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Updated calibration and results of the REMS-H humidity sensor of the MSL Curiosity

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The Curiosity rover, part of the Mars Science Laboratory (MSL), landed in Gale crater in 2012 with the Rover Environmental Monitoring Station (REMS)[1] onboard. REMS includes an atmospheric relative humidity sensor, REMS-H, provided by the Finnish Meteorological Institute (FMI)[2]. REMS-H has continuously recorded hourly near-surface humidity conditions on Mars since landing, resulting in a rich dataset. As of May 2024, REMS-H has been operational for a little over 4100 sols; more than 11 Earth years, providing the longest relative humidity record from the surface of Mars.

Figure 1: REMS-H is located in the boom of Curiosity's mast. Credit: NASA/JPL-Caltech/MSSS

The current calibration of REMS-H has been evaluated using new calibration measurements performed under a Martian analogue environment at DLR PASLAB (Planetary Analog Simulation Laboratory) at the German Aerospace Center (DLR)[3]. The capacitive sensor type, that has been used in all in situ measurements so far, can be sensitive not only to relative humidity but also other variables like temperature, pressure and carbon dioxide (CO2)[4].

Based on the findings a revised calibration has been developed for REMS-H. This presentation outlines both the revised calibration and the corresponding updated results. Particularly two aspects of the calibration can now be corrected using real measurement data: the RH response function between 0% and 100% rh, and the dynamic range of the sensor in CO_2. Furthermore, a two-part calibration correction based on flight data analysis is described.

The revisited results section presents the revised interannual, seasonal, and diurnal variations in relative humidity, temperature, and derived water vapor mixing ratio (VMR). Comparisons with previous calibration results are also discussed. In general, the new calibration resulted in somewhat lower relative humidity values, although the difference varies. On average the difference is about 10% rh. In VMR, the difference is more prominent and temperature dependent. A couple of example sols with current and revised calibration are shown in Figure 2. The full dataset will be available in a subsequent manuscript that is currently under preparation [5].

The resulting new dataset is well aligned with orbital observations and M2020 MEDA HS observations from the same time period. Also the UH/FMI single-column model (SCM)[e.g. 6] has been used to evaluate the revised results with good agreement.

In conclusion, the recalibration effort has improved the accuracy and reliability of REMS-H data, aligning the results with orbital observations and simulation runs. While we believe that the new measurements provide a more accurate representation of humidity values on Mars, it's important to consider the relatively large uncertainty, particularly when RH levels are low, when using the data.

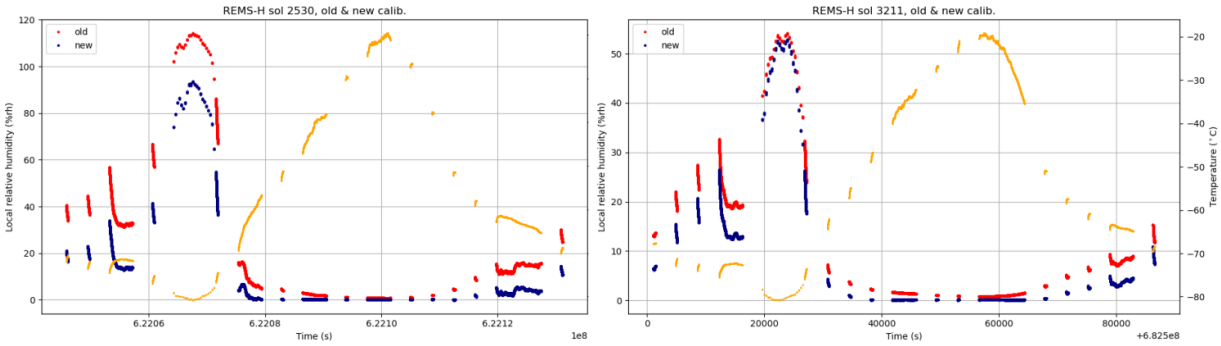

Figure 2: Example comparisons of old (red) and revised (blue) relative humidity measurements from sols 2530 (Ls=81.6°) and 3211 (Ls=87.2°) during southern winter. Sensor temperature is plotted in orange. In most sols the revised RH is lower than previously, but that is not always the case as can be seen in sol 3211 night time observations.

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