National Aeronautics and Space Administration

The surface of Titan and the interactions with the interior and the atmosphere from the analysis of Cassini VIMS and RADAR data

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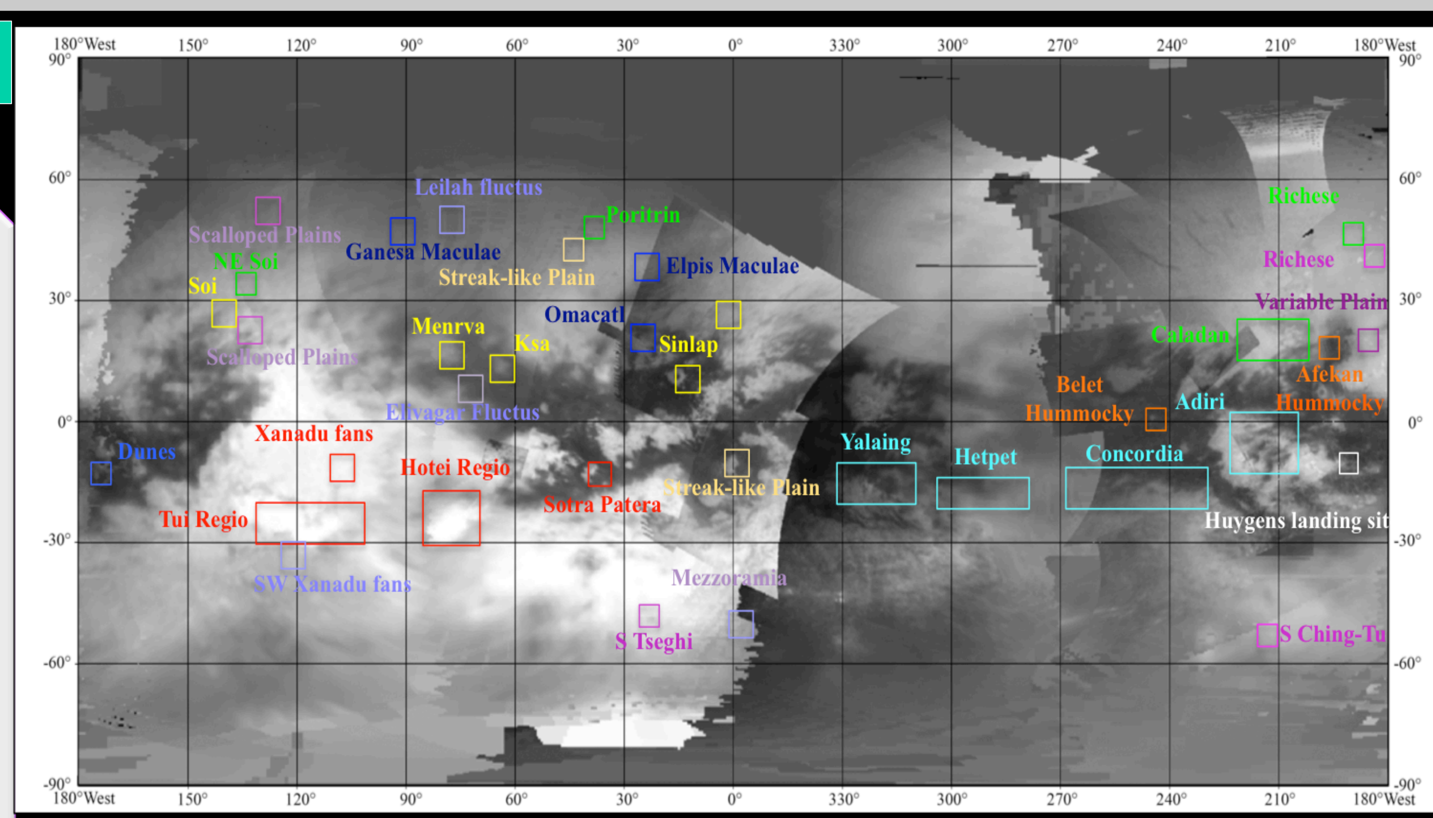
Introduction & Problem

Titan, Saturn's largest satellite, has a complex atmosphere and surface, making it a key area for planetary research.

Understanding the interplay of geologic processes on Titan is important for:

- ✧ **modelling the interior-surface-atmospheric interactions**
- ✧ **finding the CH_4 source**
- ✧ **climate evolution**
- ✧ **Unveiling surface compositions**
- ✧ **constraining habitability**

Geologically active areas could be utilized as future mission landing sites



- i. Undifferentiated Plains
- ii. Variable Plains
- iii. Streak-like Plains
- iv. Hummocky terrains
- v. Labyrinth terrains
- vi. Dunes
- vii. Candidate Evaporites
- viii. HLS
- ix. Candidate Cryovolcanics
- x. Alluvial Fans
- xi. Maculae
- xii. Impact Craters
- xiii. Scalloped Plains

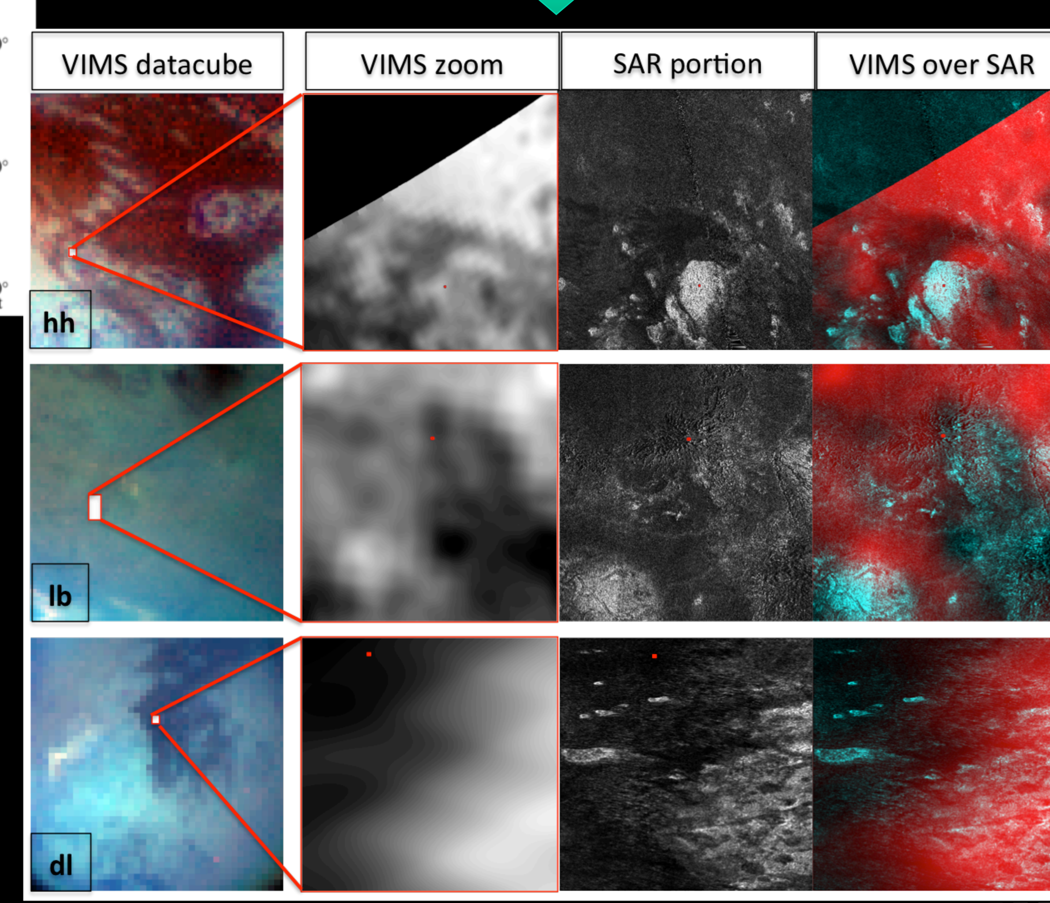
Selection of regions of interest (RoIs)

Selected regions of interest from the major geomorphological units on Titan as shown on Cassini VIMS mosaic map at 2.03 micron. The characterization of the areas is based on morphological and/or spectral characteristics from studies by Lopes et al. (2010;2016), Barnes et al. (2013), Malaska et al. (2011;2016), Niesh et al. (2015), Solomonidou et al. (2013;2014;2016), Radebaugh et al. (2016).

We use tools with updated parameters that have never been used before for the investigation of Titan's surface.

Selection of VIMS data with SAR as a base

Regions of interest and pixel selection from top to bottom: hummocky terrains (hh), labyrinth terrain (lb), dunes (dl). The 1st column shows the full VIMS datacube (R: 5.00mi, G: 2.03mi, B: 1.27mi) with observation geometries adequate for a plane-parallel approximation and good enough resolution (the red box surrounds the image shown in the 2nd column). The 2nd column shows a zoom-in of the region of interest based on the equivalent SAR resolution that is showed in the 3rd column; the red dot represent the center of location. Column 4 is a combination of the figures showed in 2nd (R:2.03mi/1.28mi, G:SAR, B:SAR) and 3rd column.



Data & Method

Studying Titan's surface requires specific tools

VIMS processed with Radiative Transfer code

✧ **aerosol and methane opacity characteristics**

All inferences of surface properties need to first account for the atmospheric contribution to the data.

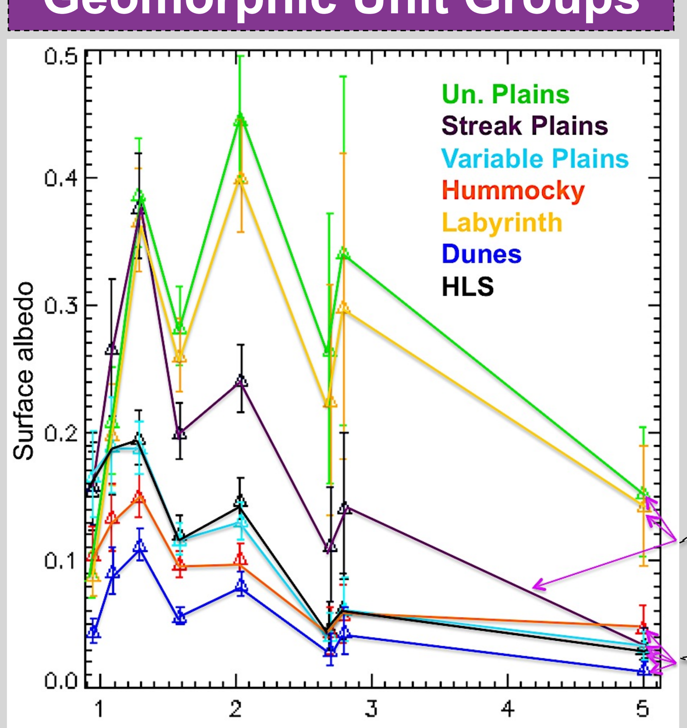
We evaluate whether surface features change appearance with time accounting for

- ✧ **atmosphere**
- ✧ **surface albedo**
- ✧ **Changes indicate active processes (possibly endogenic)**

Solomonidou et al. (2014; 2016)

Temporal Evolution Of Surface Albedo (Wrt To HLS)

Geomorphic Unit Groups



Based on surface albedo extractions

Group A:
Un. Plains
Labyrinth
Streak Plains

Group B:
Hummocky
Variable Plains
HLS
Dunes

RESULTS

Group A: ***Tholin-like material***

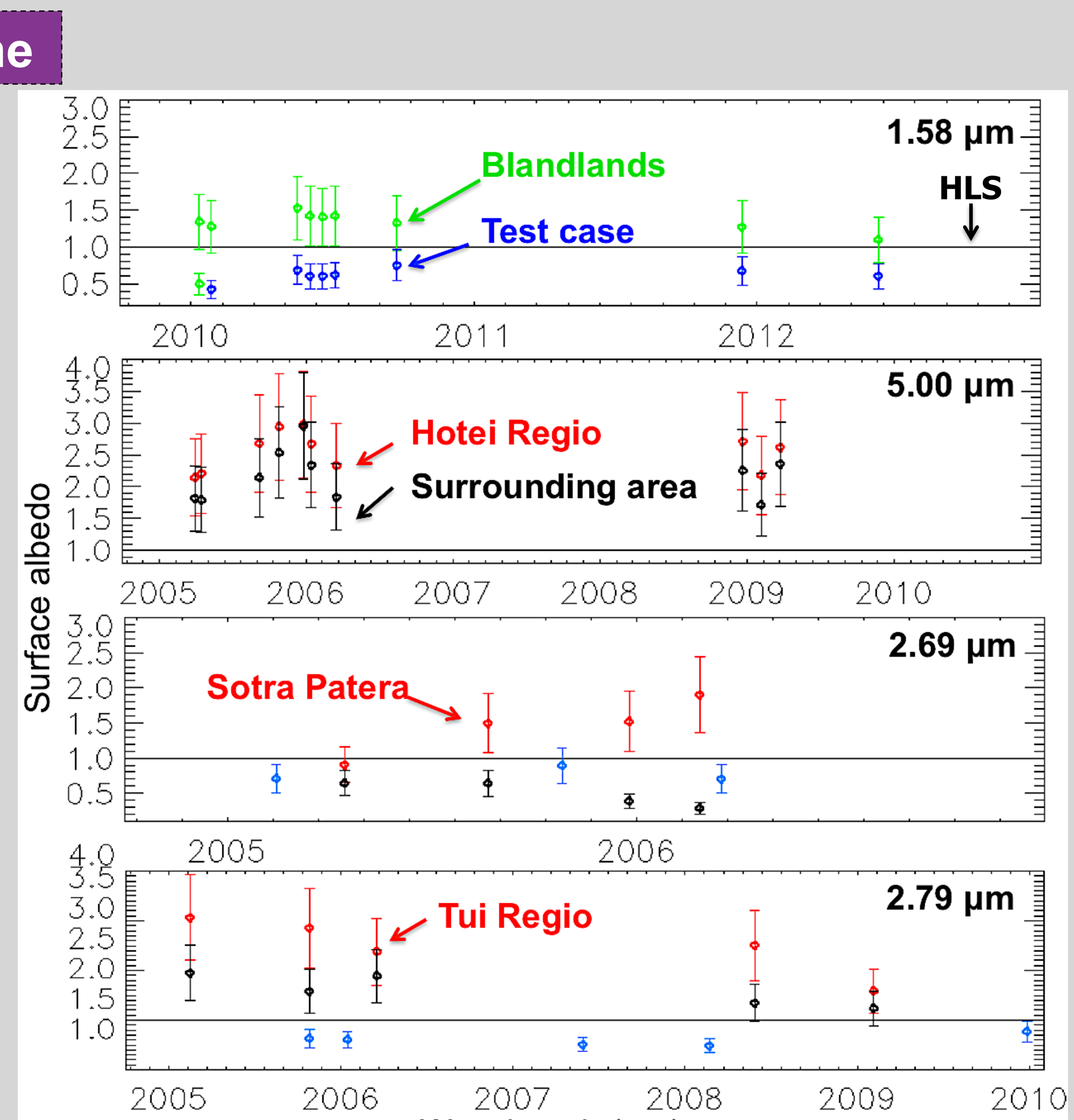
Group B: ***Very dark material***

Albedo As A Function Of Time

We tested the temporal evolution of:

Un. Plains
Cryo candidates
Dunes
Surrounding

Blandlands (2010-2012)
Hotei Regio (2005-2009)
Tui Regio (2005-2009)
Sotra Patera (2004-2006)
Test cases (dunes)



RESULTS

Blandlands **NO CHANGE**
Hotei Regio **NO CHANGE**
Tui Regio **50% DARKER**
Sotra Patera **2x BRIGHTER**

From Solomonidou et al. (2016); Sotin et al. (2016)

Conclusions and Next Steps

Tested areas	Change in albedo	Possible chemical compound
Tui Regio (2005-2009)	✓ (Solomonidou et al. 2016)	CO_2 (disappearance of CO_2 due to methane rainfall and cover up)
Hotei Regio (2004-2009)	✗ (Solomonidou et al. 2016)	-
Sotra Patera (2005-2006)	✓ (Solomonidou et al. 2016)	Deposition or exposure of bright material
Blandlands (2010-2012)	✗ (Solomonidou et al.; Lopes et al. 2016)	50-75% Tholin material
Test cases A,B,C (dune fields 2005-2012)	✗ (Solomonidou et al. 2016)	Bitumen material
Labyrinth, Streak Plains, Variable Plains Hummocky	Ongoing (Solomonidou et al. in prep.)	60-80% Tholin material 55% Tholin material 50-70% Bitumen material 40-65% Bitumen material
Evaporitic candidates (Yalaing, Hetpet, Concordia, Adiri)	Ongoing (Solomonidou et al. in prep.)	-
HLS (2004-2012)	ongoing (Sotin et al. in prep.)	-

ONGOING

The results of this analysis will shed light on geological process origination causing albedo changes with time.

Exogenic Processes

- ✧Evaporitic, fluvial, or lacustrine deposits
- ✧no connection to the interior
- ✧precipitation of methane rain and/or tholins

Endogenic Processes

- ✧Cryovolcanic deposits
- ✧Brightening or darkening due to resurfacing of an initially cryovolcanic terrain

IMPORTANCE

-energy
-methane reservoir
-interior/surface/atmosphere exchanges
-support for life

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