Orbit, clock and attitude analysis of QZS-1R

P. Steigenberger, A. Hauschild, O. Montenbruck

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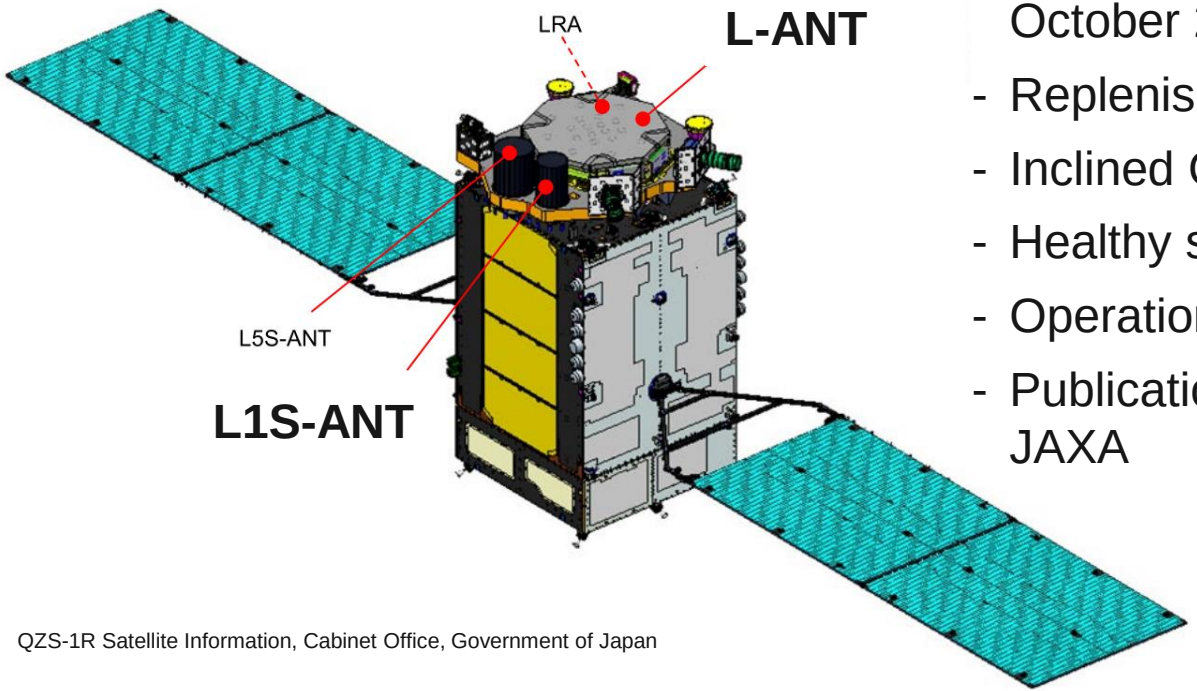
QZS-1R



- 5th satellite of the Japanese Quasi-Zenith Satellite System launched in October 2021
- Replenishment for QZS-1
- Inclined Geo-Synchronous Orbit
- Healthy since January 31, 2022
- Operational since March 24, 2022
- Publication of satellite metadata by JAXA

QZS-1R Satellite Information, Cabinet Office, Government of Japan

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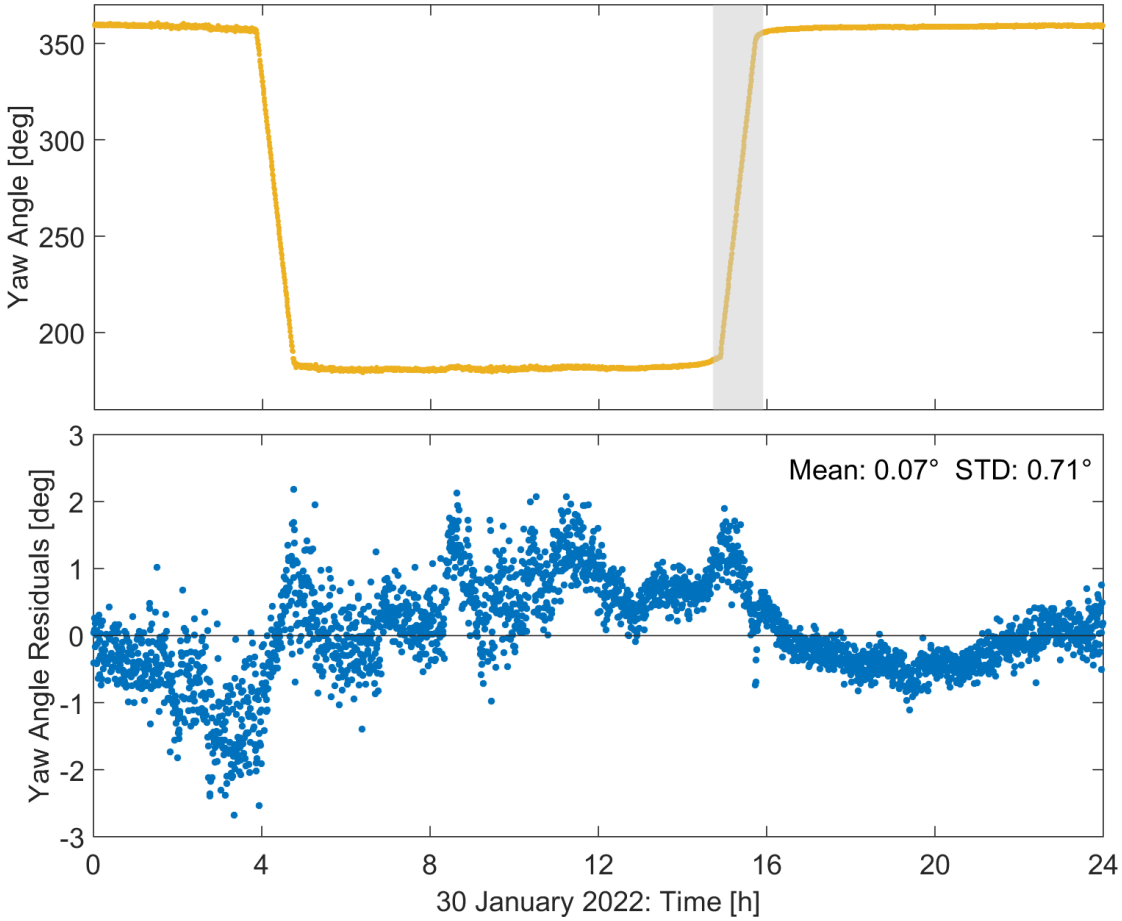
Attitude Determination

- Nominal attitude:
  - Yaw steering
  - Pseudo-yaw-steering if yaw rate exceeds 0.055 deg/s
- L1S: **S**ub-meter **L**evel **A**ugmentation **S**ervice
- Estimation of offset vector

$$|b| = 1.268 \text{ m}$$

- Estimation of yaw angle

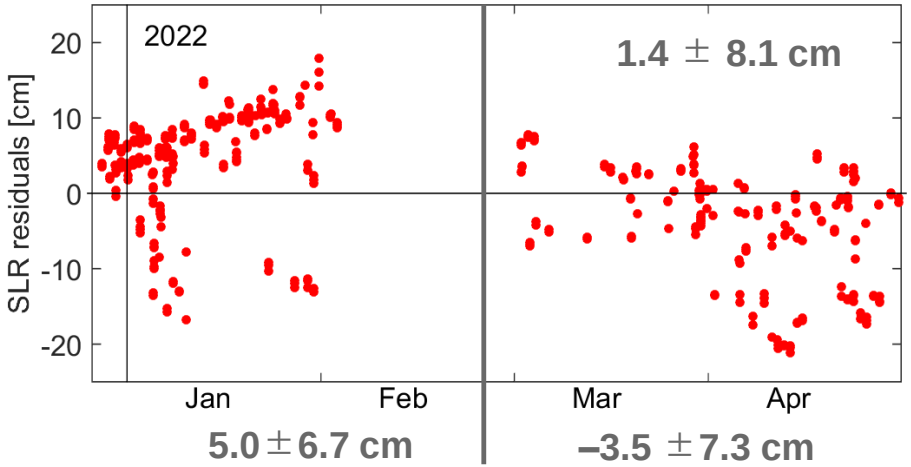


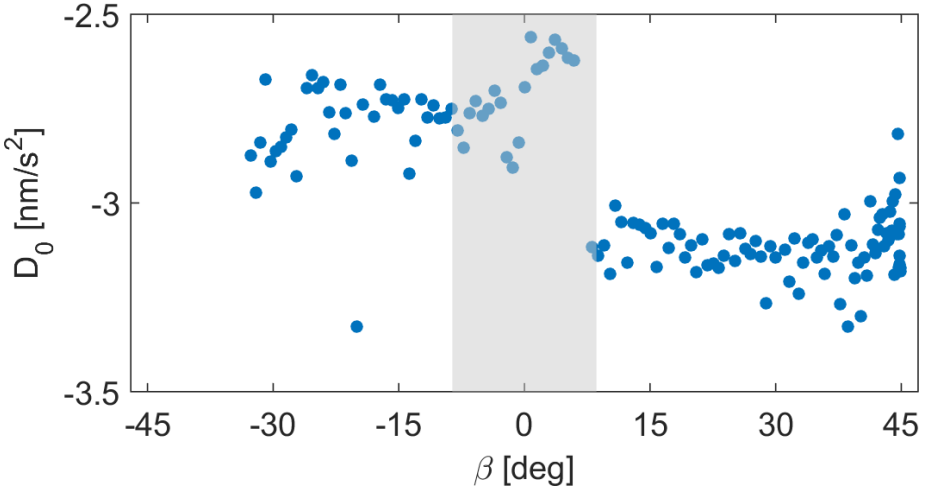
Orbit Determination

- Box-wing model from JAXA metadata + 5-parameter ECOM-1 vs. ECOM-2

Day boundary discontinuities

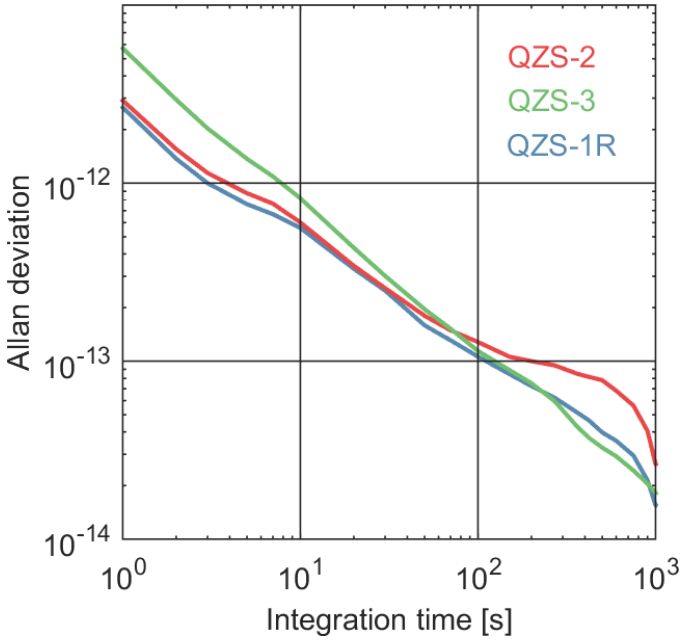
Box-wing	19.8 cm
ECOM-2	23.6 cm



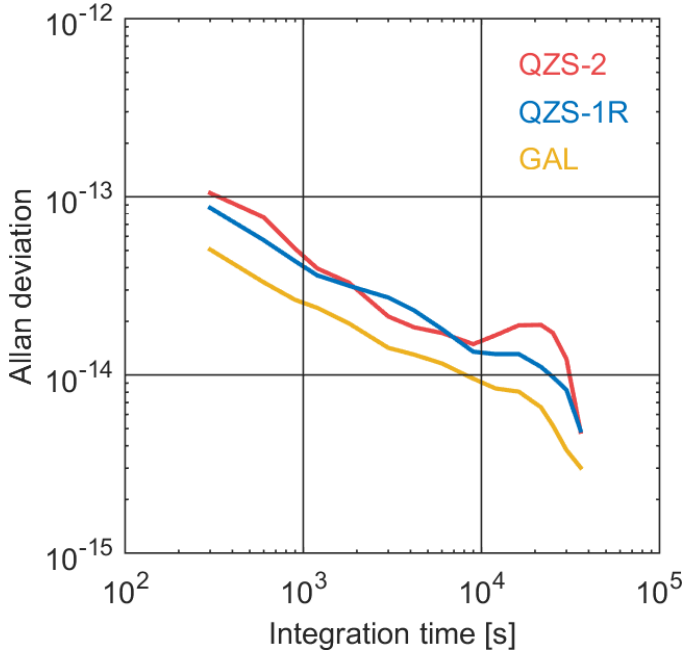


Clock Performance

1 Hz one-way carrier phase analysis



5 min clocks from POD



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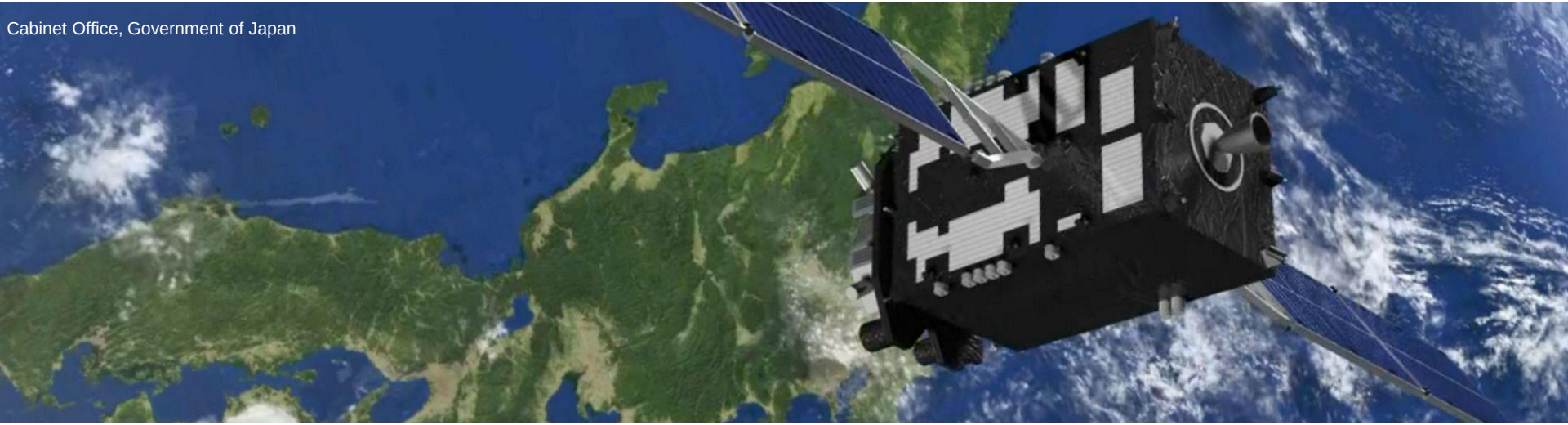

Slides as well as additional material available at

https://meetingorganizer.copernicus.org/EGU22/EGU22-4504.html

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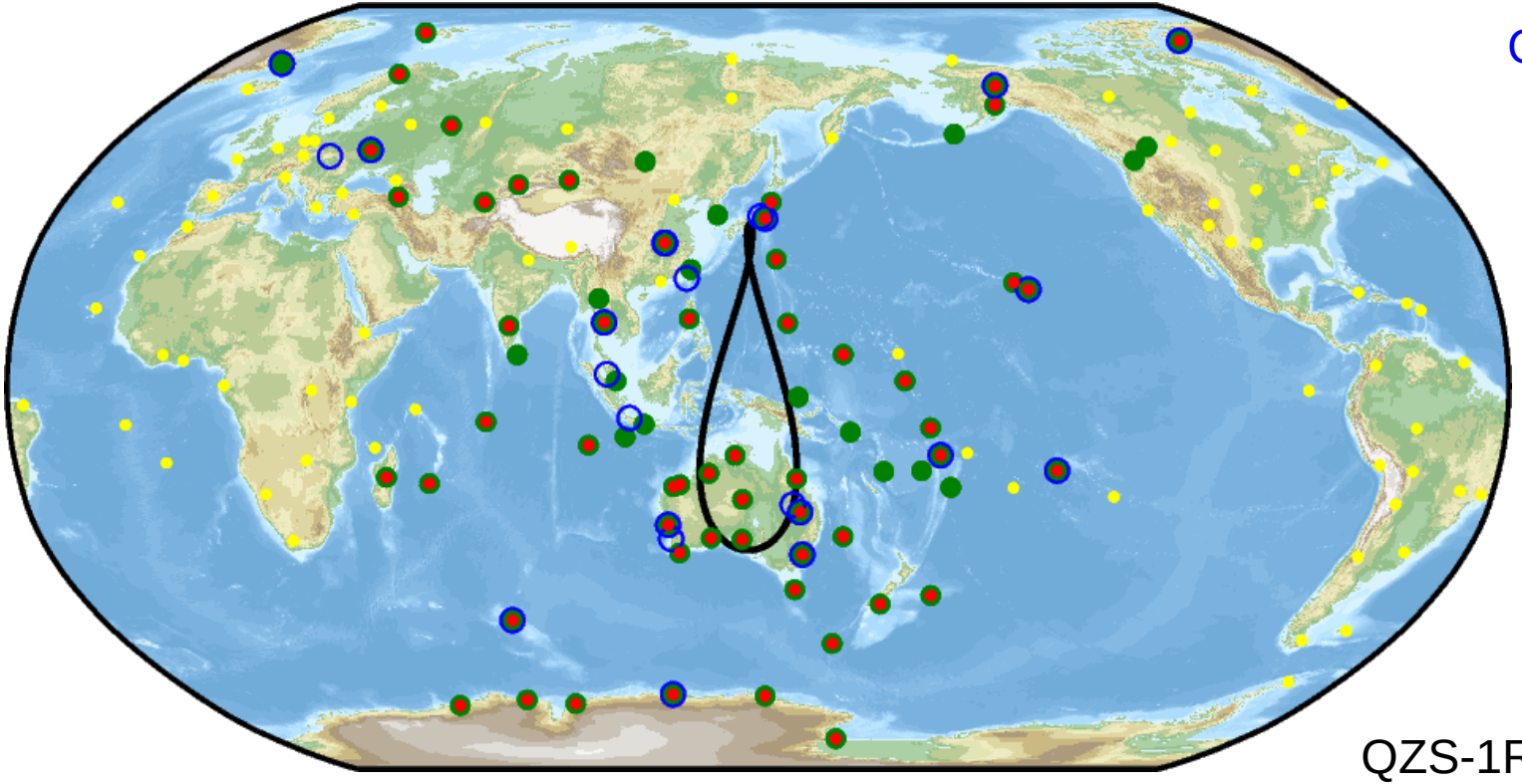
Tracking Network



QZS-1R L1S
QZS-1R
QZSS
GPS

QZS-1R Groundtrack

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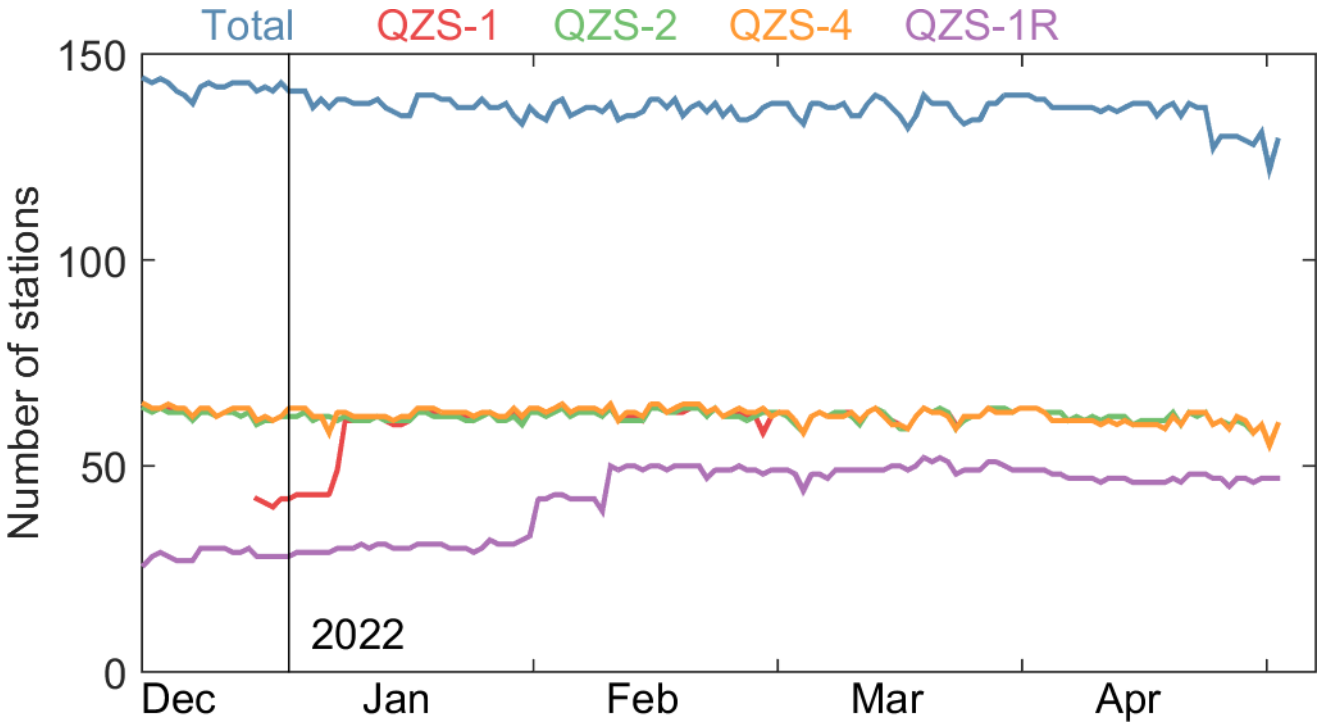
Number of Stations



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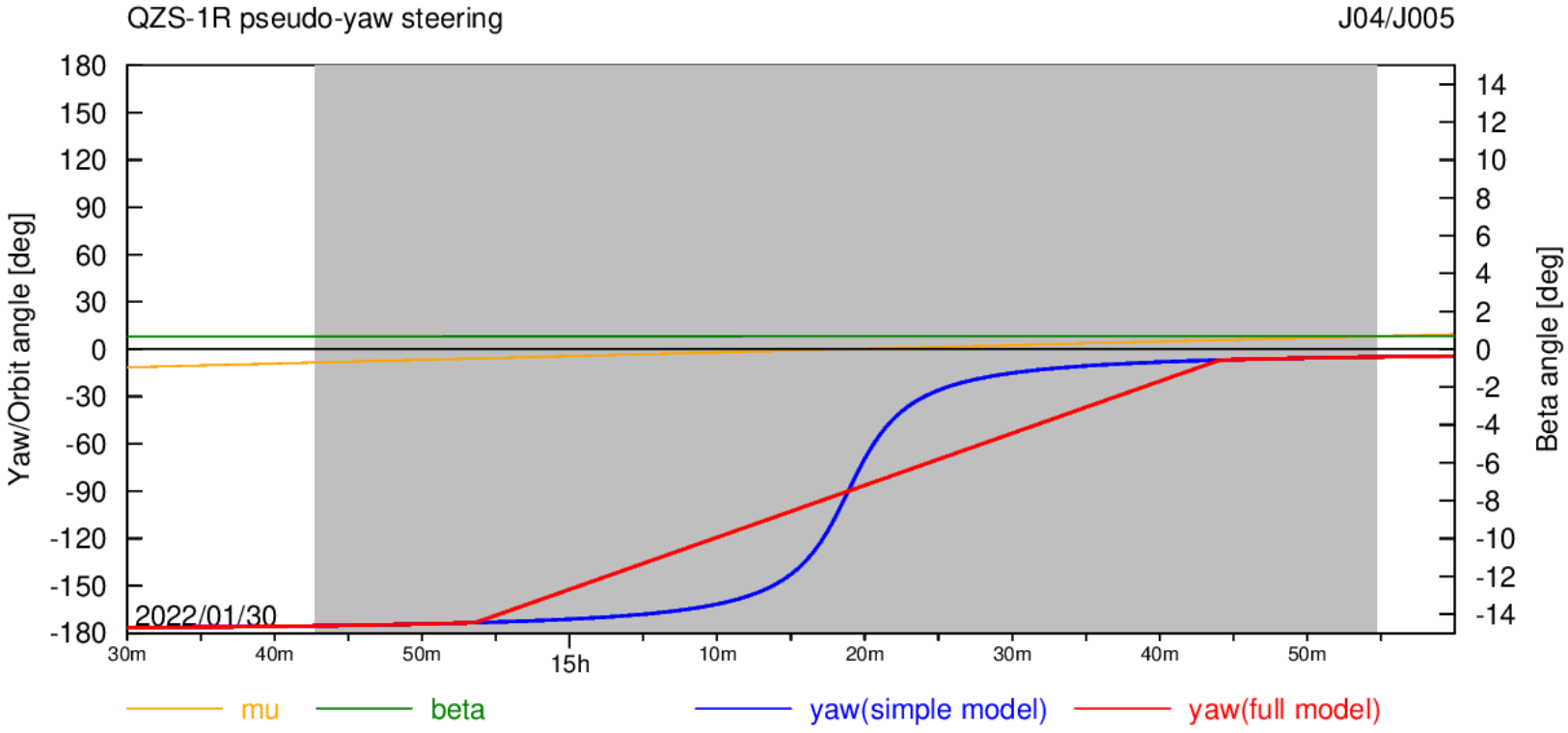
QZS-1R Attitude Model

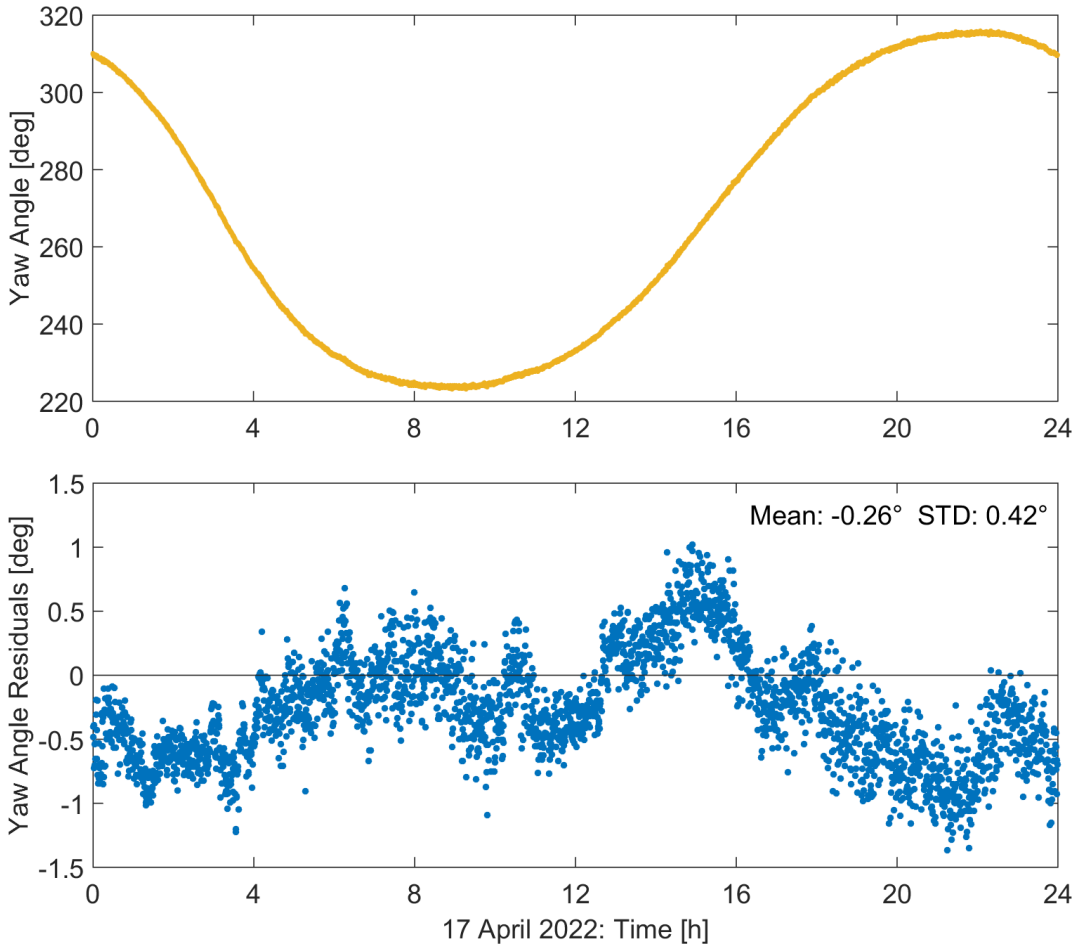


Estimated Attitude

- Yaw angle estimation based on L1 C/A and L1S observations of 23 stations
- Baseline vector:

$$
\begin{aligned}
b_x &= -1.138\ \mathrm{m} \\
b_y &= -0.530\ \mathrm{m} \\
b_z &= \ \ 0.182\ \mathrm{m}
\end{aligned}
$$

- Nominal yaw steering
- Elevation of the Sun above the orbital plane: 43.8°



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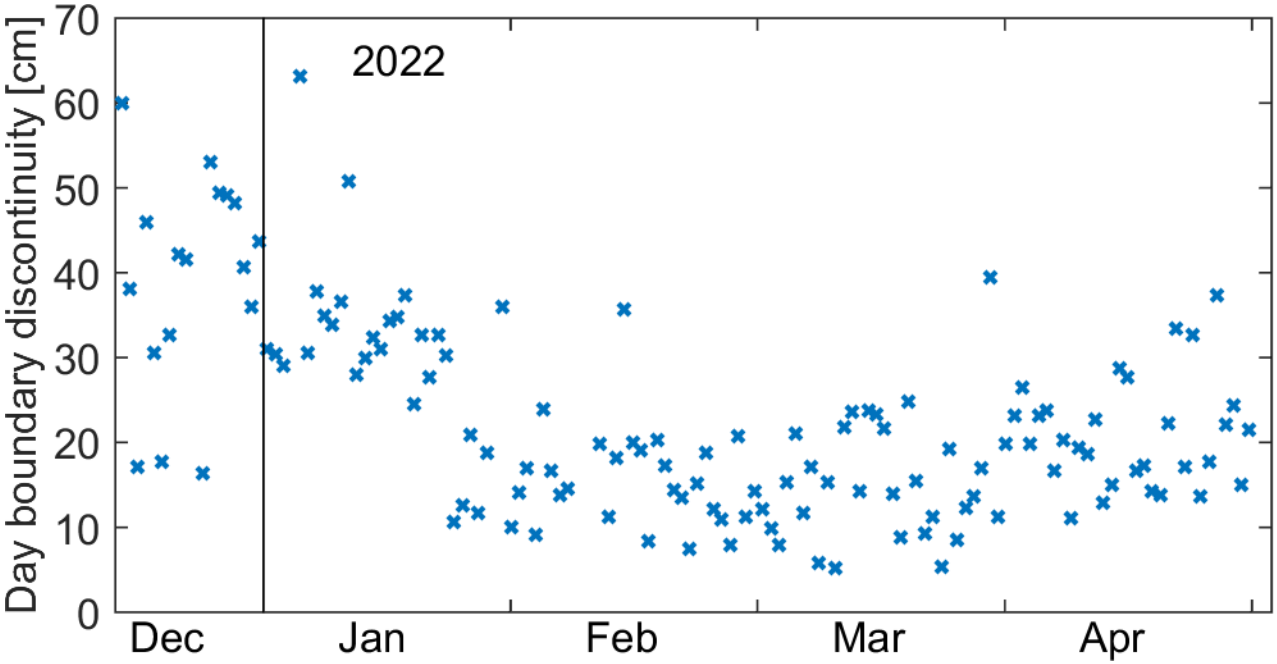
Day Boundary Discontinuities



- 1-day solution with box-wing model
- 3D orbit differences at midnight epoch
- Median value: 19.8 cm

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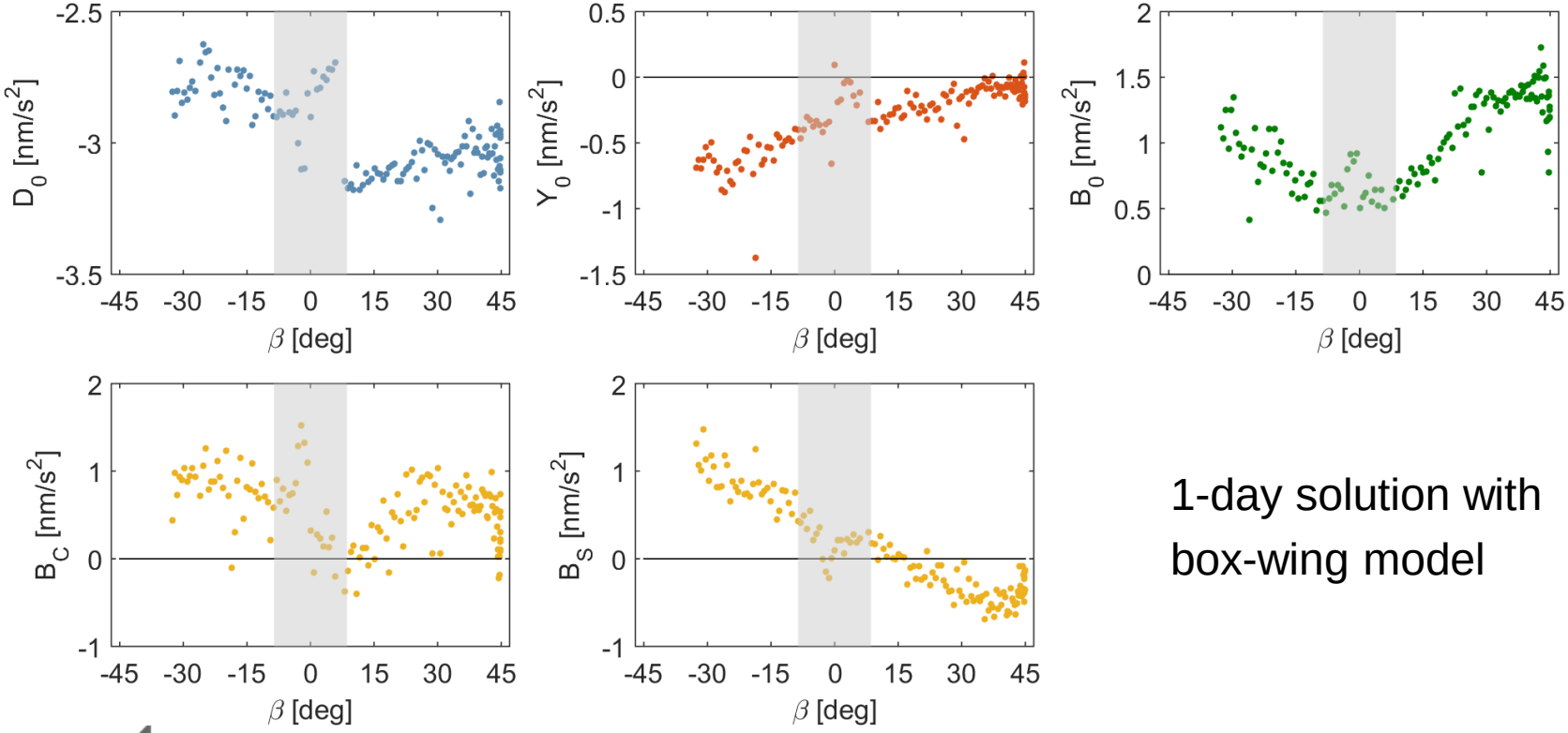
Estimated ECOM Parameters



1-day solution with box-wing model

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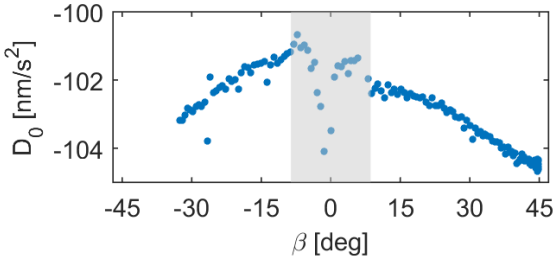
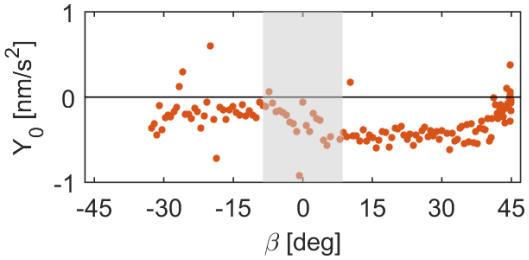
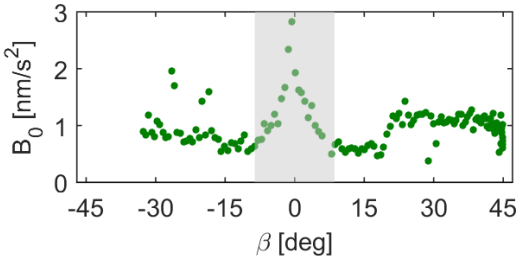
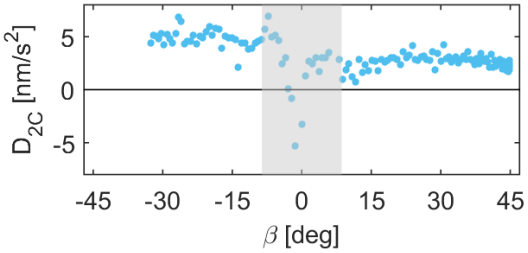
Estimated ECOM-2 Parameters

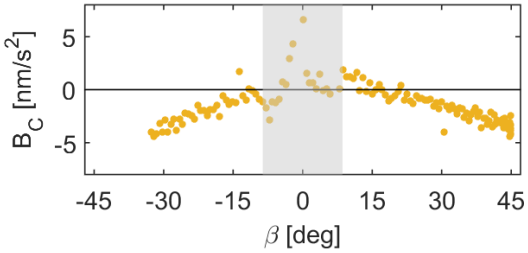


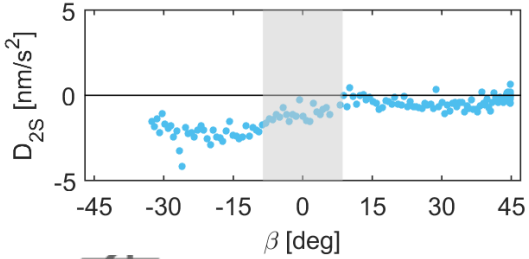


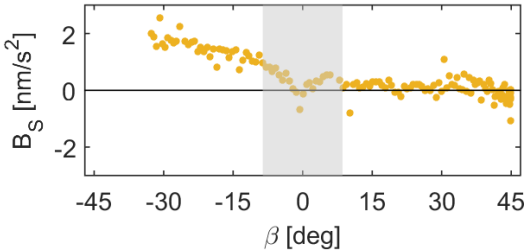




1-day solution







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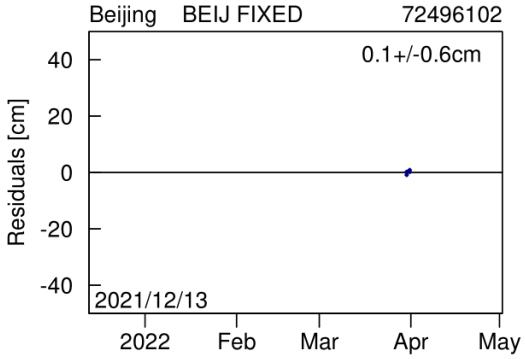
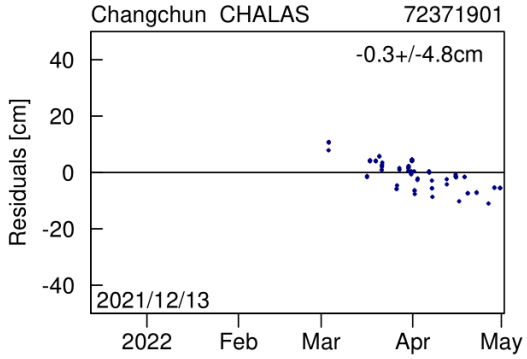
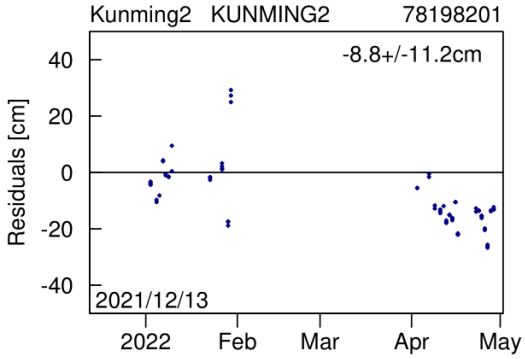
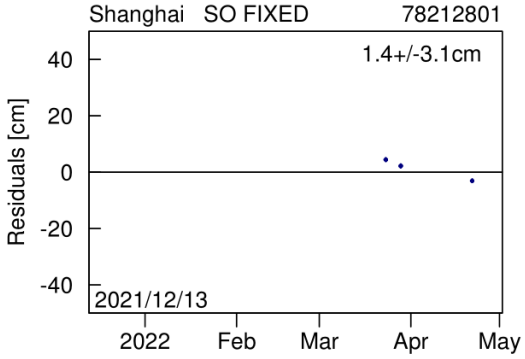
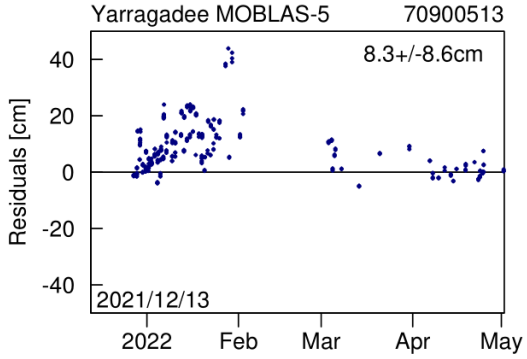
Station-specific SLR Residuals











1-day solution with box-wing model

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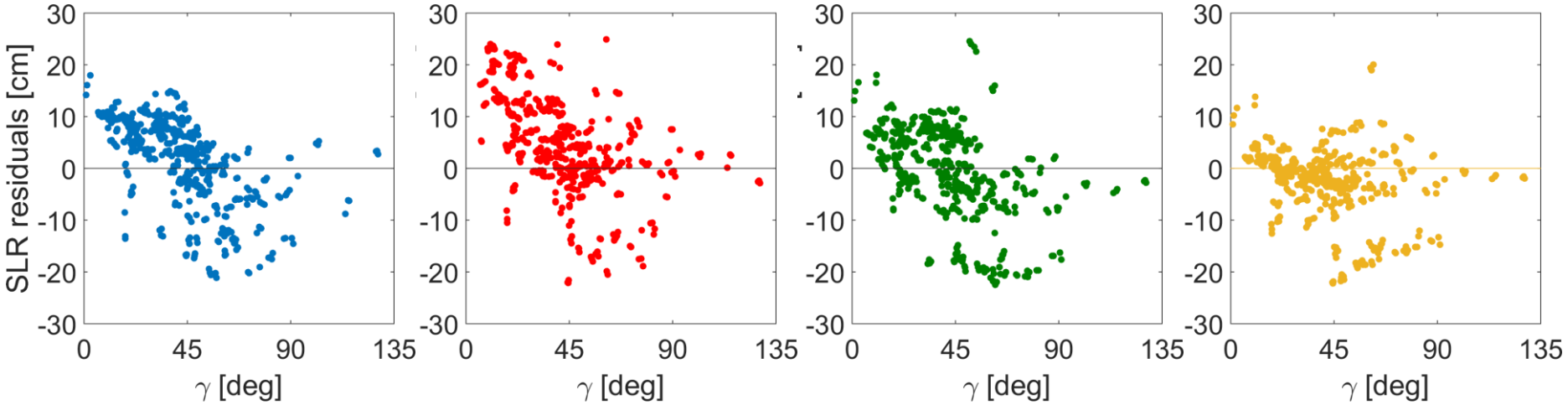
SLR Residuals vs. Sun Elongation

1-day solution with box-wing model

1-day solution with ECOM-2

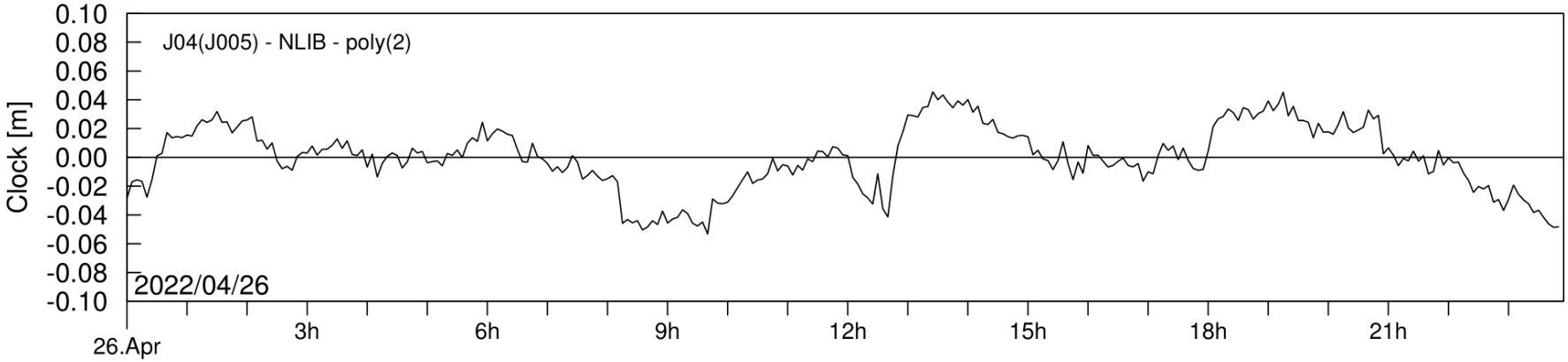
3-day solution with box-wing model

3-day solution with ECOM-2



Clock Time Series

5 min clocks, 1-day solution with box-wing model,
2nd order polynomial removed



Resources

- QZSS satellite metadata and operational history: https://qzss.go.jp/en/technical/qzssinfo/index.html
- QZSS Interface Specifications: https://qzss.go.jp/en/technical/ps-is-qzss/ps-is-qzss.html
- First transmission of L1C/B by QZS-1R: https://www.gpsworld.com/first-transmission-of-l1c-b-by-qzs-1r/