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The Nantes' Cassini VIMS data portal for Titan and Saturn's icy satellites

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Abstract

The Cassini spacecraft orbited Saturn between 2004 and 2017, taking a wealth of data of the planet and its icy moons. Team members of the Visual and Infrared Mapping Spectrometer (VIMS) located at Laboratoire de Planétologie et Géodynamique (LPG) in Nantes (France) implemented Titan observations. We recently completed a setup providing user-friendly access to the scientific content of the complete VIMS data archive of Saturn's main moons.

1. The Cassini VIMS data portal

VIMS acquired images up to 64x64 pixels wide in 352 spectral channels from 0.35 to 5.12 µm, using two separate instruments [1]. The first is a two-dimension CCD array that covers the visible range (0.35-1.04 µm) with 96 spectral channels. The second covers the infrared range (0.88-5.12 µm) with 256 channels on a linear detector array and a bidirectional mirror. Titan and the icy moons were observed both during targeted and non targeted flybys, representing several tens of thousands of individual data cubes. One of the main challenges with such a big data set is to provide tools to search and identify the most interesting data. For this purpose, we have set up a dedicated website (vims.univ-nantes.fr) which provides the ability to display false color browse products of the main moons: Titan, Enceladus, Dione, Rhea, Phoebe, Thetys, Hyperion, Iapetus (Fig. 1). In a first step, VIMS raw data coming from the Planetary Data System archive have been radiometrically calibrated using the USGS digital image processing software package ISIS3. The applied calibration corresponds to version "RC19" of the VIMS calibration pipeline [2]. In a second step, the navigation information has been added using SPICE routines to extract spacecraft and planetary ephemerides, and event kernels, to retrieve relevant geometric information such as ground latitude, longitude, incidence, emergence, phase, and pixel size.

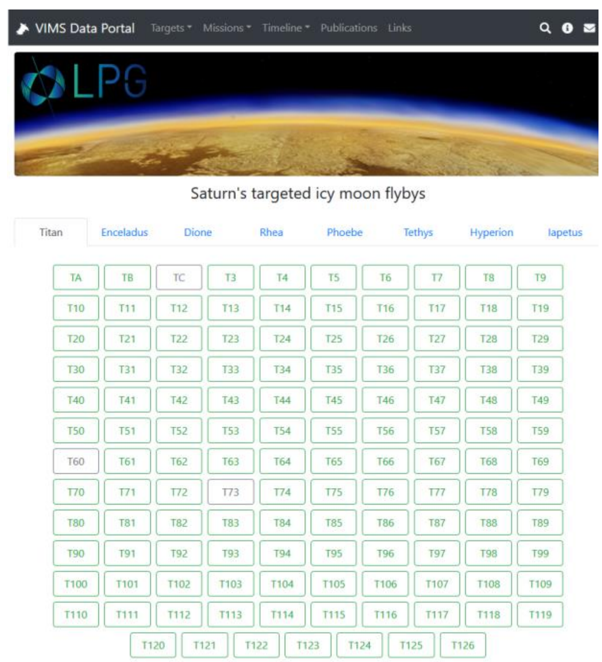

Figure 1: *Homepage of the vims.univ-nantes.fr website. The user can directly access the VIMS data of the moons, using the number of the targeted flyby.*

2. The specific case of Titan

The VIMS data set of Titan contains a wealth of information both concerning the surface and atmospheric properties. Whereas the surface of Titan can only be seen in 7 infrared windows at 1.08, 1.27, 1.59, 2.03, 2.69, 2.78 and 5 µm [3], these wavelengths can eventually be combined to reveal the spectral heterogeneities of the surface. Other wavelengths might also be useful to emphasize atmospheric properties such as clouds, haze, methane fluorescence. Example of the most relevant RGB combinations are described in details in [4] and will not be reproduced here.

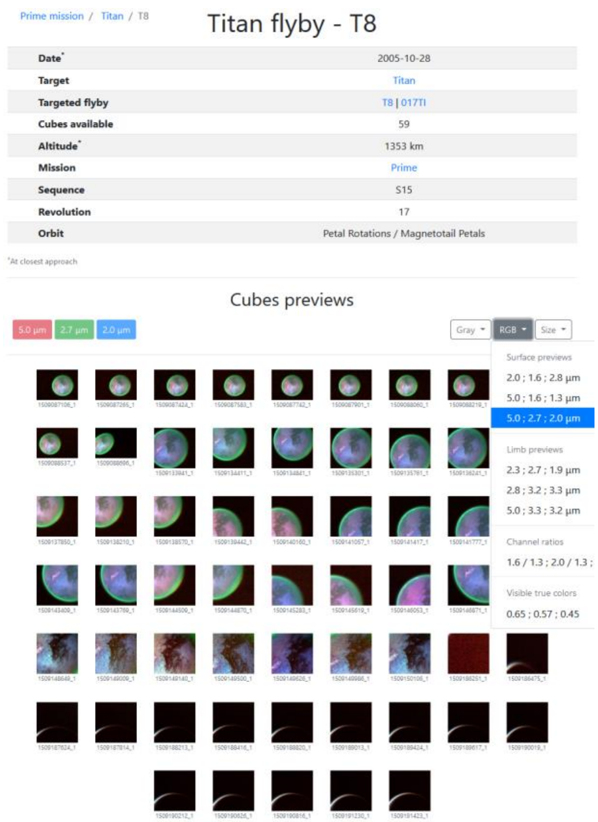

Figure 2: *After selecting a moon flyby, the second page of the website displays color composites of all VIMS cubes acquired during the flyby.*

When selecting a targeted flyby on the main entrance page of the website, the user is redirected to a second page showing previews of all the VIMS cubes acquired during this flyby, with the possibility to choose between several RGB combinations for their visualization (Fig. 2). It becomes therefore very easy to visually identify both the quality and the potential scientific content of each of the cubes.

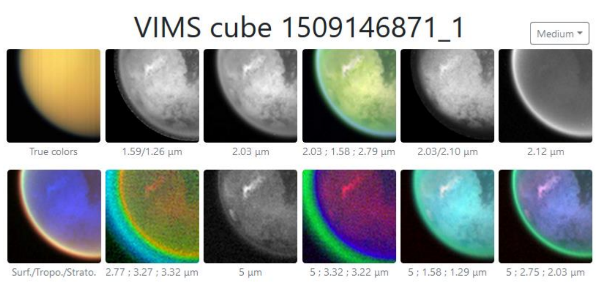

Figure 3: *Selection of false color composites directly accessible for each individual cube of Titan*

After clicking on a specific cube, the user is redirected to a third page, which displays several color composites aimed at showing the surface and atmospheric features. An example is given in Fig. 3 for the cube 1509146871_1 acquired during the flyby T8 of Titan. A link gives then access both to the corresponding raw data and to the calibrated cubes.

3. The case of icy satellites

A similar approach has been developed for the other icy satellites. In this case, a single color composite has been designed so far to catch the water ice signatures, with the 3.1 µm crystalline ice peak appearing in red (e.g. Fig. 4).

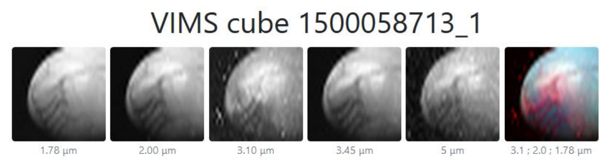

Figure 4: *Example of previews for a VIMS cube of Enceladus*

4. Conclusions

The vims.univ-nantes.fr website allows a user-friendly navigation into the VIMS archive of the main moons of Saturn. It provides the possibility to quickly identify the most relevant observations thanks to multispectral browse products. It should be noted that we did not include the cubes acquired in "noodle" mode, i.e., cubes with dimension of 1xN or Nx1 pixels. These rare observations require a specific processing in particular to remove some stripping effects due to the dark removal. They might be included in a further release. It could also be interesting to set up a similar website to distribute all the VIMS observations of Saturn and its rings, using false color composites adapted to the specificity of Saturn's properties such as gas signatures or auroras.

Acknowledgements

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References

[1] Brown, R. H., et al., Space Sci. Rev. 115, 111-168, 2004. [2] Clark, R. N et al., the VIMS Wavelength and Radiometric Calibration 19, Final Report, PDS, 2018. [3] Sotin, C. et al., Nature, p786-789, 2005. [4] Le Mouélic, S. et al., Icarus, 319, 121-132, 2019.