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Doris differential processing
First results on the Sentinel 3A-3B tandem phase

IDS AWG MEETING

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Objectives

Idea :

in GNSS processing, the clocks contributions can be removed
using measurements single differences (SD) or double differences (DD).

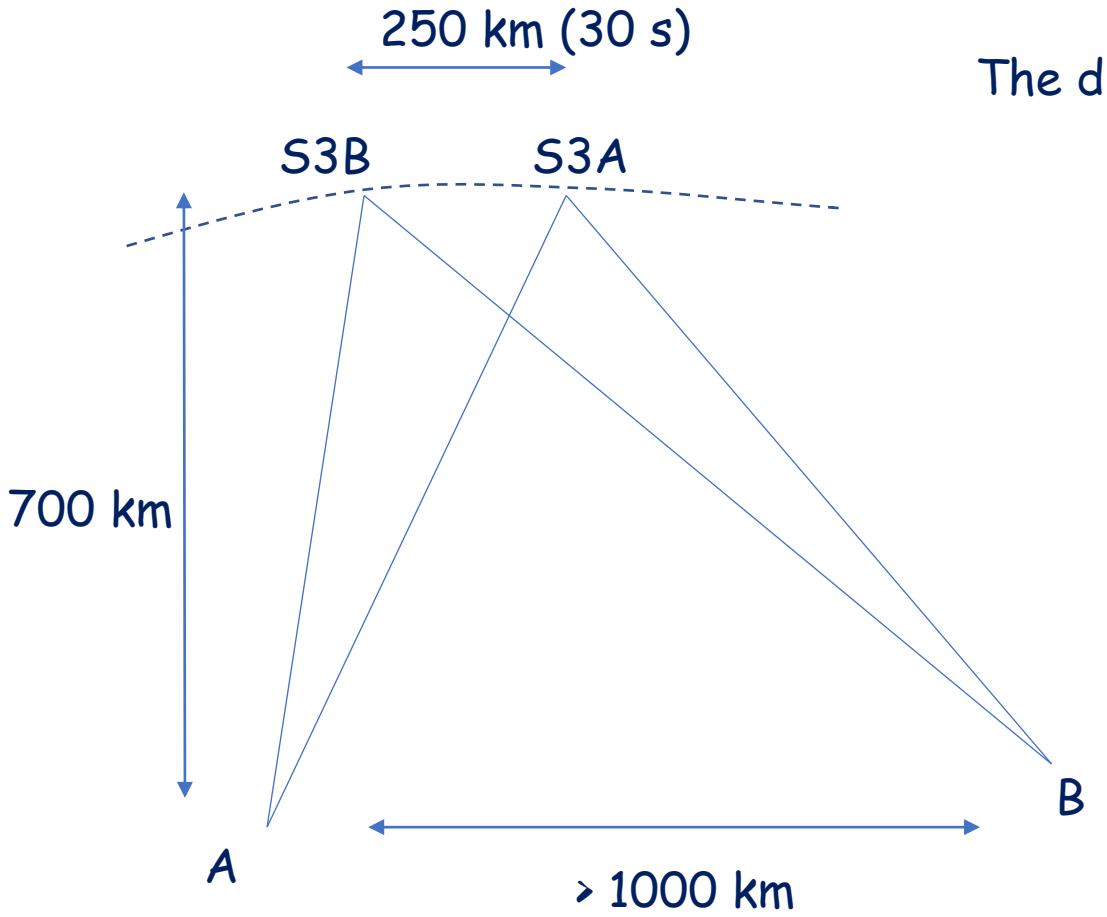
Doris application :

during tandem phase (two Doris satellites following the same ground track with 30 s delay),
a SD processing is possible

can be tested/validated on flight measurements (Sentinel 3A and 3B tandem phase)

some interesting extensions…

Tandem phase : remove beacons clocks contribution



The distances are too high to
directly remove measurements errors (iono…)

Tandem phase S3A,S3B :

- significant overlap for the measurements on a single beacon :

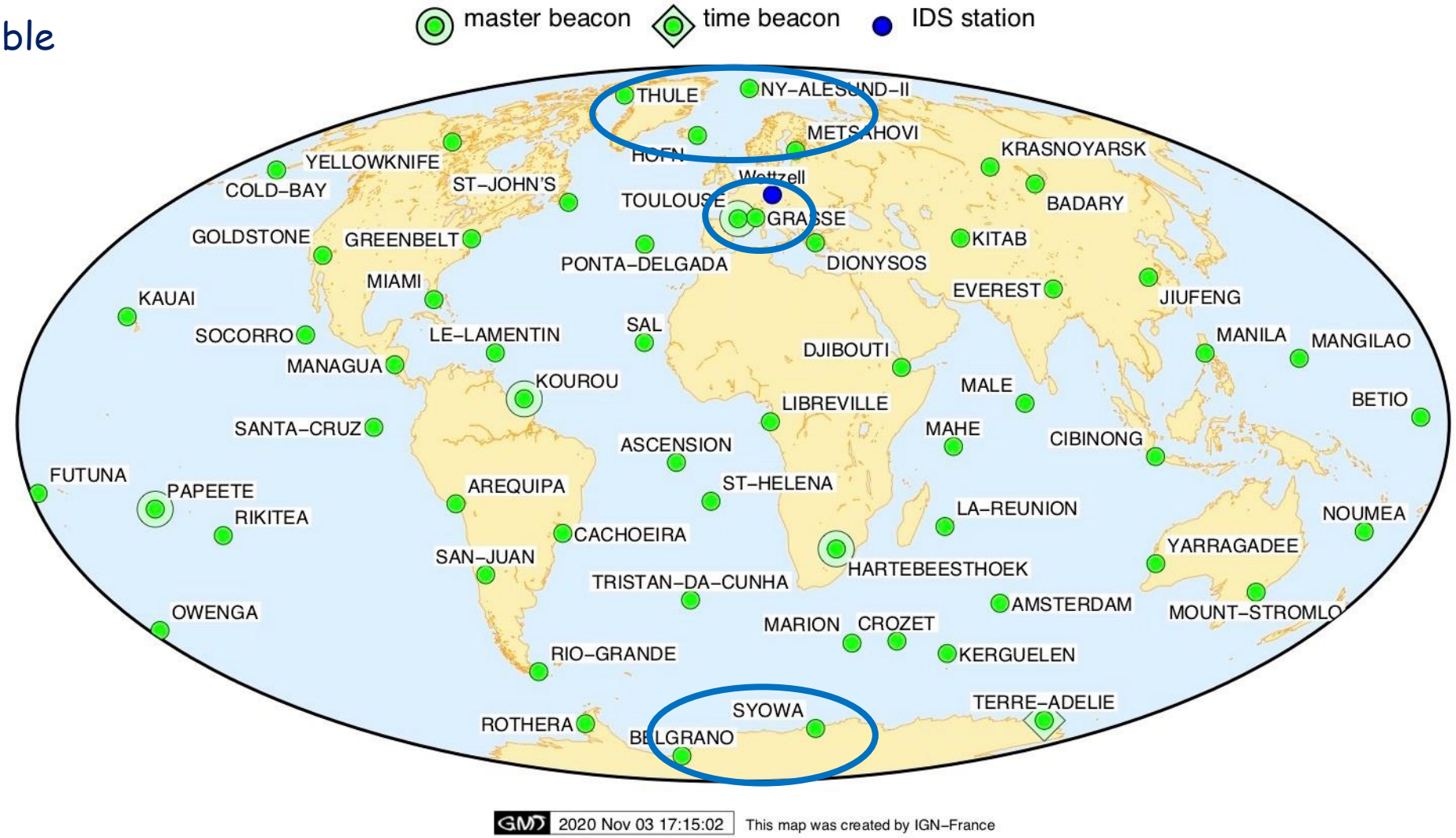
  possible elimination of the beacon frequency contribution

- important distances between almost all beacons :

  such overlaps allow to remove also the satellite frequency
  direct observation of the beacons frequency differences

Doris Network

Some areas with possible DD measurements



Analysis : Doris data preparation

Phase residuals for S3A or S3B : single pass

GPS orbit (cm precision)

Doris phase

iono-free

receiver clock

beacon clock (model)

Mapping function

$$Q_{meas} \longleftrightarrow Q_{model} = D + (h_{rec} - h_{sta}) + Tf(elev)$$

propagation, windup

ZTD

passes on the same beacon : average value of T between S3A and S3B

residuals :

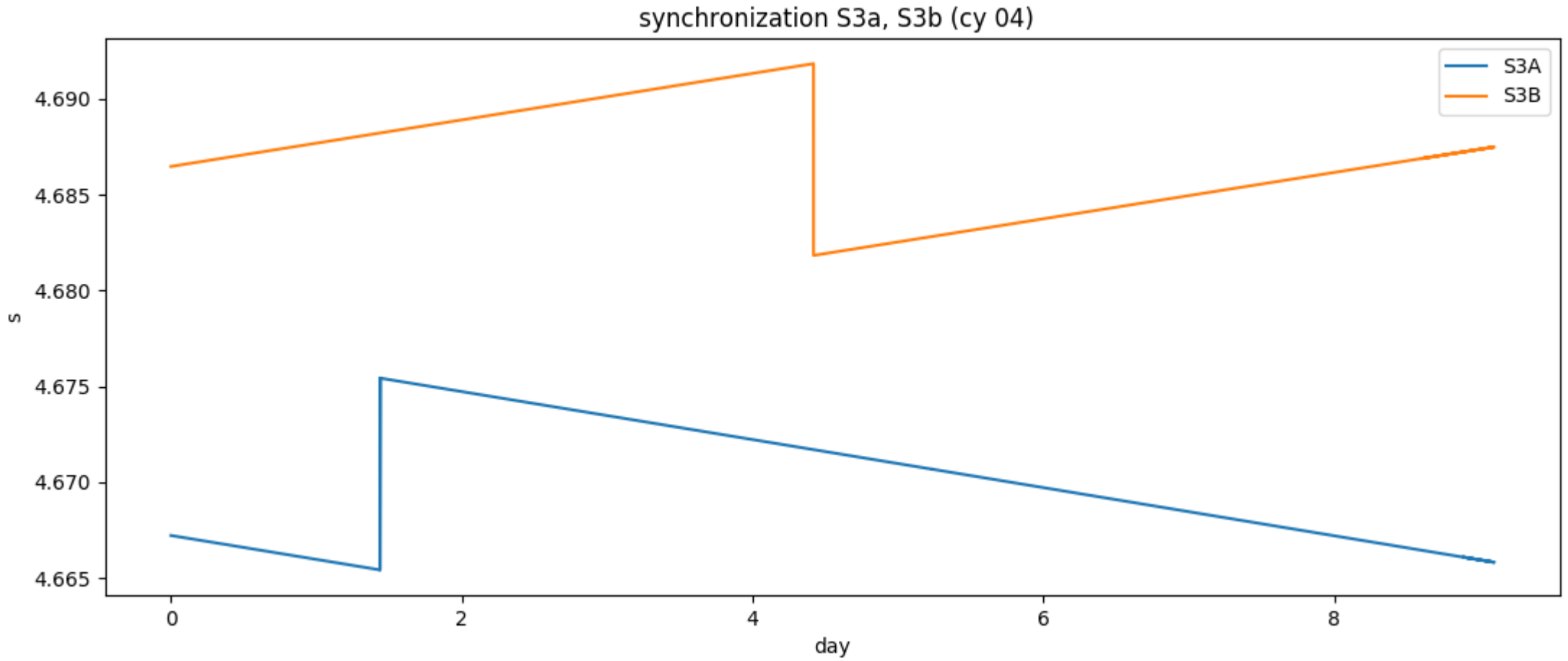
$$R_{S3A} = Q_{meas,S3A} - (D_{S3A} + h_{S3A} + Tf_{S3A})$$
$$R_{S3B} = Q_{meas,S3B} - (D_{S3B} + h_{S3B} + Tf_{S3B})$$

Remarks : - synchronization issues

both satellites measurements epochs are sufficiently close (0.01 s)

- remove a bias (phase ambiguity) on each pass residuals

Synchronization : receiver clock biases



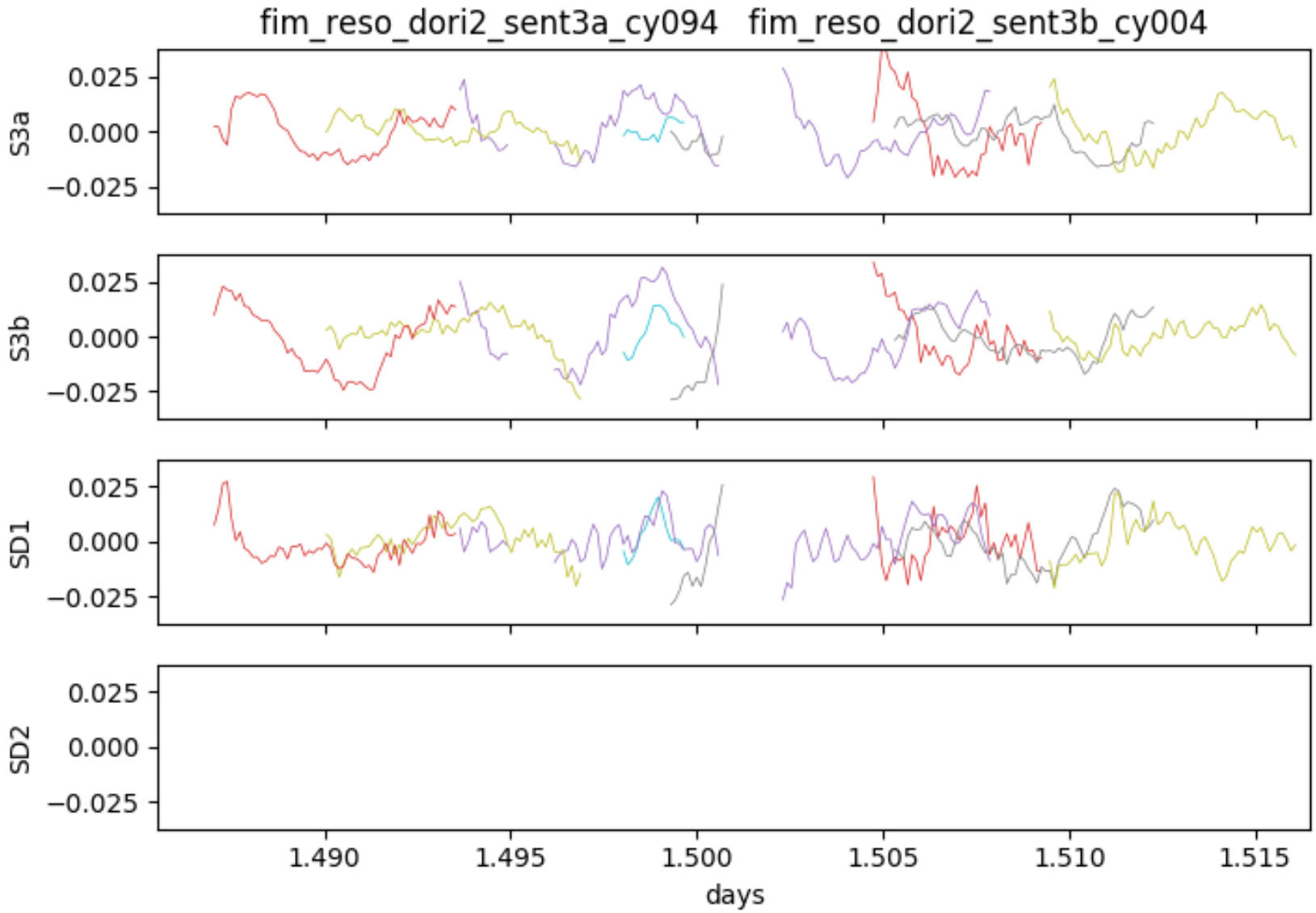
Phase residuals : S3a and S3b, and single differences

SD1 and SD2 : single diffferences

one color for each pass
(different beacons)

same epochs : $R_{S3B}(t) - R_{S3A}(t)$
remove beacon clocks

remains :
satellites clocks difference
geometry (beacon environment)



Phase residuals : S3a and S3b, and single differences

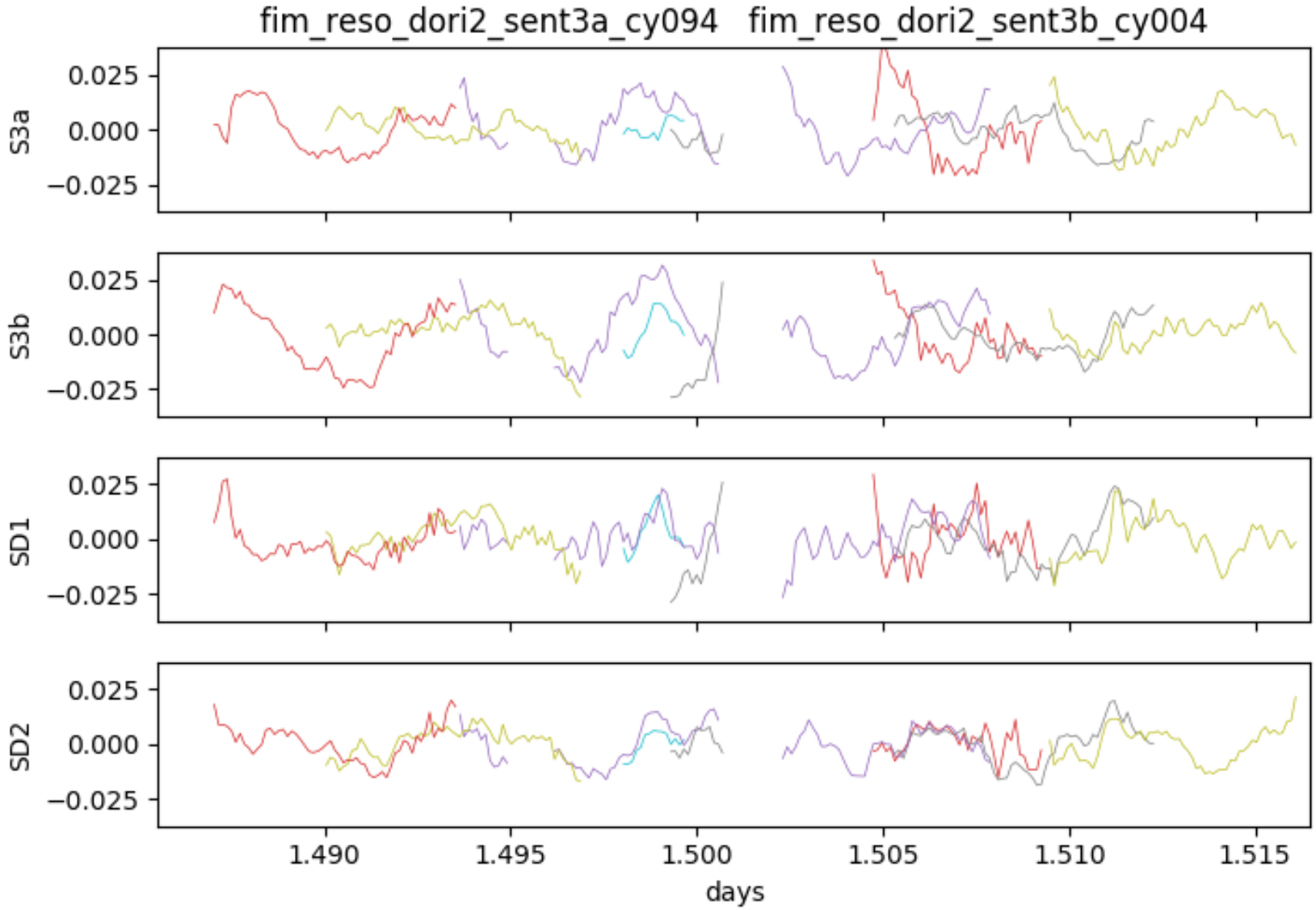
SD1 and SD2 : single differences

shifted epochs :

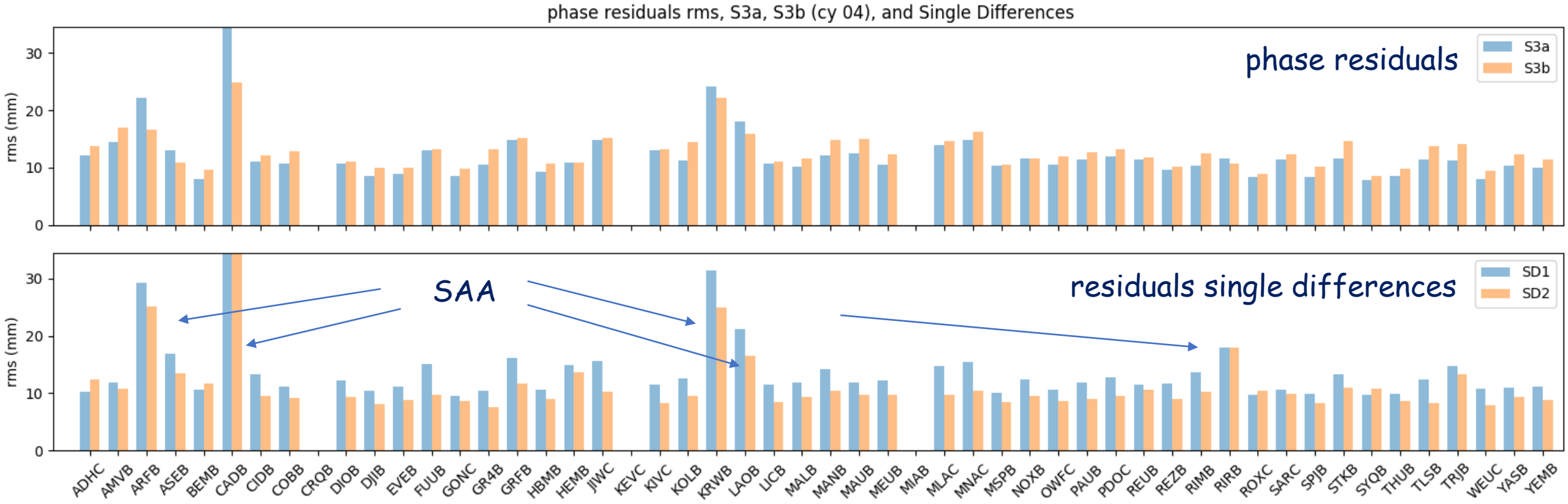
$$R_{S3B}(t) - R_{S3A}(t + 30s)$$

'short' baseline
to remove environment effects

remains :
satellites clocks differences
beacon clock variation during 30 s



Global analysis : stations residuals



The SD rms improve significantly for the shifted single difference residuals (SD2 case)

For all stations (except the SAA stations, perturbated by the S3A and S3B USO unstability) the rms is improved and very stable around 9-10 mm.

Conclusion : single differences processing

There are two important contributions in the phase residuals errors :

- the beacon clock

- the environment effects (multipath…)

For standard SD (SD1) the beacon clock is efficiently removed, the different passes are more consistent

For shifted SD (SD2) the environment effects are removed, even if in this case there is still a small contribution of the beacon clock variation over 30 s.

→

The best SD processing is to use measurements taken at the same location on the orbit (shift 30 s)

The standard SD removes correclty the beacon frequencies, but the environment contributions remain important

Thanks for your attention!