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A working model for Vesta's shape from Dawn limb images

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Abstract

Methods have been developed [1, 2] to derive the global shape of with the help of limb images taken by spacecraft. Topographic profiles are found by applying a contrast-based search along the limb. By minimizing height differences at crossover locations between the individual limb profiles their locations are improved and a global network is created. We used images taken by the Dawn spacecraft during the Vesta approach in 2011 to demonstrate the feasibility of this method. More than 400 images have been examined yielding a network of topographic profiles spanning from 80°S to 60°N. This work is undertaken as a preparation for Dawn's arrival at Ceres in 2015 where a network of limb profiles can be used for early shape estimations and as a framework for digital terrain models derived by stereo-photogrammetric methods.

1. Introduction

Several methods can be used to determine the global shape of celestial bodies, e.g. laser altimetry, stereo-photogrammetry, and stereo-photoclinometry. Another well-known procedure is the analysis of limb images [3].

2. Image data

During Dawn's approach of Vesta in July 2011 more than 400 limb images from distances between 37,000 km and 5,500 km were acquired. They possess resolutions at the limb between 0.5 km/pixel and 3.5 km/pixel. Due to Vesta's fast rotation of 1617 degrees/day [4] the obtained limb profiles provide an almost global coverage (Fig. 1). However, flight geometry and lighting conditions at the approach prevented imaging of areas north of ca. 60°N.

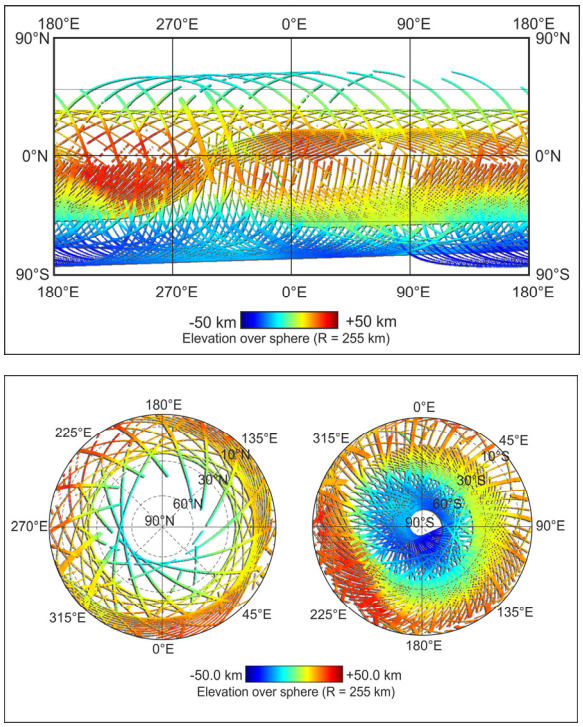

Figure 1: Vesta limb profiles in global equidistant projection (top) and in Lambert azimuthal projection for both hemispheres (bottom)

3. Method

Topographic profiles are found by applying a contrast-based search along the limb. Their locations are improved by adjusting the exterior camera orientation parameters, i.e. attitude angles, for each limb image using height differences at intersections between the profiles in a least-squares-fit. The selected images provide more than 40,000 intersections, which promise a stable adjustment.

4. Summary and Outlook

Previous work on planetary data [1] has shown the practicability and reliability of the method as an independent solution for shape modeling. Here, we demonstrate, it is possible to derive Vesta's global shape using limb images acquired within a short time frame.

Dawn will approach Ceres in March 2015. A network of adjusted limb profiles obtained from images acquired during the approach and early orbit phases can be used to derive a working model for the global shape of Ceres quickly. Furthermore, the network may be used as a framework for digital terrain models derived by stereo-photogrammetric methods.

References

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