Source of Earth's ringing? French team views ocean waves

20 April 2015, by Nancy Owano

A composite image of the Western hemisphere of the Earth. Credit: NASA

Three researchers in France have authored "How ocean waves rock the Earth: Two mechanisms explain microseisms with periods 3 to 300 s," published in *Geophysical Research Letters*, a journal of the American Geophysical Union (AGU). The paper attempts to explain the source of Earth's ringing sound.

Could it be because of earthquakes? Scientists were aware that earthquakes could cause the Earth to ring, for days or months. That reason did not fit other instances. Even in the absence of earthquakes, seismologists said in the 1990s, the planet constantly vibrates at very low frequencies, which they could make out with seismic instruments.

But why? Call it the mystery of the Noise—this continuous vibration draws scientists to search for explanations. *Wired.co.uk* brought out some interesting points about the low-frequency sound, which though inaudible to human ears can be detected by seismic instruments. There was a range of thoughts about why. "Theories suggested everything from electromagnetic radiation to earthquakes and secret military operations might be to blame. Although the sound is almost certainly too faint for humans to hear, some people claim to be plagued by a 'tinnitus'-like noise—including many residents of Bristol in the 70s, who said the sound caused headaches and even nosebleeds."

Nanci Bompey in the AGU *GeoSpace* blog reviewed the theories which the authors of the recent paper examined. One such theory had to do with ocean waves moving in opposite directions. Colliding waves make weak, "microseismic" waves that add up to a generalized ringing. They used models and found that opposing ocean waves could initiate a kind of seismic waves – those that take 13 seconds or less to complete one oscillation. The theory did not hold up when it came to slower oscillating seismic waves.

The researchers then examined the theory that suggests the movement of waves over the bottom of the ocean generates slower oscillating, very long waves. "Long ocean waves can extend all the way down to the seafloor. As they make their way back and forth to the open ocean from the coast, these long waves travel over the bumpy ocean bottom. The pressure of the ocean waves on the seafloor generates seismic waves that cause the Earth to oscillate, said Fabrice Ardhuin, a senior research scientist at Centre National de la Recherche Scientifique in Brest, France, and lead author of the new research."

So one can also point to pressure of these long ocean waves on the sea floor.

The authors' conclusion, said Bompey, was that "instead of one theory explaining all of the microseismic activity, both theories are needed – one to explain the shorter seismic waves and another to explain the longer seismic waves responsible for the Earth's hum."

Ardhuin said that understanding where the seismic signals were coming from could help researchers look for fainter seismic signals. That, he said, could allow them to better detect faint earthquakes far away from seismic stations or nuclear explosions.

More information: Ardhuin, F., Gualtieri, L. and Stutzmann, E. (2015), How ocean waves rock the Earth: Two mechanisms explain microseisms with periods 3 to 300 s. *Geophys. Res. Lett.*, 42: 765–772. DOI: 10.1002/2014GL062782

Abstract
Microseismic activity, recorded everywhere on Earth, is largely due to ocean waves. Recent progress has clearly identified sources of microseisms in the most energetic band, with periods from 3 to 10 s. In contrast, the generation of longer-period microseisms has been strongly debated. Two mechanisms have been proposed to explain seismic wave generation: a primary mechanism, by which ocean waves propagating over bottom slopes generate seismic waves, and a secondary mechanism which relies on the nonlinear interaction of ocean waves. Here we show that the primary mechanism explains the average power, frequency distribution, and most of the variability in signals recorded by vertical seismometers, for seismic periods ranging from 13 to 300 s. The secondary mechanism only explains seismic motions with periods shorter than 13 s. Our results build on a quantitative numerical model that gives access to time-varying maps of seismic noise sources.