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THE EFFECTS OF ATMOSPHERIC DUST ON OBSERVATIONS OF MARTIAN SURFACE ALBEDO; S.W. Lee and R.T. Clancy, Laboratory for Atmospheric and Space Physics, Univ. Colorado, Boulder, CO 80309

The Mariner 9 and Viking missions provided abundant evidence that aeolian processes are active over much of the surface of Mars [1; 2]. Past studies have demonstrated that variations in regional albedo and wind streak patterns are indicative of sediment transport through a region [3; 4], while thermal inertia data [derived from the Viking Infrared Thermal Mapper (IRTM) data set] are indicative of the degree of surface mantling by dust deposits [5; 6; 7; 8; 9]. The visual and thermal data are therefore diagnostic of whether net erosion or deposition of dust-storm fallout is taking place currently and whether such processes have been active in a region over the long term. These previous investigations, however, have not attempted to correct for the effects of atmospheric dust loading on observations of the martian surface, so quantitative studies of current sediment transport rates have included large errors due to uncertainty in the magnitude of the "atmospheric contamination".

We have developed a radiative transfer model which allows the effects of atmospheric dust loading and variable surface albedo to be investigated [see related abstract, 10] This model incorporates atmospheric dust opacity, the single scattering albedo and particle phase function of atmospheric dust, the bidirectional reflectance of the surface, and variable lighting and viewing geometry.

The Cerberus albedo feature has been examined in detail using this technique. Previous studies have shown the Cerberus region to have a moderately time-variable albedo [4]. IRTM observations obtained at ten different times (spanning one full martian year) have been corrected for the contribution of atmospheric dust in the following manner:

- A "slice" across the IRTM visual brightness observations was taken for each time step. Values within this area were binned to 1° latitude, longitude resolution.
- The atmospheric opacity (τ) for each time was estimated from [11]. As the value of τ strongly influences the radiative transfer modelling results, spatial and temporal variability of τ was included to generate an error estimate.
- The radiative transfer model was applied, including dust and surface phase functions, viewing and lighting geometry of the actual observations, and the range of τ [10].
- Offsets were applied to the visual brightness observations to match the model results at each τ.
- The "true surface albedo" was determined by applying the radiative transfer model to the offset brightness values, assuming $\tau = 0$ and a fixed geometry (0° incidence, 30° emission). Repetition of this technique for each time step allows values of albedo for specific locations to be tracked as a function of time (Figure 1).

The initial results for Cerberus indicate the region darkens prior to the major 1977 dust storms, consistent with erosion of dust from the surface (possibly contributing to the increasing atmospheric dust load). There is some indication of regional brightening during the dust storms followed by a general darkening, consistent with enhanced dust deposition during the storms followed by erosion of the added dust. There is only minor variability during the second year, consistent with little regional dust transport during that period.

The results of this study indicate that atmospheric dust loading has a significant effect on observations of surface albedo, amounting to albedo corrections of as much as several tens of percent. This correction is not constant or linear, but depends upon surface albedo, viewing and lighting geometry, the dust and surface phase functions, and the atmospheric opacity. It is clear that the quantitative study of surface albedo, especially where small variations in observed albedo are important (such as photometric analyses), needs to account for the effects of atmospheric dust loading. Our future work will expand this study to other regional albedo features on Mars.

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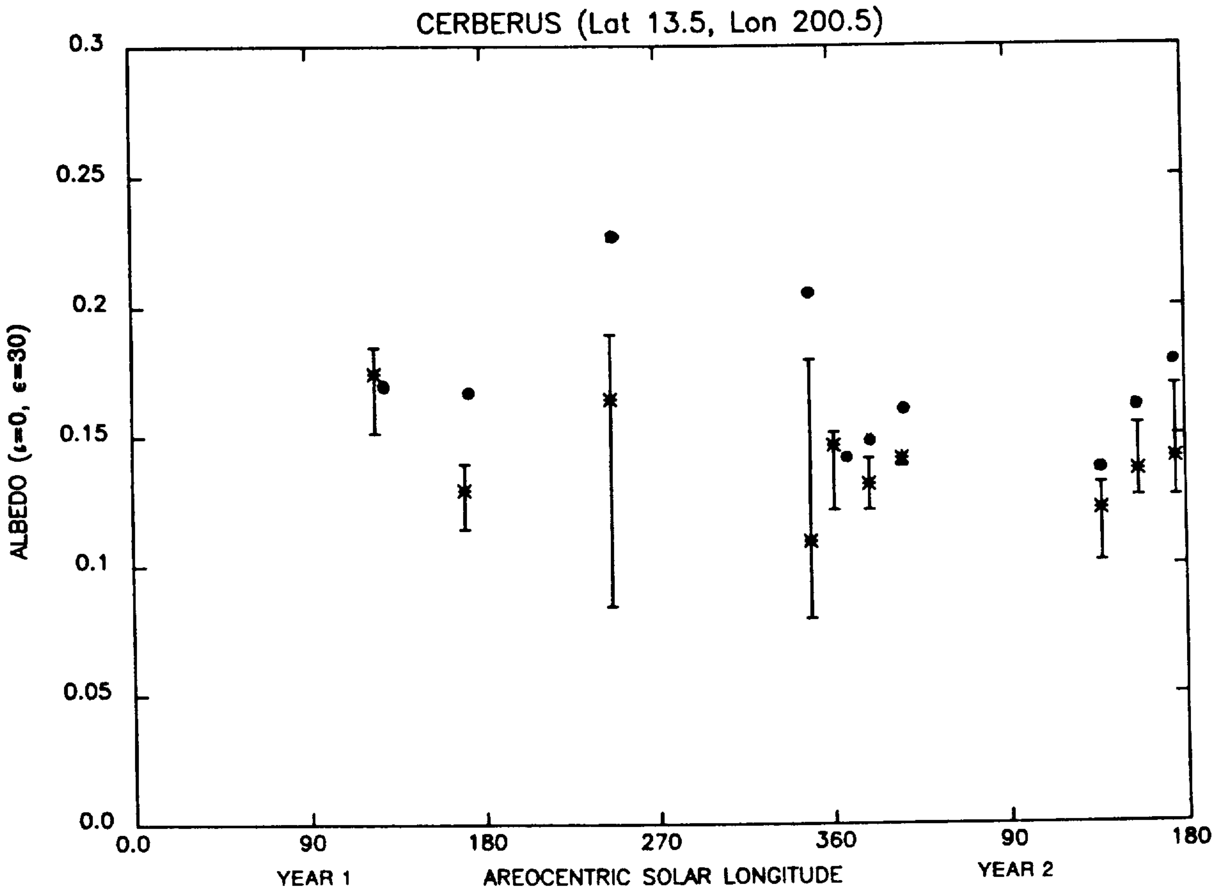

Figure 1: Temporal behavior of a dark area in Cerberus. "True surface albedos" are denoted by asterisks; error bars indicate uncertainty in τ. Uncorrected albedos are denoted by dots.