Studying different tracking strategies to LAGEOS and Etalon with respect to the weekly ILRS solution

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Overview

- Introduction
  - ILRS solution for ITRF
  - Motivation: Simulation approach

- Replacing observations by simulation

- Changing the distribution of observations between LAGEOS and Etalon

- Conclusions

- Outlook and open questions
Introduction – The ILRS targets

- 85 targets today.
- Upon completion of the Galileo constellation and others: soon 100+ targets.

https://ilrs.cddis.eosdis.nasa.gov/missions/satellite_missions/index.html
In 2016:

- In average 130000 NPs/month in total.
- 13000 NPs of those to LAGEOS.
  - 10% of total NP to only 2 of 100 satellites.
- 1200 NPs to Etalon.
  - Only 10% of the ILRS solution for the ITRF comes from Etalon.
SLR observations to LAGEOS1, LAGEOS2, Etalon1 and Etalon2 are used to estimate
- the individual ERP,
- station coordinates,
- and orbits.

(7 day arcs)

→ then combined in weekly solution.
Introduction – SLR productivity shortcomings

- Highly inhomogenous station network.
  - Station distribution, expanding the Network.
  - Increasing the productivity of stations with less observations.

- Scheduling according to priority list.
  - Study the effect of specific tracking strategies on different products.
Experiment: Reducing LAGEOS NPs

- Impact of number and distribution of observations on the LAGEOS and Etalon satellites.
  - Comparison of different scenarios:

![Graph showing the impact of number and distribution of observations on the LAGEOS and Etalon satellites.]
Comparing scenarios

RMS of Helmert transformation

Day of year 2016
Comparing Scenarios

Differences of geocenter coordinates

ΔX [cm]

ΔY [cm]

ΔZ [cm]

% Reduction
Summary

- **RMS of Helmert**: increases when reducing LAGEOS observations. Up to 20% Reduction the RMS stays within the simulation noise RMS threshold.

- **ERP, translation/rotation**: insignificant difference.

- **Orbits**: Average residuals of LAGEOS orbits slightly increase but remain at the same maximum level of ~10cm.

- **Scale factor, geocenter**: Scenarios clearly show a decrease beyond 20% reduction.

=> 20% of LAGEOS NPs could go to other targets.
Experiment: Increasing NPs to Etalon

- Taking 20% of LAGEOS observations and replace them with Etalon.

- Total number of NP in ILRS solution remains the same!

- Impact on the main parameters of the solution?
Etalon orbits

RESIDUALS IN EARTH-FIXED SYSTEM 953 and 954 2016

X

Y

Z
Etalon orbits

RESIDUALS IN EARTH-FIXED SYSTEM 953 and 954 2016

X

Y

Z

Etalon1

Etalon2
Increasing NPs to Etalon – ERPs

Δ X Pole

Δ Y Pole

Δ UT1-UTC

Reference
10% more Etalon
Summary

- **RMS of station coordinates**: on the same level as with LAGEOS.

- **Translation/Rotation**: not significant.

- **Orbits**:
  - LAGEOS: Slightly bigger average differences, but still on the same ~10cm level.
  - Etalon: Vastly improved orbits.

- **ERPs improved by 10%**
Conclusions

- Meaningful comparison of similar tracking scenarios is possible.
- Simulation of tracking strategies to evaluate improvements and benefits.
- Reduction of observations to LAGEOS by 20% without significant decrease of the quality of solution.
- Increasing the number of NPs to Etalon improves Etalon orbits and ERPs.

Each NP can make a difference!
Outlook

- Including LARES in the solution and increasing NPs for it.
- More NPs for other low flying satellites.
- Synchronized regional tracking (e.g. in Europe)
  - Same or different targets at specific passes?
- Comparison of tracking strategies to GNSS satellites in SLR+GNSS Combination
  - Less than 100NP/week per GLONASS satellite
  - Less than 1000NP/week on all GLONASS
- What else? – Looking forward to discussing ideas.

Thank you for your attention!