Early Career Scientist Award

Meant to spotlight the discoveries and remarkable work of someone having more recently started on their path of scientific discovery. We look for significant demonstration of initiative, Inspiration, collaboration skills, and other skills and attributes, including the ability to inform and inspire others.

Dr. Manuel M. Mendoza

THE NOMINATION'S COMPELLING FACETS OF THIS PERSON'S RESEARCH:

Dr. Manuel M. Mendoza, a geophysicist studying earthquakes and their hazards, is currently a postdoc in CIRES' Fellow Anne Sheehan's geophysics group at CU Boulder. The group utilizes geophysical methods to better understand mountain belts, subduction zones, and earthquakes. Matt is an expert in Distributed Acoustic Sensing (DAS), which he uses to probe human-triggered (induced) as well as natural tectonic seismicity. DAS is new within the last decade and is an innovative technique in the field of seismology.

Mendoza's work with DAS puts CIRES, CU Boulder, and our partners on the cutting edge of geophysics, exploring this new technology and its potential in several important applications. Earthquakes in the Pacific Northwest are a real threat to people and infrastructure and understanding how and when they occur will help communities better prepare. Matt's work investigates earthquakes from two angles: At tectonic plate boundaries like the Cascadia Subduction Zone, and at geothermal facilities, where humans inject fluid into the ground to capture heat, causing or "inducing" small earthquakes. He uses distributed fiber optic acoustic sensing (DAS), a new technique that allows spatially continuous measurements of ground motion over large distances. Matt dipped his toes into the up-and-coming technology while finishing his PhD — and he hoped to further explore and document the potential of DAS and its potential in earthquake studies.

DAS, fires lasers into fiber optic cables to document tremors and earthquakes. Fiber optic cables are already installed across the U.S. and spanning ocean floors, extending for miles, often used for telecommunications but can be leased to scientists with prior permission. Matt has also led a project where he buried cables in new locations. The cables are comprised of glass and have natural impurities, which produce a tiny sharp boundary that the laser can reflect off of. The signal from the laser bounces off these impurities and back to the receiver which measures the wave properties of the signal traveled detecting tremors or earthquakes. Typically, researchers have used seismometers to detect earthquakes, but DAS brings new insights and is a more accessible method for collecting many closely spaced measurements throughout the full length of the cable.

DAS has exciting potential for seismic sensing because it could enhance the seismic network at a relatively low cost, tie into existing systems, and withstand harsh conditions. In addition to being cost-effective, only the receiver, a large electronic unit, needs to be heavily protected against extreme hot or cold temperatures. Seismometers, in comparison, have electronic components

Dr. Manuel M. Mendoza

GOVERNOR'S AWARDS FOR HIGH-IMPACT RESEARCH 2024

Started in 2009, the annual Governor's Awards for High-Impact Research celebrates the brilliant ground-breaking discoveries and innovative research from Colorado's ecosystem of federally-funded laboratories and institutions.

Organized by CO-LABS, each year's event spotlights the men and women creating our future through brilliant technological and engineering discoveries in aerospace, energy, agriculture, public health, weather prediction, wildlife ecology, communication, earth science and dozens of other fields of research right here in our communities.

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THE NOMINATION'S COMPELLING FACETS OF THIS PERSON'S RESEARCH (CONTINUED)

that will fail if they become too hot, cold, or wet. The fiber optic cable can be encased and buried, or installed in wells used for fracking or oil and gas monitoring. DAS could also tie into the existing telecommunications systems that span the ocean floor, providing a significantly enhanced seismic network. Because it can withstand tough conditions, DAS could also be used for glacial seismology or exoplanetary missions in the future.

While at CIRES, Matt has pioneered new ways to use DAS technology in two projects. The first is a Utah- based geothermal project sponsored by the Department of Energy. The second took place in Washington where he leased fiber cable from a telecommunications company in the Cascadia subduction zone. In Utah, Matt installed an array of distributed acoustic sensing sensors at FORGE, an experimental enhanced geothermal facility in Utah sponsored by the Department of Energy. His goal was to detect microseismicity (tiny earthquakes) induced by facility operations by deploying DAS along the surface rather than deep underground. At this site, water is pumped into hot, dry rock to re-create or enhance an existing fracturing network within the rock. The water is heated by the rock and pumped back to the surface, and the steam generated is harnessed for geothermal energy. When the water is pumped into the rock, the creation of fractures produces microseismicity. To look at small earthquakes caused by geothermal activity, Matt dug a 2 km long shallow trench and then buried the 2 km long fiber optic cable in the shallow trench. In comparing the data with seismometers on site, the findings demonstrated that small earthquakes generated at reservoir depths could be detected using DAS.

For the second project, West of Seattle in Pacific Northwest Cascadia, Matt leased 7 km of dark fiber optic cable, already in place, from a telecommunications company to collect data on "slow earthquakes" or tremors. Dark fiber refers to unused or unlit optical fibers within existing fiber-optic cable networks. CIRES Fellow Anne Sheehan said the project was the first-ever using dark cables to pick up tremors with DAS, proving existing infrastructure can be used or repurposed to study earthquake hazards in the region. Matt's dedication to moving the field of DAS forward is demonstrated by his persistence in making the Cascadia project happen. Anne Sheehan tells the story:

> "In Spring 2023, Matt had been closely monitoring the seismically detected Washington tectonic tremor on a daily basis remotely from here in Colorado. He could see that a tremor episode was starting, but he had not received permits from the telecommunication company and was having a hard time getting them to respond. Knowing that these tremor episodes only happen once every 15 months or so, Matt decided to hop on a plane to Seattle, went directly to the telecommunication company, and knocked on their door to convince them to let him collect this valuable data. He was successful, turned on the equipment, and captured the tremor data just in time!"

In addition to his research, Matt is a user and contributor to DASCore, a first-of-its-kind Python software used to read and process DAS data and visualize the results. Since DAS is a new technology, most researchers have to write their own code to analyze data normally done with seismometer data. He's currently working on a paper co-authored with 15 others about the software — and he believes the DASCore will allow researchers to work faster and more efficiently. Matt mentored his RESESS undergraduate student, Halina Dingo, on how to use the software and provided feedback on how to make it more user-friendly based on her work analyzing data from the Utah FORGE project.

Fieldwork
Project lead for distributed acoustic sensing experiment in Cascadia April 2023–April 2024
Project lead for distributed acoustic sensing experiment at FORGE geothermal site in Utah April 2022
Aftershock experiment following the 2019 July 4th, M7.1 Ridgecrest earthquake 2019–2020
Passive source, broadband experiment in Wyoming 2019
Mini-broadband seismic array deployment to detect tectonic tremor around Anza, CA 2017–2018
Near-surface geophysics – seismic refraction, gravity, and magnetics 2016–2018
NSF rapid response aftershock network deployment for the 2015 Gorkha, Nepal earthquake 2015–2016
Mini-broadband seismic array deployment to study tremor near Parkfield, CA 2014–2018

GOVERNOR'S AWARDS FOR HIGH-IMPACT RESEARCH 2024

Outstanding Early Career Scientist Award

CIRES

WHAT STANDS OUT AS INSPIRING, INFLUENTIAL AND/OR UNIQUE REGARDING THIS PERSON'S RESEARCH CAREER SO FAR

CIRES Fellow Anne Sheehan says Matt's work is innovative.
"Matt's talent is in bringing together experts and practitioners of DAS for applications to new and emerging problems," said Sheehan. "Many people were skeptical that the surface DAS would work for geothermal monitoring, and Matt has demonstrated that this is a viable method. For the Cascadia project, Matt connected with DAS technology experts from the Colorado School of Mines, and regional geophysics experts from the University of Washington, and did the legwork to find a telecommunications company with 'dark fiber' that could be used for the project."

In addition to time spent researching and writing, Matt is dedicated to getting outside in person to advance his field. His passion has taken him from Utah's desert to Cascadia's fault zone where he's experimented with cutting-edge technologies to better understand earthquakes and their impacts.

Matt's background is unique compared to many in the geosciences — he's overcome many hardships.

Matt remembers witnessing scenes from the 2011 Tohoku earthquake and tsunami in the media from his home in Los Angeles, California — and what he saw inspired him to pursue his career as a geophysicist. Matt also faced many challenges in getting here. He grew up in Los Angeles and was homeless in middle school and high school. He, two younger siblings, and a single mother moved between shelters and hotels. Matt finished high school with a steady housing situation but poor grades, and he wasn't confident he would achieve his dream of going to college. While his mother sought cancer treatment, he worked at McDonald's and helped watch after his siblings. He attended community college part-time, and once his mother recovered, his grades improved, and he received scholarships which eventually allowed him to get a bachelor's, master's, and PhD. It's clear Matt overcame challenges during his upbringing despite the hurdles in his youth.

In addition to his own research, Matt is dedicated to helping up-and-coming students in geosciences. During his time at CU Boulder, Matt has advised two graduate students. As a thesis advisor, he is responsible for teaching students about geophysics, seismology, DAS, and programming. Additionally, he works with advisees and their thesis committee while providing editorial support and feedback.

Matt is passionate about increasing the diversity in geosciences. After his first year as a postdoc at CU Boulder, he had significant data from the FORGE geothermal DAS experiment. He applied to be a RESESS mentor to find a student who could help him dig through the data. Matt spent the summer teaching Halina Dingo, a rising senior at Penn State, about DAS. Halina learned about the field of seismology in-depth while working with the FORGE data. She also helped detect earthquakes. Halina now applies the skills she learned during her summer RESESS internship to her graduate work at CU Boulder in Anne Sheehan's group. Today, she's analyzing data collected from Matt's Cascadia DAS experiment.

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RELATED AWARDS, RECOGNITIONS AND MEDIA ABOUT Dr. MANUEL M. MENDOZA

Awards

NSF Earth Sciences Postdoctoral Fellowship. Award Number (FAIN): 2053085. 2022–2024 Project Title: Using Distributed Acoustic Sensing for Tremor Detection and Site Characterization in Cascadia to Evaluate Earthquake Hazard
CIRES Visiting Fellow, postdoctoral fellow, 2022
Roland Blanchard Fund at UC Riverside, CA Summer 2021
Shawn Biehler Distinguished Graduate Award at UC Riverside, CA Spring 2021
Graduate Division Fellowship at UC Riverside, CA 2016–2017
SSA Annual Meeting travel grant to Denver, CO 2016
Dean's Distinguished Fellowship award at UC Riverside, CA 2014–2016
SSA Geoscience Congressional Visits Day travel grant to Washington D.C. 2015
Honorable mention award for presentation at the California Alliance for Minority 2014 Participation (CAMP) Statewide Symposium, Irvine, CA
CAMP research stipend award at UC Riverside, CA 2012–2013
Summer Research in Science & Engineering (RISE) research stipend award 2011–2013
NSF-STEM Academic scholarship at Mt. San Antonio College, CA 2010–2011

Outreach & Education

Mentorship: Matt is dedicated to supporting up-and-coming researchers in his field while also dedicating time to organizations that serve underrepresented groups in science.
Currently mentoring two graduate students at CU Boulder Previously mentored five others.
Fabiana Fuentes, MS student, University of Colorado Boulder.
Halina Dingo, MS student, University of Colorado Boulder.
RESESS mentor: https://resess.unavco.org/
SurePrep Learning Tutor, Moreno Valley, California 2013–2014 Provided free-of-charge supplemental tutoring services for K-12 students from low-income families or underperforming schools
Presentations: Matt has a full resume of presentations including convening panels and poster sessions at important annual meetings like AGU and the Seismology of America Meeting
Convener AGU 23, 24 poster sessions and oral presentations

"Matt's expertise in the field of geophysics has produced innovative methods to further our understanding and detection of earthquakes," said Waleed Abdalati, director of the Cooperative Institute for Research in Environmental Sciences (CIRES). "His contribution to society is both impressive and important, and we are honored to have Matt recognized for his work through this prestigious award."

- Waleed Abdalati
Director of the Cooperative Institute for Research in Environmental Sciences (CIRES)