The 2006 slow earthquake on the Guerrero subduction zone, Mexico from InSAR analysis (+ initial results of the 2011 Japan earthquake)

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Abstract
In the last decade several large earthquakes have occurred at subduction zones: Sumatra (Mw=9.2), Maule, Chile (Mw=8.8), and now a month ago in Tohoku, Japan (Mw=9.0). The lives lost and the economic cost due to the earthquakes and associated tsunamis demonstrate the importance of improving our understanding of the hazard at subduction zones. One aspect of this involves understanding the slow earthquakes that also occur on subduction zones, and we present here an analysis of such an event in Mexico. We will also show some InSAR results for the Tohoku earthquake of 11 March 2011 together with some preliminary constraints on fault slip using direct measurements of deformation (GPS and InSAR) and indirect measurements of the tsunami.

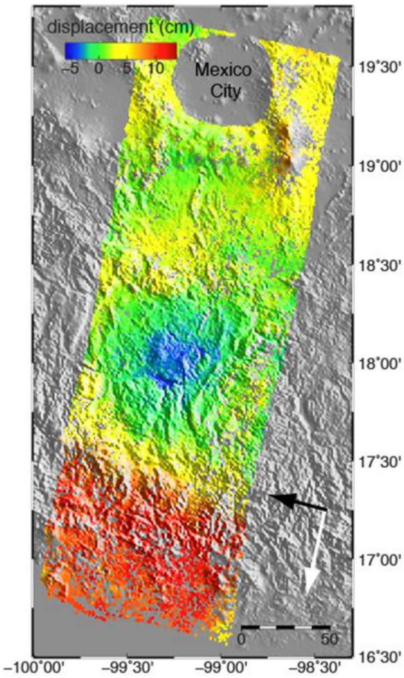
The Guerrero subduction zone, located in the southern part of Mexico, has suffered many large earthquakes in historical times. Still there is a region with a "seismic gap", where no earthquakes have occurred since 1911. It is estimated that a rupture of this gap could result in a Mw=8.0 to 8.4 earthquake. In the past few years it has become apparent that the subduction zone is also very active in terms of slow earthquakes, or Slow Slip Events (SSEs). Since 1995, one large event has been observed approximately every four years (1998, 2001, 2006 and 2010).

Up until now, most geodetic observations of the SSEs have been made using GPS techniques only. The slip solution is unfortunately not well constrained due to low spatial density of the GPS stations. By using radar imaging, the spatial resolution can be considerably increased, allowing subduction interface models to be better constrained.

The radar Interferometry (InSAR) technique enables us to measure the change in distance from a satellite to the target. Applying InSAR to Guerrero is challenging due to high decorrelation noise near the coast and large propagation delays through the atmosphere. However, by using a time series InSAR technique and by developing and applying new methods for atmospheric correction, reasonable results for the slow slip surface deformations are obtained that correlate well with the GPS observations.

Both GPS data and the obtained InSAR results were used for modeling of the SSE. The GPS data constrain the long wavelength errors in the InSAR data, while the InSAR data themselves constrain the distribution of slip at a higher resolution than possible with GPS alone. We show that the regions where slip is constrained by both the GPS and InSAR technique, the slip does not enter significantly into the seismogenic zone, as suggested by studies using GPS alone. Areas that slip coincide with an ultra-slow velocity layer detected from seismic imaging, indicating the importance of high pore pressures in the mechanism for slow slip.

Estimated deformation due to the 2006 slow slip event on the Guerrero subduction zone. The satellite was travelling in the direction of the white arrow and looking in the direction of the black arrow.



David Bekaert recently completed his master in Earth observation, dedicated to the study SSEs in Guerrero using PS-InSAR, at the Aerospace Engineering faculty of Delft University of Technology. Currently he is doing a traineeship at ESA (ESTEC).

Dr. Andrew Hooper is Assistant Professor in the Remote Sensing department at the Aerospace Engineering faculty of Delft University of Technology. His background is in geophysics. Current research interests include interferometric SAR processing algorithms and modeling of volcanic, tectonic and glacioisostatic deformation.

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