Impact of inconsistent use of IERS Conventions on PPP results

Introduction

The IERS Conventions define the standard reference systems realized by the International Earth Rotation and Reference Systems Service (IERS) and the models and procedures used for this purpose. State-of-the-art processing of space geodetic data requires, in principle, to adopt the latest version of the IERS Conventions, e.g., IERS 2010. This means, however, to frequently update analysis software packages accordingly, which cannot always be realized immediately due to several reasons, e.g., operational constraints. Small inconsistencies are an unavoidable consequence. The impact of the use of inconsistent IERS Conventions is assessed by processing GNSS data from a global station network. Orbits and clocks from GPS and GLONASS satellites resulting from a reprocessing based on the IERS 2010 Conventions are used for a Precise Point Positioning (PPP) of the stations. On the one hand, the PPP is done with consistent IERS 2010 Convention models and on the other hand, the older IERS 2003 Conventions are used for the PPP. Results of static and kinematic analyses are compared and investigated to quantify and qualify the impact of an inconsistent use of the IERS Conventions. The Bernese GNSS Software (Dach et al., 2007) is used for this assessment.

Differences in the IERS Conventions

The detailed description of the modifications and updates from the IERS 2003 to 2010 Conventions would fill a separate poster. On the one hand, algorithm/definitions have changed improving software functionalities. On the other hand, models are replaced in most cases only the replacement of an input file for the processing. The most relevant differences for this study are given here (for more details and additional references refer to Petit and Luzum, 2010): Transformation between the International Terrestrial Reference System (ITRS) and the Geocentric Celestial Reference System (GCRS): Precise rotation and precession; switch from AU2000 to AU2006 resolution. Libration in polar motion is added. Geopotential: Global geopotential model: switch from EGM96 to EGM2008. Ocean tides: switch from CSR3.0 to FE2004. Ocean pole tide added. Displacement of reference points: Ocean/loading additional constituent tides. Conventional mean pole: definition changed.

Description of Experiment

-Time period: Oct 31st - Dec 25th, 2010 (eight weeks)
-CODE (Dach et al., 2009) reprocessed GPS/GLONASS orbits and clocks fully consistent with IERS Conventions 2010
-Data: GPS + GLONASS data from 71 stations (Figure 1)
-Precise Point Positioning (PPP) with 5 min sampled data; static for all stations, additionally kinematic solutions are generated for selected stations
-Four different solutions A, B, C, D
-Table 1: Solution A is based on the IERS Conventions 2010 and serves as reference solution. The PPP solution is consistent to the input GNSS orbits and clocks. Solutions B, C, and D are mainly based on the IERS Conventions 2003, whereas some models are consistently used with the IERS Conventions 2010.

Solution A

<table>
<thead>
<tr>
<th>ITRF</th>
<th>IERS2003</th>
<th>IERS2002</th>
<th>IERS2003</th>
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<tbody>
<tr>
<td>IERS</td>
<td>2010</td>
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<tr>
<td>Ocean tide model**</td>
<td>FES2004</td>
<td>FES2004</td>
<td>CSR3.0</td>
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<tr>
<td>Gravity field model**</td>
<td>EGM2008</td>
<td>EGM2008</td>
<td>EGM2008</td>
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<tr>
<td>Reference frame</td>
<td>IGS08</td>
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-This includes other changes in the Conventions, e.g., the conventional mean pole definition.
-These models are needed for the numerical integration of the GNSS orbits.
-At CODE the IERS2003 gravity field model is used together with the IERS Conventions 2003 (except of EGM96). Solution C corresponds to the models currently used in the operational CODE processing, which will be switched to the IERS Conventions 2010 source.

Solution A is based on the IERS Conventions 2010 and serves as reference solution. The PPP solution is consistent to the input GNSS orbits and clocks. Solutions B, C, and D are mainly based on the IERS Conventions 2003, whereas some models are consistently used with the IERS Conventions 2010.

Figure 1: Stations used for PPP; three selected stations FAIR, SUTM, and IISC are marked.

Figure 2: The Static PPP results from three stations (FAIR, SUTM, IISC) from solutions B, C, and D are compared with reference solution A (Figure 2). Global systematic effects may be noticed in the Helmert parameters.

Kinematic PPP solutions (18 December 2010) from three stations (FAIR, SUTM, IISC) from solutions B, C, and D are compared with the kinematic PPP reference solution A (Figure 4).

Summary

The impact of inconsistent use of the IERS Conventions is assessed for PPP solutions. Different solutions with different level of consistency are generated and compared to a reference solution, which is consistent with the current IERS Conventions 2010. Helmert transformation parameters derived from globally distributed PPP solutions show the large systematic effect probably due to the modified definition of the conventional mean pole from IERS Conventions 2003 to 2010. Static coordinate results for single stations indicate systematic effects of up to 1-2 mm as well, but they do not directly support the findings from the Helmert transformation parameters. Kinematic results are mainly affected by the different modeling/definition of the transformation between ITRS and GCRS. The sampling of the troposphere parameters can be noticed in the results as well, at least the kinematic results for the reference solution show sometimes an opposite change in the position as the other three solutions.

Kinematic PPP solutions are more affected (up to cm) by inconsistently used IERS Conventions than static PPP solutions (few mm). For high precision applications one has to be aware of the systematic effects due to the inconsistent use of the IERS Conventions.

References

Dach et al. (2007) Bernese GPS Software Version 5.0. Astronomical Institute, University of Bern, Switzerland

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