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Revisiting ultra-rapid surface deformation in SW Taiwan using GNSS and ALOS-2 InSAR data

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Southwest Taiwan, located at the end of the Western Foothills, is mainly composed of thick mudstone layer. Two spot-like ultra-rapid surface deformation areas aligned north to south have been identified by the ALOS-1 InSAR result, situated between the Chegualin fault (CGLF) to the west and the Chishan fault (CSNF) to the east. Geodetic observations conducted at the northern spot, located at the northern entrance of Chungliao Tunnel, National Freeway No.3, reveal a vertical velocity of approximately 90 mm/yr and a horizontal rate of 20-30 mm/yr, which are larger than the plate convergence rate in Taiwan. However, is the southern ultra-rapid deformation spot located at the Hsin-young-nu-hu area reliable? why did the ultra-rapid deformation occur at these two locations? Is there a continuity of deformation between two spots? To better quantify the deformation, 6 continuous GNSS stations were installed at the southern and 6 at the northern spot since 2020. GNSS processing was carried out using the Pride-PPPAR software with Precise Point Positioning (PPP). In the northern spot, the horizontal velocity is approximately 30-40 mm/yr across the CSNF. The area between two faults experiences significant uplift, with around 40-50 mm/yr. To identify the spatial continuities between two spot-like areas, the InSAR processing was conducted using 11 ascending ALOS-2 images from 2015 to 2021 to improve the spatial resolution of surface deformation in this region. The ISCE2 was employed for interferogram generation, and the Mintpy was utilized for time series analysis. The step function is adopted while estimating the velocity field to avoid the coseismic effect from the 2016 Meinong earthquake. We introduced a priori fault locations by setting the temporal coherence to correct the unwrapping errors during the default process from the ISCE2 using the SNAPHU. Then, the continuous LOS velocity pattern of around 30-40 mm/yr is shown in a few-hundred meter narrow band between two faults. In the southern part, the high deformation gradient is well consistent with the CSNF, and deformation along CGLF in northern part is broader and appears to continue northward to the Longchuan fault. These observations provide precise constraints on the tectonics, enhancing the interpretation of this area. This ultra-rapid deformation identified in the narrow zone agrees that the hypothesis of mud-cored anticline or mud diapir that developed with two thrusts accompanying with the fault activities in the thick mudstone formation in SW Taiwan.

Keywords: GNSS; InSAR; surface deformation; Chishan fault; Chegualin fault