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Non-conservative GNSS satellite modeling: long-term orbit behavior

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Modeling of non-conservative forces is a key issue for precise orbit determination of GNSS satellites. Furthermore, mismodeling of these forces has the potential to explain orbit-related frequencies found in GPS-derived station coordinates and geocenter, as well as the observed bias in the SLR-GPS residuals. Due to the complexity of the non-conservative forces, usually they have been compensated by empirical models based on the real in-orbit behavior of the satellites. Recent studies have focused on the physical/analytical modeling of solar radiation pressure, Earth radiation pressure, thermal effects, antenna thrust, among different effects. However, it has been demonstrated that pure physical models fail to predict the real orbit behavior with sufficient accuracy.

In this study we use a recently developed solar radiation pressure model based on the physical interaction between solar radiation and satellite, but also capable of fitting the GNSS tracking data, called adjustable box-wing model. Furthermore, Earth radiation pressure and antenna thrust are included as a priori acceleration. The adjustable parameters of the box-wing model are surface optical properties, the so-called Y-bias and a parameter capable of compensating for non-nominal orientation of the solar panels. Using the adjustable box-wing model a multi-year GPS/GLONASS solution has been computed, using a processing scheme derived from CODE (Center for Orbit Determination in Europe). This multi-year solution allows studying the long-term behavior of satellite orbits, box-wing parameters and geodetic parameters like station coordinates and geocenter. Moreover, the accuracy of GNSS orbits is assessed by using SLR data. This evaluation also allows testing, whether the current SLR-GPS bias could be further reduced.