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Observation of deformations in Southeast Asia using InSAR: Its progress and problems

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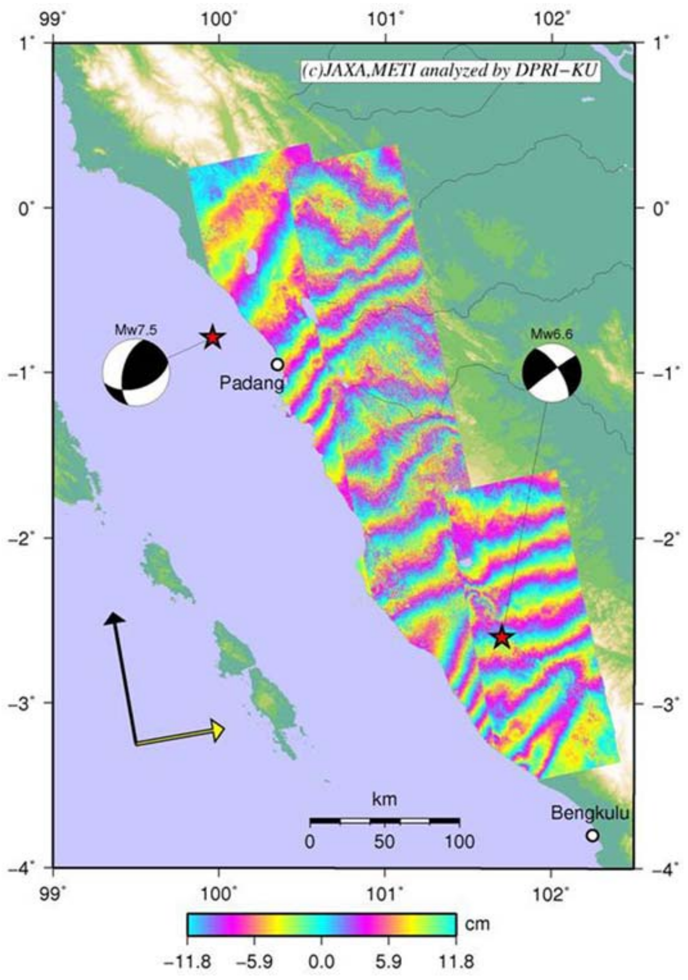
Satellite geodesy has observed a great advance during the last decade and continuous GPS (CGPS) and satellite-borne synthetic aperture radar (SAR) became standard tools to monitor the deformations related to earthquakes, volcanic eruptions, soil movements and human activity on the globe. However, CGPS sites are sparsely distributed in Southeast Asian countries, such as Indonesia, and Thailand, and C-band SAR is unsuitable for the study of surface movements in heavily vegetated tropical forests. These drawbacks have prevented us from studies of deformations in this region.



In January 2006, the Japan Aerospace and Exploration Agency (JAXA) launched a satellite with three sensors onboard. Among these sensors, the Phased Array-type L-band SAR (PALSAR) is a suitable tool for the detection of surface movements in vegetated region and steep ranges because of its long-wave length. We have been studying surface movements in Southeast Asia using the products of PALSAR, including coseismic deformations from the March 6, 2007, Central Sumatra doublets, the 2007 South Sumatra earthquake, the January 3, 2009, Papua earthquakes, the 2009 sequence in central Sumatra and earthquake near Sumbawa Island on November 8, 2009. Fault models are also studied for some of these events. For example, we found the slip distribution of a Mw6.6 earthquake that occurred on October 1, 2009, on the Sumatra fault near Padang. A peak of right lateral slip larger than 80cm was found at the depth of about 5km on a vertical fault plane.

However, we found several issues to be solved for more precise studies. The most serious one is the reduction of ionospheric disturbances. L-band SAR is more affected by ionospheric disturbances than C-band SAR, because of its long wave length. One typical example is shown in Figure. Severe disturbances were observed in this interferogram. The estimated Doppler centroid is variable in the whole image within the ranges between -370 and 650 Hz on October 25, 2009, while the range of Doppler centroid variation was between -300 and 480 Hz for the acquisition on September 9. These acquisitions were made from the ascending orbit around 22:30 (Local time). Therefore large temporal variation in TEC may have deflected the ray path.

Another serious problem is tropospheric disturbance. During the postseismic period following the occurrence of the 2007 earthquake off South Sumatra, concentrated fringes were found on the west coast of Sumatra where significant coseismic deformation was detected. We recoginzed it as postseismic deformation, but found that it is a false signal afterward.

Since ionospheric/tropospheric disturbances have little correlation between different acquisitions, analyses of consecutive images may reveal them. However, acquisition is not so frequent that examination of these disturbances is difficult. Fortunately, continuous GPS sites are increasing in Southeast Asia. These observations may give us important information on these disturbances. Collaboration between these fields should be strengthened in the future.

Keywords: InSAR, crustal deformation, Southeast Asia, coseismic deformation, ground subsidence, ALOS/PALSAR