INTERFACIAL LIQUID WATER ON MARS: CAN IT FORM HILL GULLIES? K. J. Kossacki[1] and W. J. Markiewicz[2], [1]Institute of Geophysics of Warsaw University, Pasteura 7, 02-093 Warsaw, Poland, kjkossac@fuw.edu.pl, [2]Max Planck Institute for Solar System Research, Max-Planck Str. 2, 37101 Katlenburg-Lindau, Germany.

Introduction: Water has always been a central theme in studies of Mars. It is also well known that liquid water is generally not stable on the surface of present Mars. There is however one form of liquid water which is stable under practically all conditions. This so called unfrozen or interfacial water is a thin liquid film separating frozen water ice and any mineral surface wherever these are present. The key question here is how thick this layer can be. In recent studies it has been proposed that interfacial liquid water can be responsible for surface rheologic processes on Mars [1,2]. Here we attempt to model both the diurnal and the seasonal cycle of the interfacial liquid water in the context of a possible mechanism for formation of the so called hill gullies. If the liquid interfacial layer is thick enough it could destabilize the surface layers and produce the observed gullies.

Gullies are among the most intriguing structures identified on the surface of Mars. They have been found in hundreds of locations in both hemispheres, incised into slopes of craters, pits, valleys, hills and even dunes. Gullies located on walls of impact craters, by far the largest population, are most likely formed by liquid water, probably transported by shallow aquifers [3]. The gullies found on the slopes of isolated hills are on average 50% longer than others, contradicting aquifers hypothesis, because only a small amount of water may be stored within an isolated hill [4].

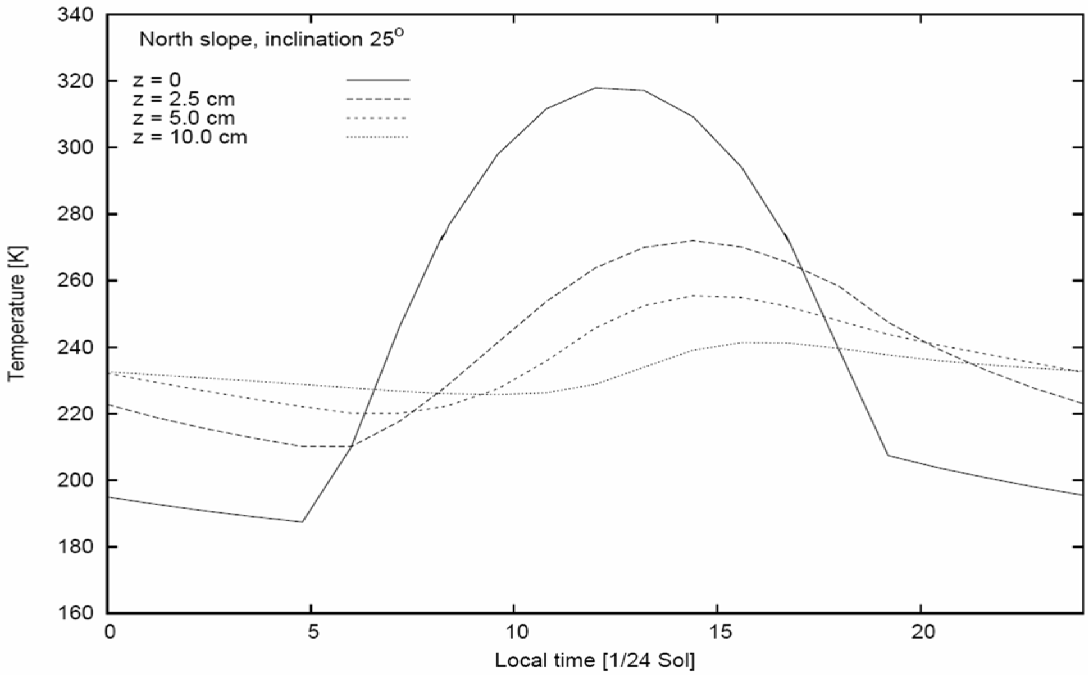
Model: Here we use a new version of the LWMRM model most recently used in [5,6]. The version used here includes the interfacial liquid water via equations described in [1,2].

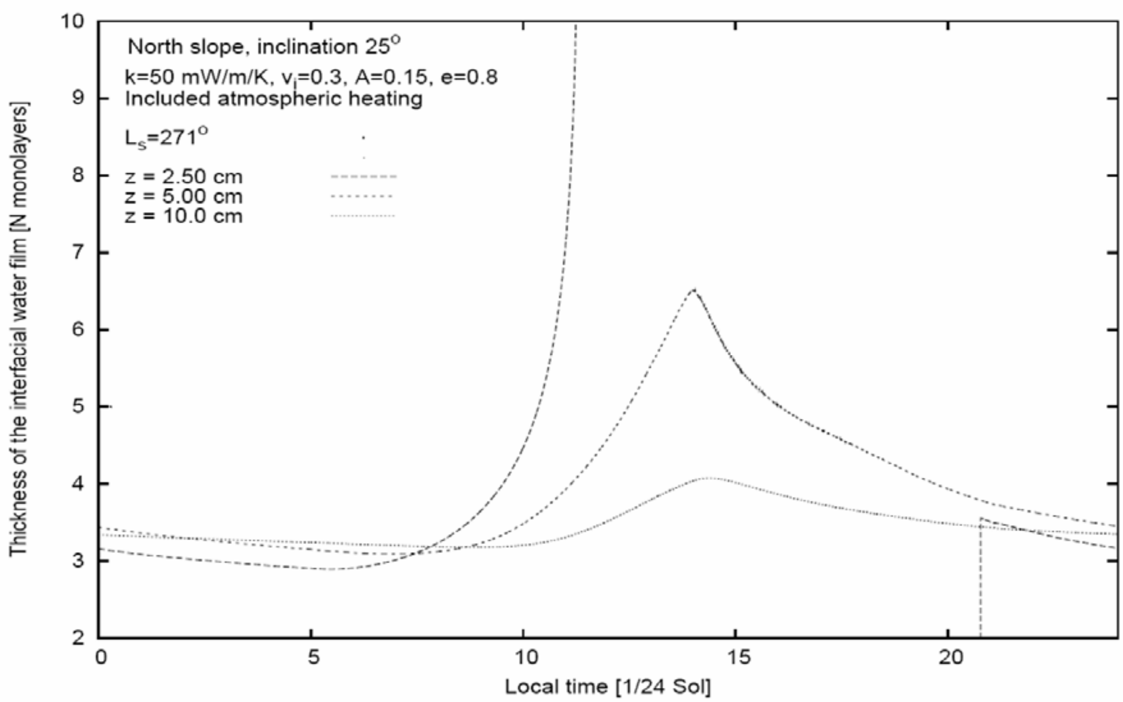
Parameters: We are interested to find the largest thickness of the interfacial water film possible. For this we require enough heating for the subsurface to reach near melting temperatures and at the same time water ice to be present. Mid latitudes satisfy best both of these criteria and we fix the latitude to be 50°S. This is also the approximate latitude where most of the hill gullies have been found so far [4]. We take albedo to be 0.15, emissivity 0.8 and thermal conductivity of the dry regolith 50mW/m/K, all extreme but still realistic values. The initial assumed volume fraction of water ice is; (i) zero at the surface, (ii) a linear function of depth down to 5 cm, and (iii) constant and equal to 0.3 below that. We looked at slopes facing the pole as well as some facing the equator. We also varied the slope and found that 25° to 30° to be optimal, which agrees well with the slopes of the hills on which gullies are found.

Results: In the figures below we show results for what we find to be an optimal case. The diurnal cycle of temperature and thickness of the interfacial film are shown for three different depths below the surface for L_s=271°. The slope is facing North which is towards equator. We see that 2.5 cm below the surface we reach melting temperatures just after noon and all of the ice disappears. A few cm lower, ice is however stable during the whole diurnal cycle. From this calculation we predict about 10 monolayers of interfacial liquid water to be present for a significant fraction of the day at a depth of about 5 cm. For other orientations and slopes the thickness of this layer is smaller. For example, for the case of the pole (South) facing slope we obtain the maximum of only 4 monolayers. The seasonal cycle shows that the film is always present and the period for the North facing slope when it is about 10 monolayers lasts from about L_s=240° to 280°.

Discussion: Is 10 monolayers of liquid water enough the make the surface layer unstable and produce a gully? This is not a question we can completely answer with the presented results but it does seem unlikely although not impossible. If we take thickness of the monolayer to be 3.5 Å, the whole film layer is only 3.5 10^{-9} m thick. We can compare this to the roughness of the grains within the regolith. The smallest grains are about 1 micron in size. Assuming the surface irregularities are 1% (10^{-8} m), we would require about 30 monolayers to fill them, which could allow films of neighboring grains to connect possibly making the material unstable. Although 30 is more than we observe in the model it is of the same magnitude and given model limitations should be considered similar. It should also be noted that gullies (of any type) found in mid-latitudes are mostly equatorial facing [4].

References: [1] Kereszturi A. et al. (2009) *Icarus*, **201**, 272-283. [2] Moehlmann G. H. (2008) *Icarus*, **195**, 131–139. [3] Heldmann J. L. et al. (2007) *Icarus*, **188**, 324–344. [4] Balme M. et al. (2006) *JGR*, E05001. [5] Kossacki, K. J. and Markiewicz W. J. (2004) *Icarus*, **171,** 272-283. [6] Kossacki K. J. et al. (2006) *Icarus*, **181**, 363-374.


North slope, inclination 25°
z = 0
z = 2.5 cm
z = 5.0 cm
z = 10.0 cm
Temperature [K]
Local time [1/24 Sol]


North slope, inclination 25°
k=50 mW/m/K, v=0.3, A=0.15, e=0.8
Included atmospheric heating
Ls=271°
z = 2.50 cm
z = 5.00 cm
z = 10.0 cm
Thickness of the interfacial water film [N monolayers]
Local time [1/24 Sol]