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Interannual variation of wind properties in the Martian planetary boundary layer

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Abstract

The Martian winds transport dust and volatiles across the planet, sculpt the landscape and are important for the spacecraft landing studies, e.g. [1]. Martian winds, particularly those aloft, are poorly characterised as they are out of reach of in situ measurements by landed spacecraft. To address this deficit of knowledge we determine the wind speed and direction using trajectory modelling of jettisoned hardware for most spacecraft landing sites since Viking, i.e. Viking landers 1 and 2, Beagle 2, Spirit, Opportunity, Phoenix, Curiosity and Schiaparelli.

1. Introduction

The MetNet mission [2] has been designed to characterise the local and global properties of the Martian climate. This would be achieved by performing simultaneous atmospheric measurements at various locations on Mars ideally with a network covering the whole globe. The meteorological properties aloft can then be characterised using high resolution atmosphere models verified against in situ measurements and observations. Ideally however meteorological properties aloft should be measured in situ to check the models.

2. Method

Here we determine the speed, direction and limited information on the vertical structure of winds from trajectory modelling of jettisoned spacecraft hardware [3]. These results are compared to the Mars Climate Database (MCD). The MCD default settings of the online version were used which produces mean values for atmospheric properties.

3. Results

We found, when comparing our results to the MCD, that there was a tight 1:1 correlation for wind direction whereas for wind speed the correlation was weak partly due to a large uncertainty in knowing the aerodynamic properties of the spacecraft and its jettisoned components. In a small number of cases the wind speed profile appears to be disturbed by small-scale circulations not resolved in the MCD data as we found for the Phoenix case.

Figure 1 shows the best fit trajectories found so far for the Phoenix lander and its jettisoned hardware. A Monte Carlo approach was used where a large number of trajectories (1000) were run. For each trajectory a function representing the wind profile was used whose parameters were randomly selected from a probability function. The resulting best fit wind direction, blowing from the north-west, and speed closely follow that of the MCD except for a layer, a few hundred metres thick, blowing from the north and centred at an altitude of 500 m.

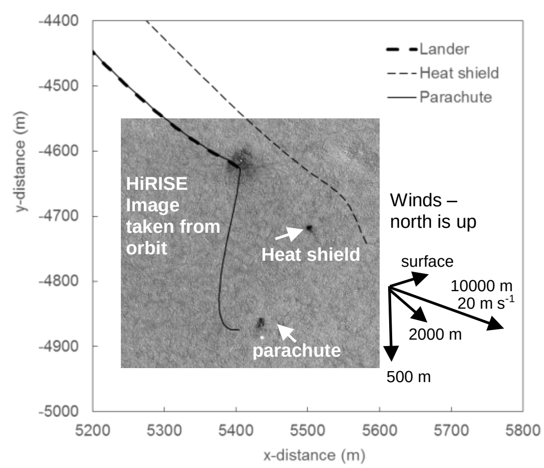

Figure 1. Trajectories of jettisoned Phoenix hardware.

References

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