PROGRESS IN IMPROVING OUR KNOWLEDGE OF THE SHAPE OF MARS FROM OCCULTATIONS; *David E. Smith*[1], and *Maria T. Zuber*[2,1], [1]Laboratory for Terrestrial Physics, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, [2]Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD 21218.

Present knowledge of the topography of Mars is inadequate for addressing a wide range of fundamental problems in geophysics, geology, and atmospheric science [1,2]. The data acquired to date by several techniques has not provided reliable and consistent values for even the equatorial and polar radii, and large uncertainties exist in the altitudes of many major surface features such as major volcanic shields [3]. One principal shortcoming of the present Mars topographic model is the lack of long wavelength (hundreds to thousands of km) control. However, a dramatic improvement can be made by re-analysis of selected existing data. Specifically, it is possible to derive a topographic field model solely from existing spacecraft occultation data that will have a radial accuracy better than 500 m at all latitudes, as compared to the current Mars Digital Elevation Model (DEM) [4], in which errors at high latitudes range from greater than two to in excess of three km.

Consequently, we have begun the re-analysis of the Mariner 9 and Viking 1 and 2 occultation results to develop an improved global topographic model for Mars. We believe that recent increases in our knowledge of Mars and the spacecraft motions can allow us to make a significant improvement in the use of these data for determining planetary radii at the occultation points. From all three missions there are some 380 occultation measurements that we are in the process of re-analyzing. We have completed an initial analysis of the Viking 1 data , almost completed the analysis of the Viking 2 data, and are about to begin the Mariner 9 data.

Analysis. In order to re-analyze the occultation data we have re-processed the DSN doppler data to derive improved positions for the spacecraft and utilized the recent gravity field [5]. Improved orbits were computed for all three spacecraft. In addition, we have utilized the most recent ephemeris models for the position and rotation of Mars. Using the times of the occultations derived by the original Principal Investigators [6,7,8] we determined new positions of the spacecraft and Mars at the instant of the occultation. A comparison of the relative positions of the spacecraft and Mars used in the original studies with those derived for this study shows differences of 1 to 3 kilometers, typically . These differences can be shown to change the calculated radius of the Mars by several hundred meters to a kilometer of two , depending on the geometry. These differences are of the order we had expected to find resulting from the improvements in the models of Mars over the last ten to twenty years.

The largest and most complicated correction that we applied to the occultation data is the refraction caused by the Mars neutral atmosphere. The magnitude of this correction is of the order of one or two hundredths of a degree and causes an average correction to the radius of the planet of the order of 2 kilometers but does exceed 15 km for geometries in which the spacecraft is many thousands of kilometers from Mars at the instant of the occultation. We have experimented with a number of simple models for the refraction based on the atmospheric pressure and temperature derived form the occultation data but we have found the most consistent results when we use the refraction angle obtained in the original study and apply it to the improved geometry. This method has been adopted for present study and Figure 1 shows the preliminary results we have obtained for all the Viking 1 occultations and for approximately 50% of the Viking 2 occultations. The remaining data are presently being analyzed.

Results. The most striking aspect of the results so far is the clear signal of the hemispheric dichotomy. In Figure 1 it is very evident that the radius of the planet is approximately 3 km greater in the southern hemisphere than in the northern hemisphere. This result was also very evident in the original occultation analyses but the dispersion is less in the new results. We also clearly see the large Hellas basin and part of the Tharsis bulge. So far there is no evidence for systematically different results coming from the two Viking spacecraft, and this is not expected to change.

Less than half of the full dataset of occultations has so far been re-analyzed. Our original intention of being able to estimate radii to an accuracy of 500 meters is still holding but we do expect greater difficulty in processing the Mariner 9 data than the Viking data, due largely to the uncertainty of calculating the refraction of the neutral atmosphere.

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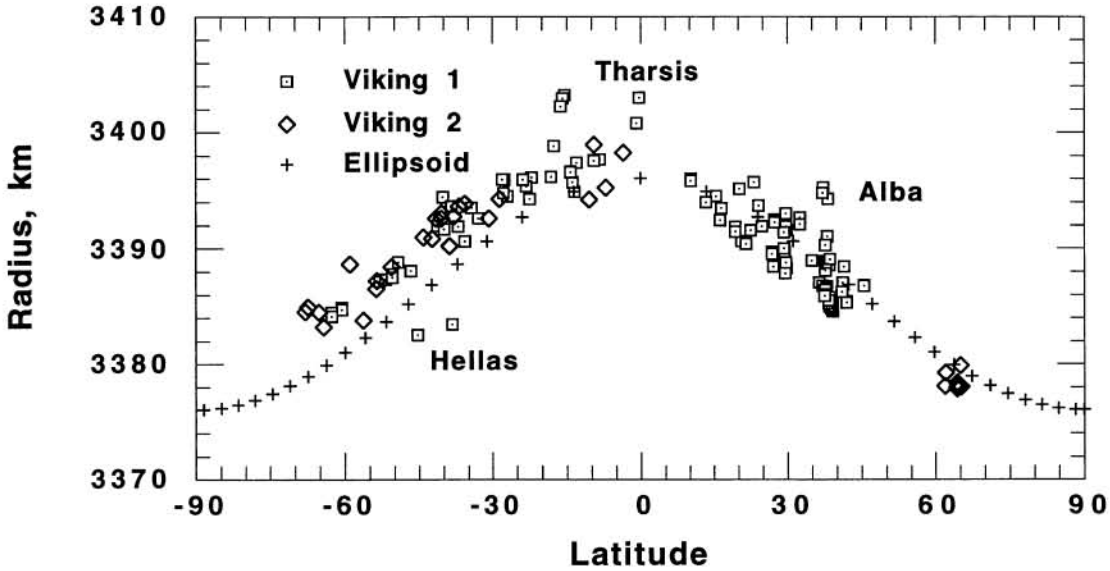

Fig. 1 Prelininary Mars radii derived from Viking1 and 2 occultations

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