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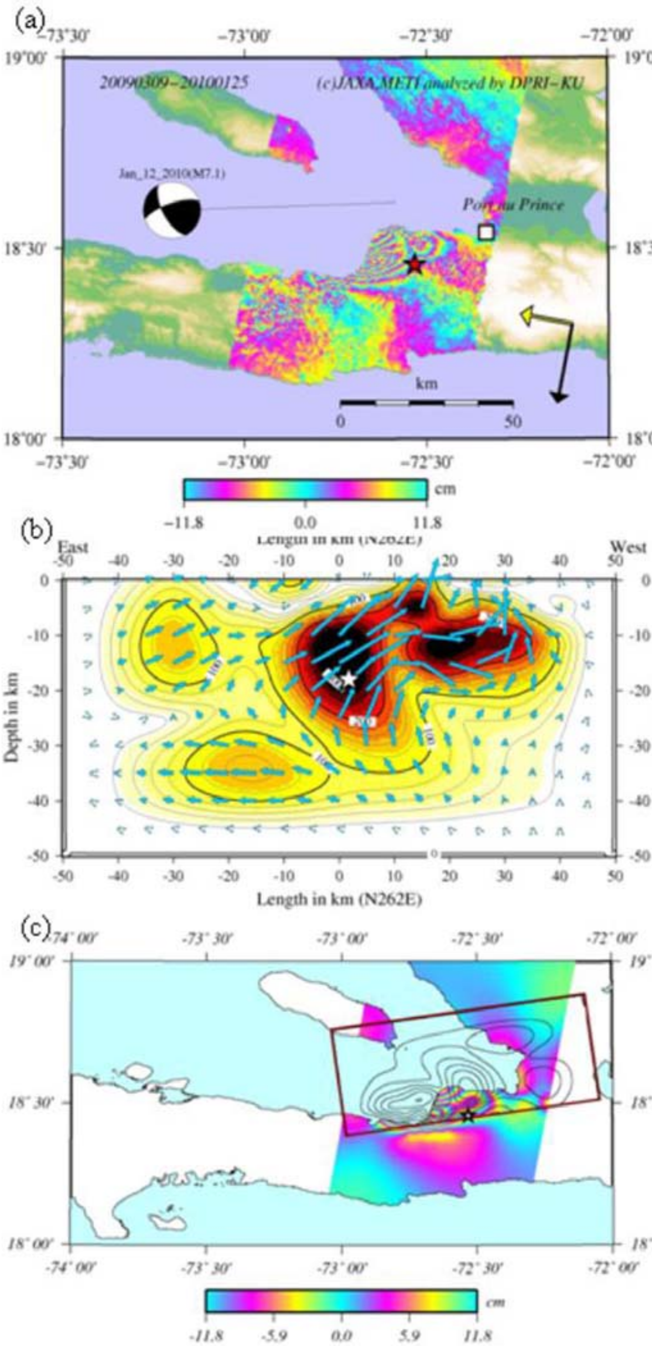
Coseismic deformation from the Haiti earthquake detected by ALOS/PALSAR and its tectonic implications

Manabu Hashimoto[1*]

[1]DPRI, Kyoto University

On January 13, 2010, a Mw7.0 earthquake hit southern Haiti and caused severe damages in and around Port au Prince. This earthquake is considered to have occurred on the Enriquillo fault. It is essential to reveal coseismic deformation from this earthquake and estimate fault parameters for the understanding of earthquake generation process and future seismic hazard evaluation. Therefore we utilize synthetic aperture radar images.



PALSAR (Phased Array type L-band SAR) is an L-band synthetic aperture radar onboard the Japanese satellite named Advanced Land Observation Satellite (hereafter ALOS). ALOS made an urgent observation of PALSAR on January 16 from the Path 138 with the off-nadir angle of 34.3 degree. Performing interferometry with the image acquired on October 11, 2007, using GAMMAR software, we obtained an interferogram with CGIAR hole-filled SRTM DEM (Jarvis et al., 2008). Perpendicular baseline is 267m. Precise state vector was available on Jan. 20, 2010. The eastern edge of the obtained image is about 30km west of the epicenter. This area corresponds to an about 30km wide peninsula which extends westward from Port au Prince. However, we found at least three cycles of fringes (~40cm), which show increase of range toward the center of fringes, on the south side of the Enriquillo fault. We also recognized three cycles of fringes on the north side of the fault, but their gradient is much steeper than the south side.

On Jan. 25, 2010, another acquisition of PLASAR image was made from a descending orbit. Figure (a) is an interferogram of the pair of images acquired on Mar., 9, 2009, and Jan., 25, 2010 (Bperp~811m). We used provisional orbit information of the image in 2010 and performed flattening since large orbital error contaminates the interferogram. Concentrated fringes can be recognized northwest of the epicenter. We can count 6 fringes with color changing in the order of yellow, magenta and blue, implying more than 70cm range decrease. Another circular fringe appears just north of the epicenter. On the other hand, 3 cycles of fringes with the opposite sense appear on the northern coast. Broad fringes can be seen on the south side of the epicenter, which corresponds to that observed in the interferogram from the ascending orbit. These observations imply rather complicated rupture process during the main shock than the results of body wave inversion studies.

I estimated the slip distribution and dip angle of the fault plane by inverting PALSAR interferograms with the method developed by Fukahata and Wright(2008). Their method can estimate dip angle and slip distribution simultaneously under the condition of minimum ABIC. The modeled fault plane is assumed to be 100km long and its depth range is 0-50km. Strike is 262deg from the north. The center of the fault plane is close to the epicenter and the fault plane is dipping northward. I searched dip angle within the range of 46 ? 90 deg with step of 2 deg. I used the interferogram of the pair with the image acquired on Feb. 28, 2009, as the master in the inversion, since it has a better coherence than that with the image in 2007, for the ascending images. I discarded data in the northern region >19N and from the island.
Figure (b) is the estimated slip distribution. Optimal dip angle is 50 deg, which is much smaller than 70 deg of CMT. There are three asperities, one of which is located near the hypocenter and has maximum of about 3m at the depth of 15km. Left lateral strike slip with slight thrust motion is recognized. Other asperities are located about 13km west at a depth of 5km and has about 2.5m slip with significant thrust component. Figure (c) shows synthesized interferograms from the decsending orbit, which roughly explain the characteristics in the observed one in Figure (a).

Keywords: Haiti earthquake, ALOS/PALSAR, coseismic deformation, Carribean plate, SAR, fault model