Martian Polar Wind Patterns Derived from Mapping of Seasonal Cap Dark Streaks S. Diniega[1], M. I. Richardson[2], S. P. Ewald[3], A. D. Toigo[4], S. Byrne[5], [1]Calif. Inst. of Tech. (serina@its.caltech.edu, MSC #194, CALTECH, Pasadena, CA 91126), [2]Calif. Inst. of Tech. (mir@gps.caltech.edu), [3]Calif. Inst. of Tech. (spe@gps.caltech.edu), [4]Cornell University (toigo@astro.cornell.edu), [5]Calif. Inst. of Tech. (shane@gps.caltech.edu).

Wind is the dominant active surface-altering process on Mars. Through the redistribution of dust and sand, many aeolian features are formed which provide important visual clues about past and present geological and atmospheric processes on Mars [1]. Of specific interest to this project, frost streaks form in the polar regions when the CO_2 icecap defrosts and exposes an underlying layer of dust [2]. The wind picks up and redistributes the dust, creating a several millimeter-thick dark streak that can extend up to hundreds of meters. These streaks provide an important and unique basis for examining the surface-level wind systems on Mars, on a regional scale. Importantly, because they form within the seasonal ice cap, these streaks provide a map of the surface wind pattern corresponding to a known range of seasonal dates.

Through an intensive survey, the location and orientation of frost streaks, were identified in Narrow Angle images taken by the Mars Orbital Camera [MOC] on the Mars Global Surveyor [MGS] [3]. From this data, a map of the southern spring polar circulation patterns was developed for early southern spring. Subsets of the same region during the same season were then examined with MM5, a mesoscale atmospheric circulation modeling program. Comparing the resultant model with the observed aeolian features allows an analysis of the parameters used in the model, as well as a study of the three-dimensional circulation system responsible for the surface winds.

Frost Streaks: Central to this project was the *frost streak* (*figure 1*), a temporal aeolian feature found in the polar regions of Mars. Unlike most other aeolian features, frost streaks occur on a sub-kilometer- to meter-scale and their formation has been observed in MOC images, thus they provide a sampling of the current wind patterns The streaks form during southern spring and summer, when wind velocities are at a maximum [4, 5]. During the southern spring, most frost streaks are erased as the southern CO_2 polar cap sublimates; in a survey done of Viking images, during the southern autumn (Ls 30°-50°) no frost streaks were evident [2].

Frost streaks are created when a thin layer of CO_2 ice in layered terrain sublimates non-uniformly. An isolated sublimation spot will defrost down to the underlying layer of fine dust, exposing the dust to the wind. If the wind velocity is sufficient, a sub-millimeters-thick dirty comet-shaped streak is deposited that can extend up to 100s of meters from the source [2]. Although most frost streaks have well-defined edges, indicating constant wind direction, some frost streaks are composed of multiple streaks and smears, reflecting daily and seasonal wind direction variations (*figure 1*).

Image Survey: An intensive survey was made of narrow-angle images taken by MOC on MGS during orbit M04 (August 1999); this orbit was chosen as it spanned the beginning of southern spring (Ls 185°-197°), and thus should contain many images of frost streaks.

In total, 333 images were examined for aeolian features. The images which contained aeolian features (*figure 2*) were then divided into 3km x 3km blocks. Within each block, a mark was made to record the relevant information: the mark's source was located at the feature-density-weighted center of the features, the type of mark corresponded to the type of aeolian feature, and the mark's orientation indicated the dominant wind direction(s).

Of the examined 333 images, frost streaks were identified and marked in 186 images *(figure 3)*. In addition to the images containing frost streaks, 50 images were marked as evidence of no net wind direction: either sublimation spots were visible with no streaking, or radial streaking from the sublimation spot in many directions, thus making it impossible to determine a net wind direction.

Models: Previous models of the martian polar regions had attempted to use the NASA Ames Mars General Circulation Model [GCM] to examine the circulation pattern at the poles [6]. The GCM had been used successfully to model the region between 70°S and 70° N [7, 8]. However, GCM's have difficulty in the polar regions because of their relatively low spatial resolution (5-7.5° latitude grid spacing) and the problem of longitude grid point conversion near the pole, which indirectly necessitates severe longitudinal filtering of the model. Application of higher-resolution, polar stereographic projected mesoscale

models suggest significant improvements in the prediction of observed wind streaks are possible.

In this study, we use a limited-area model based on the Mesoscale Model (MM5) developed by Penn. State U. and the National Center for Atmospheric Research [NCAR] for the study of terrestrial weather, and modified for the study of martian circulation [9]. We will present comparisons between our mapped, dark-streak wind directions, and predictions for early southern spring from the Mars MM5.

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Figure 1: Clear example of frost streaks. Notice the different shapes and orientations of these streaks: on the left and right the wind is moving in one primary direction. In the center of the image, the wind is blowing in multiple directions, leading to either several streaks or a wide wedge of streakage. For spatial reference, the crater seen is 1.4km across.

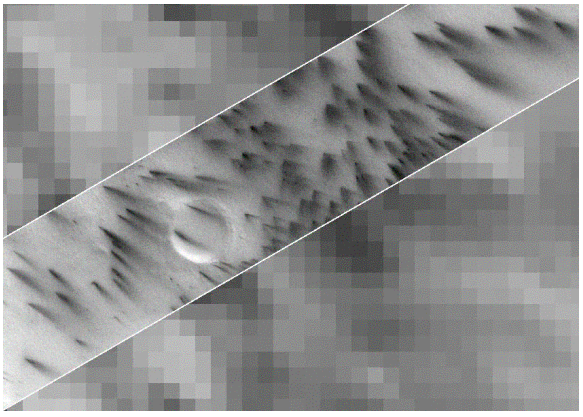

Figure 2: Martian South Polar cap. Picture is a shaded relief image derived from MOLA elevations. The thin rectangles show the locations of Narrow Angle images that contain frost streaks and/or sublimation spots.

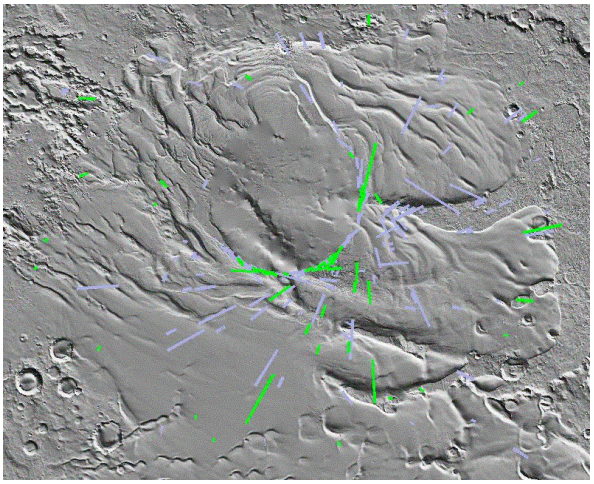

Figure 3: Example of arrows drawn to record location, dominant orientation(s), and type of frost streak within 3x3km block. MOC NA image M0401913. Arrows are 500m long.