Code/Phase Bias Products at CNES/CLS Analysis Center (1/6)
History

Short Historical part:

- Wide Lane Biases (WL) computations started end of 2009 in our group (for GPS)

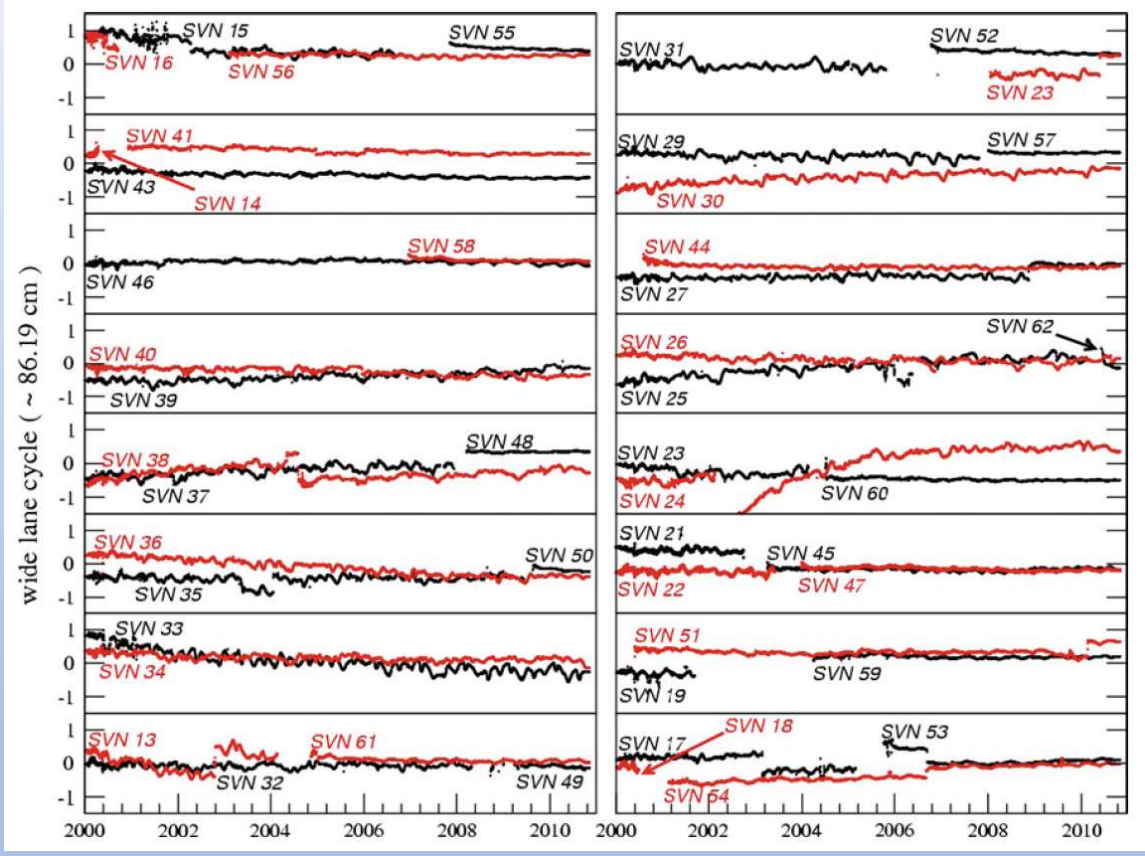
  ➔

- P1C1 biases taken since the beginning from CODE/AUIB solution

  As *Sinex-Bias format* was not defined/available at that time we did deliver our WL biaises in home-made format.

- GALILEO WL Biases start in 2018

- Others biaises were not used until last year (05/2021) when we start delivering sinex-bias files compatible with our products.



GPS WL Biases (2000-2010), Loyer et al, 2012

Sylvain Loyer (CLS)
AC: CNES/CLS igsac-cnes.cls.fr

Code/Phase Bias Products at CNES/CLS Analysis Center (2/6)
Integer clocks

Since the beginning we did focus on the « integer-phase-clocks » allowing to derive « easily » PPP-AR (or IPPP) processing.

The formalism and link with others ACs products has been described in 2020 in a paper by Simon Banville; our strategy correspond to the « strategy number 2 » of this paper or « integer clock strategy »: individual biases are related to differential biases acording to the following matrix:

$$\begin{bmatrix} \overline{\overline{dt}}^j \\ DCB_{C1W,C2W} \\ DCB_{C1W,C1C} \\ 0 \\ UPD_{WL} \\ b_{IF}^j \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & -\alpha_{IF} & -\beta_{IF} \\ 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \alpha_{IF} & \beta_{IF} \\ 0 & -\alpha_{NL} & -\beta_{NL} & 0 & \alpha_{WL} & \beta_{WL} \\ 0 & -\alpha_{IF} & -\beta_{IF} & 0 & \alpha_{IF} & \beta_{IF} \end{bmatrix} \begin{bmatrix} dt^j - \Delta t \\ \overline{\overline{b}}_{C1W}^j \\ \overline{\overline{b}}_{C2W}^j \\ \overline{\overline{b}}_{C1C}^j \\ \overline{\overline{b}}_{L1}^j \\ \overline{\overline{b}}_{L2}^j \end{bmatrix}$$

Banville, S., Geng, J., Loyer, S. *et al.* On the interoperability of IGS products for precise point positioning with ambiguity resolution. *J Geod* **94,** 10 (2020) doi:10.1007/s00190-019-01335-w

Code/Phase Bias Products at CNES/CLS Analysis Center (3/6)
Strategy

GRG/GRM Strategy (since 05/2021) ; Same strategy applied for GPS and Galileo products :

Differential biaises :

- WL Computed from raw observations (No PCO applied yet)
- Code/Phase iono-free biases computed from Code-Phase clocks (bjfs)
- DCB (C1W/C2W for GPS) computed from igs/igr ionopheric maps : similar to (*)

Observable Specific Biases (OSB) :

- Individual OSB computed according to the matrix of the previous slide and writen in sinex-bias format.

- Today we deliver these OSB for the following observations (depend from constellation) :
  * G: C1C C1W C2W L1W L2W
  * E: C1C C1X C5Q C5X L1C L5Q L1X L5X

They can be used to correct the RINEX observations following the sinex bias convention:

Observation(true) = Measurement(RINEX) - bias

(*) Montenbruck et al, 2014 : Differential Code bias Estimation using Multi-GNSS observations and Global Ionospheric Maps

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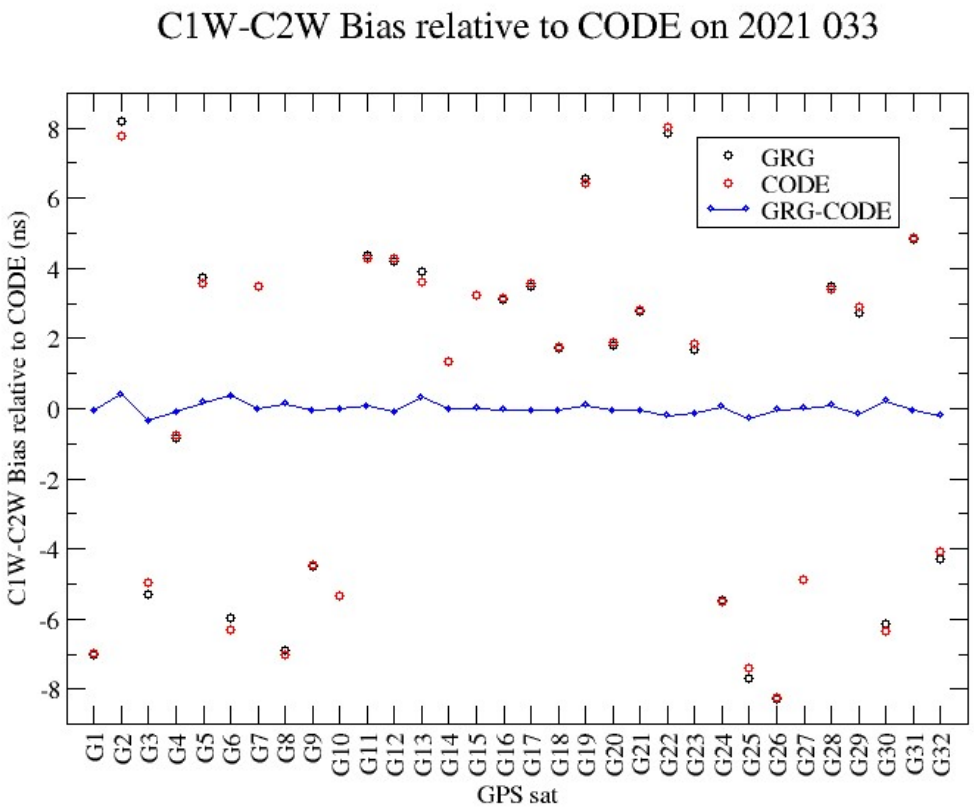
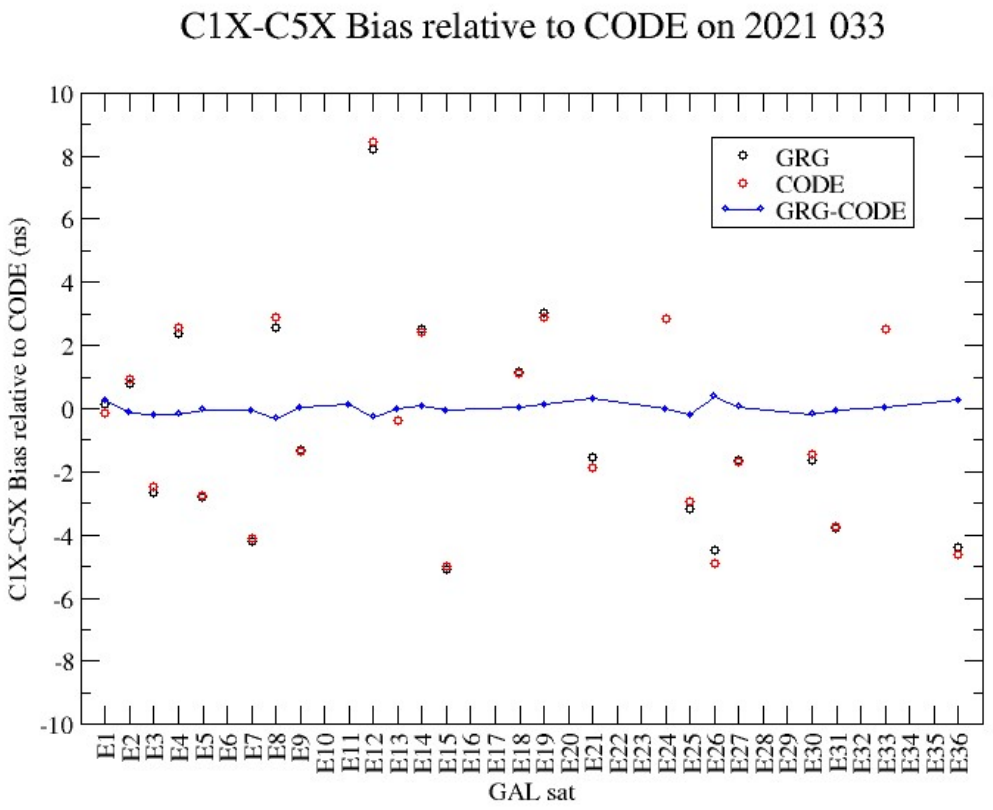
Comparisons (Examples)

Comparisons with others biases solutions only possible at the differential level.

GPS



GALILEO



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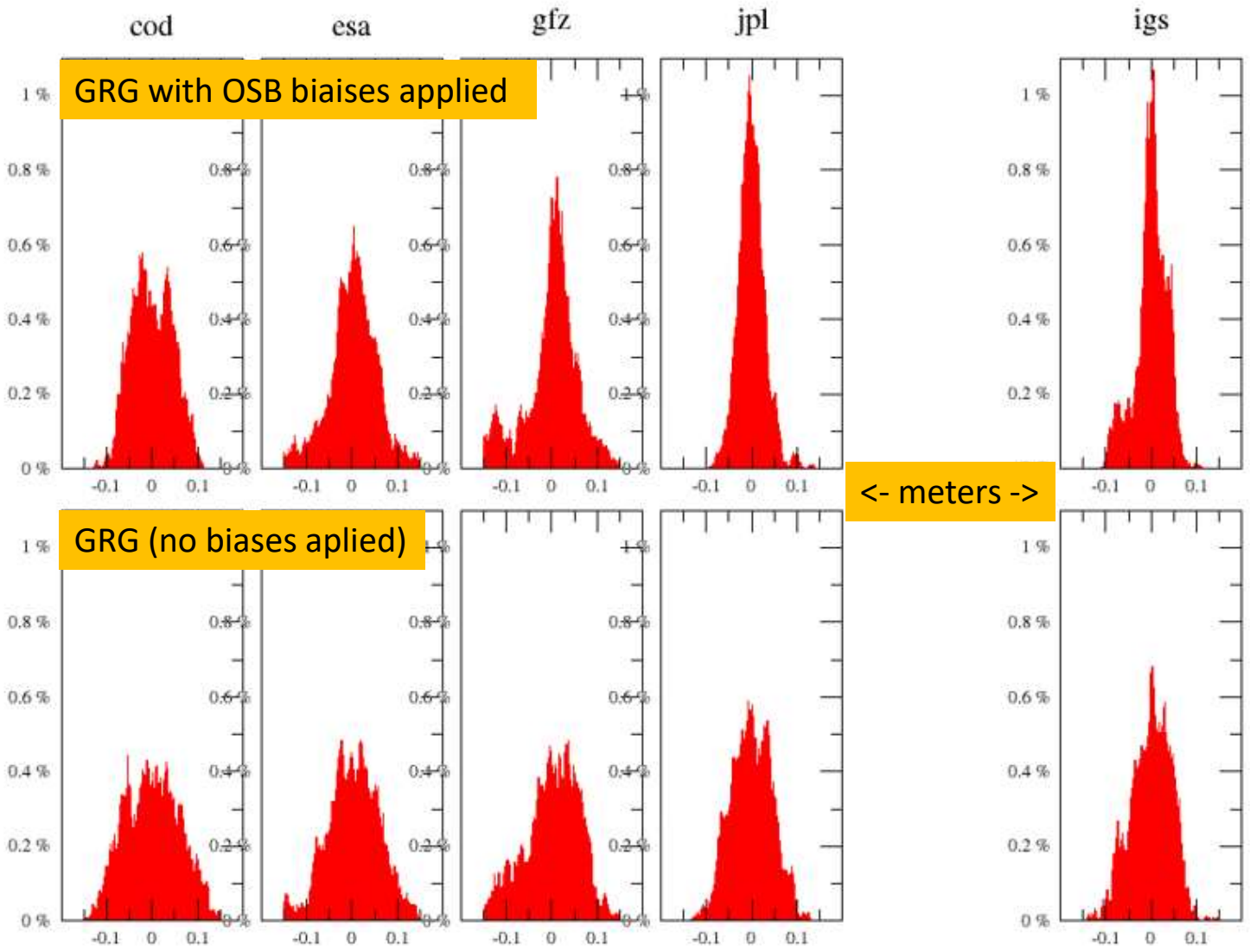
GPS clocks differences histograms between GRG and various solutions (~ 3 weeks doy 300-319/2021)



Code/Phase Bias Products at CNES/CLS Analysis Center (6/6)
Some Perspectives

Medium/Short term :

- Apply PCO of GNSS satellite before any processing
  This will make differences for WL and DCB for those satellites having frequency-dependent PCO.

- Process Beidou observations and their biases (end of 2022)

Unknown term :

- Include more signals (e.g. L5 for modern GPS satellite)

- Upgrade softwares to process raw-signal (with OSB treated as measurements parameters)

Questions ?