Orbit determination and SLR evaluation of China’s space laboratory

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Introduction

• Tiangong-2, Chinese space laboratory, launched on 15 Sep 2016

• Scientific goal:
  ▫ further verification of space rendezvous and docking technology
  ▫ space to earth observation
  ▫ experiment in space science and technology
  ▫ research in space medicine

• Orbit parameters:
  ▫ circular
  ▫ period : 92.2 minutes
  ▫ inclination : 42.8 deg
  ▫ initial height : 393 km

• Instrument:
  ▫ on-board GPS receiver - tracking and orbit determination
  ▫ SLR retroreflector – orbit accuracy validation
  ▫ cold atomic clocks, spectrometer, microwave altimeter, etc
Orbit determination & evaluation

- Based on GPS observation
- POD Method:
  - kinematic
  - reduced-dynamic
  - dynamic
- Orbit evaluation:
  - residual fitting
  - overlap comparison

Statistics on phase residual
RMS = 8.8 mm

Overlap comparison
0.43 1.34 0.39 1.49 cm
Orbit evaluation

- Orbit evaluation:
  - independent orbit comparison

![Residuals vs Day of Year (DOY)](image)
SLR validation

- Orbit evaluation: SLR validation

Dec, 2016 – Feb, 2017
SLR validation

- Orbit evaluation: SLR validation

<table>
<thead>
<tr>
<th>Station</th>
<th>Mean / cm</th>
<th>RMS / cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>7249 Beijing</td>
<td>7.68</td>
<td>0.48</td>
</tr>
<tr>
<td>7237 Changchun</td>
<td>-0.82</td>
<td>2.86</td>
</tr>
<tr>
<td>7821 Shanghai</td>
<td>0.35</td>
<td>2.08</td>
</tr>
</tbody>
</table>

Range residual ~ 2.3cm
Conclusion

• Reduced dynamic orbit determination of Tiangong-2 using onboard GPS measurement:
  - Phase residuals
    mean 8.8mm, near to noise level of GPS phase measurement
  - Overlap comparison
    R / T / N / 3D RMS ~ 0.4 / 1.3 / 0.4 / 1.5 cm

• orbits derived dynamic method and reduced dynamic method
  - quite equivalent
    R / T / N / 3D RMS ~ 3.0 / 3.6 / 2.5 / 5.4 cm

• SLR validation
  - an important evaluation method
    station-satellite range RMS ~ 2cm