Geophysical Research Abstracts
Vol. 15, EGU2013-8199, 2013
EGU General Assembly 2013

Simultaneous inversion of ground deformation and gravity changes using bodies with free geometry. Application to data from Mt. Etna (Italy).

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Persistent inflation and long-period gravity fluctuations occurred at Mt Etna (Italy) during the time interval bounded by the 1991-93 and 2001 main flank eruptions. Several studies suggest that, since 1993 and before the 2001 eruption, a large amount of magma was stored at depth. Up to date, an integrated inversion of the available ground deformation and gravity data has not been attempted, in spite of the possibility of bringing new insight into the processes that led to the 2001 eruption.
In this study we perform simultaneous, nonlinear inversion of gravity and ground deformation data collected at Mt. Etna between 1995 and 2000. We utilize a new inversion scheme that assumes bodies with a 3D free geometry to determine the best-fitting geometrical configuration of pressure and density sources. The latter are obtained through aggregating pressure and density point sources, until the best fit to the data is reached. The approach works in a step-by-step growth process that allows building very general geometrical configurations.
Preliminary results indicate constancy in time of the position of pressure and mass sources, in spite of the different phases of activity displayed by the volcano during the period of interest. A fundamental result of this study is that pressure and mass sources are widely separated in space. In particular, pressure is found to have steadily increased in a volume below the northeastern sector of the volcano, while the observed gravity changes were due to mass changes within a volume centered below the southeastern sector of the volcano, at shallower depths. The neat separation between mass and pressure sources is a key feature which needs to be properly addressed in order to understand the processes which controlled the activity of Mt Etna during the studied period.