Geophysical Research Abstracts
Vol. 16, EGU2014-10562, 2014
EGU General Assembly 2014
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Modeling of Non-Gravitational Forces for Precise and Accurate Orbit Determination

Stefan Hackel (1), Christoph Gisinger (2), Peter Steigenberger (2), Ulrich Balss (3), Oliver Montenbruck (1), and Michael Eineder (3)

(1) German Space Operations Center, Deutsches Zentrum für Luft- und Raumfahrt, 82230 Weßling, Germany (stefan.hackel@dlr.de), (2) Institut für Astronomische und Physikalische Geodäsie, Technische Universität München, 80333 Munich, Germany, (3) Remote Sensing Technology Institute, Deutsches Zentrum für Luft- und Raumfahrt, 82230 Weßling, Germany

Remote sensing satellites support a broad range of scientific and commercial applications. The two radar imaging satellites TerraSAR-X and TanDEM-X provide spaceborne Synthetic Aperture Radar (SAR) and interferometric SAR data with a very high accuracy. The precise reconstruction of the satellite's trajectory is based on the Global Positioning System (GPS) measurements from a geodetic-grade dual-frequency Integrated Geodetic and Occultation Receiver (IGOR) onboard the spacecraft.

The increasing demand for precise radar products relies on validation methods, which require precise and accurate orbit products. An analysis of the orbit quality by means of internal and external validation methods on long and short timescales shows systematics, which reflect deficits in the employed force models. Following the proper analysis of this deficits, possible solution strategies are highlighted in the presentation.
The employed Reduced Dynamic Orbit Determination (RDOD) approach utilizes models for gravitational and non-gravitational forces. A detailed satellite macro model is introduced to describe the geometry and the optical surface properties of the satellite. Two major non-gravitational forces are the direct and the indirect Solar Radiation Pressure (SRP). The satellite TerraSAR-X flies on a dusk-dawn orbit with an altitude of approximately 510 km above ground. Due to this constellation, the Sun almost constantly illuminates the satellite, which causes strong across-track accelerations on the plane rectangular to the solar rays. The indirect effect of the solar radiation is called Earth Radiation Pressure (ERP). This force depends on the sunlight, which is reflected by the illuminated Earth surface (visible spectra) and the emission of the Earth body in the infrared spectra. Both components of ERP require Earth models to describe the optical properties of the Earth surface. Therefore, the influence of different Earth models on the orbit quality is assessed.

The scope of the presentation is a detailed analysis of the orbit improvements due to sophisticated non-gravitational force and satellite macro models for the satellite TerraSAR-X.