

## Abstract

Author: Angela Cristina Carrillo Ponce

Title of thesis: Composite source processes characterization

Understanding how the Earth releases and transfers energy through earthquakes, landslides, and related processes requires physically consistent source models and robust inversion methods.

Simplified source models, such as point source moment tensors, are widely used and they successfully describe the deformation of sources generating seismic waves. Nevertheless, single point source moment tensors may not be suited for certain physical processes, such as landslides or complex earthquake ruptures, as they require a different characterization. A more accurate representation of complex processes needs modification of the source model and/or the source time function which represents how the energy is released over time.

The four manuscripts compiled in this work demonstrate how process-specific source representations, applied within the same statistical environment, can recover physically meaningful parameters across diverse frequency bands and scales. The first study analyses a complex megathrust rupture involving at least four subevents. By combining different approaches based on simultaneous inversions, the analysis reveals a slow, shallow slip episode that dominated the total moment release and explains the tsunami observed at regional tide gauges. The second manuscript focuses on a cascade event, where a massive slope failure generated a megatsunami followed by a seiche lasting over a week. A single-force inversion of long-period seismic data reproduces the persistent monochromatic ( $\sim 0.0109$  Hz) oscillation that was worldwide observed, as well as a stable horizontal force orientation consistent with the fjord geometry. The third paper investigates a bidirectional gold mine collapse, resolved as two consecutive single force pulses whose directions correspond to slope geometry and pre-failure deformation inferred from InSAR. Finally, the fourth manuscript introduces a multi-triangular source-time function which generalizes single-force parameterizations and ensures physical consistency between impulse and force within the Bayesian inversion framework.

This cumulative thesis investigates the dynamics of a broad range of seismic sources, from megathrust ruptures to gravitational mass movements, using a unified probabilistic inversion framework based on Bayesian optimization and bootstrap uncertainty quantification. Here we show the results obtained in the analysis of different landslides, such as Anak Krakatau-Indonesia 2018, Uttarakhand-India 2021, Dickson fjord-Greenland 2023 and Erzincan-Türkiye 2024, as well as the complex earthquake rupture of the South Sandwich islands doublet in 2021. Our findings show that the studied approach is versatile and can resolve landslide geometries, slope orientations, time separation of multiple signals and orientations in different environments.