Geophysical Research Abstracts
Vol. 14, EGU2012-10922-1, 2012
EGU General Assembly 2012

Continuous GPS observations in Tohoku University and recovery effort after the 2011 off the Pacific coast of Tohoku Earthquake

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The nation-wide GPS observation network which is named GPS Earth Observation Network System (GEONET) has been established by the Geospatial Information Authority of Japan (GSI) (Miyazaki et al., 1997). The network composed more than 1,200 stations with baseline length is about 20-25 km.
Tohoku University has also conducted continuous GPS observations since 1987 in the Tohoku district, Northeastern Japan (Miura et al., 1993). Recently, to investigate short-length crustal deformations such as volcanic deformation, co- and post-seismic deformation of M6-7 class earthquakes and inter-seismic deformations, we have deployed continuous GPS observation stations to complement the location of GEONET stations (Miura et al. 2000, 2002, and 2004). We installed GPS receiver, PC for data logging (ALIX series, PC Engines GmbH) and re-booter (e.g., WATCH BOOT nino, Meikyo Electric Co., Ltd.) in each station. We have secure and stable online access to each station from our university (Sendai city, Japan) using IP-VPN over fixed telephone lines (FLET'S Office service, Nippon Telegraph and Telephone East Corp.). Through this network, the data are transferred to our university and we can restart the devices if the devices hang up. Since 2010, we have tried to use on-line system through internet by prepaid mobile data-communication (b-mobile3G and b-mobileSIM U300, Japan Communications Inc.) in eight observation stations. Compared with the FLET'S Office service, we can conveniently and inexpensively establish wherever the mobile phone service is provided. The two stations are located in volcanoes, we activate the network system for an hour in every day using motor time switch, because of these devices are operated by limited DC power supplies through solar cell. In other six stations, we can use commercial AC power supplies, so that data connections are always available.
On March 11, 2011, the 2011 off the Pacific coast of Tohoku Earthquake (Mw 9.0) occurred and a huge tsunami caused more than 19,000 dead and missing. After the main shock, the electricity failure and communication failure occurred in almost entire the Tohoku district. We obtained the GPS data of co-seismic and immediately after the main shock in only about 10% of our stations.
Our observations resumed automatically in inland area as the electricity supply was resumed, while near the Pacific coastal area, recovery efforts were needed on site for resuming the observations. We carried out recovery effort in this area after March 20 when the essential utilities were almost repaired in Sendai city except tsunami-hit area. We used DC power supplies through solar cell and batteries and the prepaid mobile data-communication to operate GPS receivers and transfer data. This system is very useful in the area where fixed telephone and electric wires aren't reconstructed, because of the service of mobile phone is restored faster than fixed telephone service. We could resume the observations in almost all of our stations by April 1.
Currently, we have been constructing redundant system of power supply using batteries to avoid data missing owing to electricity failure. We need to construct redundant network system in future.