Geocentre motion and Earth's dynamic oblateness time-series derived from GRACE CSR RL06 solutions and geophysical models

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Introduction

With the launch of the Gravity Recovery and Climate Experiment (GRACE) satellite mission in 2002 (http://www.csrl.ucea.edu/grace), Satellite Gravimetry has become a unique tool to estimate hydrological water balance and mass balance of ice sheets, as well as to monitor mass redistribution in the oceans and the solid Earth. However, satellite gravimetry still suffers from a poor estimation of temporal variations in the spherical harmonic coefficient $C_{20}$ (which is associated with the Earth’s dynamic oblateness). Therefore, these variations are typically extracted from Satellite Laser Ranging (SLR) data. Furthermore, satellite gravimetry is not sensitive to variations of degrees 3, 4, and 5 spherical harmonics (i.e., $C_{30}$, $S_{30}$, and $S_{31}$), which are associated with the geocentre movement. Swenson et al. (2008) proposed to restore those coefficients using as a reference an area where the mass anomalies are known. Such an area was chosen as the entire world ocean; mass anomalies there were defined as variations of the Ocean Bottom Pressure based on an ocean circulation model. The Glacial Isostatic Adjacent (GIA) signal was also estimated by applying a remove-restore approach.

Sun et al. (2016) further developed the technique by Swenson et al. (2008). First, the Self-Attraction and Loading (SAL) effects were additionally modelled in order to estimate its effect. Water heights along the coast were calculated. These results were used to estimate the depth of the oceanic water column. The differences between the two estimates of the ocean mass variations were then used in a least squares adjustment (LRA) to determine the density anomaly. The resulting density anomalies were then used to estimate the dynamic mass from the spherical harmonic expansions.

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