A SPECTRALLY-BASED GLOBAL DUST COVER INDEX FOR MARS FROM THERMAL EMISSION SPECTROMETER DATA.

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Introduction: One of the greatest problems with any form of spectral measurement on the surface of Mars is dust that obscures the surface of rocks. This was clearly demonstrated with the Pathfinder mission and its visible/near-infrared and alpha proton x-ray measurements. In both cases, interpretations of the data measured from rocks at the landing site were confounded by the presence of the fine dust coating many of the rock surfaces. The 2003 Mars Exploration Rovers will carry a set of spectrometers that also will be affected by the presence of dust. An assessment of surface dust cover is thus an important consideration for landing site selection.

Currently, thermal inertia and albedo data from the Viking IRTM and MGS TES form the basis for the assessment of surface dust. However, thermal inertia measurements are insensitive to a dust layer less than a few centimeters thick and albedo is not a definitive indicator of dust occurrence. An alternative means of sensing the presence of dust is to exploit the spectral particle-size effects produced by fine particles.

The effect on thermal infrared spectra of decreasing particle size is well known and reasonably well understood. A reduction in spectral contrast accompanies the decrease in particle size down to ~60 µm. Below this threshold where the diameter of particles approaches the wavelength of thermal-IR light, a phenomenon known as volume scattering begins [1] . The apparent effect is the appearance of spectral features unique to fine-particulate materials. Recognition of these features in TES spectra and mapping of their geographic distribution across the planet forms the basis for a global map of surface dust.

Evidence of Particle-size Effects: The evidence of particle-size effects in TES spectra is displayed most clearly by comparing spectra from representative areas on the planet that are recognized as dust-covered and dust-free based on thermal inertia and albedo considerations. An example of a dust-covered region is central Arabia Terra while central Syrtis Major likely is free of any significant dust accumulation. Figure 1 shows emissivity spectra from these two regions that have not been atmospherically corrected. Included in this figure are laboratory spectra intended to demonstrate the spectral appearance typical of silicate materials in coarse and fine particulate form. The TES spectra are dominated by atmospheric absorption features, especially in the 1300 to ~560 cm^{-1} range, but outside of this range surface spectral character is evident. Below 560 cm^{-1} the Syrtis spectrum has lower emissivity than the Arabia spectrum, closely paralleling the behavior of the coarse- and fine-particulate basalt spectra. Above 1300 cm^{-1} the emissivity behavior is reversed, with Syrtis showing higher emissivity than Arabia, consistent with the trend of the laboratory spectra. A thorough analysis described elsewhere [2, 3] demonstrates that an average emissivity value from 1350 to 1400 cm^{-1} is a robust indicator for the presence of fine-particulate silicates in spite of the known atmospheric absorptions that effect this spectral region. This index can be mapped globally to identify surfaces on Mars that are dominated by fine particulates, i.e., dust (Figure 2).

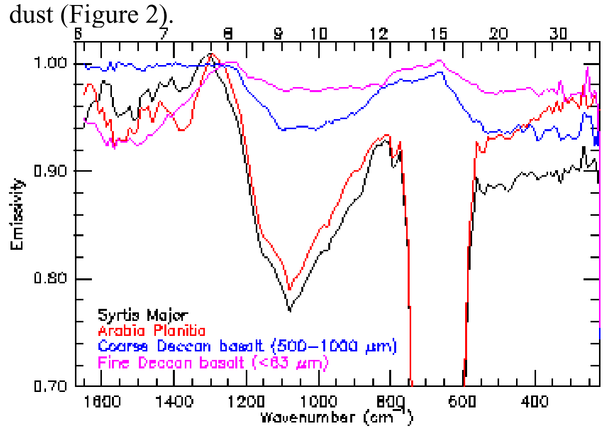

Figure 1. Evidence of particle size effects in atmospherically-uncorrected TES spectra of bright and dark regions.

Discussion: The index produces a spatially coherent map that clearly is related to albedo. Unlike albedo (and thermal inertia), this spectral index is a direct indicator of the presence of dust layers a few 10s of microns or more in thickness. Orange, red, and white areas on the map likely are completely dust mantled, while blue and minor purple areas likely are dust-free. Yellow, green, and cyan likely represent surfaces that are partially dust covered. All three previous lander sites are within the intermediate colors. Sites chosen within the blue regions likely will have the most dust-free surfaces on the planet.

References: [1] Salisbury, J.W. and A. Wald, (1992) *Icarus*, **96**, 121-128. [2] Ruff, S.W. and P.R. Christensen (1999) *The Fifth International Conference on Mars*., Abs. #6230, LPI Houston (CD-ROM). [3] Ruff, S.W. and P.R. Christensen, (2001), *J. Geophys. Res*., submitted.

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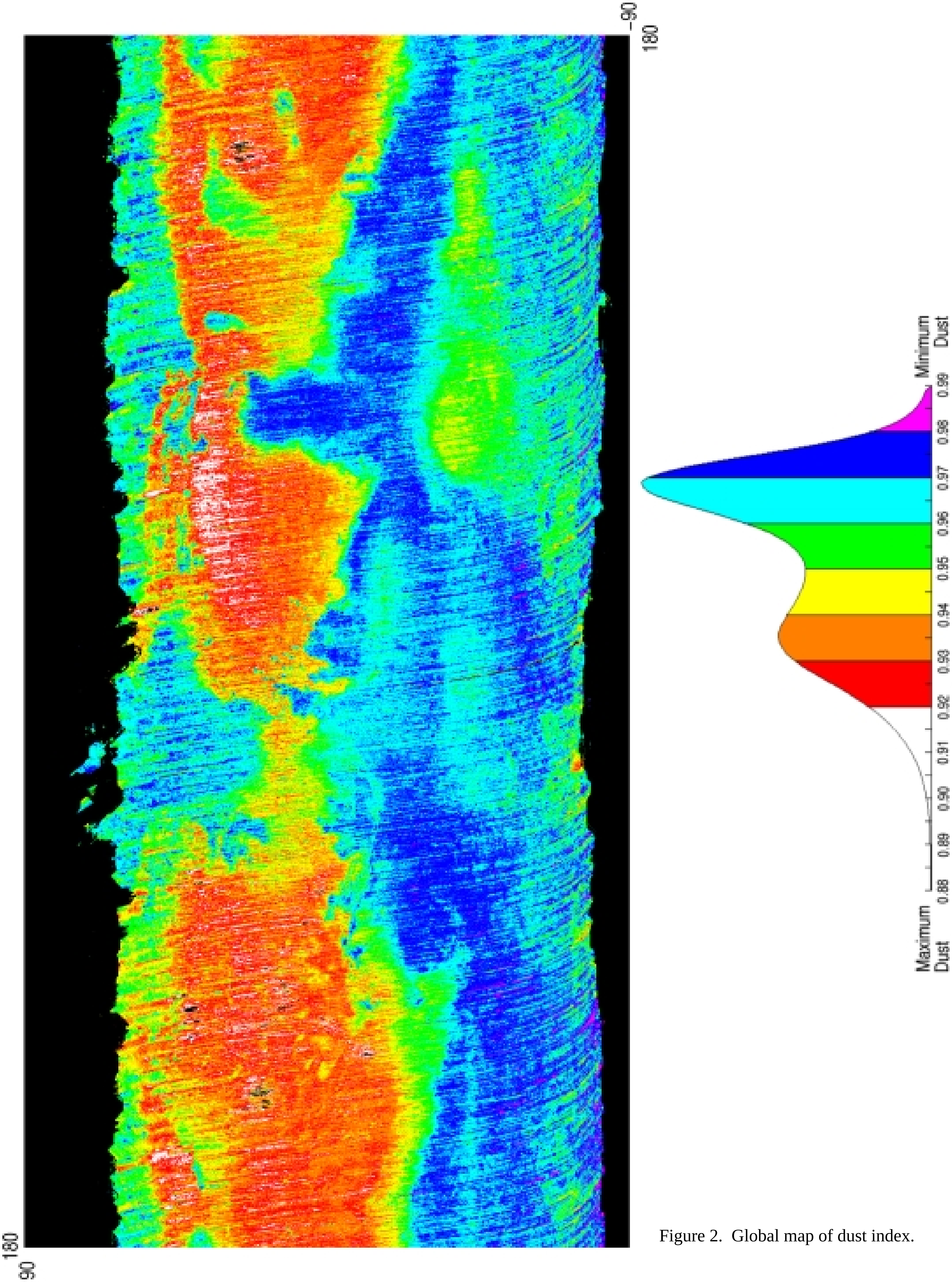

Figure 2. Global map of dust index.