



Time-variable and static gravity field of Mars from MGS, Mars Odyssey, and MRO

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The Mars Global Surveyor (MGS), Mars Odyssey (ODY), and Mars Reconnaissance Orbiter (MRO) missions have significantly contributed to the determination of global high-resolution global gravity fields of Mars for the last 16 years.

All three spacecraft were located in sun-synchronous, near-circular polar mapping orbits for their primary mission phases at different altitudes and Local Solar Time (LST). X-Band tracking data have been acquired from the NASA Deep Space Network (DSN) providing information on the time-variable and static gravity field of Mars.

MGS operated between 1999 and 2006 at 390 km altitude. ODY and MRO are still orbiting Mars with periapsis altitudes of 400 km and 255 km, respectively. Before entering these mapping phases, all three spacecraft collected radio tracking data at lower altitudes (~ 170 -200 km) that help improve the resolution of the gravity field of Mars in specific regions.

We analyzed the entire MGS radio tracking data set, and ODY and MRO radio data until 2015. These observations were processed using a batch least-squares filter through the NASA GSFC GEODYN II software. We combined all 2- and 3-way range rate data to estimate the global gravity field of Mars to degree and order 120, the seasonal variations of gravity harmonic coefficients C_{20} , C_{30} , C_{40} and C_{50} and the Love number k_2 .

The gravity contribution of Mars atmospheric pressures on the surface of the planet has been discerned from the time-varying and static gravity harmonic coefficients. Surface pressure grids computed using the Mars-GRAM 2010 atmospheric model, with $2.5^\circ \times 2.5^\circ$ spatial and 2-h resolution, are converted into gravity spherical harmonic coefficients. Consequently, the estimated gravity and tides provide direct information on the solid planet.

We will present the new Goddard Mars Model (GMM-3) of Mars gravity field in spherical harmonics to degree and order 120. The solution includes the Love number k_2 and the 3-frequencies (annual, semi-annual, and tri-annual) time-variable coefficients of the gravity zonal harmonics C_{20} , C_{30} , C_{40} and C_{50} . The seasonal gravity coefficients led us to determine the inter-annual mass exchange between the polar caps over ~ 11 years from October 2002 to November 2014.