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Combining denoising and matched filter detection to enhance Haiti's earthquake catalog

Session: T017 - Outstanding Problems in Caribbean and Central American Tectonics

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Haiti lies in an area that regularly experiences destructive earthquakes, but monitoring has been limited due to economical and political situation. Recent projects using citizen-hosted seismometers, and a temporary deployment in response to the 2021 M7.4 earthquake have provided a wealth of seismic data. Still, the high noise levels recorded at these stations mask information that can improve our understanding of tectonics or hazard assessments.

We enhanced the quality of the seismic data using the DeepDenoiser, a deep learning tool that separates signal and noise. We tested different available models on the Haiti dataset and attempted to retrain the DeepDenoiser model using data from Haiti. We find that the original DeepDenoiser trained on the Northern California catalog is the most suitable model for our dataset. Notably, this model achieves an 89-fold signal-to-noise ratio improvement.

To enhance the local earthquake catalog, we apply the DeepDenoiser to all available stations in the island of Hispaniola and perform a matched filter detection. Considering waveforms recorded at local distances (<150 km), we identify 1891 good quality templates (events recorded at least 3 stations with SNR>5), almost double the number of good quality templates using a standard bandpass 2-16 Hz filter. Cross-correlating the templates with continuous denoised waveforms, we compile a catalog of 45391 events between April 2021 and June 2022, 16-times the number of events in the analyst catalog. Additionally, although the DeepDenoiser distorts waveforms hindering local magnitude estimates, we find that relative magnitude estimation techniques with denoised and non-denoised waveforms are consistent allowing us to assess the magnitudes of the new detections.

The enhanced catalog better illuminates not only the 2021 M7.4 earthquake aftershocks, but also a swarm sequence in early 2022, providing opportunities to better study the seismicity and tectonics in the region. Updated results will be presented at the meeting.