MODELING MARS WIND STREAK FORMATION. T. I. Michaels[1], [1]Southwest Research Institute, Dept of Space Studies, 1050 Walnut St, Suite 300, Boulder, CO 80302, tmichael@boulder.swri.edu.

Introduction: Wind streaks on Mars are relatively common, but exhibit great variations in scale and appearance (and presumably in structure and formation mechanism, as well). Many types of wind streaks have a strong association with topographic perturbations, such as craters or hills. Others are associated with the stochastic deposition or removal of dust or other "tracer", such as the springtime dark fans of the south polar region and the streaks seen as Syrtis Major was stripped of dust after the major 2001 dust storm event.

Successful simulation of wind streak formation would possibly bolster one or more of the current formation mechanism theories, or alternatively, provide a strong basis for a new theory. Importantly, a better knowledge of wind streak formation (via interpretive analysis of data using numerical modeling) may significantly improve the accuracy of using past, present, and future spacecraft imagery of wind streaks as a proxy for the time- and spatially-dependent, near-surface wind direction and/or speed. Such work may also provide insight into the mechanisms and diurnal trends in dust entrainment and sedimentation that may have further application to dust devil and dust storm investigations.

Modeling Approach: The model used for this work is the Mars Regional Atmospheric Modeling System (MRAMS) [1]. MRAMS employs a nonhydrostatic, fully compressible system of equations, and may be run at the mesoscale [O(10 km)] or microscale [O(100 m)]. The detailed aerosol (dust, etc.) transport scheme described in [2] is used in these investigations, which includes lifting/injection and sedimentation processes.

Two distinct modeling techniques were utilized to investigate wind streak formation processes. The first is the standard regional (i.e., not global) mesoscale simulation, which uses all readily available global surface characteristic datasets along with relevant output from a Mars general circulation model to produce its initial state and boundary conditions. Each simulation of this type is run for up to 10 sols (Mars-days). The second is the partially idealized Large Eddy Simulation (LES), which is a microscale run that uses an initial state obtained from a relevant mesoscale run, and then is integrated forward in time for less than a sol.

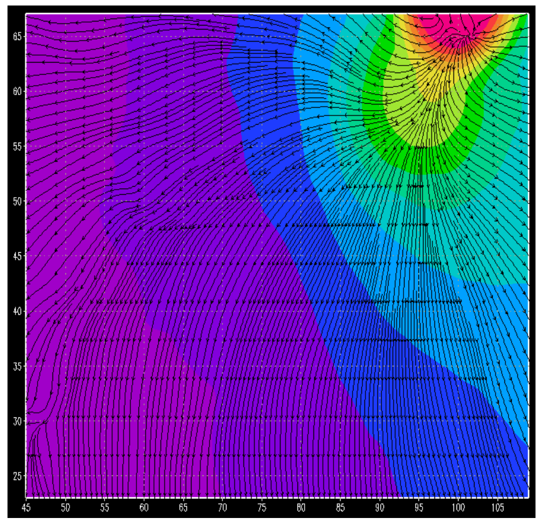

Figure 1: MOLA topography (shaded) overlain by nighttime MRAMS wind streamlines (~15 m AGL; 0930 UT), illustrating the roughly radially outward direction of downslope flow from Arsia Mons (top right corner) and the greater Tharsis Plateau.

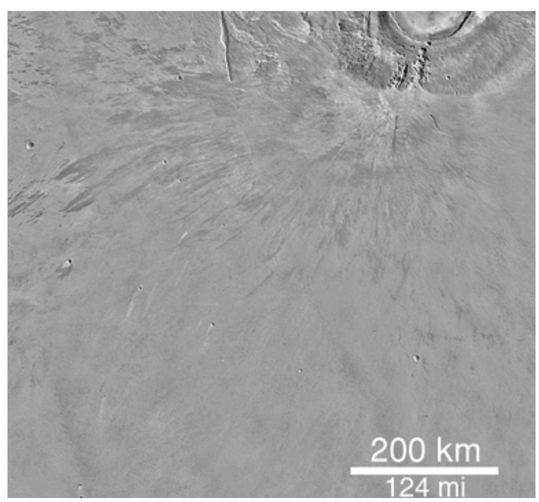

Figure 2: MOC mosaic of the portion of Daedalia Planum directly southwest of Arsia Mons (top right corner), showing dark wind streak orientations over roughly the same area as shown in Figure 1. (Image credit: MSSS/JPL/NASA)

Results: In general, regional obstacle-associated wind streak directionality correlates well with the modeled mesoscale nighttime winds (see Figures 1 and 2). This implies that the atmospheric flows that emplaced these features were either the contemporary ones, or perhaps ancient winds with a similar directionality and with no intervening "destructive" flow regimes. Similar correlations of wind streak morphology with MRAMS mesoscale wind directions have also been previously reported near Elysium Mons [3].

This investigation has found that in general, daytime winds are far less likely to generate/maintain obstacle-associated wind streaks. This appears to be due primarily to the nearly ubiquitous turbulent, unstable nature of the atmosphere during the day, which efficiently disrupts or weakens flow structures/enhancements that are directly attributable to the obstacle associated with the wind streak. It should also be noted that this disruptive effect is most pronounced for erosional wind streaks (vs. depositional ones), since the vast majority of flow/erosion enhancement mechanisms require the near-surface atmosphere to be statically stable.

During the night, however, surface-based radiation inversions (near-surface stable layers) are nearly ubiquitous, allowing the associated obstacle to generate various types of coherent flow perturbations (the kind depends on the particular vertical wind profile, etc.). One such flow perturbation scenario is the "flow shadow", where the stably stratified air balks at flowing over the obstacle, and instead takes a quasi-straight path around it, leaving a relatively calm region in the lee. Another is the " lee windstorm" case (exemplified in Figure 3), where the flow over and around the obstacle organizes in such a way that significant flow enhancements (and turbulence) are produced in the lee, greatly increasing the probability and/or efficiency of erosion there.

It is important to note that conditions conducive to wind streak formation need only occur for a short time each sol, or even only for less than a few sols per year, in the absence of processes capable of destroying and/or masking the wind streak structures. Furthermore, complex wind shear profiles (both speed and directional shear) appear to be prevalent in many wind streak regions at night, sometimes leading to modes of streak formation that can be counterintuitive. These realizations do not invalidate the use of wind streak imagery as a proxy for wind velocity, but they do reinforce the necessity of properly interpreting these data.

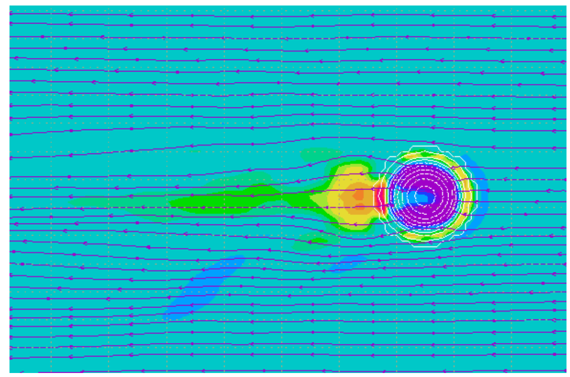

Figure 3: Surface friction velocity (shaded; warmer colors denote significantly larger values) overlain by MRAMS wind streamlines (~7 m AGL; 0600 MLST; domain shown is 14x28 km, from a grid with 200 m grid spacing), illustrating the near-surface flow perturbations due to a 3 km diameter crater (center right) in Daedalia Planum.

References: [1] Rafkin S. C. R. et al. (2001), *Icarus*, *151*, 228-256. [2] Michaels T. I. (2006), *GRL*, 33, doi:10.1029/2006GL026268. [3] Neakrease L. D. V. et al. (2005) *LPS XXXVI,* Abstract #1898.