



## **Very short-term earthquake precursors from GPS signal interference: Case studies on moderate and large earthquakes in Taiwan**

Yu-Lien Yeh (1), Kai-Chien Cheng (1), Wei-Hau Wang (1), and Shui-Beih Yu (2)

(1) National Chung Cheng University, Department of Earth and Environmental Sciences, Chiayi 62102, Taiwan (ylyeh2012@gmail.com), (2) Institute of Earth Sciences, Academia Sinica, Taipei 11529, Taiwan

We set up a GPS network with 17 Continuous GPS (CGPS) stations in southwestern Taiwan to monitor real-time crustal deformation. We found that systematic perturbations in GPS signals occurred just a few minutes prior to the occurrence of several moderate and large earthquakes, including the recent 2013 Nantou ( $ML = 6.5$ ) and Ruesuei ( $ML = 6.4$ ) earthquakes in Taiwan. The anomalous pseudorange readings were several millimeters higher or lower than those in the background time period. These systematic anomalies were found as a result of interference of GPS L-band signals by electromagnetic emissions (EMs) prior to the mainshocks. The EMs may occur in the form of harmonic or ultra-wide-band radiation and can be generated during the formation of Mode I cracks at the final stage of earthquake nucleation. We estimated the directivity of the likely EM sources by calculating the inner product of the position vector from a GPS station to a given satellite and the vector of anomalous ground motions recorded by the GPS. The results showed that the predominant inner product generally occurred when the satellite was in the direction either toward or away from the epicenter with respect to the GPS network. Our findings suggest that the GPS network may serve as a powerful tool to detect very short-term earthquake precursors and presumably to locate a large earthquake before it occurs.