Spectrum

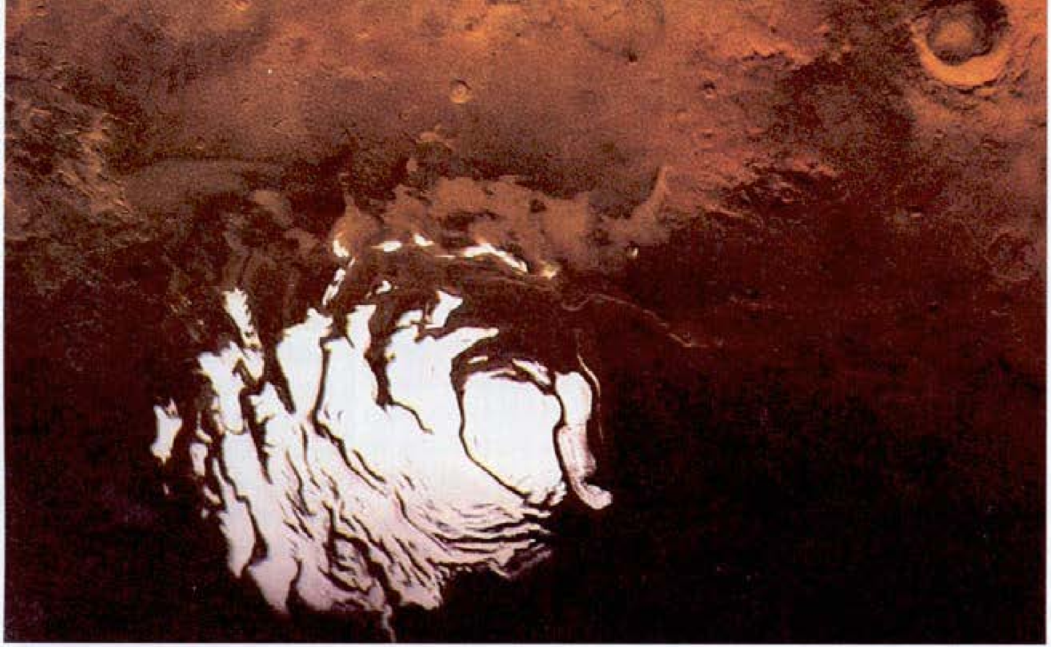
Martian winds and winters

The red planet has always exerted a powerful effect on the human imagination, perhaps because of the way in which its brightness can change so dramatically — more than any other planet's — as orbital dynamics periodically bring the Earth and Mars close and then apart.

Our thinking about the planet Mars — no longer the god of war — continues today, and plenty of questions remain on which to speculate, even after the successful series of Viking landing missions.

The change in size of the polar caps with the seasons is visible even with a small telescope, and has been observed from Earth for

A view of Mars' stony red surface taken by the Viking lander.



The South Pole of Mars seen from space during the planet's southern summer. It is made mainly of carbon dioxide ice, which freezes out of the atmosphere every winter.

centuries. We now know that these 'ice' caps are dominated not by water, but by carbon dioxide — dry ice — which freezes at −123°C.

Mars is certainly cold, and the reason is partly its greater distance from the sun (on average half as far again as we are), and partly the fact that it has such poor ability to hold its heat because of the thinness of its atmosphere (in turn caused by Mars' surface gravity being substantially less than ours — a direct consequence of its smaller mass). The Martian atmosphere, which is about 95% CO_2, has a pressure of only about 6 millibars (mb), whereas on Earth the pressure averages about 1000 mb.

Even after the Viking missions, scientists tended to think of the two caps in isolation. They knew that the frozen CO_2 sublimed — that is, moved straight from solid to gaseous form — with the arrival of spring at one pole. Similarly, CO_2 would freeze out of the atmosphere during winter at the other pole. But a recent analysis of some Viking lander data by Dr John Philip, of CSIRO's Division of Environmental Mechanics, has led to a slightly different picture.

Perhaps the best data on Mars to come from the Viking landers concern the annual fluctuation in atmospheric pressure (and in the mass of the atmosphere). This variation is about 14%, and is due to the CO_2 condensing and subliming at the two polar caps. To these data Dr Philip applied a simple mathematical model, which estimates the continuous exchange of CO_2 between the atmosphere and each of the polar caps.

He found that sublimation from solid to gas at one pole and condensation from gas to solid, at the other, were taking place simultaneously for much of the year. This means that the annual fluctuation in the quantity of CO_2 in each of the caps is about twice that previously thought. This means that the latent heat — the amount of energy associated with the sublimation and condensation of CO_2 — is a very important component in the energy budget of Mars' meteorology.

The flux between the poles as the CO_2 freezes and evaporates must result in a wind. Dr Philip calculated the wind speed necessary to account for the mass transfer, and came up with a maximum value of about 0·2 metres per second — a gentle breeze, and quite plausible. Indeed it may be difficult to measure, as the Martian weather — particularly when dust storms rage across the planet — is no stranger to strong winds.

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Similarity analysis of the Martian polar caps. J.R. Philip. *Geophysical Research Letters*, 1986, **13**, 1137–40.