Validation of Earth’s gravity field models using LAGEOS

Introduction

Precise orbit determination is an essential task for processing SLR data. The quality of the satellite orbits strongly depends on models and parameters used in the dynamic orbit determination. The Earth’s gravity field model has a crucial impact on the quality and accuracy of estimated and predicted satellite orbits. The influence of different gravity field models on LAGEOS-1 and LAGEOS-2 orbit determination is discussed. We show that not only the type of gravity field model matters, but also the choice of the maximum degree of the gravity field model is essential.

Models and data

We selected eight gravity field models for the comparison (see Tab. 1): JGM3 (based on SLR observations, satellite altitude and ground data), three models included CHAMP data, five included GRACE, and one model which achieved due to GOCE-GPS observations. Only three gravity field models were obtained considering SLR observations (JGM3, EIGEN-6G-L04C and EIGEN-7C).

Fig. 1a,b: Number of SLR observations to LAGEOS1 and 2 in 2008

Table 1: List of used Earth gravity field models

 praises the value of the solution is observed for EGM2008 and AIUB-GRACE03S gravity field models, the same effect is observed for ITG-GRACE2010, when the coefficients of degree one are not set to zero (like in ITG-GRACEx10 mod).

The smallest RMS of the solution is observed for EGM2008 model and AIUB-GRACE03S model (see Tab. 3). The quality of LAGEOS weekly solutions sorted in descending order of the mean RMS of residuals (mean values for 2008) is shown in Tab. 3.

Fig. 2: RMS of the observations in weekly LAGEOS solution

Fig. 3: The comparison between the estimated and predicted orbits (without estimating Helmert transformation parameters)

Fig. 4: The RMS of weekly solutions for different degrees and orders of gravity field models

Fig. 5: RMS of the Helmert transformation between estimated and predicted orbits for radial, along-track, out-of-plane components and scale parameter

Table 2: Quality of LAGEOS weekly solutions sorted in descending order of the mean RMS of residuals (mean values for 2008)

Fig. 6: The comparison between the orbits based on EGM2008 model and other gravity field models

Fig. 7: The comparison between the orbits based on AIUB-GRACE03S model and other gravity field models

Summary

The smallest RMS of the solution is observed for EGM2008 and AIUB-GRACE03S gravity field models. Orbits based on JGM3 model offers most w.r.t orbit parameters on other models. The same effect is observed for ITG-GRACE2010, when the coefficients of degree one are not set to zero.

LAGEOS satellites are sensitive up to degree 20 of the used gravity field models.

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