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Use of machine learning to build the catalog of the aftershock sequence from the 2010 Mw 8.8 Maule earthquake, Chile

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Understanding the rupture mechanism, distribution, and migration of seismicity following a large earthquake depends on the quality of available earthquake catalogs (uncertainties, completeness magnitude, etc.). In this study, we investigate the aftershock sequence recorded by several temporary arrays deployed in the zone of the 2010 Mw 8.8 Maule earthquake in Chile, using a combination of deep learning algorithms and template matching for earthquake detection and location. Our aim is to enhance the completeness of the earthquake catalog by analyzing a spatio-temporally sparse seismic network. We employed the Backprojection and Matched Filter (BPMF) workflow (Beaucé et al., 2021), which began with the detection and location of an initial catalog comprising 52,679 earthquakes. Subsequent relocation using the NonLinLoc algorithm improved the accuracy of the spatial distribution, thereby aiding in the creation of a template database. This resulted in a final catalog containing 470,066 earthquakes after template matching, outnumbering the initial catalog by a factor of 12. Our results highlight the spatio-temporal distribution of the aftershock sequence over one year and identify two prominent seismic cluster zones: a shallower cluster in the Pichilemu-Vichuquén zone (33.5°S and 35°S), and a deeper one associated with megathrust activity near Concepción (37°S and 38°S). There is high spatial variability of the b-value, which could be attributed to fluctuating post-seismic activity and/or the activation of diverse fault systems in the rupture zone. Our findings underscore the potential of new techniques to analyze seismic activity from old and sparse datasets, enhancing understanding of subduction processes.

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