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Migration of intermediately-sized particles across the Martian surface

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Abstract

Investigations of the sedimentary processes on Mars are often related to the saltation of sand particles or the long-term suspension of dust particles or a combination of both. A small proportion of particles on Mars will have an intermediate size between sand and dust close to the saltation/suspension transition region. The repeated ejection and suspension of such particles into Planetary Boundary Layer over long periods of time may then produce the accumulation of particles in specific regions on Mars that could be verified by observations. Such regions, if they exist could then help us understand the past and present Martian climate.

To investgate the transport of the particles we use a trajectory model combined with wind field data imported from the Mars Climate Database to visualise the transport of material across the surface of Mars. The result is similar to adding tracers into a numerical weather model but without having to run the whole simulation. The technique described here produces useful results very quickly and allows physically based modelling of the particle trajectories.

1. Introduction

Detailed observations of the Martian sedimentary cycle on Mars by orbital and landed spacecraft suggest a surprisingly active sedimentary cycle [1,2]. For example high resolution images from orbit have observed mobile sand dunes. Visually tracking of mobile particles in Gale Crater by Curiosity has been used to observe wind activity [3].

2. Background

A trajectory model, such as previously used to model the descent of spacecraft in a windy Martian atmosphere [4], can be used to realistically model the motion of objects in the PBL. Global wind fields are available from the Mars Climate Database (MCD) as shown in figure 1.

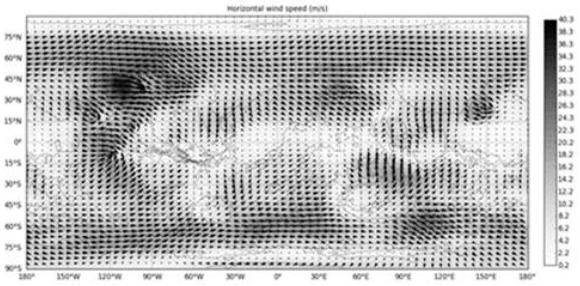

Figure 1: An example of a MCD wind field used for the trajectory calculations. It is not obvious the path, a wind blown particle released at an arbitrary location, would take by just looking at the wind data.

3. Investigation methodology

A spacecraft Entry, Descent and Landing trajectory model is used to calculate the horizontal transport and dispersion of particles in the size range of 20 to 100 μm, i.e. corresponding to the saltation/suspension transition particle size, by Planetary Boundary Layer (PBL) winds. Horizontal winds are imported into the model from the Mars Climate Database. The time of day is fixed for all longitudes.

Particles spread across the globe are then ‘released’ simultaneously in the modelled atmosphere. The particles are suspended for one Martian hour before falling to the surface. The wind field is not, at the moment, dynamically updated as time progresses. The following Martian day the particles are suspended at the same time as the previous day. Their trajectories, starting from the previous day’s location, are then calculated. Particles are initially released at longitudes and latitudes covering the entire Martian globe.

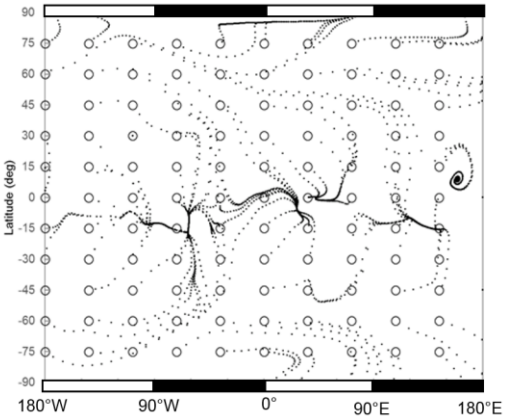

Figure 2: Paths of particles blown by winds at an altitude of between 10 and 500 m. There are 10000 ejection-descent events for each of the 110 particles modelled. During each event the particle is suspended in the atmosphere for one hour. The particle locations are plotted every 100 iterations of the trajectory model. Longitude is plotted along the x-axis. All atmospheric properties are kept constant except the wind during the model runs.

4. Summary

Maps of the paths taken by intermediately-sized particles across the Martian surface can be generated such as shown in figure 2. The maps are calculated by successfully combining the trajectory model in [4] with wind fields imported from the Mars Climate Database.

Some interesting observations so far:

- The PBL winds, in the model, blow material from the mid-latitudes to just south of the equator.
- The accumulation of PBL blown material coincides to the northern boundary of the belt of low albedo material around Mars.
- At high latitudes material in the model is blown towards towards the poles.
- There depleted zones around the mid-latitudes in the modelling results.

References

[1] Kok, J., Planetary science: Martian sand blowing in the wind, Nature, Vol. 485, pp. 312-313, 2012.

[2] Sullivan, R. and Kok, J. F., Aeolian saltation on Mars at low wind speeds, Journal of Geophysical Research: Planets, Vol. 122, pp. 2111-2143, 2017.

[3] Baker, M. M., Newman, C. E. N., Lapotre M. G. A., Sullivan, R., Bridges, N. T., and Lewis, K. W., Coarse sediment transport in the modern Martian environment, Journal of Geophysical Research: Planets, doi: 10.1002/2017je005513, 2018

[4] Paton, M. D., Harri, A. -M., and Savijärvi, H., Measurement of Martian boundary layer winds by the displacement of jettisoned lander hardware, Icarus, Vol. 309, pp. 345-362, 2018.