VERTICALLY RESOLVED AEROSOL CLIMATOLOGY FROM MARS GLOBAL SURVEYOR THERMAL EMISSION SPECTROMETER (MGS-TES) LIMB SOUNDING. T. H. McConnochie[1] and M. D. Smith[1], [1]NASA Goddard Space Flight Center, Greenbelt, MD 20902.

Introduction: The opacities of dust and water ice aerosols were routinely derived from Mars Global Surveyor Thermal Emission Spectrometer (TES) nadir-viewing radiance spectra [e.g., 1–4]. This data set has become our main source of information about martian aerosol climatology [e.g., 4]. The nadir retrievals, however, yield no information about vertical structure, and their accuracy diminishes as the surface temperature falls below 220 K [1]. In this work we present a new aerosol data set based on TES limb-sounding observations. In contrast to the nadir case, the limb geometry allows accurate retrievals over cold surfaces (i.e., polar and nighttime), and contains information about the vertical structure. The limb-sounding results are also more directly comparable with the results from the Mars Climate Sounder (MCS) on the Mars Reconnaissance Orbiter.

Method: The aerosol retrieval algorithm proceeds by solving for the mixing ratios (expressed as the change in optical depth at a reference wavelength per unit pressure drop) of dust and ice aerosols at six altitudes in the martian atmosphere between 10 and 60 km above the areoid. To do so it compares a quasi-spherical radiative transfer model with TES absolute radiance between 200 and 1200 cm^{-1}, and then iterates using Levenberg-Marquardt optimization to minimize the χ^2 residuals.

The model. We use a discrete-ordinates thermal infrared radiative transfer model that incorporates both multiple scattering and gaseous absorption. The model is plane parallel. However the inherently spherical geometry of the limb observations is approximated by integrating the radiance along the curved path traced by the TES pointing vector in the plane parallel coordinate system. The mixing ratios at the six solution levels are interpolated onto a much finer grid of model levels with a maximum spacing of 5 km in altititude or 1 millibar in pressure (whichever represents the smallest vertical distance). We assume effective particles radii of 1.5 microns for dust and 2 microns for ice, and optical constants from [5]. The temperatures at each model level are estimated from the TES radiance spectra, prior to the aerosol retrieval, as described in previous work [6]. We avoid modeling within the 15 micron CO_2 absorption band in order to minimize sensitivity to temperatures uncertainties.

Model-data comparison. The model is compared to a set of TES spectra whose pointing vectors have tangent heights between 5 and 65 km above the local surface. Each detector field of view spans just under 10 km of altitude at the limb. We use the MOLA topography data set to ensure that no point within this field of view intersects the surface.

In order to maintain the sensitivity and accuracy of our retrieval solutions at high altitudes and in the cold winter polar atmosphere, we need to address both a time-variable background component and correlated noise in the TES spectra. The time variable background is sensitive to the pointing angle of the TES instruments scanning mirror, but it is easily subtracted by constructing averages of spacelooks that have nearly the same pointing angle as the limb observations. The correlated noise problem is eliminated by using the spacelooks to estimate the principal components (eigenvectors) of the correlated noise. Then, prior to computing the χ^2 statistic, the model and data are transformed to a basis defined by the noise eigenvectors such that the noise becomes uncorrelated.

Vertically-resolved aerosol climatology database: We have completed retrievals for all three martian years of the TES limb-sounding data set. This represents 296,823 individual retrievals at regular intervals in latitude and longitude and covering all latitudes in all seasonson on both the 2 AM and 2 PM sides of the MGS orbit. To construct Figures 1–4 we have averaged all longitudes, and binned by latitude and L_s, to show aerosol extinction versus season for a full martian year at 30 and 50 km altitudes.

The most prominent feature in Fig. 1 and 3 (PM and AM dust, respectively) is a major dust event beginning near L_s 230. Note the lack of dust transport north of 40 degrees north at both levels. Also note the lack of transport to the south pole until roughly L_s 260.

Figs. 2 and 4 show a very complicated pattern in the latitudinal, seasonal, and temporal distribution of water ice aerosols. Highlights of this pattern include:a degree of anti-correlation between dayside and nightside condensates, and extensive nighttime condensates in the lower mesospher (50 km level) during the dusty perihelion season.

References: [1] Smith, M. D. et al. (2000) *JGR 105*, 9539. [2] Smith, M. D. et al. (2001) *JGR 106*, 23929. [3] Pearl, J. C. et al., (2001) *JGR 106*, 12325. [4] Smith, M. D. (2004) *Icarus, 167*, 148. [5] Wolff, M. J. and Clancy, R. T. (2003) *JGR 108,* 2003JE002057. [6] Conrath et al. (2000) *JGR 105*, 9509.

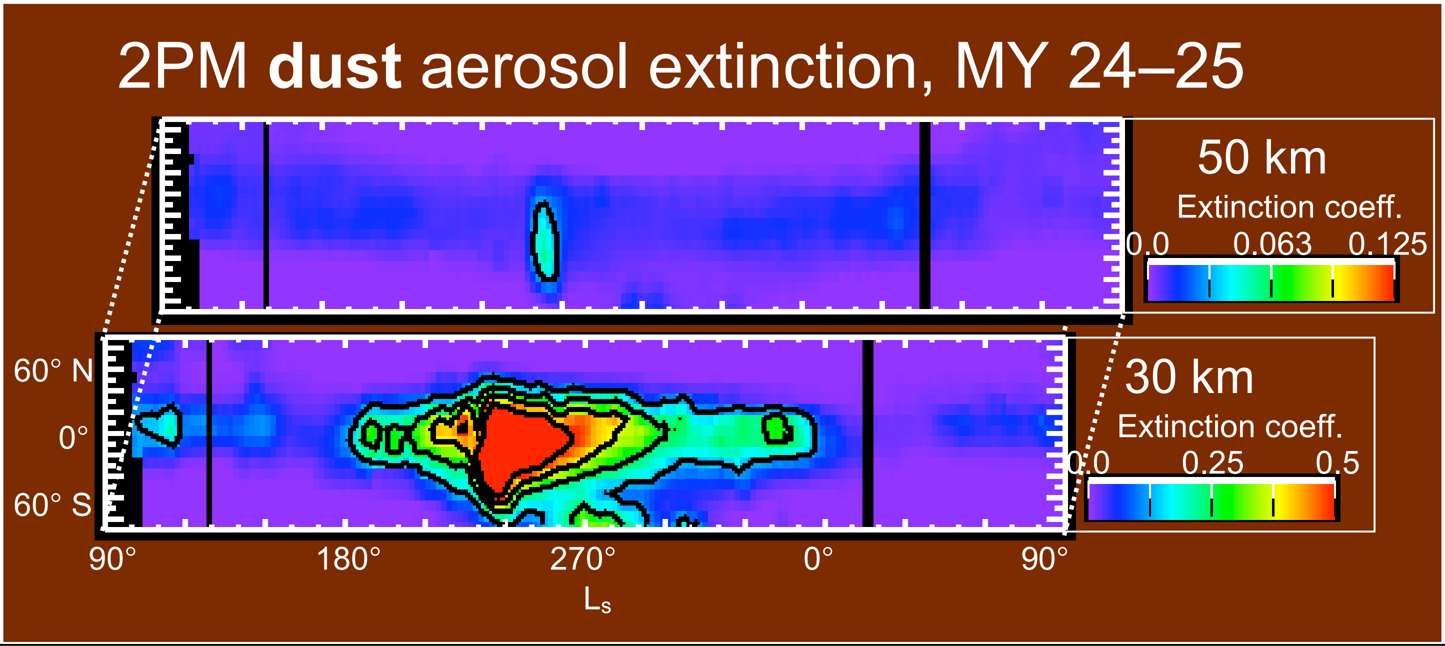

Figure 2 Dust aerosol extinction at ~2 PM in two atmospheric layers, binned by latitude and L_s, for the first of the three martian years in the MGS-TES limb-sounding data set.

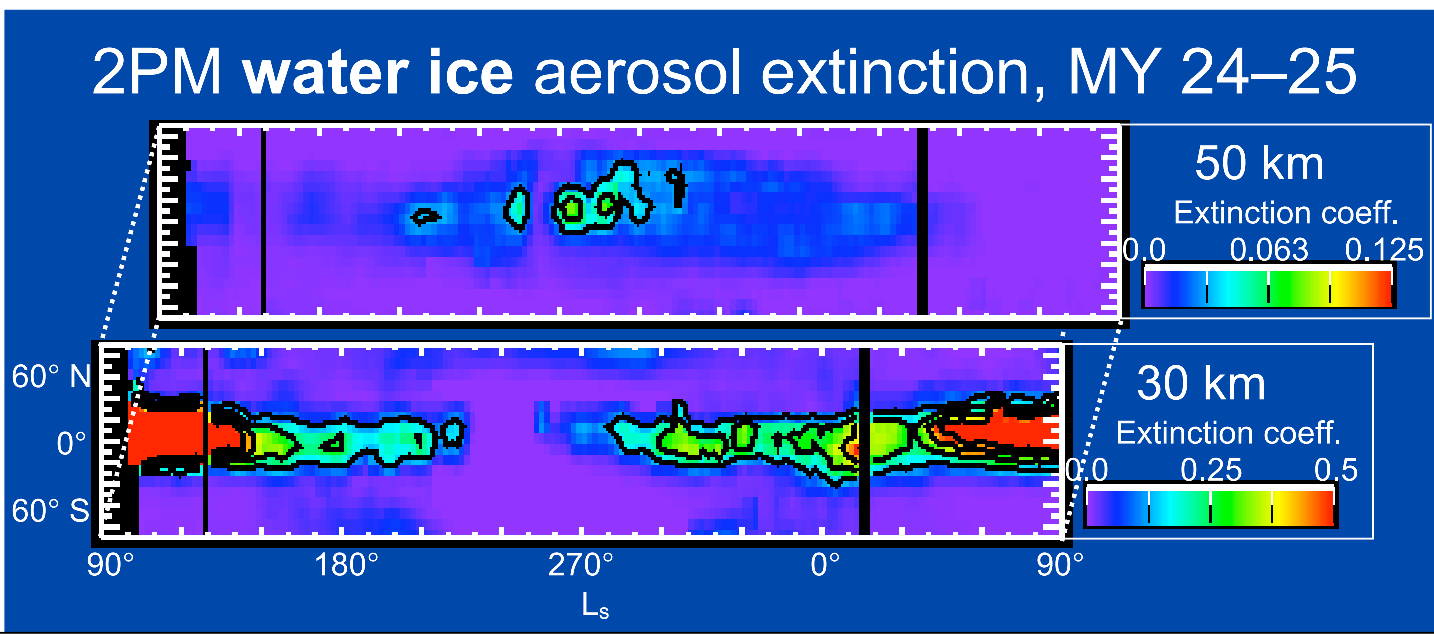

Figure 1 Water ice aerosol extinction at ~2 PM in two atmospheric layers, binned by latitude and L_s, for the first of the three martian years in the MGS-TES limb-sounding data set.

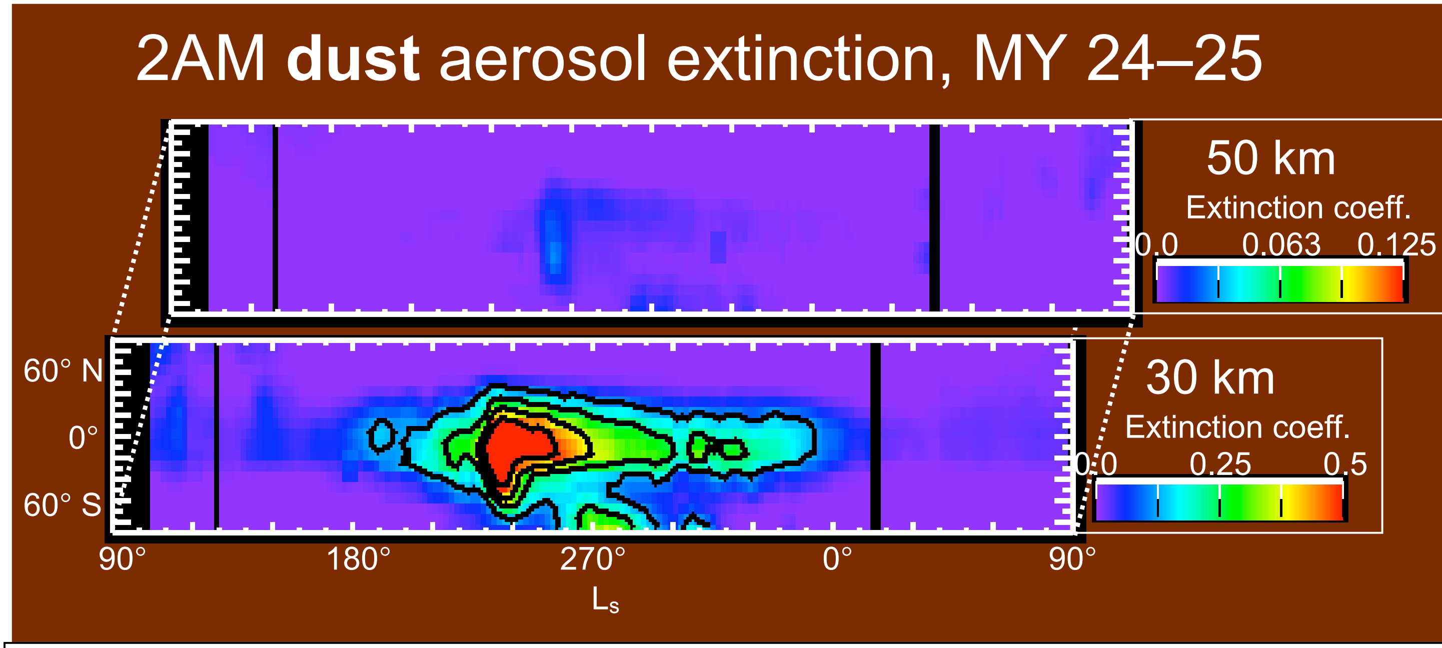

Figure 3 Dust aerosol extinction at ~2 AM in two atmospheric layers, binned by latitude and L_s, for the first of the three martian years in the MGS-TES limb-sounding data set.

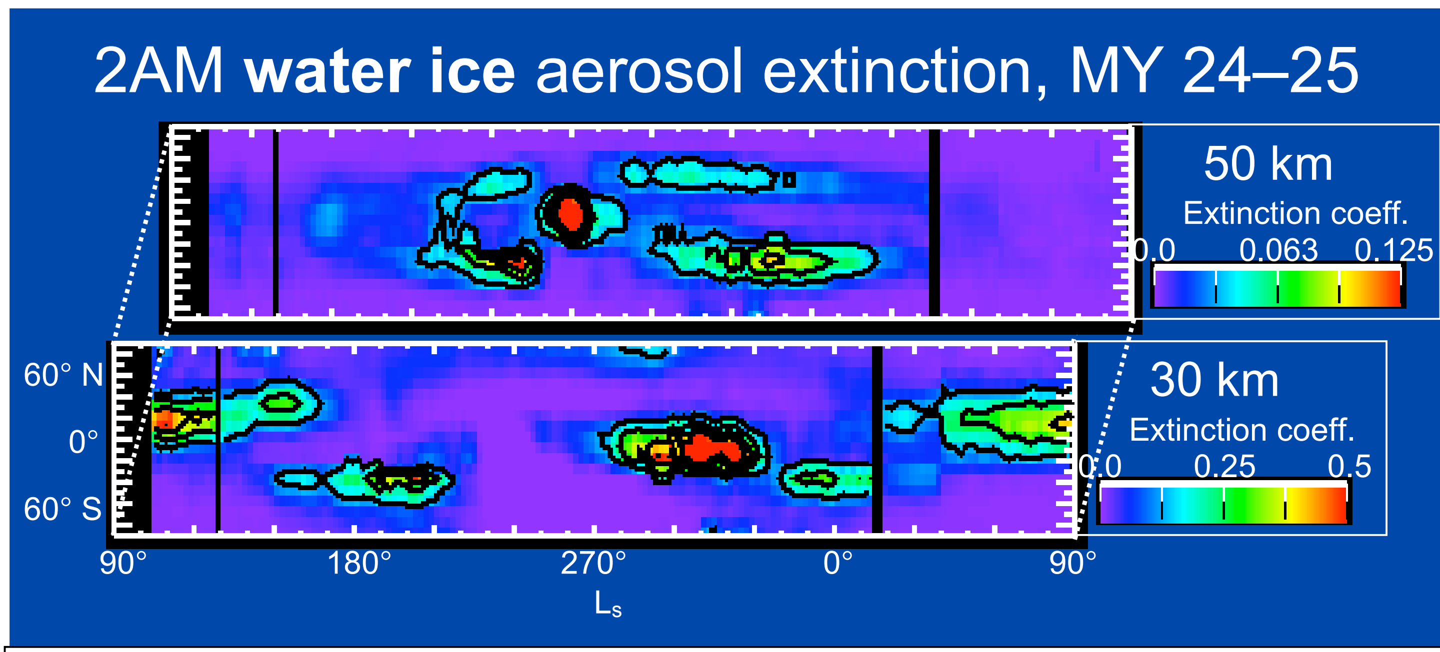

Figure 4 Water ice aerosol extinction at ~2 AM in two atmospheric layers, binned by latitude and L_s, for the first of the three martian years in the MGS-TES limb-sounding data set.