COMPARATIVE ANALYSIS OF MARTIAN DUST DEVIL TRACK MORPHOLOGIES IN GUSEV AND RUSSELL CRATERS.
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Introduction: Martian dust devils are cyclostrophic convective vortices induced by solar heating of the Martian surface. Air flows radially inward towards the low-pressure core and upwards, as warm, buoyant near-surface air displaces the surrounding cooler, denser air [1,2]. If the surface is covered with dust, then dust can be uplifted by the convective vacuum effect, making the vortex visible and exposing the darker substrate beneath the dust mantled surface. This process leaves conspicuous dark tracks that provide clues to the behavior of Martian dust devils.

Methods & Approach: We used detailed HiRISE images (25 cm/pixel) to observe the seasonal changes of dust devil tracks in Gusev (14.6°S, 175.4°E) and Russell (53.3°S, 12.9°E) craters, focusing on the temporal and morphological differences. We used the NASA Ames General Circulation Model (GCM) to compare predicted wind directions with tracks determined from inferred scallops of tracks mapped using the ESRI ArcMap GIS package [3].

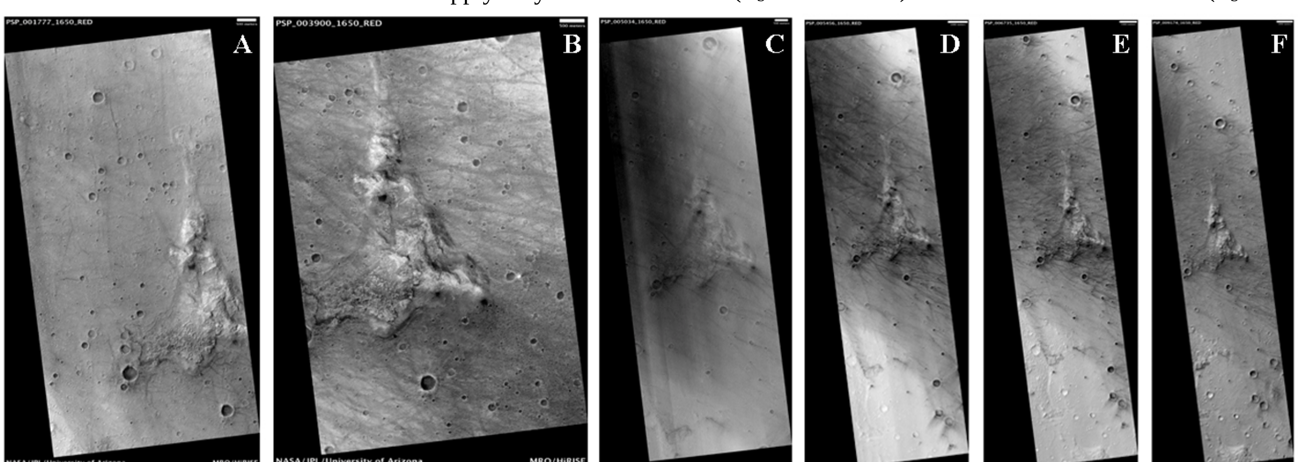
In ArcMap we measured density, length, width, and sinuosity of Russell and Gusev crater tracks. Densities were derived by identifying total tracks in each image to determine the peak of the track season and compare to new tracks.

Modeling results will be presented at this meeting. We expect to match the observed rate of dust devil track erasure with the rate of airfall sedimentation at Gusev crater constrained by atmospheric opacity values from MER *Spirit* and the dust deposited by dust devils themselves. We will also consider whether sediment supply may be a limiting factor in the creation or erasure of dust devil tracks.

Results: Figure 1 displays the dust devil season in Gusev crater. The Columbia Hills region has few remnant tracks and thin dust veneer in the winter seasons, and shows increasing activity until the dust storm displaces and redeposits dust. The dust devil activity briefly resumes and slowly decreases until the end of the season. Figure 2 depicts the seasonal changes at Russell crater. Here the season starts with complete absence of tracks as the dunes are covered in frost. Activity slowly increases, reaches peak density, and then decreases until the region is covered in dust carried and deposited by winter winds.

Russell crater tracks are curvilinear and moderately sinuous, with average width of 38 m and lengths 0.34-9 km. Russell crater tracks show anticorrelation between dust devil track length and sinuosity; the longer the track the smaller the sinuosity. No other simple correlations were found. Gusev crater tracks are less sinuous, with an average width 56 m and lengths of 2-5 km. Tracks in Russell crater are aligned with the northwesterly oriented prevailing wind as predicted by the GCM. The tracks in Gusev crater match predicted GCM peak daytime winds also from northwesterly direction; however, there are also tracks that lead to the northeast, consistent with secondary crater or winter winds.

Figure 3 shows our measurements of dust devil track density as a function of season throughout one Martian year of HiRISE observations. The dust devil season in Gusev crater is longer as indicated by the presence of tracks (L_S =139° - 90°) than that of Russell crater (L_S=



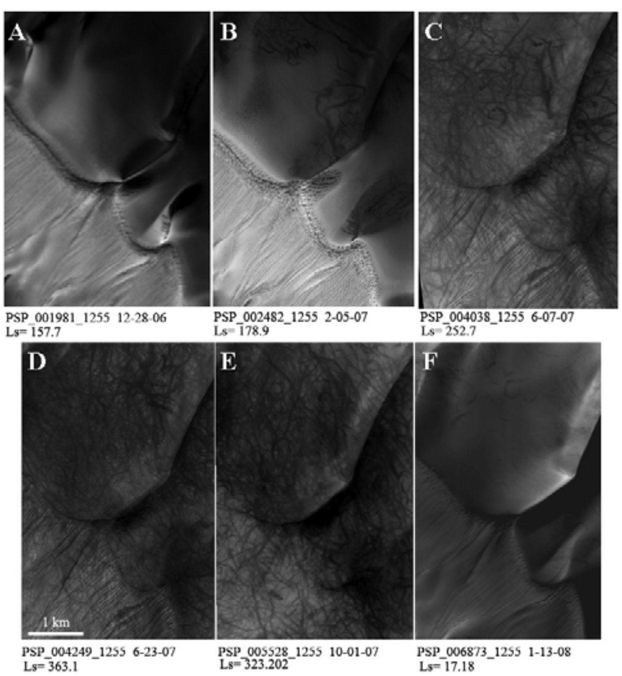
PSP_001777_1650 Ls=149.5 | PSP_003900_1650 Ls=245.9 | PSP_005034_1650 Ls=300.8 | PSP_005456_1650 Ls= 320 | PSP_006735_1650 Ls= 13.5 | PSP_009174_1650 Ls= 97.1

Figure 1: Changes in Gusev crater. A) Slow increase of dust devils. B) Increase of activity. C) Dust storm erases previous tracks. D-F) Increase of dust devils and no erasure or dust deposition to end of season.

172° - 40 °). However, new tracks in Gusev decline at L_S =~4° indicating the end of the season. The orbital observations indicate that the dust devil season in Gusev crater is longer than the season in which dust-devils have been spotted by MER *Spirit* observations (L_S = 160° - 340°) [4]. Peak dust devil frequencies occur sooner at Gusev (Spirit: L_S =250°; orbital data: L_S =235 °) than at Russell crater (L_S =316°). Track densities during this time were stable and more consistent in Gusev crater and are more variable at Russell, particularly during the early part of the season. Russell crater has a higher density of tracks than Gusev. Both craters show bimodal seasonal densities because they were affected by the 2007 global dust storm (L_S =~280-300°) which erased the tracks and redeposited dust.

Discussion: Seasonal variations in dust devil activity are influenced by topography, sediment supply, and altitude, as well as latitudinal variations in the atmospheric dust cycle and local winds. Topographical features, such as the megadune field in Russell, enhance convective circulation due to surface heterogeneity, thereby playing a key role in dust devil formation [5]. The greater the contrast between surface and air temperatures, the greater the surface heat flux and potential for dust devil activity [1,2,4,6].

Possible explanations for the differences in seasonal behavior between the study sites include: (1) average MOLA altitudes up to 2000 m higher at Russell crater than at Gusev, resulting in enhanced convective circulation; (2) increased insolation at higher southern latitudes during perihelion; (3) frost on the dunes delays the start of the dust devil season in Russell crater; (4) Topography of the ~560 m high transverse megadunes at Russell crater.



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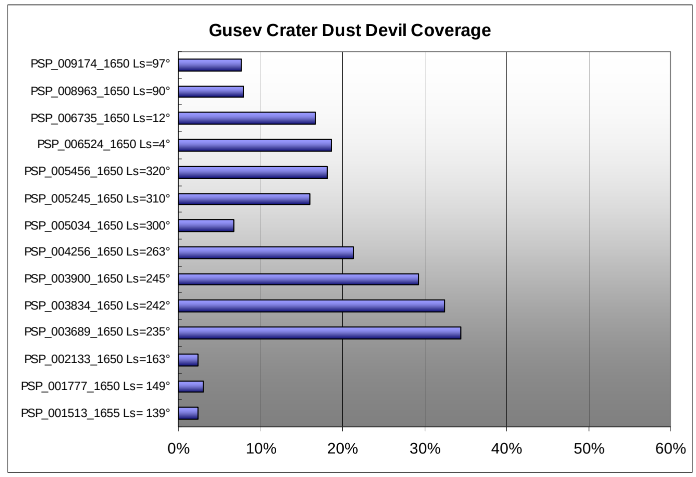

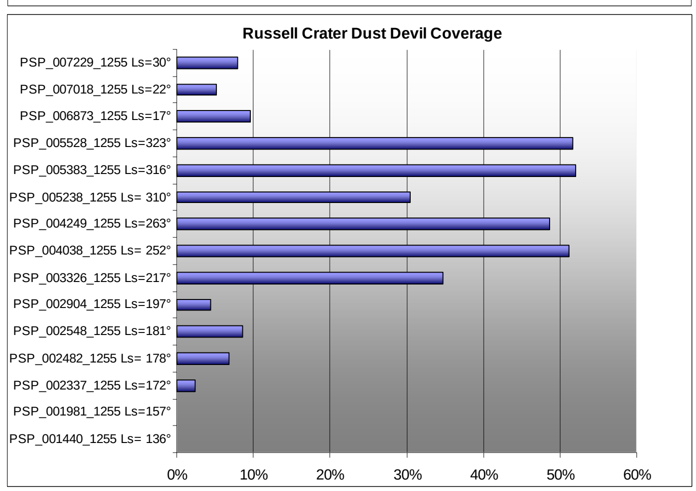

Figure 3: Dust devil density profiles of Gusev and Russell craters.

Figure 2: A-B) Dust devil track changes in Russell crater. Dunes are covered in CO2 frost early in the season; sinuous morphology as dunes defrost. C-D) Increase of dust devil activity with decrease of surface albedo. E-F)Tracks are covered as dust is deposited and dune ridges begin to freeze.