Mars Exploration Rover atmospheric imaging: dust storms, dust devils, dust everywhere. M. T. Lemmon[1] and the Athena Science Team, [1]Texas A&M University, Dept. of Atmospheric Sciences, College Station, TX 77843-3150, email: lemmon@tamu.edu.

Introduction: Since January 2004, the Mars Exploration Rovers, Spirit and Opportunity, having been exploring in Gusev Crater and Meridiani Planum, Mars. In addition to their exploration missions, both rovers have been used for an atmospheric science campaign, and this campaign now spans more than one full Mars year at each site. The rovers' atmospheric science capabilities include thermal measurements with Mini-TES [1] and visual and near-infrared imaging with Pancam and engineering cameras [2].

Dust storms: Sun and sky images taken by the Spirit and Opportunity rovers have been used to measure properties of Martian atmospheric dust. We use images of the Sun to monitor 440-nm and 880-nm atmospheric opacity through the mission. The opacity (Fig. 1) was near unity shortly after the landing of each rover, and had fallen to 0.2-0.4 at Gusev crater and 0.4-0.6 at Meridiani Planum during late southern autumn and early southern winter ($45<L_S<135$). After L_S 135 (late December 2004), both rovers experienced a series of dust storms. Through L_S 215, four storm events resulted in opacities from 1to 1.5 for 1 to 7 sols (Martian solar days), and inter-storm opacities ranged from 0.6 to 0.9. Between L_S 215 and 235, opacities steadily climbed to 2.0 for Opportunity and 1.5 for Spirit, before falling back to the 0.6-0.8 level. A final dust storm at the Opportunity site occurred near opposition, and dust has declined with no additional storm activity, since L_S 320.

Dust devils: Around L_S 170-180 (March 2005),

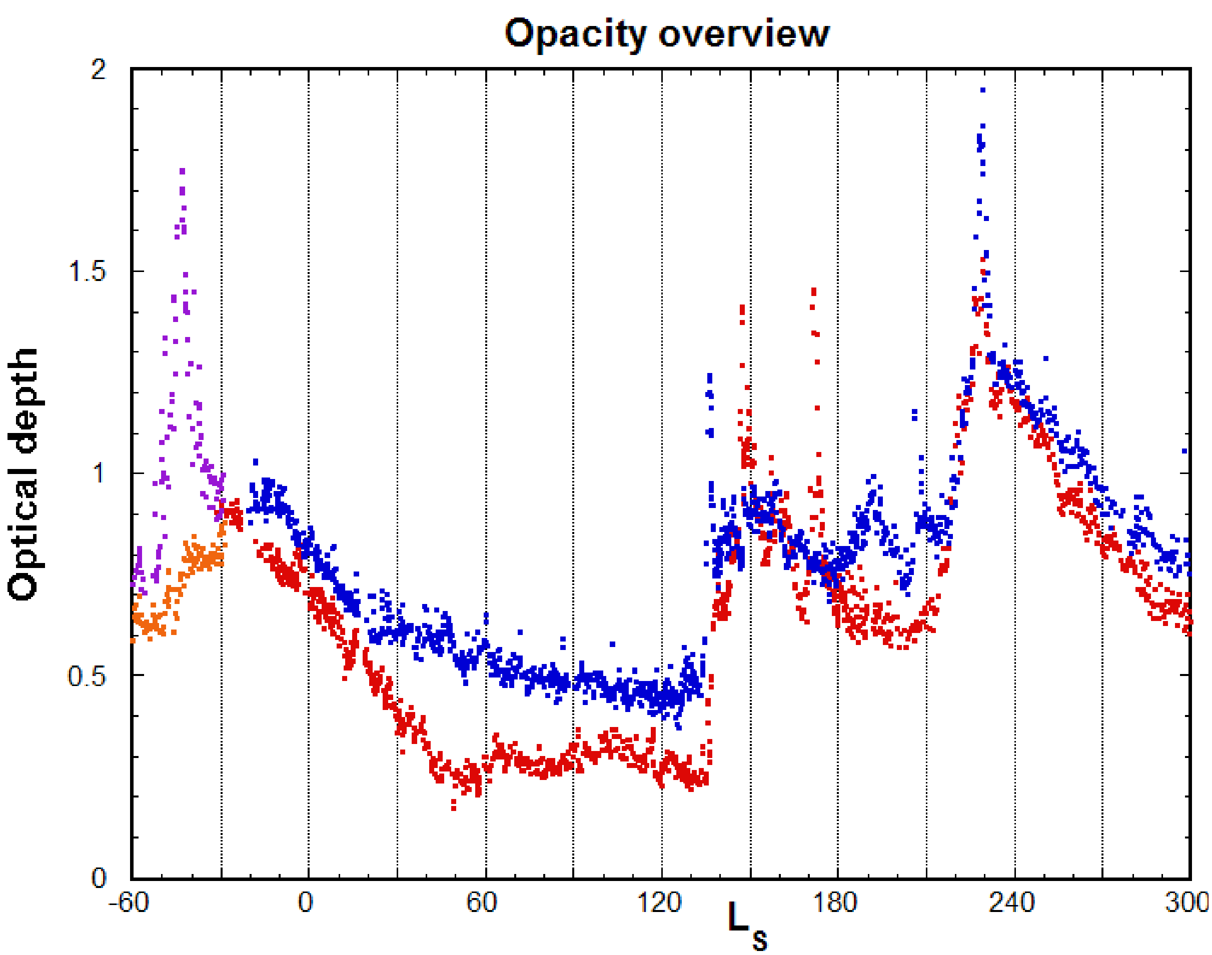

Figure 1. 440-nm optical depth over approximately the first Mars year **of operations for Spirit (red then orange) and Opportunity (blue then purple). The first Mars year began for Spirit at an areocentric solar longitude (Ls) of -30.**

there was a marked change in daily weather. Dust devil activity became common on the floor of Gusev crater (e.g., Fig 2), and the diurnal behavior of the opacity changed. Intrasol opacity variations >0.1 became common, especially at Gusev crater, with a strong tendency for dust opacity to fall between 1100 and 1700 (local true solar time) and recover by the next morning. Common dust devil activity persited through August 2005. Occust dust devil activity persisted through November and into December. While no dust devils were seen by Spirit 1 Mars year earlier, the new vantage point on top of Husband Hill allowed for additional sightings.

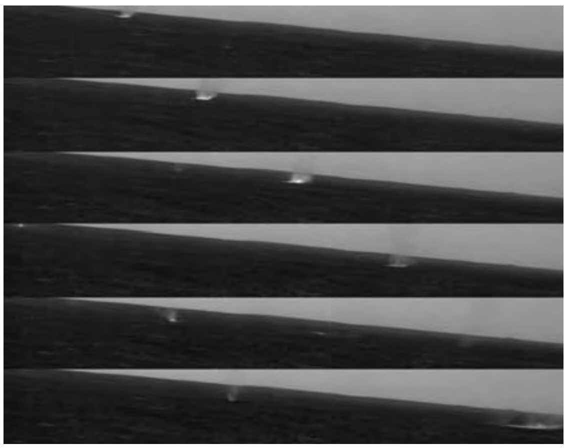

Figure 2: A series of dust devils observed by Spirit's Navcam on Sol 46~1 (20-sec intervals between frames).

Dust everywhere: A boost in solar pwer due to a combination of perihelion, southern summer, and dust being periodically removed from the solar panels left Spirit with an excess of power. On some sols, the excess power was used for astronomical observations. A subset of these were designed for studies of atmospheric opacity and the distribution of dust. First, sunset observations measure the extinction vs. elevation relation, which is moderately sensitive to the vertical distribution of the extinction. Second, night observations of stars and Phobos and Deimos allow retrieval of night time opacity and a search for diurnal variation (i.e., morning condensation clouds) for which the analysis is ongoing. Third, observations of the moons going into and coming out of eclipse is sensititve to the amount of dust in the 20-50 km altitude range. Analysis of several eclipse events will be presented.

References:

[1] Smith, M.D., et al. (1997) *Science, 306,* 1750–1753. [2] Lemmon, M.T., et al. (1997) *Science., 306,* 1753-1756. [3] .