CNES/CLS IGS AC

GRG OSB products : status & progress

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Today's bias in IGS/GRG products

Products (today)

- Finals [GRE] GRG0OPSFIN
- MGEX [GEC] GRG0MGXFIN
- Rapids [GEC] GRG0OPSRAP
- Ultra-rapids [GEC] GRG0OPSULT

➔ **All products are delivered with daily OSB**

➔ **Available biases depend on constellation considered.**

	Primary	Secondary (Finals/MGX only)
GPS	C1C/C1W C2W L1C=L1W L2C/L2W	C2L(*)
GAL	C1C/C1X C5Q/C5X L1C/L1X L5Q/L5X	C7Q/C7X(*) (E5b)
BDS-3	C1P/C1X C5P/C5X L1P/L1X L5P/L5X	-

(*) new (2025-2026)

➔ **GRG clocks are « integer-clocks » : OSB + clocks (together) allow PPP-AR** (1)

(1) 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). https://doi.org/10.1007/s00190-019-01335-w

Methods used

Main products (orbits/clocks) are computed using wide-lane, iono-free and geometry-free combinations on primary signals.

Primary OSB are derived from the four following combinations :

- Wide –lane biases (use code/phase observations).
- Iono-free phase biases which are - by definition - equal to zero in our products.
- Iono-free code biases.
- Dual frequencies code biases differences from the geometry-free ionospheric analysis.

Secondary biases (GPS/C2L and GAL/C7Q/C7X) are computed directly from RINEX observations differences (relatively to primary biases).

In the future other frequencies/signals (like G/C5, E/C6, etc…) may be computed by either one or the other method available (including direct processing of main products).

Models used

- OSB derive from DCB (obtained by one of the methods listed previously)

- As OSB are linearly dependant of DCB , when initial DCB are continuous , OSB also…

To improve continuity :

- When possible, **constrains to reference biases values** is preferred to **zero-mean condition** between the biases of available satellites.
  ➔ This avoid common jumps when one satellite is missing/new or is subject to an event.

- Differential biases are modelled either by :
  - ✓ individual realisations, variable in time (e.g. GPS Wide Lane Biases)
  - ✓ constant segments between events (e.g. Galileo/BDS Wide-Lane, some code biases like C2L-C2W, …).
  - ➔ See examples next slide.

- Resolution is - today - limited to the day.

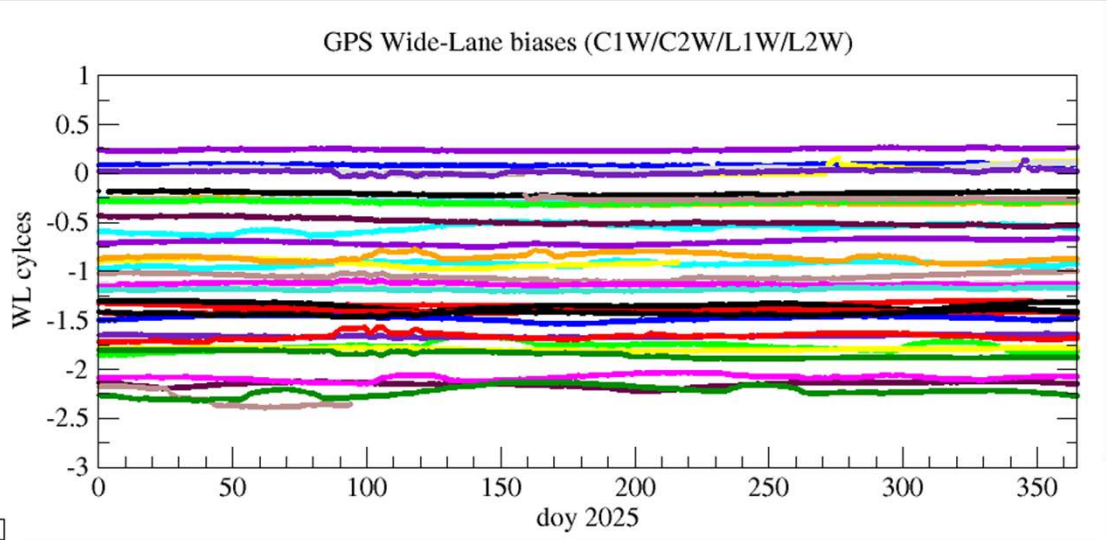
Models used : Variable or constant values ? / Examples

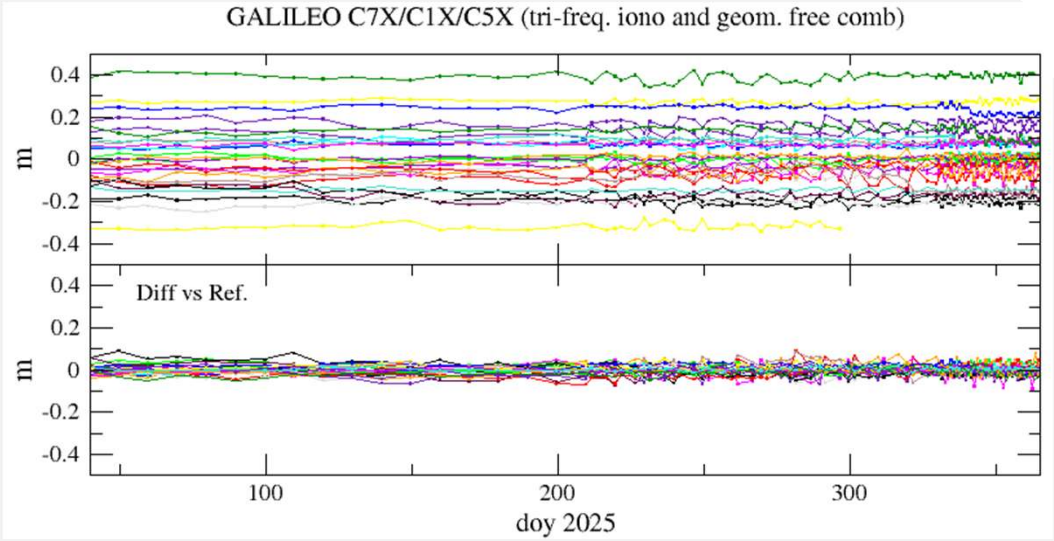
Some differential biases vary (significantly) from day to day

e.g. WL GPS biases :

- Variations: several 0.1 WL cycles
- Daily noise determination < 0.05 wide-lane cycles

➔ ***In that case(s) we choose stochastic representation***





Some differential biases seem constants

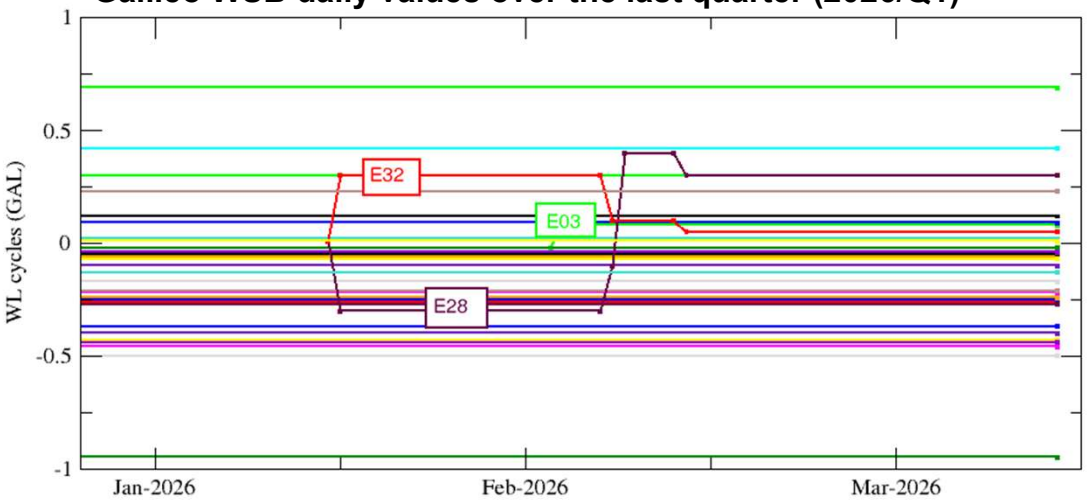
e.g. Tri-frequency iono&geom Galileo free combination :

- Variations < 1 - 2 cm
- Daily noise ~ 5 cm

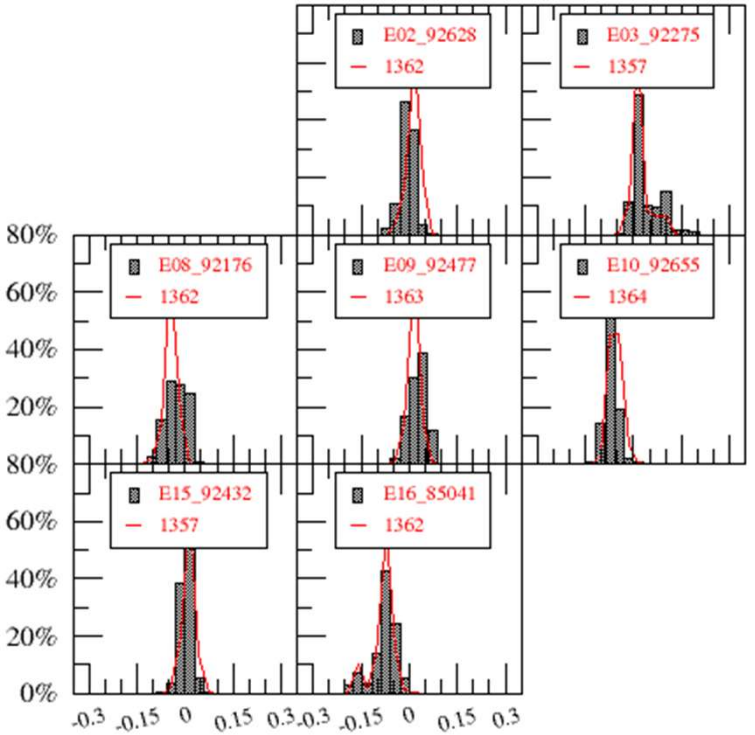
➔ ***In that case(s) we choose constant representation (with possible events)***

Constant values ? Other example

Galileo WSB daily values over the last quarter (2026/Q1)



Constant segments between (rare) events
(need a procedure to detect events) →



Histograms of Galileo Wide-Lane Satellite Biases individual realizations relative to a priori values

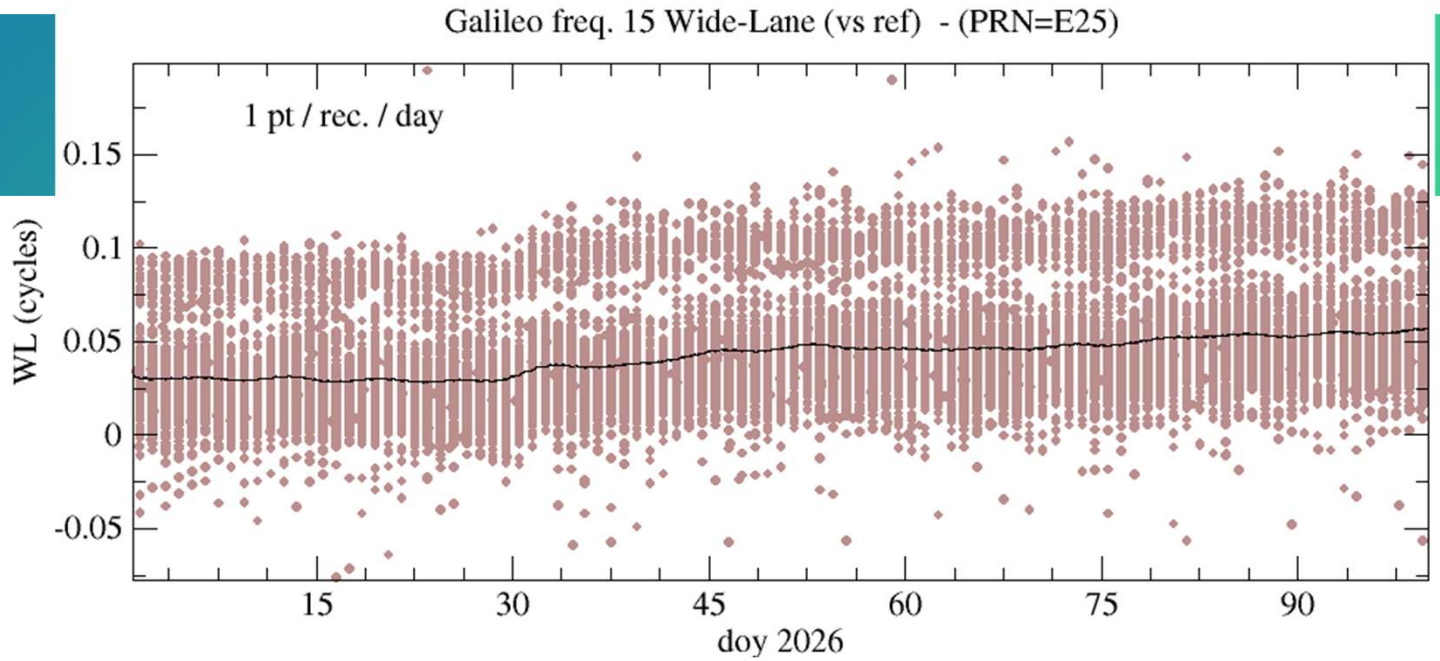
(full history, last few days). Unit= WL cycles.

Errors ~ 0.05 WL cycle (< 20 ns)

➔ **Daily resolution today , but events may occur inside day (still to be improved)**

➔ **Quality sufficient for needs even if real values may differ from constant ones (see next slide)**

Constant values ?



Wide-Lane biases of Galileo satellites are modelled as stable in time but close look exhibits:

- sligth variations in time (< 0.01 cycles/month) *visible on monthly running average*.
  ➔ compensation with « manual events » from time to time.
- at least two rec. families (apart from ~0.05 WL cycles) ← **Do not impact wide-lane fixing !**

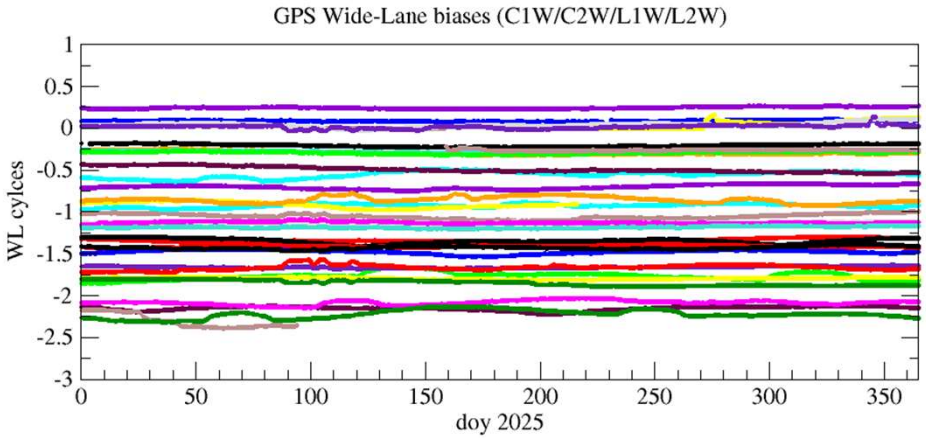
Refining constants models in the future ? Choice is a balance between noise level (e.g. of daily determination) , observed variations, and **users needs**.

Continuity/Resolution

Up to date our biases are independent each day and suffer from two « major » drawbacks that may impact users depending on their usages :

- continuity is not insured between consecutive days for all biases (may be reconstructed a posteriori)
- they are limited to a daily resolution (jumps occurring inside a day not well taken into account)

- Wide lane is already continuous, but we are still working on the geometry-free code and iono-free clocks continuity
- Investigating sub-daily resolution (some work will be presented at IGS WS 2026 in Santiago)



Missing biases / known problems

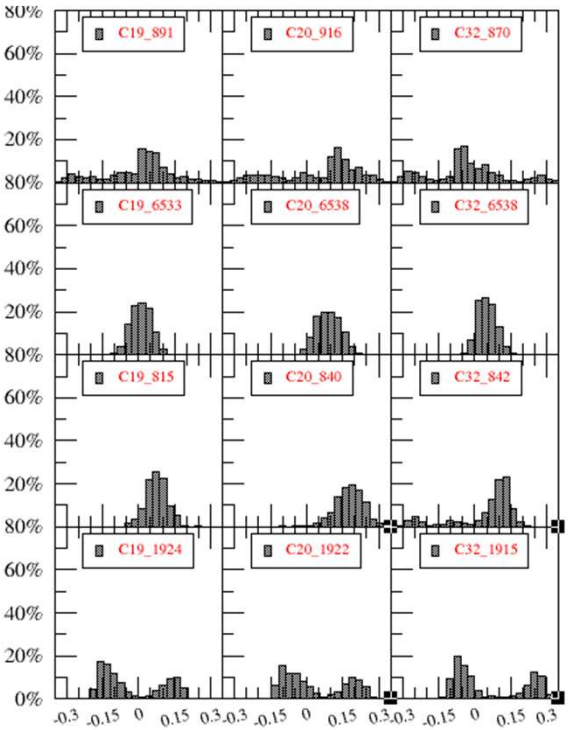
The following biases missing today in our products/analysis:

- GPS frequency 5 (G: C5/L5)
- Galileo frequency 6 (E: C6/L6)

Will be added soon ...

(Easier to implement due to consolidated tools adapted to various pilotable frequencies).

- Still working on BDS-3 WL (in particular for Trimble C1X/C5X observations) : the GRG BDS-3 biases mix today X (tracking) and P (pilot) biases.



BDS-WL cycles

LEICA (16)

SEPTENTRIO (94)

C1P/C5P

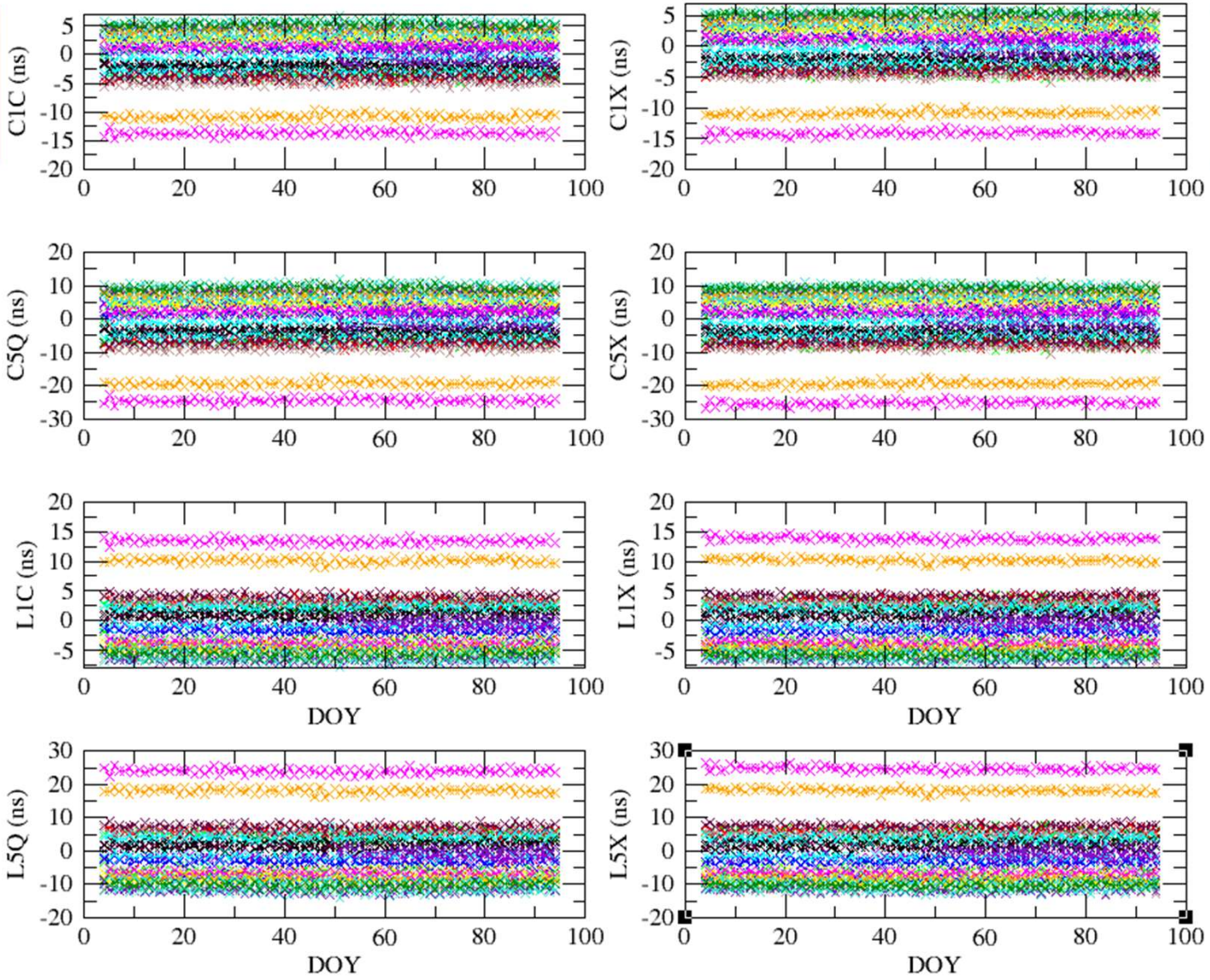
JAVAD (14)

TRIMBLE (28)

C1X/C5X

Contact : S. Loyer for any question/remarks on that point

THANKS …



Example of GRG Galileo OSB in 2026 (1 color/sat)