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Sentinel-1 interferometry and modelling of the 2014 Fogo volcano crisis

Mehdi Nikkhoo (1), Thomas R. Walter (1), and Pau Prats-Iraola (2)

(1) GFZ Potsdam, 2.1, Potsdam, Germany (twalter@gfz-potsdam.de), (2) German Aerospace Center, Microwaves and Radar Institute, Weßling, Germany

The Sentinel-1 mission is a European Space Agency's mission with the aim of earth surface monitoring on land and sea. Through the ESA project INSARAP, we aim at studying the Sentinel-1 InSAR performance for different study areas, and developing new routines for TOPS data analysis. Here we describe results achieved from Sentinel-1 acquisitions over Fogo Island, Cape Verdes. A new volcanic eruption occurred on Fogo volcano in November 2014, leading to a request for assistance communicated by the European ERCC (Emergency Response Coordination Centre). The eruption occurred after a 20 yr period of quiescence inside the Cha das Caldeiras, the embayment of a pre-historic giant landslide. The eruption affected populated areas and has lead to significant loss and destruction, forcing thousands of inhabitants to leave their homes. The timely acquisitions of Sentinel-1 data allows us the comparison of the amplitude and phase differences before and after the eruption. This is one of the first applications of Sentinel-1 data, allowing testing the system and accurate measurements of the deformation processes associated with the volcano eruption. Sentinel-1 InSAR results processed by us in ascending and descending geometry, allows developing numerical models to explain the deformation. To this aim we make use of a novel boundary element code that is based on the artifact free analytical solution of triangular dislocation elements (see Nikkhoo and Walter, 2015, Geophys. J. Int., doi:10.1093/gji/ggv035). The models consider topography and complex source geometries. We find that the magma dike is largely emplaced within the subaerial part of the volcano edifice, where the steep topography has large effects on InSAR results, the surface displacement, and the parameters of the models. Embedded in an inversion scheme, we could reproduce most of the deformation signals as determined in the Sentinel-1 InSAR data, although residuals remain in localized areas that might be associated to processes different than the considered dike. This work hence shows one of the first use of Sentinel-1 data in a volcanic crisis and helps assessing the magma path at depth and associated deformation complexities, relevant for preparation and designing monitoring networks for future eruptions.