PPP-AR Working Group

Jianghui GENG

IGS INTERNATIONAL GNSS SERVICE

5th Open AM/WG Meeting

CHARTER

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Overview of the Working Group

- Jianghui GENG, PPP-AR WG Chair, Wuhan University
- Coordinate phase bias generation in the IGS to facilitate PPP ambiguity resolution
- Main goals of the Working Group
  - Investigates the interoperability of PPP-AR products from various analysis centers (ACs)
  - Analyze the feasibility and benefits of a modernized combination process considering the consistency of the satellite clock and bias products
  - Initiate a pilot project to expose the combined clock/bias solution to open testing and cross-validate the quality of ACs' clock/bias solutions

Recommendations

- Encourage more ACs to provide quaternions whose temporal resolution should be at least equal to that of the clocks and number of decimal digits should be properly set
- Antenna PCO should be considered in DCB and Melbourne-Wübbena computations
- Routine clock/bias combination and visualization online to cross-validate AC products
- Consistent standard and modeling of group-delay variation patterns
- Study how to reduce and calculate day boundary discontinuities of integer clocks and their impact on time transfer
- Study how to produce high-quality BDS/QZSS phase bias products

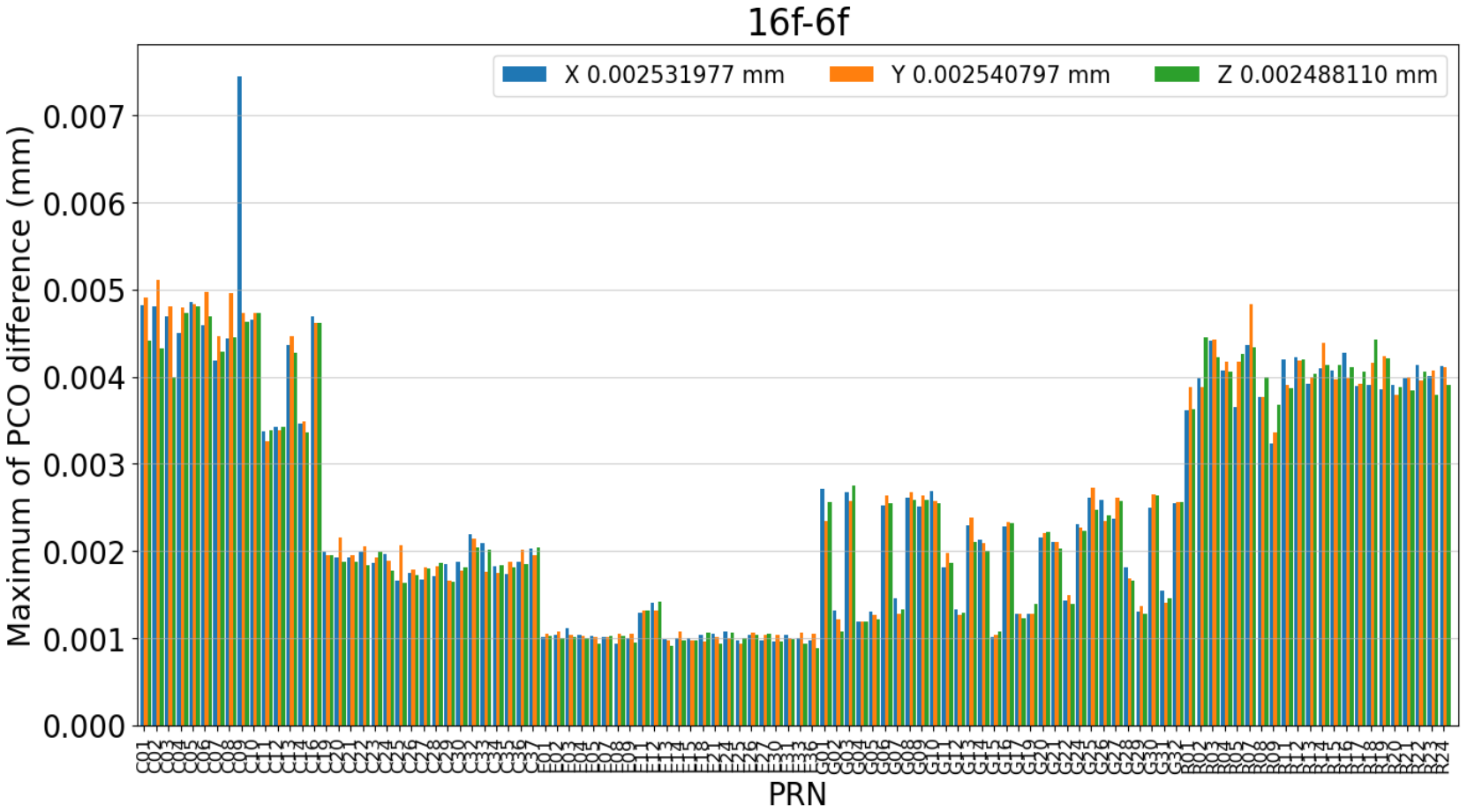
Progress since IGS 2022 Virtual Workshop (June 2022)

- Attitude quaternions from each AC

AC	Type	Phase bias	GNSS		Sampling rate (s)		
			Orbit/Clock	Quaternion	Orbit	Clock	Quaternion
COD	final	GE	GRECJ	GRECJ	300	30	30
GFZ	rapid	GEC	GRECJ	GRECJ	300	30	30
GRG	final	GE	GRE	GRE	300	30	30
WUM	final	N/A	GREC	GREC	900	30	30
	rapid	GEC	GREC	GREC	300	30	30
IAC	final	N/A	GRECJ	N/A	300	30	N/A
SHA	rapid	N/A	GREC	N/A	300	30	N/A
JAX	final	N/A	GRJ	N/A	300	30	N/A

Progress since IGS 2022 Virtual Workshop (June 2022)

- Attitude quaternions: 16 decimal digits originally



The maximum PCO differences (mm) when reducing the decimal digits from 16 to 6:

ΔX: 0.00745mm
ΔY: 0.00511mm
ΔZ: 0.00480mm

Progress since IGS 2022 Virtual Workshop (June 2022)

- The maximum PCO differences (mm) after reducing quaternion decimal digits to 3, 5, 6 or 7

Decimal digits	ΔX (mm)	ΔY (mm)	ΔZ (mm)
3	5.044	4.909	4.792
5	0.050	0.051	0.052
6	0.00745	0.00511	0.00480
7	0.000501	0.000501	0.000504

Progress since IGS 2022 Virtual Workshop (June 2022)

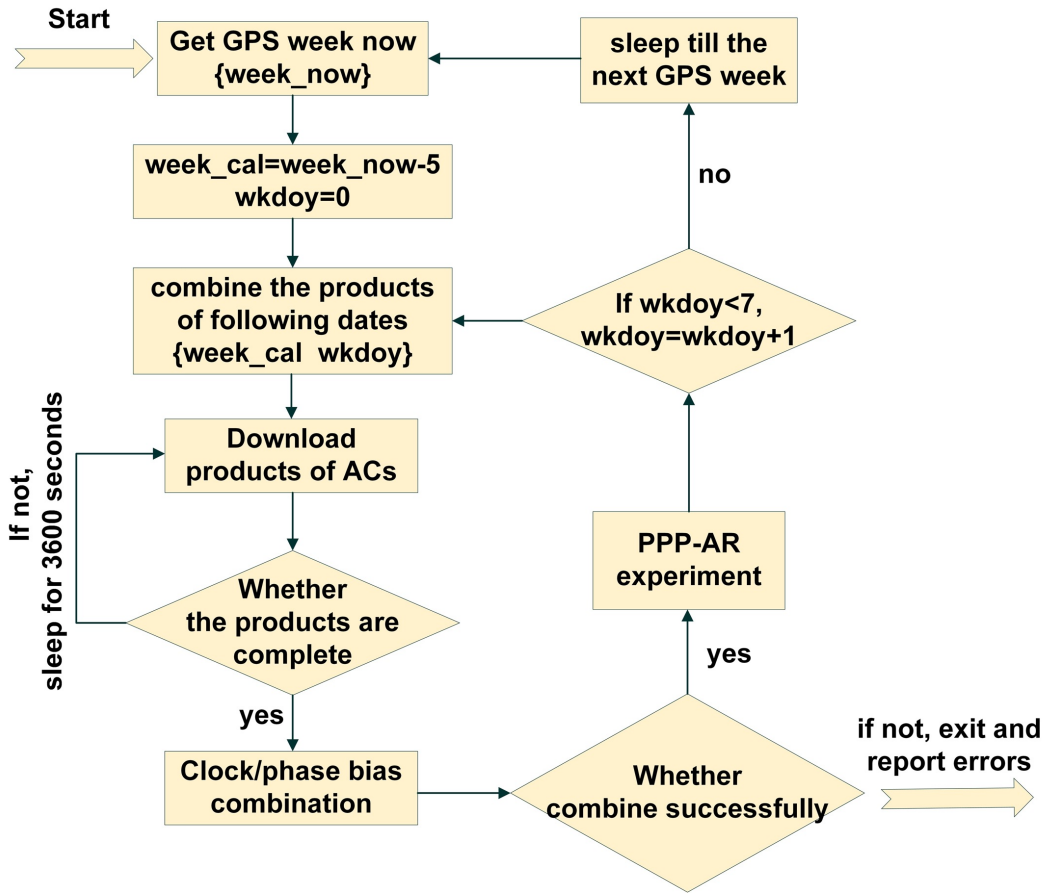
- IGSMail-8279: A new keyword 'APC_MODEL' is added to the 'BIAS/DESCRIPTION' in the format of 'APC_MODEL igs20_WWWW.atx' when APCs are applied to geometry-free biases.

```
+BIAS/DESCRIPTION
*KEYWORD_____________________________VALUE (S) ____________
 OBSERVATION_SAMPLING                        30
 PARAMETER_SPACING                        86400
 DETERMINATION_METHOD                CO-ESTIMATED
 BIAS_MODE                           ABSOLUTE
 TIME_SYSTEM                         G
 RECEIVER_CLOCK_REFERENCE_GNSS       G
 SATELLITE_CLOCK_REFERENCE_OBSERVABLES  G  C1W  C2W
 SATELLITE_CLOCK_REFERENCE_OBSERVABLES  R  C1P  C2P
 SATELLITE_CLOCK_REFERENCE_OBSERVABLES  E  C1X  C5X  C1C  C5Q
 SATELLITE_CLOCK_REFERENCE_OBSERVABLES  C  C2I  C6I
 SATELLITE_CLOCK_REFERENCE_OBSERVABLES  J  C1X  C2X
*APC_MODEL                           IGS14_2233.ATX
-BIAS/DESCRIPTION
```

A relevant article by Wuhan and GA is under review

Progress since IGS 2022 Virtual Workshop (June 2022)

- Routine clock/bias combination to cross-validate AC's products (*under internal evaluation*)



- MGEX products
  - COD/GFZ/GRG/SHA/JAX/WUMr
  - GPS/GLONASS/Galileo/BDS-2/3
- Reference orbit (*operational*)
  - WMC combination orbit by Wuhan
- Reference attitudes (*operational*)
  - by GROOPS

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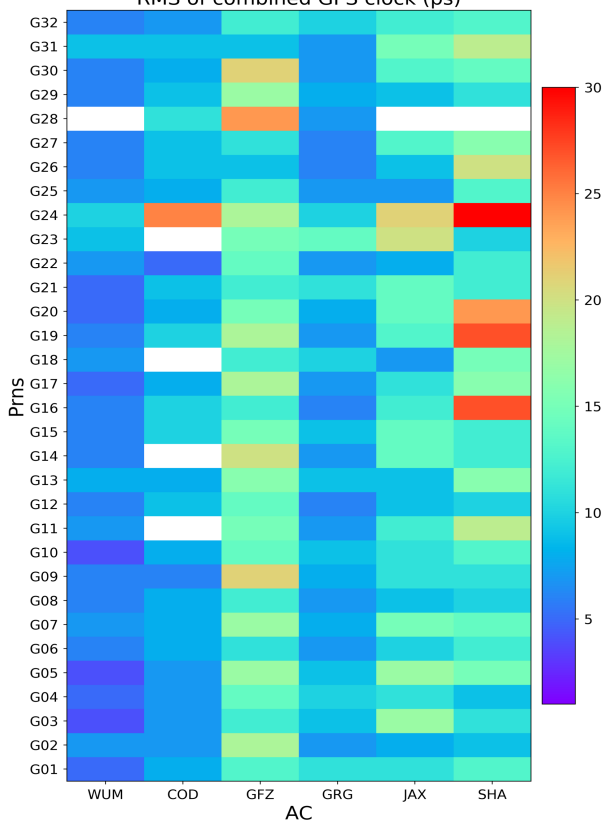
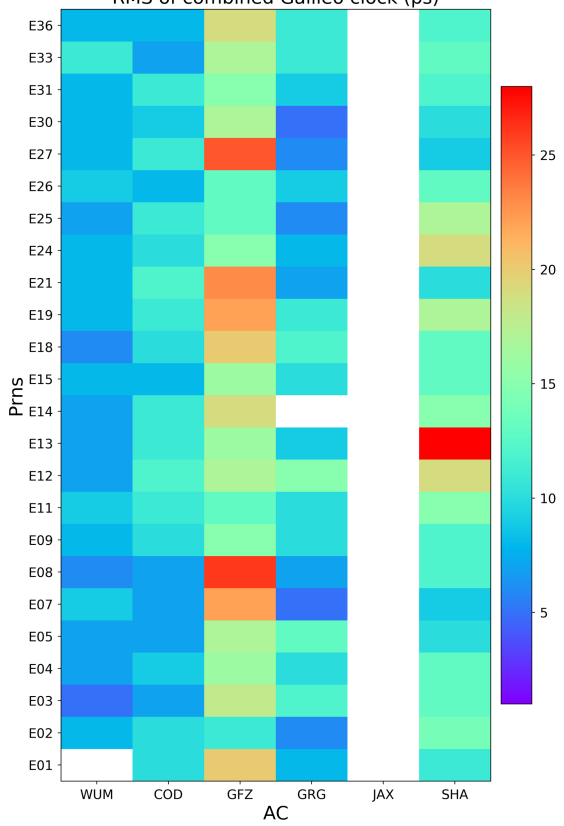
Progress since IGS 2022 Virtual Workshop (June 2022)

- Routine clock/bias combination to cross-validate AC's products (e.g., Day 268, 2022)

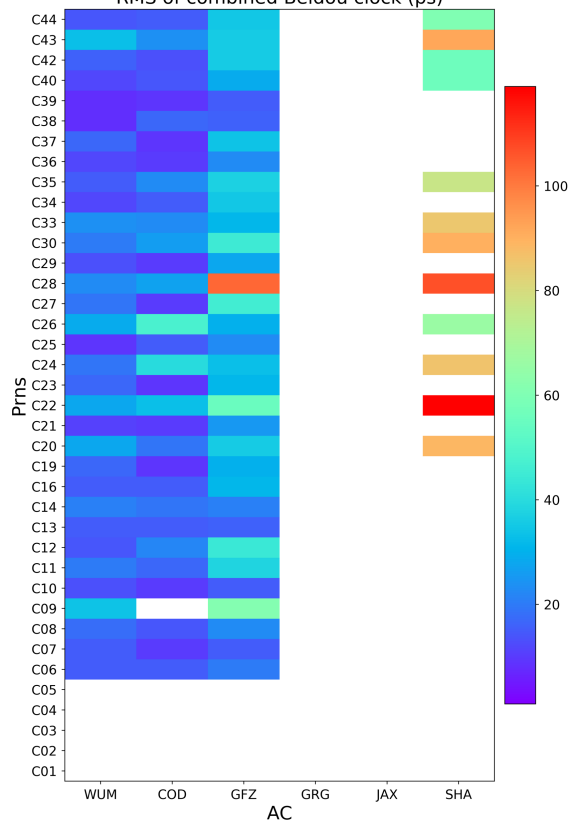
GPS (*phase clock*)



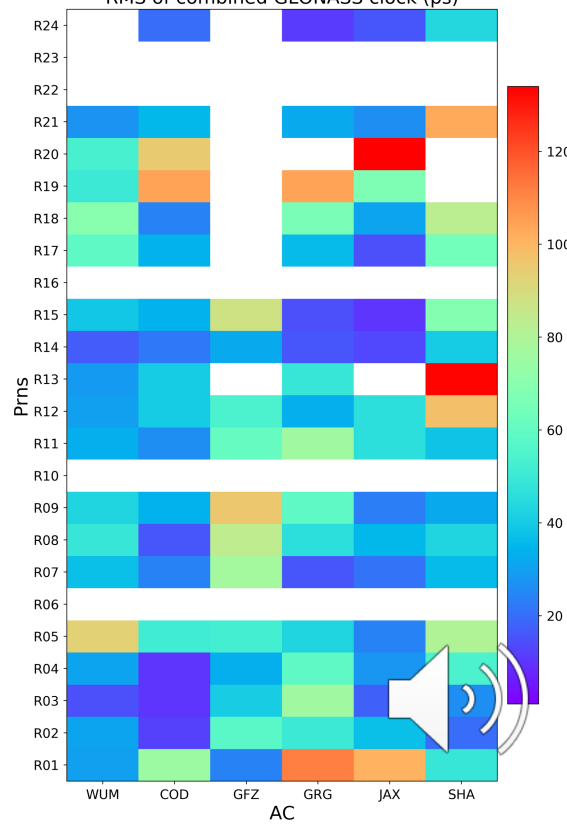
Galileo (*phase clock*)



BDS (*phase clock*)



GLONASS



Future Work

- Visualization of combination results on IGS websites
- Day boundary discontinuities of satellite phase clocks
- Standardization of group delay variations across Bias, PPP-AR and ionosphere WGs.
- Achieve multi-GNSS technical excellence
  - Coordinating the various multi-GNSS contributions to PPP-AR across all ACs
  - Advocate the benefit of multi-GNSS through case studies and demonstrations

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Thank You!

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