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Crustal deformation from the Wenchuan earthquake derived from ALOS/PALSAR Data

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On 12 May 2008, the Mw.7.9 Wenchuan Earthquake occurred in the Longmen Shan fault zone. This earthquake occurred due to the NW-SE trending compressive stress that originates from the collision of the Indian continent to the Tibet region. It is known that the fault of this earthquake has 250-300 km in length and has dip-slip components with significant right-lateral slip components from geological researches.
The purpose of this study is to examine the slip distribution of this earthquake using ALOS/PALSAR data to disscuss how this earthquake was generated.
We computed the coseismic displacements using SAR-interferometry and offset-tracking to examine the crustal movement in this area. We found coherent fringes in coseismic interferograms. These fringes indicate that the fault slips did not only have dip-slip components revealed by CMT solutions but also noticeable strike-slip components. A set of interferograms shows at least 6 fringes on the northern side of the Longmen Shan fault zone, and 5 fringes on its southern side. We also found some localized concentric fringe patterns around the faults, suggesting a complicated rupture and land slides. We could not estimate the displacements using SAR interferometry in the area closest to the faults because of the low coherence, but the offset-tracking results, which calculated the offsets between two SAR images, revealed about 3m of range increase and about 1m of range decrease on the northern side and the southern side of the faults, respectively. We also analyzed ScanSAR images which were obtained from a descending orbit. These data gave us information on crustal deformation from a different angle. In the obtained interferogram, we recognized up to 80cm range increase, which implied westward shift of subsidence.
We inverted the InSAR data to estimate slip distribution. The method is based on Fukahata and Wright (2008), which simultaneously obtains slip distribution on a fault and its dip angle by minimizing ABIC. We inverted the InSAR data from the ascending orbit and obtained the slip distribution on the fault plane with its optimum dip angle. As a result, we estimated the optimal dip angle of 48 degrees, based on ABIC. The slip is distributed in a zone with approximately 280 km length along the strike and has several peaks of maximum 5m. The thrusting is dominant in the shallower part of the fault plane, while the right-lateral strike-slip is significant in the deeper part. However, in the north-eastern part of the fault, there is a zone with notable strike slip even in the shallower depth. We also jointly inverted different combination of data such as ascending and descending InSAR data, and GPS displacements. Optimal dip angle is estimated to be 49, 50, and 47 for InSAR(ascending) + GPS, ascending + descending, and all three, respectively. Estimated maximum slips for these three cases are 7 - 8 m, and is larger than that for the ascending data only. Furthermore thrust component in the southwestern part and dextral slip component in the northeastern part are larger. These results are consistent with the surface rupture distribution revealed by Lin et al.(2009) and Xu et al.(2009).

Keywords: Wenchuan earthquake, ALOS/PALSAR, inversion, fault model, InSAR, coseismic deformation