HECATES THOLUS, MARS: NIGHTTIME AEOLIAN ACTIVITY SUGGESTED BY THERMAL IMAGES AND MESOSCALE ATMOSPHERIC MODEL SIMULATIONS

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Introduction. Hecates Tholus is the northernmost of the Elysium volcanoes. Recently *Mars Odyssey* and *Mars Express* imaged the volcano using the *Thermal Emission Imaging System* (THEMIS) and the *High Resolution Stereo Camera* (HRSC), respectively. Nighttime infrared (IR) images from THEMIS [1] show previously undescribed wind streaks radial to the summit but centered on the northwest flank. Mouginis-Mark et al. [2] suggested that the large albedo feature on the northwest flank of Hecates Tholus is indicative of pyroclastic deposits [1], which could include a significant source for fine-grained particles amenable for wind transport. The streaks of interest are difficult to identify in most visible-band images but are prominent in the nighttime infrared THEMIS images. Their orientation is consistent with modeled nighttime winds, in contrast to the general assumption that most aeolian activity occurs in the afternoon when surface heating is at a maximum for the day.

Observations. Images from the *Mars Global Surveyor* (MGS) *Mars Orbiter Camera* (MOC), *Mars Odyssey* THEMIS, and *Mars Express* HRSC were examined for wind streaks in the Hecates Tholus area. Wind streaks were identified in the nighttime IR THEMIS images, but not easily seen in any of the visible band images (MOC, THEMIS, or HRSC). Upon further inspection of the visible band images, the wind streaks can be identified as short, dark features corresponding in orientation and location to the bright radial streaks seen in the nighttime IR image on the volcano.

In addition, bright wind streaks are seen in the visible images on the surrounding plains that show a northward trend around base of the volcano on the western side. These plains-streaks are also visible as dark streaks in the THEMIS nighttime IR.

Modeling. A mesoscale atmospheric model was used to investigate the wind patterns around Hecates Tholus. Using the Southwest Research Institute's *Mars Regional Atmospheric Modeling System* (MRAMS)[5], seasonal and diurnal variations in airflow were modeled for the Elysium region. Initial and boundary conditions for the MRAMS are provided for larger areas by the NASA Ames *Mars General Circulation Model* (MGCM), which has a 7.5° latitude by 9.0° longitude resolution and incorporates MGS *Mars Orbiter Laser Altimeter* (MOLA) topographic data. MRAMS then calculates the distribution of wind fields at much higher spatial resolution by simulating the atmosphere (for several sols) in successively more detailed nested grids over the area of interest. In our study Hecates Tholus was the target, although the MRAMS included the important topographic effects of Elysium Mons to the south. Primary large-scale wind patterns in the MRAMS solution are quite similar to the NASA Ames MGCM fields. However, local effects, such as those due to various topographic features (volcanoes, craters) are detected only by the MRAMS model.

Interpretations. Preliminary maps of wind patterns from the MRAMS simulations (Figure 2) suggest that late nighttime (~0400 LST) winds are most likely responsible for the streaks observed in the THEMIS nighttime IR images. Streak patterns on Hecates Tholus and the surrounding plains can be generated by the same wind regime according to the model. The general flow across Hecates Tholus is due to the circulation of wind around Elysium Mons to the SSW. These winds are deflected around the base of the volcano, constructively interfering with local downslope flow (which originates just NNW of the Hecates summit) on the SE and WNW flanks, and thus is most likely responsible for the surrounding plains' streaks.

Dark wind streaks in visible bands (bright in IR) corresponding to consolidated materials or bedrock typically have been identified as erosional features [4], resulting from topographic interference that blocks wind flow. Winds flow around topographic features creating "horseshoe" vortices that preferentially erode away material in the "shadow zone" of the feature [6]. Similarly, bright streaks in visible bands (dark in IR) are usually described as being depositional features composed of bright dust and fine sand. The radial pattern of streaks on Hecates Tholus suggests that there is an atmospheric down-welling that occurs near the summit of the volcano that produces winds capable of scouring erosional patterns behind small craters on the flanks. The "depositional" streaks of the surrounding plains show a northward down wind trend of deflection around the base of Hecates Tholus.

Wind speeds predicted by the MRAMS are puzzling because the highest wind speeds are seen in

the surrounding plains (visible bright streaks) – upwards of 20-25 m/s, yet there is deposition. On the flanks of Hecates Tholus (visible dark streaks), wind speeds range between 10-15 m/s and erosional features are present. One possible explanation for this result is that the craters generating the erosional streaks on the flanks have higher topographic relief than the features responsible for the depositional streaks on the plains.

Future Work. Future work will include investigating seasonal variations in the strength of this radial wind pattern over Hecates Tholus by running further MRAMS simulations. Comparisons of nighttime wind patterns over different seasons could provide insight on the stability or longevity of this radial pattern and/or suggesting which season is most likely responsible for producing the streaks.

References. [1] Williams et al. *J. Geophys. Res. (in review).* [2] Mouginis-Mark et al. (1982) *J. Geophys. Res., 89,* 9890-9904, Mouginis-Mark et al. (1984) *Earth, Moon, & Planets, 30*, 149-173. [3] Mouginis-Mark et al. (1992) *Mars,* 424-452. [4] Thomas et al. (1981) *Icarus, 45,* 124-153. [5] Rafkin et al. (2001) *Icarus, 151*, 228-256. [6] Greeley et al. (1974) *Science, 183,* 847-849.

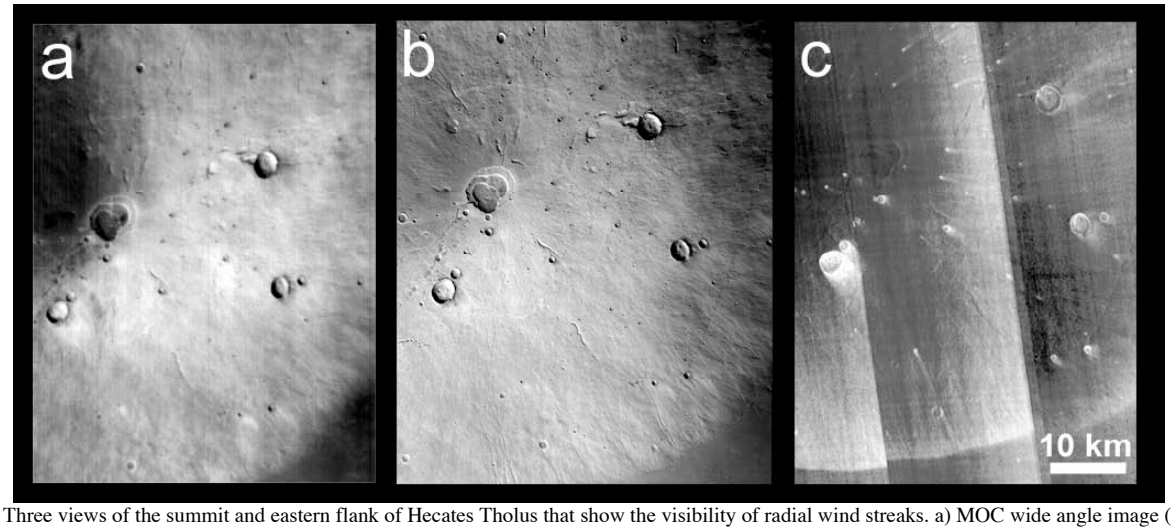

Figure 1. Three views of the summit and eastern flank of Hecates Tholus that show the visibility of radial wind streaks. a) MOC wide angle image (red wavelength) – small dark streaks appear to be erosional features; b) HRSC nadir image (red wavelength) again showing small dark erosional streaks; c) Nighttime THEMIS IR image, in which erosional streaks are clearly visible as elongated bright streaks.

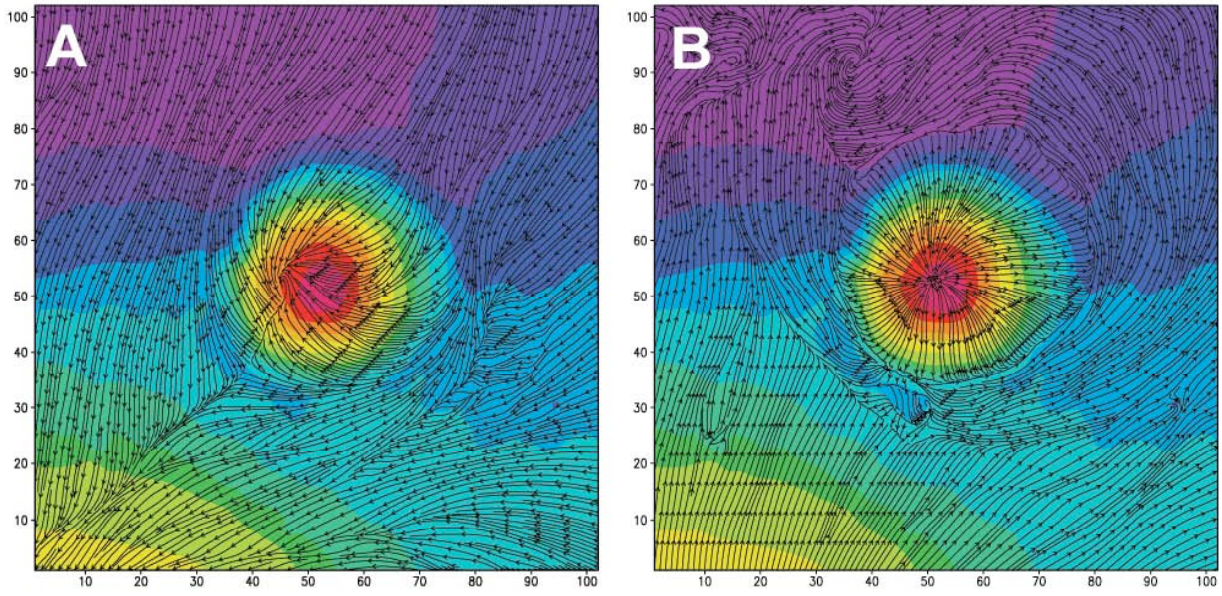

Figure 2. Comparison of daytime (A) MRAM simulations with nighttime runs (B). (A) Daytime runs have general flow from NE with light winds flowing toward the summit (color contours are MOLA topography). (B) Nighttime flow is from the SW and show similar trend to the wind streaks in Figure 1 (color contours are MOLA topography).