



Federal Agency for
Cartography and Geodesy



Analysis of differential residuals of SLR observations to GNSS: Methodology and results from analyzing 25 years of data

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ADDITIONAL MATERIAL

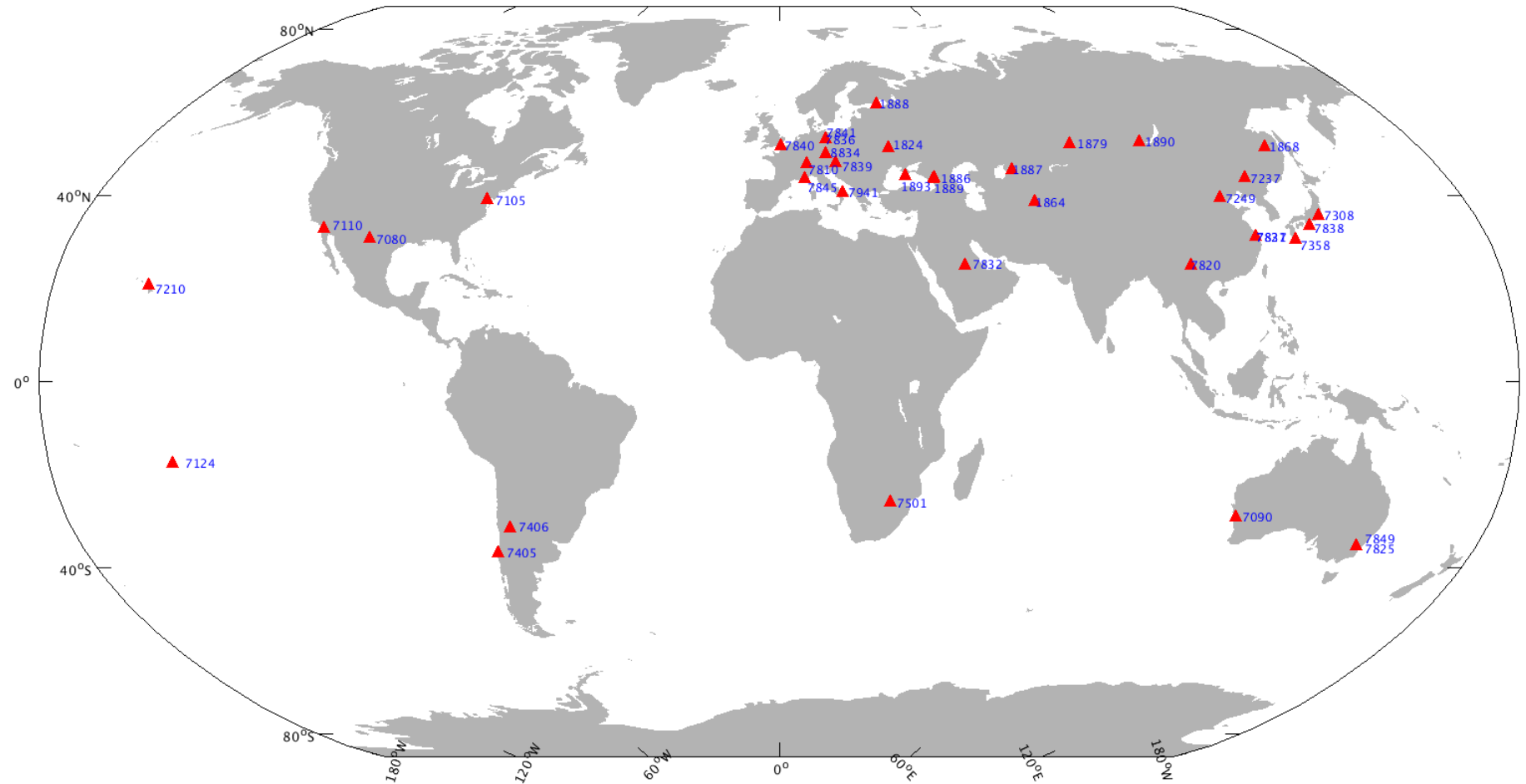
Test Network

Test Network:

38 stations
in total

49 satellites

1994-2018

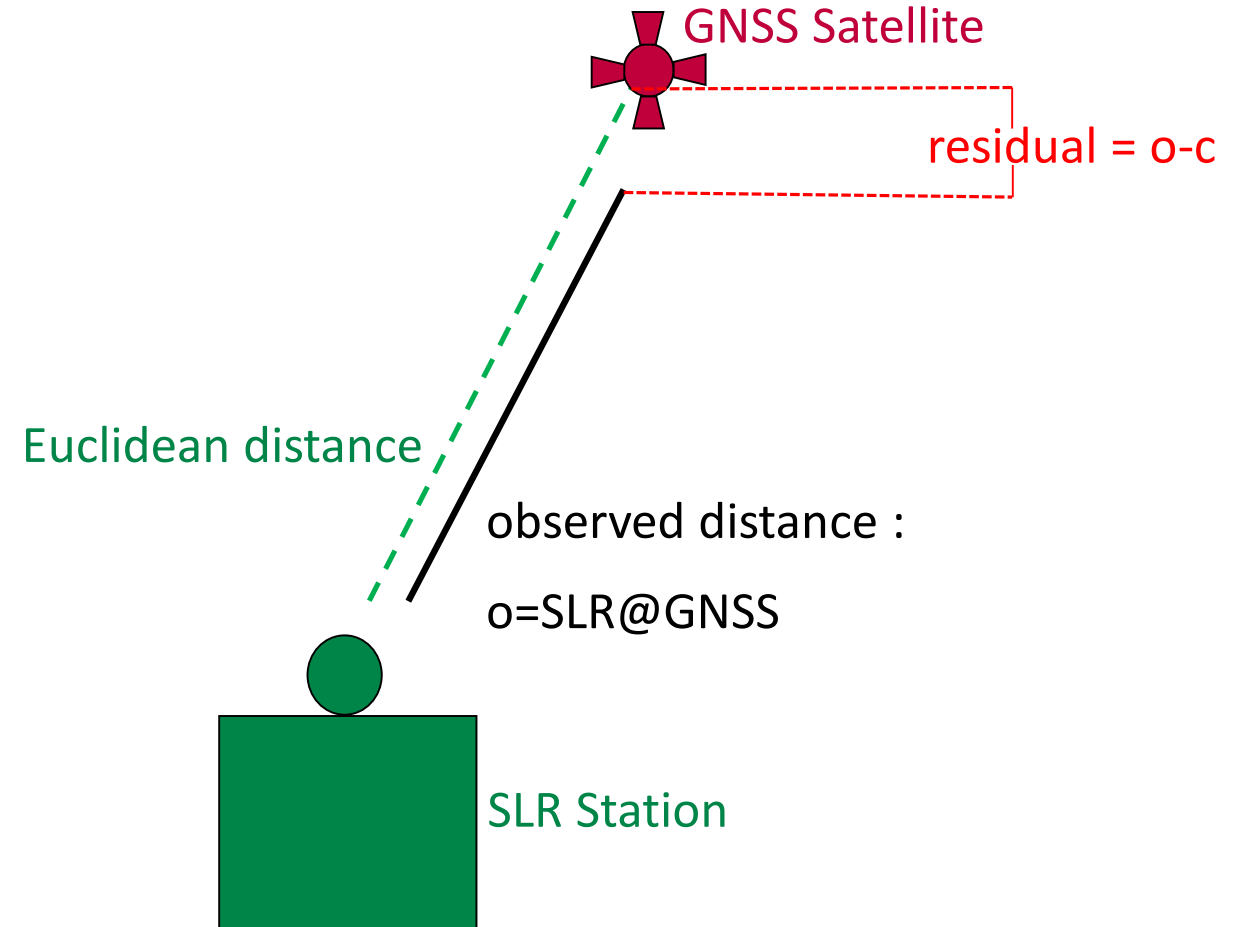


The Absolute Residual Analysis

Absolute Residual Analysis (ARA)

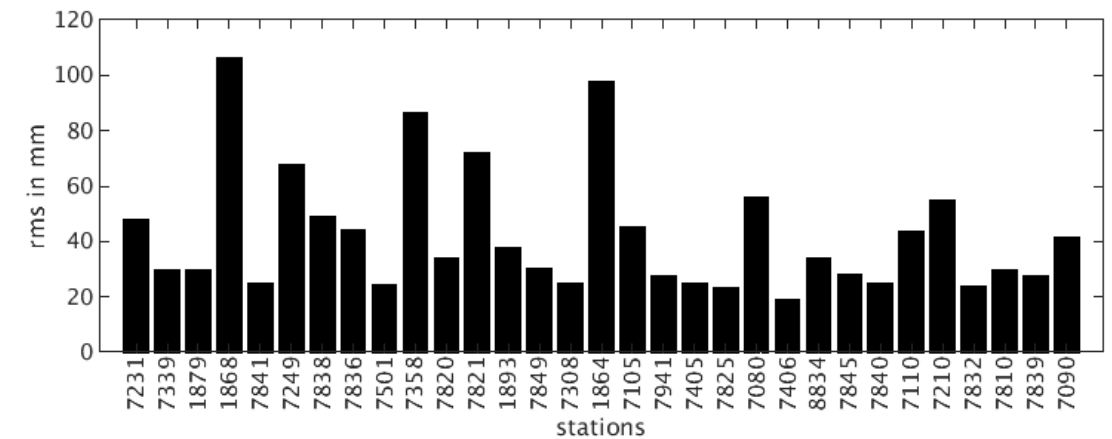
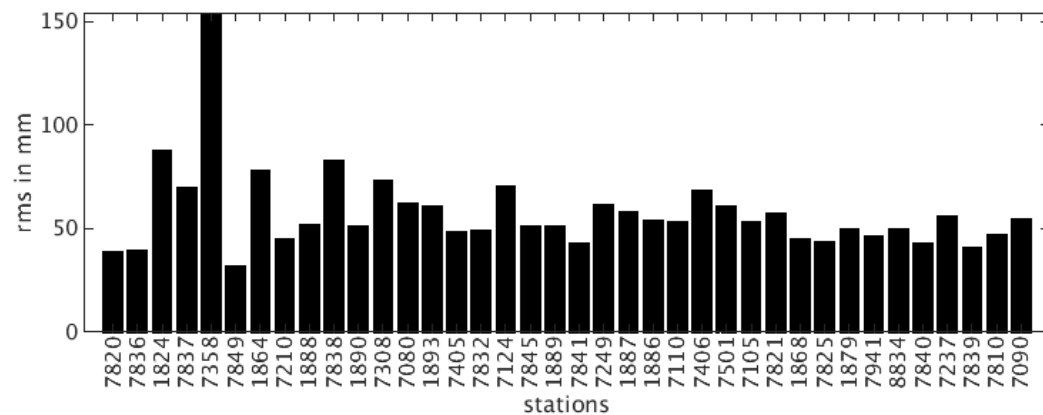
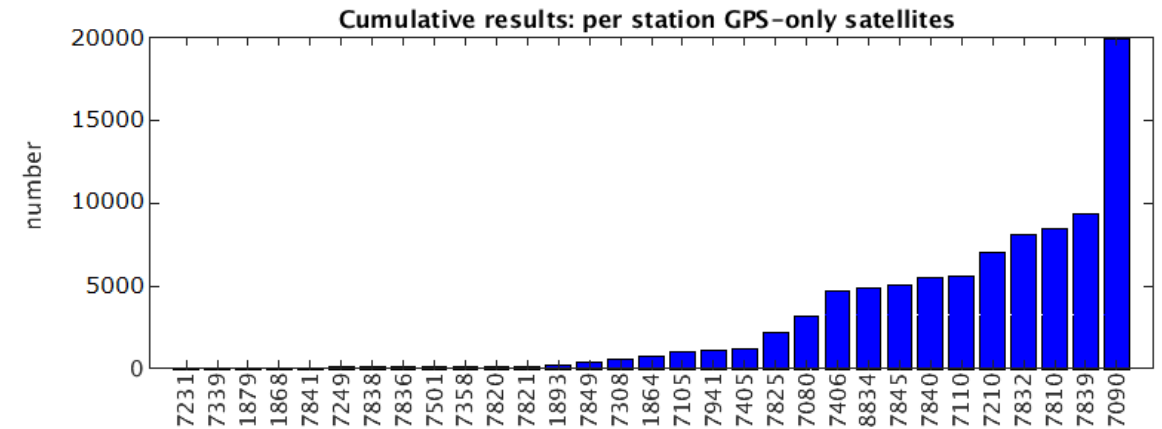
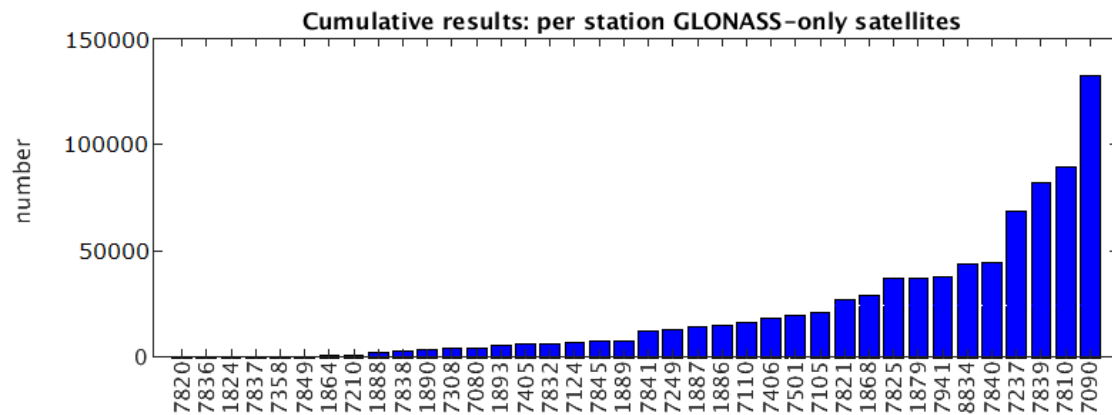
The ARA absorbs various biases:

- station-related (SLR telescope's accuracy) and
- satellite-related (satellite orbits and satellites Laser Reflector Arrays/LRA).



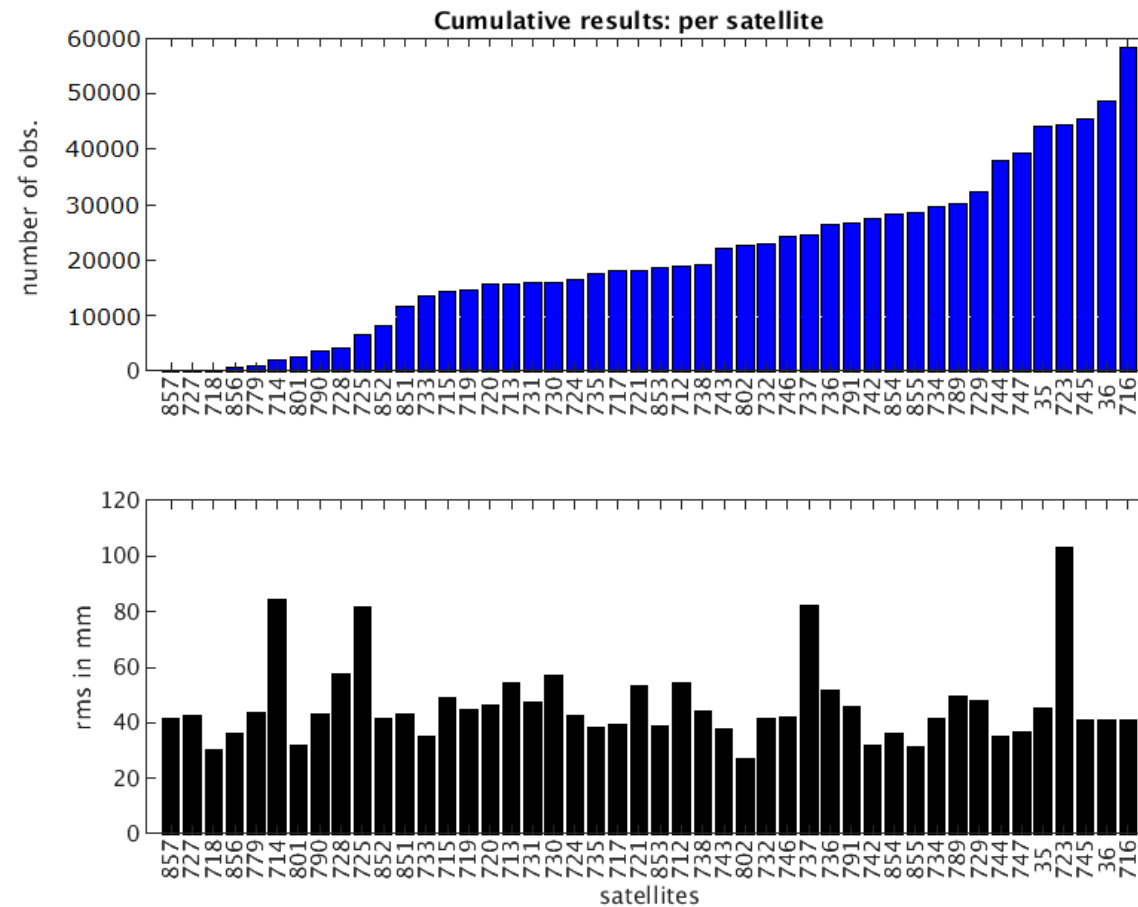
ARA Results per station and per satellite

ARA per station and per satellite group (after removing outliers- 3 sigma criterion)



ARA Results per satellite

ARA per satellite (after removing outliers- 3 sigma criterion)

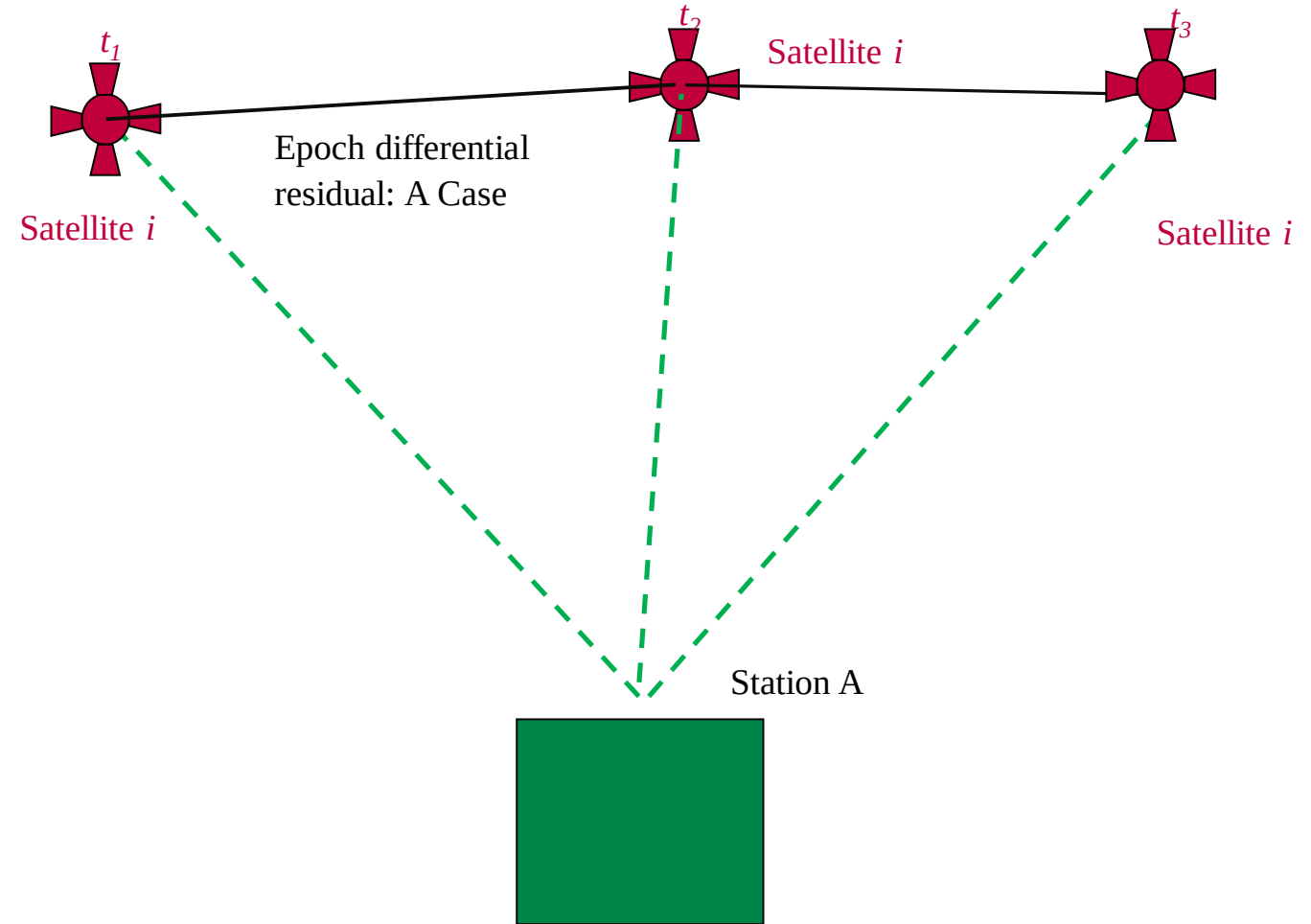


We present **3 different cases** that are applicable to eliminate different sources of biases in SLR residuals.

The basic principle of the EDRA bases on the time-dependent differences of the absolute SLR residuals (after ARA application).

CASE A

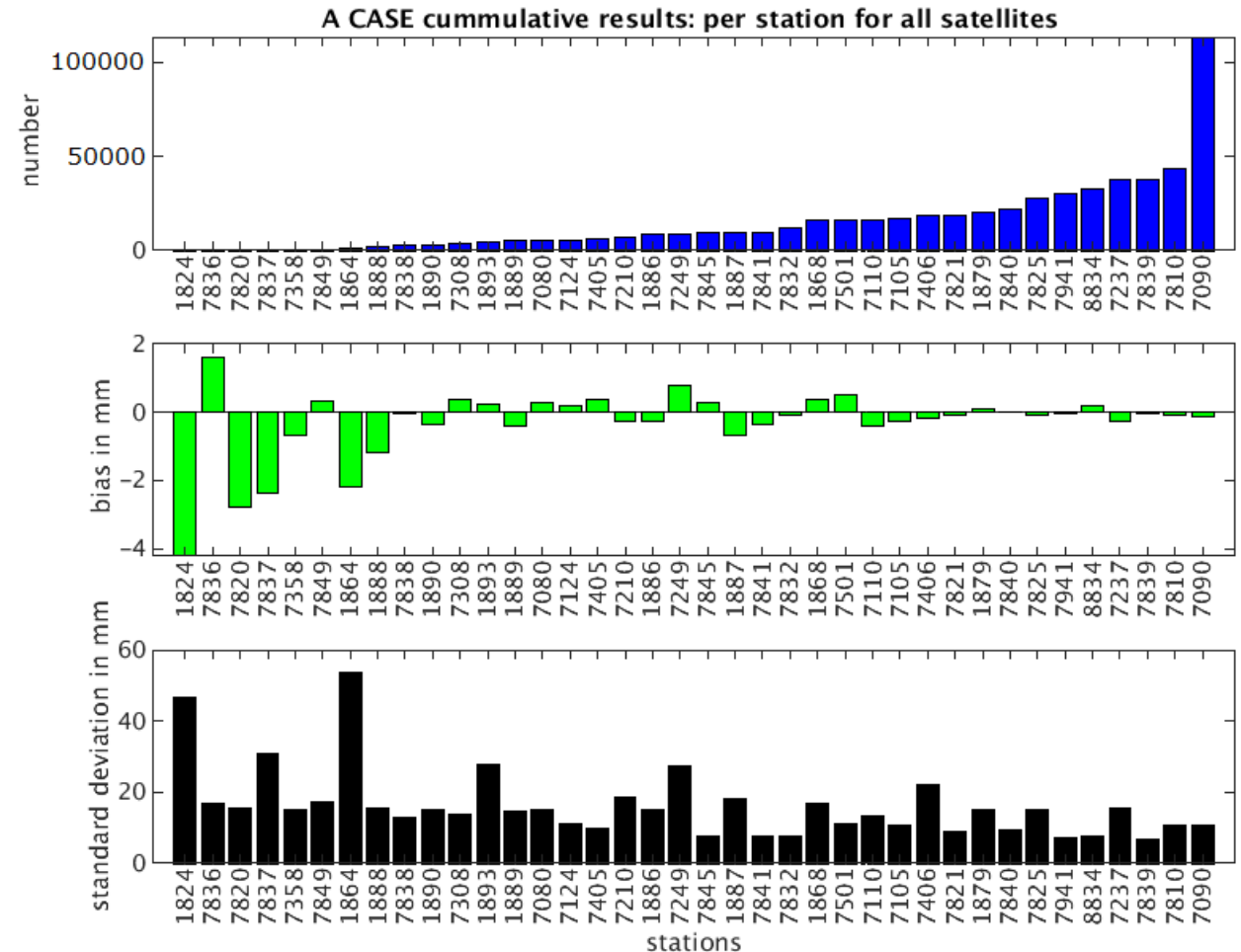
The difference between two successive absolute residuals (the time difference should be not larger than 2 h) for a common satellite and a common station: Elimination of satellites and stations biases: The precision of station's telescope



Case A : Results per station

CASE A : Results per station (mean average)

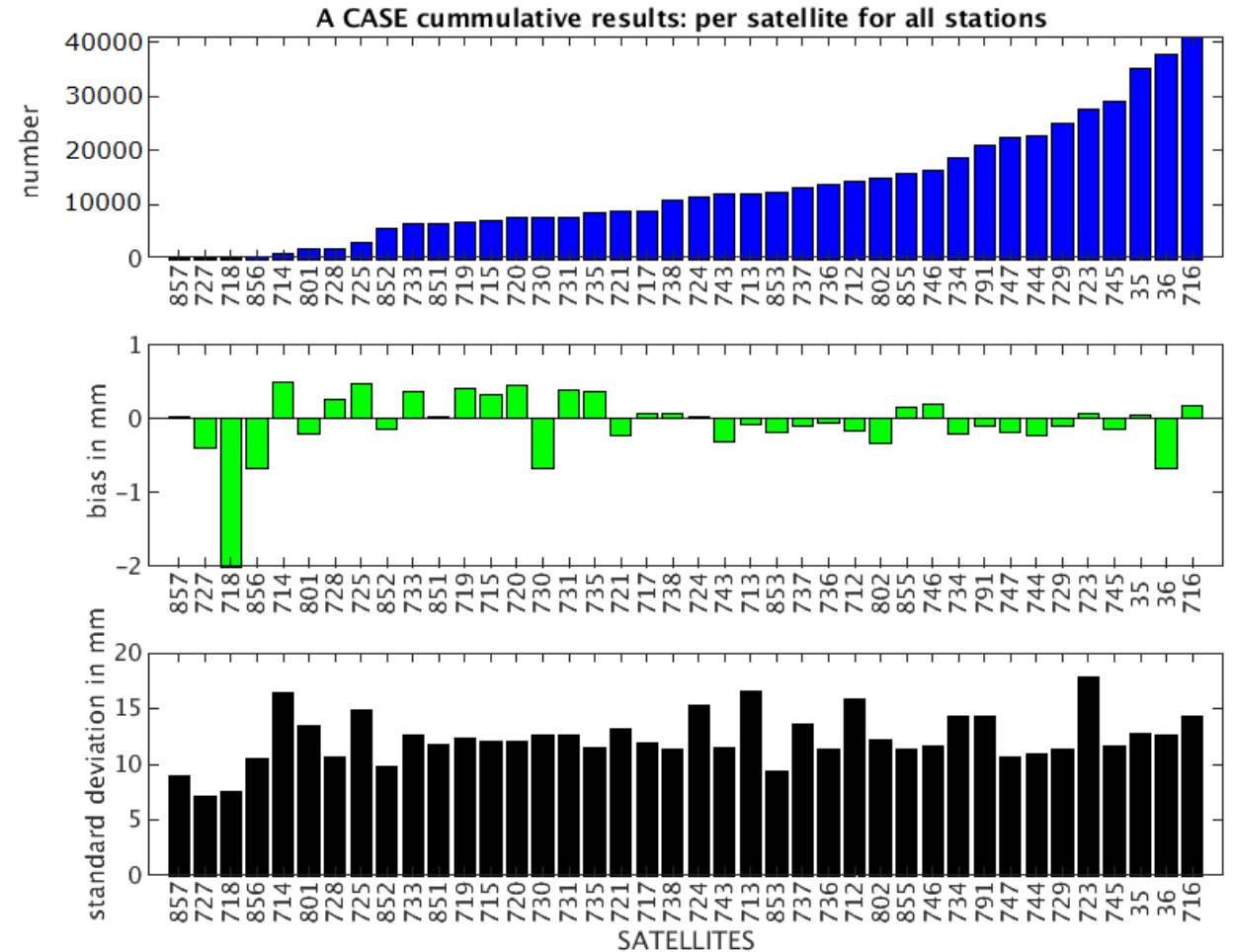
- For the ‚good stations‘ we do not observe significant biases
- The standard deviations of the ‚good stations‘ is at the level of 10-15 mm



Case A : Results per satellite

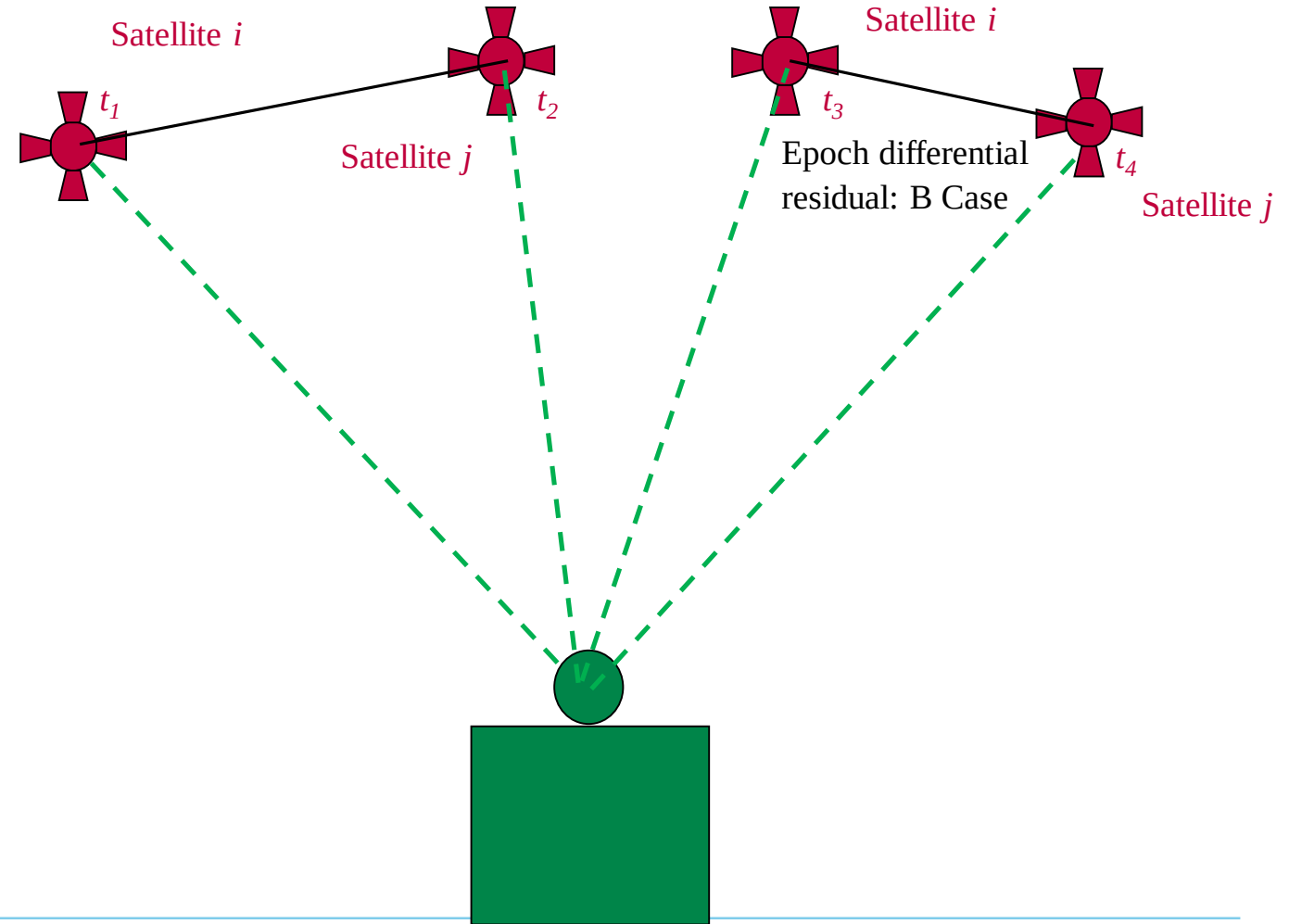
CASE A: Results per satellite (mean average)

- For the ,good satellites‘ we do not observe significant biases
- The standard deviations of the ,good satellites‘ are at the level of 10-20 mm



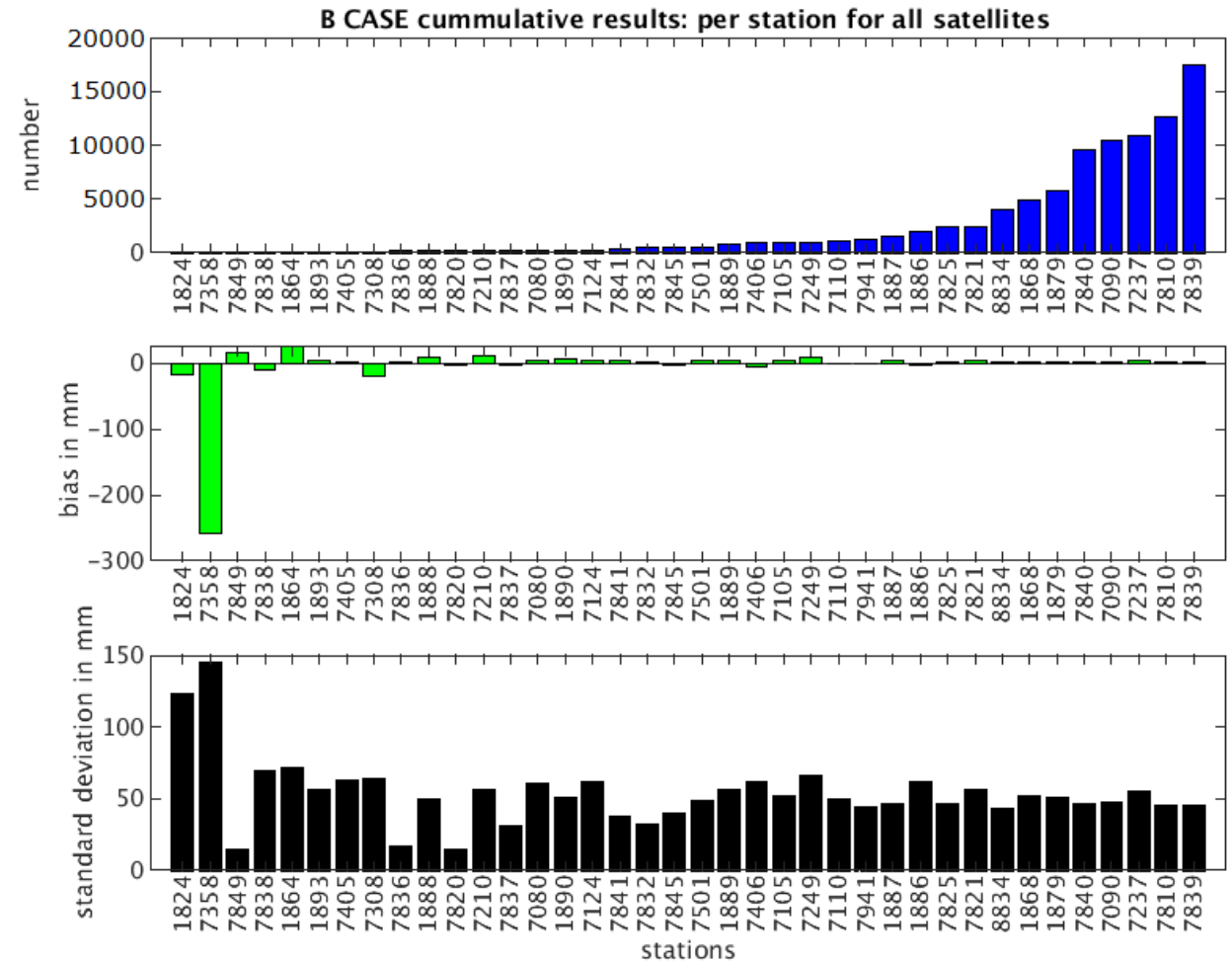
CASE B

The difference between two successive absolute residuals (the time difference should be not larger than 2 h) for two different satellites and a common station. Elimination of station-related biases: Only relative satellite-related biases remain.



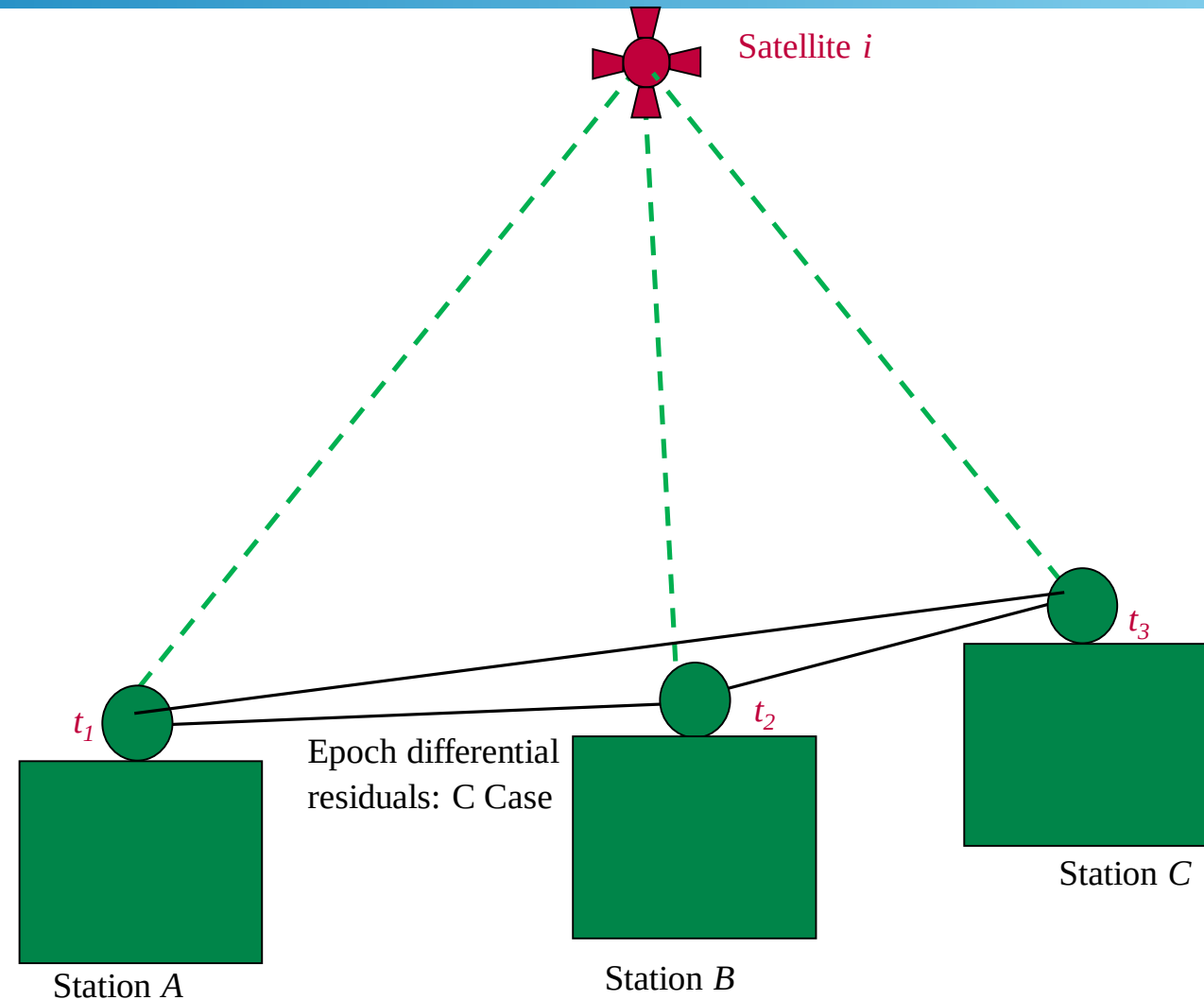
CASE B: Results (mean average per station)

- Small relative biases (2-8 mm, except one Japanese station)
- The standard deviations of the relative residuals are at the level of **40-60 mm**



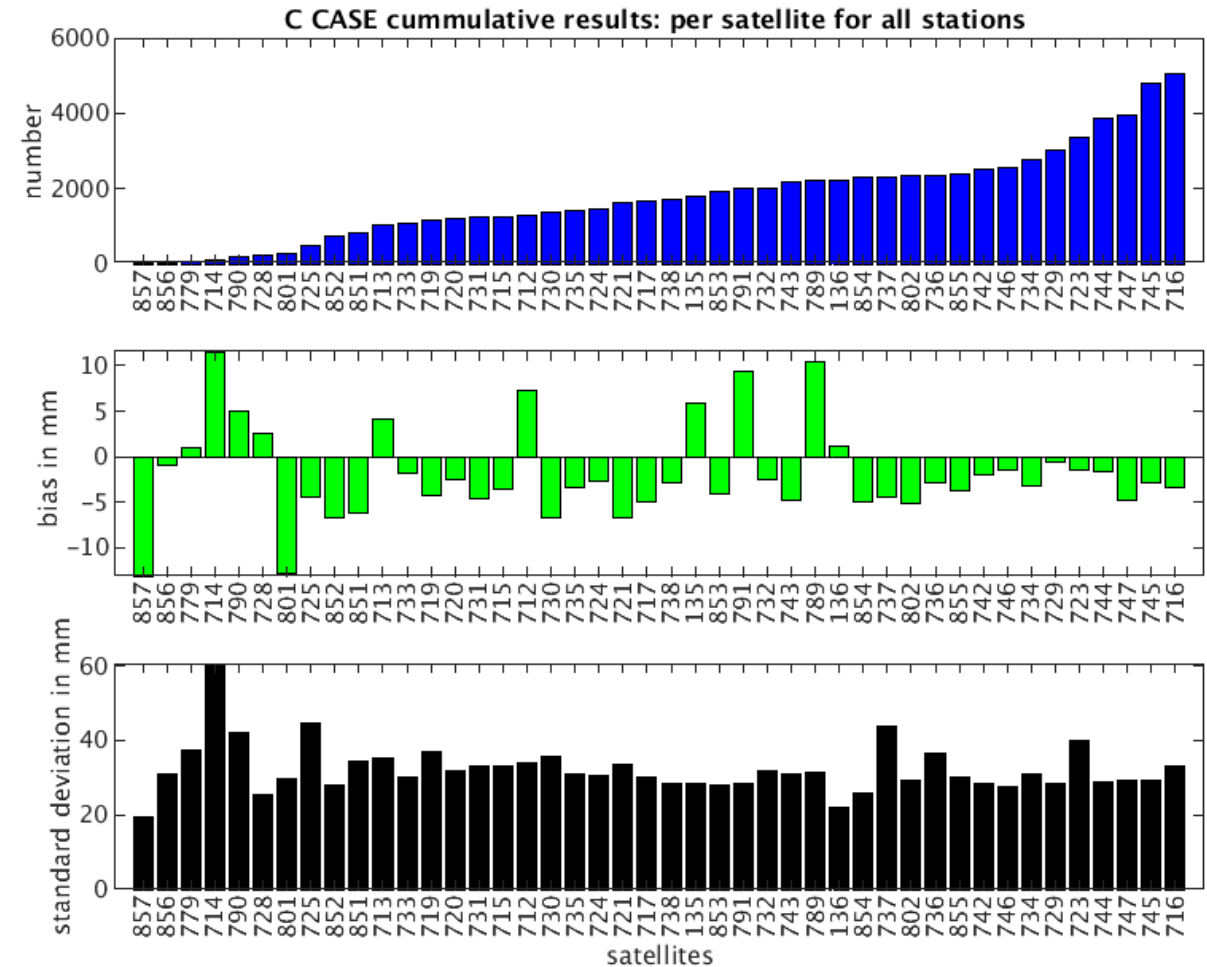
CASE C

The difference of the absolute residuals between a common satellite and 2 quasi-simultaneously tracking stations (the time difference should not be larger than 2-h). Elimination of the satellite-related biases. Only relative station-related biases remain.



Case C : Results (mean average per satellite)

- Relative biases up to 13 mm
- The standard deviations of the relative residuals are at the level of 20-40 mm



Conclusions

- The EDRA investigates the biases of the SLR@GNSS observations, in order to get a better insight into the sources of the residuals.
- For the Case A of EDRA almost no biases are left, with an RMS of only 10-15 mm
- The Case B of EDRA points out the relative satellite-related discrepancies, found at the level of 40-60 mm.
- For the Case of EDRA the differential residuals are found to be the largest EDRA with mean values up to 13 mm. The RMS is at the level of 20-40 mm.



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Thank you for your kind attention!