THE RELATIONSHIP OF MOLA NORTHERN HEMISPHERE TOPOGRAPHY TO THE 6.1 MBAR ATMOSPHERIC PRESSURE SURFACE OF MARS. M. T. Zuber[1] and D. E. Smith[2], [1]Dept. Earth, Atm. & Planet. Sci., MIT, Cambridge, MA 02139, [2]Lab. for Terrestrial Phys., NASA/Goddard Space Flight Center, Greenbelt, MD 20771.

A preliminary new topographic model for the northern hemisphere of Mars [1] has been derived from the MGS laser altimeter (MOLA) [2] that is believed to be a significant improvement over previous models. For that model we have adopted the zero level contour as that which has a total potential (gravitational plus rotational) equal to the potential of Mars' mean equatorial radius. The preliminary mean equatorial radius derived from the first 18 tracks of MOLA data is 3396.0 km ± 200 m. This radius and the GMM-1 gravity model [3] (which has been updated with the most recent IAU coordinate system parameters for Mars [34) provides the potential of the mean equatorial radius which we have defined as zero elevation. This potential surface is then extended to all latitudes as the reference level for zero geopotential topography. This surface and its potential are preliminary and will be revised as more altimeter data become available to better describe the equatorial radius and as our knowledge of the Mars gravity field improves [5, 6].

Previous models of the topography of Mars [7] have adopted the 6.1 mbar atmospheric pressure surface as the zero of elevation. It was derived from a fitting of the pressure information from Mariner 9 occultations [8, 9] to a low degree and order gravity field model [10]. The advantage of this reference surface is that it provides an estimate of mass of the atmospheric column above the particular location, which is critical in consideration of potential landing sites. Thus it is highly desirable to relate the precise MOLA topography to the 6.1 mbar pressure surface. However, note that because the 6.1 mbar pressure surface is not fixed it is not appropriate for geophysical or geological studies of the planet, which require a static geopotential surface for the reference. To accommodate landing site studies, we have derived an empirical relationship between the MOLA topography and atmospheric pressure that is dependent on L_s. The model has utility for assessment of landing safety, at least for locations between 10°S and 80°N, which represents the current extent of MOLA coverage.

Radio occultations provide estimates of atmospheric pressure and temperature as function of altitude, and also of the planetary radius at the time of occultation. Use of these data provides the mechanism for relating atmospheric pressure and planetary radius. In a previous study we have reanalyzed the Mariner and Viking occultations [11] and now use the pressure information to connect with topography. First, we compared the occultation surface pressures with the topography implied by the occultation radii and derived a pressure/topography relationship. We then compared the occultation topography with the MOLA topography (Fig. 2), which enabled us to relate the Mariner and Viking atmospheric pressures to the MOLA topography.

The surface pressures obtained at the Viking lander sites [12] showed significant variation throughtout the Martian year. Thus it was necessary to apply a correction based on the seasonal argument L_s. For this we used information [13] provided by the Ames General Circulation Model [14] for the variation of surface pressure with L_s by surface location and corrected all the occultation surface pressures to an approximate L_s=3.7° (Fig. 1). This correction had a full range slightly in excess of 3 mbars, equivalent to an altitude change of about 3.5 km. From the variation of pressure with topography we estimated the 6.1 mbar level for L_s 3.7° as equivalent to a topographic altitude for the occultations of approximately -1800 meters based upon a potential surface whose mean equatorial radius was 3396.0 km. We then compared the point values of topography from the occultations with the closest MOLA altimeter-based topography (Fig. 2). The difference in geopotential elevation between MOLA altimeter tracks and the 14 occultation points that lie within a distance of 15 km is -18 ± 118 m , or effectively zero. When the number of occultations is increased to 18 by extending the distance to <20 km the difference changes to +34 ± 106 m, also equivalent to zero. Thus we find complete agreement between MOLA altimetry and Mariner 9 occultation observations within the formal error bounds.

On the basis of this preliminary analysis we conclude that for the MOLA topography the 6.1 mbar height level occurs at approximately -1800 m for L_s =3.7° and should be adjusted depending on the date (L_s). Seasonal variations could amount to as much as 1.5 to 2 km.

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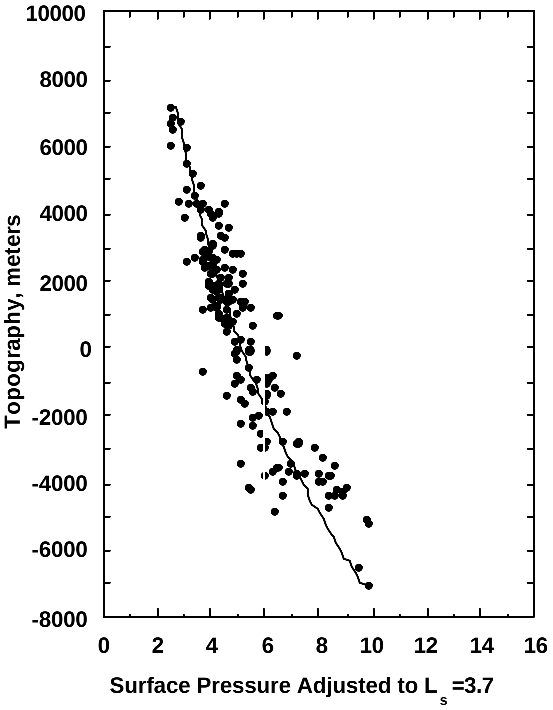

Figure 1. Variation of surface pressure with topography.

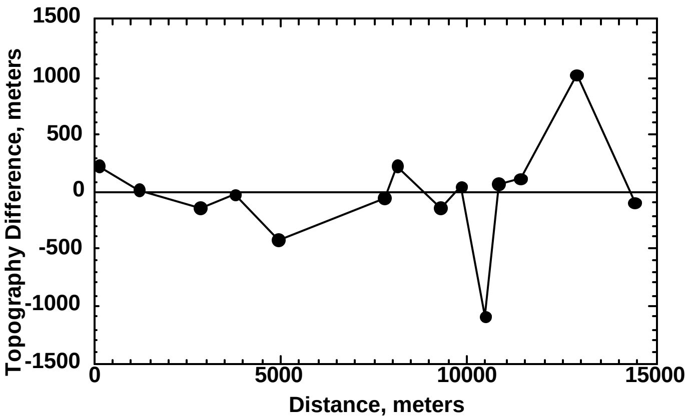

Figure 2. Dependence of difference between occultation and altimeter topography on distance between the observations.