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Sharp geodetic fault slip models for an improved understanding of volcano flank dynamics

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The study of the stability of volcano flanks has been an active topic of research for the last few decades. In 2018, two major events renewed attention in this hazardous processes. In May 2018, following the beginning of a flank eruption at Kilauea volcano in Hawai'i, a M6.9 earthquake occurred along the Southern flank of Kilauea marking a dramatic but transient acceleration from its secular deformation rate. Alternatively, in December 2018, an intense period of volcanic activity preceded a catastrophic sector collapse which triggered a devastating tsunami at Anak Krakatau volcano (Indonesia). The two contrasting behavior events reveal our poor understanding of the physical processes controlling volcano stability.

Ultimately, instability of volcano flanks is characterized by the development and evolution of failure surfaces (faults and/or basal shear zones). Once established, for example at a rheological interface, a decollement fault should be a key element in the control of the mechanical interplay between the volcano-tectonic and gravitational forces. In this communication, I review our ability to map surface displacements measured with geodetic techniques into frictionally distinct regions on the fault surface. I explore a range of inverse modeling methods to estimate bounds on the extend of geodetically constrained fault slip areas. I apply the methods to the Southern flank of Kilauea volcano. The range of different solutions for fault slip models allows to critically assess whether there are regions of stable or variable frictional conditions. Mapping accurately the frictional behavior and constraining its location region will allow to generate more realistic dynamic models of volcano flanks and improve our understanding the physical processes controlling volcano stability.