Sub-centimeter SLR precision with the SLRF2005/LPOD2005 network


16th International Workshop on Laser Ranging
Poznan, Poland
October 13-17, 2008
SLR processing at GSFC

- topez (slr+doris; 10 day arc)
- jason1 (slr+doris; 10 day arc)
- lageos1 (slr; 30 day arc)
- lageos2 (slr; 30 day arc)
Consistent POD models across satellites

Models include:

<table>
<thead>
<tr>
<th>Reference frame and displacement of reference points</th>
<th>SLR</th>
<th>SLRF2005 + LPOD2005 (version 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DORIS</td>
<td>DPOD2005</td>
<td></td>
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<tr>
<td>Earth tide</td>
<td>IERS2003</td>
<td></td>
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<tr>
<td>Ocean loading</td>
<td>Got4.7 all stations</td>
<td></td>
</tr>
<tr>
<td>Tidal CoM &amp;EOP</td>
<td>Got4.7; VLBI high frequency terms</td>
<td></td>
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</tbody>
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Gravity

<table>
<thead>
<tr>
<th>Static</th>
<th>Eigen-Gl04s</th>
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</thead>
<tbody>
<tr>
<td>Time varying</td>
<td>Linear C20-dot, C21-dot, S21-dot (IERS2003) + 20x20 annual terms from GRACE</td>
</tr>
<tr>
<td>Atmospheric</td>
<td>ECMWF, 50x50@6hrs</td>
</tr>
<tr>
<td>Tides</td>
<td>Got4.7 (ocean); IERS2003 (Earth)</td>
</tr>
</tbody>
</table>
## SLR residual summary

<table>
<thead>
<tr>
<th></th>
<th>Mean (cm)</th>
<th>RMS (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>jason1 cycles 1-237</td>
<td>0.254</td>
<td>1.255</td>
</tr>
<tr>
<td>jason1 slrf2005</td>
<td>0.171</td>
<td>1.181</td>
</tr>
<tr>
<td>jason1 lpod2005</td>
<td>0.178</td>
<td>1.188</td>
</tr>
<tr>
<td>jason1 cycles 38-222</td>
<td>0.219</td>
<td>1.032</td>
</tr>
<tr>
<td>jason1 lpod2005</td>
<td>0.079</td>
<td>0.901</td>
</tr>
</tbody>
</table>

The graph shows the SLR RMS residuals (cm) over the years from 2002 to 2009. The data points are color-coded to represent different datasets:

- Blue: jason1 slrf2005
- Pink: jason1 lpod2005
- Yellow: lg1 lpod2005
- Cyan: lg2 lpod2005

The inter-comparison span indicates the range of values for each dataset.
Jason1 station performance; cycles 1-237; 24 primary stations

* LPOD2005
Station position/bias mis-modeling affects Jason1 orbit
Example slrf2005-only Jason1 orbit corrupts Matera (7941) evaluation
Jason1 Riyadh mean SLR residuals

Mean (cm)

Arc epoch
Jason1 Ajacio mean SLR residuals

![Graph showing Jason1 Ajacio mean SLR residuals with data points for slrf2005 and Ipod2005.]
Yarragadee mean SLR residuals

YARA 7090 SLRF2005 Mean residuals; Ipod2005 orbit

- cm

- Arc epoch

- Topex
- Jason1
- Lageos1
Wettzell mean SLR residuals

WETZ 8834 SLRF2005 Mean residuals; Ipod2005 orbit

- Topex
- Jason1
- Lageos1
- Lageos2

Arc epoch
Herstmonceux mean SLR residuals

RGO 7840 SLRF2005 Mean residuals; Ipod2005 orbit

Graph showing the mean SLR residuals for different satellite orbits from 2000 to 2009.
Conclusions

• SLR processing now at the 1-cm level for Jason and Lageos, and 1.5-cm for Topex
• At this level differentiating between station biases and position /velocity error is difficult, but critical for further improvement.
• LPOD2005 significantly improves primary stations Zimmerwald, Riyadh, and Ajacio.
• Herstmonceux shows a 1.2 cm bias beginning about Feb 12, 2007. Wettzell shows 1-cm level mean residuals and a possible trend.
• Such analysis applied to all the primary stations will be presented at the upcoming OSTST November 2008 meeting.
BACKUP
Jason1 radial 5-mm annual amplitude due to time varying gravity
Jason1 station performance; cycles 1-237; all 57 stations

** adjust bias per pass;
* adjust bias per arc
Mean SLR residuals correspond to range bias

Jason1 RGO_7840 SLR residuals; slrf2005 orbit
Goddard SLRF2005 mean residuals

GRF 7105  Mean SLR residuals

- Arc epoch
- cm

- Topex
- Jason1
- Lageos1