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A Simulation Study of Earth Gravity Field Model Inversion from SWARM Mission

Hao Zhou (1), Zhicai Luo (1,2,3), Bo Zhong (1,2), and Qiong Li (1)

(1) School of Geodesy and Geomatics, Wuhan University, 129 Luoyu Road, Wuhan 430079, China, (2) Key Laboratory of Geospace Environment and Geodesy, Ministry of Education, 129 Luoyu Road, Wuhan 430079, China, (3) State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, 129 Luoyu Road, Wuhan 430079, China

Abstract: SWARM is the fifth Earth Explorer mission in ESA's Living Planet Program, and it can be treated as the combination of Orsted, SAC-C and CHAMP mission. The main objective of this mission is to provide the geomagnetic field and its temporal evolution with unprecedented accuracy, while the special constellation structure (SWARM A+B flying side-by-side at low altitude and SWARM C flying at high altitude) shows great potential to modify the current earth gravity models. Hence, a simulation study of earth gravity field model inversion from SWARM mission was carried out in this study. Firstly, the simulation state of each satellite in designed orbit was calculated with Gauss-Jackson integrator, and the EIGEN-6C2 model was used as the non-spherical gravitational force. Then, the new earth gravity field models were recovered on the basis of the perturbation between the 'real orbit' and reference orbits which are computed by lower precision models (EGM96 was used here). In order to analysis the probable contribution to earth gravity field model inversion from SWARM mission, several numerical computations are conducted as follows. (1)Since the SWARM constellation was formed with one satellite flying at 530km and the other pair satellites flying at the altitude range from 450km to 280km, the relationship between the different altitude and the contribution to different wavelength signals of earth gravity field model was built. (2)The design orbit inclination of SWARM A+B and SWARM C is 87.4 and 86.8, respectively. We analyzed the spatial distribution of observations from different satellites, and calculated several earth gravity field models with different satellite combination, e.g., SWARM A+B, SWARM A+C and SWARM A+B+C. (3)The east-west separation between the SWARM A and SWARM B is between 1 and 1.5 degree in longitude, while the north-south separation between the GRACE A and GRACE B is about 1.8 degree in latitude. In order to analysis the different frequency band response of earth gravity field between these two constellations, we simulated analogous GRACE orbits at the SWARM A+B altitude and inclination, and compared their contribution to zonal, sectorial and tesseral harmonics coefficients, respectively. (4)The released precision of SWARM onboard payloads are as follows, i.e. 10cm for satellite position in all directions, 1.75*10-8 ms-2 for non-gravitational force determination, and 0.1 degree for satellite attitude. The expectation accuracy of earth gravity field model from SWARM mission will be demonstrated on the basis of these onboard payloads.

Key words: SWARM; earth's gravity field; dynamic approach; GRACE

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