How a 'weather bomb' shook the Earth – and why that's not an earthquake

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Credit: AI-generated image (disclaimer)

The Earth beneath your feet is "humming" all the time. Typically these vibrations are too faint and low-frequency for your ears to hear. But they can be detected by seismometers, the instruments designed to study the generally more powerful vibrations that emanate from earthquakes.

Now researchers have used an array of seismometers in Japan to show that a group of tremors they detected had their origin in a violent "weather bomb" storm on the other side of the planet off the coast of Greenland. There's a danger that this research could be misreported as an Atlantic storm causing an earthquake in Japan. The reality is that the Japanese scientists detected an intensification of the usual background hum. But these vibrations could prove useful in helping us to study the structure of the planet.

The Earth typically hums slowly, with most energy transmitted at about ten seconds per vibration. But this is mixed up in a noisy continuum of overlapping "background noise", vibrations lasting from less than a second to half a minute each. These come from many sources including ocean waves in general, weak earthquakes deep within the Earth, and the planet creaking as it is deformed by tides.

When researchers Kiwamu Nishida and Ryota Takagi analysed the Earth's hum on December 9-11 2014, as recorded by Japan's "hi-net" array of seismometers, they realised they were picking up some unusual signals. By working out the direction and distance the vibrations had travelled, the researchers back-tracked them to their source and showed that they came from storm waves shaking the shallow, sloping sea-floor off the south-east coast of Greenland. These waves were particularly violent because the local atmospheric pressure at the time was plummeting, creating a so-called "weather bomb".

This was the perfect storm to set up pressure waves that resonated between the sea surface and the sea floor, passing their energy to corresponding vibrations in the bedrock that could be detected as far away as Japan. Nishida and Takagi do not say they had detected earthquakes that were caused by the storm. They were well aware that this was just an intensification of the usual background hum.

Why not an earthquake?

The vibrations caused by the Greenland storm are not an earthquake. Most naturally-occurring earthquakes happen near the boundaries between the tectonic plates into which the Earth's rigid outer layer is divided. The plates are moving relative to each other at speeds of a few centimetres per year, but at the fault surfaces where one plate grinds past another the motion is not smooth. Friction and irregularities bind the two sides together until enough strain has been built up to overcome the resistance. The fault then gives way in a near-instantaneous jolt – much more powerful than the humming caused by storm waves that the Japanese researchers found.

Tectonic earthquakes are not restricted to plate boundaries, however. They can occur, usually less powerfully, when ancient faults move a little, or the Earth's crust adjusts to the changing load of sediment upon it. A recent example was the magnitude 4.2 earthquake in Kent, England in 2015.

There are also some Earth tremors caused by human activity. This includes tremors caused by the ground shifting in former coal mining areas, and efforts to pump water into the ground to heat it for electricity generation.

And then there is fracking. Here, deep layers of shale are artificially fractured to liberate trapped reserves of natural gas. This is a potentially vital source of gas for the UK if it wishes to free itself from dependence on Russian gas, but it has had a bad press since fracking below Morecambe bay triggered a (non-damaging) magnitude 2.3 earthquake in 2011. This was a result of water pumped into the well lubricating a previously jammed fault rather than of the fracking process itself. Similarly, Oklahoma has seen a dramatic rise in magnitude 2 and 3 earthquakes since gas extraction from fracked shale began. These have caused mostly only minor damage, but it seems that the lesson is, if we want natural gas, then the fracking wells need to be situated well away from fault zones.

The tremors picked up in Japan might not have counted as an earthquake, but we may be able to use these kind of vibrations in a similar way as we do earthquakes to study the internal structure of the planet. For example, the speed at which waves travel through the Earth can reveal how dense the rock is that they are passing through. Knowing we can isolate the signals from storms could be particularly useful because the region where the "weather bomb" occurred almost never experiences earthquakes. So storms elsewhere may in time prove equally useful.

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