µm, B: 2.75µm) differentiates the clouds and surface/near-surface. We call this color scheme the wet-sidewalk color composite (R: 5µm, G: 2µm, B: 2.75µm). Clouds take a purplish hue in this color composite while other features on surface or near surface take a reddish hue (Figure 1). We then use the RADAR and ISS maps of the North Pole to locate the region's location-solid or liquid. Spectral comparisons and simulations [5, 6] to understand the uniqueness for the bright regions are underway.

3. Summary and Conclusion

We have so far detected broad specular reflections from at least three other observations of Titan's North Pole (apart from the first detection made in the T120 flyby). This temporal variation study of broad specular reflections acts as a weather monitoring methodology for Titan and will help in understanding seasons and the long term climate of Titan. We haven't been able to separate the wet-sidewalk features from low surface fogs or clouds [7] that we are working on to hash out using a radiative transfer model [8].

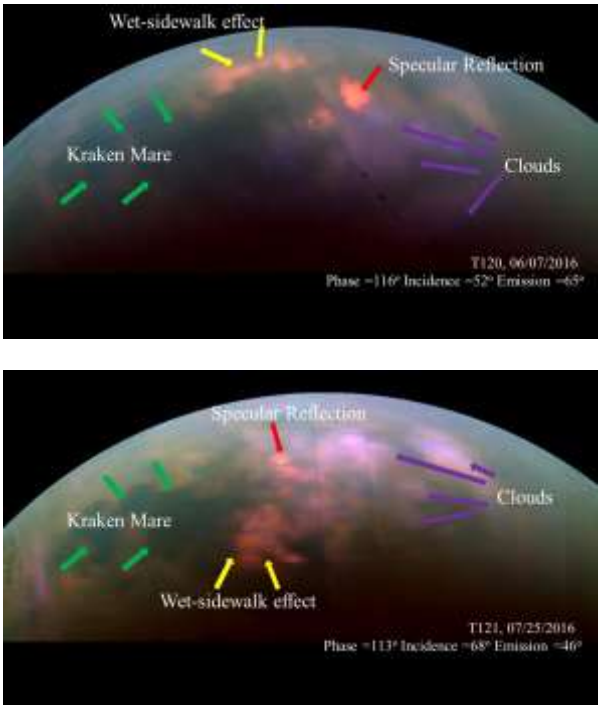

Figure 1: Titan's north pole showing wet sidewalk glints and clouds in wet-sidewalk color composite (R=5µm, G= µm, B=2.75 µm). Top shows the north pole of Titan (T120 flyby (June 07, 2016)) (b) T121 flyby in VIMS "wet-sidewalk color composite"

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