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4D imaging of the seismic energy release before the 2011 El Hierro eruption (Canary Islands)

Rubén García-Hernández[1], Luca D'Auria[1,2], José Barrancos[1,2], and Germán D. Padilla[1,2]
[1]Instituto Volcanológico de Canarias (INVOLCAN), San Cristóbal de La Laguna, Tenerife, Spain
[2]Instituto Tecnológico y de Energías Renovables (ITER), Granadilla de Abona, Tenerife, Spain

The estimation of the spatial and temporal variations of the b-value of the Gutenberg-Richter law is of great importance in different seismological applications. However, its estimate is strongly dependent upon the selected spatial and/or temporal scale due to the heterogeneous distribution of the seismicity. This is especially relevant in volcanic and geothermal areas where dense clusters of earthquakes often overlap to the background seismicity.

For this reason, we propose a novel multiscale approach allowing a consistent estimation of the b-value regardless of the considered spatial and/or temporal scales. Our method, named **MUST-B** (**MU**ltiscale **S**patial and **T**emporal estimation of the **B**-value), basically consists in computing estimates of the b-value at multiple temporal and spatial scales, extracting for a given spatio-temporal point a statistical estimator of its value, as well as an indication of the characteristic spatio-temporal scale. This approach includes also a consistent estimation of the completeness magnitude (M_c) and of the uncertainties over both b and M_c, as well as, estimates of the seismic energy release rates.

We applied this method to the seismic datasets of El Hierro submarine eruption, started on October 2011 and linked to a precursor seismic unrest episode that initiated on July 2011. The seismicity showed a very complex spatial distribution, which also changed over time, showing a migration from the north of the island to the south. Results show that the high resolution 4D mapping is of great importance to understand the distribution of the seismic energy release in volcanic islands, which is possibly correlated to a variable geothermal fluid flow paths and/or magmatic sources. What is also remarkable is that even in highly heterogeneous catalogues, as for the 2011 El Hierro dataset, the MUST-B method could provide reliable estimates.