Geophysical Research Abstracts
Vol. 17, EGU2015-5890, 2015
EGU General Assembly 2015

Mars' gravity field and upper atmosphere with MGS, Mars Odyssey, and MRO radio science data

Antonio Genova (1,2), Sander J. Goossens (3,2), Frank G. Lemoine (2), Erwan Mazarico (2), David E. Smith (1), and Maria T. Zuber (1)

(1) Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Sciences, Cambridge, United States (antonio.genova@nasa.gov), (2) Planetary Geodynamics Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, (3) Center for Research and Exploration in Space Science and Technology, University of Maryland Baltimore County, Baltimore, MD 21250, USA

The Mars exploration program conducted by NASA during the last decade has enabled continuous observations of the planet from orbit with three different missions: the Mars Global Surveyor (MGS), Mars Odyssey (ODY), and the Mars Reconnaissance Orbiter (MRO). These spacecraft were equipped with on board instrumentation dedicated to collect radio tracking data in the X-band. The analysis of these data has provided a high-resolution gravity field model of Mars.
MGS and ODY were inserted into two separate frozen sun-synchronous, near-circular, polar orbits with different local times, with their periapsis altitude at $\sim$370 km and $\sim$390 km, respectively. MGS was in orbit around Mars between 1999 and 2006, whereas ODY has been orbiting the planet since January 2002. Using the radio science data of these two spacecraft, gravity models with a maximum resolution of degree and order 95 in spherical harmonics (spatial resolution of 112 km) have been determined. MRO has been orbiting Mars since August 2006 in a frozen sun-synchronous orbit with a periapsis at 255 km altitude. Therefore, its radio data helped significantly improve Mars' gravity field model, up to degree and order 110 (spatial resolution of 96 km). However, mismodeling of the atmospheric drag, which is the strongest non-conservative force acting on the spacecraft at MRO's low altitude, compromises the estimation of the temporal variations of the gravity field zonal harmonics that provide crucial information on the seasonal mass of carbon dioxide in the polar caps.
For this reason, we implemented the Drag Temperature Model (DTM)-Mars model (Bruinsma and Lemoine 2002) into our Precise Orbit Determination (POD) program GEODYN-II. We estimated key model parameters to adequately reproduce variations in temperatures and (partial) density along the spacecraft trajectories. Our new model allows us to directly estimate the long-term periodicity of the major constituents at MGS, ODY, and MRO altitudes ($\sim$255-450 km). In this region of the Martian upper atmosphere, CO_2, O, and He represent the dominant species. MRO data primarily determine the annual and semi-annual variability of CO_2 and O since these two elements are the major constituents along its orbit. MGS and ODY sample altitudes where He is the most abundant species and thus they help constrain the long-term variations of O.
We will present an update on the DTM-Mars model using MGS, ODY, and MRO radio science data. The improved atmospheric model provides a better prediction of the long-term variability of the dominant species. Therefore, the inclusion of the recovered model leads to improved orbit determination and an improved gravity field model of Mars using MGS, ODY, and MRO radio tracking data. The solution will be especially based on 8 years of MRO data from August 2006 to June 2014.