ANALYSIS OF ATMOSPHERIC MESOSCALE MODELS FOR ENTRY, DESCENT AND LANDING. D. M. Kass, J. T. Schofield, *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA*, T. I. Michaels, S. C. R. Rafkin, *Southwest Research Institute, Boulder, Colorado, USA*, M. I. Richardson, *California Institute of Technology, Pasadena, California, USA*, A. D. Toigo, *Cornell University, Ithaca, New York, USA*.

Each Mars Exploration Rover (MER) is sensitive to the martian winds encountered near the surface during the Entry, Descent and Landing (EDL) process. These winds are strongly influenced by local (mesoscale) conditions. In the absence of suitable wind observations, wind fields predicted by martian mesoscale atmospheric models have been analyzed to guide landing site selection. Two different models were used, the MRAMS model [1] and the Mars MM5 model [2]. In order to encompass both models and render their results useful to the EDL engineering team, a series of statistical techniques were applied to the model results. These analyses cover the high priority landing sites during the expected landing times (1200 to 1500 local time). The number of sites studied is limited by the computational and analysis cost of the mesoscale models.

Four primary statistical measures were computed. They concentrate on the mean wind speed and on the vertical structure of the horizontal winds. Both aspects are potentially hazardous to the MER landing system. In addition, a number of individual wind profiles from the mesoscale model were processed into a form that can be used directly by the EDL Monte-Carlo simulations.

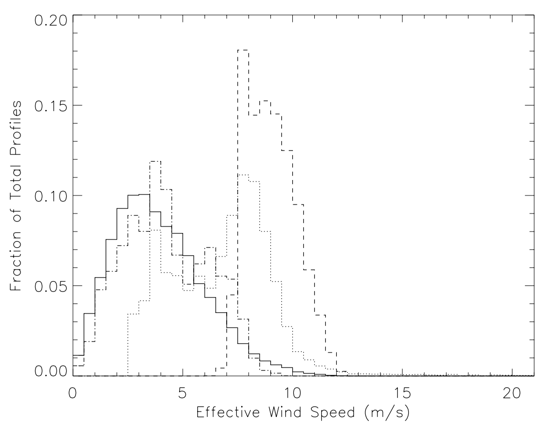

Figure 1. Model Mean Wind Speed Histogram. This figure shows a histogram of the effective wind speed (m/s) distribution for some of the landing sites. These are shown in 0.5 m/s bins as a fraction of the total number of profiles analyzed. The solid line is for the Meridiani Planum, the dotted line for the Gusev Crater site, the dashed line for the Isidis Basin site and the dash-dotted line for the Elysium Planitia site.

The effective mean wind speed is a measure of the horizontal speed the winds impart on the lander during its descent. It is computed for each wind velocity component (or direction) independently and then the two are combined to get the wind speed. The effective mean wind is a weighted mean between ~ 300 m and ~ 5 km. An exponential weighting function that peaks at the bottom of the integral and decays with a ~ 2.5 km scale height is used. The integration range and scale height are chosen to match the MER landing system. Figure 1 shows the binned statistics for the four prime canidate landing sites.

The vertical structure was studied in three ways. The first statistic was used to measure the long wavelength shear. A spacial Fourier transform of each profile from the surface to 5 km was performed. The mean ratio to an engineering standard was calculated for wavelengths between 5 km and 350 m. The second statistic studied was the mean TKE (Turbulent Kinetic Energy) over the tubulent boundary layer. This scaled and used as a proxy for the higher frequency shear not reprensented directly in the model profiles. The third and simplest statistic was to calculate the average thickness of the turbulent boundary layer at each landing site.

In order for the engineers to use the wind information in their EDL Monte-Carlo simulation, it was necessary to prepare actual wind profiles. This was done by randomly selecting mesoscale wind profiles from within the landing ellipse and extending them vertically to 50 km by using a profile from the Ames MGCM [3]. A high frequency turbulence component, whose magnitude and vertical structure were controlled by the TKE field of the specific profile, was also added via a Monte-Carlo type process. This was done to insure the effects of these higher frequencies would be captured in the engineering simulations.

The statistical and engineering analyses indicates that the Meridiani Planum and Elysium Planitia landing sites are probably safe. While the wind regimes are different at the two sites, they are equally safe within the uncertainty of the modeling. The winds at the Gusev Crater and Isidis Basin sites are more dangerous to the landing system. But they appear to be within the capabilities of the MER landing system. Finally, while there are some differences in the two models, the winds at the Melas Chasma landing site (and presumably other Valles Marineris landing sites) appear likely to be quite dangerous.

While the statistical parameters selected for these studies were primarily of engineering and landing safety interest, the techniques are potentially useful for more general scientific analyses. One interesting result of the current analysis is that the depth of the convective boundary layer (and thus the resulting energy density) appears to be primarily driven by the existence of a well organized mesoscale (or regional) circulation—primarily driven by large scale topographic features at Mars.

References: [1] Rafkin S. and T. Michaels, (in press) *JGR*. [2] Toigo A. and M. Richardson, (in press) *JGR*. [3] Joshi M. *et al.* (2000), *JGR 105*, 17,601-17,615.