Geophysical Research Abstracts
Vol. 20, EGU2018-18429-1, 2018
EGU General Assembly 2018

Topography-induced bias in models of volcano deformation at Chiles-Cerro Negro volcano, Colombia

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A source model of deformation was developed in this work for the Chiles-Cerro Negro Volcanoes on the Colombia-Ecuador border region using the Finite Element Method (FEM) and RADARSAT-2 Interferometric Synthetic Aperture Radar (InSAR) images from May of 2014 to November of 2014. Uplift of up to 20 cm at the South flank of Chiles Volcano and subsidence of up to 5 cm to the East of it were found, believed to be related either to magma intrusion or slip on a nearby fault. We first modelled the deformation analytically, following the methodology used in Parks et al. (2014), using two types of sources: a spherical pressurized reservoir and an oblique dislocation. The dislocation produced a better fit with the observed data, with a total slip of 1.05 m, width of 1.3 km, length of 4.2 km, depth of 1.9 km, rake of 122 degrees, dip of 47 degrees and strike of 189 degrees from North, which differed slightly from the results of Parks et al. (2014). We then used the finite-element method to explore the effects of including topography in the region. We found that the surface deformation for changed significantly when the same parameters were used in a FEM model which included the local topography, indicating that the half-space assumption is not valid for modelling deformation in this region. Our model shows that the deformation can mainly be explained by an oblique fault, but given the strong influence of topography on the source model parameters, more complicated models than the analytical ones, including heterogeneities in the material properties, should also be explored.The region also experienced intense seismic activity during the same period (> 500000 events in 2013-2015). These events form a cloud roughly located at the same position as the InSAR deformation with depths ranging from 2 to 6 km. While some events are of volcano-tectonic origin, many show long period (LP) and very-low-frequency (VLF) signatures and some tremors were also observed. LP, VLF and tremors are often associated with fluid displacements at volcanoes. The simultaneous observation of tectonic together with long-period seismicity means that faulting and fluid-related processes are likely inter-connected in this region. This work seeks to enhance the knowledge of the Chiles-Cerro Negro region and contribute to efforts on the mitigation and prevention of volcanic hazards in the region.