EGU21-3310
https://doi.org/10.5194/egusphere-egu21-3310
EGU General Assembly 2021

Velocity models for routine earthquake monitoring at volcanoes: from deterministic to Bayesian

Jeremy Pesicek[1], Trond Ryberg[2], Roger Machacca[3], and Jaime Raigosa[4]
[1]Volcano Disaster Assistance Program, U.S. Geological Survey (jpesicek@usgs.gov)
[2]GFZ German Research Centre for Geosciences
[3]Instituto Geofísico del Perú
[4]Servicio Geológico Colombiano

Earthquake location is a primary function of volcano observatories worldwide and the resulting catalogs of seismicity are integral to interpretations and forecasts of volcanic activity. Ensuring earthquake location accuracy is therefore of critical importance. However, accurate earthquake locations require accurate velocity models, which are not always available. In addition, difficulties involved in applying traditional velocity modeling methods often mean that earthquake locations are computed at volcanoes using velocity models not specific to the local volcano.

Traditional linearized methods that jointly invert for earthquake locations, velocity structure, and station corrections depend critically on having reasonable starting values for the unknown parameters, which are then iteratively updated to minimize the data misfit. However, these deterministic methods are susceptible to local minima and divergence, issues exacerbated by sparse seismic networks and/or poor data quality common at volcanoes. In cases where independent prior constraints on local velocity structure are not available, these methods may result in systematic errors in velocity models and hypocenters, especially if the full range of possible starting values is not explored. Furthermore, such solutions depend on subjective choices for model regularization and parameterization.

In contrast, Bayesian methods promise to avoid all these pitfalls. Although these methods traditionally have been difficult to implement due to additional computational burdens, the increasing use and availability of High-Performance Computing resources mean widespread application of these methods is no longer prohibitively expensive. In this presentation, we apply a Bayesian, hierarchical, trans-dimensional Markov chain Monte Carlo method to jointly solve for hypocentral parameters, 1D velocity structure, and station corrections using data from monitoring networks of varying quality at several volcanoes in the U.S. and South America. We compare the results with those from a more traditional deterministic approach and show that the resulting velocity models produce more accurate earthquake locations. Finally, we chart a path forward for more widespread adoption of the Bayesian approach, which may improve catalogs of volcanic seismicity at observatories worldwide.