DGFI part of project PN 5
Status report

Ralf Schmid, Mathis Bloßfeld, Michael Gerstl, Detlef Angermann

Deutsches Geodätisches Forschungsinstitut der TU München (DGFI-TUM)
Munich, Germany
e-mail: schmid@tum.de
VLBI processing software DOGS-RI

- consistent with IERS 2010 Conventions
- \((dX, dY)\) instead of \((d\psi, d\varepsilon)\)
- correct relativistic calculation of partial derivatives w.r.t. parameters
- difference quotients replaced by time derivatives
- slightly different clock parameterization

Comparisons shown on the following slides refer to the **first week** of the **CONT08 campaign**. For the session-wise solutions, the following parameters were set up: station and source coordinates, Earth orientation parameters, troposphere and clock corrections.
Clock parameterization (1)

Clock drift of SVETLOE -- offset -11200.0 ns

Clock correction of SVETLOE

piecewise linear clock correction does no longer contain linear and/or quadratic terms (per day)
Clock parameterization (2)

piecewise linear clock parameters are only set up for intervals with observation data
CONT08 troposphere parameters

smaller zenith delay jumps at day boundaries
CONT08 station coordinates (1)
CONT08 station coordinates (2)
CONT08 Earth orientation parameters

OCCAM
DOGS-RI

[Graph showing Earth orientation parameters with various lines and markers.]
DOGS-RI: next steps

- participation in the "VLBI Analysis Software Comparison Campaign 2015" organized by the Chalmers University of Technology with OCCAM and DOGS-RI
- submission of DOGS-RI **test solutions** (one year of data?) to the IVS Combination Center for validation
- **parallel submission** of OCCAM and DOGS-RI solutions for the routine R1 and R4 sessions
- switch from OCCAM to DOGS-RI
- reprocessing with DOGS-RI using the OCCAM preprocessing options
OCCAM reprocessing

• in order to include **radio source coordinates**
• current status: consistent set of solutions from December 2004 until August 2015 available (about 10.5 years)
• latest session solutions validated via the official **IVS rapid combination**; no quarterly solutions since mid of 2014
## (Combined) Multi-year reference frame

<table>
<thead>
<tr>
<th></th>
<th>GNSS</th>
<th>SLR</th>
<th>VLBI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institution</strong></td>
<td>CODE</td>
<td>DGFI-TUM</td>
<td>DGFI-TUM</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Bernese</td>
<td>DOGS-OC</td>
<td>OCCAM</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>daily</td>
<td>weekly</td>
<td>session-wise</td>
</tr>
<tr>
<td><strong>Time span</strong></td>
<td></td>
<td>July 2005 - August 2015</td>
<td></td>
</tr>
<tr>
<td><strong>Datum conditions</strong></td>
<td>NNR/NNT/NNS</td>
<td>NNR</td>
<td>NNR/NNT</td>
</tr>
<tr>
<td><strong>Coord. jumps</strong></td>
<td></td>
<td>according to DTRF2014 processing</td>
<td></td>
</tr>
</tbody>
</table>
Solution characteristics

GNSS:
- CODE's contribution to repro2/ITRF2014 ("cf2"), complemented by operational solutions ("cof") for the latest months

SLR:
- DGFI-TUM solution based on LAGEOS-1/2
- 7-day orbits
- stations with less than 10 normal points excluded

VLBI:
- DGFI-TUM solution considering more than 1400 24-hour sessions (all types of sessions)
- stations contained in less than 7 sessions excluded
- NNR condition w.r.t. ICRF2 defining sources
## Transformation parameters w.r.t. DTRF2014

<table>
<thead>
<tr>
<th>Method</th>
<th>Offset [mm]</th>
<th>Tx</th>
<th>Ty</th>
<th>Tz</th>
<th>Scale</th>
<th>STD</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNSS</td>
<td>Offset [mm]</td>
<td>2.3</td>
<td>0.7</td>
<td>0.7</td>
<td>-0.7</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Rate [mm/a]</td>
<td>0.4</td>
<td>0.1</td>
<td>0.2</td>
<td>-0.1</td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>SLR</td>
<td>Offset [mm]</td>
<td>4.5</td>
<td>-0.3</td>
<td>2.0</td>
<td>-2.1</td>
<td>4.3</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Rate [mm/a]</td>
<td>0.9</td>
<td>-0.1</td>
<td>0.6</td>
<td>-0.4</td>
<td></td>
<td>1.0</td>
</tr>
<tr>
<td>VLBI</td>
<td>Offset [mm]</td>
<td>1.2</td>
<td>0.8</td>
<td>0.5</td>
<td>-2.3</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Rate [mm/a]</td>
<td>-0.3</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>
VLBI stations

Hannover meeting (R1/R4 sessions only): 22 stations
VLBI stations

Hannover meeting (R1/R4 sessions only): 22 stations
Frankfurt meeting (all session types): 55 stations
Radio sources

Hannover meeting (R1/R4 sessions only): 565 sources
Radio sources

Hannover meeting (R1/R4 sessions only): 565 sources
Frankfurt meeting (all session types): **1851 sources**
Source corrections (1)

\[ \Delta \text{declination [mas]} \]

\[ \Delta \text{RA} \times \cos(D) \text{[mas]} \]

Definition of sources:
- Other sources

Plot: Scatter plot of \( \Delta \text{declination [mas]} \) and \( \Delta \text{RA} \times \cos(D) \text{[mas]} \) against declination [deg].
Source corrections (2)

\[ \Delta \text{declination [mas]} \]
\[ \Delta \text{RA} \times \cos(\text{DE}) [\text{mas}] \]

---

defining sources
## Solutions considering seasonal station variations

<table>
<thead>
<tr>
<th>Method</th>
<th>Offset [mm]</th>
<th>Ty</th>
<th>Tz</th>
<th>Scale</th>
<th>STD</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLR</td>
<td>4.5</td>
<td>-0.3</td>
<td>2.0</td>
<td>-2.1</td>
<td>4.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Rate [mm/a]</td>
<td>0.9</td>
<td>-0.1</td>
<td>0.6</td>
<td>-0.4</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>SLR seas. signal</td>
<td>4.6</td>
<td>0.0</td>
<td>1.9</td>
<td>-0.6</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Rate [mm/a]</td>
<td>0.5</td>
<td>0.0</td>
<td>0.9</td>
<td>-0.4</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>VLBI</td>
<td>1.2</td>
<td>0.8</td>
<td>0.5</td>
<td>-2.3</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Rate [mm/a]</td>
<td>-0.3</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>VLBI seas. signal</td>
<td>0.1</td>
<td>1.9</td>
<td>-3.2</td>
<td>0.5</td>
<td>7.7</td>
<td>7.1</td>
</tr>
<tr>
<td>Rate [mm/a]</td>
<td>-0.3</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

Amplitudes for a small subset of well-distributed stations fixed to zero (SLR: 5 stations, VLBI: 7 stations)
Impact of seasonal station variations on pole
Impact of seasonal station variations on UT1-UTC

Δ UT1–UTC (VLBI only; harmonic – linear)

year
Summary

- DOGS-RI ready for final validation steps
- consistent VLBI time series available from December 2004 to August 2015
- accumulation of all IVS session types to multi-year reference frame successful
- systematic EOP differences between solutions with and without seasonal station variations
- 10-year GNSS, SLR and VLBI solutions ready for combination and further studies