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Comparison of a 1D column model with temperature soundings in the Martian atmosphere

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Abstract

A 1D column model is compared to temperature soundings from the Mars Climate Sounder (MCS) aboard the Mars Reconnaissance Orbiter currently orbiting Mars. Such comparisons could help isolate non-local and local climate phenomena and so help improve our understanding of the regional and global-scale atmospheric processes on Mars.

This investigation could also help to further verify the accuracy of a 1D column model by including more representative atmospheric properties. For example by including more representative temperature profiles imported from a climate model.

1. Background

A 1D column model, previously used to investigate the properties of the atmosphere and surface at spacecraft landing sites, is used [1,2]. The observed temperature soundings are obtained from MCS. The Mars Climate Database, which includes results from a global climate model, will provide temperature profiles for greater realism when running the 1D column model.

2. Investigation methodology

Python code has been written that searches the MCS data and imports a temperature profile for a specific date, time and location. The 1D column model can then be automatically run by the code at the specified location and then the resulting temperature profile can be compared to the MCS temperature profile. The comparison is made by first calculating the average temperatures for both the observed profile and model profile.

There is also the option available to fit the 1D column model to the MCS profile by automatically varying a parameter in the model such as, e.g. thermal inertia, albedo, dust content. The 1D column

model thermal inertia and albedo is initialised from published global maps of Mars.

3. Results

The results so far suggest that the 1D column model can accurately reproduce the observed temperature profile up to or above the middle of the troposphere. Above this altitude temperature variations are present in the observations presumably due to regional-scale processes.
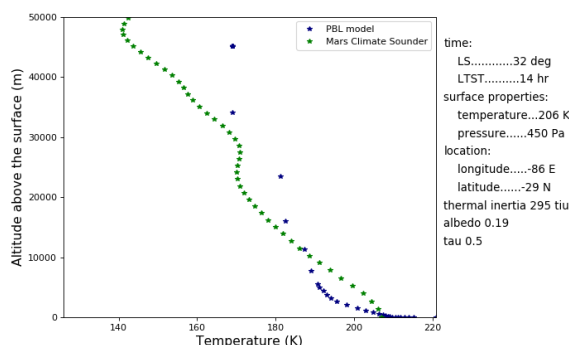

Figure 1. One of the first examples produced by the Python code for comparing a 1D column model with observation from MCS.

References

[1] Savijärvi, H. I., Paton, M. and Harri, A-M., New column simulations for the Viking landers: Winds, fog, frost, adsorption?, Icarus, Vol. 310, pp. 40-53, 2018.

[2] Paton, M. D., Harri, A. -M., Savijärvi, H., Mäkinen, T., Kemppinen O. and Hagermann, A., Thermal and microstructural properties of fine-grained material at the Viking Lander 1 site, Icarus, Vol. 271, pp. 360-374, 2016.