CHARACTERIZING DAYTIME EROSION POTENTIAL ON MARS USING THE MRAMS LES. L. K. Fenton[1] and T. I. Michaels[2], [1]Carl Sagan Center, NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035-1000, lfenton@carlsagancenter.org, [2]Southwest Research Institute, tmichael@boulder.swri.edu.

Introduction: A significant goal of Mars science is to understand the present-day interaction between the atmospheric environment and the planet's surface that ultimately results in climatically- and geologically-important aeolian phenomena (*e.g.*, dust storms, dust devils, albedo changes, dune migration, surface erosion). Although the potential impact of larger atmospheric flows on surface-atmosphere interactions has been studied at length with mesoscale atmospheric models and global circulation models [*e.g.*, 1-3], studies of simulations resolving the complex, highly three-dimensional dry convective circulations that produce dust-lifting events are still uncommon [*e.g.*, 4, 5].

We present preliminary results of large eddy simulations (LES) of two areas on Mars, corresponding to the Viking Lander 1 (VL1) and the Phoenix (PHX) landing sites. We demonstrate that: 1.) although mesoscale model output indicates that no particle entrainment should occur, convective activity in the LES does produce winds above an estimated saltation threshold friction velocity, and 2.) although the simulations at the two locations were run at similar seasons and local times, the degree of particle entrainment at the two sites differs, in part because of varying degrees of local convective activity ("gustiness").

MRAMS Large Eddy Simulations: The Mars Regional Atmospheric Modeling System (MRAMS) is a non-hydrostatic, finite-difference, limited domain mesoscale model [6, 7]. MRAMS acts as an LES when the subgrid scale turbulence is modified to explicitly model eddies down to the domain resolution, based on the method of [8].

The LES domains use periodic boundary conditions and consist of 200 x 200 horizontal grid cells with a spacing of 100 m x 100 m and 80 vertical cells stretching in thickness from 4 m at the surface to 150 m at the domain ceiling (z ~ 9.5 km). Initial conditions (wind velocity, temperature, and interpolated pressure) are taken from the nearest available grid cell from a mesoscale simulation (with a horizontal resolution of 5 km x 5 km). Each LES was run for one half hour of Mars time (following an hour of spinup).

The VL1 LES (22.3ºN, 312.1ºE) was timed to coincide with high frequency VL1 MET data, overlapping with mesoscale model output at mean local solar time (MLST) = 13.32 h and L_s = 102.7º. The PHX LES (68.25ºN, 234.5ºE) was timed to coincide with the Phoenix Lander EDL, at a similar time of day as the VL1 LES run, overlapping with mesoscale model output at MLST = 12.96 h and L_s = 76º.

Particle Entrainment: The distribution of friction velocity u_* across each LES domain is assumed to represent "gusts" caused by regional winds and convective turbulence in the planetary boundary layer at that instant in time. In some locations the gusts (either wind gusts or vortices) may be strong enough that friction velocities exceed the saltation threshold friction velocity u_{*t}, causing any available sand grains to saltate, which in turn impact the surface and kick any available dust grains into suspension. The distribution of LES-derived friction velocities may be superimposed onto mesoscale model friction velocities, which are assumed to represent the mean friction velocity in each mesoscale grid cell. Mesoscale threshold friction velocities were calculated using [9], assuming 100 µm diameter basalt sand grains ($\rho = 3200$ kg m^{-3}) and ambient pressure and air temperatures from the corresponding mesoscale model output.

Results: The left side of Figure 1 shows output from the VL1 LES; the right side shows output from the PHX LES. At the top are vertical winds (w) in red (↑) and blue (↓), and horizontal winds (u, v) at z = 1.9 m (every 4th arrow is plotted). In the middle are histograms of LES-derived perturbation friction velocity components u'_{*u} and u'_{*v} such that

$$u'_{*u}(i,j) = u_{*u}(i,j) - \bar{u}_{*u} \quad \text{and} \quad u'_{*v}(i,j) = u_{*v}(i,j) - \bar{u}_{*v}$$

where u_{*u} and u_{*v} are friction velocity components ($\bar{u}_{*u}$ and $\bar{u}_{*v}$ are horizontal domain averages of these). Note how the PHX LES friction velocities are less variable ("gusty") than the VL1 LES values, indicating that local convective activity differs from one location to another. The bottom panels of Figure 1 show LES-derived perturbation friction velocity magnitudes u'_* superimposed on mesoscale model friction velocities, U_*. Although the VL1 mesoscale model friction velocity falls well below the saltation threshold, gustiness in the VL1 LES produces local winds that occasionally blow above this threshold, potentially entraining dust. Dust entrainment never occurs in the PHX LES, suggesting that local variations in convective activity can create spatial patterns in dust lifting.

References: [1] Toigo A.D. et al. (2002) *JGR, 107*(E7) doi:10.1029/2001JE001592. [2] Haberle R.M. et al. (2003) *Ic., 161*, 66-89. [3] Armstrong J.C. and Leovy C.B. (2005) *Ic., 176*(1), 57-74. [4] Toigo A.D. et al. (2003) *JGR, 108*(E6), doi:10.1029/2002JE002002. [5] Michaels T.I. (2006) *GRL, 33*, doi:10.1029/2006GL026268. [6] Rafkin S.C.R. et al. (2001) *Ic., 151*, 228-256. [7] Michaels T.I. (2002) MSc thesis, San Jose St. Univ. [8] Deardorff J.W. (1980) *Bound.-Layer Meteorol., 18*, 495-527. [9] Iversen J.D. and White B.R. (1982) *Sedimen., 29*, 111-119.

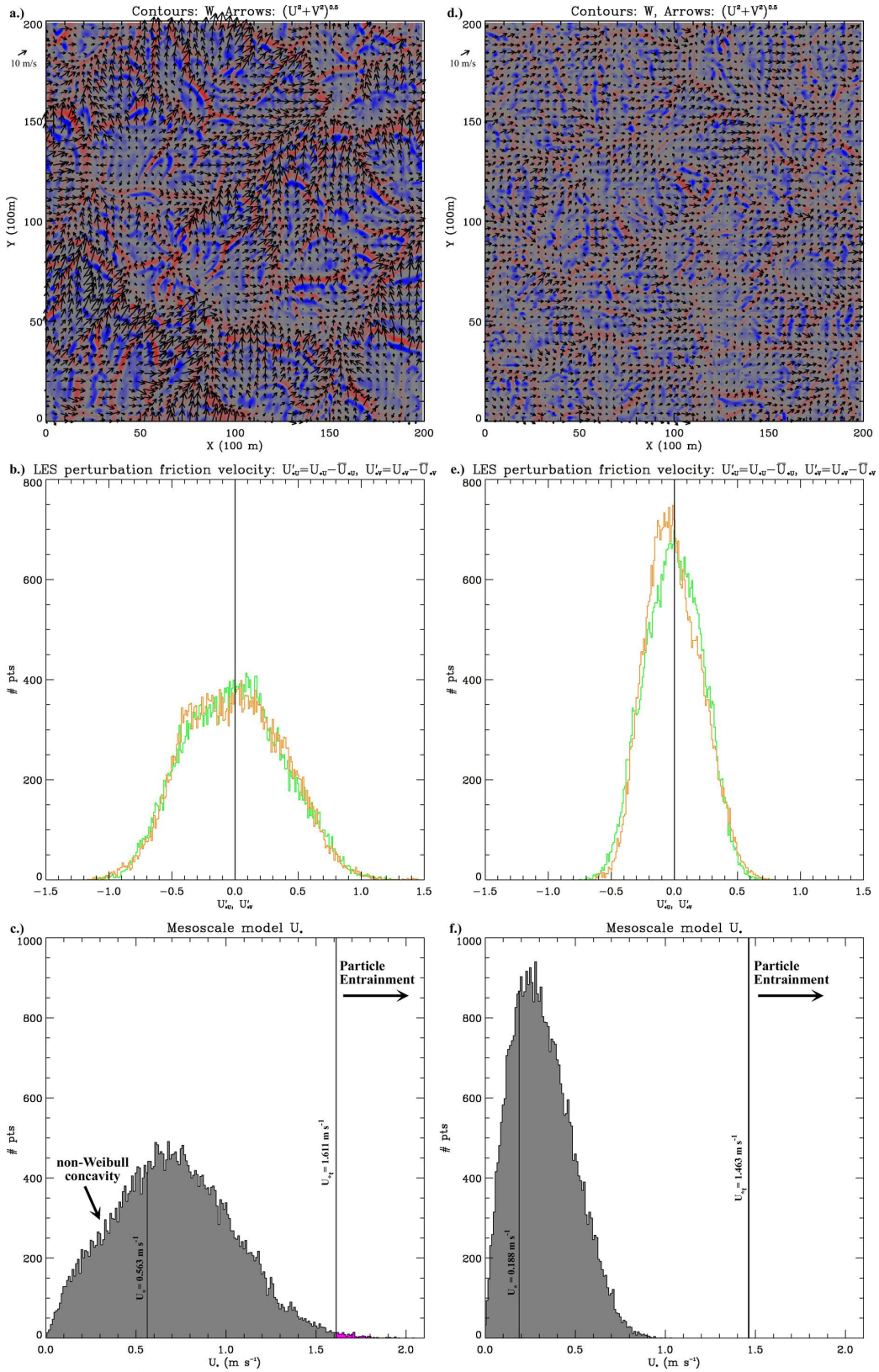

Figure 1. VL1 LES run: a.) Near surface vertical wind, *w*, (red is upwelling, blue is downwelling) overlain by horizontal wind vectors *u* and *v*, b.) Friction velocity perturbation components u'_{*u} (orange) and u'_{*v} (green) showing the distribution of friction velocity values in the LES, c.) $U_* + u'_*$, the resulting spread in friction velocity values in the mesoscale model. d.), e.), and f.) are the same but for the Phoenix LES run. Note the narrower distribution of relatively weak winds in the Phoenix simulation, with no occurrences of winds above the saltation threshold u_{*t}.