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Geoscientific Instrumentation Methods and Data Systems
Discussions

Interactive comment on "Martian atmospheric model with a high-fidelity subsurface thermal scheme" *by* M. D. Paton and A.-M. Harri

Anonymous Referee #2

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Review of GI-2012-19 Martian atmospheric column model with a high-fidelity subsurface thermal scheme

General comments

The authors take an existing 1D atmospheric column model for the martian atmosphere and modify the surface boundary condition to allow more complex scenarios, including stratigraphy and depth and temperature variable thermal properties. The paper mainly discusses the thermal model, and refers to previous publications for the presentation of the atmospheric model. The changes to the model are primarily in reformulating the problem to use a fully implicit numerical scheme to solve the heat equation, rather than a semi-implicit Crank-Nicholson solver. The model is shown to give similar results to the previously published version, and, coupled with the atmospheric model, derives ther-

mal inertia of the Martian surface by fitting to the atmospheric temperatures measured by the Viking 1 lander. Several more examples are given to demonstrate the effect of sub-surface layering, although the more interesting of the stated scenarios (dust-ice mixes, and temperature dependent thermal properties) are not demonstrated.

"Thermal schemes" are mentioned throughout the paper - it is understood that this refers to a numerical scheme for solving the heat equation, but this is not explicitly mentioned and is probably best re-phrased – "thermal scheme" by by itself is not sufficiently descriptive. For example "layered subsurface thermal schemes" could be "thermal models including layering" or similar. This also applies to the (revised) title "High-fidelity subsurface thermal scheme for a Martian atmospheric model".

Scientific comments

1. The ability of the model to use temperature dependent thermal properties is mentioned several times, but no examples are given (e.g. specific heat capacity and thermal conductivity).

2. As well as "slab" models, continuously varying physical properties with depth would also be of interest (e.g. allowing for a dust layer with increasing density with depth)

3. Ice and dust-ice layers are mentioned several times, but it is not clear how these would be included in such a model (and how this would affect the stability of the numerical method)

– in particular sublimation/condensation processes

– no mention of the volatile transport within the subsurface is mentioned

– if the model can handle such cases this should be mentioned, or otherwise clarified

– perhaps this just means expanding on the sentence "Surface sublimation is modeled using a constant soil moisture fraction."?

4. Thin "slabs" (i.e. a fine grid) are needed where the temperature gradient is steep, i.e.

close to the surface or boundaries where sublimation/condensation might take place, but not everywhere. Could a variable (e.g. exponential) step size not have been used?

Technical corrections

1. Some references are to “Fig. n” and some to “Figure n”

2. Eq.1: it might be worth showing the dependencies of e.g. k (on temperature, depth etc.)

3. “On Earth the surface temperature may vary only a few degrees during the day for locations in, or surrounded by, an ocean to variations of up to 50 K in desert regions” - perhaps this could be worded “On Earth the diurnal temperature variation may be only a few degrees in oceanic regions and up to 50 K in desert regions” or similar.

4. p. 742, l.23: "framework material" – matrix material or similar?

5. p. 742, l.26: "which is representative from vertically homogeneous dust, sand, solid rock to ices" - meaning that the range of thermal inertia covers this range of materials, respectively?

6. p.743, l.5: "Most trenches were typically around a few centimtres in 11 depth that uncovered water-ice bearing soils" - meaning is not clear - most trenches were 11 cm deep, or most trenches that uncovered water-ice were 11 cm deep?

7. Also centimtres -> centimetres.

8. p.743, l.13 "The subsurface thermal scheme" - as before, "thermal scheme" is not very descriptive

9. p.745, l.21: "surface layers" -> "subsurface layers"?

10. p. 746, l.25: "level thickness" = layer thickness? Or rather the vertical spacing of control volume cells in your model?

11. p.746, l.2: "the results from the altered model was subtracted from" - either "results

were subtracted from" or "result was subtracted from"

12. p.747, l.4: "stability criteria for the explicit scheme are" or "stability criterion for the explicit scheme is"

13. p.747, l.6: conductiviy -> conductivity

14. p.747, l.7: give units for conductivity, as other values

15. p.747, l.8: "This corresponds to the lower value of the level thickness found in the simulations featured in figure 4." - meaning 100 cm? or 200 cm? please specify.

16. p.747 l.16: "The surface temperatures calculated with the atmosphere present results": either "calculated temperatures result in" or "calculate temperature results in"

17. p.747 l.26: "assumed in figure 6." -> "assumed." (the figure has already been mentioned in this sentence)

18. p.748 l.12: "(i.e. summer, autumn and spring)" - Figure 7 has four panels, including winter

19. p.749 l.23: "The lag of the temperature maximum is not significantly affected until the dust layer is about 1 cm" - the graph shows only 0 and 1 cm, what intervals were tested in between? And what was the grid resolution for these tests?

20. general: spelling seems to be mostly British, but there are some exceptions (e.g. “modeled”).

Comments on figures

Figure 4: "sensitivity of the model on the depth of the fixed temperature" might be better "sensitivity of the model to variations in the depth of..."

Figure 4: add that this is the temperature difference at the surface.

Figure 4: it would be interesting to also plot the solar input (forcing function) here, for comparison

Figure 5: text states 14 mm and 50 mm depth, figure legend shows 14 cm and 50 cm

Figure 6: change legend "Model" to "New model" or similar, for clarity

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