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

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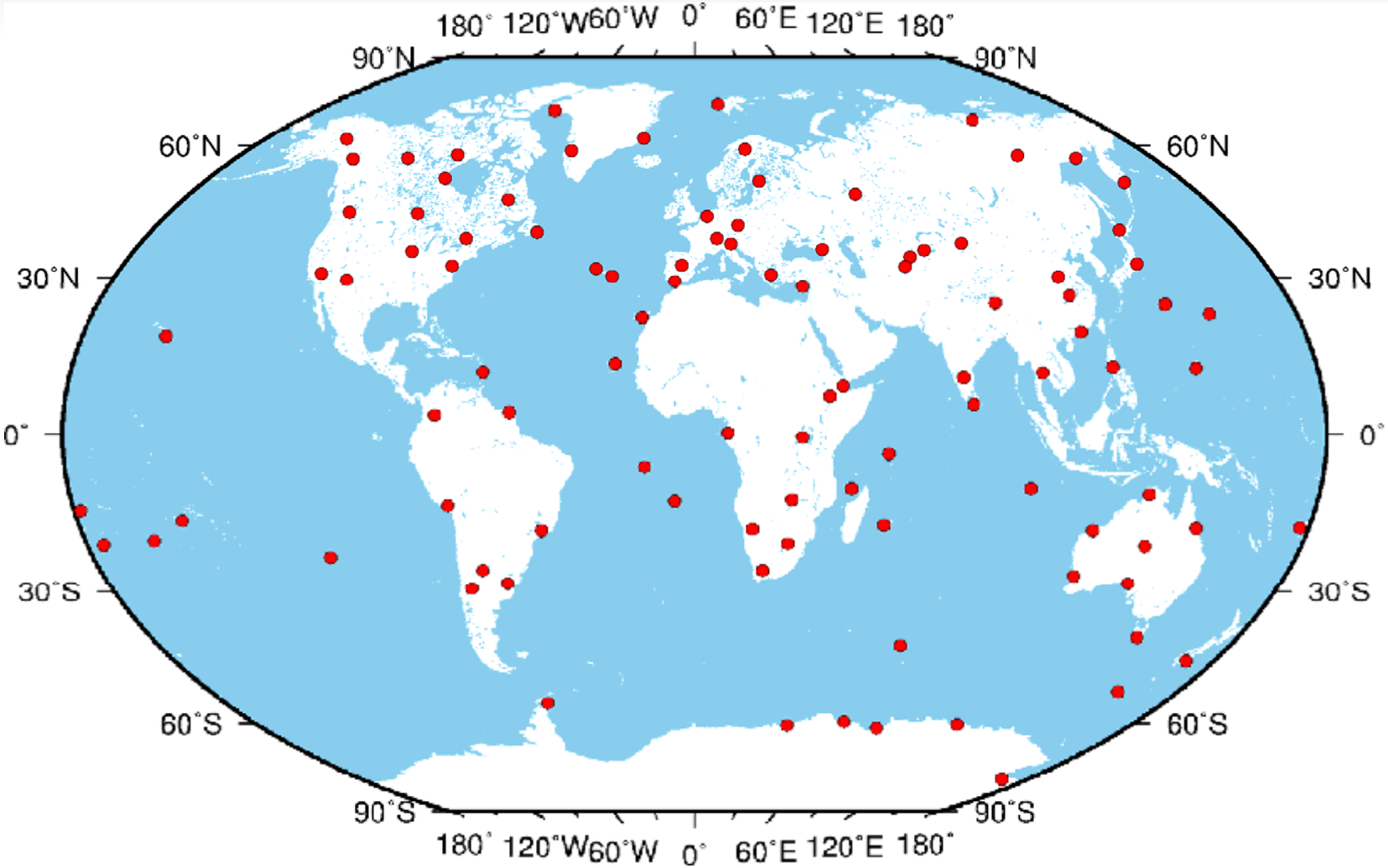
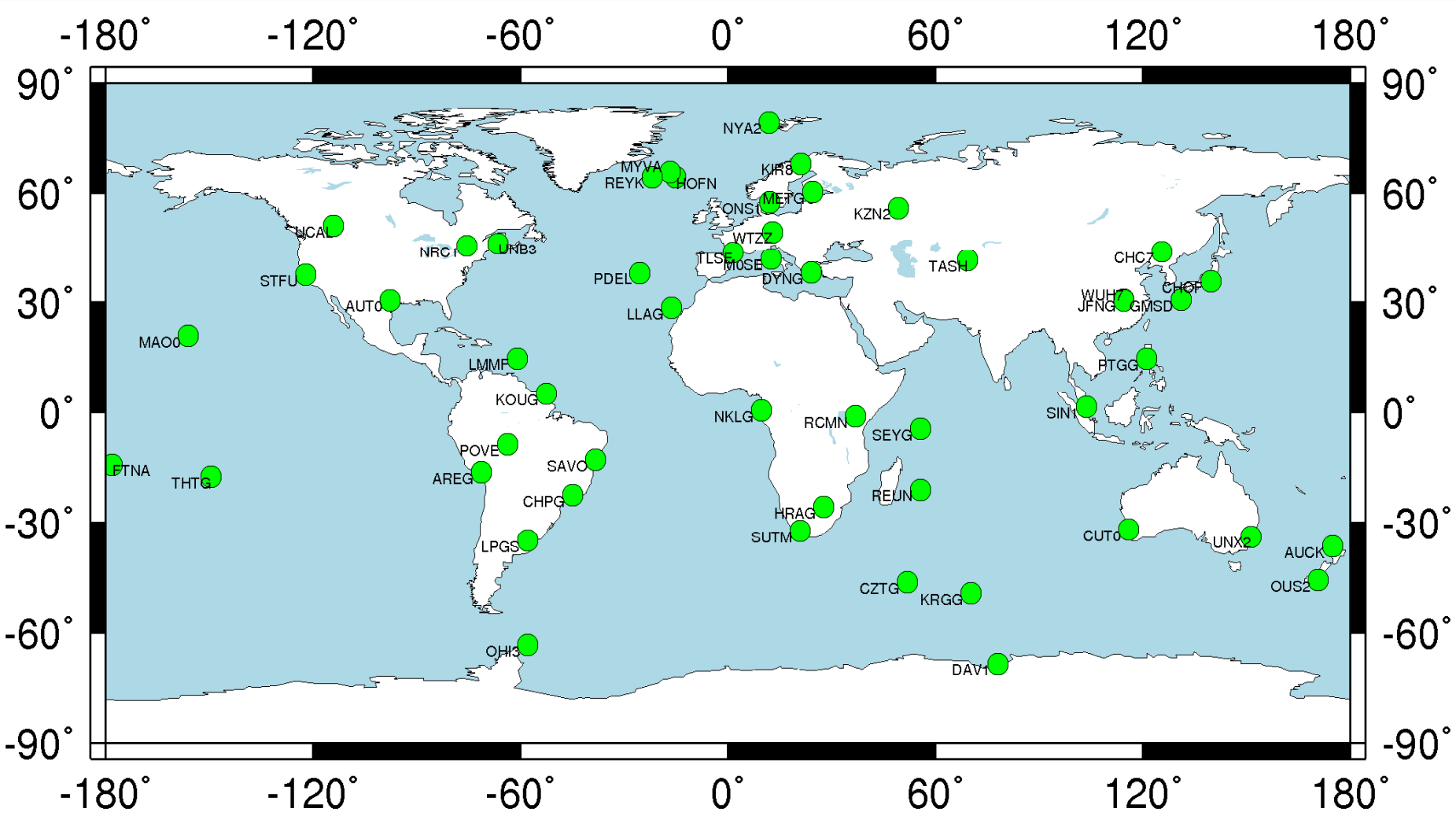
Content

Multi-GNSS hourly data



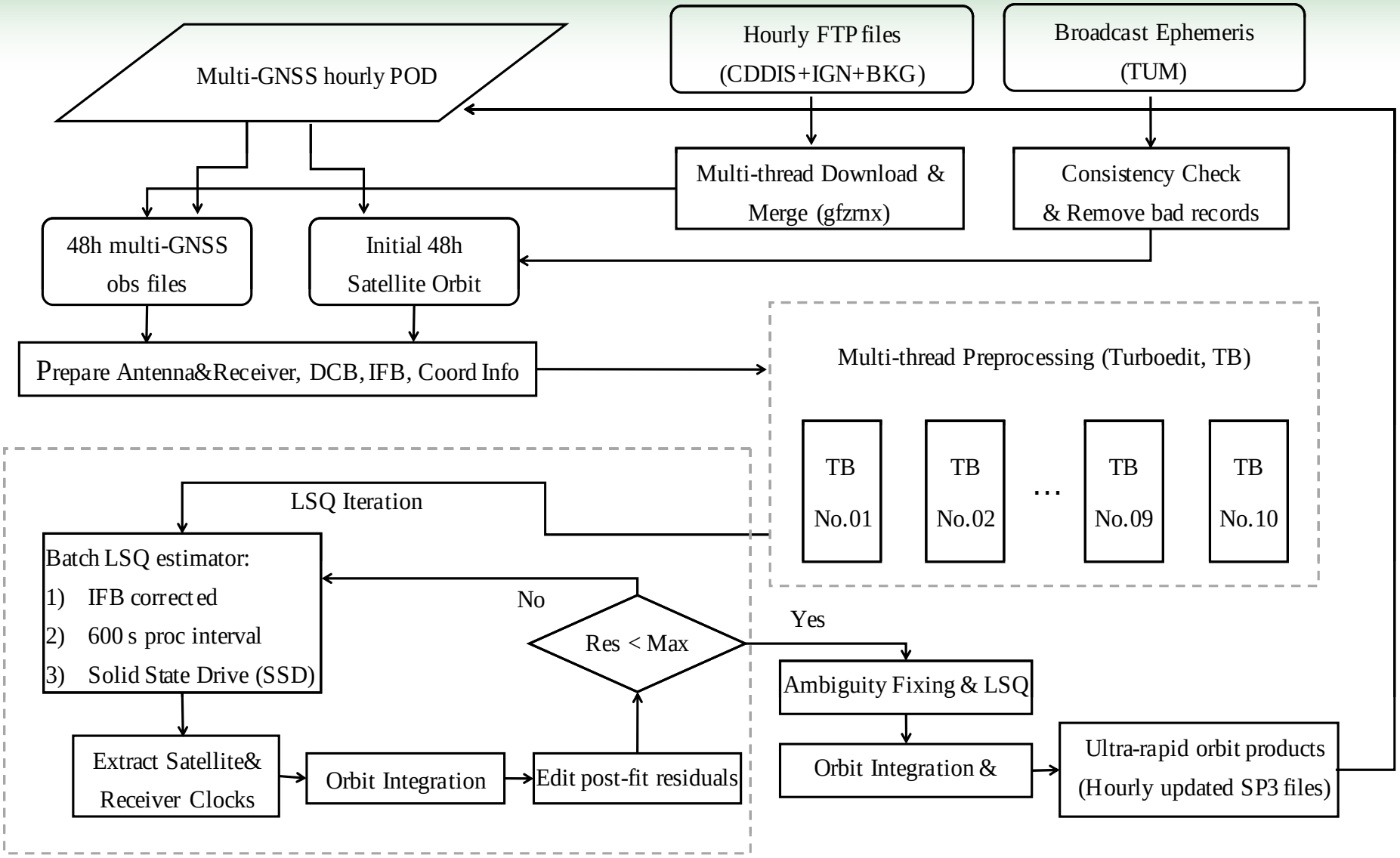
The tracking stations selected for hourly multi-GNSS POD
(CDDIS+IGN+BKG archives)

Multi-GNSS real-time streams



MGEX real-time streams selected for real-time PCE

Multi-GNSS hourly POD



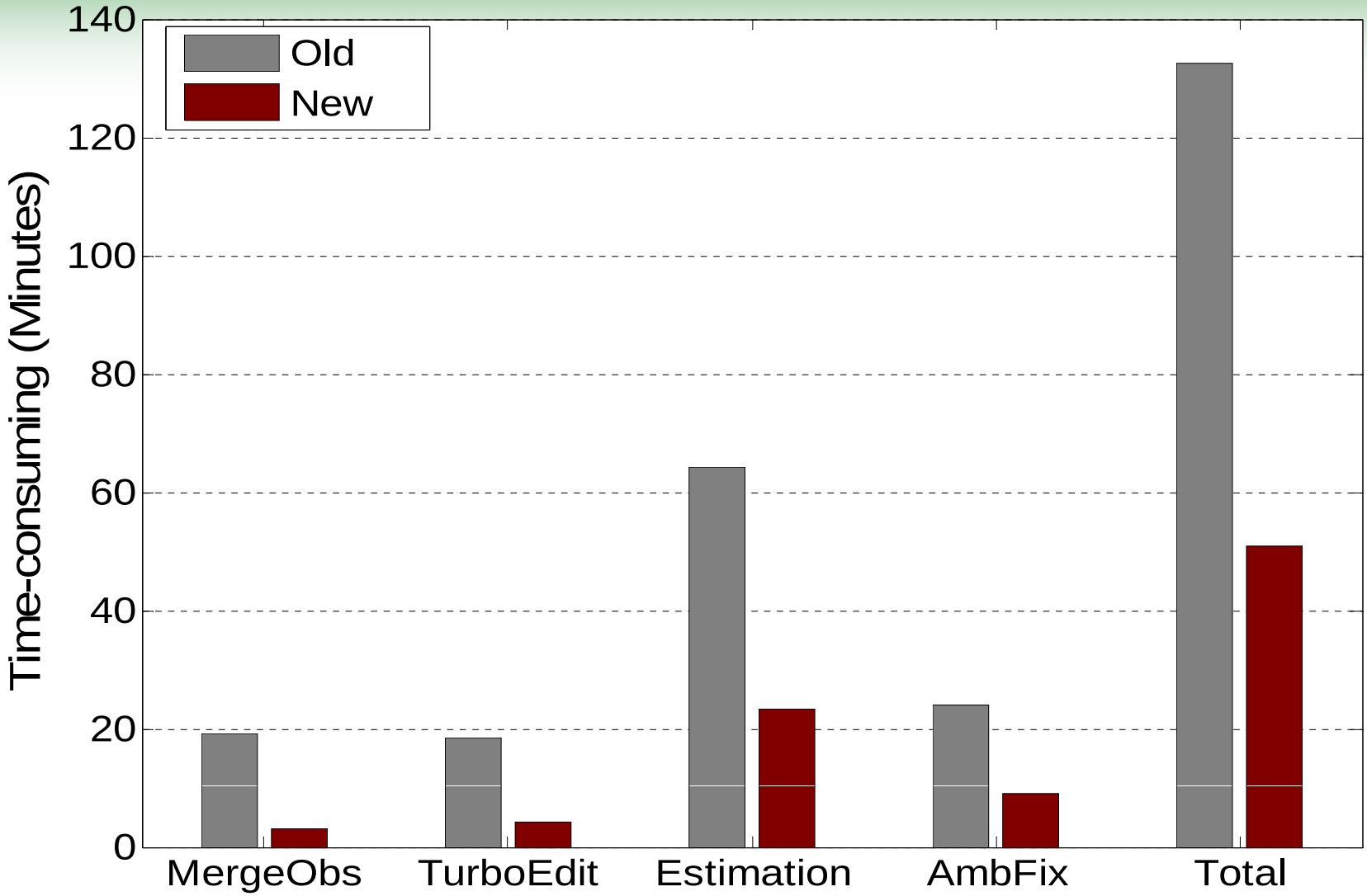
The improved strategy for multi-GNSS ultra-rapid POD

Multi-GNSS hourly POD

Item	Old strategy	New Strategy
Orbit Update	Every 3 hours	Every 1 hour
Orbit arc	1-day solution	2-day solution
Processing interval	300 s	600 s
ISB&IFB	ISB&IFB estimated as constant	ISB estimated & IFB corrected
Download & Merge Obs	Single-thread	Multi-thread
Data preprocessing	Single-thread	Multi-thread
Orbit Prediction	Single-thread	Multi-thread
Read & Write	Conventional hard drive	Solid state drive

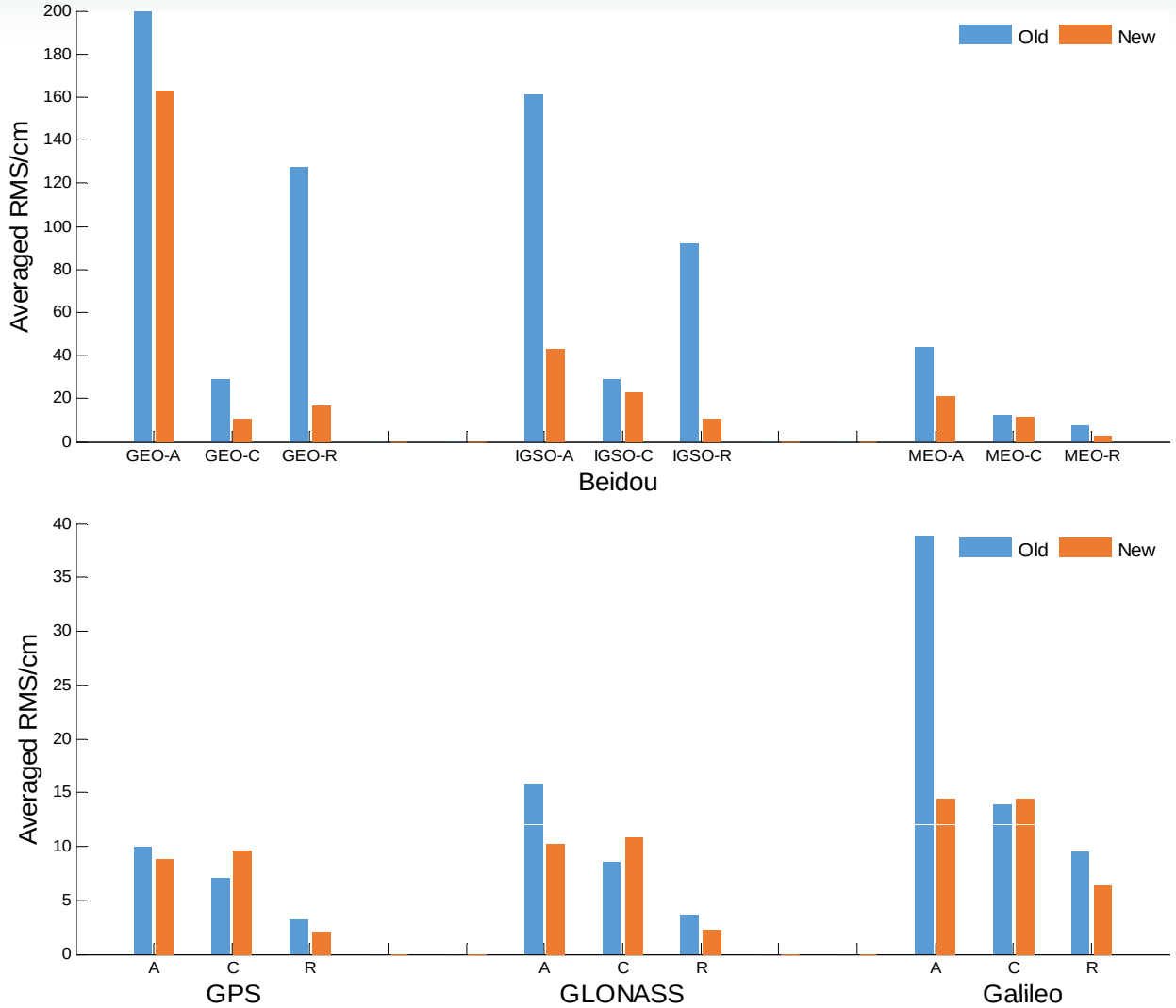
The comparison of old and new strategies used for Multi-GNSS ultra-rapid POD

Multi-GNSS hourly POD



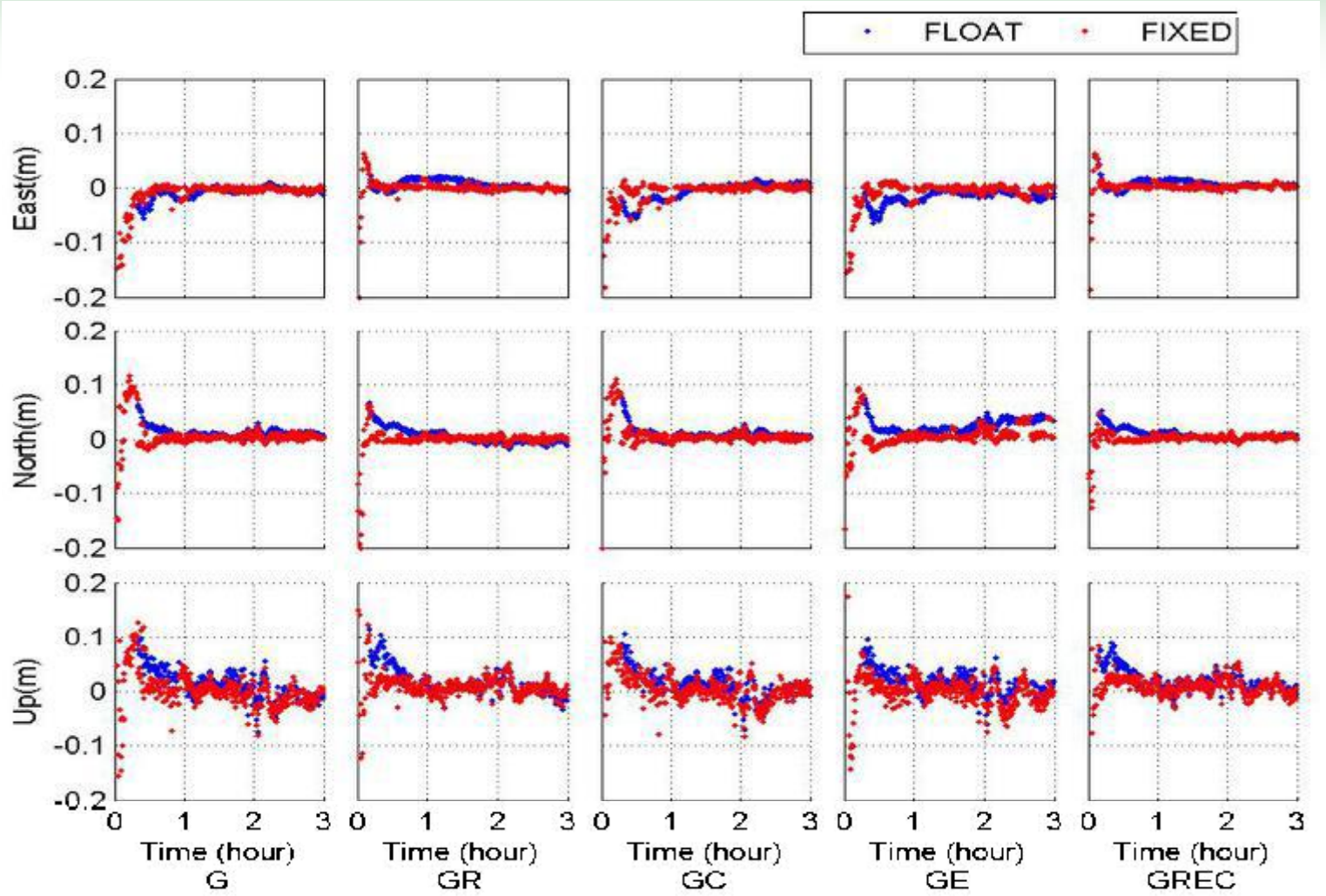
The comparison of old and new processing strategies for multi-GNSS ultra-rapid POD in terms of computational efficiency

Multi-GNSS orbit&clock products



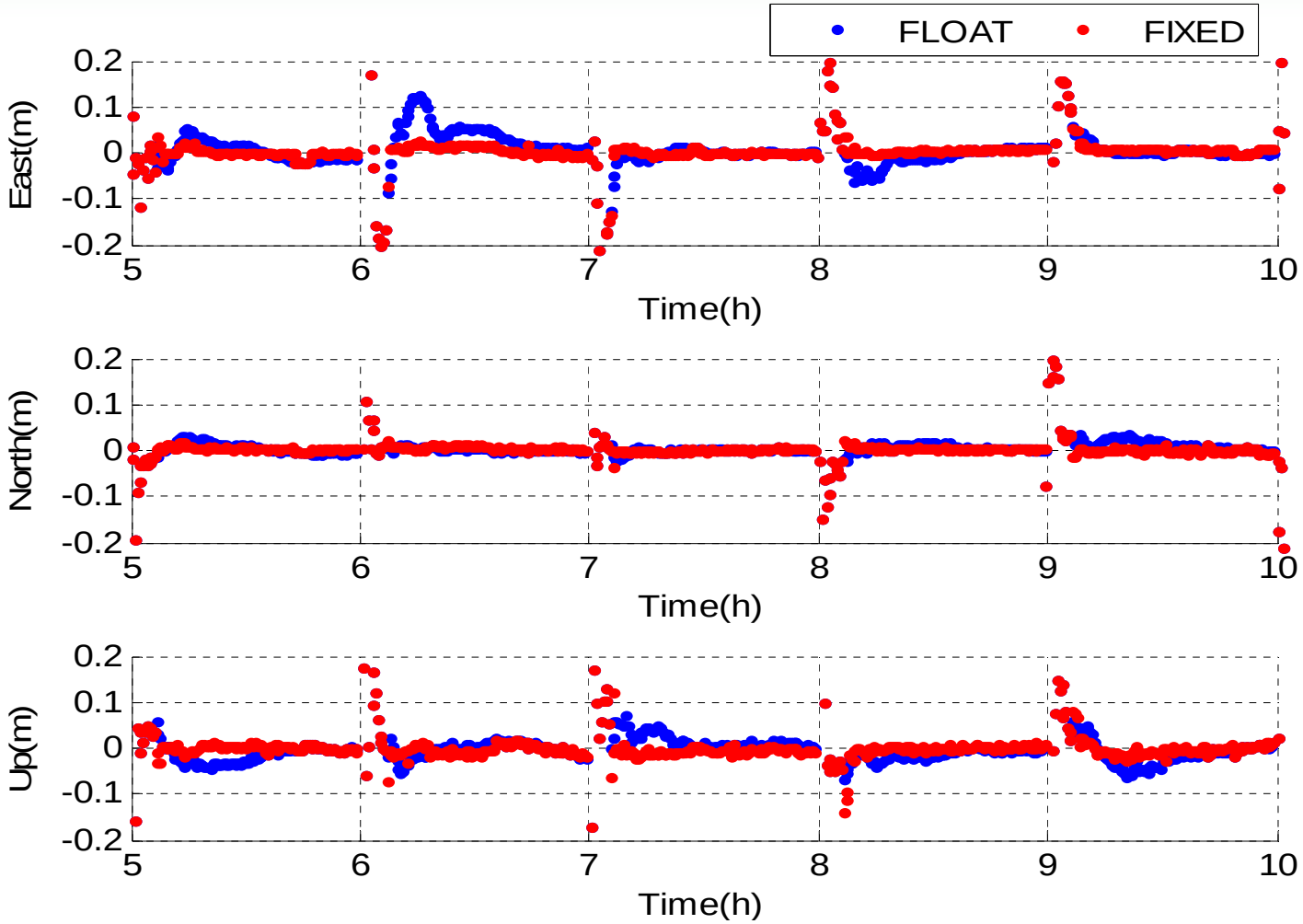
Orbit accuracy with respect to the whr precise orbit products

Multi-GNSS PPP-AR



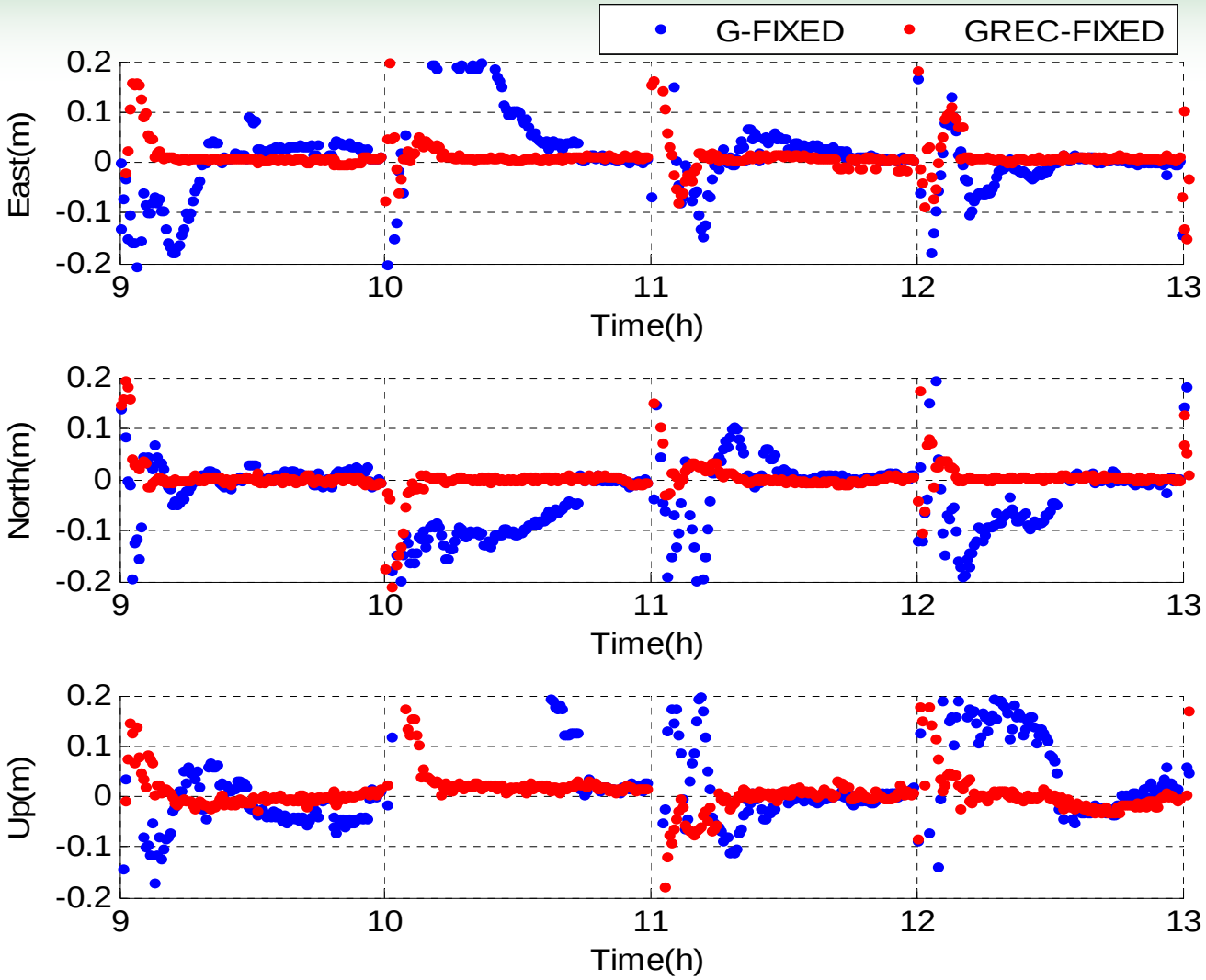
Float vs Fixed PPP at SCTB station

Multi-GNSS PPP-AR



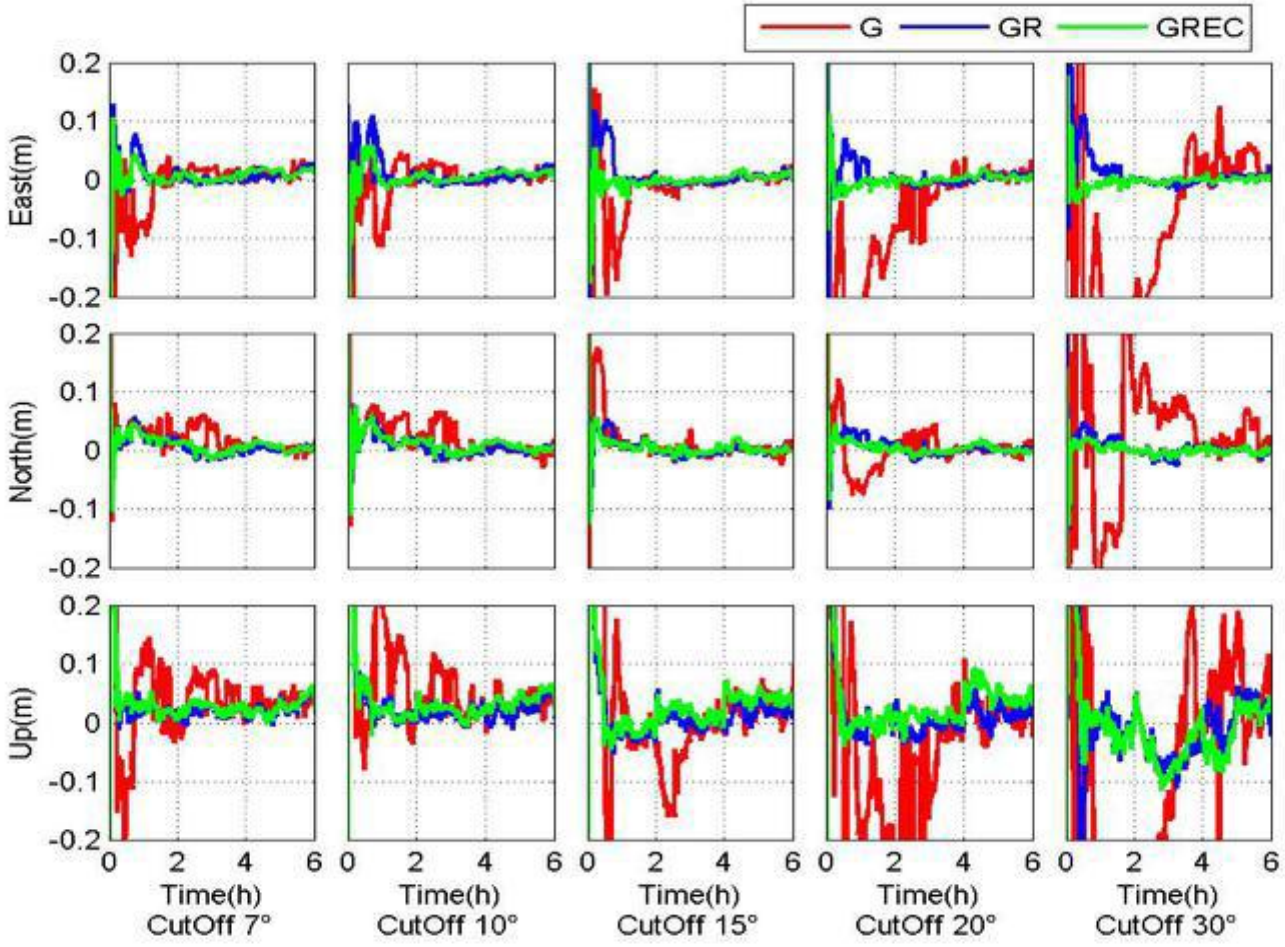
Float vs Fixed PPP (GREC) at BOR1 station

Multi-GNSS PPP-AR



GPS vs GREC Fixed PPP at BOR1 station

Multi-GNSS PPP-AR



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	?

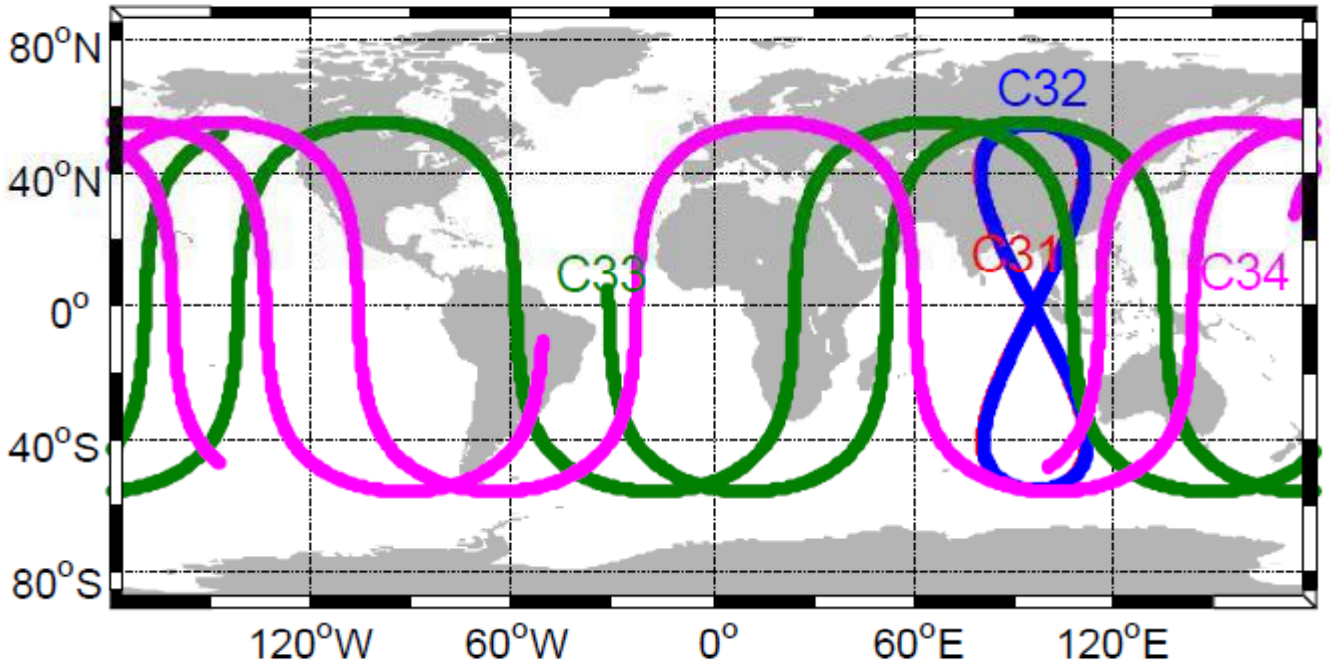


Fig. 1 The ground tracks of the new-generation BDS satellites on 25~26 June 2016

BDS new satellites and signals

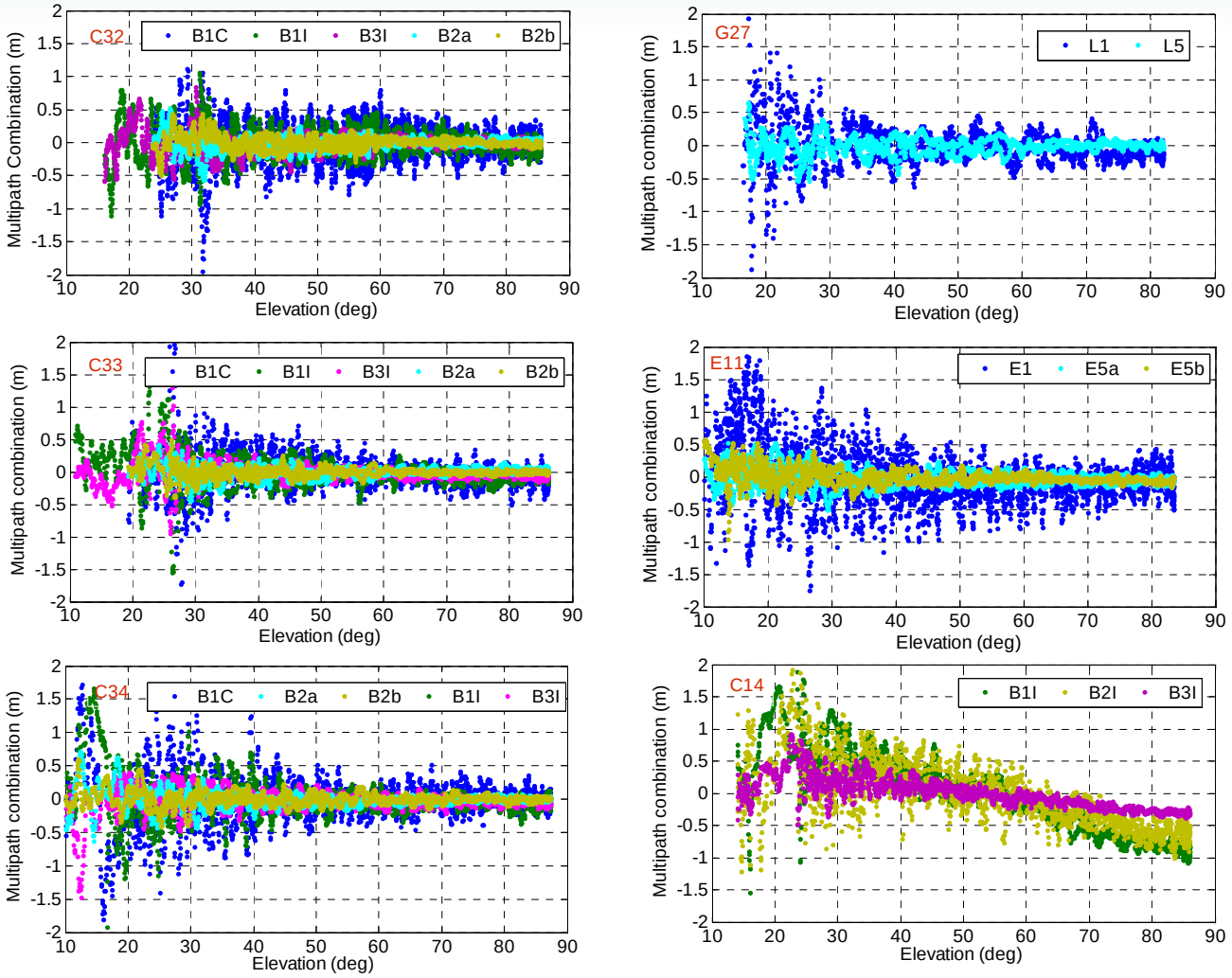
Table 3 Signals tracked by the civil receivers for new-generation BDS satellites C32, C33, and C34

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



MP combinations against elevation for C32-34, G27, E11, and C14

BDS new satellites and signals

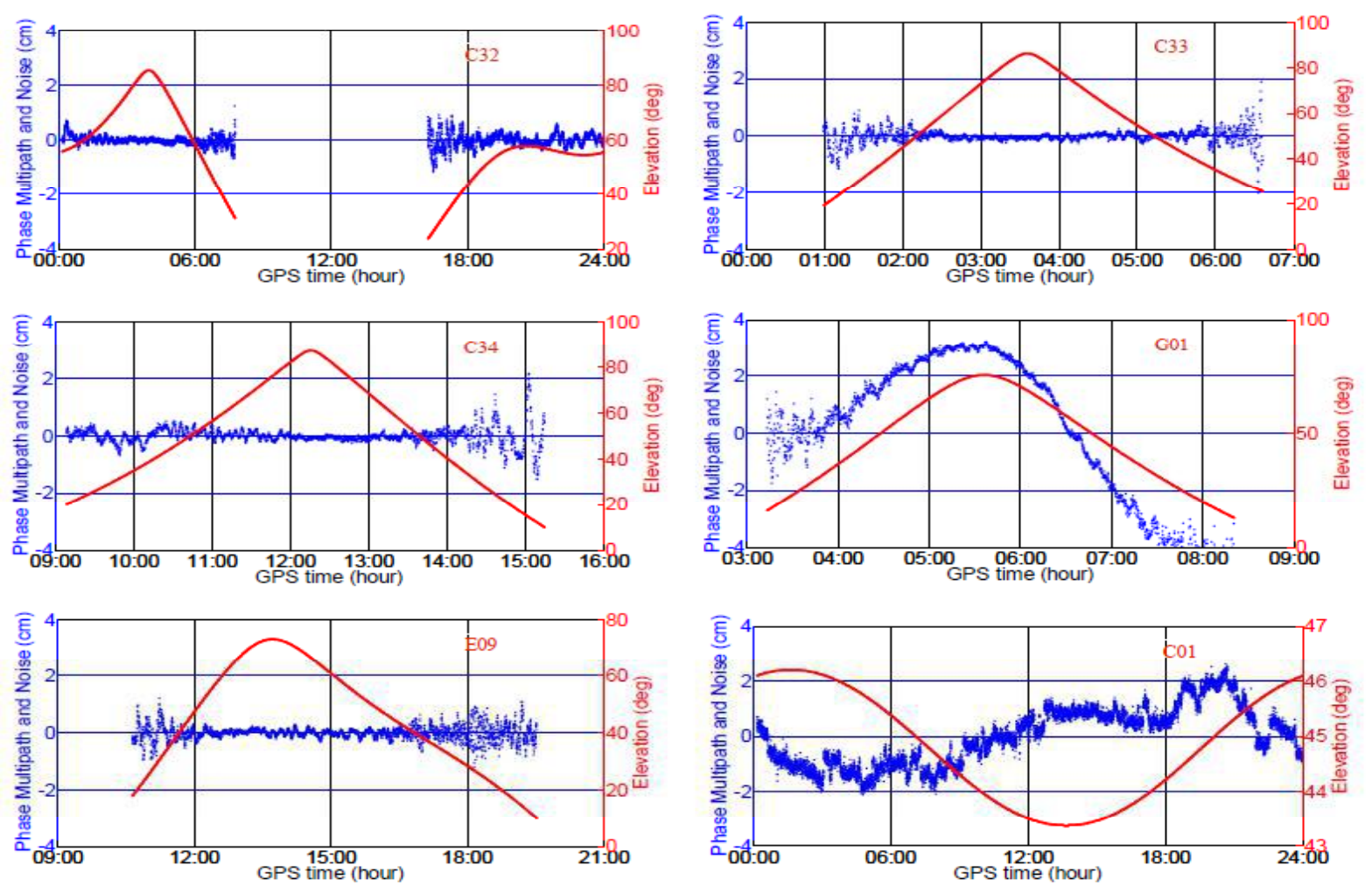


Fig. 12 Triple-frequency carrier phase multipath and noises for C32 (top left), C33 (top right) and C34 (mid left), G01 (mid right), E09 (bottom left), C01 (bottom right)

$$DIF(\varphi_1,\varphi_2,\varphi_2) = IF(\varphi_1,\varphi_2) - IF(\varphi_1,\varphi_3)$$

$$= \left(-\frac{f_1^2}{f_1^2-f_2^2}\right)\frac{f_1^2}{f_1^2-f_3^2}\cdot\lambda_1\varphi_1 \quad \frac{f_2^2}{f_1^2-f_2^2}\cdot\lambda_2\varphi_2 + \frac{f_3^2}{f_1^2-f_3^2}\cdot\lambda_3\varphi_3$$

Discussions

- New satellites , new signals, multi-frequency;
- Accuracy, various biases, ambiguity-fixing;
- Efficiency, especially for real-time five-system processing;
- Stability, especially for BDS;
- .....

Thanks a lot !

Announcement of a Special Issue of *Advances in Space Research* on

Multi-constellation GNSS: Methods, Benefits, Challenges, and Geosciences Applications

Papers are invited for a special topical issue of *Advances in Space Research* (ASR) entitled "Multi-constellation GNSS: Methods, Benefits, Challenges, and Geosciences Applications".