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Non-linear corrections in orbital perturbation equations for CHAMP-like satellite

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Abstract: Based on the theory of the dynamic approach which can estimate the gravity field models using the CHAMP-like satellite's SST data,the article discusses the linearization of the orbital perturbation equation in detail. It is analyzed that under the accuracy levels of the GRACE non-gravitational measurement $3.0\times$m/s^{2}the residual orbits between the real orbit and reference orbit can't exceed 12 meters due to the linearization. As the omitted terms in the derivations can be expressed clearly, the observation equations of the spherical harmonic coefficients of gravitational field are established for the GRACE based on the solutions of orbital perturbation equations including the nonlinear corrections. Especially,it is analyzed and examined by numerical simulations for GRACE mission. Compared with the linearized orbital perturbation differential equations, the one with the nonlinear corrections has two improvements. Firstly,under the measurement accuracy of the non-gravitational accelerations reaching to 3×10^{-10}m/s^2, the residual orbit between the real orbit and reference orbit are not more than 3 km. It means the long time-arc can also recover the gravity field at the same accuracy level by the nonlinear equation,compared with the linearized equation using short arc. Secondly,the nonlinear method can improve two to three degrees using short arc relative to the linear method.