

# **GFZ prototype for GPS-based real-time deformation monitoring**

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## ➤ **Background**

- G-SEIS (GPS - SurfacE Deformations withIn Seconds )

## ➤ **Prototype software**

- Program structure
- Satellite clock estimation
- PPP solution for single station
- Network solution

## ➤ **Real-time investigation and implementation**

- Orbit influence
- Network influence
- Tropospheric parameter
- Real-time implementation

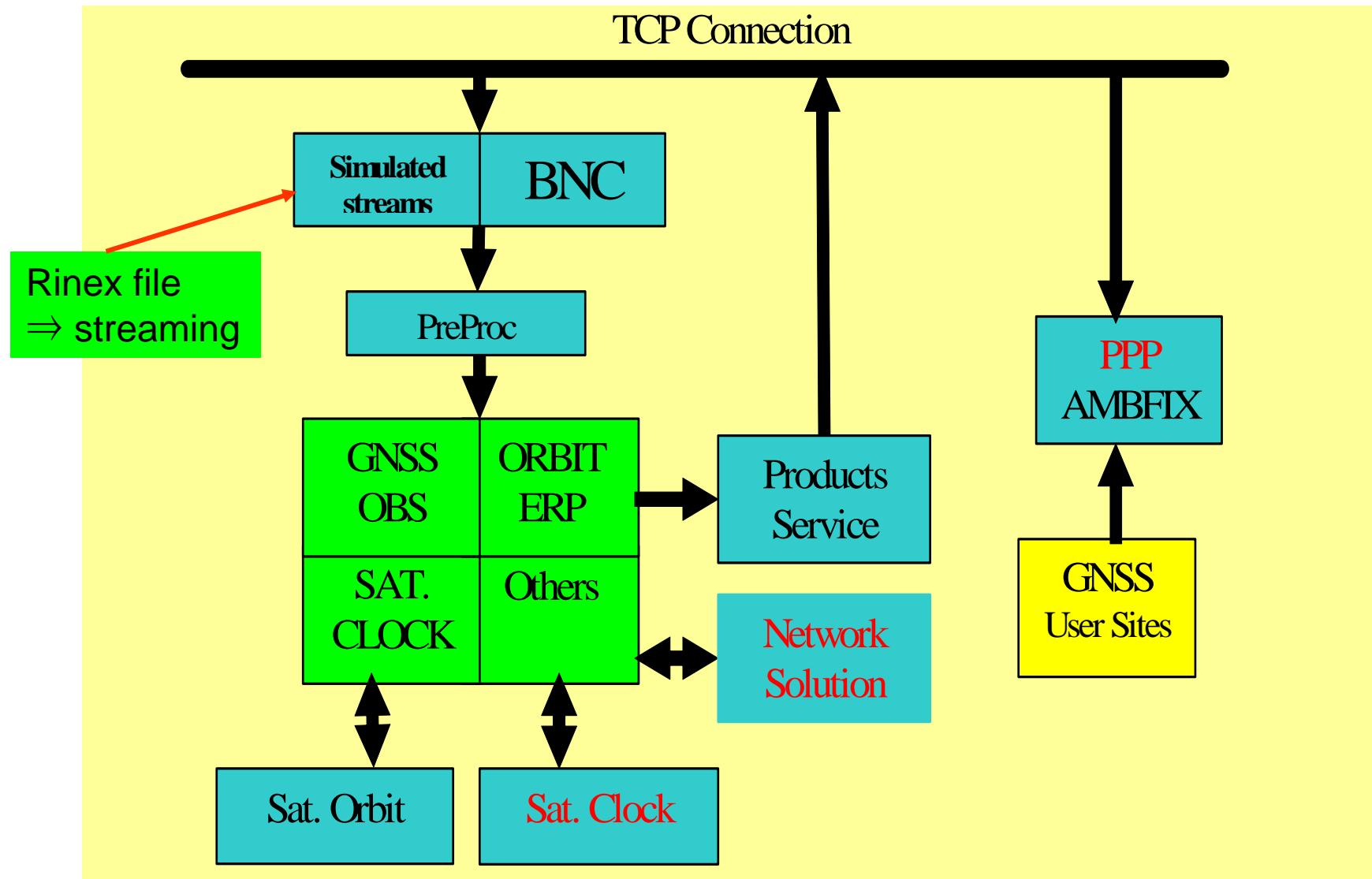
## ➤ **Conclusions**

## G-SEIS: GPS - SurfacE Deformations withIn Seconds

- 1.Design and development of new series of multi-parameter stations
- 2.Development of new and automated real-time GPS/GNSS software

- providing satellite orbits and clocks in real-time
- kinematic monitoring of station positions in real-time
  - PPP and Network mode
- Special studies
  - high-rate GNSS data
  - GNSS combined solutions comprising GPS, GLONASS and the upcoming GALILEO system

# Structure of GFZ prototype software



# Deformation monitoring

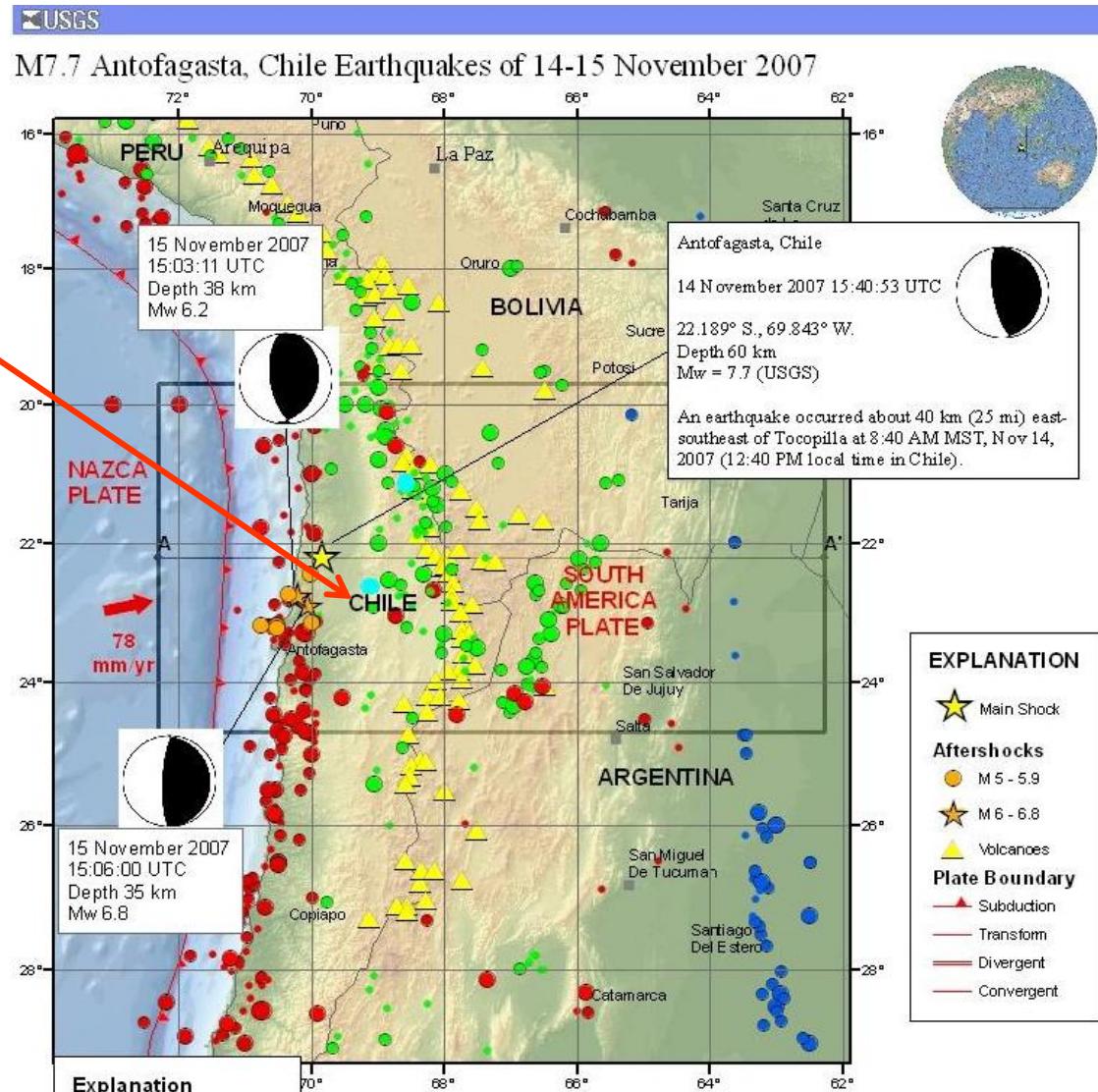
- Mw 7.7 earthquake  
(Chile, 14-15.11.2007.  
Doy 318,2007.)

- TALA (100 km away  
from epicenter)

- Simulated real-time  
processing

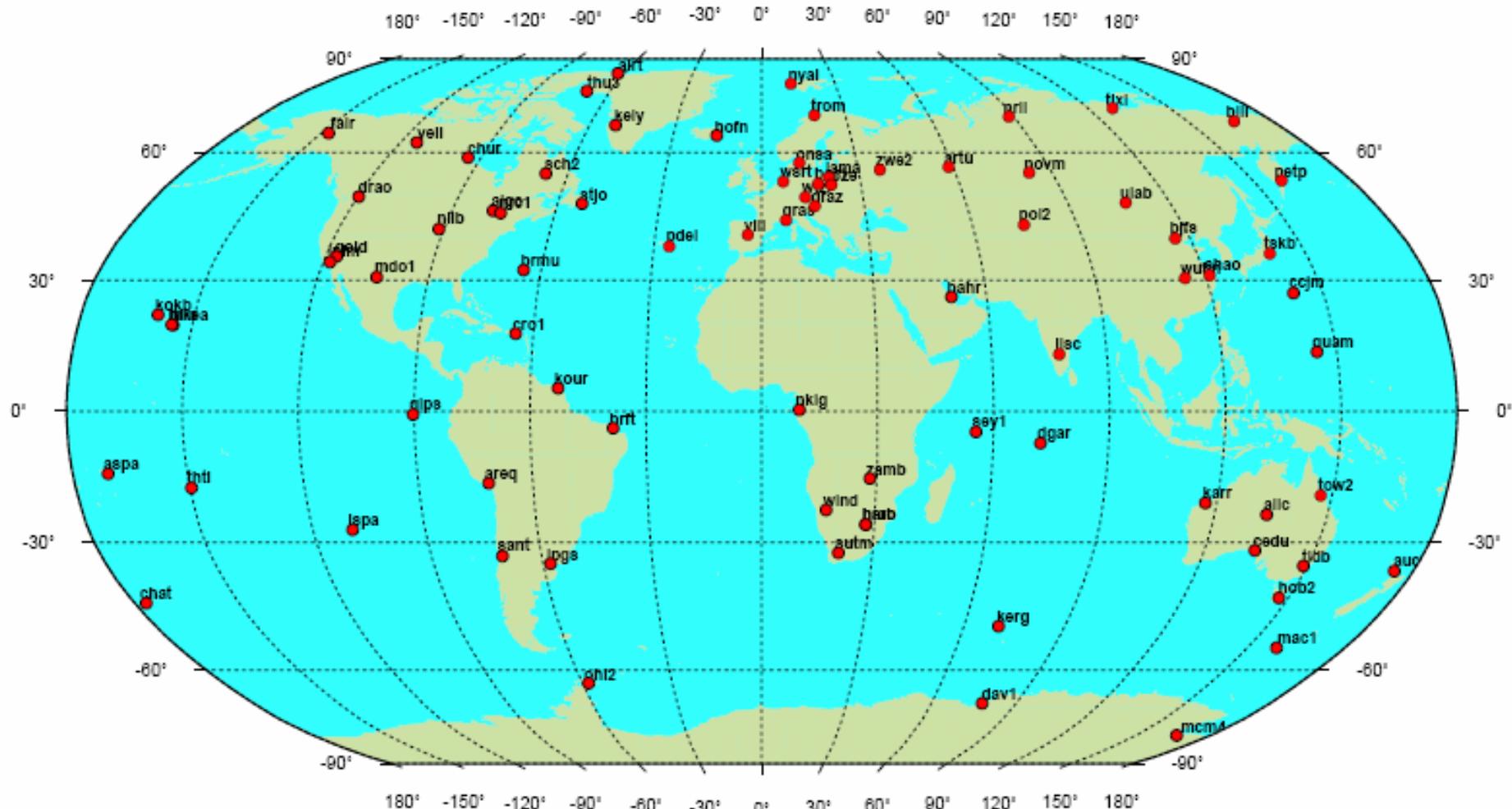
Rinex file  
⇒ streaming

Picture From U.S.Geological Survey web (USGS)



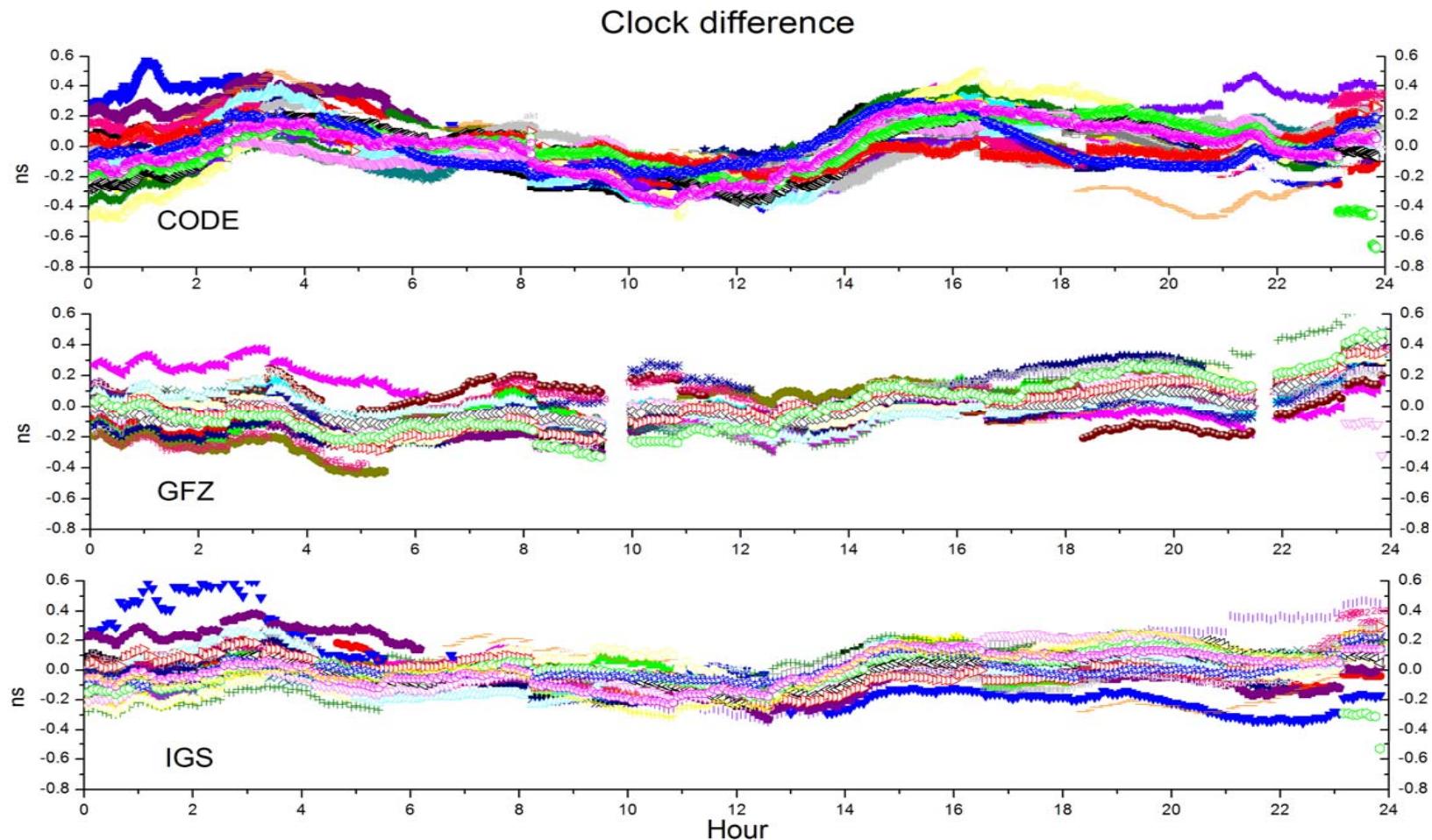
# **Satellite clock estimation**

## ➤ Selected network (GFZ IGR network), Doy 318,2007, sampling:30 sec



# Satellite clock estimation

➤ Clock estimation (compare estimated clock to IGS AC's clock)

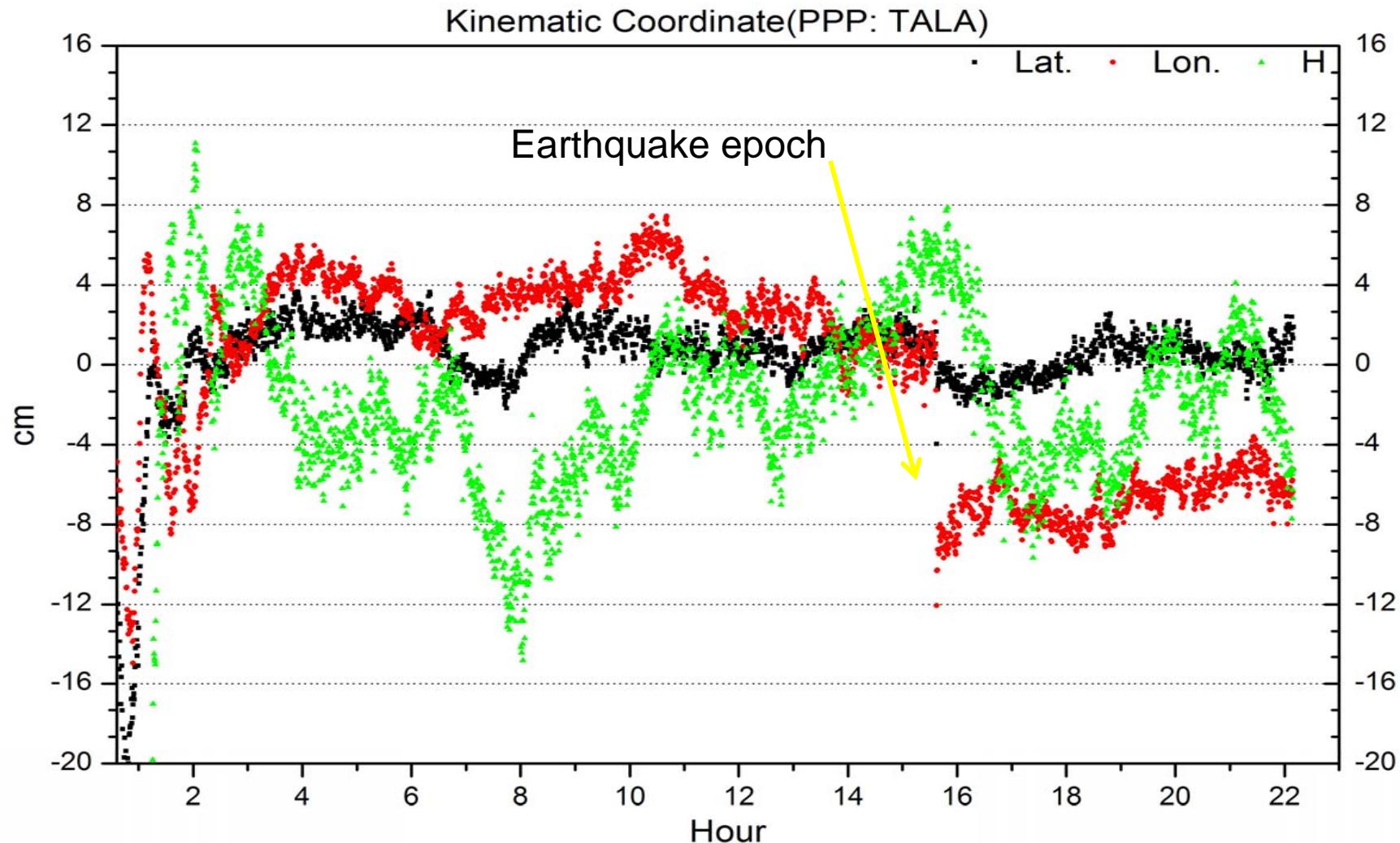


	IGS	GFZ	CODE(30s)
Average Stdev. (ns)	0.11	0.14	0.16

# Deformation monitoring (PPP)

➤ Mw 7.7 earthquake (Chile, 14-15,11,2007 )

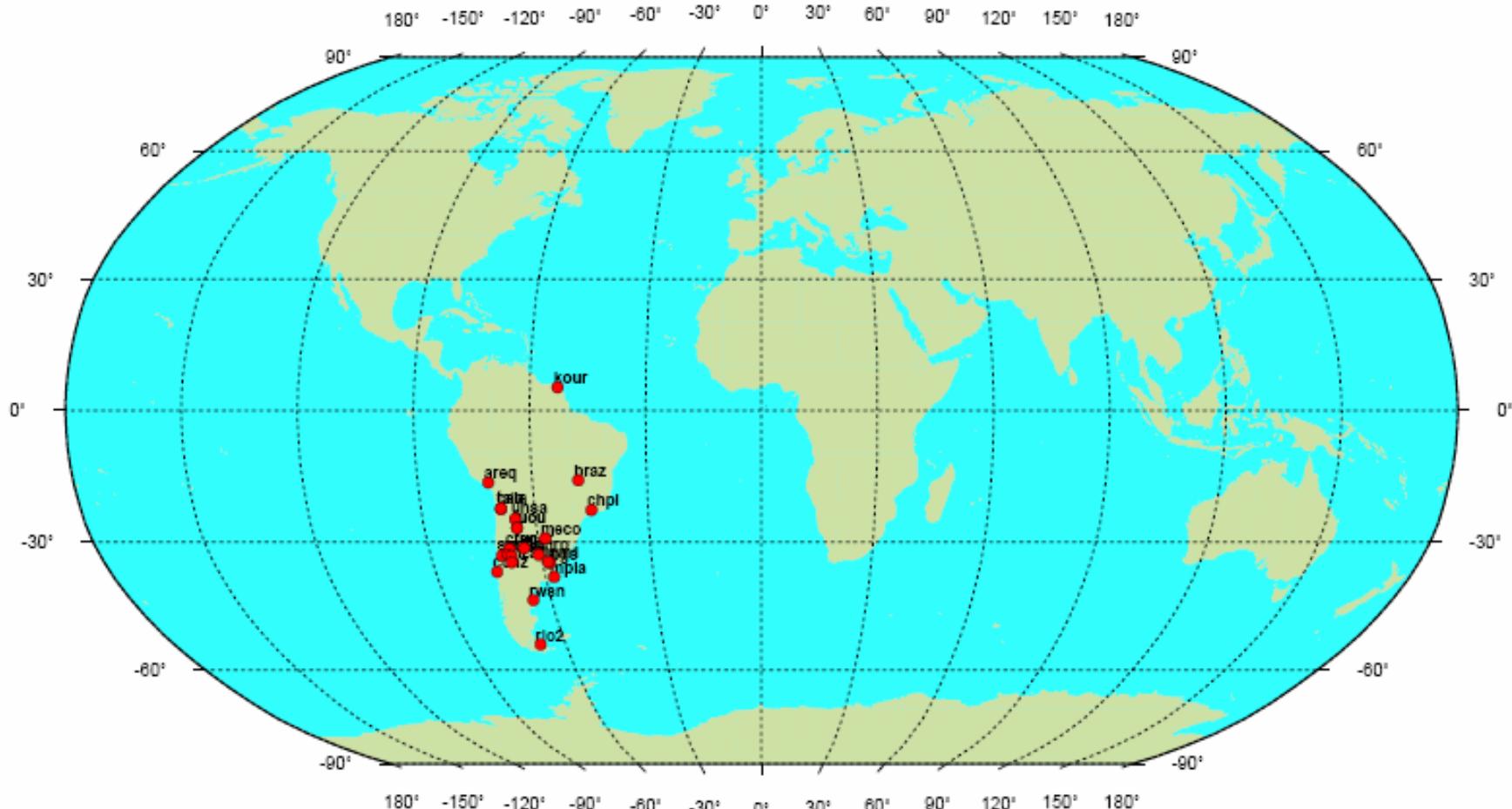
Kinematic coordinate (TALA: difference from daily solution)



# **Network mode solution**

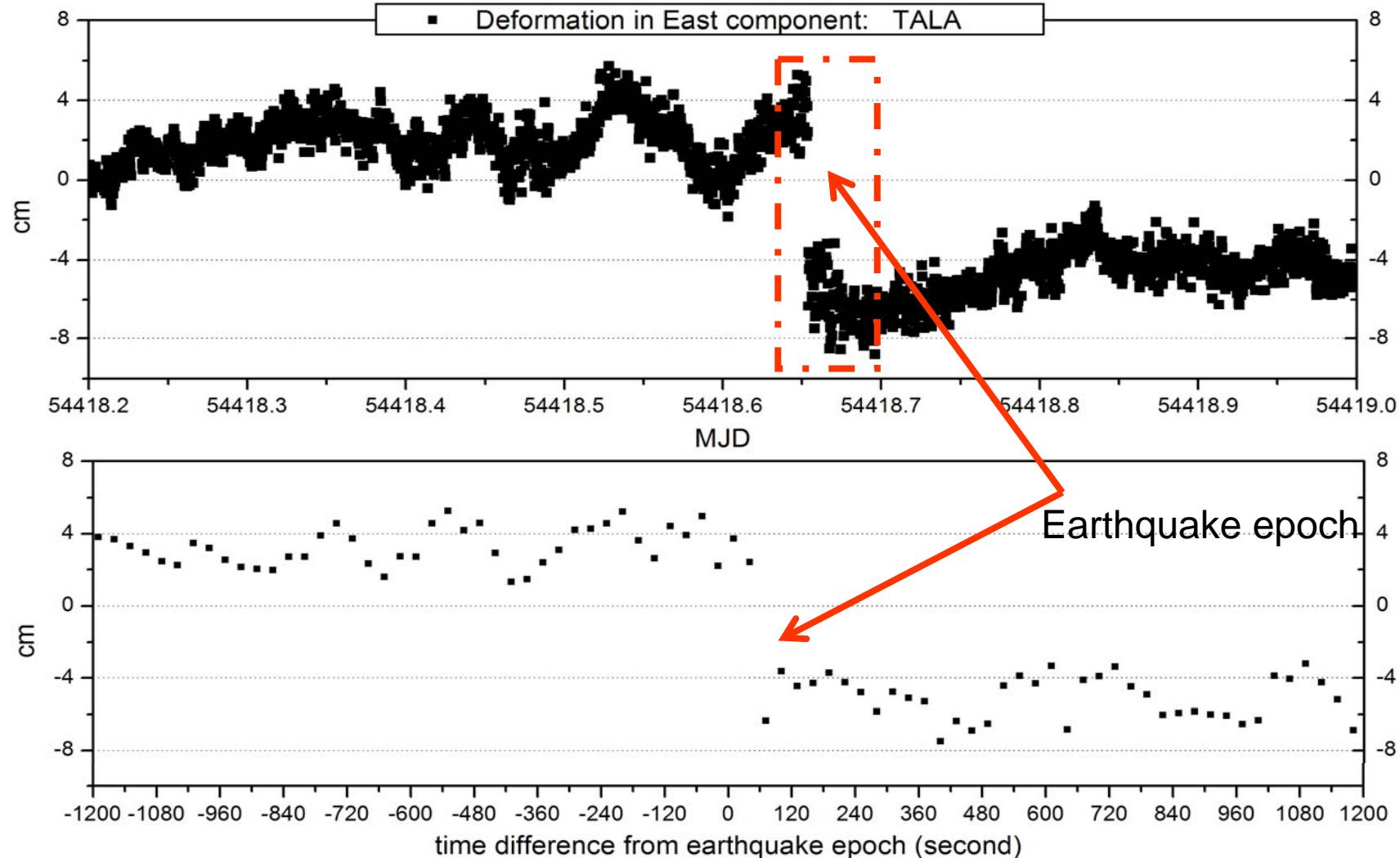
## ➤ Network:

- RAMSAC(Argentine network for continuously satellite monitoring)
- Nearby IGS stations
- Kinematic station near Earthquake Epicenter



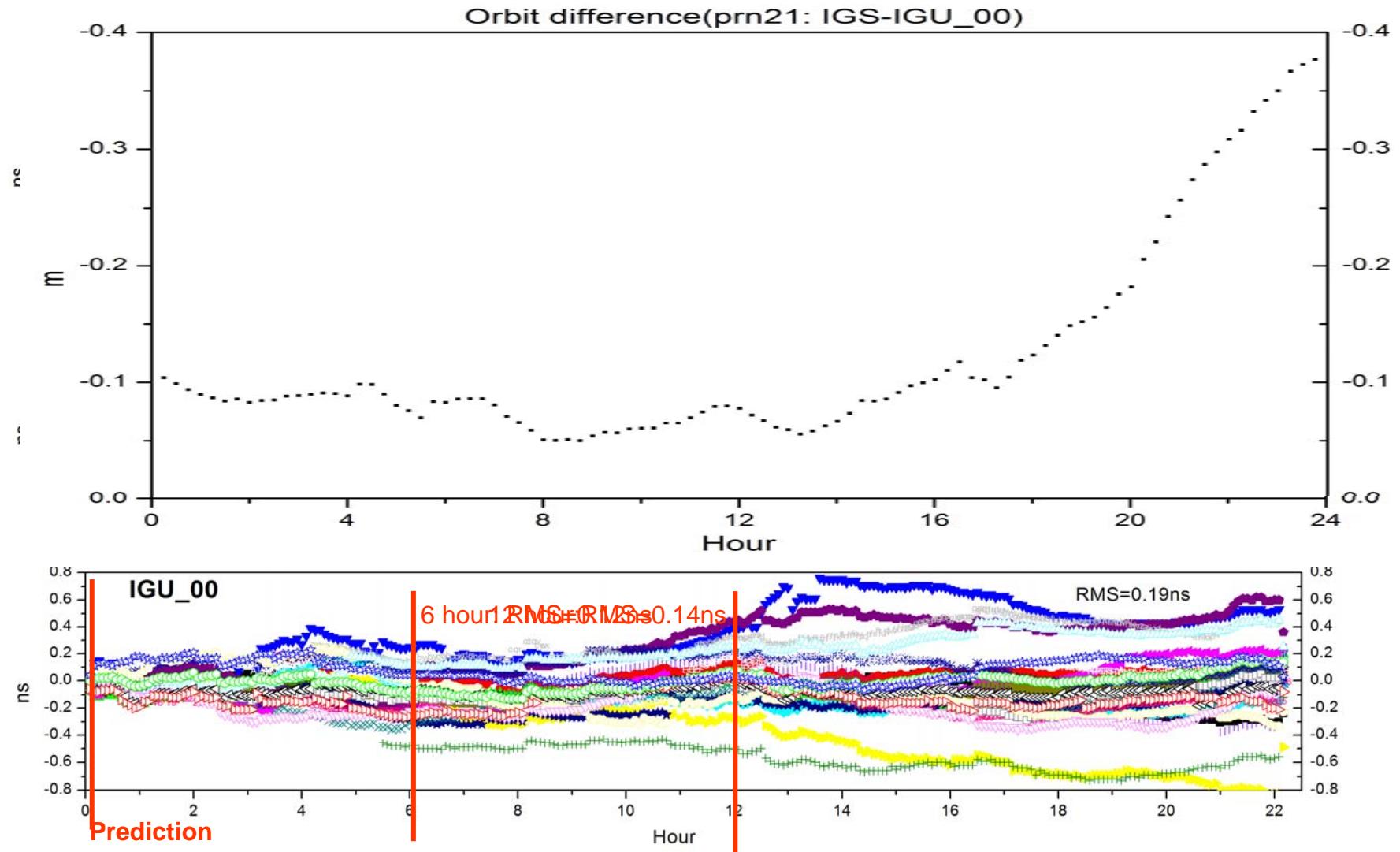
# Network mode solution

➤ Kinematic coordinate (TALA, difference from daily solution)



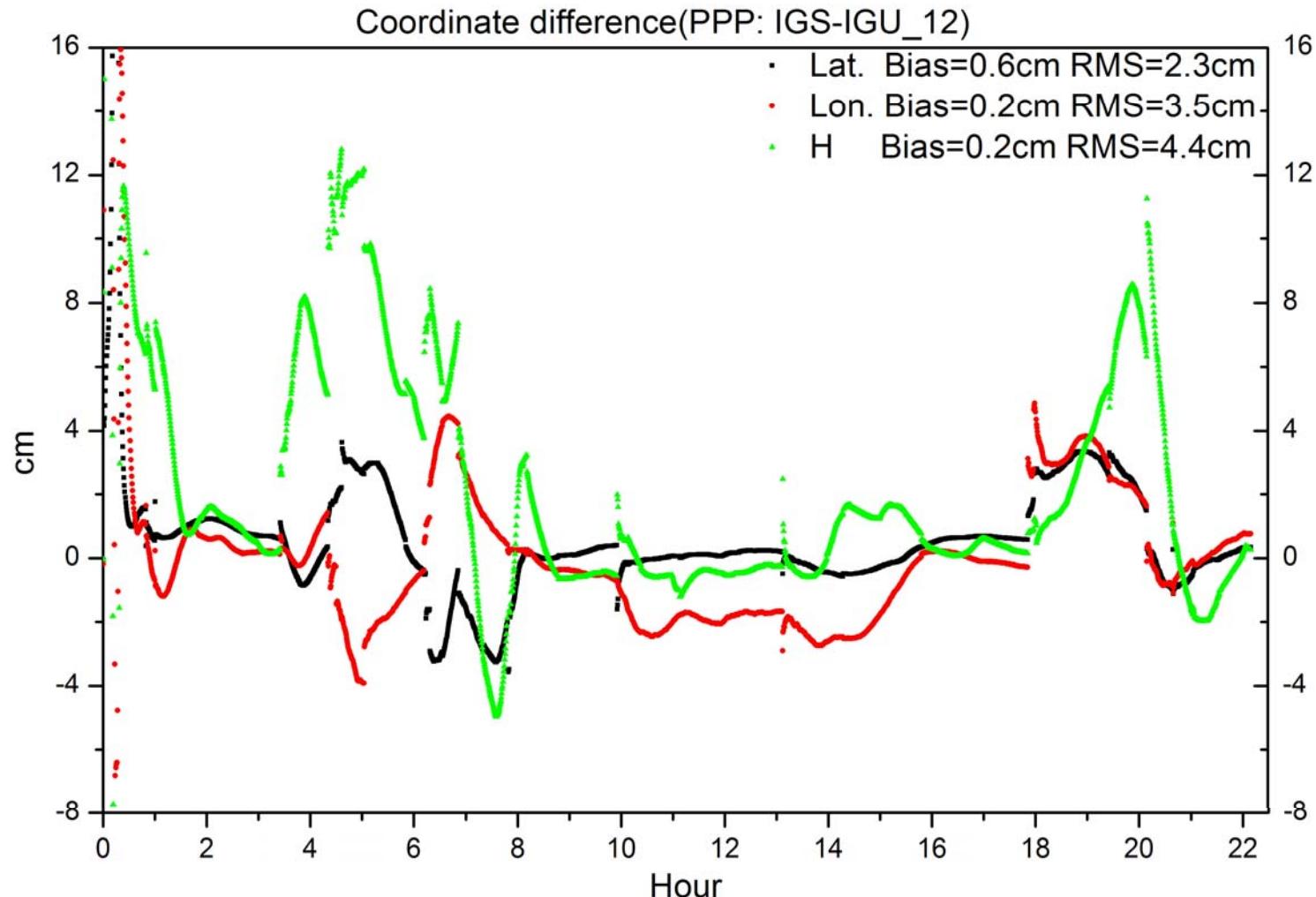
# Orbit influence(1/2)

➤ Clock estimation using different orbit (Estimated clock vs. IGS final clock)



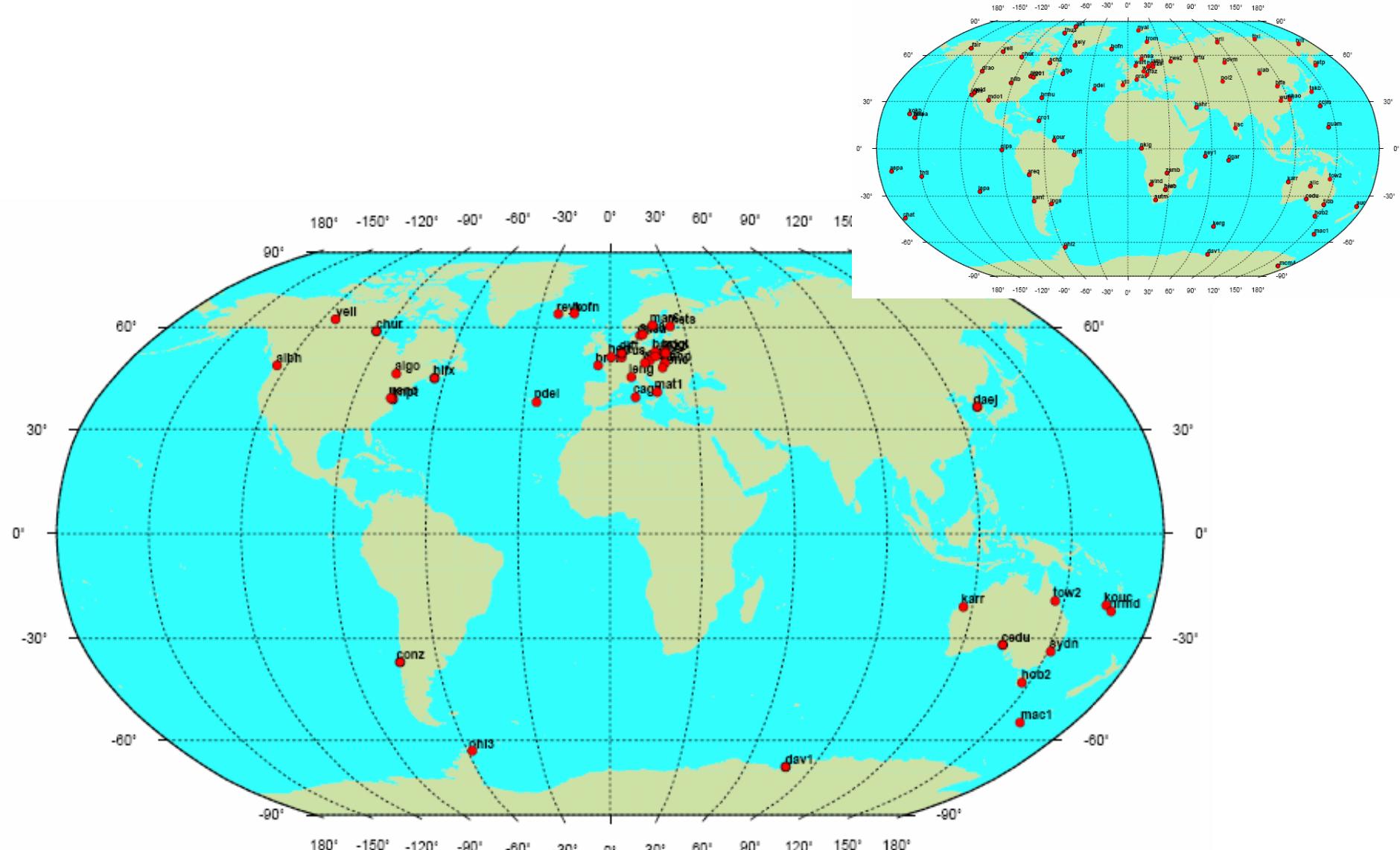
# Orbit influence(2/2)

➤ Kinematic coordinate difference of TALA using sat. clock estimated from IGS Final orbit and IGU\_12 orbit)



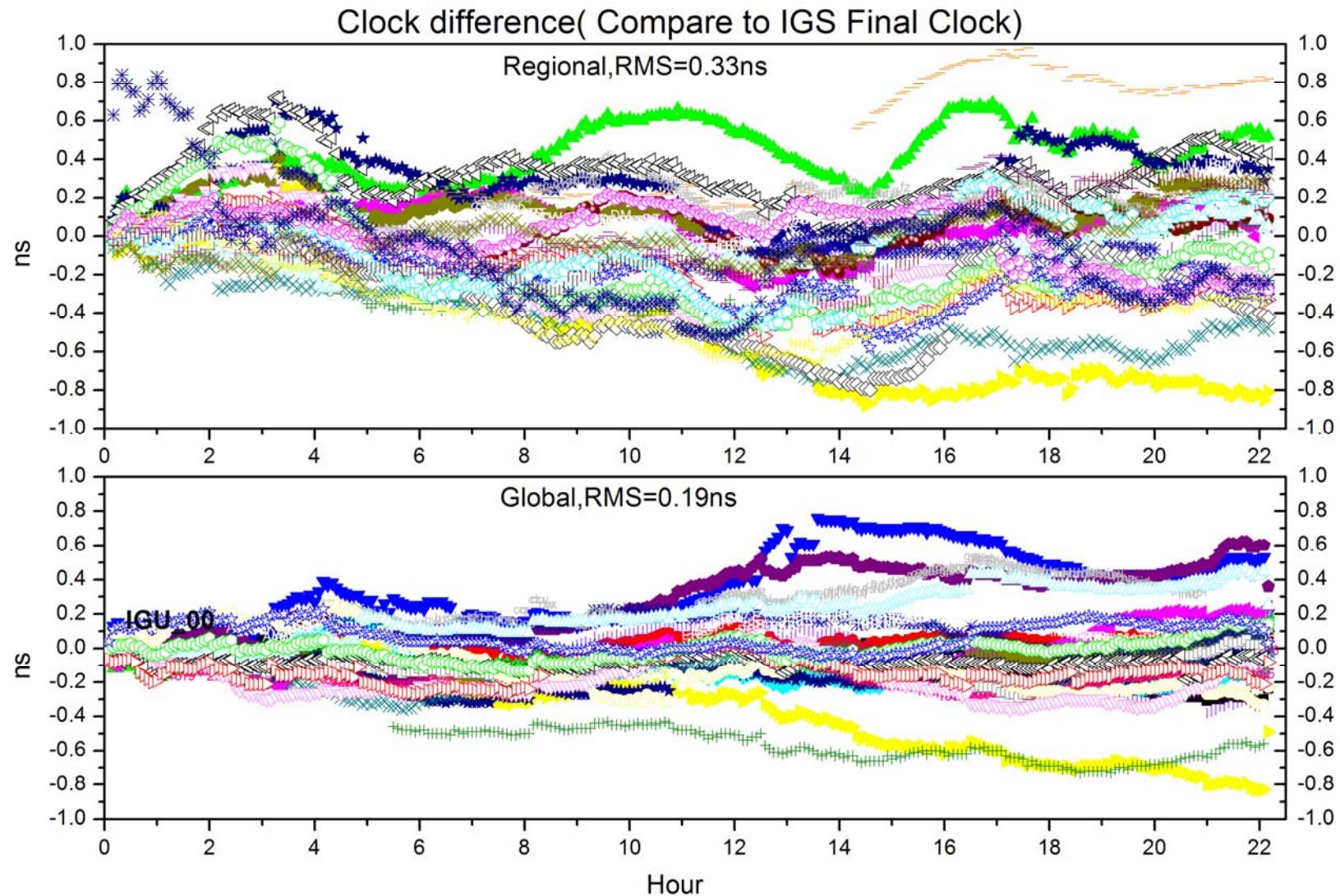
# *Network influence(1/2)*

➤ Selected network (similar with IGS real-time network)



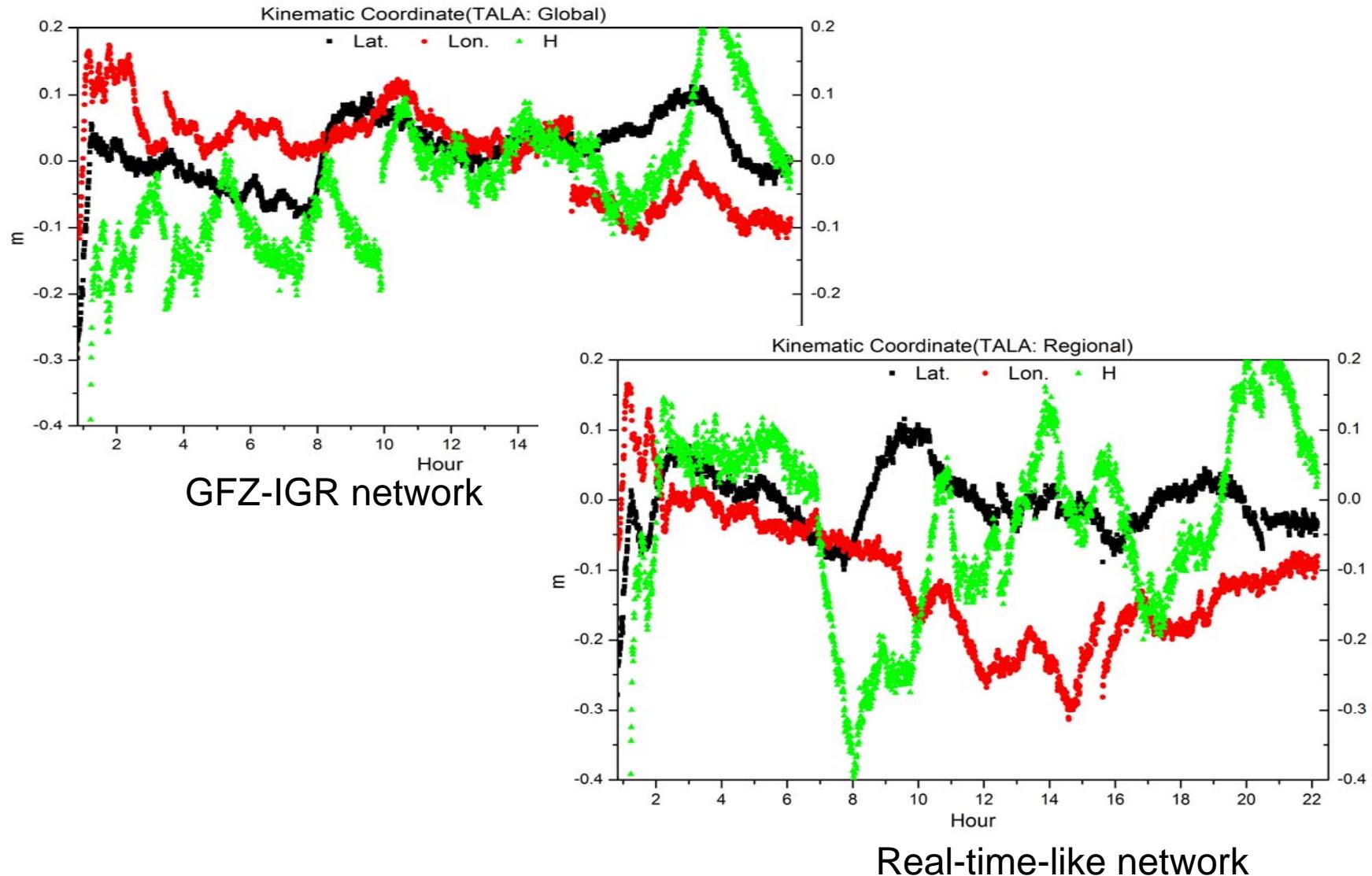
## ***Network influence(1/2)***

## ► Clock estimation from different network (based on IGU\_00 orbit)



# Network influence(2/2)

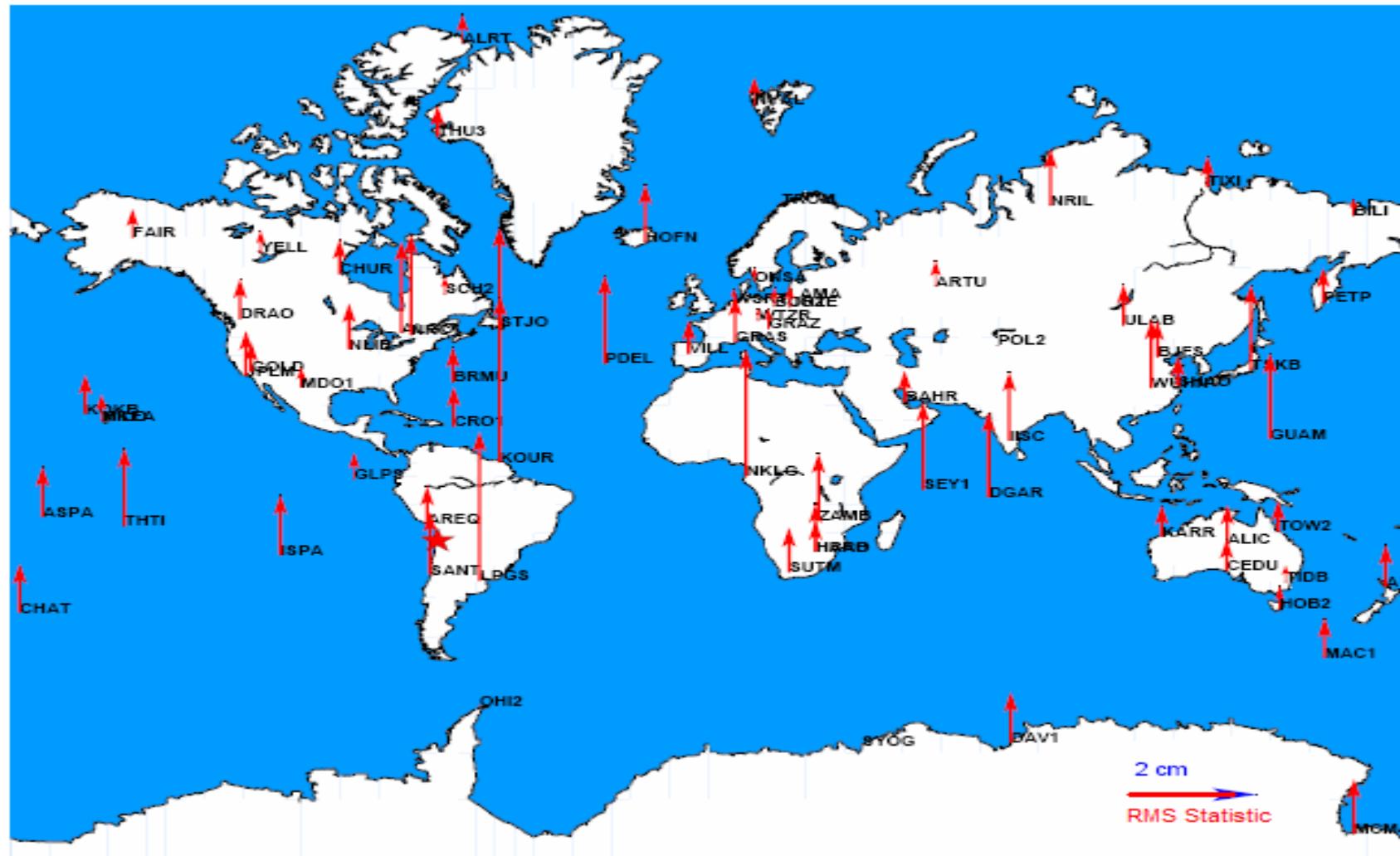
➤ Kinematic coordinate of TALA (sat. clock from global and “real-time” network)



# Troposphere parameter

➤ Ztd (estimation vs. GFZ final solution)

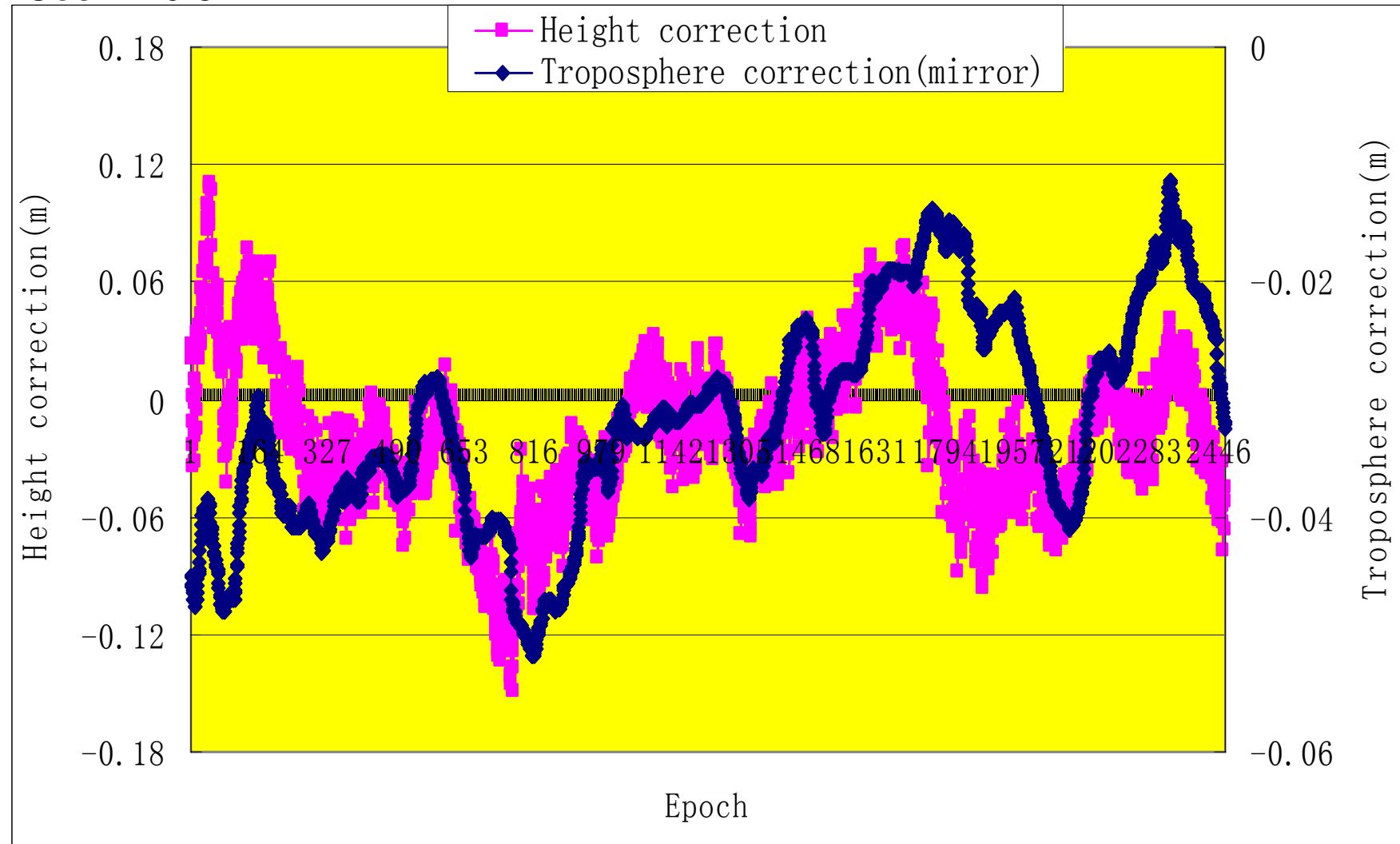
Bias:0.4cm, RMS:1.2cm



# Troposphere parameter

## ➤ Correlation between Trop. and station height

Coef.= -0.6



# Real-time implementation

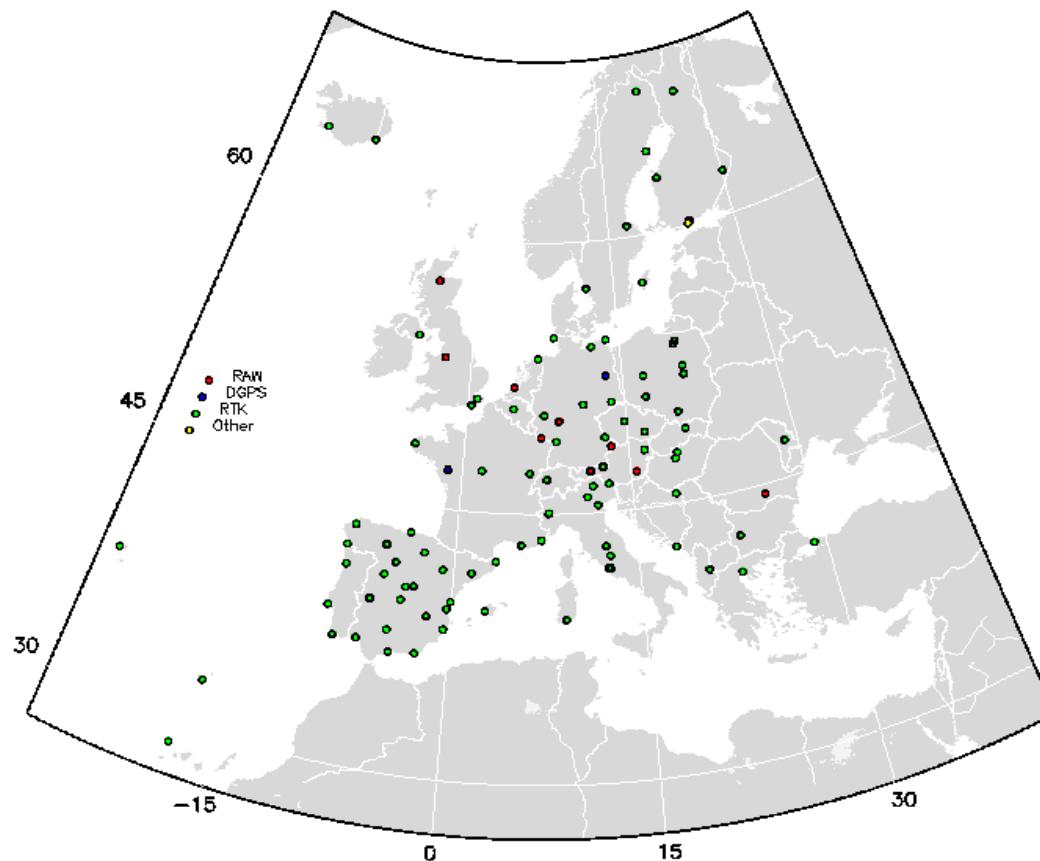
## ► Network:

Real-time GNSS Data Stream in Europe (picture from BKG web)

30 stations were used, sampling: 1 second

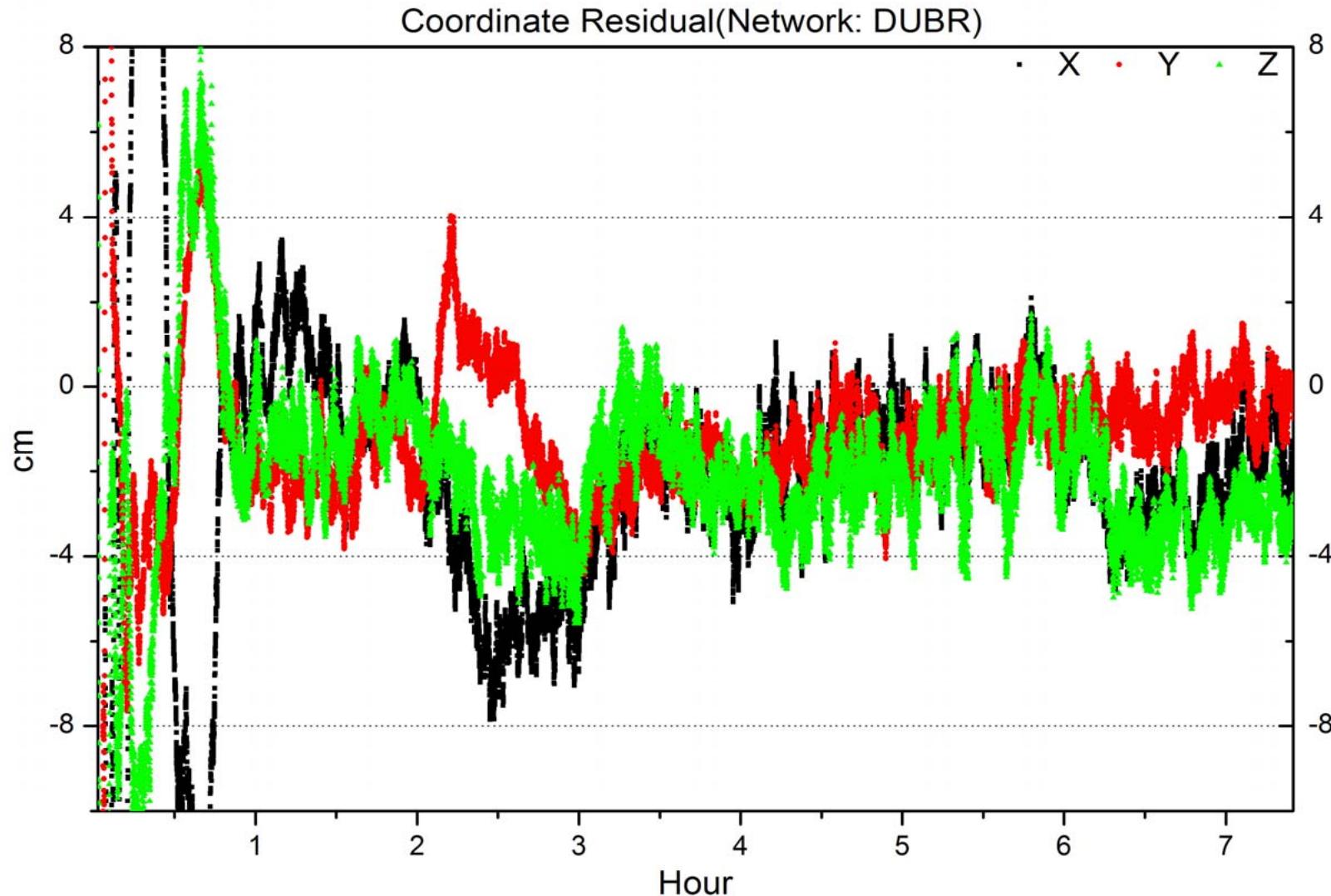
**orbit: IGU, a-priori clock: Broadcast**

Real-Time GNSS NtripCaster EUREF-IP, Status 080410



# Real-time implementation

➤ Kinematic coordinate from network solution (DUBR, Croatia)



# Conclusions

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## ➤ **Performance of prototype software**

- Satellite clock estimation accuracy : ~0.1ns
- Kinematic coordinate accuracy: Horizontal 2~4 cm, Height<10cm
- Surface deformation (cm level) can be detected during earthquake

## ➤ **Real-time investigation**

- Orbit update: < 6 hour.
- Real-time Network: In Africa and Asia, stations should be installed

## ➤ **Real-time implementation**

- European network monitoring.

## ➤ **Further Works**

- Filter Initialization
- Ambiguity-Fixing in PPP
- Troposphere Delay Modeling

# Acknowledgement

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**Dr. Juan Carlos Báez Soto from Universidad de Concepción (Chile) is acknowledged for providing raw data of TALA.**

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***Thank you!***