AIMING AT A 1-CM ORBIT FOR LOW EARTH ORBITERS: REDUCED-DYNAMIC AND KINEMATIC PRECISE ORBIT DETERMINATION

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Abstract. The computation of high-accuracy orbits is a prerequisite for the success of Low Earth Orbiter (LEO) missions such as CHAMP, GRACE and GOCE. The mission objectives of these satellites cannot be reached without computing orbits with an accuracy at the few cm level. Such a level of accuracy might be achieved with the techniques of reduced-dynamic and kinematic precise orbit determination (POD) assuming continuous Satellite-to-Satellite Tracking (SST) by the Global Positioning System (GPS). Both techniques have reached a high level of maturity and have been successfully applied to missions in the past, for example to TOPEX/POSEIDON (T/P), leading to (sub-)decimeter orbit accuracy. New LEO gravity missions are (to be) equipped with advanced GPS receivers promising to provide very high quality SST observations thereby opening the possibility for computing cm-level accuracy orbits. The computation of orbits at this accuracy level does not only require high-quality GPS receivers, but also advanced and demanding observation preprocessing and correction algorithms. Moreover, sophisticated parameter estimation schemes need to be adapted and extended to allow the computation of such orbits. Finally, reliable methods need to be employed for assessing the orbit quality and providing feedback to the different processing steps in the orbit computation process.

Keywords: precise orbit determination, reduced-dynamic, kinematic, GPS, LEO

1. Introduction

The launch of CHAMP in July 2000 has triggered significant efforts by many scientific institutes in the field of precise orbit determination (POD). Without very high precision orbit determination, one of the most important mission objectives of CHAMP cannot be reached, namely a significant improvement in global Earth gravity field modeling (Reigber et al., 1999). High-precision orbit determination becomes even more of a challenge for the upcoming GRACE mission (launch in March 2002) and the future GOCE mission (expected launch in early 2006). These missions are much more demanding in terms of gravity field modeling performance than CHAMP and even more stringent orbit accuracy requirements are imposed. In order to get the most out of these missions, an orbit accuracy at the cm level is aimed at (NRC, 1997; ESA, 1999). All previously mentioned missions are Low Earth Orbiters (LEOs) flying at very low altitudes, in the 240–450 km height range

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