CHARACTERIZING WIND STREAKS FROM FRESH IMPACTS ON MARS. A. L. Gao[1], I. J. Daubar[1], G. D. Bart[2], and A. D. Etgen[2]. [1]Brown University, Department of Earth, Environmental, and Planetary Sciences, Providence, RI (Annabelle_Gao@brown.edu, Ingrid_Daubar@brown.edu), [2]University of Idaho, Department of Physics, 875 Perimeter Dr. MS 0903, Moscow, ID 83844-0903, USA.

Introduction: Fresh impact craters on Mars are generally small, with a diameter of less than 50 meters, display features like rays and halos, and can be temporally constrained using before and after images [1-3]. Some of these fresh impacts also display distinctive albedo streaks, which are linear, elongated features that extend out from the center of the crater in one direction and can either be brighter or darker than the surroundings. These streaks can be differentiated from rays and diffuse halos through their strong directionality and size (usually at least five times longer than rays). Due to their strong directionality, we hypothesize that these are wind streaks, caused by wind blowing ejecta and/or loosened surface material at the time of impact. Because they very rarely extend in multiple directions, we consider it less likely that they are the product of wind acting over longer time periods after the impact (Fig. 1).

Investigating these wind streaks, their distribution across Mars, and the other conditions that influence their formation can shed new light on localized wind patterns, dust mobility, and surface/atmosphere interactions on Mars.

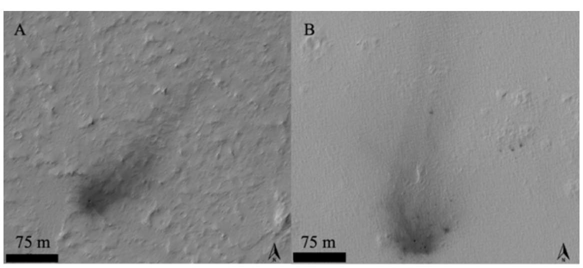

Fig. 1. *(A) a single crater with a wind streak (HiRISE image ESP_017003_1825). (B) a cluster of craters with a wind streak (HiRISE image ESP_017492_1890).*

Fresh impacts can usually be temporally constrained within a couple of years using Context Camera (CTX) images [4] with other datasets. Wind streaks can be compared against annual global atmospheric circulation simulations to investigate agreements and discrepancies to test whether their formation is related to highly localized wind patterns, wind strength, and/or topography. The following are preliminary statistics and insights into the possibility for wind streaks to serve as a form of proxy for local wind patterns and conditions at the time of impact.

Methods: A total of 124 fresh impacts with associated wind streaks were identified and studied. Wind streak direction, length, and map sampling for fresh impact sites were performed using the JMARS program [5]. The wind streaks for each impact were measured as vectors, with the azimuth direction a number between 0° and 360° used to denote the clockwise deviation from north. The magnitude of the vector corresponds to the to the length of the streak starting from the center of the impact for single craters and ending when the wind streak is no longer discernable in a contrast-stretched image. For clusters, or groups of craters, the vector starts at the center of the largest crater in the cluster. If the craters in the cluster have similar diameters, the vector starts at the center of the cluster. Map sampling in JMARS was used to obtain information on elevation (128ppd, [6]) and annual average wind speed (128ppd, [7]).

Effective diameters for the impact craters were based on the new crater catalog in Daubar et al. 2022. For single craters, the effective diameter was the diameter of the crater. For clusters, the expression $D_{eff} = \left(\sum_i D_i^3\right)^{1/3}$ was used to determine the effective diameter.

Preliminary Results: For the 124 fresh impact wind streaks, the average wind streak length was 422 meters with a standard deviation of 425 meters, the median length was 264 meters, and the range was 2764 meters. Across these widely distributed lengths, 24 of 124 (19%) wind streaks extended between 152 and 202 meters. Another 16 (13%) wind streaks extended between 102 and 152 meters. The lengths of wind streaks were weakly positively correlated with the effective diameters of their source craters. A polynomial ($y = -1.2057x^2 + 88.467x - 72.224$) can be used to describe the relationship with an R-squared value of 0.39. However, no clear relationship was observed between the lengths of wind streaks and the map sampled annual average wind speed. The five longest wind streaks originated from impacts with an elevation between 2,000 and 4,000 meters.

The direction of the wind streaks ranged from 0.99° to 357.66°. Of the 124 wind streaks, 11 were at an angle between 120° and 130° and 8 were at an angle between 0° and 10° (Fig. 2). When the wind streaks were divided into three longitudinal bins, some clearer trends appear. For the 0°-50° longitudinal bin, 9 of 21 wind streaks were at an angle between 280° and 10°, suggesting a directional tendency towards the north and northwest. For the 50°-200° longitudinal bin, 9 of 18 wind streaks were at an angle between 220° and 310°, suggesting a directional tendency towards the west and southwest. Finally, for the 200°-360° longitudinal bin, 42 of 84 wind streaks were at an angle between 30° and 130°, suggesting a directional tendency towards the east and southeast.

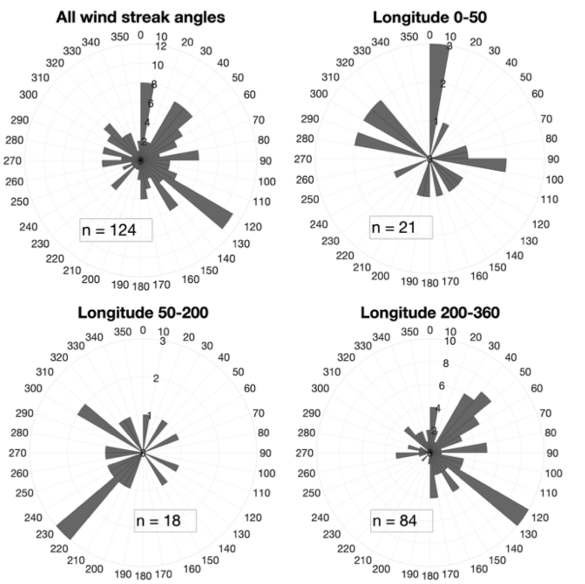

Fig. 2. *Rose plots to illustrate the distribution of wind streak directions as a function of longitude. Top-left: all wind streaks, top-right: wind streaks between long 0°-50°, bottom-left: wind streaks between long 50° -200°, bottom-right: wind streaks between long 200°-360°.*

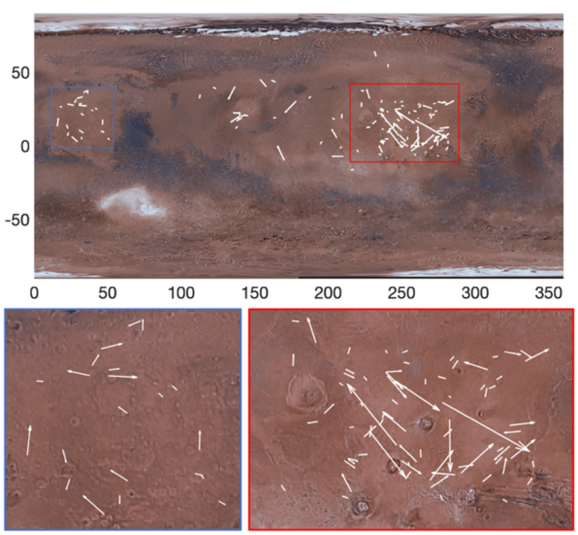

Fig. 3. *Distribution of 124 fresh impact wind streaks across Mars. Each wind streak vector has been scaled up by 500x and the relative magnitudes of arrows are accurate. Basemap citation: [8]*

The overall distribution of wind streaks across Mars correlates with the distribution of manually-identified fresh impacts (Fig. 3) and with the surface thermal inertia [3]. In general, the most wind streaks are found around 250° longitude and 25° latitude. The longest streaks are also located in this area.

Preliminary Conclusions: A lack of a strong correlation (R-squared = 0.02) between the length of the wind streak and the annual average wind speed at that location suggests that there are other factors influencing the formation and length of the wind streak. Elevation may be one such factor. Elevations between 2,000 and 4,000 meters appear to favor the formation of longer wind streaks. Another factor may be how quickly the elevation changes from the center of the impact to the end of the wind streak. The more prominent positive correlation between the lengths of wind streaks and the effective diameter of the source crater suggest that the size of the impact and impactor also influence the creation of wind streaks.

At higher elevations and lower atmospheric pressure, dust can move more easily, whether that movement is through aeolian transport or saltation. Wind streak magnitudes do not peak at the highest elevations, which is suggestive of other processes that either hinder dust movement at very high elevations or encourage dust movement at 2,000-4,000 meter elevations.

It is possible that with a larger sample size, subtle trends can be made clearer. For instance, there were fewer fresh impacts with an associated wind streak in the 4,000-6,000-meter elevation bin than in the 2,000-4,000-meter elevation bin. The same is true of the 6,000-8,000-meter elevation bin; only 5 fresh impacts fell into this category. Wind streak length may not be able to serve as a proxy for broader wind patterns now, but with a larger sample size and further investigation of confounding factors, they may still be informative.

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