GNSS Analysis Center at SHAO

陈俊平

junping.chen@shao.ac.cn

Content

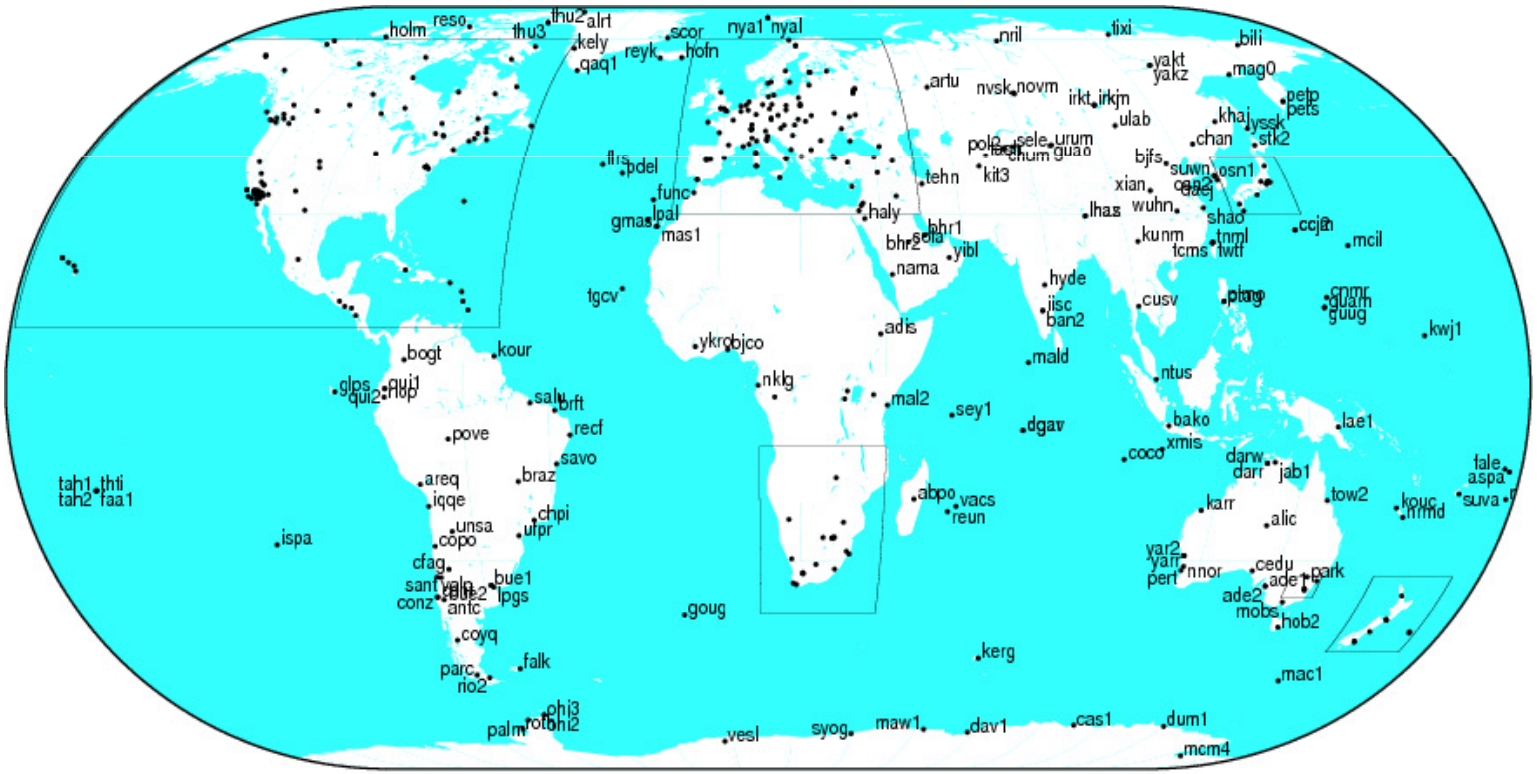
- IGS data/products
- GNSS Analysis Center at SHAO
  - Post-Processing
  - Real-time GNSS
- Challenging tasks for GNSS Data Analysis

International GNSS Service (IGS)

IGS DATA

Active hourly sites map
Reference Frame stations ("IGS08") map
Reference Frame stations ("IGS08") map - core network
GPS/GLONASS stations map
Active high rate LEO sites map
All maps on one page
Real-Time Network map, IGS-IP NTRIP Broadcaster

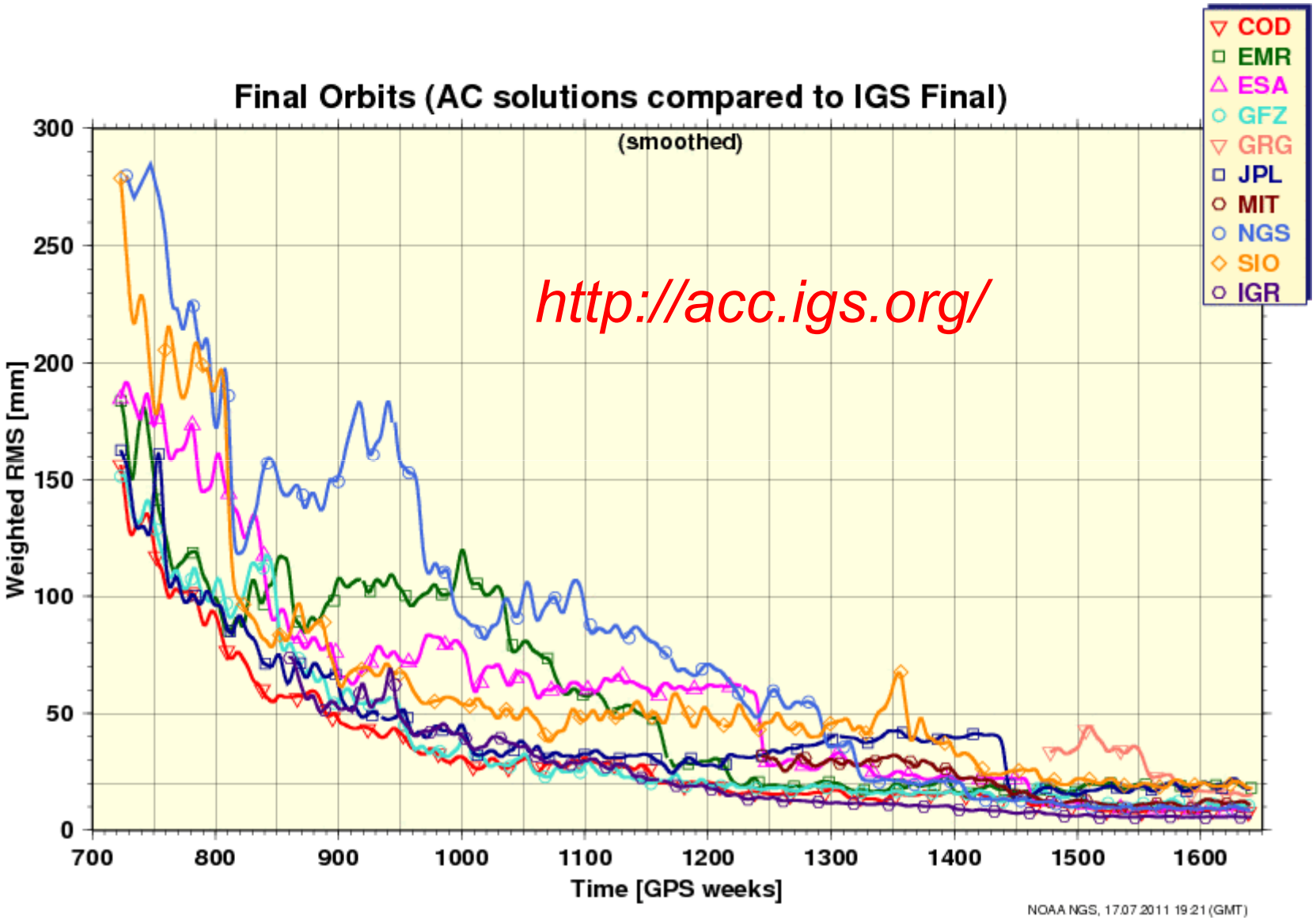
igscb.jpl.nasa.gov



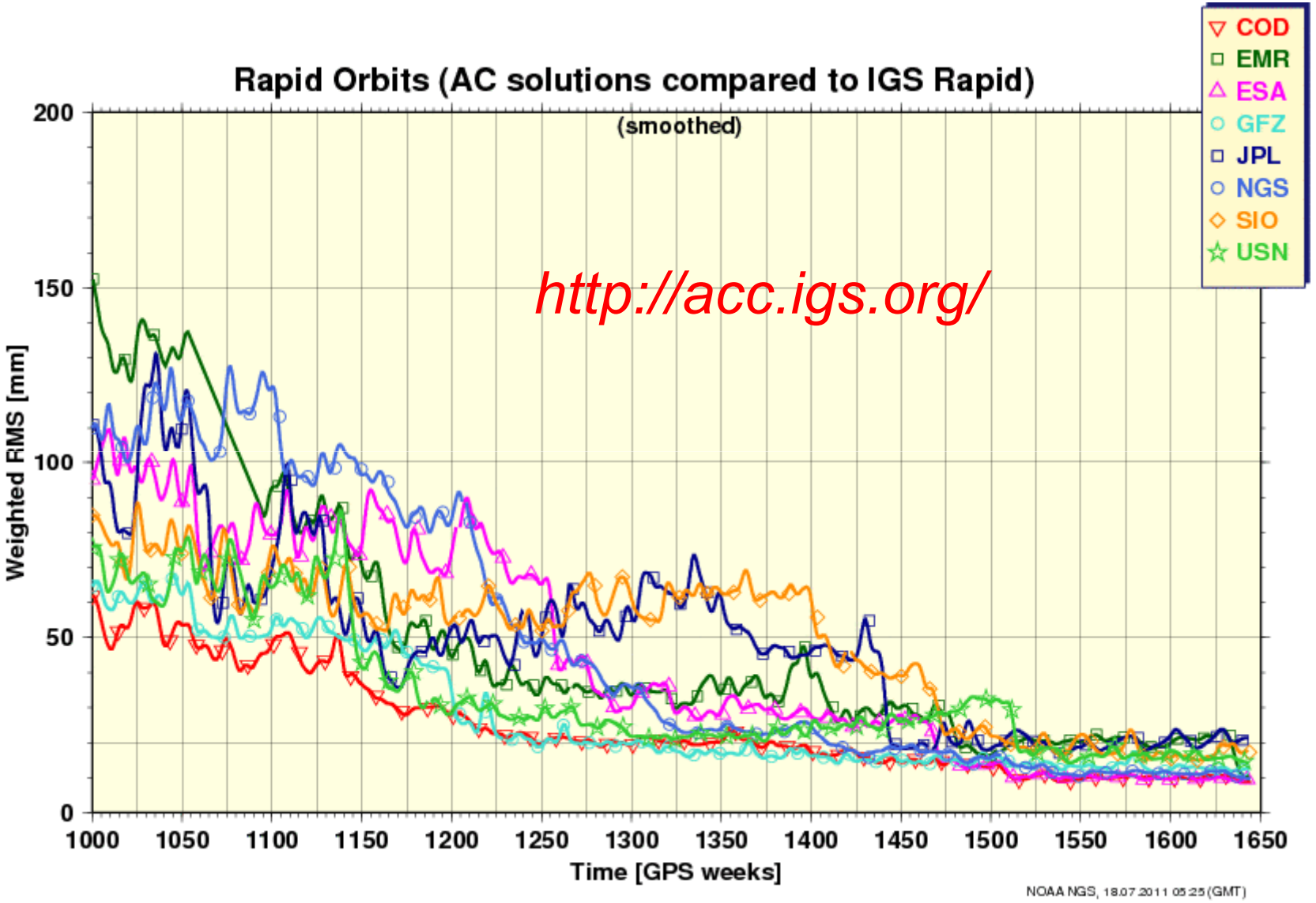
IGS Products

Products	Latency	Orbit	Clocks	ERP	Sta-Position	Velocity
Final	10-14 day	2 cm	0.03 ns	0.03mas 0.01 ms	3-8 mm	2-3 mm/y
Rapid	1 day	3 cm	0.05ns	0.04mas 0.01 ms		
Ultra Rapid (Prediction)	Real-time	5-10				

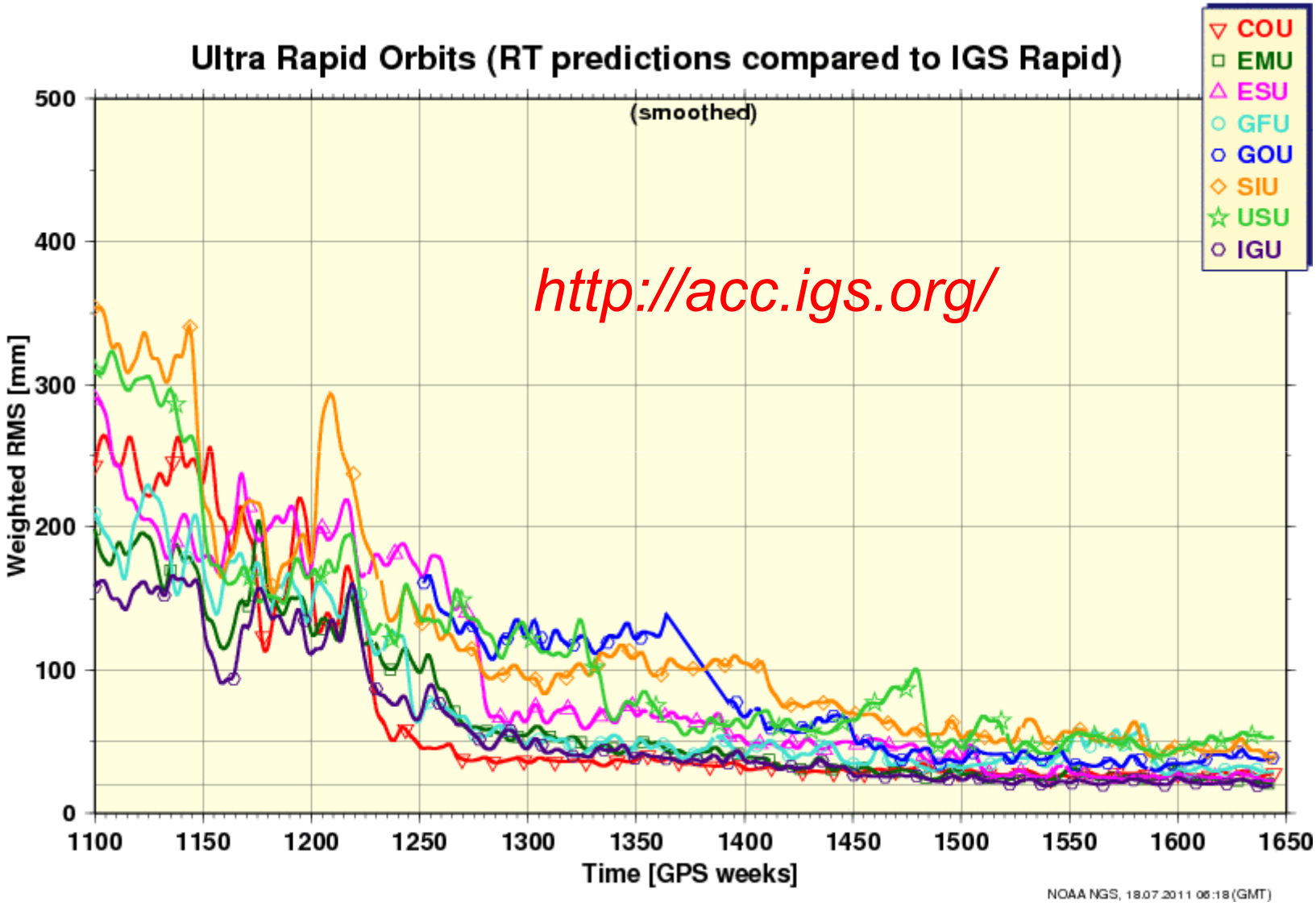
GPS Final Orbit



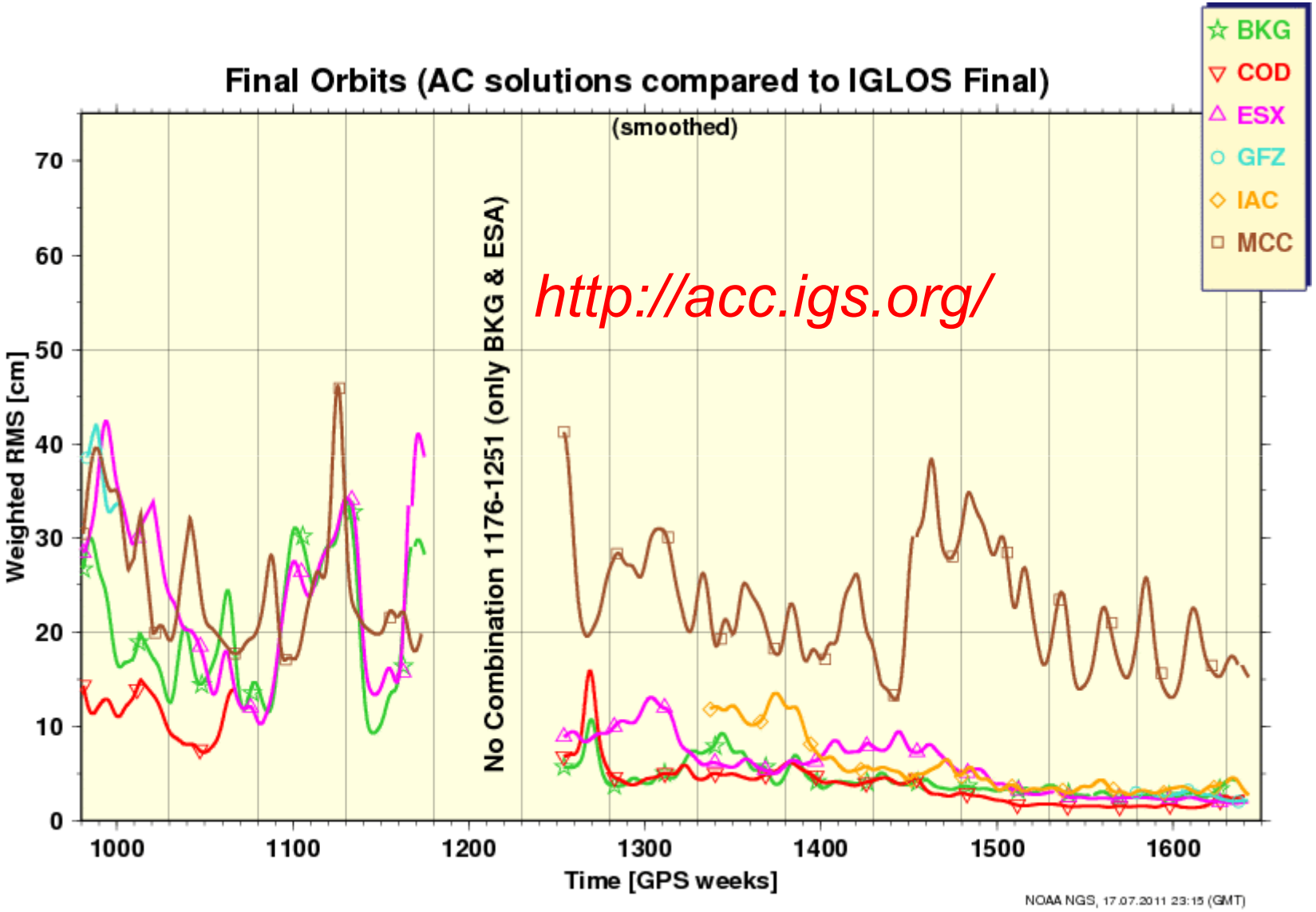
GPS Rapid Orbit



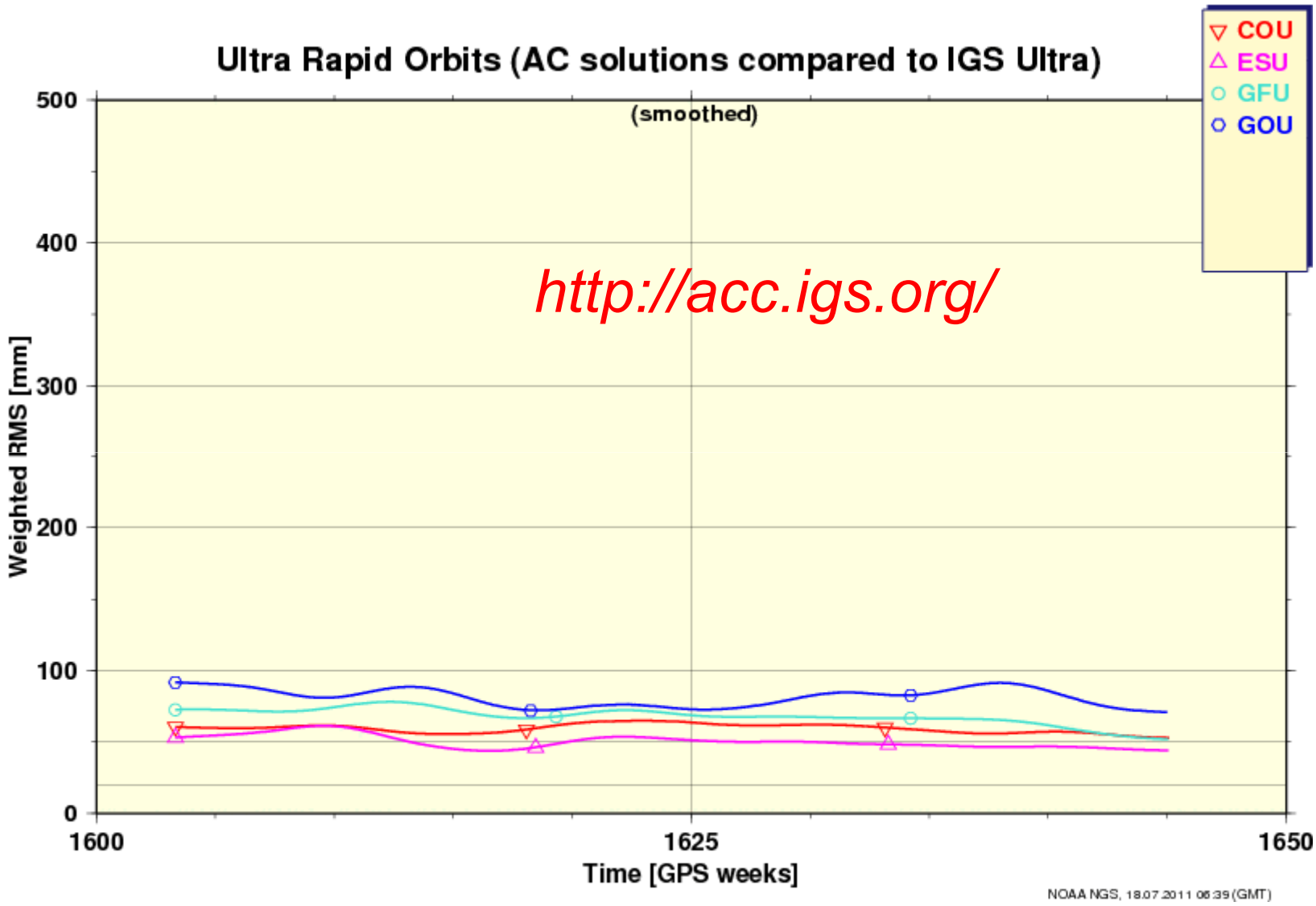
GPS Ultra-Rapid Orbit



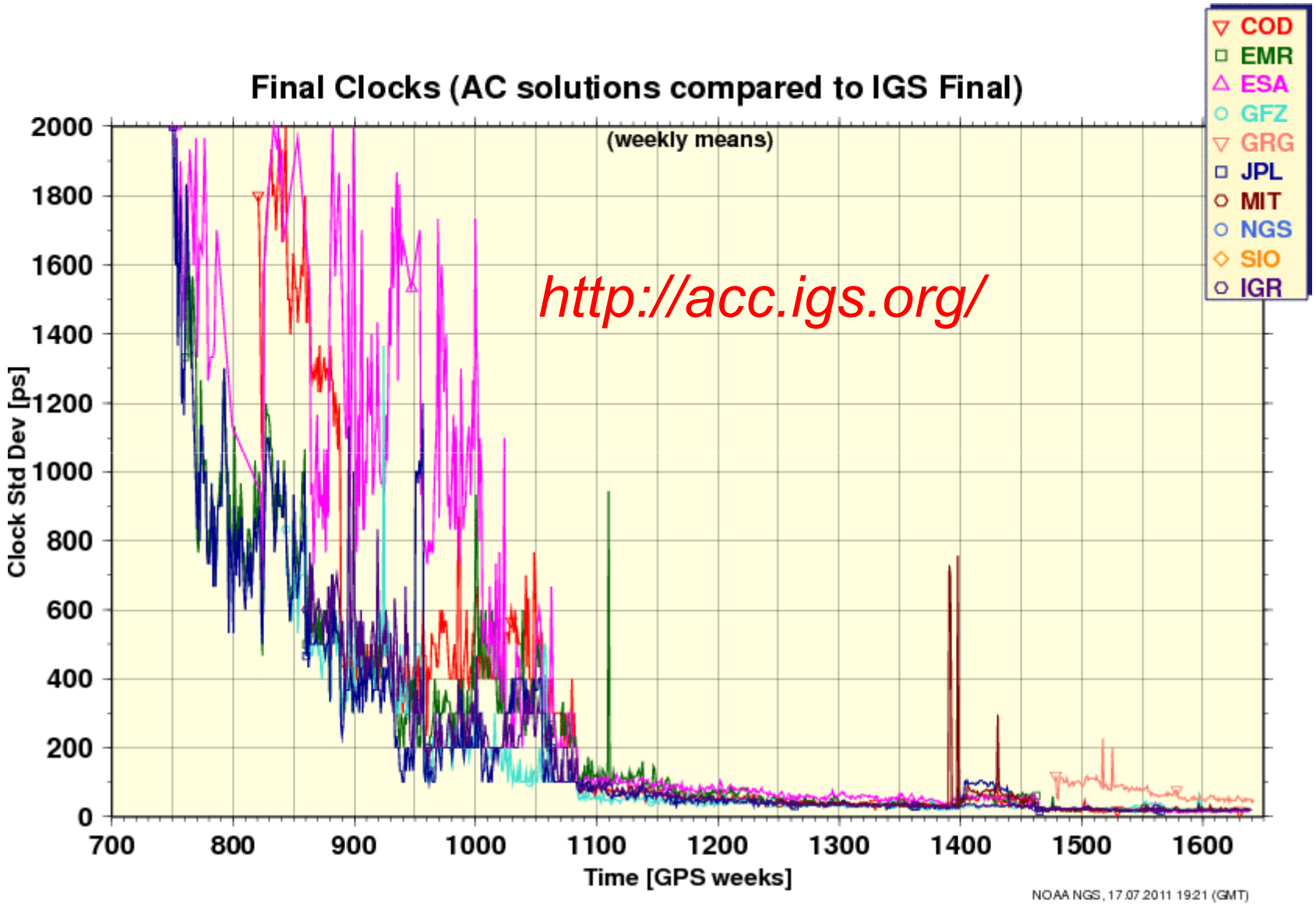
GIONASS Final Orbit



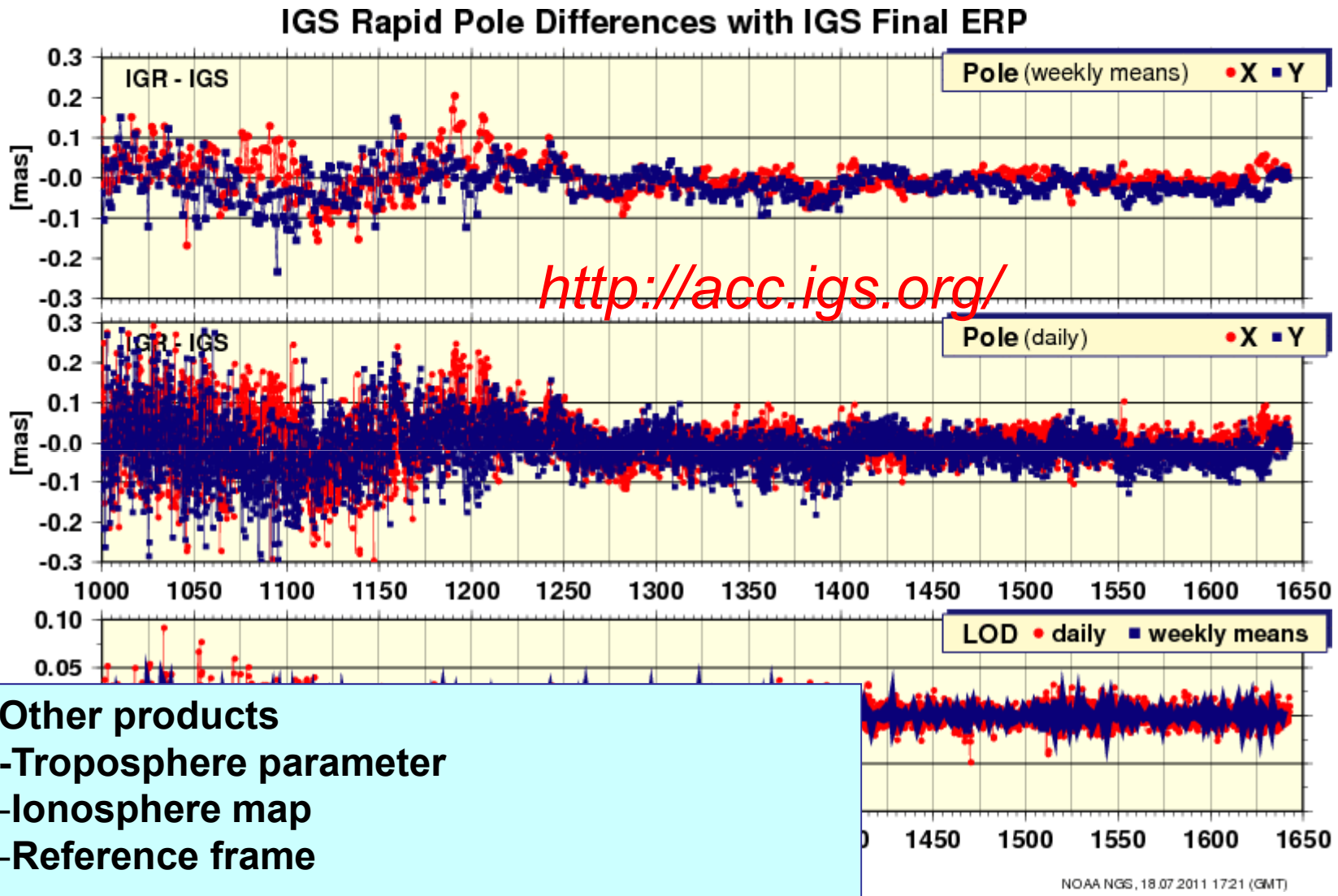
GLONASS Ultra-Rapid Orbit



GPS Final clock



ERPs



Other products
-Troposphere parameter
-Ionosphere map
-Reference frame

-.....

GNSS Analysis center at SHAO (SHA)

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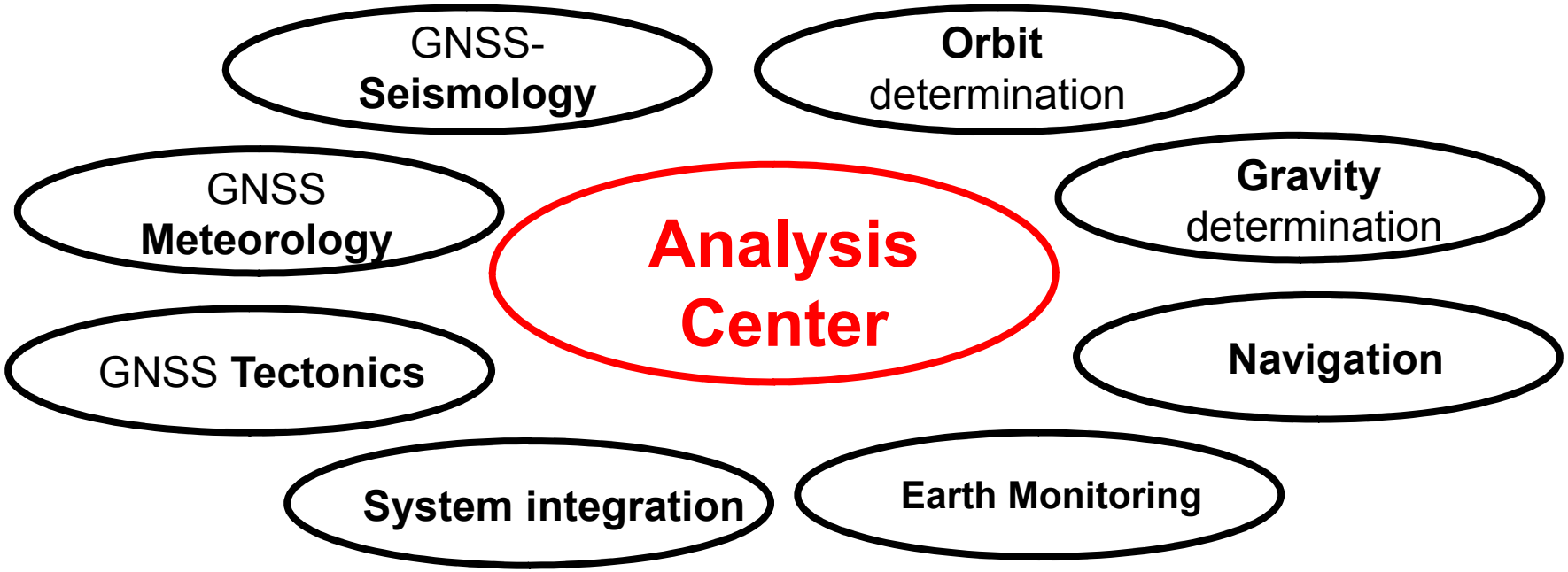
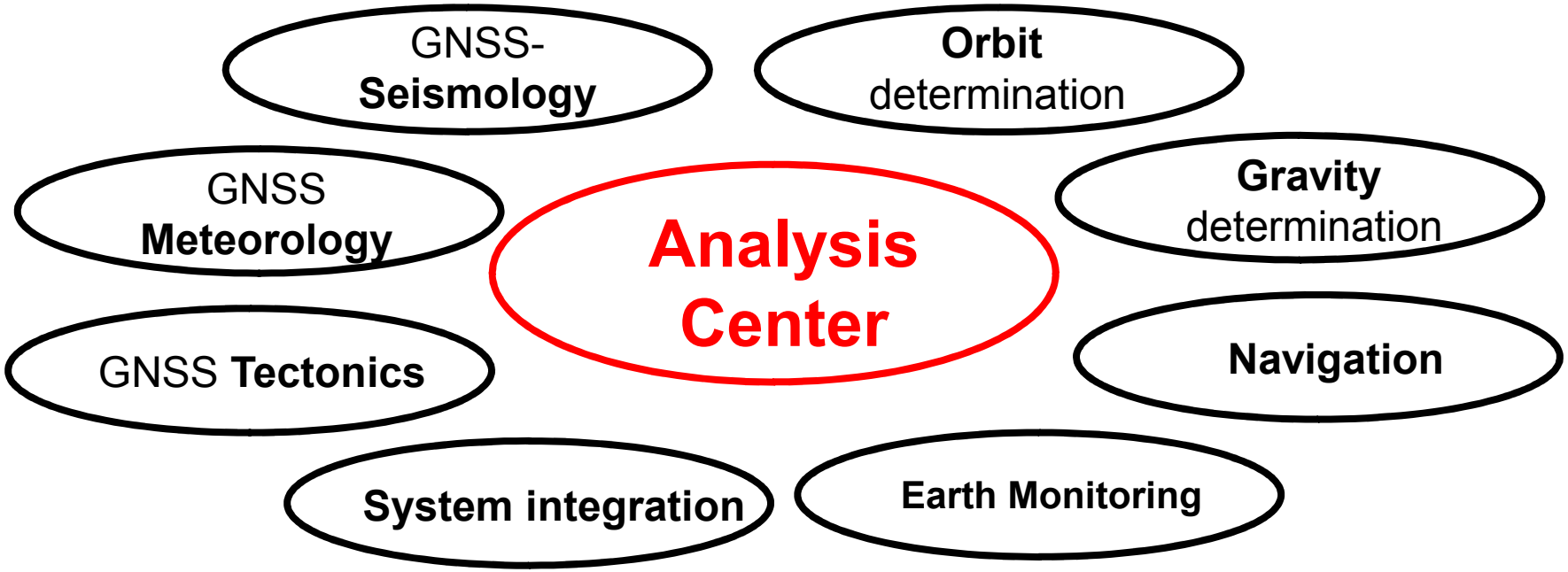


- **Platform for most of the GNSS research and projects**
- **Platform to validate and generate new knowledge**
- **International communication and regional service**
- **Facility to get access to measurements**
- **Facility to do routine data analysis**
- **Operational System to be flexible for multi-GNSS, multi-technique**
- **Developing and operating team**

GNSS Analysis center at SHAO (SHA)



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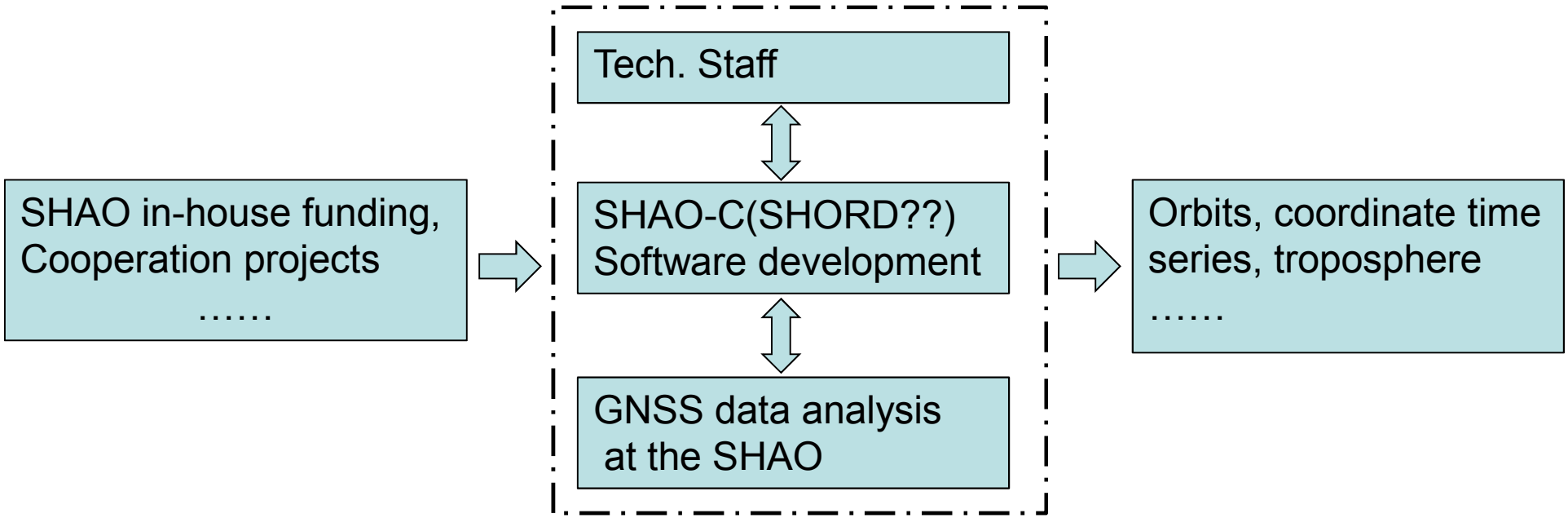
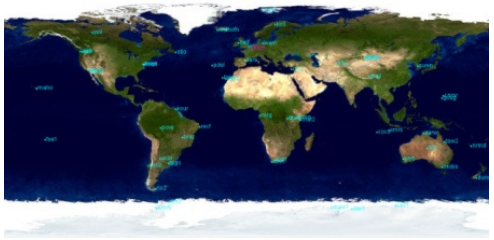


GNSS Analysis center at SHAO (SHA)

GNSS Data Center

1.Global GNSS network
2.CMONOC network
3.IGS general
4.IERS bulletin
…….



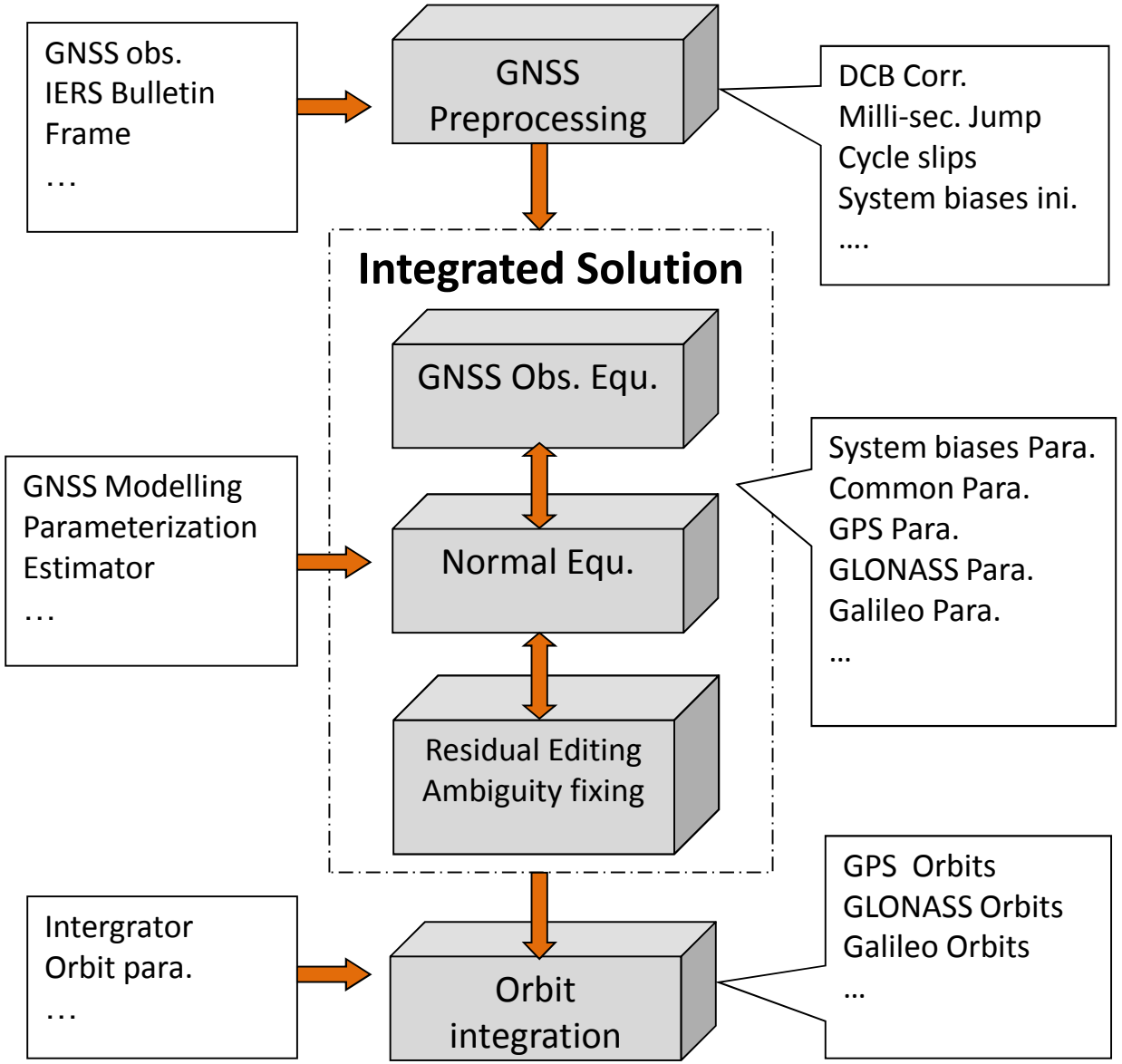
GNSS Analysis Center

1. GNSS Preprocessing
2.GNSS Estimator
3.Ambiguity fixing
4.Orbit integration
…….

GNSS Product Service

1.GNSS Orbits, Clocks
2.Atmosphere
3.ERPs
4.Reference Frame
……..

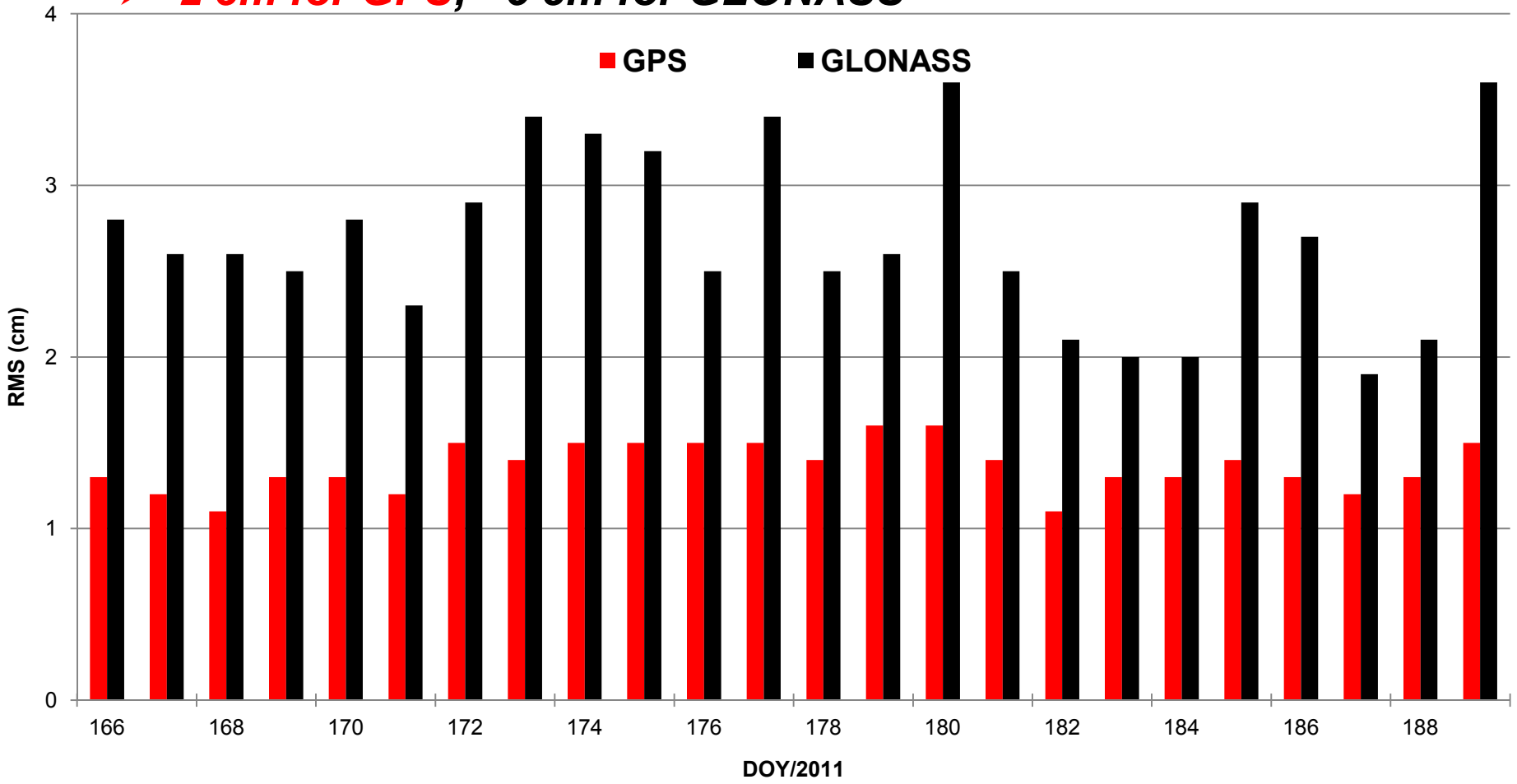
GNSS Analysis center at SHAO (SHA)



Products of SHA

GNSS Orbits

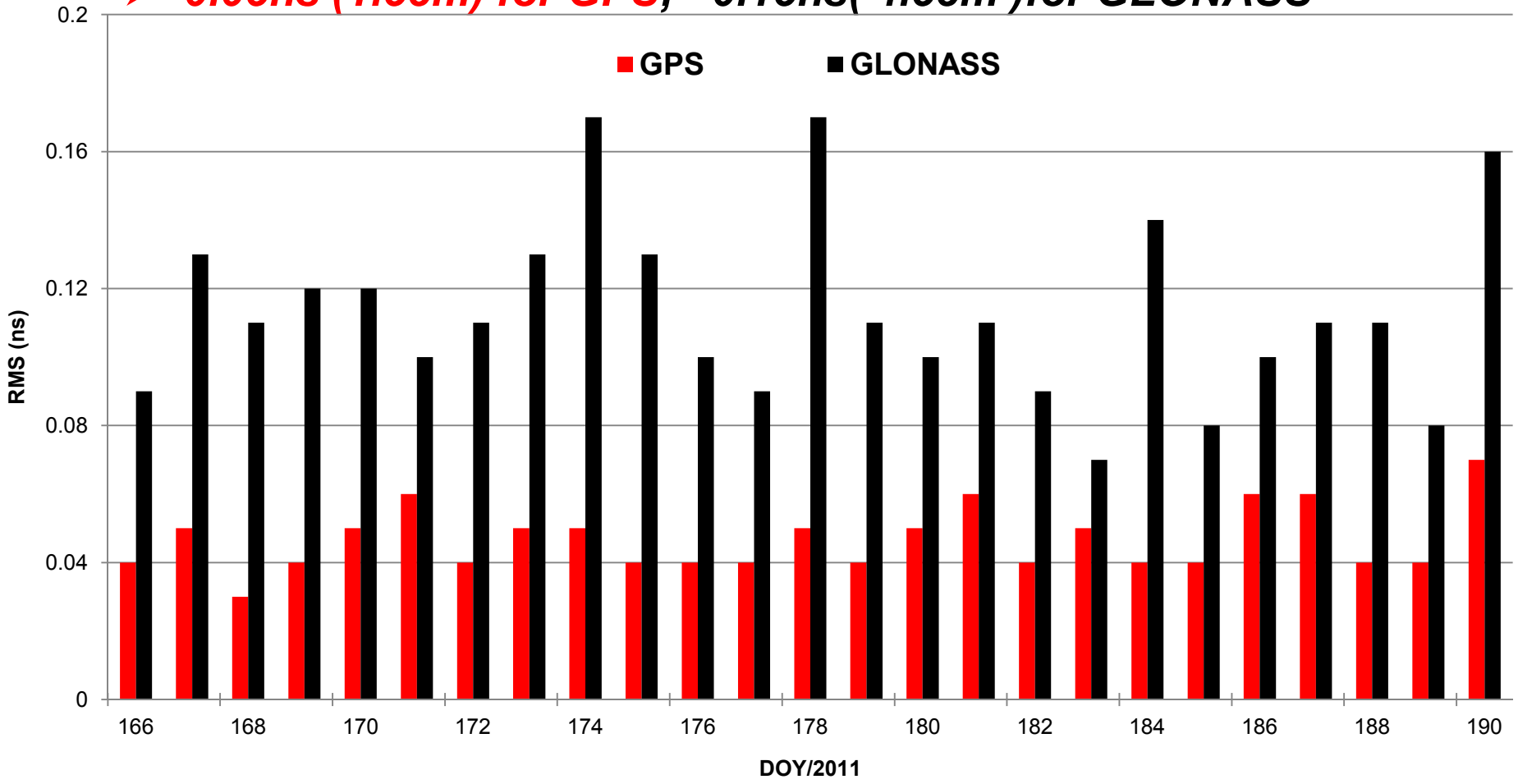
- GPS+GLONASS
- Compared to IGS
- ***~2 cm for GPS; ~5 cm for GLONASS***



Products of SHA

GNSS Clocks

- GPS+GLONASS
- Compared to IGS
- ***~0.05ns (1.5cm) for GPS; ~0.15ns(4.5cm)for GLONASS***

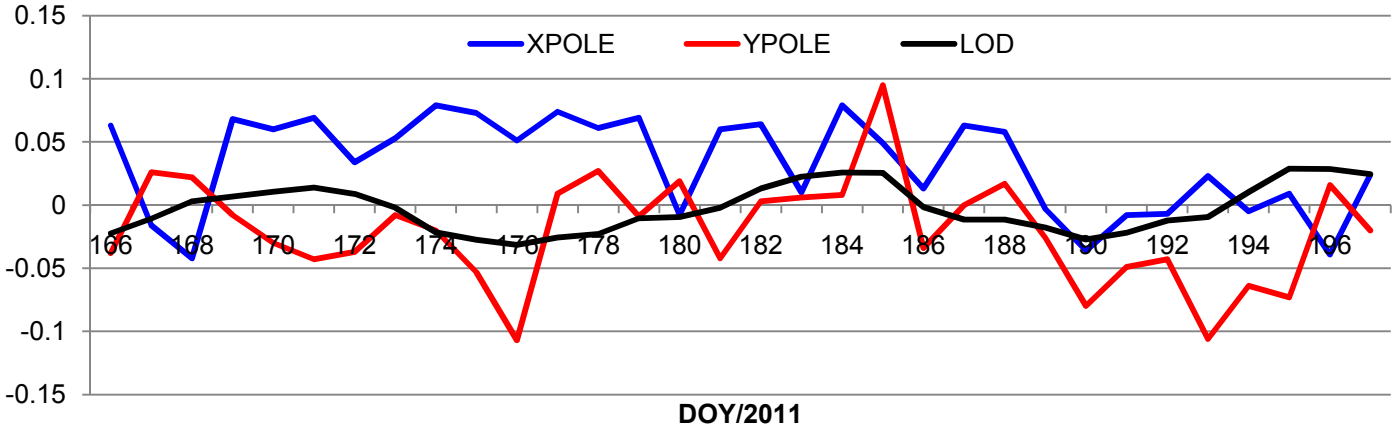


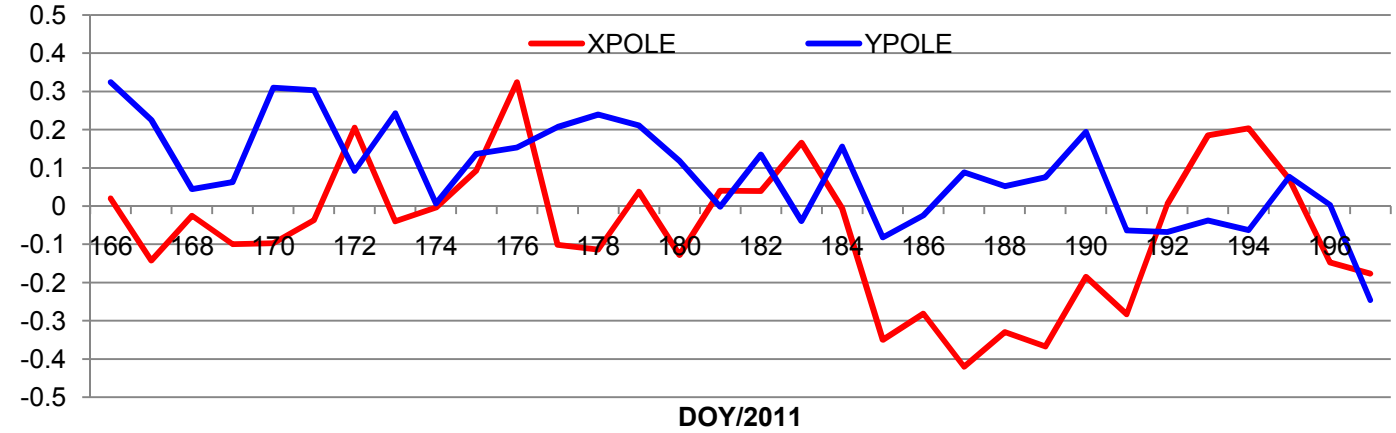
Products of SHA

ERP

- GPS+GLONASS
- Compared to IGS

POLE	0.03mas
LOD	0.01 ms
POLE-rate	0.2mas/day





Real-time GNSS

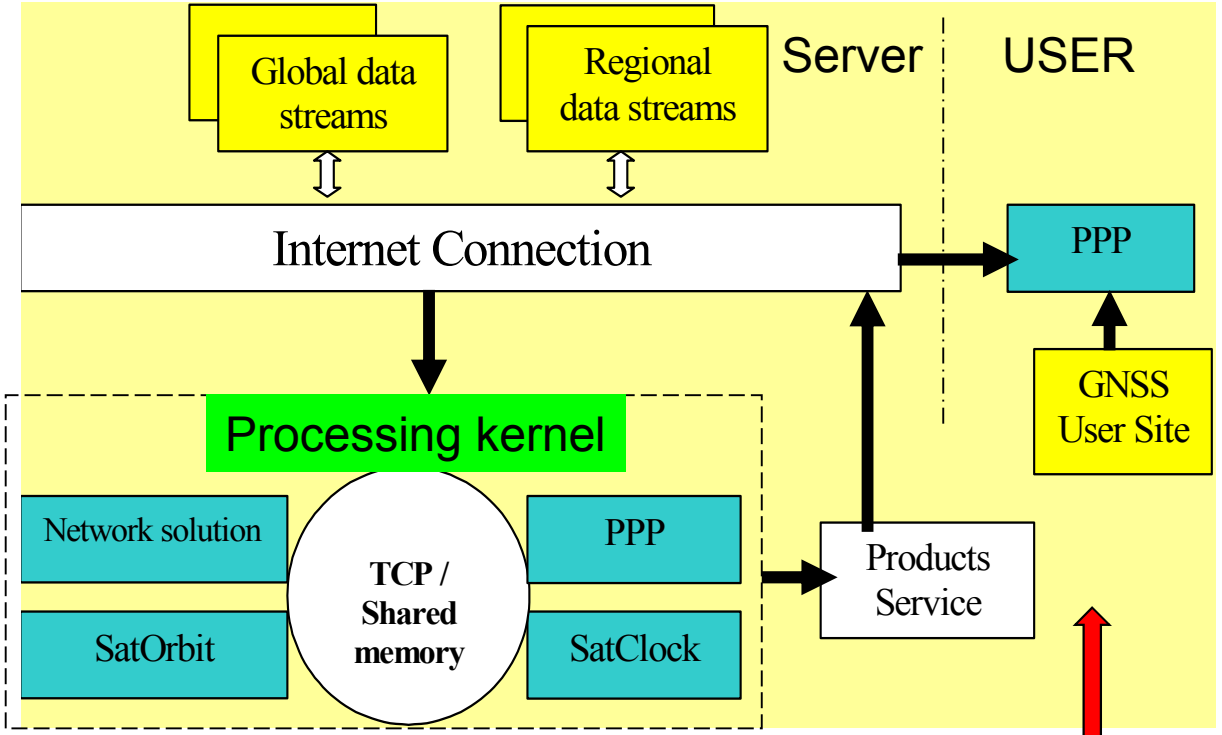
实时GNSS处理系统

实时通信数据流

- Ntrip通信
- 实时数据服务器(Server)
- 实时数据客户端(Client)

实时处理GNSS软件

- 实时处理/后处理
- 多站网络解算/单站定位
- 提供实时产品

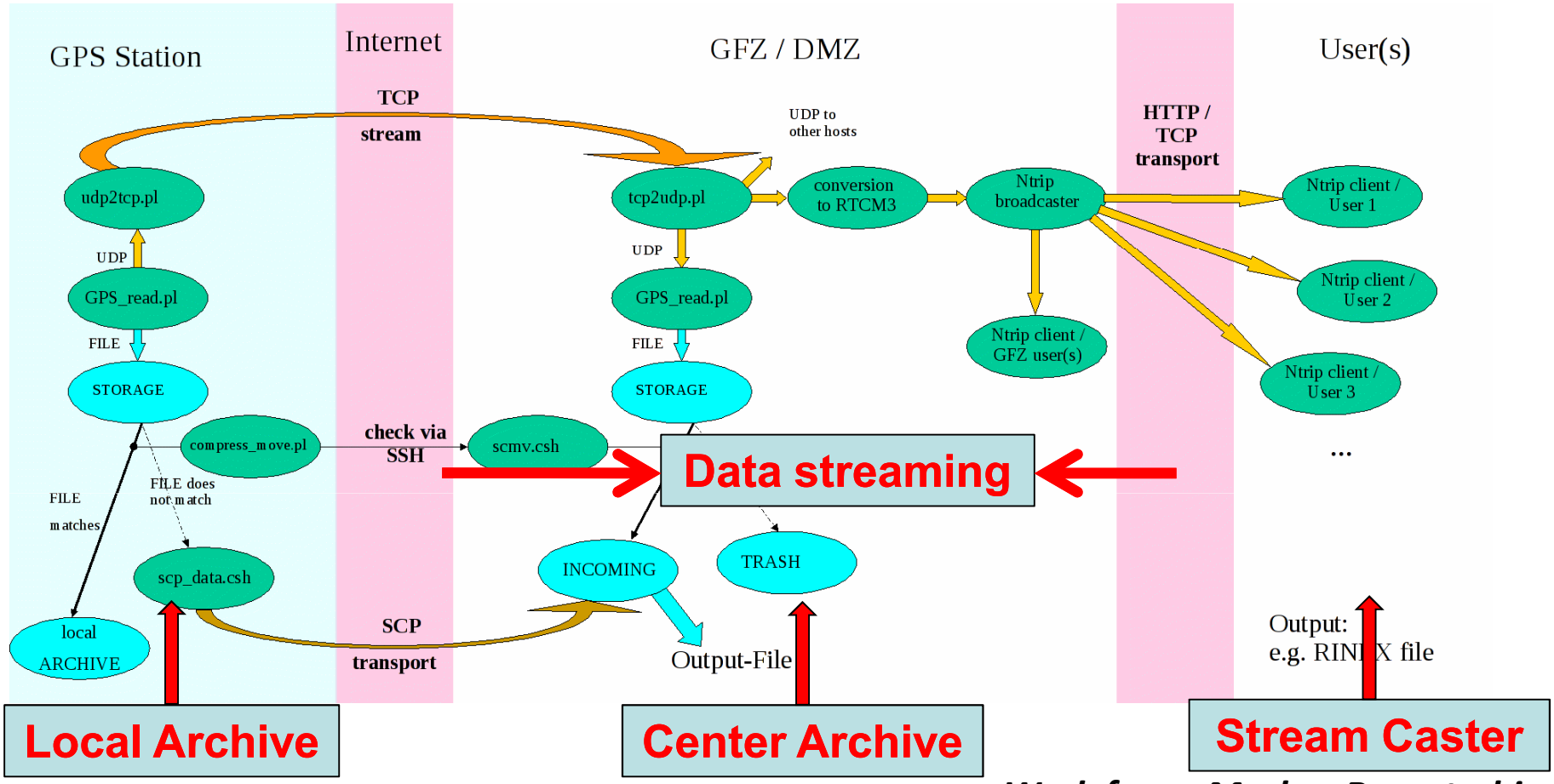


- 实时产品接收
- 单站定位
- 测站监测

产品服务用户定位

实时GNSS数据处理系统：Ge et al.; Chen et al. GFZ

Real-time Data Transfer

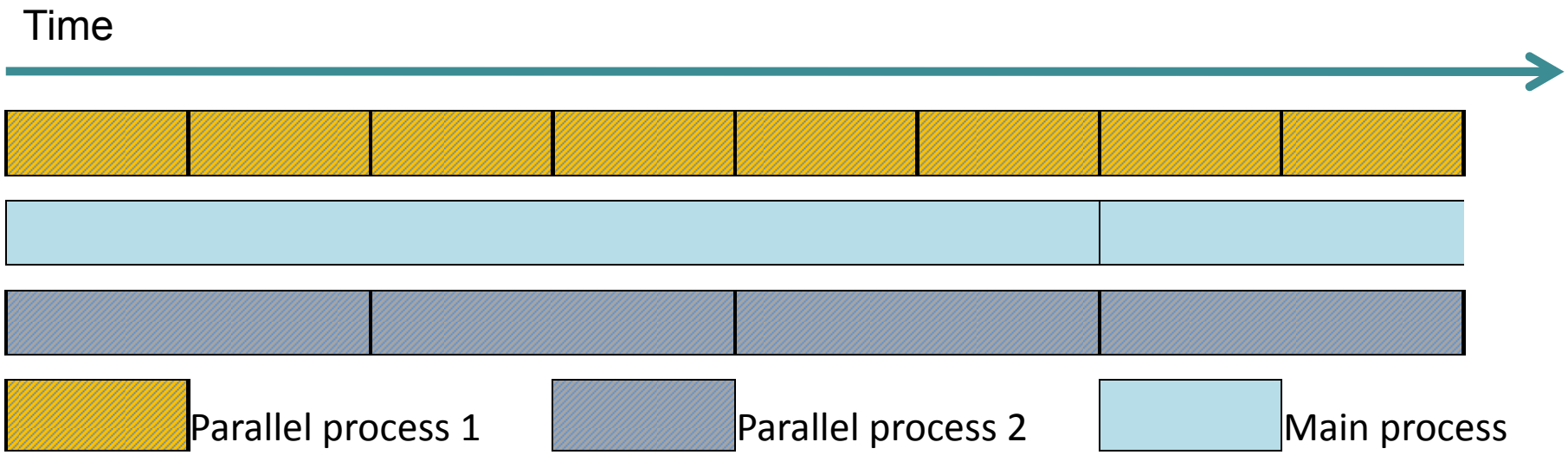


Work from: Markus Ramatschi

GNSS data streaming with1-Hz data rate:

- Based on UDP (User Datagram Protocol)/TCP(Transmission Control Protocol) and Ntrip (Networked Transport of RTCM via Internet Protocol)
- Up to 100 data streams processed in parallel without problems

GNSS Analysis center at SHAO (SHA): Real-time

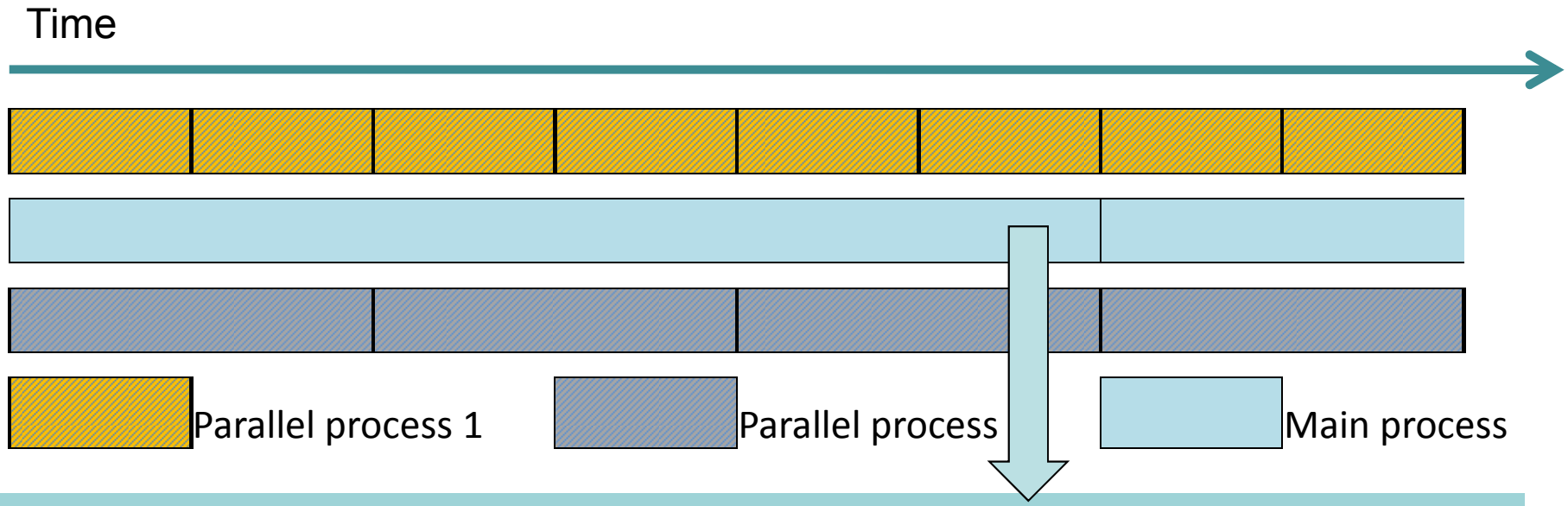


Main Process: real-time processing engine
Parameter: satellite/station clocks,ambiguities,coordinates

Process 1: Fast updating
Troposphere delay...

Process 2: Slow updating
Orbits, ERP,coordinates

GNSS Analysis center at SHAO (SHA): Real-time



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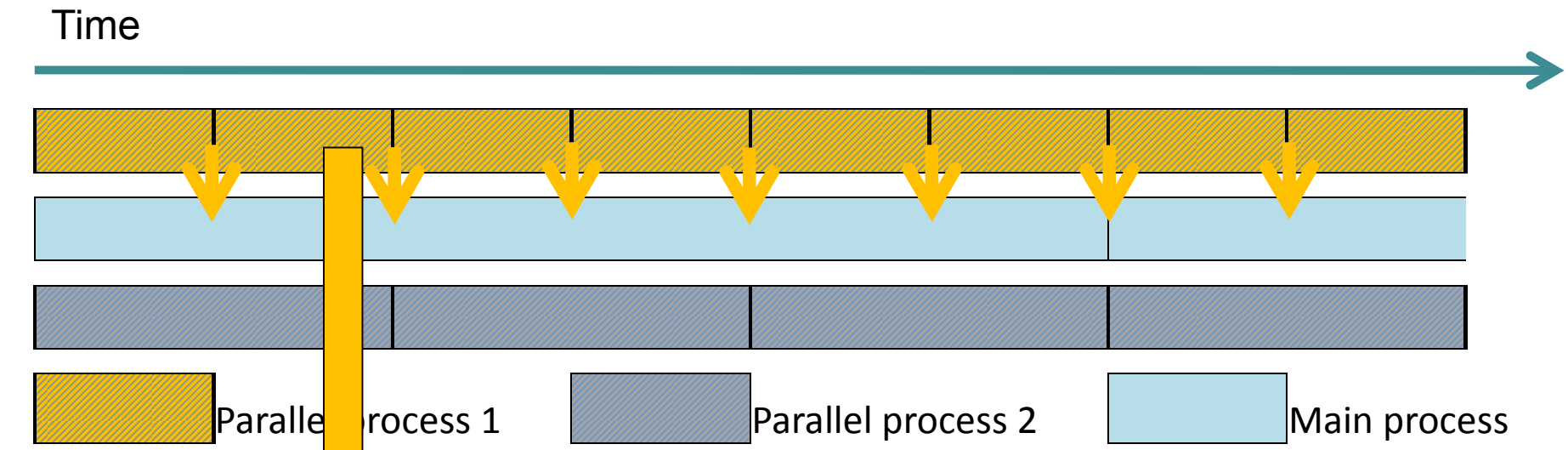

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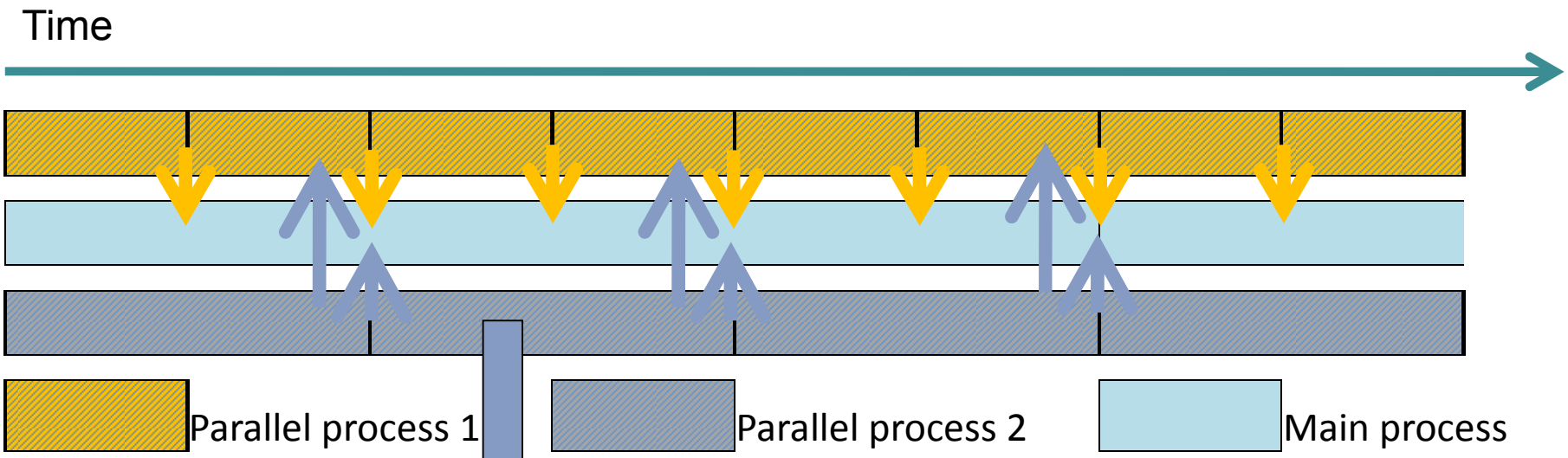

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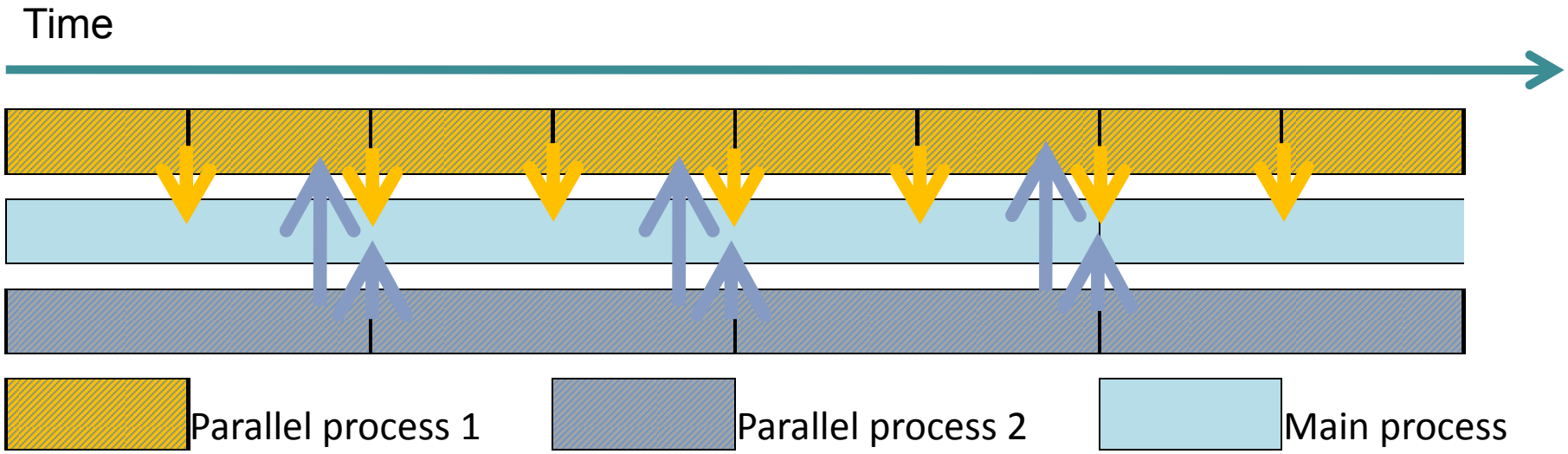

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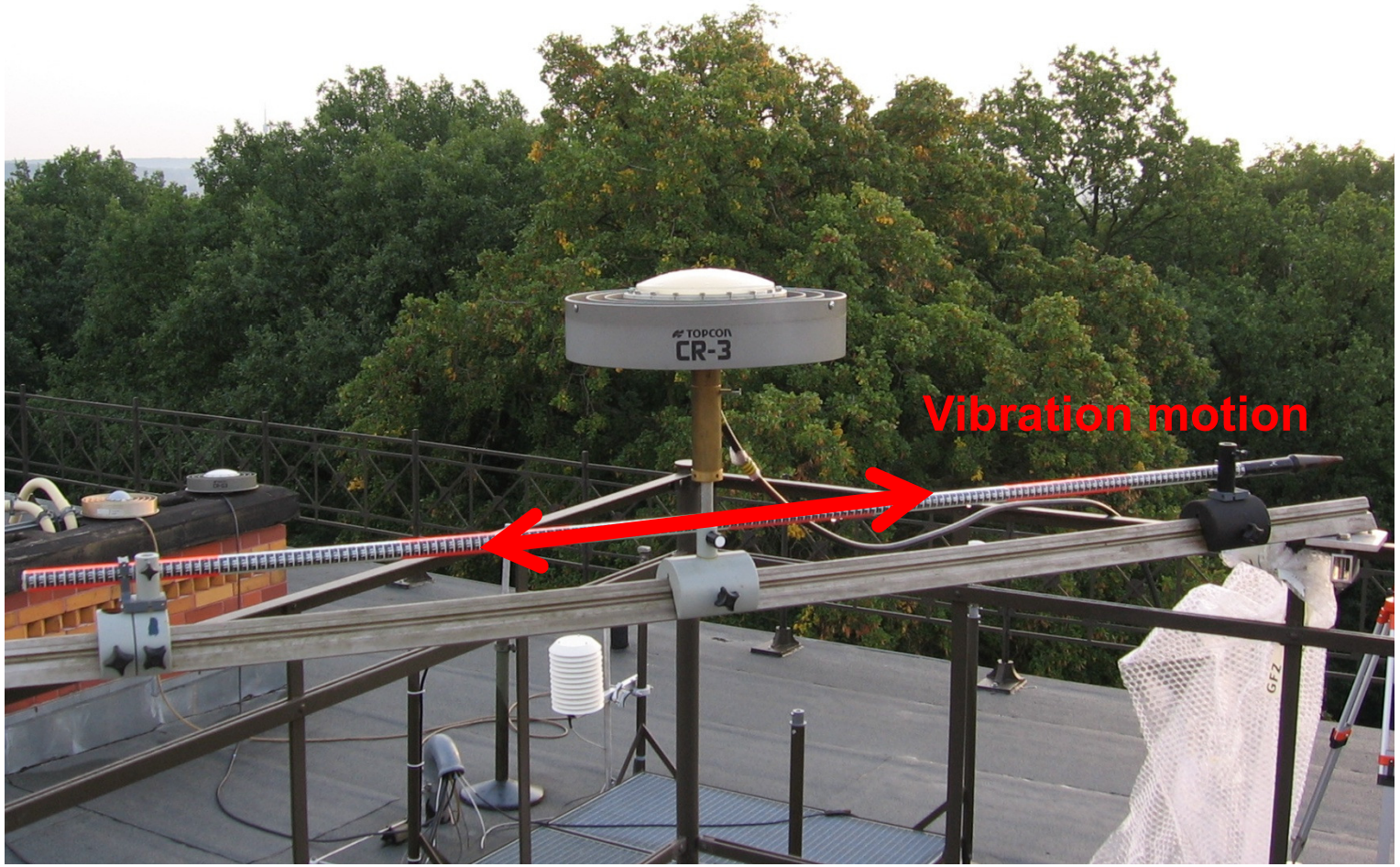
Orbits, ERP,coordinates

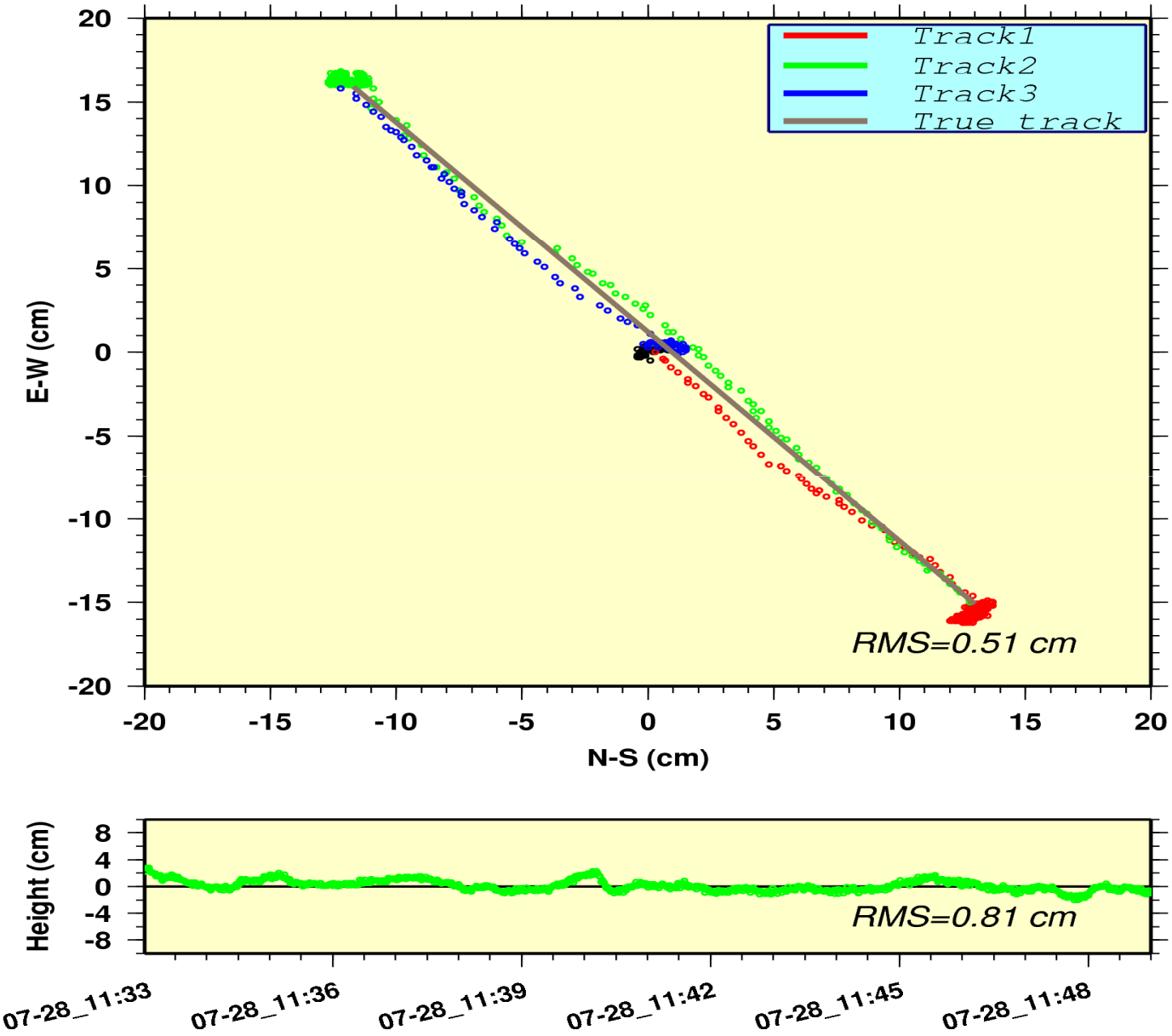
Real-time Validation

Linear table on the roof of Building A17,
controlled station motion along the table



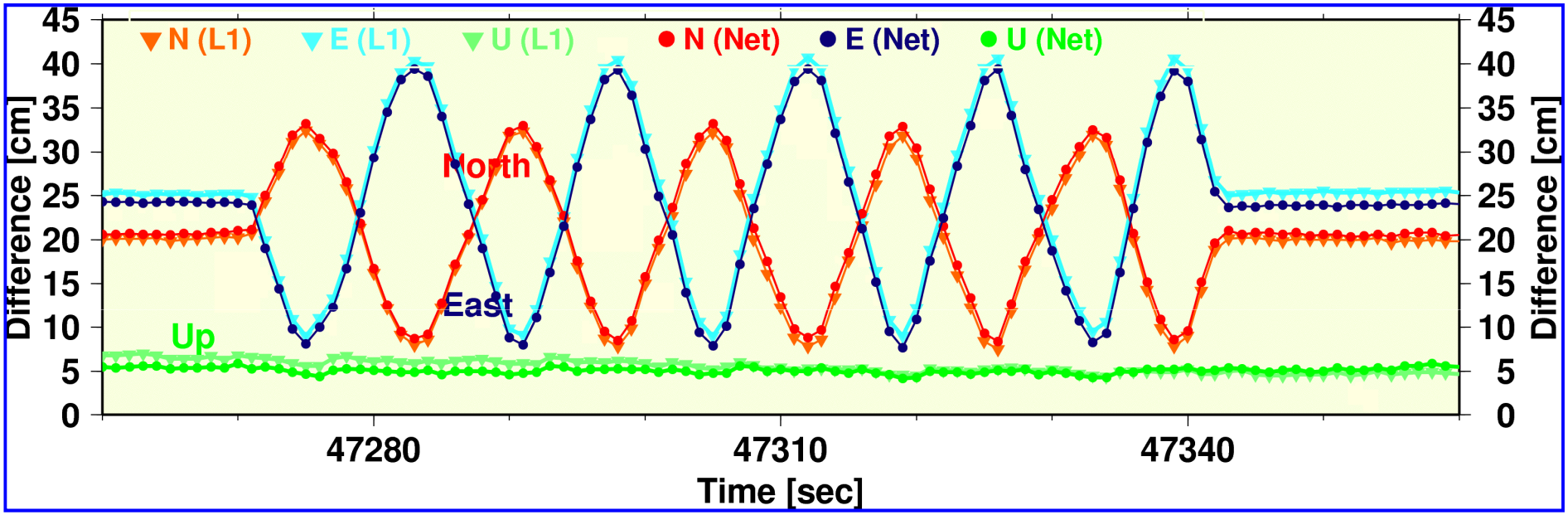
Chen et al. GFZ

Real-time Motion Monitoring



Real-time Motion Monitoring

Simulated „Earthquake“

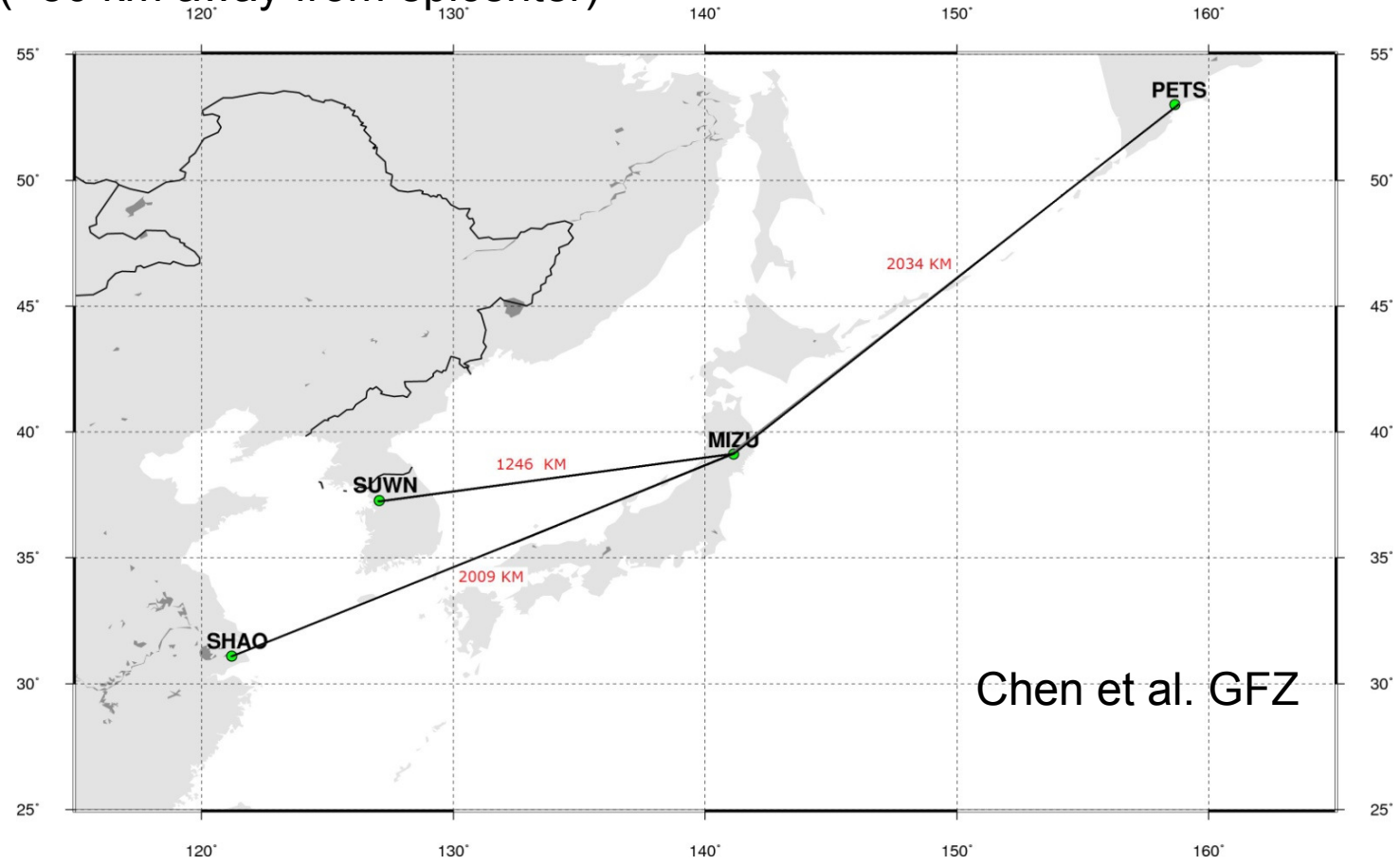


- **PPP kinematic coordinate**
  - Horizontal 2~3 cm
  - Height ~5 cm

- **Kinematic coordinate in network solution**
  - Horizontal ~1 cm
  - Height 2-3 cm

Co-seismic Deformation

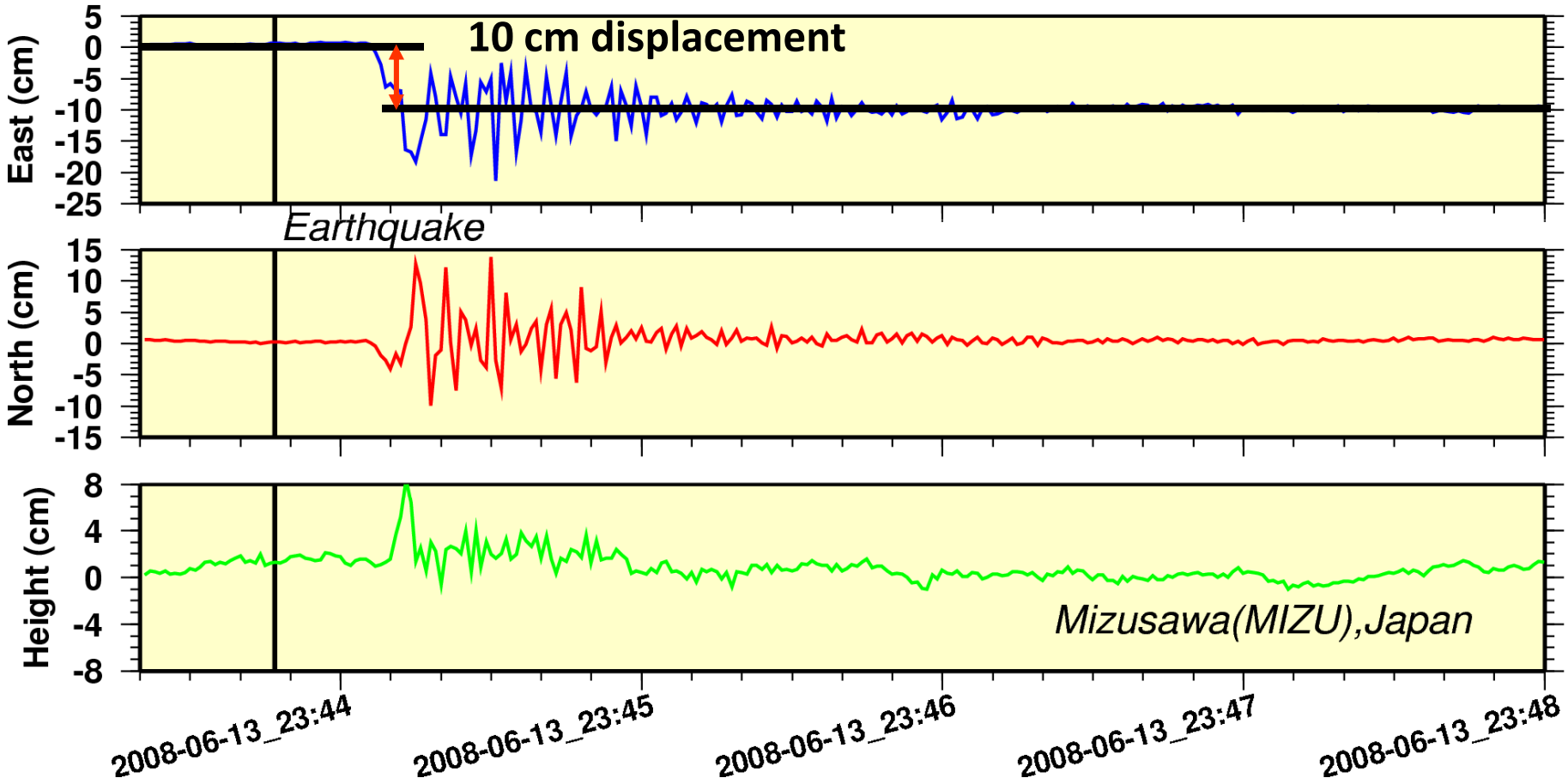
- 13 June, 2008, Mw 6.9 earthquake, EASTERN HONSHU, JAPAN
- Reference stations: PETS(Russia), SUWN(South Korea) and SHAO(China)
- MIZU:(~50 km away from epicenter)



- Orbits & ERP fixed to GFZ ultra-rapid products
- Estimation: Kinematic coordinates, ambiguities, satellite & receiver clocks and ZTDs

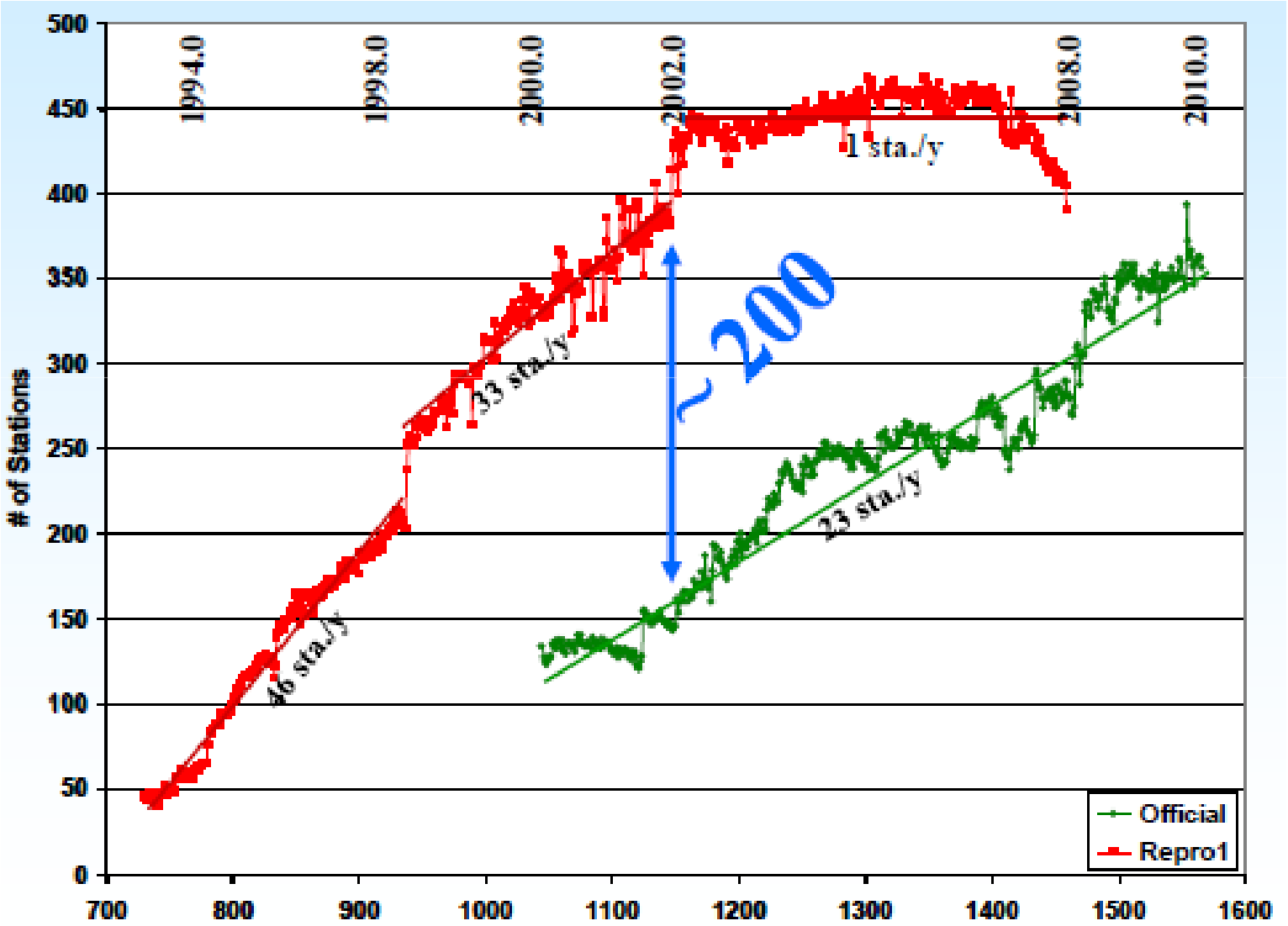
Co-seismic Deformation

- Kinematic coordinates (a set of coordinates at each 1 second)
- Compare to coordinates from one day before

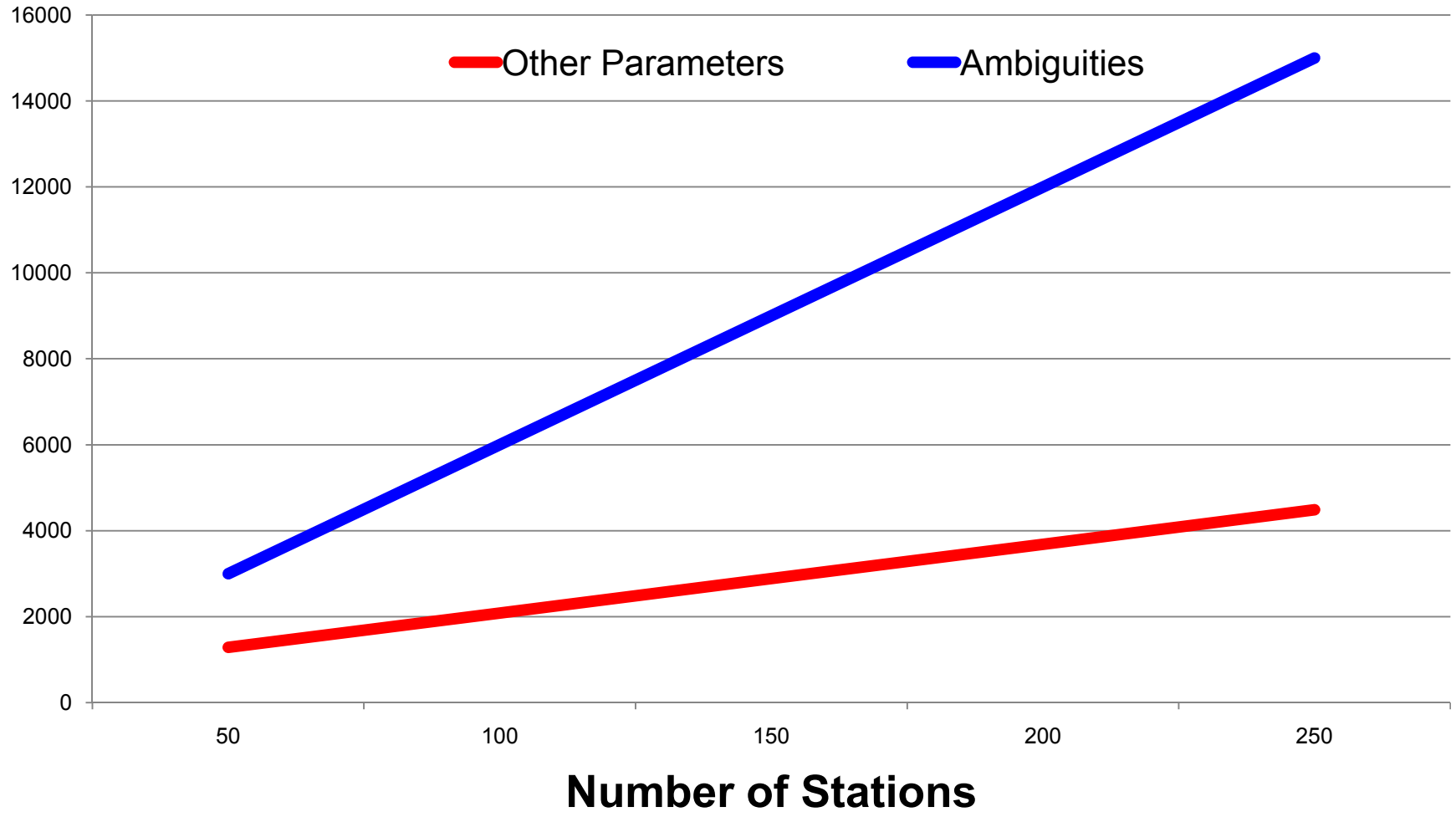


Challenging tasks

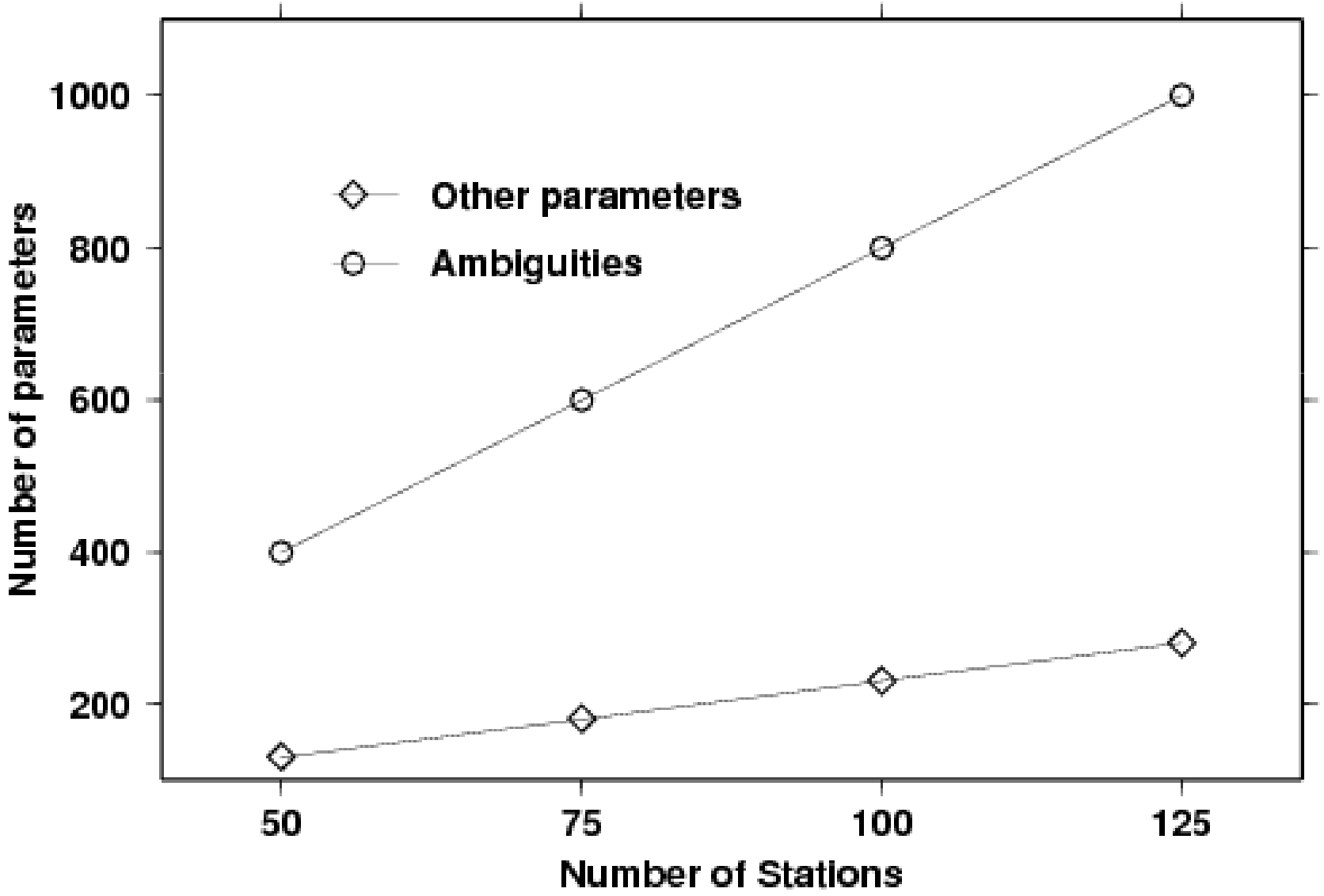
Huge network solution



Huge network solution (30 sat. 2 ambiguities/per sta/per sat)



Huge network solution (real-time)



Challenging topics

Multi-system solution

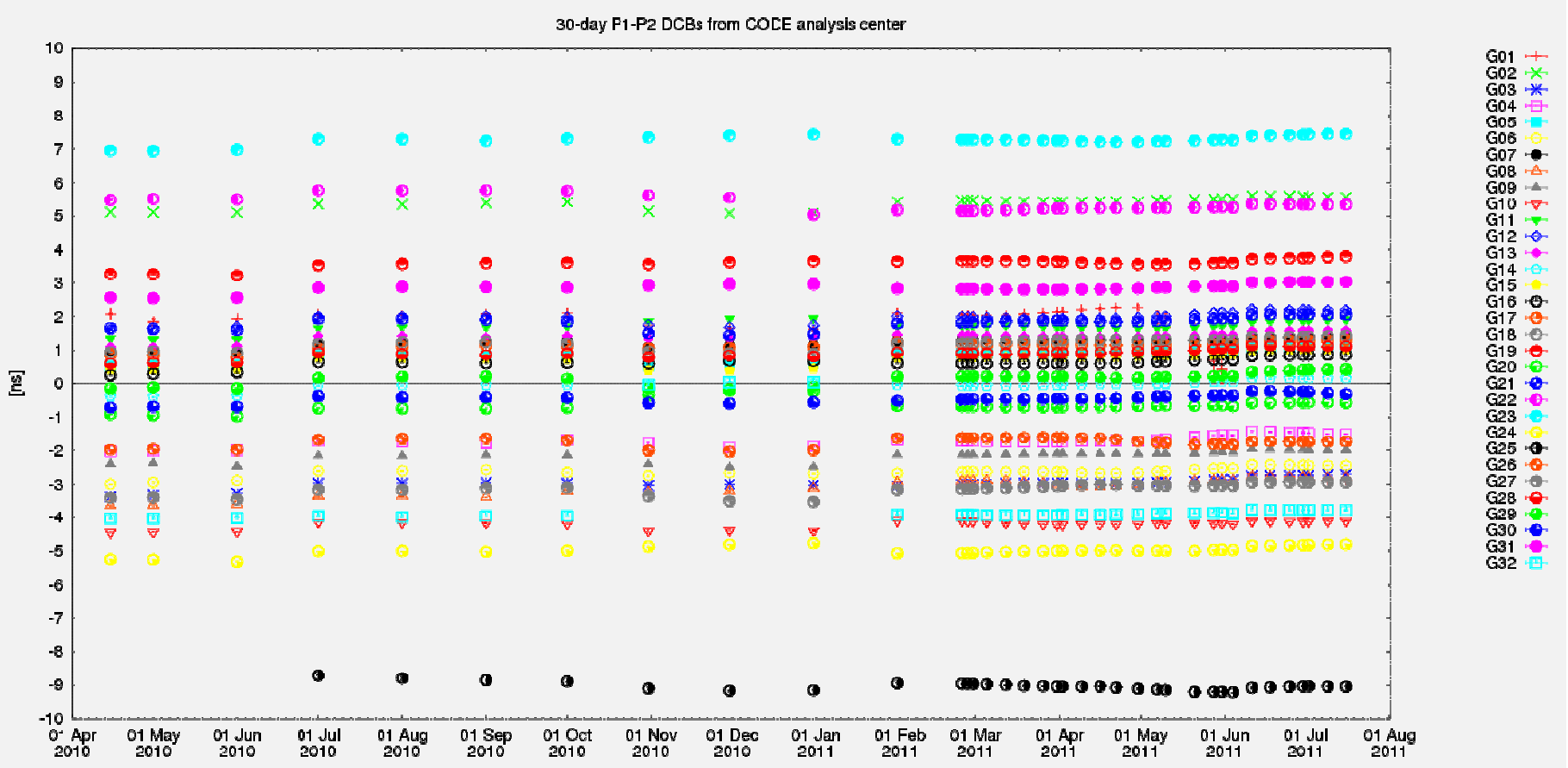
More Frequency, New Satellite System;
Biases issue; Reference issue
……

Multi-technique solution

More Observation, Integrated solution;
Local-ties; Parameterization
……

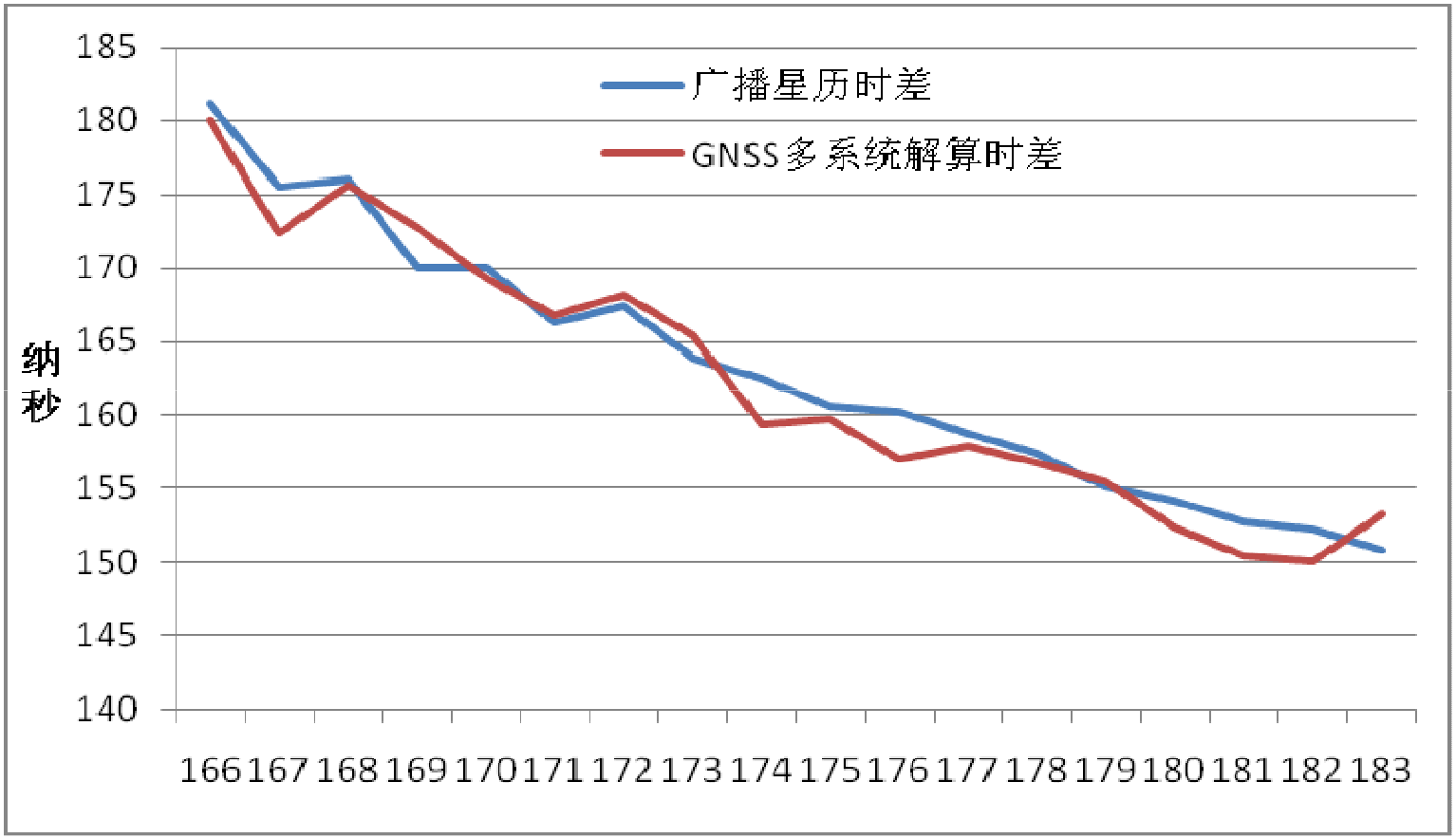
More frequencies

- Bias issue



Multi-GNSS

- System time offset

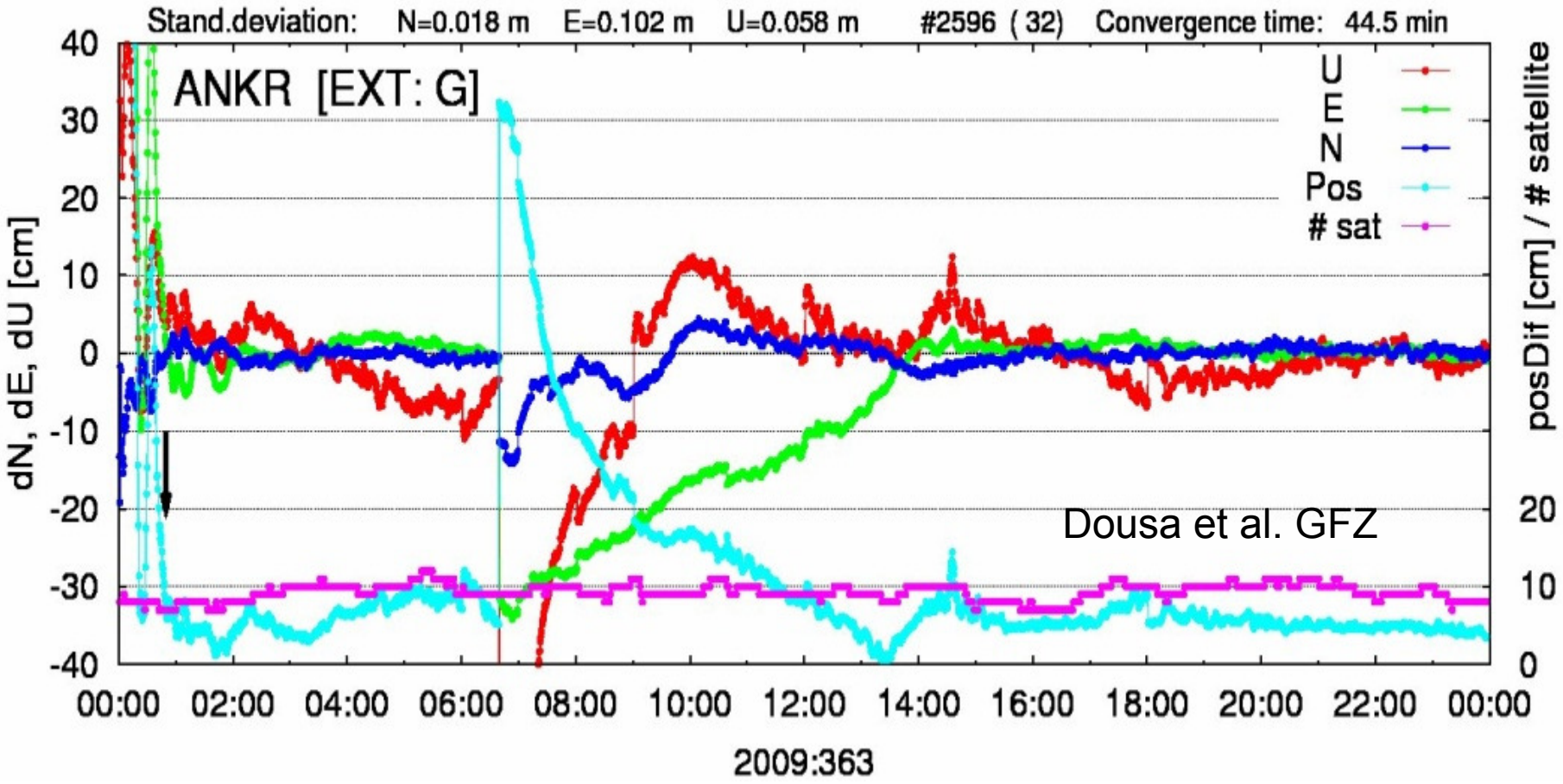


- Unified reference frame

Multi-GNSS

- Kinematic PPP
- 90 selected IGS reference station

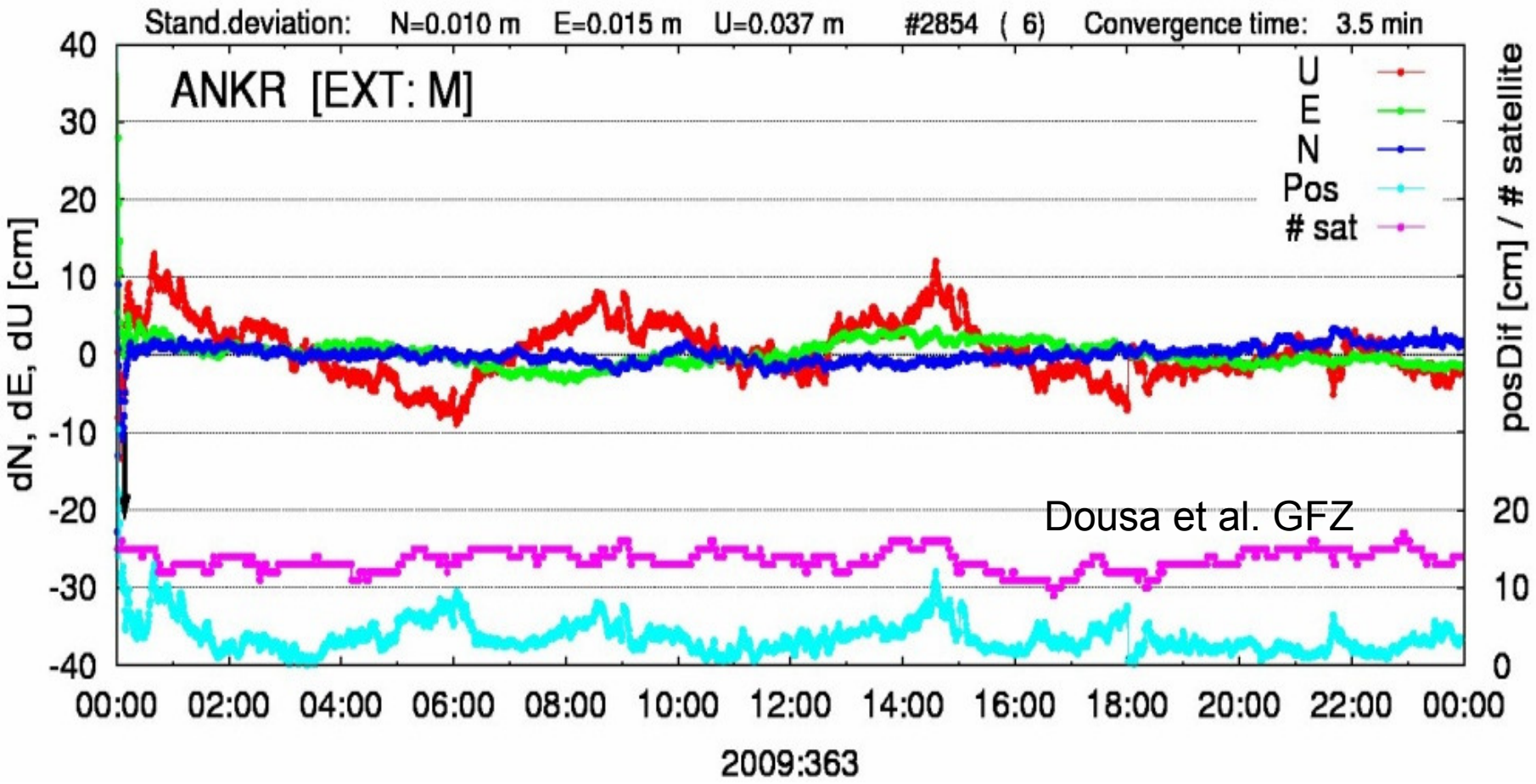
GPS only



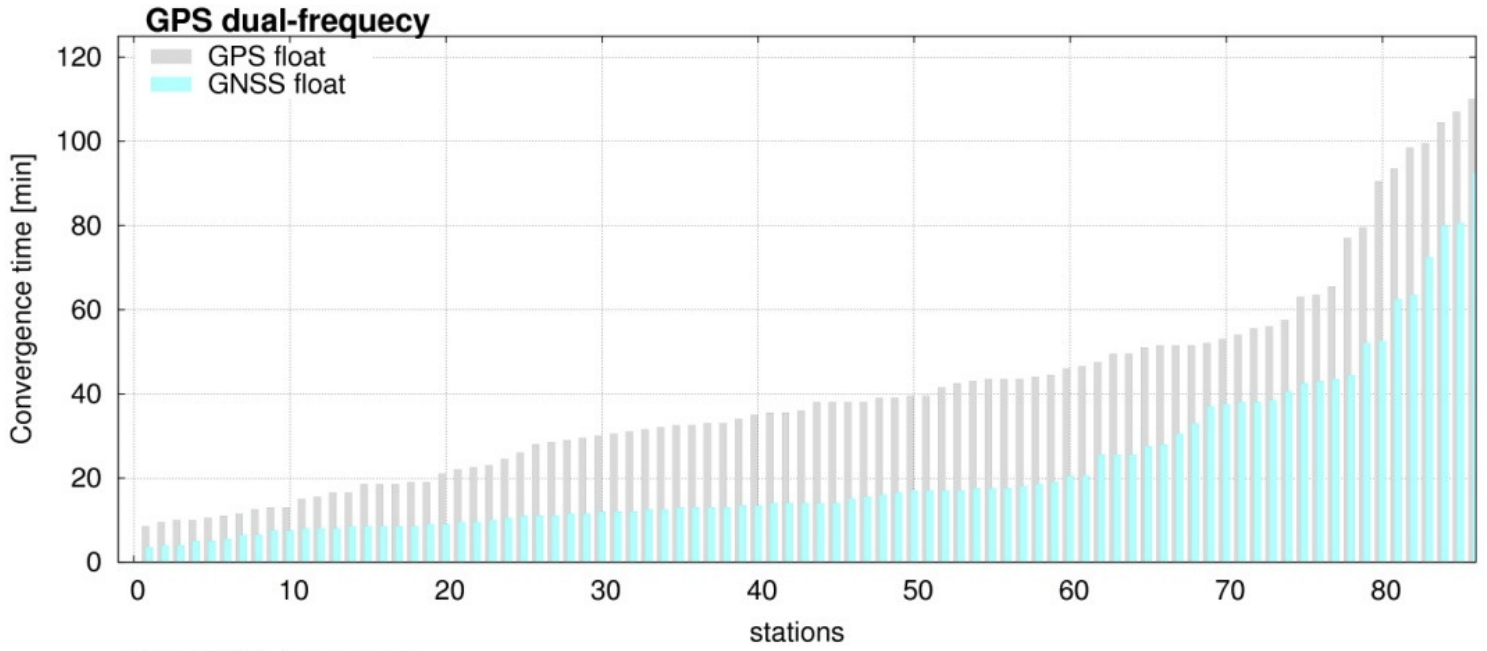
Multi-GNSS

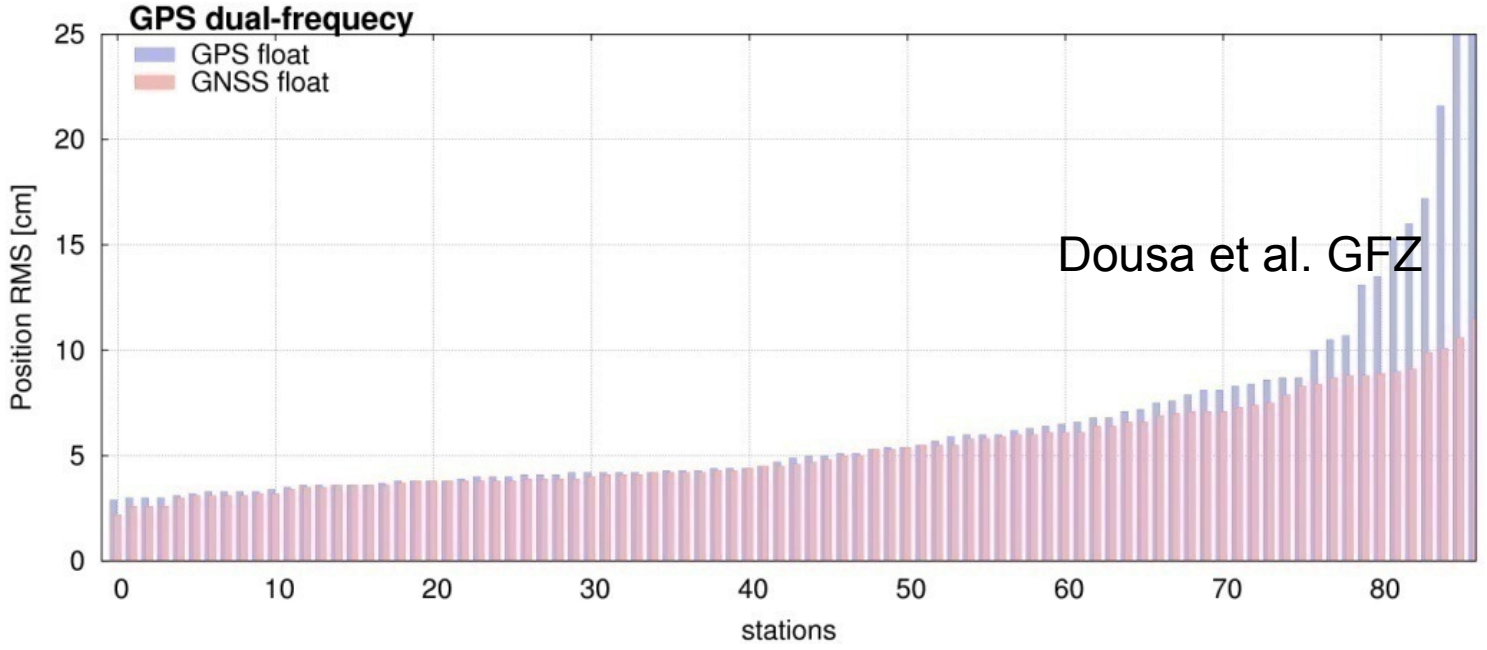
- Kinematic PPP
- 90 selected IGS reference station

GPS + GLONASS



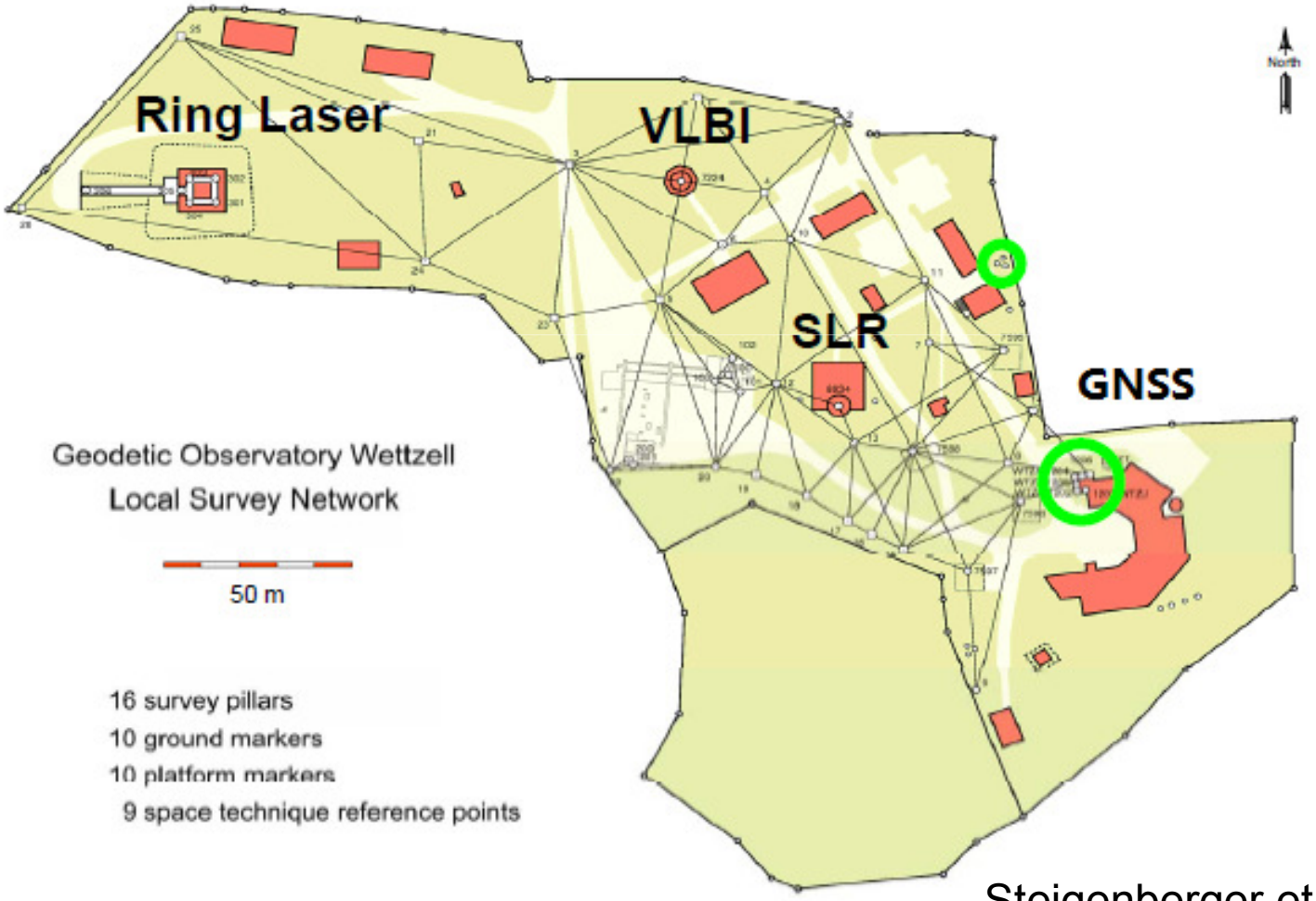
Multi-GNSS


GPS dual-frequecy
GPS float
GNSS float
Convergence time [min]
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
stations


GPS dual-frequecy
GPS float
GNSS float
Position RMS [cm]
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
stations
Dousa et al. GFZ

Multi technique

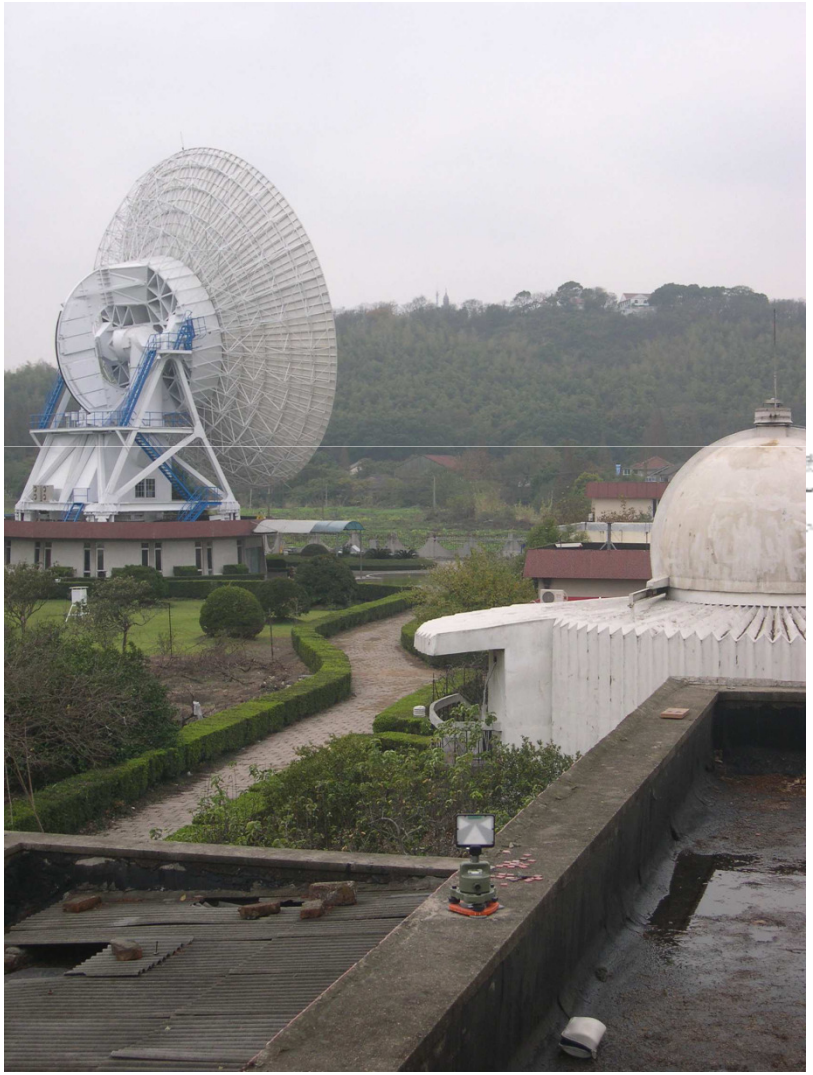
❑Geodetic Observatory at Wettzell, Germany

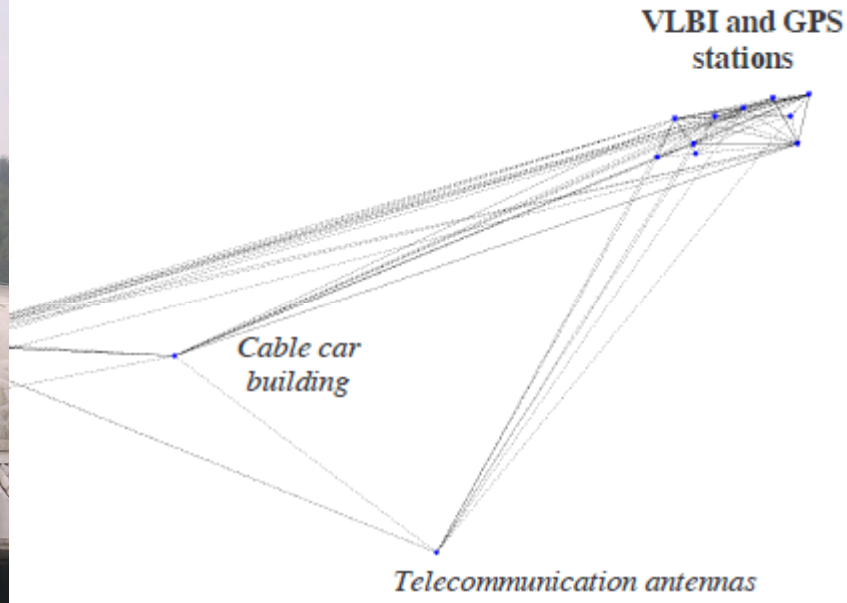


Steigenberger et al. DGFI

Multi technique

❑SHAO: Sheshan Geodetic Observatory





Multi technique

Multi-technique solution

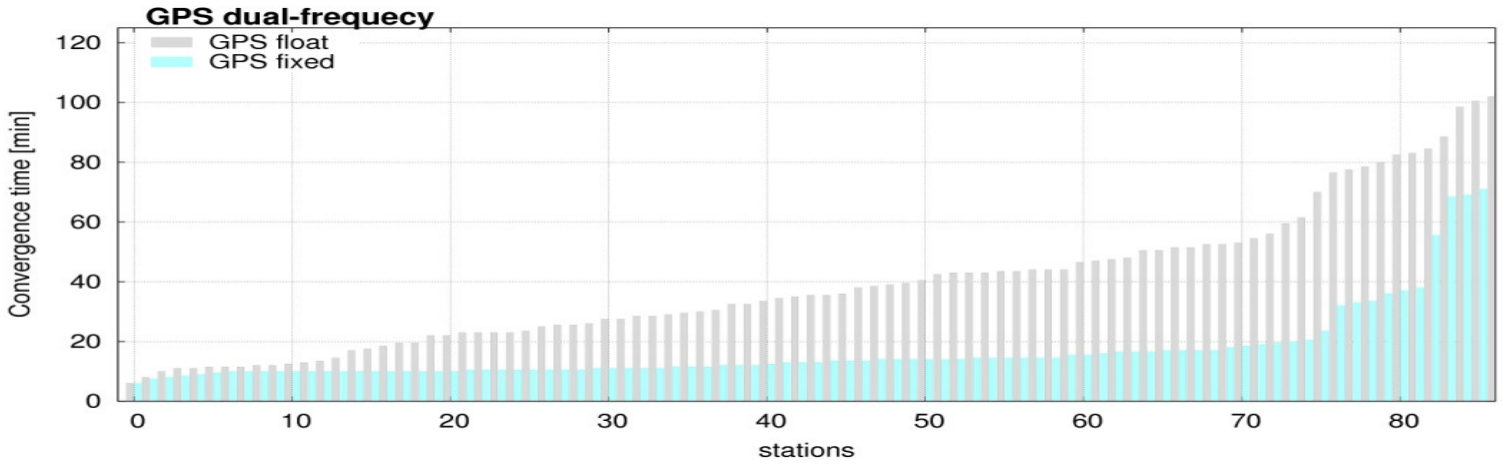
More Observation, Integrated solution;
Local-ties; Parameterization

Unified Analysis

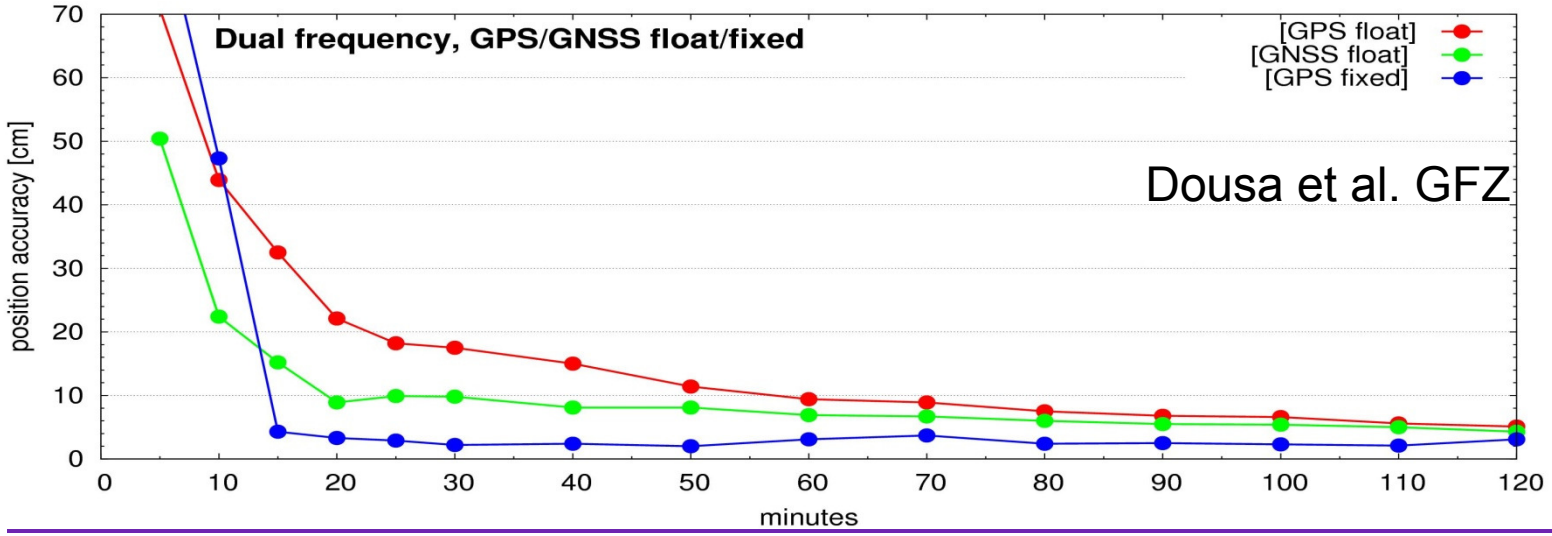
On the raw data level

Challenging topic: PPP Ambiguity fixing

- PPP ambiguity fixing

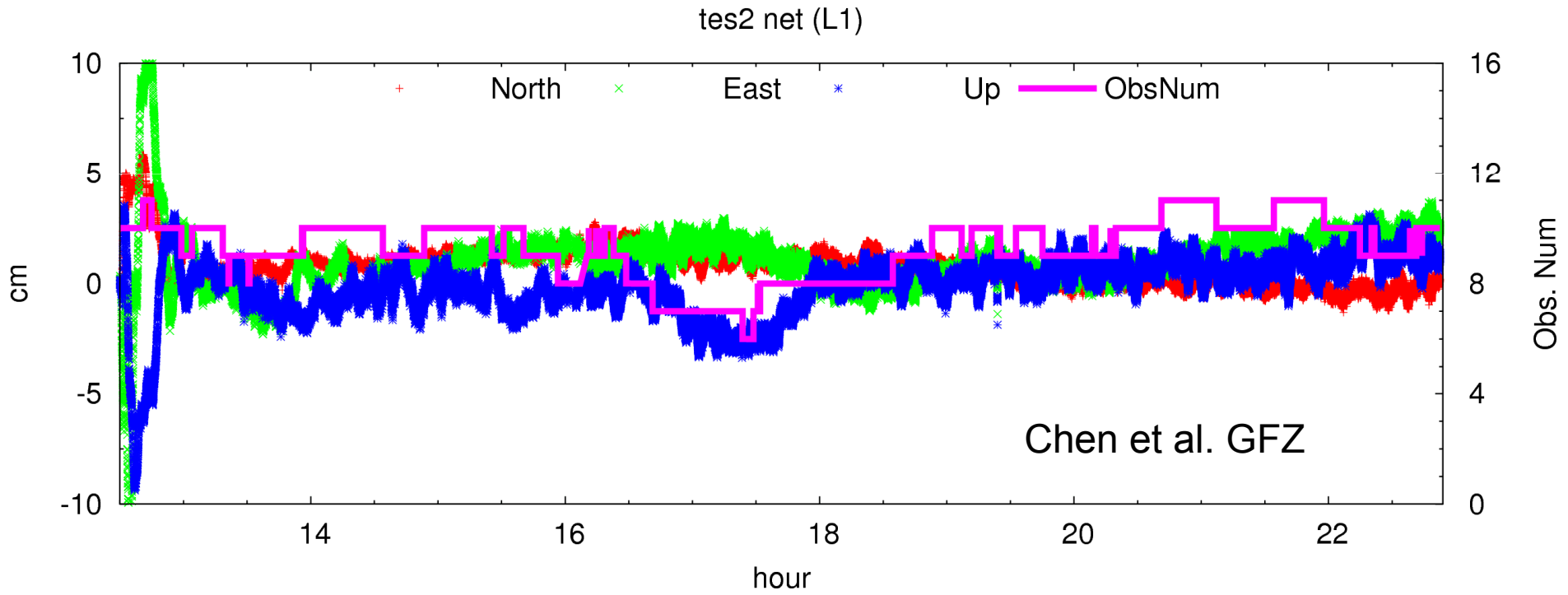


- Integer ambiguity resolution in PPP supports:
  - improved accuracy and high stability after TTFF



Challenging topics: high rate GNSS analysis

- Experiment at GFZ with two stations: A17D and TES2
- Data sampling: 10 Hz
- Kinematic solutions



http://www.shao.ac.cn/shao_gnss_ac

Thank you!