**IMAGER FOR MARS PATHFINDER WINDSOCK EXPERIMENT** Robert Sullivan[1], Ronald Greeley[1], Gregory Wilson[1,2], Peter Smith[3], and Chris Cooper[4]. *[1]Department of Geology, Arizona State University, [2]NASA-Ames Research Center, [3]Lunar and Planetary Laboratory, University of Arizona, [4]Carleton College.*

The Imager for Mars Pathfinder (IMP) camera[1] will be launched aboard the Pathfinder spacecraft toward Mars in December, 1996 for a July, 1997 arrival on the surface. Three windsocks were developed for attachment to the one-meter mast of the Atmosphere Structure Instrument/Meteorology (ASI/Met) package. The windsocks will be imaged repeatedly (with sub-framing and compression) over short intervals to allow measurement of the wind speed boundary-layer profile, including determination of aerodynamic roughness ($z_0$), wind friction speed ($u_*$), and shear stress ($\tau$) on the surface due to wind. The ability to determine these parameters allows evaluation of the potential of wind to move fine particles across the landing site. Changes in the surface distribution of mobile materials during the mission can be related to $z_0$ and $u_*$ determined from IMP windsock images. Surface changes and winds at the landing site might also be related to wind streaks and other albedo features within the landing ellipse seen in Viking Orbiter images.

Each windsock consists of an aluminum cone rigidly joined to a steel and aluminum counterweight spike which together pivot on a small, low-friction gimbal mount (Fig. 1). Each windsock assembly is less than 10 cm long and is mounted (flexibly) at the end of a support strut extending 10 cm from the ASI/Met mast. The windsocks are counter-balanced for sensitivity to wind at typical martian surface pressures. The design was tested at one atmosphere in the wind tunnel and in the field, and at equivalent martian atmospheric pressure in the ASU low-pressure wind tunnel at NASA-Ames, and found to be aerodynamically stable at all deflection angles. All windsock materials are fully conducting, and each windsock unit is grounded to prevent static charge affecting windsock deflection. Each windsock assembly can withstand structural accelerations of several hundred Gs. The three windsocks are mounted at heights of 33.1, 62.4, and 91.6 cm.

Three flight models and three flight spares were calibrated at one atmosphere and at equivalent martian atmosphere. At one atmosphere each flight unit was imaged simultaneously from horizontal and vertical directions at seven azimuths and seventeen deflection angles, and at five more azimuths at seven deflection angles. At martian equivalent atmospheric pressure, each flight unit was similarly imaged at seven azimuths at an average of eleven deflection angles. Some minor hysterisis (1-2 degrees in deflection) was encountered during early experiments, so all data were obtained at both increasing and decreasing wind speeds.

Results for windsock flight unit 1 at one atmosphere for the representative azimuth of 60 degrees are summarized in Fig. 2. Deflections in Fig. 2 are measured from vertical. Dead zone deflections (neutral, no wind) of 5-6 degrees indicated in Fig. 2 are representative of other azimuths. Wind speeds and deflections at one atmosphere can be related to wind speeds at other atmosphere densities (temperatures and pressures) and surface gravities by the torque-balance relation

$$u = \sqrt{\frac{2\,R_1\,M\,g\,\tan\theta}{R_2\,A_d\,\rho}} \qquad (1)$$

where $u$ = wind speed, $R_1$ = distance between pivot and center of mass, $M$ = non-counter-balanced mass, $g$ = acceleration of gravity, $\theta$ = deflection from vertical, $R_2$ = distance between pivot and center of aerodynamic pressure, $A_d$ = effective aerodynamic cross-section, and $\rho$ = atmospheric density (a function of pressure and temperature). As an example, preliminary predicted behavior of windsock #1 for martian conditions of 8 mb, 225 K, and 3.7 m/sec$^2$ is indicated in Fig. 2. Expected sensitivities for martian conditions are from about 5-40 m/sec. It is anticipated that eq. (1) will be refined as analysis of the 2800 flight unit calibration pictures continues.


Figure 1. IMP windsock #7 in the NASA-Ames wind tunnel. Wind direction is left-to-right.

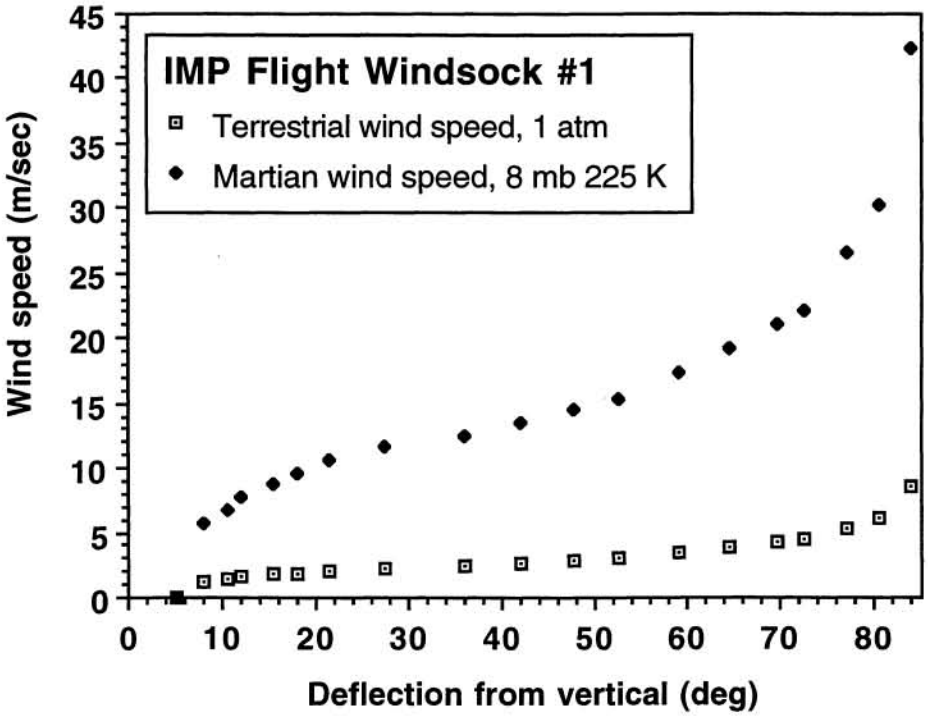


Figure 2. IMP flight windsock #1 calibration data for 60 deg azimuth.

**Reference:** (1) Smith, P. H., Britt, D. T., Doose, L. H., Singer, R. B., Tomasko, M. G., Gliem, F., Greeley, R., Sullivan, R., Keller, H. U., Knudsen, J. M., and Soderblom, L. A., 1995, LPSC XXVI, pp. 1321-1322.