

Hi, Reddit! I'm Kris Karnauskas, a professor at the University of Colorado and Editor of AGU's Journal of Geophysical Research-Oceans. I'm here to talk with you about oceanography and climate science

AmGeophysicalU-AMA <sup>1</sup> and r/Science AMAs<sup>1</sup>

<sup>1</sup>Affiliation not available

April 17, 2023

### Abstract

Hello! I'm Kris Karnauskas, faculty member at the University of Colorado Boulder's (<http://www.colorado.edu>) Department of Atmospheric & Oceanic Sciences (<http://www.colorado.edu/atoc/>) and Cooperative Institute for Research in Environmental Sciences (<http://cires.colorado.edu/>). I'm also an editor of AGU's Journal of Geophysical Research-Oceans (<http://tinyurl.com/ztaob5k>). I lead the Oceans & Climate Lab (<http://www.colorado.edu/oclab/>), which aims to understand what makes the climate system tick, the role of the ocean in climate, and what are the effects of climate change on marine ecosystems and human society. My team just published a study about some ongoing changes in the Pacific Ocean near the equator (<http://tinyurl.com/gohynr9>), and what they mean for penguins hanging in the balance. With one of the strongest El Nino events in recorded history peaking just last month, it has been an incredibly exciting year to be an oceanographer and climate scientist! Talk to you soon! I'll be back at 12 pm EST (9 am PST, 7 pm UTC) to answer your questions, ask me anything!

[REDDIT](#)

# Hi, Reddit! I'm Kris Karnauskas, a professor at the University of Colorado and Editor of AGU's Journal of Geophysical Research-Oceans. I'm here to talk with you about oceanography and climate science

[R/SCIENCE](#) AMGEOPHYSICALU-AMA

Hello! I'm Kris Karnauskas, faculty member at the University of Colorado Boulder's (<http://www.colorado.edu>) Department of Atmospheric & Oceanic Sciences (<http://www.colorado.edu/atoc/>) and Cooperative Institute for Research in Environmental Sciences (<http://cires.colorado.edu/>). I'm also an editor of AGU's Journal of Geophysical Research-Oceans (<http://tinyurl.com/ztaob5k>). I lead the Oceans & Climate Lab (<http://www.colorado.edu/oclab/>), which aims to understand what makes the climate system tick, the role of the ocean in climate, and what are the effects of climate change on marine ecosystems and human society. My team just published a study about some ongoing changes in the Pacific Ocean near the equator (<http://tinyurl.com/gohynr9>), and what they mean for penguins hanging in the balance. With one of the strongest El Nino events in recorded history peaking just last month, it has been an incredibly exciting year to be an oceanographer and climate scientist!

Talk to you soon!

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How does being located in a land-locked state like Colorado affect your oceanographic studies? Does it require you to rely more on data others have collected, or plan more trips to collect your own data than perhaps you would otherwise need to make if you were on the coast? Or does it actually not really make a difference because of the kinds of studies you undertake?

[shaggorama](#)

The shortest answer is the last thing you said - it does not make much of a difference. Let me copy/paste something I said in response to a similar question: In these modern times, one does not need to actually live on the coast to conduct scientific research on oceanography. I would say the majority of scientists who study the ocean do so through means other than being on a boat or standing at the end of a dock. We now have many satellites orbiting Earth, sending back incredible amounts of data, there are vast collections of data from the global ocean collected over decades and beyond that need to be analyzed, and computer models to test hypotheses about the ocean and its role in the global climate system. As much as I enjoy actually being on (or near) the ocean, it is not a requirement. Ironically, in my six years at the Woods Hole Oceanographic Institution (Atlantic coast), I spent most of my time conducting research on the Pacific!

Thanks for doing this AMA! My question is, is there a way to undo the damage that's already done?

[ki10\\_butt](#)

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Hi ki10\_butt. I like showing figures from this paper in my introductory course here at CU called "Our Changing Environment." <http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2923.html> What it shows is that even if we (humans) stopped emitting CO2 entirely today, the effects of the industrial revolution in terms of atmospheric CO2 concentration, temperature, and sea level rise would last for thousands of years. This doesn't mean it's not worth trying!

Hey Kris! My question is a bit a general one: If mankind continued polluting the atmosphere and oceans at the current rate, what would the earth be like in 100 years? What are some significant changes we maybe aren't aware of at all until now?

[m4dc00kie](#)

Hey m4dc00kie! Thanks for this important question. In fact, this is the idea behind the experiments that scientists conduct using climate models. We'd like to have an estimate of what changes to expect by the end of this century under different assumptions about what we'll do – ranging from strong abatement policies, to "business-as-usual" emissions. The go-to reference on this, although it might come off a bit dry, is the IPCC report. You can find information on predicted future changes in sea level, sea ice, glaciers, temperature, drought, etc. for different emissions scenarios. There was also a nice paper that came out recently called "Consequences of twenty-first-century policy for multi-millennial climate and sea-level change" (<http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2923.html>) that takes a much longer-term perspective – from the last ice age to the very distant future. It is amazing to see what a lasting impact we humans can have on the planet, but also how much it depends on what we do this century.

Might be stupid question but here It is, is it true that over 90% of the oceans are still unexplored?

[yamateh87](#)

I've heard statistics like that - I think it just depends on how you define the ocean. 90% of the sea floor vs. 90% of the total volume of the ocean vs. 90% of the ocean surface? I'm sure a boat has at one point explored just about every part of the surface, and what this statistic refers to is the deep. Either way, I think it's fair to say that we do know more detail about the surface of the moon and Mars than our own ocean floor. There is a simple and realistic reason for this. The ocean surface is difficult to penetrate with satellites, so all we can usually "see" is the surface (but this is changing with some new satellites).

Hey Mr. Karnauskas, nice of you to stop by! My question is what area of oceanography is least "attractive" to research and deserves more attention?

Cheers!

[Fistopher\\_Robbin](#)

I like this question! I would have to say that we need to invest more in understanding the interactions between physical and biological oceanography. For example, how is the life in the ocean affected by ocean currents, temperature, waves, etc. – and likewise how does the life in the ocean influence the physical environment? With a better understanding of these interactions, we might be able to do a better job predicting ecosystems just like we do with weather and short-term climate these days. I think this may be less "attractive" at the moment just because many funding agencies and scientific journals are still structured the single disciplines. Just a shameless plug here, but the Journal of Geophysical

Research-Oceans (<http://agupubs.onlinelibrary.wiley.com/agu/jgr/journal/10.1002/%28ISSN%292169-9291>) is a multidisciplinary journal that welcomes scientific contributions in any area of oceanography but we editors especially like seeing novel ways of cutting across disciplines to make discoveries that would have been impossible otherwise.

Hi there, Kris!

I'm an early career ocean-atmosphere scientist (just started a postdoc last September at COLA in ENSO research!) and had a couple of field and career related questions.

Career Q: Obviously networking and publishing are two of the most important things to an early career scientist. What other things can an ECS do to attract notoriety and improve their chances at landing a job within the field? On that note, was there a sort of a-ha moment that pushed you toward a tenure-track position vs. an industry position?

Science Q: I'm currently working with CESM, and was wondering what your opinion is on state of the art coupled ocean-atmosphere climate models. What shortcomings do they have? Where should we be focusing our efforts on improving them?

Personal Q: Did Dr. Busalacchi ever give you any good stories about his PhD advisor, JJO? Jim's a real hoot.

Okay I could ask a million more questions but I'll can it there. Thanks for your time and consideration if you answer any of these!

[Colostro](#)

Hi Colosro!

You're right; networking and publishing are important. I would say if you can find some teaching experience, that will help if you plan to apply for faculty positions any time in the near future. Faculty positions are becoming so fiercely competitive that I believe that having some teaching experience already under your belt can be a tie-breaker if your research is already solid. Strangely, we sometimes forget that teaching is a big part of the job even if it's not what we're "known" for outside of the university community. I had my a-ha moment as a senior in college. I was majoring in Atmospheric & Oceanic Sciences at the University of Wisconsin-Madison, and some of the professors were so inspiring to me and seemed to love their jobs so much that I knew I wanted to what they were doing.

Your science question is a loaded one! I'm sitting about 5 miles from NCAR, in fact!! There are some review papers looking at improvements (or remaining "challenges") between CMIP3 and CMIP5. I was on a NOAA Task Force charged with pulling together an assessment of North American climate in CMIP5 models; we published a three-part series in Journal of Climate which might be of interest to you: North American Climate in CMIP5 Experiments. Part I: Evaluation of Historical Simulations of Continental and Regional Climatology <http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00592.1> North American Climate in CMIP5 Experiments. Part II: Evaluation of Historical Simulations of Intraseasonal to Decadal Variability <http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00593.1> North American Climate in CMIP5 Experiments: Part III: Assessment of Twenty-First-Century Projections <http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-13-00273.1> I think we always need to remember what global climate models were designed for—global problems. I have published some studies trying to get more mileage out of climate models by combining them with in situ observations or with regional, high-resolution models. Here are a few recent examples: Mitigation of Coral Reef Warming Across the Central Pacific by the Equatorial Undercurrent: A Past and Future Divide <http://www.nature.com/articles/srep21213> Climate change and larval-transport in the ocean: Fractional effects from physical and physiological factors <http://onlinelibrary.wiley.com/doi/10.1111/gcb.13159/full>

Equatorial refuge amid tropical warming

<http://www.nature.com/nclimate/journal/v2/n7/full/nclimate1499.html>

Yes, I'm looking forward to the International CLIVAR conference in China this fall! I joined the US CLIVAR Scientific Steering Committee recently, and hoping there will be strong US participation at the meeting.

What is the simplest way to explain climate change to a climate change deniers.

[a atop](#)

Hi atop. This question is similar to one by the5issilent, so I'll just repeat some of what I said to her/him. These are the essential facts: (1) atmospheric CO<sub>2</sub> is increasing, (2) fossil fuel combustion is responsible for the increasing atmospheric CO<sub>2</sub>, (3) the increasing atmospheric CO<sub>2</sub> is causing the temperature and chemistry of both the atmosphere and ocean to change, and (4) global warming has (and will have) serious impacts on both human and natural systems on Earth. Which one of those facts is being denied? If (1), then I would discuss the record of observed CO<sub>2</sub> since the 1950s (<http://www.esrl.noaa.gov/gmd/ccgg/trends/full.html>). There are longer records, of course, which reveal that the increase began around the beginning of the Industrial Revolution. If (2), then you might discuss how we know that the increase in CO<sub>2</sub> is due to fossil fuel emissions; carbon atoms that results from fossil fuel combustion have a distinct isotopic fingerprint. The science on this is a bit dense, but here is one of the main papers in case you're interested (<http://adsabs.harvard.edu/abs/1999TellB..51..170F>). If (3), then I would discuss the physical underpinnings of the greenhouse effect, and the hundreds of climate model experiments that show that the only way to explain 20th century warming is by increasing greenhouse gases. For (4), it sounds like this is where you already have some great ideas for experiential changes. In the end, you might consider asking your family if they'd be willing to look at the Summary for Policymakers from the latest IPCC report, freely available online here: <http://www.ipcc.ch/report/ar5/wg1/>. The IPCC is a UN effort to comprehensively review and summarize the current state of the science on climate change.

Some scientists believe that the 'climate plateau' we saw in the early from approximately 1996-2014 was due to oceans burying and disguising a lot of the excess heat in our atmosphere. Do you agree or disagree with this? Do you have any research of your own that sheds some light on this phenomenon? <http://www.climatecentral.org/news/temperature-plateau-is-likely-due-to-warming-of-deep-oceans-16280>

[thewhitesuburbankid](#)

Hi thewhitesuburbankid. Great question! Let me put it this way: I agree, but I don't think it's the whole story anymore. A few years ago (around the time of the CC story you cite), we were uncovering that the ocean was accumulating energy at a faster rate during the so-called 'global warming hiatus' (or 'climate plateau,' as you called it), so the logical answer was that the ocean was ramping up the rate at which it was absorbing heat excess heat from the atmosphere. This hypothesis was supported by both observational evidence (<http://science.sciencemag.org/content/early/2015/07/08/science.aaa4521.abstract>) and model experimentation (<http://www.nature.com/nclimate/journal/v1/n7/full/nclimate1229.html>). However, several recent studies have revealed that the hiatus (in terms of atmospheric temperature) may never have happened at all! I suggest reading this story about a recent paper by my colleagues out of Stanford: <http://news.stanford.edu/news/2015/september/global-warming-hiatus-091715.html> One of my postdocs is also working on a paper about this, but it's premature to discuss.

I've seen Japanese scientists write about El Niño & La Niña Modoki conditions in addition to "regular" EN's & LN's, while Americans & others just talk about "neutral" conditions. During EN Modoki conditions, the warm surface water is in the central Pacific rather than the eastern Pacific like EN's, & during LN Modoki conditions, it's in both the eastern & western Pacific rather than just the west like typical LN's.

They say this is important because the worst tropical cyclones in the northwestern Pacific ("typhoons") occur during El Niño Modoki conditions, with "regular" El Niño conditions second. Do you think they're onto something? Will our classification of the ENSO get more complicated? Or will we just stick with "neutral" for the things they subdivide?

[PG\\_Antioch](#)

Hey PG\_Antioch. Great question. This issue of ENSO "diversity" (as in how every El Niño or La Niña event looks a bit different from the last) is a new and very rapidly expanding area of research. I am also enthused that it is a topic with very broad international participation. In fact, "modoki" means something like "similar, but different" in Japanese – although I know the translation must not be that simple. I was part of an international "working group" that tried to pull together a synthesis of what we know and don't know about ENSO diversity. Please see this article of ours called "Understanding ENSO Diversity," which was on the cover of BAMS back in June of 2015 (<http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-13-00117.1>).

Hi Kris,

Thank you for doing this AMA. I am only aware of one underwater research laboratory (the Aquarius Reef base), which was a place meant for scientific research and experimentation. In 2013, the NASA-funded budget for this facility was cut to zero dollars, and it is now partially funded by Florida International University. It seems that such facilities are becoming dinosaurs (like my Atari 2600), and are just not getting the funding they used to have. Do you feel that these sorts of habitats could aid in your research, or are they something that are no longer needed? Also, would you ever consider working in an underwater lab?

[Propane13](#)

Hi Propane13! I would probably prefer not to work in an underwater lab, but that's just personal taste. That said, I would not be surprised if some important insights into oceanography could be gleaned from that kind of unique laboratory setting. Sometimes it seems like it's easier to conduct an experiment in space than under the sea these days...

Thanks for doing this AMA! I was wondering if you could shed light on how the increasing amount of fresh water from thawing is affecting acidification (or pH balance in general), and how the altering pH affects the local marine life?

[ranaparvus](#)

Hi ranaparvus. Great question! I actually don't know, but I'll spin my wheels for a second. Water in liquid form that has already been near the surface of the ocean for some time has had the chance to draw down CO<sub>2</sub> from the atmosphere (especially cold water, where CO<sub>2</sub> is more soluble). My guess is that melting ice puts water with less dissolved CO<sub>2</sub> into the ocean, but the effect is small. Consider the surface area of the ocean (71% of the planet) compared to the rates at which fresh melted water is being put into the ocean at very localized spots.

There are some responses elsewhere here on this AMA about acidification. I hope you can find what you're looking for by searching for the word acidification.

Hello Kris, thank you for doing an AMA.

How many years does humanity have before we hit the point of no return with regards to climate change? I'm almost thirty, is it something that I'll see occur in my lifetime if our world leaders don't start committing to change?

[Arterialite](#)

We don't know when the tipping points are. Let's just hope something real and positive comes out of the Paris agreement! For the record, I'm feeling more hopeful this time around.

I'm sort of new here so I really don't know if this belongs elsewhere, but can you explain the effects that pollution from plastics (such as the Great Pacific Garbage Patch and microbeads) will have for our future generations? We are rightfully focused on climate change, but I'm personally afraid we are hypervigilant in finding its solution that we are overlooking a catastrophic buildup of non-organic compounds in our oceans that have the potential to completely destroy ecosystems.

[SillyPhillyDilly](#)

Hi SillyPhillyDilly. I agree with you - climate change (as it is usually thought of) and "environmental" concerns like plastic in the ocean should not be studied separately in isolation. At the moment, if I'm honest, the scientific communities studying these two issues are doing so more or less in isolation. We have our hands full, don't we?

Hi Kris! Thanks for the AMA! I've got a question...

What effects do you think climate change (including elevated sea levels and increasing intensity of the typical storm) will have on the distribution of the human population? Are the conflict refugees just the first taste of what will soon become climate refugees? Where will they come from (Florida? Indonesia?) and where can they go?

Thanks Kris!

[Geo\\_Doug](#)

Hi Geo-Dough. I do think this is something that we will need to deal with this century, and I'm not sure how it's going to work. Consider the differences in urgency or time scale. Conflicts flare up and refugee crises are immediate. How they are dealt with becomes clear early on. Comparatively, climate change is a slow creep. I can think of no good analog in human history - maybe someone else can. Something I'm working on at the moment is estimating future water shortages on small islands scattered around the world. Usually, we think of them having "too much" water (i.e., sea level rise) but there are some island nations where there may be severe freshwater shortages in the future as the rainfall regions shift due to climate change. How will they adapt if their civil infrastructure is set up to depend on rainwater for drinking and other essential use. A slightly accelerated version of all this I think is playing out in Syria: <http://www.scientificamerican.com/article/ominous-story-of-syria-climate-refugees/>

Kris,

History has shown us that on geologic time scale the Earth has undergone many periods of glaciation as well as periods of above average temperature. Where are we now in this cyclic pattern, and how

much do you think anthropomorphic pollution is effecting this pattern?

PS: thanks for doing this AMA, I have a BS in geology and really enjoyed oceanography, marine geology etc..

[Hart9](#)

Hi Hart9. Glad you brought this up, as it's easy for some to use this and say "well, climate has always been changing, why is this any different?" Over the last 800,000 years - or the last 8 or so glacial cycles - the atmospheric CO<sub>2</sub> varied from about 200 parts per million (ppm) in cold or "glacial" times to about 300 ppm in warm or "interglacial" times. We just passed 400 ppm. To be more exact, the atmosphere had 280 ppm CO<sub>2</sub> in 1813, and 2015 saw 403 ppm (and climbing, obviously). If we continue at this rate of emission, we'll approach 1,000 ppm by year 2100. There's absolutely no doubt - we have our hand on a very powerful dial.

Kris thanks for taking the time to do this AMA. My question is: To what degree is the impact from nuclear weapons testing on our oceans and marine life? Is this irreversible?

[bassbuddha](#)

Hi bassbuddha. I wish there was an answer to this question, but unfortunately we do not even know the extent of the impact of nuclear weapons testing on the ocean.

Hey Kris! I come from a family that's ultra conservative and as a result they are fierce deniers of climate change. My family loves to talk about issues, but I can't seem to reach past the rhetoric that appears to be engrained in them and convince them that climate change is real. Mostly I can't seem to convince them that we are responsible.

Do you have any simple observations that they can make themselves to help see the reality of it? I've tried to point to glacial retreat, arctic ice disappearing and record average warming year after year, but still no success. My family respects science, they're engineers, but it seems to me they're doing mental gymnastics to hold to their belief.

Thanks for your time!

Edit: Re-worded after typing on Mobile

[the5issilent](#)

Hi the5issilent. I bet you have some interesting family gatherings! Everyone is entitled to his or her opinion, right? It is tough to think of a direct observation that can be made by one person at one time that would reveal the reality of climate change, as detection of climate change naturally requires careful observation over time. These are the essential facts: (1) atmospheric CO<sub>2</sub> is increasing, (2) fossil fuel combustion is responsible for the increasing atmospheric CO<sub>2</sub>, (3) the increasing atmospheric CO<sub>2</sub> is causing the temperature and chemistry of both the atmosphere and ocean to change, and (4) global warming has (and will have) serious impacts on both human and natural systems on Earth. Which one of those facts is being denied? If (1), then I would discuss the record of observed CO<sub>2</sub> since the 1950s (<http://www.esrl.noaa.gov/gmd/ccgg/trends/full.html>). There are longer records, of course, which reveal that the increase began around the beginning of the Industrial Revolution. If (2), then you might discuss how we know that the increase in CO<sub>2</sub> is due to fossil fuel emissions; carbon atoms that results from fossil fuel combustion have a distinct isotopic fingerprint. The science on this is a bit dense, but here is one of the main papers in case you're interested (<http://adsabs.harvard.edu/abs/1999TellB..51..170F>). If (3), then I would discuss the physical

underpinnings of the greenhouse effect, and the hundreds of climate model experiments that show that the only way to explain 20th century warming is by increasing greenhouse gases. For (4), it sounds like this is where you already have some great ideas for experiential changes. In the end, you might consider asking your family if they'd be willing to look at the Summary for Policymakers from the latest IPCC report, freely available online here: <http://www.ipcc.ch/report/ar5/wg1/>. The IPCC is part of a UN effort to comprehensively review and summarize the current state of the science on climate change. You could also email me and I'd be glad to provide some lecture materials that I have that developed over the years. I hope this helps!

Could marine life adapt to the increasingly acidic oceans? Is acidification a genuine threat or just fearmongering?

[MadhutyRotMG](#)

Ocean acidification is a genuine threat to many species, especially those that build shells in their life cycle and coral reefs. However, there is a lot of research showing that some species can be more "resilient." Adaptation in the evolutionary sense takes too long, so what I am referring to is species that are "used to" rapid changes from one year or season to the next may be better able to withstand the long-term trend in pH, temperature, etc.

I'm sorry if this isn't as detailed and scientifically minded as the other questions, but I'm hoping you find an interesting way to answer it:

If I wanted to study the ocean, why would I go to a university in Colorado?

[DUNE\\_IS\\_A\\_SHIT\\_BOOK](#)

Fair question! In these modern times, one does not need to actually live on the coast to conduct scientific research on oceanography. I would say the majority of scientists who study the ocean do so through means other than being on a boat or standing at the end of a dock. We now have many satellites orbiting Earth, sending back incredible amounts of data, there are vast collections of data from the global ocean collected over decades and beyond that need to be analyzed, and computer models to test hypotheses about the ocean and its role in the global climate system. As much as I enjoy actually being on (or near) the ocean, it is not a requirement. Ironically, in my six years at the Woods Hole Oceanographic Institution (Atlantic coast), I spent most of my time conducting research on the Pacific!

It's extremely hot up here the Philippines. We severely lack water. Is it gonna get worst?

[vincetan789](#)

Hi there, vincetan789. I'm very sorry to hear about the heat and water situation in the Philippines. It pains me to say this, but it isn't looking good for this spring. The go-to source for seasonal climate predictions is the International Research Institute for Climate and Society (IRI) at Columbia University, and their predictions for March-April-May in the Philippines are showing continued above-normal temperatures, and also a very high probability of below normal rainfall. You can see the forecasts here: <http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/> Some of this has to do with the ongoing El Nino event, which takes the warm water and rainfall from where it is normally situated (over the western Pacific) and moves it to the eastern Pacific - away from your homeland. I wish I had better news, but hopefully (for you) the situation will improve later in the year.

Do you enjoy what you are doing ?

[DDekker](#)

Great question, DDekker. Yes, I truly love what I do. Being a professor (scientist + teacher) as well as a journal editor is a great deal of fun. In my own research, I have the freedom and independence to pursue the questions I think are most interesting or important. The best part is that I don't go it alone – it is fun to be surrounded by a wonderful group of faculty colleagues, postdocs, graduate students, undergrads, etc. all doing the same. I am pulled away from my research to prepare for teaching courses and after giving a lecture, I am totally exhausted but it is a great feeling. The nature of research is such that sometimes you can feel like you got stuck in the mud, but teaching keeps me sane. I feel like I've accomplished something if I gave a good lecture and the students seemed to really understand or appreciate something they didn't know when they woke up this morning.

I hope you enjoy what you do, too. Good luck.

I live in Australia and am lucky to have been diving on the Great Barrier Reef a number of times. Could you expand on the threat of climate change to our reef systems and specifically the process of coral "bleaching"?

Thanks for doing this AMA.

[wezofoz](#)

Hi wezofoz. Thanks to Cmel12 for pointing out the great resource on the NOAA oceans website. I'd also recommend this stunning video showing bleaching actually happening!

<http://www.popsoci.com/how-coral-bleaching-happens-video>

Hey Kris! I am an aspiring bio major in my second year of undergrad. I have always been concerned and passionate about the environment. As a young individual I am worried about our global ecosystems and the effects we seem to have on them. What can you recommend academically as well as steps post-undergrad to become involved in studies such as the one in which you are participating?

[masterloch\\_95](#)

I hate to say it, but you'll do yourself a favor if you take some extra math and programming classes. You clearly have the passion, which is at least half of it. I would also reach out and try to get involved in research while you are an undergrad. Many professors and scientists at federal labs are happy to have motivated students work with them on their projects, and that will look great on your graduate school applications.

To what extent does computation play a role in your research? Do you use the local [Research Computing](#) resources or other systems? Will the addition of [Summit](#) later this year aid your research?

[anderbubble](#)

Computing plays a very large role in my own research. Whether analyzing "big data," or running new climate/ocean model experiments, we require fairly intensive computing resources. For most purposes, I can get away with using a modest sized HPC cluster that I share with another faculty member here at

CU. I have yet to use Janus, but was aware of the upcoming acquisition of the new Summit system so I look forward to that. Thanks for the good question.

Do you think a scenario as pictured in the movie "The Day After Tomorrow" could be possible? That the North Atlantic current gets disrupted and causes an ice age? (english is not my first language so I hope you get what I mean)

[Nixar](#)

Hi Nixar. Good question. While the movie may have been a bit dramatic for entertainment purposes, the general physical idea is not outlandish. We know that the Gulf Stream is vital for moving extra heat from the tropics to the high latitudes. Fluctuations in that current, which is an important part of what we call the global thermohaline circulation, could indeed have an impact on climate in temperate latitudes like the continental U.S. and Europe.

Can't help but as this cliché question.

How can you the scientists and we the muggles can show to the politicians, leaders and decision makers that Climate Change is undeniable and an huge threat?

[SkyNights](#)

Hi SkyNights. Great question. Let me turn it on it's side a little bit. I feel like the politicians, leaders, and decision makers have been shown the science. The show is over. It's time to act.

Hi Ms. Karnauskas, I will be studying Marine Science in University next year, and I am glad you're doing this AMA. I think we need more scientists from ocean-related fields to demonstrate the research/work they do considering the importance of the ocean to life on Earth. My question is, does the depletion of stratospheric ozone have any indirect effects on the ocean that most people don't think about (besides damaging surface phytoplankton, etc)?

[FishesNBitches](#)

Wow, great question. I have not seen much research on this topic, but I know a good colleague of mine here at CU Boulder is working on exactly that. Stay tuned.

Is there a formulae to calculate the wave or swell 'shadow' caused by islands, like how long are they based on island size, swell velocity etc. Or would that require a good simulation to account for depth of the ocean, reflections and refractions in the waves?

[Kaea](#)

Hi Kaea, great question. I think it could be worked out using theory (i.e., the "shallow-water equations" as we call them in geophysical fluid dynamics) but as a researcher, I would rather use or build a model so I can change the parameters and see what it really depends on. Short answer is no, at least I'm not aware of a universal formula for that.

Hi Kris, about the EEP/Galapagos penguin study you posted: while an expansion of the cold pool may benefit penguin populations, would an expansion of OMZs potentially counteract this growth? And if so,

by how much?

[katerific](#)

You know, this is a good question, katerific. I read your question, sat here for a minute, and went "humph." I don't know the answer, but I didn't want you to think I didn't like the question. Thanks!

Hi Kris, just curious your thoughts on the Obama Justice Dept. revelation yesterday that they have been working on prosecution options to go after those who question the theory of anthropogenic climate change, particularly energy companies?

[1778](#)

Hi 1778. Thanks for this question. My own read of the news so far is that there appear to be some profound similarities between the fossil fuel industry purposely muddying the science around the causes and effects of climate change, and the tobacco industry muddying the science linking smoking to health problems. Big tobacco has been sued for this, and lost. That's all I can say this morning, as this is obviously breaking news.

How do you feel about the recent cuts to the CSIRO, and in particular to the climate science divisions?

[The Last Continent](#)

The situation at CSIRO is very disconcerting. An open letter from the scientific community to the Australian Government and CSIRO, titled "Australia's Climate Research Is Far From Done," can be found here: <https://docs.google.com/document/d/1AdCOi52MxYPMRHJFT72nith3fnKi9t-iajjoibF3Vw/edit?pref=2&pli=1>

How much do you teach your students about general communication/persuasion skills?

I keep reading articles by climate scientists (not in journals) who clearly know their shit, yet don't seem to have a sense of how to phrase the findings in a way that will make people care.

[ZMech](#)

Hi there, ZMech. I can commiserate with you on this, but I can't claim to be above it all either. I try to communicate with many different audiences about the science that I work on and the implications for humanity as I see them. I am constantly blown away with so many of my colleagues who are exceptionally good at connecting with students and communicating with the public, media etc. I just take it in. In terms of education, it's still relatively uncommon to blend science and communication into single curricula, but I have seen some great examples lately. This is one with which I have some familiarity: <http://climatesociety.ei.columbia.edu/>

Hello Kris, what are your thoughts on paleoclimate data informing future projections using GCMs? Can they be useful?

Also, I would love to hear your opinion on centennial-scale variability in the Pacific Ocean - do you think it is a change in mean state causing this or do you think it is a series of "more active" and "less active" ENSO years?

Thanks for the AMA!

[planktic](#)

Hi planktic. I am not a paleoclimatologist, but I work with many. I have come to appreciate how important the long-term perspective on past climate change is when considering future projections of climate change. However, we are changing the composition of the atmosphere more rapidly than any time in the past - the rate of change even puts the Paleocene-Eocene Thermal Maximum to shame. So, we have no perfect analog from the past, but paleo data can certainly help with things like constraining or estimating the global climate sensitivity. And thanks for the great question about the Pacific. I think the mean state and the ENSO variability may be inseparable. Theoretical studies from a while ago (Fedorov, Philander, etc. come to mind) show that ENSO variability depends on the mean state, and I have published a paper showing how changes in ENSO variability can cause slow (centennial) changes in the mean state. Chicken or egg? This question is still wide open and I hope to keep working on it. <http://www.whoi.edu/oceanus/feature/pco>  
<http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-11-00421.1>

How big of a problem is the acidification of the oceans? A lot of people don't think it's real and don't want to accept that CO2 is a pollutant.

[Pakamaniac](#)

Great question, Pakamaniac. This is similar to a question by arcofnoah, so I'll repeat myself a bit. I am especially concerned with ocean acidification, which is a byproduct of the carbon dioxide being emitted into the atmosphere. The ocean is currently absorbing up to half of the CO2 being emitted! After entering the ocean, the CO2 undergoes some chemical reactions that ultimately lower the pH of the seawater, which is called acidification. This makes it more difficult for shell-building organisms in the ocean to survive and may have similarly detrimental effects on coral reefs like bleaching. My previous scientific home, where much of the world-leading research on the topic is happening, has a great page with readable information (<https://www.whoi.edu/main/topic/ocean-acidification>). Also, as untumulted pointed out, the Journal of Marine Science recently published an entire issue dedicated to the problem (<http://icesjms.oxfordjournals.org/content/current>).

What geoengineering solutions to combating global warming do you support? What is your opinion on Russell Seitz's idea of micro bubbles to make the earth more reflective? ( as discussed by Bill Nye )

[njboland](#)

Hi njboland. I would rather support efforts to reduce anthropogenic emissions of carbon dioxide.

Does the climate change effect fish mentally? Last year, in NC alone, there were (i think) 7 shark attacks during the summer. Can it change their way of heading from point A to point B so drastically that they wind up getting lost and just roam the coast? Or is it just some renegade shark going on a rampage?

[Rio101](#)

Hi Rio101. I'm a bit of a fish out of water on this one, but I do know that climate change can affect fish and other species early on in life – in their larval stage. For example, larvae metabolize faster in warmer water, which will reduce their larval duration (and potentially their life span if they don't find a suitable home in time). Changes in currents also affect population connectivity and biodiversity between different locations in the ocean. For sharks, my guess is they might feel the pressure of a changing environment, which might include shift in their physiologically optimal environment, or

perhaps more importantly, where there food supply lives. This article might interest you:  
<http://www.climatecentral.org/news/climate-change-sharks-19221>

Thank you for doing the AMA. This is a question that has been on my mind but I never articulated it well. I hope it isn't too trivial!

In physical oceanography, the conservation of potential vorticity is an important concept. Absolute vorticity is defined as the sum of relative (to Earth) vorticity and planetary vorticity. The conservation principle then affects flows. However I never really understood why you can simply sum these, when the rotational motions happen often in obviously different planes - especially near the equator. That is how does reducing the planetary vorticity simply increase the relative vorticity? Because the movement also affects the plane of the rotation?

I believe it's true but it still doesn't feel intuitive to me! Maybe I need to just read better derivations for the equation and follow it very closely...

[eleis](#)

Hi eleis. Great question, and tough to reply in a box without being able to write out some math. One of my favorite texts in this area written by a master is Mid-Latitude Atmospheric Dynamics: A First Course by Jon Martin.

Does it feel weird to be studying the Ocean from a land locked state?

[Ryanhdd](#)

Hi Ryanhdd. This question is similar to another user's question "If I wanted to study the ocean, why would I go to a university in Colorado?" In these modern times, one does not need to actually live on the coast to conduct scientific research on oceanography. I would say the majority of scientists who study the ocean do so through means other than being on a boat or standing at the end of a dock. We now have many satellites orbiting Earth, sending back incredible amounts of data, there are vast collections of data from the global ocean collected over decades and beyond that need to be analyzed, and computer models to test hypotheses about the ocean and its role in the global climate system. As much as I enjoy actually being on (or near) the ocean, it is not a requirement. Ironically, in my six years at the Woods Hole Oceanographic Institution (Atlantic coast), I spent most of my time conducting research on the Pacific!

Hey man! I'm a human ecologist and thanks for making this AMA :) Do the effects of climate change we are experiencing today have incremental effects that contribute to worsening climate change? If so, is there any chance we can combat it in my lifetime? I'm 21 :)

[spontaneous66](#)

Hey there, spontaneous66. Great question. Yes, I do believe we can and should work on reducing emissions in your lifetime (even mine!) but there are already changes in the pipeline, so to speak, so some adaptation strategies will be needed meanwhile. One challenge here is that there are feedbacks in the climate system. What this means is that the response of the climate system is not exactly proportional to the forcing at the end of the day. One example is ice-albedo feedback. Ice reflects sunlight, but as the ice melts, the Earth looks "darker" on average, which absorbs more solar energy and thus warms up faster. There are many other examples, which is why this is such a challenging scientific problem.

Thanks for doing AMA! Because I strongly doubt that humanity will react appropriately before the consequences of global warming become too obvious and the weather becomes too dangerous for global ecosystem, my question is: Are there any ideas how we could relatively quickly tone down world temperature, safely?

(sorry for my English)

[\\_perAsperaAdAstra](#)

Hi perAsperaAdAstra. Great question. I think you are referring to geoengineering, which is a category of possible actions aimed at mitigating the effects of climate change without working on the root of the problem (emission of greenhouse gases). Many options have been proposed, but it's the "safely" part of your question that has many scientists very concerned. I think this is a philosophical matter, and while I do share your doubts to some extent, I suppose I'm also hopeful that our generation will have the courage and ingenuity to address the problem head on.

NOAA recently undertook the El Nino Rapid Response field campaign, which as I understand it was developed on a short timescale to make use of existing reconnaissance flight resources. From what I've heard, the mission was very successful.

Are you aware of any plans to continue the El Nino field campaigns in the future?

[bellcrank](#)

Hi bellcrank. I've heard similar stories of success. I might have had the opportunity to go down to Edwards AFB earlier this year to help NOAA out with the Global Hawk missions, but didn't end up going after all. Not sure about future plans, but I suppose we'll have at least a couple years to think about success/challenges it and plan for next time.

What's the scariest thing that's happened to you while out in the ocean?

[photographyraptor](#)

Hi photographyraptor! Great question, but I do not go out to sea very often myself. My longest stint was 28 days in the remote tropical Pacific (between the Marshall Islands and Hawaii). Nothing scary happened, fortunately - it was an enormous NOAA ship. A few years ago, my colleagues at WHOI and I sent some graduate students on a similarly long trip but on a very small boat. They ran out of gas just before reaching the Gilbert Islands, which must have been unnerving. (They made it.)

Hello Kris. Other than the increased carbon in the atmosphere is there any other naturally occurring cause that is responsible for the increased acidity of the oceans that we are witnessing today and is that activity present today?

[johnlaw58](#)

Hi johnlaw58. There is a great review of the topic in a special issue of Oceanography:  
<http://tos.org/oceanography/issue/volume-22-issue-04> It would be hard to explain the recent rate of pH decrease (acidification) in the ocean by natural causes.  
<http://www.pmel.noaa.gov/co2/file/Hawaii+Carbon+Dioxide+Time-Series>

Hey Kris, quick question: Sko Buffs? Or no Sko Buffs?

[TestSubject45](#)

Sko Buffs. Come on.

Hi,

What's your take on the ICES Journal of Marine Science Feb/March issue:

[Towards a Broader Perspective on Ocean Acidification Research?](#)

Thanks.

[untumulted](#)

Hi untumulted. I have to admit I haven't had a chance to look at that issue of JMS yet. However, I especially look forward to reading "Ocean acidification affects productivity but not the severity of thermal bleaching in some tropical corals" by our Australian colleagues Sam Noonan and Katharina Fabricius.

Hey Kris, Thanks for taking the time to do this!

I was wondering, do you still enjoy seafood after working so close with the oceans?

Thanks again for doing this, have a great day!

[iTalk2Pineapples](#)

I like fish tacos... I'm human! You have a great day, too.

I hear a lot of talk about their being more plastic than fish in the ocean by 2050. How significant is this, will the oceans run out of fish?

[Mrbrown683](#)

Hey Mrbrown683. That is a frightening predicted statistic! I don't think the oceans will run out of fish, but even small changes or shifts in marine life have real effects. For example, over billions people depend on fish for a substantial fraction of their protein intake.

Which chemical is harming our oceans the most ?

[arcofnoah](#)

Hi arcofnoah. There is probably not a single best answer here, but I am especially concerned with ocean acidification, which is a byproduct of the carbon dioxide being emitted into the atmosphere. The ocean is currently absorbing up to half of the CO<sub>2</sub> being emitted! After entering the ocean, the CO<sub>2</sub> undergoes some chemical reactions that ultimately lower the pH of the seawater, which is called acidification. This makes it more difficult for shell-building organisms in the ocean to survive and may have similarly detrimental effects on coral reefs like bleaching.

Seems like a land locked University would be the wrong place to study oceanography.

[bmoorewiz](#)

I seem to be getting a question like this quite a bit this morning! In these modern times, one does not need to actually live on the coast to conduct scientific research on oceanography. I would say the majority of scientists who study the ocean do so through means other than being on a boat or standing at the end of a dock. We now have many satellites orbiting Earth, sending back incredible amounts of data, there are vast collections of data from the global ocean collected over decades and beyond that need to be analyzed, and computer models to test hypotheses about the ocean and its role in the global climate system. As much as I enjoy actually being on (or near) the ocean, it is not a requirement. Ironically, in my six years at the Woods Hole Oceanographic Institution (Atlantic coast), I spent most of my time conducting research on the Pacific!

I know this probably isn't your field, but what do you think about the discovery of the gravitational waves? Will it in any way affect how you study the environment? I keep hearing how gravitational waves opens up a whole new frontier for researching a lot of other things and was wondering if climate study can also be included in the circle of things the discovery of gravitational waves can affect. Like maybe in terms of new equipment or anything?

Sorry if I'm confusing, i cant put my thoughts in words in an effective way

edit: tried to be a wee bit coherent

[Evilux](#)

Hi Evilux. Interesting question! I was also excited by the recent confirmation of gravitation waves as predicted long ago by Einstein, but as you pointed out, not quite in my wheelhouse. I read about it in the New York Times just like some of you probably did (<http://www.nytimes.com/2016/02/12/science/ligo-gravitational-waves-black-holes-einstein.html>).

Why did you choose the University of Colorado, in stead of a more conveniently located university closer to the ocean?

[Watarilejikooh](#)

Hi WaltarLejikooh. This is fairly similar to some other questions asked, so I'll repeat myself...

Fair question! In these modern times, one does not need to actually live on the coast to conduct scientific research on oceanography. I would say the majority of scientists who study the ocean do so through means other than being on a boat or standing at the end of a dock. We now have many satellites orbiting Earth, sending back incredible amounts of data, there are vast collections of data from the global ocean collected over decades and beyond that need to be analyzed, and computer models to test hypotheses about the ocean and its role in the global climate system. As much as I enjoy actually being on (or near) the ocean, it is not a requirement. Ironically, in my six years at the Woods Hole Oceanographic Institution (Atlantic coast), I spent most of my time conducting research on the Pacific!