A modern-day Mars climate in the Met Office Unified Model: dry simulations

Response to referees:

Dec 2022

We thank the referees for their report and continued engagement. Below is a combined response to the reports.

- Fig. 11 captions have been fixed, they now correctly link to the appendix.
- Figures have been replaced with a .pdf format to improve scaling, rather than .png as they were previously. As such they might look different when zoomed out, but the content is the same.
- Reference on line 644 has been fixed.
- Punctuation on line 177 now reads "(an Earth atmosphere; Marticorena)" instead of "(an Earth atmosphere, Marticorena)".
- The Woodward 2022 reference (which was "pending" at the time of writing, but has since been accepted) has been updated.
- Line 295 now reads "This is likely due to the absence of forced dust uplifting and a dust devil parameterisation in the UM, which is present in the PCM".
- We have added another paragraph (the penultimate paragraph in the "Discussion/conclusion" section) that talks more about the significance of a high-altitude dust layer. The paragraph is given below:

"Despite the absence of the aforementioned parameterizations, including a dust devil parameterization and prescribed dust quantities in the UM RA, our model still produces a high-altitude dust layer using a free dust scheme. This offers a promising development in Martian climate modelling (Montabone and Forget, 2017; Montabone et al., 2020). While the dust quantities and their seasonality in the UM RA are not entirely similar to those in PCM (e.g. the UM RA features a single dust storm season, while Mars features two seasons in reality; Madeleine et al., 2011; Read et al., 2015; Martínez et al., 2017), the ability to simulate seasonal dust levels with distributions characteristic of the PCM without forcing emphasises the scientific relevance of the UM. Once more parameterizations are implemented (as mentioned in the previous two paragraphs), results may be better matched across diurnal and monthly cycles, allowing further work investigating these temporal periods. For this reason, we hope the UM will prove a vital tool in the further research of the Martian climate using GCMs."