AEOLIAN PROCESSES AS DRIVERS OF LANDFORM EVOLUTION ON THE SOUTH POLE OF MARS. I. B. Smith[1], J. W. Holt[1], A. Spiga[2], A. D. Howard[3]. [1]University of Texas Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, TX 78758 isaac@ig.utexas.edu. [2]Laboratoire de Météorologie Dynamique and Universite Pierre et Marie Curie,Paris, France. [3]Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia.

Introduction: Mars' south polar layered deposits (SPLD) are composed primarily of water ice and dust. Landforms on the SPLD are modified by erosion, through winds and mass wasting, and by deposition, through precipitation and frost.

These processes have been attributed to the formation of landforms such as large spiral troughs, giant chasms, and scallops [1], although other processes have been invoked, such as basal melting [2], tectonics [3] and viscous ice flow [4].

Based on arguments of morphology, it has been suggested that the SPLD scalloped terrain is one of the most likely to have been influenced by aeolian processes. The "gull-wing" like scarps with asymmetrical ridges resemble barchan dunes in a bimodal wind regime [1].

Global climate and mesoscale models have been developed for many years to predict atmospheric circulations and clouds, yet few studies have attempted to relate the landforms on the SPLD to modeled winds. Here we test hypotheses of formation of spiral troughs and scalloped terrains with the mesoscale model from the Laboratoire de Météorologie Dynamique (LMD) [5] and available observations of clouds from imagery. Trough clouds have been shown to indicate the location of katabatic jumps, near the location of banded terrain and excess deposition [6].

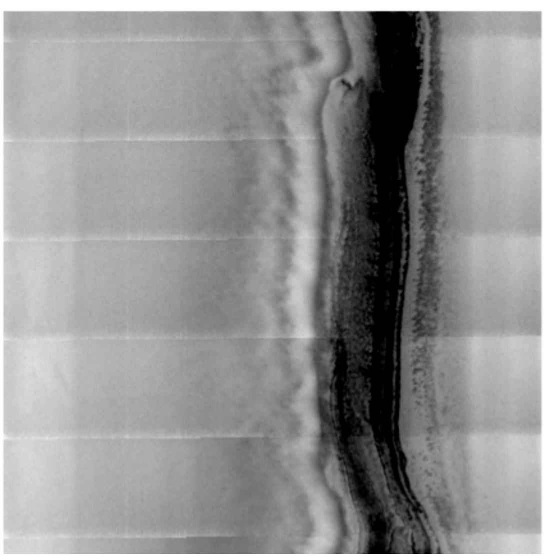

Fig. 1: Portion of THEMIS image V08216005 from L_s 284. Trough cloud on SPLD resembles undular clouds on NPLD and indicates possible site of deposition.

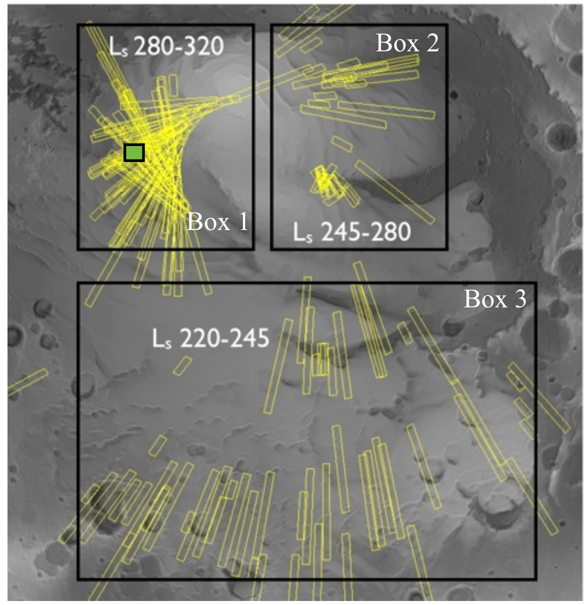

Fig. 2 Map of THEMIS VIS footprints containing trough clouds. Bounding boxes indicate date range of clouds in each region. Green box is approximate location of Fig. 1.

Observations: Similar to our approach for the north polar layered deposits (NPLD) [6], we are strategically examining Thermal Emission Spectrometer (THEMIS) visible observations over the SPLD during Mars years 26 - 30. We seek near surface linear clouds located in proximity to troughs ("trough clouds") (Fig. 1), indicating the occurrence of katabatic jumps [6,7]

We focus our search during southern spring (L_s 210 - 280), complementary to the springtime observations of all observed north polar trough clouds [6]. L_s range 280 to 320 was also examined. Images at other dates were examined less comprehensively. In all, ~ 60% of 11,000 will be examined.

During these periods, we find ~260 images of trough clouds (Fig. 1s, 2) on the SPLD (an additional ~ 80 are questionable). This compares to the ~260 found on the NPLD [6] for the same length of time. Trough clouds have similar appearances on both poles and are always found downhill of topographic features.

In both hemispheres trough clouds are found primarily near the end of their respective spring season, but unlike on the NPLD, trough clouds on the SPLD are found in distinct regions at various dates. SPLD low-latitude regions experience trough clouds earliest

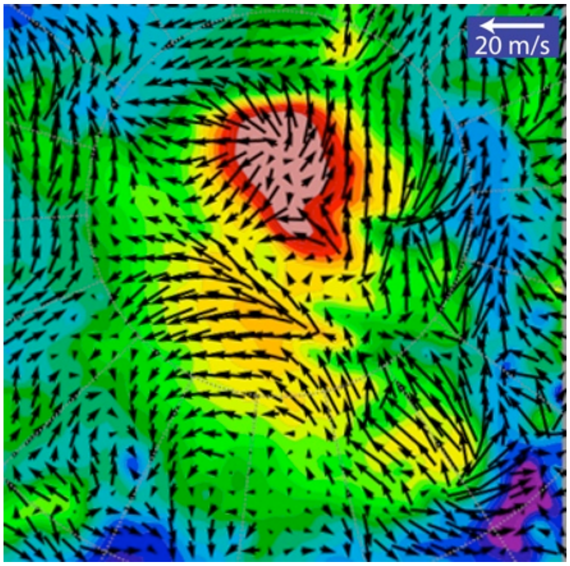

Fig. 3 Snapshot of LMD simulation of horizontal wind vectors over SPLD topography, ~L_s 220. Wind directions are influenced by topography in some locations, but are more likely forced by atmospheric processs in others. Areal extent is approximately the same as in Fig.2.

in the season (L_s 220-245). Intermediate latitudes experience trough clouds from L_s 245-280, and highest latitudes, nearest the permanent CO2 deposits, experience trough clouds from L_s 280 to 320.

Model: We employ the LMD mesoscale model [8] to study winds over the SPLD. A horizontal resolution of 20 km was chosen to determine regional wind patterns: regional slopes are resolved but not troughs. We ran this model at four L_s dates: 220, 260, 290, and 320.

Within a single sol near L_s 220 (period during observed trough clouds) the scalloped terrain (Box 3, Fig. 2) experience reversing winds. The primary wind direction is from south-east to north-west, but for a few hours during the sol the wind direction is opposite. Simulated winds reverse elsewhere at other seasons. Near Box 2 (Fig. 2) the primary wind direction at L_s 290 is downhill, but for short periods during the sol, winds blow uphill, also resulting in a bimodal regime.

Interpretations: We interpret the trough clouds found on the SPLD to be water-ice clouds, as we have interpreted those found near the NPLD troughs [6]. The finding of trough clouds on both poles suggest that the same processes occur in the north and south, including katabatic jumps, enhanced sublimation from accelerating katabatic winds, asymmetric accumulation, and possibly snowfall at the site of trough clouds.

While the locations of NPLD trough clouds correspond to banded terrain [1] and sites of recent accumulation [6], stratigraphy on the SPLD often deviates from the north pole model, indicating that other factors must be considered.

One such factor may be that the wind regime is less uniform than at the north pole. Primarily katabatic influence, with modulation through Coriolis deflection and large-scale waves, was found for wind directions on the NPLD. Mesoscale modeling shows that the katabatic influence is less prevalent in south pole regions (Fig 3). Large-scale waves appear to play a larger role.

A bimodal wind regime was predicted for scallops on the SPLD based on surface morphology (reverse ridges) and stratigraphy [1]. Structures at the sites have a primary morphology resulting from strong south-easterly winds, with secondary crest lines that suggest a short term reversal. Our modeling supports this conclusion for locations north of -80° and possibly near the large spiral troughs of Australe Lingula.

Conclusions: We find that atmospheric processes, rather than hypothesized tectonics or viscous ice flow, could be responsible for many of the landforms observed on the SPLD, supporting interpretations based on optical observations [1]. This conclusion is in general agreement with studies of landforms in the north polar region [6, 7]. The exhibition of trough clouds in the north and south polar regions suggests that the same processes occur on both poles.

While the PLD surfaces may be products of similar processes, no features on the NPLD display the reversed ridges that are observed on the SPLD, nor are winds modeled that would give rise to these bedforms. This suggests that SPLD meteorology could be more complex than at the NPLD, but at the same time could provide more unique information into current and recent-past climate than the northern counterpart.

A caveat of this conclusion is that much of the SPLD (and possibly the terrains in question) formed during another wind regime, one that occurred during a time with a more extensive perennial ice cover, allowing wind transport of ice. Currently, dust covers the majority of the SPLD and serves to protect the ice deposits from sublimation and wind transport.

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