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High resolution deformation maps of Volcán de Colima, Mexico, derived from a year-long TerraSAR-X Spotlight time series

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Volcán de Colima is a steep sloped explosive stratovolcano located in southern Central Mexico, and one of the most active volcanoes in North America. Major recent historical eruptions occured in 1818 (VEI 4) and 1913 (VEI 5), which removed several hundred meters from the summit of the volcanic edifice [1], and point towards the activity being marked by 100-year cycles which terminate in a large Plinian eruption. Also, five large flank collapse events have been identified during the Holocene [2]. Since the beginning of the most recent eruptiove period in 1998, the type of activity has been varying between predominantly explosive, dome building and dome collapse.

Between 2007 and 2011, the activity at Colima was characterized by dome extrusion. The volcano then entered a period of low activity, which lasted until January 2013, when a series of explosions took place which initiated a new, still ongoing period of dome growth. The historical eruption of 1913, as well as the renewal of the activity in 2013, were both preceeded by longer periods of low activity, and only very limited short term precursors. The year 2012 at Volcán de Colima is therefore a good example to study volcanic activity in periods of quiescence, but leading up to an eruption. Furthermore, the possibility of a larger event in the future make it a particularly important volcano to study.

We have acquired TerraSAR-X data in spotlight mode for ascending and descending tracks over Colima, obtaining a high spatial resolution of up to 2 m, and a temporal resolution of up to 11 days. Here we present the time series of the dome deformation between February and December 2012.

We generated interferograms using an updated version of DORIS, accounting for the doppler variation in along track direction [3] and subsequently analysed the time series of the deformation pattern with the small baseline – persistent scatterer (PS) approach implemented in the StaMPS software. We removed the topographically correlated atmospheric contribution by applying a linear correction to each small baseline interferogram. In combination with a high resolution LIDAR digital elevation model the spotlight data allows the detection and quantification of slow deformation in the region of the dome in an unprecedented spatial and temporal resolution, considerably higher than those achieved by other methods.

The results from the PS approach are compared to those from processing the interferograms using the GAMMA software, and deriving the time series from the filtered, unwrapped and geocoded interferograms using GIAnT. We find that, in this scenario, using GIAnT offers disctinct advanages, in particular the faster processing time and overall spatially smoother results.

The velocities in either look direction reach up to 10cm/year in line of sight, the maximum subsidence being directed towards the centre of the dome, but very low velocities at its borders. The velocities in the center of the dome strongly decrease over the time period analysed, with only a fraction of the total displacements occuring the last months of 2012. We explore whether this pattern may be explained with cooling, the collapse of bubbles in the viscous dome material, or even presents a first sign for the looming renewal of volcanic activity at the beginning of 2013 [4].

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4. Salzer, J.T., et al., Satellite radar data reveal short-term pre-explosive displacements and a complex conduit system at Volcán de Colima, Mexico. Frontiers in Earth Science, 2014. 2.