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I cover the underlying drivers of energy, technology and society.

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Radioactive Fukushima Waters Arrive At West Coast Of America

Presenters at the annual Ocean Sciences Meeting of the American Geophysical Union in Honolulu in late February said ocean water containing dissolved radionuclides from Fukushima's crippled nuclear reactors has reached the northern west coast of North America (msn.com).

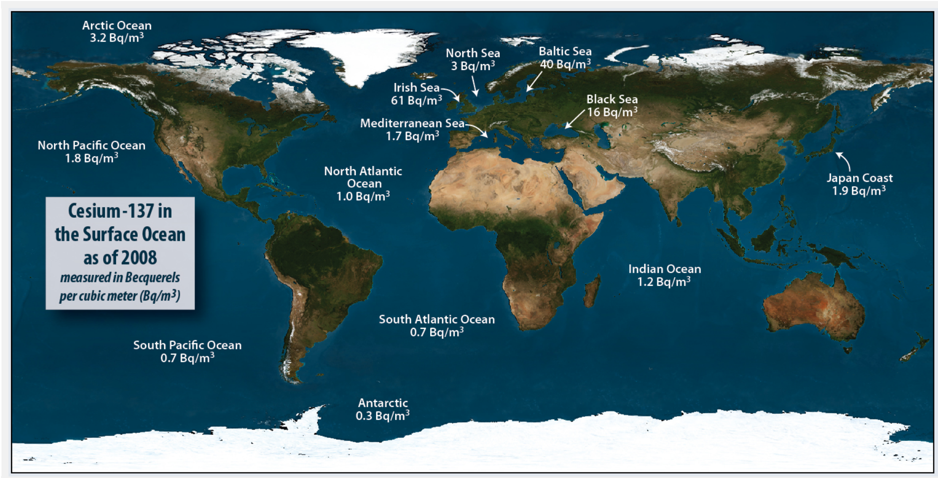
The scientific community found it interesting in an academic way. Some folks in the non-scientific community were quite worried.

The amount of Fukushima radioactivity in this seawater is miniscule, about a Becquerel per cubic meter of water, or Bq/m3 of short-lived Cs-134, and poses no concern at all. *And never will.* By comparison, the EPA drinking water standard for its sister radionuclide, Cs-137, is about 7,400 Bq/m3, and for all radioactive materials is almost a million Bq/m3.

But since we can see a single atom disintegrating, we can detect this trace amount of radioactivity easily, way better than we can detect toxic compounds like mercury. This Fukushima rad-signature has already taken its seat alongside that left over from above-ground nuclear tests in the 1950s and 60s as a curious and interesting phenomenon we can use scientifically to track water and air circulation patterns, and to use in forensic oceanography.

But the Fukushima rad-concentrations are nowhere near as high as that left over from the old bomb tests, which are nowhere near as high as that of natural background. In fact, Fukushima's rad-signature is so low that we need to separate the Cs-134 from the Cs-137 just to know it's from Fukushima. Cs-134 has such a short half-life (2.1 years versus 30 years for Cs-137) that it has long decayed away from the old tests. The Cs-137 from Fukushima is so low it's totally eclipsed by the leftover Cs-137 from the 50s and 60s.

Rule of thumb – ten half-lives till gone.



Measured in atomic disintegrations per second (Becquerels or Bq) of cesium-134,137 in a cubic meter of water (Bq/m3), the background level of Cs radionuclides in seawater varies around the world. The primary source of Cs-137 is historic above-ground nuclear weapons testing from the 1950s and 60s, but some regions have experienced additional inputs. The Irish Sea shows elevated levels compared to large ocean basins as a result of radioactive releases from the Sellafield reprocessing facility at Seacastle, U.K., and levels in the Baltic and Black Seas are elevated from the 1986 Chernobyl fallout. By comparison, the EPA drinking water standard for Cs-137 is 3,700 Bq/m3. The amount of Cs-134 from Fukushima found off the west coast of Canada was less than 1 Bq/m3. Fukushima will not result in any global increase in radioactivity outside its local region. It takes water radioactivity levels from all sources of over a million Bq/m3 to cause concern. Image courtesy of the Center for Marine and Environmental Radioactivity and Jack Cook (Woods Hole Oceanographic Institution) and the MARIS data base from the International Atomic Energy Agency.

We see these signatures all the time from many events and sources, and I would be worried if we did not see this Fukushima signature because that would imply we were not doing our jobs. Or that we did not understand oceanic circulation (Woods Hole Oceanographic Institution).

Moreover, we've been expecting to see this trace radioactivity for two years. It's been foreshadowed by trace amounts in fish, and was first picked up in tuna off the coast of San Diego in the excellent work done by Professor Nicholas Fisher and co-workers (Proceedings of the National Academy of Sciences).

Much worse than radiation, is the biologicals attached to the Fukushima Flotsam floating over from Japan as a result of the tsunami. These are being burned, or otherwise biologically sanitized, in an attempt to stop invasive species from causing ecological harm (The Oregonian).

Let me be really, really clear – *there is no concern whatsoever that radioactivity from Fukushima could ever harm America*. The levels of radioactivity are too low by the time they leave the area around the crippled power plant. Even if the entire Fukushima site slid into the ocean, it wouldn't raise Cs concentrations above trace levels in the ocean at large, let alone anywhere near drinking water standards, this far away.

The global variations of Cs-137 in seawater is beautifully described by researchers at the Woods Hole Oceanographic Institution, particularly Dr. Ken Buesseler, as seen in the accompanying figure (Cs-137 Ocean Map). Radioactivity in water is measured in units of Becquerels per cubic meter of water, or Bq/m3. A Bq is the disintegration of a single nucleus in a second. It takes 37 billion Bq to make one Curie (Ci).

The background level of radiation in seawater varies around the world but is very low, averaging about 14 Bq/m3. It results overwhelmingly from naturally occurring radioactive materials (NORM) in the Earth's crust that reach the ocean after weathering, particularly U-238/235, Th-232, K-40 and their daughter products. These radionuclides usually drop out as particulates, sorb onto materials near the shore, or precipitate out of solution, before they get to the deep ocean, which is why seawater is much less radioactive than soil and vegetation.

Of the man-made radionuclides, Cs-137 left over from old bomb testing dominates the radioactivity we see in water and soil. In seawater, Cs-137 concentrations average less than 2 Bq/m3. The primary source of Cs-137 is the historic above-ground nuclear weapons testing from the 1950s and 60s, but some regions have experienced additional inputs. The Irish Sea shows elevated levels of 61 Bq/m3 as a result of radioactive releases from the Sellafield nuclear reprocessing facility at Seacastle, U.K., and levels in the Baltic and Black Seas are elevated up to ten or twenty times background-Cs because of fallout from the 1986 Chernobyl event.

The EPA drinking water standard for Cs-137 is about 7,400 Bq/m3. The amount of Cs-134 from Fukushima found off our West Coast was less than 1 Bq/m3. Fukushima will not cause any global increase in radioactivity outside the local region near Fukushima itself, and even that should resemble these other local events after ten years or so.

Note: Cs-134 is 14 times more radioactive than Cs-137, so dominates the Cs activity until it decays away to below Cs-137 activity, which will be in about the year 2019 since Cs-134's half-life is 2.1 years.

Compare these levels with the drinking water limit for tritium, which is 740,000 Bq/m3. In contrast, Americans eat about 10,000 Bq per day in our food, primarily from natural ^{40}K, with input from Ra, U and Th, in foods like potatoes, nuts, beets and other vegetables.

The 740,000 Bq/m3 drinking water limit for tritium is about equivalent to a background dose of 4 mrem/year (NRC). General background in the U.S. is about 300 mrem/year, although it varies from place to place from about 150 mrem/year to well over 1,000 mrem/year, based on elevation and rock type. So for seawater to contain the normal background levels of radiation we see everyday in our lives would require water radioactivity levels of over a million Bq/m3.

This will never happen anywhere in the world because of Fukushima. We haven't even seen that in the waters right near Fukushima.

This is why you hear that these levels in seawater from Fukushima are not dangerous, because they are a million times lower than what we already experience from natural background. If you don't see levels near a million Bq/m3 then you are not in danger at all.

A good discussion of these limits can be found at EPA Safewater. Other basic discussions of radiation and exposure can be found at Listing of Common Radiation Exposures and at EPA: Sources of Radiation Exposure. Note that Cs exhibits bio-uptake, but it does not exhibit significant bio-accumulation, and does not sufficiently increase in concentration going up the food chain to pose any risk, unlike Hg or Ra.

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