

Multi-GNSS real-time precise positioning and Initial assessment of BDS-3

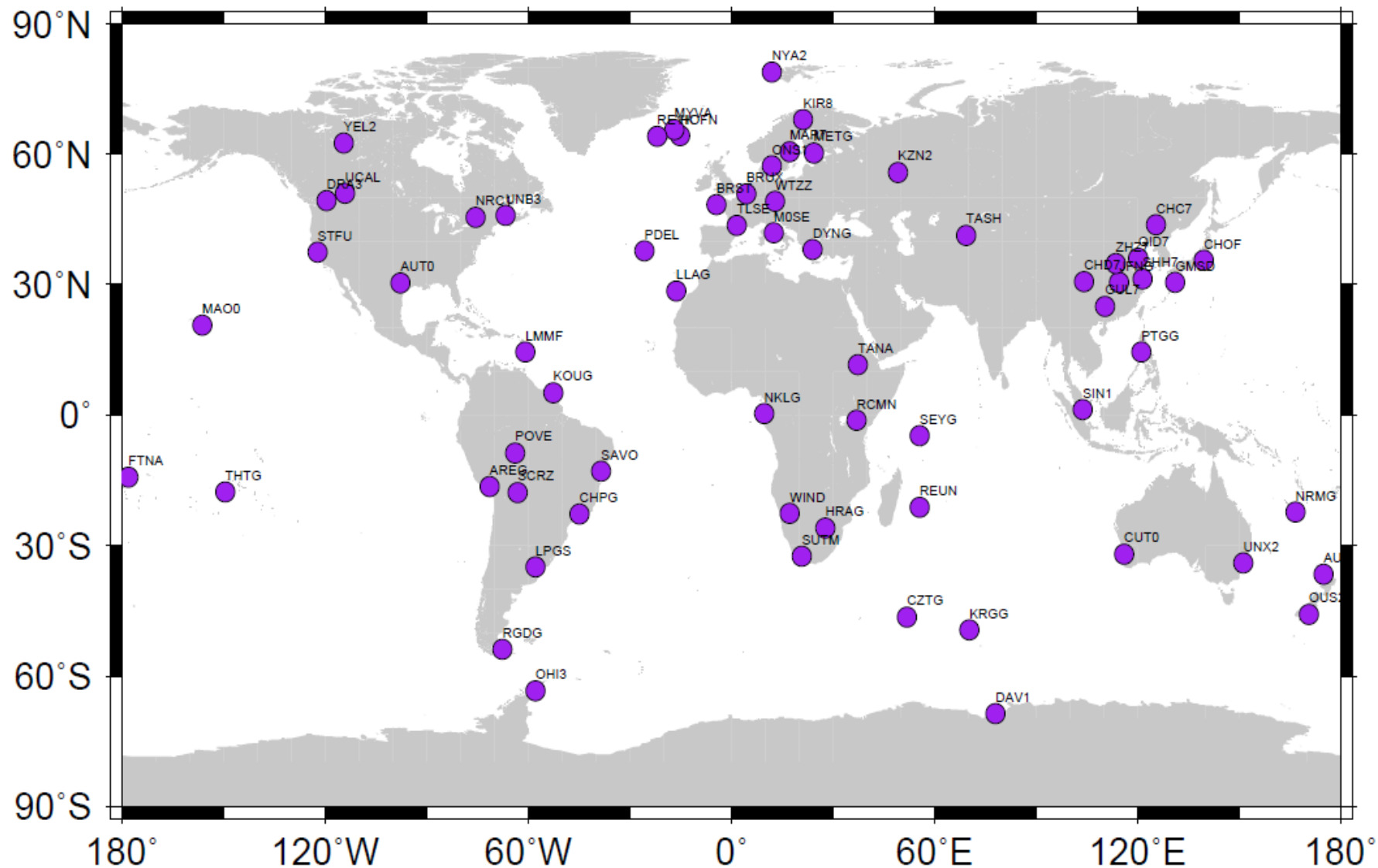
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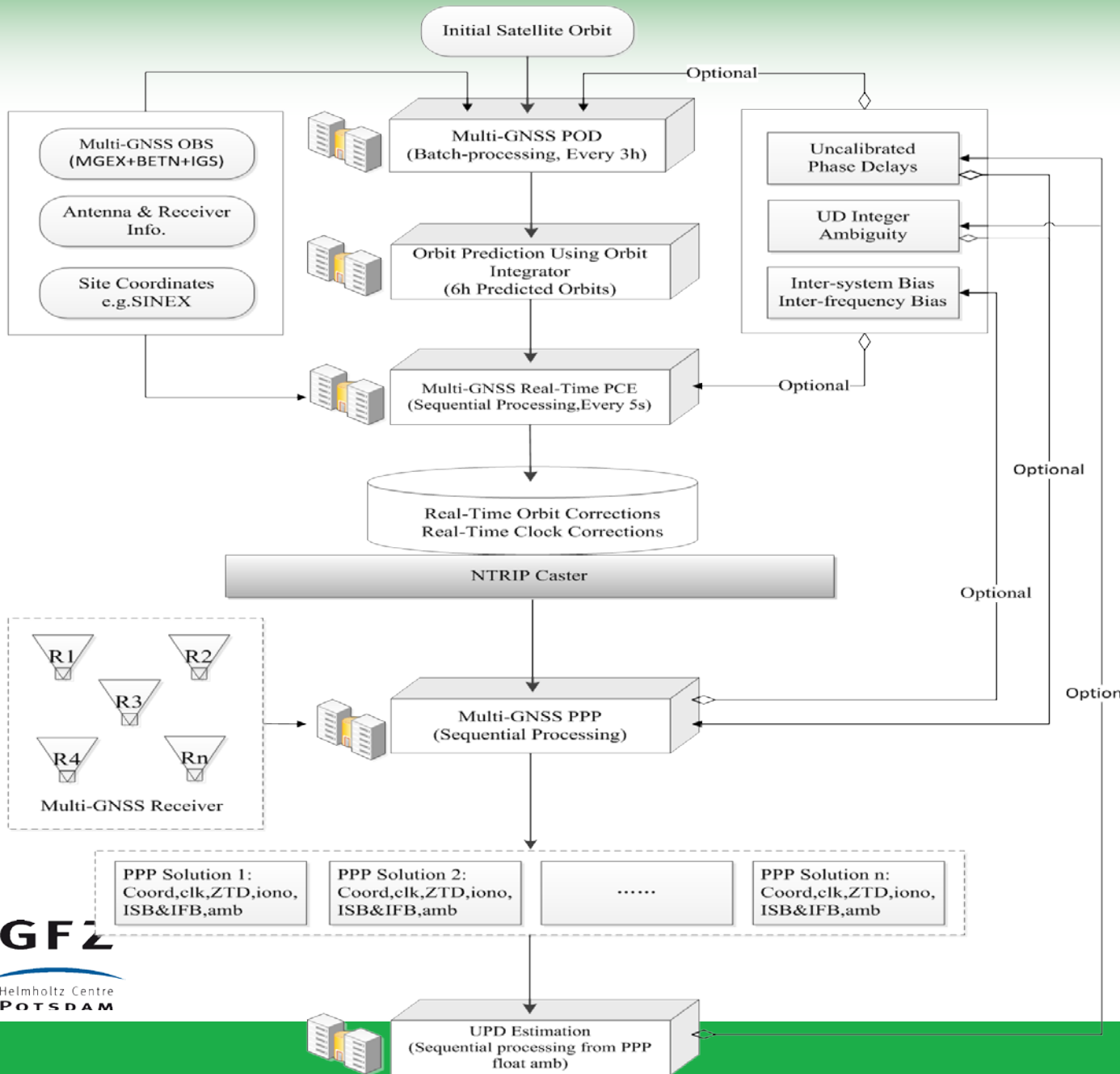
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Current multi-GNSS status



Multi-GNSS data processing



The structure of the multi-GNSS real-time PPP service system at GFZ.

Li et al (2015), Accuracy and reliability of multi-GNSS real-time precise positioning: GPS, GLONASS, BeiDou, and Galileo. *J. Geod.*, 2015, 89(6): 607-635.

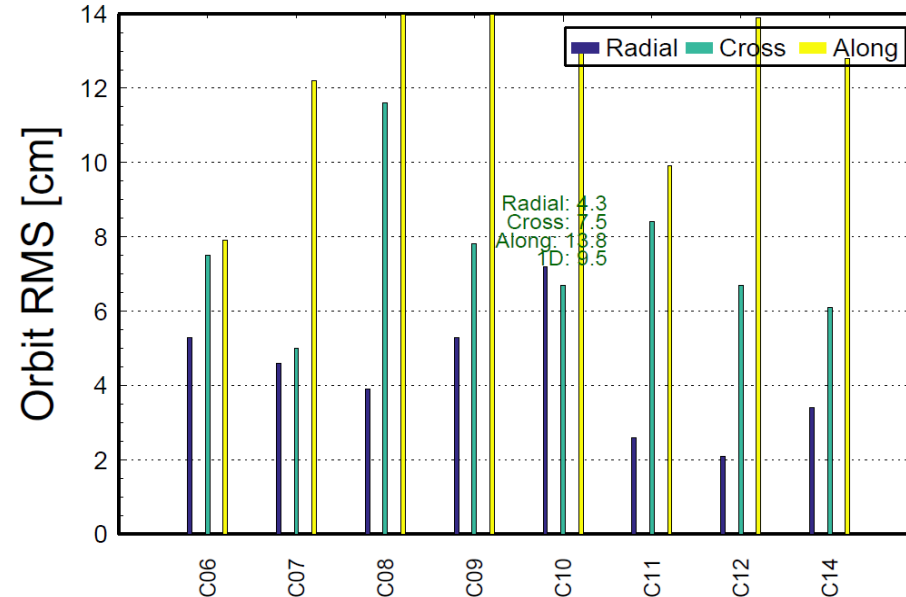
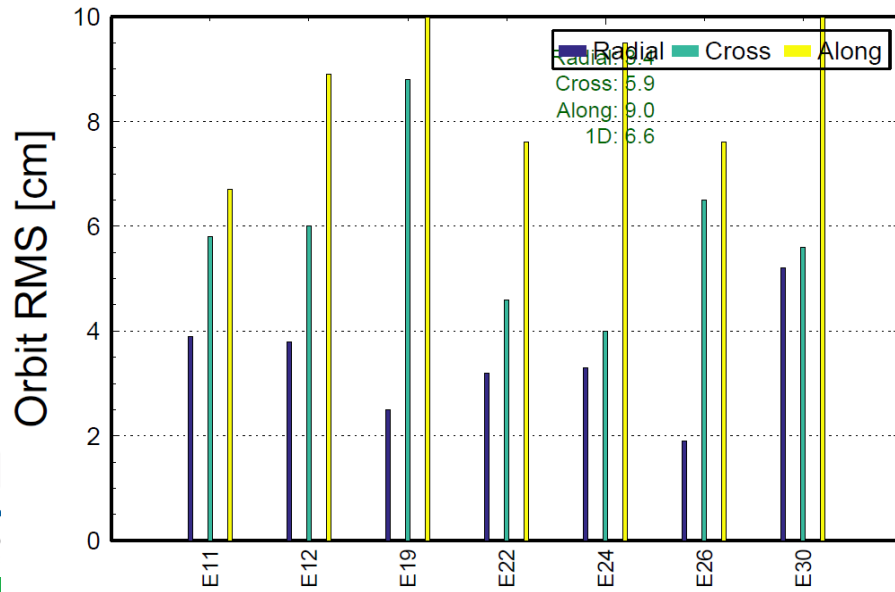
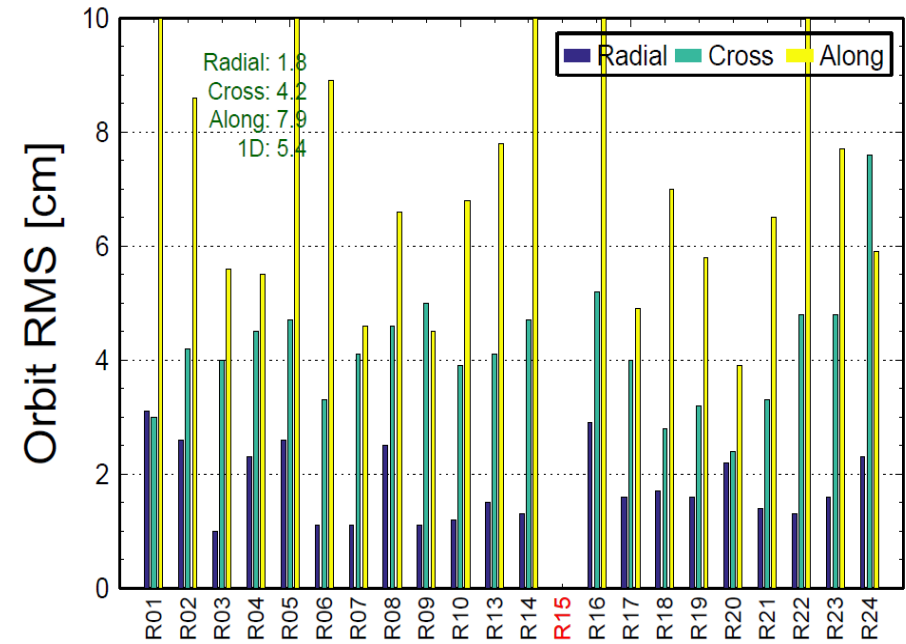
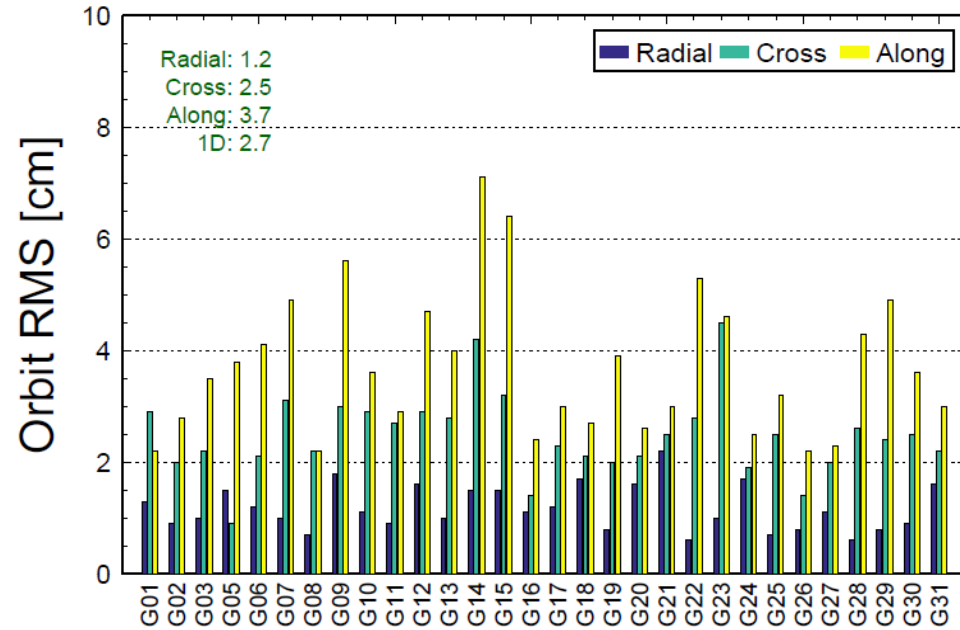
Real-time orbit and clock

kg3-dmz.gfz-potsdam.de:4080/streams.html

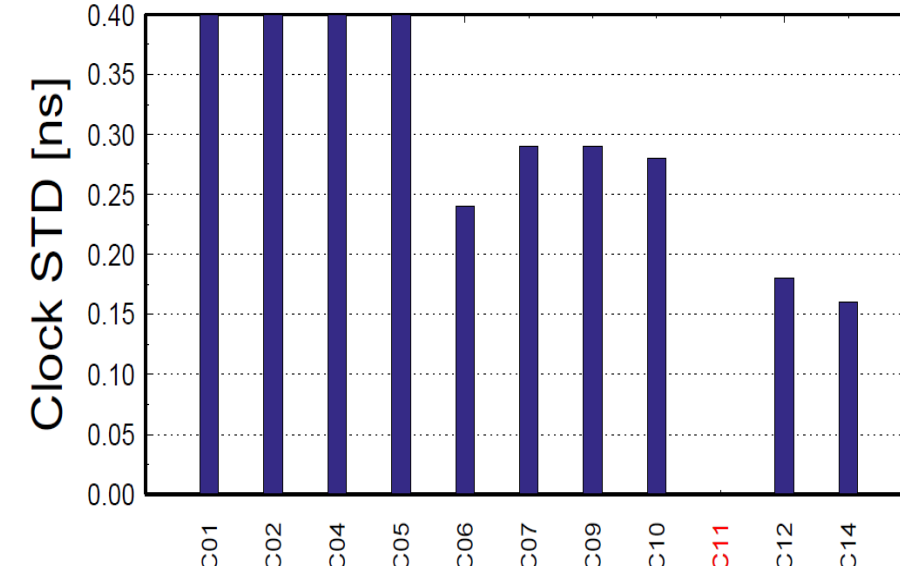
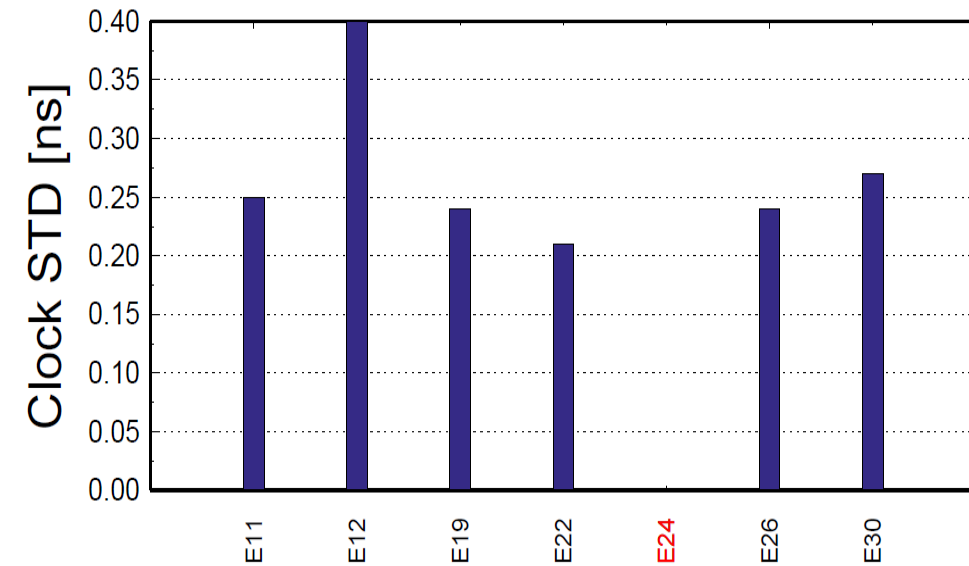
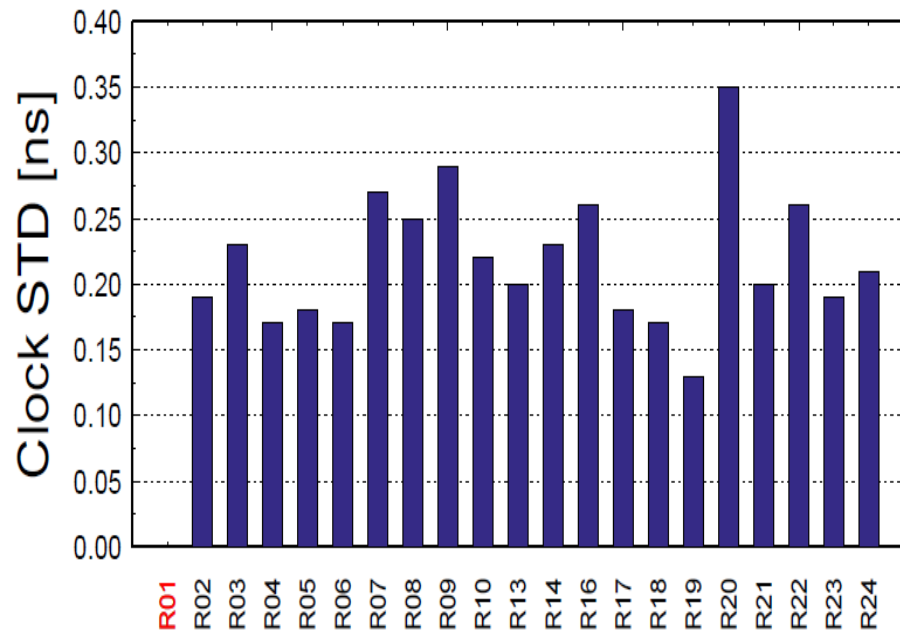
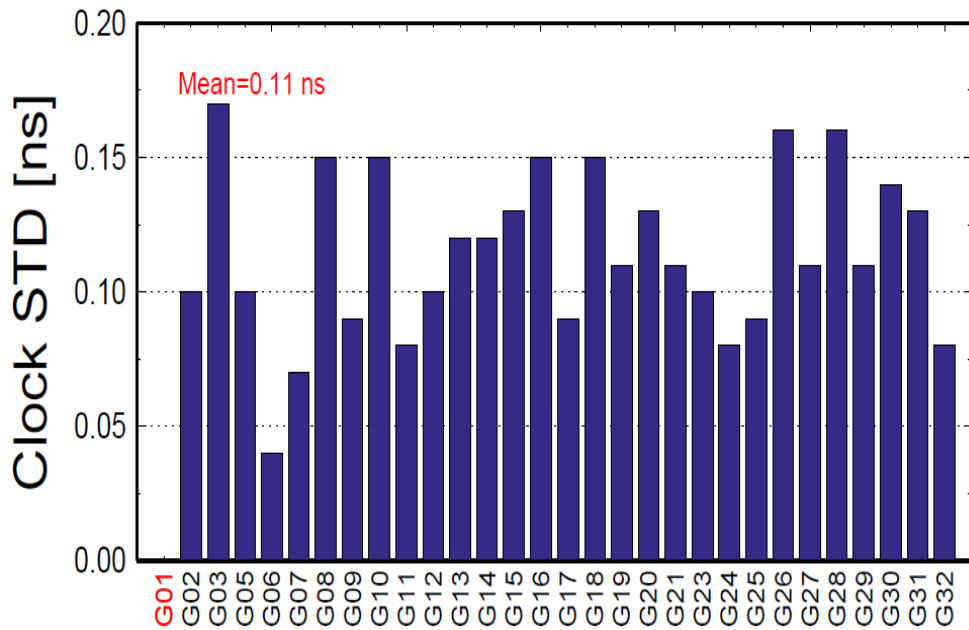
数据 生活 英语 邮箱 实时 Google

GFZ2_UPD_RTCM	no connection active						
GFZA0	1	944.551 MB	124620 bytes/min	2016-05-01T12:45:22 (5d 09:11:32)	gseis	NTRIP PDM/1.0	139.17.56.157
GFZA1	0	105.954 MB	13928 bytes/min	2016-05-01T12:48:28 (5d 09:08:26)	gseis	NTRIP BNC/2.12	139.17.56.126
GFZA2	0	105.954 MB	13928 bytes/min	2016-05-01T12:48:28 (5d 09:08:26)	gseis	NTRIP BNC/2.12	139.17.56.126
GFZA4	no connection active						
GFZB0	1	875.172 MB	98027 bytes/min	2016-04-30T09:05:32 (6d 12:51:22)	gseis	NTRIP PDM/1.0	139.17.56.153
GFZB1	0	196.051 MB	21983 bytes/min	2016-04-30T09:05:42 (6d 12:51:12)	gseis	NTRIP BNS/1.3	139.17.56.153
GFZB2	0	196.051 MB	21983 bytes/min	2016-04-30T09:05:42 (6d 12:51:12)	gseis	NTRIP BNS/1.3	139.17.56.153
GFZB4	no connection active						
GFZC0	1	808.336 MB	105720 bytes/min	2016-05-01T12:44:57 (5d 09:11:57)	gseis	NTRIP PDM/1.0	139.17.56.126
GFZC1	1	89.603 MB	11641 bytes/min	2016-05-01T12:48:07 (5d 09:08:47)	gseis	NTRIP BNC/2.12	139.17.56.126
GFZC1INF	no connection active						
GFZC1SP3	no connection active						
GFZC2	0	89.603 MB	11641 bytes/min	2016-05-01T12:48:07 (5d 09:08:47)	gseis	NTRIP BNC/2.12	139.17.56.126
GFZC2INF	no connection active						
GFZC2SP3	no connection active						
GFZC4	no connection active						
GFZC5	no connection active						
GFZC6	no connection active						
GFZCSP3	no connection active						
GFZD0	1	640.705 MB	138120 bytes/min	2016-05-03T11:32:03 (3d 10:24:51)	gseis	NTRIP PDM/1.0	139.17.64.31

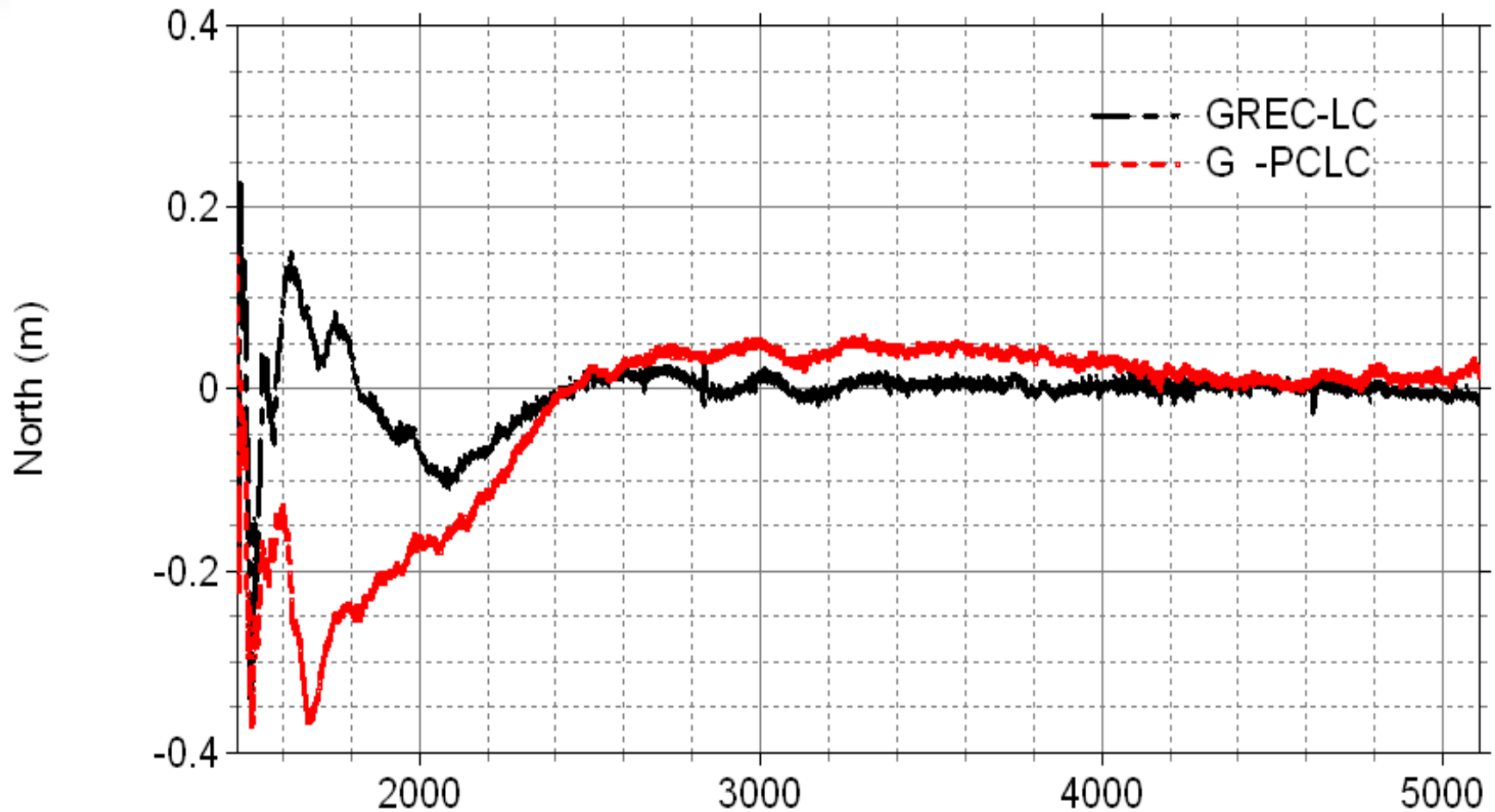
Real-time orbit and clock



Real-time orbit and clock



Multi-GNSS real-time PPP



BDS new satellites and signals

Table 1. Status of new launched new-generation BDS satellites (July, 2016)

Satellite	Launch time	RRN	Launch site	Carrier Rocket	Orbit	Status
BDS I1-S	2015/03/30	C31	Xichang LC-2	Chang Zheng 3C/YZ-1	IGSO, 55° inclination	Operational
BDS M1-S	2015/07/25	C34	Xichang LC-2	Chang Zheng 3C/YZ-1	MEO, ~21,500km	Operational
BDS M2-S	2015/07/25	C33	Xichang LC-2	Chang Zheng 3C/YZ-1	MEO, ~21,500km	Operational
BDS I2-S	2015/09/29	C32	Xichang LC-3	Chang Zheng 3B	IGSO, 55° inclination	Operational
BDS M3-S	2016/02/01	?	Xichang LC-2	Chang Zheng 3C/YZ-1	MEO, ~21,500km	?

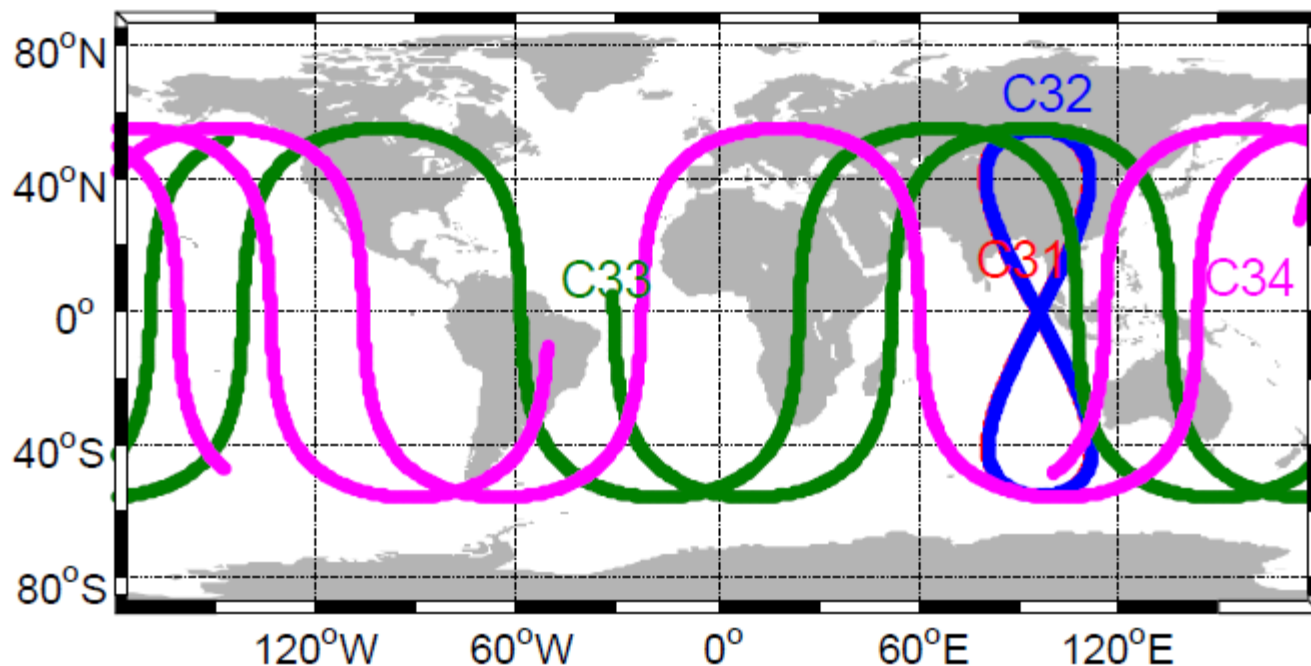


Fig. 1 The ground tracks of the new-generation BDS satellites on 25~26 June 2016

BDS new satellites and signals

Table 3 Signals tracked by the civil receivers for new-generation BDS satellites C32, C33, and C34

Band	Frequency (MHZ)	Modulation
B1I	1561.098	BPSK(2)
B3I	1268.52	QPSK(10)
B1C	1575.42	TMBOC(6,1)
B2a	1176.45	AltBOC(15,10)
B2b	1207.14	AltBOC(15,10)

Table 4 Characteristics of the experiment conducted for this contribution

Receiver type	UNDT
Antenna type	Trimble TRM59900.0 choke ring
Location	Wuhan University, Wuhan
Enabled signals	GPS: L1, L2, L5 GAL: E1, E5a, E5b BDS: B1, B2, B3 (C01-C15, C31) B1I, B3I, B1C, B2a, B2b (C32-C34)
Cutoff angle	10°
Sampling interval	10s
Date time	GPST: July 6 2016~ July 14 2016

BDS new satellites and signals

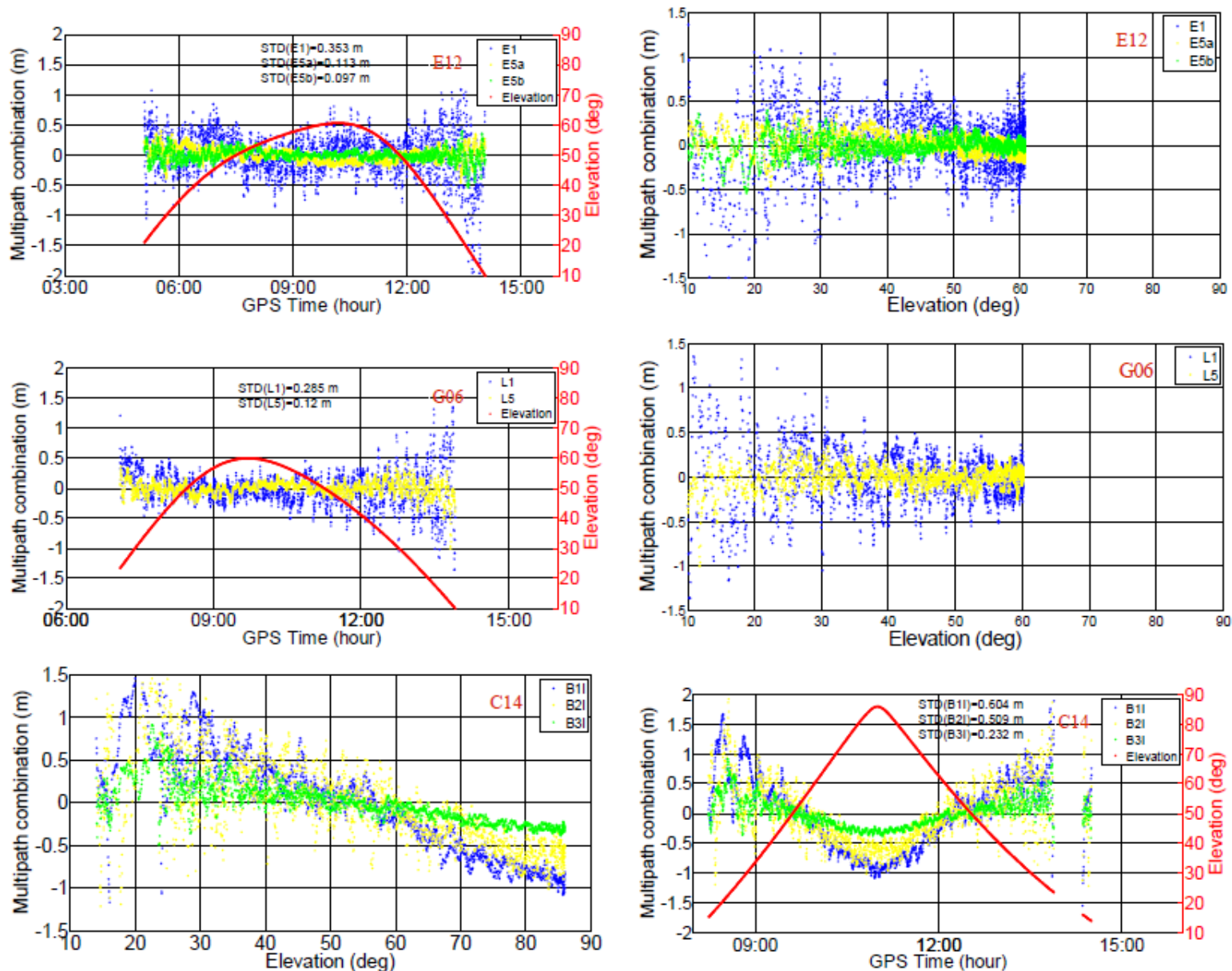


Fig. 8 MP time series (left) and MP against elevation (right) for E12 (top) E1/E5a/E5b and G06 (mid) L1/L5 and BDS-2 C14 (bottom) B1/B2/B3 signals

BDS new satellites and signals

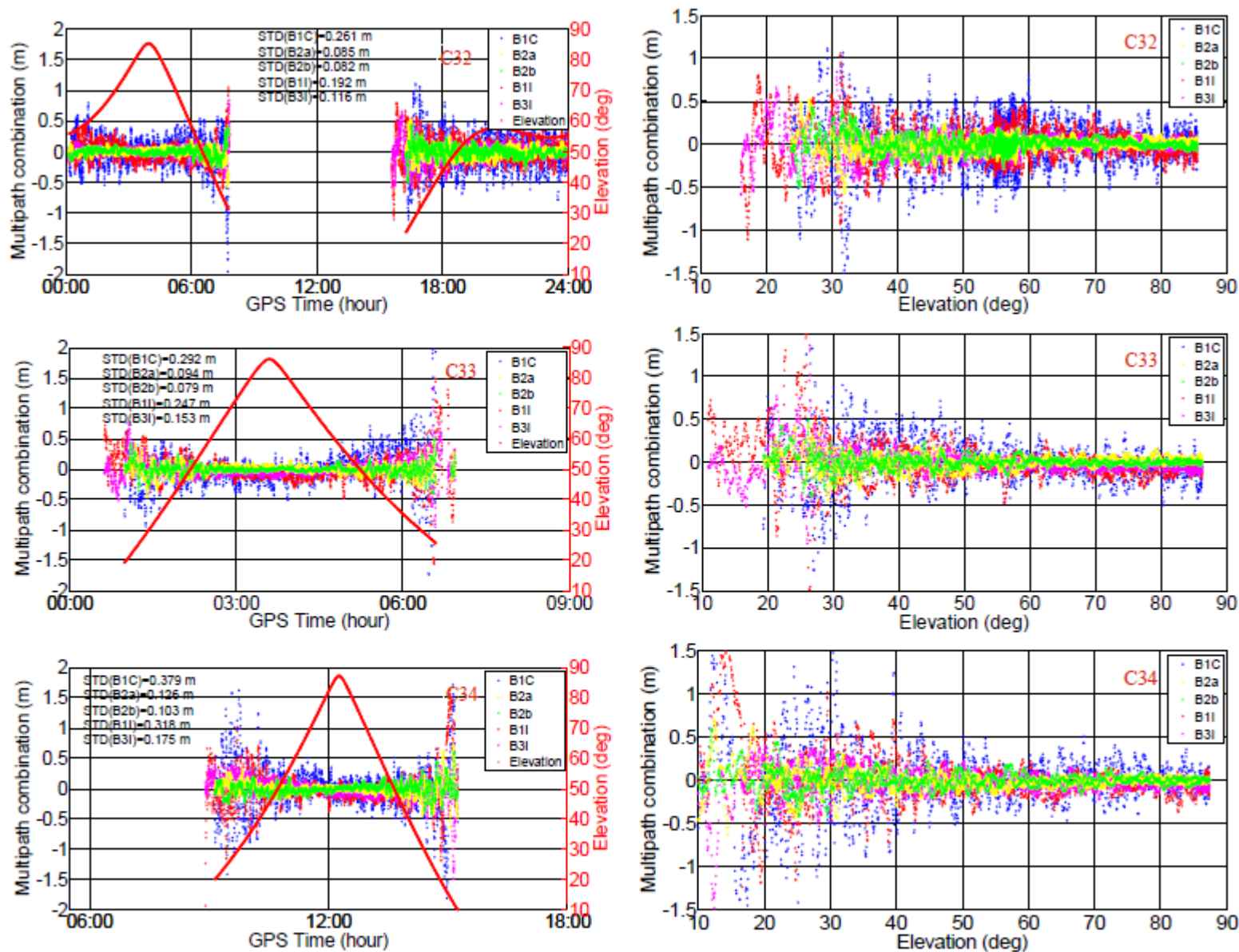


Fig. 7 MP time series (left) and MP against elevation (right) for C32 (top), C33 (mid), and C34 (bottom)

B1C/B2a/B2b/B1I/B3I signals

BDS new satellites and signals

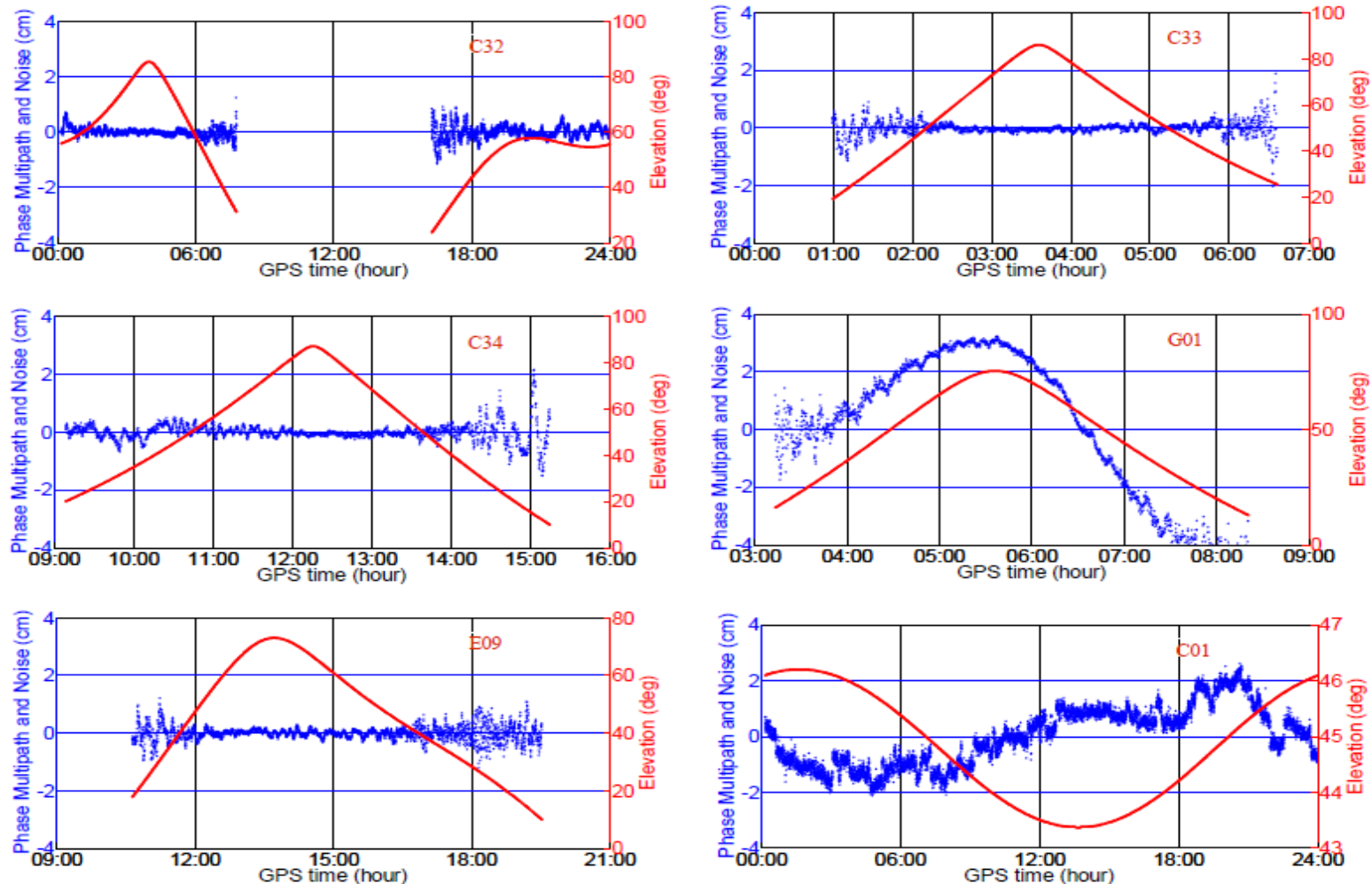
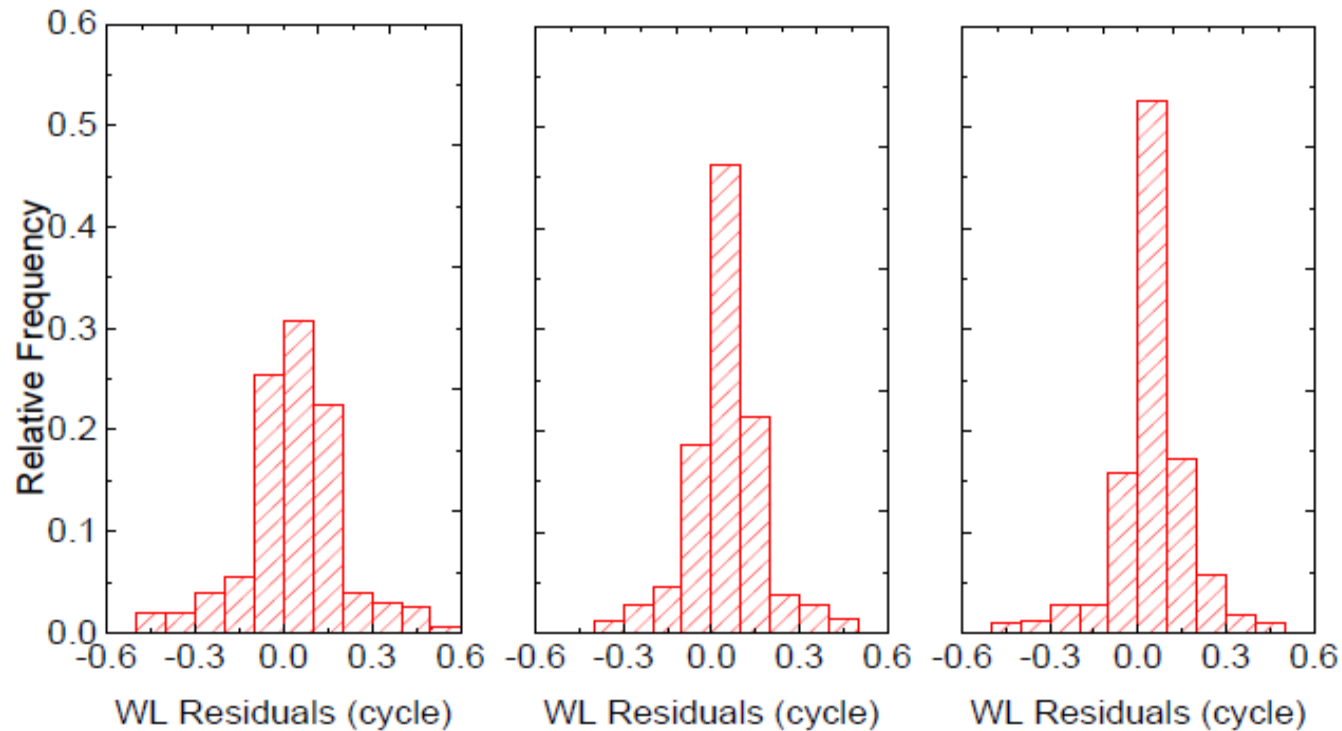


Fig. 12 Triple-frequency carrier phase multipath and noises for C32 (top left), C33 (top right) and C34 (mid left), G01 (mid right), E09 (bottom left), C01 (bottom right)

$$\begin{aligned}
 DIF(\varphi_1, \varphi_2, \varphi_3) &= IF(\varphi_1, \varphi_2) - IF(\varphi_1, \varphi_3) \\
 &= \left(\frac{f_1^2}{f_1^2 - f_2^2} \right) \frac{f_1^2}{f_1^2 - f_3^2} \cdot \lambda_1 \varphi_1 - \left(\frac{f_1^2}{f_1^2 - f_2^2} \right) \frac{f_1^2}{f_1^2 - f_3^2} \cdot \lambda_1 \varphi_1 + \left(\frac{f_2^2}{f_1^2 - f_2^2} \right) \cdot \lambda_2 \varphi_2 + \left(\frac{f_3^2}{f_1^2 - f_3^2} \right) \cdot \lambda_3 \varphi_3
 \end{aligned}$$

BDS new satellites and signals



Residual distributions of the WL ambiguity bias (cycle) for BDS-2 satellite and BDS-3 satellites.

Discussions

- ◆ New satellites , new signals, multi-frequency;
- ◆ Accuracy, various biases, ambiguity-fixing;
- ◆ Efficiency, especially for four-system processing;
- ◆ Stability, especially for BDS;
- ◆

Thank you !