COMPARISON OF GEOMORPHICALLY DETERMINED WINDS WITH A GENERAL CIRCULATION MODEL: HERSCHEL CRATER, MARS

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Introduction: Wind is the dominate geologic process currently at work on the surface of Mars [1]. An understanding of surface winds is paramount if we are to understand Mars as a planet. Further, winds and the entrained particles within them can have a detrimental impact on equipment, structures, and future missions [2]. The Russian probe *Mars 3,* for example, is thought to have been rendered inoperative by winds it encountered during landing [3].

General circulation models (GCM) have been created for surface winds of Mars [4, 5]. These GCM are powerful tools for describing and understanding surface winds of a planet. However, the GCM for Mars have not been thoroughly validated due to a lack of ground truth data. Interpretation and correlation of wind regimes from geomorphic analogy may be useful for validating GCM in the absence of ground truth data.

Studies on the relationship between wind and landforms observed on Earth are plentiful [6-9]. Bagnold's 1941 book, *The Physics of Blown Sand and Desert Dunes*, details not only dune types but the types of winds, materials and material supplies required to create them. Authors such as Lancaster [10] have updated and refined Bagnold's work and today eolian landforms, especially dunes and the winds required to generate them, are reasonably well characterized for Earth. These studies have benefited from extensive field work and later the aid of remote sensing. Through geomorphic analogy, the knowledge gained from terrestrial studies can be applied to Mars.

Though ground truth data for Mars is limited, remotely sensed data from flyby and orbiter missions is extensive. Our current Martian image catalog consists of data from nearly a dozen successful orbiter missions with spatial resolutions as high as 1.4 meters per pixel.

In a previous study by the authors [11], these remotely sensed data in combination with geomorphic terrestrial analogy have been used to infer wind directions in Herschel Crater. In this study we compare the results of the inferred determinations to a general circulation model (GCM) of surface winds for the area.

Herschel Crater: Herschel Crater is a 300 km diameter impact crater located in the southern highlands of Mars northeast of Hellas Basin and in the eastern part of Mare Tyrrhenum. It is centered at approximately 228° W longitude and 15° S latitude (Figure 1). The area was chosen after a preliminary search of data revealed that some of the remote sensed imagery for the location contained eolian features suitable for inferring wind direction. Figure 2 is an example of one such image.

Figure 1. Herschel Crater, Mars. MGS MOC Color Mars Digital Image Mosaic (MDIM) from the USGS PIGWAD map server at http://webgis.wr.usgs.gov/mars.htm

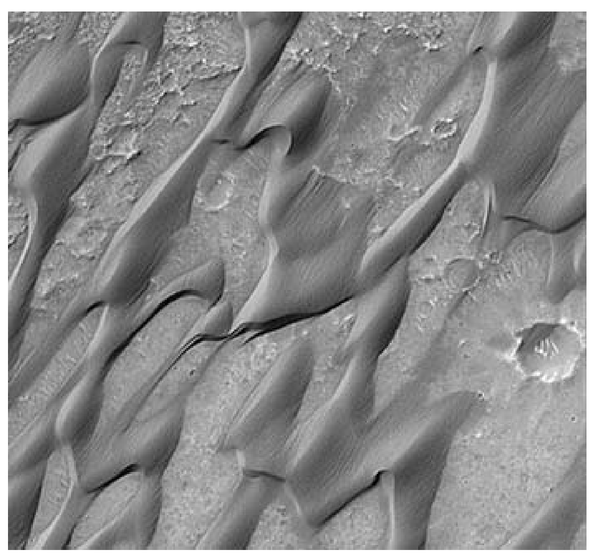

Figure 2. MOC NA Image of dunes inside Herschel Crater. Modified from NASA Planetary Photo Journal Image #PIA04472, http://photojournal.jpl.nasa.gov/target/Mars

Methodology: In the authors' previous study [11], prominent wind directions were inferred from 23 MOC Narrow Angle (NA) images and plotted on a Viking mosaic of Herschel Crater (Figure 3). To determine a predominate wind direction for Herschel Crater in general, these inferred directions were averaged. One outlier was excepted from the average (yellow arrow in Figure 3). For more in-depth information on how individual wind direction determinations were made, please see Stanley et al., in this publication [11]. We used the averaged inferred direction for comparison to GCM results.

The GCM output chosen for comparison in this study is one created by Fenton in her 2003 work [4]. Fenton used the Mars GCM developed at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory. The output used is for present-day seasonal average surface winds.

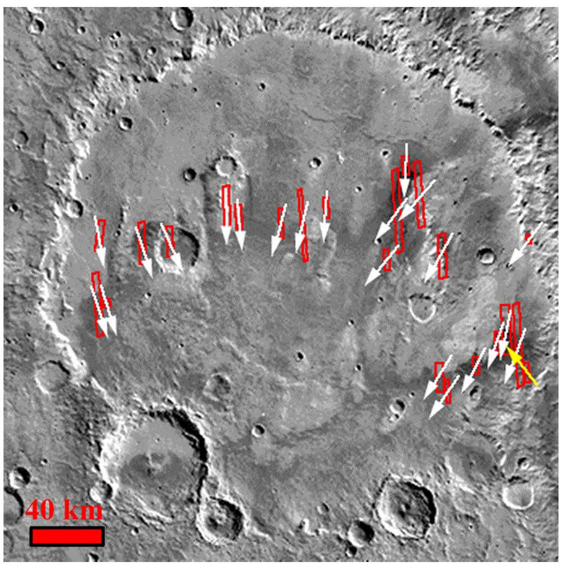

Figure 3. A Viking mosaic of Herschel Crater. Red boxes indicate the MOC NA images analyzed. Arrows indicate the inferred wind direction. Taken from [11]. NASA Planetary Photojournal base image, located at http://photojournal.jpl.nasa.gov/target/Mars

Results and Conclusions: The interpreted prominent wind directions from MOC NA images are plotted on a Viking mosaic of Herschel Crater (Figure 3). The results of our work indicate a predominant wind direction from the North-northeast (195°) for the area in general.

Our results correlate with Fenton's 2003 [4] surface winds GCM for the southern hemisphere summer on Mars (Figure 4). However, winds during the fall and winter are generally from the south according to the GCM and we see no evidence of this in our study area (with one exception). It is possible that winds of formative strength do not occur in the area except during the southern hemisphere summer. This agrees with the accepted idea that the Martian southern summer and northern winter are more extreme seasons than their counterparts due Martian orbital eccentricity. It is during the southern summer that Mars is 20% closer to the Sun and receives a higher energy input possibly driving stronger winds.

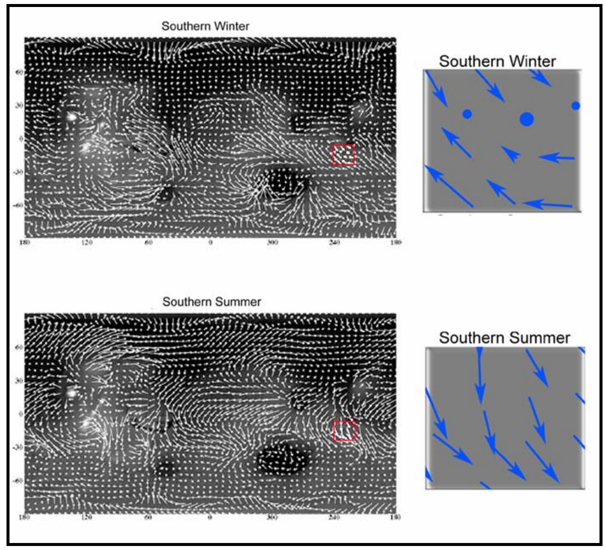

Figure 4. In the left half of the figure are planet wide GCM results from Fenton 2003 [4]. The results have been magnified and redrawn on the right for the region containing Herschel Crater.

References:

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