EPSC Abstracts
Vol. 9, EPSC2014-4-5, 2014
European Planetary Science Congress 2014

Martian Dust Devil Tracks Width Measurements

T. Statella (1), P. Pina (2) and E. A. Silva (3)
(1) Instituto Federal de Educação, Ciência e Tecnologia de MT, Brazil (thiago.statella@cba.ifmt.edu.br) (2) Instituto Superior Técnico, Lisboa, Portugal (ppina@.ist.utl.pt), (3) UNESP, Brazil (erivaldo@fct.unesp.br)

Abstract

This abstract shows the results of mean and mean maximum Martian dust devil tracks width measurements carried out in HiRISE and MOC images. The method we applied is automatic and is based on Mathematical Morphology.

1. Introduction

Dust devils are convective vertical vortices that lift dust from the surface and thus become laden with airborne dust [1]. As dust devils remove bright air fall dust from the surface, the tracks left behind may reveal a darker substrate. Martian dust devil tracks display linear, curved, and irregular morphologies that generally range from 10 m to greater than 200 m in width and can be up to a few kilometers in length [2-4]. In this abstract we present how to obtain additional information to describe dust devil tracks. For that, we have calculated the mean width of Martian dust devil tracks in HiRISE and MOC images using an automatic approach based on Mathematical Morphology.

2. Method

In order to calculate mean and mean maximum track width we used a Mathematical Morphology tool called Granulometric Analysis which give us information on size distribution of the connected components in the image. A series of morphological openings is used to filter those components whose shape does not fit disks of increasing size. The first opening filters all image components that do not fit a disk of one pixel radius. Then a second opening by a disk of two pixels radius is applied and so forth. The amount of pixels removed by each opening can be plotted versus the radius of the disk in the successive transformations in a graphic called pattern spectrum. From the pattern spectrum we can then infer the mean and mean maximum width of tracks in a binary image containing tracks. As an input for the method we used binary images in which dust devil tracks had been automatic detected by [7]. For detailed information on granulometric analysis please refer to [5, 6]. As an example, Fig. 1 show the HiRISE image PSP_006163_1345 (a) and the binary image (b) resulting from the detection method described in [7].

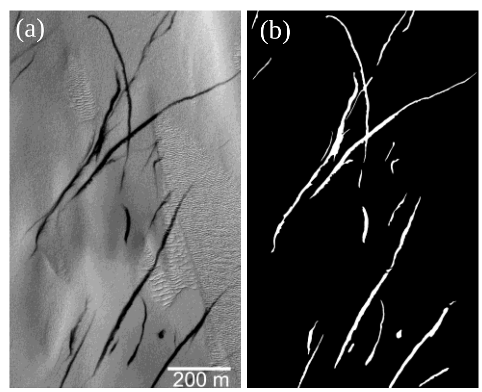

Figure 1: Image HiRISE PSP_006163_1345 (a) with dust devil tracks detected (b).

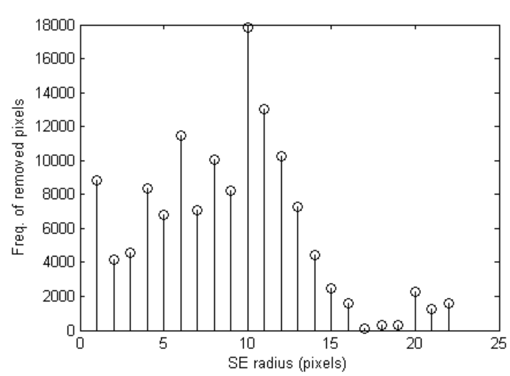

Figure 2: Pattern spectrum of dust devil tracks of image HiRISE PSP_006163_1345.

In Fig. 2 we show the pattern spectrum of the dust devils tracks identified in image HiRISE PSP_006163_1345.

3. Results

We applied the method to 200 images from Hellas, Eridania, Noachis, Argyre and Aeolis regions. The images were previously processed by [7]. in order to detect automatically dust devil tracks. The mean width and the mean maximum width of the tracks created by dust devils are shown in Table 1. In the table, MTW and MMTW stand for Mean Track Width and Mean Maximum Track Width, respectively. And σ stands for standard deviation. In [8] the authors performed a seasonal study on Russel and Gusev craters, located in Noachis and Aeolis regions, respectively, using HiRISE images focusing dust devil tracks. According to them, tracks in Gusev are primarily formed by rare, large dust devils and smaller vortices fail to leave tracks that are visible from orbit, perhaps because of limited surface excavation depths.

Table 1: Width of dust devil tracks.

Region	MTW (m)	σ (m)	MMTW (m)	σ (m)
Aeolis	43.58	±24.41	283.46	±114.05
Noachis	36.96	±26.31	159.93	±121.38
Argyre	28.83	±31.41	106.63	±113.21
Eridania	51.35	±60.98	208.41	±274.04
Hellas	64.24	±54.80	272.60	±218.33

On the other hand, they say Russell crater displays more frequent, smaller sinuous tracks than Gusev, which may be due to the thin dust cover in Russell, allowing smaller dust devils to penetrate through the bright dust layer and leave tracks. [8] observed larger dust devils (track widths 40–60 m) on Gusev, whereas more numerous, smaller dust devils (widths of 30–40 m) in Russell crater. The dust devil tracks in Russell crater are more numerous but shorter, more sinuous, and narrower than those in Gusev crater. According to Table 1 our results agree with [8]. We found a mean track width of 43.58 m ± 24.41m for Aeolis, larger than the mean track width of 36.96 m ± 26.31 m we found for Noachis. The mean maximum track width was also larger for Aeolis (283.46 m ± 114.05 m) than for Noachis (159.93 m ± 121.38 m).

6. Conclusions

In this abstract we have applied an automatic method for calculating mean and mean maximum dust devil track width in MOC and HiRISE images. The method is based on Mathematical Morphology and uses Granulometric Analysis to infer the tracks width. It is suitable to be applied in binary images containing tracks as input. The input images for the experiments were obtained by [7]. Track widths were calculated for 200 images from Martian regions of Aeolis, Eridania, Hellas, Noachis and Argyre. Our results, obtained by an automatic method, agreed to a manual analysis performed by [8]. in Russel and Gusev craters, located in the regions Aeolis and Noachis, respectively. In future work we will span the application of this approach to other regions of Mars.

References

[1] Balme, M. and Greeley, R.: Dust devils on Earth and Mars, Review of Geophysics, Vol. 44, RG3003, 2006.

[2] Balme, M.R., Whelley, P.L. and Greeley, R.: Mars: dust devil track survey in Argyre Planitia and Hellas Basin, Journal of Geophysics Research, Vol. 108, E8, 2003.

[3] Edgett, K.S. and Malin, M.C.: Martian dust raising and surface albedo controls: Thin, dark (and sometimes bright) streaks and dust devils in MGS MOC high resolution images, Lunar and Planetary Science Conference XXXI (abstract 1073), march 2000, The Woodlands, USA, 2000.

[4] Fisher, J.A., Richardson, M.I., Newman, C.E., Szwast, M.A., Graf, C., Basu, S., Ewald, S.P., Toigo, A.D. and Wilson, R.J.: A survey of Martian dust devil activity using mars global surveyor mars orbiter camera images, Journal of Geophysics Research, Vol. 110, E03004, 2005.

[5] Serra, J.: Image Analysis and Mathematical Morphology, Academic Press, London, 1982.

[6] Soille, P.: Morphological Image Analysis, Springer-Verlag, 2004.

[7] Statella, T., Pina, P. and Silva, E.A.: Image Processing Algorithm for the Identification of Martian Dust Devil Tracks in MOC and HiRISE Images, Planetary and Space Science, Vol. 70, pp. 46-58, 2012.

[8] Verba, C.A., Geissler, P.E., Titus, T.N. and Waller, D.: Observations from the High Resolution Imaging Science Experiment (HiRISE): Martian dust devils in Gusev and Russell craters, Journal of Geophysics Research, Vol. 115, pp. 1-11, 2010.