Precise Orbit Determination of Low Earth Satellites at AIUB using GPS and SLR

Introduction

The Astronomical Institute of the University of Bern (AIUB) has a well-documented record concerning the scientific analysis of Global Navigation Satellite System (GNSS) data with the Bernese GNSS Software. The Center for Orbit Determination in Europe (CODE), a global analysis center of the International GNSS Service (IGS), runs a complete, official Bernese service for the International Laser Ranging Service (ILRS). The CODE service generates all IGS parameters, SLR-specific range biases, and geopotential estimates at AIUB together with Earth rotation parameters and SLR station coordinates following the standards of the analysis centers.

LAGEOS-1/2

LAGEOS satellites are orbiting the Earth at an altitude of almost 6,000 km, and due to their large spin coverage, a purely dynamic orbit representation is aimed at. The strongest non-gravitational perturbations caused by solar radiation pressure are modeled as independent vectors for the radial, along-track, and cross-track directions, and piecewise constant models are used in the along-track direction.

Starlette / Stella / AJISAI

Starlette, Stella, and AJISAI 7-day solutions are computed in close analogy to LAGEOS 7-day solutions with range biases estimated for all SLR stations. Because of a lack of precise Center-of-Mass corrections for these satellites, due to the much lower orbital altitude the orbit parameterization has to account for an additional, non-gravitational perturbation, which is modeled according to the NRLMSISE-00 model. Scaling factors and piecewise constant orbit accelerations are estimated in the along-track direction with an a priori standard deviation of 10 m/s. The solution without taking into account the non-gravitational acceleration is performed at AIUB by simultaneously estimating gravity field parameters, e.g., by fixing orbit parameters to the CODE global reference frame (GREF).

Conclusions

LEO POD using either GPS or SLR data is performed at AIUB for satellites at very different altitudes and for a wide range of applications. The combination of GPS tracking data with SLR data for simultaneous orbit determination isbest suited for spaceborne GNSS data collected by LEO satellites that record – depending on the mission’s orbit altitude – observations at nadir angles of up to 17°. GPS tracking data from several LEO missions, e.g., Jason-2 and MetOp-A, were used to extend the GPS satellite antenna PCV’s to nadir angles beyond 14°. Satellite-specific GPS and LEO antenna PCV’s were simultaneously estimated to derive the recently published block-specific extension of the ig08.atm model beyond nadir angles of 14° (Schmid et al., 2013).

References


Contact address

Astronomical Institute, University of Bern
Sidlerstrasse 5
3012 Bern (Switzerland)
Astronomical Institute, University of Bern
Sidlerstrasse 5
3012 Bern (Switzerland)

1 Astronomical Institute, University of Bern, Bern, Switzerland
2 German Federal Agency of Cartography and Geodesy, Frankfurt a.M., Germany