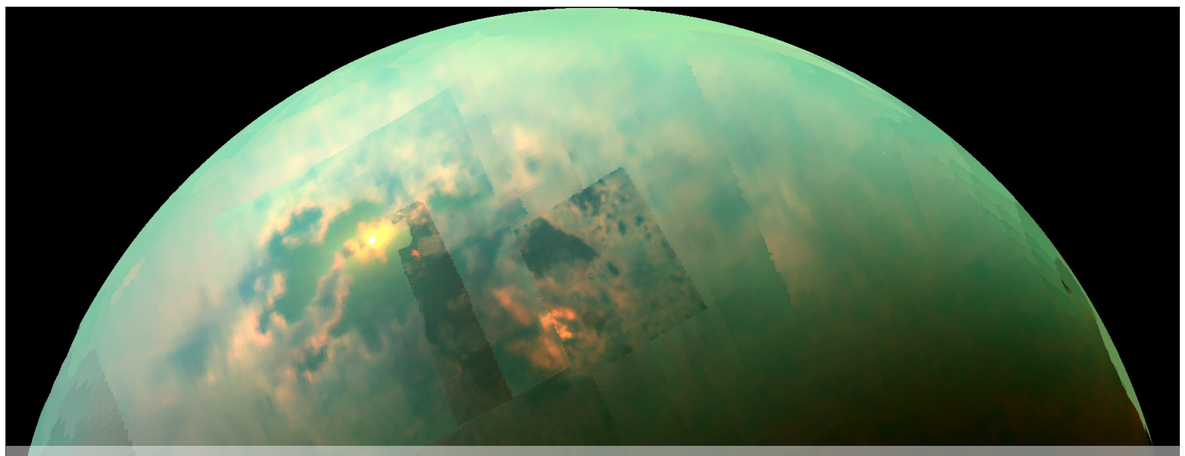
Titan's North Pole: Defining the Spectral Units

Shannon MacKenzie[1], Jason Barnes[1], Chase Chivers[1]
[1]Department of Physics, University of Idaho

Motivation

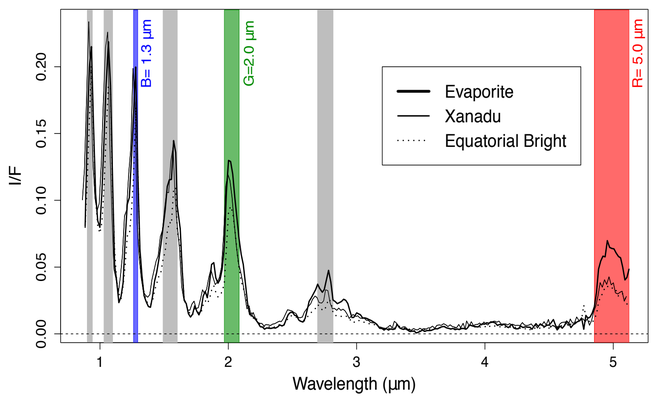


Saturn's moon Titan is the only moon with an active hydrological exchange between the surface and atmosphere. Titan's thick, hazey atmosphere rains methane onto the surface. And yet, most of the surface liquid on Titan is located at Titan's north pole. We do not fully understand what makes this region uniquely suitable for the numerous lakes and seas.

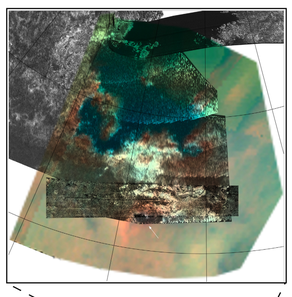
A recent study by Birch et al. (2016) mapped this region in the RADAR data set and suggested a sedimentological history based on their results. Cassini's Visual and Infrared Mapping Spectrometer (VIMS) is sensitive to the very near surface composition and thus can offer important contex to exploring Titan's north pole.

Data

VIMS has viewed Titan's north pole at high resolution (~a few km/pixel) during 6 flybys. VIMS can only see down to the surface of Titan in 7 wavelength windows. Even within these windows, surface reflected light is affected by atmospheric interactions.

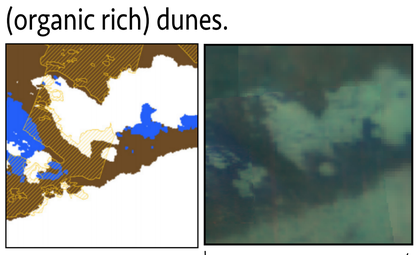


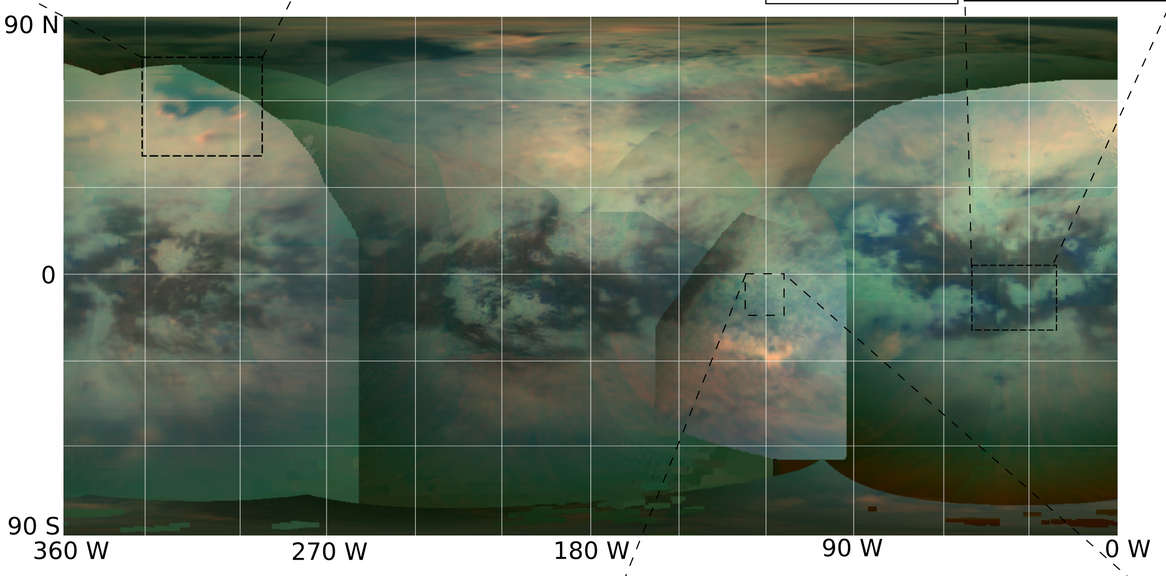
Given these limitations, it is difficult to discern definitive absorption features in VIMS spectra. Instead, we map the relative composition of Titan's surface by dividing regions of similar reflectance behavior into spectral units.



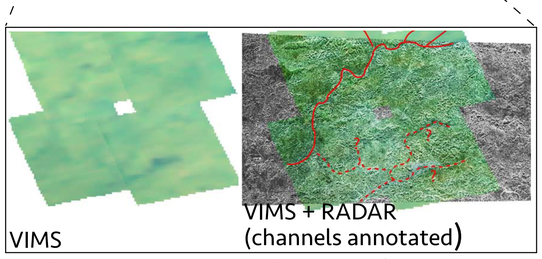
Uniquely dark blue liquid bodies (Kraken Mare and Hammar Lacus) surrounded by 5 um bright evaporites (pink) (MacKenzie et al. 2014)

Dark blue (water ice rich) units bordering the dark brown (organic rich) dunes. (Rodriguez et al. 2014)



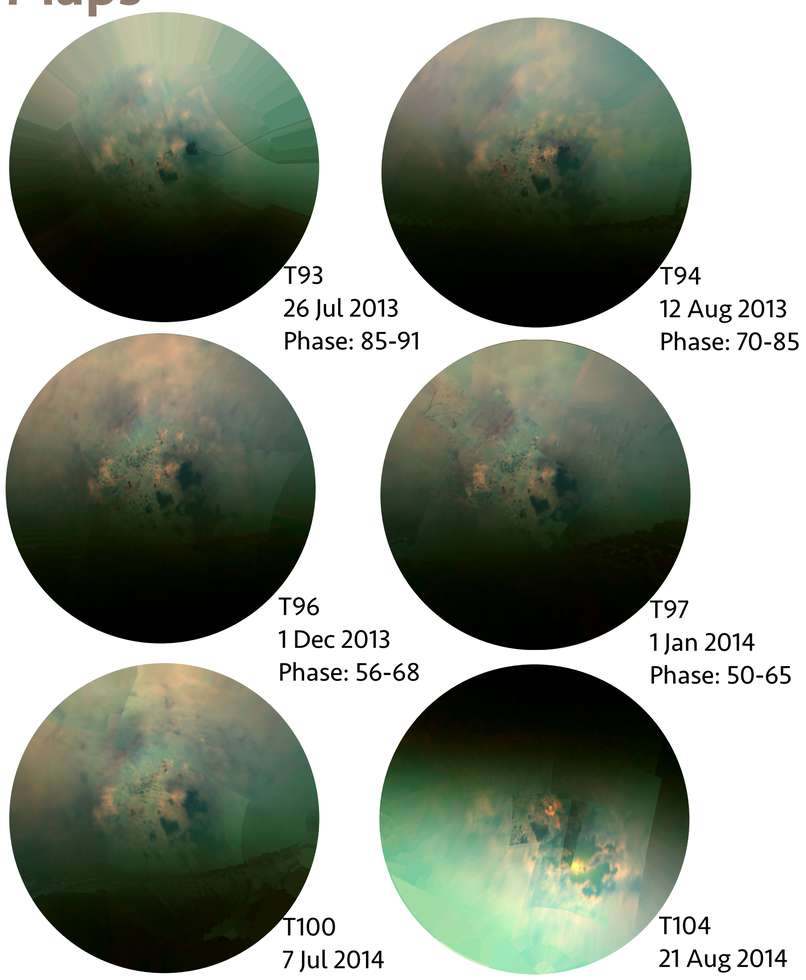


As in previous studies of other regions of Titan, we define the spectral units in the VIMS data over the north pole to provide the compositional context for understanding this enimatic region and to look for changes over the Cassini mission.



Bright green-blue Xanadu region (bright at 2 um and shorter wavelengths) and blue mountains and channels (Barnes et al. 2007)

Maps

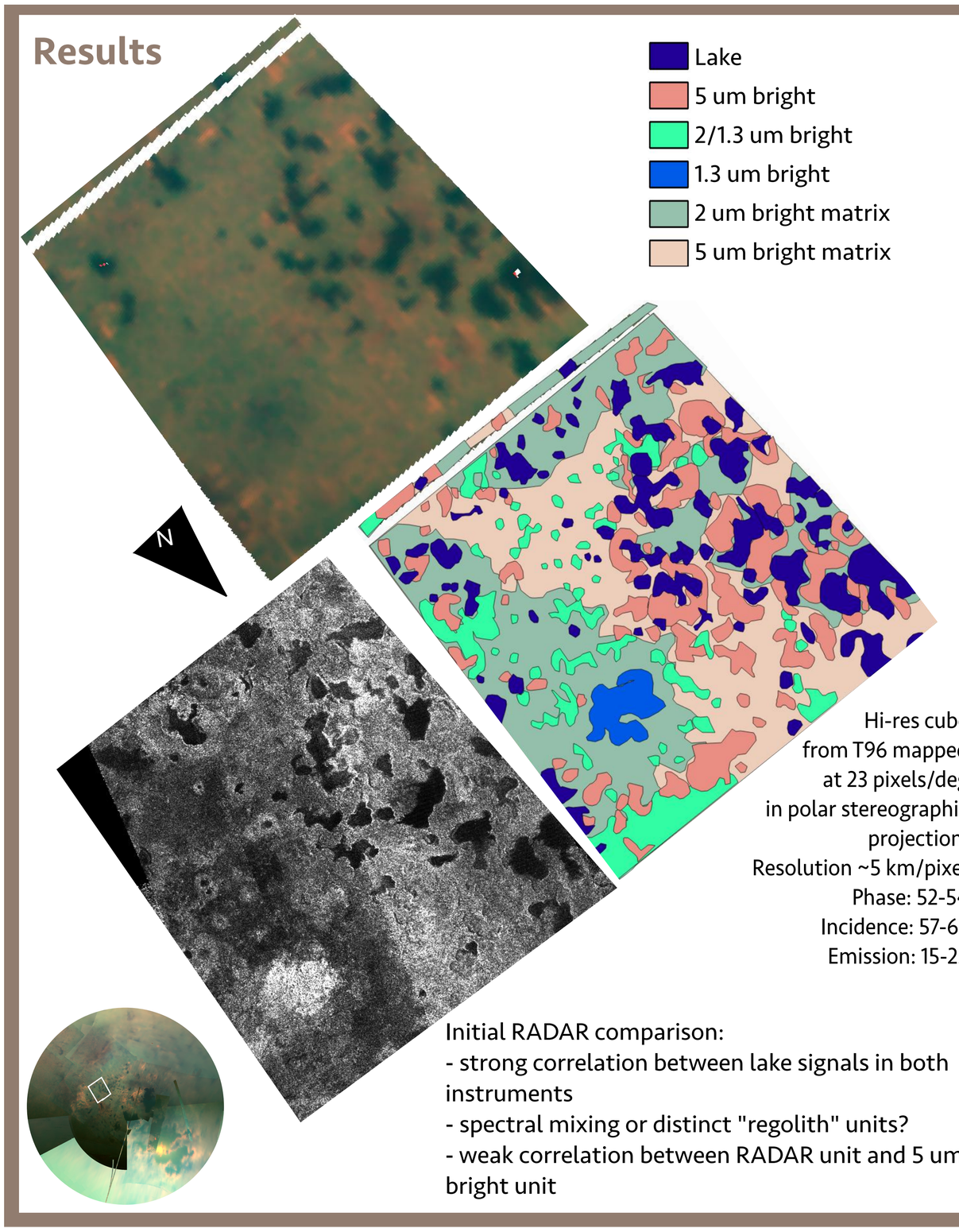


These six flybys cover different regions at various resolutions and viewing geometries, making temporal comparisons difficult, though not impossible.

The generally high phase angles also prevent the use of radiative transfer corrections that rely on the plane-parallel approximation. We therefore use the data as calibrated according to the newly updated VIMS pipeline.

Even coarser resolution images contain useful information: the degree of spectral mixing often allows for analysis.

Results



Hi-res cube from T96 mapped at 23 pixels/deg in polar stereographic projection.
Resolution ~5 km/pixel
Phase: 52-54
Incidence: 57-67
Emission: 15-23

Initial RADAR comparison:
- strong correlation between lake signals in both instruments
- spectral mixing or distinct "regolith" units?
- weak correlation between RADAR unit and 5 um bright unit

Special thanks to the OPAG committe for providing travel support. This work was supported by NASA Headquarters under theNASA Earth and Space Science Fellowship Program — grant NNX14AO30H to S.M.M.