On the Thermal Feedback Process Leading to the Global Brightness Dichotomy of Iapetus Including the Effect of Orbital Precession.

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Introduction The surface of Iapetus is famous for its global black-and-white dichotomy. The leading side of Iapetus, called *Cassini Regio*, is covered by very dark material (albedo 0.06 ± 0.01 in [1] and 0.04 in [2]), while its poles and trailing side are relatively bright (albedos up to 0.4 ± 0.07 in [1] and 0.5 in [2]).

Figure 1 Cassini ISS image of Iapetus from the targeted flyby on September 10th, 2007. The diameter of Iapetus is 1471 km

The Driving Process A thermal feedback process has been proposed as the cause for this dichotomy [[3] and [4]). In this feedback process, the dark material is the lag deposit that remains after sublimation of the water ice where the dark, more refractory material was originally embedded. At every location where an enrichment of dark material already occurs, the albedo decreases. As a result, more sunlight is absorbed and the sublimation gets even more efficient. In the SOM (supporting online material) of [3], several different models for the amount and angular distribution of exogenic infall have been computed. An in-depth study of dust falling on the surface of Iapetus was published by [5]. The calculation of the infall triggering the feedback has taken into account the precession of the Iapetus orbit around Saturn.

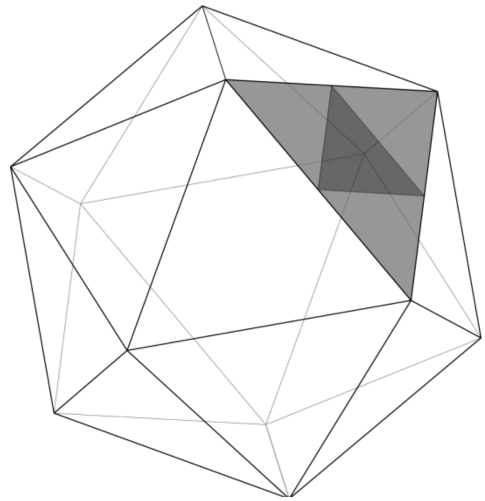

Figure 2 Sketch of the tesselation of the sphere by subdivision of the triangles of an icosahedron

Our Approach: We calculated the global migration of water ice taking into account exogenic infall and precession of the orbit. Our model accounts for a flow rate network on a sphere tessellated in triangles. The transported mass is calculated using ballistic trajectories under the assumptions of isotropic emission of the water molecules and a Maxwellean velocity distribution with a vapor temperature equal to the surface temperature at the location of emission. Angles and velocities are binned (in degrees and m/s) and for each pair [θ, v_0] a resulting flight distance on an orthodrome is calculated. The net flux between two areas is then dependent on the temperature of the emitting area. This approach has the numerical advantage that no singularity exists at the poles and for each area an antipodal area does exist. This approach enables us to take into account different models for the infall and the efficiency of the darkening by the enrichment with the lag deposit. The darkening process can also be cut off by the effect of overburden as proposed by [6]

Comparison to Reference Model: When calculating water ice migration under the same conditions as the additional material of [3] describes in "Model B" we obtain comparable results with regard to the time needed for the feedback process.While within the first 800 million earth years of simulation time the linear factor of the dust infall to the leading side dominates the process, afterwards the feedback begins to get more effective. Within two billion years it dominates and the cassini region darkens essentially to the albedo of the modeled dark material (albedo 0.04). Within the limitation of different discretization grids we obtain polar and equatorial albedos in agreement with the original paper [3].

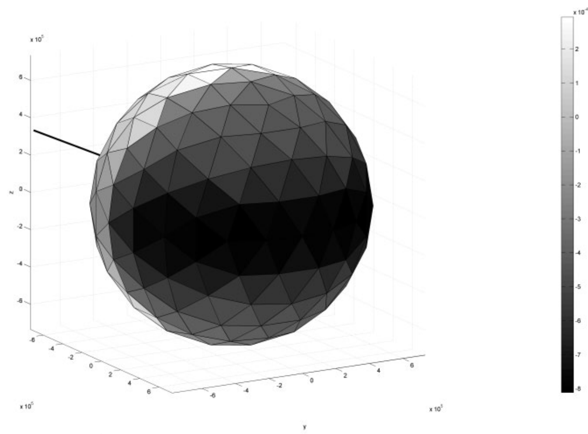

Figure 3 The net difference in albedo after the first 500 million earth years. The infall is most efficient up to 60° from the forward direction and dominates the system.

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