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Science AMA Series: I'm Ken Buesseler, an oceanographer who has been studying the impacts of Fukushima Dai-ichi on the oceans. It's been 5 years now and I'm still being asked – how radioactive is our o

KEN_BUESSELER R/SCIENCE

I'm Ken Buesseler, an oceanographer who studies marine radioactivity. I've looked at radioactive fallout from atmospheric nuclear weapons testing that peaked in the early 1960's, studied the Black Sea after Chernobyl in 1986, the year of my PhD, and now we are looking at the unprecedented sources of radionuclides from Fukushima Dai-ichi in 2011. I also studying radioactive elements such as thorium that are naturally occurring in the ocean as a technique to study the ocean's carbon cycle http://cafethorium.whoi.edu
Five years ago, images of the devastation in Japan after the March, 11 "Tohoku" earthquake and tsunami were a reminder of nature's power. Days later, the explosions at the Fukushima Dai-ichi nuclear power plants, while triggered by nature, were found to be man-made, due to the building of these critical plants on this coast, despite warnings of possible tsunami's much higher than the 35 foot sea wall built to protect it.
More than 80% of the radioactivity ended up in the oceans where I work- more ocean contamination than from Chernobyl. Since June of 2011, we've spent many research voyages sampling with Japanese, US and international colleagues trying to piece together the consequences to the ocean. We also launched in in January 2014 "Our Radioactive Ocean"-a campaign using crowd funding and citizen scientist volunteers to sample the N. American west coast and offshore for signs of Fukushima radionuclides that we identify by measuring cesium isotopes. Check out http://OurRadioactiveOcean.org for the participants, results and to learn more.
So what do we know after 5 years? This is the reason we are holding this AMA, to explain our results and let you ask the questions.
I'll be back at 1 pm EST (10 am PST, 6 pm UTC) to answer your questions, ask me anything!
Thanks to everyone for some great questions today! I'm signing off but will check back tonight. We released some new data today from OurRadioactiveOcean.org Go to that web site to learn more and propose new sites for sampling. We need to continue to monitor our radioactive oceans.
Thanks to our moderator today and the many collaborators and supporters we've had over these past 5 years, too numerous to list here.
More at http://www.whoi.edu/news-release/fukushima-site-still-leaking

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I live in Osaka, Japan. How safe would you say is the seafood caught off the coast of western Honshu?

YourNameHere

Off Japan today, except for those in the vicinity of the reactors, seafood and other products taken from the Pacific are currently below strict limits set by the Japanese for human consumption. Tens of thousands of fish have been and are being tested off Japan. If fish are found above the limits, commercial fishing remains closed. In 2011 about half the fish caught near Fukushima were above Japan's limit (100 Bq/kg). In 2014 that had dropped to 1%. BTW, none of the fish caught on "our side" of the Pacific have been found to be above any of the limits set by Japan or higher limits in US/Canada.

Buesseler, an oceanographer who has been studying the impacts of Fukushima Dai-ichi on the oceans. It's been 5 years now and I'm still being asked – how radioactive is our o, *The Winnower* 3:e145735.52993 , 2016 , DOI: 10.15200/winn.145735.52993

see http://www.whoi.edu/fileserver.do?id=215606&pt=10&p=115754 http://fukushimainform.ca/

Have you found that the radiation "pools" or collects between the ocean currents like the plastic islands patches in the pacific?

Edit: I guess I was misleading people to believe that we can just skim it off the top with the use of the word island.

SmashesIt

Depending upon the chemical form, radioactive contaminants in the ocean move or concentrate depending upon their chemistry. For cesium, it behaves as potassium, a dissolved salt in the ocean. Concentrations will decrease with distance and time as cesium is carried by ocean currents and mixed as it travels the 5000 miles across the Pacific. It is not like plastic in that regard and does not accumulate in the same way as plastic trash along our beaches

Have you found that the radiation "pools" or collects between the ocean currents like the plastic islands patches in the pacific?

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SmashesIt

Similar to plastics the radioactive elements in the ocean are carried by currents. * Unlike plastic however radioactive elements will diffuse in the ocean waters and slowly be diluted, whereas plastics that float will tend to concentrate at the surface with currents.

In the last 5 years have you seen or heard of any attempts by external parties to obfuscate data or otherwise hinder the release of information?

Any other *curious* things to note?

TerraObstinata

Early after the accident, I did have a Japanese co-author who worked at a government lab who had to remove his name from a scientific paper, as we were trying to compare Fukushima to Chernobyl. In other cases, I've had great and open interactions with several Japanese scientists working at their Universities and others in the national labs of Japan.

1. What is the estimated scale of radiation released into the ocean, from Fukushima, in terminology, or comparison, a layman might understand
2. How does the radiation distribute itself throughout the layers of the ocean, does it eventually just sink to the sea floor, or are these soluble substances that will continue to circulate through the water column
3. What level of radiation released into the ocean would have a catastrophic mass extinction event throughout the entire ocean, & how far off is Fukushima's release from that hypothetical amount?

lickwid

To answer #1.

Total levels and scales vary depending upon the mix of contaminants, but if we pick just one, cesium-137, there was about 10 times more cesium-137 released during nuclear testing globally, than Chernobyl. And for cesium-137, Chernobyl was 2-5 times greater than Fukushima, but then again most of the Chernobyl fallout fell on land, not in the ocean.

Thanks for taking the time to do this.

Preface: I was reading up on the nuclear bomb tests from the 60s that took place in the ocean, and most people seemed to claim that the ocean does a pretty good job of diluting the radiation. I read somewhere that within a few weeks the area affected by the testing had nearly returned to normal.

I cant imagine it was able to return to normal in such a short time.

Question: Can you give any insight on how long it took for the ocean to return to normal after the atomic tests, and perhaps compare it to the Fukushima leak?

farseen

In the 1960, immediately after the end of testing on the Pacific atolls, the concentration of radioactive cesium in the Pacific off the coast of Japan was about 50 Becquerels per cubic meter (Bq/m3) and 10 Bq/m3 off California. By 2011 immediately before the earthquake and tsunami, that had fallen throughout the Pacific to about 2 Bq/m3 as a result of radioactive decay. Today, the highest we have seen off the coast of North America is 6 Bq/m3. Off the coast of Japan after the accident, (aside from the extremely high levels detected at the source of release from the reactors) we recorded a high of 4,500 Bq/m3. You can see more about pre-Fukushima levels worldwide here: http://www.whoi.edu/cms/images/OceanRadiationMap2_en_135993.jpg

Living in San Francisco during and the the years after Fukushima, I heard about people taking iodine tablets as a precautionary measure against radiation poisoning. Was I right in ignoring this as an overreaction since Japan is half a world away?

jnish

The California Coastal Commission had a report in 2014, that if you were in California in 2011 and drank tap water at the highest levels found and breathed in the air at its peak level- both for an entire year- your dose or net health impact would be about 5 micro Sieverts or about the same exposure as a single dental X ray. This is not zero, but a very low dose indeed. And no need to be taking iodine tablets, though remember at that time it was less certain what was going on and if it was going to get worse

In terms of Bq/L, what is the highest concentration of radioactivity you have found and where was it? What are the normal background levels in that area?

EDIT: Assuming that the highest concentrations are found in the immediate area of Japan, what are the areas of highest concentration outside the immediate Japanese coast, and what are the levels?

nowordsleft

In early June of 2011, we found up to 4,500 Becquerel per cubic meter (Bq/m3) about 60 miles from Fukushima Dai-ichi in the surface ocean. That was much higher than levels prior to the accident, which were about 2 in the same units. Then again this is much lower than in early April 2011 when contamination levels in the ocean were at the peak, where the Japanese reported up to 50 million Bq/m3 for radioactive cesium.

Today those levels are around several hundred near the reactors- evidence of ongoing leaks, but much lower than before.

My PhD research deals with looking at long-lived fission products, specifically, Sr-90 and Cs-137, and I see that you indicated that Cs-137 and Cs-134 were the two radionuclides you were seeing the most. Therefore, I am curious why you think that you were not seeing as much Sr-90?

H-M-Murdock

Good question. Cesium was released more readily than strontium-90 from Fukushima, in large part because cesium is more volatile, so released during those initial hydrogen explosions with the higher temperatures.

Initially in 2011 we found 40 times less strontium-90 than cesium-137 in the ocean in 2011. On land, however, there is over 1,000 times more cesium-137. Over time, my lab and our colleagues in Spain, Switzerland, and Australia will continue to monitor strontium-90, tritium and several other isotopes in the ocean, seafloor and marine biota.

What was the most unexpected things about your findings?

Eeveelutions

Sampling off Japan in 2011, we were more worried about hitting debris and harming our research vessel, than the levels of radioactivity which we were measuring with hand held devices as we sampled.

Another thing, maybe not unexpected but disappointing is the fact that no US Federal agency takes responsibility for ocean radioactivity studies

I teach middle school science. What is one major misconception about oceanic radioactivity that I (and the Internet) should clear up immediately?

weaponexpat

The danger is in the dose, so while we should be concerned about any level of exposure to radioactivity, there is a huge difference in the levels, in this case in cesium from Fukushima, which ranged from 2 to 50 million in the units we use. That is like the difference in the temperature on earth and the temperature on the center of the sun. There's already radioactive forms of cesium in the ocean. So it is a good question how much more radioactive cesium did Fukushima add, but we need to be aware that since the testing of atomic weapons there are many radionuclides we can measure in the ocean and on land.

(1) To what extent do radionuclides *generally* bioaccumulate (increase in concentration in an individual organism/population)?

(2) To what extent do radionuclides *generally* biomagnify (increase in concentration with trophic level)?

(3) Do the *specific* radionuclides released from Fukushima Dai-ichi differ in terms of their potential for bioaccumulation/biomagnification from other naturally occurring radionuclides in the ocean, e.g., Cesium?

Thanks for doing this AMA - Can't wait to share the results with my own students!

funknjam

Different radionuclides do not behave the same in all marine organisms, just as for other non-radioactive contaminants. For example cesium, which behaves like a salt, will accumulate in fish by a factor of 50 to 100 times the levels in water, but as a salt, it will also flush out of organisms quickly, about half in 2 months, through normal bodily functions and therefore does not bioaccumulate at higher levels. Strontium however behaves more similarly to calcium in humans and animals and is taken up and concentrated in bones where it remains with a biological half life of a couple years.

Think of it this way. If a cesium-137 contaminated fish were to be canned, it would take 30 years (the radiological half-life) for 50% of the cesium-137 to disappear. In contrast, if that same fish were to swim to cleaner waters, it would lose 50% of its radioactive cesium burden in just two months.

Hi, fisheries scientist and former conservation NGO sector person here. I find that many laypeople have vastly overblown concerns about things that aren't really a danger to them or the environment (e.g., radiation from Fukushima, "no fish by 2048", etc.), but simultaneously under-estimate other, far more pressing concerns (e.g., ocean acidification, ocean dead zones associated with nutrient runoff from terrestrial agriculture, etc.).

This frustrates me, because there's a very strong case to be made that certain types of seafood are among the most "sustainable" protein sources out there, especially when compared to other animal protein sources. I'd feel very comfortable arguing that a kilo of sardines has less impact on the ocean than a kilo of pork raised in the Mississippi valley, for example. When people swear off seafood due to misplaced fears, and instead replace that seafood with pork, or beef, or lamb, etc., I fear that it's often a net loss for the oceans.

As a result of this mismatch of popular concern with actual scientific evidence, I find myself in the position of having to encourage people to actually eat more fish. To do so, I first have to calm their various overblown fears.

For this reason, I have to say that I'm disappointed in the name that you've chosen for your organization. Our ocean is not "radioactive" in the sense that a layperson understands radioactivity. Godzilla is not about to rise out of the depths, and a person won't grow extra limbs - or be exposed to any degree of meaningful radiation - from eating wild Pacific salmon from the North American coast.

So, I fear that the name of your organization is unnecessarily frightening - it literally states that the oceans are radioactive, even when your initial findings state that *"the levels of contamination remain well below government-established safety limits for human health or to marine life."* And it's going to convince even more people to stay away from seafood. Honestly, if I were in the beef business, I'd consider giving you guys a donation for the name alone.

So, my question is this: given what you know, if someone on the street said "My understanding is that our oceans are radioactive", would you agree with them? If not, why the name?

splitnose

Our point is precisely that--that the ocean is, in fact, radioactive and that it contains many different radioactive isotopes in different amounts. Some of these are natural (potassium-40), some are the result of human activity (cesium-134 and -137). The question we are trying to get at is "How much is there?" For the most part, levels of all of these elements do not pose a threat to humans and marine life.

How are the radiation levels looking off the west coast of Canada? What about California?

loveyourlies

The highest levels we have seen off British Columbia, Canada are near Uclulet (Vancouver Island) where we saw 5.8 Bq/m3 of 137Cs and 1.4 Bq/m3 of 134Cs in February 2015. The highest concentrations we have seen on California beaches is 2.0 Bq/m3 of 137Cs with no 134Cs detected at Scripps. Offshore from San Diego we have seen higher levels 2 to 4.5 Bq/m3 of 137Cs and 0.2-0.5 Bq/m3 of 134Cs. These results and more can be found under "Results" on http://Ourradioactiveocean.org/results

Hello and thanks for doing this AMA! I am interested to know about the specific impact of Fukishima on microbes: has the impact of radiation on bacteria been studied? Have bacterial community composition shifted? Also, has the use of bacteria in removing thorium from oceans been investigated in the Fukushima case? If not, would that be interesting for you/your team to study?

Thank you very much!

Kateth7

The levels that would be of direct threat to marine life (microbes included) would likely be in the millions of Becquerels per cubic meter (Bq/m3). These levels were only seen very close to the reactors for a short period in 2011. That being said, we have not seen any studies focusing specifically on marine microbiology. As for bacteria removing thorium, you can only concentrate or immobilize radioisotopes. You can't actually remove it (even if you physically remove it, it still exists). It has to decay away.

What kind of vetting process do you have for the citizen scientist volunteers, and how do you ensure their data are accurate?

moktharn

We do not have a vetting process for citizen scientists and feel that those willing to raise the donation amount required for processing a sample are committed enough to do a good job sampling for us. All that is required by citizen scientists is to fill a container with seawater as temperature is measured by a sensor in the container and other parameters are measured in our lab. Rest assured if we find a sample that is different than all the others, we'd send someone we know to follow up on repeat sampling.

Despite the generally negative view of this event, are there any possible benefits? For example has this radiation helped to break down the plastics in the great pacific garbage patch? Can algae adapt to consume or resist radiation?

Thanks for doing this

SpaceSamurai

The concentrations of radioactive elements in the ocean are not in high enough concentrations to breakdown other particles such as plastics and we would have a lot of other issues to worry about if they were.

In addition to measuring the concentration and spread of radioactivity in the ocean, scientists can also use these radioactive contaminants to learn about ocean properties and processes. Oceanographers use substances called tracers to study the path and rate of ocean currents and of processes such as mixing that are important parts of the global ocean and climate systems.

Does radiation sink or float?

EasyiceFPV

This all depends upon the chemical properties of each radioactive element. Two of the forms we study- radioactive cesium and strontium- are largely dissolved in the ocean, so behave like salt, or any other dissolved element. Radioactive elements diffuse through water and spread out based on ocean currents and so will largely in seawater. A small fraction, <1% is associated with marine particles (plankton or clay particles for cesium), and this fraction does end up being associated with the seafloor.
see Black and Buesseler, 2014 http://www.biogeosciences.net/11/5123/2014/bg-11-5123-2014.pdf

How unfortunate (Or fortunately) located was this disaster with regards to global geography? Where in the world could this disaster have caused more, or less damage to the environment /humankind?

androuman

First off, nowhere is a good place for something like this to happen. But in one respect, it was fortunate that this occurred on the coast downwind from land (it is much more difficult to deal with evacuation of people and eventual cleanup (and disposal) of contaminated soils). With regards to the marine setting, Fukushima is near the point where the Kuroshio current (a strong western boundary current like the Gulf Stream) turns away from Japan and moves into the central north Pacific. As a result, it carried contamination away from shore and into the deep waters of the Pacific where contaminants were greatly diluted. Of course, the eastern end point of all this movement of water is North America, but the degree to which this contamination was diluted is evident in the very low levels we are detecting off California and British Columbia. You can see current results of testing here: http://ourradioactiveocean.org/results.html

Should I, Joe Blow Average from Seattle, be concerned about radioactivity in my daily life?

CORRRRRRRRRRRRRRRGI

Among the biggest exposure pathways are medical procedures. Average background radiation you or I are exposed to is 2-3 millisieverts. If you get a full-body CT scan, you are exposed to an additional 10 millisieverts, but you have to weigh the risk of /not/ getting a procedure to the additional, risk posed by that radiation. Other sources are relatively small in comparison to even background.

If all of the radioactive wastewater currently being stored in tanks near the reactor were suddenly released into the ocean/groundwater- how serious would the consequences be?

TokyoGuy

We remain most concerned about the potential of new releases from the thousands of storage tanks on the site, which contain highly radioactive water awaiting processing. In fact there was hundreds of times more strontium-90 in those tanks than ever released in 2011. Some leaks have been reported, and one reason we continue to monitor strontium is to look for signs of these leaks. Given that strontium concentrates in bones, this radionuclide could become a larger concern in small fish such as sardines, which are often eaten whole. So far, however, evidence suggests that levels of strontium-90 in fish remain much lower than those of cesium-137. - See more at: http://www.whoi.edu/page.do?pid=83397&tid=3622&cid=94989#sthash.zytWQDe6.dpuf

My understanding is that the major nuclides that was released from Fukushima Dai-ichi was 134-Cs.

Given that isotopes comparatively short half-life, how long do you expect to be able to usefully detect it in the ocean, and how do your results compare with Broecker and Peng's classic work on the longer-lived radioactive tracers?

perivane

About 20% of cesium-134 is left today after 5 years. We can continue to detect it for another 3-5 years, depending on sample size. 134Cs is important as a tracer, and as a fingerprint for Fukushima--because it is relatively short-lived, any amount we find must have come from Fukushima, which allows us to further determine how much cesium-137 in our samples came from Fukushima.

Has there been recorded radioactivity in the Bering sea and or gulf of Alaska? If so.. does this effect the millions of salmon and other animal species that pass through these areas?

slednecker

We have processed two samples from the Bering sea at the tip of St. Lawrence Island where we were able to detect approx. 1.3 Bq/m3 of 137Cs but no 134Cs in both August 2015 and April 2014. These are background levels for this area and no sign of any Fukushima derived contamination.

In the Gulf of Alaska we have seen up to 2.7 Bq/m3 of 137Cs and 0.2 Bq/m3 of 134Cs. Despite signs of Fukushima in the Gulf of Alaska fish do not have elevated levels.

See http://fukushimainform.ca/ for more details regarding fish concentrations.

I was surfing up in the Myiagi prefecture earlier this year, and was wondering if there are still measurable radioactivity effects on humans who spend hours in the water, ~100 kilometers up north from the Dai-ichi plant. Any litterature/measurements on the subject?

Chronolitus

Miyagi is affected more by the south-flowing Oyashio current and a smaller coastal current that also flows primarily south. The highest level recorded off Miyagi (north end of Sendai Bay) was around 10 Bq/m3 (Becquerels per cubic meter), which is similar to the highest levels we are finding on this side of the Pacific and north of Hawaii. Even for someone who spends hours in the water at a time, this does not pose a significant risk.

I remember reading after the disaster that governments were raising the "Safe levels" of radiation in food to combat the hysteria caused by the disaster. As to appear safe to eat. Is this true?

ded2me

Japan in fact lowered what it considered safe from 500 to 100 Bq/kg (a factor of five) in April 2012, one year after the accident. That was in my opinion more of a political choice than based on any new health physics evidence. The idea was that by having the lowest limit (still in place today) they could regain public confidence. Unfortunately changing these limits without further education confuses a public who were told it was safe to eat fish as 500 Bq/kg in one year, and in the next, no, only if it is below 100.

FYI, our limit and most of EU and Canada is more like 1,000-1,200. A limit twice as high as the original 500 Bq/kg limit made sense as Japanese eat far more seafood than we do.

The topic is also complicated by the presence of other contaminants in fish, including naturally occurring polonium-210 which generally results in your highest dose but is considered safe.

The bottom line, is using these strict levels, Japanese are controlling what does and does not get to markets. They are not selling off food above their safe level to other countries. When I go to Japan I eat the fish and feel confident that they are monitoring their food supply better than any other country.

Is there any effective way to clean up things like this incident?

Shakenbakers

The oceans were already radioactive prior to Fukushima. The largest sources are from radioactive materials that occur naturally, like radioactive forms of uranium and potassium. Since the advent of nuclear weapons and nuclear power, we've added new radioactive elements to the environment, the so called "anthropogenic radionuclides". Some of the more common one's are radioactive forms of cesium, strontium and plutonium. Each of these has a different chemical property, but also different physical properties and forms of radioactive decay which impacts transport in the ocean and potential health effects.

Any truth that dangerous levels of radiation can be found all the way to Canada?

BedriddenSam

There is no truth to that- that being the word "dangerous", which I don't like to use, or its counterpart "safe" as that is a personal choice of a risk.

Put it this way- the highest we have measured near Canada (6 Becquerels per liter) is only slightly above what it was before the accident. That does mean an additional dose, but if cesium were as high as 10, you could swim every day in the ocean for one year and get a dose from the direct contact with cesium that is more than 1000 less than a single dental x-ray

You can follow the results of our testing here: http://ourradioactiveocean.org/

How many bananas would the radiation level above the natural be equal to?

Mtwat

Bananas contain a lot of potassium- which is good for you! A small amount of that potassium is in the form of radioactive potassium-40. Each banana has about 12 Becquerels (Bq) of potassium-40, with one Bq being a measure of one radioactive decay event per second. While we can use this radioactive banana unit to compare to seawater cesium, its not necessarily the same radioactive element or concern.

What is important too, is to acknowledge we live in a radioactive world and know more about when to be concerned (like in 2011 some parts of Japan) and when not to be (2015 along the west coast).

What can be done to "clean" the ocean of this radio activity?

sirolfreversed

Unfortunately nothing can be done to clean away the radioactivity in the ocean other than waiting for time to cause the elements to decay away. Ongoing decommissioning activities at the Fukushima Di-

Ichi plant and surrounding area however will reduce further contamination into the ocean, however some sources, like the seabed off Fukushima, will remain a small source of radionuclides like cesium for decades, or until these isotopes decay away (cesium-137 has a thirty year half-life for radioactive decay)

How radioactive is our ocean? and should I be concerned?

PinataPlethora

There are many naturally occurring radioisotopes (potassium-40 and polonium-210) as well as contaminants resulting from human activity (cesium-134 and -137). Aside from a few locations very near the power plant site for a short time in 2011, none of of these, individually or combined, have occurred at levels of concern to humans or marine life.

Since the Earth's oceans are all connected, will the radioactive water eventually make its way around the world and become an issue for other continents?

Autohead

Yes in theory the radioactive water would eventually spread all over the world. The mixing rate of the ocean is however fairly slow and the half life of 134Cs is 2 years, 137Cs is 30 years and 90Sr is 29 years. The signal from these elements will not be detectable by the time it were to move from the Pacific, as these mixing times to make it around the world are centuries to thousands of years, depending upon where you are looking.

Was the sample size a Liter of water? Also, could you talk a little bit about the activity results you found in 2011, compared to those found most recently, and what those changes mean in lay-terms?

EDIT: So I got back to a desktop where I could actually explore your site a bit more, and was able to answer my first question. I'm not sure what the highest activity obtained around 2011 was, but I noticed a sample around ~480 or so Bq. To me, that's a pretty small number on the order of activity, and especially considering all of this is entering such a huge environment as the Pacific Ocean.

My biggest question is this: Considering the activity and it's dilution across the Pacific ocean over the past 4 years, do you think there was then or is now any reason for people to be concerned when consuming seafood obtained from around Japan?

One more, just out of curiosity: I noticed the sampling locations moved over the years, what sort of model were you using to sample these areas, instead of right around Japan?

Karakanov

- sample size is typically 20 Liters (about 5 gallons) of seawater to measure cesium at pre and post Fukushima levels. We measure radioactivity levels in terms of Becquerel (Bq) per cubic meter. A Bq is a measure of one decay event per second. A cubic meter is a lot of water- 1000 Liters or about 260 gallons.
- Levels at their peak were up to 50 million Bq/m3. At that level there can be direct harm to marine life. Levels decreased quickly to the 1,000-10,000 range, where we are no longer concerned about direct contact, but remained concerned about seafood consumption near Japan. Today off the west coast of N. America the highest value we found is about 10 in these same units.
- FYI sampling around Japan depends greatly upon the existing Japanese plans, as we've been

collaborating withe academic community there since our first trip in 2011. We can sample on their ships within 1 km (half mile) of the nuclear power plants with no restrictions.

You posted this picture in response to somebody's comment.

My question is: why are surface concentrations of Cesium-137 so much higher (relatively speaking) in the seas around Europe than in seas and oceans elsewhere?

mayflowerf

That is the result of releases from the Selafield nuclear re-processing site in the U.K.

Why was the nuclear plant built there in the first place? It seems pretty obvious that the whole area is under tremor and tsunami threat.

GodMode_Activated

This is a good question. By modelling the movement of the radiation in the ocean and by learning from this experience future planning for reactor locations can be more informed to hopefully prevent such an event from recurring.

Are the long term effects of Radiation possibly beneficial to a species? *Using Chernobyl as an example of the positive effects of radiation fallout years later as wildlife flourishes with no trace of gene mutations.

poplockholmes

There is a line of thought that small dose radiation could lead to genetic changes that influence the evolution of a species in a beneficial or harmful way. Researcher Tim Mousseau with the University of South Carolina studies this and more information about his research is found in this article: http://www.nytimes.com/2014/05/06/science/nature-adapts-to-chernobyl.html

What parts of the North American West coast have seen/are seeing the most radioactivity?

samislegend

The highest concentrations we have seen thus far are offshore halfway between Hawaii and the Aleutian islands where we saw approx. 9.3 Bq/m3 of 137Cs and 2.0 Bq/m3 of 134Cs for a total of 11.3 Bq/m3 of radioactive cesium. Onshore beaches along the west coast from California to Alaska are fairly consistent between 1 and 2 Bq/m3 of cesium 137 except one location in British Columbia (Canada) where we found 5.8 Bq/m3 of 137Cs and 1.4 Bq/m3 of 134Cs in February 2015.

Thanks for this AMA. That was one of the most heart wrecking moments in history and would like to make a shoutout to the family and friends whom were affected by it. Never to forget natural disasters in our lifetime. My questions are:

1. How long will it theoretically take for the ocean to be cleared and radioactive free?
2. How far did this radioactivity in the ocean travel?
3. From the sounds of it, how scary can this be/get?

MathGeekWannaBe

1. The ocean will never be cleared of radioactive material--there are many naturally occurring isotopes.
2. It has traveled across the Pacific from Japan to the West Coast of North America.
3. This is perhaps more subjective. But I continue to eat fish and swim in the ocean and have even traveled by boat to within 1/2 mile of the reactors. I am more concerned by the lack of public understanding (and information) about radiation in the environment.

I had always assumed the amount of radioactive material leaked was less than our h bomb test trials in atoll so I'm wondering how does an event like Fukushima compare to that nuclear testing in terms of radioactive debris spread out In our oceans and the effects it carries?

Malachhamavet

The amount released by Fukushima is roughly 1/10 that released by nuclear weapons testing in the Pacific.

The Pacific Coast is experiencing massive deaths of starfish and other marine creatures. In the case of the starfish, it is being deemed a virus that has been "smoldering at a low level for a very long time." -http://www.pbs.org/newshour/rundown/scientists-solve-mystery-of-west-coast-starfish-deaths/

Do you think the Fukushima disaster could be partially to blame for the sudden change in the virus coming out of its previously dormant state?

Thank you for the AMA.

nukkin_futs

There is at least one Japanese paper that points to a slight decrease in invertebrates on the seafloor near Fukushima. Here in the eastern Pacific, where radiation levels are much lower than near Japan, the dieoffs or population declines being recorded among marine mammals, fish, invertebrates, and seabirds are more likely associated with other environmental conditions (temperature, food supply, toxic algal blooms). For echinoderms specifically (sea stars, sea urchins, etc.) there is some evidence that they experience boom/bust population changes http://dx.doi.org/10.1890/07-2136.1.

I do a lot of fishing off of the East Coast of Australia, should I be concerned with radiation exposure?

Indeeptrouble

No.

If you opinion what's the most concerning result for the oceans of the Fukushima disaster?

JUmstead12

Perhaps the most troubling result is that it has taken focus away from what are likely the true drivers (warming, changing food supply) behind mass mortality events among marine mammals, invertebrates, and seabirds.

I keep hearing that more radiation is continually leaking out along with seeing articles about mass die

offs of species. Will the Pacific ocean end up dying if we don't do something about it? Or will the radiation sort itself out?

Smoy

To date, there have been no reliable links made between radiation in the Pacific and mass die-offs of marine mammals, birds, fish, or invertebrates. Some of these die-offs have been attributed to viruses, warming water, and other changes to the marine environment that need to be addressed.

If there were effects from radioactive contamination, we would expect to see the largest effects off Japan, not the West Coast of North America, and this has not been seen.

For example, see previous reddit Reddit about starfish dieoffs https://www.reddit.com/r/science/comments/3fv6to/plos_science_wednesdays_hi_im_laura_jurgens_here/

and articles such as scientists may have solved 2011's mysterious marine die-off along the Pacific coast https://www.washingtonpost.com/news/energy-environment/wp/2015/06/04/scientists-may-have-solved-2011s-mysterious-marine-die-off-along-the-pacific-coast/

Where does "Woods Hole" get it's funding? How does your organization protect itself agains the corrosive effect of the funding coming inherently from mostly sources that are interested in a particular outcome?

We want to believe in scientists and their autonomy from these issues-but that is neither a rational expectation nor does history show it to be a wise one. What are your thoughts on keeping your industry honest and trustworthy?

tl:dr Are you in the pocket of "Big Nuclear" "Big Government" "Big Fish" or "Big Cancer"? <kidding>

misunderstandingly

WHOI's fundamental methods and scientific standards do not change based on funding. Researchers are free to propose and pursue investigations guided by their interests and expertise. In my case, I've had funding from pro and anti-nuclear groups as part of crowd funding for OurRadioactiveOcean.org as well as private Foundations and government sponsors in the past.

Research integrity is something that is at the core of WHOI's work and fiercely defended http://www.whoi.edu/DoR/page.do?pid=145156

Are radioactive elements released into seawater "breeding" additional radioactive elements from the minerals naturally dissolved in sea water?

shiningPate

Cesium 137 decays into stable barium 137 and cesium 134 decays to barium 134 neither of which are radioactive. Strontium, with a half life of 29 years decays to yttrium 90, which has a half life of 64 hours and decays to zirconium 90 which is stable.

FYI, one of the main areas I study are the naturally occurring radionuclides, which often are the result of uranium decay. These long decay chains have mulitiple radioactive "progeny" that need to be considered

Why is ocean radioactive?

dank_memeologist_420

There are many naturally occurring radioisotopes (potassium-40, polonium-210) as well as contaminants from human activity (cesium-137 and -134 as a result of Fukushima and nuclear weapons testing).

How do the levels of radiation released by Fukushima into the ocean compare to the levels of radiation released by nuclear testing in the 20th century? Was Fukushima far more damaging to the oceans?

SCDrunkPunk

The total amount released during nuclear weapons testing was 10 times more than what came from Fukushima to date.

You my not be qualified to answer this as your field is oceanography, but had the releases from Fukushima been to the air/land rather than the ocean, how different would the effects have been?

fiercelyfriendly

There was a release to the air (fallout) from Fukushima. Fortunately for Japan, winds blew >80% of this offshore. Most landed close to Japan in the ocean but we (and others) detected trace levels in the air- here in Woods Hole about 10 days after March 11. BTW, levels here were higher in the air after Chernobyl (a bigger event) but in both cases, health effect were not seen.

Remember, if you are looking for impacts, the closer to the source (Fukushima) and earlier in the releases after March 11, 2011, the short lived radioactive contaminants like 131-iodine are of greater health concern than far field effects.

What's the worst bit of misinformation you've heard about the incident? Like has there been anything that could get someone killed, either by radiation-induced illness or radiation paranoia?

pds314

Early reports of increases in infant death in the US is about the worst. It played on our fears, but is simply not possible at the levels measured.

Lately, its the link being made between the massive die-offs of marine life on the west coast and Fukushima. There are several reasons for these horrible die-offs, linked to record warm waters, harmful algal blooms, viruses, etc. And think about it- if it was so bad on west coast for marine life because of Fukushima, think how much worse it'd be off Japan where mass die-offs are not more extensive and widely reported

Quite stupid question honestly but how does this catastrophe afffect me personally as a European?

asdfdude1234

It probably affects you most from the policy perspective, as more European countries re-think their use of nuclear energy and almost certainly have to make up some of the lost generating capacity with fossil fuels. Or perhaps it will push the development of more large-scale alternative sources.

Will this wake up Godzilla and when will he be attacking Tokyo?

gravitygotmynutsack

Do you know about the not well named "Lucky Dragon" fishing vessel from Japan in 1954? It became contaminated after one of the US hydrogen bomb tests in the Marshall Islands, causing radiation poisoning of the crew and contaminating their catch (and others) of Tuna, that shut down fish markets in Japan causing public panic, much like after Fukushima.

I mention this as the original Godzilla movie was a protest against US nuclear testing that had in the story line released Godzilla from the ocean depths. Seems Japan has had more than its share of radiological disasters.

I visited the nuclear testing sites on Bikini and Enewetak atoll about a year ago and now 60 years/3 generations later, there are still the same concerns about whether it is safe to move back and grow their own food, and lack of measurements on ongoing leaks.

Its a different story but some similar plot themes

How evenly distributed are radioactive isotopes from Fukushima in the ocean? Is it possible to say there will be no "hot-spots" in the ocean where radioactivity concentrates? Can we be fairly sure that a random sample of water in an area is fairly representative of that area's water radioactivity?

Do any particular sea flora or fauna bio-accumulate radioisotopes?

sartorResartus

We've measured over 900 samples for Fukushima cesium in seawater. Some in 2011 near Japan were "hot-spots" but over time all values are decreasing. We were among the first to point out that levels were not decreasing to what they were prior to Fukushima, so yes, there are ongoing leaks.
What we and all the other scientists measure today is lower than before as the radioactive contaminants mix in the ocean and spread across 5000 miles to our coast

Kelp would filter, grow, and sequester the radiative materials within its fibre. What about dropping rock, broken concrete, and welding rebar wireframes in patterns to create artificial reef and kelp water filters. The kelp could later be harvested from the filter zones then burnt through the pyrolysis process leaving behind activated char coal with the radiation locked up inside of it permanently.

It is the only solution that I know of that we are capable of implementing with current technology.

KainX

not enough kelp and they are better at extracting iodine (including radioactive forms) than kelp

see Kelpwatch for another group looking at this using kelp as an indicator of Fukushima cesium (which they don't see)

https://kelpwatch.berkeley.edu/

I read an article about a study that found a lot of pacific tuna now contain crazy high levels of radionuclides. I also read that if you ingest one radionuclide you are pretty much done for. These statements are obviously gross oversimplifications, but you get the jist. I haven't eaten tuna since the Fukushima incident. Am I an idiot?

smokemarajuana

Not an idiot, just its hard to get your head around radioactivity and when to be concerned or not. FYI, levels in even the most contaminated tuna were not crazy high- there is a small amount of radioactive cesium in all the oceans and in all fish. A better question is how much more did Fukushima add. At the peak of the accident and close to Fukushima the numbers were high enough to close commercial fishing in many areas off the east coast of Japan. That has changed as levels decrease. The limits are set as threasholds- so don't exceed every day. Like may other contaminants- think mercury- the danger is not usualy from one meal, but eating tuna every day for a year can increase your mercury levels, but eating once in a while not a big deal

Have El Niño or other climate change phenomenon had any effect on the spread of the radioactive fallout?

And can/has this level of radioactivity damage marine ecosystems?

blue_thor

El Nino and warming in the Pacific has changed ocean currents and the marine ecosystems along the west coast. Predictions were that the cesium would be found along the coast line earlier than we found it in BC Canada a year ago. In fact much of the contamination is staying off shore, held there by the same currents that are not allowing the warm "blob" waters mix away as they usually would more quickly

Are you familiar with Radcast.org, do you think collective radiation monitoring is effective, and if so, which monitor would be a good choice?

nocoffeeenema

SAFECAST based in Tokyo is a great group with citizens carrying hand held geiger counters to map out radioactivity on land

http://blog.safecast.org/

It doesn't work as well on the ocean (we tried but levels are lower), but on land you can see hot spots in Japan

I don't have a question for you but want to thank you for taking the time to respond to all of these questions professionally and in such great detail. It has been a fascinating thread to read through. Good luck with your future research.

SwoopnBuffalo

thanks! its been a struggle, in part because of lack of US Federal funding for ocean radionuclide studies.

Why do you say "unprecedented sources"?

Because it's not true to say "unprecedented levels" but you wanted it to sound like that and trick people into thinking that is true?

Darktidemage

Not sure of the "trick"? but compared to Chernobyl, the ocean levels after Fukushima were thousands

of times higher (not because Chernobyl was smaller, but it was much further from the oceans). In that sense, Fukushima remains an unprecedented event for the ocean.

Where are his replies?

freediverx01

replies were from 1-3 today
I'm getting back to a few more tonight