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MSL In Situ Humidity Observations - the First Martian Year

A.-M. Harri (1), M. Genzer (1), O. Kemppinen (1), J. Gomez-Elvira (2), J. A. Rodriguez-Manfred (2), T. McConnochie (3), H. Savijarvi (4), J. Polkko (1), M. De La Torre-Juarez (5), M. Mischna (5), M. Richardson (6), C. Newman (6), N. Renno (7), G. Martinez (7), S. Rafkin (8), J. Martin-Torres (9), M.-P. Zorzano (2), R. Haberle (10), L. Vazquez (11), P.-Y. Meslin (12), M. Komu (1), T. Makinen (1), M. Paton (1), W. Schmidt (1), T. Siili (1), M. Wong (7) and the MSL Science Team.
(1) Finnish Meteorological Institute, Helsinki, Finland, (2) Centro de Astrobiologia, Madrid, Spain, (3) University of Maryland, US, (4) University of Helsinki, Finland, (5) Jet Propulsion Laboratory, NASA, (6) Ashima Research Inc., (7) University of Mischigan, US, (8) Southwest Research Institute, Boulder, US, (9) Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Granada, Spain, (10) NASA Ames Research Center, US, (11) Universidad Complutense de Madrid, Spain, (12) Universite de Toulouse, UPS-OMP, IRAP, 31028 Toulouse, France.

Abstract

The Mars Science laboratory (MSL) landed successfully at Gale crater early August 2012. MSL carries an environmental instrument package called the Rover Environmental Monitoring Station (REMS) as a part of its scientific payload. REMS comprises instrumentation for the observation of atmospheric pressure, temperature of the air, ground temperature, wind speed and direction, relative humidity (REMS-H), and UV measurements. We discuss the initial observations during the first Martian year of MSL operations and constrain the REMS-H results by comparing them with earlier observations and modelling results.

1. Introduction

The REMS-H device is based on polymeric capacitive humidity sensors developed by Vaisala Inc. and it makes use of transducer electronics section placed in the vicinity of the three (3) humidity sensor heads. The humidity device is mounted on the REMS boom providing ventilation with the ambient atmosphere through a filter protecting the device from airborne dust. The final relative humidity results appear to be aligned with modelling results and earlier indirect observations of the total atmospheric precipitable water content.

2. Results

The REMS-H humidity observations during the first Martian year of MSL operations at Gale crater show diurnally and seasonally varying humidity. The Gale crater appears to be relatively dry compared to the estimated humidity levels at the Viking and Phoenix lander sites. The maximum relative humidity readings were about 90% RH during the period of MSL sols 540-570 measured at the REMS-H observational altitude of about 1.5 m above the ground. The maximum values were measured always in the early morning timeframe, when the atmospheric temperatures were on their lowest level. The conditions at the ground level may have been close to saturation during the early mornings , because only a s few degrees of Kelvin in terms of temperature difference between the ground and the REMS-H observational altitude are needed to reach saturation at the ground. Due to the fact that the amount of absolute humidity in the atmosphere at the REMS-H altitude is low, the possible frost formation is diffiucult to detect. Hence we have not yet been able to settle the question whether for-

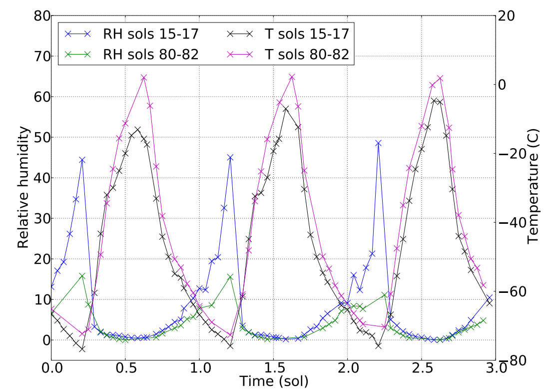

Figure 1: Relative humidity observations during sols 10-12 and 80-82. There is a clear temperature-driven difference in relative humidity between the two groups of sols, even if also the absolute humidity is lower during the later sols.

mation of frost on the surface is really taking place at Gale crater.

During the first Martian year of the MSL mission the water mixing ratio in the atmospheric surface layer appears to be below 100 ppm and is mostly varying between 10 to about 70 ppm. When assuming uniform mixing of atmospheric humidity, the precipitable water content of the atmosphere is ranging from a few to less than 10 precipitable micrometers. The humidity observations appear to be aligned with earlier indirect observations of the total atmospheric precipitable water content.

3. Summary and Conclusions

The REMS-H observations are giving out an interesting picture of the atmospheric water conditions at the Gale crater. Distinct local variation seems to be prevailing, and we may have detected seasonal trends that have been observed by earlier indirect observations. Overall, the Gale crater area seems to be dry when compared with the landing sites of the Mars Phoenix and Viking Landers. The Martian atmospheric humidity will be discussed by combining the REMS-H observations with other MSL observations as well as with earlier indirect observations and modelling results.

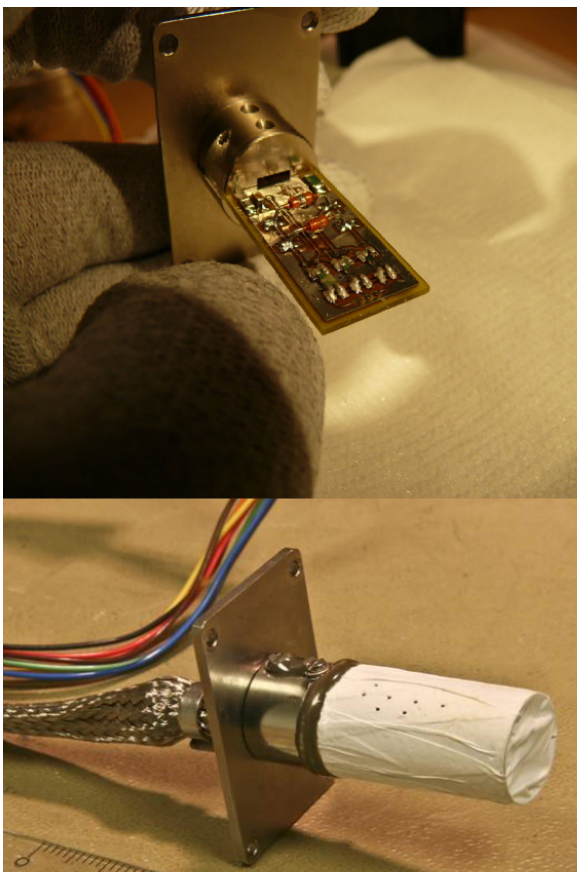

Figure 2: The REMS-H instrument depicted without the dust filter (upper pane) and with the filter (lower pane).

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