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Seasonal changes of near-surface relative humidity on Mars

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Abstract

The seasonal changes of relative humidity on Mars near the surface calculated from the output of LMDZ GCM are presented.

1. Introduction

Mars has been of key importance in the search for extraterrestrial life for decades now. During its geological history there were most likely times, when the planet had lakes, rivers, even oceans [1], however mainly because of its lack thick of atmosphere and general dryness, water cannot exist as a liquid in large volumes nowadays. Based on recent results, liquid water might emerge on microscopic scale on the surface of hygroscopic materials [2] if the environmental factors (e.g. relative humidity, temperature) are favourable [3]. To understand the possibility of deliquescence on the planet, it is important to examine the global variations of relative humidity near the surface.

2. Methods

We investigated the seasonal changes in relative humidity (RH) first by modelling approach using the output from LMDZ GCM detailed in [4], which is the second generation of the climate model developed in the LMD described in [5, 6], then with the measurements from the MGS TES. From these two different datasets we calculated the RH described below. In this abstract we only present the findings from GCM. To examine the annual variations of RH we chose four specific locations of the Mars on its route around the Sun. To mark the time of a year on Mars, we used solar longitude (Ls), Northern spring equinox at Ls = 0°, Ls = 90° at the Northern summer solstice, Ls = 180° at the Northern autumn equinox and Ls = 270° for the Northern winter solstice.

2.1. Calculations from GCM

To get the **relative humidity** values the saturation water vapor volume mixing ratio (WVVMR) needed to be calculated. This can be done with the following equation:

$$Q_{sat} = \frac{100}{P} \cdot 10^{2.07023 - 0.00320991 \cdot T - \frac{2484.896}{T} + 3.56654 \cdot \log(T)} \quad (1)$$

where P is the surface pressure, T is the surface temperature. To calculate the RH directly above the regolith, the WVVMR was assumed to be well mixed between the first two altitude layers of the model, the first being at approximately 4 m, and the second at approximately 23 m above sea level. Using this assumption the WVVMR at the surface (Q_0) is equal to those at the first level. Such, the RH can be calculated as:

$$RH = \frac{Q_0}{Q_{sat}} \quad (2)$$

3. Results

In this section the GCM calculated RH values are shown for the four chosen times (LS 0°, 90°, 180° and 270°), first with local time changing by longitude. This is to illustrate the differences between day and night and to see how it changes throughout a Martian year. Next we demonstrate figures with times unchanged with geographical longitude, where it is 2 am LT everywhere. This local time was selected, because the TES measured at roughly 2 am and 2 pm everywhere and by modelling for the same local times it allows us to see global trends and variations coming from two different methods, thus giving us the full picture in a greater detail. On these figures we can examine the seasonal changes excluding daily variations.

On Figure 1. we can see, that the region east from Alba Patera (AP) and Tharsis (T) seems to show elevated RH values during all seasons during evening hours. Arabia Terra (AT) is also 2-3 orders of magnitude more wet, than its surroundings, especially during northern spring and autumn. At the time of northern

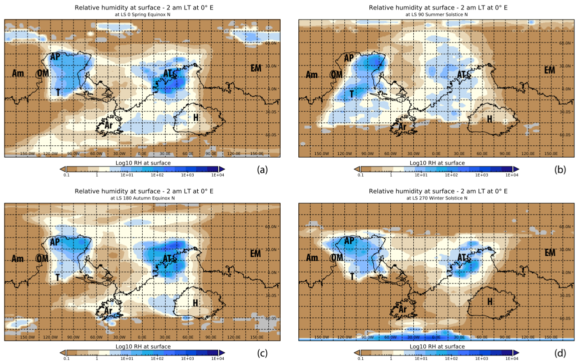

Figure 1: RH values directly above the surface calculated from GCM modelled data at the time of northern spring equinox (a), northern spring solstice (b), northern autumn equinox (c) and northern winter solstice (d), 2 am local time at 0° E.

summer, it's RH is still 1 order of magnitude higher, than the neighboring area, but it is less significantly more humid, than during the other three seasons. It is interesting to notice, that the zone between 60° W - 15° W is rather dry, despite that it is 10 pm - 12 am LT there at the figure.

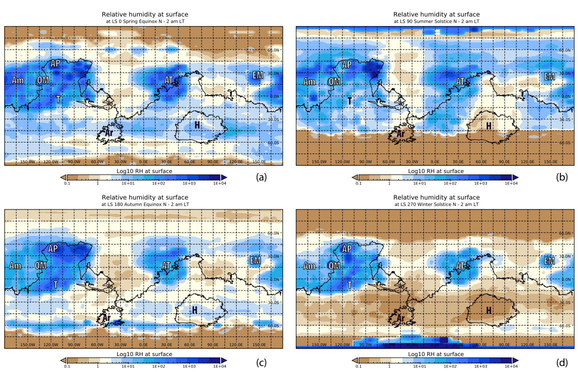

Figure 2: RH values directly above the surface calculated from GCM modelled data at the time of northern spring equinox (a), northern summer solstice (b), northern autumn equinox (c) and northern winter solstice (d), 2 am local time globally.

On Figure 2. we can see the snapshots, where it is 2 am LT everywhere on the planet. During all seasons on the GCM model result three distinct areas appear as oversaturated regions, the first zone being encircled by Amazonis (Am), Alba Patera (AP) and Tharsis (T); the second around Arabia Terra (AT); and the third is the region around Elysium Mons (EM). They are the least defined during the time of northern summer solstice, during this time the regions south from Tharsis (T), Amazonis (Am) and Arabia Terra (AT) stretch further down south, with similar RH values, thus there is no well-defined edge present to the wet zones. The three zones are visible the most clearly during northern winter, at which time their RH values are 2-3 magnitudes of order higher, than the rest of the planet surface.

4. Summary and Conclusions

The northern spring and autumn show quite similar characteristics on both types of figures (maximum RH, overall global pattern of the location of elevated RH values), however during spring the northern polar region seems rather dry compared to autumn. There is also a band between 30° S and 55-60° S, what seems more wet, than it's vicinity. The differences are more apparent between the northern summer and winter seasons, with the northern hemisphere being more wet during northern summer, and parts of the southern hemisphere during northern winter. Further results will be presented at the EPSC meeting.

Acknowledgements

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