

Water ice and sub-micron ice particles on Tethys and Mimas

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1. Abstract

We present our ongoing work, mapping the variation of the main water ice absorption bands, and the distribution of the sub-micron particles, across Mimas and Tethys' surfaces using Cassini-VIMS cubes acquired in the IR range (0.8–5.1 μm). We present our results in the form of maps of variation of selected spectral indicators (depth of absorption bands, reflectance peak height, spectral slopes).

2. Introduction

Mimas and Tethys are Enceladus' orbital neighbors, lying inside and outside Enceladus' orbit, respectively. It is therefore likely that Mimas' and Tethys' surfaces interact with icy particles from the E-ring, resulting in a spectral, color modification.

The most prominent feature on Mimas' surface is the crater Herschel with a diameter of 130 km, one-third of the satellite's diameter. Mimas has the most uniform surface among Saturn's principal satellites, with its trailing side just 10% brighter and redder than the leading one. The uniformity of Mimas extends to spectral appearance as well [1,2].

On Tethys' leading hemisphere a 400 km in diameter crater, Odysseus, is present. Its dimension represents ~40% of Tethys' diameter [1,2].

3. Data analysis

The Cassini VIMS spectrometer acquires hyperspectral data in the 0.3–5.1 μm spectral range. We selected VIMS cubes of Tethys and Mimas in the IR range (0.8–5.1 μm), and minimized photometric

effects due to different illumination conditions by normalizing all spectra at 2.23 μm . For all pixels in the selected VIMS cubes, we measured the band depths for water-ice absorptions at 1.25, 1.5 and 2.02 μm and the height of the 3.6 μm reflection peak, whose value relates to grain size. Moreover, we considered the main spectral indicators in the IR range for ice particles smaller than 1 μm [3]: (i) the 2 μm absorption band is asymmetric and (ii) it has the minimum shifted to longer λ ; (iii) the band depth ratio 1.5/2.0 μm decreases; (iv) the reflection peak at 2.6 μm decreases; (v) the Fresnel reflection peak is suppressed; (vi) the 5 μm reflectance is decreased relative to the 3.6 μm peak. To characterize the global variation of water-ice band depths, and of sub-micron particles spectral indicators, across Mimas and Tethys, we sampled the two satellites' surfaces with a $1^\circ \times 1^\circ$ fixed-resolution grid and then averaged the band depths and peak values inside each square cell.

4. Results

For both moons we find that large geologic features, such as the Odysseus and Herschel impact basins, do not correlate with water ice's abundance variation. For Tethys, we found a quite uniform surface on both hemispheres. The only deviation from this pattern shows up on the trailing hemisphere, where we notice two north-oriented, dark areas around 225° and 315° . For Mimas, the leading and trailing hemispheres appear to be quite similar in water ice abundance, the trailing portion having water ice absorption bands lightly more suppressed than the leading side. No correlation with the visible-color/thermal anomaly features has been found.

References

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