Latest progress of IGS BAR and WCC

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Workshop on GNSS Bias & Products' Combination in EGU

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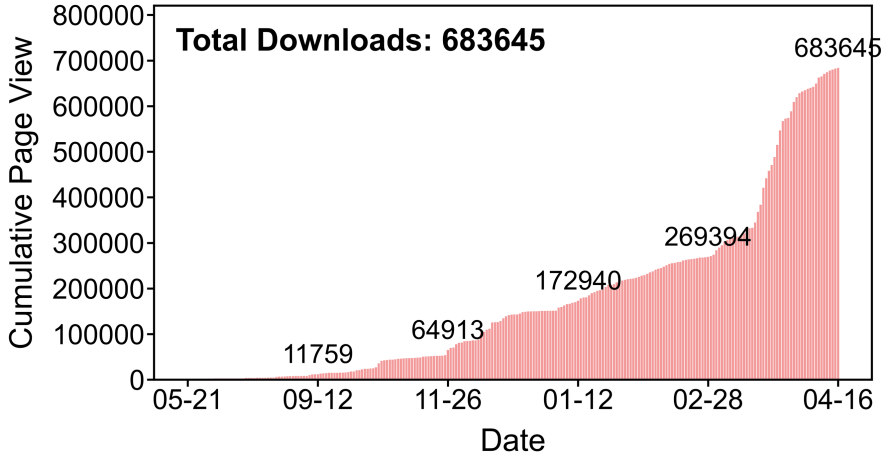
Vienna Austria

Wuhan Combination Center (WCC): overview

- Routine combination of final/rapid products has been online since GPS week 2357 (Mar, 2025), along with the maintenance of the WCC website (**https://igs.org/wg/wcc**) and the public storage service (**ftps://bdspride.com**)
- New channel code biases (GPS C2L, C2S, C2X) and phase biases (L2L, L2S, L2X) to accommodate the ESA Copernicus POD project

WCC webpage



WCC product downloads

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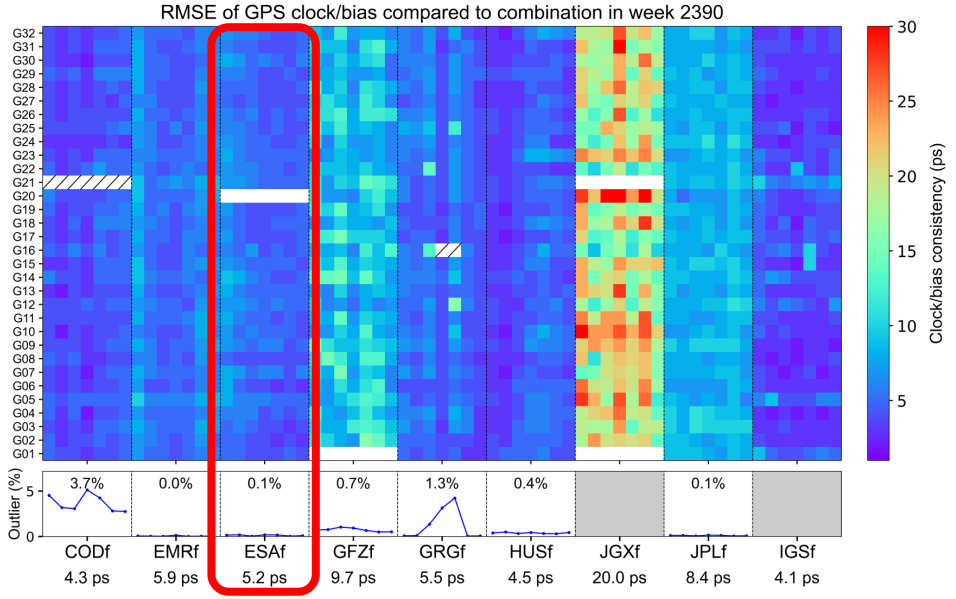
*BIAS SVN_ PRN OBS1
 OSB  G080 G01 C1C
 OSB  G080 G01 C1W
 OSB  G080 G01 C2W
 OSB  G080 G01 L1C
 OSB  G080 G01 L1W
 OSB  G080 G01 L2W
 OSB  G080 G01 L2S
 OSB  G080 G01 C2S
 OSB  G080 G01 L2L
 OSB  G080 G01 C2L
 OSB  G080 G01 L2X
 OSB  G080 G01 C2X
```

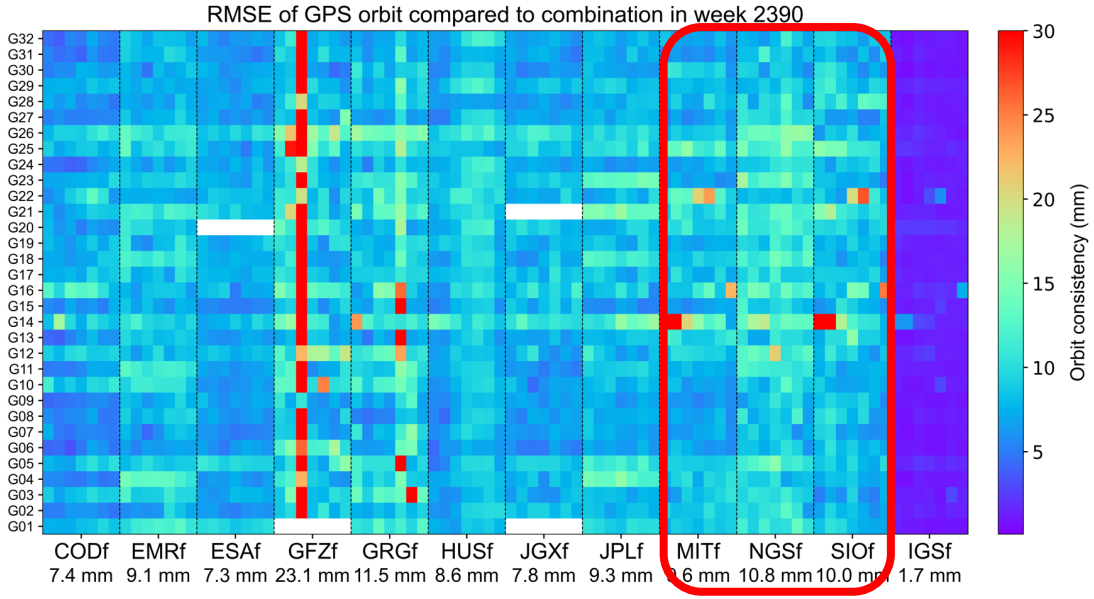
GPS OSB product

Wuhan Combination Center (WCC): overview

- Incorporate EMR products into daily combination
  - better **clock stability** and **positioning precisions**
- Incorporate NGS, SIO and MIT products into orbit combination
  - better **orbit stability** over most ACs



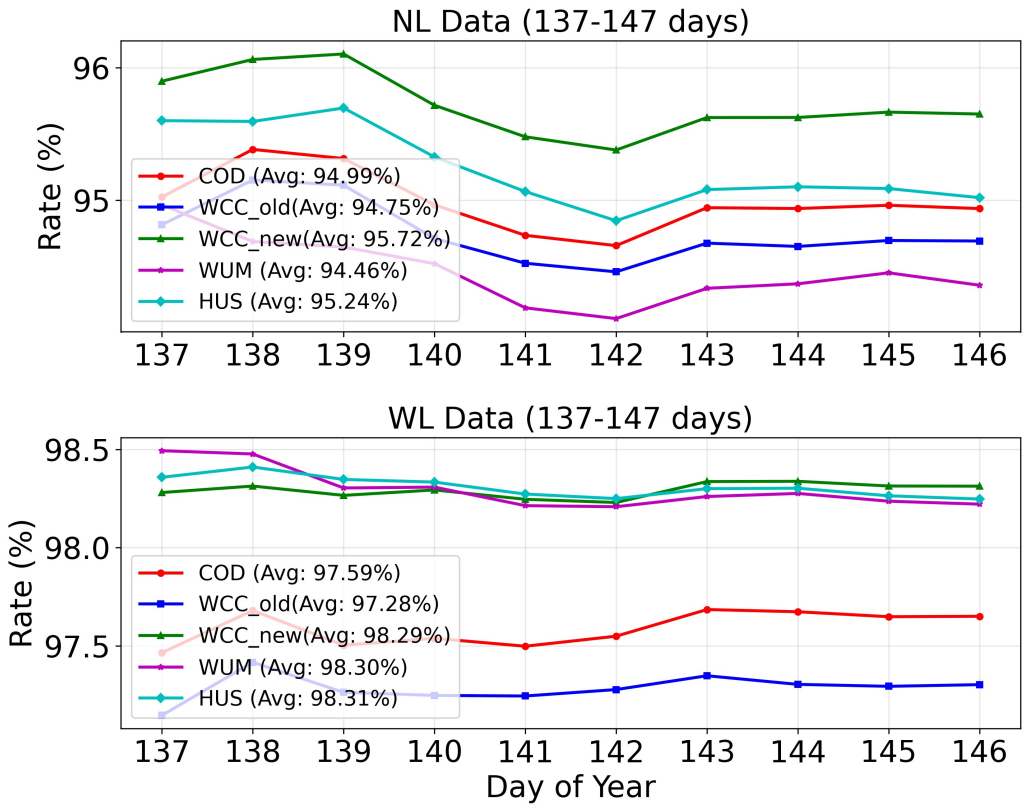
Clock/Bias consistency



Orbit consistency

Wuhan Combination Center (WCC): overview

- Combination method improvement
  - Improve the combination approach for Galileo mixed channel code/phase biases



45 Galileo mixed code stations, 10 days

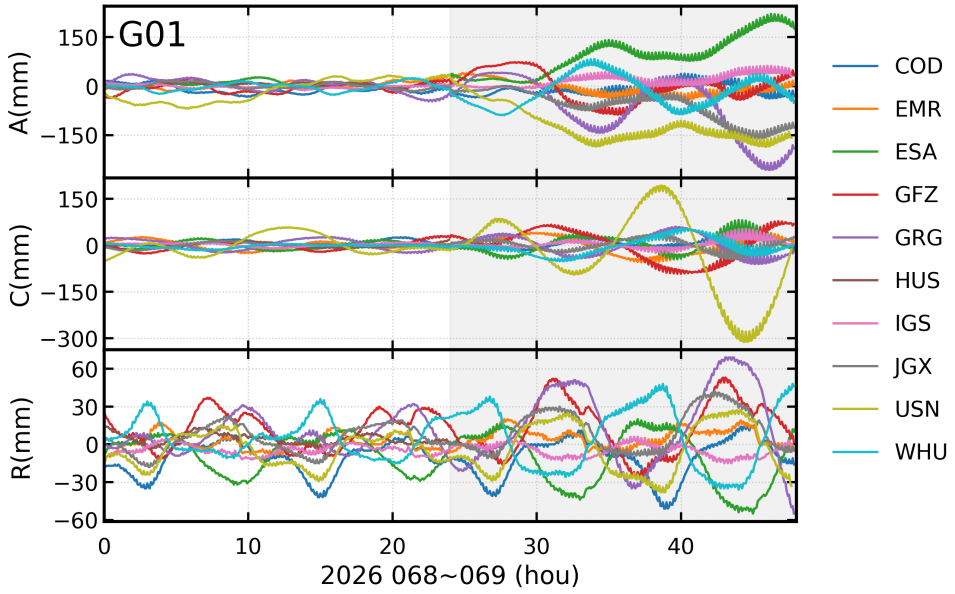
	NL/%	WL/%	N/mm	E/mm	U/mm
COD	94.99	97.59	1.78	2.05	11.24
HUS	95.24	98.31	1.94	2.49	11.29
WCC_old	94.75	97.28	1.70	2.21	11.25
WCC_new	95.72	98.29	1.70	2.16	11.28
WUM	94.46	98.30	2.21	2.53	11.44

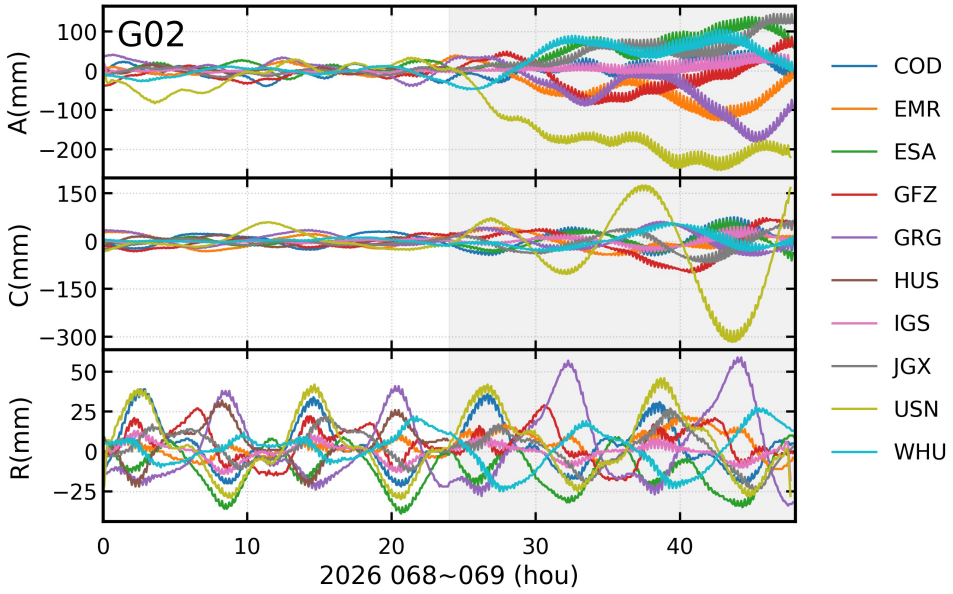
Wuhan Combination Center (WCC): ultra-rapid products

- Combination status of ultra rapid products
  - **9 ACs**: COD EMR ESA GFZ GRG HUS JGX USN WHU
  - Combine G/R/E orbits/clocks once if sufficient ACs (5-min sampling, 3-h latency)
  - COD clocks are excluded
  - HUS (informal AC) to detect gross errors and for comparison only
  - Outlier rejection is not carried out with respect to the predicted part
- **Webpage** for WCC ultra rapid product (https://igs.org/wg/wcc#ultra)
  - Update latency is ~1 week

Wuhan Combination Center (WCC): ultra-rapid orbits

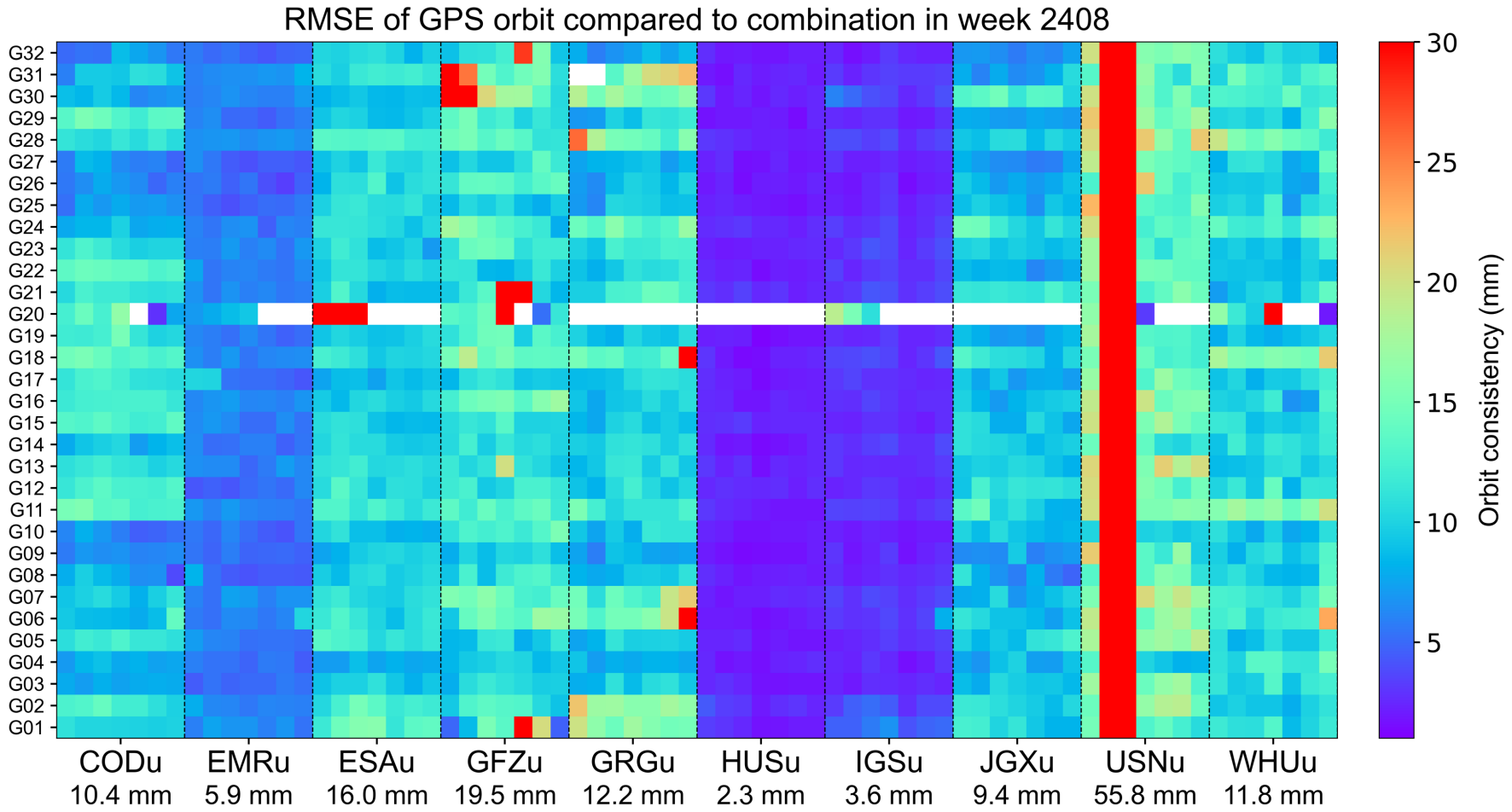
- Orbit consistency (a.k.a. RMS errors) among ACs
  - Period: 2026 068~069, PRN: G01, G02
  - The observed part shows good agreement of < 3 cm
  - The agreement for the predicted parts is within 20 cm





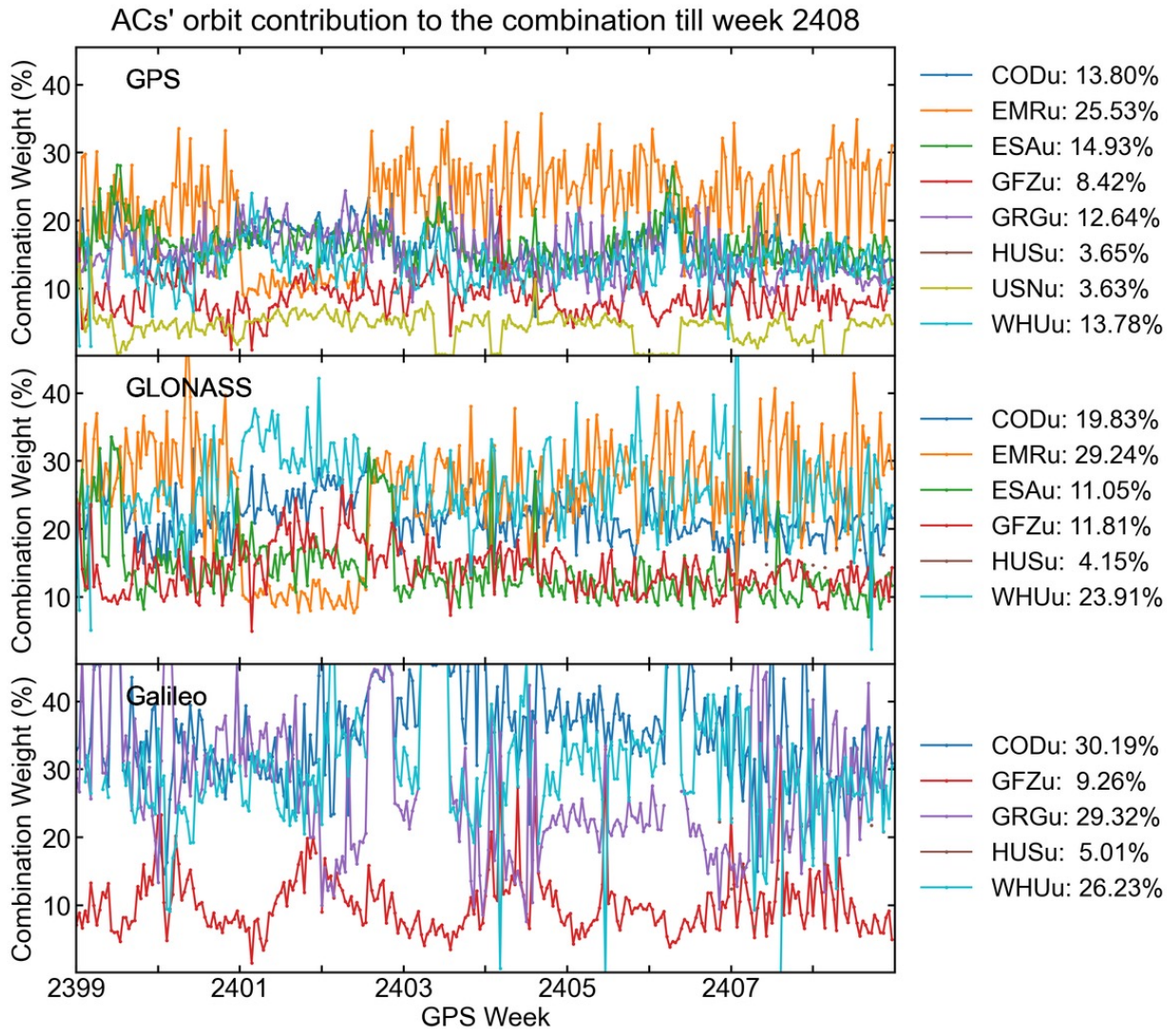
Wuhan Combination Center (WCC): ultra-rapid orbits

- Ultra-rapid observed orbit consistency (RMSE) over a week



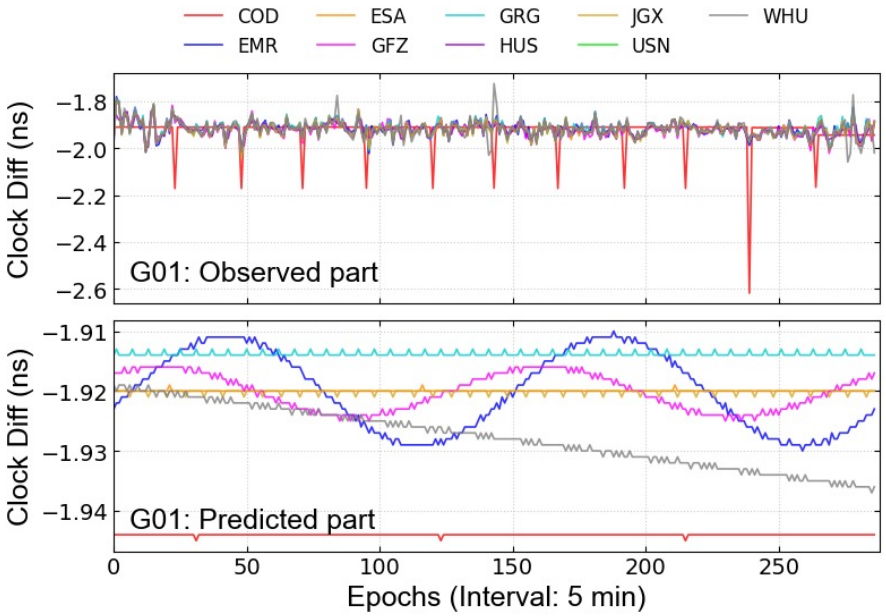
Wuhan Combination Center (WCC): ultra-rapid orbits

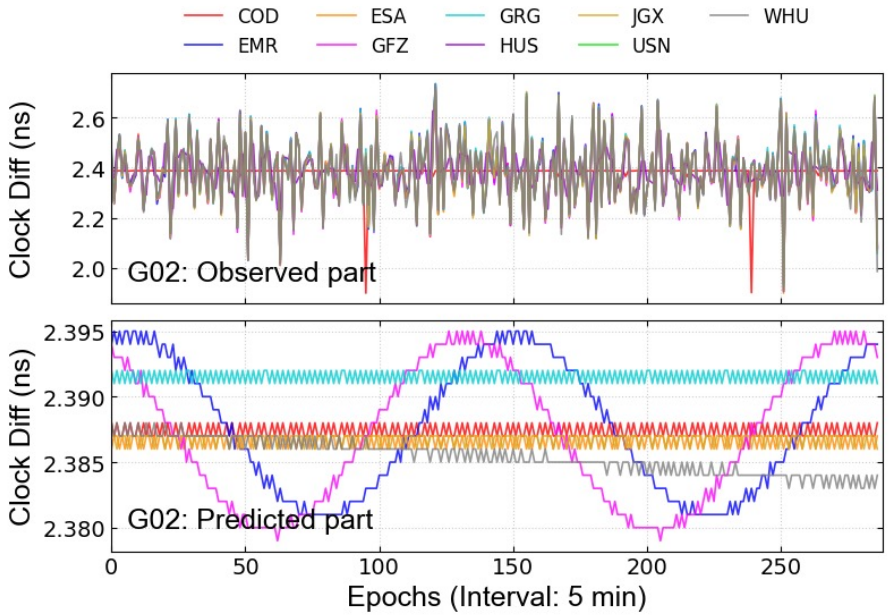
- Ultra-rapid orbit weighting for observed part
  - Some ACs' weighting are more stable than others
  - Galileo orbit weighting fluctuates dramatically



Wuhan Combination Center (WCC): ultra-rapid clocks

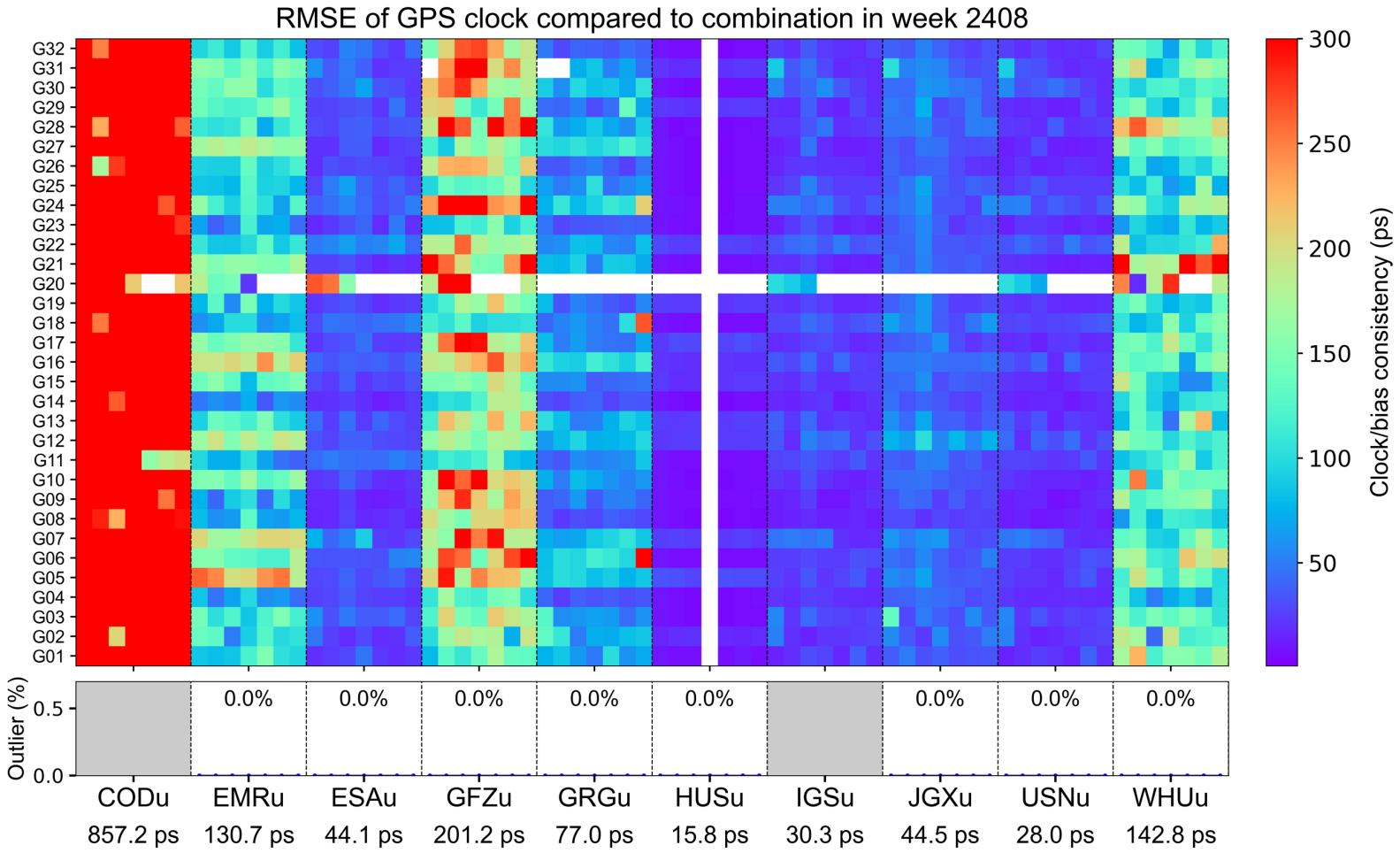
- Clock consistency (a.k.a. RMS errors) among ACs
  - Time: 2026 068~069, PRN: G01, G02
  - The observed part shows regular gross errors for some ACs (e.g., COD)
  - The predicted part shows systematic discrepancies among ACs





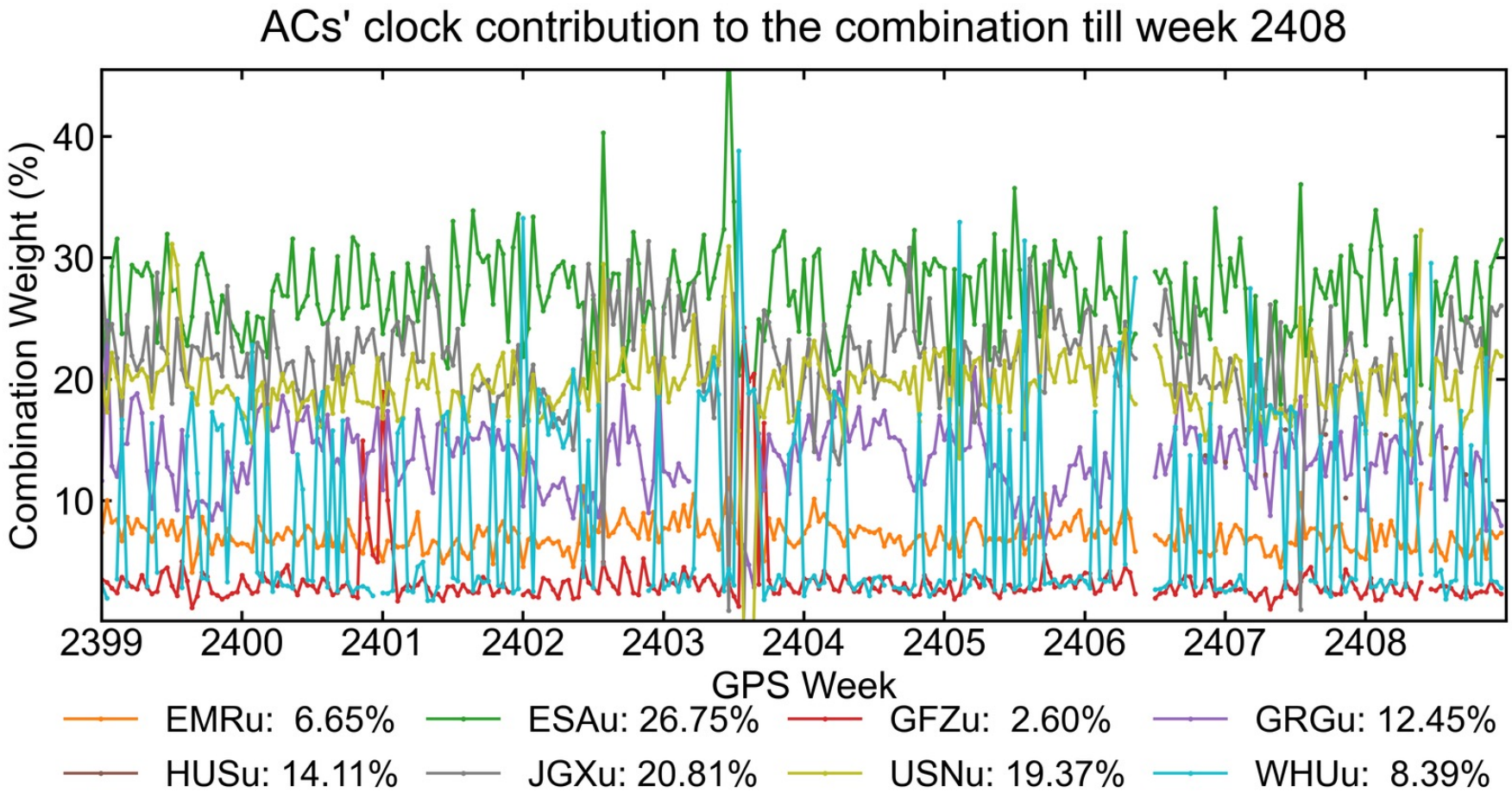
Wuhan Combination Center (WCC): ultra-rapid clocks

- Ultra-rapid observed clock consistency (RMSE) over a week



Wuhan Combination Center (WCC): ultra-rapid clocks

- Ultra-rapid clock weighting for observed part

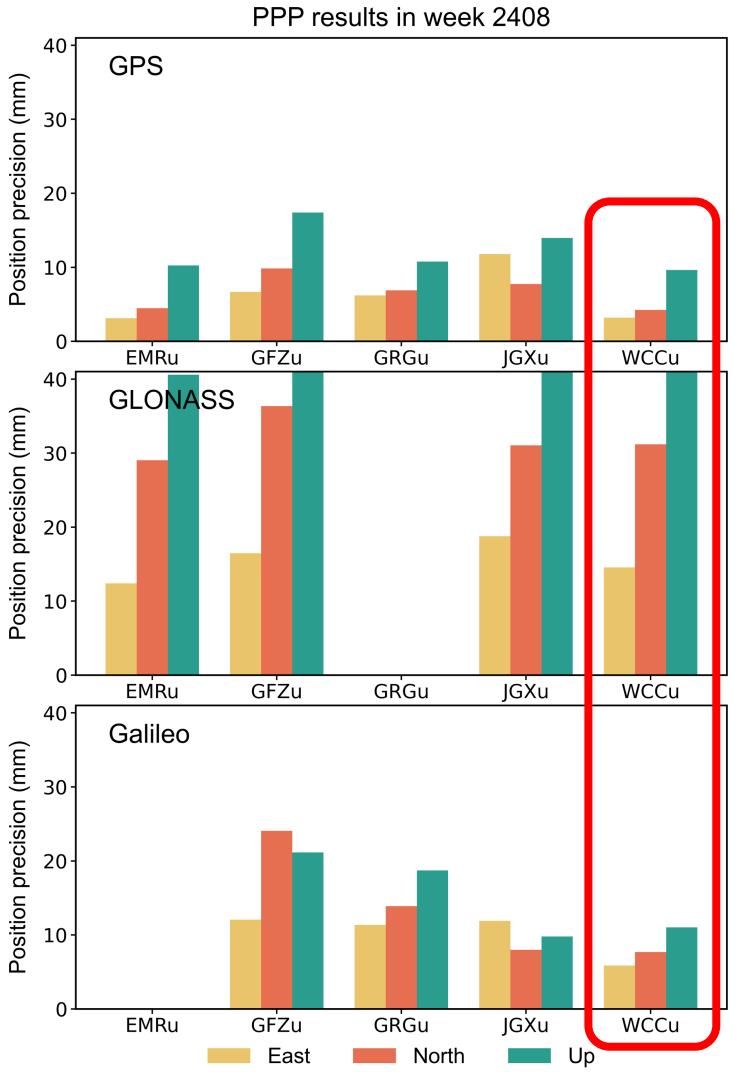


Wuhan Combination Center (WCC): PPP test

- Ultra-rapid product combination
  - PPP validation using the observed part

WCC results, Week 2408

Constellation	E(mm)	N(mm)	U(mm)
GPS	3.2	4.3	9.6
GLONASS	14.6	31.2	47.9
Galileo	5.9	7.7	11.0



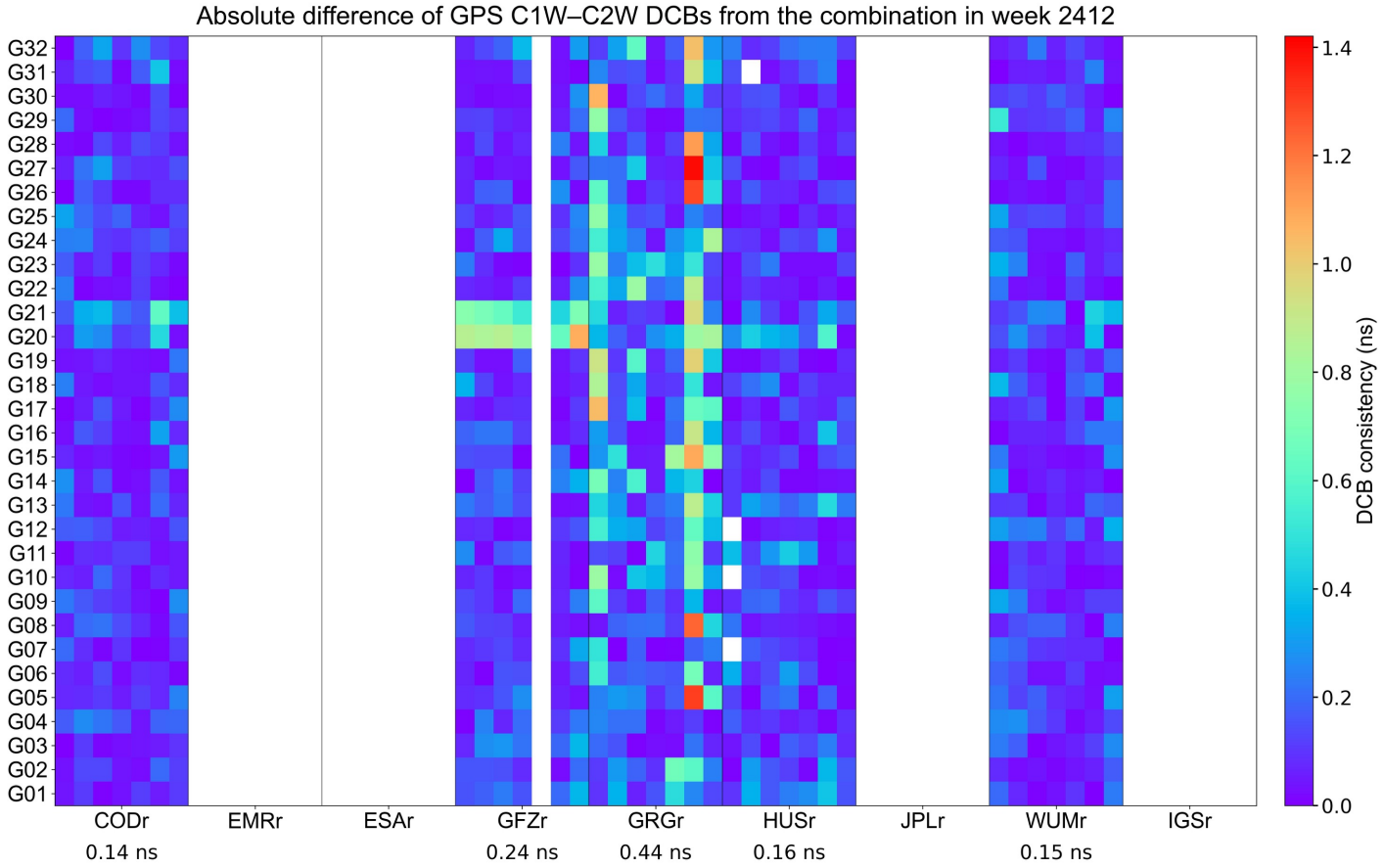
WCC: Format & standard for combination statistics

- A format for ACs to **easily inspect** their products' artifacts
- A format for PPP users to **easily exclude** outlier products

- 【Complete】Discuss the goals of the task force
- 【Complete】Discuss the contents of combination statistics
- 【Complete】Investigate the YAML format for the combination statistics
- 【Complete】ERP and station position combination into the statistics
- 【In progress】A preliminary format specification for the YAML combination statistics

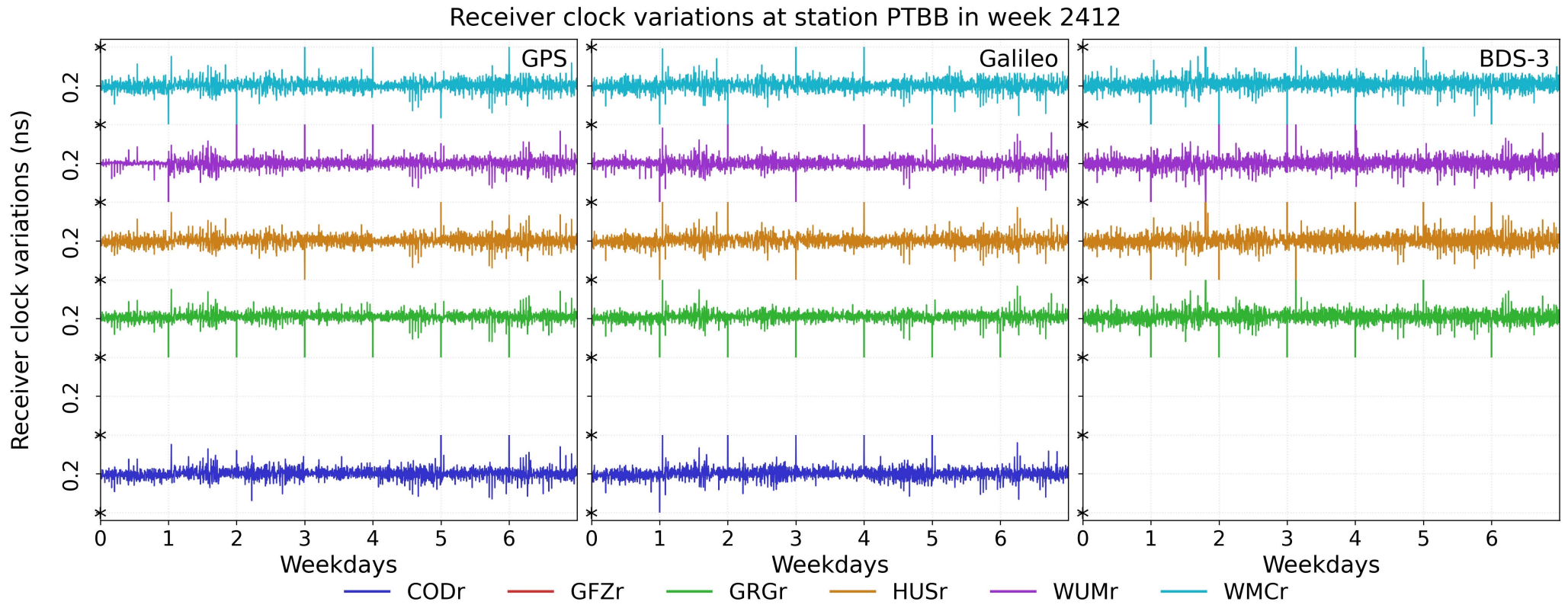
Bias & Ambiguity Resolution (BAR)

- Code bias consistency added
  - GPS: C1W-C2W, Galileo: C1C-C5Q, BDS: C2I-C6I



Bias & Ambiguity Resolution (BAR)

- Receiver clock stability added
  - PTBB station, one-week continuous PPP-AR processing



Future Steps

- Ultra rapid product combination officially online before IGS Workshop — Jun, 2026
- Initiate open testing of the ultra-rapid combined for the public — Jun, 2026
- A format standard for product combination statistics — Dec, 2026

Thank you for your attention!

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