Final Project
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Science Communication
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Context:

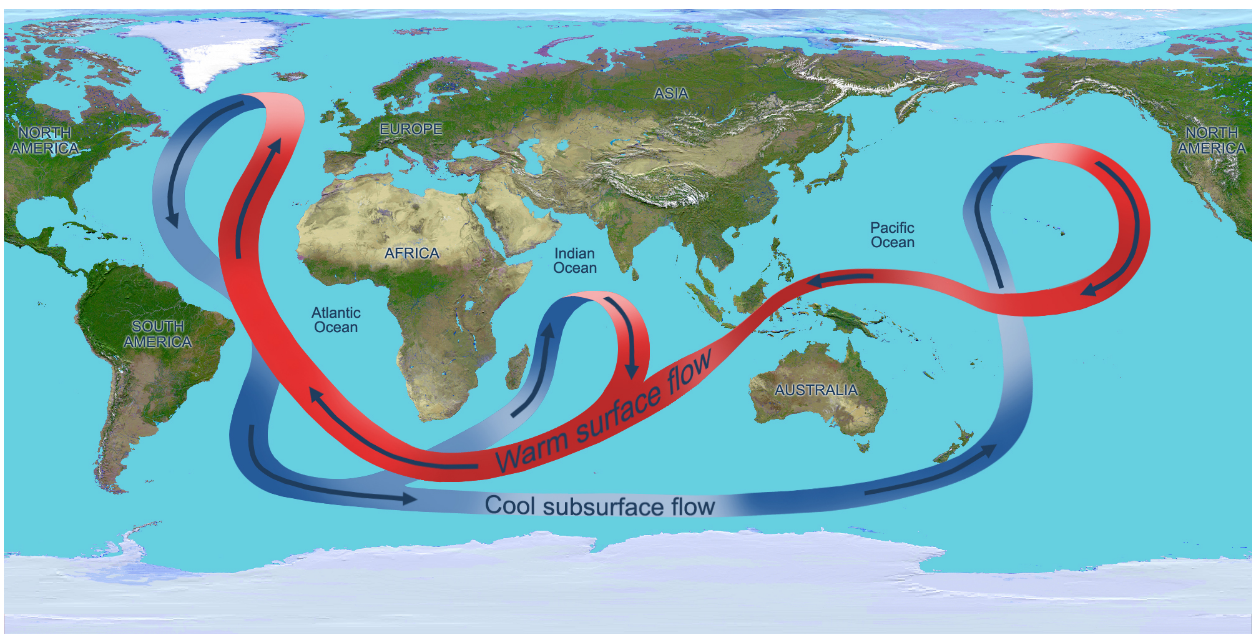
This communication is aimed towards educated teenagers and young adults ages 17-21 in the United States. Presumably, they are aware of climate change through both media coverage and their education so they would not need to be convinced of its existence. This article would be found in a news outlet that is oriented towards a younger, more casual audience. While this outlet covers important stories, the voice of the publication is fun, quirky, and (for lack of a better word) very millennial. This article is intended for online viewing and aims to get young people engaged and excited about the content. This is not a persuasive piece but, rather, a piece that aims to educate young people about a new scientific discovery in a way that may encourage them to look deeper into the topic and become enthusiastic about science. In essence, the article aims to have young people finish reading it thinking, “That is so freaking cool.”

Yes, We Can Actually Measure Ocean Warming Using Earthquakes. Here's How.

Using current and past earthquake data, scientists use the speed of seismic waves to detect changes in ocean temperature.

Lorenzo Sampson
Reporter

Water. It makes our planet able to sustain life and covers 70% of its surface. Its incredible ability to absorb heat, called its heat capacity, makes it an important player when it comes to climate change. As the planet warms, the ocean absorbs that heat and moves it around through a series of currents called the Global Conveyor Belt.

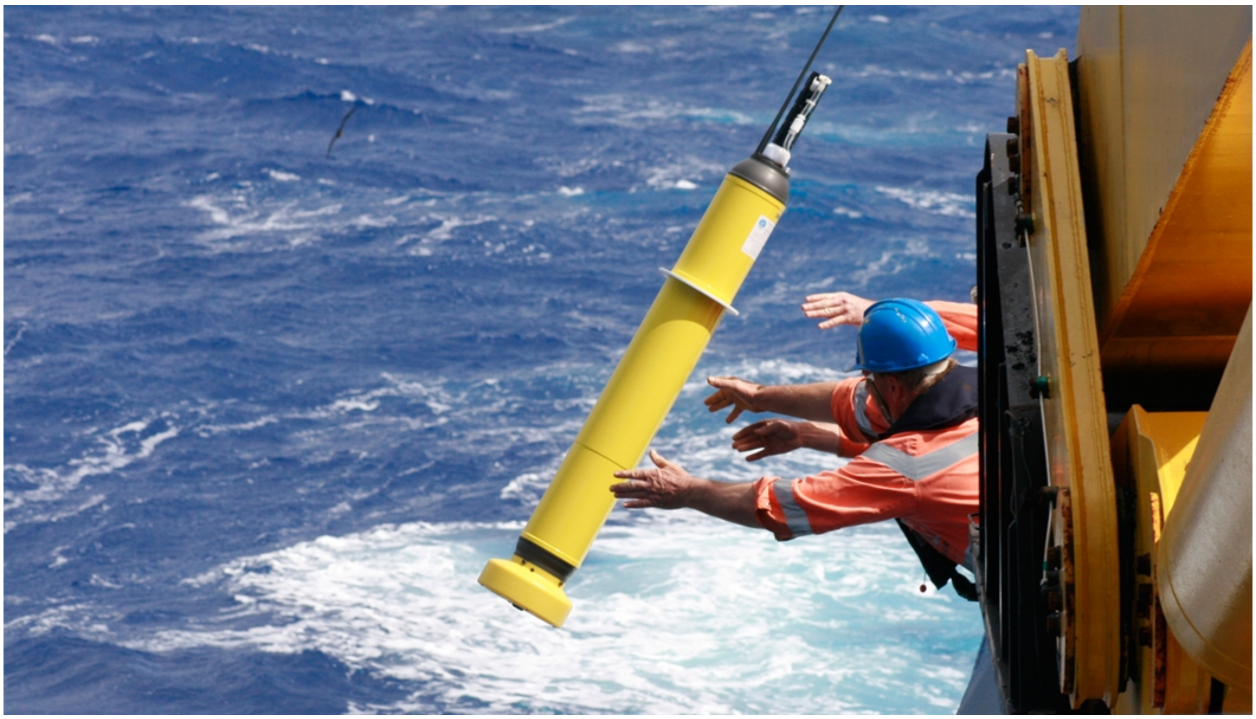


Global Conveyor Belt. *NASA.*

The heat stored in the ocean does not just go away. It can melt ice shelves, it can re-heat the atmosphere in a different place, and it can even make the ocean expand, causing sea-level rise. None of this is good. The worst part is that the ocean stores this heat for decades and will negatively affect the environment even if climate change were to stop this very second.

For this reason, it's important to keep tabs on what the ocean is up to. Monitoring the temperature of the ocean can help us to know what types of impacts to expect. But you can't just stick a thermometer in the ocean and call it a day. Some parts of the ocean are warmer than others. So, to get a complete picture of ocean warming, the temperature has to be measured all over the ocean and at all different depths.

Currently, this is done through the use of about 4,000 bright yellow robotic flotation devices collectively known as Argo. Over the course of 10 days, each device takes temperature measurements at depths up to 2,000 meters.



Deployment of Argo floatation device. *NOAA*.

However, this technology is limited. For scale, the ocean is about 3,688 meters deep on average. That leaves over 45% of that average depth unmeasured. The devices also can't be deployed in regions covered by sea ice. To top it off, this technology isn't cheap. Each device costs as much as $150,000 or, in other words, the price of a brand-new Mercedes. But if you're on a budget, you can score the cheapest model for $20,000 or the price of a Honda Civic.

Luckily, Wenbo Wu and his team at the California Institute of Technology have pioneered a new way to measure ocean temperature that blows Argo out of the water. Wu and his team, oddly enough, have figured out how to take the ocean's temperature using earthquakes. They call this process seismic ocean thermometry.

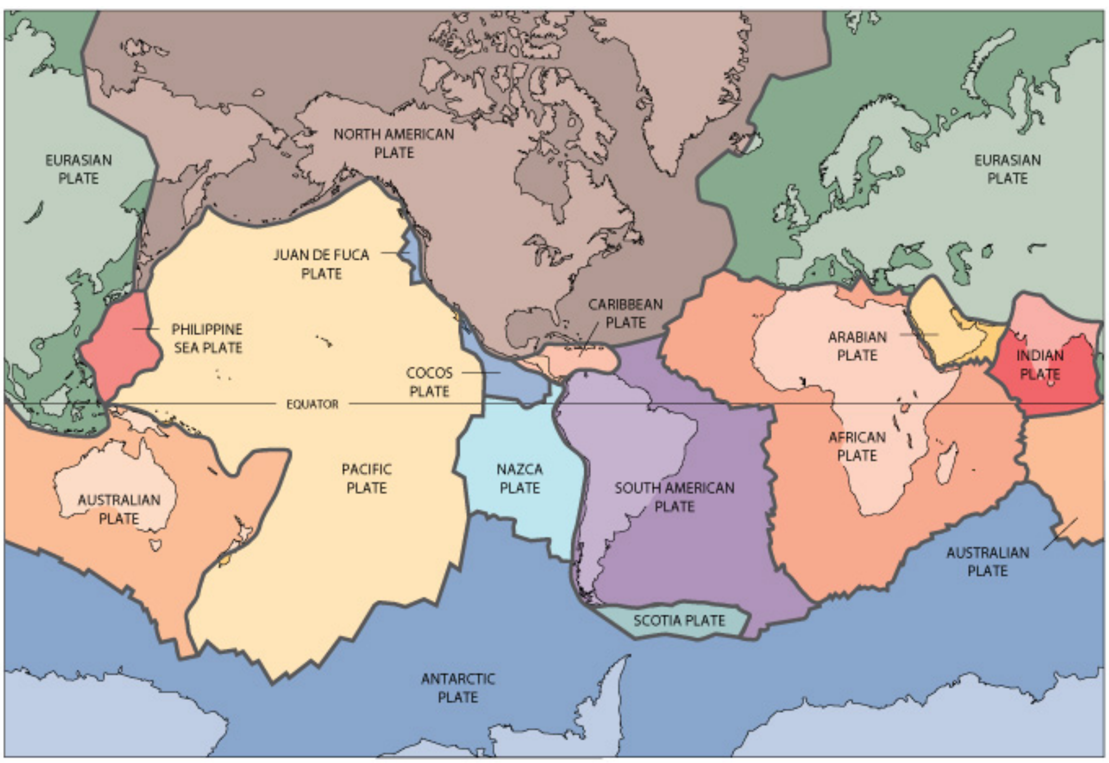
The idea behind this method is surprisingly straightforward: "The speed of sound in seawater depends on temperature," writes Wu. The warmer the water, the faster the sound. So, in order to detect changes in temperature, the team looked towards "changes in the travel time of sound waves between a source and a receiver." But the team looked to a less conventional source for their sound: earthquakes.

Humpback whale behavior is altered by artificial sources of sound used by scientists to measure ocean temperature. *Ullstein Bild—Getty Images.*

Historically, scientists have used an artificial source from which to measure the speed of sound waves. This involves dropping what can only be called a low-frequency, waterproof, quasi-speaker into the depths of the ocean. Scientists then record the sound from the speaker as it travels to the surface. This technology is expensive, complicated to use, and has caused concern about the health of marine mammals exposed to these sounds. So, it was eventually abandoned for global usage.

So why earthquakes? First, they happen naturally, without the team needing to spend time and money to generate the sound themselves. Second, earthquakes are constantly occurring on the ocean floor which allows for consistent measurements. Third, the technology to record earthquakes already exists. Fourth, there is over a century of historical earthquake data scientists can use to reconstruct ocean temperatures throughout history.

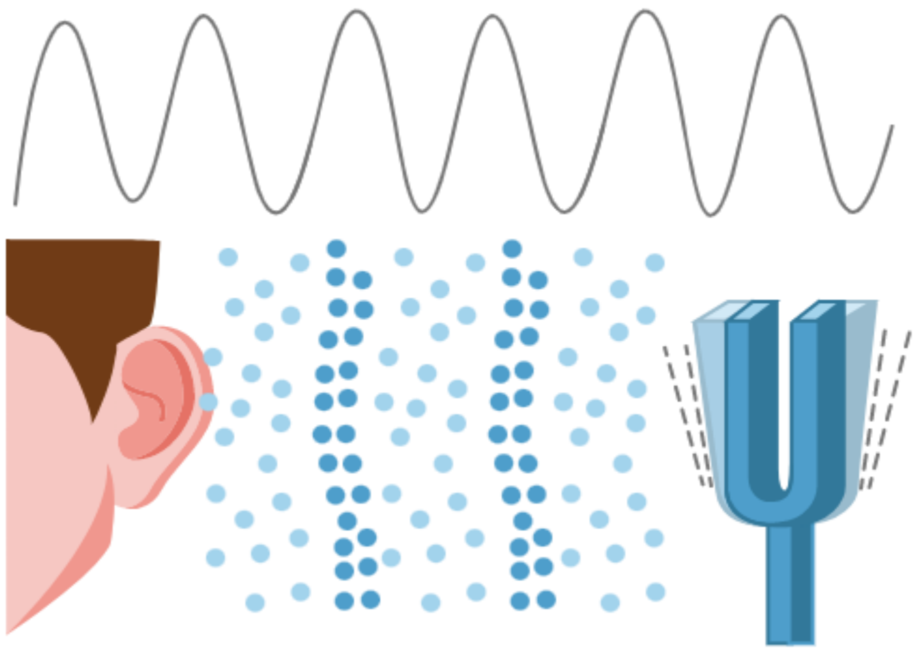
Now, to get technical. The outermost layer of our planet is a thin, rocky layer called the crust. This crust is cracked into seven large pieces (and eight smaller ones) called tectonic plates. Where the edges of two tectonic plates meet is called a tectonic plate boundary. Many of these are in the middle of the ocean, on the seafloor.



Map of tectonic plates. US Geological Survey

Earthquakes occur when tectonic plates move. They can crash into each other, pull away from each other, or scrape past each other. Regardless of the direction, the movement of these plates causes everything around it to rumble, kind of like the rumble you feel under your feet when a truck or train passes by.

This rumble is the result of what's called a seismic wave, and it's the movement of these waves through the Earth's surface that causes it to vibrate. But these rumbles are not just felt, they're heard. How? The same vibration you feel below your feet is felt by the air that sits on top of the ground. When the ground rumbles, it jostles the air above it, causing it to vibrate too. And what is vibrating air? Sound.



Hitting a tuning fork causes it to rumble which makes the air around the fork vibrate with it.
The vibration of the air back and forth creates a sound wave which our ears pick up on. *Chegg.*

The same process occurs in water and it's what allows Wu and his team to determine the temperature of the ocean. As earthquakes happen on the ocean floor, they rumble the water above, which causes the water to vibrate and produce a sound wave. These particular sound waves can be captured on the same machine that records seismic waves from earthquakes: a seismograph.

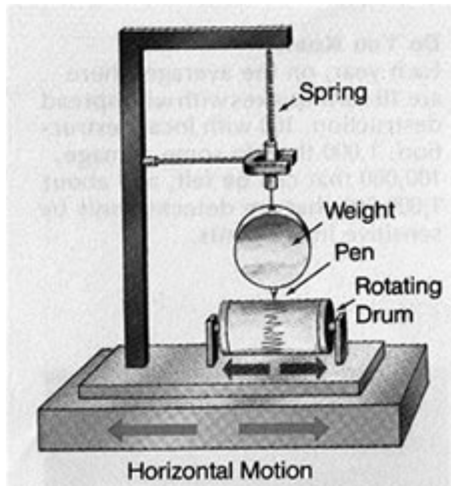


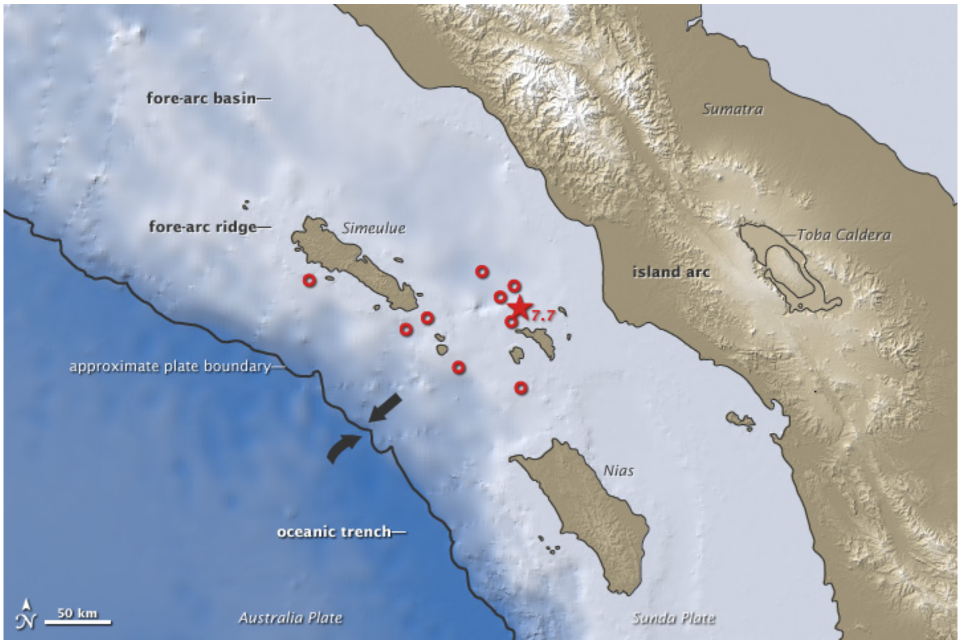
Diagram of a seismograph. *US Geological Survey*

The idea behind seismographs has been around since the year 132 C.E. but the first seismograph as we know it today was made around since 1875. And since then, scientists have been recording the earth's movements. That means there's a record of earthquake data extending for over a century. Wu was able to use this wealth of data to find earthquakes he called "repeaters." Repeaters are earthquakes of about the same size that occurred in about the same place, only at different times.

Wu used the seismic record to find thousands of these repeaters in the same region in the Indian Ocean. For each pair, he averaged the time it took the sound wave to travel through the ocean. He did this to develop a baseline speed for the sound waves in that region that could be compared against past and future measurements. The coolest part is that the more repeaters Wu finds, the more accurate the baseline becomes.

After Wu calculates a baseline, new earthquakes in the region would be able to show if the temperature of the ocean changed. If the sound travelled faster than the normal baseline, scientists would know that the ocean was warmer and by exactly how much.

In fact, Wu and his team figured out that, near Indonesia, the ocean was warming almost twice as much as the Argo floats predicted.



Tectonic plate boundary off the coast of Indonesian island of Sumatra. Earthquakes from here were used by Wu to calculate the warming of the Indian Ocean. *NASA.*

Wu's method is especially valuable because it allows scientists to analyze changes in ocean temperatures in new places. Because an earthquake-caused sound wave starts on the ocean floor, its speed describes the temperature of the entire ocean, not just the top 2,000 meters.

Sound is also able to travel through ice. This allows scientists to measure ocean temperature in places where sea ice would normally disrupt other ways of measuring temperatures like Argo.

Notably, Wu's method allows scientists to estimate ocean temperatures of the past. Specifically, the time between the widespread adoption of the seismograph and the launch of Argo. Without any expensive new technology.

Sea ice is a limitation for Argo but not for Wu's earthquake method. *NASA.*

All in all, Wu and his team have developed a widely useful method of researching ocean temperature changes using earthquakes. Their discovery is an important supplement to the existing ways ocean temperature is monitored. It extends the analysis of ocean warming to new horizons without requiring new investments in technology.

It's safe to say that Wu's discovery is making waves.

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