CASSINI VIMS SPECTRAL COMPARISON OF THREE BRIGHTENING EVENTS ON TITAN'S SURFACE. K. Farnsworth[1], J. M. Soderblom[2], T. Cornet[3], S. Rodriguez[4], V. Chevrier[1]. [1]University of Arkansas, Center for Space and Planetary Sciences FELD 202, University of Arkansas, Fayetteville, AR 72701. (kkfarnsw@email.uark.edu). [2]Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Sciences, 77 Massachusetts Ave, Cambridge, MA 02139. [3]European Space Astronomy Centre (ESA-ESAC), Villanueva de la Canada, Madrid, Spain. [4]Institut de Physique du Globe de Paris (IPGP), CNRS-UMR 7154, Université Paris-Diderot, USPC, Paris, France

Introduction: Titan and Earth are the only bodies in our solar system with stable liquids on their surfaces resulting from a hydrologic cycle. Because of Titan's distance from the sun, methane comprises its rain, while methane, ethane, and nitrogen are the main constituents in the lakes.

Two rain events have been unambiguously recorded by Cassini: one near the south pole in 2005 [1] and the other in the southern tropics in 2009 [2]. In both events, the surface initially darkened after clouds passed over the region [3]. Subsequently, the darkening of the 2005 event conformed to topography [3]. After the initial darkening, the surface brightened well past its original albedo; over the course of a month for the equatorial event and a year for the south polar event [3,4]. Finally, the equatorial region was observed to return to its original albedo ~9 months after the storm [4], while the south polar region was still bright 2+ years after the storm [3]. Wind erosion or freezing hydrocarbons are hypothesized to have caused the bright albedo [4]. Because of the persistence of the south polar brightening event and predicted low surface winds [5], the latter is a more likely candidate [3].

In this study, we propose to examine Cassini VIMS spectra of three brightened areas from the 2009 equatorial storm: Adiri, Yalaing, and Hetpet, which have observing geometries allowing an atmospheric correction using a plane-parallel approximation. Because of the high absorbance of atmospheric methane and scattering properties of tholins, it is difficult to determine an exact composition from the spectra. Therefore, this study focuses on the similarity/differences between these three events.

Through this investigation we seek to determine if the bright material observed during these two events have similar spectra and, therefore, similar composition. These results will allow us to determine if the resulting brightened regions were created by similar processes and indeed caused by the freezing of hydrocarbons

Methods: We use two VIMS cubes from flyby T76 and one from T79 that were atmospherically corrected using a radiative transfer (RT) model [6] that corrects for scattering and absorption in Titan's atmosphere. For each cube, we extracted spatial-averaged spectra of the bright units. We then compared both the average spectral shape across all of Titan's atmospheric windows and the detailed shape within two of the clearest windows: those at 2 and 5 µm.

Results: The average bright-unit spectra from Adiri, Yalaing, and Hetpet are presented in Fig. 1. The three units exhibit very similar spectra across the full VIMS-IR wavelength range. Looking more closely at the 2-µm window the spectral shape of the three units is very similar, with only a modest albedo difference between the three spectra (Fig. 2). At 5-µm, the spectra again display similar shape, though with greater variability (Fig. 3), likely reflecting the lower SNR of the data at 5 µm. Finally, spectral averages within the peaks of each window show very similar values at shorter wavelengths and higher variability at longer wavelengths.

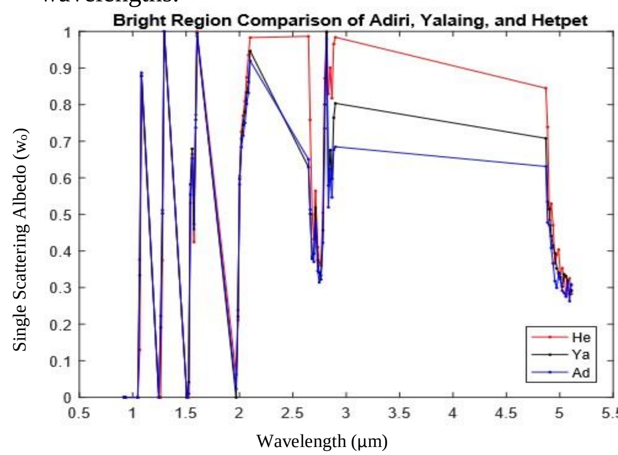

Figure 1. A spectral comparison of the averaged bright units observed at Adiri, Yalaing, and Hetpet.

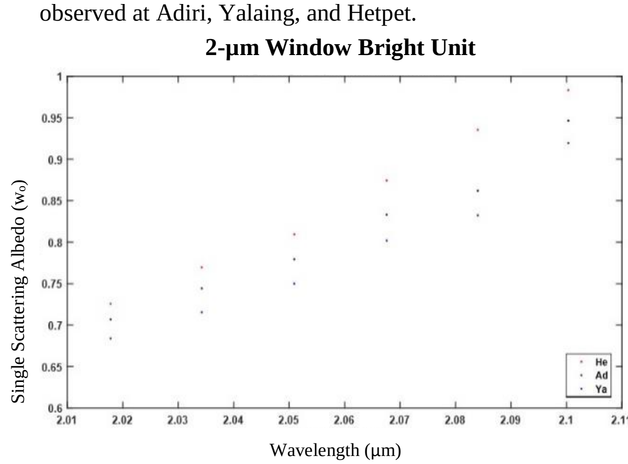

Figure 2. Comparison of Adiri, Yalaing, and Hetpet in the 2-µm window.

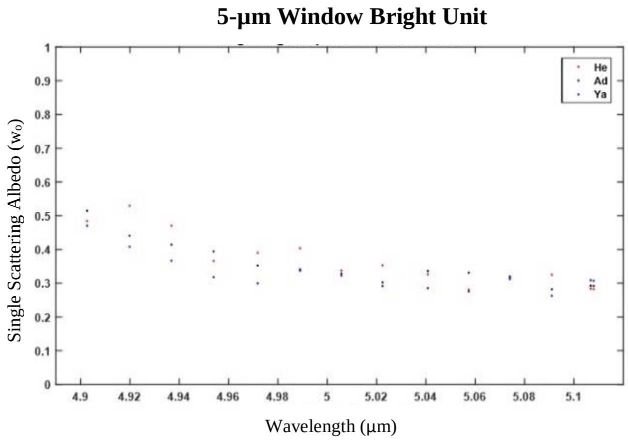

Figure 3. Comparison of Adiri, Yalaing, and Hetpet in the 5-µm window.

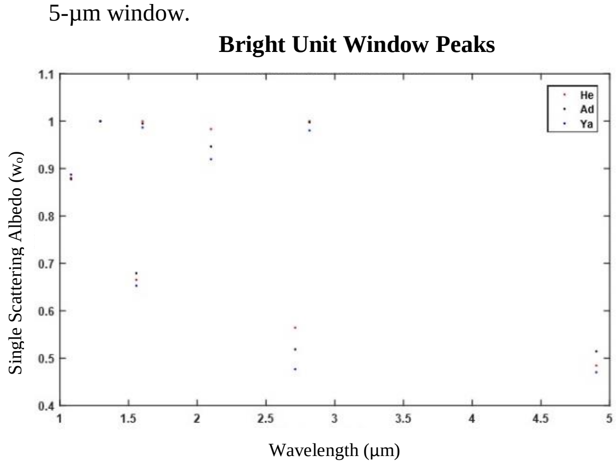

Figure 4. Comparison of surface albedo at the center of each atmospheric windows (averages of of spectral channels sensitive to surface – see figures 1 & 2) from Adiri, Yalaing, and Hetpet.

Discussion: The preliminary spectral comparison of the three equatorial brightening events is promising. While these three units indicate slight albedo differences, the overall shapes are relatively similar. We find Hetpet to be the brightest while Yalaing is the darkest. This discrepancy may result from residual errors in the radiative transfer correction from difference in viewing geometries (Table 1) — the Hetpet observation has a significantly higher emission angle. The minor deviation in albedo signifies a change in brightness but not necessarily a change in composition as the overall spectral shape is more indicative of a compositional change.

Future work includes comparing these results to Arrakis, a location in the south polar region associated with the 2005 storm. These results will help us to better understand the composition of Titan's rain and how it interacts with Titan's surface.

Location	*Phase*	*Incidence*	*Emission*
Adiri	23.94 °	34.97 °	13.88 °
Yalaing	42.38 °	40.39 °	21.33 °
Hetpet	45.35 °	31.36 °	53.81 °

Table 1. The average phase, incidence, and emission angles for each of the observations used in this study.

Conclusion: We use Cassini VIMS cubes to analyze three brightening events on Titan's surface: Adiri, Yalaing, and Hetpet. These cubes were atmospherically corrected using a radiative transfer model provided by Cornet, et al. [6]. Then the retrieved surface albedos from the bright units in each location were averaged and compared.

We find that the overall spectral shape of the bright material observed at Adiri, Yalaing, and Hetpet are very similar, but have slight differences in overall albedo. For example, Hetpet has a higher albedo, and is thus brighter, at almost all wavelengths. This discrepancy may be due to a difference in viewing geometries instead of differing compositions. Further analysis will elaborate on the similarities/differences of these three events.

Our next step is to use a curved-atmosphere approximation for the RT model to allow analysis of the south polar brightening observed within Arrakis Planitia. The results of this study will improve our understanding of the composition and processing of the fluids participating in Titan's hydrologic cycle.

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References: [1] Turtle E. P., et al. (2009) *GRL*, 36, L02204. [2] Turtle E. P., et al. (2011) *Sci.*, 331, 1414-1417. [3] Soderblom J. M., et al. (2014) *AAS DPS*, 46. [4] Barnes J. B., et al. (2013) *Planet. Sci.*, 2, 1. [5] Schneider T., et al. (2012) *Nature*, 481, 58-61. [6] Cornet, et al. (2017) *LPSC XLVIII*, Abstract #1847.