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]). A thermal feedback process has been proposed as the cause for this dichotomy ([3] and [4]).

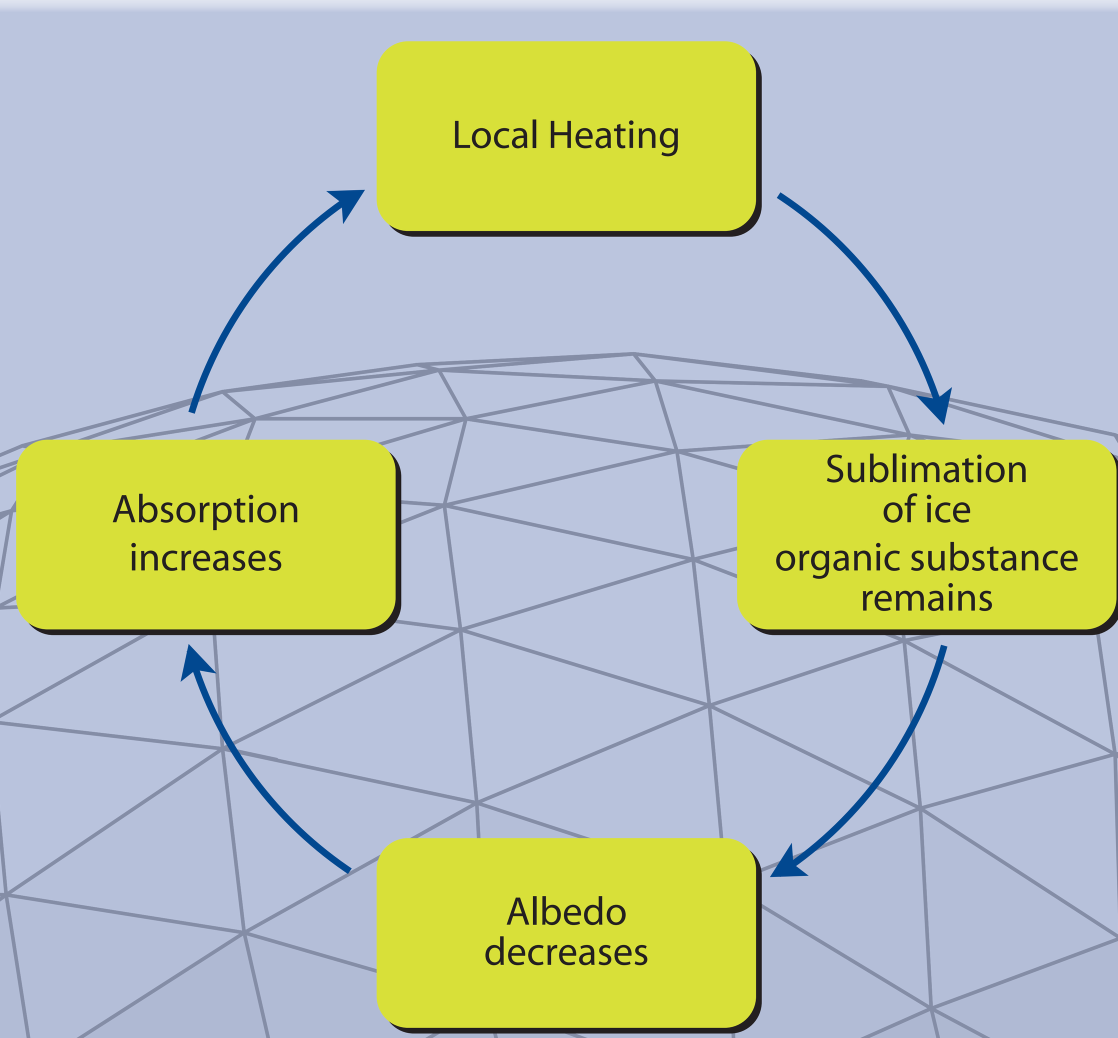


Figure 1 The thermal Feedback process as decribed in *Spencer and Denk ([3])*

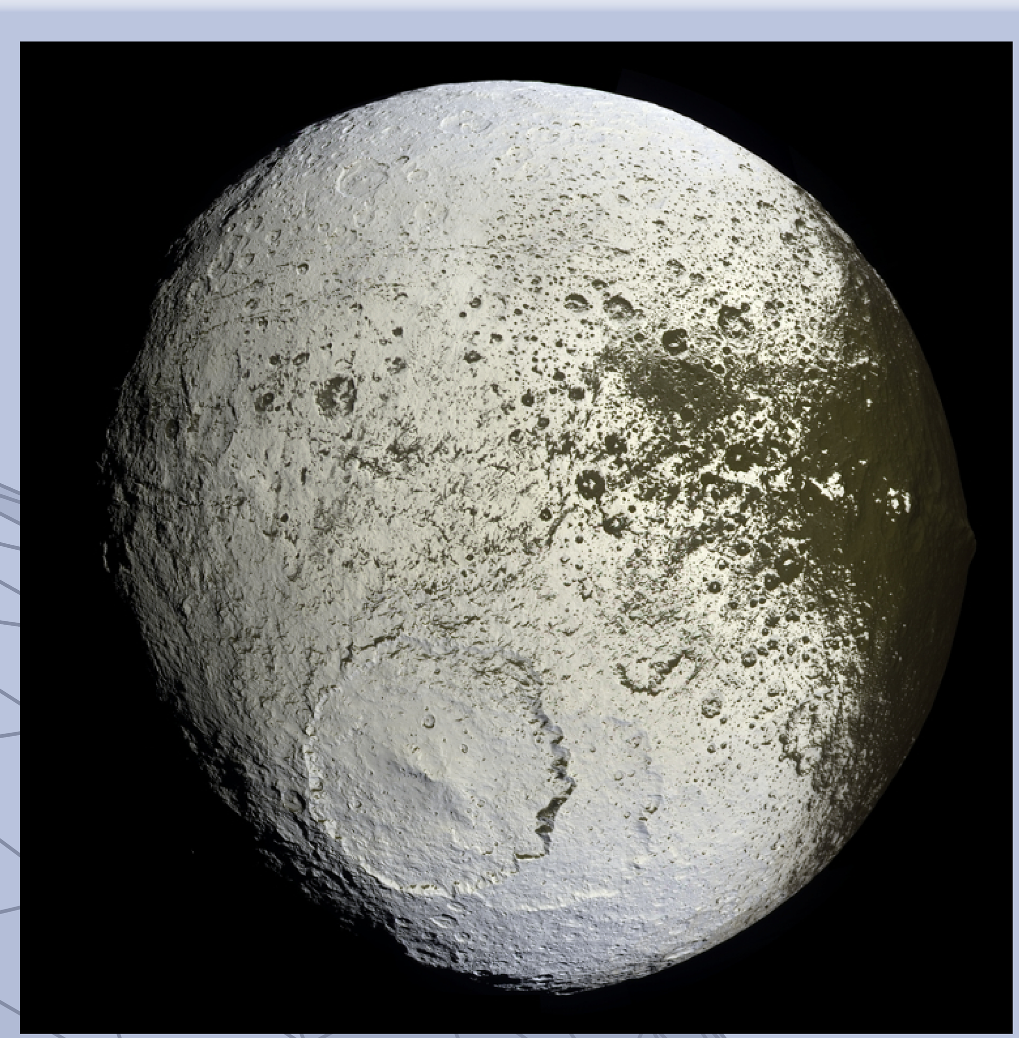


Figure 2 Cassini ISS image of Iapetus from the targeted flyby on September 10th, 2007. The diameter of Iapetus is 1471 km

Numerical model

Our model accounts for a mass flow rate network on a sphere tessellated in triangles. We calculated the global migration of water ice taking into account exogenic infall and precession of the orbit. Angles and velocities of trajectories are binned (in degrees and m/s), and for each pair $[\Theta, v_0]$ 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.

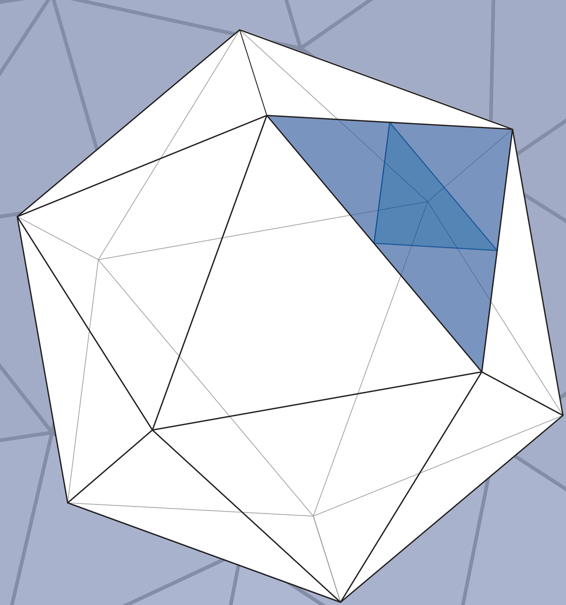
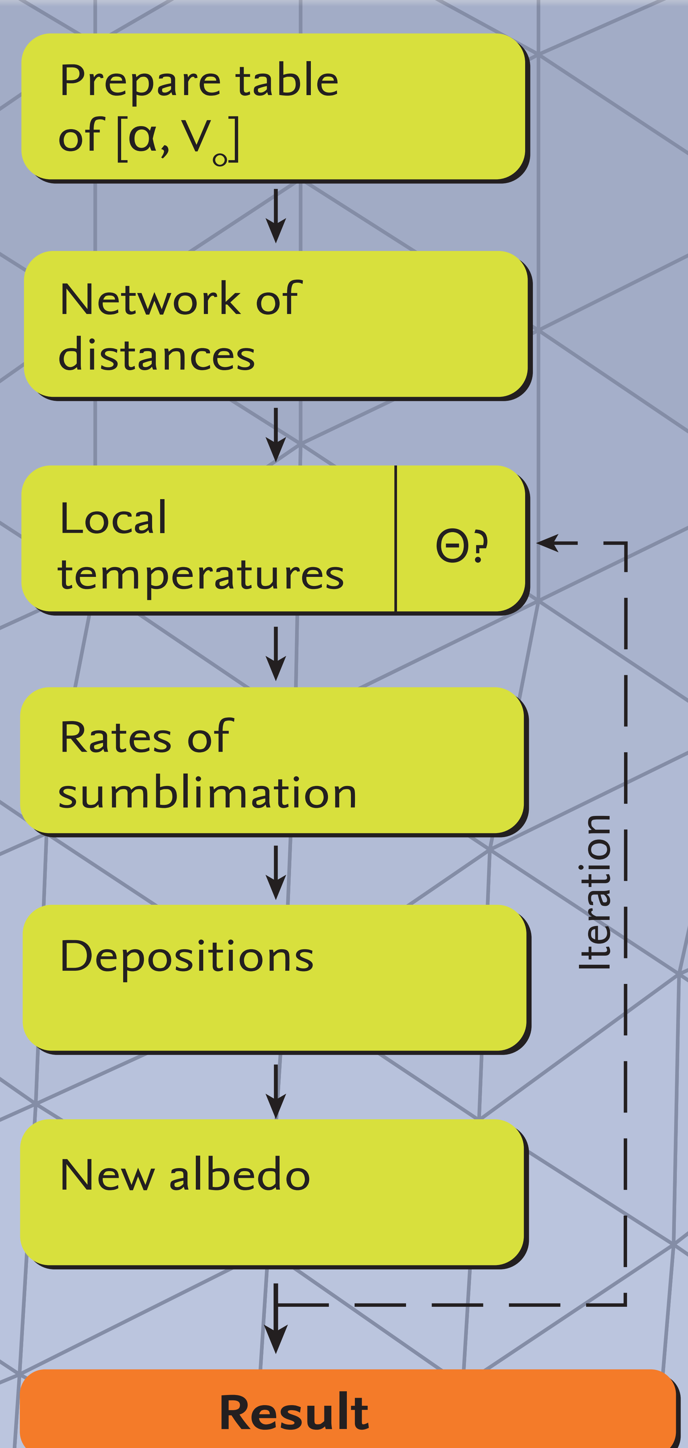


Figure 3 Sphere tesselation



Physical model

The transported mass is calculated using ballistic trajectories under the assumptions of isotropic emission of the water molecules and a Maxwellian velocity distribution with a vapor temperature equal to the surface temperature at the location of emission. 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. Different scenarios for the cut-off are reduced sticking or the diffusion limiting effect of overburden as proposed by [5].

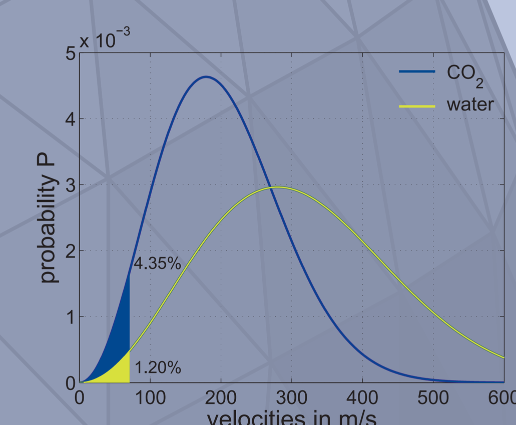


Figure 4 Maxwellian velocity distribution

Results

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. In 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. The next billion years it dominates and the *Cassini Regio* darkens essentially to the albedo of the modeled dark material (albedo 0.04). As in „Model B" of [3] the poles are too dark in our simulation. The precession lets the equatorial darkened region grow broader and dampens the feedback process. First results for different scattering effectivities of the ice matrix embedding the dark material show that a slightly more efficient scattering already leads to noticeably brighter poles.

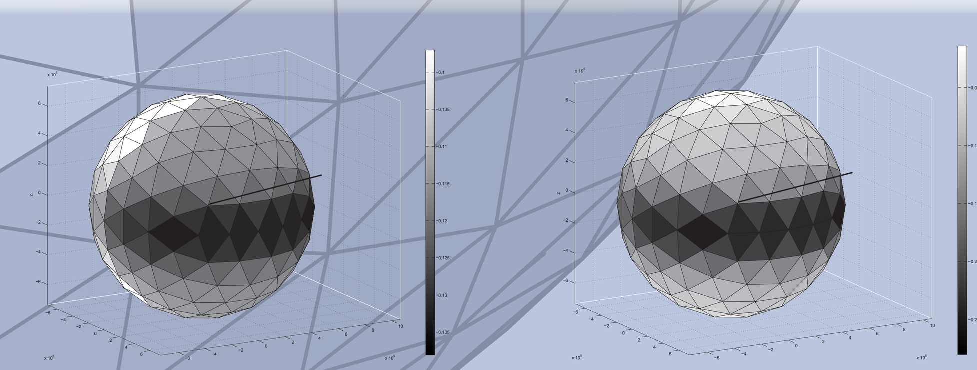


Figure 5 750 and 1500 million years in the process

Acknowledgements

We gratefully acknowledge funding of this work by the German Space Agency (DLR) Bonn through grant no. 50 OH 1102.

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