Geophysical Research Abstracts
Vol. 13, EGU2011-11916, 2011
EGU General Assembly 2011

Present scenario and new perspectives for Differential SAR Interferometry in volcanic areas

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A well established and widely used technique for volcano analysis is the Differential SAR Interferometry (DInSAR) approach, which permits to map Earth's surface deformation through the exploitation of the phase difference (interferogram) between two SAR acquisitions. Originally developed to investigate single deformation phenomena, the DInSAR technique has been extended during last years to study the temporal evolution of the displacements, allowing the generation of deformation time-series by combining multiple interferograms. This extension was needed to exploit the huge SAR data archive collected by a number of C-band (wavelength of about 5.6 cm) satellites (ERS-1/2, ENVISAT, RADARSAT-1) since 1992, permitting to have an almost continuous and complete coverage of the Earth's surface, with a revisit time of approximately one month and a spatial resolution of about 4 by 20 meters. By exploiting the above mentioned archive, the extended DInSAR techniques allow nowadays analyzing almost 20 years of surface displacements, with accuracies ranging the 5-10 millimeter interval.
Learning the lesson provided by these 20 years of observations, a second-generation of satellites has been recently launched, opening new insights in DInSAR scenario. We refer in particular to the X-band (wavelength of about 3 cm) satellite constellations such as COSMO-SkyMed and TerraSAR-X, which permit to monitor surface deformation with a sampling time up to 8 days (theoretically 4 days for the COSMO-SkyMed constellation) and a spatial resolution up to 1 by 1 meter.
In this work, we discuss the present volcano monitoring DInSAR scenario and how it has changed during the last years. First of all, we give an idea of the more recent DInSAR time-series results in a number of volcanoes around Earth, obtained by applying the extended DInSAR technique known as Small BAseline Subset (SBAS) to data collected by first-generation satellites. Then, we present the deformation time-series of the SAR data acquired by second-generation satellites (mainly the COSMO-SkyMed constellation) on the Etna volcano since 2008. In particular, we show and analyze the impact of the new sensors to detect the temporal evolution of deformation phenomena, in terms of increased time sampling (reduced revisit time), improved accuracy (reduced wavelength), increased spatial resolution and coverage. Moreover, we also show the implications that these characteristics and the DInSAR time-series analysis have in volcano monitoring scenario.