PRELIMINARY ATMOSPHERIC HAZARD ASSESSMENT FOR MSL EDL. Scot C. Randell Rafkin and Timothy I. Michaels, Southwest Research Institute, 1050 Walnut Street, Suite 400, Boulder, Colorado, USA, 80302, rafkin@boulder.swri.edu.

Introduction: Engineering constraints at MSL landing locations require steady horizontal and vertical wind speed to be less than 30 m/s and 10 m/s, respectively, at altitudes between 0 and 10 km above the surface [1]. Similar constraints were required for the Mars Exploration Rovers (MERs) [2], and atmospheric models were used to identify potential landing sites that might fail to satisfy the atmospheric environmental constraints [3]. Unfortunately, because the models were applied late in the MER site downselection process, a considerable amount of effort had already gone into evaluating landing sites that were ultimately unselectable.

The analysis presented herein provides a first cut at identifying areas, based on NASA Ames Mars General Circulation Model (MGCM) simulations, that are near or above the atmospheric wind constraints. By providing this information early in the selection process, it is hoped that effort can be directed toward identifying sites that have the greatest chance of meeting the atmospheric environment constraints.

The MGCM provides information on the large-scale. Areas with strong large-scale winds are likely to be unsafe even at the local scale. However, the converse is not necessarily true. Large-scale areas with winds below threshold criteria might experience hazardous winds on the local scale. Therefore, potentially hazardous areas can be identified with the GCM, but even areas with acceptable large-scale winds might later prove to be hazardous after detailed analysis such as with a mesoscale model [3].

The MGCM cannot provide information about local vertical winds. Such information will need to be obtained from site-specific mesoscale or LES modeling [3][4], which is premature at this point in the site selection process and well beyond the scope of this work. However, some general rules of thumb regarding vertical velocity will be provided, time permitting, during the presentation.

MGCM Configuration: The NASA Ames MGCM was configured with 5x6^{o} grid spacing in latitude and longitude and with 30 vertical layers. Atmospheric dust loading was specified as a function of latitude and time so that the zonally averaged optical depth matches a typical (non-global dust storm) Mars year as observed by the MGS Thermal Emission Spectrometer [5]. The model is run for two Mars years. The first year is discarded as spin-up, and the second is used for analysis. Model output is archived at 1.5 hour intervals, or equivalently, 16 times per sol.

MGCM Results: Figure 1 shows the maximum wind speed from 0-10 km AGL from Ls=120-150.

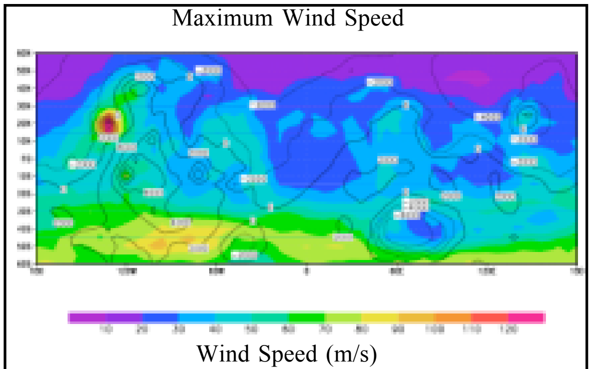

Figure 1. Maximum wind speed during the landing window of Ls=120-150 over altitudes 0-10 km AGL. Colors above dark blue violate the mean wind criteria of 30 m/s.

Immediately, it can be seen that most of the southern hemisphere and good portions of the northern hemisphere experience mean winds in excess of 30 m/s at some point. The maximum in southern middle latitudes is a product of the polar jet, which is strongest during the winter. There is also a modest correlation of wind speeds with topography; the highest terrain has the strongest winds.

Examination of the maximum wind speeds over 10 sol intervals throughout the landing window indicates that the same basic pattern in Fig. 1 prevails more or less from sol to sol (not shown). Therefore, the wind speeds in Fig. 1 are not a result of occasional strong winds, but the result of persistent climatological circulations.

It is possible that the strong winds are more common at specific time periods within a sol. The variation of winds as a function of time of day will be presented during the talk.

Conclusion: A preliminary look at MGCM winds during the MSL landing window indicates that a restriction of 30 m/s winds from 0 to 10 km AGL may eliminate nearly all of the southern hemisphere from landing site consideration. A large portion of the northern hemisphere may also be eliminated.

A more detailed examination of wind speed variation as a function of time of day may indicate that there are windows of time in which the winds weaken. Besides relaxing the wind speed restrictions, this would be the only way to open up previously unexplored terrain to the MSL rover.

References:

[1] Mars Science Laboratory Engineering Constraints

Document. [2] Kass, D. *et al.* (2003) *J. Geophys. Res.,* 108(E12). [3] Rafkin S. C. R. and T. I. Michaels (2003) *J. Geophys. Res.*, 108(E12). Michaels and Rafkin (2004) *Quart. J. Roy. Me. Soc.*, 130. [5] Smith, M. (2006) *2nd Mars Atmospheric Modeling and Observation Workshop*, Granada, Spain.