PROGRESS IN THE DEVELOPMENT OF THE GMM-2 GRAVITY FIELD MODEL FOR MARS; *F.G. Lemoine*[1,2], *D.E. Smith*[1], *F.J. Lerch*[1], *M.T. Zuber*[3,1] and *G.B. Patel*[4], [1]Laboratory for Terrestrial Physics, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, [2]Astronomy Department, University of Maryland, College Park, MD 20742, [3]Dept. of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD 21218, [4]Hughes-STX Corp., Lanham, MD 20706.

Last year we published the GMM-1 (Goddard Mars Model-1) gravity model for Mars [1]. This new model makes several improvements: it extends the size of the field in degree and order, moves the calculations to the 1991 IAU reference frame[2], takes into account the effects of Phobos and Deimos, introduces new atmospheric corrections to the tracking data[3], and applies an elevation cut-off of 10 degrees to the tracking data to reduce contamination by Earth troposphere and ionosphere effects. New station coordinates were introduced, and the effect of plate motions, ocean loading and pole tide on the station coordinates were accounted for. Where appropriate, the antenna corrections defined by Moyer[4] were applied. In anticipation of the arrival of Mars Observer at Mars, we used the new DE-234 set of planetary ephemerides and associated constants[5]. The switch to the new reference system changed the reference radius for the gravity field from 3394.2 km to 3397.0 km as recommended by the IAU[2]. Finally, where the Culp and Stewart Mars atmospheric drag model was used in GMM-1[6], we applied the newer Stewart drag model in GMM-2 [7].

We have completely re-analyzed the Viking and Mariner 9 tracking data in the development of the new field, designated GMM-2. The model is complete to degree and order 70. Many orbital issues which were unresolved in GMM-1 have been accounted for in GMM-2. Our present solution includes 282 arcs, compared to 270 in GMM-1. Arcs which had inexplicably high RMS of fit, or which overlapped the periods of the Viking Bistatic Radar Experiment[3] were divided into smaller segments. Six additional arcs of high altitude, VIking-1 1500 km periapse height data were added to the solution. These data spanned the period from orbit insertion on June 20, 1976 through July 23, 1976. Although the elevation cutoff criterion of 10 degrees deleted approximately one to three percent of the data, depending on the satellite and periapse altitude, the number of observations in GMM-2 is greater than in GMM-1 (232,322 Doppler observations in GMM-1 vs. 233,814 Doppler observations in GMM-2).

We anticipated that some of the larger anomalies, such as those associated with the Tharsis bulge, would be larger because of the higher resolution, but this does not appear to have been the case. We assume that the large size of the new field and the improved modeling have extracted almost all the available gravity information from the tracking data. We find that the estimate of supporting parameters, including those associated with solar radiation pressure and atmospheric drag, are more stable in the new solution.

The introduction of *a priori* constraints on the drag coefficients dramatically improves the RMS of fit to the low altitude periapse (300 km) data. The RMS of fit to the high altitude periapse (1500 km and 800 km) remains essentially unchanged. However, to prevent spurious artifacts from appearing in the anomaly maps, once per revolution acceleration parameters have been estimated for each Viking-1 and VIking-2 300 km arc. This slight change in the method of solution enhances the power of the coefficients in GMM-2 compared to GMM-1. We attribute the improvement to better separability between the drag parameters and gravity coefficients. The impacts of the changes in the solution methodology continue to be investigated. In the latest solution, the location of the gravity anomaly low associated with the Hellas basin correlates more closely with the topographic low than in GMM-1 (see Figure 1).

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Figure 1. Free air gravity anomalies computed from the preliminary solution for GMM-2. The contour interval is 50 mGals. The anomalies are plotted relative to a reference ellipsoid with an inverse flattening of 191.1372. The line contours in the plot represent a 50 x 50 spherical harmonic expansion of the Mars DEM [8], with topographic values referred to the GMM-2 geoid. The contour interval is 1 km.