SURFACE METEOROLOGY AT THE PROPOSED MSL LANDING SITES.

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Introduction:

The Mars Science Laboratory (MSL) is equipped with a meteorological instrument package (REMS) that will measure, among other parameters, standard meteorological variables of temperature, pressure, and winds. Although the existing observational meteorological data at the surface of Mars are limited to three locations (VL1, VL2, Pathfinder), numerical model results suggest that local meteorology is high-

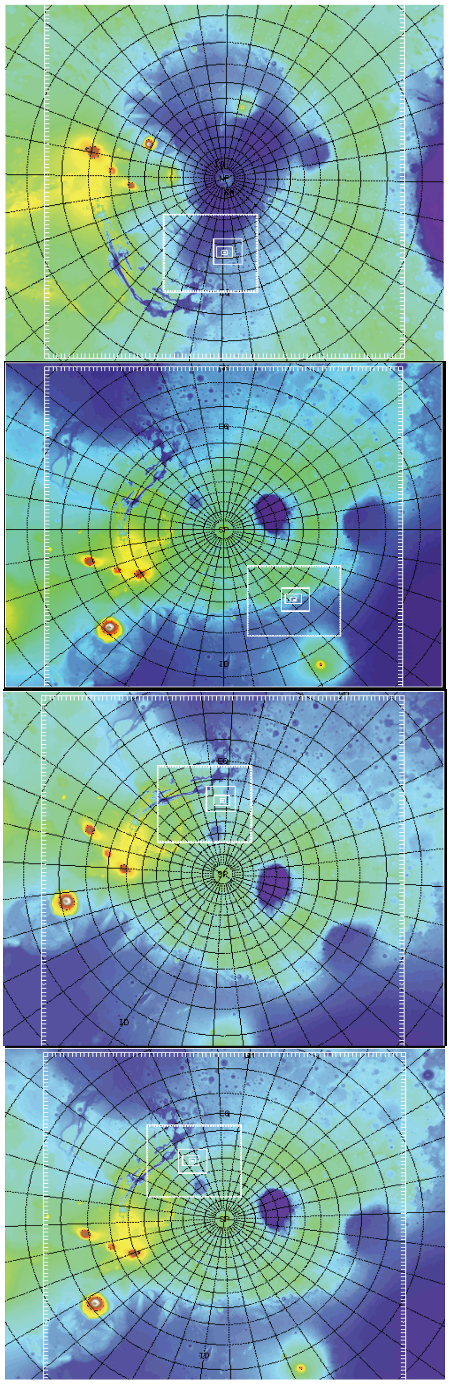

Figure 1. Computational for each of the proposed MSL landing sites. From top to bottom: Mawrth Valles, Gale Crater, Eberswalde Crater, Holden Crater. White boxes with tick marks indicate grid nesting and horizontal spacing.

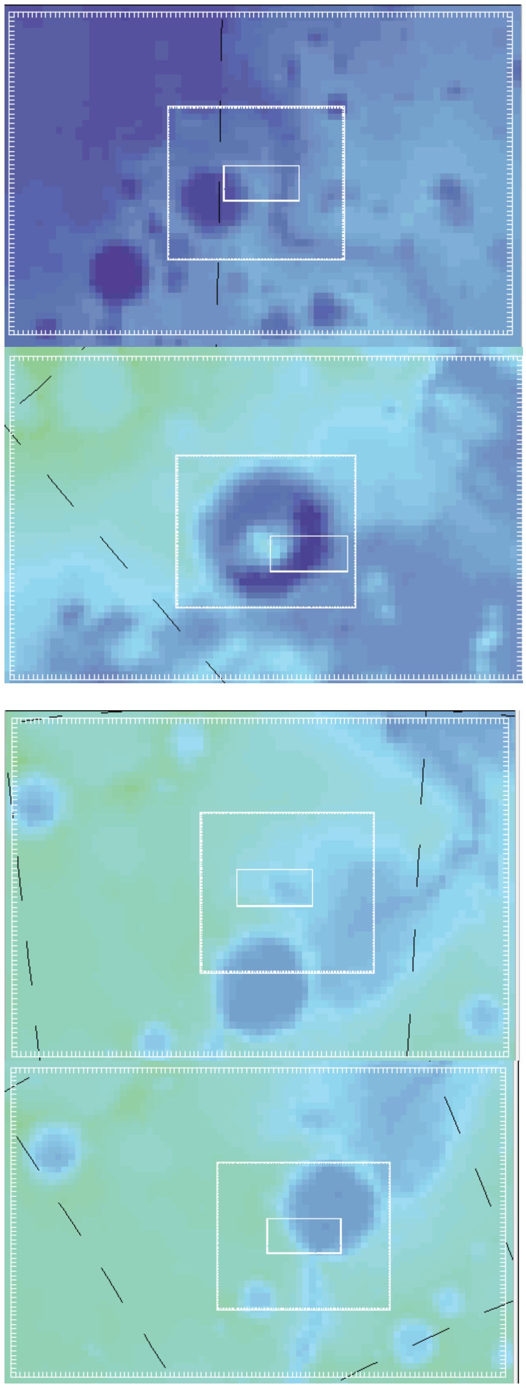

Figure 2. Views of grids 2-4 showing the topography in the region of each landing site. Order of images is the same as in Fig. 1.

ly variable (Rafkin et al 2003). Unlike previous landed locations, the four potential MSL landing sites [Mawrth Valle (22.3 N, 16.5W) , Gale Crater (5.4S, 137.7E), Holden Crater (26.1S, 34W), and Eberswalde Crater (24S, 33W)] are all in regions of complex topography that should contribute to meteorological complexity (Fig. 1 and Fig. 2). In addition, two of the sites (Holden and Eberswalde) are in the southern hemisphere, potentially providing the first ever measurements in this hemisphere.

The final selection of the landing site will balance potential science return against landing and operational risk. Atmospheric modeling studies conducted with the Mars Regional Atmospheric Modeling System (MRAMS) is an integral part of the selection process. This is the same model that was used to explore the meteorology and entry, descent and landing hazards for the Mars Exploration Rovers (Rafkin et al 2003), Beagle (Rafkin et al 2003), and Phoenix (Michaels et al 2008). At each of the landing sites, numerous simulations have been conducted. Here, we present model predictions of the meteorology that would be observed by MSL REMS at the surface of Mars.

Model Configuration:

MRAMS is configured with six grids starting at horizontal grid spacing of 240 km and nesting down by a factor three on each successive grid until reaching ~1 km on the final grid. Vertical spacing starts at a few meters near the surface and stretches to several km at the top of the model near 60 km.

The model is run with four grids for ~30 sols using input and boundary conditions from the NASA Ames GCM. The fifth and sixth grids are added by restarting the model at a given time within the 30 sol period. This configuration is typically only run for a few sols because of the large computational demand. Results from these higher resolution grids are not shown in this abstract. Nominal dust conditions based on TES observations are specified for opacity and the depth of the dust is tuned via the conrath-v parameter to best match TES temperature retrievals at Ls=170. High dust and dust storm conditions are also simulated, but these are not shown here.

Results:

The surface meteorology of the individual sites are discussed below. Regardless of the location, all the sites show typical diurnal circulation and thermal patterns that result from a superposition of large-scale circulations and mesoscale circulations forced by heating and cooling over topographic relief (Fig. 3). Where large-scale and mesoscale circulation patterns are in the same direction, wind speeds are increased. There is destructive interference when the circulations are opposed. In the vertical, strong upward motion is generally enhanced along the edges of craters and hills. The strongest motion occurs where horizontal convergence is present, often the result of opposing large-scale and regional motion.

The daily cycle of temperature and winds for each of the sites is shown in Fig. 4. Overall, the patterns at each of the sites is repeatable and each site

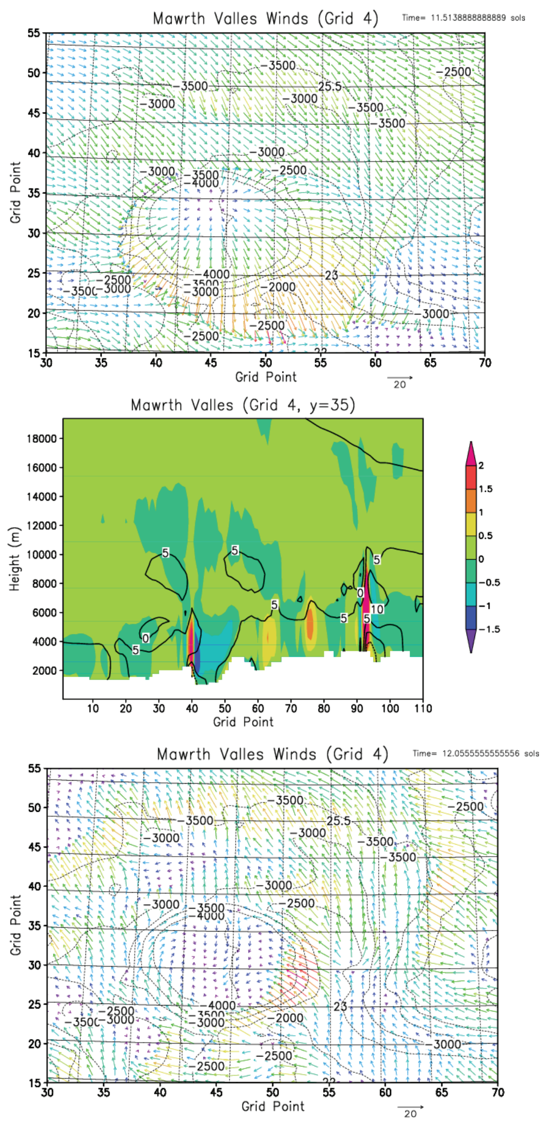

Figure 3. Typical wind patterns during the afternoon (top) and night (bottom), and vertical motion in the convective afternoon (middle) taken from grid 4 (~9 km spacing) of the Marwrth Valles circulation. The vertical cross-section is taken along y=30 in the top panel. Colors indicate wind speed. Note that horizontal winds are enhanced where the large-scale and local forcings constructively interfere. Destructive interference decreases horizontal wind speeds but produce enhanced convergence boundaries.

has a unique characteristic variation due to the circulations surrounding the local topography. The south-southern sites tend to be coldest due to seasonal cycles, but they also show a gradual warming over time. The variability of wind speeds at the southern locations is also indicative of the influence of baroclinic storm systems. Similar variations are seen in pressure (not shown) and each site has a characteristic pressure cycle.

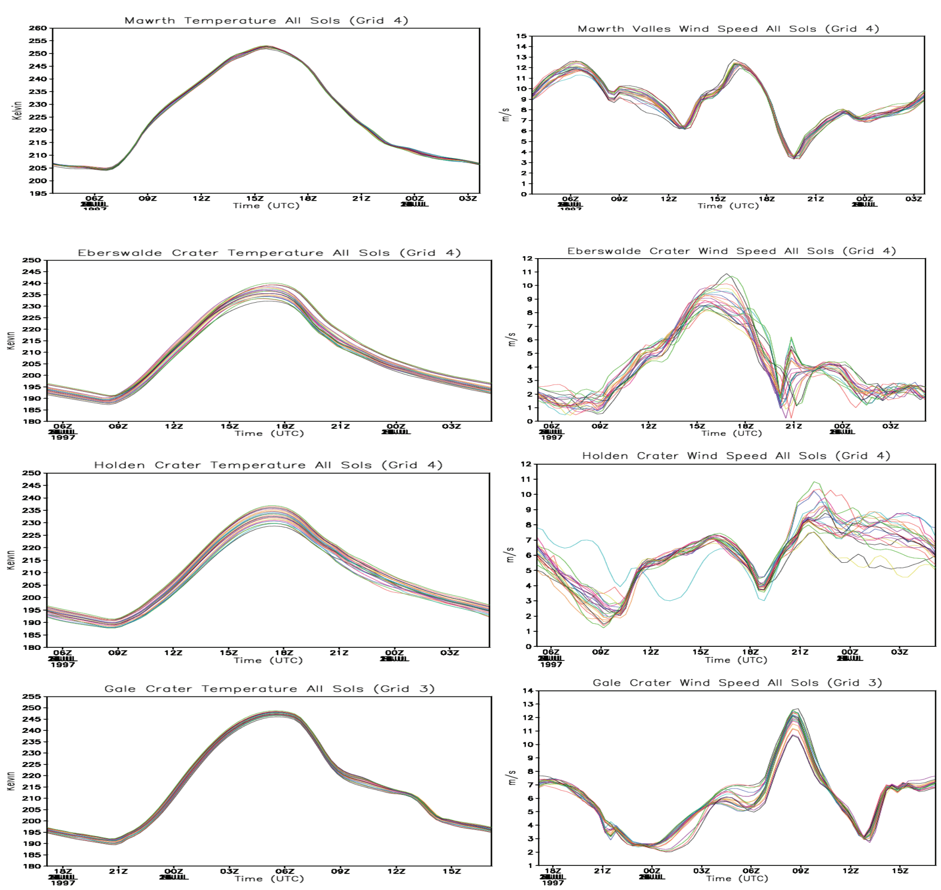

Figure 4. Temperature and wind speed time series for each of the sols at all four of the proposed MSL landing sites. The patterns at each site are generally highly repeatable, although there is noticeable exceptions in the variability of wind speed at Eberswalde and Holden Craters. This larger variability is likely due to perturbations of the large-scale circulation associated with weak baroclinic storms. Both of these southern hemisphere sites also show a near secular increase in daily temperature associated with the seasonal warming of the southern hemisphere at Ls=170.

Because MSL is mobile and long-lived, it is likely that a wide variety of local circulation regimes will be encountered and measured. Therefore, the meteorology package (REMS) on MSL will provide crucial information that can be used to study local circulations and to validate the model-predicted circulations in an unprecedented manner.

Although measurements are only taken it the surface, it is further possible the reflections of disturbances aloft could be recorded in the surface meteorological record. For example, in some instances, large amplitude gravity waves are generated by boundary layer convection and by flow over topographic barriers (Fig. 5). Winds and especially pressure might record these phenomena as they propagate over the rover.

References:

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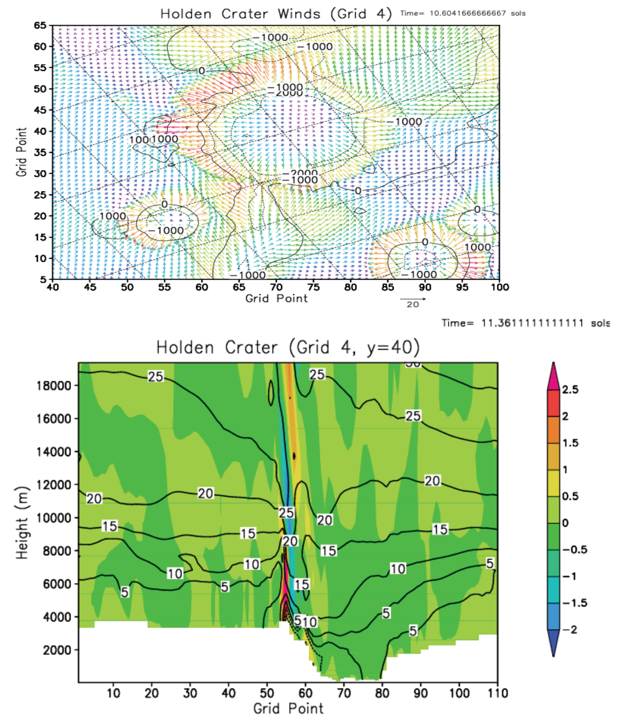

Figure 5. Large amplitude gravity waves are generated by the interaction of wind and topography and by thermal convection in the afternoon boundary layer. The upslope winds in Holden Crater (top) trigger vertically propagating gravity waves above the western rim of the crater. These waves should be evident in the surface pressure field.