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Terrain Darkening on Iapetus: An Analysis of Processes Leading to Global and Local Dichotomy Features

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The surface of Iapetus is famous for its global albedo dichotomy. The leading side of Iapetus, which is called *Cassini Regio*, is covered by very dark material, while its poles and trailing side are relatively bright.

In images of the trailing side, dark crater floors and troughs with dark floors are common at low latitudes. These smaller-scaled dark areas have very sharp edges. Even at the highest resolution in images from the Cassini imaging experiment (ISS), the typical length of a drop-off in albedo is below the resolution limit ([1]). At low-latitudes, the whole floor of a crater is usually darkened, while at mid-latitudes, only the walls facing toward the equator are darkened (Fig. 1). At high-latitudes we do not see darkened craters at all.

A thermal feedback process has been proposed as the cause for the *global* albedo dichotomy ([1],[2]). In this feedback process, the dark material is the lag deposit that remains after the embedded ice sublimed. At every location where an enrichment of the lag deposit already occured, the albedo decreases due to the enhanced amount of dark lag on the surface. As a result, more sunlight is absorbed and the sublimation gets more efficient (runaway effect).

The aforementioned papers explain the global albedo dichotomy - yet the comparatively small dark patches on the trailing side give us a high amount of additional information which complement the data of the global dichotomy pattern in regard to the threshold that determines whether a specific location gets blackened by the process. This approach is valid as the local darkening is caused by the very same runaway feedback-process as the global dichotomy.

The difference in the global instance of this effect and the local one is that the triggering mechanism must differ in its characteristic length. For the global process, an a-priori difference between the leading and the trailing side due to in-fall of exogenic material on the leading side only was proposed as the crucial different in the boundary conditions ([2]). As the trigger mechanism acting locally within the craters on Iapetus' trailing side, we propose an explanation derived from the geometry of the craters themselves. An increased amount of sunlight irradiated onto the crater wall opposed to the equator is caused by the concave curvature of these features. We studied the insolation geometry using different models for the reflection. A model derived from [3] with a linear interpolation between lunar and Lambert-like scattering reproduced the dark patterns relatively well (Fig. 2). To understand the exact nature of the threshold necessary for the darkening process, we simulated different crater characteristics. Taking the latitude of the craters into account, we get an averaged energy flux. With the knowledge of the temperature-dependence of the sublimation (compare [4]) we can estimate the sublimation rate needed to trigger the feedback and compare it with estimates for the global process.

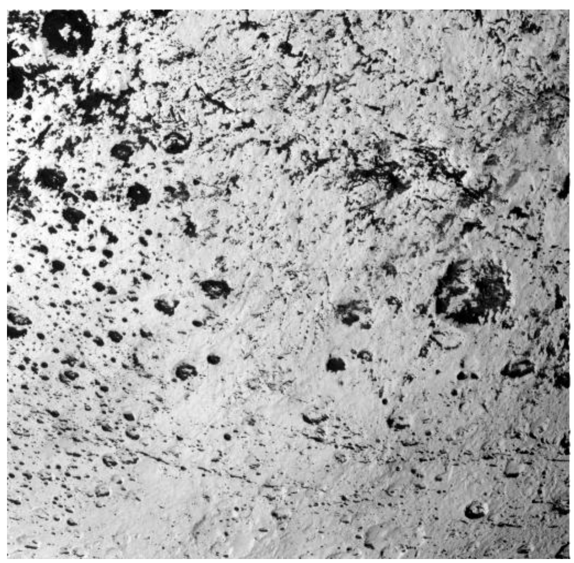

Figure 1: Some typical dark crater floors. The crater Hamon (center right) has a diameter of 96 km

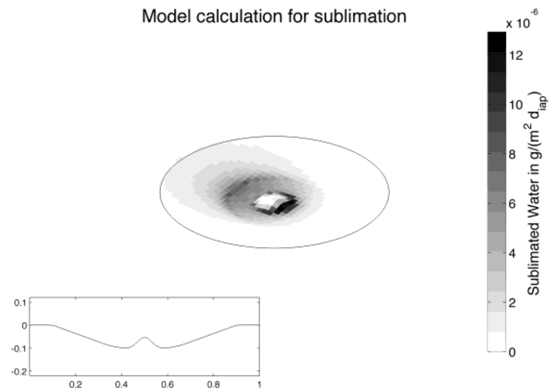

Figure 2: A model crater with estimates for the sublimation

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