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Toolkit for bootstrap-based probabilistic dislocation source optimisation from heterogeneous datasets: Analysis of Mayotte Island swarm activity and volcanic uplift in Iceland

Marius Isken (1,2), Sebastian Heimann (2), Henriette Sudhaus (1), Daniela Kühn (2,3), Andreas Steinberg (1), Simone Cesca (2), Torsten Dahm (2), Gesa Petersen (2,5), Hoby Njara Tendrisoa Razafindrakoto (2), and Simon Daout (4)

(1) University of Kiel, Germany, (2) GFZ German Research Centre for Geosciences, (3) NORSAR, Norway, (4) University of Oxford, UK, (5) University of Potsdam, Germany

We present a versatile open-source software framework for inversion and characterisation of various displacement sources in layered media, Grond. Our forward modeling approach is based on flexible and computationally efficient Green's function databases, which can deliver geodetic models (InSAR, GNSS and Gravity) together with synthetic seismic wave forms.

This forward modelling approach enables the combination of diverse observations (InSAR, GNSS and seismic wave forms) for displacement source characterization. Together with the developed probabilistic bootstrap-based inversion scheme the framework can deliver expressive parameter uncertainties, trade-offs and margins by efficient exploration of the full model space. The program is highly flexible with respect to the adoption to specific dislocation problems, the design of the objective functions, and the diversity of the empirical data set.

We demonstrate the flexibility of the framework by two analysis of transients offshore Mayotte, Comoro Islands, and at Theistareykir volcano, Iceland. The analysis of the ongoing volcanic crisis offshore Mayotte, Comoro Islands (January 2019) includes (1) examples of full-waveform seismic source inversion of swarm events and (2) a time-evolution analysis of GNSS displacements observed on Mayotte island. The expressive uncertainty analysis of the toolkit aids to understand the volcanic processes under the poor azimuthal coverage of seismic and GNSS stations in this region. Due to the event's location in the Mozambique Channel, the vast Indian ocean to the West and Africa to the East. Further, we display an inversion of a volcanic uplift signal from InSAR data, observed at the Theistareykir volcano (Iceland) in 2006, alongside with a brief introduction of the InSAR post-processing toolkit Kite. Kite can be used to prepare satellite InSAR data for displacement optimization. The software eases the spatial quadtree reduction of unwrapped interferograms and the estimation of the data co-variance to facilitate the estimation of realistic error margins for the deformation source solutions.