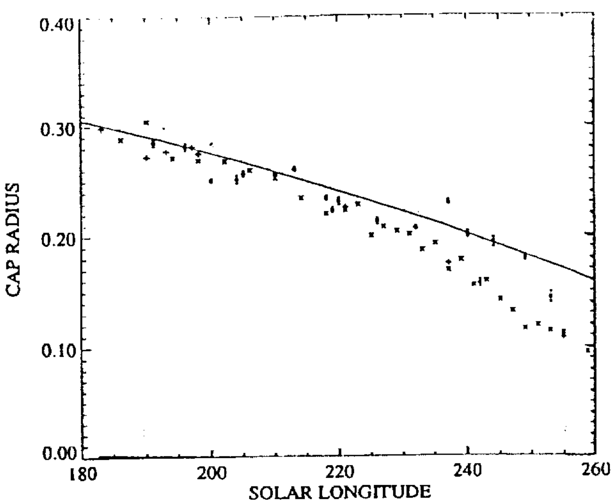


**Fig. 3.** The regression of the south polar cap, as observed in 1986 (solid circles), 1971 (crosses), and 1977 (plus signs) (taken from [21]) and as simulated by my model (thin line), as a function of the aerocentric longitude of the Sun ($L_s$). Two-sigma error bars are indicated for the 1986 data; the errors are smaller for the denser 1971 data and for the 1977 Viking data.

south pole. Unfortunately, the model does overpredict polar cap extent in early southern summer (see Fig. 2).

In summary, it appears possible to construct an energy balance model that maintains seasonal $CO_2$ ice at the south pole year round and still reasonably simulates the polar cap regression and atmospheric pressure data. This implies that the $CO_2$ ice observed in the summertime south polar cap could be seasonal in origin, and that minor changes in climate could cause $CO_2$ ice to completely vanish, as would appear to have happened in 1969 [3]. However, further research remains before it is certain whether the $CO_2$ ice observed in the summertime south polar cap is seasonal or is part of a permanent reservoir.

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**THE INTERANNUAL VARIABILITY OF POLAR CAP RECESSIONS AS A MEASURE OF MARTIAN CLIMATE AND WEATHER: USING EARTH-BASED DATA TO AUGMENT THE TIME LINE FOR THE MARS OBSERVER MAPPING MISSION.** L. J. Martin[1] and P. B. James[2], [1]Lowell Observatory, 1400 West Mars Hill Road, Flagstaff AZ 86001, USA, [2]Department of Physics and Astronomy, University of Toledo, Toledo OH 43606, USA.

**Seasonal Cycles of Dust, Water, and $CO_2$:** The recessions of the polar ice caps are the most visible and most studied indication of seasonal change on Mars. Strong, if circumstantial, evidence links these recessions to the seasonal cycles of $CO_2$, water, and dust. These phenomena and their interactions will be the subject of an MSATT workshop next year titled "Atmospheric Transport on Mars." Briggs and Leovy [1] have shown from Mariner 9 observations that the atmospheric polar hoods of the fall and winter seasons are at least partially water ice clouds. Around the time of the vernal equinox, this water ice may precipitate onto the surface that includes $CO_2$ frosts. The sublimation of the outer edge of the seasonal cap begins about this same time, and we begin to observe its recession. During the recession of the north cap we also observe cirumpolar clouds that are believed to be formed by water vapor from the subliming cap [2]. Some observations suggest that at least part of the sublimed water and/or $CO_2$ reforms as surface ice toward the cap's interior. This "new" ice is probably the bright component of the polar caps that is seen on Earth-based observations. This would explain the south cap's appearance as that of a shrinking donut during its recession [3]. Near the edge of the shrinking cap, dust activity is also evident on the Viking images [4]. This may result from off-cap winds generated from sublimation and/or dust that might be released from within or beneath the ices. It has been found that all of Mars' major dust storms that have been observed to date occurred during the broad seasons when either the north or south polar cap was receding [5]. There are short seasonal periods around the beginning and ending of cap recessions when no major dust storms have been observed. Variable recession rates for the polar caps were suspected from Earth-based data and proven by Mariner 9 and Viking observations. The cycles for water, $CO_2$, and dust are thought to vary with the cap recessions, although the nature of the variations is not yet known. The possible relationship between variable recession rates and dust storm activity has been investigated by James et al. [6]. Iwasaki et al. [7] proposed a correlation between retarded cap recessions and the occurrence of major storms that seems plausible, although more data are needed. Certainly, the polar cap recession rates are at least one phenomenon that needs to be monitored in conjunction with dust storm activity. Since there is evidence that cap recessions may accelerate prior to the onset of encircling storms [5], this monitoring might even lead to predicting these storms. The possible advent of a planet-encircling storm during the Mars Observer (MO) Mission will provide a detailed correlation with a cap recession for that one martian year. We will then need to compare that cap recession with other storm and nonstorm years observed by other spacecraft and from Earth. MO data will also provide a stronger link between cap recessions and the water and $CO_2$ cycles. Cap recession variability might also be used to determine the variability of these cycles.

**Observations—Present, Past, and Future:** After nearly a century of valiant attempts at measuring polar cap recessions [8], including using Mariner 9 and Viking data [9–11], MO will provide the first comprehensive dataset. In contrast to MO, the older data are much less detailed and precise and could easily be forgotten, except that it will still be the only information on interannual variability. Since the MO mission will map just one martian year, it will provide a singular set of seasonal data. Standing alone it will not be possible to be certain which MO data are "seasonal" or whether an "average" or "abnormal" year is portrayed. Of course, even if MO could continue its work indefinitely, it might take a very long time to accumulate enough data to have a representative sample of Mars years. Therefore, we are obliged to retain and refer back to the still-viable historical records, including spacecraft data. These records will be easier to interpret and evaluate based upon new insights from MO data: By obtaining simultaneous Earth-based observations (including those from Hubble Space Telescope) during the MO mission, we will be able to make direct comparisons between the datasets. This will be very helpful in interpreting and measuring the Earth-based data taken during other periods. Continued Earth-based observations will be needed after MO to monitor the martian climate and extend the time line of the data. Improved techniques will allow us to monitor longer seasonal segments of martian years and to better interpret and measure the data. Eventually we may be able to establish limits on the degrees of variability of the polar cap recessions and, consequently, variations in the $H_2O$, $CO_2$, and dust cycles. Many of the questions presented by MO data and its upgraded portrayal of Mars can be addressed to longer-term, albeit cruder, Earth-based observations.

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**DUST TRANSPORT INTO MARTIAN POLAR LATITUDES.** J. R. Murphy[1,2] and J. B. Pollack[2], [1]National Research Council Associate, [2]NASA Ames Research Center, Moffett Field CA 94035.

The presence of suspended dust in the martian atmosphere, and its ultimate return to the planet's surface, is implicated in the formation of the polar layered terrain and the dichotomy in perennial $CO_2$ polar cap retention in the two hemispheres. We have been employing a three-dimensional numerical model to study martian global dust storms. The model accounts for the interactive feedbacks between the atmospheric thermal and dynamical states and an evolving radiatively active suspended dust load. Results from dust storm experiments, as well as from simulations in which we are interested in identifying the conditions under which surface dust lifting occurs at various locations and times, indicate that dust transport due to atmospheric eddy motions is likely to be important in the arrival of suspended dust at polar latitudes.

The layered terrain in both the northern and southern polar regions of Mars is interpreted as the manifestation of cyclical episodes of volatile ($CO_2$, $H_2O$) and dust deposition. The cyclical nature of this deposition is assumed to be driven by long-period variations that arise from orbital and axial tilt variations and influence the climatic conditions. The dust is assumed to be provided primarily by the occurrence of global-scale dust storms that fill the atmosphere with large quantities of suspended dust, some of which settles back to the surface in the polar regions. The dust settles onto the cap either independently due to gravitational sedimentation or incorporated into $CO_2$ snow [1], possibly serving as condensation nuclei for such a process. The dust storms develop at southern subtropical latitudes, and barring any other sources (which is probably a poor assumption), the dust that appears in suspension at polar latitudes is transported over long distances. It has been a common belief that an intensified Hadley-type circulation is responsible for transporting the dust to high northern latitudes. However, two-dimensional