

Time-dependent Dust Accumulation on the Mars Phoenix Wind Indicator

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Abstract

Time dependent dust accumulation on the Telltale fibers was observed during the Phoenix mission. Laboratory experiments were performed to determine the critical wind speeds needed to remove the accumulated dust.

The Kevlar fibers were originally monitored for dust accumulation to assess the possible error to the wind measurements. Laboratory tests have shown that this effect introduces a negligible error, however the time dependency of the dust accumulation displays interesting features.

1. Observations

The NASA Mars Mission Phoenix lasted 152 sols corresponding to $L_s = 76^\circ$ to 148° [1]. During this time wind speeds and directions were measured with a mechanical anemometer, the Telltale (Fig. 1), by analyzing the position of the Kapton cylinder in pictures taken with the Surface Stereo Imager (SSI).

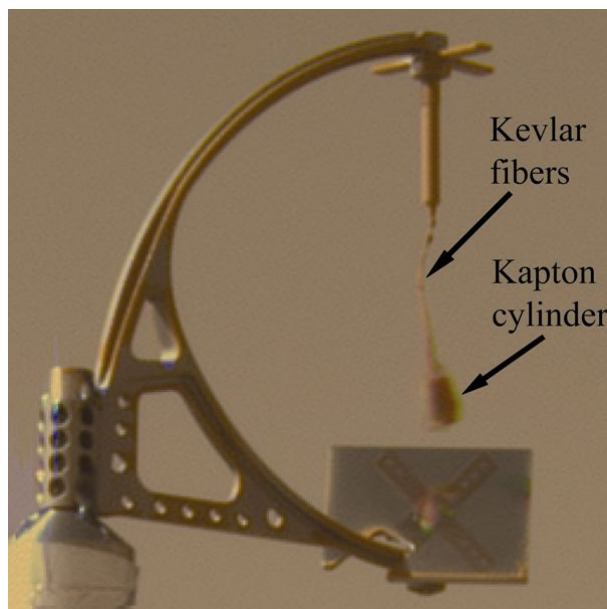


Figure 1: Color composite image of the Telltale taken on $L_s \sim 119^\circ$ [2]

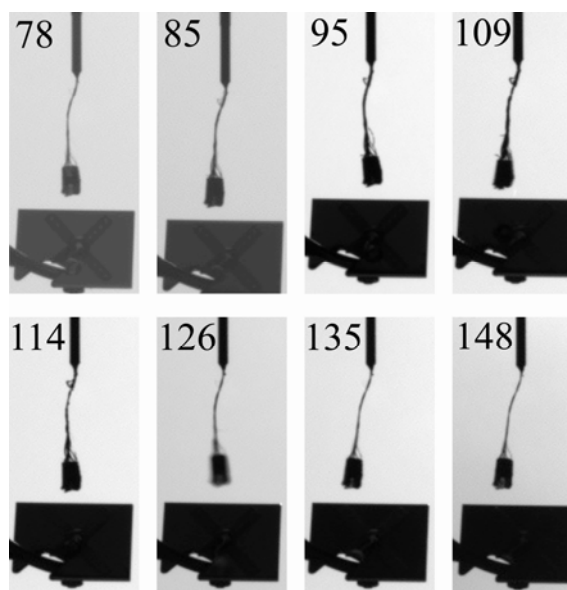


Figure 2: Images of the Telltale taken around 15:35 LMST at the solar longitudes indicated [2].

The dust accumulation can be seen in the Telltale images (Fig. 2). Since neither the fibers nor the dust thereupon are optically thick, a dust factor was calculated assuming exponential absorption through the dust loaded fibers (Fig. 3). At $L_s \sim 78^\circ$ the dust accumulation is minor as seen from the contrast between the fibers and the background. This contrast increases steadily until $L_s \sim 114^\circ$.

On later sols, the fibers appear thinner, indicating that they have been partially cleared of dust. The first major dust-devil days, were at $L_s \sim 112^\circ$ and $L_s \sim 120^\circ$ (Fig. 4), suggesting that dust devils could have cleaned dust off the fibers. The behavior appears to be more erratic hereafter, but there are clear indications of periods with accumulation and removal.

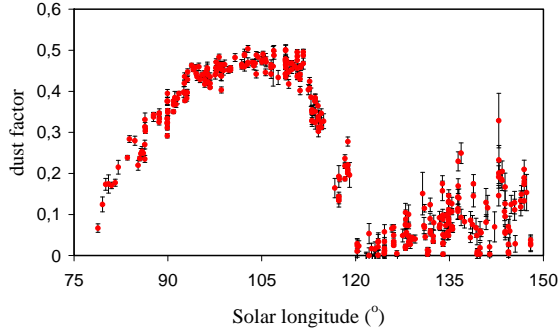


Figure 3: The calculated dust factor of the dust loaded fibers as a function of solar longitude.

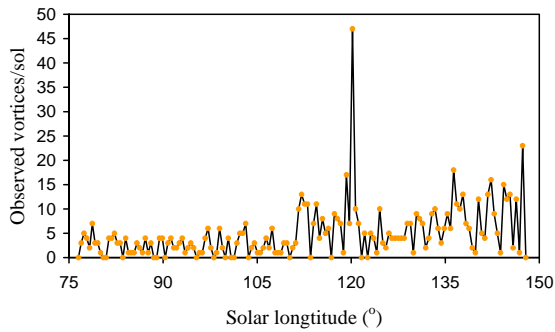


Figure 4: Number of vortices per sol observed at the Phoenix landing site by characteristic 5-20 sec. drop in the pressure (from [3]).

2. Experimental work

To determine if dust devils could clean the Telltale fibers a series of experiments were performed in the Aarhus Wind Tunnel Simulator (AWTS) [5] by depositing dust on fibers and increasing wind speeds until the dust was cleared. The dust deposition and removal experiment was repeated for 9, 10, 11, 14, 20 and 100 mbar with regular air in the wind tunnel and once at 9 mbar with CO_2 gas. The experiments determined that dust was removed from the fibers at 10(2) m/s, which was achieved daily after $L_s \sim 120^\circ$ (Fig. 5). This date coincides with the beginning of the dust devil season (Fig. 4) and corresponds with the

period of dust removal as observed during the mission (Fig. 3).

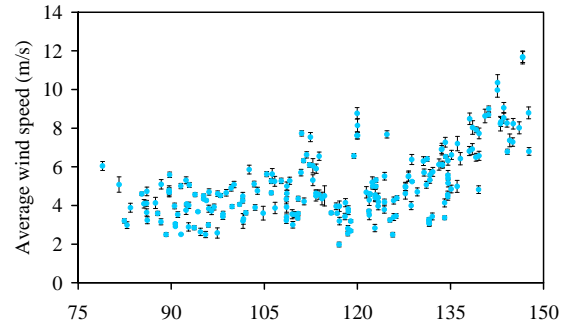


Figure 5: Average Telltale wind speeds for each series of images as a function of solar longitude.

3. Summary and Conclusions

The highest wind speed recorded at the Phoenix landing site of 16 m/s [2] can only just lift sand particle agglomerates from the surface [4]. Dust devils can host wind speeds of up to ~40 m/s [3] and the passing of these were considered the main cause of dust removal from the Telltale fibers.

Experiments have shown that wind speeds of only 10(2) m/s are needed to remove dust from the Telltale fibers, thus eliminating the need for dust devil passages. The threshold value also shows that the otherwise intermittent Telltale data is accurate with regard to the wind pattern, since any non-recorded higher wind speeds would be mirrored in the dust accumulated on the Telltale fibers.

References:

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