Task Force for the Format of Combination Statistics

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KOM for the format of Combination Statistics
Wuhan Combination Center (WCC) December 2025

Agenda today

- A brief self-introduction for each participant (10’)
  - Video recording removed once minutes completed
- Introduction to the task force and preliminary preparation (20’)
- Open discussion (40’)
- Plan for the following steps (10’)

Motivation

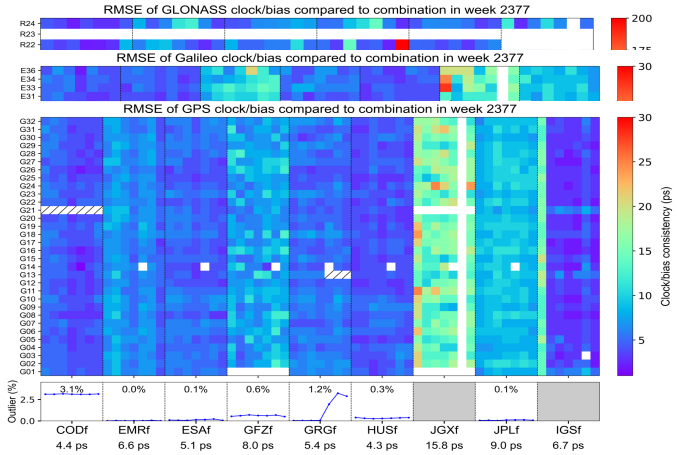
- ACs (analysis centers) cannot easily inspect problems of their products
  - Combination statistics haven't been recorded in a standard format
  - Visualizing product quality statistics is not straightforward
  - No meta data (e.g., which ACs, systems, antennas, etc.)

File1: *CLS.SUM (Clock)

File2: *SUM.SUM (Orbit)

Combination statistics are stored in **separate files**

Combination Summary



No ready-to-use plotting tools

```
cls-file Version 2.0
GPS week: 2373   Day: 5   MJD: 60860

RESULTS OF FINAL WEIGHTED COMBINATION
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CEN  |  NREPO NBEPO  NRCLK  NRBAD  OFFSET
     |                              (ps)
-----+-------------------------------------
brd  |     96     0   3072      0     -28
cod  |    288     0  32491    266    -875
emr  |    288     0  21934    524   -1497
esa  |    288     0  37225   3274   -4165
gfz  |    288     0  30567   1405    -376
```
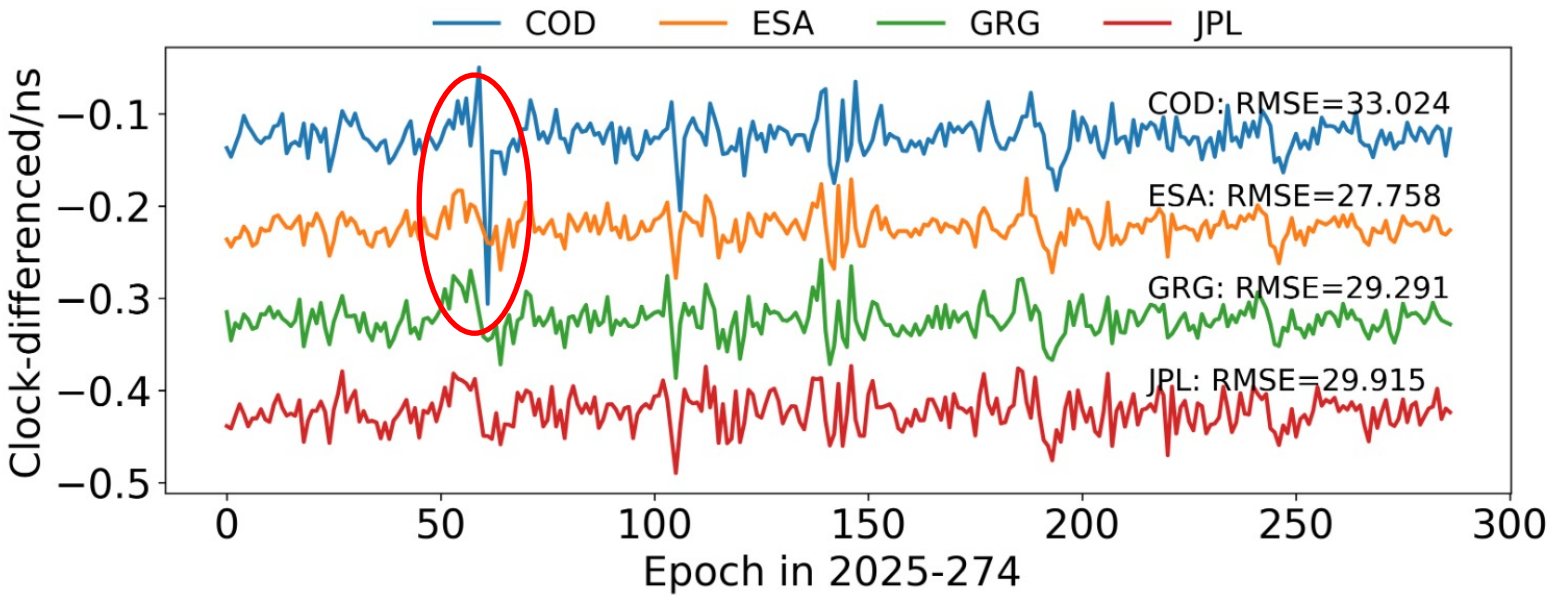

'Summary' header: no meta data

Motivation

- PPP users can hardly know the outlier epochs within AC-specific products
  - Anomalies in ACs' products cannot be detected all by users themselves
  - Missing outlier statistics in combination (e.g., epochs for outlier clocks/biases, etc.)



Satellite clock variations (ns) from epoch to epoch

Goals of the task force

- A format for ACs to **easily inspect** their products' artifacts
- A format for PPP users to **easily exclude** outlier products
- **Auxiliary scripts** to plot the combination statistics

What to be included in the format

- Meta data
  - Combined AC-specific products
  - Basic models: antennas, etc.
  - Combination strategies: constellation/satellite specific weighting, etc.
  - Other relevant information: reference observables, sampling rate, etc.

What to be included in the format

- Orbit
  - Helmert parameters
  - Consistency across ACs in terms of RMSE (along-track/cross-track/radial)
  - Weights and *outliers*

What to be included in the format

- Clock
  - Consistency across ACs in terms of RMSE (satellite, station clocks)
  - Weights and outliers

What to be included in the format

- Bias
  - Observable codes or signal frequency
  - Consistency across ACs in terms of RMSE
  - Weights and outliers

Discussion I

- JSON, SINEX or others?
  - Time consumption for reading the Helmert blocks as a demonstration

Format	File size	Time consumption
SINEX	2.61 kb	194 μs
JSON	5.07 kb	186 μs

```
+COD/HELMERT
 SYS DX_mm_ DY_mm_ DZ_mm_ RX_uas_ RY_
   G   0.00   0.00   4.00   24.00   19
   R   0.00   2.00   4.00    6.00   22
   E   0.00   0.00   3.00   19.00   21
-COD/HELMERT
```

SINEX

```
{
  "COD": {
    "HELMERT": {
      "GPS": {
        "DX": 0.0,
        "DY": 0.0,
        "DZ": 4.0,
        "RX": 24.0,
        "RY": 19.0,
        "RZ": 5.0,
        "SCL": 0.02
      },
      "GLONASS": {
        "DX": 0.0,
        "DY": 2.0,
        "DZ": 4.0,
        "RX": 6.0,
        "RY": 22.0,
        "RZ": 17.0,
        "SCL": -0.03
```

JSON

Discussion 2

- Product types or Analysis centers as level-1 heading?

Product types

```
+COMB/HELMERT
 AC_ SYS DX_mm_ DY_mm_ DZ_mm_
 COD   G   0.00   0.00   4.00
 COD   R   0.00   2.00   4.00
 COD   E   0.00   0.00   3.00
-COMB/HELMERT
```

Analysis centers

```
+COD/HELMERT
 SYS DX_mm_ DY_mm_ DZ_mm_
   G   0.00   0.00   4.00
   R   0.00   2.00   4.00
   E   0.00   0.00   3.00
-COD/HELMERT
```

Discussion 3

- ERP (Earth Rotation Parameters) combination statistics or not?

```
+COMB/ERP
*AC_ DATA_START____ DATA_END______ XPRES_uas YPRES_uas XRTRES_uas/d YRTRES_uas/d LODRES___
 ESA 2025:106:00000 2025:107:00000    -3.00     -3.00       -46.00       -44.00     -3.00
 JGX 2025:106:00000 2025:107:00000   -14.00      2.00        20.00        47.00     -4.00
 JPL 2025:106:00000 2025:107:00000    11.00      2.00        37.00        18.00      6.00
 HUS 2025:106:00000 2025:107:00000   -16.00      6.00        24.00       -97.00      2.00
-COMB/ERP
```

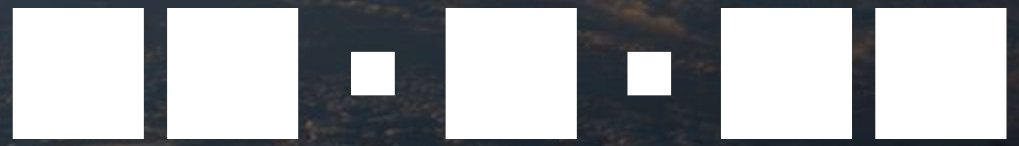
Discussion 4

- Consider multi-frequency signal biases or not?
  - Phase biases cannot easily be assessed without being combined with clocks

AC_	SYS	SVN_	PRN	OBS1	OBS2	DATA_START____	DATA_END______	UNIT	NEPO_	NBAD_	_OFFSET_	__RMSE__
WUM	G	G080	G01	C1C	C5Q	2025:106:00000	2025:107:00000	ps				230.000
WUM	G	G069	G03	C1C	C5Q	2025:106:00000	2025:107:00000	ps				1820.000
WUM	G	G074	G04	C1C	C5Q	2025:106:00000	2025:107:00000	ps				710.000
TUG	G	G067	G06	L5X		2025:106:00000	2025:107:00000	ps				610.000
TUG	G	G074	G04	L5X		2025:106:00000	2025:107:00000	ps				421.000
WUM	G	G072	G08	C1C	C5Q	2025:106:00000	2025:107:00000	ps				128.000
WUM	G	G068	G09	C1C	C5Q	2025:106:00000	2025:107:00000	ps				1705.000
WUM	G	G068	G09	C5X	C5Q	2025:106:00000	2025:107:00000	ps				903.000

Schedule afterwards …

- Virtual meetings every 2-3 months in 2026
  - E-mail communications as well
- Format and scripts to be concluded before the Dec., 2026 GB meeting
- Any other recommendations?



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Thank You!

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