ENHANCED SEISMIC RUPTURE IMAGING USING OCEAN BOTTOM DAS DATA

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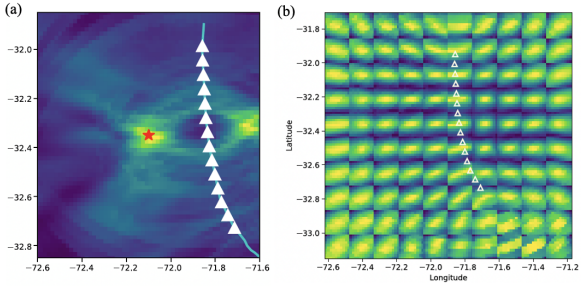
Submarine fiber optic cables for Distributed Acoustic Sensing (DAS) provides dense, extensive seismic data near potential major earthquake sources. This study presents an optimized back-projection imaging method for earthquake rupture analysis using DAS data offshore Chile, aiming to significantly enhance the resolution and accuracy of the imaging of large earthquake ruptures.

Our methodology integrates several advancements: (i) the conversion of measured DAS strain into displacement to mitigate wave scattering and to increase spatial waveform coherence, (ii) travel time refinement through shallow sediment adjustments, and (iii), array processing over overlapping cable segments for accurate slowness calculation.

Preliminary tests with a 120-km cable portion revealed a region where the location of seismic sources can be determined with high precision, extending 80 km laterally and down to a depth of 15 km, and less impacted by velocity structure uncertainties. Applied to data from around 50 local earthquakes (magnitudes 1.5 to 3), our method consistently achieved back-projection images with high spatial accuracy, within 1 to 4 km.

Additionally, our approach also effectively images larger earthquakes. Using synthetic waveforms from a magnitude 7 event, simulated based on empirical Green's functions, we demonstrated precise detection and location of sub-sources despite the presence of strong coda waves, after advanced travel time calibration. Further enhancements, including the use of a 3D velocity model, are planned to boost the resolution and accuracy of our method. Those improvements will further support the use of back-projection in accurately imaging medium to large earthquakes and enhancing tsunami early warning systems.



(a) Back-projection imaging result of a Magnitude 1.9 Earthquake. The background color represents the joint spatial probability distribution of the source location. The red star indicates the catalogued epicenter, white triangles represent subarray centers, and the blue curve outlines the cable's geometry. (b) Spatial resolution assessment.