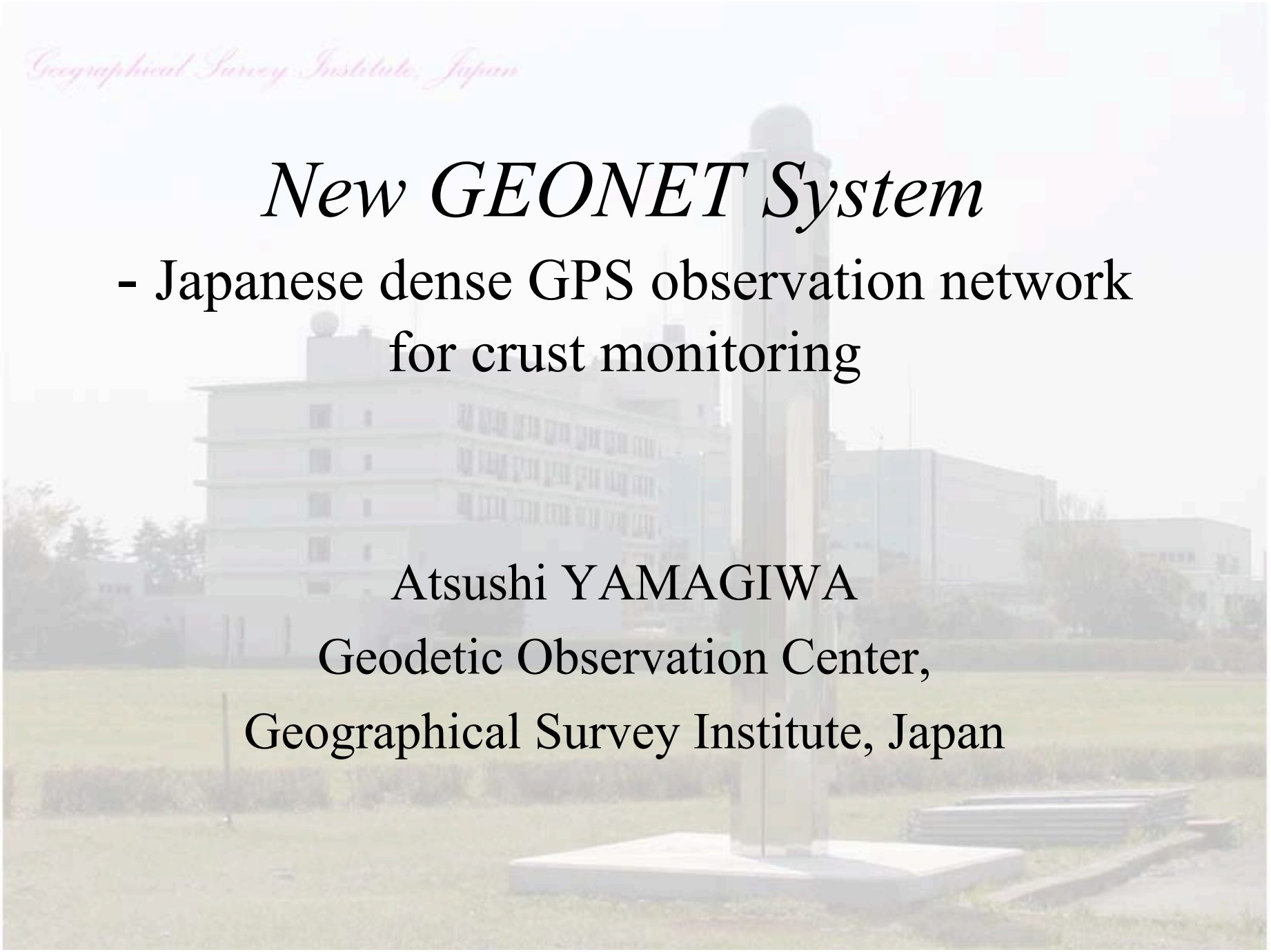

New GEONET System

- Japanese dense GPS observation network for crust monitoring

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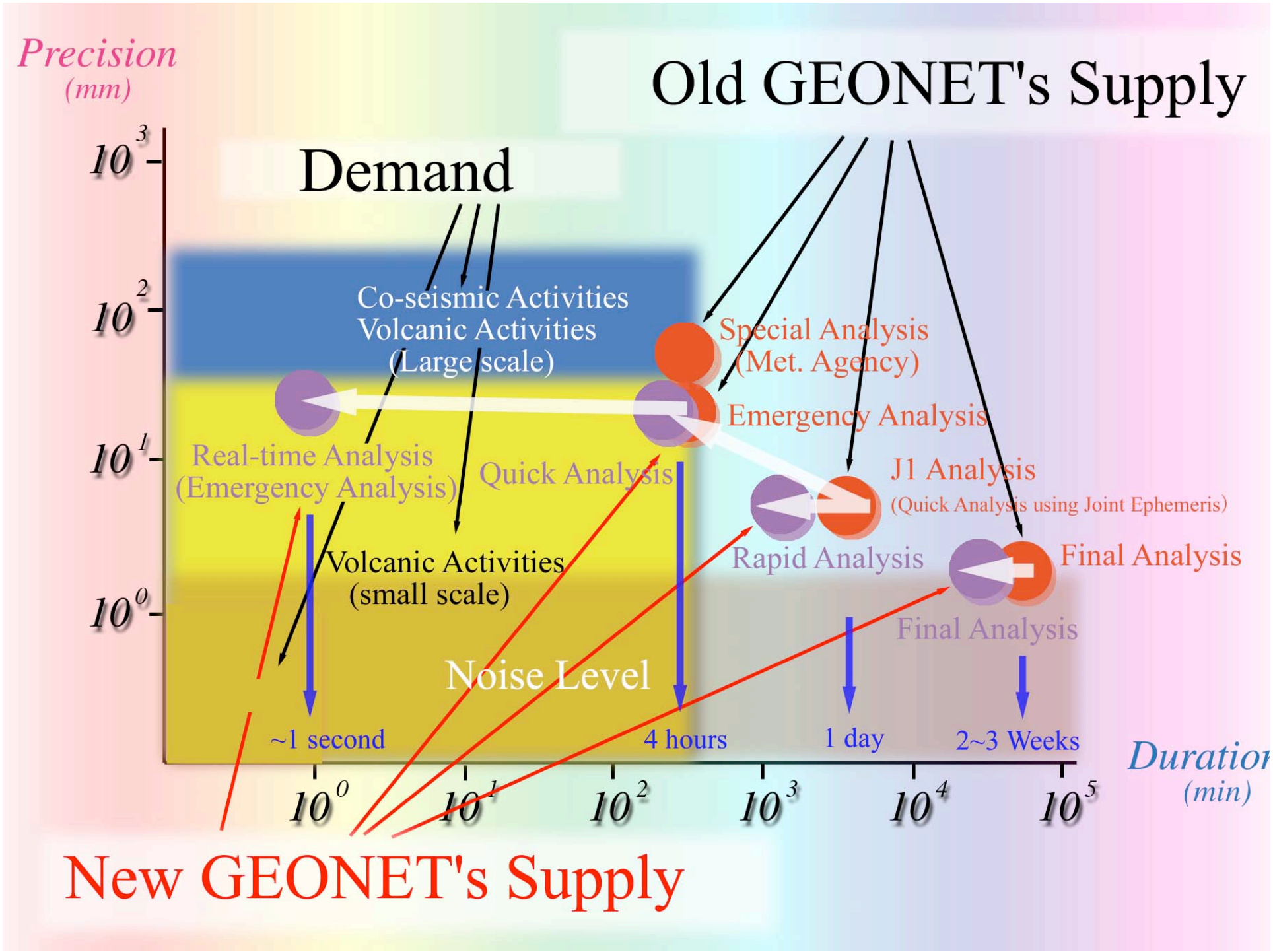
- 1. Demand and Supply among Current GEONET System for Crust Monitoring
- 2. Optimal Observation Period for Single Session of Precise Positioning
- 3. Basic Concept of New GEONET System
- 4. New GEONET's Function and Structure
- 5. New GEONET's Application for Crust Monitoring

1. Demand and Supply among Current GEONET System for Crust Monitoring

- GEONET has been used for crust monitoring against natural hazards such as earthquakes, volcanic activities etc.
- The performance of GEONET should meet current (and potential) needs (demand) within its ability (supply).
- Important factors of demand and supply are;
  - Time: (how fast)
  - Precision (how precise)


Precision
(mm)
Old GEONET's Supply
Demand
10^3
10^2
10^1
10^0
Co-seismic Activities
Volcanic Activities
(Large scale)
Special Analysis
(Met. Agency)
Emergency Analysis
Real-time Analysis
(Emergency Analysis)
Quick Analysis
J1 Analysis
(Quick Analysis using Joint Ephemeris)
Rapid Analysis
Final Analysis
Volcanic Activities
(small scale)
Final Analysis
Noise Level
~1 second
4 hours
1 day
2~3 Weeks
Duration
(min)
10^0
10^1
10^2
10^3
10^4
10^5
New GEONET's Supply

2. Optimal Observation Period for Single Session of Precise Positioning

- To get the results as soon as possible, GEONET should…
  - 1. realize real-time communication - done
  - 2. reform the system - done
  - 3. shorten the observation period
- There's trade-off relationship between observation period and the precision of results.
- What is the optimal solution?

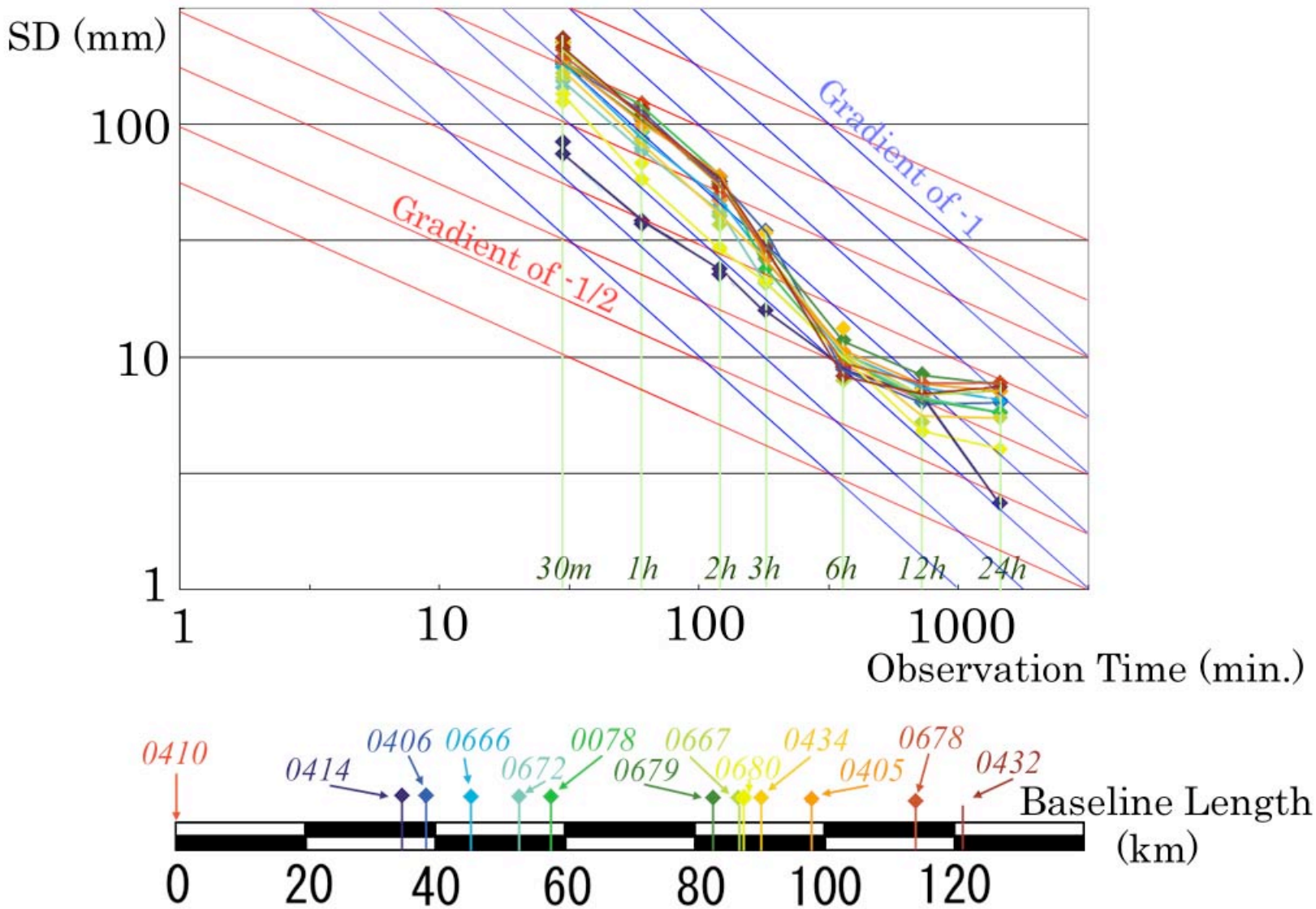


Figure 6. Relation between observation time and precision (represented by standard deviation of the estimated coordinates of the stations) from experimental analysis of GEONET (same as emergency analysis). Statistically, the trade-off curve between above two elements is expected to have a gradient of -1/2 on logarithmic scale. But the result suggests that the gradient of the curve became about -1 when observation time was shorter than 6 hours.

3. Basic Concept of New GEONET

- To resolve the problem with old GEONET system, new system should…
  - 1. be flexible to any combination of receivers/antennas.
  - 2. standardize the data format used in the system (RINEX / RTCM data be used)
  - 3. control the data flow relevantly
  - 4. be compatible with old system for smooth update.

4. New GEONET's Function and Structure

- 1. Reinforcement of the network
- 2. Real-time data transmission
- 3. Structure of the new system
- 4. Enhancement of routine analysis

4-1. Reinforcement of the network

- Number of Stations: 1224
  (as of April 2004)
- Average spacing: ~20km
- New stations include,
  - Mt. Fuji

  The highest mountain in Japan
  - Minamitorishima

  The unique island in Japan on the Pacific Plate

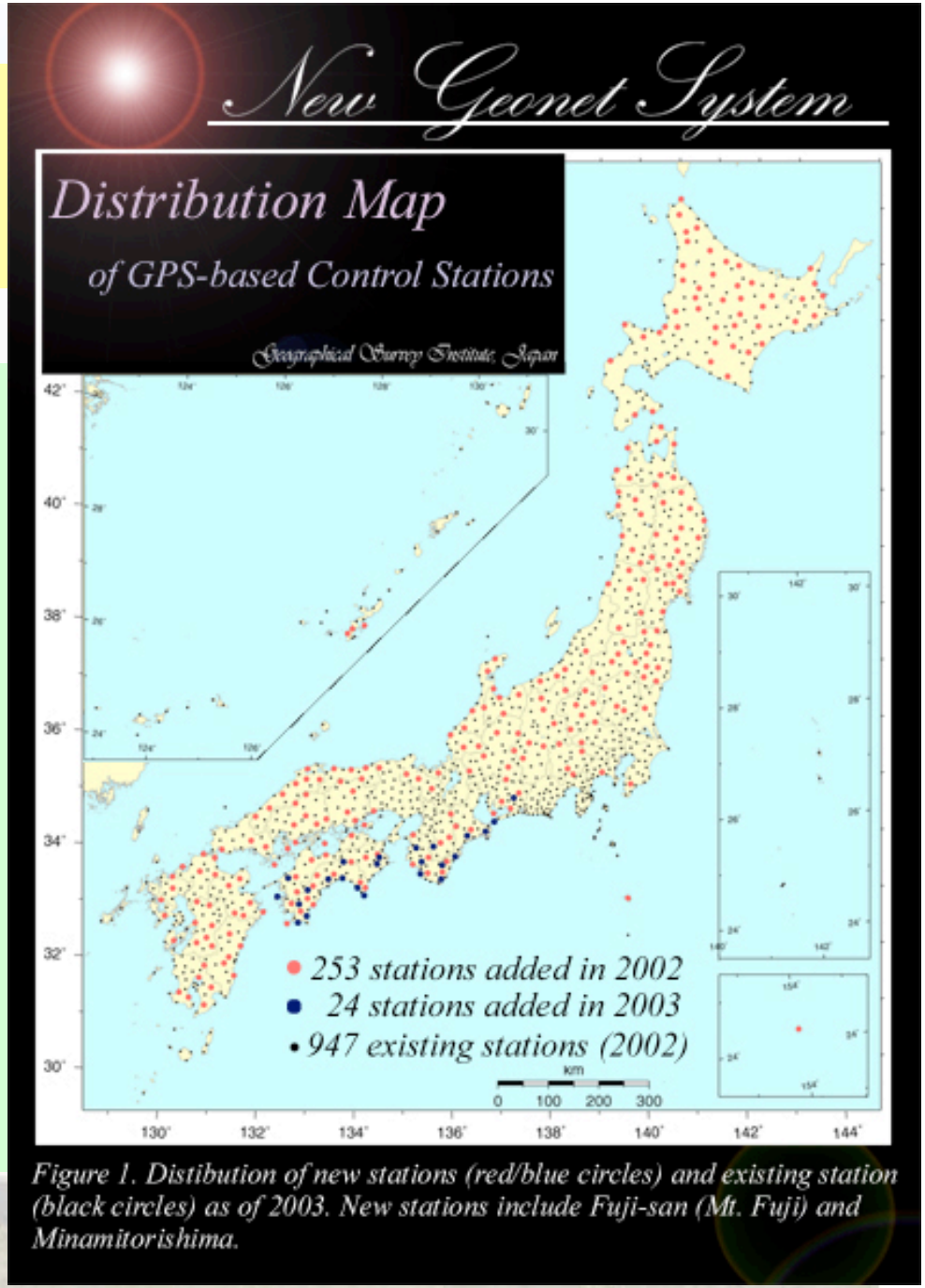


Figure 1. Distibution of new stations (red/blue circles) and existing station (black circles) as of 2003. New stations include Fuji-san (Mt. Fuji) and Minamitorishima.

New Geonet System

New Geonet System

GPS-based Control Station
"Mt. Fuji"

GPS-based Control Station
"The Minamitorishima Island"

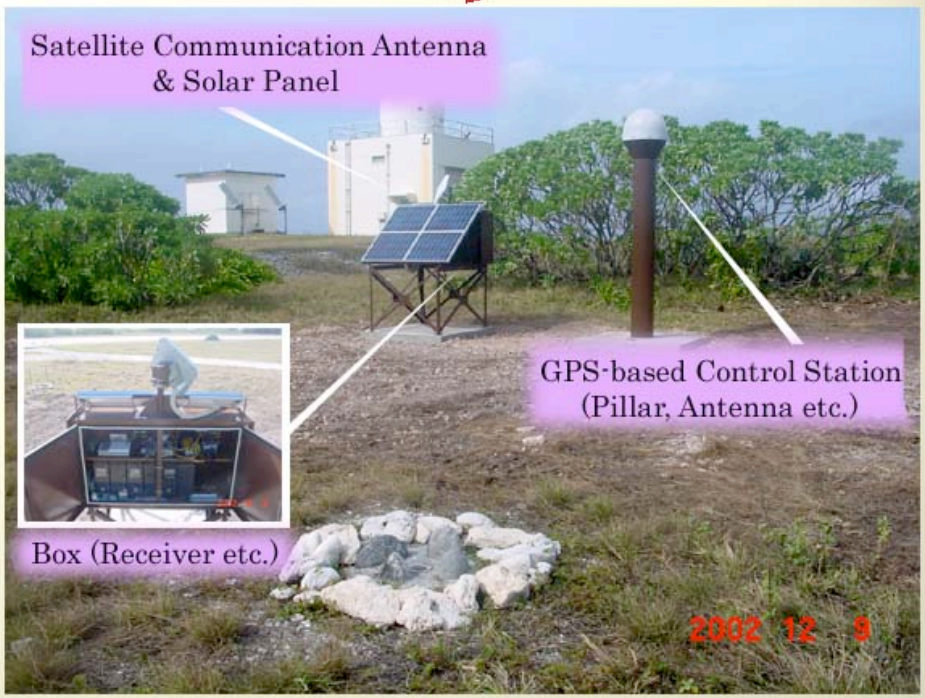


Figure 2. GPS station of GEONET (GPS-based Control Station) "Mt. Fuji" and "The Minamitorishima Island". Each station is equipped with solar panels for power supply and satellite communication instruments for data transmission.

Figure 3. Remarkable features of the new stations (and reformed existing stations).

4-2. Real-time data transmission

- 1 Hz observation at each site
- Real-time communication using IP/VPN network
- 1 Hz data are available to users via distributor (nonprofit organization)

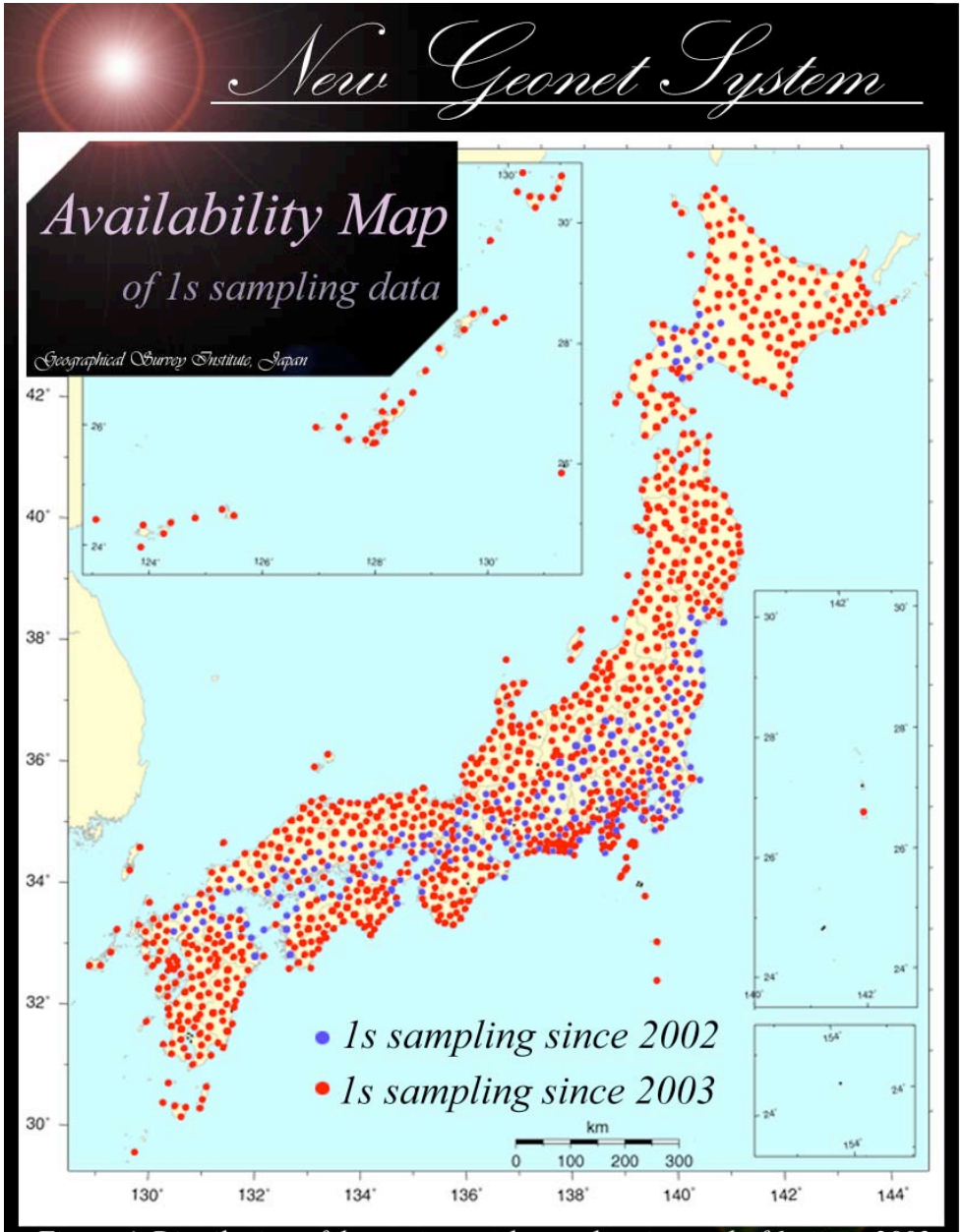


Figure 4. Distribution of the stations with sampling interval of 1s since 2002 (blue circle), and since 2003 (red circle). In 2003, GEONET will realize real-time sampling and real-time data transmission for almost all stations.

4-3. Structure of the new system

- GEONET is functionally divided into 2 parts;
  - 1) GPS observation stations
  - 2) Data Processing System.

- Data Processing System is also divided into 7 parts;
  - 1. Real-time Communication Operating Unit
  - 2. Non-real-time Communication Operating Unit
  - 3. Administration System
  - 4. Data Storage Server
  - 5. Static Data Analysis Unit
  - 6. Real-time Data Analysis Unit
  - 7. Display Units

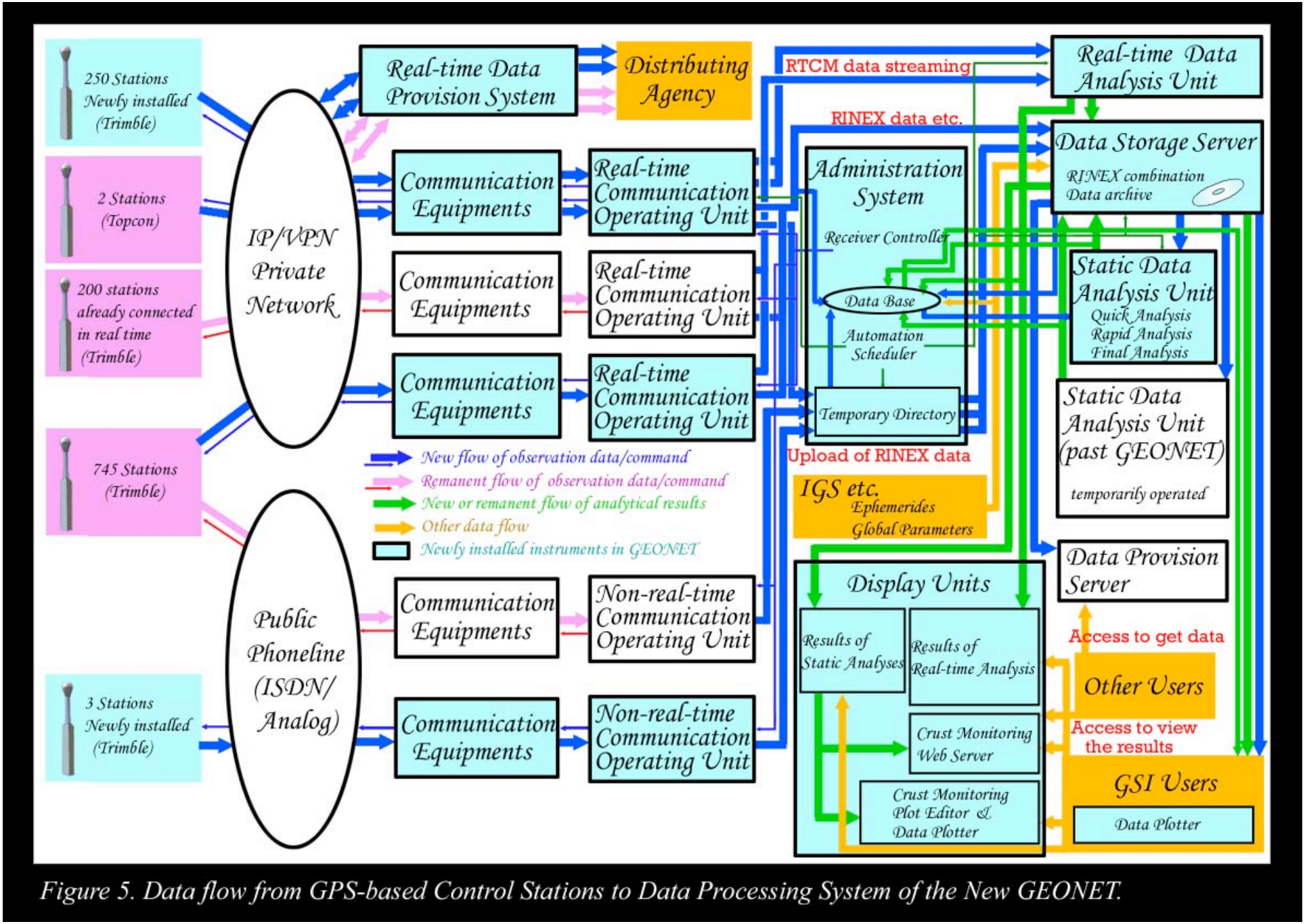
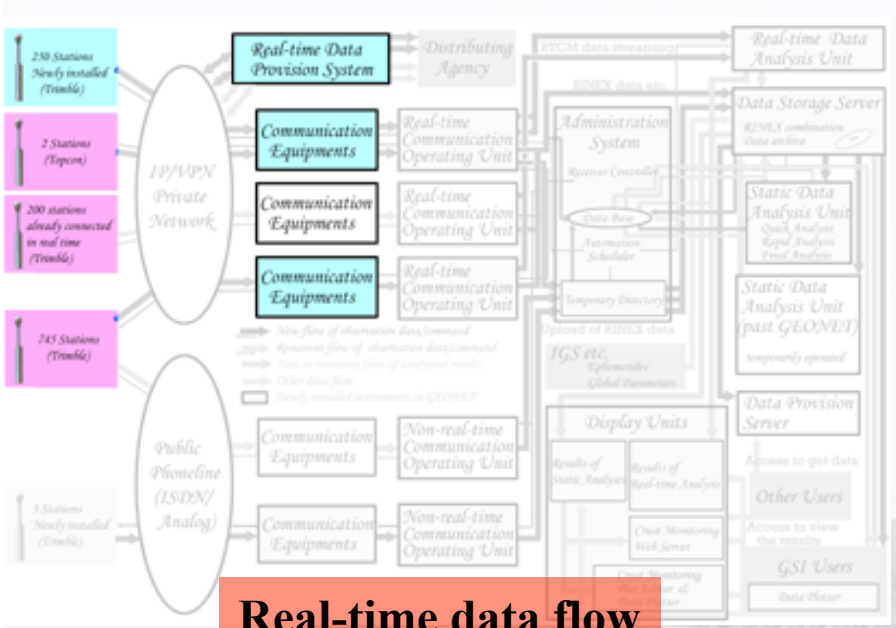
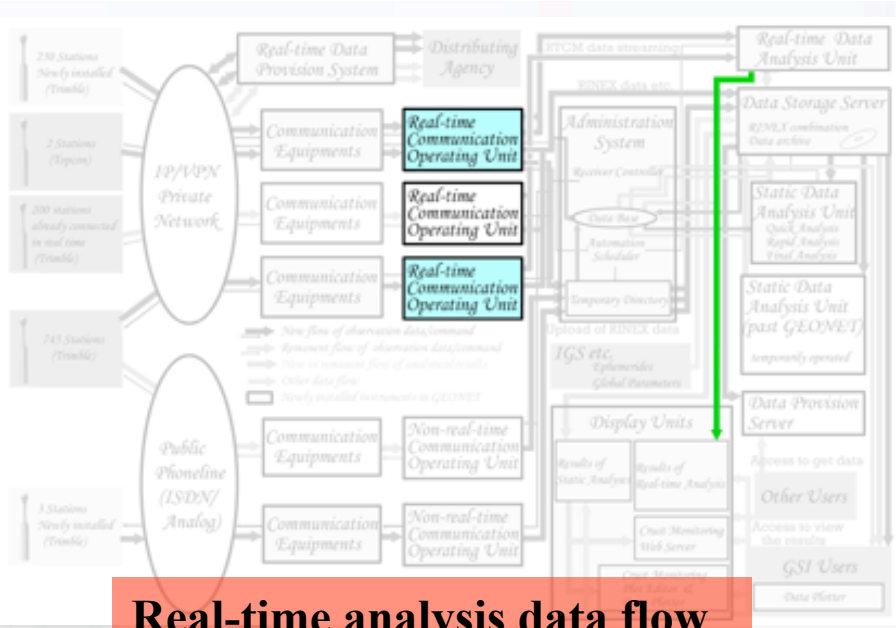


Figure 5. Data flow from GPS-based Control Stations to Data Processing System of the New GEONET.

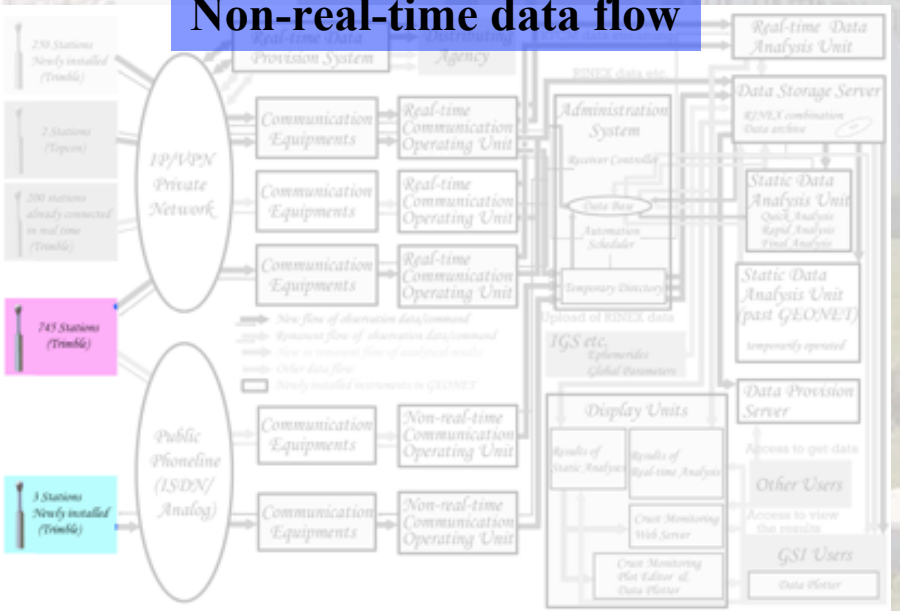


Real-time data flow

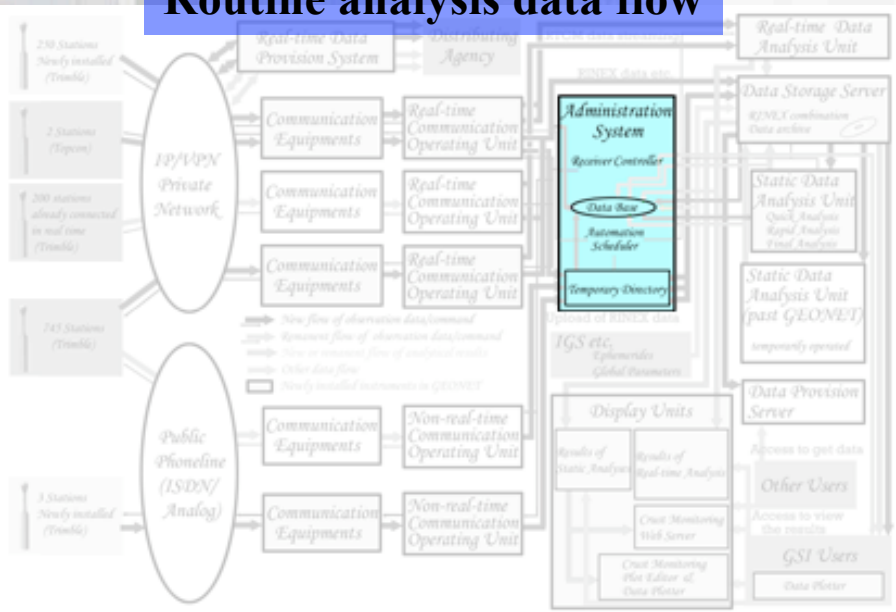


Real-time analysis data flow

Non-real-time data flow



Routine analysis data flow



4-4. Enhancement of routine analysis

- New routine analysis "Quick analysis"
  - 8 times per day
  - For all sites, using 6-hours data
- Special features in analytical strategy.
  - From "receiver-dependent sub-networks" to "region-dependent sub-networks (clusters)"
- 2 real-time analysis machines
  - RTnet (manufactured by GPS solutions Inc.)
  - 3D Tracker* (manufactured by Condor Inc.)

(*limited to 12 baselines, post-processing only)

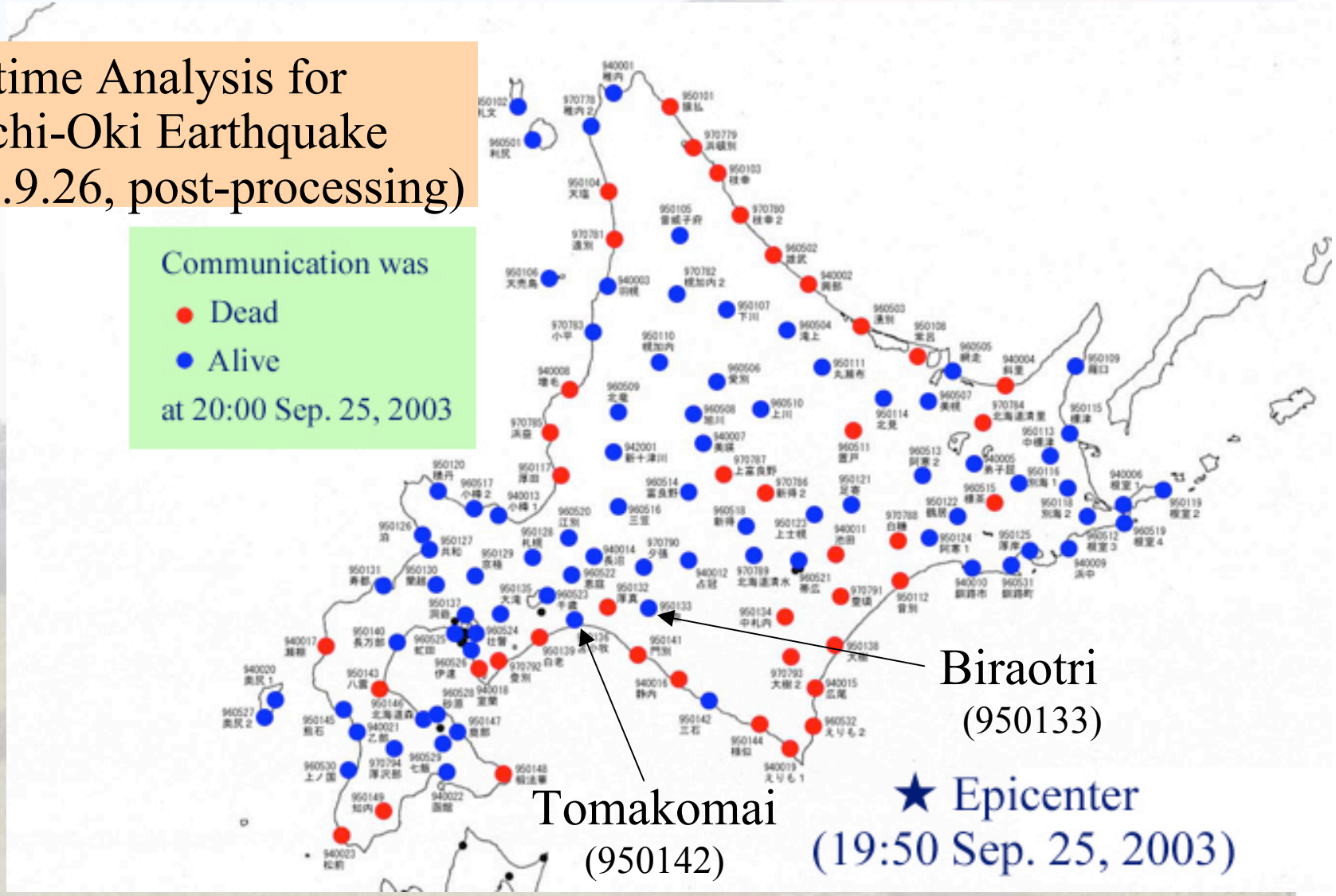
4-4. Enhancement of routine analysis

Input data in routine/emergency analyses of GEONET

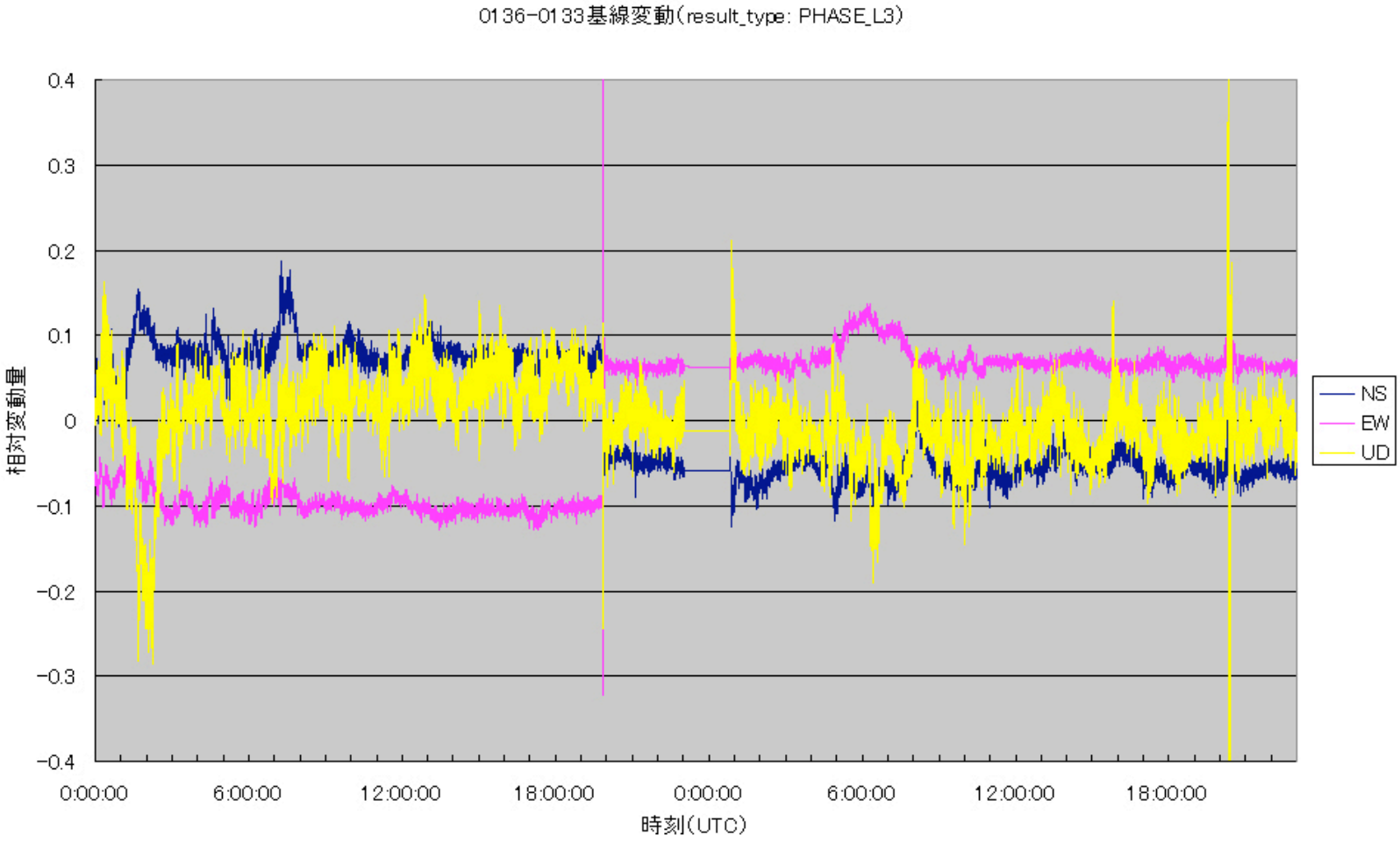
	Former GEONET (~2003)	New GEONET (2004~)
Final analysis	24-hour data of all stations IGS final orbit	24-hour data of all stations IGS final orbit
Rapid analysis	24-hour data of all stations Jointed ephemeris from IGS rapid and predicted orbits	24-hour data of all stations IGS ultra rapid orbit
Quick analysis		6-hour data of all stations IGS ultra rapid orbit
Emergency analysis	6-hour data of 30 stations in maximum CODE predicted orbit	1Hz real-time data of 50 stations in maximum IGS ultra rapid orbit

5. GEONET's Application for Crust Monitoring

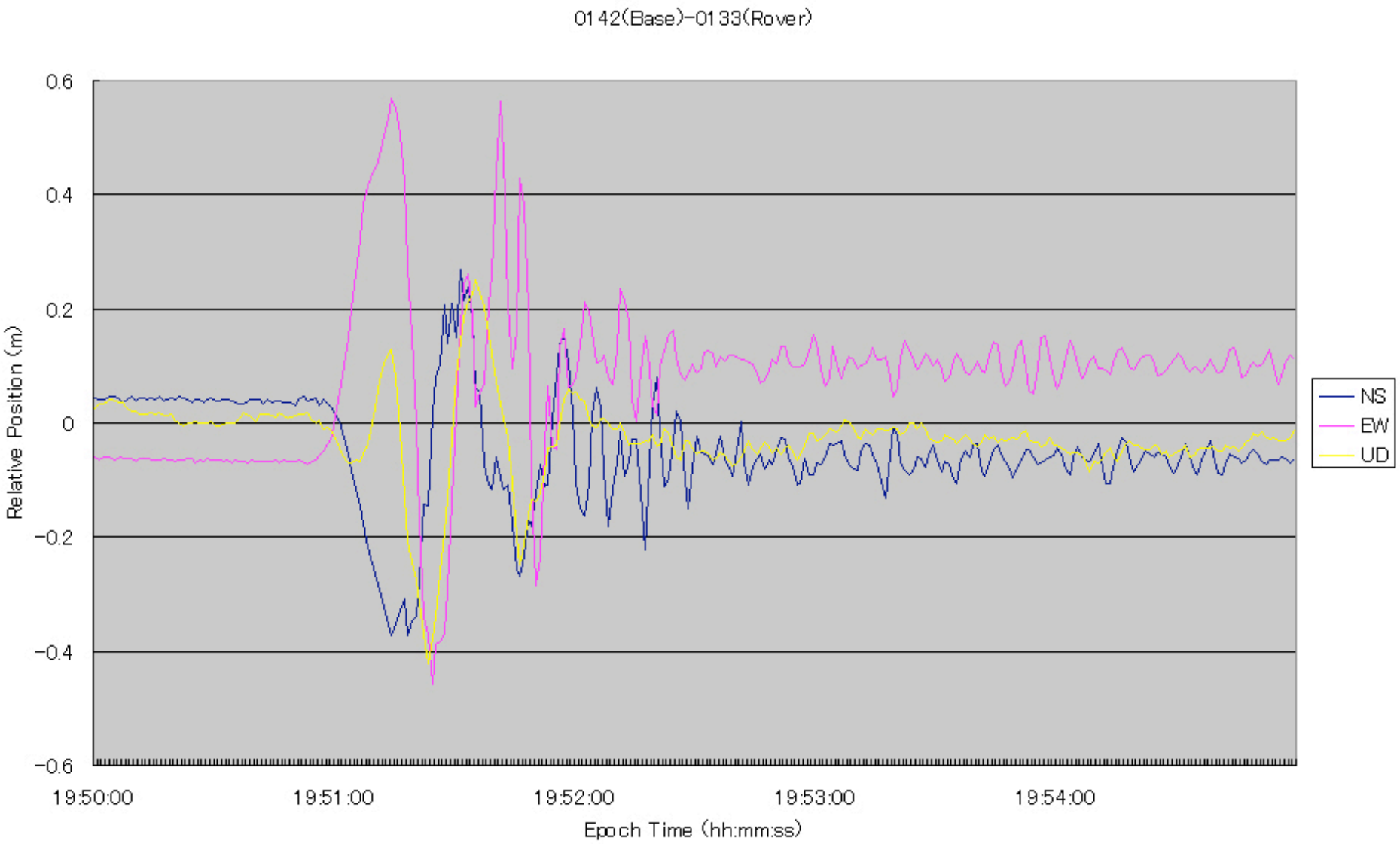
– Real-time Analysis for Tokachi-Oki Earthquake (2003.9.26, post-processing)



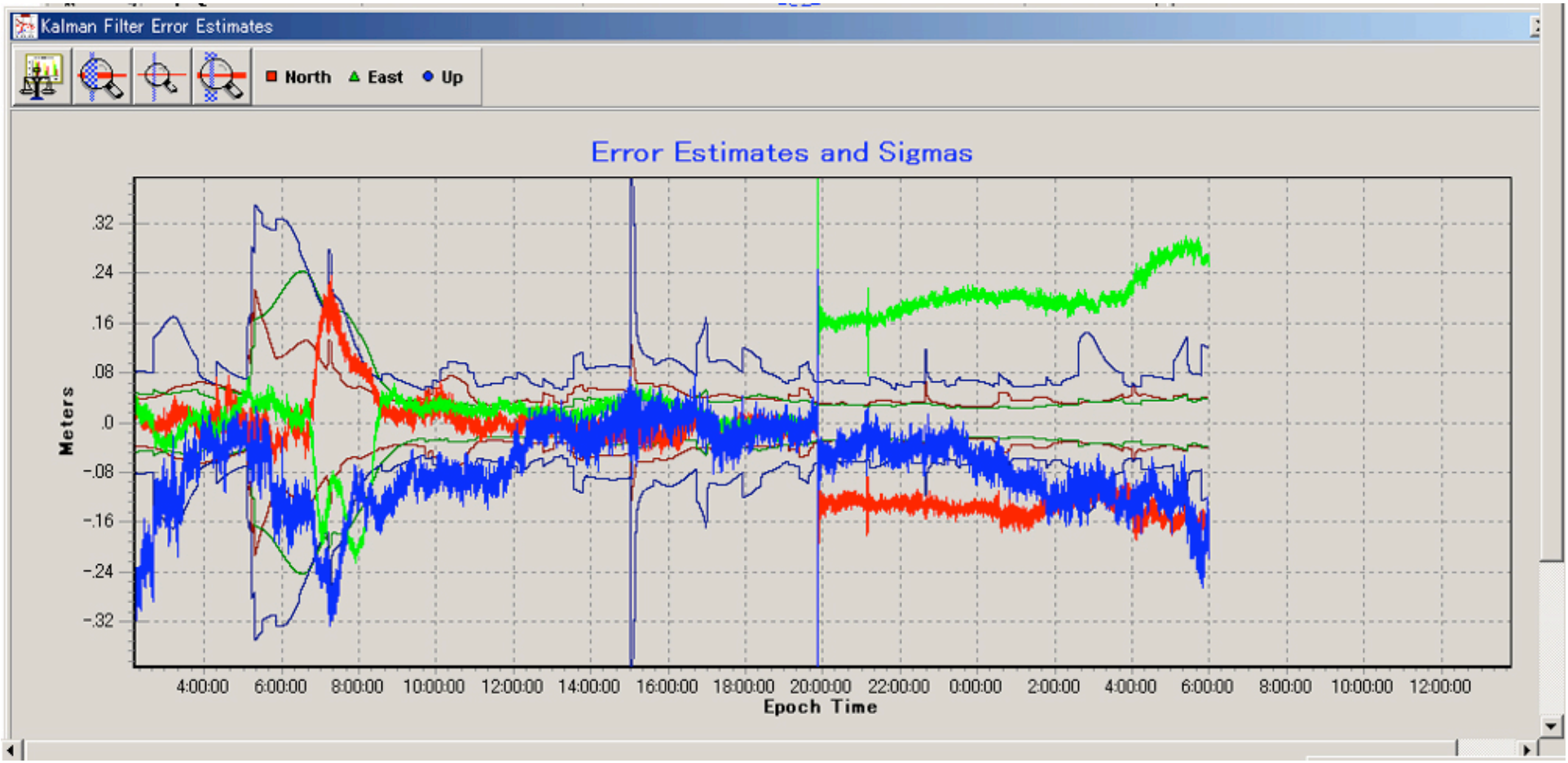
Results from “RTnet” (0:00 Sep. 25 – 24:00 Sep. 26)



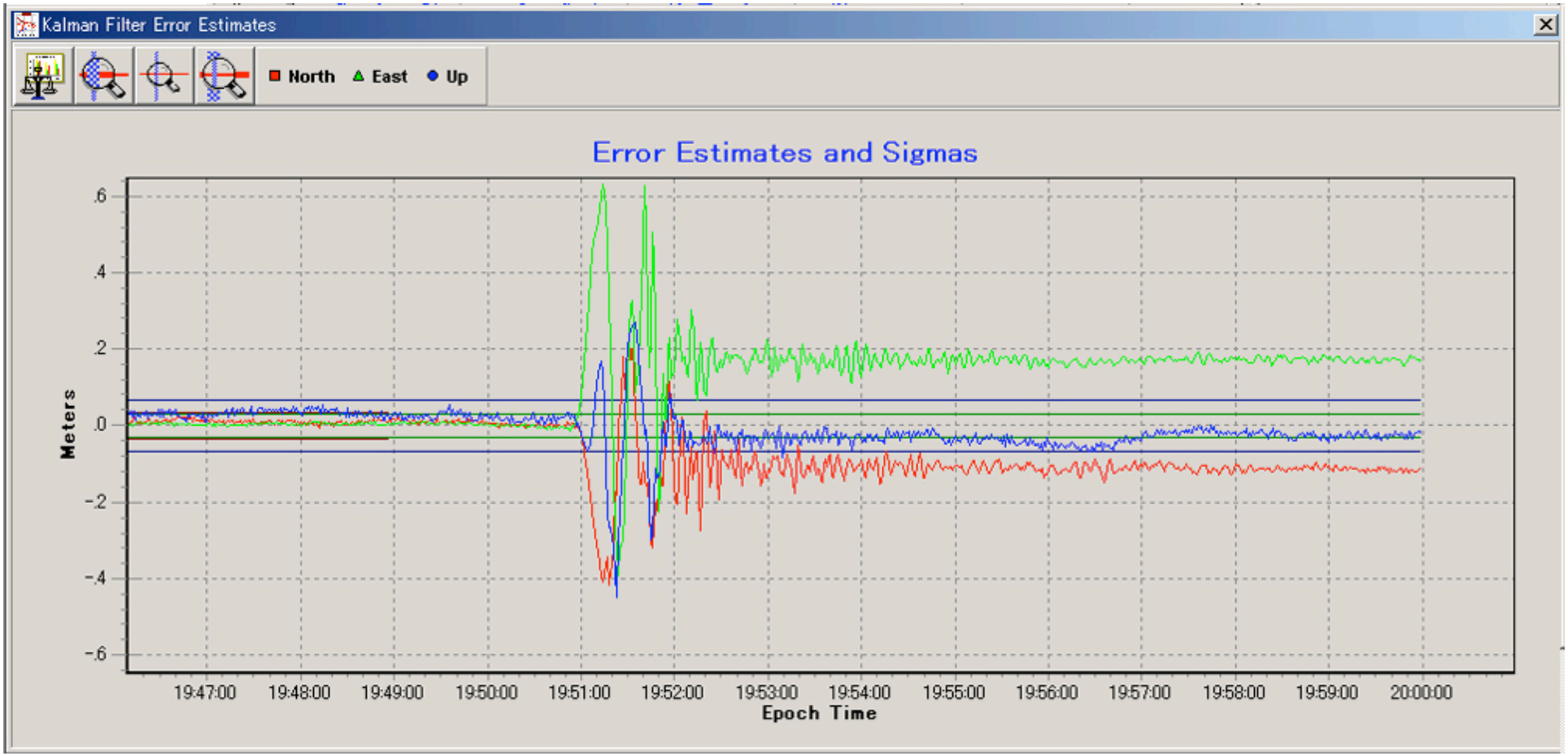
Results from “RTnet” (19:50 – 19:55, Sep. 25)



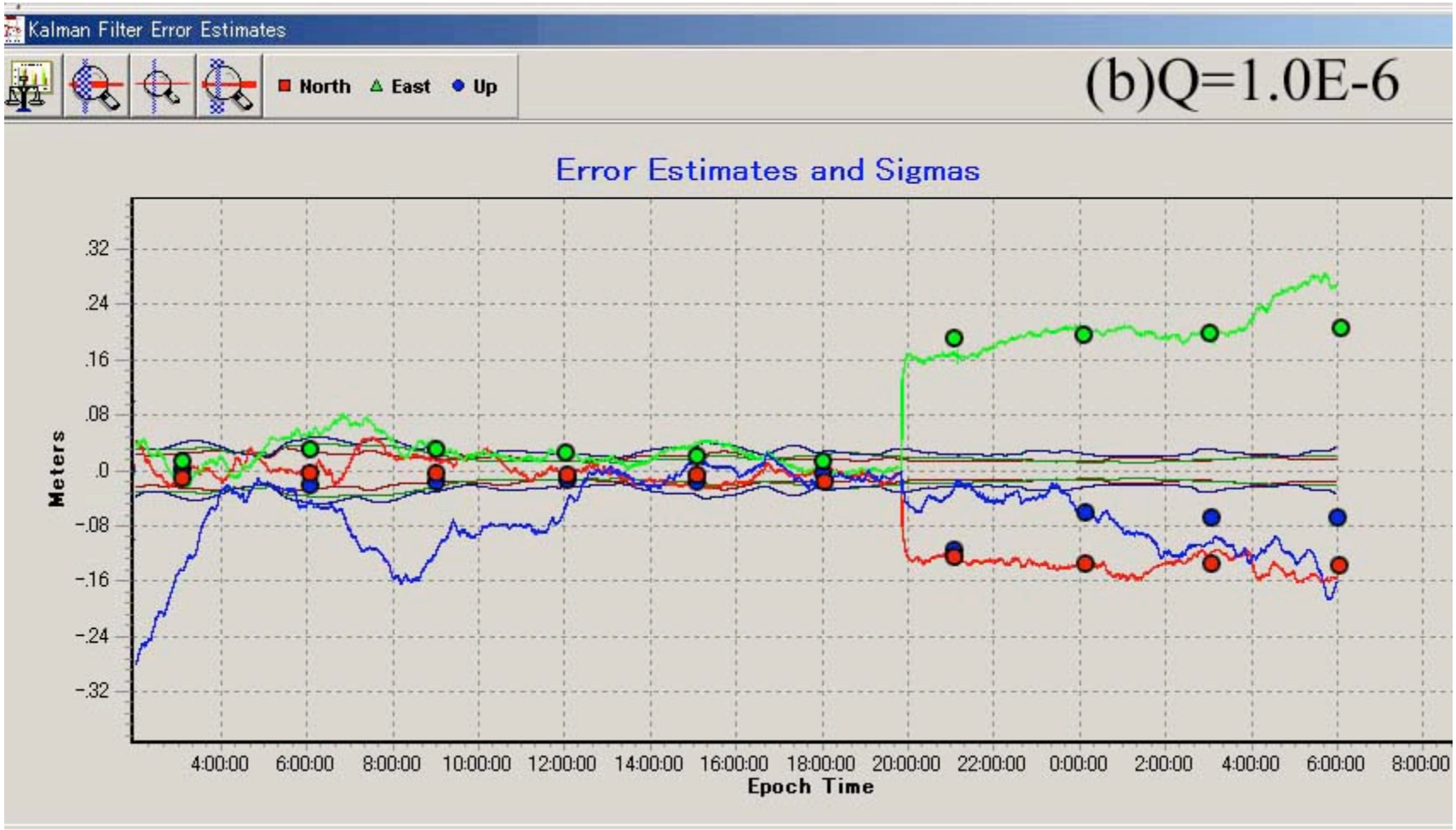
Results from “3D Tracker” (0:00 Sep. 25 – 6:00 Sep. 26)



Results from “3D Tracker” (19:46 – 20:00, Sep. 25)



Comparison of the result from real-time analysis with that from GEONET's emergency analysis



Summary

- 1. Demand and Supply among Current GEONET System for Crust Monitoring
  - New GEONET System can meet current demand
- 2. Optimal Observation Period for Single Session of Precise Positioning
  - 6 hours
- 3. Basic Concept of New GEONET System
  - flexible to any receivers/antennas, standard data format
- 4. GEONET's Function and Structure
  - 1224 stations, real-time, new analyses
- 5. GEONET's Application for Crust Monitoring
  - Real-time crust monitoring

Additional information

Data / Information providing service

- You can get 30-sec interval observation data of restricted period (within the latest Japanese fiscal year) in 5 hours after observations as well as daily solution of the final analysis via anonymous ftp
  - server: terras.gsi.go.jp
  - directories: GPS_products/yyyy/doy/ for obs data
  - coordinates_F1/yyyy/ for old results
  - coordinates_F2/yyyy/ for new results

  yyyy: 4-digit year, doy: 3-digit day of year
- And you can also browse some results as a vector map at http://mekira.gsi.go.jp/ENGLISH/