TO Brownbag Seminar
Thursday, July 24, 2014
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Improve SAR image offsets by considering scattering characteristics

Abstract
Synthetic Aperture Radar (SAR) imagery is a powerful tool that allows for mapping ground movement with the resolution of a few meters. While Interferometric SAR (InSAR) has become the main technique to study earthquake deformation, it only provides one-dimensional measurements along the satellite Line-Of-Sight (LOS) look direction, and it often suffers from interferometric decorrelation. SAR image offsets, on the other hand, can provide unambiguous ground displacements in both the LOS and the along-track (azimuth) directions. However, most SAR offset applications use the conventional offset-measurement method based on cross-correlating regularly spaced sub-images (windows) throughout single SAR images, yet does not take into consideration the variety of scattering characteristics on the ground. Here we show how SAR offsets measurements can be improved by considering the variety of ground scattering characteristics, and by exploring huge volumes of SAR images that have been acquiring in the last two decades.

We will present our recent results of four earthquakes:

1) The 2011 Van (Turkey) earthquake. In this case we show that by focusing on pre-detected sub-images containing strong reflectors, the reliability and accuracy of SAR offsets can be significantly improved.

2) The 2013 Balochistan earthquake. In this case we show that decorrelated SAR images, even in non-interferometry modes, can still be useful in deriving the 3D coseismic displacement field.

3) The 2001 Bhuj (India) earthquake. In this case we show that by taking advantages of multi images, SAR offsets between ERS and ENVISAT datasets can be achieved to reveal, for the first time, the near-field coseismic displacement field.

4) The 2005 Fukuoka earthquake. In this case we show that by properly masking the amplitude images using full resolution coherence map from time-series SAR images, we are able to obtain relative small and smooth displacements in the azimuth direction.

The four cases presented here demonstrate that the application of SAR image offsets can be further extended for many cases that are lack of coherent SAR images. The proposed technical framework allows for retrieving new displacement measurements for many earthquakes occurred in the last two decades, which may help geophysics better understand what happened beneath the surface.