

Prototype of Multi-Constellation Augmentation Service System in China

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The GNSS Research Center of Wuhan University

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Outline

- Introduction
 - Software and Platform (PANDA software)
 - Our work in RTPP Program & RTIGS
- Prototype of MASS(**Multi-Constellation Augmentation Service System**)
 - Wide Area Augmentation
 - Regional Augmentation
- COMPASS Augmentation and Primary Results



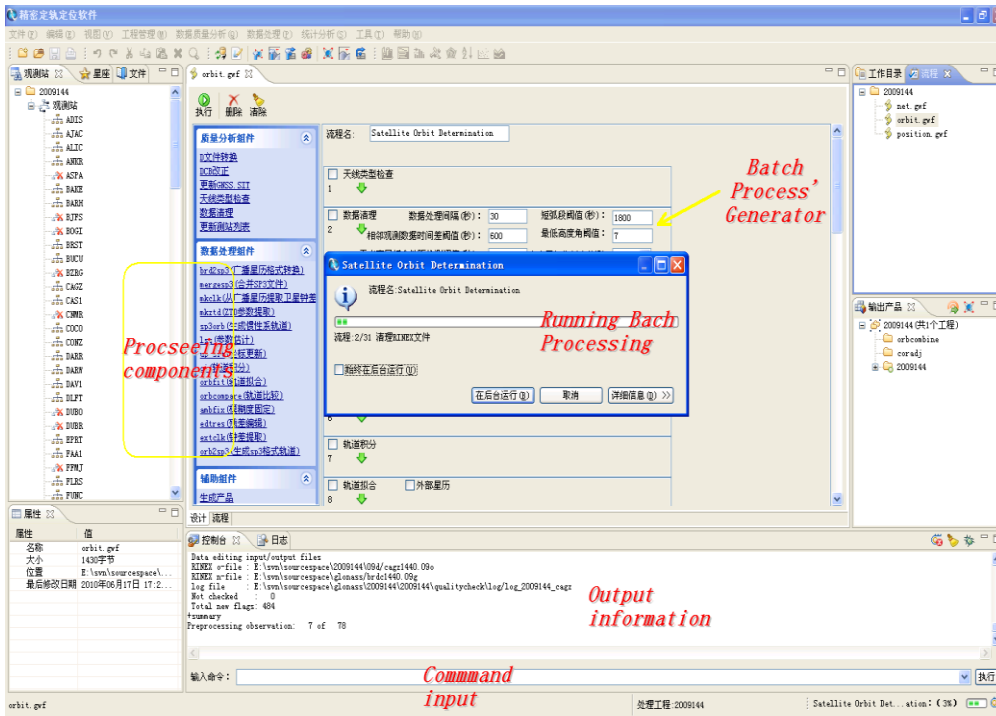
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Software and Platform

PANDA : Positioning And Navigation Data Analyst

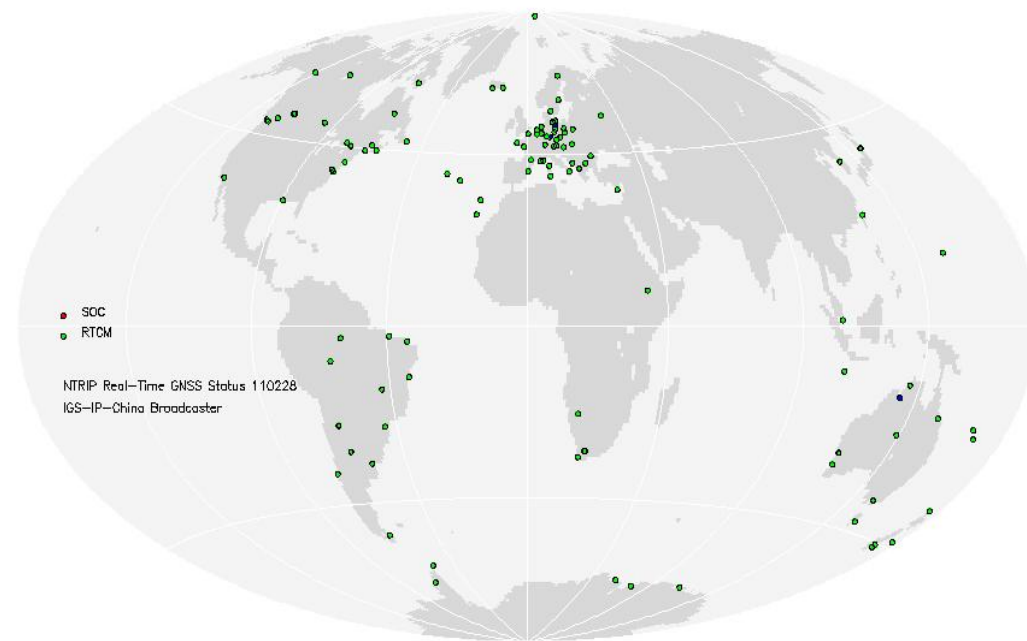


- Start by Dr. M. Ge and J. Liu 10 years ago
- To derive possible information from GNSS/SLR/ VLBI/DORIS data
- Real-time Processing function from 2007
- Current Applications
 - POD of GNSS (GPS, GLONASS, COMPASS, GALILEO)
 - POD of LEOs (CHAMP, GRACE, COSMIC, JASION)

Ongoing application projects in China (973, 863) – Huge Network data processing, PPP
 Aim to IGS analysis center
 Aim to Compass analysis center



Real-time Relay Center



WHU relay 150 stations;
More than 20 research
institutions as users.

(<http://ntrip.gnsslab.cn>)

Thanks for supporting by IGS-RTTP !

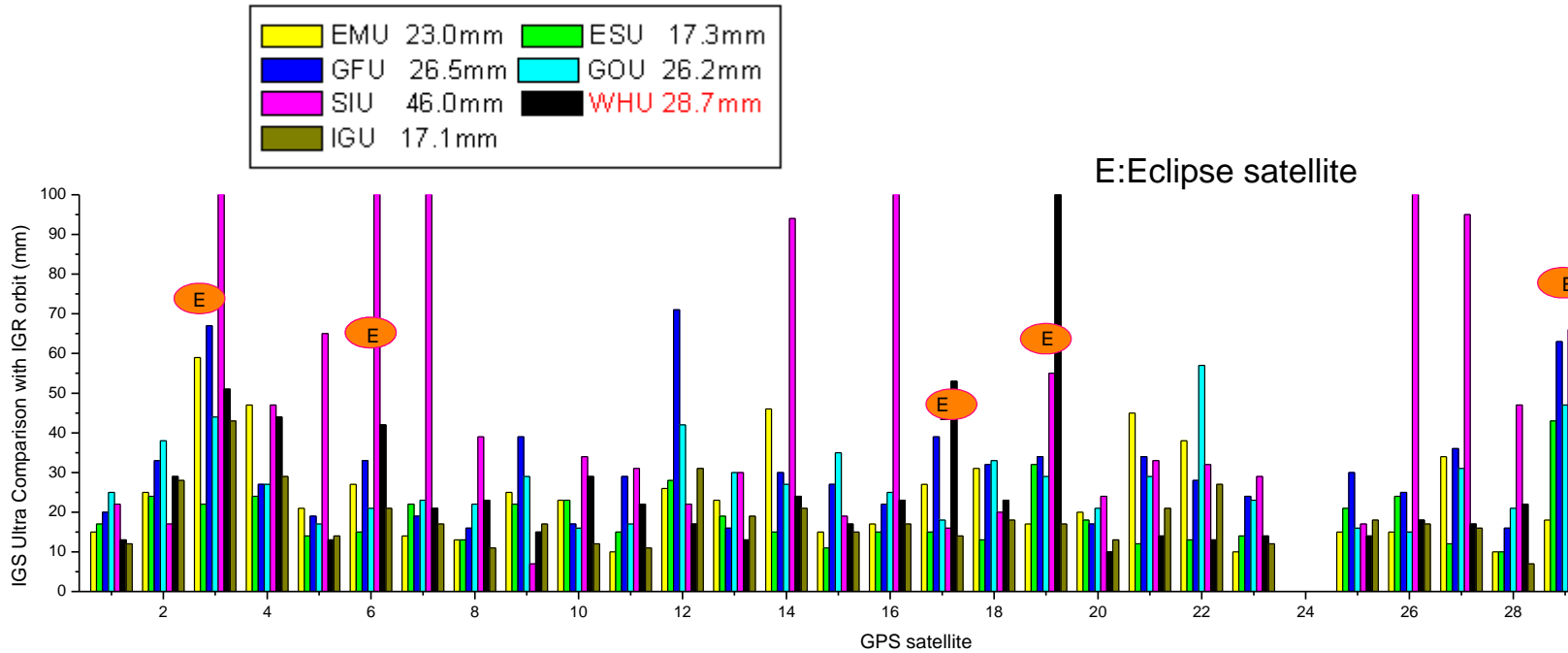


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Ultra-rapid Orbit VS. IGR



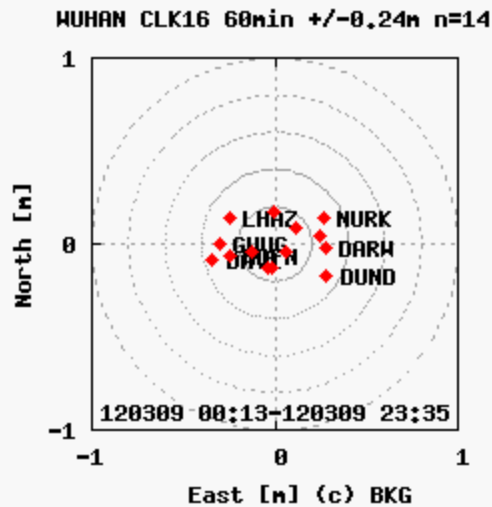
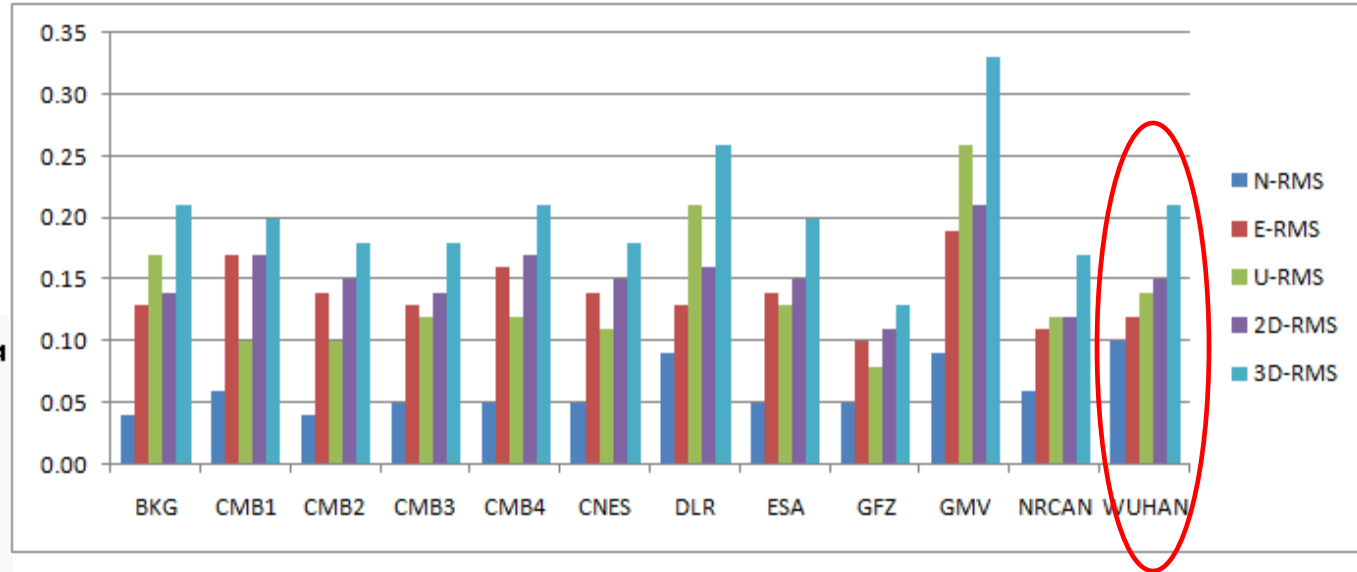
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Real-time clock products

- WHU_CLK15
- WHU_CLK16



IGS RTPP daily clock report

RTIGS PPP Performance Report



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Prototype of Multi-Constellation Augmentation Service System



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Prototype of MASS

- Goals
 - Augmentation with GPS/GLONASS/COMPASS/Galileo
 - Integration Global PPP and Regional PPP-RTK
- Current Status
 - Beginning of 2007, supported by 863 program In China
 - Developing Software and platform
 - Achieving Prototype of MASS (preliminary)
 - Providing Several Service
- Method and Software
 - PPP (wide area) & PPP-RTK(regional)
 - RT-PANDA(orbit/clock/ion/PPP...)



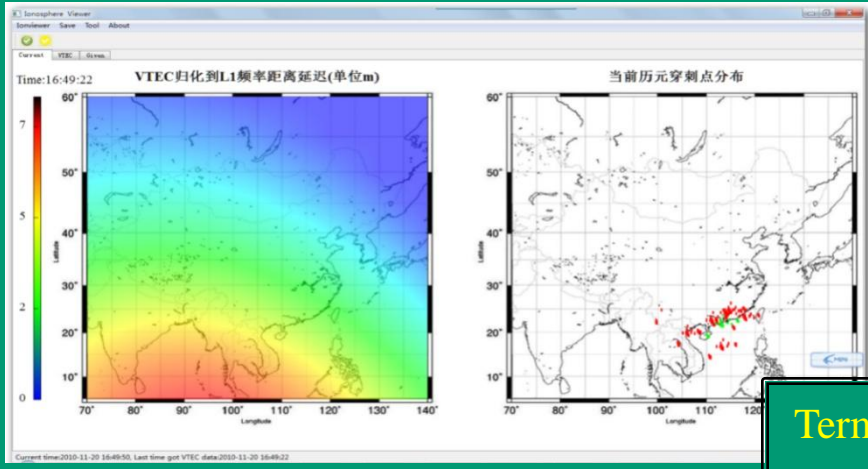
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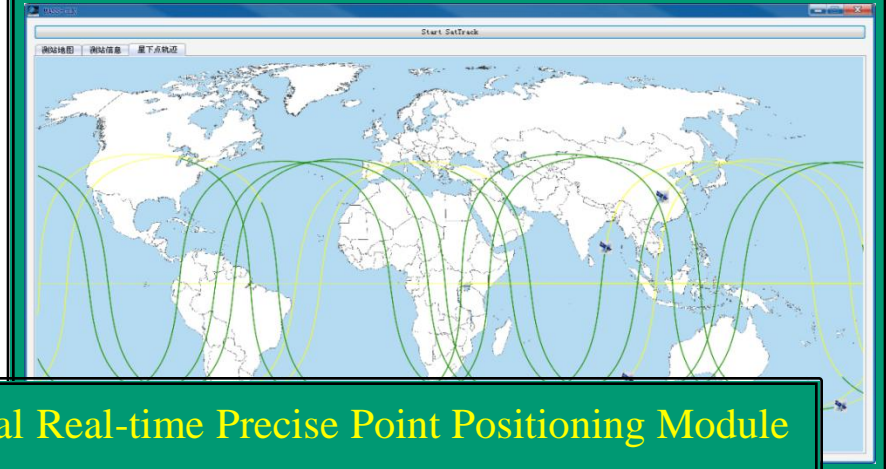


Wide-area Augmentation Software

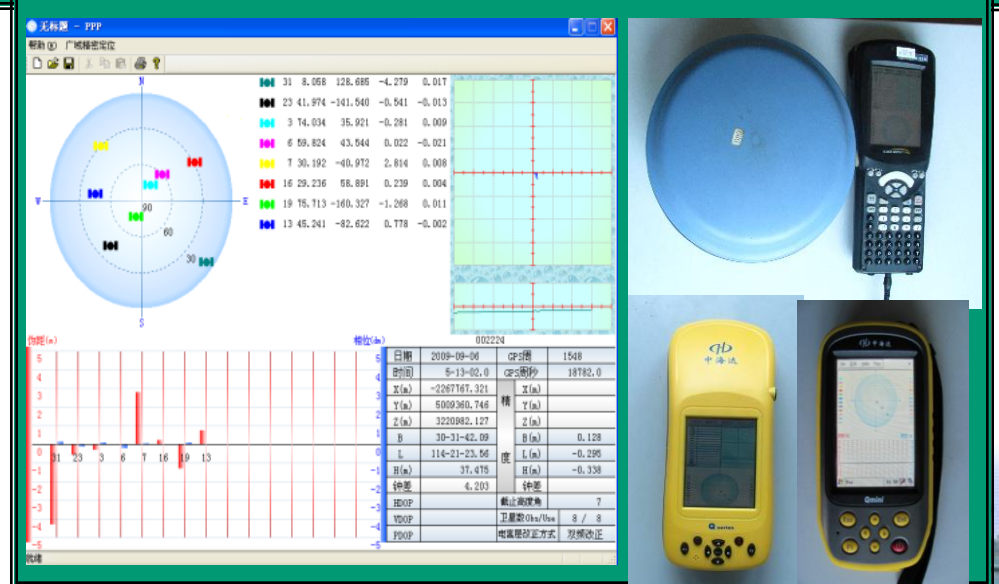
Regional Ionospheric Delay Modeling Module



Satellite Clock Estimation Module



Terminal Real-time Precise Point Positioning Module



Products Broadcast Module

The screenshot shows the Products Broadcast Module software interface, displaying a list of broadcast products for various satellites. The data is organized into columns for satellite ID, X, Y, Z coordinates, and other parameters.

No. of Sat	X(m)	Y(m)	Z(m)	Other
002	-46.9100	51.0490	31.0400	50.3520
003	33.4210	-10.0320	-62.0140	36.6670
004	-73.9420	23.5530	9.3570	61.9600
005	-14.3290	-2.9110	83.9710	-51.2730
006	1.5190	-26.5300	-92.7480	40.7100
007	-61.2320	-44.3190	44.4050	65.6010
008	-70.4250	-50.3780	-4.5660	4.5660
009	32.1410	1.9760	-19.6720	25.1960
010	-51.0600	10.1420	97.0750	-63.0440
011	-40.1050	-86.1330	-89.0840	-40.7690
012	14.5950	27.0360	1.4450	-51.5750
013	-60.6250	-70.0770	71.6950	7.3730
014	66.8930	-99.8590	-69.5690	85.5610
015	53.5720	18.8520	-30.0680	-65.9650
016	36.6700	-0.5390	-73.3770	-17.5390
017	-79.5780	11.1300	-28.4760	68.0990
018	47.6010	81.7080	-24.3860	8.7420
019	98.6080	-52.3520	-71.2950	-90.3720
020	-21.8590	-6.4810	97.3290	36.9250
021	29.1090	69.5970	16.1760	-73.5640
022	93.8150	-89.1610	-14.5200	49.2290
023	-29.4630	-99.8200	43.5330	14.5490
024	-73.8220	-91.8230	-1.1140	47.6650
025	92.8720	33.0780	53.8320	-50.8630
026	-53.5260	66.5600	-15.8020	-6.2150
027	3.4300	70.5310	-30.9150	46.2390
028	-81.7390	-29.3930	-69.5150	94.2040
029	82.3890	48.6660	45.4160	2.0320
030	43.7260	-56.5910	67.3620	7.9130
031	70.4370	-44.3140	66.9310	44.6470



Regional Augmentation Software

Processing of reference network

Calculate corrections

Broadcast the correction information

User

名称: RT_gd
测站或网名: 子网
通讯类型: TCP/IP
验证方式: 无
数据源: HLD_NET1

用户数据信息

序号	用户	上
1		

数据源: HLD_NET1

实时数据输出

时间	Frn	CA	Li	SN	Ele	Azim
2011-11-12 09:48:38	8	20486151.524	107655406.649	0	0.0	0.0
2011-11-12 09:48:40	11	20903491.182	109323034.265	0	0.0	0.0
2011-11-12 09:49:11	7	20724301.102	108906659.690	0	0.0	0.0
2011-11-12 09:49:14						
2011-11-12 09:49:15						
2011-11-12 09:49:26						

连接接收机 xxxz 成功!

File Setting
Network Data
Conn. Type: TCP/IP
Data Source: []
Setting: 127.0.0.1-8091
Data Type: RTTPP_OMC
Obs. Time: 0
NRTK COR: 12
satlock: []
IGU ORB: []
Sat. Number: 0
com: 8

Rover Receiver Data
Conn. Type: TCP/IP
Setting: 59.41.181.35:8093
Data Type: RTCM 3.0
Obs. Time: 1661
Sat. Number: 9-0

Connect Network | Disconnect Rover | Start File Mode | EXIT

PPP Results
Time: [] Rms: [] VRms: [] Ratio: []
X: [] B: [] Vx: [] nPrn: []
Y: [] L: [] Vy: [] PDOP: []
Z: [] H: [] Vh: [] mode: []

NRTK Results
Time: [] Rms: [] VRms: [] Ratio: []
X: [] B: [] Vx: [] nPrn: []
Y: [] L: [] Vy: [] PDOP: []
Z: [] H: [] Vh: [] mode: []

Data Writer
Position Results: []
Rover Raw Data: c:\myb\20111112_093956_raw 99.9K 186
Network Raw Data: c:\myb\20111112_093957_network_raw 594.2K 1441

输出

360
270
180
90



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PPP-RTK Online Service

http://192.168.254.101:8080/pppol/gnss_data_process.jsp Ongoing internal testing

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国家卫星定位系统工程技术研究中心-研究发展部
Nation Engineering Research Center for Satellite Positioning System

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登陆 注册 退出 admin, 欢迎您!

精密单点定位

Static or Kinematic?

Static or Kinematic?

静态精密单点定位 动态精密单点定位

观测数据文件 (支持的文件格式: .gz, .Z, .o, .d)

上传进度

平均速度 KB/s

已用时间 s

所剩时间 s

Upload your observation data

如果您把天线类型设置为NONE, 请确定您的观测数据文件中已经填写了正确的天线类型

Antenna type

Antenna height

天线W/E/N (单位为米)

为您处理的进度

Data processing progress

copyright技术支持: 武汉大学卫星导航定位技术研究中心

PPP results:
10-20 cm
<20 minutes

PPP-RTK results:
cm-level
<10 minutes



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Users Accuracy of wide-area tests



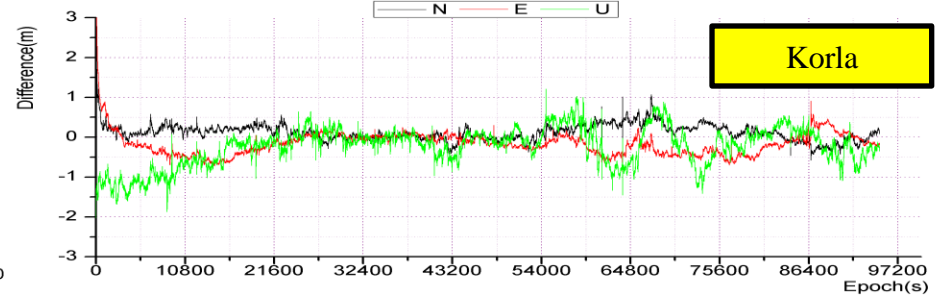
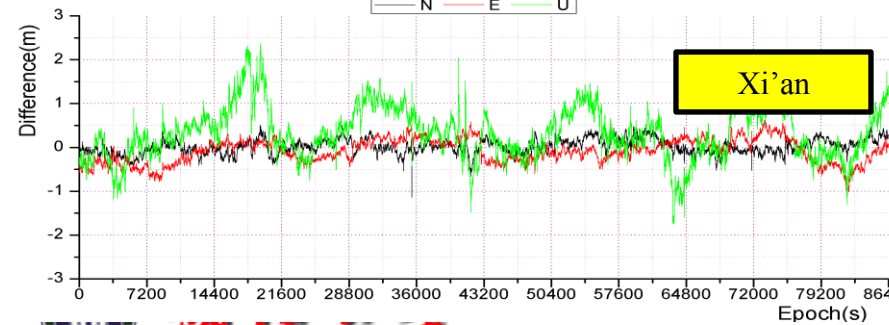
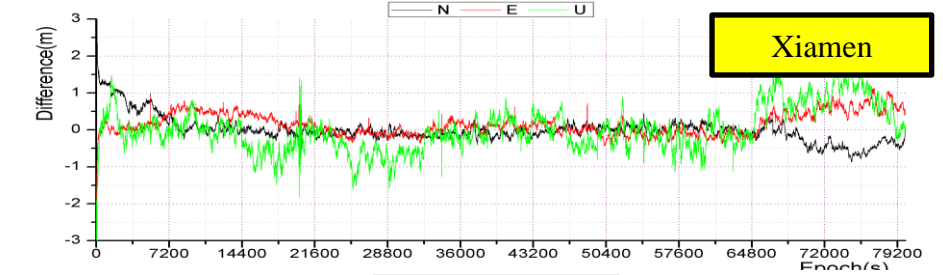
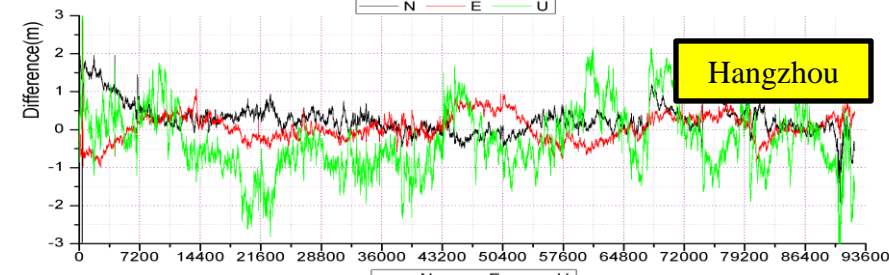
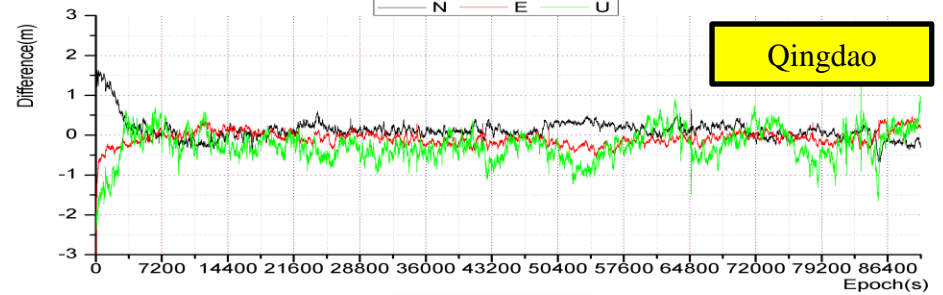
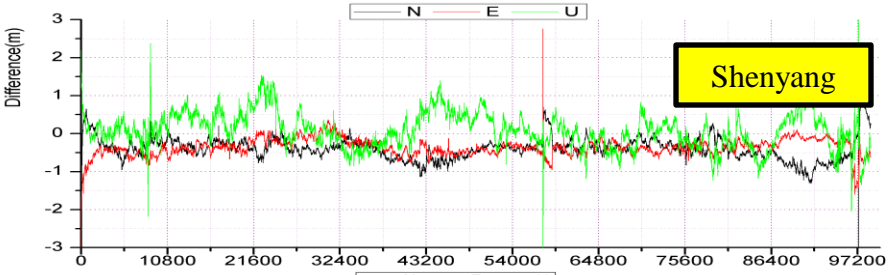
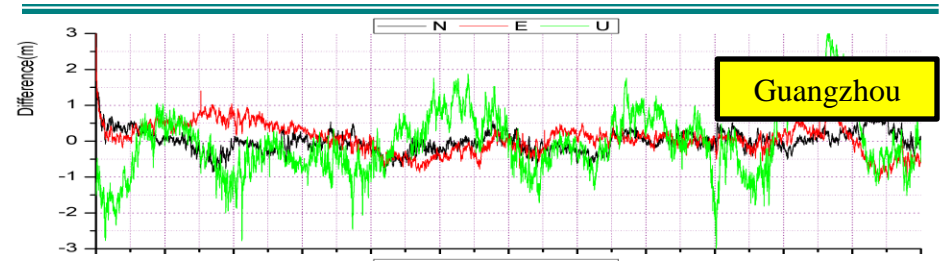
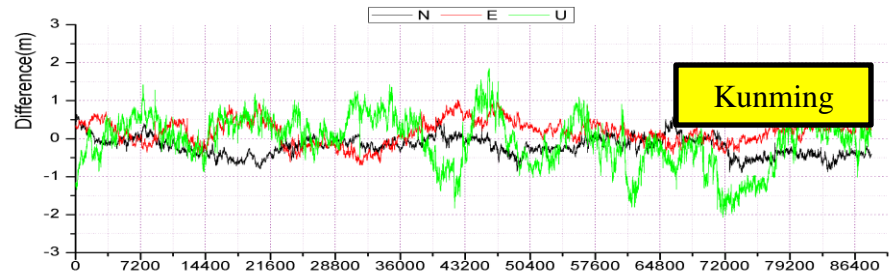
June 25 ~ July 11,
2011, 24-hour test



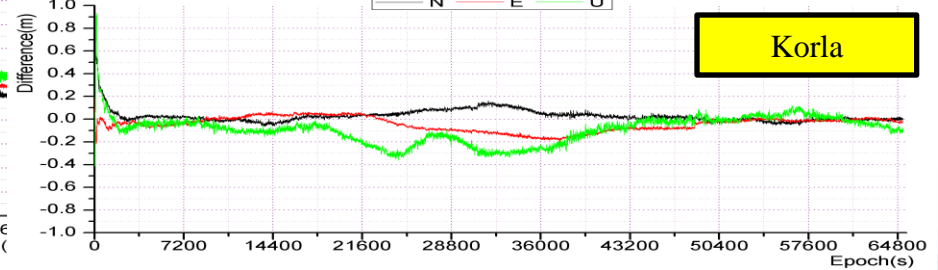
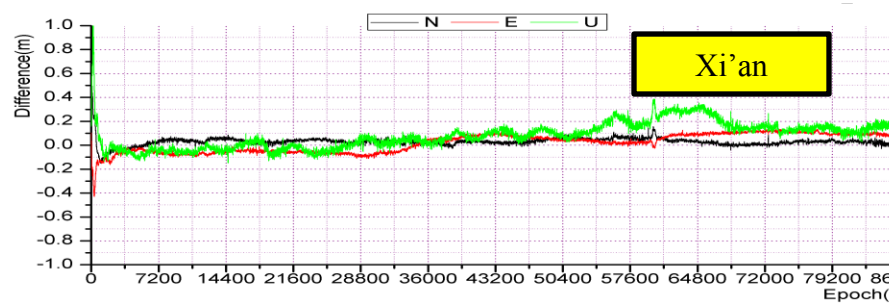
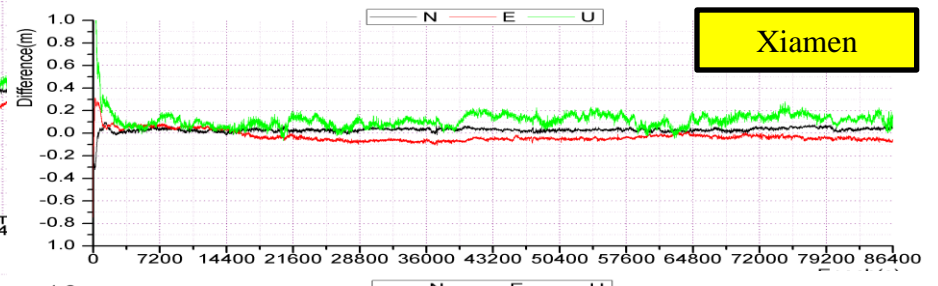
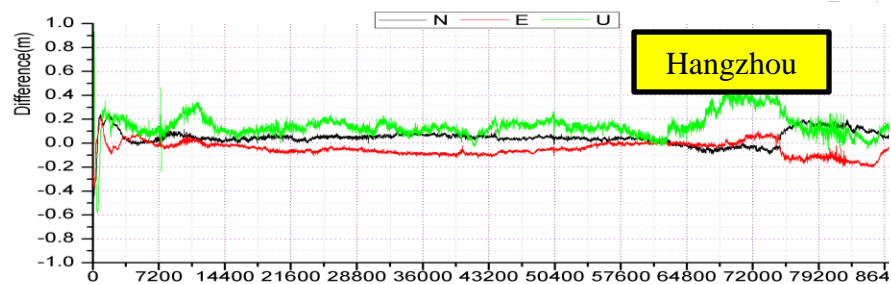
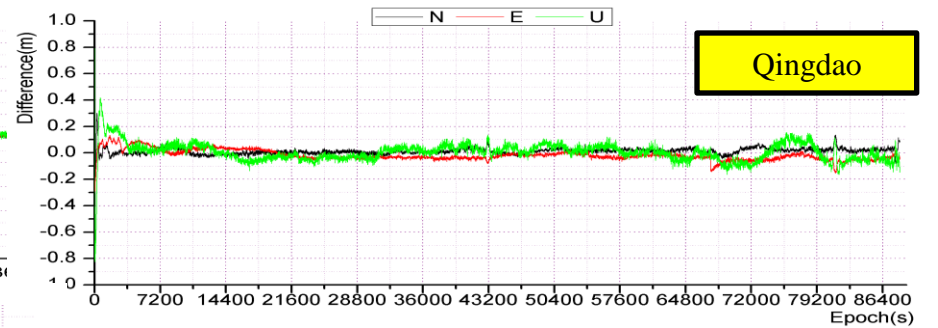
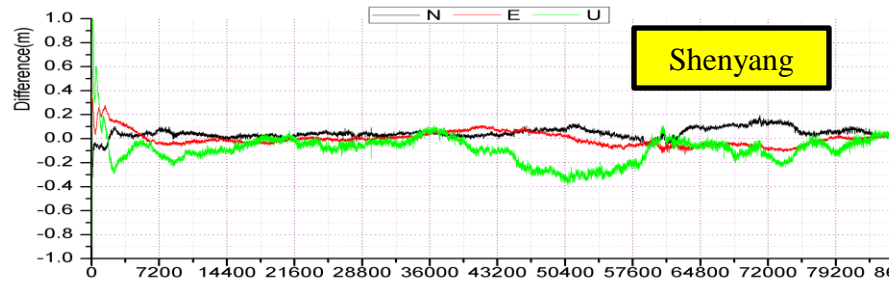
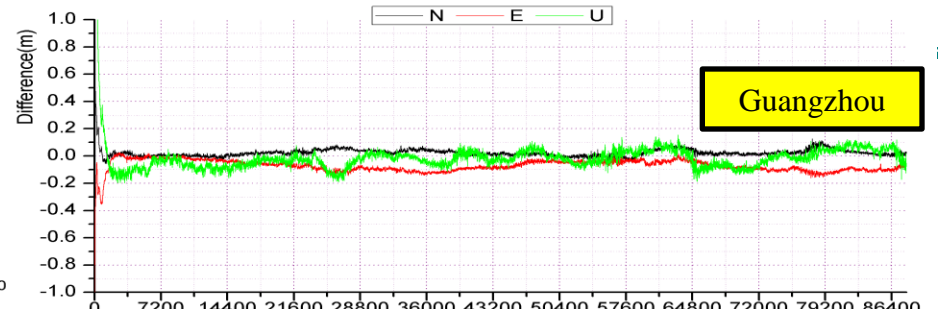
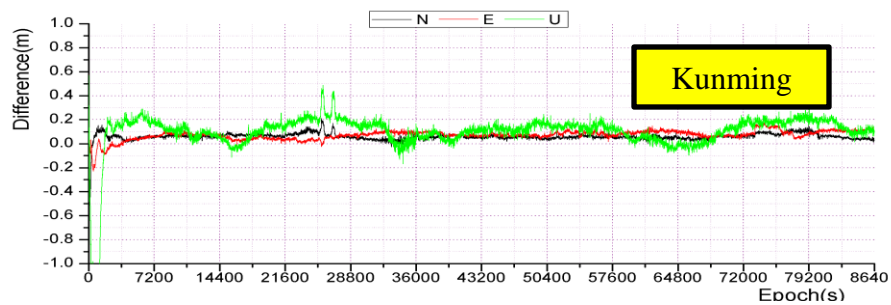
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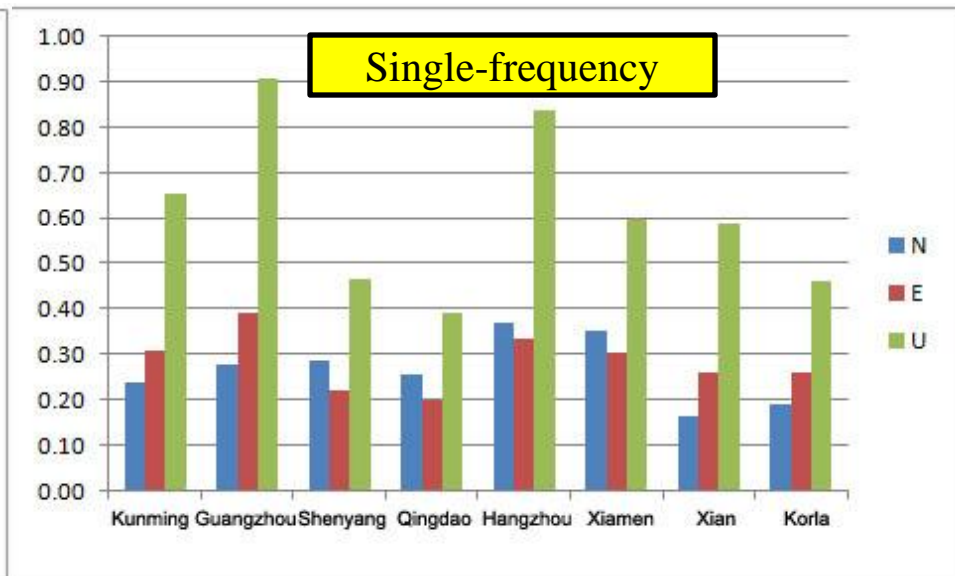
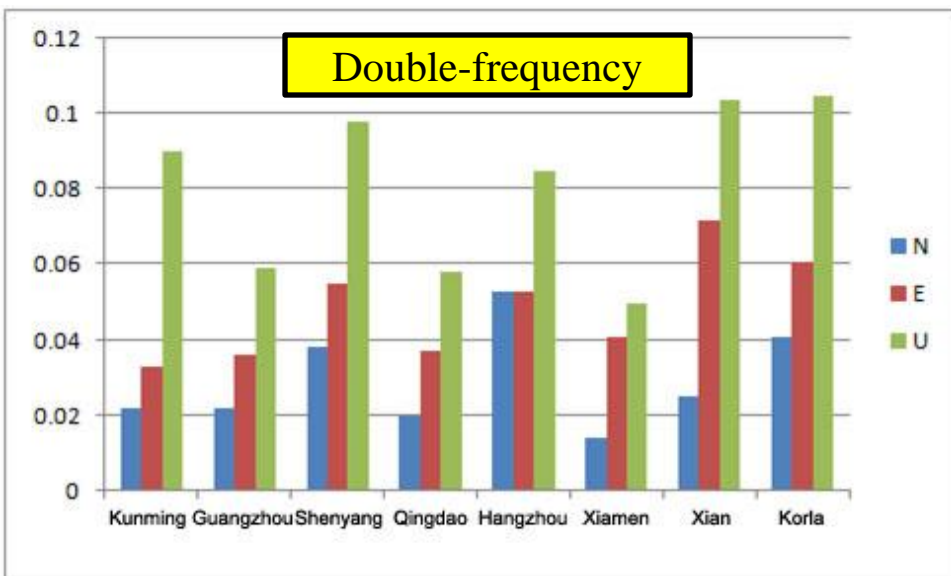
The time series of single-frequency test results



The time series of double-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



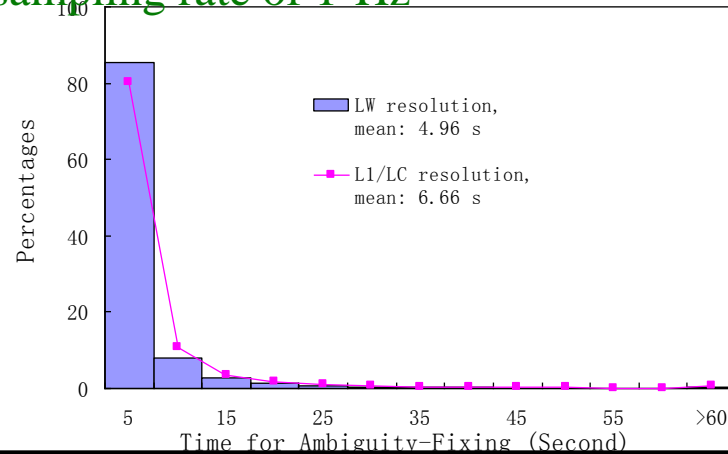
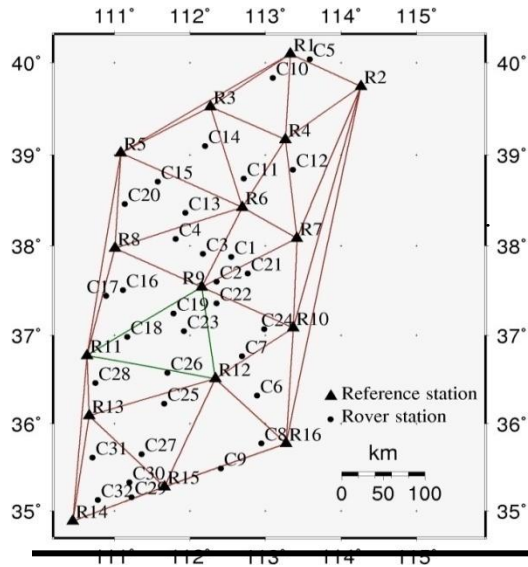
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CORS Based PPP-RTK Test

May 21 2010 from 9:00 am to 12:30 pm
with a sampling rate of 1-Hz



Reference station		Rover station	Testing section					
Num	distance	Num	Total Num	LW	L1	Fixed Num	rate	
16	149.4km	32	59701	41	4	59656	99.92%	
Ambiguity resolution time (s)			Positioning RMS (cm)					
LW	L1/LC		North		East		Up	
4.96	6.66		LW	L1/LC	LW	L1/LC	LW	L1/LC
			2.17	1.71	2.93	2.21	4.49	3.39



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COMPASS Augmentation and Primary Results



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Overview

- COMPASS Experimental Tracking Stations (CETS)
- Several kinds of Experiments of COMPASS Positioning
 - Single Point Positioning
 - Pseudo-range Differential
 - Carrier phase differential (Post-processing & Real-time)
 - PPP(Static & Kinematic)
 - GPS/COMPASS combined processing



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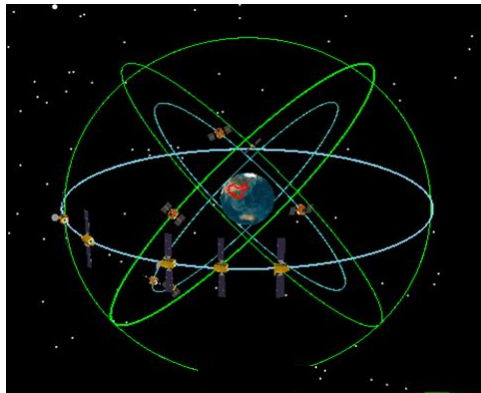


Status of COMPASS System

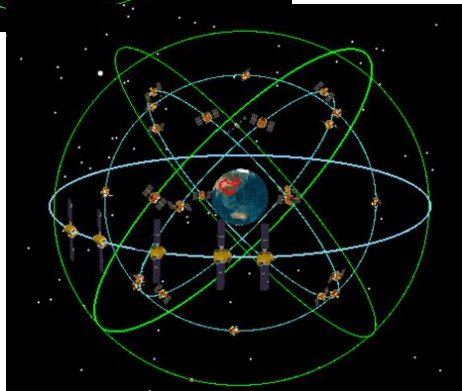
Working Satellites: 3GEO+5IGSO

2012: 5GEO+5IGSO+4MEO (Regional Service)

2020: 5GEO+3IGSO+27MEO (Global Service)



2012

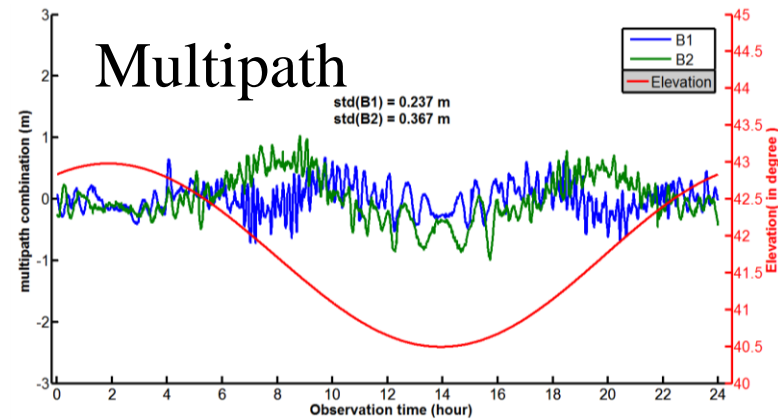
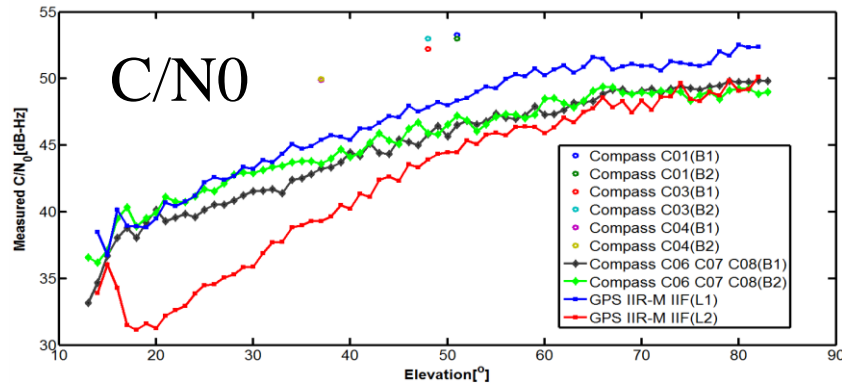


2020



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Introduction of Experiments

- The experiment equipment
 - Compass/GPS receiver: UNICORE UB240
 - Compass/GPS receiver: OLinkStar GNS100-BG
 - Compass/GPS receiver: Unistrong (Three frequency)



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Case1: SPP & Pseudo-range Differential

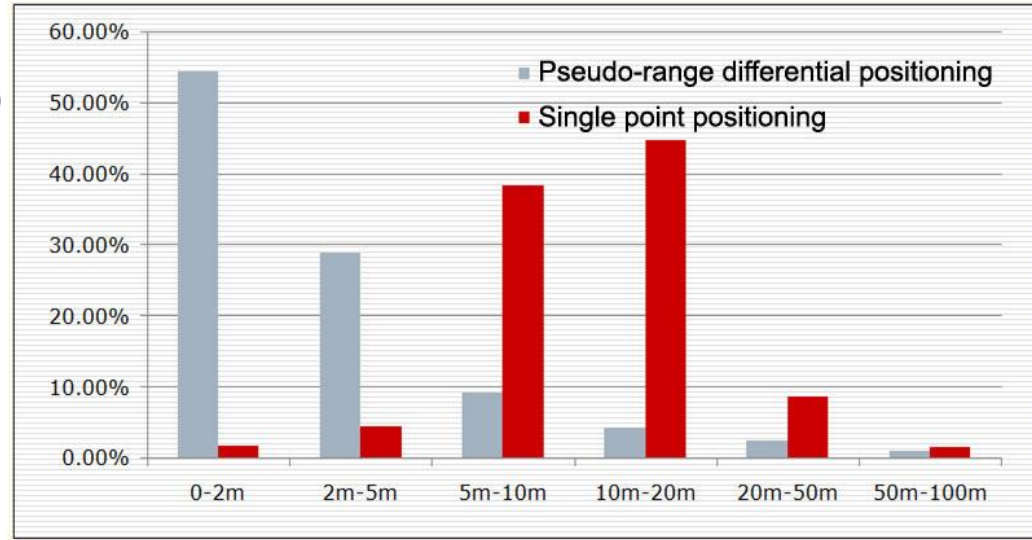
Time: 2011-09-15

Location: Wuhan - Nanchang (250km away)

Equipments:

Reference station_UNICORE UB240

Rover_station_UNICORE UB240



Comparison results between pseudo-range differential positioning and single point positioning (95%)

Positioning Mode	Horizontal (m)	Vertical (m)	3D (m)
Pseudo-range differential positioning	4.306	6.616	7.406
Single point positioning	15.05	37.05	43.575



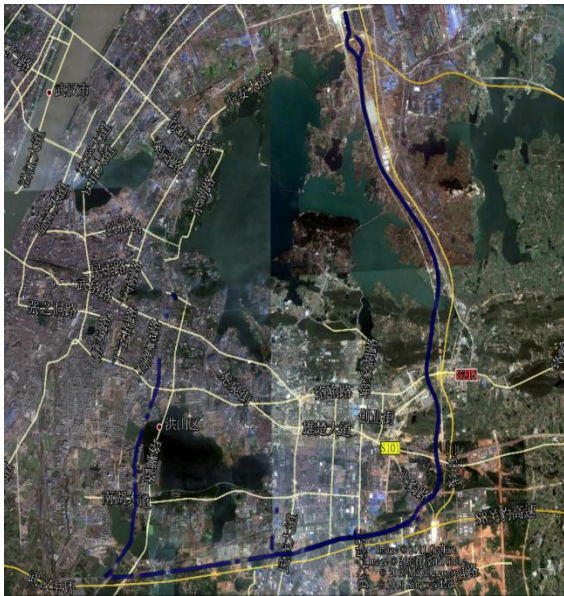
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Case2: Carrier-phase Differential & RTK

- Time: 2011-10-27 Location: Wuhan (20km away)
- Equipments of reference and rover stations: UNICORE UB240 (double-frequency)



Positioning type		Compared with GPS-RTK (m, 95%)		
		Horizontal	Vertical	3D
Single point positioning with Compass		15.217	25.246	27.113
Pseudo-range differential positioning	Real-time	2.812	7.129	7.447
	Post-processing	2.180	6.028	6.353
Carrier phase differential positioning	Real-time	0.086	0.165	0.174
	Post-processing	0.057	0.144	0.146

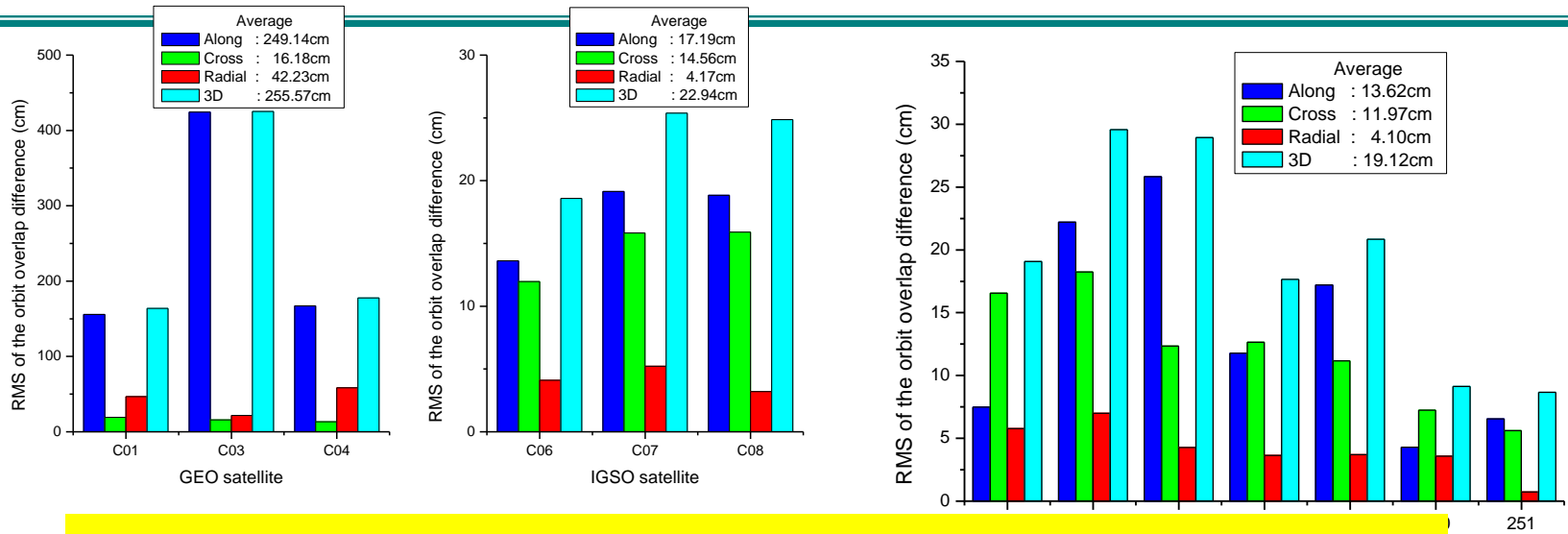


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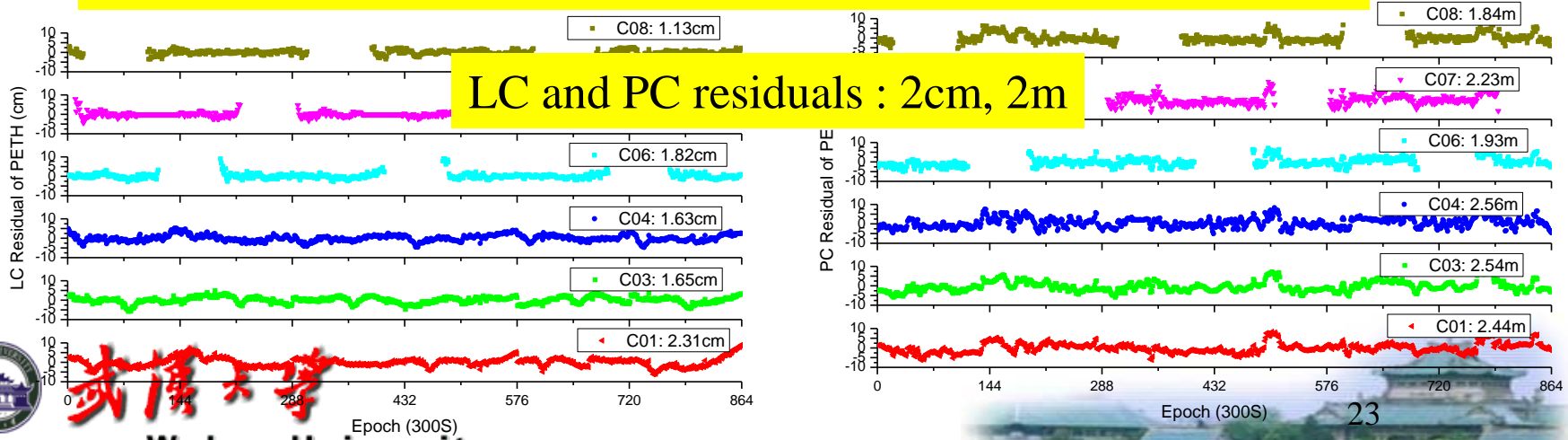
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Case3: POD for PPP

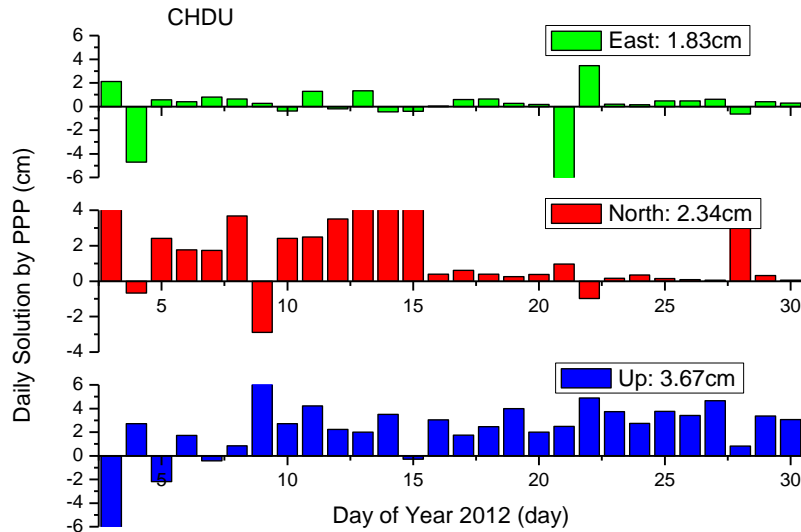


Average Overlap difference of COMPASS satellites from 245 to 251 of 2011
 The 3D RMS of IGSO is about 20cm
 The 3D RMS of GEO is dominated by the along constant bias.



Case3: Daily Static PPP (Jan. 2012)

Daily PPP by COMPASS compared with GPS solution



	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.	2.38	1.37	3.66

CHDU not used for orbit determination

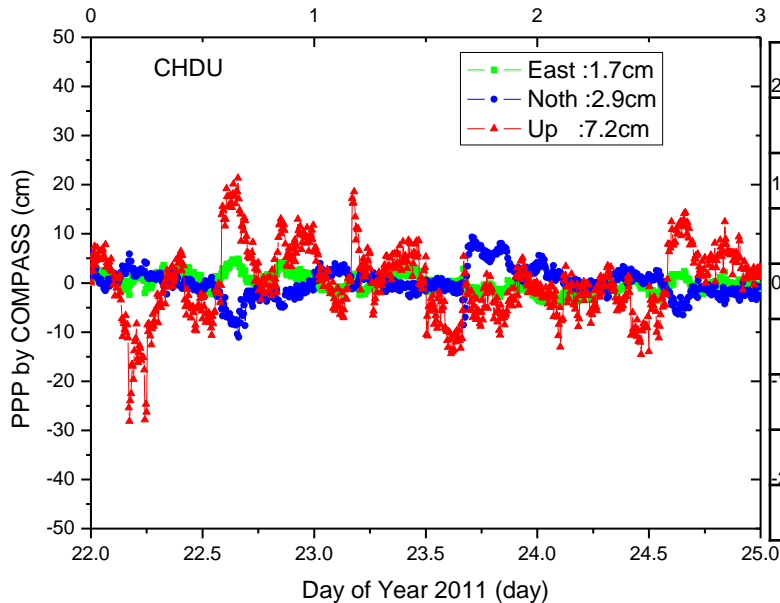


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Case3: kinematic PPP (PP mode)



	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.	1.93	4.24	8.78

Kinematic PPP from DOY 21 to DOY 25

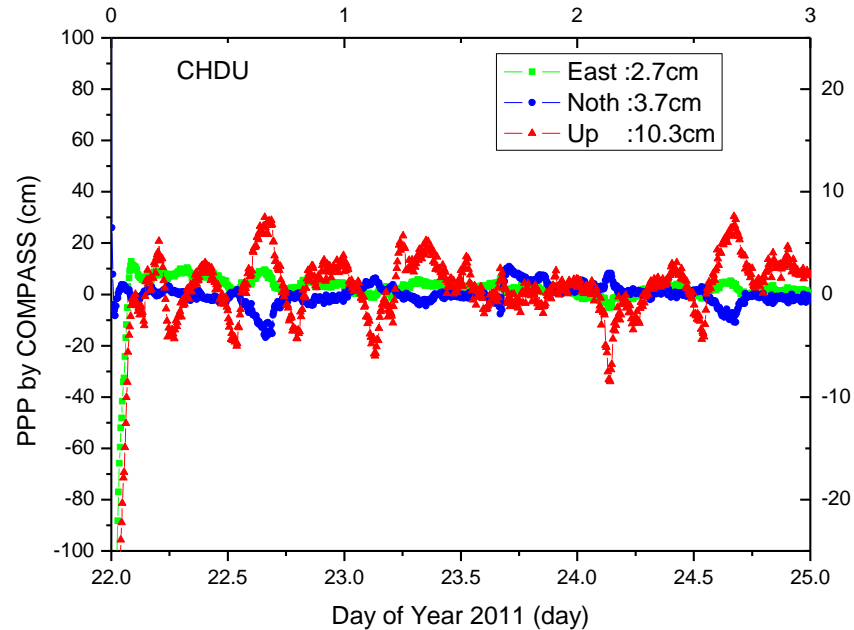


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Case3: kinematic PPP (RT mode)



from DOY 21 to DOY 25

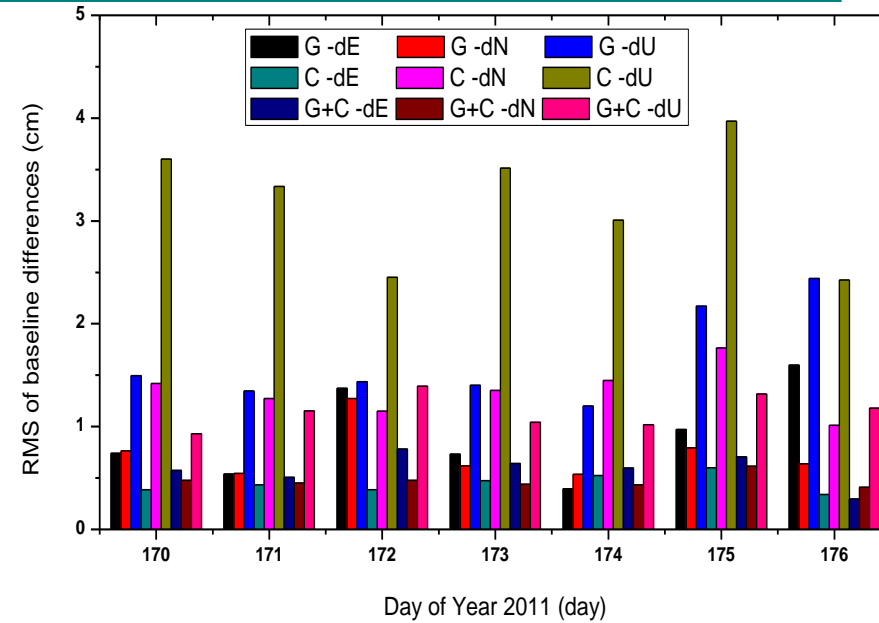
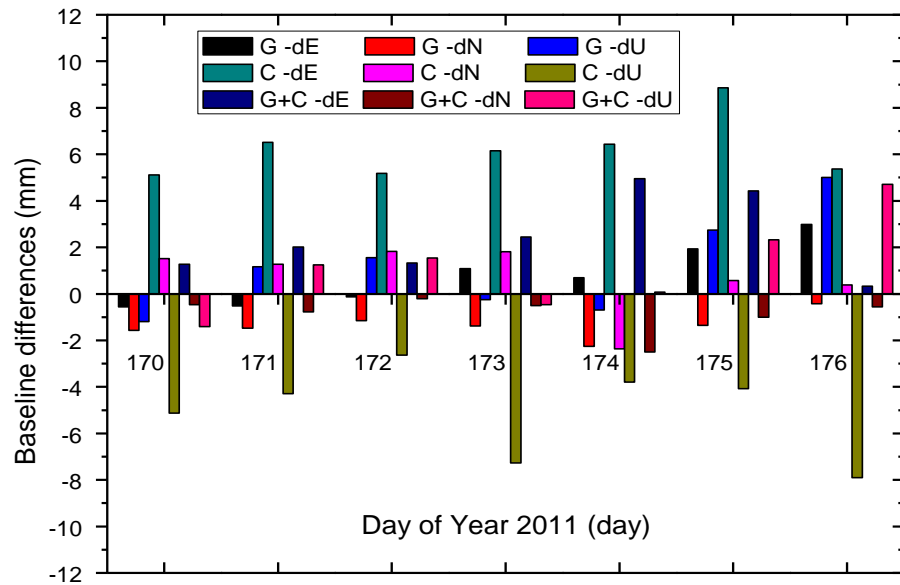


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Case4: COMPASS/GPS combined baseline processing



	static			kinematic		
	East(mm)	North(mm)	Up (mm)	East(mm)	North(mm)	Up (mm)
GPS	0.80	-1.60	1.20	9.10	7.40	16.70
COMPASS	6.20	0.70	-5.00	4.50	13.40	31.90
GPS+ COMPASS	2.40	-0.90	1.10	5.90	4.70	11.50

400m baseline:

33.3%、28.6%、29.4%



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Summary and Outlook

● Summary

- Achieving Prototype of MASS
- Wide area augmentation (10cm)
- Some experiment of Regional augmentation
- Some experiment of COMPASS data processing
 - PPP, RTK ,

● Outlook

- Aim to be a RT IGS Analysis Center
- Integration of global (PPP) and regional Augmentation (PPP-RTK)
- Combined of GPS/GLONASS/COMPASS/GALILEO data processing

The 3rd China Satellite Navigation Conference (May. 2012)

<http://www.beidou.org>



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Thank You for your attention!

自強不息
弘毅
求是
拓新

The GNSS Research Center of Wuhan University

shi@whu.edu.cn ydlou@whu.edu.cn lim@whu.edu.cn



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