# Enhancing geological and structural elements through PCA of SAR, integrated high-resolution radiometry and VIMS data on Titan

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**Introduction:** Where multiple image overlaps occur on Titan, the use of the Principal Component Analysis (PCA) allow the enhancement and extraction of unique information that can aid interpretation and mapping. SAR, high-resolution radiometry, VIMS and SARTopo data of several areas across Titan were considered, of which the Hotei Arcus example is reported here.

**Hotei Arcus:**
The Hotei Arcus area is characterized by a rim of bright terrain, defining the arc, and a mixture of bright and dark terrains within the basin enclosed by the arc. Evidence of basin infilling in association with channels has been previously suggested [1,2]. The basin formation is not clear, but it might have an impact origin or be a reactivation from the edge structure of the Xanadu region [3].

**SAR data** The Hotei Arcus is covered by 3 image-pairs encompassed by the overlap of T41-T43, T41-T121, and T43-T121. PCA technique was used to enhance surface elements based on look direction, incidence angle differences, and backscattering variance distribution. Image-pairs were co-registered, using as image based the image with the higher resolution encompassing the overlap of the analyzed image-pair [4]. Additional work is ongoing using multiple images, for instance T41, T43, and T121 to investigate results in higher order principal components, along with the use of despeckled SAR data [5] as input to PCA processing.

**Radiometry data:** High-resolution radiometry acquired during SAR passes is particularly helpful in delineating possible transition due to compositional or textural variations of the Titan's surface, with less sensitivity to geometry of observation than SAR data [6,7]. In particular, the correlation of radar bright terrains and radiometry cold areas suggest volume scattering while radiometrically warm regions are generally associated with dunes or basin infilling sediments of possible organic nature.

**SARTopo data**: SARTopo [8] is very useful in corroborating and quantifying PC's enhanced transitions and complementary to the information derived from the central beam high-resolution radiometry (Fig.1).

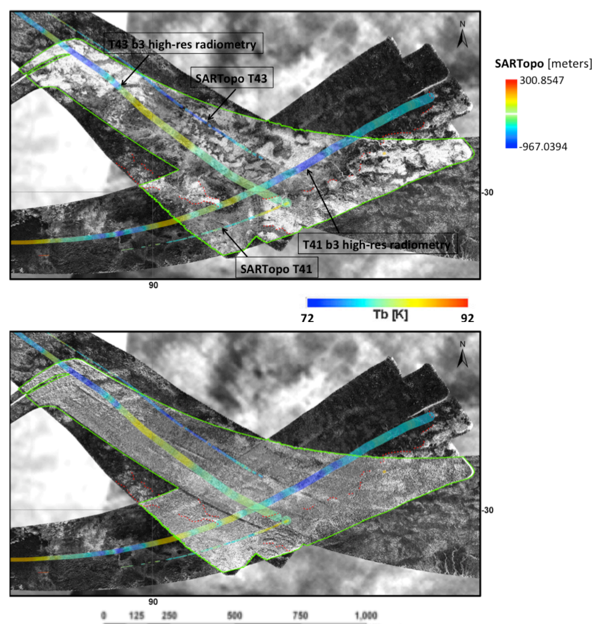


*Fig. 1. PC1 and PC2 SAR mosaic and beam 3 high-resolution radiometry of Hotei Arcus T41-T43-T121.*

**VIMS data**:
The Hotei Arcus is of particular interest as it shows one of the brightest features in ISS near-IR data and in the 5 micrometer VIMS channel [9,10] and possible presence of water-ice [2]. The latest coverage of Hotei Arcus by VIMS flyby T47 is promising (Fig. 2). Ongoing work is underway in the use of PCA to isolate unique contribution to outline surface compositional differences. Correlation with SAR principal components may allow enhancing possible links between geological structures and local composition (e.g. water-ice vs. organics).

**Discussion:**
Analysis through PCA using SAR and VIMS is ongoing, including comparisons to other regions on Titan, such as the Belet sand seas covered by T08, T21-T50 and T61, which would offer a good coverage in terms of azimuth and incidence angles. In SAR, additive noise introduced by geometric effects is removed in the PCA components. In VIMS, additive noise from atmospheric scattering, still present in most of the infrared windows, might be reduced through PCA, thus integration of SAR and VIMS components, along with radiometry data and SAR-Topo, could help in the interpretation of water-ice vs. organics components in relation to surface features and structures on Titan.

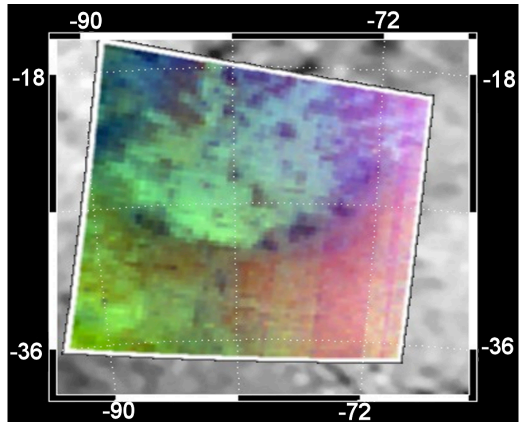


*Fig. 2. VIMS cube (R =1.59/1.27µm, G=2.07/1.27µm, B=1.27/1.08µm) of Hotei Arcus at T47.*

**References:** [1] Wall et al. (2009) *Geophysical Research Letters,* 36. [2] Soderblom et al. (2009) *Icarus 204*, 610. [3] Radebaugh et al. (2011) *Icarus 211, 672* [4] Paganelli et al. (2016) *Eos Trans AGU*, Abstr. P51C-2158. [5] Lucat et al. (2014) *JGR* 10.1002/2013JE004584. [6] Paganelli et al. (2007) *Icarus* 191, 211. [7] Janssen et al. (2016) *Icarus* 270, 443. [8] Styles et al. (2009) *Icarus 202, 584.* [9] Barnes et al. (2005) Science 310, 92. [10] Rodriguez et al. (2006) PSS 54, 1510.