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Illumination Conditions in Phobos' Polar Areas

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Phobos underlies strong temporal and regional variations of solar irradiation and features seasons just like Mars. Precise illumination and thermal models are critical aspects for landed mission planning and require careful analysis of direct solar irradiation, indirect contributions like solar light scattered or reflected by Mars, thermal emissions from the Martian surface and self-heating of Phobos' surface.

With previous investigators lacking detailed shape models, [1,2] used a simple ellipsoid model to derive Phobos surface temperatures and heat propagation including effects of solar radiation, Mars thermal and reflected radiation and eclipses caused by Mars. Models of diurnal surface temperatures for specific latitudes, longitudes and seasons were presented. In contrast, [3, 4] modelled the direct incident solar flux on Phobos using a recent shape model [5] to produce global charts of incident solar flux for certain fixed dates in different seasons and a global chart of average incident solar flux for a complete Martian year, respectively.

In this study, we focused on the polar areas (> |+/- 65°| latitude) and their unique light conditions. Applying methods described by [6] and [7] the irradiation function for a time-span of one Martian year, including seasonal variations in solar distance and the effect of Sun occultation by Mars were computed, applying recent shape [5] and rotational models [8]. To include single-scattering by Phobos' surface onto other parts of Phobos the view factors F_{ij} (giving the fraction of flux radiated by facet j that reaches facet i) for these areas were computed. The contributions of single-scattering to the total incoming flux are small but relevant for facets that are not directly illuminated. Simulations in short time steps of 10 minutes (rotation period of Phobos: approx 7.65 hrs) show intricate and fast-changing illumination patterns. We assessed the correctness of the simulations and the quality of the shape model by generating synthetic images, based on the shape model and illumination geometry at a given time. In particular, we assumed camera parameters of the SRC (HRSC Super Resolution Channel, aboard Mars Express) and illumination geometries of selected Mars Express Phobos flybys. The synthetic images were then compared with the actual SRC images.

At the conference, we demonstrate the intricate illumination patterns in Phobos' polar regions.

We plan for continuing studies of Phobos' thermal environment. To that end we will also take into account thermal radiation emanating by other facets of Phobos as well as Mars shine. A complex thermal environment on Phobos is expected being characterized by very local temperature patterns.

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