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'Understanding volcanoes and society: the key for risk mitigation'



Recent unrest (2002-2015) imaged by InSAR geodesy at Villarrica and Calbuco volcanoes (Southern Andes)

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Villarrica and Calbuco are two of the most active and dangerous volcanoes in the Southern Andes and we use Interferometric Synthetic Aperture Radar (InSAR) observations from multiple satellites (ENVISAT, ALOS, RADATSAT-2, COSMO- SkyMed, TerraSAR-X and Sentinel-1A) to constrain ground deformation between 2002 and 2015, including eruptions at both edifices. We find transient ground deformation that we invert using analytic elastic half space models to make some of the first geophysical inferences about the source depths of potential magma chambers. At Villarrica, the March 3 2015 eruption was followed by a short lived uplift burst of ~5 cm in the SE part of the volcano from a source depth of ~6 km and the April 22-23 2015 Calbuco eruption produced 12 cm of coeruptive subsidence from a source at a depth of ~8-11 km and offset ~2 km SW from the summit. Importantly, we do not find clear evidence that the March 3 2015 and April 22 2015 eruptions at Villarrica and Calbuco were preceded by either transient or continuous ground uplift. There are several possible explanations for the lack of precursory deformation at each volcano – it is possible that it occurred only hours before the eruption (e.g., at Calbuco), it might be related to an open conduit volcano that passively degasses with no cumulative deformation (e.g., at Villarrica) or it is below the current detection rates. At both volcanoes X and C band interferograms decorrelate in a few weeks due to vegetation, snow and ice, and have persistent atmospheric phase delays that we find cannot be reliably removed with available global weather models. The low number of SAR acquisitions therefore makes it challenging to reliably measure unaliased deformation. We recommend a multi-satellite observing strategy with short repeat periods that may improve the temporal resolution of measurements.