
Introduction: Recent MER Spirit and MGS MOC observations of dust devils crossing Martian plains (see below) demonstrate the similarity of Mars to terrestrial deserts. Near-surface thermal contrast builds during the day and promotes growth of dust-raising vortices. Evidence for corresponding transient thermal behavior has also been shown in MER MiniTES up-looking temperature profiles. How prevalent is such dust activity? Is the raised dust sufficient to modify the column dust opacity? Pollack et al [1] reported no diurnal variation in dust opacity at the Viking Lander sites. The answers have implications for mission operations as well as for atmospheric science.

A related problem is the occurrence of large storm fronts like those in terrestrial deserts and in some MGS MOC wide-angle images. Do they occur only at certain times of day? It is well known that dust fronts can move across increasingly large areas on successive days, but is the process continuous, or do the fronts build each day?

Approach: The dust opacity technique employed with Viking IRTM data in 1986 and 1993 [2,3] has been used here with the addition of a correction to the 15 µm temperature, following Wilson and Richardson [4]. For this work, we set an emission angle limit of 60º, and avoided data with T20 values below 165 K. This eliminates situations with unusable signal in the 7 µm band. We also collected values for T7-T20 and T9-T20 independently within a lat/lon/local time bin, before adding T20. This ensures that temporal and spatial variation within a bin affects the T7 and T9 difference to an equal degree, to the extent possible. That step is useful because the IRTM fields of view for 7 µm were not coincident with those for 9 µm.

Global Mapping: We have chosen an Ls bin size of 20º to provide adequate longitudinal coverage for most periods. The general opacity behavior is as shown by Martin and Richardson [3] but the separation of the data into time of day bins is new. We see in Fig. 2 the static nature of the opacity in the clearest periods such as Ls 40-60º, where the topography of Hellas and Tharsis drives the basic appearance of the maps. Periods near the start of major dust storms are omitted here because aliasing between Ls and local time makes analysis difficult when changes are rapid. But there is an apparent tendency for high opacity values to diminish in the afternoon.

![Fig. 1. Dust devils at Gusev crater, sol 568](image)

![Fig. 2. Selected opacity maps for various 20º Ls periods: beginning at (from top) 0, 40, 180, 220, 240, 280, 300, 320, and 340º; local time bins are shown at top. Lat/lon bins are 10º. Color bar is for opacities of 0-1.0, except periods 220, 280, and 300º have maximum opacity 2.0. West longitude is shown, with 0º at the right edge. No elevation corrections are applied.](image)
To make differences more clearly visible, we constrain time of day comparisons to lat/lon bins that are sampled within 2° Ls of each other.

Specific Sites - Phoenix Candidate Landing Sites:  
At the time of our work, the following candidate sites existed.

<table>
<thead>
<tr>
<th>Site</th>
<th>Latitude</th>
<th>W. Longitude</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>65-72 N</td>
<td>90-110</td>
</tr>
<tr>
<td>B</td>
<td>65-72</td>
<td>220-240</td>
</tr>
<tr>
<td>C</td>
<td>65-72</td>
<td>275-295</td>
</tr>
<tr>
<td>D</td>
<td>65-72</td>
<td>110-130</td>
</tr>
</tbody>
</table>

We chose for these sites three Ls ranges: 70-90, 90-110, and 110-130°, providing good Viking diurnal coverage and spanning the nominal length of the Phoenix mission. Note that the maximum opacity of 0.5 in the 9 µm band is equivalent to ~1 in the visual region.

The Phoenix site data show generally excellent coverage in local time. For three of the sites, opacities decrease with Ls (red to green to blue in the plot). That behavior is consistent with the zonal mean opacity record from MGS TES data derived by M. Smith [6]. However, Site C is definitely more dusty during the middle period. Site B is considerably more dusty than the others during the first interval. The differences may be due to circumpolar storms or fronts raising dust selectively. Thus these data might be simply snapshots of one season’s behavior.

Specific Sites: Elevation effects. We explored the effect of elevation, found by Whelley [7] to be important in Argyre in production of dust.
devils, by comparing sites with the same latitude but differing elevations. We observed four sites at -30 to -35° lat between Hellas (-5 km) and Tharsis (+4 km). Opacities up to ~0.8 (IR) for these sites at many seasons can be remarkably constant with local time (Fig. 6). Above that value, there is a definite trend to decrease in afternoon hours. Elevation seems to play no role in this behavior.

Specific Sites: Meridiani and Gusev. The MER landing site at Gusev has shown dramatic dust devil activity during Ls 175-280° [8]. Lemmon reported also a diurnal trend of lowering opacity after 11H local time. We find no such trend in the Ls 168-185° period (Fig. 7), but we do see a decline in the inter-storm period Ls 250-274°, as well as 310-330° (Fig. 8).

Conclusions: There is a tendency for dust opacity to peak during midday for periods when the overall opacity is high due to global or regional activity. There is not a clear connection of opacity to dust devil occurrence in places where they appear most frequently. The tendency of opacity to decline in the afternoon is common globally as well as observed at the Spirit MER site. If dust is not raised in sufficient quantity daily by dust devils, then it must be raised by other wind events, in order to sustain a daily decrease in the dust opacity.