Recent DORIS analysis at Geodetic Observatory Pecny

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IDS Workshop, La Rochelle, France, 31 October - 1 November 2016
Recent activities of GOP IDS analysis

- Routine data processing (data processed until June of 2016)
- Merging of the software versions Bernese/DORIS and Bernese 5.2
  - Update of the Bernese/DORIS version finished
  - About 10 years of independent development
  - DORIS not in the official version
- DORIS/RINEX processing implementation
  - Reading routines
  - Onboard clock estimation
  - COM corrections (nominal or measured attitude)
- Testing COM corrections from data files vs. calculated corrections
- LOD estimation
Testing COM corrections from data files vs. calculated corrections

Motivation:
1. Verification of the software tools
2. Scale increment issue

Data span: 320/2011 - 220/2012 (period of the scale increment)
Satellites: SPOT-(4,5), Envisat, Cryosat, Hy-2A, Jason-2

Nominal attitude
1. CNES POE processing satellite models
2. Nominal Phase center vector (time dependent)

Measured attitude – quaternions, Jason-2 only
Scale increment in 2012

No significant differences for solutions with data file CoM corrections and solutions with calculated CoM corrections
POD: CoM corrections vs. nominal vs. measured attitude

- RMS of the fit and comparison to SSALTO orbits
- For all satellites except Jason-2 no significant differences
- Results for Jason-2 summarized in the following tables

<table>
<thead>
<tr>
<th></th>
<th>Data correction</th>
<th>Nominal Attitude</th>
<th>Measured Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS of the fit (mm)</td>
<td>4.109</td>
<td>4.121</td>
<td>4.107</td>
</tr>
<tr>
<td>Mean radial (cm)</td>
<td>-0.10</td>
<td>-0.10</td>
<td>-0.10</td>
</tr>
<tr>
<td>Mean tangential (cm)</td>
<td>-0.60</td>
<td>-0.47</td>
<td>-0.81</td>
</tr>
<tr>
<td>Mean normal (cm)</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>RMS radial (cm)</td>
<td>1.07</td>
<td>1.11</td>
<td>1.05</td>
</tr>
<tr>
<td>RMS radial (cm)</td>
<td>3.93</td>
<td>4.30</td>
<td>3.86</td>
</tr>
<tr>
<td>RMS radial (cm)</td>
<td>4.65</td>
<td>4.94</td>
<td>4.54</td>
</tr>
</tbody>
</table>
Earth Rotation Parameters from Space Geodesy techniques

- XP, YP – all techniques, including DORIS (all the ACs)
- UT1-UTC only from VLBI
- Length of day (LOD – variation of UT1-UTC) from satellite techniques
  - From DORIS in the past with non-geodetic accuracy
  - Correlated with further parameters
    - the orbital node
    - gravity field (zonal parameters)
- For IERS models (C04), UT1-UTC directly from VLBI, satellite techniques not used due to correlation. (LOD is obtained from UT1-UTC)

**LOD DORIS estimation**

- Preliminary results (2 years of data) presented at DORIS IDS workshop, Toulouse 2015
- **Necessary condition: Cross track harmonics not adjusted**

**New testing campaign**

- 9 years of DORIS data (2006-2014)
- Satellites: all available except Jason-1.
- Orbit model:
  - Estimated SRP, Drag (satellite dependent number of parameters)
  - A priori model for direct Earth radiation and Albedo
  - Estimated Once per revolution along track parameter (cross-track not estimated)
  - A priori model of gravitation parameters EIGEN-6S2 (data till 2012.0, extrapolation after 2012.0), consisting time varying gravity field (periodical 1 year + ½ year + piecewise linear elements), restricted to order 100.
- Estimating LOD with removed tidal variations (LODR)
LOD from DORIS and IERS C04

LOD value
Combination of all available satellites
Multi-satellite solutions per year

Single-Satellite solutions (max. time span)
LOD from DORIS and IERS C04 – Fourier spectrum

DORIS and IERS C04

DORIS and IERS C04 difference
LOD from DORIS w.r.t. IERS C04
LOD from DORIS w.r.t. IERS C04 – Short periodic signal

- Undetected for whole time span (signal phase changes? numerical issue?)
- Significant signal of periods about 14 and 28 days detected for shorter time window (but not for all of them)
- The same also for X,Y pole
- Tides? Weekly solutions?
- Examples: MJD 55359-55759 (left), MJD 54147-54247 (right)
LOD from DORIS – Gravity field

- Experiment - for 2013 LOD re-estimated not applying annual and semiannual gravity field variations
- RMS w.r.t. IERS C04 increase 0.119 -> 0.123 ms
LOD - Conclusions

- Skipping estimation of cross track harmonics improves LOD quality from DORIS significantly (mean offset to C04 = 0.026 ms and RMS = 0.152 ms in our tests).
- RMS in last years of campaign close to 0.1 ms, about twice higher than from SLR. (SLR LOD Accuracy (ILRS official product info): ILRS(A) Mean 0.003 ms, RMS 0.47 ms, ILRS(B) Mean - 0.003 ms, RMS 0.54 ms.)
- Significant mean offset, also varying among satellites. Change in offset to C04 after 2012 may be caused also by extrapolating gravity field in the a priori gravity model.
- Signal w.r.t. IERS C04 (annual, 14 days, 28 days)
- Better accuracy would be achieved also by IDS combination, from more AC's.
Thanks for the attention