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Midnight temperature fluctuations at Mars Phoenix lander: Influence from Heimdal crater?

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Abstract

The Phoenix lander carried three thermocouple temperature sensors mounted on a 1 m meteorological mast situated on the lander deck (about 1 m above ground, cf. Figure 1) [1].

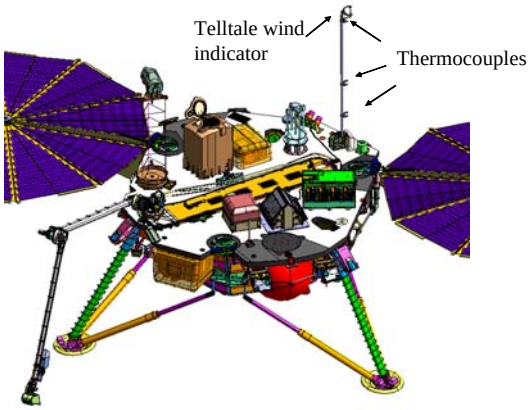

Figure 1: The Phoenix lander, showing the position of the thermocouples and the Telltale wind indicator.

The temperatures measured show a general trend throughout the mission with 10-20 K fluctuations in the daytime and smoother profiles during night-time. The temperature fluctuations due to daytime turbulence die out in the late afternoon (~17 LMST) and start again in the early morning (~06 LMST). However, at around midnight, significant fluctuations are observed. An example is shown in Figure 1.

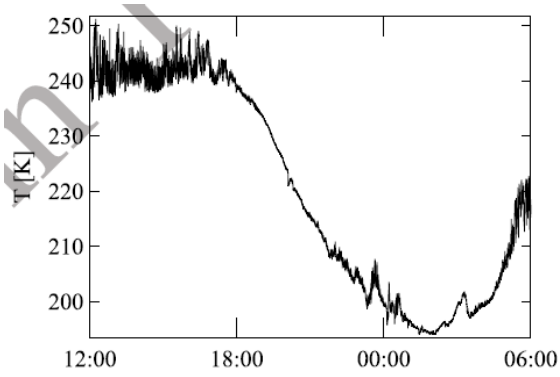

Figure 2: Atmospheric temperature measured at the sampling frequency of 0.5 Hz with the top thermo-couple on sols 55/56 from 12 noon till 6 am.

The midnight temperature fluctuations repeated every night around the same time for the first couple of months. To visualize these fluctuations better, we applied a filter to pick out 1 minute fluctuations and then applied a 90 second running average. The results are shown in Figure 3.

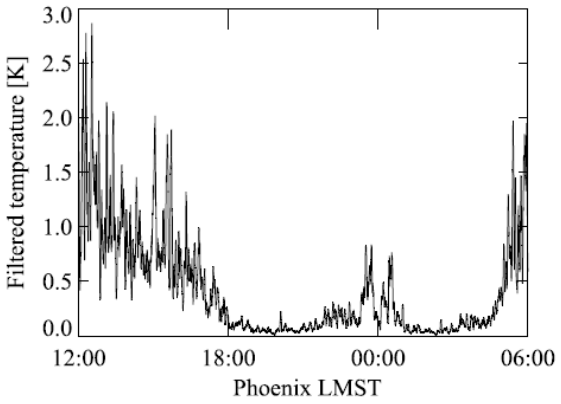

Figure 3: One minute temperature fluctuations derived from the data in Figure 1 using the methods described in the text.

Simultaneous wind measurements with the Telltale wind indicator [2] during midnight temperature fluctuations [3] show only minor changes in the wind directions and speed, not characteristic for daytime turbulence.

With turbulence absent, the temperature fluctuations represent instead an air mass that has not been completely homogenized. Based on Telltale data, winds are generally from East at this time of day, and it seems possible that this behaviour is due to an air mass that has passed over Heimdal crater (cf. Figure 4).

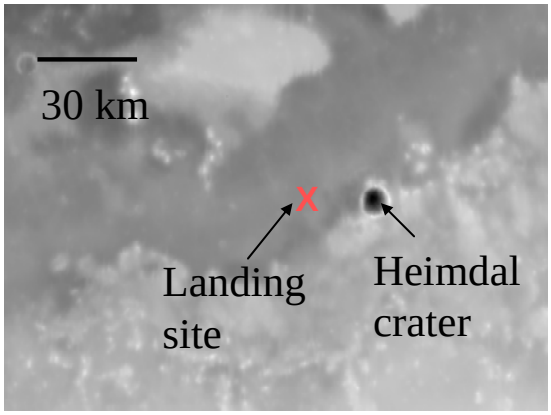

Figure 4: MOLA picture showing the landing site within "Green Valley" and the nearby Heimdal crater.

Heimdal crater is 10 km across and being only 20 km away from the Phoenix lander it is the only major geographical feature in the vicinity [4]. MOLA data shows that Heimdal has slopes reaching 4-7 degrees, far exceeding the 1 degree slope of Green Valley, where Phoenix sits, and the 1.4 degrees of the area southeast of Heimdal.

Wind directions changed late in the mission and after sol ~120 (L_S ~ 141°) winds from the West dominate the early morning and late evening data. Filtered temperature data from sol 137 show the absence of the up to ~1 K fluctuations in these data (cf. Figure 5). Winds do not pass over Heimdal crater indicating that the midnight temperature fluctuations are possibly related to Heimdal crater.

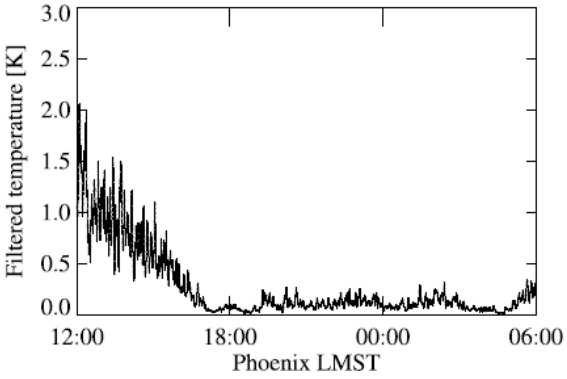

Figure 5: Filtered temperature data from sols 137/138 (L_S ~141°) where the night-time temperature fluctuations are absent.

References

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