Estimation of phase center offset corrections for Sentinel satellites

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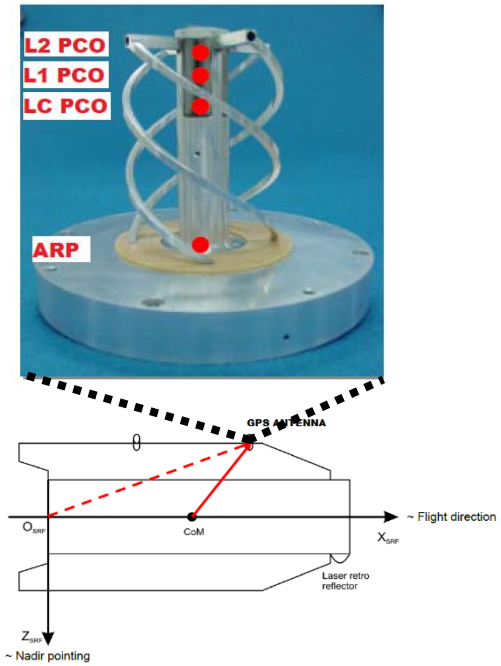
Introduction

- At AIUB precise orbit solutions of Sentinel satellites are computed (Copernicus POD Service QWG)
- Dynamic LEO Precise Orbit Determination (POD) using the Bernese GNSS Software on centimeter precision level (Mao et al. 2021)
- Knowledge of exact signal receiving point is essential, whereby receiving point is composition of Antenna reference point (ARP) and Phase Center Offset (PCO)



LEO Precise Orbit Determination

- Dynamic orbit representation
  - ➢Solar radiation pressure, Earth radiation pressure, airdrag
  - ➢No scaling factors for non-gravitational forces estimated
  - ➢Piecewise-constant accelerations in along- and cross-track every 30min, constrained to $0.5\,nm/s^2$
- Fixing integer ambiguities in the process of PCO correction estimation
- No phase center variations (PCV) applied

Processed LEOs

Sentinel-1A/B

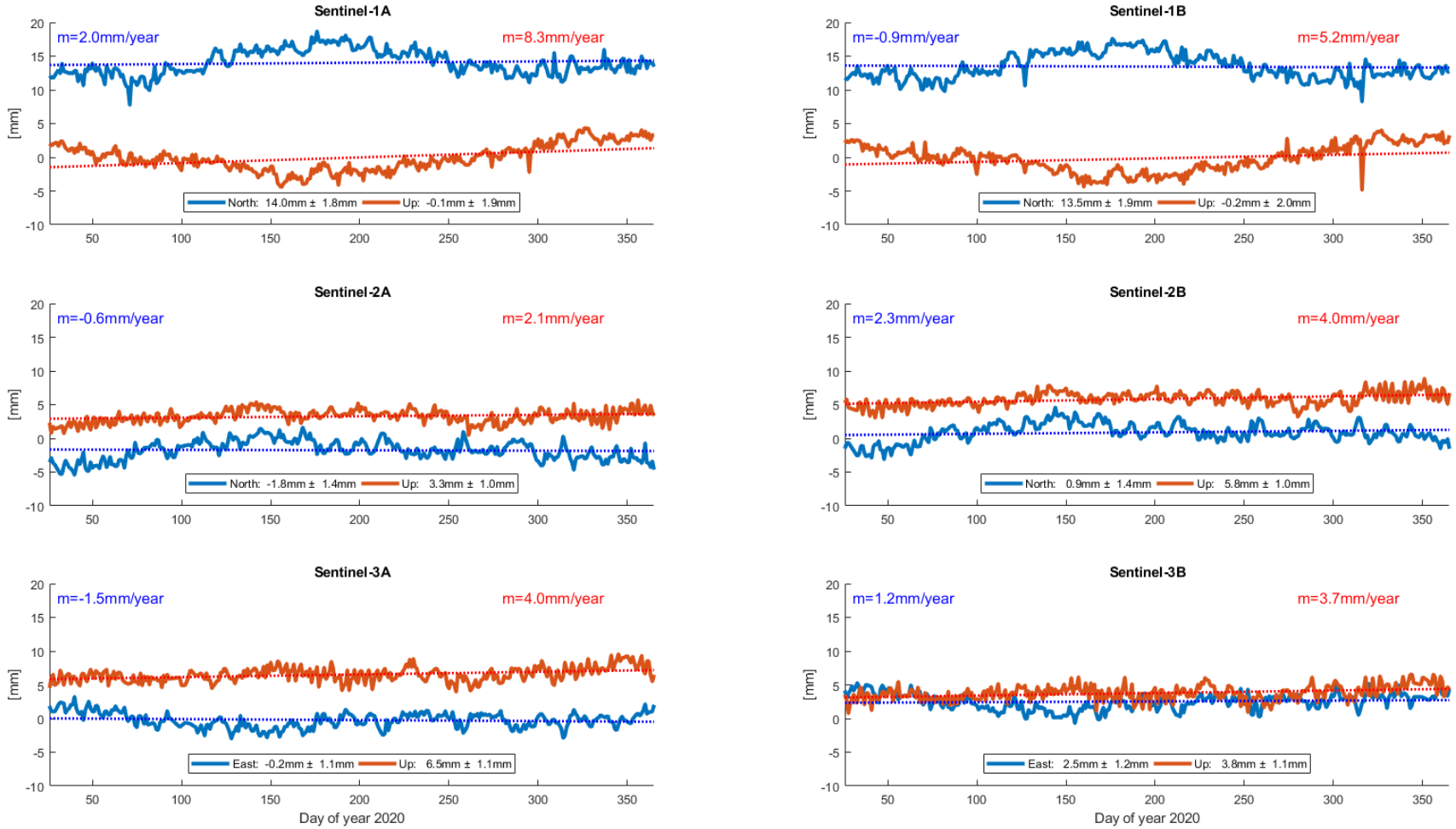
Sentinel-3A/B

Sentinel-2A/B

Sentinel-6A

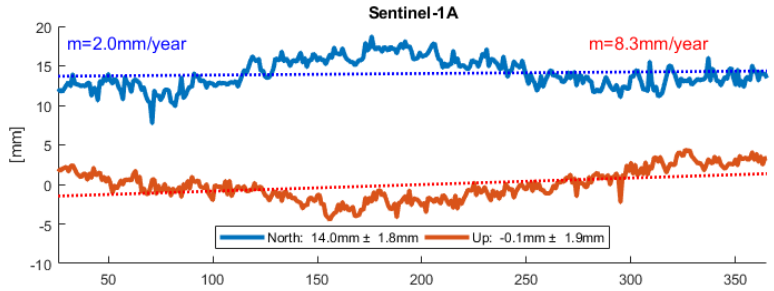
Image credit: ESA

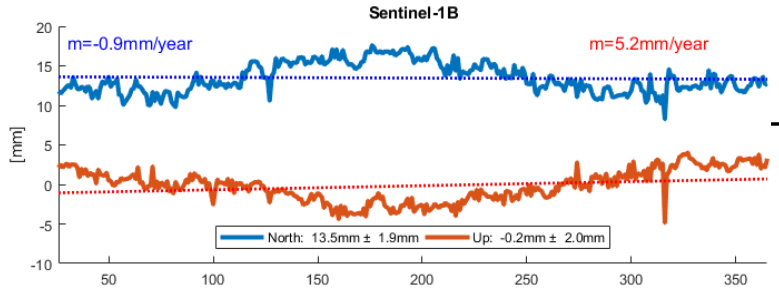
Estimated PCO corrections (S1A/B, S2A/B, S3A/B)



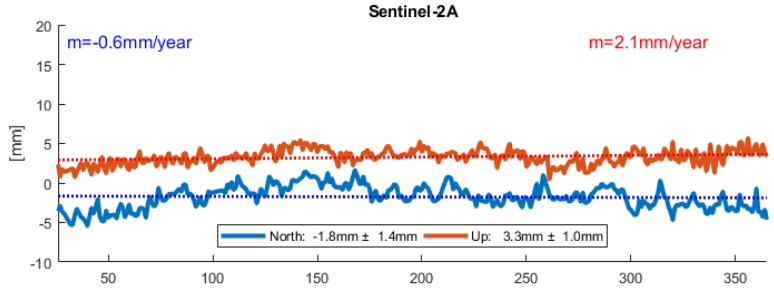
→ Results using default settings for Sentinel POD at AIUB

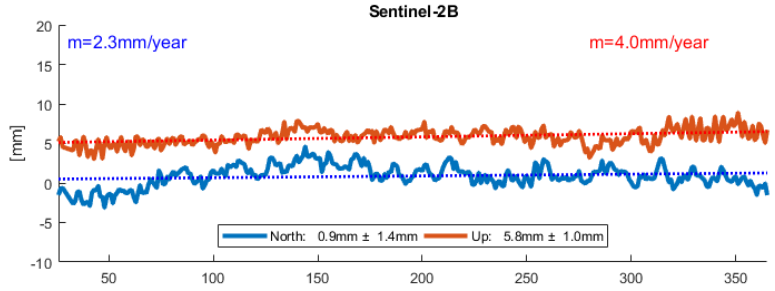
Estimated PCO corrections (S1A/B, S2A/B, S3A/B)

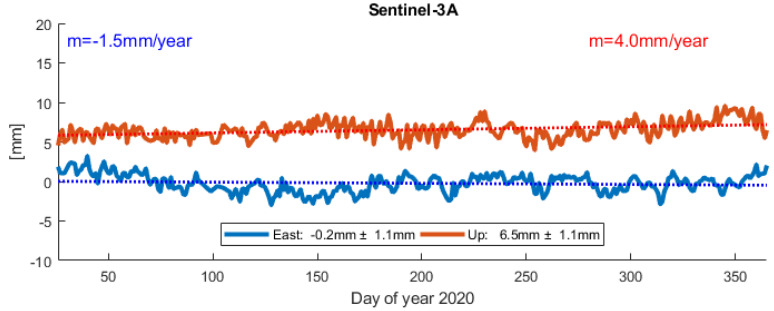


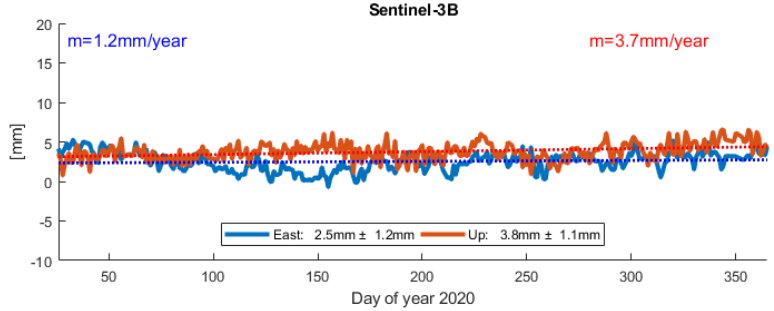


→ β-dependency





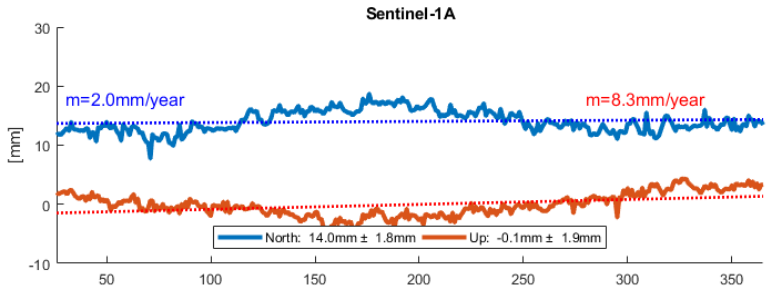


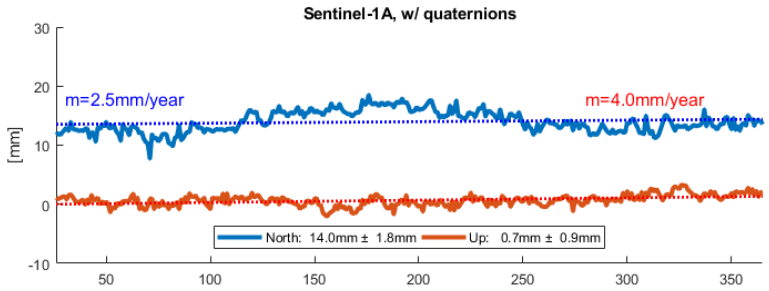


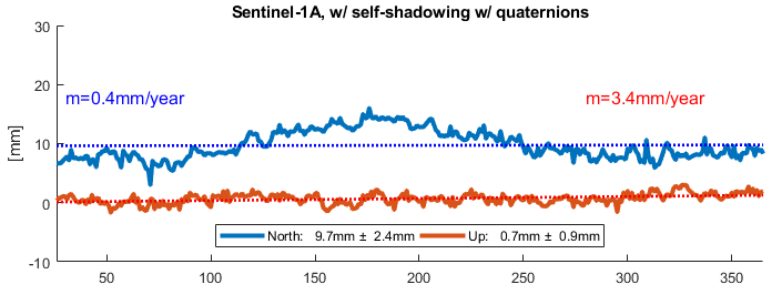
→ Results using default settings for Sentinel POD at AIUB

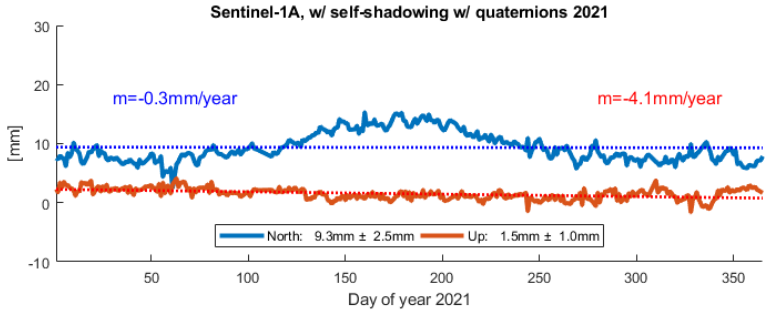
Sentinel-1A

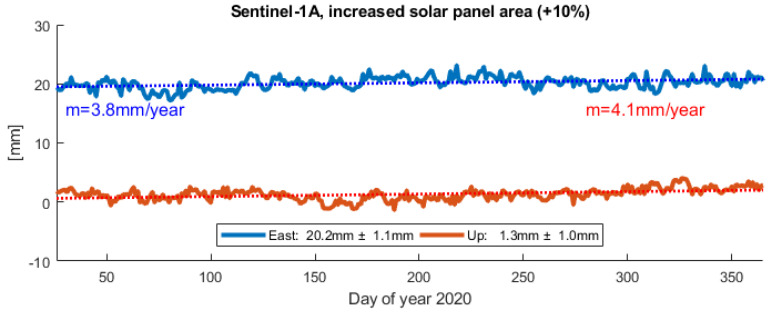
- Attitude: Quaternions vs nominal model
- Self-shadowing
- Trend in estimated PCO corrections
- Macro model modifications

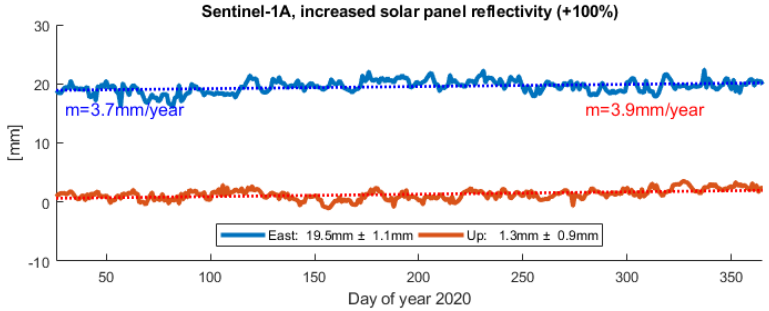












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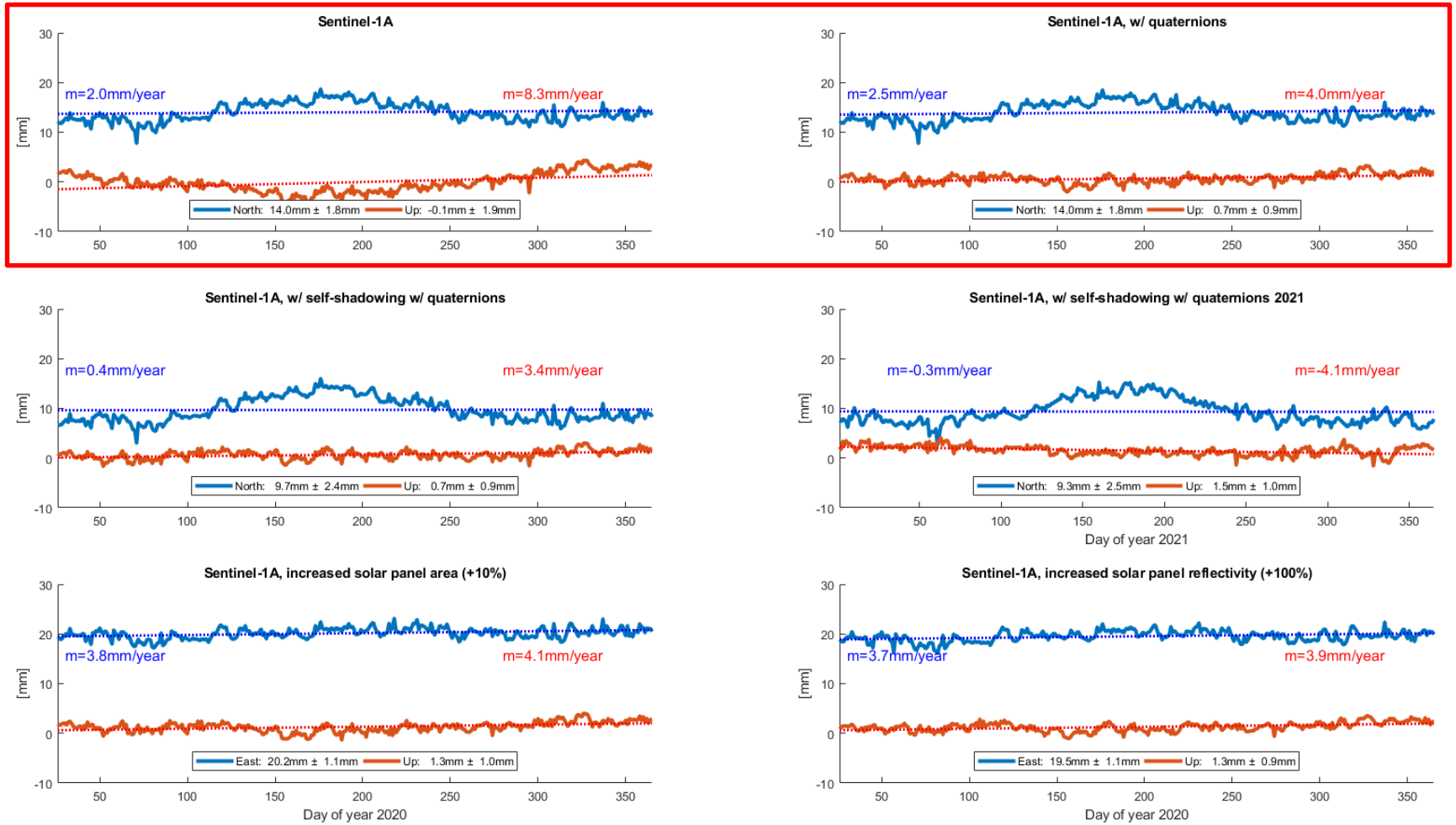

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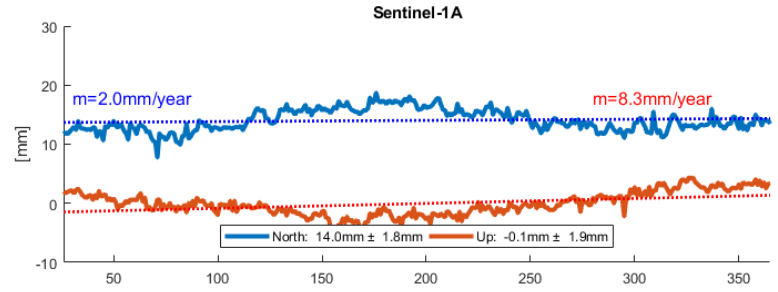

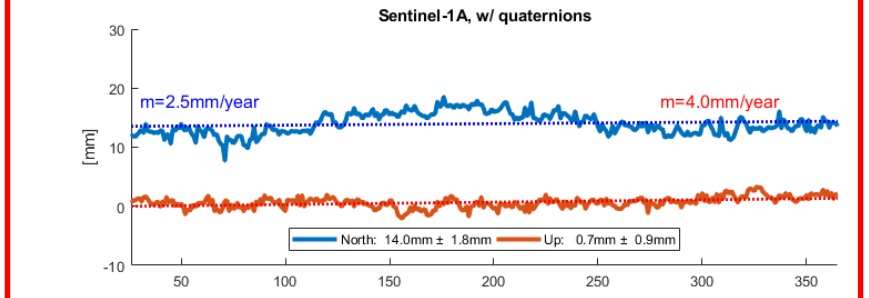

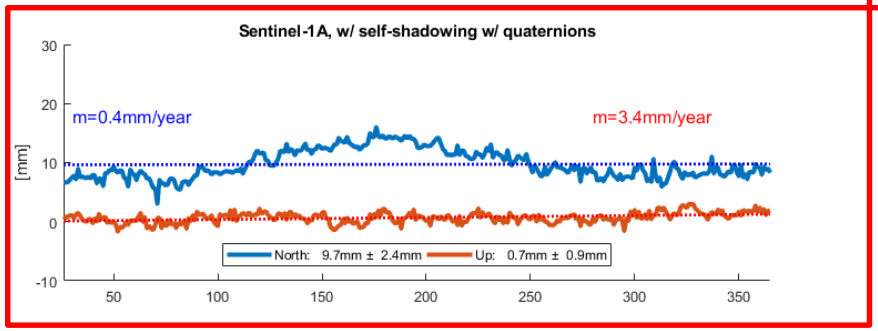

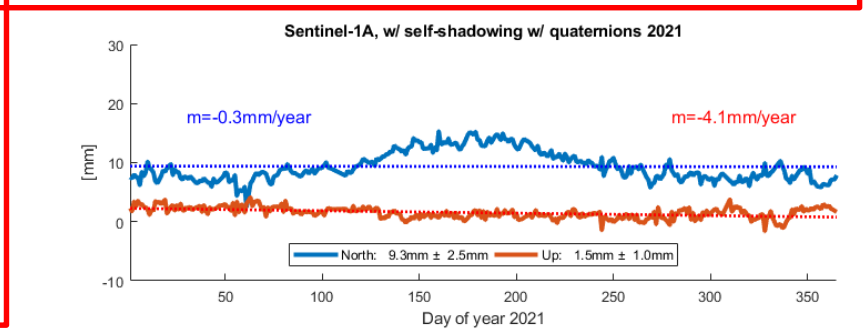

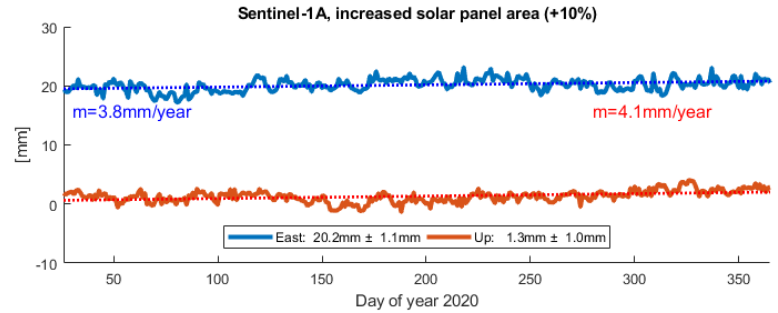

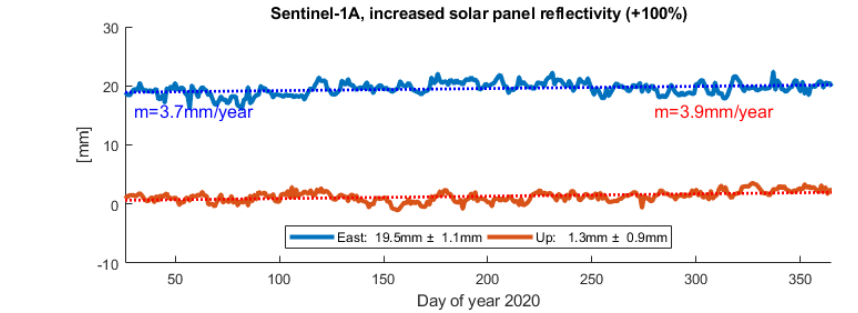

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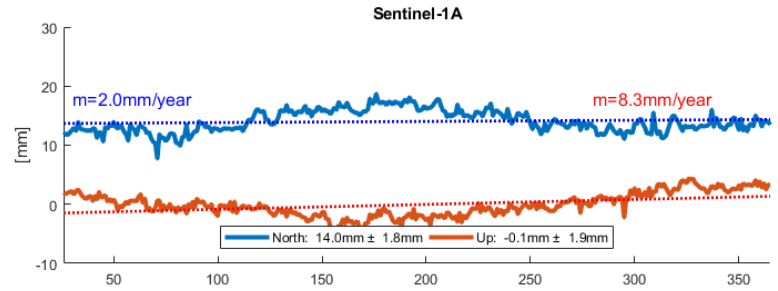

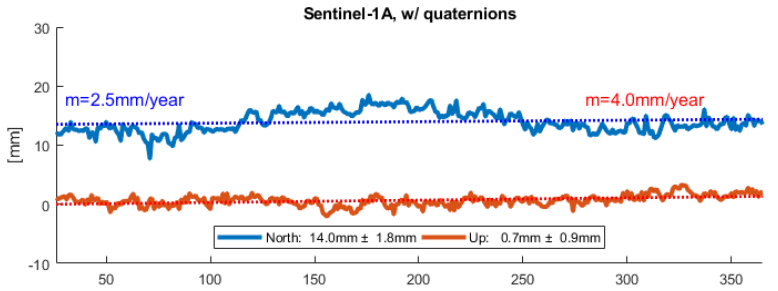

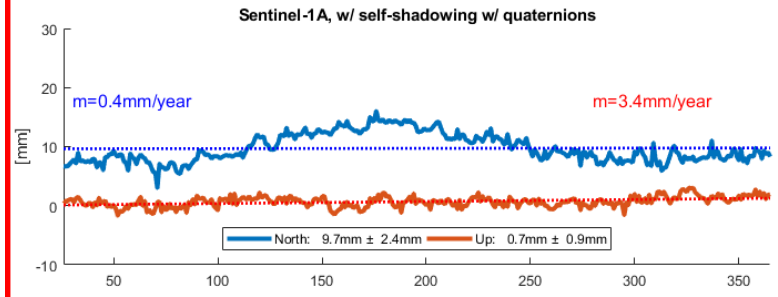

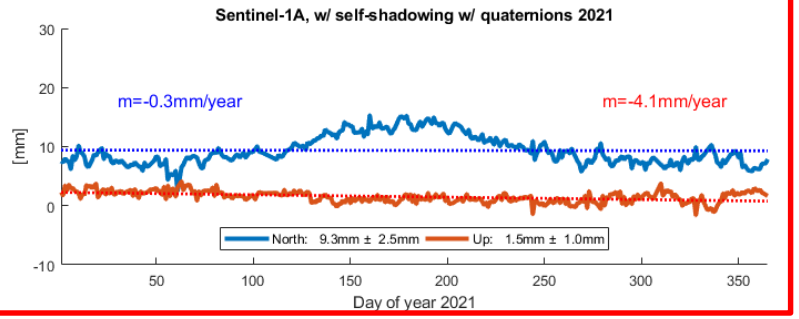

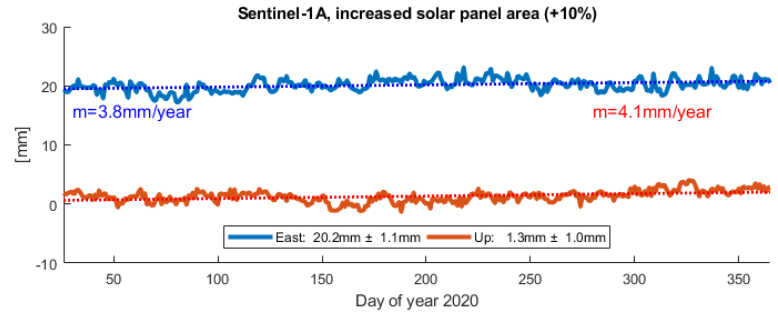

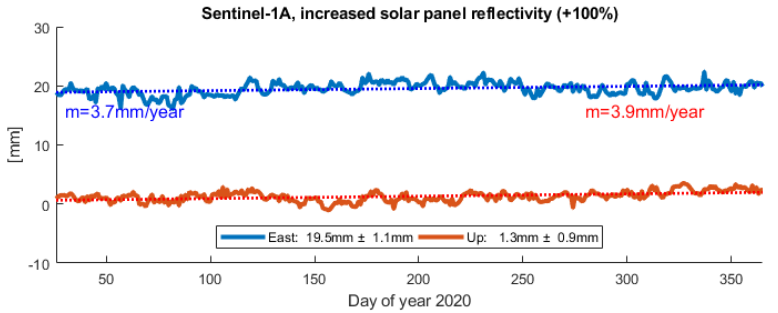

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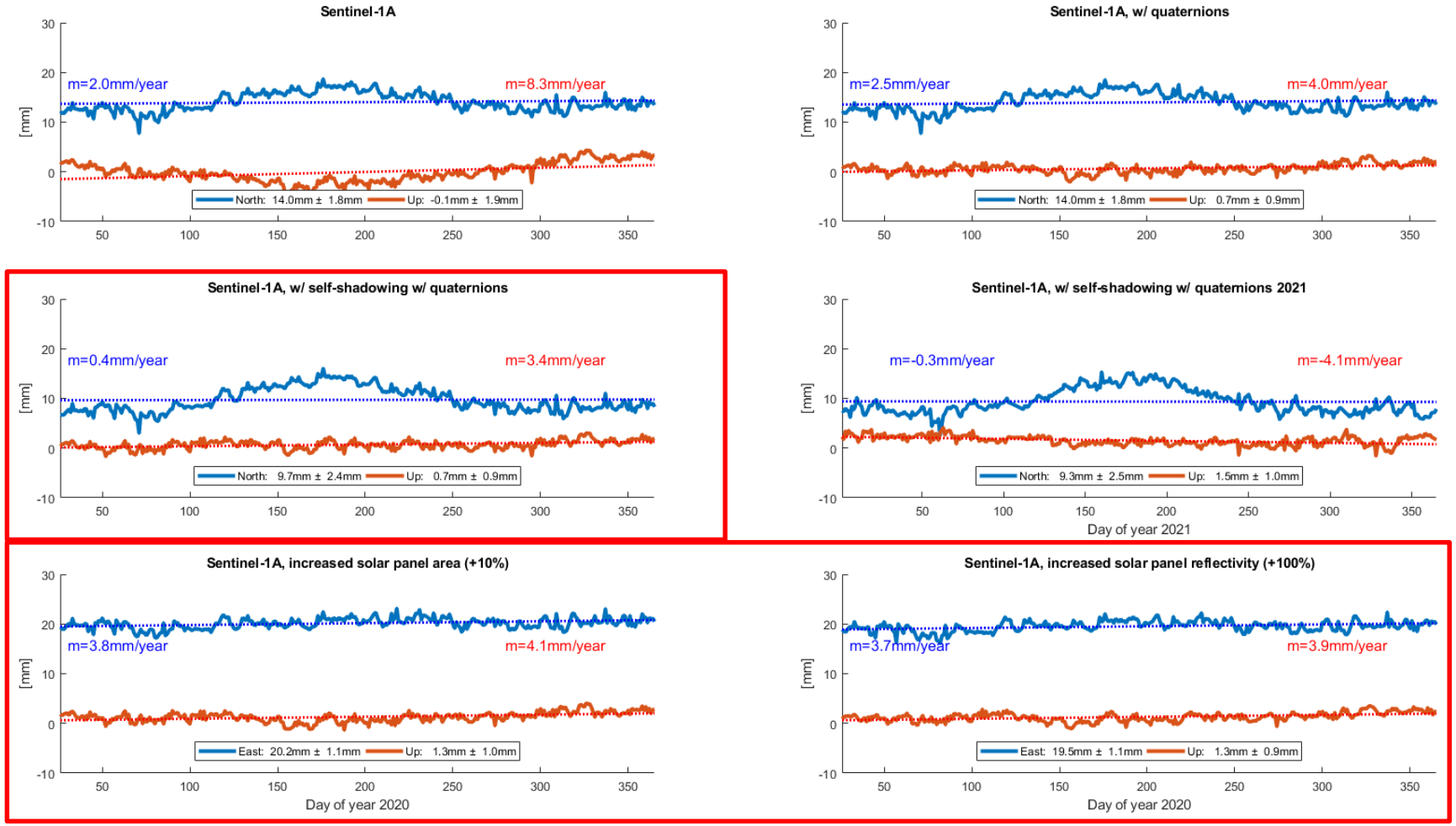
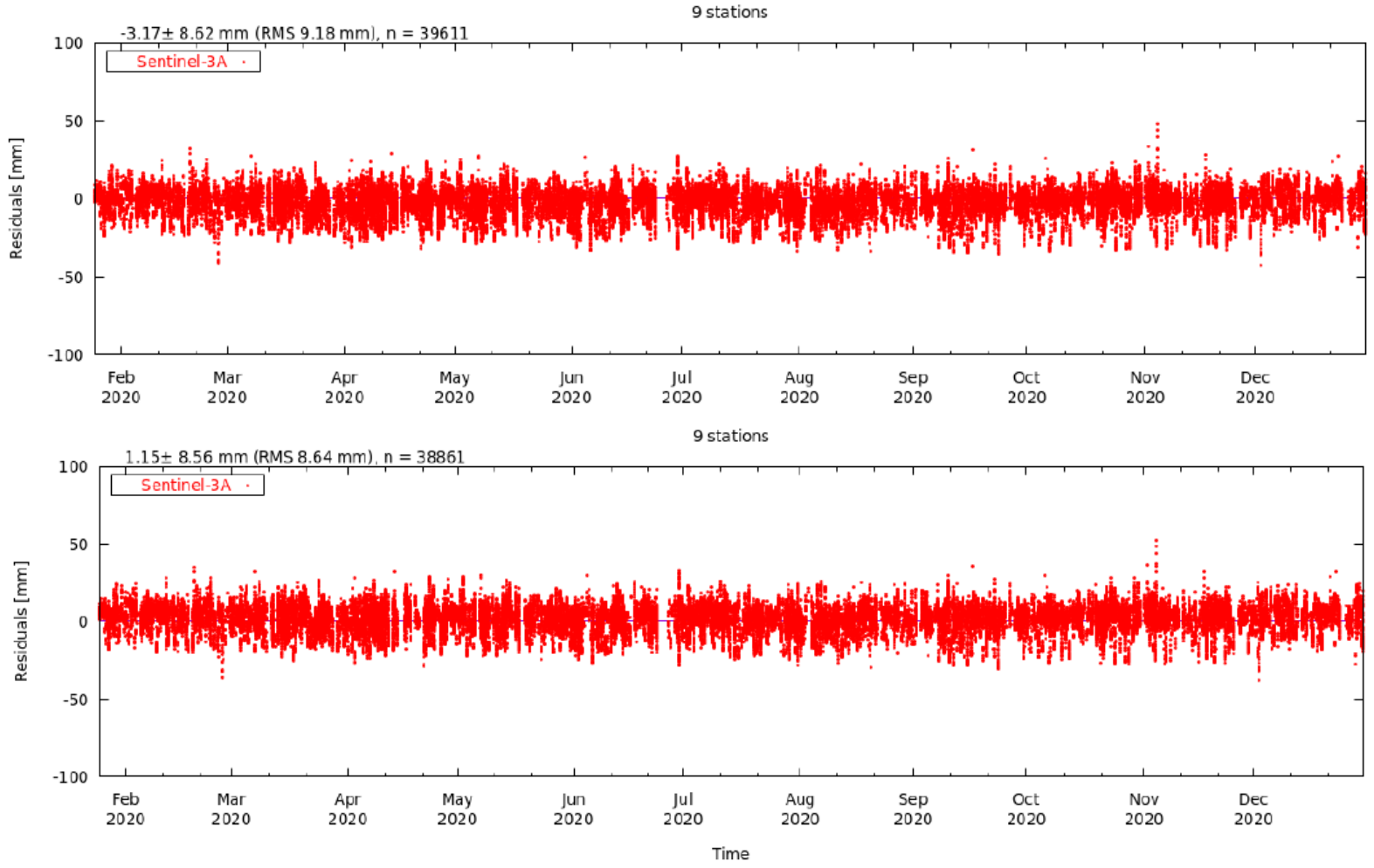


Sentinel-3A

- SLR Validation of Reduced-dynamic orbit solutions, original/corrected PCO used in POD

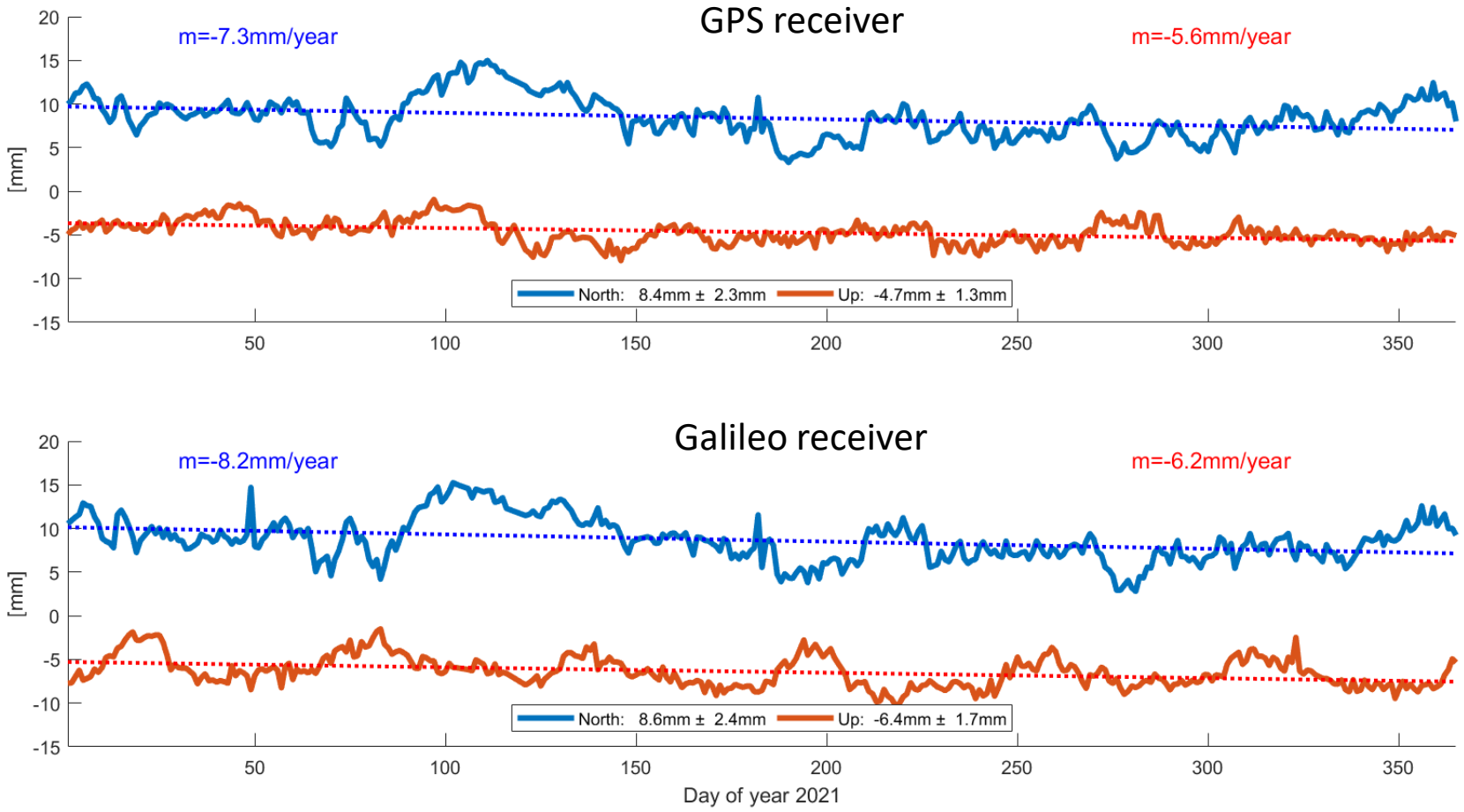


Original PCO
-3.17mm±8.62mm

Corrected PCO
1.15mm±8.56mm

Sentinel-6A

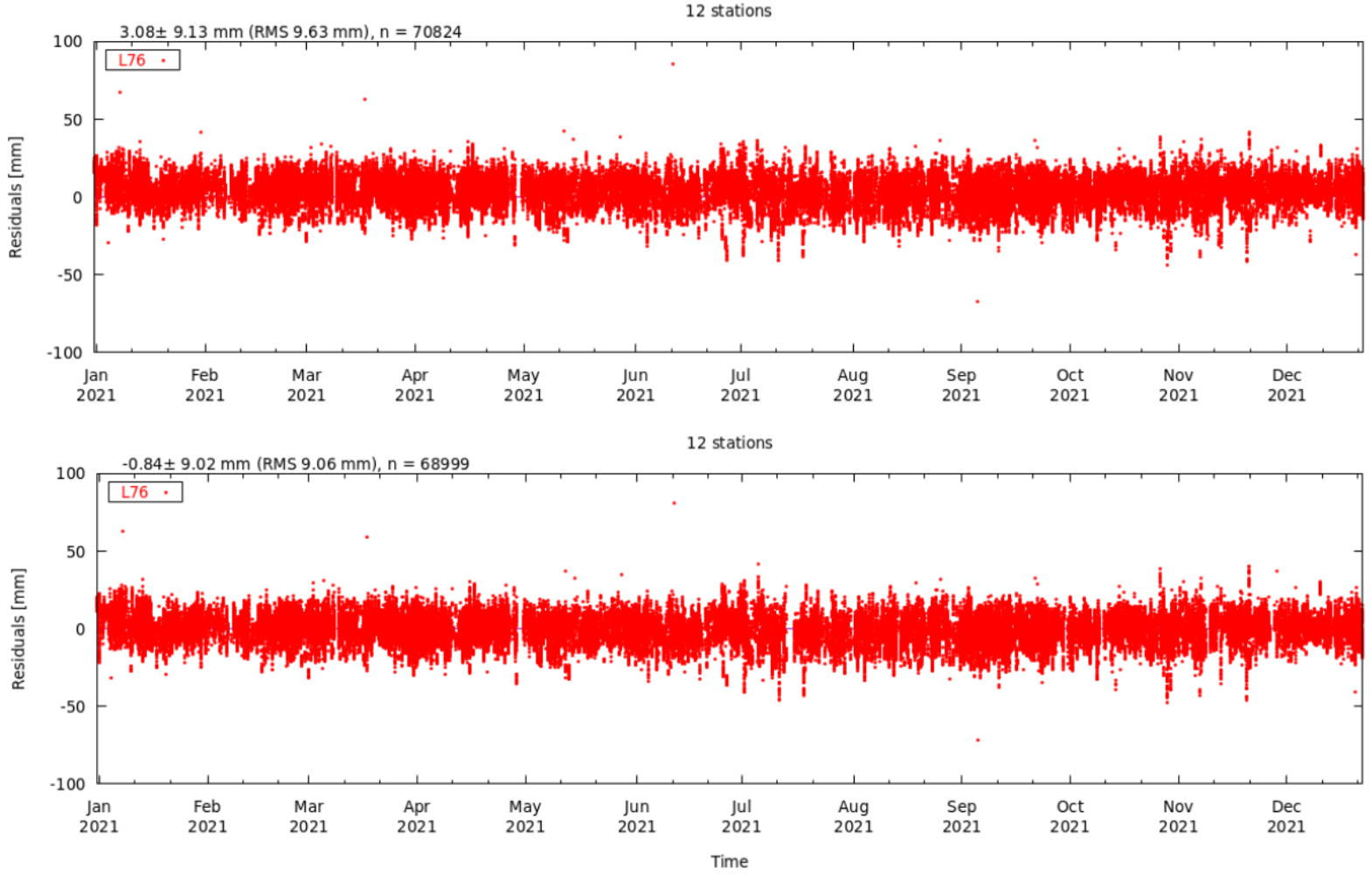
- PCO correction estimation for GPS and Galileo receiver



- GPS/Galileo only solutions
- For both receivers an offset in north direction of ~8.5mm is estimated
- For both receivers a significant correction in up direction is estimated

Sentinel-6A

- SLR Validation of Reduced-dynamic orbit solutions, original/corrected PCO used in POD



Original PCO
3.08mm±9.63mm

Corrected PCO
-0.84mm±9.02mm

Summary

- PCO correction estimation with Bernese GNSS Software gives reliable results
- PCO correction estimation can serve as reference to detect modelling deficiencies
- According to SLR validation applying estimated PCO offset corrections lead to reduced-dynamic orbit solutions of improved quality, since mean and standard deviation are smaller when using a corrected PCO in the POD process

THANK YOU FOR YOUR ATTENTION!