# Luis Vazquez — Ph.D.

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Seismologist passionate about natural hazards, numerical simulations, and data science. I have experience on tsunami and seismic wave propagation in complex media across different scales. I apply statistical tools to leverage deterministic earthquake simulators and earthquake rupture forecasts. I have a deep understanding of probabilistic seismic (and tsunami) hazard models, as well as full waveform tomography. More recently, I have gained experience in machine learning applied to seismological problems.

## Education

**University of Southern California** — **Los Angeles, CA**
*Ph.D., Geophysics* — *June 2019–June 2025*

**Universidad Nacional Autónoma de México (UNAM)** — **Mexico City**
*B.Eng., Geophysics* — *August 2013–June 2018*

## Positions

**Graduate Student Researcher** — **University of Southern California**
*6/2019–6/2025*

**Academic Cooperation Program Intern** — **Lawrence Livermore National Laboratory**
*1/2025–Present*

**Graduate Student Intern** — **Lawrence Livermore National Laboratory**
*5/2024–8/2024*

**Graduate Student Intern** — **Lawrence Livermore National Laboratory**
*5/2023–8/2023*

**Undergraduate Student Researcher** — **Universidad de Chile, Beauchef**
*8/2018–11/2018*

**Undergraduate Student Researcher** — **Universidad Nacional Autónoma de México**
*9/2017–2/2019*

## Technical Skills

**Deep Learning:** Fourier Neural Operators for rapid and accurate seismic waveform simulations. Full waveform inversion based on automatic differentiation in Pytorch. (internship work under the supervision of Qingkai Kong)

**Statistical Seismology:** Earthquake rupture forecasting and PSHA. Analysis of Magnitude Frequency Distributions and earthquake scaling relationships. Bayesian inference. Supervised and unsupervised machine learning algorithms. Significance testing. (PhD work under the supervision of Prof. Thomas H. Jordan)

**Global Full Waveform Inversion:** Numerical methods for wave simulations (spectral element methods), seismogram windowing (using Pyflex), misfit computations (using PyAdjoint), adjoint methods applied to the globe (using specfem), L-BFGS inversion algorithms. (internship work under the supervision of Christina Morency and Nathan Simmons)

**Full Waveform Inversion:** Numerical methods for wave simulations (finite element and spectral element methods), misfit computations, adjoint and scattering-integral methods. (PhD work under the supervision of Prof. Thomas H. Jordan)

**Earthquake Catalogs with Machine Learning:** Picking and detection with Earthquake Transformer, EQTransformer. Association with Rapid Earthquake Association and Location, REAL. Relocation of events with PyKonal. (Class project for Yehuda Ben-Zion with supervision of Dr. Malcolm White)

**Structural Seismology:** Shear wave splitting techniques to measure anisotropy in the upper mantle and determine mantle flow patterns. (Undergraduate work under the supervision of Profs. Raul Valenzuela and Xyoli Perez-Campos)

**Tsunamis:** Generation of stochastic slip distributions to use those as inputs for tsunami simulations. (Undergraduate work under the supervision of Profs. Diego Melgar and Sebastian Riquelme)

## Computer Skills

**Languages:** Python, Matlab, Fortran, Shell script.

**Python modules:** Numpy, matplotlib, pandas, seaborn, scipy, sklearn, Pytorch.

**Seismological Data Processing:** Obspy, SAC, Seisan.

**Full Waveform Inversion:** Hercules and SpecFem for seismic wave simulation, adjTomo and MATLAB for misfits, adjoint sources, and sensitivity kernels computations.

**HPC:** OpenMP and MPI.

**Image Processing and Map Making:** GMT, pyGMT, Inkscape, mmap (MATLAB).

## Publications

(6) **Vazquez, L.**, Qingkai, Q., Rodgers, A, and C. Doody, (202?). Full waveform inversion with Fourier Neural Operators and explosion datasets., in prep.

(5) **Vazquez, L.**, and T.H. Jordan, (202?). Best model selection from an ensemble based on proper scoring rules., in prep.

(4) **Vazquez, L.A.**, and Thomas H. Jordan, (2025). Assimilation of Deterministic Multicycle Earthquake Simulations into Probabilistic Rupture Forecasts. Geophysical Journal International, Volume 241, Issue 2, May 2025, Pages 1243–1261, https://doi.org/10.1093/gji/ggaf101

(3) Celis, S., **Vazquez, L.**, Valenzuela, R. W., Perez-Campos, X., and Leon-Soto, G., (2024). Teleseismic Measurements of Upper Mantle Shear-Wave Anisotropy in Southern Mexico. Tectonophysics, 888, 230465.

(2) **Vazquez, L.**, M. Medina, S. Riquelme, and D. Melgar, (2021). Numerical simulation of tsunami coastal amplitudes in the Pacific Coast of Mexico based on non-uniform $k^{-2}$ slip distributions, Pure Appl. Geophys., 178(9), 3291-3312.

(1) **Vázquez Aragón, Luis Alberto**. (2019). Anisotropía sísmica del manto y estructura con datos del proyecto del proyecto geometría de cocos. (Tesis de Licenciatura). Universidad Nacional Autónoma de México, México.

## Presentations

(17) **Vazquez, L.**, Kong, Q., Matzel, E., et al. (2024). Accelerating Full Waveform Inversions with Fourier Neural Operators. Poster, SCEC 2024 Annual Meeting.

(16) **Vazquez, L.**, Morency, C., and Simmons, N. A. (2024). LLNLGlobeFWI: First Iterations Using a Semi-Automatic FWI Framework Applied to the Globe with SPiRaL as the Starting Model. Talk, SSA Annual Meeting.

(15) **Vazquez, L.**, and Jordan, T. H. (2024). Bayesian assimilation of deterministic multicycle earthquake simulations into probabilistic rupture forecasts. Talk, StatSei13 Biannual Meeting.

(14) **Vazquez, L.**, Morency, C., and Simmons, N. A. (2023). LLNLGlobeFWI: First Iterations Using a Semi-Automatic FWI Framework Applied to the Globe with SPiRaL as the Starting Model. Talk, AGU Fall Meeting.

(13) **Vazquez, L.**, and Jordan, T. H. (2023). Bayesian Assimilation of Deterministic Multicycle Earthquake Simulations into Probabilistic Rupture Forecasts. Talk, AGU Fall Meeting.

(12) **Vazquez, L.**, and Jordan, T. H. (2022). Full 3D Fréchet Kernels For Low-Frequency Slowness Perturbations Measured Across Seismic Arrays. Talk, SSA Tomography What comes next? Meeting.

(11) **Vazquez, L.**, and Jordan, T. H. (2022). Using RSQSim to inform UCERF3 Time-Independent forecasts. Poster, StatSei12 Biannual Meeting.

(10) **Vazquez, L.**, and Jordan, T. H. (2022). Bayesian Assimilation of Multicycle Earthquake Simulations into Probabilistic Forecasting Models. Poster, SCEC 2022 Annual Meeting.

(9) **Vazquez, L.**, and Jordan, T. H. (2022). How Can Probabilistic Forecasts Learn From Physics-based Simulators? A Full-bayesian Approach to Forecast Recalibration. Talk, SSA 2022 Annual Meeting.

(8) **Vazquez, L.**, and Jordan, T. H. (2022). Full 3D Fréchet Kernels For Low-Frequency Slowness Perturbations Measured Across Seismic Arrays. Poster, SSA 2022 Annual Meeting.

(7) **Vazquez, L.**, and Jordan, T. H. (2020). Assimilating Multi-cycle Rupture Simulations into Probabilistic Forecasting Models. Talk S040-02, AGU 2020 Fall Meeting.

(6) Celis, S., **Vazquez, L.**, Valenzuela, R., and Perez-Campos, X. (2020). Seismic Anisotropy Provides Insight Into Upper Mantle Flow and its Relationship to Subduction of the Cocos Plate in Southern Mexico. Poster DI029-0022, AGU 2020 Fall Meeting.

(5) **Vazquez, L.**, and Jordan, T. H. (2020). Assimilating Multi-cycle Rupture Simulations into Probabilistic Forecasting Models. Poster Presentation at 2020 SCEC Annual Meeting.

(4) Santa Maria, J. T., **Vazquez, L.**, and Jordan, T. H. (2020). Covariance Analysis of the UCERF3-TI Logic Tree. Poster Presentation at 2020 SCEC Annual Meeting.

(3) **Vazquez, L.**, Riquelme, S., and Melgar, D. (2019). Numerical Simulation of Tsunami Run-Ups in the Pacific Coast of Mexico Based On Non-Uniform $k^{-2}$ Slip Distributions. Poster NH43F-0994, AGU 2019 Fall Meeting.

(2) **Vazquez, L.**, Valenzuela, R., and Pérez-Campos, X. (2019). Shear Wave Anisotropy, Mantle Flow, and Structure of the South Cocos Plate, Mexico. Talk S43A-08, AGU 2019 Fall Meeting.

(1) **Vázquez-Aragón, L.A.**, Valenzuela, R., Pérez-Campos, X., and Clayton, R. (2018). Shear Wave Anisotropy, Mantle Flow, and Its Relationship to a Possible Slab Tear in the South Cocos Plate, Mexico. Talk, SSA 2018 Annual Meeting.

## Teaching

**ENST 150: Environmental Issues in Society** — **University of Southern California**
*Spring 2023, 30 total students*

**GEOL 107: Oceanography** — **University of Southern California**
*Spring 2022, 45 total students*

**GEOL 450: Geosystems** — **University of Southern California**
*Fall 2020, 15 total students*

**GEOL 108: Crises of a Planet** — **University of Southern California**
*Fall 2019, 45 total students*

## Awards

**2020**: Second place in the first Earth, Space and Marine Sciences online contest in Mexico organized by the Mexican Geophysical Union.

**2019**: Honorific Mention for bachelor thesis defense, Universidad Nacional Autónoma de México, Facultad de Ingeniería

**2019**: Outstanding Student, $2^{nd}$ out of 120, Universidad Nacional Autónoma de México, Facultad de Ingeniería

## Outreach and Public Engagement

**9/12-13/2019:** Ecuador Science Diplomacy Workshop on the CTBT in Quito, Ecuador. I was the the CTBT Youth Group (CYG) representative. I presented the CYG work and achievements to the diplomats and decision makers of Ecuador. I also helped with the workshop organization.

**10/27/2019-11/1/2019:** Mexican Geophysical Union Annual Meeting in Puerto Vallarta, México. I presented the CYG to the Mexican community in a booth for four days with the other CYG members who attended the meeting. Additionally, I participated in the Kermés de las Ciencias de la Tierra y del Espacio in which we taught how to locate earthquakes to the general public in Puerto Vallarta.

## Fieldwork

**3/2020:** Deployment to image the internal structure of the southern San Andreas fault., under the supervision of Yehuda Ben-Zion.

**12/2019:** Deployment to detect temporal changes of seismic velocities in the San Jacinto fault zone, under the supervision of Yehuda Ben-Zion.

## Grants

**09/2024**: SCEC Travel Grant to the SCEC Annual meeting in Palm Springs, California.

**10/2022**: SSA Travel Grant to the SSA Tomography meeting in Toronto, Canada.

**7/2018:** Métodos de Investigación Interntship Research Grant at Universidad de Chile in Santiago, Chile.

**5/2018:** IASPEI/LACSC Travel Grant to the 2018 LACSC-SSA Conference: Seismology of the Americas in Miami, Florida.

## Invited Seminar and Talks

**Lawrence Livermore National Laboratory, Seismology Group Seminar:** Livermore, 2024.

**University of Utah, Seismology Seminar:** Salt Lake City, 2024.

**Lawrence Livermore National Laboratory, Seismology Group Seminar:** Livermore, 2023.

**Universidad Nacional Autónoma de México, Geophysics Institute Seminar:** Mexico City, 2019.

## Languages

**French:** Intermediate fluency

**Spanish:** Native fluency

**English:** Native fluency

## Societies and Memberships

American Geophysical Union

Seismological Society of America

Mexican Geophysical Union