Observation of aseismic crustal deformation in Taiwan by analysis of InSAR and GPS data

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In general, it is difficult to detect aseismic crustal deformation by InSAR because the interferograms usually contain as long wavelength noises as crustal deformation. In this study, we report aseismic crustal deformation detected by InSAR images and GPS data in southwestern Taiwan where is characterized by high convergence rate and very low seismicity. GPS observation network has been well established there, which is preferable to correct noisy interferograms. A previous study using C-band satellites reported crustal deformation in urban areas, but not successful in the mountainous areas (Huang et al, 2016). In this study, we use SAR data of L-band satellites (ALOS and ALOS-2) to obtain coherent images even for dense forests.
We created three interferograms for ascending orbit spanning from (1) March 4, 2007 to October 25, 2009, (2) April 21, 2008 to March 15, 2011, and (3) June 6, 2008 to October 28, 2010. For descending orbit, we created only one interferogram spanning February 18, 2007 to November 23, 2008 due to the sparse acquisition. For ascending images, we selected these pairs based on the long time span and small perpendicular baseline. All interferograms are independent each other. We used GAMMA software suite for interferogram generation and SRTM DEM to remove topographic fringes.
After removing long wave-length noise and height dependent term from interferograms using the GPS velocity field (Tsai et al, 2015) and DEM, three ascending interferograms look similar to each other. We stacked the corrected interferograms for further noise reduction. The descending interferogram was corrected in the same way. Using these images, we derived the quasi-vertical and quasi-east velocity fields. Looking at the quasi-vertical component (Fig. 1), we found very rapid uplift in the area stretching about 25 km in the N-S direction with about 5 km E-W width. The uplift rate increases from south to the north, and it changes smoothly in western flank, but shows step-wise change in the eastern flank (Fig.1 A-A’). Ching et al, (2016) reported up to 20 mm/yr uplift rate detected by leveling survey passing through the southern part of the uplift area (Fig.1). The quasi-uplift rate obtained by InSAR at the southern part is consistent with those given by leveling survey, which means good accuracy of the corrected interferograms. On the other hand, the maximum uplift rate detected by InSAR reaches up to 45 mm per year at the northern part (Fig.1), twice as large as the rate along the levelling route. Judging from very low seismicity in this region, the severe crustal deformation we detected with InSAR is aseismic.
Ching et al, (2016) suggested that the leveling results cannot be explained only by fault movement but mud diapir is also necessary. The 2-D distribution of whole uplift rate obtained by InSAR (Fig.1) also seems impossible to explain only by fault motion, and mud diapir should be another important factor. We further found a sharp displacement discontinuity across AA’ in Figure 1 in the coseismic interferogram of the Meinong earthquake (M6.4) on February 5, 2016 using ALOS-2 data, which implies that the aseismic uplift is mainly driven by the mud diapir, but the shallow active fault works as a pre-existing weakness.

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