EXPERIMENTS IN TIMELAPSE CAMERA OBSERVATIONS OF DUST DEVIL ACTIVITY AT ELDORADO PLAYA, NEVADA R. D. Lorenz.[1], [1]Space Department, Johns Hopkins University Applied Physics Laboratory, Laurel, MD 21046, USA. ralph.lorenz@jhuapl.edu).

Introduction: Dust devils [1] are a key feature of Mars meteorology, influencing the dust loading of the atmosphere, possibly driving oxidant chemistry via triboelectric charging, and causing visible tracks on the surface. They may also affect operation of vehicles on the surface by removing dust from solar panels or radiators. On Earth they influence air quality and can be an occasional cause of structural damage and aircraft accidents [2]. Perversely, some statistics of dust devils on Mars are better-known than on Earth [3] : while systematic analysis of image sequences has been conducted with MER data, terrestrial surveys have so far relied upon manual surveys which typically have poorer size discrimination and may have sampling biases. Here I describe experiments with the aim of acquiring a large unbiased dataset on terrestrial dust devils using newly-available digital timelapse cameras [4].

Instrumentation: Experiments were conducted near Eldorado playa, south-east of Las Vegas. Experiments were conducted with various cameras : the principal results here are from a modified Brinno 'Gardenwatchcam' unit, with a custom housing and power supply (using alkaline D-cells instead of the AA capability with which they are manufactured). The camera records a sequence of ~2 megapixel color digital images acquired at set intervals (usually 1 or 5 minutes) as an .avi file on a 2GB USB memory stick .

A significant advantage over a previously-used camera is that a timestamp is automatically applied to each image (since the cameras are left for many days, and no images are recorded in darkness, the image frame number is not a completely deterministic indicator of acquisition time).

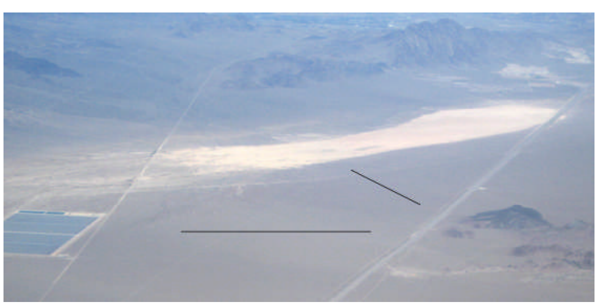

Figure 1. Playa seen from incoming commercial flight. Dark lines denote approximate FOV of camera.

Various locations on and near the playa were tried. Best results were observations from a hill some distance to the southeast of the playa. In addition to image sequences obtained during a collaborative field campaign in late June 2010, the camera was deployed May-December. The longest image sequence, limited by battery depletion, was July 28-November 21, with some 18247 frames at 5 minute intervals.

Data Analysis: An excellent visual impression of patterns of dust devil activity is obtained simply by watching the movie. However, timelapse imagery offers its most significant advantages for quantitative analysis.

Of course, large datasets of this type lend themselves to automated analysis: future experiments are planned in this direction. At present a semi-automatic tool has been coded in IDL to perform the following steps, illustrated in figures 2-4.

Figure 2. Example raw image in grayscale, dust devil at left. Average pixel value is ~170 DN

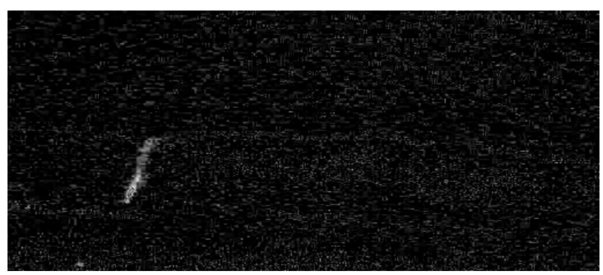

Figure 3. Differenced image (stretched). Peak intensity is ~15DN

Figure 4. Dust devil feature identified by dilation/ANDing algorithm.

1. a running average image is subtracted from each frame, to highlight features that change between frames. Dust devils tend to be the most prominent features left, although vehicles and cloud motion also appear, as do crepuscular rays at sunset.

2. if no features are observed, a mouse click on a GUI allows rapid progression to the next frame; if instead the operator identifies a dust devil, the cursor is set on that and a mouse click initiates step 3

3. the feature is defined by recursively dilating a region (initially the point clicked), ANDing with the thresholded image, dilating again etc. until the region ceases to grow.

4. the key parameters are written to a file. These include the image #, (x,y) positions of the base of the dust devil, its width, height and crude shape metrics, the total area in pixels and the total 'brightness' (integral of the pixel values) as a proxy for dust loading.

The output file facilitates automatic re-analysis (e.g. using different thresholds). Example dust devil feature sizes in raw pixels are shown in figure 5 as a demonstration. Of course, these must then be converted into physical sizes (using the y-coordinate as a proxy for distance) and timestamps introduced once per day. While this example is only 3% of the full dataset, the tool allowed these 600 frames to be processed in only 20 minutes.

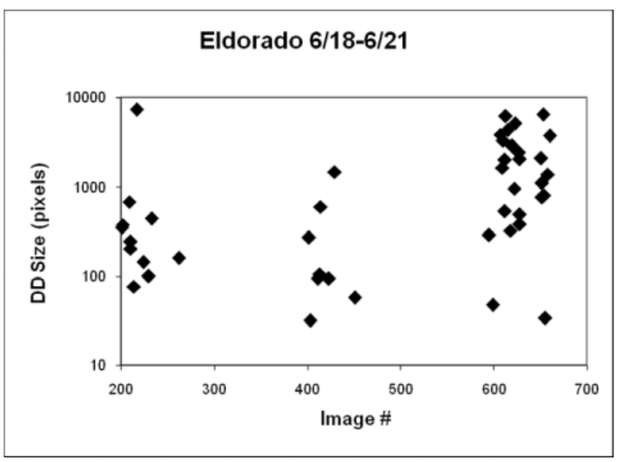

Figure 5. An example set of results (dust devil feature size in pixels) from 3 days of the data. The periodicity is evident, as is the emergence of a population of much larger devils on 6/21/2010.

Some Observations At the range employed here, it is seen that 1-minute intervals allow tracking of many individual dust devils across the scene; 5-minute intervals are useful for overall inventory and periodicity studies. Given overall data volume and battery lifetime considerations, a tradeoff exists between duration of run and time resolution. However, a run covering months can be obtained and analyzed with a couple of days effort to install and retrieve the camera and a few days of analysis : the camera technology is an effective 'force multiplier'.

One immediate finding from this work - where cameras were left unattended for many days and operated until darkness fell - is that, remarkably, dust devils are not uncommon at even ~6pm local time. This is significant as most manual surveys tend to end soon after 4pm due to a combination of observer fatigue and declining activity.

Conclusions: . A fuller analysis of the present dataset is now underway and will be presented at the meeting. Timelapse imagery affords a new and efficient window into terrestrial dust devil behavior, enabling a more rigorous comparison with Martian dust devils and complementing other field measurement approaches.

References: [1] Balme, M. and Greeley, R., Reviews of Geophysics, 44, RG3003, 2006 [2] Lorenz, R., and M. Myers, J. of Meteorology, 30 (No.298) 178-184, 2005 [3] Lorenz, R., Icarus, 203, 683-684, 2009 [4] Lorenz, R., B. Jackson, and J. Barnes, Journal of Atmospheric and Oceanic Technology, 27, 246-256, 2010

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