Meteorological Results From the Surface of Mars: Viking 1 and 2

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We deal here primarily with the surface meteorological data for both Viking landers during the nominal missions (44 sols for lander 1 and 61 sols for lander 2). The diurnal patterns of wind, temperature, and pressure were strongly similar from sol to sol, as was expected in the summer. The chief characteristics of the wind data are that winds were light (a few meters per second), with a complex hodograph at VL-1 dominated by counterclockwise turning of the wind and a simpler hodograph at VL-2 marked by clockwise turning of the wind. This repetitive pattern of wind has begun to break down at VL-2 with advancing season, and several episodes of protracted northeasterly winds have occurred. Some of these are associated with lower than normal temperatures. Examples are given of wind and temperature traces over short periods, illustrating the effects of convection, static stability, and lander interference. We present a theoretical argument based upon the horizontal scale dictated by heating of slopes and upon vertical mixing of momentum to explain the different sense of rotation of the wind vectors at the two sites. Analysis of the semidiurnal pressure oscillation suggests that absorption of solar radiation is an important thermal drive but that convective heat flux from the surface is also significant. The seasonal variation of pressure extending past the end of the nominal missions shows a decrease of pressure to a minimum at L_s $\approx$ 149° with a rapid rise thereafter. This is clearly due to condensation and sublimation of CO_2 on and from the southern polar cap.

INTRODUCTION

The meteorology experiment aboard the Viking Mars landers (VL-1 and VL-2) was designed to measure atmospheric temperature, wind speed, wind direction, and pressure. The scientific objectives have been described previously [*Hess et al.*, 1972]. In brief, the objectives are to obtain information about the local environment and meso-scale and planetary-scale systems and processes, to investigate boundary layer phenomena, and to obtain a better understanding of earth's atmosphere through comparison with the simpler Mars atmospheric behavior.

The instrumentation has been described by *Chamberlain et al.* [1976]. In brief, the temperature and wind sensors are mounted at the end of a boom which was deployed shortly after landing. Figure 1 shows the boom-mounted sensors, while Figure 2 shows the deployed boom on Mars (VL-1 site). In the deployed position the sensors are nominally 1.6 m above the ground, 0.7 m above the top of the lander body, and slightly more than 0.3 m horizontally outward from the closest portion of the lander body. The objective of the deployment was to place the sensors as far as practicable from lander effects. The pressure sensor is mounted underneath the lander body and is the same sensor used to obtain pressure profiles during the parachute phase of entry. It is of the variable reluctance, stressed diaphragm type and measures over the range 0–20 mbar with least digital step about 0.09 mbar. Its measurement accuracy is much better than 0.09 mbar.

The ambient temperature sensor consists of three Chromel-Constantan thermocouples wired in parallel. It is capable of measuring over the entire range of expected Martian temperatures with an accuracy of about ±1.5°C. Wind speed is measured by means of two hot film (platinum) sensors mounted 90° apart in the horizontal plane and maintained at a nominal overheat temperature of 100°C above ambient as measured by a reference temperature sensor. Wind speed accuracy is about ±10% over most of the range (~2–150 m s^{-1}) but degrades somewhat for very light winds. Lander interference, i.e., wind from over the lander, also degrades accuracy, but ground testing indicates that the degradation should not be much in excess of ±10% for the system as a whole. The wind speed sensors also measure wind direction but with a fourfold ambiguity. Selection of the proper quadrant is accomplished by a quadrant sensor, consisting of a heated cylindrical core surrounded by four thermocouple junctions at equal angles and distance about the core. The thermocouples sense the thermal wake from the heated center core. Overall accuracy in wind direction measurement is about ±10°. All electronics, except the bridge circuit for the ambient temperature sensor, are located within the lander body.

The instruments have performed well during the primary mission (from the Mars landing to the solar conjunction period beginning in early November 1976) except for two anomalies. The first concerned the ambient temperature sensor on VL-2 and was observed shortly before launch. The readings exhibited a temperature-dependent error, increasing as lander body temperature decreased. Also, the error gradually decreased after application of power to the electronics, approaching a steady state value after 30–40 min of operation. A series of checkouts was performed during the cruise phase, and it was concluded that the probable cause of the anomaly was a temperature-dependent resistance change somewhere within the electronics. Analysis of the landed data and comparison with the reference temperature sensors on VL-1 and VL-2 and the ambient sensor on VL-1 permitted a suitable correction to be applied. This required that power be on continuously to eliminate the drift. This was done from VL-2 sol 25 onward. (A sol is defined as 1 Martian day, and a VL-2 sol as the number of sols after VL-2 landing. In like manner a VL-1 sol is the number of sols after VL-1 landing.) Because of this anomaly the reference temperature sensor was utilized as the measure of VL-2 atmospheric temperature throughout most of the primary mission. It is much more susceptible to radiation and conduction errors, but corrections for these have been applied, and it is believed to have a residual error of less than ±4°C. The correction to the VL-2 ambient temperature sensor should bring its error to within ±3°C.

The second anomaly involved the VL-1 quadrant sensor. The heater for the sensor core exhibited intermittent behavior on VL-1 sol 45 and failed shortly thereafter. This precluded

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