Early Meteorological Results from the Viking 2 Lander

Abstract. *Early results from the meteorological instruments on the Viking 2 lander are presented. As on lander 1, the daily patterns of temperature, wind, and pressure have been highly repetitive during the early summer period. The average daily maximum temperature was 241°K and the diurnal minimum was 191°K. The wind has a vector mean of 0.7 meter per second from the southeast with a diurnal amplitude of 3 meters per second. Pressure exhibits both diurnal and semidiurnal oscillations, although of substantially smaller amplitude than those of lander 1. Departures from the repetitive diurnal patterns begin to appear on sol 37.*

We have previously reported on the early meteorological results at the Viking 1 (VL1) site in Mars' northern tropics, 22°N, 48°W (*1*). The Viking 2 lander (VL2) has provided an opportunity to sample meteorological conditions at a mid-latitude site during summer (48°N, 226°W). At this season, latitude variations in ground temperature are small (*2*). Consequently, atmospheric temperatures were expected to be similar to those at the VL1 site, and winds were expected to be light (*3*). The VL2 meteorological sensors are identical to those on VL1. They have provided information on temperature, wind, and pressure. We report here on the observational results for the early sols of VL2 (*4*).

As was expected, the atmospheric temperatures at the 1.6-m instrument height were very similar to those measured thus far by VL1 (*5*). The average daily maximum is near 241°K, the average minimum is near 191°K, and the times of maximum and minimum are, respectively, about 3 hours after noon and near sunrise.

Winds during these early sols were found to be light and, as at the VL1 site, the diurnal pattern was extremely uniform from one sol to the next. The hodograph plot of VL2 winds averaged over sols 12 to 31 is shown in Fig. 1. The daily vector mean wind is 0.7 m/sec from the southeast, and the wind vector sweeps out a rough ellipse with its long axis oriented NNW to SSE, with an amplitude of about 3 m/sec. In contrast to the VL1 daily wind hodograph, the sense of rotation of the wind vector is clockwise. The large-scale terrain slope at the VL2 site is upward toward the SSE, with a slope of about 1/600, while at the VL1 site the large-scale slope is upward toward the west, with a slope of about 1/100 (*6*). It is interesting to note that the wind is directed upslope near 1900 local time at each site. This behavior is quite consistent with that expected for winds driven by heating on the slope; the flow accelerates upslope during the hours of maximum heating, so that the velocity reaches its upslope maximum about one-quarter of a diurnal cycle after the time of maximum heating (*7*). Other aspects of the hodograph, for example, the counterclockwise hodograph rotation at VL1, indicate that other factors are also influencing the diurnal wind pattern.

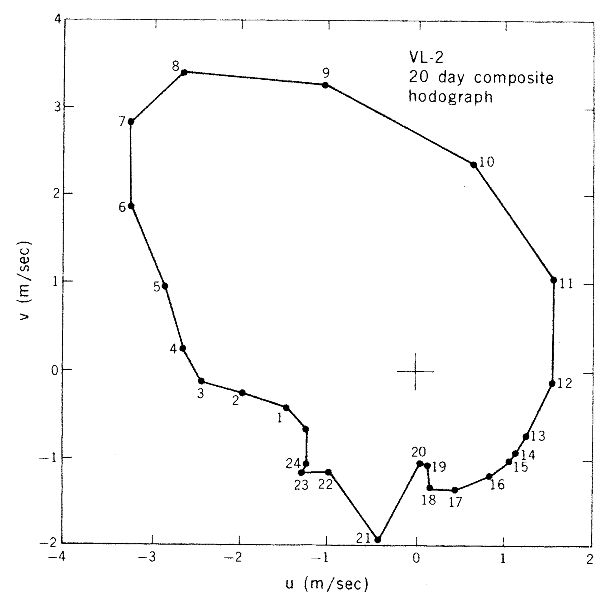

Fig. 1. Average diurnal wind hodograph for sols 12 to 31. The plotted points represent the tip of the wind vector directed from the origin at the indicated lander local times (L.L.T.). Smaller scale fluctuations, such as those observed between 18:00 and 00:00 L.L.T., are not considered significant. *v*, northward component of the wind velocity; *u*, eastward component of the wind velocity.

The daily variation of wind gustiness is similar at the two sites. The wind becomes gusty shortly after sunrise, as the surface boundary layer becomes convectively unstable, and remains gusty until midafternoon. During this gusty period, the wind direction fluctuates as well as wind speed, and this directional variability contributes to the low magnitudes of the time-averaged vector winds during the afternoon. The peak observed gust was 17 m/sec.

Although wind speeds measured thus far by VL1 and VL2 are much too light to raise surface particles, Mariner 9 observations have provided evidence for a very different regime during winter, with

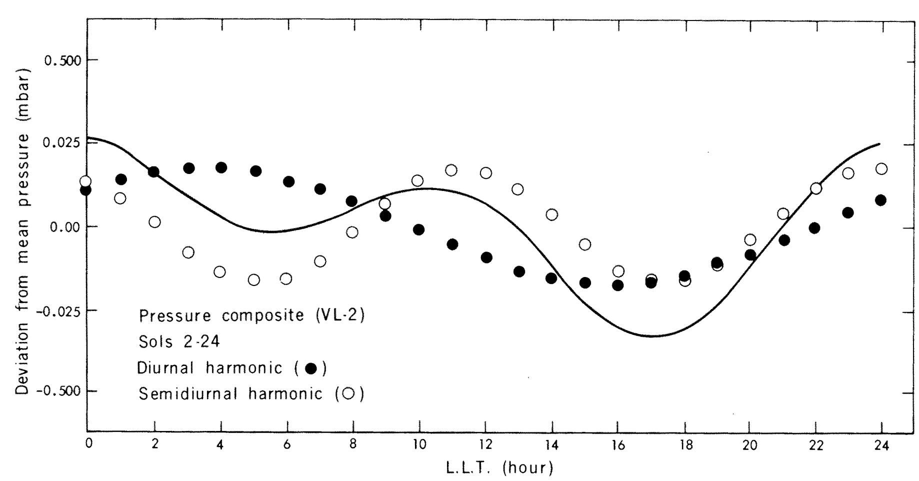

Fig. 2. Second-order, least-squares harmonic analysis of the pressure data from VL2 for sols 2 to 24. The solid curve is the composite of the two harmonics.

Table 1. Amplitudes (peak to peak) and times of maxima for diurnal and semidiurnal components of the surface pressure oscillations at the VL1 and VL2 sites. Values given are averages for sols 1 to 20 on VL1 and sols 2 to 24 on VL2; L.L.T., lander local time.

Item	Amplitude (mbar)	Time of maxima (L.L.T.)
VL1		
Diurnal	0.16	03:12
Semidiurnal	0.07	10:50 23:10
VL2		
Diurnal	0.03	03:24
Semidiurnal	0.03	11:15 23:40

much stronger winds (8). We plan to obtain data for the winter period during the Viking extended mission.

Pressure measurements at the VL2 site exhibited a downward trend similar to that observed at the VL1 site. Thus, they supported our earlier interpretation of the pressure decrease in terms of atmospheric mass loss due to CO_2 condensation at the southern winter polar cap. We have also observed diurnal and semidiurnal pressure variations at the Viking 2 site, although with much reduced amplitude compared with those observed at the Viking 1 site (Fig. 2 and Table 1). The reduction in amplitude between the two sites is consistent with the behavior of the most important planetary scale atmospheric tidal modes. For example, the amplitude of the semidiurnal mode of largest planetary scale, the $S_2^{2,2}$ mode, would be expected to be about one-fourth as large as at the VL1 site (9). Although the observed ratio is somewhat larger than this, we believe that this $S_2^{2,2}$ mode is the dominant contributer to the semidiurnal pressure variation.

The repetition of diurnal patterns from one sol to another is to be expected in summer on Mars because the regular radiation regime dominates, and because horizontal temperature gradients and winds are too small to support various forms of meteorological instability. We have already seen evidence that this regularity is breaking down at the VL2 site. Departures from the wind pattern of Fig. 1 have become increasingly evident since sol 37. This behavior is under intensive study.

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References and Notes

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4. The term "sol" refers to the martian day of 24.660 hours and is used to avoid confusion with the terrestrial day. Sol 0 refers to the date of landing of the designated lander.
5. As on VL1, the primary temperature sensor is a thermocouple array; however, on VL2 the measurements from this sensor showed indications of noise and bias arising from the electronics. We have, therefore, used the wind reference temperature sensor to provide the VL2 temperature information reported here. Readings from this instrument are subject to radiation and conduction errors which have been corrected on the basis of experience gained with the same sensor on VL1. However, the corrected temperature readings on VL2 with an estimated error of ± 2°K are less accurate than those on VL1.
6. According to the 1/25,000,000 scale topographic map of Mars, M 25M 3RMC, prepared by the U.S. Geological Survey under NASA contracts L55232, WO-8122, and W-13709 for the Viking project.
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10. Supported by NASA contract NAS 1-9693.

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