GOCE Gravity Gradients in an Orbital Aspect

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This work includes a study of the possibility of the Gravity Field and Steady-State Ocean Circulation Explorer Mission (GOCE) satellite orbit improvement using gravity gradient observations. The orbit improvement is performed by a dedicated software package, called Orbital Computation System (OCS), which is based on the classical least squares method. In an iterative process, the corrections to the initial state vector components of the satellite are estimated, using dynamical models describing gravitational perturbations. An important component implemented in the OCS package is the Cowell 8th order numerical integration procedure, which directly generates the satellite orbit. Taking into account the GOCE real and simulated gravity gradients, different variants of solution of the orbit improvement process were obtained. The improved orbits were compared to the GOCE reference orbits (Precise Science Orbits of the GOCE satellite delivered by the European Space Agency) using the root mean squares (RMS) of the differences between the satellite positions on the improved orbits and on the reference ones. The comparison between the improved orbits and the reference ones was performed with respect to the inertial reference frame (IRF) at J2000.0 epoch. RMS values for the solutions based on the real gravity gradients measurements are at a level of hundreds of kilometers and more. This means that the orbit improvement using the real gravity gradients is ineffective. However, all solutions using the simulated gravity gradients, have RMS values below the threshold determined by RMS values for the computed orbits (without the improvement). The most promising results have been achieved here in the case of improving of short orbital arcs with the lengths from a few to tens of minutes. For these short arcs, RMS values reach the level of centimeters, which is close to the accuracy of Precise Science Orbit of GOCE satellite. Additional research have provided requirements for the effective orbit improvement in terms of the accuracy and spectral content of measured gravity gradients.