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The study on the coefficients of Earth's gravitational field using Scaled Sensitivity Matrix method

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The estimated monthly mean gravitational field parameters from one or two satellites only represent the linear combinations of a few primary spherical harmonic coefficients due to the limited sensitivity to the Earth's gravitational field. Using multiple satellites at various altitudes and inclinations increase the sensitivity and mitigate the non-unique problem. In practice, however, the explorations with a few satellites are still inevitable, such as the moon and deep space missions. Furthermore, the problem of the estimated parameters contaminated by the other un-estimated parameters due to the high correlation exists widely among various disciplines. Thus the quantitative assessment of the influence of un-estimated parameters on the estimated parameters provides important insight into the nature of the obtained solutions.
In this paper, we study the estimated monthly mean, uncorrelated gravitational field parameters (, , and) from the Lageos1 and Lageos2 Satellite Laser Ranging (SLR) data for the 10 years period (2004-2013). Using the Scaled Sensitivity Matrix (SSM) method, we investigate the contributions from the other 73 un-estimated gravitational coefficients from degrees and orders 2 through 8 to the 4 estimated gravitational parameters. Our results confirm the reasonableness of the previous zonal combination coefficients from the orbital node analysis. Meanwhile our results reveal time-dependent correlations between the estimated non-zonal parameters and the un-estimated gravitational coefficients.