Geophysical Research Abstracts
Vol. 15, EGU2013-6937, 2013
EGU General Assembly 2013
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Application of TanDEM-X interferometry in volcano monitoring

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Traditional repeat-pass SAR interferometry (InSAR) has proven to be useful to monitor deformations at active volcanoes. In this so called monostatic mode, images recorded during different satellite passes from slightly changing antenna positions are used to map topographic changes of the earth surface on centimeter scale. However, problems regarding changing atmospheric conditions between the different satellite passes influence the quality of the results. Moreover, the backscattering conditions between two passes need to be tolerably stable to be used for interferometry. As far as the changes in the volcanic environment are slow, repeat-pass InSAR is a great monitoring tool. However, fast changing backscattering conditions result in low coherency, making a classical interferometric deformation analysis impossible. Especially dome-building volcanoes can change on meter scale per second in active phases, preventing the observation with repeat-pass InSAR.
To solve these problems, we are currently testing the ability of the German TanDEM-X mission to monitor large deformations at active volcanos. The bistatic TanDEM-X mission consists of two radar satellites (TerraSAR-X and TanDEM-X) flying in a close formation, taking images of the earth surface at the same time. In contrast to the repeat pass mode, this results in two nearly absolutely coherent images, which means that there are no atmospheric disturbances and backscattering errors in the interferometric pair. This allows generating digital elevation models (DEMs) at several times. A simple time series analysis of the models enables for the first time to quantify large topographic changes at active dome-building volcanoes.
We chose Volcán de Colima, Mexico as test site. While being a dome building volcano, phases of quiescence are interrupted every few years by dome collapses, pyroclastic flows and deposition of volcanic material. At present, Volcán de Colima seems to be stable. Nevertheless, an explosion at the crater rim signaled the end of magma ascent in June 2011. The bistatic TanDEM-X data gives important information on this explosion as we can observe material changes in the summit area when comparing datasets taken before and after the explosion. Our results indicate that repeated DEMs with great detail and good accuracy are obtainable, enabling a quantitative estimation of finite volume changes in the summit area of the volcano. Additionally, we highlight the importance of employing remote sensing methods to collect data in volcano research.