EPSC Abstracts
Vol. 6, EPSC-DPS2011-480, 2011
EPSC-DPS Joint Meeting 2011

Titan's Northern Lakes at 5 microns

K. J. Lawrence(1), C. Sotin(1), B. Reinhardt (1), J. W. Barnes(2), R. H. Brown(3), A. G. Hayes(1), S. Le Mouélic(4), B. J. Buratti(1), R. N. Clark(5), S. Rodriguez(6), L. A. Soderblom(7), R. Jaumann(8), J. M. Soderblom(3), K.Stephan(8), K. H. Baines(1), P. D. Nicholson(9).

(1) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA. (Kenneth.J.Lawrence@jpl.nasa.gov); (2) Department of Physics, University of Idaho, Engineering-Physics Building, Moscow, ID 83844, USA; (3) Department of Planetary Sciences, University of Arizona, Lunar and Planetary Laboratory, 1629 E. University Blvd., Tucson, AZ 85721, USA; (4) Laboratoire de Planétologie et Géodynamique, CNRS-UMR 6112, Université de Nantes, 2 rue de la Houssinière, 44322 Nantes, France ; (5) United States Geological Survey, Mail Stop 964, Box 25046, Denver Federal Center, Denver, CO 80225, USA; (6) Laboratoire AIM, Université Paris Diderot – Paris 7/CNRS/CEA-Saclay, DSM/IRFU/SAp, France ; (7) United States Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001, USA; (8) DLR, Institute of Planetary Research, Rutherfordstrasse 2, D-12489, Berlin, Germany; (9) Department of Astronomy, Cornell University, 418 Space Sciences Building, Ithaca, NY 14853, USA.

Introduction

The Cassini mission, currently in orbit about Saturn, is a joint NASA, ESA and Italian space agency effort. During the Cassini Equinox Mission (the first extended mission from 2008 – 2010), the Visual and Infrared Mapping Spectrometer (VIMS) was allocated three flybys at closest approach. VIMS is able to acquire hyperspectral images in 352 channels from 0.3 to 5.2 μm [1]. Since August 2009, the beginning of Titan's spring, the North Pole has been illuminated. Despite being encased in a thick atmosphere, the surface of Titan can be observed in seven narrow atmospheric windows with VIMS [2]. These windows are centered at 0.93, 1.08, 1.27, 1.59, 2.03, 2.70 and 5.0 microns. The images acquired in June 2010, during the flyby labeled T69, allowed us to study the large Ligeia Mare, numerous small lakes and the solid surface near the North Pole. The goal of these observations was to mosaic the illuminated North Pole region. The VIMS mosaic overlaps and complements the radar images from 2007 [3] (Fig. 1, left).

Observations

The sequence of images for this observation began fifteen minutes prior to closest approach. At closest approach, Cassini was at an altitude of 2050 km over Titan's North Pole region. Images of 64x64 pixels were obtained at integration times from 60 to 240 ms. Line-mode data were obtained when the spacecraft's tangential velocity, relative to Titan, was on the order of 6 km/sec. Mosaics of the large images were assembled using three spectral windows centered at 2.03 μm, 2.71 μm and 5.02 μm and projected using a polar orthographic projection centered on the North Pole. The mosaic at 5 μm, which is the less sensitive to the blurring effect of atmospheric aerosols, is shown in Figure 1, right.

Ligeia Mare

Ligeia Mare, one of three large lakes near Titan's North Pole, was observed at high and medium resolution with pixel scales between 3 and 7 km. With incomplete radar coverage, the question as to the extent of the large Mare remains. It appears, within the VIMS data, that the southwestern tip of Ligeia extends to Kraken Mare, a second large lake, such that the two bodies seem to be connected by a swamp-like area or rivers smaller than the VIMS pixel size. So far, this area has not been observed by

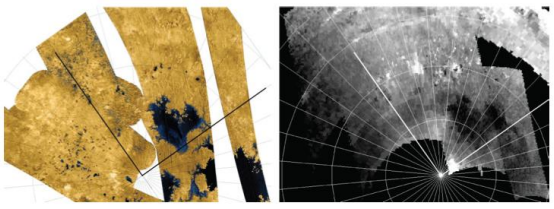

Figure 1: The comparison of the VIMS 5-μm mosaic (right) obtained during T69 and the radar mosaic (left) of the same location from T28 and T29. Longitudes 90E and 180 are bold to ease identification.

radar, but was imaged by the ISS imaging system [4]. The contour of the Ligeia Mare shoreline was examined in the radar and VIMS data and the surface area was determined to be approximately 125,000 km^2 in both.

The Small Lakes

The VIMS T69 mosaic has confirmed all of the small lakes previously discovered by radar. Furthermore, the VIMS mosaic shows four additional lakes. Of these four, three have been named by the International Astronomical Union in April 2011. We have determined the position of the central point of all the small lakes. There is a strong correlation between the locations of the lakes in the two data sets.

The small lakes observed in the VIMS and radar data sets allow us to constrain Titan's orbital parameters and test the non-synchronous rotation between April 2007 and June 2010. The difference between the locations of the lakes has a standard deviation of 0.194° (8.7 km) and 0.264° (4.1 km) in latitude and longitude, respectively. These values are on the order of the VIMS pixel scale and provide an upper bound for a potentially non-synchronous rotation of $2.3.10^{-4}$ °/day. This value is 50% smaller than the corrected valued reported by Stiles et al. [5].

Summary and Conclusions

The VIMS mosaic obtained from the T69 Titan flyby overlaps and complements the radar images from 2007 with an excellent correlation between the numerous small lakes and mare. The location of the shoreline of Ligeia Mare in both data sets is similar and, therefore, suggests that the liquid filling is not changed significantly. The surface area is no more than 125,000 km^2. VIMS observations also suggest a connection between Kraken and Ligeia Mares by either a well-defined rivers or a "swamp" area. The observations of distinct surface features, such as the small lakes, at different epochs can be used to constrain Titan's orbital parameters. An upper limit for the non-synchronous rotation between 2007 and 2010 of $2.3.10^{-4}$ °/day has been determined.

Acknowledgements

We thank the VIMS team for the implementing the observations. The research described here has been carried out, in part, at the Jet Propulsion Laboratory, California Institute of Technology under contract with NASA.

References

[1] Brown, R. H., et al., "The Cassini Visual and Infrared Mapping Spectrometer Investigation," *Space Sci. Rev*s. 115, 111-168, 2004.

[2] Sotin, C., et al., "Release of volatiles from a possible cryovolcano from near-infrared imaging of Titan," Nature 435 (7043), 786–789, 2005.

[3] Stofan, E.R., et al., "The lakes of Titan," Nature 445, pp. 61–64. 2007.

[4] Turtle, E. et al. "Cassini imaging of Titan's high-latitude lakes, clouds and south-polar surface changes," Geophys. Res. Lett., 36, 2009.

[5] Stiles, et al. Erratum: "Determining Titan's spin state from Cassini radar images" (2008, AJ, 135, 1669); Astronomical Journal, 139, 311, 2010.