HK Clocks @LPNHE
Status of the GNSS data-taking

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Description

GNSS data-taking

Setup description

On the 18th of January, at ~3.30pm, started two simultaneous data-taking:

1. Pps residuals, with GNSS receiver, using Rb 10MHz as external reference

2. Frequency measurement, with frequency counter 2, of 5MHz Rb using 5MHz PHM as external reference, 0.1mHz resolution

Results so far

Preliminary results

Correction description

The correction performance is evaluated using the ASD of the Rb frequency series measured against the PHM.

1. The frequency $y^i_{RbvsPHM}$ series is converted in time series $dt^i_{RbvsPHM}$
2. The time series is corrected:
   $dt^i_{RbvsPHM,\,corr} = dt^i_{RbvsPHM} - a \times i^2 - b \times i - c,$ where a, b and c are extracted form the fit of the pps residuals with GNSS over a certain time window Δt
3. The ASD of the corrected time series is compared for different values of Δt

Preliminary results

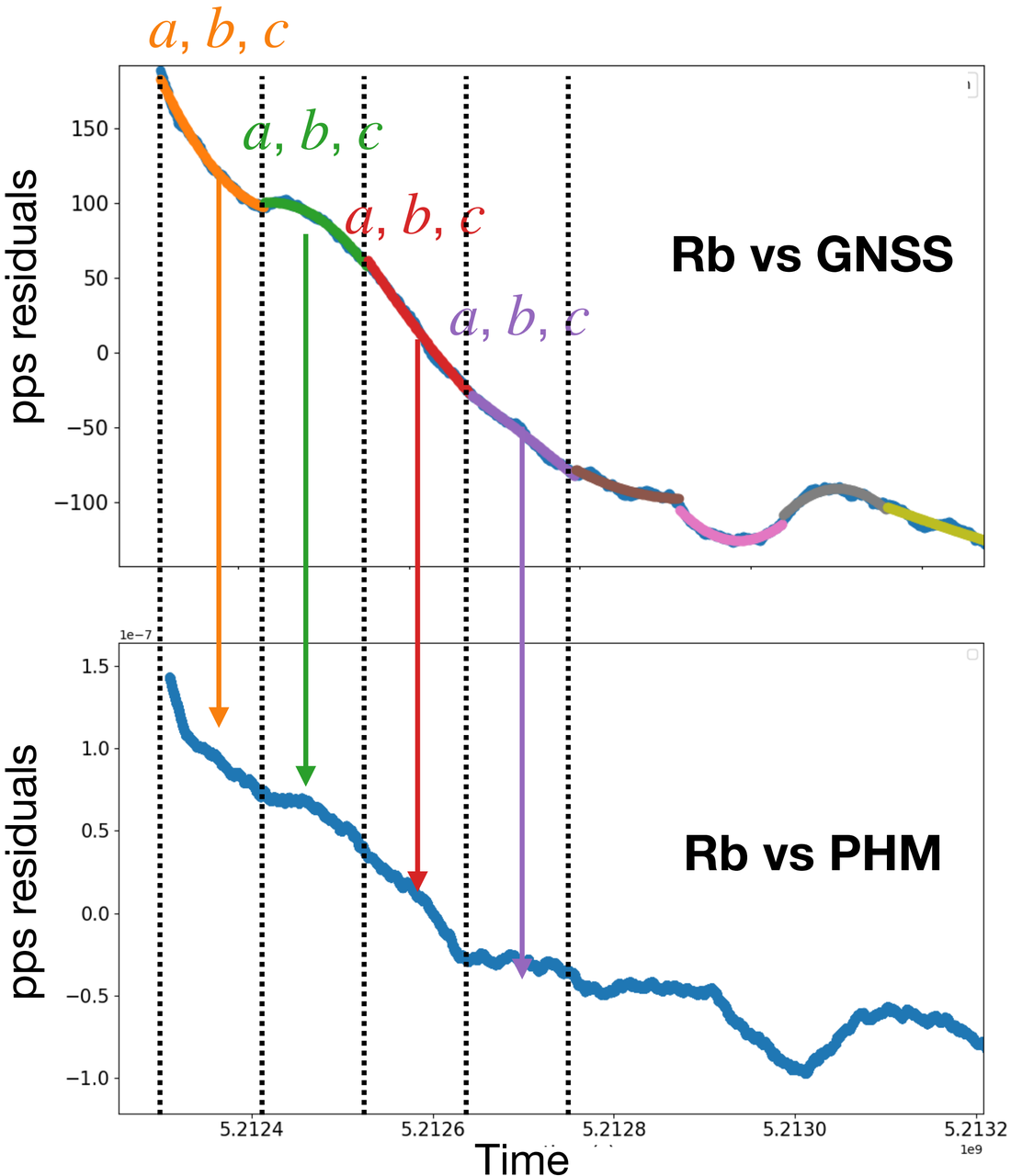
Correction description

Two correction principle possible:

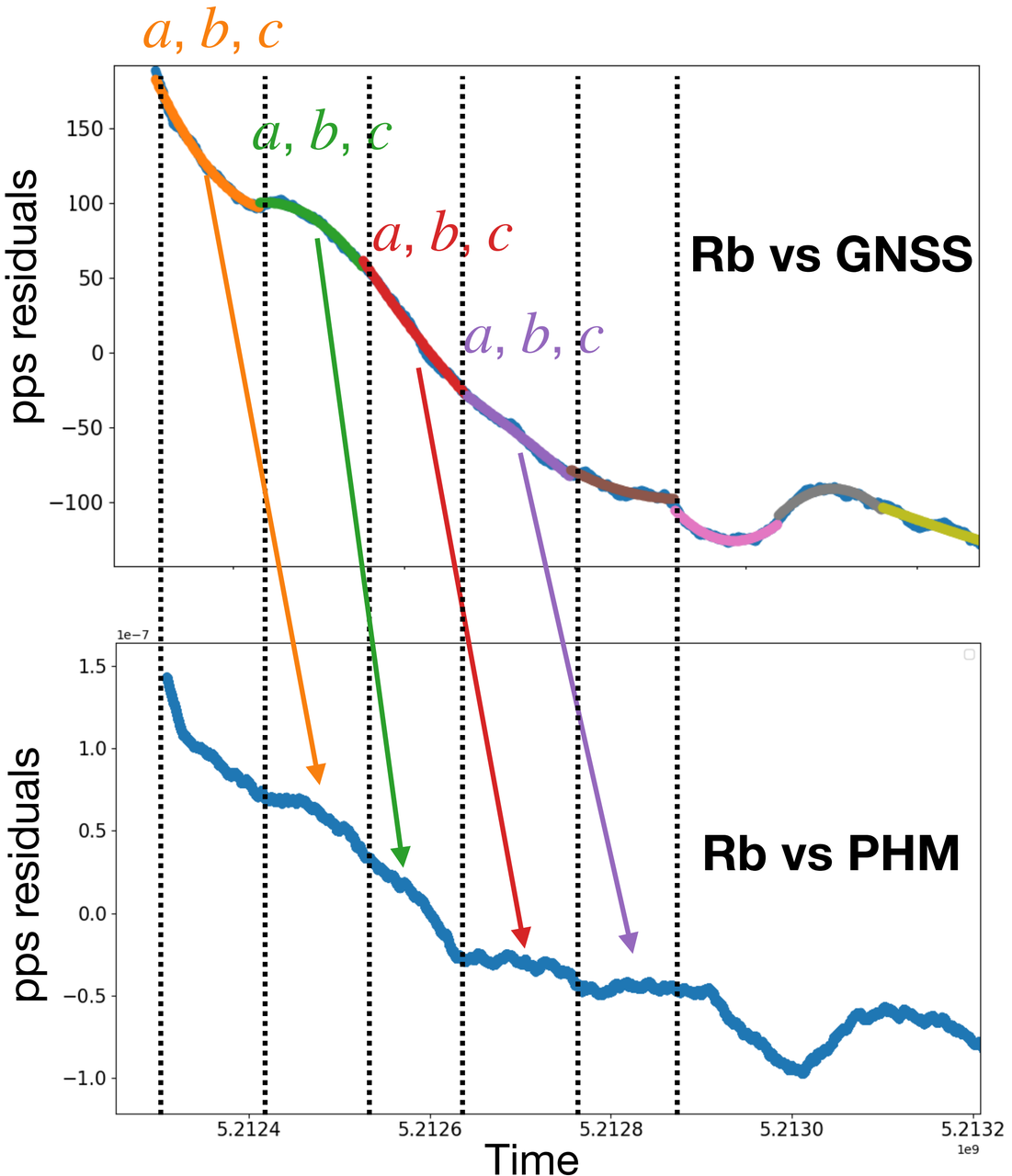
1. Offline: we fit consecutive subset of the residuals with GNSS to get a, b and c; we correct the corresponding (simultaneous) subset of RbvsPHm time series.

2. Online: The RbvsPHM time series is corrected with the latest values of a, b and c; a, b and c are updated every time we receive enough new pps residual from the GNSS receiver.

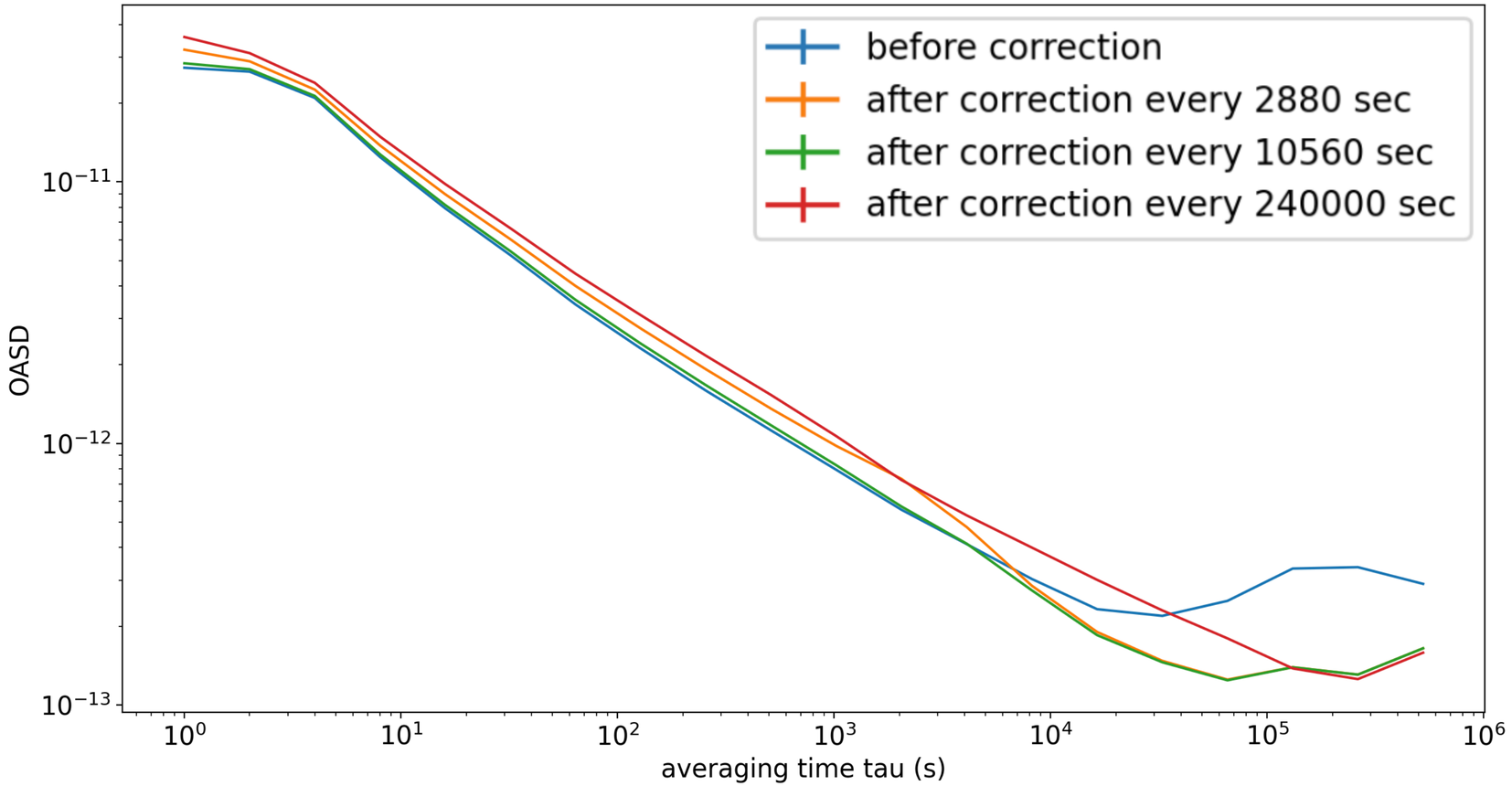
Offline correction



Online correction

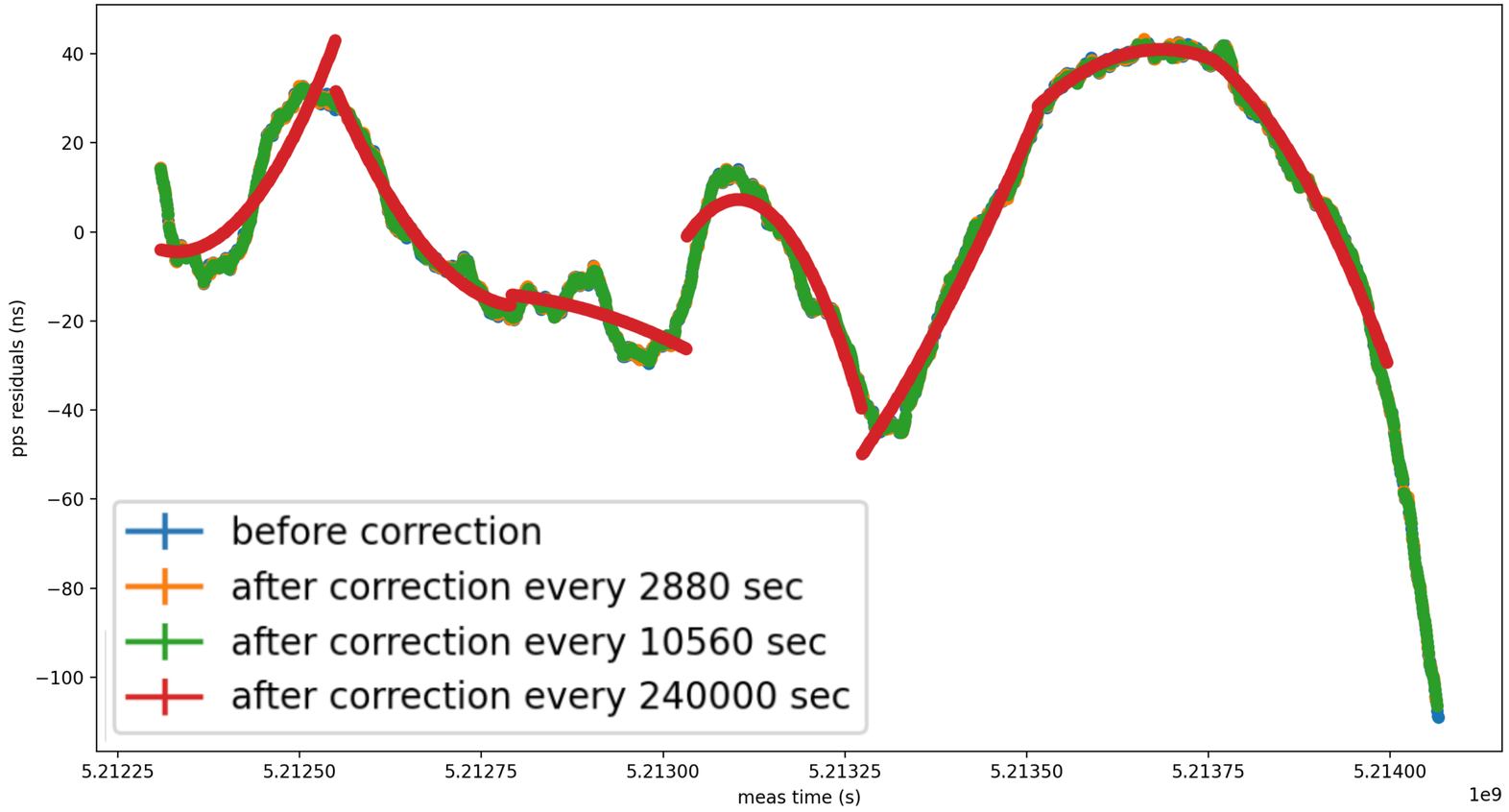


ASD Rb vs PHM



Why the short term performance is also reduced in the “under-corrected case”

Rb vs GNSS fitted residuals



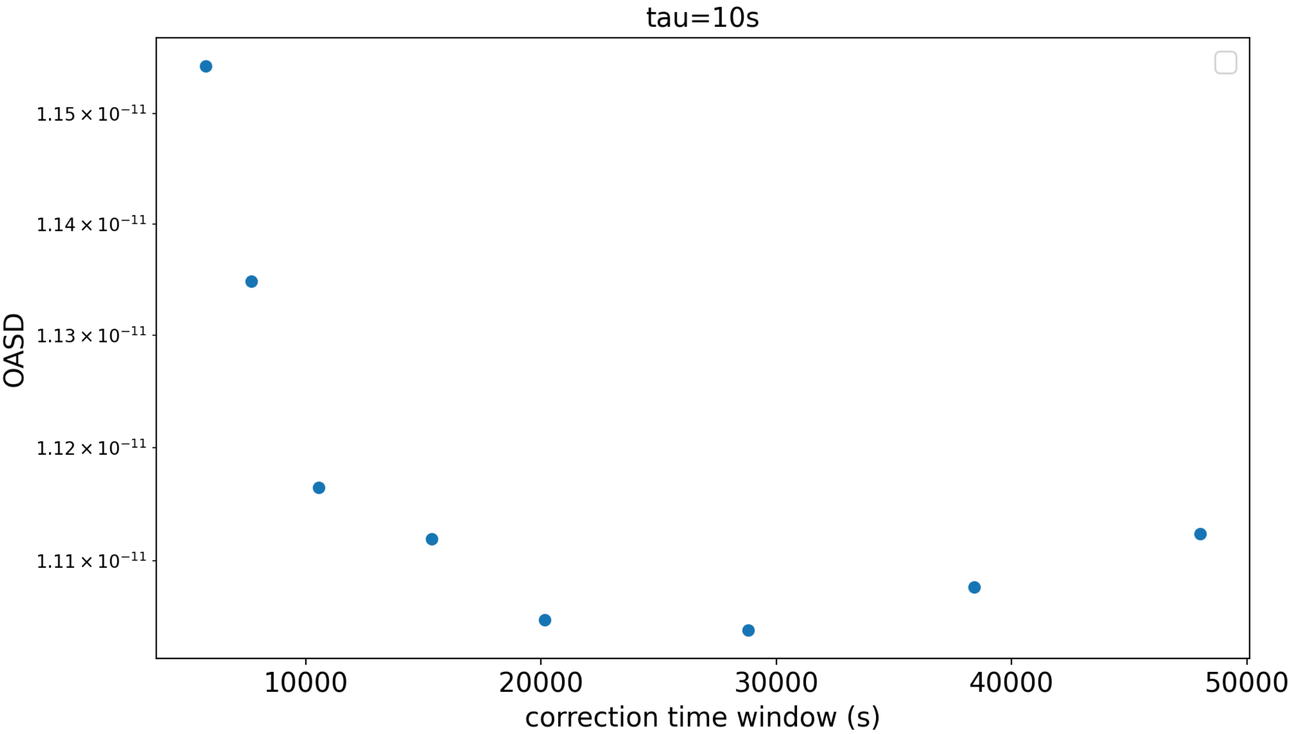
Because the fit quality is too bad (time scale of fit >> time scale of significant variations)

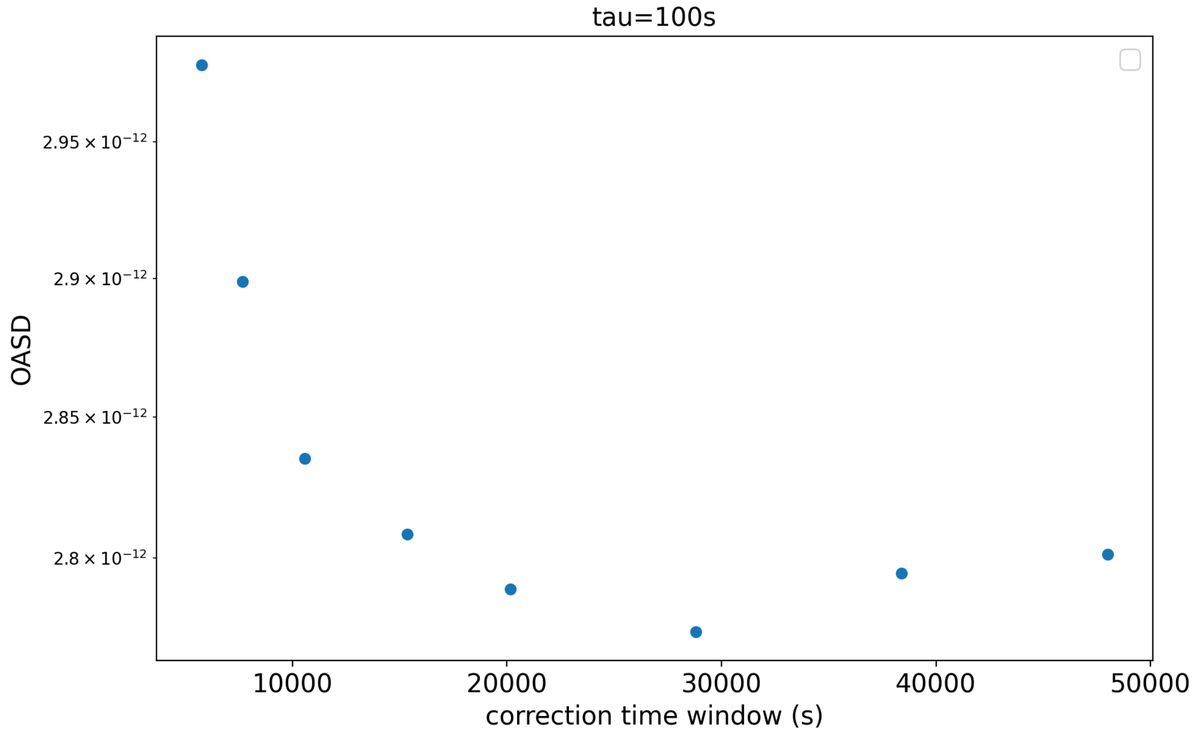
Correction time window optimisation

From previous observations, we guess that the optimal time window is around 1e4s for both short and long term stability.

Time window optimisation

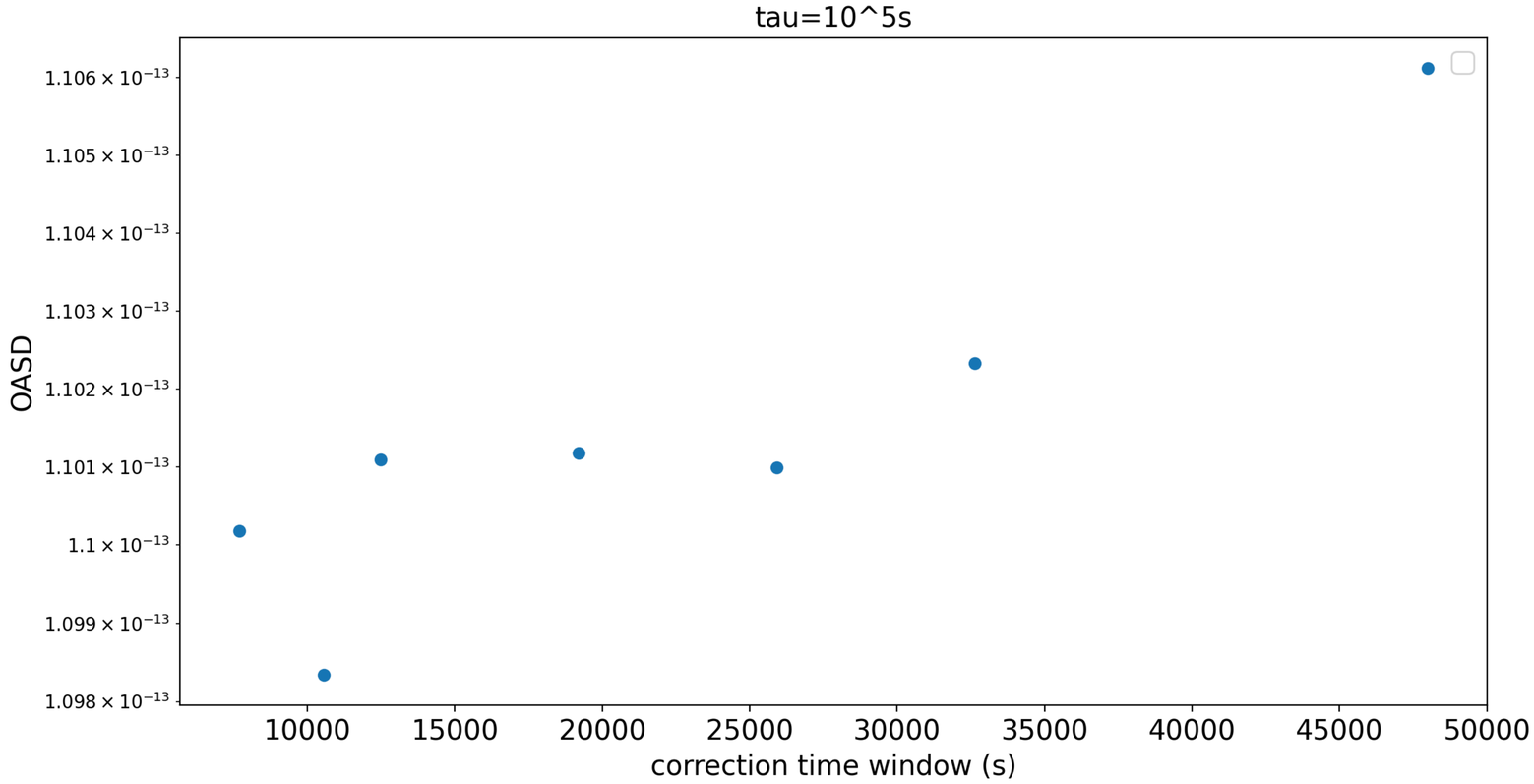
short term stability





Time window optimisation

long term stability



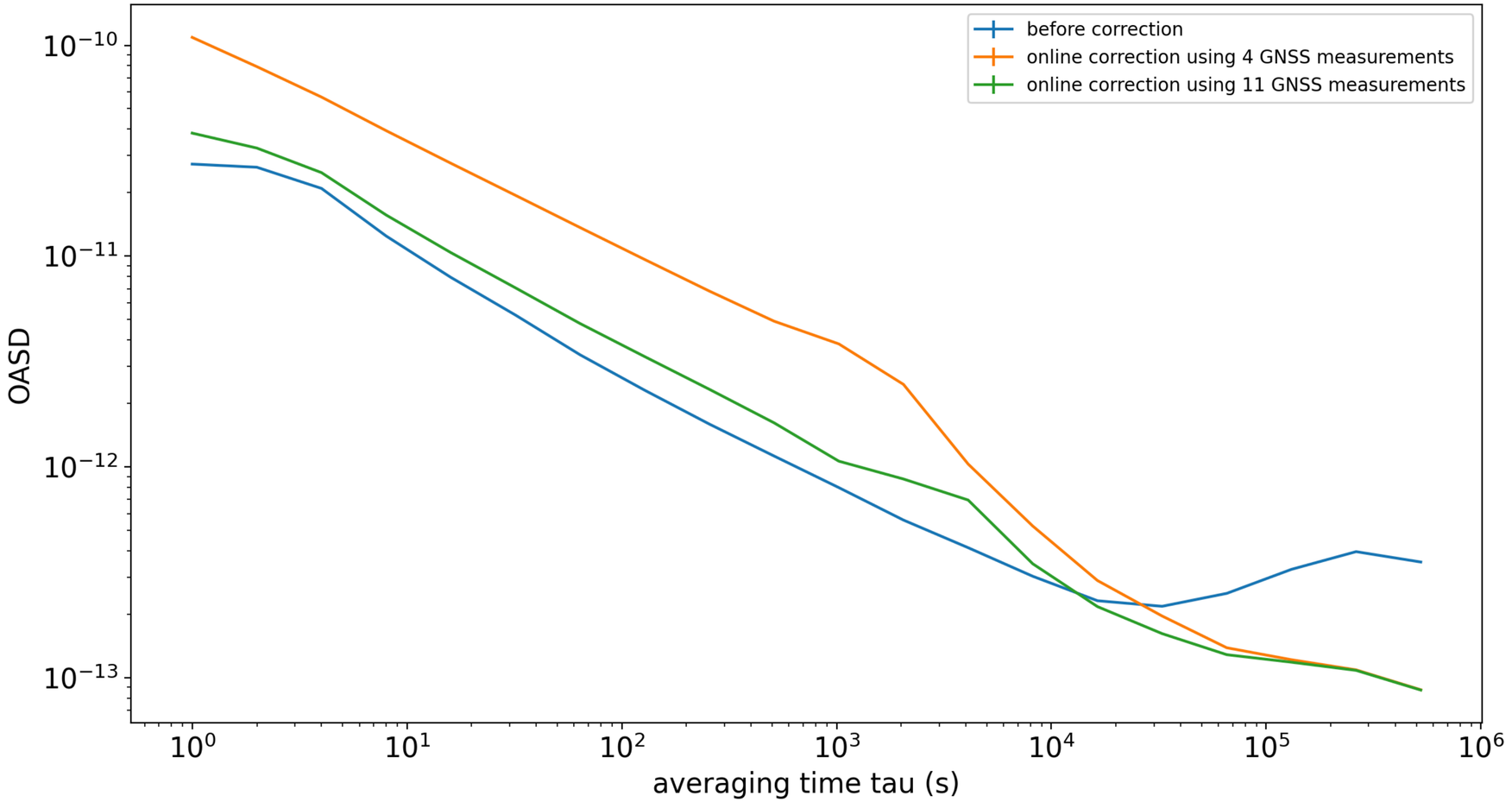
Preliminary results

Conclusion

The corrected ASD behaves more or less like we expected:

- For a too small time window: the short term performance is reduced because we get the GNSS phase WN (over-correction)
- The ideal time window seems to be around 1e4 s (2-3 hrs)
- For a too big time window:
    1. the short term performance is reduced because we cannot fit properly the variations of the pps residuals with GNSS (jumps are introduced
    2. Expect a reduction of the long term performance but to assess this we need more data

Test of online corrections

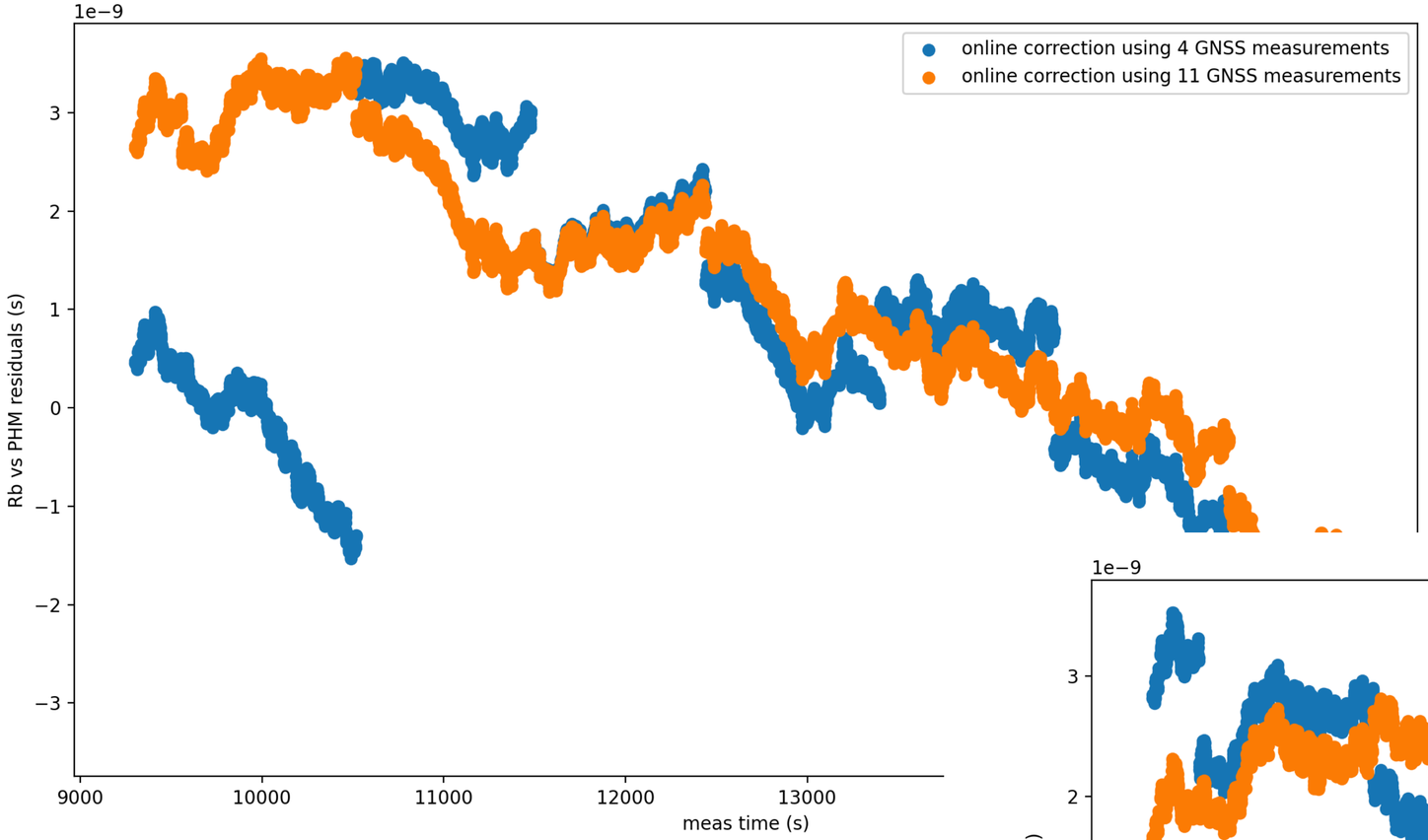


More phase WN for same time windows as offline correction.

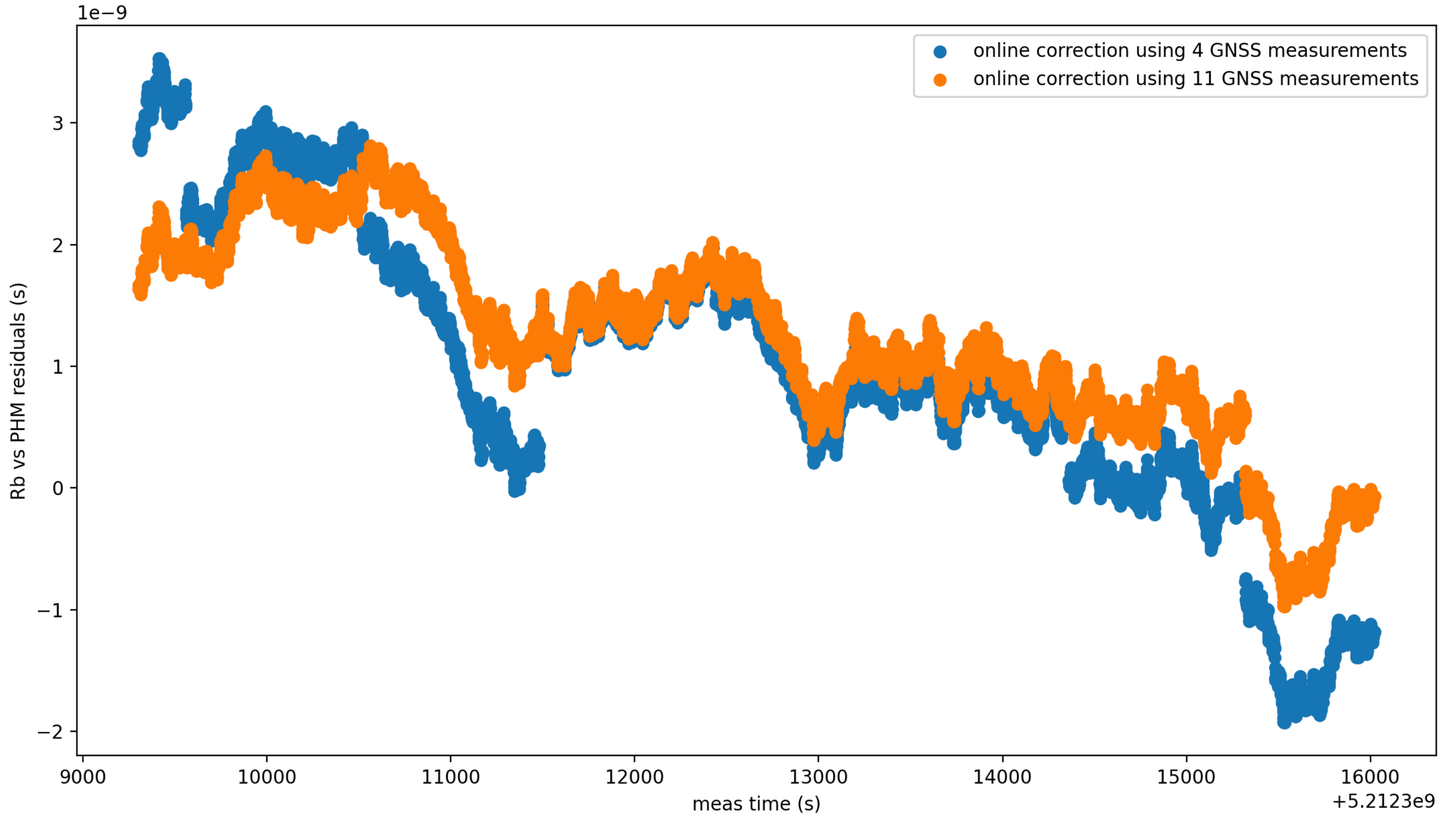
This can come from the fact that we overfit on data from the past (integrated RbvsGNSS pps residuals) to correct our present Rb time signal. The fit does not generalise well to near future.

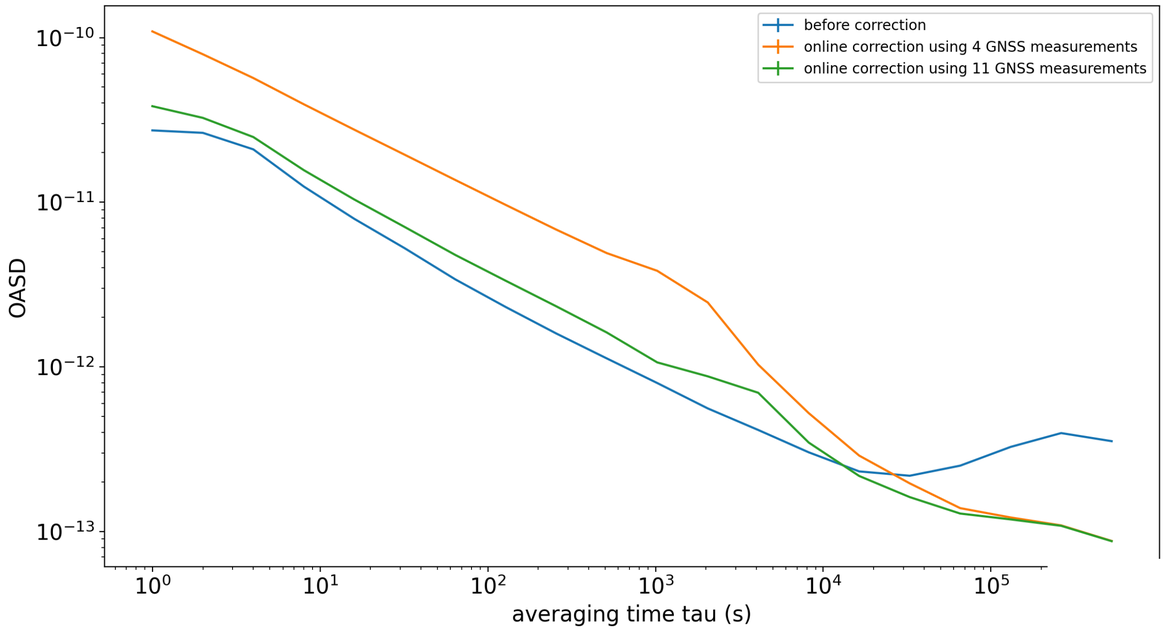
If that is true, we should obtain a better performance with linear fit (less degrees of freedom —> more generalisable)

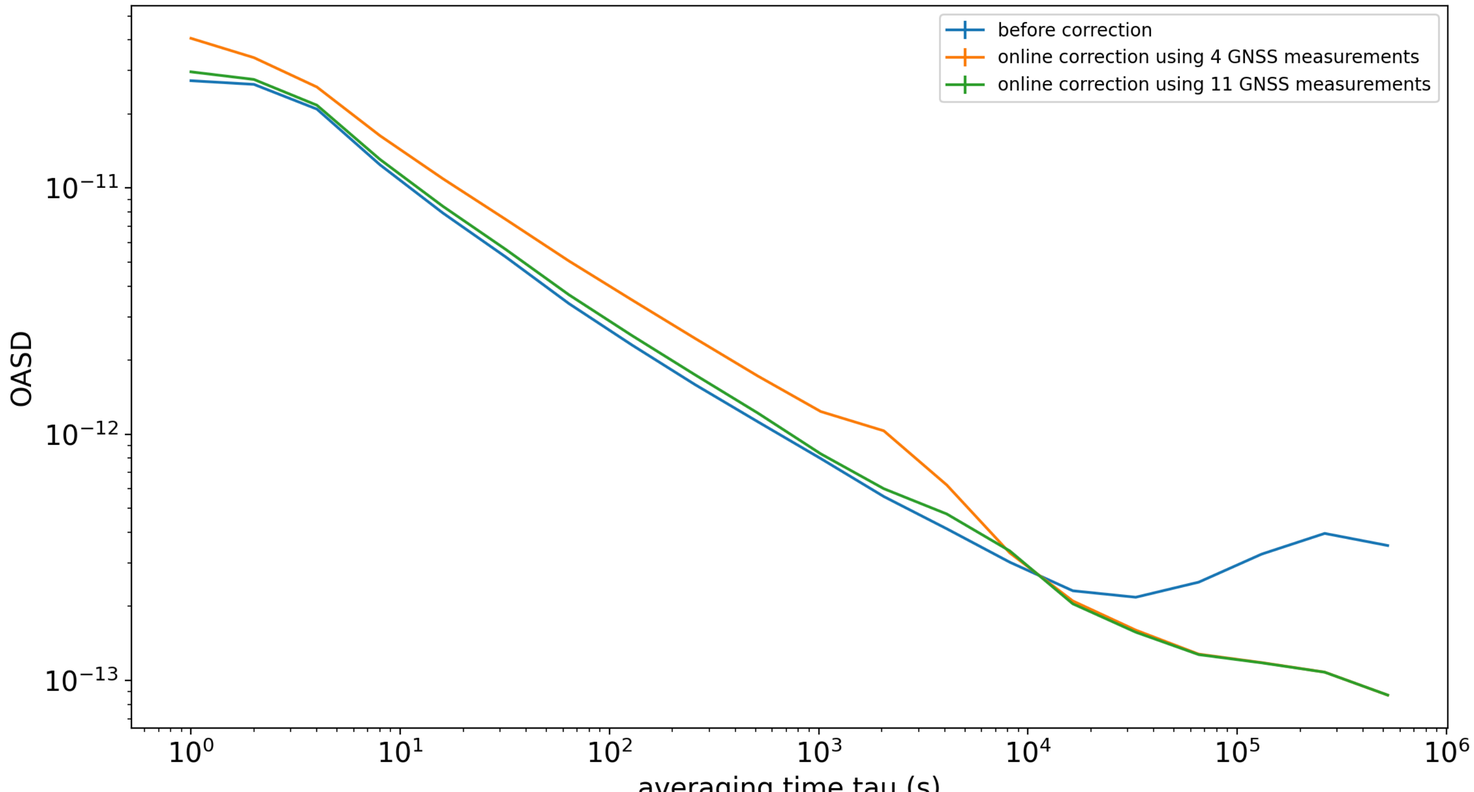
Using 2nd degree polynomial fit



Using linear fit

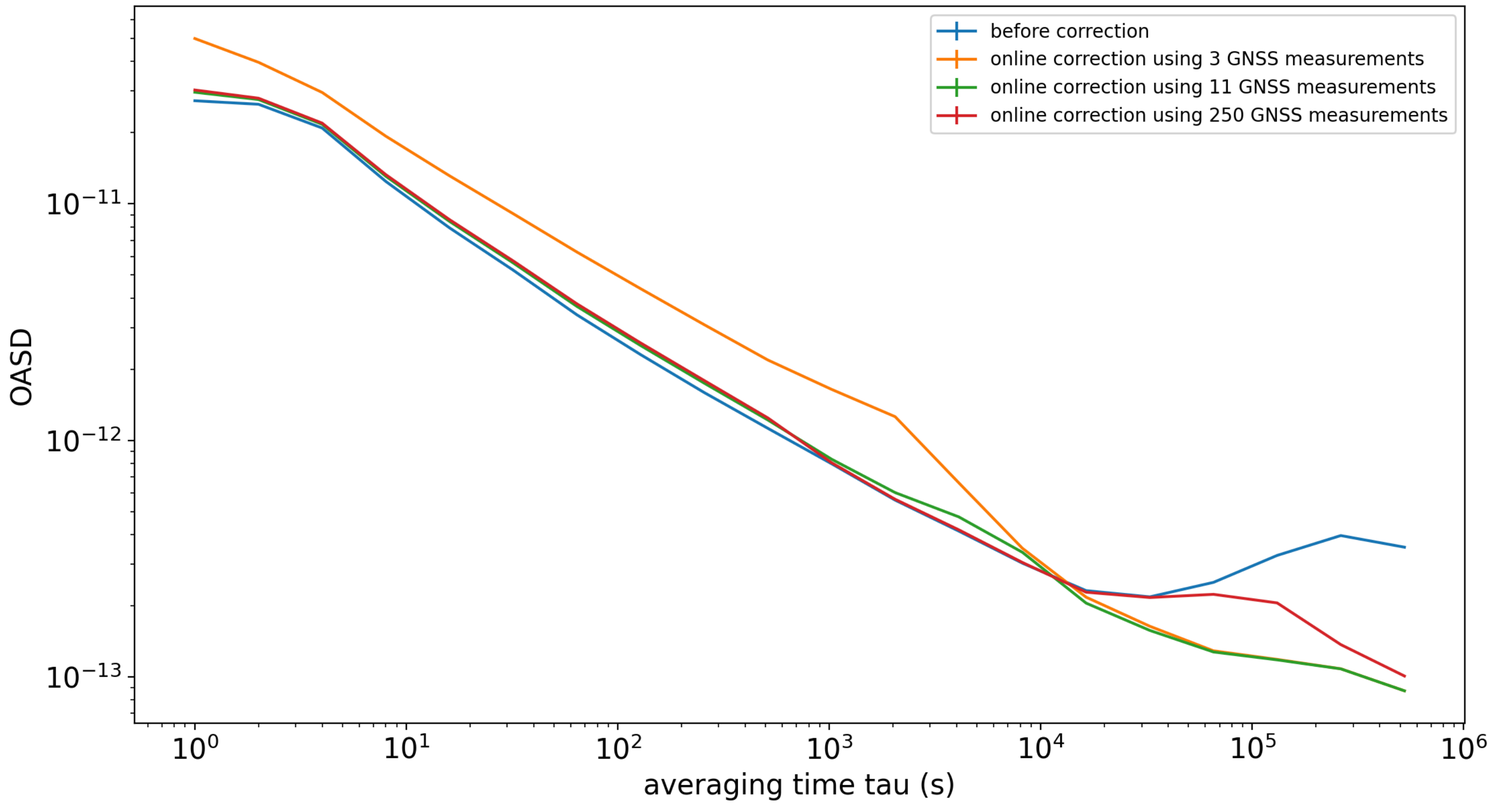






Better performance if we correct with linear fit of the RbvsGNSS pps residuals

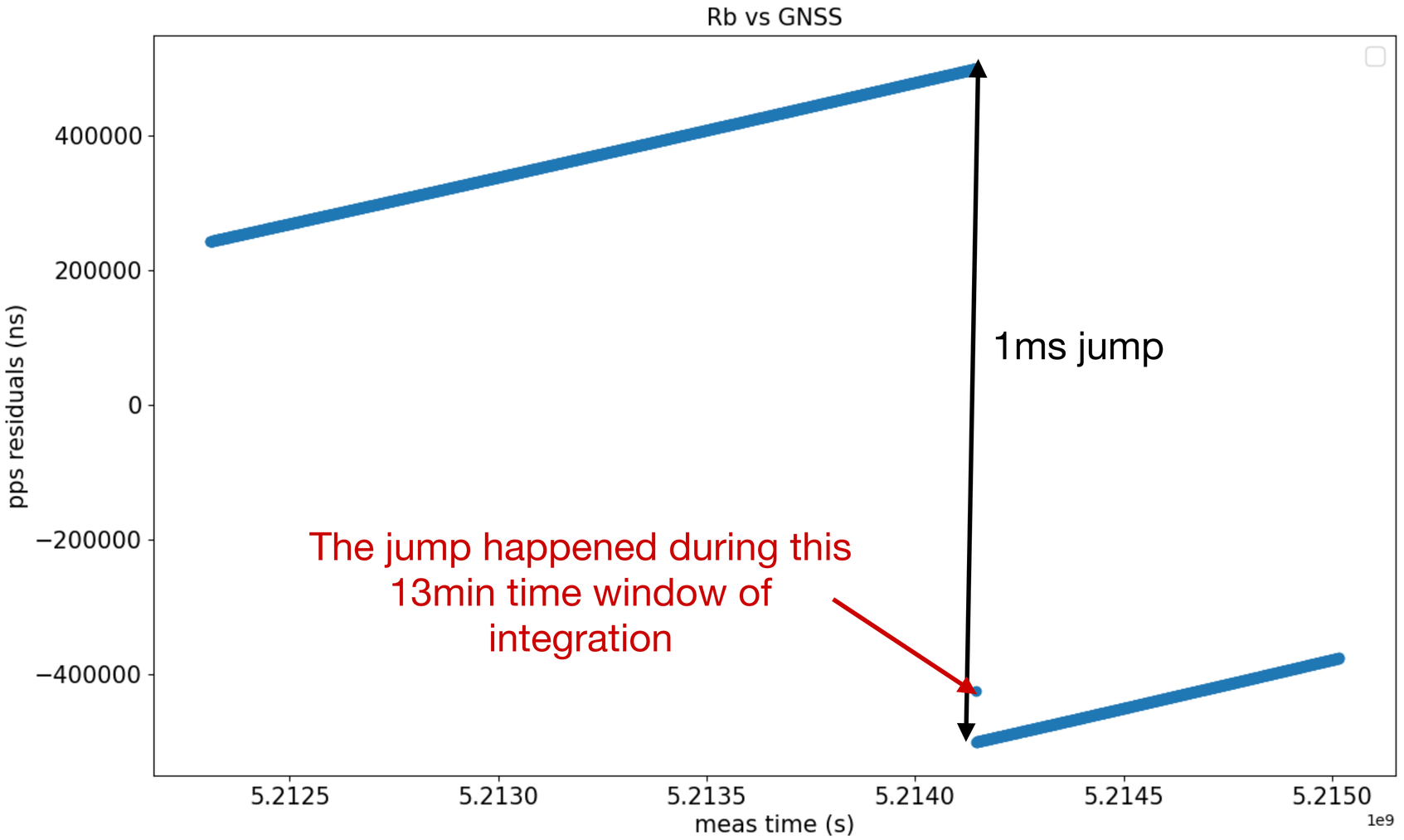
Online correction with linear fit of GNSSvsRb pps residuals



With online correction, thanks to overlapping fit time windows, we don’t introduce jumps in the “under-corrected case” (red short-term performance is same as green).

We start to see the degradation of long term performance in the under-corrected case.

Jumps in the receiver data



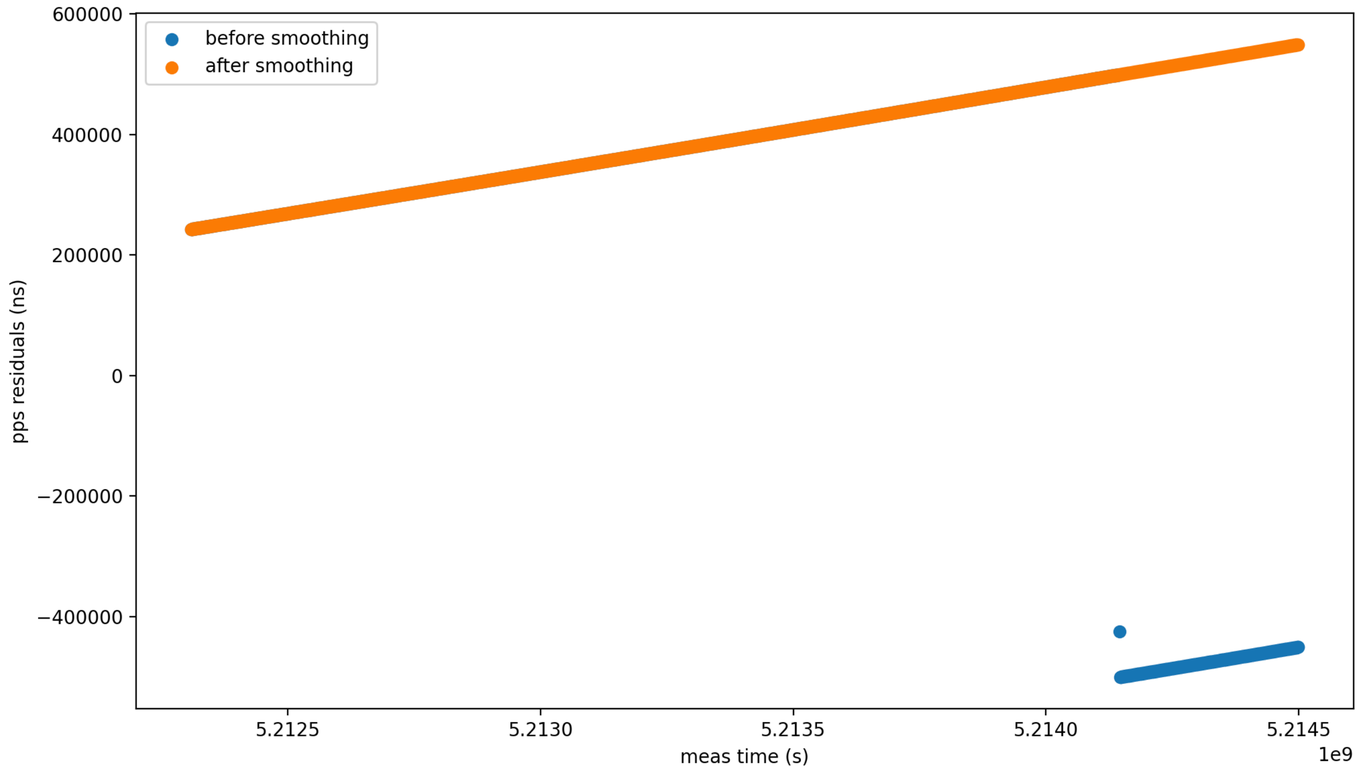
If the Rb drifts too much and the pps difference exits from the [-500μs, +500μs] window, the Septentrio internal clock jumps to accommodate.

It is a common effect but not sure how it impacts our measurements.

Given the Rb drift, the next jump should happen mid-April. We can play with the SF parameter to tune the Rb frequency and change the slope.

Possible solution

I smoothed the distribution to apply the corrections



Future plans

Future plans

- Continue this data-taking with free running Rb up to mid-March
- After mid-March, can start playing with SF parameter to tune Rb frequency and anticipate or postpone the new jump in RbvsGNSS data
- Measurement of Rb drift as function of SF parameter (could be done in parallel with the runs in progress if we find another counter? Or with the oscilloscope?)
- Far future plan: another run with frequency counter 2 for pps residual measurement between SYRTE and Rb. For that need to repare the WR switch pps connector.