Prelimenary Results from MASS & BeiDou first Continuous Operating Reference System in Hubei Province

GNSS Research Center

Wuhan University

Outline

- Introduction of PANDA software
- MASS Using PANDA
- COMPASS Precise Position Results
- SUMMARY

Positioning And Navigation Data Analyst

- To derive possible information from GNSS/SLR/VLBI/DORIS data
- Real-time Processing function from 2007
- Current Applications
  - POD of GNSS (GPS, GLONASS, COMPASS, GALILEO)
  - POD of LEOs (CHAMP, GRACE, COSMIC, JASION, HY-2A,ZY-3)
  - Ionosphere and Troposphere Modeling
  - Huge Network data processing
  - Real-time PPP, PPP-RTK
  - SINEX Combination

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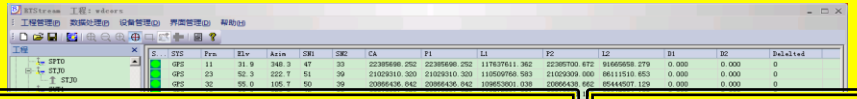
Prototype of Multi-Constellation Augmentation Service System(MASS) in China

- Goals
  - Using GNSS data stream in China and global stations
  - Processing for Real-time GNSS orbit, Clock And atmosphere parameters
  - Products broadcast by sat. and Mobile internet
  - Augmentation with GPS/COMPASS in Wide-area, Dm level RT-PPP for double-frequency, Better than 1m accuracy for single-frequency
- Support by National High-tech R&D Program (863 Program) of China

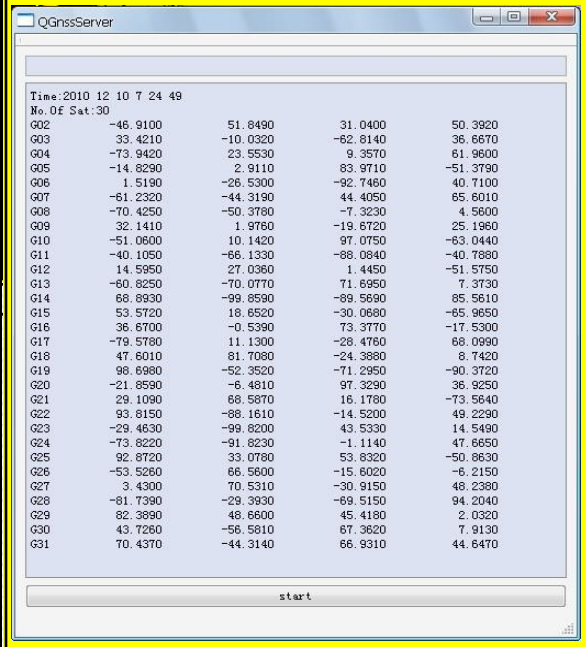
Wide-area Augmentation Processing Platform

Data stream management

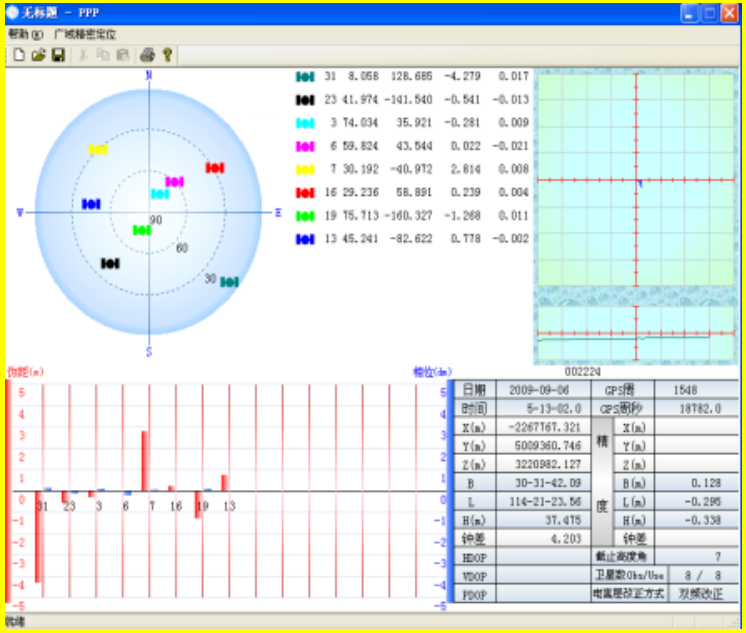


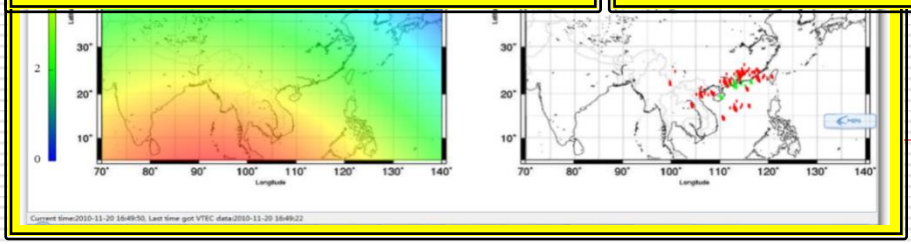
Satellite Real-time Orbit Processing

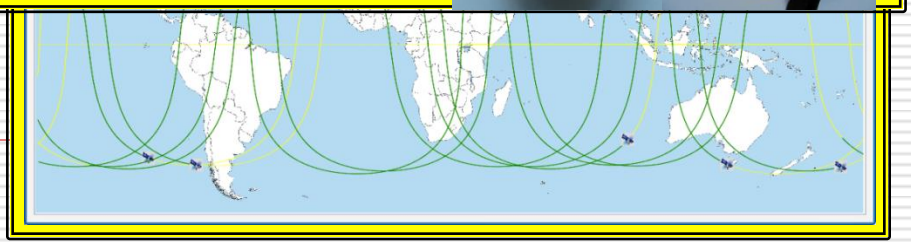
Products Broadcast



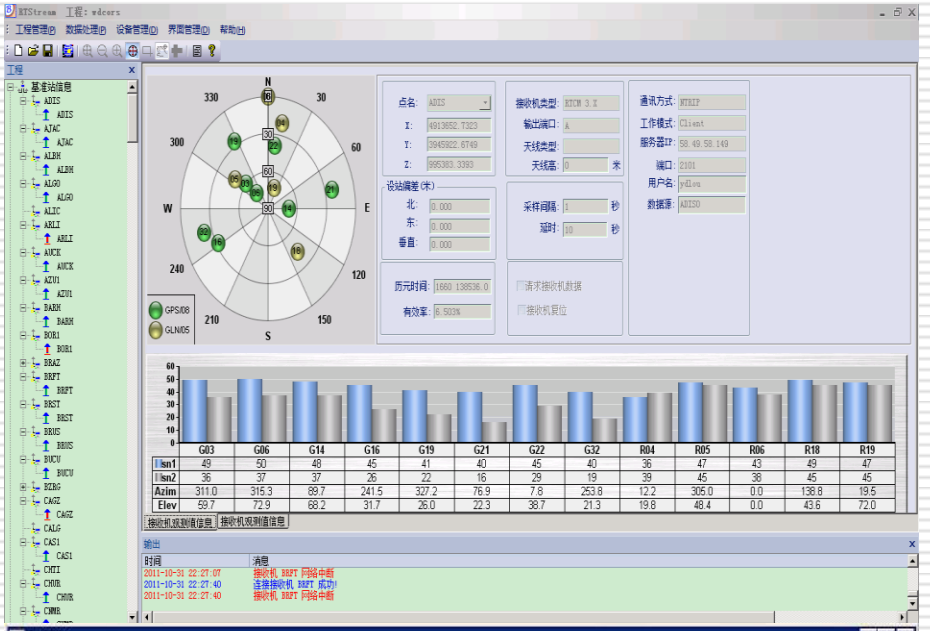
Terminal Real-time Precise Point Positioning

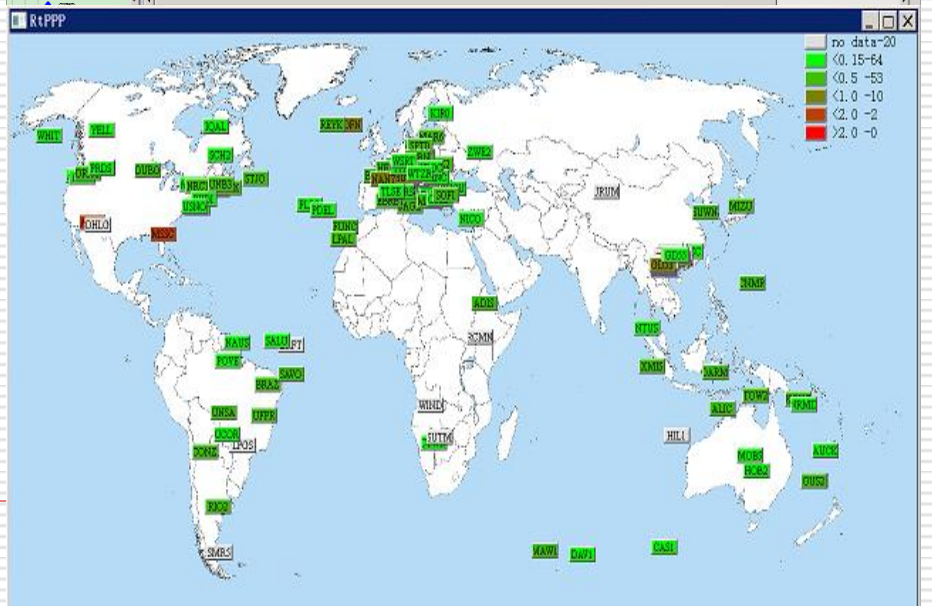




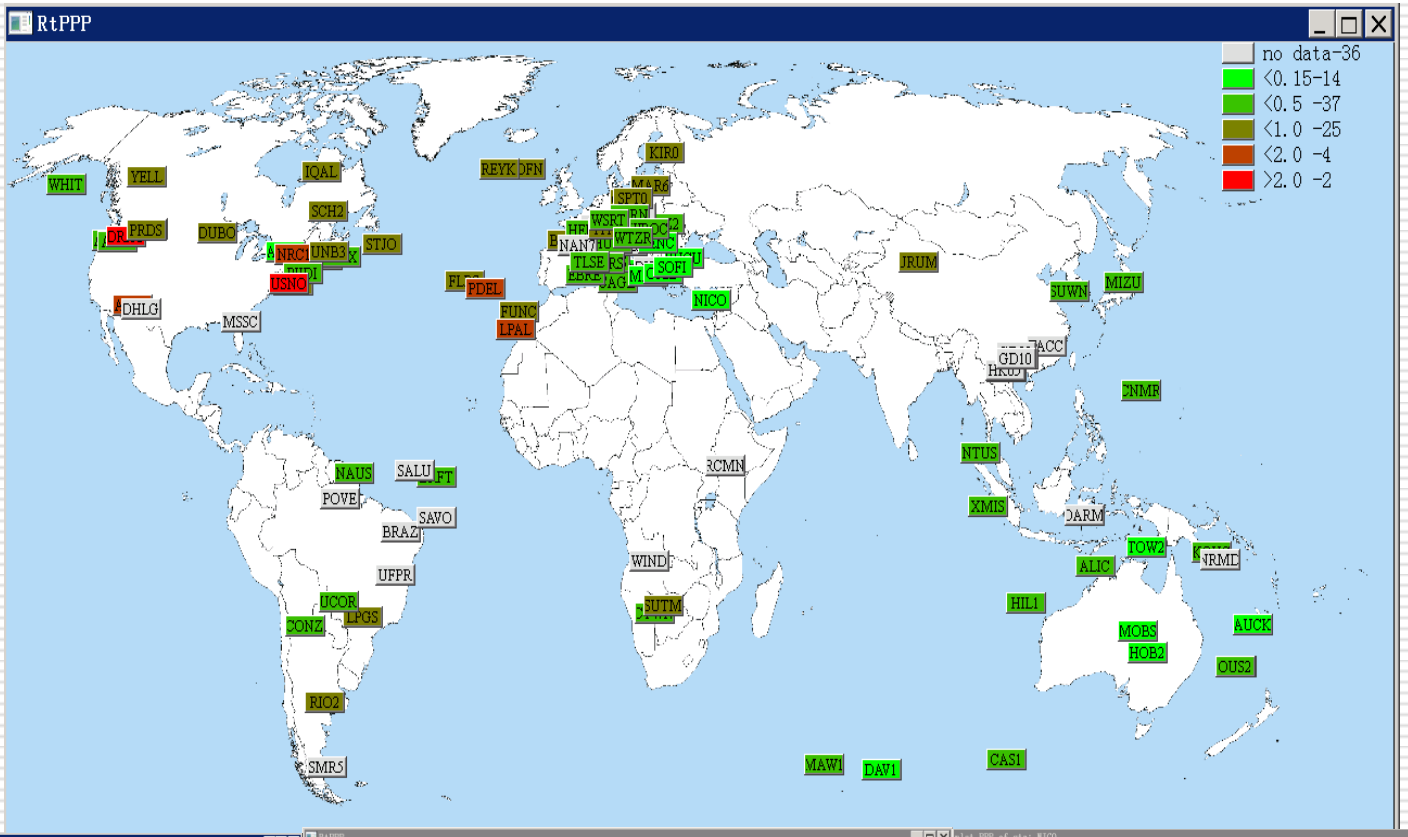


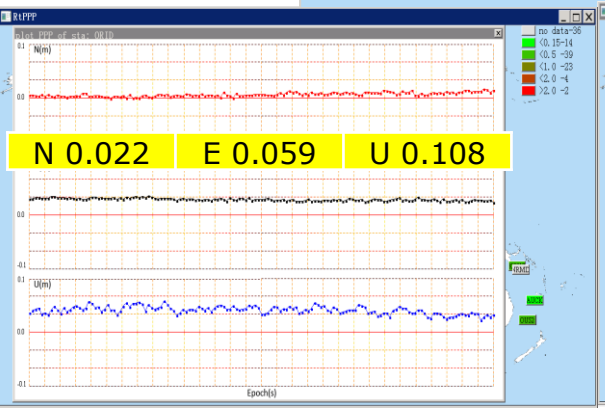
Monitoring and Control System

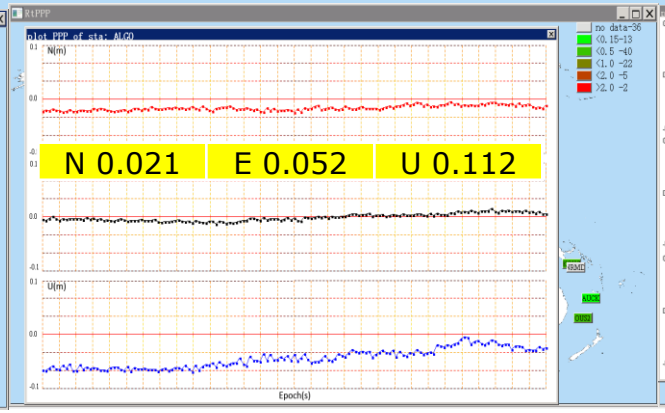


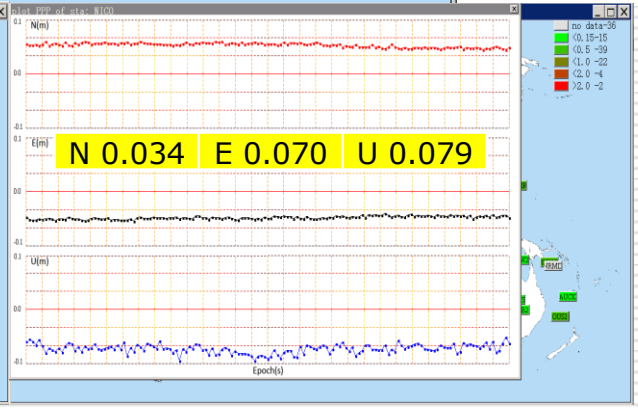


Global Real-Time Precise Positioning Monitoring

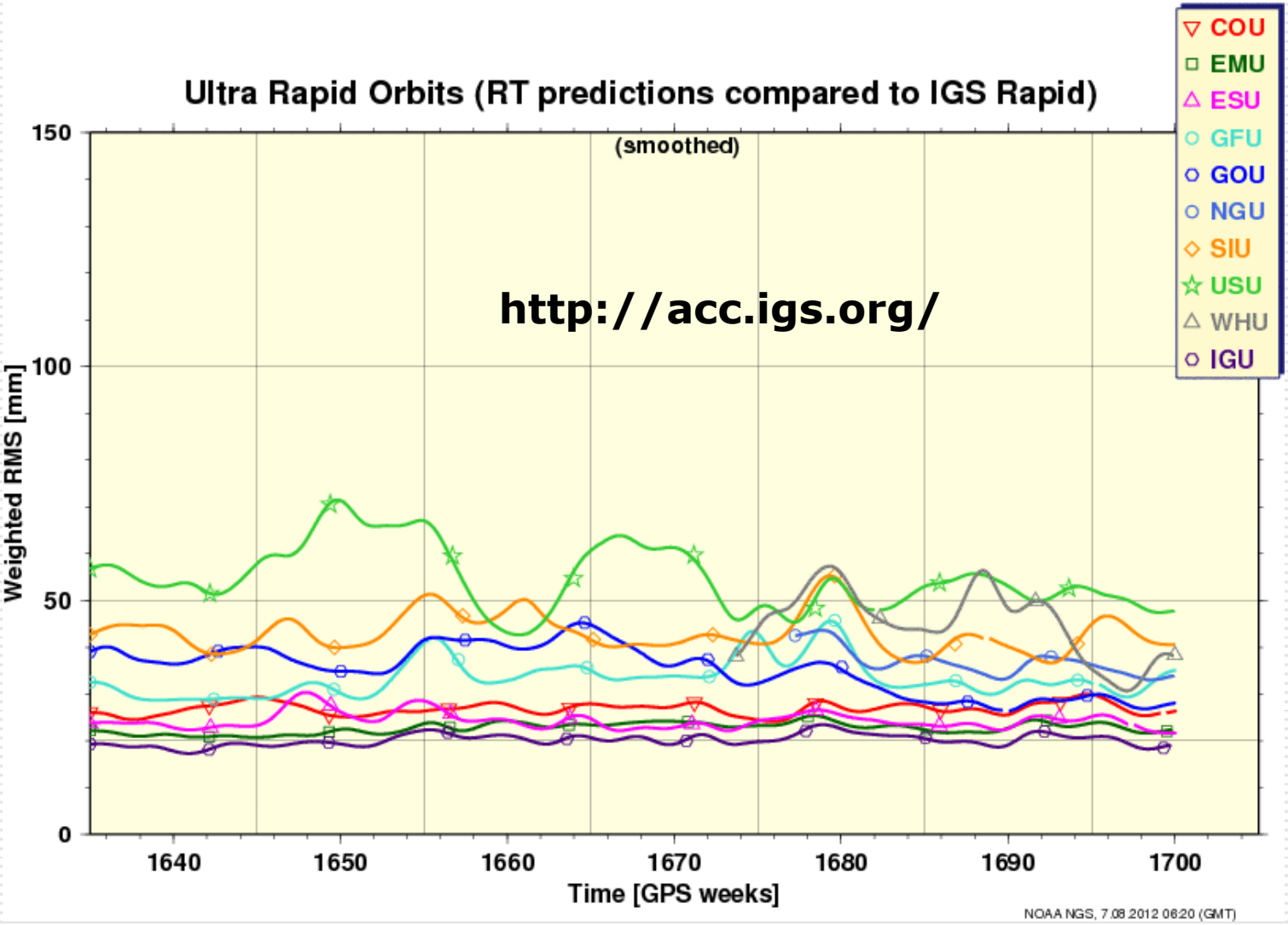


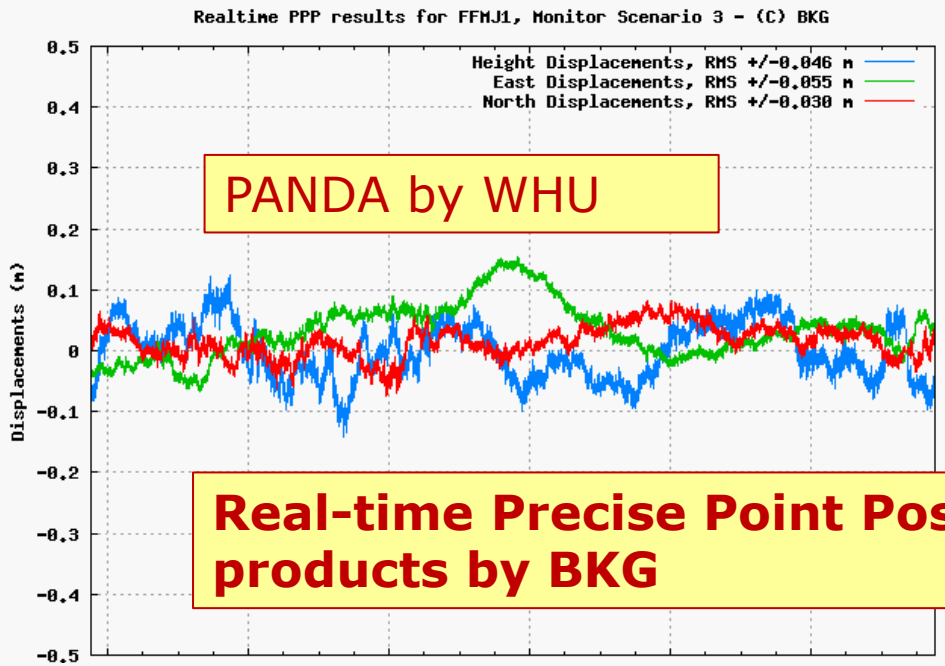


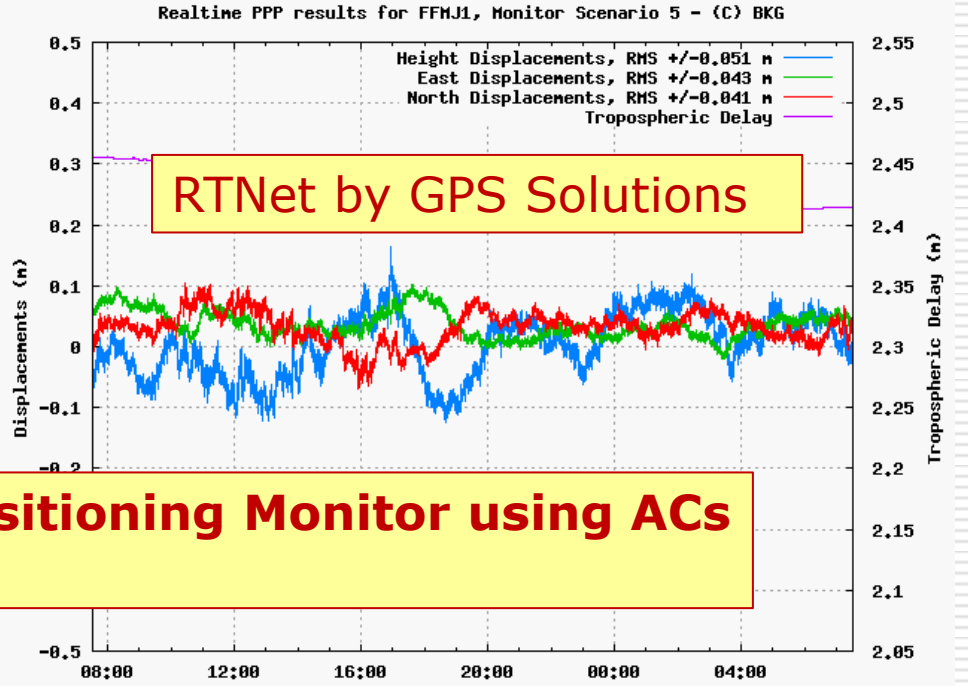




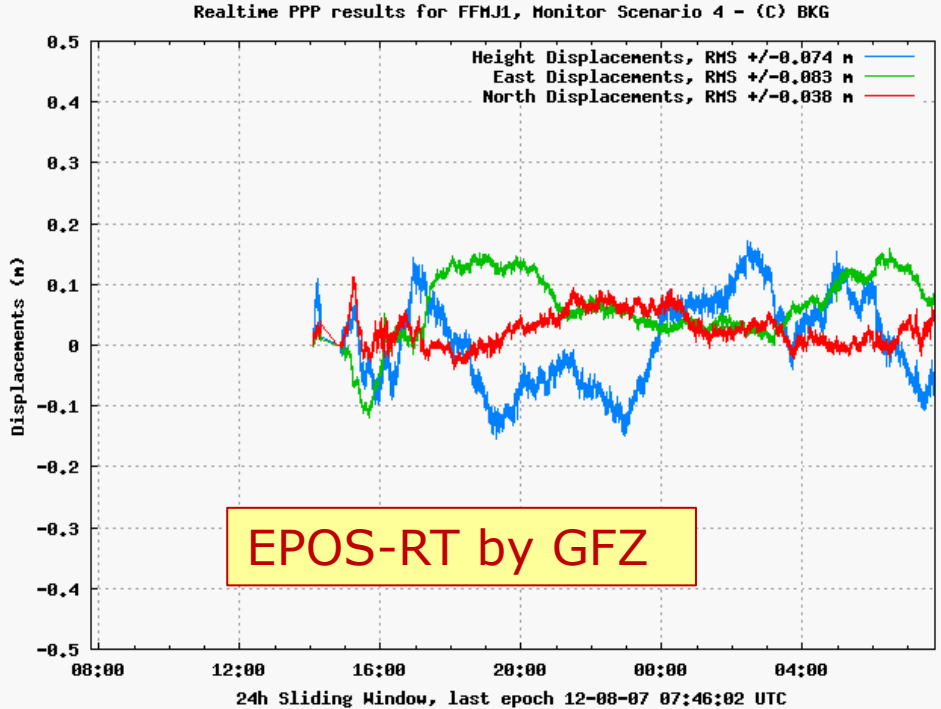
Ultra-rapid orbit Quality by PANDA

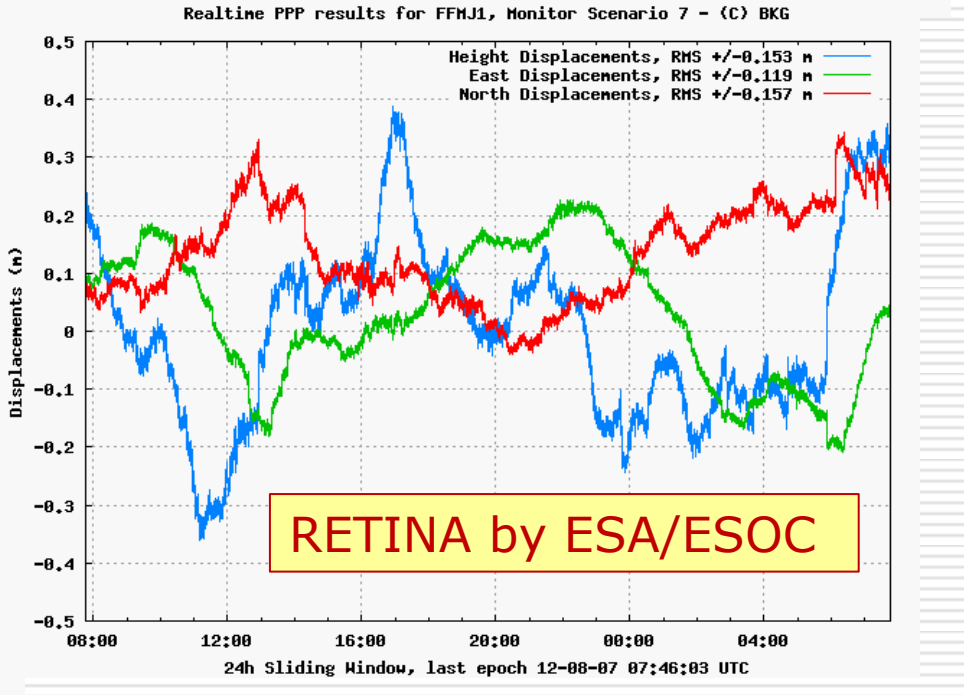






Real-time Precise Point Positioning Monitor using ACs products by BKG

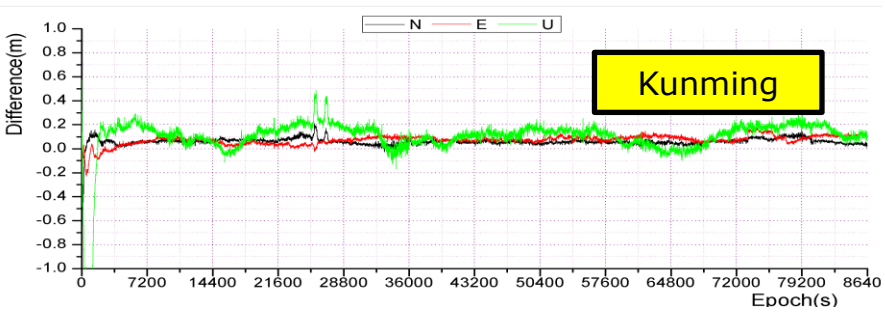


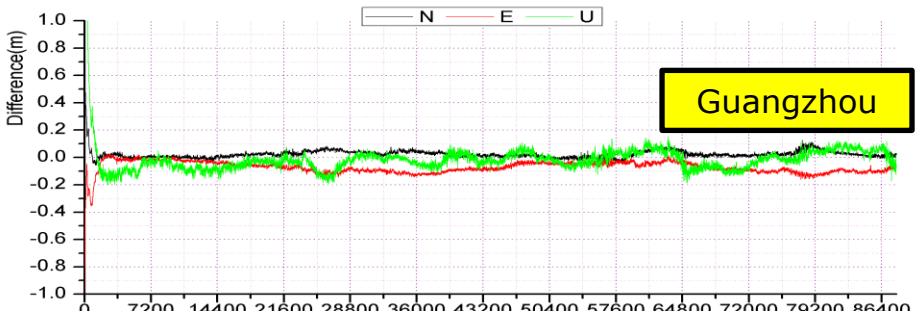


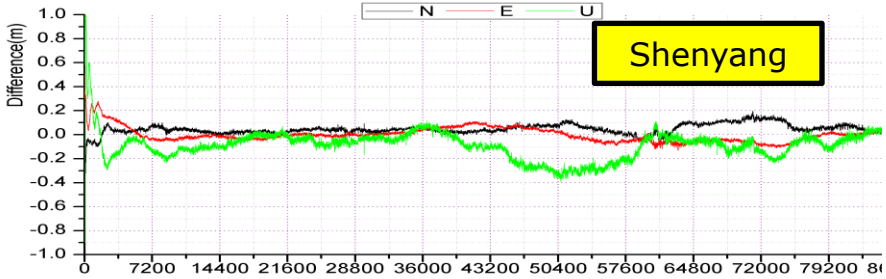
Accuracy tests of MASS in China

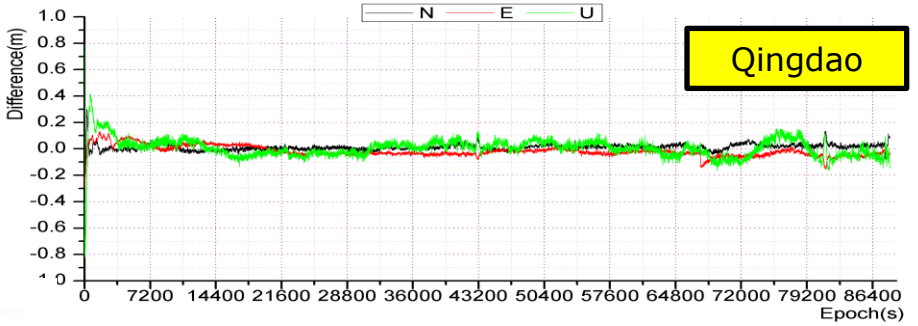
June 25 ~ July 11, 2011, 24-hour test

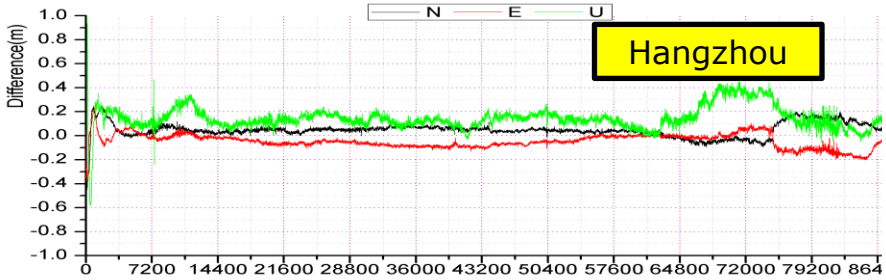
The time series of double-frequency test results

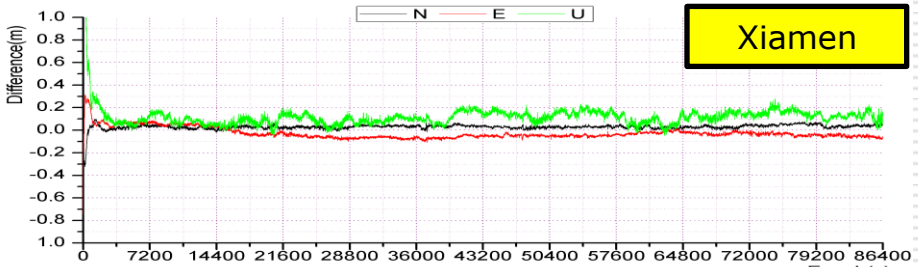


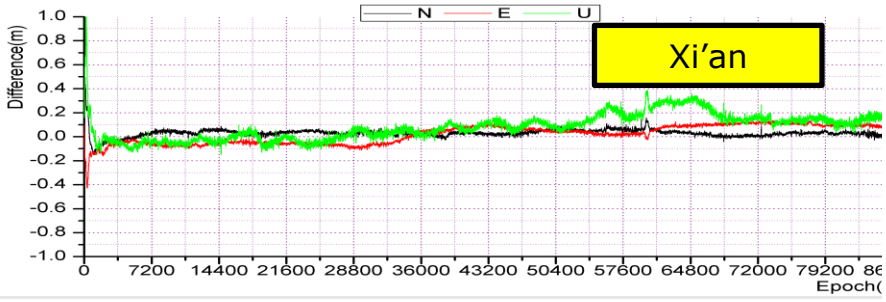


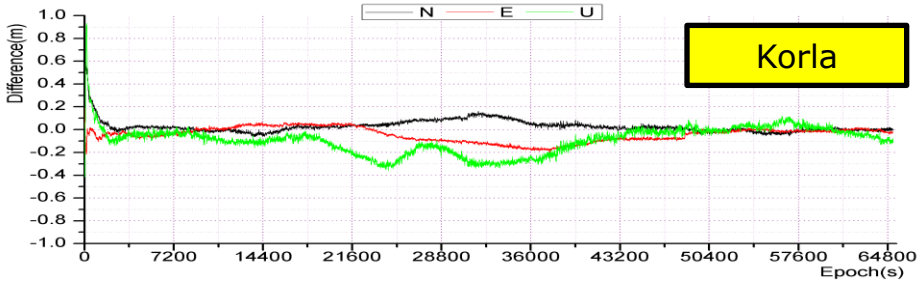




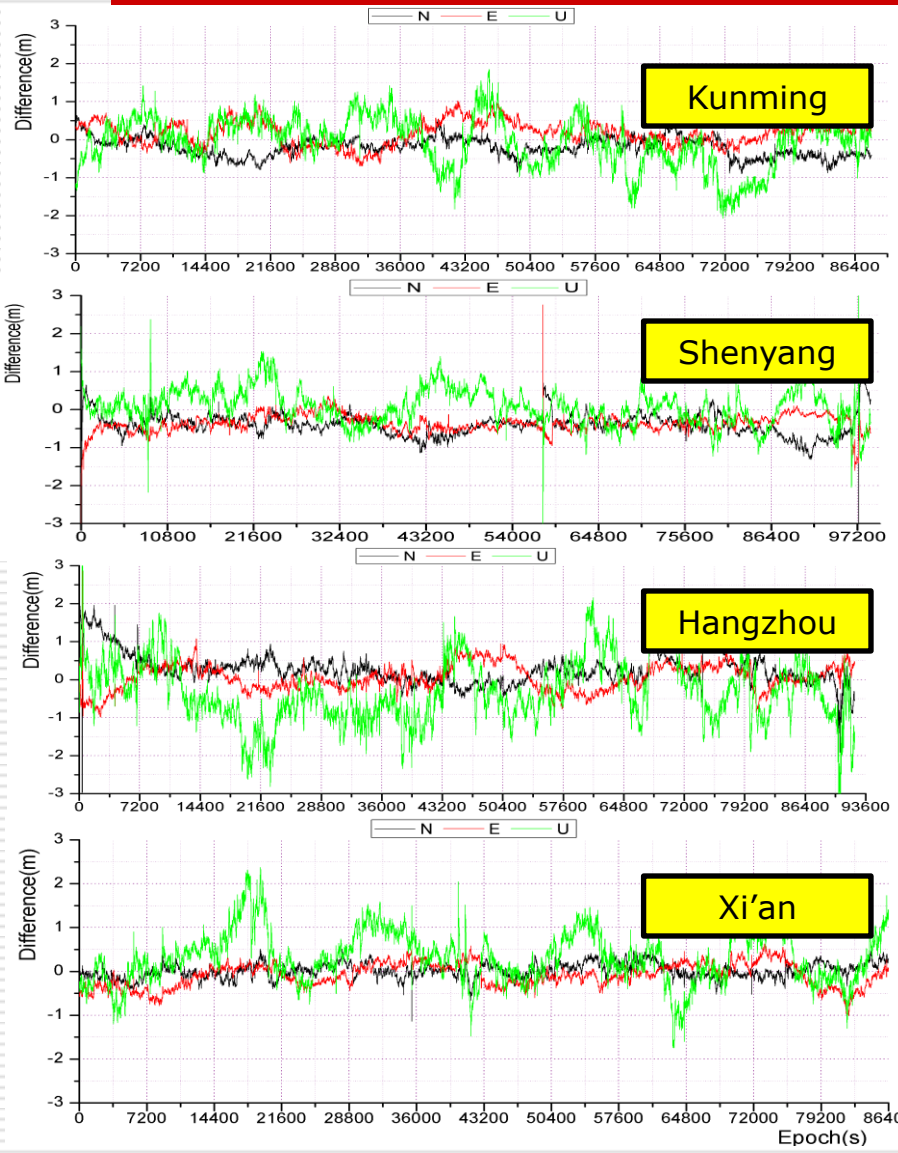


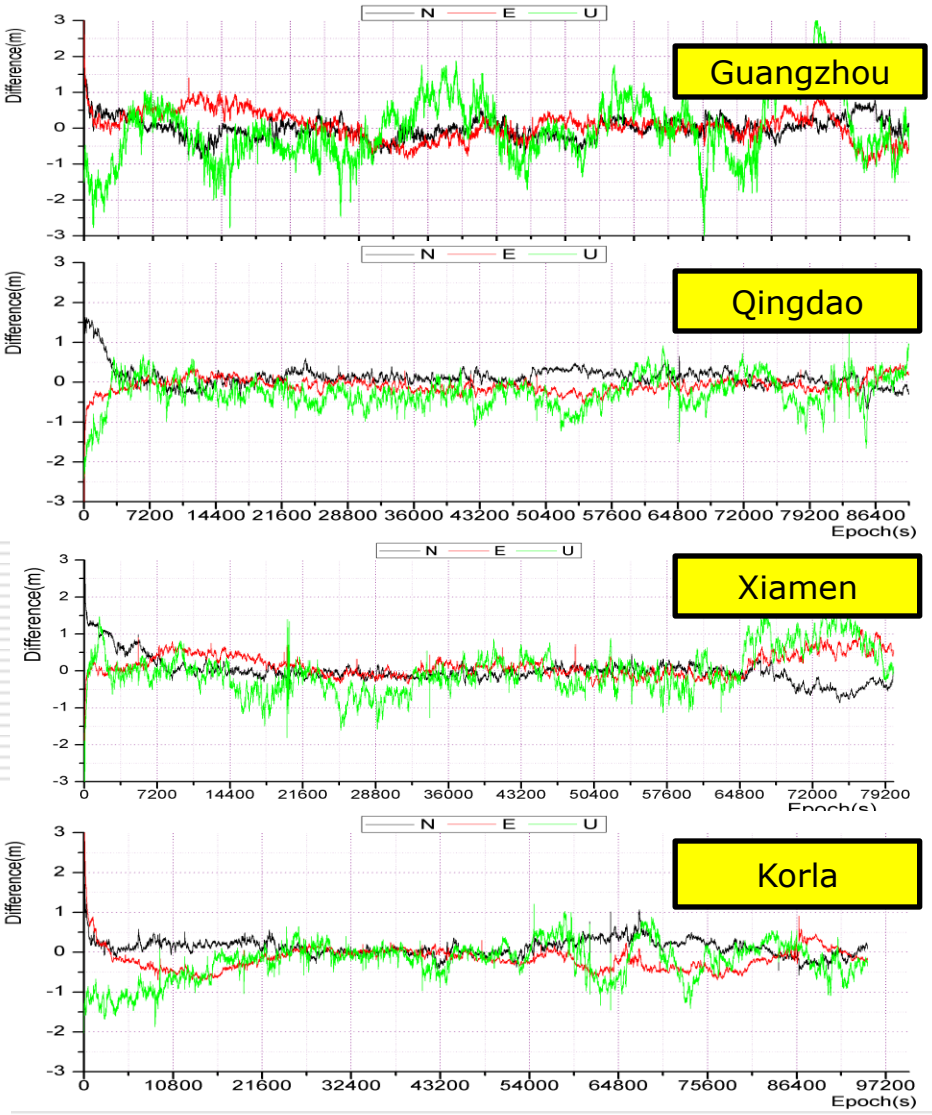




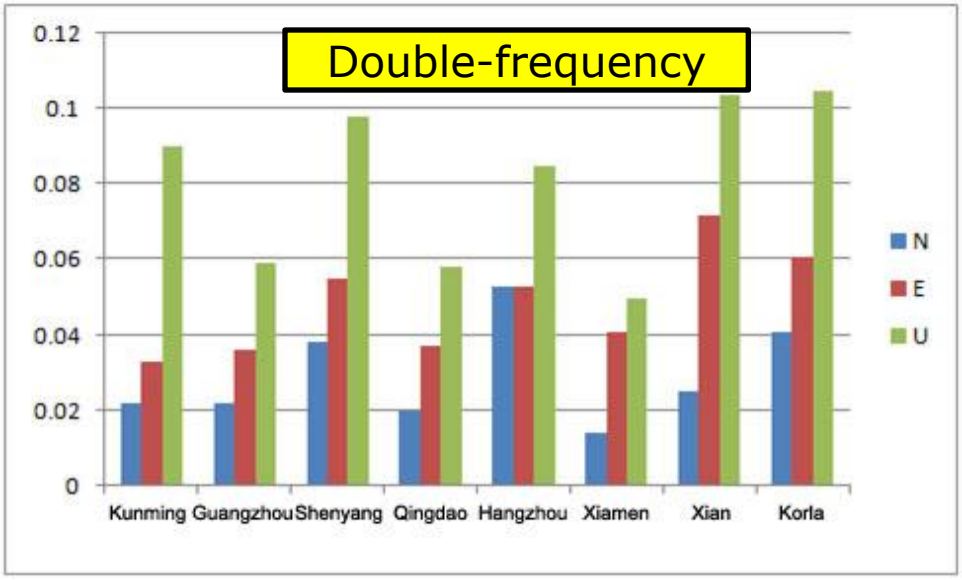


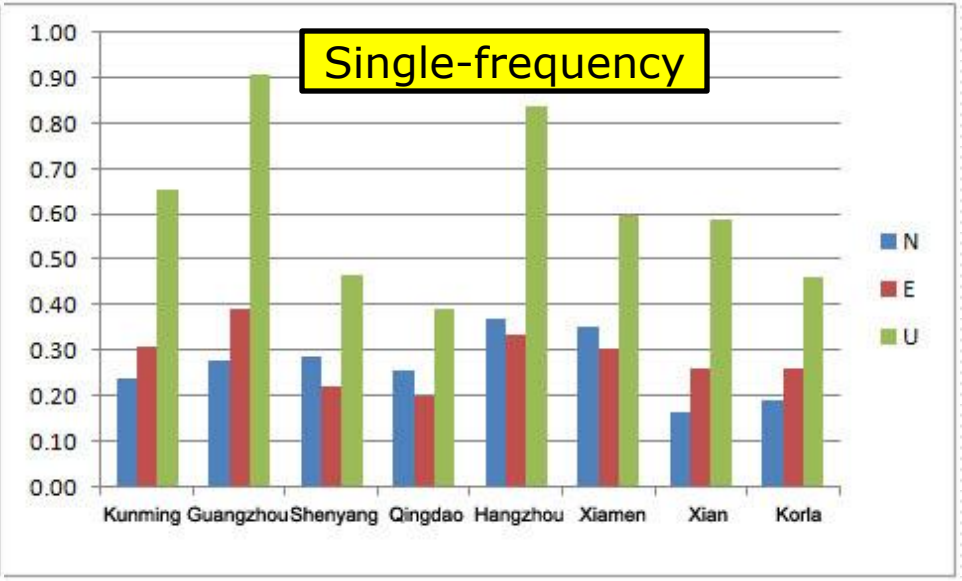
The time series of single-frequency test results





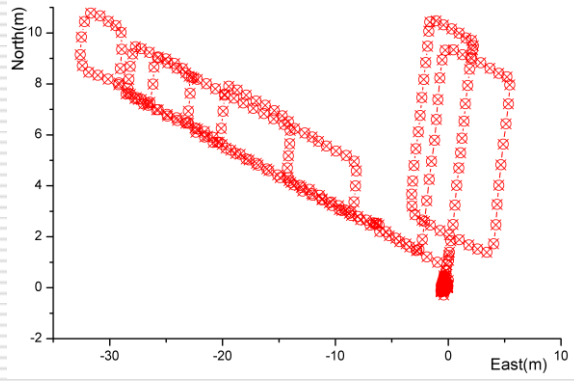
Test Result Statistics



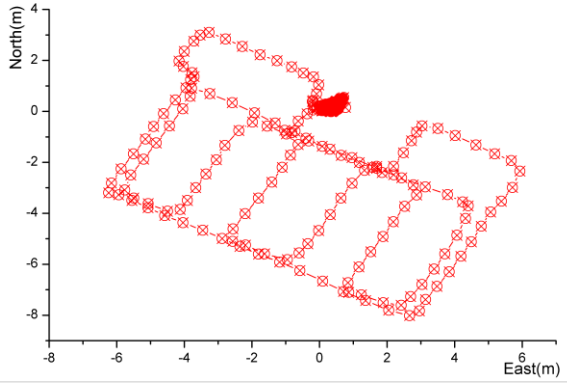


RMS (m)	N	E	U
Double-frequency	0.029	0.049	0.081
Single-frequency	0.268	0.286	0.614

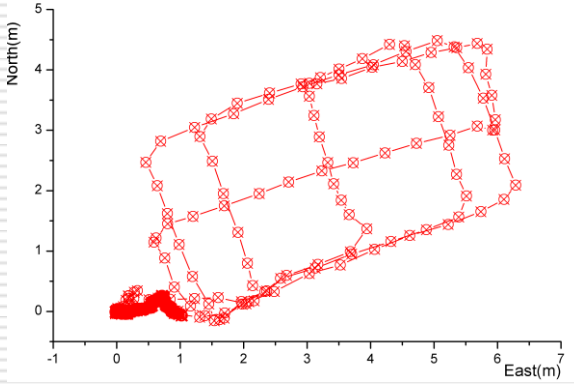
Kinematic RT-PPP (double-frequency)



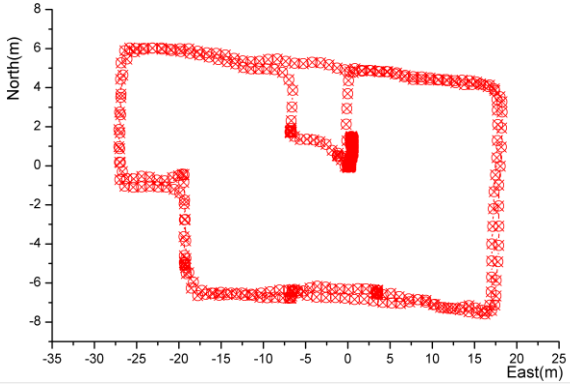
Guangzhou



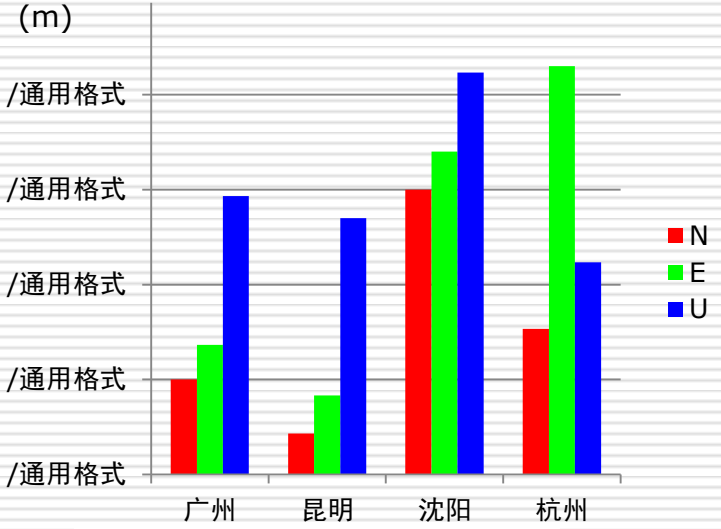
Shenyang



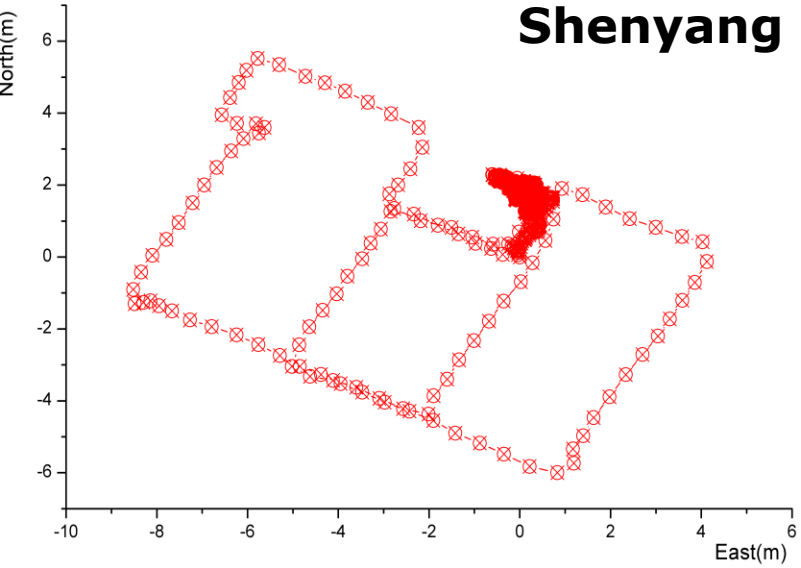
Kunming

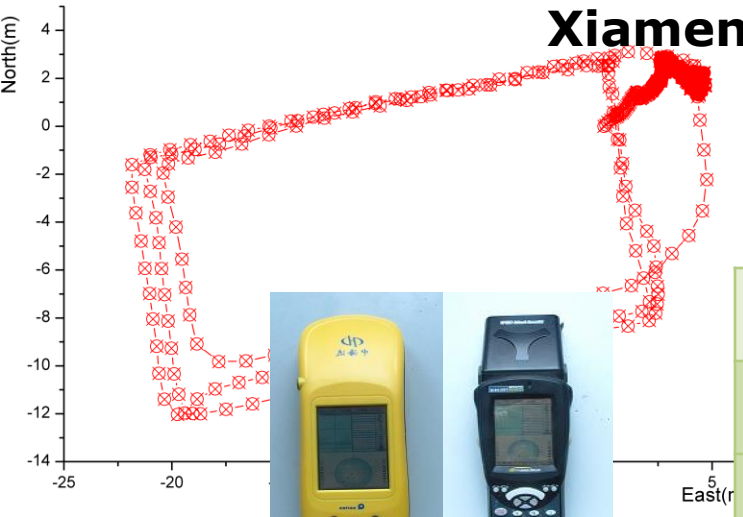


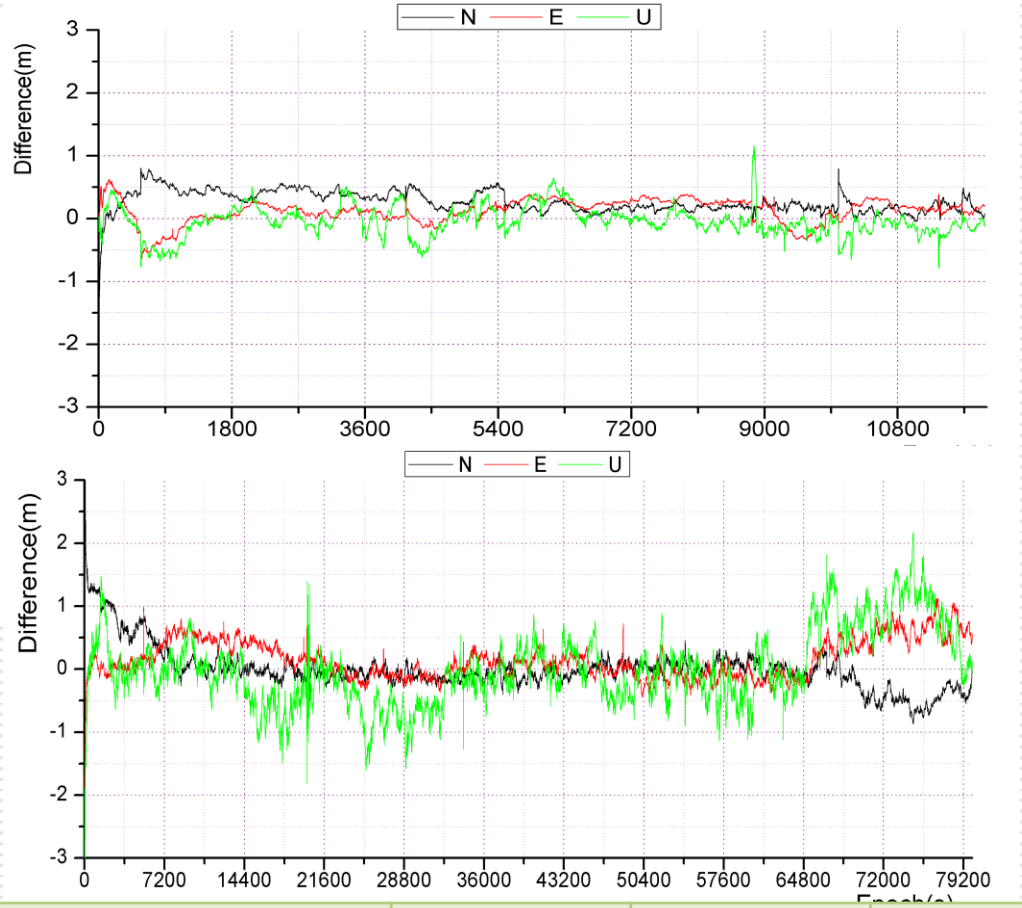
Hangzhou



Kinematic RT-PPP (Single-frequency)

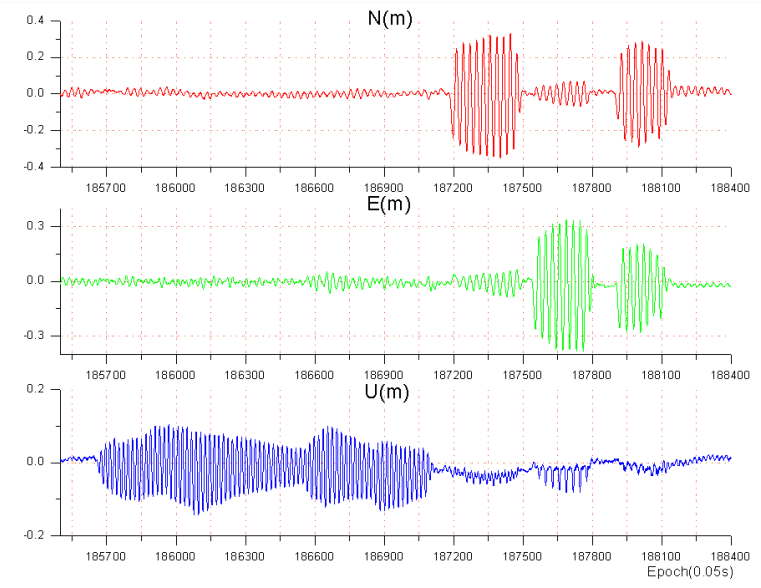


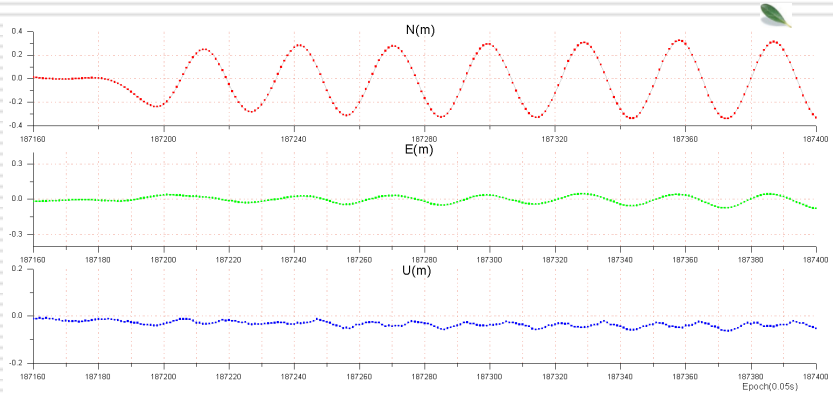




		N(m)	E(m)	U(m)
Shenyang	STD	0.170	0.188	0.236
Xiamen	STD	0.324	0.435	1.086

Real-time Kinematic RT-PPP test





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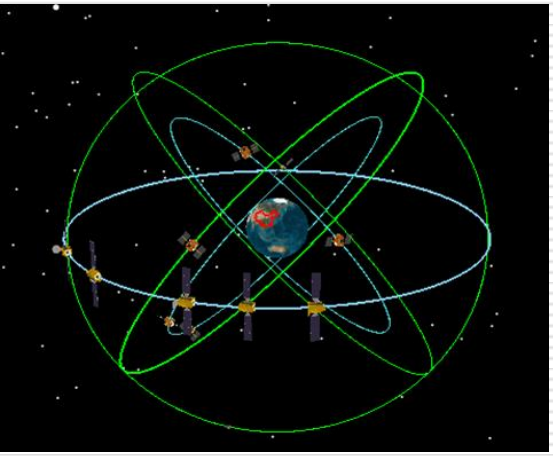
COMPASS Precise Positioning and Navigation

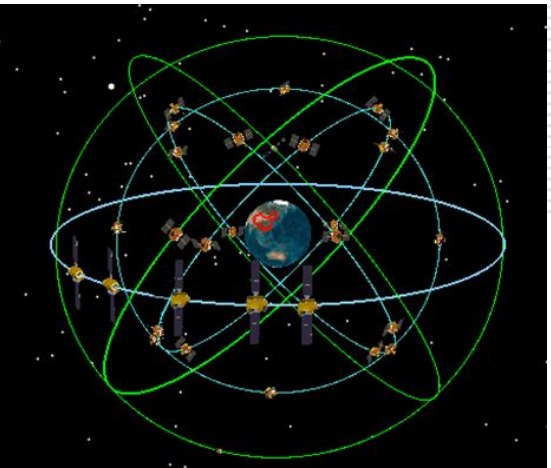
- Status of COMPASS
- Baseline solutions (mm-level)
- COMPASS RTK (cm level)
- COMPASS PPP (dm level)
- D-COMPASS Navigation (m level)
- Benefit of GPS+COMPASS

Status of COMPASS

- Current operational Satellites: 4GEO+5IGSO+2MEO
- 2012: 5GEO+5IGSO+4MEO（Regional Service）
- 2020: 5GEO+3IGSO+27MEO（Global Service）

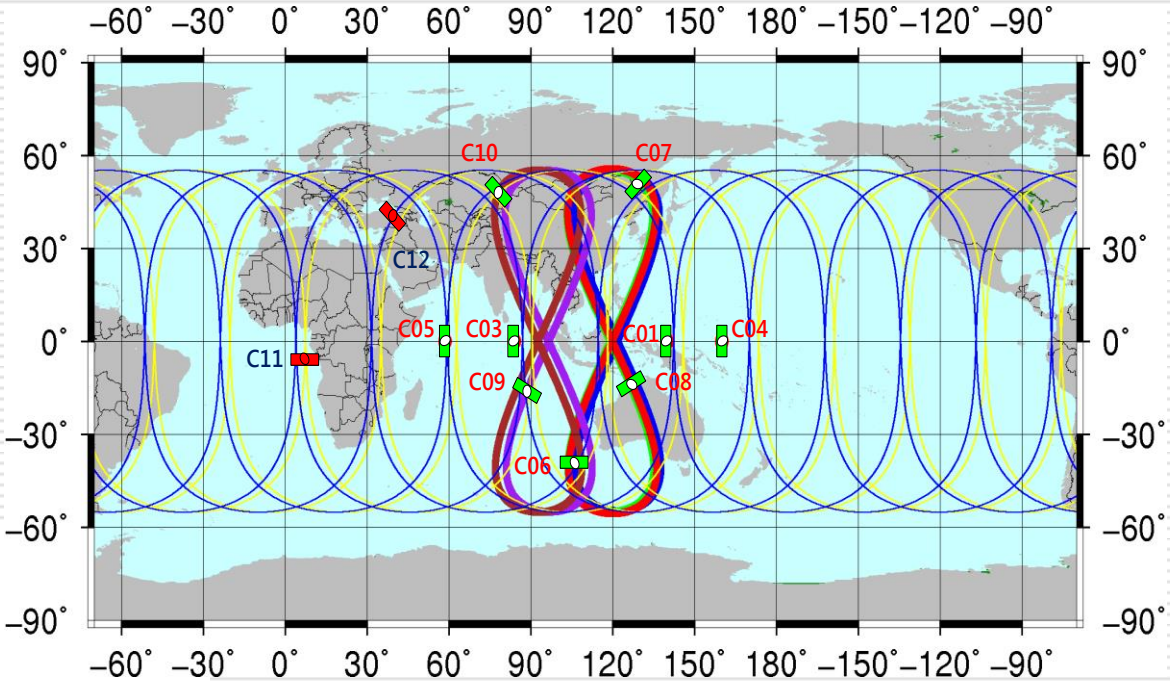


2012

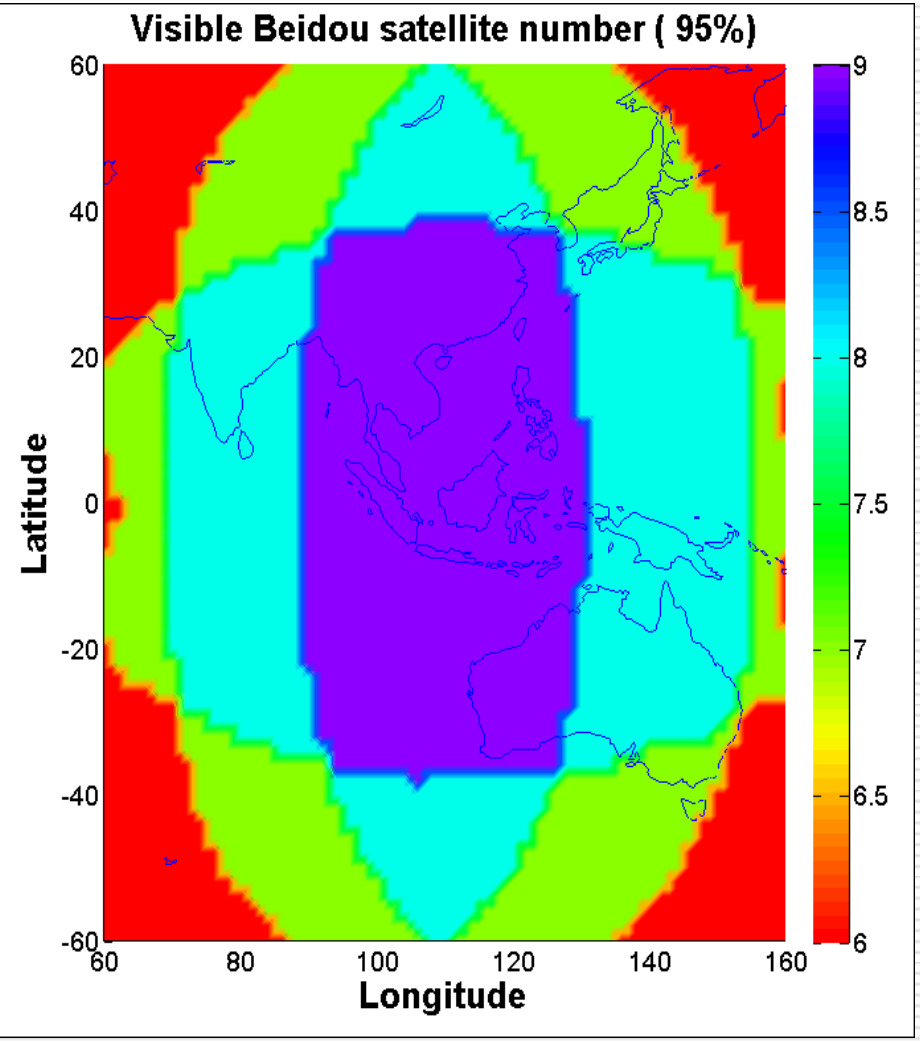


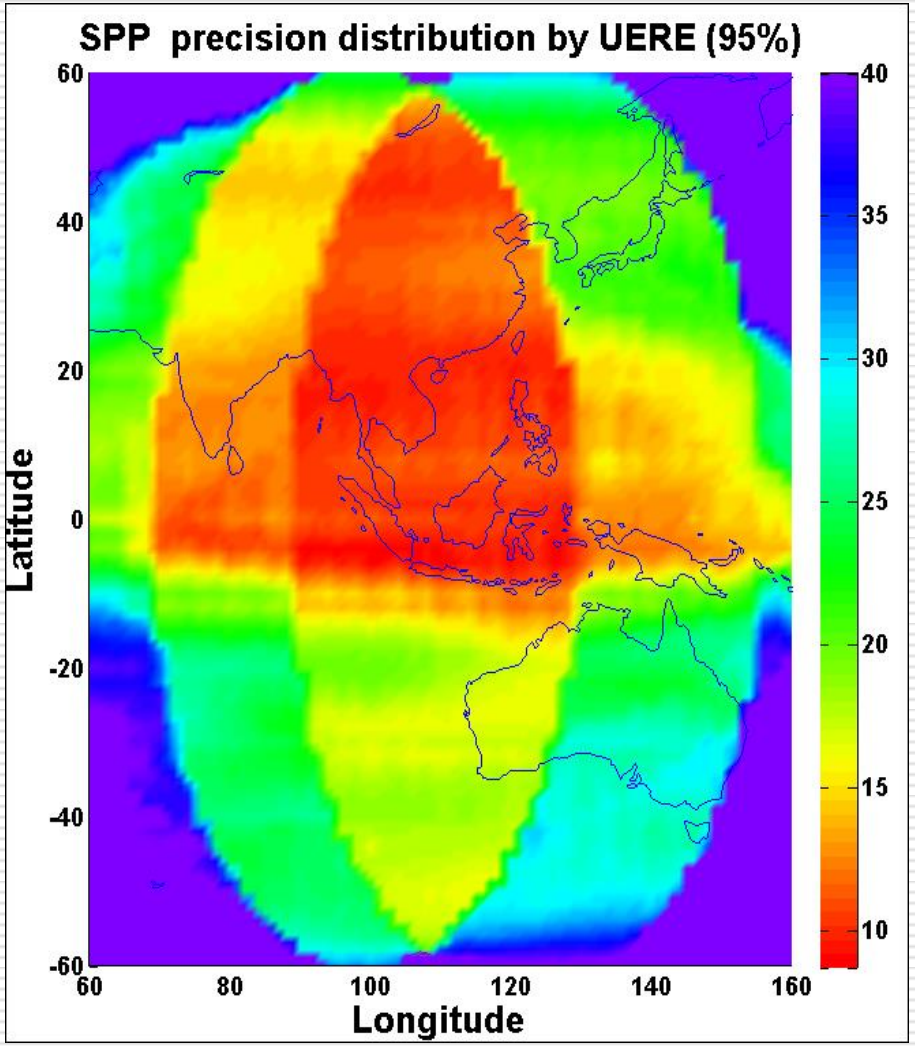
2020

July,2012



SPP Performance of Current Constellation





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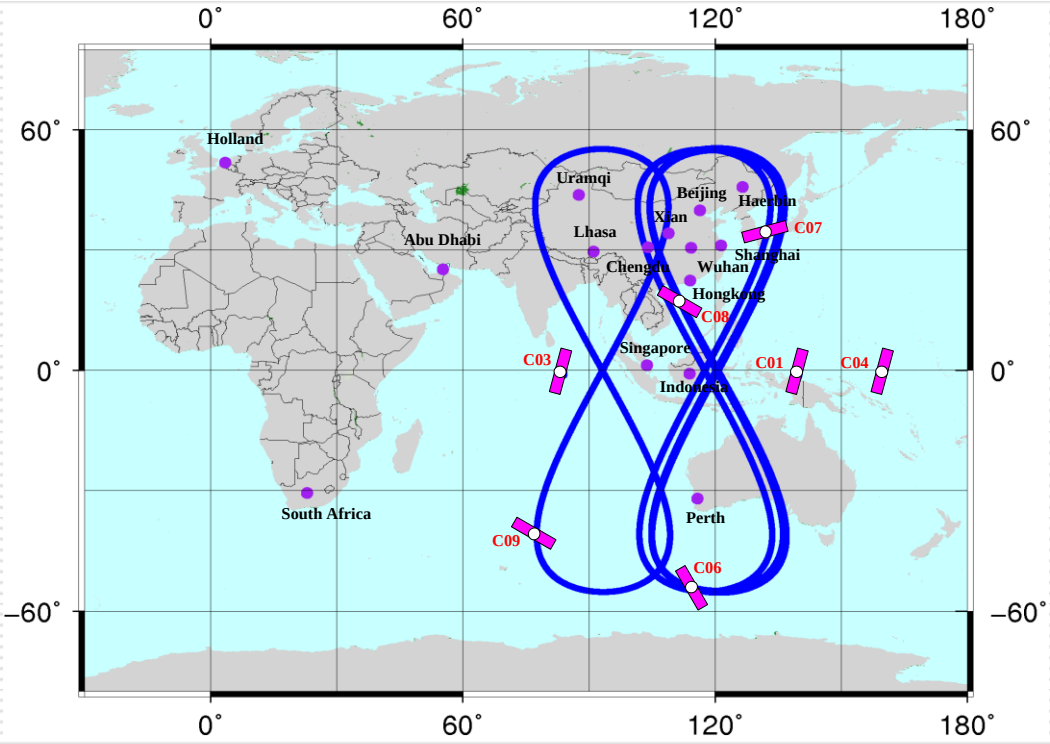
Beidou Tracking Network by Wuhan University



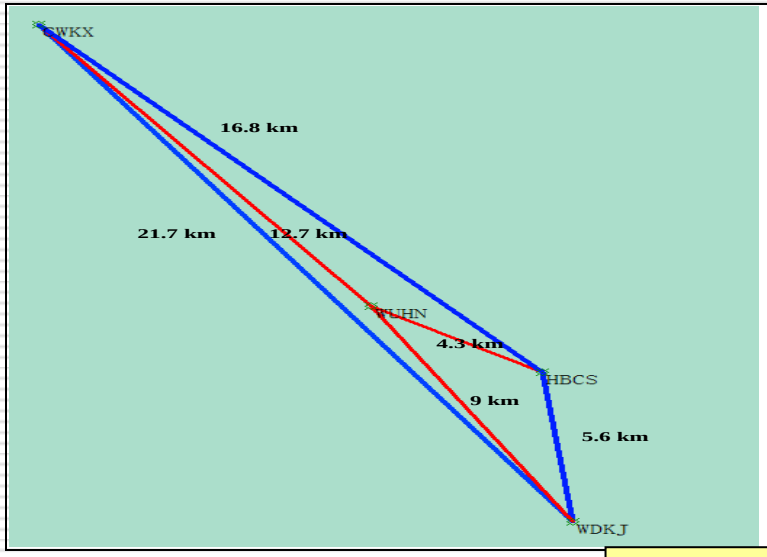
境内（12个）：上海、北京、武汉、香港、西安、成都、拉萨、乌鲁木齐、哈尔滨、沈阳、广东
境外（8）：荷兰、佩斯、新加坡、南非、希腊、阿联酋、印尼、墨尔本

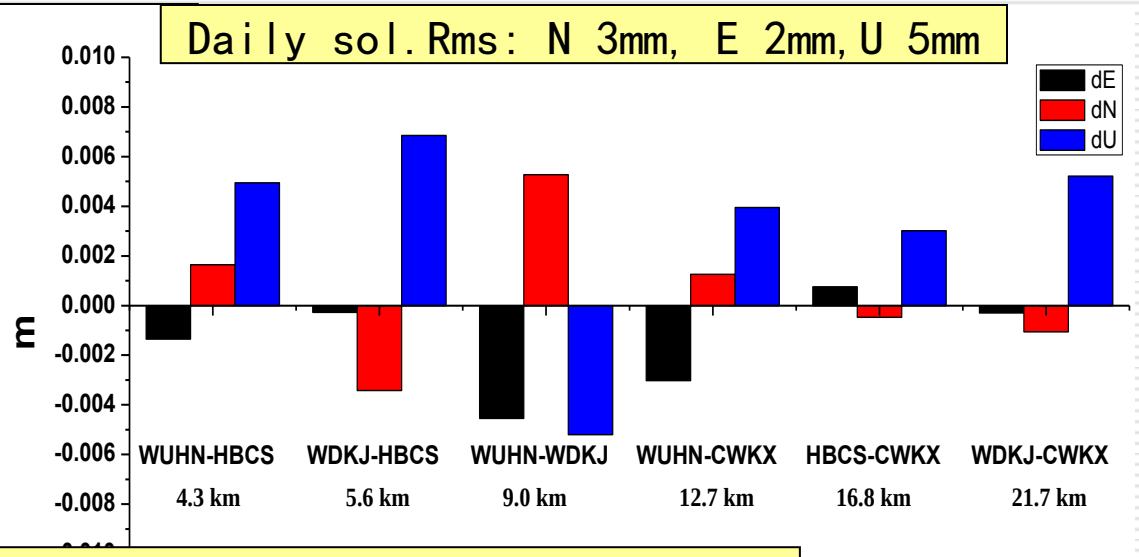
北斗/GPS双频观测

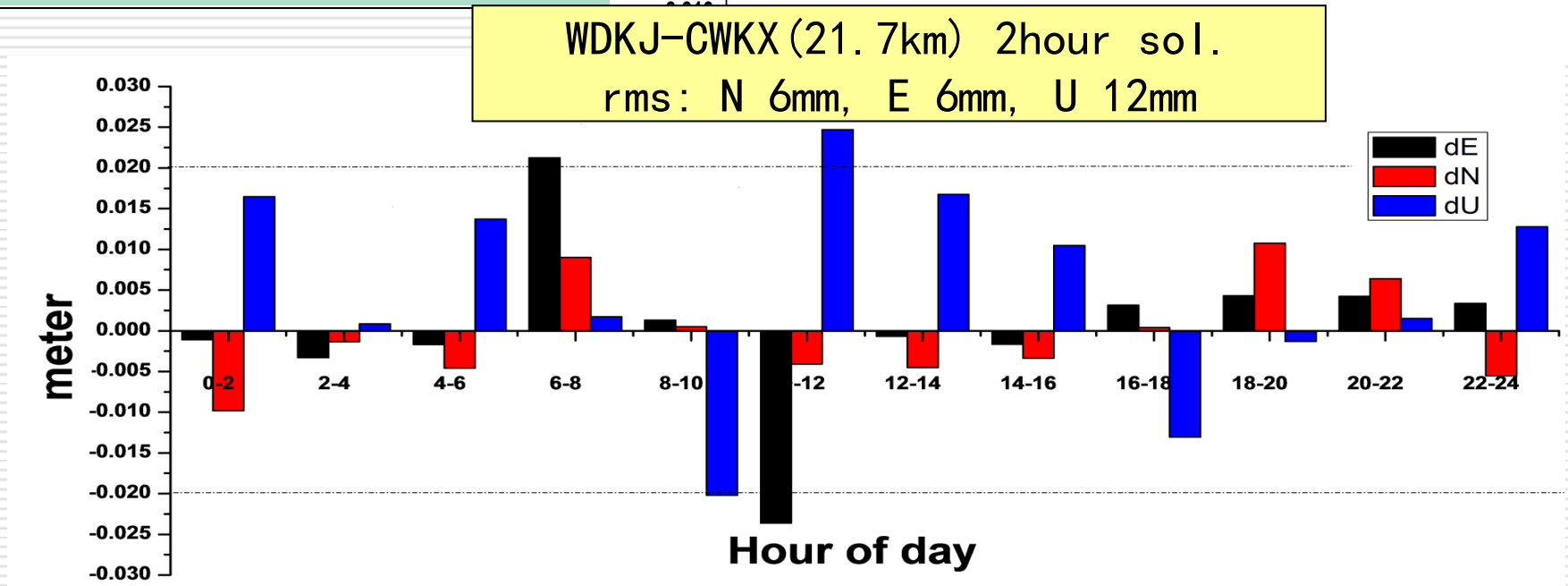
First Beidou CORS Network

6个框架网点+24个区域网点

COMPASS baseline solutions compared to GPS







COMPASS Baseline Compared with Laser Result

Baselines	Laser Distances (m)	Obs.	GNSS vs laser (mm)	
			Compass	GPS
SH00 - SN41	1008. 179	B1/L1	2.0	3.0
SH00 -SN37	528.101	B1/L1	2.0	1.0
SH00 - JD01	28070.411	BC/LC	9.0	8.0

COMPASS Precise Positioning and Navigation

- Status of COMPASS
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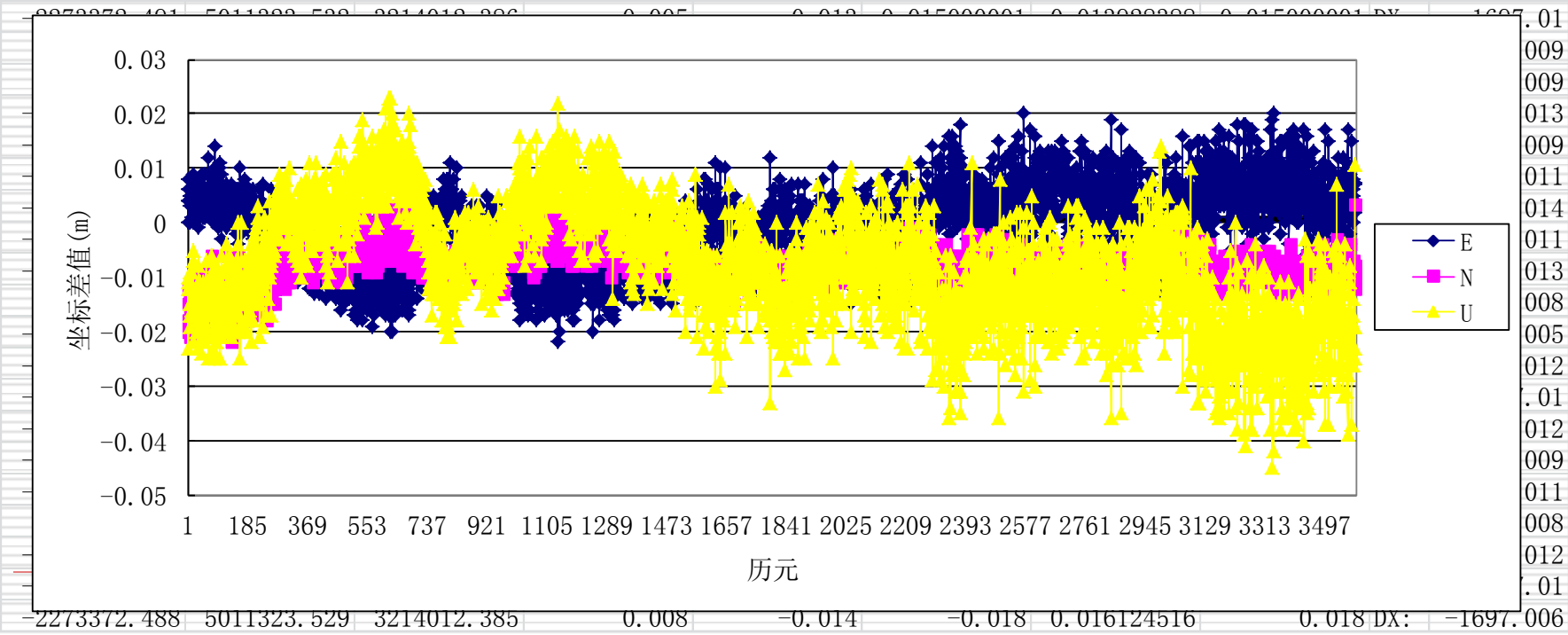
COMPASS RTK Results

- Receiver: reference and rover: UNICORE UB240 (dual-frequency)
- Ambiguity fixed ： 99.987%
- Real-time rms（Compare with GPS RTK）：

  E:7mm, N: 3mm, U:11mm

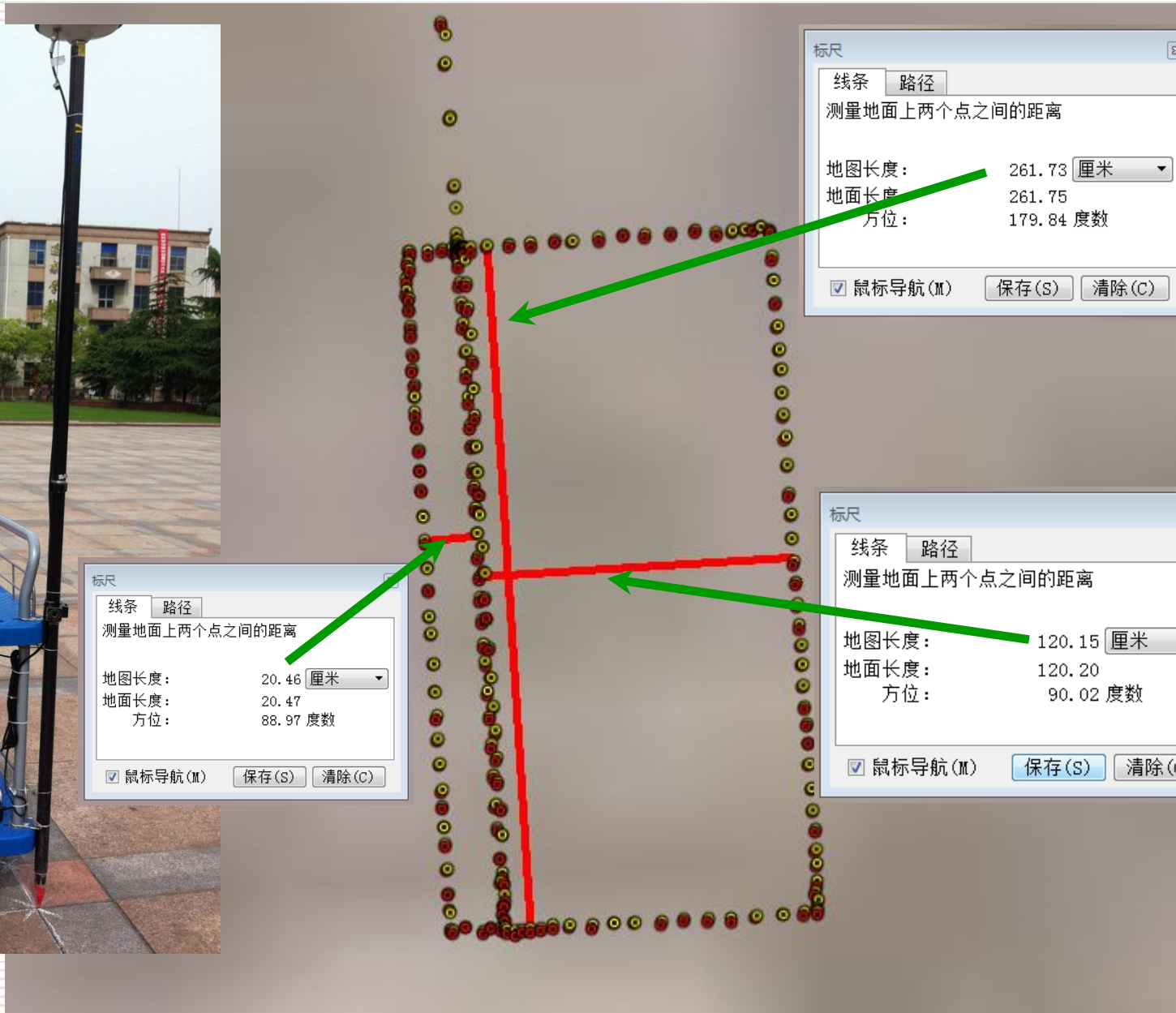


Network RTK Precision

- BDS Network RTK Precision
  - Rover：South S82-C（BDS Triple+GPS double Freq）、Hi-Target V30（BDS double+GPS double Freq.）
  - 34rovers used，5 positioning modes invovled

mode	Success rate of AMB Fix	Initial Time(s)	Internal precision/m (average)		accuracy/m (average)	
			plane	height	plane	height
GPS+BDS3	100%	5.76	0.004	0.018	0.010	0.036
GPS+BDS2	80%	27.46	0.003	0.015	0.011	0.042
BDS3	83%	16.40	0.007	0.020	0.013	0.052
BDS2	40%	50.78	0.003	0.015	0.014	0.045
GPS	44%	40.28	0.006	0.021	0.012	0.048

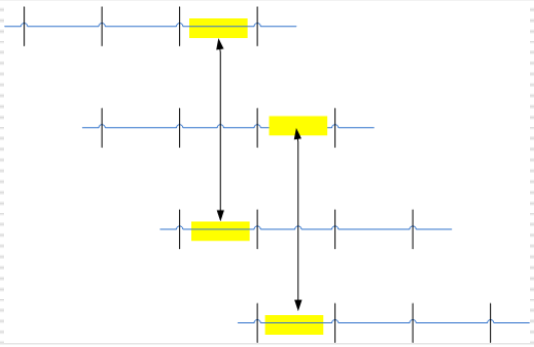
COMPASS RTK Test VS. GPS RTK

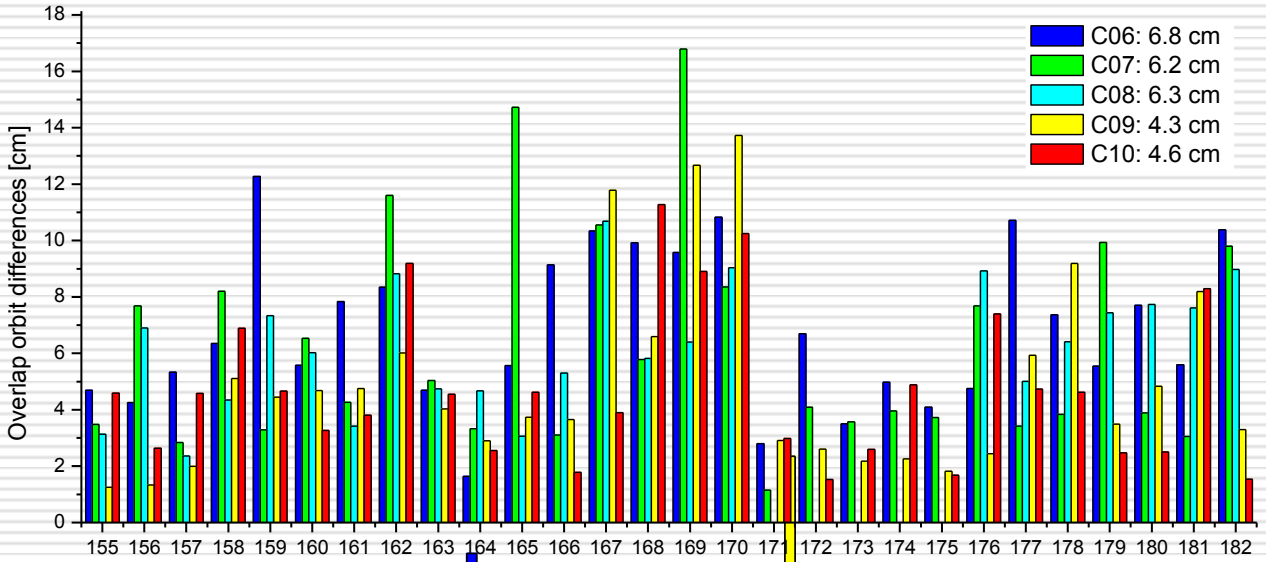


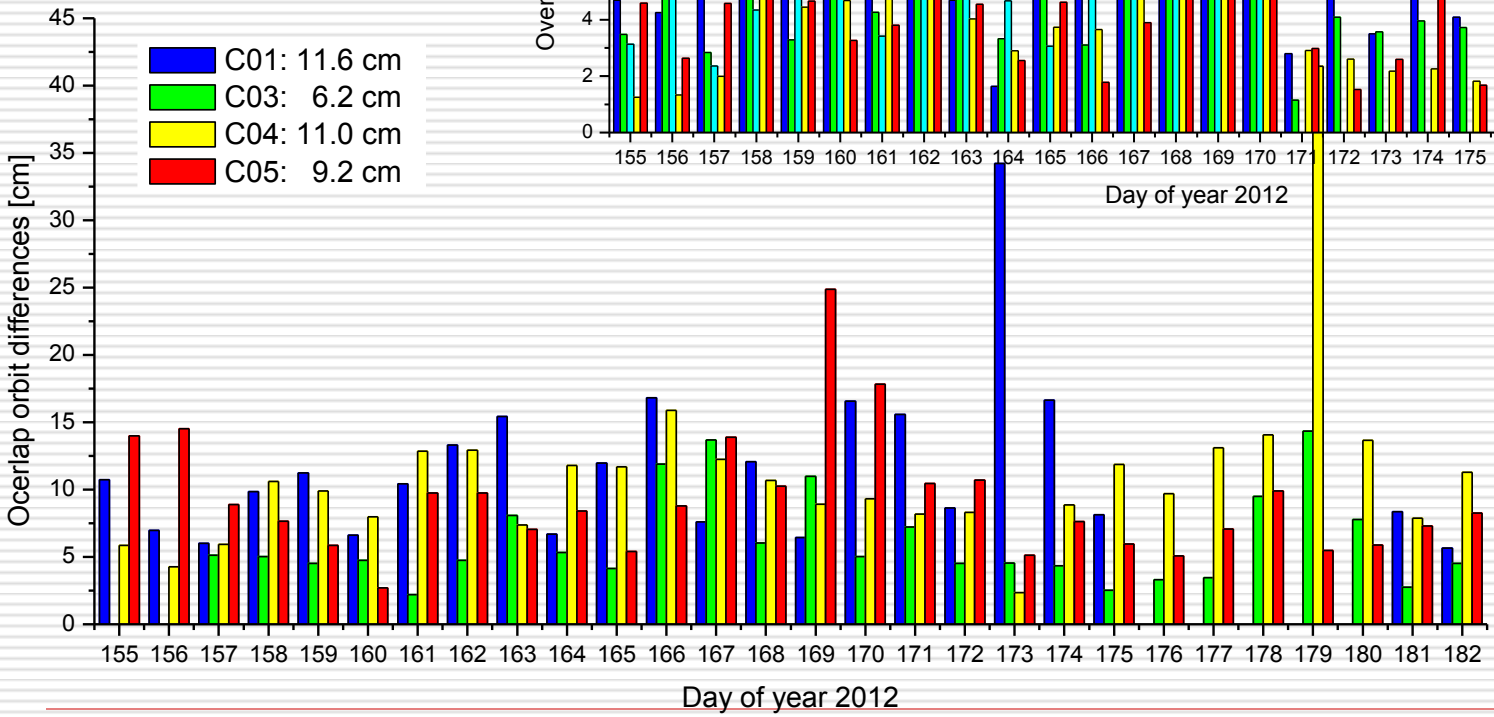
COMPASS Precise Positioning and Navigation

- Status of COMPASS
- Baseline Solutions (mm-level)
- COMPASS RTK (cm level)
- COMPASS PPP (dm level)
- D-COMPASS Navigation (m level)
- Benefit of GPS+COMPASS

POD for COMPASS Satellites

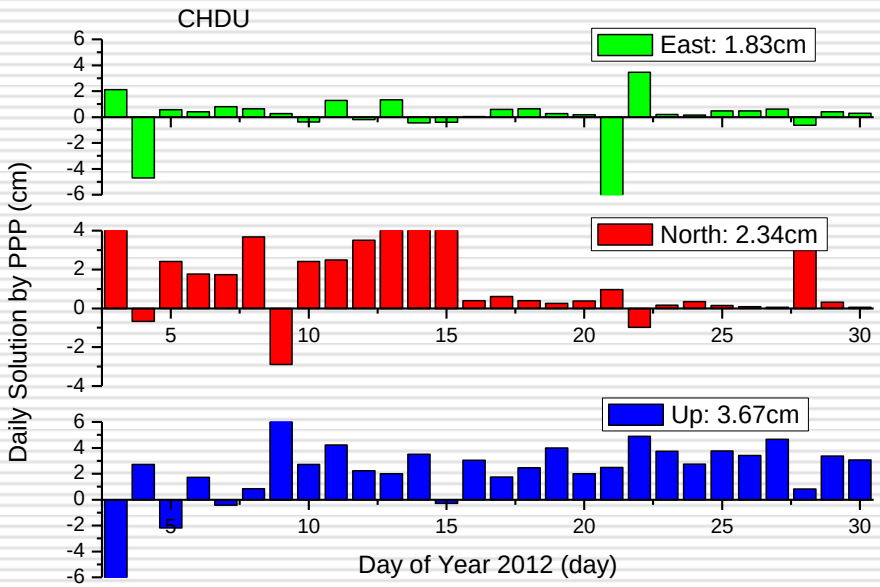






Orbit Overlap difference(Radial) RMS: 10cm

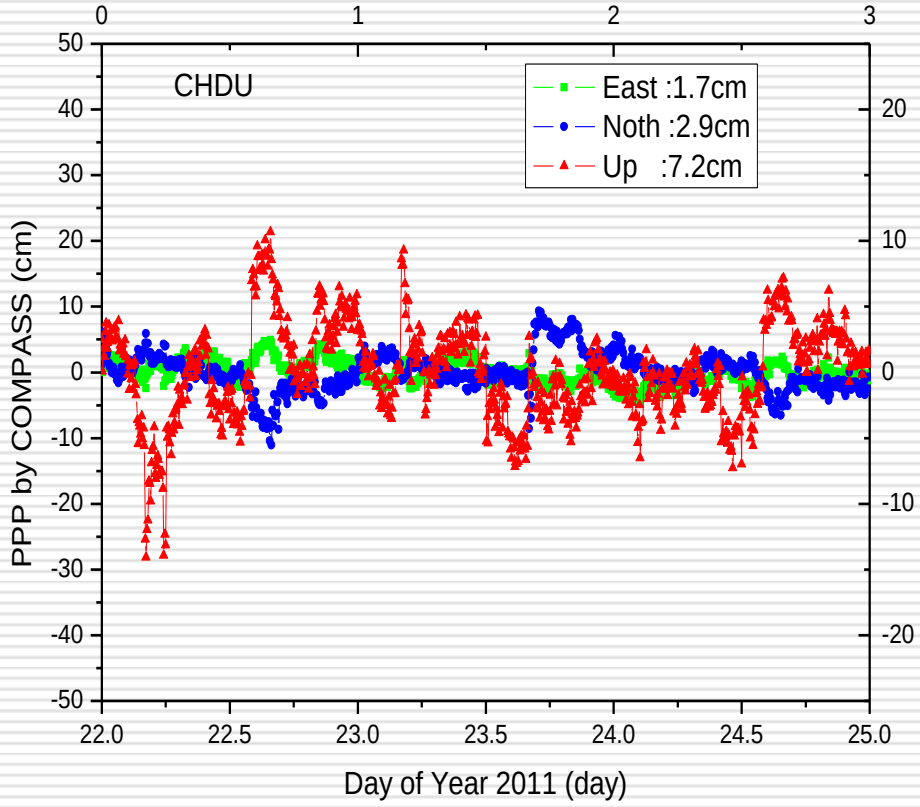
Daily Static PPP (Jan. 2012)



	East(cm)	North(cm)	Up(cm)
CENT	1.83	0.75	3.54
CHDU	1.83	2.36	3.67
SHA1	2.45	1.24	2.97
XIAN	1.43	1.58	1.74
BJF1	2.63	0.84	2.70
SIGP	3.73	1.43	5.53
HRBN	3.89	2.19	6.45
Avg.	2.54	1.48	3.80

CHDU not used for POD

Kinematic PPP (RT-PPP mode)

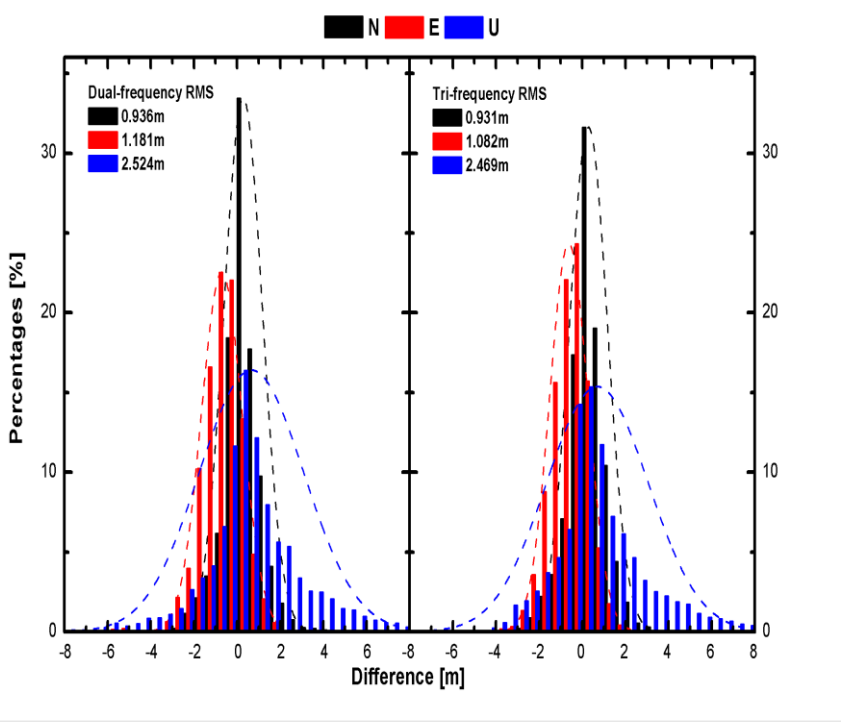


	East(cm)	North(cm)	Up(cm)
CENT	1.18	1.91	6.66
CHDU	1.73	2.93	7.24
SHA1	1.45	4.02	8.62
XIAN	0.92	2.00	6.62
BJF1	2.06	5.02	10.91
SIGP	2.62	3.03	4.63
HRBN	1.48	7.01	10.91
Avg.	1.63	3.70	7.94

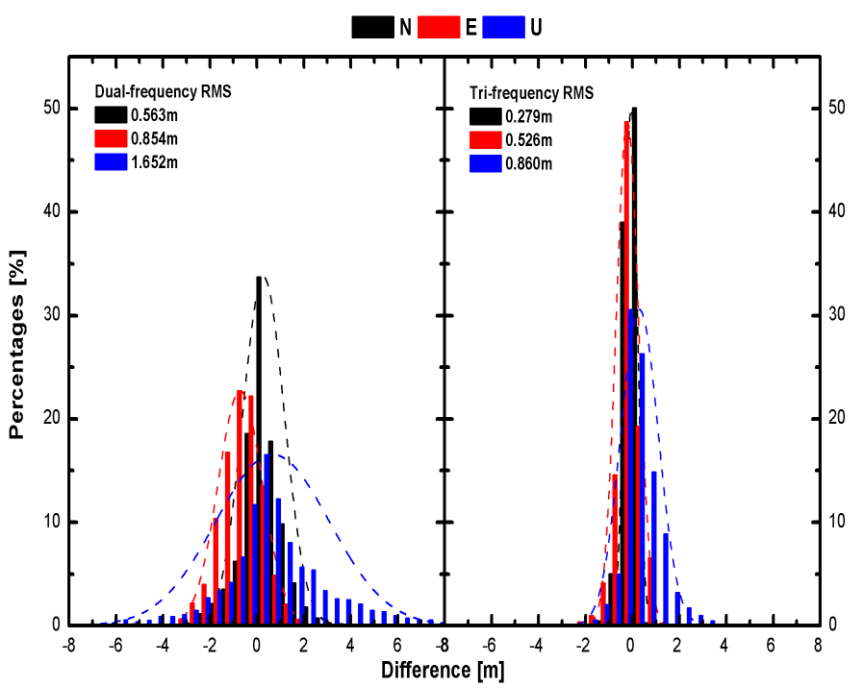
Kinematic PPP from DOY 21 to DOY 25

PPP Convergence with BDS Double/Triple Frequency OBS

iterms	
Data source	Hubei BDS CORS Network, about 27 BDS/GPS/GLONASS sites
sessions	2013.02.01～2013.02.28, sampling rate: 30s
strategy	BDS double/triple frequency PPP

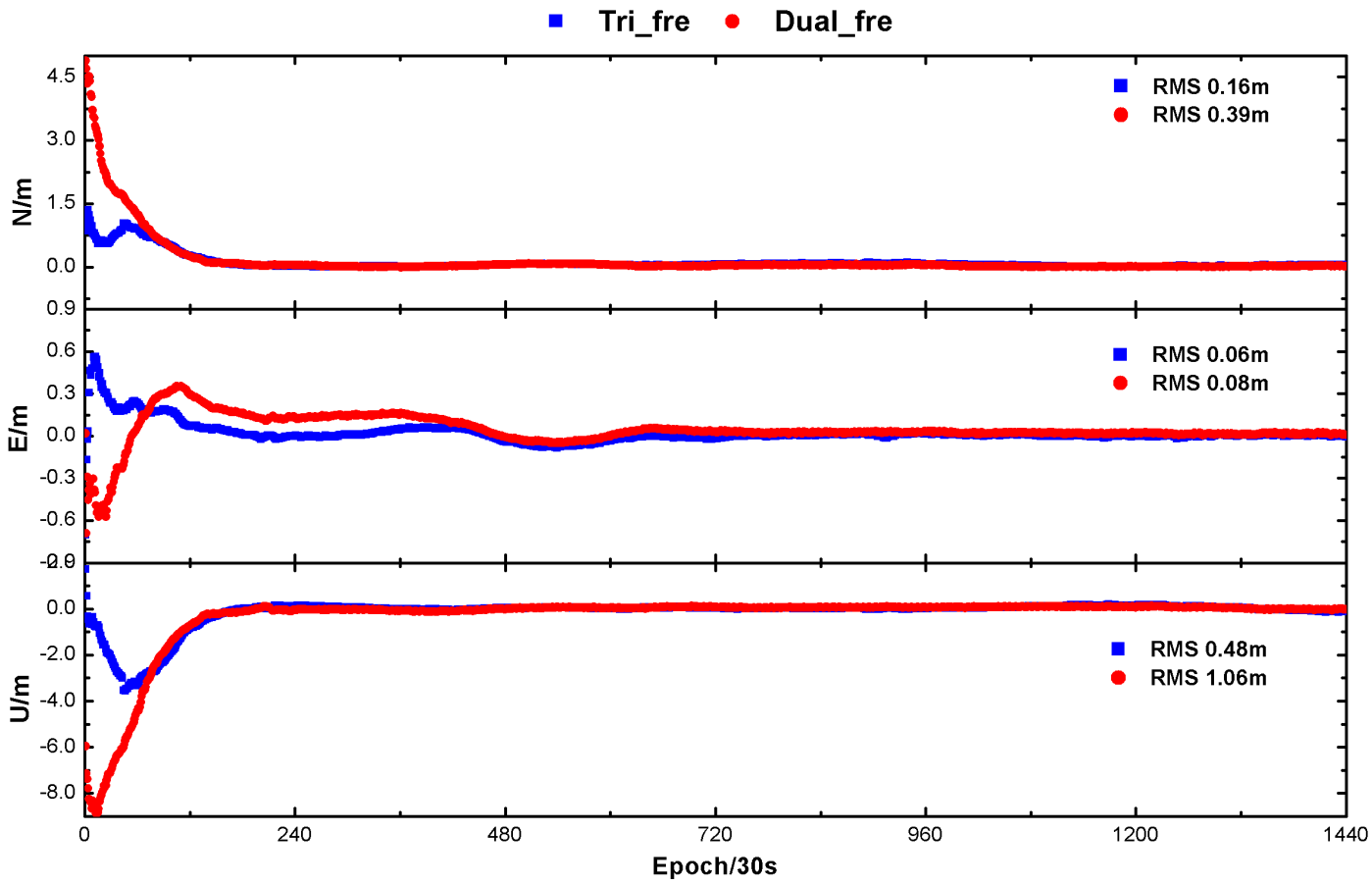


NEU Precision in firt 0～30 minutes



NEU Precision in firt 30～60 minutes

PPP Convergence with BDS Double/Triple Frequency OBS



PPP Convergence Example at site ES02 on 2013.02.07

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- COMPASS PPP (dm level)
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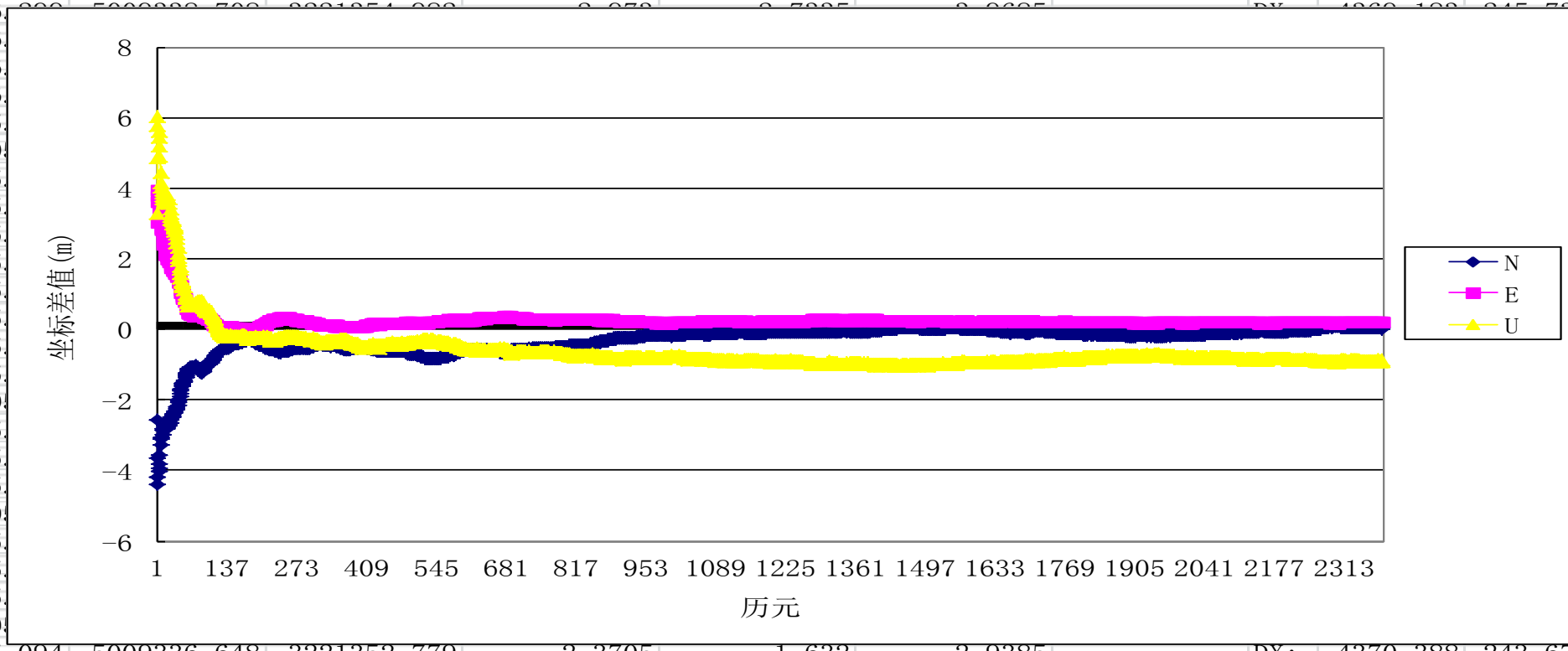
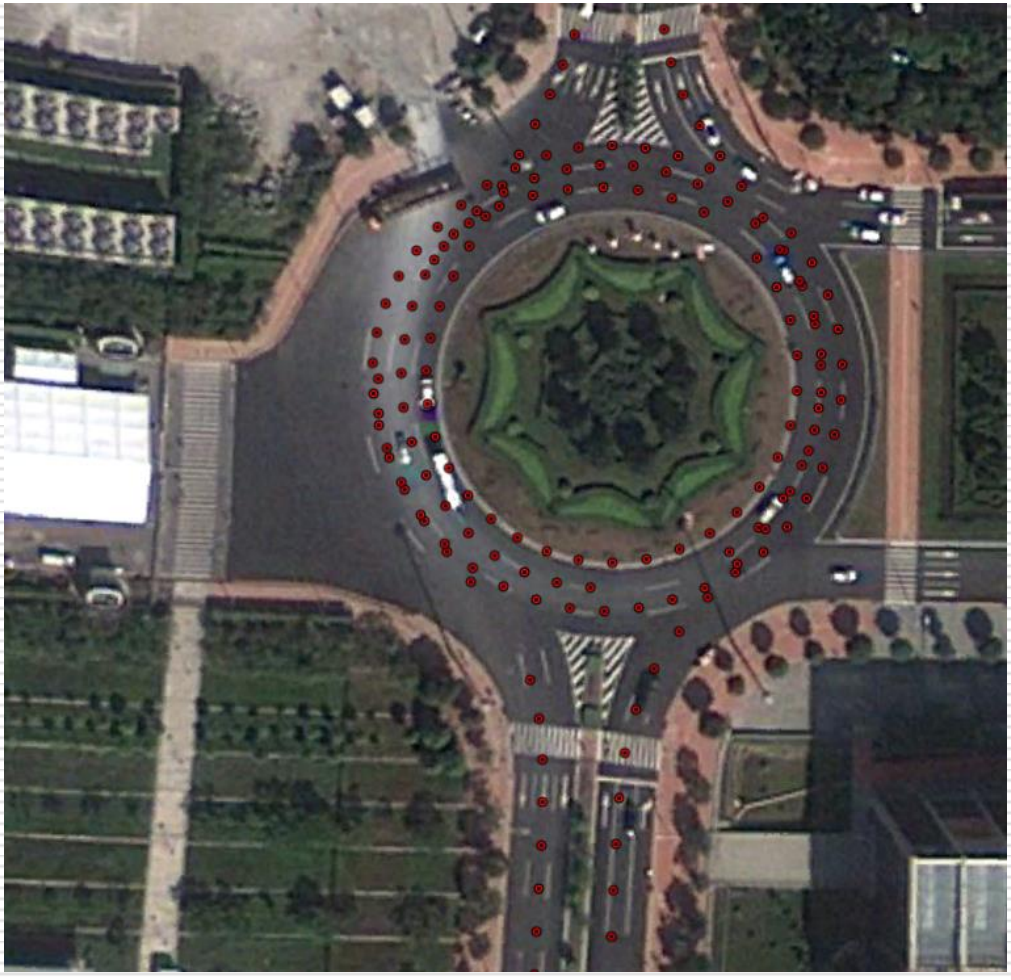
Pseudo-range Differential COMPASS

- Reference: UNICORE UB240
- Rover: CNS100-BG (single-frequency)
- Real-time rms（Compare with GPS RTK）:
  H:0.8m, V: 1.2m



D-COMPASS Navigation



COMPASS Precise Positioning and Navigation

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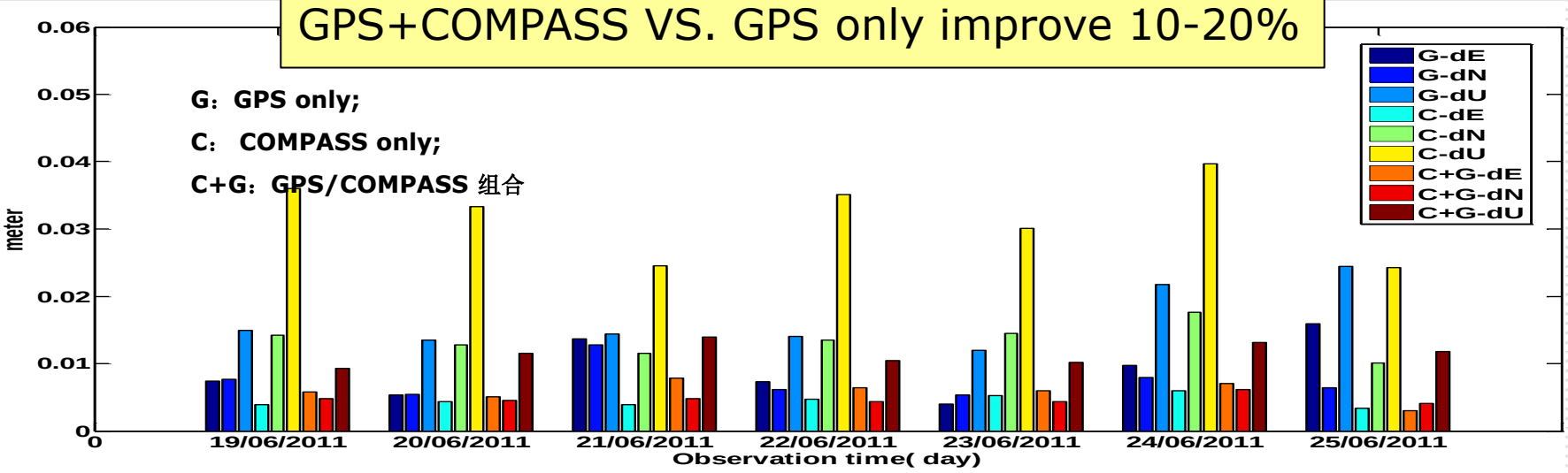
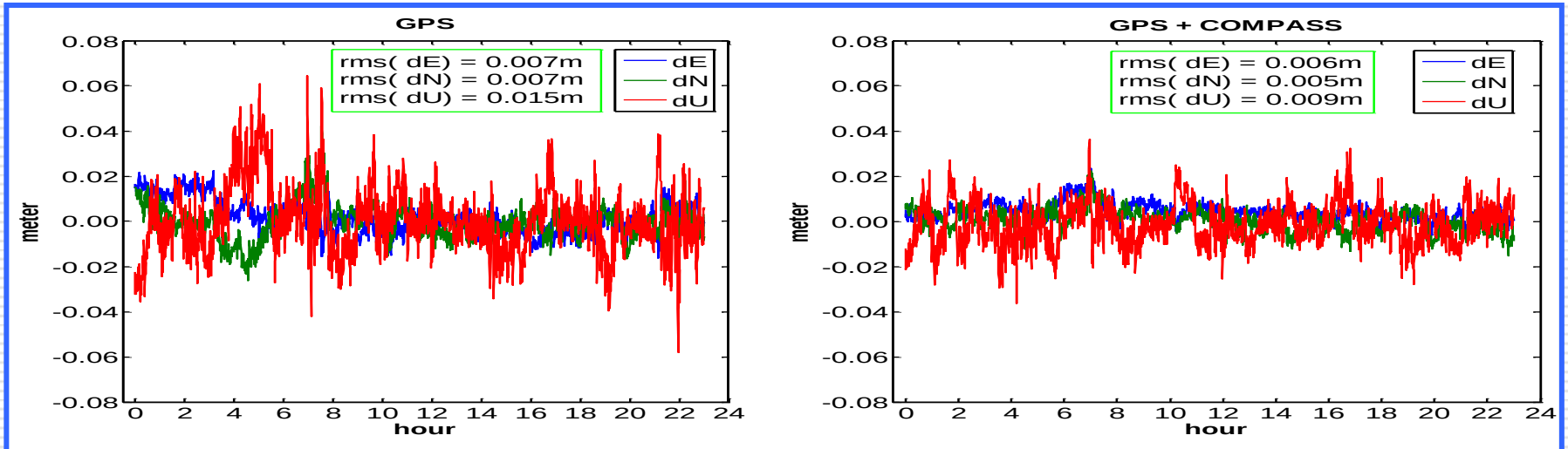
Benefit of GPS+COMPASS

GPS+COMPASS VS. GPS only improve 10-20%



7 day Baseline Kinematic solutions



DOY170 Kinematic solution (epoch by epoch)

Summary

- PANDA software
  - GNSS real-time products: orb., clo., ion., trop.,,,
  - Dm level RT-PPP
- MASS developed in China
  - Dm level RT-PPP for double-frequency
  - Better than 1m accuracy for single-frequency
- COMPASS results
  - Baseline: mm level @ 30km
  - RTK: cm level
  - PPP: dm level
  - Pseudo-range Differential: meter level
  - Comparing with GPS only, emerging Compass data could improve the accuracy of baseline kinematic solution about 10-20%

Thank You for your attention!

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