GEOMETRIC SHIELDING OF SURFACE ROCKS ON MARS. Christina L. Smith[1] and John E. Moores[2], [1]York University, 4700 Keele Street, Toronto, ON, M3J 1P3, chrsmith@yorku.ca, [2]York University, 4700 Keele Street, Toronto, ON, M3J 1P3, jmoores@yorku.ca.

Introduction: It has been documented both on Earth (e.g. Southwest USA, [1], as described by [2]) and on Mars [3] that a preferred orientation of cracks has been observed to exist, which develop after clast deposition occurs. Two methods that could result in this bias are: Solar induced thermal stresses, where the bias is introduced by the cyclical heating and cooling of the rocks caused by the Earth's rotation, and differential insolation whereby geometric shielding allows some orientations of crack to retain moisture better than others, and subsequently grow faster than others. The latter method has been investigated by [2] and the results for the Southwest USA predict three populations of crack orientations to exist: N-S population (shallowest initial crack depth), ESE-WNW and ENE-WSW population and an E-W population (deepest initial crack depth). The first two populations correlate well with the observations of [1] and the lack of the latter may be due to lack of sufficiently deep initial cracks. The method of solar induced thermal stresses on Mars has been examined by [3] and discussed in the context of their observations from the Spirit rover. Their observations show a crack orientation bias of NE-SW with a higher variance than those of Earth rocks. Their numerical modelling of Solar induced thermal stresses shows that sufficiently high stresses are induced to promote fracturing.

As geometric shielding has been shown to be a potential cause of the orientation preference of cracks at mid-latitudes on Earth, it is important to investigate the effect that shielding may have on Martian surface rocks. By modelling this effect under Martian conditions, any preferred crack orientation can be identified and compared with the orientations reported in [3]. The remainder of this abstract details the models and methods used to identify whether this could contribute to the observed orientation bias and to assess the relative dominance of this effect in comparison with Solar induced thermal stresses.

Models: Within this work, a combination of two codes are used. The first is the doubling and adding radiative transfer code of [4], and a detailed description of the code can be found therein. The code is based upon the doubling and adding method of [5]. For this work, the doubling and adding code has been used in a two level, one layer configuration. The values for the atmospheric variables, such as particle scattering parameters, have been taken from [6]. The outputs

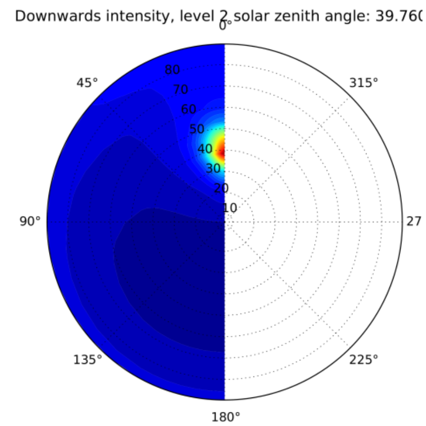

Figure 1: The downwards flux intensity for the Tomasko model. The concentric rings represent the zenith angle and the outer labels represent the azimuth angle.

from this code include flux tables describing the upwards and downwards flux at each level on a quarter sphere grid of azimuth and zenith angles. An example of the downwards flux output at the lower level of the model is shown in Fig. 1. This output is copied and mirrored to give the full hemisphere of atmospheric flux which is then used in subsequent analyses.

The second code is a new geometric code written in python. The geometric code takes as input the relative crack dimensions (width, length and depth) and the full hemisphere downward flux table at the lowest level outputted from the doubling and adding code. The crack is modelled as an oblong impression in a horizontal plane with zero gradient.

At each atmospheric emission point in azimuth and zenith angle, as defined by the downward flux table, the flux emanating from that point is assumed to be a parallel vector field with direction equal to the normal vector of the emission surface and magnitude equal to the intensity at the emission point.

Depending upon the dimensions and orientation of the crack and the direction of the vector field, some proportion of the crack will be in shadow. This has been modelled geometrically, assuming no reflection of incident radiation from the sides of the crack and shadows occur solely due to self-shielding by the edges. An example of the shadow cast by a single vector field of arbitrary intensity on a crack using this geometric model is shown in Fig. 2.

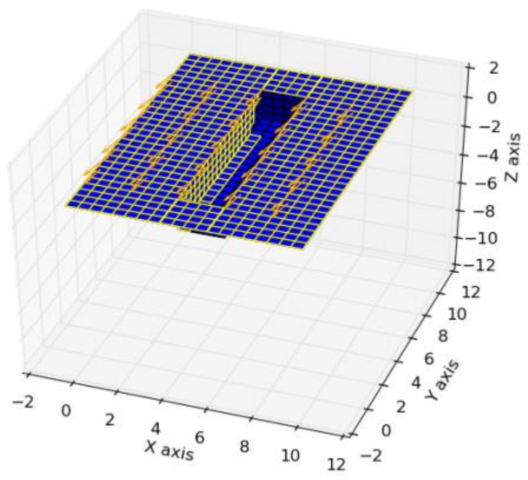

Figure 2: An example of the shadow cast by an single vector field of arbitrary intensity. The orange arrows represent the vector field, the yellow and black grid overlays on the blue surface represent the regions in light and in shadow respectively.

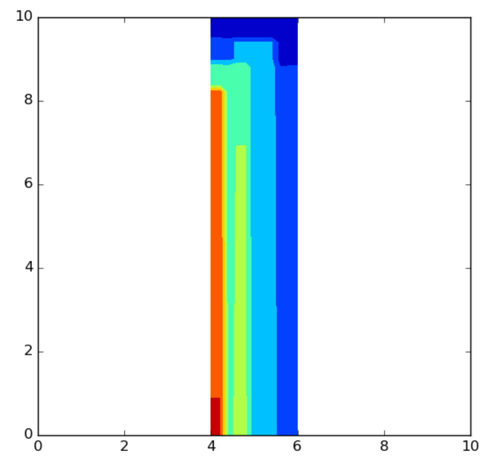

Figure 3: Intensity of radiation that reaches the bottom of the crack from all emission points. Red regions indicate maximum intensity and blue regions the minimum. The x and y axes are defined as in Fig. 2.

The shadowing is calculated for each emission point and the total intensity that reaches the bottom of the crack from all directions is calculated. An example of the intensity pattern calculated at the base of the crack is shown in Fig. 3. The amount of radiation received by a crack over the course of a day can be computed by providing the known position of the Sun in azimuth and zenith angle at different times on a particular sol to the two codes and summing the results.

Ongoing work: In order to identify whether the combination of models described above predict a preference for crack growth in a specific orientation, the total radiation received by cracks of a variety of orientations and relative dimensions over entire sols distributed throughout the Martian year must be calculated. These calculations are currently underway and the results will be available by the date of the Lunar and Planetary Sciences Conference. These results will be compared with the observed orientation preference reported in [3], allowing the effective assessment of the effect of geometric shielding on crack growth promotion in Martian surface rocks.

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