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VIS-IR Albedo and Spectral Indicators Maps of Saturn's Icy Satellites Surfaces by Cassini/VIMS

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Abstract

With the aim to explore surface composition and properties of Saturn's icy satellites, a protocol able to produce photometric-corrected maps of Cassini-VIMS [1] disk-resolved data has been developed and tested. The method allows to correct reflectance spectral data for the illumination and viewing geometry of a given observation to retrieve albedo, a quantity directly correlated with surface composition and physical properties [2].

We adopt the photometric correction proposed by [3] to derive equigonal albedo maps of Mimas, Enceladus, Tethys, Dione and Rhea. Equigonal albedo is modeled at null incidence and emission angles from observations acquired at phase angle $\geq 10°$. The equigonal albedo is in general lower than the geometric albedo because it do not includes the opposition effect surge. The full dataset returned by VIMS is exploited with the aim to maximise the spatial coverage and resolution for each satellite. After having applied a similar methodology to Dione's [4] and Tethys' data [5], we report about the main results for the remaining satellites. Photometric parameters are computed at five visible (0.35, 0.44, 0.55, 0.70, 0.95 μm) and five infrared (1.046, 1.540, 1.822, 2.050, 2.200 μm) wavelengths. Cylindrical maps of equigonal albedos and spectral indicators (visible slopes, water ice band depths) are rendered at $0.5° \times 0.5°$ angular resolution in latitude and longitude following the method presented in [6]. The maps are built by mining the full VIMS dataset to select only pixels having incidence and emission angles $\leq 80°$ acquired from distances $\leq$100000 km. The $0.5° \times 0.5°$ bin corresponds to spatial resolutions (at equator) of 1.7 km/bin on Mimas, 2.2 km/bin on Enceladus, 4.7 km/bin on Tethys, 4.5 km/bin on Dione and 6.7 km/bin on Rhea.

Moreover, to increase robustness of the results we adopt a strategy in which each VIMS pixel intercepting satellites' surface is photometrically corrected before averaging the resulting equigonal albedo on the corresponding $0.5° \times 0.5°$ bin on the map. Geometry parameters are computed by means of ISIS routines using reconstructed SPICE kernels for each VIMS pixel (center and four corners). Despite the lower instrumental spatial resolution of VIMS with respect to ISS cameras, the resulting VIMS maps of the icy satellites are in good agreement with similar maps generated from ISS images [10].

A synergic study of the 0.35-0.55 and 0.55-0.95 μm spectral slopes together with the water ice 1.5-2.0 μm band depth maps allow 1) to trace the leading-trailing hemisphere dichotomy visible on many regular satellites of Saturn [10]; 2) to constrain the shape and dimensions of the equatorial lenses generated by the bombardment of high energy magnetospheric electrons on Mimas' and Tethys' leading hemispheres [5]; 3) to detect the more fresh material on the floors and ejecta of many impact craters [11] and 4) to trace water ice and dark materials distribution on Dione's [12] and Rhea's [11] whispy terrains.

A comparison between average equigonal albedo and disk-integrated reflectance spectra of Saturn's satellites [7, 8, 9, 13] will be discussed.

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References

[1] Brown, R. H., Baines, K. H., Bellucci, G., Bibring, J.-P., Buratti, B. J., Capaccioni, F., Cerroni, P., Clark, R. N., Coradini, A., Cruikshank, D. P., Drossart, P., Formisano, V., Jaumann, R., Langevin, Y., Matson, D. L., McCord, T. B., Mennella, V., Miller, E., Nelson, R. M., Nicholson, P. D., Sicardy, B., Sotin, The Cassini Visual And Infrared Mapping Spectrometer (Vims) Investigation. *Space Science Reviews*, 115, 111-168 (2004).

[2] Ciarniello, M. and Capaccioni, F. and Filacchione, G. and Clark, R. N. and Cruikshank, D. P. and Cerroni, P. and Coradini, A. and Brown, R. H. and Buratti, B. J. and Tosi, F. and Stephan, K., Hapke modeling of Rhea surface properties through Cassini-VIMS spectra. *Icarus*, 214, 541-555, (2011)

[3] Shkuratov, Y. and Kaydash, V. and Korokhin, V. and Velikodsky, Y. and Opanasenko, N. and Videen, G., Optical measurements of the Moon as a tool to study its surface. *Planetary Space Sciences*, 59, 1326-1371 (2011)

[4] Filacchione, G. and Ciarniello, M. and D'Aversa, E. and Capaccioni, F. and Cerroni, P., and Buratti, B. J., and Clark, R. N., and Stephan, K., and Plainaki, C., Photometric Modeling and VIS-IR Albedo Maps of Dione From Cassini-VIMS. *Geophysical Research Letters*, 45, 2184-2192 (2018a).

[5] Filacchione, G. and Ciarniello, M. and D'Aversa, E. and Capaccioni, F. and Cerroni, P., and Buratti, B. J., and Clark, R. N., and Stephan, K., and Plainaki, C., Photometric Modeling and VIS-IR Albedo Maps of Tethys From Cassini-VIMS. *Geophysical Research Letters*, 45, 6400-6407 (2018b).

[6] Filacchione, G. and Capaccioni, F. and Ciarniello, M. and Raponi, A. and Tosi, F. and De Sanctis, M. C. and Erard, S. and Morvan, D. B. and Leyrat, C. and Arnold, G. and Schmitt, B. and Quirico, E. and Piccioni, G. and Migliorini, A. and Capria, M. T. and Palomba, E. and Cerroni, P. and Longobardo, A. and Barucci, A. and Fornasier, S. and Carlson, R. W. and Jaumann, R. and Stephan, K. and Moroz, L. V. and Kappel, D. and Rousseau, B. and Fonti, S. and Mancarella, F. and Despan, D. and Faure, M., The global surface composition of 67P/CG nucleus by Rosetta/VIRTIS. (I) Prelanding mission phase. *Icarus*, 274, 334-349 (2016).

[7] Filacchione, G. and Capaccioni, F. and McCord, T. B. and Coradini, A. and Cerroni, P. and Bellucci, G. and Tosi, F. and D'Aversa, E. and Formisano, V. and Brown, R. H. and Baines, K. H. and Bibring, J. P. and Buratti, B. J. and Clark, R. N. and Combes, M. and Cruikshank, D. P. and Drossart, P. and Jaumann, R. and Langevin, Y. and Matson, D. L. and Mennella, V. and Nelson, R. M. and Nicholson, P. D. and Sicardy, B. and Sotin, C. and Hansen, G. and Hibbitts, K. and Showalter, M. and Newman, S., Saturn's icy satellites investigated by Cassini-VIMS. I. Full-disk properties: 350-5100 nm reflectance spectra and phase curves. *Icarus*, 186, 259-290, (2007).

[8] Filacchione, G. and Capaccioni, F. and Clark, R. N. and Cuzzi, J. N. and Cruikshank, D. P. and Coradini, A. and Cerroni, P. and Nicholson, P. D. and McCord, T. B. and Brown, R. H. and Buratti, B. J. and Tosi, F. and Nelson, R. M. and Jaumann, R. and Stephan, K., Saturn's icy satellites investigated by Cassini-VIMS. II. Results at the end of nominal mission. *Icarus*, 206, 507-523 (2010).

[9] Filacchione, G. and Capaccioni, F. and Ciarniello, M. and Clark, R. N. and Cuzzi, J. N. and Nicholson, P. D. and Cruikshank, D. P. and Hedman, M. M. and Buratti, B. J. and Lunine, J. I. and Soderblom, L. A. and Tosi, F. and Cerroni, P. and Brown, R. H. and McCord, T. B. and Jaumann, R. and Stephan, K. and Baines, K. H. and Flamini, E., Saturn's icy satellites and rings investigated by Cassini-VIMS: III - Radial compositional variability. *Icarus*, 220, 1064-1096, (2012)

[10] Schenk, P. and Hamilton, D. P. and Johnson, R. E. and McKinnon, W. B. and Paranicas, C. and Schmidt, J. and Showalter, M. R., Plasma, plumes and rings: Saturn system dynamics as recorded in global color patterns on its midsize icy satellites. *Icarus*, 211, 740-757, (2011).

[11] Stephan, K. and Jaumann, R. and Wagner, R. and Clark, R. N. and Cruikshank, D. P. and Giese, B. and Hibbitts, C. A. and Roatsch, T. and Matz, K.-D. and Brown, R. H. and Filacchione, G. and Cappacioni, F. and Scholten, F. and Buratti, B. J. and Hansen, G. B. and Nicholson, P. D. and Baines, K. H. and Nelson, R. M. and Matson, D. L., The Saturnian satellite Rhea as seen by Cassini VIMS. *Planetary Space Sciences*, 61, 142-160, (2012).

[12] Clark, R. N. and Curchin, J. M. and Jaumann, R. and Cruikshank, D. P. and Brown, R. H. and Hoefen, T. M. and Stephan, K. and Moore, J. M. and Buratti, B. J. and Baines, K. H. and Nicholson, P. D. and Nelson, R. M., Compositional mapping of Saturn's satellite Dione with Cassini VIMS and implications of dark material in the Saturn system, *Icarus*, 193, 372-386, (2008).

[13] Hendrix, A. R., Filacchione, G., Paranicas, C., Schenk, P., Scipioni, F., Icy Saturnian satellites: Disk-integrated UV-IR characteristics and links to exogenic processes, *Icarus*, 300, 103-114 (2018).