International GeoScience Education Organisation

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President’s Message

Dear IGEO members,

At the same time that the world populations start to have access to vaccines, many earth science education activities are ongoing as you can read in this newsletter.

If you are involved or aware of some earth science education initiative, projects, or any good practice that you would like to share, please get in contact with Michael (michael@earth2class.org). Thanks Michael for newsletters preparation!

Among the international projecst that are ongoing I was particularly impressed by the ENGIE project that have the aims to “empowering girls to became the geoscientist of tomorrow”: https://www.engieproject.eu

The preparation of the online International Earth Science Olympiad (IESO) is in progress. Three webinars have already been done with good participation of IESO mentors, a 4th one will be held in the next few weeks. The webinars have been recorded. Who have interest in bring a team to next IESO could get in contact with Jean-Luc (berenguer@unice.fr) for get access to the recorded video.

IGEO have not yet adopted a Code of Ethics and Code of Procedures. So IGEO is now working to create a Commission of Ethics with the mandate to prepare a Code of Ethics and a Code of Procedures. It soon will be ready to be presented to the IGEO community.

Enjoy the reading of the newsletter,

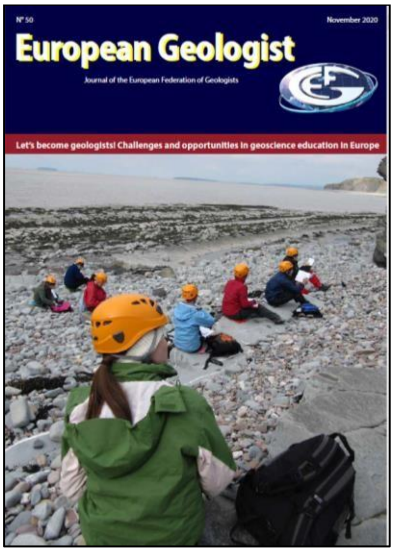
Roberto Greco

Geoscience Education Field Officer publications

The EGU Field Officers and the IUGS/IGEO Field Officers, working together, have recently published two articles on their work in the first pilot year of the initiative.

They are:

- Geoscience Education Field Officer International Programme - *ASE International*, 10, 11-21.
- EGU (European Geosciences Union) Education Field Officer programme: teachers' appreciation, perceptions and needs - *European Geologist*, 50, 10-14. https://eurogeologists.eu/journal/



Following the pilot year involving EGU Field Officers in France, Italy, ~~Portugal, and Spain and~~ IGEO/IUGS Field Officers in India and Morocco, the plan was to expand the network by training and appointing EGU Field Officers in Albania, Germany, Hungary, and Turkey and IGEO/IUGS Field Officers in Chile, Malaysia, and Togo. Sadly, these plans are on hold because of the coronavirus epidemic.

Planetary Boundary Layer Workshop for Underrepresented Students in the Time of COVID

David N. Whiteman, Charles Ichoku, Ricardo Sakai, Adrian Flores, Howard University,
Jose D. Fuentes, Pennsylvania State University
William R. Stockwell and Rosa M. Fitzgerald, University of Texas El Paso
Belay Demoz, Ruben Delgado, University of Maryland Baltimore County
Ariel Stein, NOAA/Air Resources Lab
Jeff McQueen, NOAA/National Weather Service
John T. Sullivan, NASA/Goddard Space Flight Center
James Boyle, Ryan Auvil, David Krask, Maryland Department of the Environment Sen Chiao, San Jose State University

A two-week summer workshop for under-represented early career graduate and senior undergraduate students focused on atmospheric weather and air pollution processes was held during July 13-24, 2020. The workshop was funded by the National Science Foundation (NSF) under the Physical and Dynamic Meteorology program. The original plans for an in-person workshop at the Howard University Beltsville Campus in Beltsville (HUBC), MD were changed due to the COVID pandemic so that the entire workshop was offered in a virtual format using Microsoft Teams. Students from Howard University, University of Maryland Baltimore County, Pennsylvania State University, the University of Texas, El Paso, San Jose State University, and the University of Michigan were involved. The workshop offered tracks in three areas of planetary boundary layer (PBL) research from which the students chose one as their focus: 1) instrumentation, 2) numerical modeling, 3) in-depth analysis of an existing dataset (See Table 1). However, the three tracks overlapped in such a way that all students were exposed to the three research areas. In addition, students received professional development training through preparation and delivery of conference-quality oral scientific presentations.

The workshop had broader impacts in STEM fields that addressed important national priorities, especially in atmospheric and environmental sciences. Under-represented students were especially sought to participate in the workshop and formed the majority of the attendees. The goal was to provide an intense, hand-on, research experience in close collaboration with researchers as motivation to advance students' research capability and to continue the study of atmospheric and environmental sciences at higher levels.

The workshop was computationally intense in all three track areas. To address students' differing levels of skills, a computational assignment was distributed to all the students and was due several weeks prior to the start of the conference. Virtual meetings were scheduled for the students to discuss and exchange ideas about the assignment. This pre-workshop assignment was well-received based on the postworkshop survey.

There were challenges presented by the all-virtual format. The modeling and air quality analysis tracks were able to proceed reasonably similarly to original plans. However, the hands-on training that was planned for the instrumentation track could not be provided which compromised students' learning experience. Also, the comradery that is achieved by an intense 2-week workshop with all students working hard together was lacking and there were conflicts created by students continuing to have responsibilities in their home locations. The net result of this was that a small number of students who could perhaps have benefited most from the in-person workshop experience were not able to keep up with the virtual workshop and dropped out of the workshop. The lesson learned from this latter experience is that mentors need to be much more proactive in reaching out to students early to assess any difficulties they are having with the assignments.

By and large, though, we were able to provide a meaningful virtual educational experience for a student audience comprised mostly by underrepresented students. Valuable training occurred in the areas of planetary boundary layer modeling, air quality data analysis and instrumentation used in PBL studies.

No travel funds were used for the virtual conference. Therefore, with the remaining funds, we have scheduled a three-day in person workshop to be held at HUBC August 3-5, 2021. The focus is again on advanced undergraduate and early career graduate students with preference given to underrepresented students. All travel costs will be supported for students coming from out of the Washington-Baltimore area. Stipends will be provided to all students. Applications are being accepted for workshop attendance. The application can be found at the workshop website of https://dnwsite.weebly.com/pbl-workshop2021.html.

Table 1: Workshop Topics in Each Track		
Instrumentation	**Numerical Modeling**	**In Depth Analysis of an Existing Dataset**
Radiosonde, Ozone Lidar, Multifilter Rotating Shadowband Radiometer, Wind profiler, PM2.5 Measurements, Ceilometer	Solar Actinic Flux Impact on Air Quality, Atmospheric Chemistry, Air Quality Box Models, Air Quality 1-D Models, Air Pollution Meteorology, 3-D Air Quality Models, Evaluation of Model Simulations with Observations, 3-D Air Quality Modeling Data Assimilation, Applications to Estimate Health Impacts, Applications to Inform Public Policy	Hysplit Modeling, Meteorological Boundary Layer Box Models, Meteorological Boundary Layer Box 1-D Models

Figure 1 Microsoft Teams screen capture of the opening session on July 13, 2020.

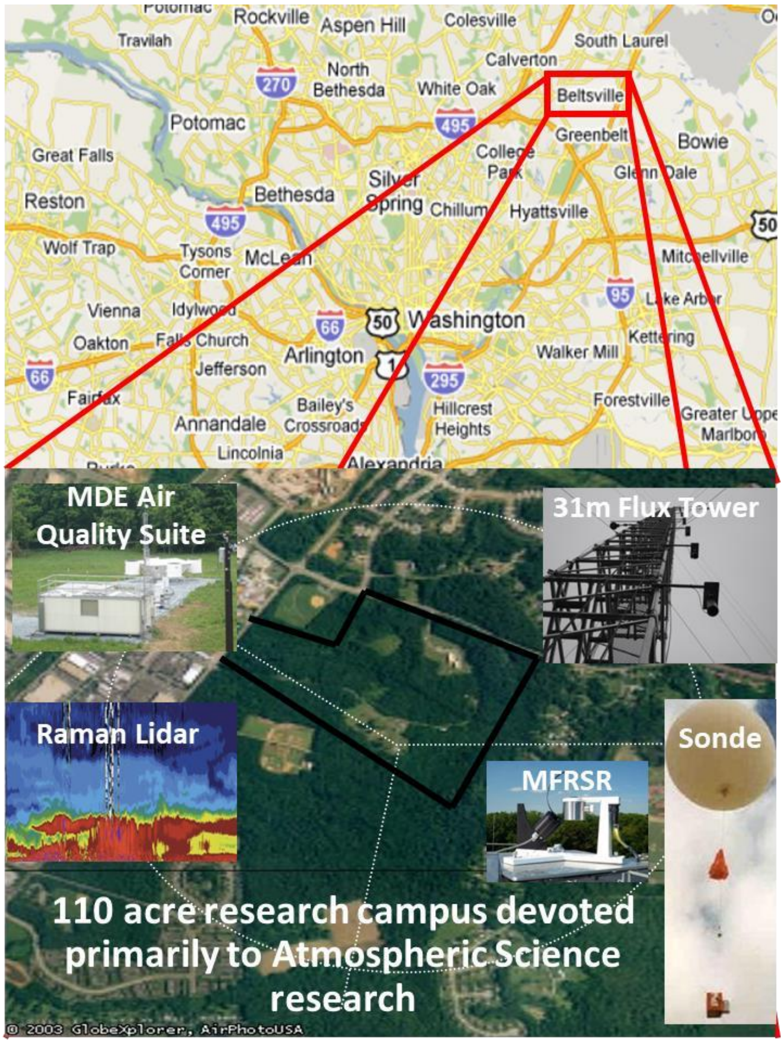


Figure 2 Howard University Beltsville Campus, Beltsville, MD. Location with respect to Washington, DC, and illustration of instrumentation at the site are shown.

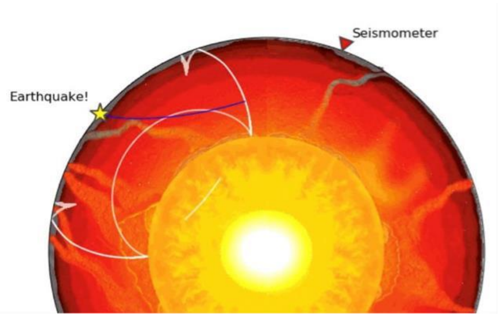
Deep Earth Explorers
Sedgwick Museum of Earth Sciences 2020-2021

Earth science outreach in the time of COVID-19 with the Deep Earth Explorers

By Stuart Russell and Dr. Jennifer Jenkins
University of Cambridge

As researchers in Earth Science, we are surrounded by people that are as passionate about the Earth as ourselves. We do our research, read journal articles, attend seminars and conferences, and discuss scientific ideas over coffee or even just in the corridor. However, for most people reading a newspaper article, watching a documentary, or an occasional visit to a museum are the only interactions with science that they have. Therefore, when we at the Global Seismology research group at the University of Cambridge had the opportunity to design an exhibit for the Sedgewick Museum of Earth Sciences, we wanted to convey our passion for deep Earth geophysics to the everyday museum visitor.

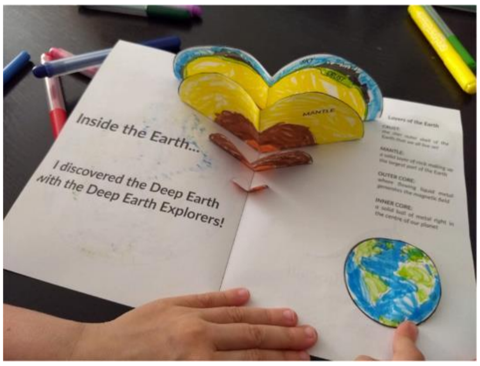
The field of deep Earth geophysics is relatively young and constantly evolving. The Earths' core was only discovered a century ago and the theory of Plate tectonics is only half a century old. Basic Earth structure and plate tectonics are now taught in schools, but new discoveries are rarely discussed outside of academia. In such an environment, it is easy to forget how little some people know about the deep Earth, or how confusing the jargon can be. Therefore, during the project we worked with a dedicated public coordinator to create an exhibit that was engaging and accessible. We went through several rounds of public consultation during the design stage, so the exhibit could be guided by the ideas and interests of the intended audience. What did they want to learn about? What did they already know? What did they think was the best way to convey the information? Based on public the feedback and our own wish for the exhibit to be different to the standard rows of specimen cases, we designed it to be as interactive as possible. We utilised touch screen technology to allow visitors to interact with mantle convection, by adding their own hot or cold anomalies and observing the effects, or by simulating an earthquake in the solid earth simply by tapping on the screen. There were also a range of videos that users could select to play, explaining how different seismic waves have been used to make key discoveries in the history of the field. A 3D Earth model with movable parts allowed visitors to open the Earth and look at different parts while timelines and backboards provided a visual accompaniment.



Left to right: Touch screen interactive mantle convection simulation, snapshot of a video explaining earthquake waves, 3D Earth model complete with moving parts.

The greatest surprise during public consultations, was that people were interested not only in the deep Earth, but they were also interested in us - the researchers. What do we do on a day-to-day basis? How did we end up doing what we do? What do we find most interesting about our jobs? These personal questions were not something we expected yet changing perceptions about scientists proved to be central to the exhibit. Working with a talented illustrator, we created a storyboard to show what we as deep Earth seismologists do. No, we do not wear white coats, and no deep Earth seismologists do not do field work. Instead, we operate in a world of scientific computing and mathematics. This is completely different to the common stereotype of an Earth scientist - usually a geologist walking around at the bottom of a cliff with a hammer. This aspect of the exhibit also allowed us to highlight the diversity in our research group and show that careers in Earth science are open to all.

Unfortunately, soon after the exhibit launched on the 6th of March 2020 the UK, like the rest of the World, was struck by the coronavirus pandemic. In England strict measures were put in place and the museum had to close. Even 9 months later, social distancing restrictions mean than the museum can only accept small numbers of visitors and the impact of the physical exhibit is severely limited. Touch screens are absolutely not allowed, indeed touching anything apart from the hand sanitiser bottle is discouraged. This has proved a challenge for our interactive exhibit which now has automated displays so that information can be imparted from a safe distance. We realised that if we wanted to have the same level of impact then we would need to adapt our approach.

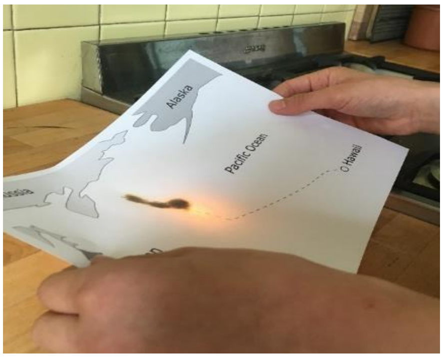


Left to right: A traditional specimen case now filled with a TV playing videos and a cartoon storyboard, a completed pop-up card activity showing the layers of the Earth.

Thankfully, the internet has proved to be an incredible resource for spreading information. We created a Deep Earth Explorers website which allowed us to not only include the content from the exhibit but also researcher profiles, information on how to become an Earth scientist, teaching resources, home activities and much more. The activities are complete with instructions, such as making a pop-up card of the Earth, turning your smart phone into a seismometer, or patterns for knitting your own Earth. These activities are perfect for families or individuals stuck at home during the pandemic.

The free teaching resources linked to the project are aimed at students aged 11 - 16 and are linked to the UK syllabus for KS3 and KS4. They include a set of science lessons around the theme of earthquakes and earth structure, a set of maths lessons based on planetary structure, and a workshop about imaging the inside of the Earth. These were designed by three dedicated student interns, who worked closely with secondary school teachers and students to ensure that the material was curriculum appropriate and was practical in terms of classroom delivery by teachers without an Earth science background. The workshop was adapted for home-based learning, including several handson experiments such as making silly putty, creating convection in a tank, and even burning a volcanic hotspot track, allowing young people to engage academically with Earth science from home.





Example of activities in the home learning workshop. Left to right: silly putty, convection in a tank, burning a hotspot track.

We hope that with a vaccine on the horizon, the situation will improve and the days of interactive exhibits and face to face outreach can soon return. But until then we are glad to have had the chance to extend our audience beyond just in-person museum visitors, through the creation of the website and the resources on it. We hope these will continue to provide insight and inspiration for the next generation of Earth scientists. For more information or to access the free resources yourself visit the Deep Earth Explorers website at: https://deepearth.esc.cam.ac.uk/.

Seismographs for Citizens of Planet Earth:

Opportunities and Challenges at the Intersection of Basic Research, Science Education, and the Public Good

Alan L. Kafka Weston Observatory Department of Earth and Environmental Sciences Boston College

bit.ly/Alan_Kafka_Website

Introduction

Seismographs in classrooms and other public and private citizen settings provide great opportunities for integrating basic research, science education, and citizen science. A variety of terms are used to refer to this type of endeavor, such as “seismographs in schools”, “educational seismology”, and “citizen seismology.” For brevity below, I use the terms “citizen seismographs” and “citizen seismology” to refer to the range of such endeavors, and in this context, I mean citizens of Planet Earth, not citizens of any particular political entity.

This enterprise is beneficial for improving science education and for contributing to basic research in seismology. But, unlike some other citizen science initiatives, such as engaging citizens in measuring atmospheric temperature, rainfall, or wind speed, seismological measurements do not typically reveal direct, intuitive information about the phenomena they are used to explore. Understanding what is recorded by a seismograph requires a level of abstract conceptual reasoning to bridge the gap between what is observed and the phenomena it represents. People have direct experiences of temperature, rainfall, and wind speed, but vibrations associated with most seismic phenomena recorded on citizen seismographs are too weak for people to feel. And large, widely felt, earthquakes do not happen very often.

That makes it difficult to implement citizen seismology programs as "Do-It-Yourself" educational experiences. Rather, it requires a well-trained seismologist partner to guide participants in interpreting what is recorded on their citizen seismograph. And it takes many years of experience for professional seismologists to learn how to interpret, and convey an accurate picture of, what is typically recorded on a seismogram. That level of understanding of seismology is generally more than can be routinely expected of teachers and other citizen scientists. Thus, citizen seismograph initiatives, and their promise of integrating basic research, science education, and citizen science, will only work for a wide audience if professional seismologists are willing to commit time and effort to be active partners in this endeavor.

Recording Earthquakes with Low-Cost Citizen Seismographs

Many professional seismologists are engaged in partnering with science educators and citizen scientists to operate seismographs in schools and other public and private venues (e.g., Kafka, et al., 2006; Kafka and Fink, 2019; Bravo, et al., 2020). The science of seismology forms an excellent foundation for engaging people in this type of endeavor because:

- It is an interdisciplinary science that requires understanding a wide range of scientific concepts.
- It teaches students how the natural environment impacts our everyday lives.
- It offers possibilities for introducing students of all ages to the nature of scientific inquiry.

It is fascinating that it is possible to record earthquakes that occur thousands of km away from us using seismographs. Seismographs measure the pulse of the Earth, and provide useful information about earthquakes, plate tectonics, and the structure of the Earth's interior. Thus, having their own seismograph enables people to collect real-world data and make measurements that provide an understanding of the internal structure of the Earth and of processes by which the Earth changes.

Two common types of low-cost seismographs are the so-called EQ1 seismograph and the more recently introduced "Raspberry Shake" (RS) seismograph, based on the "Raspberry Pi" computer (Figure 1, raspberryshake.org, raspberrypi.org). Both types have pros and cons for educational and research purposes. In many ways, the RS is turning out to be quite ideal for this endeavor. Figure 2 shows seismograms recorded in New England (at Weston Observatory, and at a middle school and a science education center) from a magnitude 7.5 earthquake that occurred in Alaska. The seismographs used for the recordings shown in

Figure 2 are RS devices that cost about $400 (compared with the thousands of dollars cost of research grade seismographs, see upper right of Figure 1). The RS seismograms do not, of course, exhibit all of the signal characteristics as well as those of the expensive instruments. But the RS signals do have many characteristics necessary for monitoring and research, and you can easily put these low-cost instruments in citizen seismology locations.

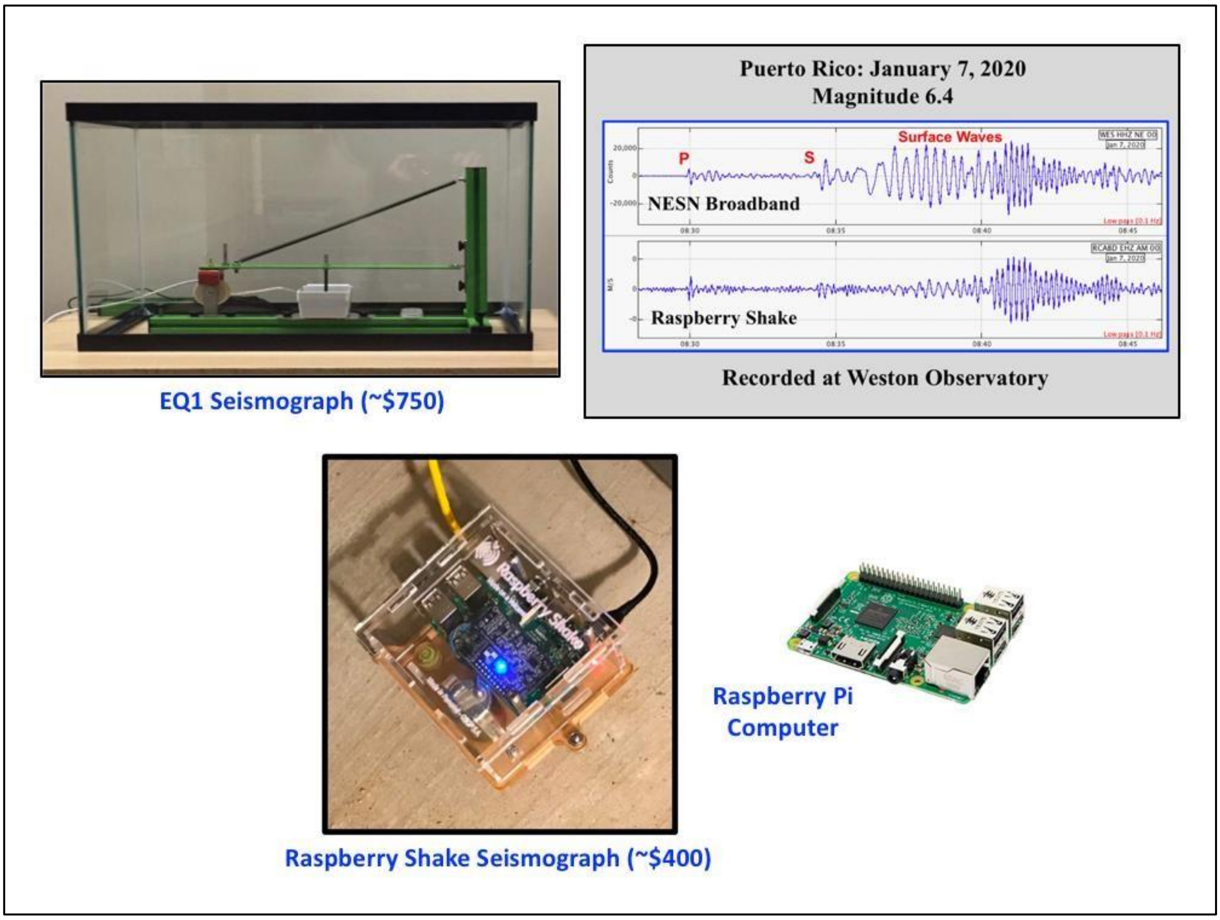


Figure 1: Two common types of low-cost seismographs are the so-called EQ1 seismograph and the more recently introduced "Raspberry Shake" (RS) seismograph, based on the "Raspberry Pi" computer (raspberryshake.org, raspberrypi.org).

Once the seismograms are plotted and interpreted (usually requiring the help of a seismologist partner), displays like that of Figure 2 become very useful resources for teachers, students, and other citizen scientists. That, in itself, is a worthwhile outcome of citizen seismology projects. But to complete the picture and bring these endeavors to their full potential, we need to also assess the extent to which these low-cost seismographs can be more than just an educational enhancement: Are citizen seismographs "just for display", and for "Wow, look what we recorded!?", and for some very basic traditional educational purposes. Or can they also offer opportunities for students and other citizen scientists to be research partners in the scientific community? To what extent are affordable seismographs technically capable of recording data at a level of quality that, given the right educational and research circumstances, authentic research is possible based on the recorded seismograms?

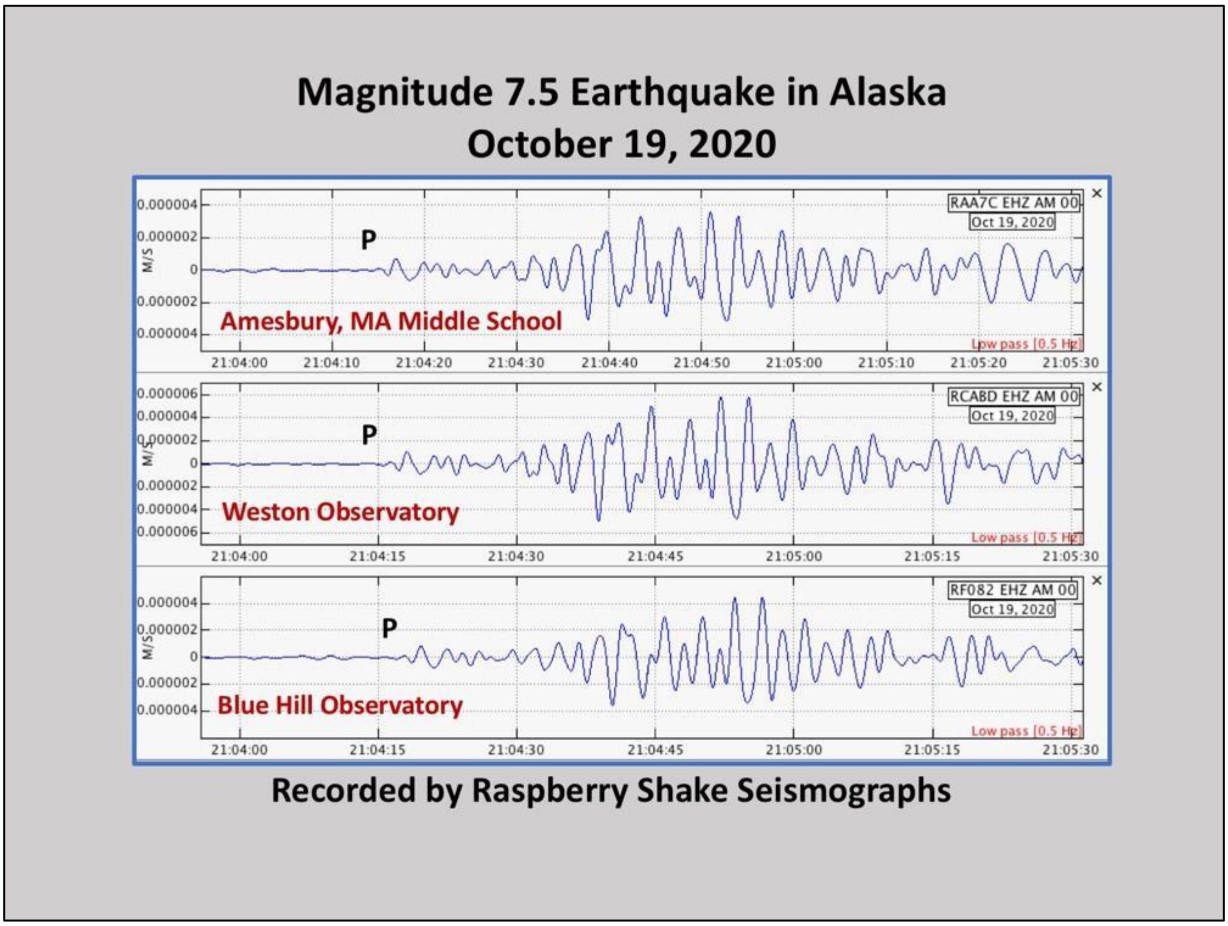


Figure 2: Seismograms recorded in New England (at Weston Observatory, and at a middle school and a science education center) from a magnitude 7.5 earthquake that occurred in Alaska.

A Complicated, but Interesting, Example: Recording a "PKIKP" Wave with Low-Cost Citizen Seismographs

An example of high-quality research-grade data recorded with a low-cost seismograph is shown in Figure 3, in which seismograms are plotted for four Boston-area RS records of a magnitude 6.9 earthquake in Indonesia. These recordings are of a seismic wave called "PKIKP", which penetrates deep within the Earth's outer and inner core and arrives, well-recorded, at RS sites. This observation illustrates aspects of how (in 1936) the inner core was discovered by seismologist Inge Lehman. Also shown in Figure 3 is the path of the PKIKP wave, from the earthquake through the deep interior of the Earth, and eventually arriving at the citizen seismograph stations.

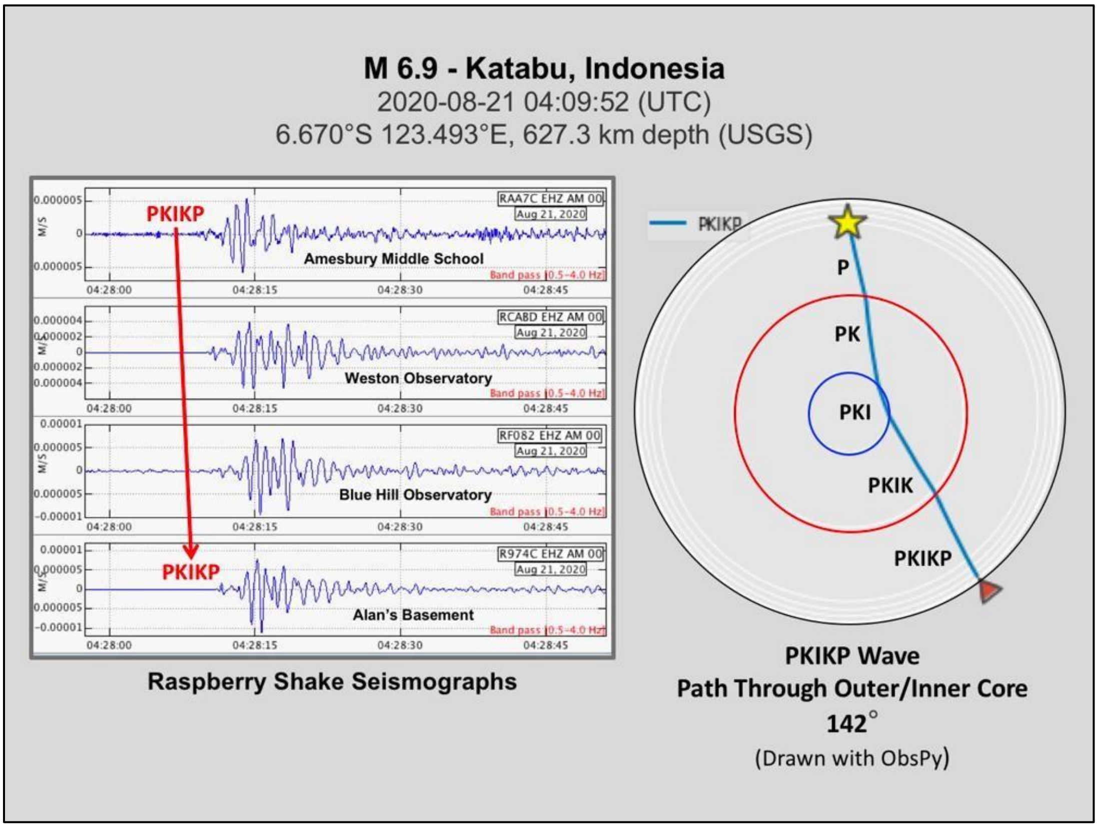


Figure 3: Four seismograms recorded by RS seismographs in the Boston-area from a magnitude 6.9 earthquake in Indonesia. These recordings are of a seismic wave called "PKIKP", which penetrates deep within the Earth's outer and inner core and arrives, well recorded, at the RS sites.

This observation is fascinating, illustrates a lot about seismology and Earth structure, and can be used to show citizen seismologists how details of seismic waveforms are important observations used in research studies. But it would be very hard for non-seismologists to recognize this waveform (and its significance), and making this display required me to think through and experiment with a lot of geophysics and signal processing. It is unlikely that this observation would have been identified and understood in a typical citizen seismology situation without a well-trained seismologist partner. And yet, it is an excellent example of the pedagogical value of people having their own low-cost seismograph.

Also, the waveform of the PKIKP wave on these seismograms is complex, and not like some textbook diagrams of simple P-wave pulses. These types of complexities are both a challenge for identifying and interpreting the seismic signal, as well as a great opportunity for learning a lot of science, if the citizen scientists have a trained seismologist guide.

More Examples of Complicated, but Interesting, Seismograms: Regionally Recorded Earthquakes

Many different kinds of earthquakes, in many different kinds of situations, are well-recorded by RS seismographs. But each situation involves a lot to explain that usually cannot be interpreted without extensive training in seismology. The observed seismograms are the result of effects due to different earthquake sizes, depths, and mechanisms of faulting, as well as different types of instruments, frequency bands, signal amplitudes, and background noise. All of these effects combine in complex ways that result in the observed seismograms, which are usually very different from textbook cases. And untangling how these kinds of effects result in the observed seismogram lies at the essence of seismology research.

At the same time, there are characteristics of these real seismograms that do show aspects of what is seen in textbook cases. And a well-trained seismologist can explain how all of that fits together. Figure 4 shows earthquakes that were recorded on RS seismographs at regional distances from earthquakes in New England. Seismograms recorded at these regional distances are typically very complicated, because they have high-frequency (and short wavelength) content which is affected by complex details of the crust in the region and local site effects. Compare these regional seismograms with that of the magnitude 6.4 earthquake in Puerto Rico, also shown in Figure 4. Although the Puerto Rico seismogram does exhibit some complexity beyond that of a simple "textbook" seismogram, seismic waves at these longer distances have lower frequency (and longer wavelength) content which makes them less affected by complex details of Earth structure. Thus, the Puerto Rico seismogram looks closer to what is often shown in a textbook.

But regional seismology is perhaps the best application of citizen seismographs. People want to know about earthquakes and earthquake hazards "in their own backyard." They might feel the shaking and directly experience the phenomenon of earthquakes. And yet, the complex nature of regional seismograms means that this is a situation in which you would want to have a trained seismologist around to help you interpret what it is that you recorded. And interpreting all of these complexities of regional seismograms is what enables research seismologists to solve problems regarding the nature of earthquakes and earthquake hazards "in your backyard."

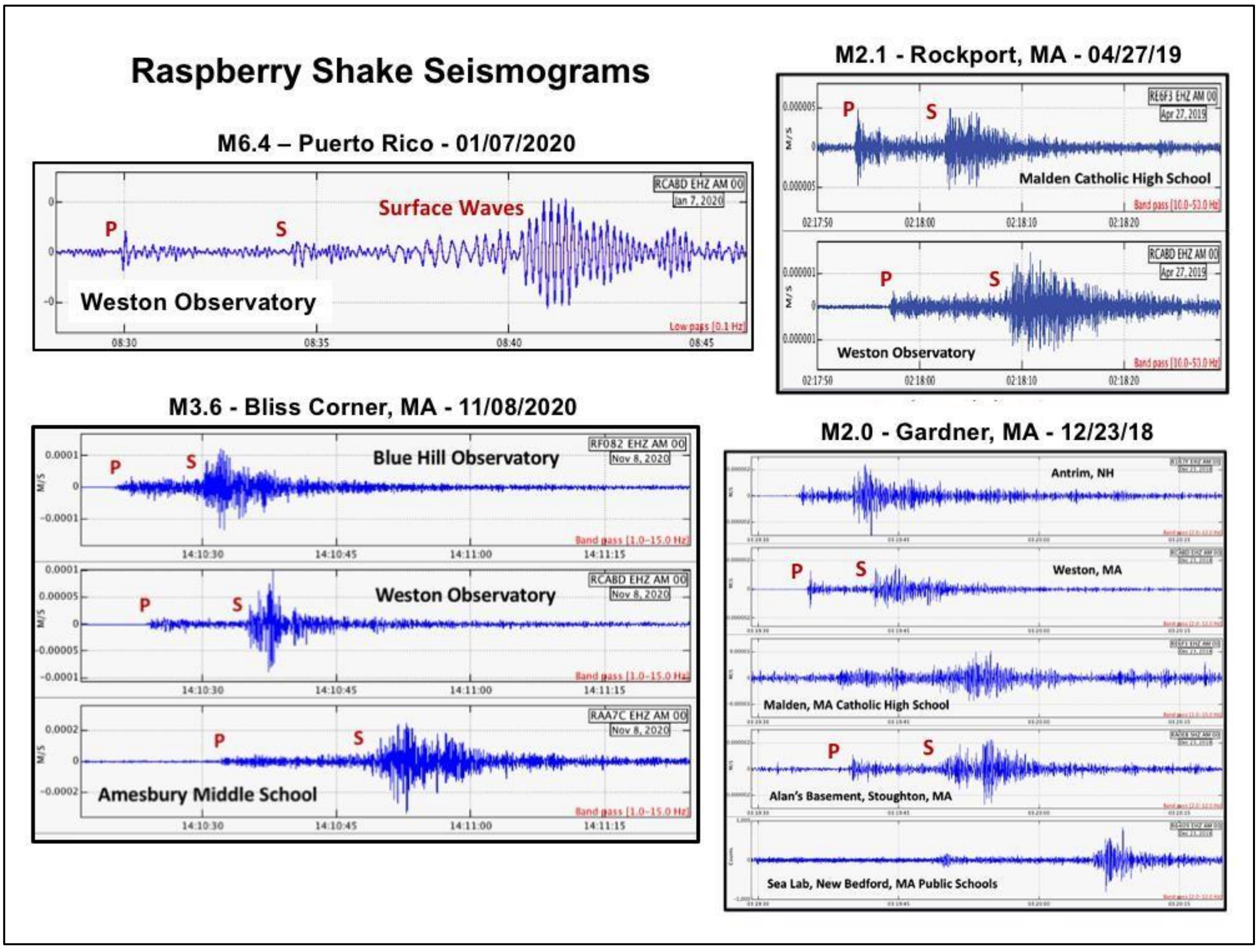


Figure 4: Earthquakes that were regionally recorded on RS seismographs in New England, and the magnitude 6.4 earthquake in Puerto Rico (also recorded by an RS in New England).

Integrating Basic Research, Science Education, and Citizen Science:

There is a growing number of examples of projects around the world where the overlapping missions of earthquake monitoring, research, science education, and citizen seismology are well integrated using RS seismographs. A few notable examples are projects in Haiti (e.g., Calais et al., 2019), Nepal (e.g., Subedi, et al., 2020), Oklahoma (e.g., Walter, et al., 2020), and Greenland (e.g., Jeddi, et al., 2020). These, and other, examples involve projects in which RSs are used to complement and densify existing seismic networks, lower detection thresholds for monitoring and studying earthquakes, engage and inform residents about earthquake hazards and preparation, and improve education in science, technology, engineering, and math for students of all ages.

A recent example of how citizen seismographs can be valuable in research is the Lecocq et al. (2020) study of global seismic quieting due to COVID-19 lockdowns. Citizen seismographs can be quite noisy because they are often purposely installed near people and other human cultural noise sources, such as road traffic. We want our citizen seismographs to be near where people are. That can be a problem for seismic monitoring of earthquakes, but it is not always bad for other aspects of the science of seismology.

Thomas Lecocq of the Royal Observatory of Belgium, and 75 seismologist colleagues from around the world, analyzed hundreds of global stations, and about a third of those were RS citizen seismology sites. They made use of the citizen seismographs in noisy locations to complement other research seismographs in a study of changes in human activity around the world due to COVID-19 lockdowns. When the COVID-19 lockdowns were imposed there was a drop-in human activity such as walking, driving, and use of public transportation. This meant there was a decrease in ways that humans create seismic vibrations of the Earth beneath our feet. Lecocq et al. (2020) were thus able to, with the help of citizen seismographs, quantify the decrease in global human activity due to the pandemic lockdowns. This demonstrated the possibility of using citizen seismographs to help monitor the effectiveness of COVID-19 lockdown measures.

Opportunities (and Challenges) Ahead for Citizen Seismology

Low-cost seismographs are not just providing new opportunities for improving education. They also offer opportunities for students and other citizen scientists to participate as research partners in the scientific community. These types of partnerships provide new ways for scientists to engage with a more public audience, making science more approachable to a wider audience. But this will only work for a wider audience of students and other citizen scientists if professional seismologists are willing to commit time and effort to be active partners in this endeavor.

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The InSight mission is extended for two years!

Jean Luc Berenger

NASA agency has extended the InSight space mission, following an external review of their scientific productivity. An independent review panel, composed of experts, found the InSight missions has "produced exceptional science" and recommended NASA continue this mission.

An amazing opportunity for teachers and students to continue the adventure of exploring Mars from the classroom, especially as InSight lander and Curiosity will soon be joined by the robot Perseverance (Mars2020).

Students following InSight mission from Dublin French School

Searching for and identifying Marsquakes, the mission team collected data clearly demonstrating the robust tectonic activity of the Red Planet, and enhanced our knowledge of the planet's atmospheric dynamics, magnetic field, and interior structure.

InSight's extended mission will focus on producing a long-duration, high quality seismic dataset. Continued operation of its weather station and burial of the seismic tether using the spacecraft's Instrument Deployment Arm (IDA), will contribute to the quality of this seismic dataset. The extended mission may continue deployment (at low priority) of the spacecraft's Heat Probe and Physical Properties instrument (HP3), which remains close to the surface.

The Namazu Contest: the best opportunity to keep in touch with Mars

The best way to follow the space mission is to join the Namazu contest, a playful challenge between schools. The episode #2 had many challenges: finding the use of a mystery object from the Mars2020 mission, building a model of the solar system, moving a rover under 'Scratch', and interviewing a scientist from the Mars2020 mission...

NASA agency has extended the InSight space mission, following an external review of their scientific productivity. An independent review panel, composed of experts, found the InSight missions has "produced exceptional science" and recommended NASA continue this mission.

An amazing opportunity for teachers and students to continue the adventure of exploring Mars from the classroom, especially as InSight lander and Curiosity will soon be joined by the robot Perseverance (Mars2020).

Searching for and identifying Marsquakes, the mission team collected data clearly demonstrating the robust tectonic activity of the Red Planet, and enhanced our knowledge of the planet's atmospheric dynamics, magnetic field, and interior structure.

InSight's extended mission will focus on producing a long-duration, high quality seismic dataset. Continued operation of its weather station and burial of the seismic tether using the spacecraft's Instrument Deployment Arm (IDA), will contribute to the quality of this seismic

Practical activity with scratch software

InSight & Mars2020 missions


Un Système solaire pour la salle de classe.

Now comes episode 3! Students will have to discover a little more about the Martian missions InSight and Mars2020 with new challenges.

So, are you ready to bury a pen like the HP3 "mole" in InSight? Ready to drop an egg like the Perseverance rover? ...

To join the Namazu contest :

https://insight.oca.eu/fr/namazu-contest

contact > namazu@geoazur.unice.fr

Latin America Chapter of IGEO

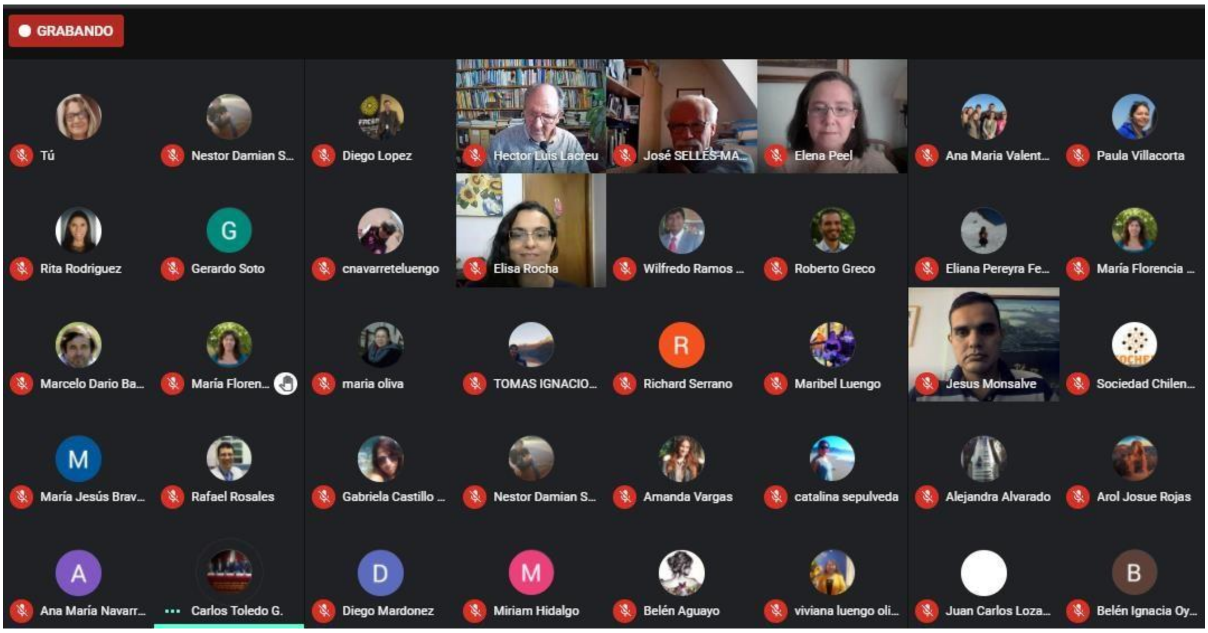
Regional Talk

On December 12, a Regional Talk called "Reflections on the Geosciences teaching in COVID19 times in Latin America and the Caribbean", to examine the challenges on Earth Science education in the region since the declaration of the COVID-19 pandemic global health emergency was held. In the talk, an expert panel identified the issues and opportunities arising from this situation in the online teaching and access to geoscientific information in this framework.

Representatives from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Panama, Paraguay, Peru, Uruguay, and Venezuela attended the discussion.

It was possible to recognize on the talk that the realities of Latin America are quite similar, sharing common difficulties and big challenges, especially in terms of coverage and quality of internet access. In turn, the lack of practical and field activities related to the teaching of Earth Sciences, especially at the university level, was mentioned as a negative result of the situation.

The opportunity that arose of online teaching, developed in extensive as a result of the pandemic, was stressed by the majority of the representatives of the delegations. Access to classes, webinars, workshops from different parts of Latin America and worldwide was mentioned and also, the opportunities to expand the way of reaching knowledge and enabling the dissemination of Earth Sciences to more people. It was also highlighted that this virtual modality promoted the work between different research groups and the interaction between geoscientific communities.



Support Letter for a bachelor's degree thesis on Geosciences education

The request for support to LAIGEO made by an undergraduate student of the Faculty of Geology at the National University of Colombia shows a shared reality concerning the education of Geosciences in the region. The student requested the support to reply to the rejection of his final degree project, called "Teaching of Geosciences in basic and secondary education in Colombia: A methodological proposal". It was declined by the Committee of the mentioned institution, as being considered that it does not correspond to the career research lines. This refusal reveals the lack of evaluation in the area of Geosciences education as a field of research and professional development.

UNIVERSIDAD NACIONAL DE COLOMBIA

LAIGEO
International Geoscience Education Organisation Latinoamérica

CARTA N° 006-2020-LAIGEO
Asunción (Paraguay), 16 de diciembre de 2020

Dra. Clemencia Gómez González
Departamento de Geociencias
Universidad Nacional de Colombia. –
Asunto: Proyecto de Tesis de Pregrado "Enseñanza de las Geociencias en la educación Básica y media de Colombia"

Es grato dirigirme a usted para saludarla cordialmente en mi calidad de coordinadora general del capítulo latinoamericano de la Organización Internacional para la educación en Geociencias (LAIGEO), comunidad conformada por geólogos y especialistas en ciencias de la Tierra de América latina y El Caribe, tengo a bien manifestar que, hemos sido notificados de la desaprobación de la propuesta de investigación titulada "Enseñanza de las Geociencias en la educación Básica y media de Colombia" por no considerarse enfocada en las líneas de investigación de la Universidad Nacional de Colombia.

Regional Workshop on Standardization of Terminologies and methodologies During February, a Regional Workshop will be held on terminologies and methodologies standardization for geoscience education in Latin America and the Caribbean. It pursues the review of terminologies and methodologies commonly used in Geosciences education in the region and also a better understanding of local education systems.

It is expected as a result of the workshop, to improve the interaction with the users of geoscientific information, for example, decision-making authorities; as well as establishing the commitment of the countries participating in the activity to consider the guide as a set of terminology and methodology accepted at the regional level.

The entire Latin American and Caribbean community is invited to participate in this activity. The program and the final dates will be announced on our website and RRSS.

Discussions at 2020 AGU on Enabling Scientists in Public Engagement and Virtual Engagement Efforts

Christine Shupla (she, her, hers)
Education and Public Engagement Manager, LPI
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Scientists, educators, and communication specialists provided a variety of presentations on the ways in which scientists are sharing their science, with particular insight on engaging audiences virtually at the AGU 2020 conference sessions "Sharing Their Science: Enabling Scientists in Public Engagement and Virtual Engagement Efforts." Two oral sessions were conducted on December 10, 2020 during the virtual AGU conference. The sessions encompassed the variety of ways in which scientists are sharing their science, with broader session goals of developing a deeper understanding of how the science education and communication communities can better support scientists' engagement efforts.

Some of the presentations focused on effort to assist or prepare scientists to engage audiences. In *We Are All Potential Role Models*, Jessica Taylor described the role model training for STEM professionals, particularly efforts to prepare NASA subject matter experts (SMEs) to conduct virtual classroom visits. *"On the Spot" Feedback Tactics to Improve Virtual Scientist Engagement with The Public* by Linda Shore described the Astronomical Society of the Pacific's research on enabling scientists to incorporating assessment tactics into outreach and the impact of that feedback on the scientists. Beth Bartell described a virtual workshop on science communication in *Going Virtual with Science Communication Training.* In *Virtual Programs with NASA Scientists for Libraries*, Christine Shupla described how scientists were prepared to deliver virtual programs to library patrons. Paige Graff described trainings to prepare SMEs at NASA Johnson Space Center to engage audiences virtually in *Virtually Engaging Audiences.*

Some presenters described how their programs were enabling more diverse scientists to communicate with the public. In *Reclaiming Stem: A model for inclusive science communication and policy training*, Evelyn Valdez-Ward described a workshop on science communication and policy for marginalized scientists, which was conducted virtually in 2020. Alexandra Phillips (substituting for Camilla Penney) spoke about an international movement to increase the visibility of women in STEM in *Telling Diverse Stories in 280 Characters: Lessons from the Women Doing Science Twitter*.

Speakers also described new or revised programs that engaged audiences virtually. *A Cooperative Pivot into Virtual and At Home STEM Education by a Scientist-Educator Partnership* by M. Elise Rumpf described how the PLANETS program (Planetary Learning that Advances the Nexus of Engineering, Technology, and Science) shifted focus to providing content that learners can access and complete at home, independently or with limited oversight. Sanlyn Buxner described how the Toolbox for Research and Exploration (TREX) scientists are providing online talks and training for schools, camps, and museums

in *TREX Public Engagement.* In *Effectively Engaging the Audience in a Virtual World* Sha'Rell Webb described virtual programs by the Lunar and Planetary Institute to connect scientists with children and their families at home. Stephen Pugh shared how museum exhibits were developed by the Deep Earth Explorers program and then replicated for an online platform in *Give Them What They Want.* Hazel Gibson described how the European Geosciences Union reformatted their conference to a virtual conference in just 6 weeks in *Six Weeks To #ShareEGU20.* In *Connecting Classroom Teachers and Students with Volcanologists*, Michael Passow shared the Earth2Class workshops model conducted by the Lamont-Doherty Earth Observatory, which includes scientists' presentations for teachers and students, now conducted virtually. Lynne Harden described how the Multidisciplinary Drifting Observatory for the Study of Arctic Climate
(MOSAiC) Expedition uses question campaigns, virtual reality, scientist blogs, and live video chats in *Engaging the Public in Science Learning with the 2019-2020 MOSAiC Arctic Research Expedition*. In *Lights, Camera, Action! Video content production and dissemination during distance learning*, Wendy Bohon described how IRIS produced and disseminated videos over a variety of social media platforms. Sheri Klug Boonstra described how NASA's Lucy Student Pipeline Accelerator and Competency Enabler (L'SPACE) Program provides online academies for diverse undergraduate students, in which SMEs provide virtual "Just in Time" content for students.

Several presenters explored ways to communicate virtually with audiences. In *Lights, Camera, Action! Video content production and dissemination during distance learning*, Wendy Bohon described SAGE's videos produced and shared over a variety of platforms. Carol Paty described her undergraduate student seminar in public writing in *Training the Next Generation in Public Writing.* Marlo Garnsworthy provided pointers in creating a website and on using social media in *A Site for Sore Eyes--Creating Your Own Science Website* and *All Hands on Tweetdeck--A Social Media Crash Course for Scientists*.

Programs also explored the research their programs are yielding in how to engage audiences. Pugh shared findings that informed how museum exhibits were developed. Taylor shared the barriers for SMEs in engaging audiences and that participants needed intermediary services, including matchmaking to connect them to audiences after training. Shupla shared that both librarians and scientists needed preparation in order to conduct a successful program for patrons.

Many of the speakers noted that conducting programs virtually enabled them to reach broader audiences. Valdez-Ward indicated that her workshop had international attendees. Gibson indicated that the EGU conference went from an anticipated 18,000 to 20,500 attendees. Buxner shared that their program is working with new partners and conducting a workshop for writers with disabilities. Webb shared that their virtual programs allowed LPI to reach diverse audiences they had not served in the past.

Another finding of programs in general is that often audiences are particularly interested in learning more about the scientists and researchers. Pugh described how they pivoted their exhibits to provide more information about scientists and created cartoon panels highlighting what they do and profiles about the scientists. Harden described efforts to make scientists more relatable and approachable. Graff recommended that scientists share their STEM story as part of their virtual presentations.

There was an excellent conversation for each of the sessions with many great questions. A similar session was conducted at the 2019 AGU conference; the conveners hope to offer another session in 2021.

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Celebrating 25 years of seismology at schools in France

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Abstract. An educational program focusing on seismological activities for school and university students that trains in observational sciences and raises citizen awareness of natural hazards has been active in France since 1995. Over this quarter century, different generations of students have learned various lessons concerning instrument installation, data recording, and analysis. These actions have led them into the field of scientific interrogation and interpretation, making them better prepared for our modern technological societies. We describe these student commitments that have been motivated by the installation of the first educational broadband seismometer in southern France. Analysis of regional earthquakes has generated a greater awareness of the seismic hazards where students live, while records of strong earthquakes all around the world have led to interaction between students, especially after the deployment of additional seismometers in schools. The natural extension of such an educational seismic network, first at the national level in France in 2006 and later in many countries through various collaborations, has enriched the pedagogical practices of teachers, increasing their skills in seismology and natural sciences among various other disciplines and complementing standard educational resources. We describe the necessary and sustainable relations between teachers and researchers over time. Combining students' motivation, teachers' experience and researchers' expertise has led to different hosting structures over the years. We conclude by presenting the feedback from a survey carried out in 2019 among all the teachers involved, highlighting the strong and weak points of such a long-term adventure. Recent integration into the official syllabus of the new Geosciences high school curricula in France illustrates the impact of such an exceptional experience.

1Introduction

Earthquakes occur suddenly and cause severe damage to the infrastructures of our modern societies, leading to high numbers of casualties. These events are unavoidable, but their impact can be significantly mitigated. They remain unpredictable even with our current scientific knowledge. Moreover, although they are both worrying and fascinating to us.

This is why emphasis must be placed on awareness, especially in the school system where the causes and effects of these hazards are studied. The idea of an educational seismic network arose in the United States with the Princeton Earth Physics Project (PEPP) proposed by Nolet and Phinney in 1993 (Steinberg et al., 2000). Pursuing the same objective, an educational seismic network was initiated in France in 1995 and is still active after 25 years.

Today, many other educational seismic networks exist around the world, including the United States, Great Britain, Greece, Portugal, Australia, Nepal, Taiwan, Haiti, and more, providing an indication of the importance of and need for distributing seismic sensors to schools for educational purposes. The installation of seismometers at schools promotes learning based on original records. Such learning makes students familiar with scientific data. With acquired experience, students can download other data from environmental agencies for their own investigations. The program also allows for collaboration between teachers and researchers in order to better collect and analyze the seismic data. Such interactions allow teachers to develop teaching materials for their classes. Moreover, this teaching material is provided on a website to other educators within the same discipline. It has been observed that these online resources have been used by a broader community of teachers in many fields, including natural sciences, history, geography, and social sciences.

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Through this unique, long-term experience, this paper contributes to answering the following questions: how and why has the French educational system evolved over time and benefited from the deployment of a dedicated seismic network? Why is collecting scientific data inside a school important for both teachers and students? How have motivated teachers been able to expand online educational exercises to studying their own data and the data that has become increasingly available on the web? How have such original educational resources been shared with other teachers across school and national boundaries? What skills and support are needed to maintain an active educational network? Why can we not rely only on the open data sets available on the web? How has such an experience impacted French teaching programs?

2Sismo des écoles: the first French school network

In 1995, thanks to the PEPP initiative, the design of a dedicated educational seismometer began in France, including a broadband three-component velocimeter associated with a 24-bit high dynamic digitizer synchronized by GPS with a precision of 1ms (Fig. 1a). It was installed at the International Campus of Valbonne (CIV; pilot school). This sensor and its control card were monitored via a personal computer and a telephone line. In order to share scientific information between schools, the automatic nightly gathering of time-windowed records of local, regional, and long-distance events, when strong enough, was generated from the earthquake catalogs of international agencies. At that time, seismic sensors and related seismograms were more or less an abstraction for the school community. The first active group of 12 high school students was created, meeting weekly to share the analyses of seismograms from the station and related information collected through newspapers. This very committed group was supervised by a teacher who interacted closely researcher, and both were involved in this prototype project at the CIV. For the very first time, students had immediate access to global earthquake seismicity from the seismometer within their school. The seismometer and its records provided some concrete aspects to virtual questions related to seismic hazards and to the knowledge of the Earth’s structure, which are key scientific topics for French high school education. Students and teachers tracked seismic events, such as the Chi-Chi earthquake (Fig. 1b), and other natural or anthropogenic vibrations (sea swell, human activity, quarry blasts, etc.).

In 1996, the French Ministry of Education decided to connect all the schools to the internet for student training. However, these institutions were very concerned about the added pedagogical value of using the internet in schools. The seismic network thus benefited from this advancement in connectivity; the prototype seismometer was connected to the network. The first online educational seismic database was born. Teachers in other schools were able to work on the online seismic data sets. At the same time, regional political concerns focused on the education of young people about natural hazard awareness in one of the most active seismic zones in France. The prototype station demonstrated that an in-school seismic network to promote educational program was possible. A first financial grant was given to the Alpes Maritimes region. A network of five schools equipped with three-component broadband sensors was set up in the south of France (regional deployment in Fig. 1c; Virieux et al., 2000) and proved to be so successful that the extension to a national configuration was proposed. The organization of such a network was based on voluntary proposals from a team of teachers. The equipment was provided free of charge, while maintenance was the responsibility of the volunteer school.

3 An increasing network of teachers specializing in seismology.

This network, which is constantly increasing, has been supported by different regional and national funds. In 2006, the French national Sciences à l'École organization integrated the existing Sismo des écoles network into their national educational projects. This cooperation enabled the transformation of local actions into widespread initiatives. The network, renamed SISMOS à l'École, was first deployed on a national level, followed by international deployment in French schools abroad, as illustrated in Figure 1c. This figure shows the role of the professional and educational sensors. (See the data availability section at the end of the paper for further details.) In order to fulfill the educational target of seismic hazard education and scientific approaches, having teachers who are well trained in seismological skills as an interface between teachers and researchers is mandatory and requires specific workshops. Each school with an installed sensor has an identified researcher (one teacher is paired with one researcher who acts as a mentor). Researchers have comprehensive knowledge of seismic phenomena and teachers have the pedagogical skills to describe these phenomena to students. Researchers have also contributed to the numerous training sessions through scientific refresher lectures. Furthermore, the researchers also use the network's data sets to integrate them into the seismicity study of the considered areas (Berenguer et al., 2013; their Fig. 6).

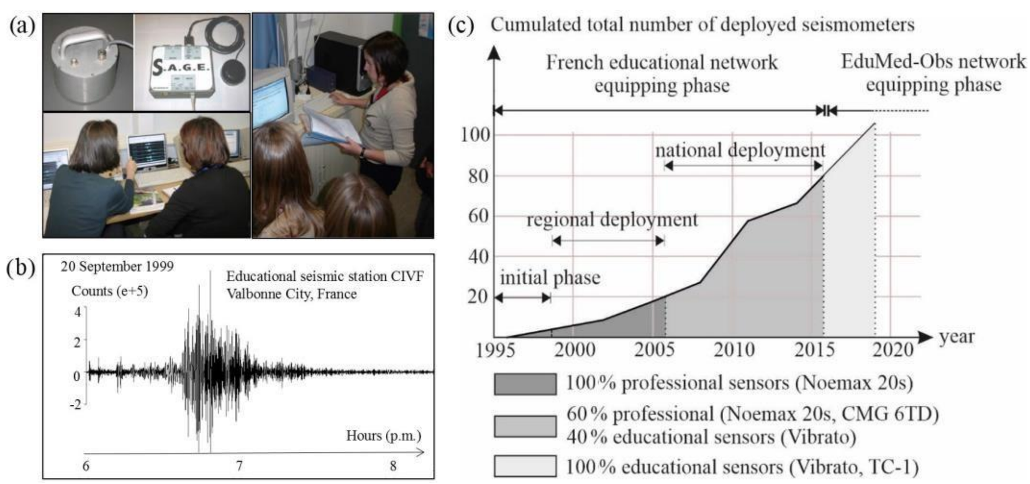

Figure 1. First educational seismic stations deployed at the International Campus of Valbonne (CIV). (a) Students working on seismograms from a specific educational database. Informed consent was provided by the individuals pictured for the publication of these identifiable images. (b) Record of the Chi-Chi earthquake (Taiwan, M_W 7.6), which occurred on 20 September 1999 and was recorded at the French educational CIVF seismic station. Values in abscissa are the after-noon hours of the current day (universal coordinated time – UTC). (c) Evolution of the number of educational seismometers deployed during from the past (equipping phase of the French educational network) to the present with the EduMed-Obs project. Colors under the curve and corresponding-colored boxes give an indication of the kind of sensors deployed during each phase. (See the data availability section at the end of the paper for further details.)

3.1 Regional, national, and international teachers' workshops

In the last 25 years, different meetings have been offered to any teacher who wanted to increase their own skills in seismological topics. In order to maintain significant momentum within the national (and overseas) network, six national meetings have been held since the beginning of the project, with a total of 200 teachers attending at least one of the proposed meetings. These ongoing training sessions thus keep the educational network alive. Topics are related to following items:

- scientific conferences presented by scientists and specialized teachers,
- practical workshops around data sets from the network, and
- poster presentations to share experiences in different schools.

This format was finally recognized as very useful and helpful for the optimal use of scientific data sets through the interaction of researchers participating in these teachers' workshops and with the participation of the young students whose awareness has been raised. At a different scale, European teachers' workshops were organized under the umbrella of European research projects, such as the NERA, O3E, and SERA projects (see the Acknowledgements). These workshops, supported financially by European projects, have provided the opportunity to mix the different cultural styles of educational training that one can find among the different European countries.

3.2 A long-standing production of teaching resources

At the early stage of the network, the teachers shared their pedagogical experiences of exploiting inschool seismometers and available data sets on the web. Initial activities focused on the interpretation of dates, travel times, and the recognition of seismic waves. With the accumulation of new data combined with their increasing seismological skills, teachers started to produce better-developed activities focusing on different and more complex aspects. The development of digital tools at schools has enabled the development of original activities to manipulate numerical quantities. For example, by combining information from seismic catalogs and spreadsheet tools, students are able to display coordinates of listed seismic events on a map and observe that the distribution of each plot enables them to highlight areas which look like tectonic plates. Manipulating these catalogs by themselves enhances their understanding of where and how the information is obtained, which is an added value with respect to push-button applications. An extensive collection of different shared activities was undertaken and finalized through an exercise book *Le cahier d'activités du SISMO* (*The seismo hands-on book*; Berenguer et al., 2009; Fig. 2a; see the data availability section at the end of the paper for further details). This collection is an illustration of what can be done with the help of seismic data collected in schools. Quite sophisticated scientific topics may be tackled in a simple and pragmatic way during teaching and training. We can cite an example of a practical activity that has become very popular in the classroom. The experiment consists of causing the rupture of a rigid material (polystyrene, uncooked lasagna sheets, hard chocolate, etc.) and recording, with the help of simple piezoelectric cells, the waves that propagate around the rupture (*Le cahier d'activités du SISMOS*, pp. 24–25). More activities are available in the digital version available online (see the data availability section at the end of the paper for further details).

3.3 Successive web platforms to improve sharing.

All records and activities have also centralized on successive dedicated web platforms for open sharing. At the outset of the project, a web server was hosted by the regional services of the French Ministry of Education. Thus, the records from regional and global seismic activity feed an online database and constitute a seismic resource center for education. Teaching requires a didactic approach to resources. The need for a more sophisticated platform emerged; this is why the web interface of our educational program goes beyond a simple data center. In 2010, the Edusismo website (http://www.edusismo.org/, last access: 30 October 2020) was developed through funds provided by the French ministerial “Sciences à l’École” program. This website was a cornerstone for providing tools (experiments, software, and simulation) to properly exploit the available data sets and many different educational paths to learning. The two first main digital tools used were as follows:

- SeisGram2K (Lomax, 2000; see the data availability section) software, an interface for the seismological research community and adapted for schools. Students can display seismograms, apply filtering processes, pick wave arrival times, and more.
- EduCarte geographical information software (see the data availability section) which enables users to plot geo-referenced information, work with seismograms, display GPS measurements, create cross sections, and more.

Making these data sets didactic through simple and welldeveloped steps remains the priority of our program. to recharge my batteries

4 New impetus for natural risk prevention with the EduMed Observatory

In 2017, the University of Côte d’Azur took over with a program called Educational Mediterranean Observatory (shortened to EduMed-Obs; http://edumed.unice.fr, last access: 6 December 2020). EduMed-Obs focuses on implementing an interface based on a geoscience data set concerning the Mediterranean basin. The theme does not only focus on seismology; landslides, meteorology, hydrology, and sea-level variations are also considered. Data mining is developing and has become more important in current teaching programs (Bigot-Cormier and Berenguer, 2017). These data sets are intended not only for middle and high schools but also for university students. EduMed-Obs also provides data sets from research centers. This aspect is important for strengthening the visibility of the activities of research institutes. It is an excellent opportunity for students to compare data sets from their own sensors with research data sets. Making communities aware, through student training, of the role of Earth science observatories is crucial and promotes a better understanding of the seismological (and environmental) nature of the territory in which students live. How these observatories participate in our seismic risk awareness is also better understood by governmental structures, leading to improved territorial management such as tsunami mitigation. This new educational observatory already includes some 70 European schools in the countries around the Mediterranean that host sensors and which implement scientific teaching focused on natural risk education (schools map available at http://edumed.unice.fr/fr/le-reseau-edumed, last access: 6 December 2020). The schools that are twinned within this network can share their experiences of natural risks along the Mediterranean coast. EduMed-Obs is a partner of many innovative field camp training courses organized around the Mediterranean, like “InsegnaciEtna 2019” in Sicily (http://site.ietna.eu/, last access: 6 December 2020). This expertise is already being exported through initiatives in central America, where a network is being built on the Caribbean arc from Haiti to Venezuela via the French West Indies (http://edumed.unice.fr/fr/eduseis, last access: 6 December 2020). The recent creation of EduMed-Obs and its present and future actions are directly inspired by the feedback from the teachers involved in this project over the past 25 years. Below, we propose a description of the key points mentioned by the teachers over the years.

5 A look at the past actions of the French educational seismological network.

Teachers have reported a number of positive points from their experience, including the students' enthusiasm for recording quakes, the ease of understanding online databases, the development of autonomy, students' responsibility in managing a seismological station, and the importance of natural risks within the theme of sustainable development. One of the great strengths of the network has been its integration into teaching programs, and it has fulfilled various expected educational objectives, such as the following:

- practice a scientific approach,
- demonstrate observation skills, curiosity, critical thinking,
- experience autonomy, and

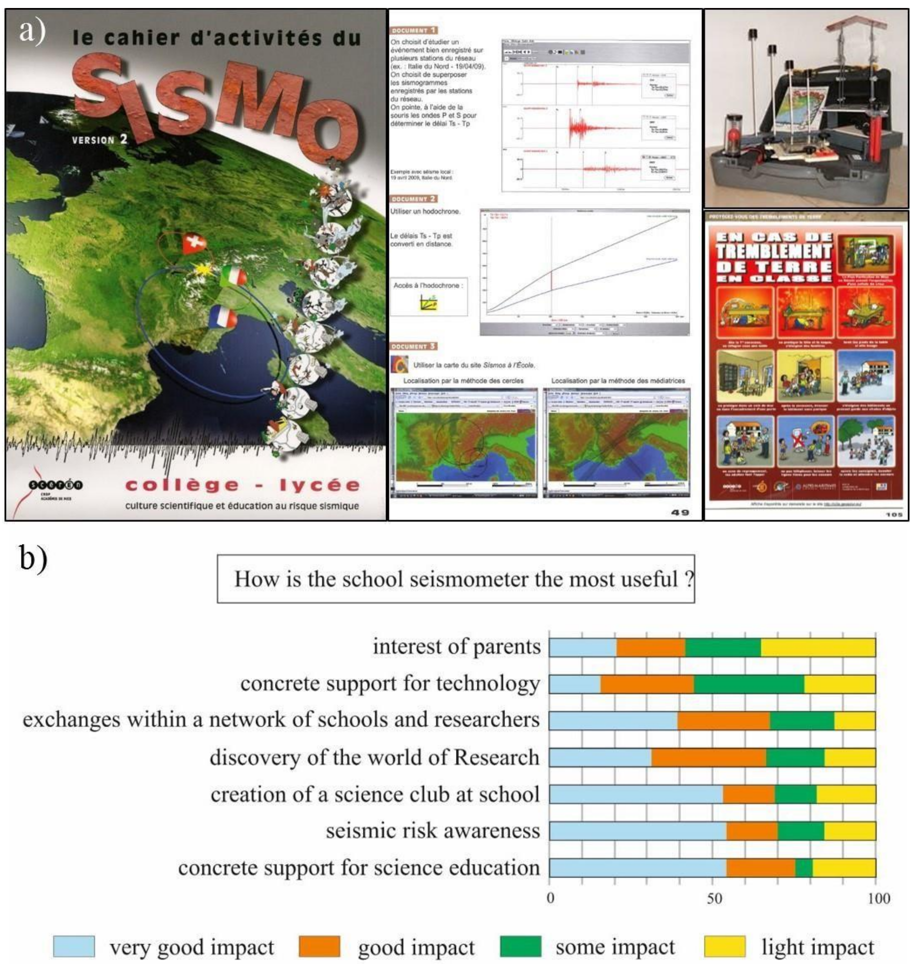

Figure 2. Pedagogical resources produced by the French educational network. (a) The seismo exercise book and the seismo box used to illustrate many aspects of the seismic phenomenon. (b) Focus on teachers' answers to the survey. In this case, the graph shows the impact of the installation of a seismometer at a school relative to different considerations.

- communicate in scientifically appropriate language, i.e., oral, written, graphical, and numerical.

The installation of seismometers at schools in different areas of Europe and abroad has given schools the necessary impetus to use a scientific approach for the improved development of activities concerning the knowledge of hazard, the realtime manipulation of information and scientific databases, and a better understanding of matters related to risk and territorial management (Courboulex et al., 2012). However, it remains important to evaluate how this has spread scientific culture and risk education to generations of students.

The 25 years of the French seismology at school survey

After 25 years, the time had come to make an overview of the teachers' vision of the impact of this network on their teaching and on student training. A survey was conducted in November 2019 among all teachers who have participated in the various actions of the program since it began. Note that these teachers are all teachers who are, or who were, the school reference person for the seismometer installed at one of the 105 schools in the network. Several of them are (or were) in charge of teacher training sessions in France and abroad. The number of responses may seem small, but their answers reflect the feelings of many more people. Collecting all feelings, reflections, and suggestions accumulated within the different special events carried out by the network should provide critical information for the future evolution of the educational network. Questions were listed to quantify the impact of the program on their teaching and on the awareness of science culture and risk education among students. The results presented in Fig. 2 are based on the responses of the 73% of the teams that have sent feedback, i.e., a total of 250 teachers. In France, Earth science is traditionally taught by biology and geology teachers. They provided the major contribution (85% of the answers) to the survey (compared with the contribution of only 15% of physics teachers). Half of them are teachers who have participated in an educational seismology program for more than 6 years. They consist in equal numbers of middle and high school teachers. A total of 80% of them (200 teachers) have participated in at least one of the training seminars on seismology and seismic risk described above. The main objective of the survey concerns the pedagogical value of installing a seismometer at a school. What is the greatest contribution of such instrument in a classroom? The interests are listed in descending order. The program has proven to be a facilitator for the following:

- practical support for science education (75.3%)
- seismic risk awareness (70.1%)
- creation of a science club (68.8%)
- discovery of the world of research (66.3%)
- exchanges within a network of schools and researchers (65.6%)
- practical support for technology (58.5%)
- stimulation of the interest of parents (45.5%).

The survey confirms that a seismometer installed at schools is an essential educational element for the majority of teachers. From teacher feedback, we also note that, through this sensor installed at the school, most of the students acquired skills to become ambassadors for seismic risk. Indeed, teachers mentioned that many students were invited to participate in scientific events in order to present their work. It can be considered that at least 20000 students have been able to participate in and benefit from the educational seismology program in France. Many of them are adults today, some of them have chosen a scientific career, but all are citizens who have been made aware of seismic risk by studying seismic phenomenon through the analysis of seismic data provided by educational and research seismometers.

6Conclusion

All teachers agree on the fact that the presence of a seismometer at school is of great importance for the fulfillment of the main objectives of scientific culture and seismic risk education. Many other seismological networks for educational purposes have also emerged in Europe and around the world. Such educational programs have shown a positive impact among students (Zollo et al., 2014). Educational seismological networks also draw their strength from the interaction between teachers and researchers, which has occurred under various circumstances. If citizen science and educational seismology occupy such a prominent place in society today, it is because they ask for citizen commitment on important issues such as the prevention of seismic risk and, more generally, of natural risks. Schools play a central role when addressing a young public. The place of scientific research is also essential for better mitigation of natural hazards and for better understanding of the anthropogenic impact on environmental systems. Therefore, through this long-standing educational program with the driving motivation of building a seismic network across different educational communities in Europe, we must definitely focus on prevention through education. Educational seismology networks do more because they encourage students to adopt a scientific approach based on observation and measurement, enabling them to understand the causes of earthquakes, the internal dynamics of the globe – and to learn how the systems behave.

Similar programs can be developed in other countries if the education system in those countries is taken into account. However, one of the strongest elements for success is the training of educators, who are a key ingredient of the program. This training has followed teachers throughout the last few years. Indeed, any new educational project must support teachers by ensuring that they improve their scientific skills, specifically in Earth sciences. In order to achieve this goal, bringing teachers closer to researchers in a reciprocal interaction is important. Other key elements are the use of friendly, usable technical tools for manipulating scientific data and teaching resources, including learning aspects and assessment items. The way these features are developed is country dependent. Over the years, the French program has taken care to develop these activities (training courses, seminars, and conferences) for the various users, such as students, teachers, and researchers.

Thus, teaching seismology using real, recent data from online sensors gives a lot of satisfaction to students and teachers alike. This experience with educational seismology has now enabled the University of Côte d’Azur to set up an educational observatory of the Mediterranean environment (EduMed). This observatory offers a data center for teaching topics beyond seismology. Thus, using a similar educational approach, students and teachers have access to hydrogeological data with a range of diversity (river characteristics and karstic cave distribution). Meteorological data (rain, wind, and temperature) are another set of physical data to be analyzed and understood. Data from buoys at sea provide crucial data for the oceanic realm.

Over its first 3 years of operation, the access to various quantitative physical data related to the environment has allowed students to investigate different environmental subjects with the help of teachers in different disciplines who have different teaching expertise and interests. This extended program has broadened student skills, their education of natural risks, and their awareness of their natural and societal environments.

Finally, the challenge of educational seismology is the improved training of our students in Earth sciences so that they have a better understanding of how science is constructed and how it progresses. Undoubtedly, trained citizens are better equipped to face their future with a strengthened science–citizen link, and scientific vocations are the rewards of such innovative and attractive training.

Data availability. The book *Le Cahier d'activités du SISMO*, version 2 (Berenguer et al., 2009), funded by the Alcotra Program (European Union), was developed in 2009 and published by the school district of Nice (France). A digital version is available at http://namazu.unice.fr/EDUMEDOBS/seismo/ seismobook-version2.zip (last access: 6 December 2020, Berenguer et al., 2009). SeisGram2K and EduCarte (developed by Anthony Lomax and Jean-Luc Berenguer) software is downloadable from http://edumed.unice.fr/fr/contents/news/tools-lab/ SeisGram2K (last access: 6 December 2020, Lomax, 2000, https://doi.org/10.1785/gssrl.71.5.589) and http://edumed.unice.fr/ fr/contents/news/tools-lab/EduCarte (last access: 6 December 2020, Lomax and Michelini, 2009, https://doi.org/10.1111/j.1365246X.2008.03974.x).

The professional seismometers deployed during the initial, regional, and national phases were the SAGE station, with a threecomponent velocimeter (Noemax 20s). During the national phase, Güralp CMG-6TD devices were also deployed, such as the educational Vibrato station (https://www.staneo. fr/vibrato.php, last access: 6 December 2020, Berenguer et al., 2013). This device and the TC1 seismometer (Van Wijk et al., 2013, https://doi.org/10.1119/1.4830072) are currently deployed (EduMedObs phase).

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Using Tree-Ring Research to Introduce Students to Geoscience Fieldwork

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In 2000, Dr. Pam Blanchard began the Coastal Roots program at Louisiana State University (LSU) in an effort to bring students into the field. Today, this effort has grown to 50+ local schools (plus 3 schools in Chile!) and has introduced more than 25,000 middle- and high-school students on field trips aimed to plant more than 175,000 tree seedlings in coastal Louisiana, an area especially susceptible to sea-level rise.

In this time, Dr. Pam (as her students know her) has seen assistants from numerous other faculty and graduate students who greatly support the addition of outdoor experiences in young people's formal education. Most recently, the Coastal Roots program, as well as faculty from four other departments at LSU, received $200,000 from Louisiana Sea Grant to introduce a new pilot program to Coastal Roots.

In addition to their annual tree planting trip, five Coastal Roots participating schools became part of a pilot program aimed at teaching these students how tree-ring science is conducted in the field.

Students were taught how to take GPS measurements, how to measure the diameter and height of a tree (Figure 1), and eventually how to extract a small core from the tree used in further analysis (Figure 2).

These tree cores were given to a tree-ring laboratory at LSU and scientists were able to date the tree rings accurately and give students the data from their trees (Figure 3). Students were able to understand periods of drought stress in wetland trees and periods of hurricane wind stress in other trees (Figure 4). In the sociological part of the pilot program, students were given pre- and post-tests to determine what they had learned. Results indicate that student understanding of tree ring science and the scientific process increased 30-45% as a result of bringing students into the field portion of tree-ring research. Due to the success of this pilot program, project leaders now believe that these students could also be taught how to date tree rings and understand patterns seen in the rings, thus becoming the first citizen tree-ring scientists!

Two manuscripts about the project are currently processing in peer review. Look out later in 2021 if you would like to know more specifics about this project, or email one of the project leaders with questions: Clay Tucker (cstucker3@ua.edu) or Jill Trepanier (jtrepa3@lsu.edu).

Figure 1: Project lead Jill Trepanier teaching students how to measure the diameter of a tree.

Figure 2: Project lead Clay Tucker extracting a tree core from a tree using an increment borer.

Figure 3: Tree cores mounted for further analysis in a laboratory.

Figure 4: A high-resolution scan of a tree core. Note that each dark/light combination represents one year of growth. For this particular tree, small rings indicate years of low growth corresponding to hurricane events.

Expanding Geoscience Learning through Graduate Student Experiences Abroad

By: Keiko Wilkins & Angelique Rosa-Marín

Geosciences extend beyond continental boundaries requiring collaboration between countries to expand knowledge. Initiating international collaborations is not always an easy task. Finding the right person to work with and navigating the logistics of the association can be difficult. However, these collaborations are essential to advancing our knowledge and creating bridges fostering mutual cultural understanding. These types of collaborations occur with researchers and academics in many different fields, but often do not include graduate students.

To help graduate students learn how to successfully complete an internationally collaborative project and be better prepared to initiate these types of collaborations, the

Association for the Science of Limnology and Oceanography (ASLO) created the Limnology and Oceanography Research Exchange (LOREX) . This program trains students through professional development events and funds US-based graduate students to participate in a 4–8-week research exchange program at an international university **(Figure 1)**. Students design and lead the research project during their time at their host institution.

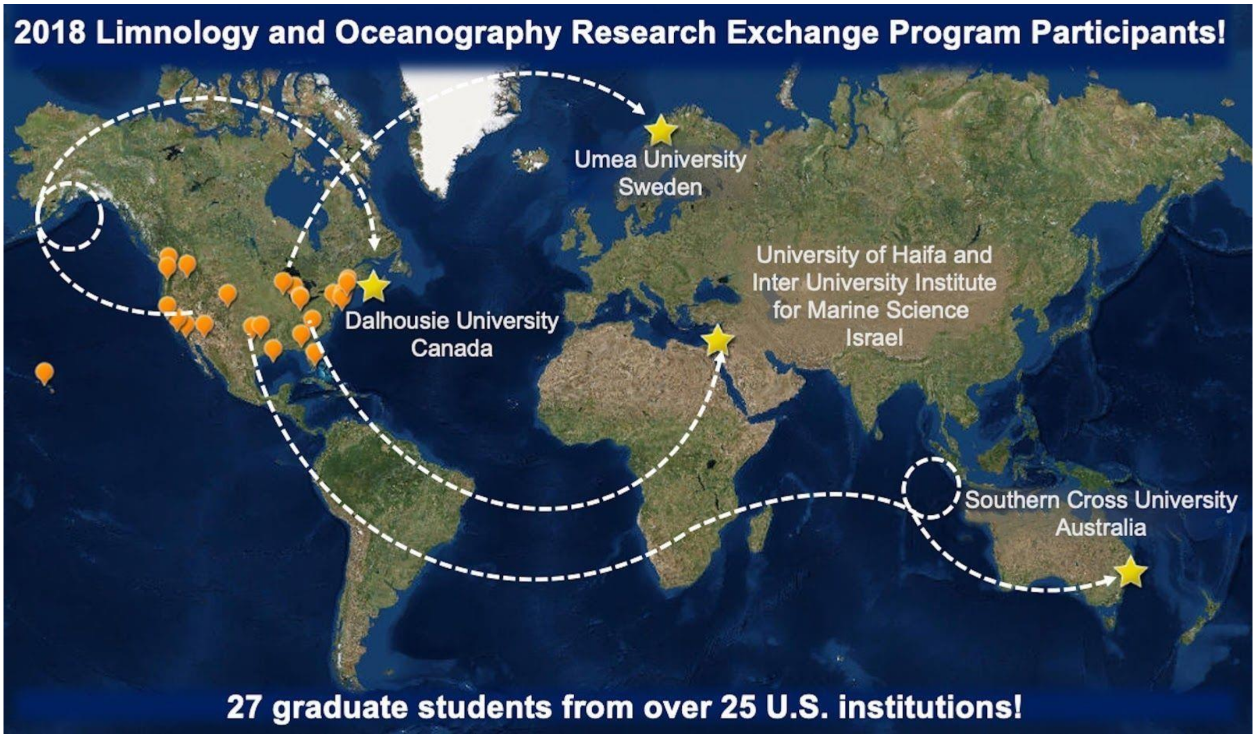

Figure 1: Available universities for LOREX Cohort 1 students to attend for their LOREX exchange. More universities have since been added to the list. Taken from Wilkins et al. 2020.

LOREX provides students with some logistical help, but students are responsible for the remainder of the planning for their research project. LOREX coordinates the logistics of flights to the host site as well as housing and a living stipend, but not the logistics of the research project. To help prepare students for the collaboration, there is a handbook for reference (International Collaboration Advice) . A lot of the research experience is determined by the student's ability to be flexible. Many students expressed how their LOREX experience increased their confidence as a researcher in a variety of areas and their confidence as a person (Wilkins et al. 2020). Without experiences like LOREX, graduate students likely would not be given the opportunity to obtain these same skills within their graduate program.

The exposure to these new experiences and ways of doing research has profound effects on the way in which students view geoscience research. LOREX participants stated that their perspectives on research and what it means to be a researcher greatly changed by being exposed to other cultures and seeing how science is conducted in other countries (Wilkins et al. 2020). Students were able to explore areas of research that were not necessarily available at their host institution and home in on potential research projects for the future.

During the exchange program, students work with their collaborator to complete the project with the goal of disseminating this information to other scientists and the public. The LOREX program has seen much success with students sharing their findings in a variety of mediums (LOREX Outcomes). Students are given the opportunity to share their work on a publicly available ASLO LOREX blog (LOREX Blog) and the ASLO social media accounts. They are also encouraged to share the findings of their research at scientific conferences and in peer-reviewed journals.

LOREX is the first of its kind, but it should not be the last. Much can be learned from this program and the many successful outcomes. Giving graduate students the opportunity to participate in research programs allows them to gain the hands-on experience that most of them often want **(Figure 2)**. LOREX also brings opportunities for minority students to be involved in an international experience that may not otherwise be available. Ultimately these students increase global science knowledge towards a better future.

Figure 2: LOREX students participating at Southern Cross University (Lismore, Australia) for them research exchange.

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