MCS Views of the Northern Polar Atmosphere during Phoenix Approach.

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Introduction: The Mars Climate Sounder (MCS) is an atmospheric remote sounding instrument on the Mars Reconnaissance Orbiter (MRO). MCS observes the limb of Mars with a 9 channel infrared radiometer [1]. The primary goal of the instrument is to measure vertical profiles of temperature, dust, water ice, water vapor and CO_2 ice versus pressure. These are retrieved from the measured radiance profiles.

The Phoenix mission landed in the high northern plains [2]. Knowledge of the atmospheric density structure was important to help ensure a successful landing. This led to an intensive campaign to study the atmosphere near the landing site (and in the polar region) during the late northern spring (L_s 59° to 77°).

Observations: The polar MRO orbit covers all longitudes in 13 orbits (each separated by ~27°) over 24 hours 20 minutes. Each day, the ground track "walks" ~5° to the east. For a location on the surface, such as the center of the Phoenix landing ellipse, this results in a pattern of nearby observations where the closest track migrates from day to day. For example, one day two tracks will straddle the site, each 15° from the ellipse center. Then the next day, the nearest track will be 10° to the west, then 5° to the west, etc. To provide a regular weather report, the closest track was selected (with a western/upwind bias where appropriate). Along this track, all retrieved MCS profiles with centers between 63° N and 73° N (usually 7 or 8 profiles) were averaged to produce the landing site estimated temperature profile (and its deviations).

Figure 1 shows the atmospheric temperature profiles measured on 2008-05-05 and 2008-05-19, as well as the individual retrievals near the landing site on the latter day. The general trend for these latitudes at this season is a vertical region from the pressure of the lowest retrieved temperature up to ~30 Pa with a lapse rate around 2 K/km. While this region exhibits some variability and structure, it is dominated by this fairly high lapse rate. There is a temperature minimum (around 145 K) at 20 Pa. Above this, there is significantly more day-to-day and latitudinal variability, but there is usually a wave structure and a second, slightly colder, minimum between 0.3 Pa and 0.7 Pa.

Discussion: The regional distribution of dust was the most interesting and variable feature observed. Retrievals of MCS data produce profiles of dust opacity that can be integrated to produce column opacities, with the assumption that the dust is well mixed below the lowest retrieved altitude (generally 10 to 15 km). The estimated column opacity was mapped daily and provided an interesting view of the regional weather.

The region poleward of 80° N remains essentially dust free during this entire season. Dust is enhanced in the 270° E to 360° E quadrant between 60° N and the clear polar region. Chasma Borealis is in this sector and it probably drives the dustier atmosphere either due to the fast katabatic winds channeled by the chasma or perhaps due to being an enhanced source of dust (or both). For other longitudes, enhanced dust is usually associated with relatively small air masses (dust storms?) that appear to be flowing counterclockwise in the polar atmospheric circulation. These can often be tracked from day to day around the planet, moving around 30° to 60° of longitude per day. There was a tendency for the dust to pass north of the Phoenix landing site, causing this region to experience fewer dust events than other longitudes. This is suspected to be due to the influence of Tharsis south of the landing site.

Of particular interest in the last few days before landing was a dusty parcel (perhaps supported by a baroclinic storm) that moved out of the Chasma Borealis quadrant on May 17th. This activity continued around the planet and first appeared over the site on May 22, with the bulk of the dust moving over the site the next day. It then appears that the storm slowed down sufficiently so that the atmosphere was still dusty (although probably clearing) on May 25, landing day. The dust had a noticeable impact on the temperature structure of the atmosphere.

Conclusions: Phoenix landed safely despite the excitement provided by the dust activity.

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References:

[1] D. J. McCleese, J. T. Schofield, F. W. Taylor, S. B. Calcutt, M. C. Foote, D. M. Kass, C. B. Leovy, D. A. Paige, P. L. Read, and R. W. Zurek. Mars Climate Sounder: An investigation of thermal and water vapor structure, dust and condensate distributions in the atmosphere, and energy balance of the polar regions. *J. Geophys. Res.*, 112, 2007.

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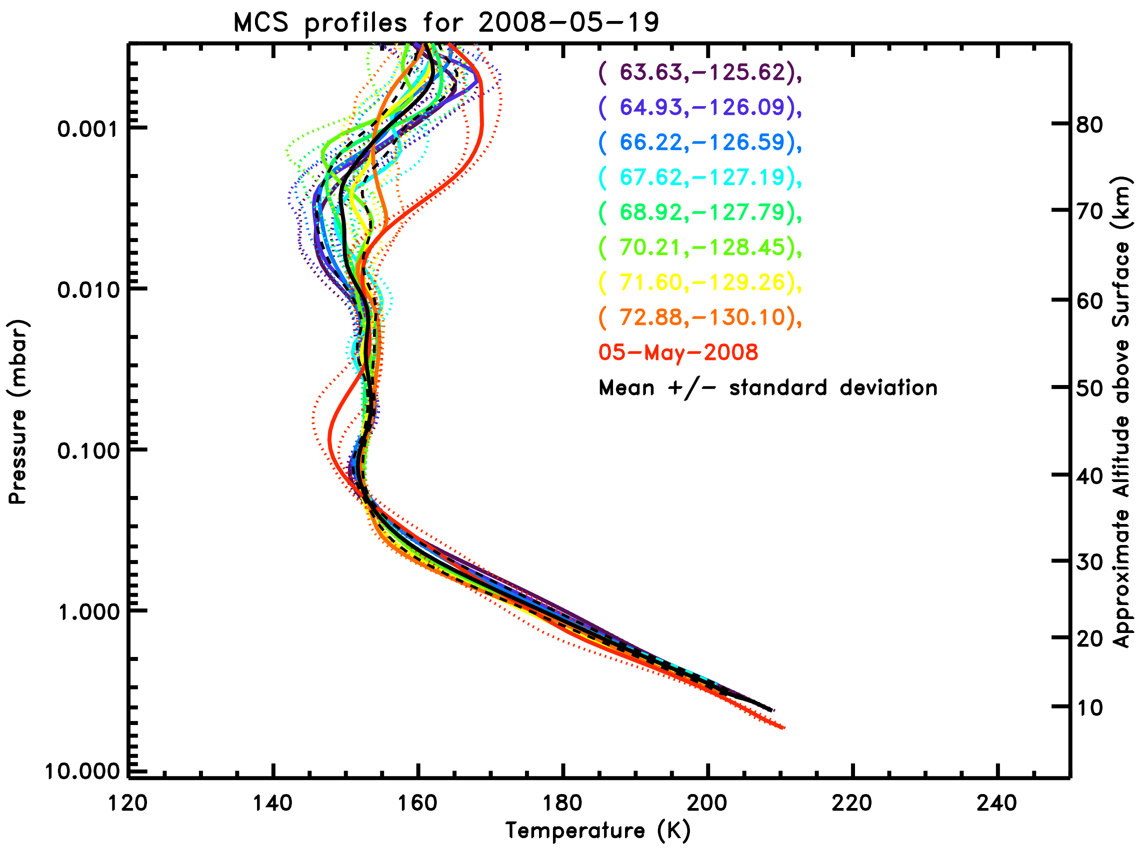

Figure 1: MCS temperature profiles near the Phoenix landing site on May 5th (red) and May 19th (black). The data on the latter day include the 8 profiles nearest the landing site in purple through orange (with their location) as well as the mean profile.