NATURE, DISTRIBUTION, AND ORIGIN OF TITAN'S UNDIFFERENTIATED PLAINS. R.M.C. Lopes[1], M.J. Malaska[1], A. Solomonidou[1,2], A. LeGall[3], M.A. Janssen[1], C.D. Neish[4], E.P. Turtle[5], S.P.D. Birch[6], A.G. Hayes[6], J. Radebaugh[7], A. Coustenis[2], A. Schoenfeld[1], B.W. Stiles[1], R. L. Kirk[8], K.L. Mitchell[1], E.R. Stofan[9], K.J. Lawrence[1] and the Cassini RADAR Team. [1]Jet Propulsion Laboratory / California Insititute of Technology, Pasadena, CA 98109. [2]LESIA, Observatoire de Paris, CNRS, UPMC Univ Paris 06, Univ. Paris-Diderot, Meudon, 92195, France. [3]Laboratoire Atmospheres, Milieux, Observations Spatiales (LATMOS), Universite Versailles Saint Quentin (UVSQ), Guyancourt, France. [4]Department of Physics and Space Sciences, Florida Institute of Technology, Melbourne, FL, 32901, USA. [5]Johns Hopkins Univ. Applied Physics Lab., Laurel, MD 20723, USA. [6]Astronomy Department, Cornell University, Ithaca, NY, USA. [7]Department of Geological Sciences, Brigham Young University, Provo, UT 84602, USA. [8]U.S. Geological Survey, Branch of Astrogeology, Flagstaff, AZ 86001, USA. [9]Department of Earth and Planetary Science, University College London, WC1E 6BT, UK. (Rosaly.M.Lopes@jpl.nasa.gov)

Abstract: The Undifferentiated Plains on Titan, first mapped by Lopes et al. [1], are vast expanses of terrains that appear radar-dark and fairly uniform in Cassini Synthetic Aperture Radar (SAR) images. While the interpretation of several other geologic units on Titan - such as dunes, lakes, and well-preserved impact craters - has been relatively straightforward, the origin of the Undifferentiated Plains has remained elusive. SAR images show that these "blandlands" are mostly found at mid-latitudes and appear relatively featureless at radar wavelengths, with no major topographic features. Their gradational boundaries and paucity of recognizable features in SAR data make geologic interpretation particularly challenging. We have mapped the distribution of these terrains using SAR swaths up to flyby T92 (July 2013), which cover > 50% of Titan's surface. We compared SAR images with other data sets where available, including topography derived from the SARTopo method and stereo DEMs, the response from RADAR radiometry, hyperspectral imaging data from Cassini's Visual and Infrared Mapping Spectrometer (VIMS), and near infrared imaging from the Imaging Science Subsystem (ISS). We examined and evaluated different formation mechanisms, including (i) cryovolcanic origin, consisting of overlapping flows of low relief or (ii) sedimentary origins, resulting from fluvial/lacustrine or aeolian deposition, or accumulation of photolysis products created in the atmosphere.

Data: The main dataset used in our study is from the Cassini RADAR instrument, a multimode Ku-band (13.78 GHz, λ=2.2 cm) radar instrument (Elachi et al., 2005b) designed to map the surface of Titan. Data from other Cassini instruments, the Visual and Infrared Mapping Spectrometer (VIMS) and the Imaging Science Subsystem (ISS) were also used. Mapping was carried out identifying individual features in shapefiles using the software ArcGIS 10.2. For general mapping of the Undifferentiated Plains, we used a scale of 1:1,500,000.

Interpretation of origin and nature. Our analysis strongly suggests that the Undifferentiated Plains, which cover vast expanses of Titan's mid-latitude regions, are sedimentary in origin [2]. The composition of the Undifferentiated Plains is consistent with organic rather than icy materials. We propose that aeolian activity was the major contributing process to the formation of the Undifferentiated Plains. Although contributions from photolysis is likely, a uniform photolysis deposit would produce compositional and structural uniformity on Titan's surface that is not seen in the data. Contributions from fluvial, lacustrine, or pluvial activity are also possible, as well as erosional activity from the Hummocky/mountainous and Labyrinth materials, but our analysis is not consistent with these being major contributing processes. There is strong evidence for aeolian movement on Titan's surface [3] and the distribution of Undifferentiated Plains, both at local and global scales, is consistent with aeolian deposition being the major process contributing to their formation. Since the Undifferentiated Plains do not have spectral and radiometric characteristics consistent with icy materials, they appear to be composed of insoluble organic materials which may have been cemented by an organic substance and/or wetted by methane. The Undifferentiated Plains represent an important reservoir of organic material on Titan.

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References: [1] Lopes, R.M.C. et al. (2010) *Icarus, 205*, 540-558. [2] Lopes, R.M.C., et al. (2016) *Icarus*, *270*, 162-182. [3] Malaska, M.J. et al. (2016) *Icarus*, *270*, 130-161.

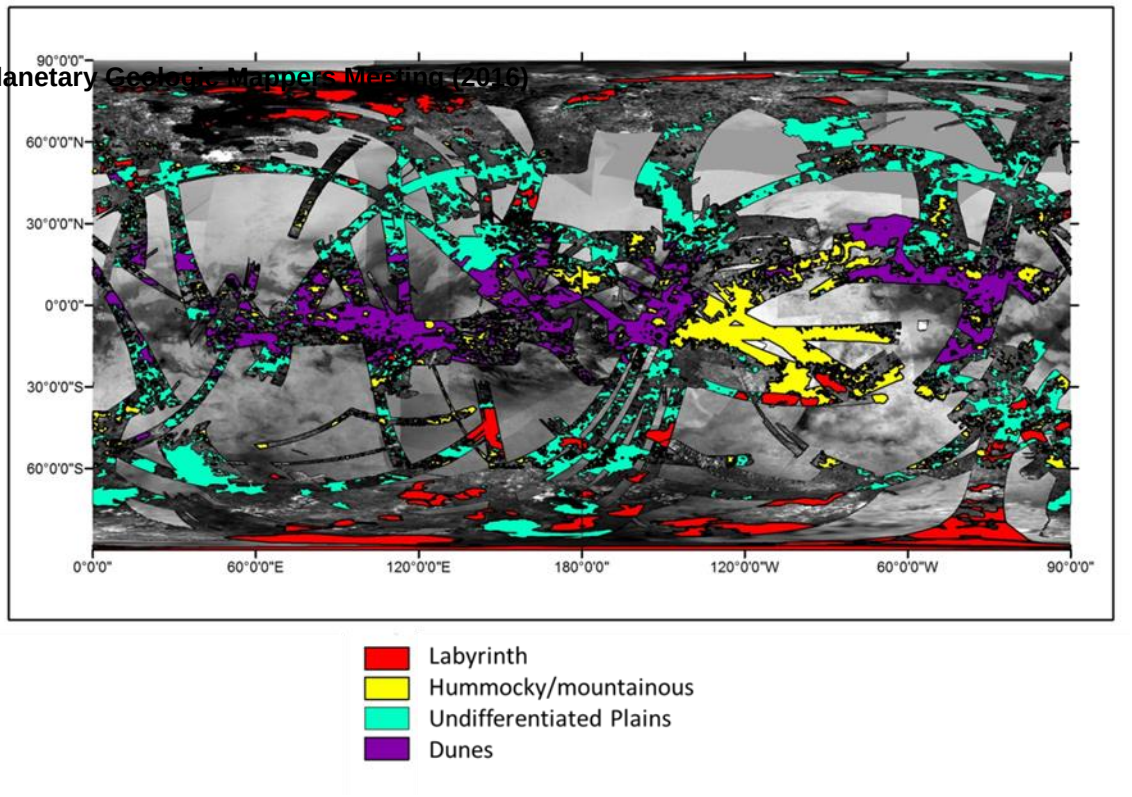

Fig. 1. Global distribution of Undifferentiated Plains (green) compared to other major geomorphologic units on Titan: Dunes (purple), Labyrinth (red), and Hummocky/mountainous terrains (yellow). Map is at 1:1,500,000. Some areas remain unmapped at this scale, either due to resolution constraints or because they were unclassified. The ISS global map (NASA/JPL-Caltech/Space Science Institute -PIA14908) is placed under the SAR swaths for context. From Lopes et al. [2]

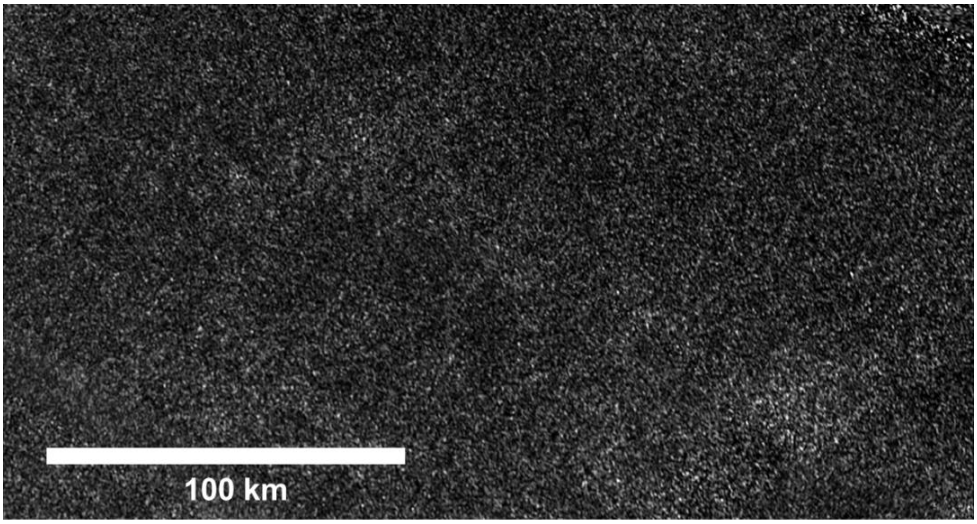

Fig. 2. Example of Undifferentiated Plains ("blandlands") in Cassini SAR data. These plains appear relatively homogeneous and dark in the SAR data. This image shows an area of ~36,000 km^2 located in Caladan Planitia centered near (16.3ºN, 217ºW). From Lopes et al. [2]