EPSC Abstracts
Vol. 9, EPSC2014-428, 2014
European Planetary Science Congress 2014

Martian pressure cycle model driven by radiatively forced sublimation of polar CO_2

Osku Kemppinen (1,2), Ari-Matti Harri (1), Mark Paton (1) and Hannu Savijärvi (1)
(1) Finnish Meteorological Institute, Helsinki, Finland (osku.kemppinen@fmi.fi)
(2) School of Science, Aalto University, Helsinki, Finland

1. Introduction

The Martian atmospheric pressure cycle is driven by sublimation and deposition of CO_2 at polar caps. In the thin atmosphere of Mars the surface energy balance and thus the phase changes of CO_2 ice are dominated by radiation. Additionally, because the atmosphere is so thin, the annual polar cap cycle can have a large relative effect on the pressure.

2. Methods

In this work we utilize radiative transfer models to calculate the amount of radiation incoming to Martian polar latitudes over each sol of the year, as well as the amount of energy lost from the ground due to thermal radiation. The energy budget calculated in this way allows us to estimate the amount of CO_2 sublimating and depositing at each hour of the Martian year. Since virtually all of the sublimated CO_2 is believed to enter and stay in the atmosphere until depositing, this allows us to calculate the annual pressure cycle, assuming the CO_2 is distributed approximately evenly over the planet. The pressure evolution acquired this way can be validated against the multitude of different pressure measurements made on Mars. The model also calculates the CO_2 polar cap sizes and depths, which can be validated independently from the pressure validation by comparing them to various orbital measurements.

Various dust and solar activity scenarios can be incorporated into the model. This allows for studying for example how the pressure behaves and the polar caps change between high dust versus low dust years.

3. Results

The model is running with physically plausible parameters and producing encouragingly good fits to in situ measured data made by e.g. Viking landers (Fig. 3). The model is currently not perfectly stable, that is, the pressure at the end of the yearly cycle is slightly different from the value at the beginning of the yearly cycle. In addition, some of the features of the pressure curve are not replicated perfectly. These issues are likely to be corrected with a more accurate treatment of some of the key components of the model. It is also good to note that there are likely to be unique features in each of the measurement sets due to for example local geographical features. Because of that, a more thorough comparison should be made against several independent data sources.

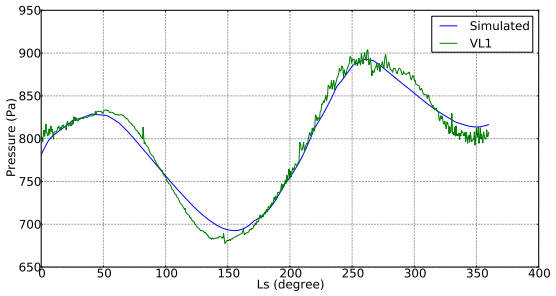

Figure 1: The pressure produced by the CO_2 evaporation model compared to Viking Lander 1 pressure of one full year

In the next phase we will validate the simulation runs against polar ice cap size and thickness measurements. In addition, we plan to compare the calculated CO_2 source and sink strengths to the sources and sinks of the global atmospheric models. One of the objectives of this work is to verify and possibly improve CO_2 source and sink parameterizations and the dynamical albedo of the polar caps used in global models.