Surface deformation of Asama Volcano, Japan, detected by time-series InSAR combining persistent and distributed scatterers, 2014-2018

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Asama volcano, located in Central Japan, is one of the most active volcanoes in Japan. Surface deformation at Asama volcano has rarely been documented because of its high topography and snow cover at the summit. In this study, we present first Interferometric Synthetic Aperture Radar (InSAR) observation of ground deformation of Asama volcano with 120 Sentinel-1 SAR images from both ascending and descending tracks and 20 ALOS-2 images from a descending track acquired between 2014 and 2018. We exploited both persistent and distributed scatterers to overcome SAR signal decorrelation and applied the three-dimensional unwrapping method to retrieval displacement time series efficiently. Our observations reveal asymmetric deformation at Asama volcano with two main deformation regions at the northeast and southeast flanks of the volcano, respectively. The northeast flank (NEF) exhibits line-of-sight (LOS) extensions in all the three SAR datasets with maximum velocities of 14, 10, and 12 mm/year for the descending ALOS-2, ascending and descending Sentinel-1 measurements, respectively. The southeast flank (SEF) shows LOS extension in the ascending observations and LOS shortening in the descending observations with velocities between -12 and 9 mm/year, respectively. Decomposition of the LOS displacements reveals nearly pure vertical subsidence at the NEF, while the SEF also shows an evident eastward component other than vertical subsidence. Comparisons of the vertical subsidence at two continuous GPS stations near the summit crater with our InSAR observations indicate small discrepancies smaller than 3 mm/year. We interpret that the subsidence at the NEF is primarily due to the cooling contraction of pyroclastic deposits emplaced in the 1783 eruption, and the SEF is susceptible to flank instability. The asymmetric deformation of the volcano may also be related to the hydrothermal activity that is controlled by the underground structure of the volcano. This study highlights that much more efforts should be taken to monitor the slope instability of Asama volcano in the future.

Keywords: Synthetic Aperture Radar, Time-series analysis, Thermal contraction

