

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 $\geq 10^\circ$. The equigonal albedo is in general lower than the geometric albedo because it does not include 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 $0.5^\circ \times 0.5^\circ$ 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 $\leq 80^\circ$ acquired from distances ≤ 100000 km. The $0.5^\circ \times 0.5^\circ$ 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 $0.5^\circ \times 0.5^\circ$ 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] wispy 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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