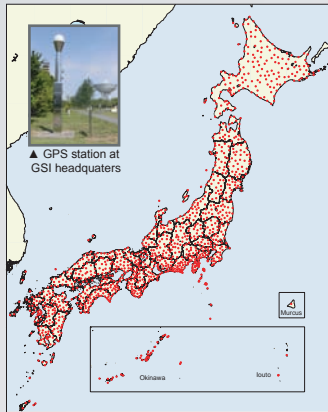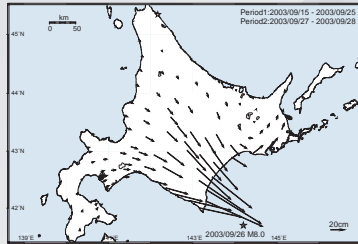# Results and future plan of GEONET real time analysis

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Geographical Survey Institute (GSI), Japan operates a nationwide GPS observation array, GEONET. About 1,220 GEONET stations are operated with a real-time data transmission and a high sampling rate mode. GSI processes the GPS data routinely, not in real time, in order to provide location information for the public and to monitor crustal movement. To monitor crustal movements, it is better to process all the data in real time. However, the data streaming from the stations are too huge to process together in real-time. Therefore, we set up small clusters with limited number of stations and process kinematic GPS in both real-time and post-processing mode when volcanoes become active or earthquakes occur.

The post-processing analysis detected over 80cm horizontal displacement with the 2003 M8.0 Tokachi-oki earthquake. In addition, we detected smaller displacement for several M~7 earthquakes. We are planning to develop the system for near real-time post-processing analysis and to estimate an earthquake fault model utilizing the earthquake early warning service by JMA (Japan Meteorological Agency). Using an earthquake information including occurrence time, magnitude, and location helps us to detect the coseismic displacement from noisy results of kinematic GPS. In the case of the 2004 M6.8 Chuetsu-oki earthquake, estimation of earthquake source fault model with near real-time post-processing are well consistent with a result form GEONET routine analysis.

▲ GPS station at GSI headquaters

▲ Distribution map of GEONET stations. 1223 stations are operated in real time mode

GEONET
(GPS Earth Observation Network)

GPS observation array

Real-time data transfer via IP/VPN communication

GSI

Japan Association of Surveyors

Analysis Unit

Private companies

Real-time analysis 1hz data post-processing

Real-time data Provision

Period1:2003/09/15 - 2003/09/25
Period2:2003/09/27 - 2003/09/28

Horizontal displacement vectors of GEONET stations calculated from results of GEONET routine static analysis (24 hour data with IGS final orbit). A star shows the epicenter of M8.0 Tokachi-oki earthquake occurred at 2003/09/25. The maximum displacement is about 87cm.
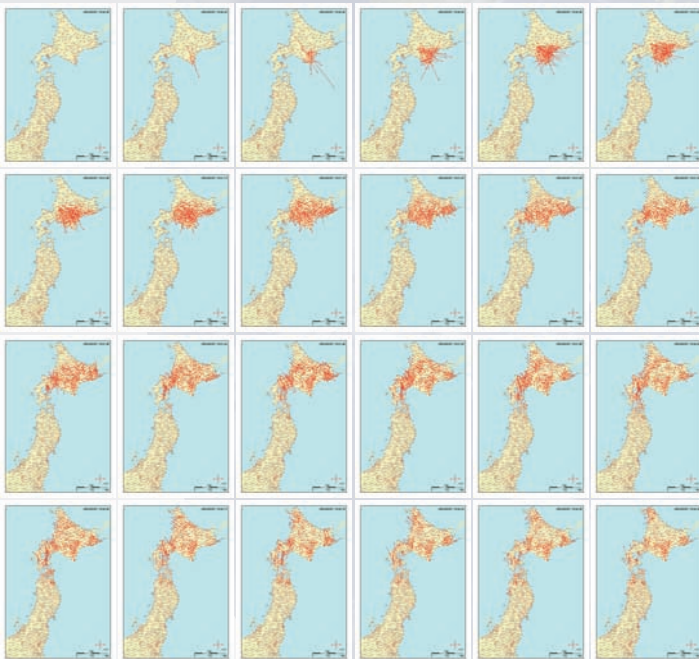
▲ Horizontal strain variation calcuated from GEONET 1Hz data post-processing. Analysis software is RTD (geodetics). Display interval is 5 seconds. The results show both shaking and displacement.
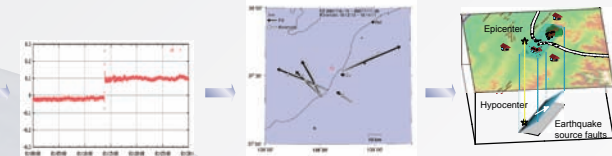
Near real-time post-processing analysis

JMA (Japan Meteorological Agency) earthquake early warning System

earthquake information
- occurrence time
- magnitude
- location

Within 10 - 30 seconds

1) Setting up small clusters with limited number of stations around the epicenter
2) Kinematic GPS processing in both real-time and post-processing mode
3) Calculate horizontal displacement vectors with the analysis result
4) Estimate earthquake source fault model with the displacements

An examle of the post-processing analysis

2007/07/10 - 2007/07/15
2007/07/17 - 2007/07/18

7/16 M6.8
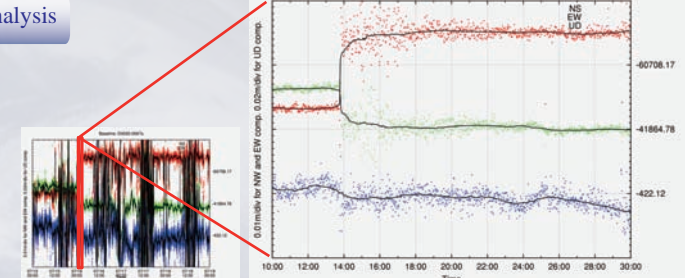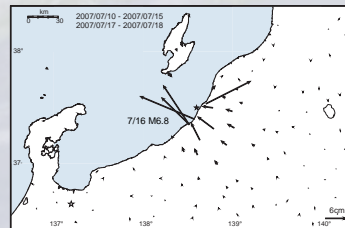
Horizontal displacement vectors of GEONET calculated from results of GEONET routine static analysis (24 hour data with IGS final orbit). A star shows the epicenter of M6.8 Chuetsu-oki earthquake occurred at 2007/07/16. The max displacement is 17cm.

Baseline: D050-0567s

▲ Coordinates time series of GEONET 1Hz data post-processing. Black line is moving median of 121 seconds. The gaps shown in the time series are caused by the 2007 Chuetsu-oki earthquake.
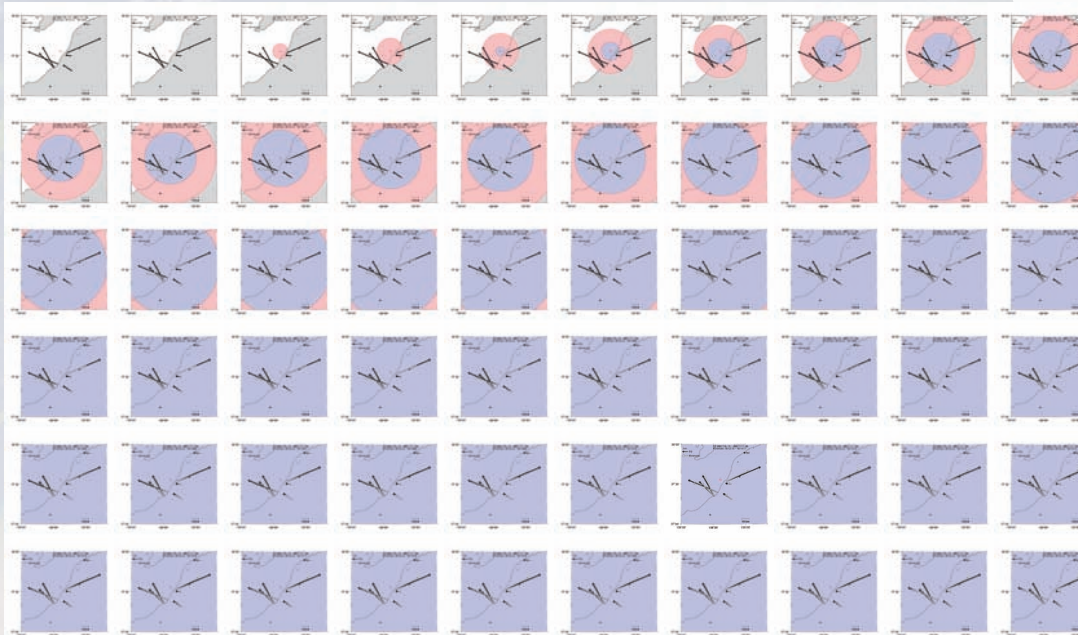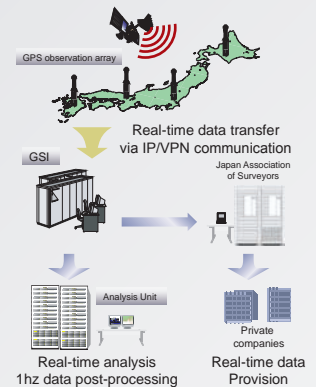
▲ Time series of horizontal displacement vector map around the epicenter of 2007 M6.8 Chuetsu-oki earthquake. The interval is one second. Red circle shows propagation of P wave, purple circle shows propagation of S wave. Black vectors are displacements of GEONET routine static analysis results. The displacements are getting larger with time, and the vectors become stable about 60 seconds after the earthquake occurred. The displacements are calculated from the difference between moving median of 121 seconds before and after the earthquake. This means at least two minutes is necessary to get reliable displacement values.