Geophysical Research Abstracts
Vol. 20, EGU2018-14193-1, 2018
EGU General Assembly 2018

Application of the co-registration method for studies of Martian topography and dynamics

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We present a co-registration technique which performs the alignment of two topographic data sets in the three-dimensional space. The method is conceived to operate with the pair of data constituted by laser altimetry profiles (LA) and gridded Digital Terrain Models (DTMs); the transformation is performed from the coordinates of the laser profile to the best matching position on the reference surface of the DTM. This technique has been implemented and previously been applied for the study of Mercury's rotation state (Stark et al., 2015).
For Mars, the co-registration has been performed in the MC11 quadrangle. We use data of 1345 topographic tracks by the Mars Orbiter Laser Altimeter (MOLA) on Mars Global Surveyor (MGS), which we co-register with the gridded DTM obtained from stereo images captured by the High-Resolution Stereo Camera (HRSC) on Mars EXpress (MEX). Given the 50 m resolution of the stereo DTM, the technique returned the alignment of the two data sets with sub-pixel positional accuracy and a final root mean square of the height residuals below 40 meters. The shifts of each profile are between (-50,+50) meters in latitude and longitude directions, with formal uncertainty up to 0.5 m, and between (-10,+10) m in radial direction, with an uncertainty lower than 1 m. In the polar regions of Mars, we aim at co-registering the time-dependent altimetry measurements of MOLA profiles to the DTM static representation in order to retrieve the variation of the spin axis' orientation over time.
Here we report on the similarity of the method with the well-known procedure of the "cross-over analysis" (Neumann et al., 2001). The shifts obtained when co-registering the not-cross-over-corrected MOLA profiles to the HRSC DTM, has been compared with the corresponding corrections applied by the MOLA team on the laser profiles. The comparison shows each pair of corrections to be directly correlated. This suggests a potential application of the co-registration technique in corrections of the MOLA tracks for orbit and pointing errors, as well as in the study of planets' dynamics, as done by cross-over analysis. The altimetric offsets can give insights not only on the rotation, but also on the tidal deformation of the observed body. For instance, with the help of the co-registration technique one could be able to retrieve the h2 Love number (topographic deformation due to tidal effects) of Mercury, Moon or icy satellites. For Mars, the measurement of the seasonal changes in the snow depth at polar caps is another example for the application of this approach.

References:
Neumann et al., 2001. JGR, 106, 23753-23768.
Stark et al., 2015. GRL, 42, 7881–7889.