Geophysical Research Abstracts
Vol. 17, EGU2015-9487-1, 2015
EGU General Assembly 2015

Sar interferometry time series analysis of surface deformation for Piton de la Fournaise volcano, Reunion Island

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Piton de la Fournaise, located on the south-eastern side of Réunion Island in the Indian Ocean, is a hotspot oceanic basaltic shield volcano whose activity began more than 500,000 years ago. It is one of the most active volcanoes in the world with a high eruptive frequency on average one eruption every 9 months since 1998. In April 2007, Piton de la Fournaise experienced an exceptional eruption which is considered as the largest historical eruption ever observed during the 20th and 21th centuries, characterized by an effusion of 210 $\times$106 m3 volume of lava with a 340 m consequent collapse of the Dolomieu crater and the onset of a landslide on the eastern flank. ENVISAT and ALOS data analysis showed that the subsidence of central cone and landslide of eastern flank continued deforming after this eruption at least until June 2008, but no clear ground deformation has been detected after this date from Band-C or Band-L radar images. We so perform a detailed spatio-temporal analysis of ground motions on Piton de la Fournaise using X-band InSAR time series acquired from 2009 to 2014. X-Band was chosen because it provides high spatial resolution (up to 1 m), short revisit period (minimum 11 days) and a highest sensibility to ground deformation. Our large dataset of X-band radar images is composed of 106 COSMO-SkyMed and 96 TerraSAR-X Single-Look Complex images acquired in ascending and descending orbits. The interferograms were generated using DORIS. A high resolution reference Digital Elevation Model (DEM) (5m x 5m Lidar DEM) was used to model and remove the topographic contribution from the interferograms. We employed next StaMPS/MTI (Hooper et al., 2012) to generate the displacement time series and we analyzed the time-dependant behavior of surface displacement using a principal component analysis (PCA) decomposition. This analysis clearly reveals that the large eastward motion affecting the eastern flank of Piton de la Fournaise remained active (LOS velocity of about 25 mm.y-1) at least until July 2012. Another important result is that the displacement maps show evidence of time-dependant processes acting at the central cone.