Impact of GNSS orbit modeling on LEO orbit and gravity field determination

GRACE POD
Reduced-dynamic and kinematic GRACE orbits are computed using the latest development version of the Bernese GNSS Software. Based on the ionosphere-free linear combination of undifferenced GPS phase observations the following parameters are estimated in a least-squares adjustment with floating or fixed parameters:

- Reduced-dynamic orbits: Initial conditions, constant empirical accelerations in radial, along-track, and cross-track directions, 6 min precise constant-velocity accelerations ( constrained) in the same directions, receiver clock corrections per epoch, carrier phase ambiguities
- Kinematic orbits: Three-dimensional positions and receiver clock offsets per epoch, carrier phase ambiguities

For this study the orbit solutions D3_3, D4_1, and D0_3 of the year 2006 are compared. For the computation of all solutions empirically derived phase center variation (PCV) maps are applied. They are obtained from the stacking of phase residuals from a D4-type reduced-dynamic orbit determination.

Orbit validations
Figure 2 shows the daily RMS values of the ionosphere-free carrier phase residuals for the three solutions.

Figure 3 shows the consistency between the reduced-dynamic and the kinematic orbits.

Table 1: The GNSS products used for this study and the names of the corresponding GRACE orbit and gravity field solutions.

<table>
<thead>
<tr>
<th>Product</th>
<th>GRACE-A</th>
<th>GRACE-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour of day</td>
<td>06/001</td>
<td>06/001</td>
</tr>
<tr>
<td>Date (year/doy)</td>
<td>06/032</td>
<td>06/032</td>
</tr>
<tr>
<td>3D RMS [cm]</td>
<td>2.20 cm</td>
<td>2.80 cm</td>
</tr>
<tr>
<td>D4_3</td>
<td>2.23 cm</td>
<td>2.84 cm</td>
</tr>
<tr>
<td>D4_1</td>
<td>2.31 cm</td>
<td>2.92 cm</td>
</tr>
<tr>
<td>D0_3</td>
<td>4.2 mm</td>
<td>4.5 mm</td>
</tr>
</tbody>
</table>

Table 2: Mean and RMS values in mm of SLR residuals over the entire year 2006.

The GRACE-B orbit differences for the day January 1, 2006 in radial, along-track, and cross-track direction.

Figure 4: SLR residuals for the reduced-dynamic (left) and kinematic (right) GRACE-A orbit.

Table 3: Models and parameters employed and estimated in the CMA for the gravity recovery.

Gravimetry fields
The kinematic GRACE orbits serve as pseudo-observations for a GPS-only gravity field computations in the Collocated Mechanical Approach (CMA; Beutler et al., 2010). Daily normal equations are set up for the parameters listed in Table 3. The daily SDQs are then accumulated over longer time spans and inverted.

Summary and conclusions
- To analyze the impact of the GNSS orbit modeling and the arc length used for the GNSS orbit and clock processing, three different, but consistently produced product series have been introduced for GRACE POD. Three orbit series have been computed (see Tab. 1).
- The orbit validations show small differences. In general, the D4_3 solution performs best, followed by D4_1. The D3_3 solution (based on GNSS products obtained with the original version of the ECOM) performs worst.
- Using the CMA, GPS-only gravity fields have been computed from the three series of GRACE-A kinematic orbits. The differences between these gravity fields are marginal, the update of the ECOM seems to be slightly beneficial for the lowest degrees.

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References