First activities of the IGS Antenna Working Group

Comparison of ground- and space-based satellite antenna maps

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Should additional regional networks be considered?
Recent update of receiver antenna corrections

- Converted field calibration replaced by robot calibration for several EPN antenna types (igs05_1480.atx).
- Update only possible, as antenna types **not** in use!
- Still lots of antenna types with converted field calibrations and/or uncalibrated radomes within the IGS network.
- Current IGS reprocessing started without an update of the receiver antenna corrections.
Problems with converted field calibrations

1. Uncertainties with high and low elevations

2. Missing azimuth-dependence
z-offsets for latest satellites

• For **newly launched satellites** block mean values are used, until satellite-specific z-offsets are available.

• At the moment 15 satellites are affected:
  6 **GPS Block IIR-M**: G07, G12, G15, (G17), G29, (G31)
  9 **GLONASS-M**: R09, R10, R11, R13, R14, R15, R17, R19, R20 (more than half of the GLONASS constellation)

• Weekly **SINEX** files of several ACs contain satellite antenna offset estimates: COD, GFZ, MIT, (EMR)

• Could the procedure to generate z-offsets for new satellites somehow be added to the routine IGS SINEX combination?
z-offsets estimated for all satellites

- large biases between individual ACs
- AC offsets would have to be trend-corrected to epoch 2000.0 (about +15 cm)
Known z-offsets fixed

- data of the early days of a satellite not usable
- GFZ with data gap
- scatter of about ±10 cm
- good agreement on the proportion of the offsets to each other
- fewer problems with biases and trend-correction
Block IIR-B/M z-offsets

- excellent agreement with IGS05 for G17
- biggest inconsistencies for latest satellites (G29, G07)
- deviations of up to 15 cm from block mean value
Major goals of the IGS Antenna WG

• maintenance of **IGS antenna files** and file formats; setting up of rules for the maintenance

• combination of ground- and space-based satellite antenna corrections (in view of **azimuth-dependence** and PCV values for **big nadir angles**)

• comparison of different receiver antenna calibration procedures; recommendations for antenna mounts

• **frequency-specific** phase center corrections (L1/L2 instead of LC, GLONASS, Galileo)

• contact point for antenna manufacturers and the user community
## Ground- vs. space-based satellite antenna maps

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<th>ground-based (IGS05)</th>
<th>space-based (JPL)</th>
</tr>
</thead>
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<tr>
<td>method</td>
<td>global solution including all relevant parameters</td>
<td>stacking of LEO (GRACE, Jason-1,...) tracking data residuals</td>
</tr>
<tr>
<td>scale</td>
<td>ITRF scale has to be fixed</td>
<td>orbit scale from dynamical POD constraint (GM)</td>
</tr>
<tr>
<td>troposphere</td>
<td>correlated with phase center corrections</td>
<td>troposphere-free</td>
</tr>
<tr>
<td>receiver antennas</td>
<td>deficiencies of individual calibrations might cancel out</td>
<td>dependence on the calibration of one single tracking antenna</td>
</tr>
<tr>
<td>azimuth-dep.</td>
<td>test results available</td>
<td>fully available</td>
</tr>
<tr>
<td>nadir angle</td>
<td>$&lt; 14.3^\circ$</td>
<td>$&lt; 15.4^\circ$ (at GRACE altitude)</td>
</tr>
<tr>
<td>estimation possible for</td>
<td>all satellites (system operational, enough tracking stations)</td>
<td>all satellites active during LEO mission (Block I ?)</td>
</tr>
<tr>
<td>freq., signals</td>
<td>LC only</td>
<td>LC and PC (pseudorange)</td>
</tr>
</tbody>
</table>
Separation of the phase center correction into PCV and PCO is arbitrary. PCV/PCO have to be consistent! Differing bias for Block IIR-B can be explained by special weighting.
Ground- vs. space-based z-offsets (II)

Consistent bias:

II/IIA  81.0 cm
IIR-A  77.9 cm
IIR-B/M  82.8 cm

Basically a scale problem (≈ 6 ppb)
**z-offsets compared to block mean value**

peak-to-peak:
- II/IIA $\sim 70$ cm
- IIR-A $\sim 40$ cm
- IIR-B/M $\sim 20$ cm

mean difference:
- II/IIA $3.2$ cm
- IIR-A $4.4$ cm
- IIR-B/M $4.6$ cm
Nadir-dependent PCVs

- error bars show difference between GFZ and TUM
- good agreement for Block IIR
- systematic difference
Azimuth-dependent PCVs (nadir angle = 14°)

- TUM results based on a few days of data only (Schmid et al., 2005)
- JPL values shifted by 90° in azimuth direction
- different resolution in nadir: 14° (TUM), 1° (JPL)
Azimuth-dependent PCVs (different nadir angles)

- different resolution in nadir: 5° (TUM), 1° (JPL)
- nearly perfect agreement in amplitude and phase
IGS05 vs. NGA z-offsets

- origin of NGA values not clear
- better agreement after scaling NGA values

(1 Inch = 2.54 cm)
Conclusions

- Replacement of **converted field calibrations** essential for highest precision.
- Update of **z-offsets for latest satellites** pending; routine procedure should be installed.
- Partially excellent agreement between IGS05 and JPL phase center corrections.
- **Scale difference** of about 6 ppb has to be analyzed.
- **Azimuth-dependent** satellite antenna PCVs should be considered.
- Contact to the providers of the NGA values would be worthwhile.
Thanks for your attention!

Photo: Enrique Cabral, UNAM