Interactions of the IGS reprocessing and the IGS antenna phase center model

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## Transition to absolute phase center modeling

<table>
<thead>
<tr>
<th>Model</th>
<th>Receiver antenna</th>
<th>Satellite antenna</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PCO</td>
<td>PCV</td>
</tr>
<tr>
<td><strong>igs01.pcv</strong></td>
<td>relative to reference antenna <strong>AOAD/M_T</strong></td>
<td>ignored</td>
</tr>
<tr>
<td>(1996-2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>igs05.atx</strong></td>
<td>absolute, i.e., independent of a reference antenna</td>
<td>considered, if calibration available</td>
</tr>
<tr>
<td>(2006-2010)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discontinuities in time series (week 1400)

TRF scale difference w.r.t. IGb00/IGS05

Weston & Hilla (2008)
Timeline: antenna model vs. IGS reprocessing

2005  Estimation of GPS satellite antenna corrections with scale fixed to IGb00 (based on *relative* receiver antenna corrections); radome calibrations added afterwards

2006  GLONASS satellite antenna corr. from *separate* solution

5 Nov  **Switch** from relative to absolute antenna model and from IGb00 to IGS05; IGS05 station coordinates corrected for differences from parallel AC processing

Feb   Start of first IGS reprocessing campaign repro1 with igs05.atx *unchanged*; repro1 period: 1994-2007

2010  Compilation of igs08.atx using repro1 SINEX files and operational solutions (2008-2010)
Benefit from IGS reprocessing

• Repair of **discontinuities** (e.g., in week 1400)

• Update of **receiver** antenna corrections (up to five years old) before or after the reprocessing campaign

• repro1 started without an update of the antenna model
  – pros: consistency between repro1 and operational solutions
  – cons: inconsistency between new reference frame and antenna model, if update afterwards

• Update of **satellite** antenna corrections
  – new satellite-specific z-offsets for latest satellites
  – based on longer time span: 11 years → 16 years
  – more analysis centers: 2 → 3-5 (GPS); 1 → 2 (GLONASS)
First IGS reprocessing campaign repro1

Phase center estimates in repro1 AC SINEX files:

<table>
<thead>
<tr>
<th>Analysis Center</th>
<th>GPS satellite antennas</th>
<th>GLONASS satellite antennas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PCO</td>
<td>PCV</td>
</tr>
<tr>
<td>CODE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRCan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFZ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JPL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NGS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **SINEX format extension necessary** for CODE.
- **GLONASS observation data will probably be considered for follow-up campaign repro2** for ESA.
- **→ no update** for GFZ.
- **→ separate solution necessary** for NGS.
GPS satellite antenna z-offsets

- **dm level biases** between individual analysis centers
- estimation of satellite-specific z-offsets for the latest satellites
- deviation of about 15 cm from block mean value for SVN55

Mean bias: 5.4 cm
• GLONASS constellation completely changed since 2005/06
• scale difference partly due to differing albedo modeling
• impact on station coordinates: < 1 mm (small impact of GLONASS)
Receiver antenna calibrations

GPS:
• additional robot calibrations (e.g., for TPSCR3_GGD)
• impact on station coordinates: up to several mm
• update for existing robot calibrations

Statistics for stations in the IGS network (December 2009):

<table>
<thead>
<tr>
<th>Model</th>
<th>absolute calibration</th>
<th>converted field calibration</th>
<th>uncalibrated antenna/radome combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>igs05.atx</td>
<td>62%</td>
<td>18%</td>
<td>20%</td>
</tr>
<tr>
<td>igs08.atx</td>
<td>69%</td>
<td>11%</td>
<td>20%</td>
</tr>
</tbody>
</table>

GLONASS:
• GLONASS-specific calibrations not considered so far
• available for about 60% of the combined GPS/GLONASS stations
• impact on station coordinates: < 1 mm
Timeline for igs08.atx

• Jan/Feb 2010: generation of IGS08 reference frame
• Feb/Mar 2010: back-solve repro1 (1994-2007) SINEX files and operational solutions (2008-2010) with ITRF2008/IGS08 kept fixed to get GPS satellite antenna z-offsets
• Mar 2010(?): long-time combined solutions by CODE and ESA with GPS z-offsets kept fixed to get GLONASS satellite antenna z-offsets/PCVs
• Apr 2010: compilation of igs08.atx (satellite and receiver antenna corrections, including GLONASS-specific values)
• Apr/May 2010: analysis of coordinate jumps due to antenna model update by certain analysis centers
• May 2010: adoption of new IGS reference frame and igs08.atx in operational solutions
Conclusions

- **Consistency between ITRF2008/IGS08 and igs08.atx** will be far better than between IGS05 and igs05.atx
- Ex post update of receiver antenna calibrations causes slight inconsistencies between reference frame and igs08.atx
- Transition to igs05.atx was much more dramatic, but accompanied by an extensive parallel AC processing
- Improved percentage of IGS stations with state-of-the-art calibrations, whereas **uncalibrated radomes** remain a problem
- Highly improved GLONASS satellite antenna corrections (more satellites/tracking stations/analysis centers)
- **SINEX format extension** desirable in order to estimate satellite antenna PCVs from repro2 SINEX files
Thanks for your attention!

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