EPSC Abstracts
Vol. 13, EPSC-DPS2019-1641-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Assessment of meteorological conditions for the formation of liquid brine on Mars using a mesoscale model

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Abstract

Liquid water or liquid brine are not stable on the Martian surface. However, perchlorates and chloride-bearing deposits can lower the freezing point and melt the water ice and form liquid water. Formation of liquid brine depends on the local meteorological conditions, surface temperature and relative humidity. In this study, we will perform mesoscale simulations to evaluate the possibility of liquid brine formation for different regions, including Phoenix landing site, where observational evidence was found for liquid brine formation.

1. Introduction

Despite the fact that Mars has large reservoirs of water ice, it is unlikely to observe liquid water on the surface of Mars due to the low pressure. However, the possibility of subsurface liquid water is quite important for the aspect of the current habitability of Mars. Perchlorates and chloride-bearing deposits, which can melt the water ice and produce liquid saline water, were detected on Mars [1]. For the formation of liquid saline water, two main mechanism have been suggested. The first one is based on the absorption of water vapor after a certain value of relative humidity [3]. The other possible mechanism is its formation by salts melting water ice when the temperature is higher than the eutectic temperature of salts within the water ice. The dependence of liquid brine formation on surface meteorological condition is presented in Fig. 1.

2. MarsWRF

MarsWRF is a multiscale atmospheric model including the nesting option and generalized map projection formulation. The model uses the classical terrain-following coordinated on a C-grid and the base-line model, WRF, has been modified by adapting the transport equations on the non-conformal grid configuration. Model can be run as a mesoscale model as well as a global circulation model. Several different physical processes are parameterized by using the sub-grid schemes, which are set according to a previous study [5]:

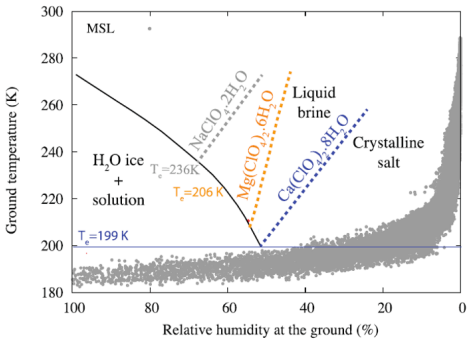

Figure 1: Stability diagram of different salt compositions with the imposed observations of MSL rover. Source [2]

- CO_2, dust and water cycles
- A wideband longwave and shortwave radiation parameterization schemes in addition to a UV heating parameterization scheme.
- Different dust scenarios including the ones based on the TES observations or specific dust scenarios like MGS dust-scenario.
- Subsurface schemes to model the heat and mass transfer within the Martian soil.
- Surface layer and planetary boundary layer schemes for the parameterization of turbulent fluxes within the boundary layer.

3. Mesoscale simulations

First, simulations will be performed for Phoenix landing sites, corresponding to Sols 8, 31, 34 of the

mission, when sphereoids, resembling liquid brine droplets, formed on the robotic arm of Phoenix lander [2]. Afterwards, further simulations will be performed for the South and North polar regions, where dark dune spots and flow-like features have been reported on the framework of High Resolution Imaging Science Experiment [4].

Acknowledgements

This work was financially supported by the Belgian PRODEX program managed by the European Space Agency in collaboration with the Belgian Federal Science Policy Office.

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