ATMOSPHERIC OPACITY FROM MARS OBSERVER LASER ALTIMITER OBSERVATIONS. Anton B. Ivanov, Duane O. Muhleman, *California Institute of Technology, Pasadena, CA, 91125, USA, anton@gps.caltech.edu*.

MOLA has performed a unique measurement of the reflected laser energy from the underlying terrain. This quantity can be interpreted as a product of albedo of the surface(A) and atmospheric transmission ($e^{-2*\tau}$), where τ is the total opacity at our 1.064 micron wavelength. It is not possible to separate the above two parameters without an additional information. We used Viking Orbiter Color Mosaic images as a first order estimate for the albedo of the surface. Using this estimate we are able to calculate atmospheric opacity. The filter closest to MOLA wavelength of the Viking Orbiter Camera is red (0.5-0.7 micron). Tenatively, we have adopted an average scaling factor of 0.8 to convert those images to 1.064 micron, which is consistent with spectroscopic observations of the average Martian surface in visible and infra-red wavelengths [1].

We should note, however, that this method does not allow to obtain absolute values of the opacity, since Viking images are not corrected for the relevant atmospheric opacity. Hence, the measured quantity is the difference between the atmospheric opacities in the Viking image and in MOLA measurement. We have used images so close together in time ($L_s = 46$) that opacity for all of them is the same, so relative values of measured opacity are correct. We estimate that the relevant opacity for the Viking images was about 0.4 which was added to the MOLA data for presentation here.

MOLA has sampled almost all landforms of Mars including volcanoes and canyons. We present two cases : tracks across Valles Marineris and Arsia Mons volcano. Tracks across the layered terrain are discussed in a separate presentation. Figure 1 shows opacity variation across Coprates canyon in Valles Marineris. The jump in opacity is apparent as we go into the canyon. We have observed similar behaviour in other parts of Valles Marineris. The working hypothesis is that this sudden increase is due to the afternoon clouds in the canyon, which were also observed by MOC [2]. Another, but less likely, possibility is that the decreased reflected energy is due to the roughness on the bottom of Valles Marineris which was not removed by rationing with the Viking albedos.

Track over Arsia Mons does not show any significant variations in reflectivity with increasing height. However, we have observed increased reflectvity in the caldera, a factor of 2 greater than that from the Viking red filter image. Possible explanations include is that there is a frost formed in the caldera, or some other material which is very bright at 1 micron wavelength.

We have calculated opacities for several tracks that occurred north of the Elysium region. This allows us to compare our values with those of Viking 2 Lander. This comparison is plotted on Figure 2 and shows average opacities in the region of 55N to 65N for each of the tracks used. Opacities rise from a value of 0.4 (L_s = 179) to 1.0 (L_s = 210), as we go into a dust storms season. Our measurements are consistent with those of Viking 2 Lander [3]. Similar estimates for the equatorial region show opacities in the range 0.1-0.2. This estimate is less than that of Pathfinder [4] but supports earlier findings by Hubble Space Telescope [5]

We have also found some local variations of reflectivity spanning about 180km in the region of 60N-65N (Figure 3). They are uncorrelated with any albedo features on the surface, hence we suggest that those variations are due to changes in opacity. Estimates show that in such places opacity increased by 1 compared with surroundings, reaching values of 1.5 - 2. We think that such attenuation is due to water ice clouds. Such clouds are known to form in the northern part of Mars at this season.

Correlations of the MOLA reflectivity data with that from the TES and MOC instruments will be valuable when all of the data are available.

References

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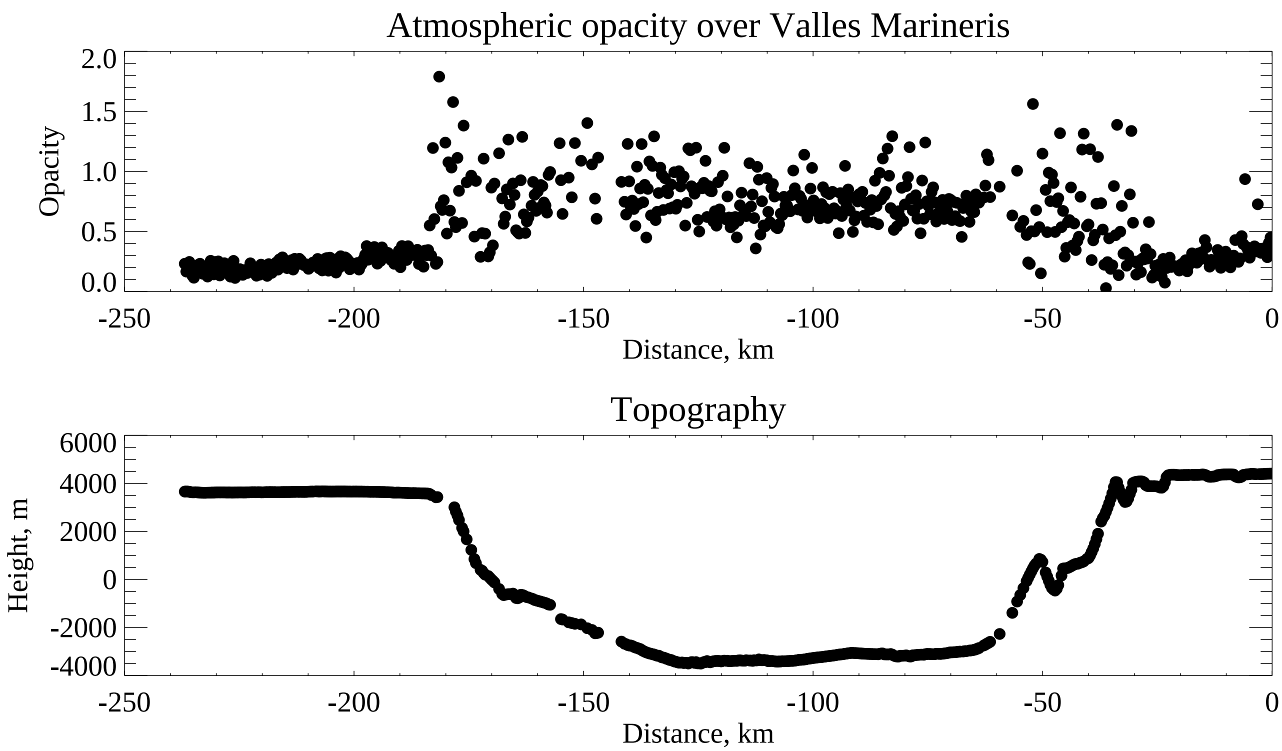

Figure 1: Atmospheric opacity over Valles Marineris

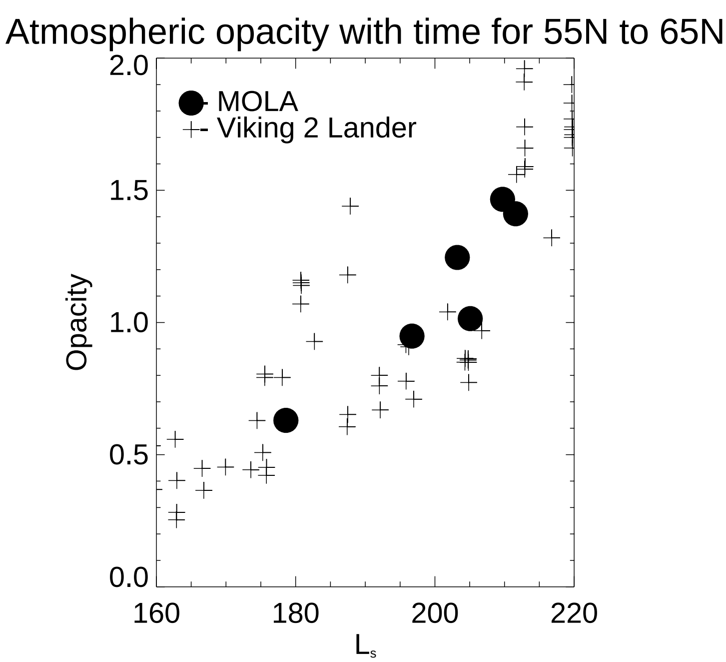

Figure 2: Opacity increase with L_s. MOLA data is shown by filled circle, Viking 2 lander data is shown by plus sign.

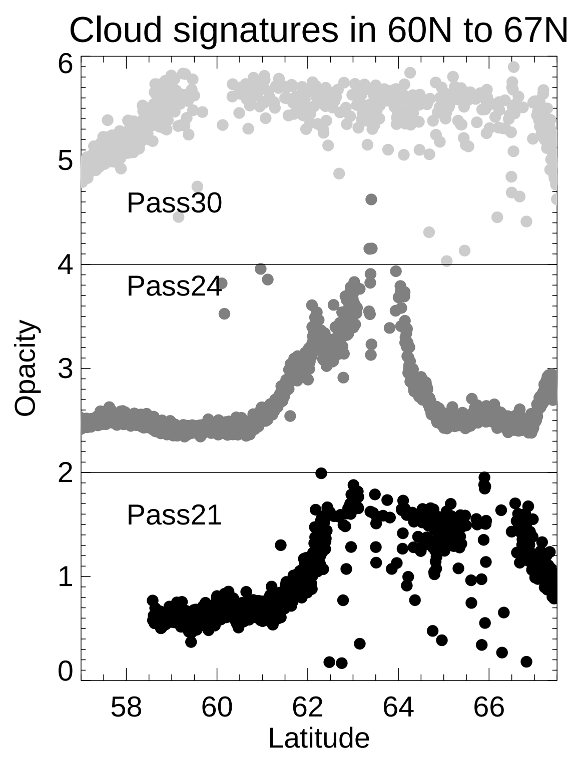

Figure 3: Cloud signatures from 3 selected tracks in the region 60N to 67N. Opacities offseted by 2. Solid lines are zero levels for each of the tracks.