Geophysical Research Abstracts
Vol. 18, EGU2016-14303, 2016
EGU General Assembly 2016

A Blind Test Experiment in Volcano Geodesy: a Benchmark for Inverse Methods of Ground Deformation and Gravity Data

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The inversion of ground deformation and gravity data is affected by an intrinsic ambiguity because of the mathematical formulation of the inverse problem. Current methods for the inversion of geodetic data rely on both parametric (i.e. assuming a source geometry) and non-parametric approaches. The former are able to catch the fundamental features of the ground deformation source but, if the assumptions are wrong or oversimplified, they could provide misleading results. On the other hand, the latter class of methods, even if not relying on stringent assumptions, could suffer from artifacts, especially when dealing with poor datasets.
In the framework of the EC-FP7 MED-SUV project we aim at comparing different inverse approaches to verify how they cope with basic goals of Volcano Geodesy: determining the source depth, the source shape (size and geometry), the nature of the source (magmatic/hydrothermal) and hinting the complexity of the source. Other aspects that are important in volcano monitoring are: volume/mass transfer toward shallow depths, propagation of dikes/sills, forecasting the opening of eruptive vents.

On the basis of similar experiments already done in the fields of seismic tomography and geophysical imaging, we have devised a bind test experiment. Our group was divided into one model design team and several inversion teams. The model design team devised two physical models representing volcanic events at two distinct volcanoes (one stratovolcano and one caldera). They provided the inversion teams with: the topographic reliefs, the calculated deformation field (on a set of simulated GPS stations and as InSAR interferograms) and the gravity change (on a set of simulated campaign stations). The nature of the volcanic events remained unknown to the inversion teams until after the submission of the inversion results.

Here we present the preliminary results of this comparison in order to determine which features of the ground deformation and gravity source are best retrieved by the different methods, to propose useful guidelines for the proper interpretation of inversion results and to highlighting possible pitfalls. A further aim is to foster a wide discussion about the inversion of ground deformations in the whole Volcano Geodesy community, by eventually proposing a future version 2.0 of this experiment.