IN SITU STUDIES OF TERRESTRIAL DUST DEVILS AND AMBIENT METEOROLOGY: FIELD MEASUREMENTS OF VORTICITY. A. Spiga[1], A. Pathare[2], M. Balme[1,2], N. Renno[3], F. Saca[3], D. Halleaux[3] and S. Metzger[2], [1]Dept. of Physics and Astronomy, The Open University, Milton Keynes, United Kingdom (spiga@lmd.jussieu.fr); [2]Planetary Science Institute, Tucson, AZ, USA; [3]Dept. of Atmospheric, Oceanic & Space Sciences, University of Michigan, Ann Arbor, MI, USA

Figure 1: Dust devil observed in Eloy, Arizona on May 26th, 2009.

Introduction: Dust devils are common on both the Earth and Mars [1]. These small whirlwinds—caused by heating of the surface and made visible by entrained dust and sand—act to enhance aerosols in the atmosphere through vertical transport of mineral dust (Figure 1). Dust devils are suspected to be the mechanism that supports the ongoing dustiness of the martian atmosphere, and their dust-lifting capabilities have begun to be included in General Circulation Models (GCMs). This past summer, a field campaign was initiated to study terrestrial dust devils and ambient meteorology in both Eloy, Arizona and Eldorado Valley, Nevada. The main purpose of the work described in this abstract is to relate measured ambient vertical vorticity with simultaneous observations of dust devil size and frequency [2, 3].

Measurements: Figure 2 illustrates the general approach to the field campaign. All of the dust devils observed within a triangular study area of ~500m side length defined at its vertices by meteorology stations were recorded by two or more central field "spotters." The size frequency distribution of dust devils within the study area was determined using parallax digital photography in order to accurately record dust devil distance and diameter [2]. Simultaneous measurements of ambient vorticity, sensible surface heat flux, boundary layer temperature profile, convective boundary layer (CBL) height, and overall wind regime were also conducted. Ambient data was collected using three 10-m high meteorology masts whose positions were precisely determined by GPS.

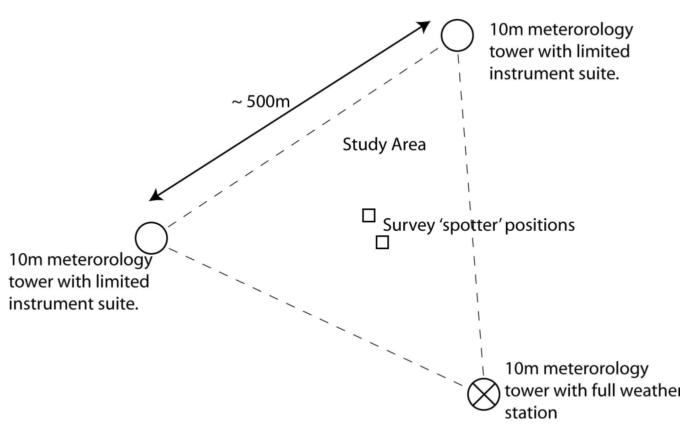

Figure 2 : Sketch of field setup.

Figure 3: View of the 10m meteorology tower with limited instrument suite. Data from the top anemometer are used for vorticity calculations.

Calculations and Results: The meteorological data allows us to investigate the local conditions associated with dust devil formation. Ambient vorticity was computed from wind speed and direction sensors located at the top of each 10-m high mast (Figure 3). A preliminary averaging of data must be performed to filter out turbulent variations of wind and only retain the mesoscale / large-scale wind variability. As in many boundary layer studies, a 1-hour temporal smoothing window is utilized, yielding satisfactory results. Averaged winds from each mast are then used for ambient vorticity calculations: computations of this quantity is actually performed on three points situated on a rectangle embedded in the field work triangle. Although this requires an additional interpolation, calculation of vorticity is greatly facilitated by this method. Note that the distance between points (approximately 500-700 meters) is considered small with respect to the characteristic scale of variability considered (mesoscale to large-scale i.e. at least tens of kilometers). Figure 4 depicts a preliminary example of our vorticity calculations. We will present more detailed results obtained from processing all of the data collected over multiple weeks of field observations. Comparisons with simultaneous dust devil size and frequency observations will also be presented.

Impact: This work will help improve the ability of GCMs to describe dust lifting by dust devils by providing significantly more data on the amount of dust each vortex can lift as a function of local meteorology. The proposed work will also provide testable relations between size and frequency of dust devil formation and the local climate (ambient vorticity is addressed here, but surface heat flux and boundary layer height are of particular importance too). Results can then either be used to improve current dust devil model parameterizations or form the basis of new parameterizations.

References: [1] Balme and Greeley, *Review of Geophysics*, 2006 [2] Balme et al., LPSC 2010 (this conference), [3] Pathare et al. LPSC 2010 (this conference).

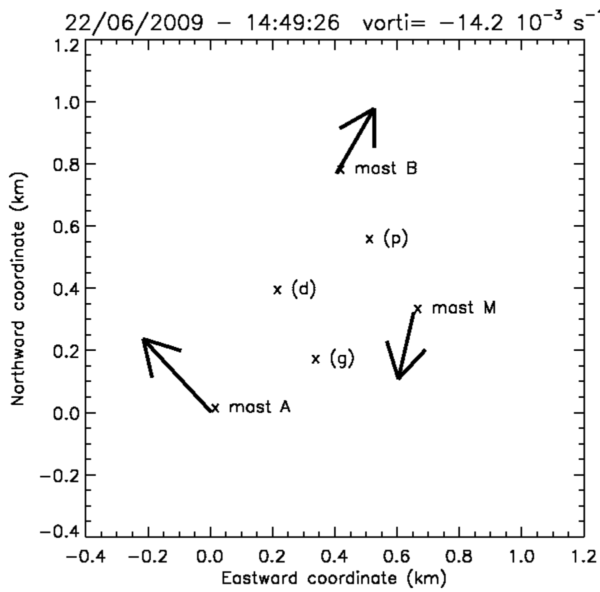

Figure 4 : Sample instantaneous vorticity calculations. Measured wind vectors are superimposed (wind speeds are about 2-3 m/s). Points d, g, d are used for vorticity calculations as explained in the text. Vorticity is the measurement of the local rotational properties of the wind field: it is negative here (clockwise rotation of the wind). Instantaneous vorticity is significant; in situation of strong wind blowing on the whole site towards a given direction, value of vorticity would be much lower. Note that the picture is presented in order to illustrate the adopted methodology. Preliminary averaging on measured wind is needed to obtain reliable values of ambient vorticity: such complete retrievals of vorticity will be presented at the conference.