PHOENIX: SUMMER WEATHER IN GREEN VALLEY (126W, 68N ON MARS)

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Introduction: Near continuous measurements of temperatures and pressure [1] on the Phoenix Lander and winds from the Telltale [2] and inferred from SSI camera video Zenith movies are used to indicate the typical daily cycles of temperature, pressure and winds at the Phoenix site (126W, 68N) during mid summer on Mars.

Data from the first 60 sols of the Phoenix mission indicate that, for this site, most days are approximately the same with temperatures 2-m above the surface varying from a low of -80C at around 0200 local time to a high of about -30C at about 1400 local. Wind directions veer almost continuously and we suggest that this is caused in part by local slope winds. Optical depths determined by the SSI camera [3] have generally decreased since landing, apart from dust events related to evaporation from the polar region.

Temperatures: Figure 1 shows a very typical diurnal cycle of temperature at three heights on the 1-m MET mast. Note that the heights are heights above the deck which itself is approximatele 1m above the regolith. Temperatures are measured with fine wire, butt-welded Chromel-Constantin thermocouples referenced to a "cold" junction in an isothermal block at the base of the mast which also has the reference platinum resistance thermometer.

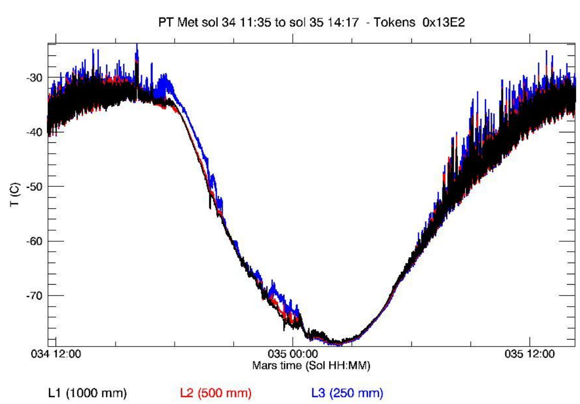


Figure 1: Preliminary Phoenix MET temperature data from Sols 34/35.

There are concerns that temperaturees measured by the lowest temperature sensor (at the 250 mm level) is being affected by heat emanating from the deck or from equipment and heaters on the deck while these effects are less evident or absent at the 500 mm and 1000 mm levels in this plot, although later in the mission on days with very calm winds, there are suspicions that temperatures at all levels may be affected by heating from the deck.

The time constant of the thermocouples is generally less than 1 s while effects of direct solar heating of the thermocouple junctions themselves is expected to be less that 1 degree [1].

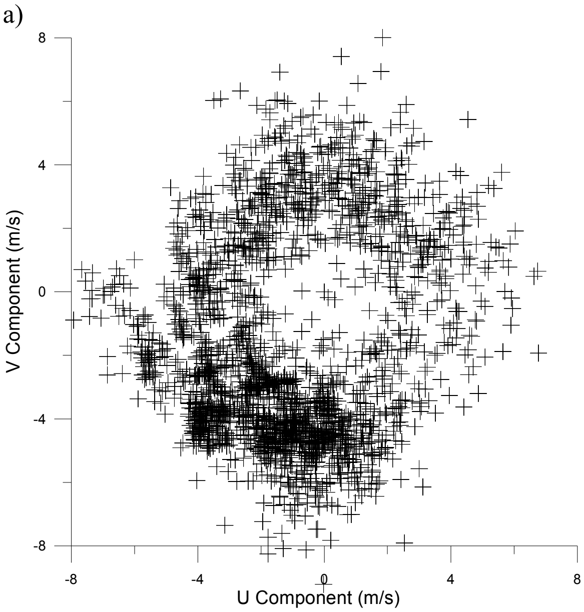
The diurnal cycle includes an extended period from about 0800-1800 with significant temperature fluctuations of up to about 10 K associated, we presume, with highly convective turbulent conditions. During the "night", although at this time of year at this latitude the sun remains above the horizon all the time, temperature variations are smaller. By late afternoon solar irradiance on the surface is reduced and the air cools leading, we believe, to stable stratification and calm conditions. This is evident from the generally much reduced temperature fluctuations through the 1800-0600 period, except for occasionalo bursts of "turbulence". We will discuss this further in relation to the wind direction data.

Winds: For a variety of reasons including mass and cost limitations we were unable to install a hot wire or sonic anemometer on Phoenix. Also by the time it was accepted that some wind measurement was essential the only option available to us was to make use of the SSI camera to observe the deflections of a windsock or telltale. With considerable ingenuity Gunnlaugson et al [2] built and calibrated a miniature telltale that has provided us with wind data at the top of the MET mast, 2 m above the surface. These data are not continuous and depend on the availability of the SSI camera to image the telltale – typically taking about 30 images over a 30 min period in order to get a meaningful average.

As with the temperature data there is generally a repeated pattern day after day, with winds predominantly from the E overnight, veering to southerly near mid-sol and on to northerly by late afternoon. The distribution of data points is not at all even throughout the sol, and relatively sparse at night, but the preliminary data shown in Figure 2 illustrate the fact that winds come from all directions, have speeds generally in the range 2 – 6 m/s and appear to veer almost continually through the day.

The local terrain, over scales of 10 km, and based on MOLA data, show a slight upward slope (1.5 degrees) to the E and S, and also show that the Heimdall crater lies about 20 km E of the landing site. We also use winds determined from SSI camera "movies" of dust and cloud patterns passing over the lander at heights assumed to lie within the 4-km deep boundary layer. Upper level winds often indicate wind speeds that are in the same direction but have lower speed than those

a)



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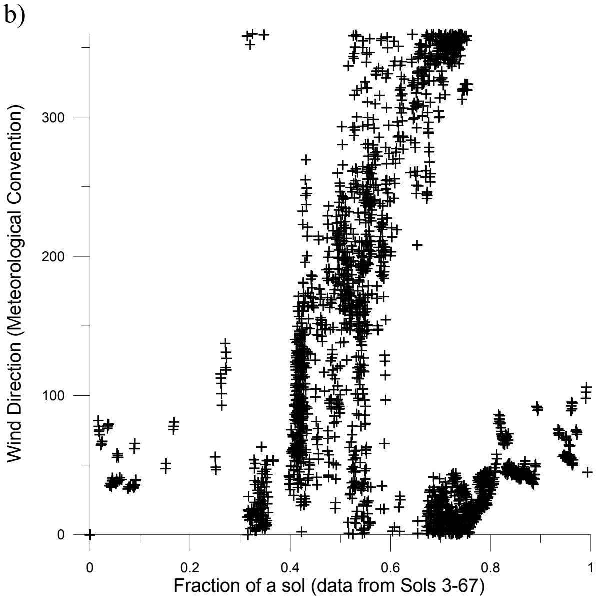

Figure 2. Preliminary telltale wind data from Sols 3-67. a) U and V components, b) Wind direction vs time of sol. (LMST)

from the telltale near the surface. We strongly suspect that the winds are in fact dominated by anabatic and katabatic winds on the rather gentle slopes. The companion paper by Sun and Taylor (2008) suggests that this is indeed possible

Night-Time turbulence: We can note from Figure 2b that by late evening the winds have veered from N to E and now come from the direction of the Heimdall crater – a significant piece of topography that could initiate gravity waves or eddy shedding and lead to the features appearing in the tempewrature record at around midnight. Another factor to be considered is the location of the mast on the Phoenix lander deck. With winds from the N and E the mast is close to the upwind edge of the deck while from other directions the flow has passed over the, rather cluttered and often warm, deck or over the solar panels. While passing over these potential heat sources it is probable that air reaching the lowest (250 mm) thermocouples will have been heated and this may explain the anomaly of higher night-time temperatures at the lowest thermiocouple levels that often occur during the early evening and later in the night. This is not very evident in Figure 1 but is more pronounced on other sols, as in Figure 3 below.

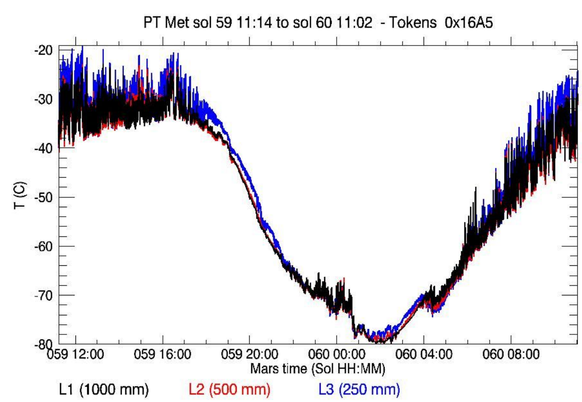

Figure 3. Preliminary Phoenix MET temperature data from Sols 59/60.

Conclusions: The Phoenix mission has collected a unique set of in situ meteorological data from northern Arctic regions on Mars. Summer days are rather boring, much the same conditions every day, but as fall approaches we anticipate more variability, more clouds, frost etc. and maybe some stronger winds and more dust. In the summer period investigated, local, quite gentle, slopes appear to play an important role.

References:

[1] Taylor, P. A., D. C. Catling, M. Daly, C. S. Dickinson, H. P. Gunnlaugsson, A. Harri, and C. F. Lange (2008), Temperature, pressure, and wind instrumentation in the Phoenix meteorological package, J. Geophys. Res., 113, E00A10, doi:10.1029/2007JE003015

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