GLONASS Satellite Orbit Modelling

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Summary from IGS Workshop
Session #08: Orbit Modelling
03–07. July 2017, Paris, France
Overview

Data problem in GLONASS satellites

Re-estimating GLONASS SAOs

Applying the estimated satellite antenna offsets

Discussion and summary
Data problem in GLONASS satellites from preprocessing in CODE rapid solution.
Data problem in GLONASS satellites

Influence of station distribution on GNSS satellite orbits

IGSWS2016
International GNSS Service
Workshop 2016
8 - 12 February 2016, Sydney, Australia

SNW 1 coverage – GLONASS tracking stations

Fig. 4: SNW 1 coverage plot. The number of stations covering a particular GLONASS satellite - epoch wise - is given by the color from the scale bar.
Data problem in GLONASS satellites

Influence of station distribution on GNSS satellite orbits

Fig. 5: SNW 2 coverage plot. The number of stations covering a particular GLONASS satellite - epoch wise - is given by the color from the scale bar.
Data problem in GLONASS satellites

Influence of station distribution on GNSS satellite orbits

Fig. 10: Ground track residual from orbit solutions SNW1(CODE) and SNW2(CODE) - radial & epoch wise plots for satellite R09. The color scale bar [12cm, -12cm] indicates the residual values.
Data problem in GLONASS satellites

Influence of station distribution on GNSS satellite orbits

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Fig. 11: Ground track residual from orbit solutions SNW1(ESOC) and SNW2(ESOC) - residual & epoch wise-plots for satellite R09. The color scale bar [12cm,-12cm] indicates the residual values.
Estimated satellite antenna offsets (SAO) for satellite SVN 734 (R05) in m

Orbits are based on a three-day long-arc solutions.
Re-estimating GLONASS SAOs

Estimated satellite antenna offsets (SAO) for satellite SVN 735 (R24) in m

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

Estimated SRP parameters for satellite SVN 736 (R09/R16) in nm/s²

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna antenna offsets

Using estimated original SAOs

B1C
B1S
D2C
D2S

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Summary from IGS Workshop, 03–07. July 2017, Paris, France

Astronomical Institute, University of Bern
Applying the estimated satellite antenna offsets

Estimated SRP parameters for satellite SVN 737 (R12) in nm/s²

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

Using estimated original SAOs
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 736 (R09/R16)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 736 (R09/R16)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 737 (R12)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 737 (R12)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 735 (R05)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

SLR residuals for satellite SVN 735 (R05)

Orbits are based on a three-day long-arc solutions.
Applying the estimated satellite antenna offsets

Quantile 25%, 50%, and 75% of SLR residuals per year in mm

- Using original estimated SAOs
- Satellites: 715, 716, 717, 719, 721, 723

Year: 2009 to 2017

Astronomical Institute, University of Bern
Applying the estimated satellite antenna offsets

Quantile 25%, 50%, and 75% of SLR residuals per year in mm

Using original estimated SAOs

- Sat. 725
- Sat. 728
- Sat. 730
- Sat. 732
- Sat. 734
- Sat. 735
Applying the estimated satellite antenna offsets

Quantile 25%, 50%, and 75% of SLR residuals per year in mm

![Graphs showing SLR residuals for different satellites (736, 737, 738, 744) with years from 2009 to 2017.]

Orbits are based on a three-day long-arc solutions.
### List of estimated satellite antenna offsets

<table>
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<tr>
<th>Satellite</th>
<th>from</th>
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<th>∆X</th>
<th>∆Y</th>
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<th>SAO-Y</th>
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Available as paper
What could be the reason at the spacecraft?

Shift of the center of mass:
If the satellite has roughly a mass of 1500 kg, 150 kg need to be shifted by 1 m in order to generate a COM shift of 10 cm.

http://spaceflight101.com/spacecraft/glonass-m/
Discussion and summary

**What could be the reason at the spacecraft?**

**Issue with satellite antenna:**
Not likely because SAO-Z is not affected in most cases and the SAO-X/Y estimates do not show a pattern

![Graph showing SAO-X and SAO-Y estimates for GLONASS and GLONASS-M](http://spaceflight101.com/spacecraft/glonass-m/)
Discussion and summary

What could be the reason at the spacecraft?

Satellite attitude misorientation:
The satellite plane with the navigation antenna and the SLR reflector is about 2 m away from the center of mass.
A shift of 10 to 15 cm results in a tilt of the 3 to 4 degree of the satellite body.

http://spaceflight101.com/spacecraft/glonass-m/
Discussion and summary

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  A shift of 10 to 15 cm results in a tilt of the 3 to 4 degree of the satellite body.

The usage of the estimated SAOs obviously helps to reduce the SLR residuals and should be considered for repro3 after verification.
THANK YOU
for your attention

Publications of the satellite geodesy research group:
http://www.bernese.unibe.ch/publist