Preliminary report on detection of deformation caused by tsunami loading using kinematic GPS

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In recent years, there are many studies on geophysical phenomena with duration shorter than one day by means of kinematic GPS (KGPS) analyses using high sampling-rate data (e.g. Larson[1], Ohta et al.[2]). In principle, GPS measurements enable us to estimate ground displacements directly, without any band limitation except for Nyquist frequency. However, variance of coordinates derived by KGPS analyses increases with sampling-rate. Particularly, there are some literatures reporting trade-off in kinematic solutions with multi-path and tropospheric delay for a bandwidth between tens of minutes to a day.

The 2004 Sumatra-Andaman earthquake generated a large tsunami, which can be loading source causing ground deformations. Previous studies reported on detection of tilt changes caused by tsunami (e.g. Ozawa[3], Tanaka and Tanaka[4]) Nawa et al.[5] detected deformation caused by the 2004 Sumatra-Andaman tsunami using broadband seismometers and a superconducting gravimeter at Syowa station, Antarctica, and compare them with synthetics. The theoretical ground displacement is less than 1mm, so they concluded that it is too small to detect by GPS observation.

In this study, we try to detect ground displacement caused by tsunami using GPS data. From GPS sites with sampling interval of 1 second operated by International GNSS Service (IGS), we selected Diego Garcia (DGAR) located in the middle of Indian Ocean. For GPS data analyses, we utilize a software GPS Tools ver. 0.6.3 (Takasu et al.[6]), which can estimate epoch-by-epoch site coordinates with the precise point positioning (PPP) strategy. We also analyzed data of broadband seismometers (STS-1) at DGAR, derived through Incorporated Research Institutions for Seismology (IRIS) for comparison. The sampling interval of the STS-1 is also 1 second.

As a preliminary result, we detected the signal caused by tsunami loading in the data of broadband seismometer, which can be characterized by its onset time preceding the arrival of the tsunami. On the other hand, GPS displacements show much lower S/N ratio than seismometer and no clear signal in time-series, however, we can see some weak signal in running spectrum. In this presentation, we will discuss noise assessment of KGPS analyses and compare tsunami loading effects with systhetics.

Reference:

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