INDEPENDENT VERIFICATION OF MARS-GRAM 2010 WITH MARS CLIMATE SOUNDER DATA. H. L. Justh[1] and K. L. Burns[2], [1]NASA, Marshall Space Flight Center, Mail Code EV44, Marshall Space Flight Center, AL, 35821, USA, Hilary.L.Justh@nasa.gov, [2]Raytheon/Jacobs ESSSA Group, 106 Jan Davis Drive, Huntsville, AL, 35816, USA, Kerry.L.Burns@nasa.gov.

Introduction: The Mars Global Reference Atmospheric Model (Mars-GRAM) is an engineering-level atmospheric model widely used for diverse mission and engineering applications. Applications of Mars-GRAM include systems design, performance analysis, and operations planning for aerobraking, entry, descent and landing, and aerocapture. Atmospheric influences on landing site selection and long-term mission conceptualization and development can also be addressed utilizing Mars-GRAM. Mars-GRAM's perturbation modeling capability is commonly used, in a Monte Carlo mode, to perform high-fidelity engineering end-to-end simulations for entry, descent, and landing.[1]

Mars-GRAM is an evolving software package resulting in improved accuracy and additional features. Mars-GRAM 2005 has been validated [2] against Radio Science data, and both nadir and limb data from the Thermal Emission Spectrometer (TES) [3]. From the surface to 80 km altitude, Mars-GRAM is based on the NASA Ames Mars General Circulation Model (MGCM). Above 80 km, Mars-GRAM is based on the University of Michigan Mars Thermospheric General Circulation Model (MTGCM). The most recent release of Mars-GRAM 2010 includes an update to Fortran 90/95 and the addition of adjustment factors. These adjustment factors are applied to the input data from the MGCM and the MTGCM for the mapping year 0 user-controlled dust case.[4] The adjustment factors are expressed as a function of height (z), latitude and areocentric solar longitude (Ls).

Mars-GRAM 2010 Adjustment Factors: To generate the adjustment factors found in Mars-GRAM 2010, a comparison analysis was completed between Mars-GRAM, TES and aerobraking data from Mars Global Surveyor (MGS), Mars Odyssey (ODY), and Mars Reconnaissance Orbiter (MRO). As a part of this comparison analysis, Mars-GRAM was evaluated from the surface to 80 km at locations and times of TES limb observations and adjustment factors, the ratio of observed TES density to Mars-GRAM (MGCM) density, were determined. For altitudes from 80 km to 135 km, Mars-GRAM (MTGCM) densities were compared to aerobraking densities measured by MGS, ODY, and MRO. The adjustment factors generated by this process had to satisfy the gas law: $p = \rho RT$ as well as the hydrostatic relation: $dp/dz = -\rho g$.

The greatest adjustments are made at large optical depths such as tau >1. The addition of adjustment factors to Mars-GRAM 2010 resolved the issue of previous versions of Mars-GRAM being less than realistic when used for sensitivity studies for mapping year 0 and large optical depth values, such as tau equal to 3. Several validation runs were completed prior to the release of Mars-GRAM 2010 comparing Mars-GRAM profiles with TES data as well as MGS, ODY, and MRO aerobraking data. The results of this validation study [4] demonstrated that the addition of the adjustment factors in Mars-GRAM 2010 led to better correspondence to TES Limb data from 0-60 km altitude as well as improved agreement with MGS, ODY and MRO aerobraking data at approximately 90-130 km altitude.

Comparison Study with Mars Climate Sounder Data: The current study compares Mars-GRAM 2010 and its included adjustment factors with data from the Mars Climate Sounder (MCS) [5] on Mars Reconnaissance Orbiter (MRO) [6]. The MCS dataset contains over 4 million individual profiles with near global coverage of the surface of Mars. A sampling of MCS profiles will be compared with Mars-GRAM 2010 for differing locations and varying atmospheric conditions. Density comparisons will be completed for these locations. Identification will also be made of any discrepancies that are found during this comparison and will be the subject of a future analysis. Verification of Mars-GRAM 2010 using MCS instrument data independent of that utilized in the generation of the adjustment factors will provide an independent verification of Mars-GRAM 2010.

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