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A new mesoscale modelling tool for Martian surface-atmosphere interactions

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Abstract

As the Martian atmosphere and surface are studied in ever greater detail it is necessary to realistically model the subsurface whose vertical composition may vary (such as the presence of ice layers) and will interact via heat and mass transfer processes with the atmosphere. A new thermal scheme is introduced for use with the University of Helsinki 1D column atmospheric model. This model has been successfully used to characterise the local atmopsheric behaviour from in situ measurements by landers e.g. [1]. The model, with the updated subsurface thermal scheme, is designed to be used to investigate the subsurface for layered material and to provide more accurate modelling of the Martian atmosphere.

The updated model produces atmospheric temperature profiles similar to in situ temperature measurements, made at an altitude of 1.6 m, by the Viking 1 lander as shown in figure 1.

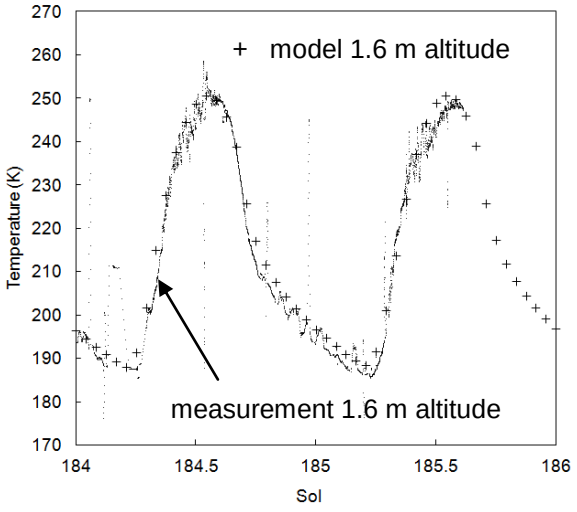

Figure 1 : Temperature of the Martian atmosphere measured by the Viking 1 lander compared to the updated model using I=380 J m^{-2} K^{-1} s$^{-1/2}$.

The updated model was used to investigate the effect of a layered subsurface on the surface and near-surface temperatures. A dust layer on rock produces a significant alteration to the diurnal temperature range produced by a rock only subsurface as shown in figure 2. It was also found that the lag in the time of maximum temperature is useful for deciphering whether the surface is layered or not. It may then be possible to constrain subsurface composition and structure using surface, or near surface hourly temperature measurements, and the updated model.

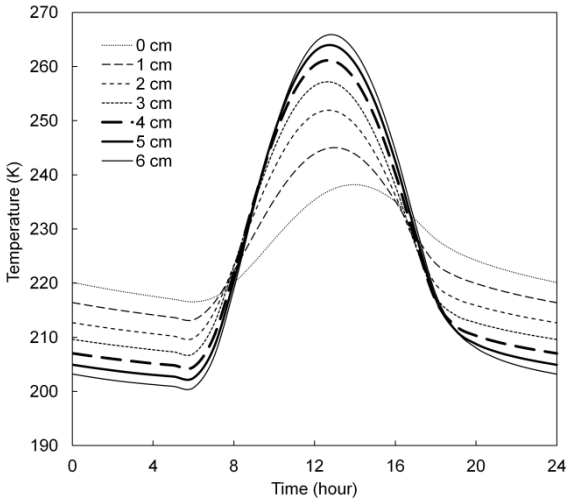

Figure 2 : Simulated diurnal surface temperatures profiles for a range of dust layer thicknesses (see legend) on solid rock using the updated model.

Finally we discuss how to infer the vertical composition of the subsurface from single daily temperature measurements of the surface.

References

[1] Savijärvi, H., Määttänen, A., Kauhanen, J. and Harri, A-. M.: Mars Pathfinder: New data and new model simulations, Q. J. R. Meteorol. Soc., Vol. 130, pp. 669-683, 2004.