Geophysical Research Abstracts
Vol. 12, EGU2010-11877, 2010
EGU General Assembly 2010

Numerical Inversion of SBAS-DInSAR time series

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Differential SAR Interferometry (DInSAR) is a remote sensing technique that allows producing spatially dense surface deformation maps with sub-centimetric accuracies. Moreover, advanced DInSAR algorithms such as Small BAseline Subset (SBAS) technique, allow investigating the temporal evolution of the detected deformation by means of displacement time series. The interpretation of the retrieved geodetic signal is usually performed setting up inverse problems. The latter use derivative-based searching algorithms, e.g. the Levemberg-Marquadt (LM), and/or Monte Carlo optimization techniques, e.g. the Simulated Annealing (SA) and the Genetic Algorithm (GA), in order to constrain the physical and geometrical parameters of the causative sources. In general, these methods exploit the problem's solution space by iterating forward analytical models, which consider simplified geometries and homogeneous isotropic distribution of the material properties in static conditions. However, several recent studies have shown that oversimplified forward models often lead to misinterpretations of the retrieved source parameters. In this context, Finite Element (FE) method is a powerful numerical tool that might be used to overcome these limitations, implementing models that jointly consider complex geometries, material heterogeneities, and/or different time dependent physical processes.

In this work, we show how a FE environment may be implemented within optimization procedures in order to analyze spatially dense deformation velocity maps and displacement time series. We include in the FE numerical models complexities like topography, vertical and lateral heterogeneities, and time-dependent material properties retrieved from independent geophysical studies. Finally, we present preliminary results of the application of the herein described numerical tool to SBAS-DInSAR measurements relevant to several volcanic and seismogenic areas.