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A GLOBAL SURVEY OF MARTIAN DUST DEVILS: MOC OBSERVATIONS, 1997–2005

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A planet-wide survey of Martian dust devils was conducted using all >205,000 Mars Global Surveyor Mars Orbiter Camera (MOC) wide and narrow angle images (15 September 1997 – 5 August 2005). Our survey includes >3 Mars years of monitoring of 3 sites of frequent activity (north Amazonis, 34.7-36.7°N, 154.8-161.3°W; Syria-Claritas, 14.0-15.6°S, 107.5-109.6°W; east Meridiani, 4.0-6.1°S, 349.2-350.6°W). MOC detected >10,900 individual dust devils (southern hemisphere >1000, northern hemisphere >9900). They exhibit a range of sizes from 10s of meters to 100s of meters across and >6 km high. Dust devils have been observed at different stages of development, from initial formation (Fig. 1a) to fully developed (Fig. 1b). Shadow measurement of plume dimensions (Fig. 1b) serve as probes of lower atmospheric structure. Some dust devils create light or dark streaks; these are readily distinguished from the unidirectional streaks created by wind gusts (Fig. 2). The most active dust devil region is in northern Amazonis. Excluding that site, the majority of dust devil activity has been observed in the southern hemisphere. Martian dust devils occur in all seasons in both hemispheres, but at latitudes >30°, the activity tends to be seasonal and follow the subsolar latitude (Fig. 3a). Dust devil streaks occur at all elevations and nearly all latitudes; active dust devils have been imaged deep in Hellas and up on the slopes of Arsia Mons (Fig. 3b); and streaks have been seen in the north polar dune fields. The onset and abatement of dust devil activity has generally been interannually invariable to within ±8.0° of L_s, especially at the monitoring sites, a result not unexpected, as these vortices are thermally driven. Differences in dust devil numeric density have been observed; more dust devils occurred at the monitoring sites in the 2004–2005 season, through L_s=160°, than in the previous 3 Mars years, at which time the activity abated to the level observed back in 2001. Small, shorter-term increases in activity associated with the passage of local, transient dust storms have also been observed. MOC images provide no evidence that dust devils initiate dust storms. Instead, several storms in Amazonis had dust devil activity along their leading fronts, suggesting that approaching storms may initiate some dust devil activity, a phenomenon also observed on Earth. Dust storms, especially those that result in a global dust veil, typically lead to a diminishment of dust devil activity when the atmospheric dust optical depth approaches 2.0. First-order dust flux calculations (0.3-5.5x10^{-8} kg m^{-2} s^{-1}) suggest that dust devils may play a significant role in sustaining the low-level background dust opacity observed during the northern spring and summer seasons.

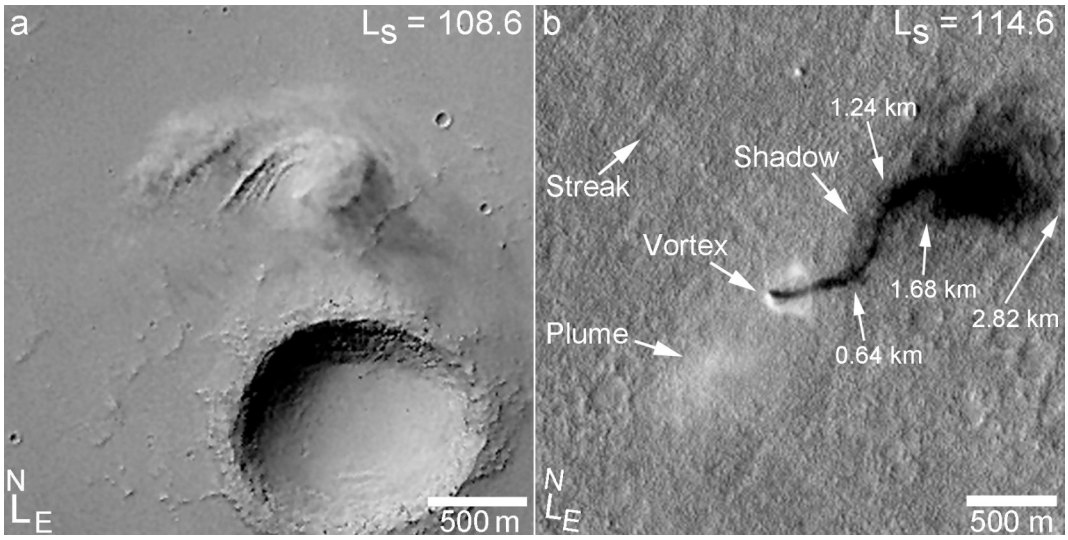

Figure 1. Martian dust devils in different stages of development: (a) Initial vortex near a crater in Syria (E23-01274) and (b) a full-blown dust devil in Amazonis (R22-01762).

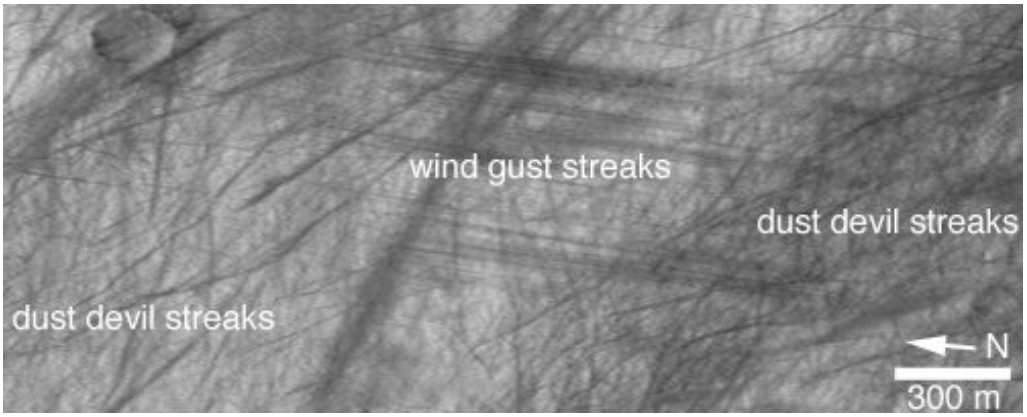

Figure 2. Distinction between Martian wind streaks and dust devil streaks (R11-03946).

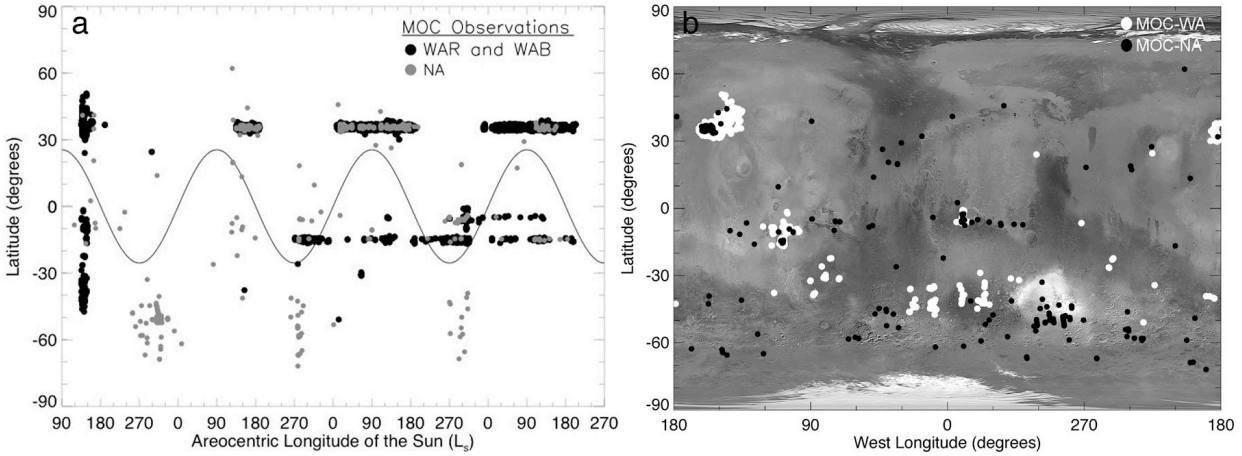

Figure 3. Latitudinal, temporal, and spatial distribution of dust devils observed by MOC during ~3.5 Mars years. L_s 90° on the left corresponds to 29 January 1999; L_s 270° on the right corresponds to 16 August 2005.