We're climate scientists Katharine Hayhoe (Texas Tech) and David Easterling (NOAA/NCEI). Ask us anything about climate change in the United States!

AmMeteorologicalSoc [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

Abstract

In a year where we experienced record-breaking forest fires, floods, hurricanes, heat waves, and cold spells, one can't help but wonder - in what ways is climate change already impacting American communities? Are the extreme weather events that the US has endured in the recent past indicative of climate change, or are the just a run of bad luck? If they are, how should we expect them to change in the future? But most importantly - how do we communicate the complexities of these answers to the public? To answer these questions and more, we've assembled a group of scientists who have dedicated significant effort to collaborate with other like-minded researchers and put together documents such as the National Climate Assessment and the Climate Sciences Special Report. Panelists Katharine Hayhoe is an atmospheric scientist whose research focuses on understanding what climate change means for people and the places where we live. She is a professor and directs the Climate Science Center at Texas Tech University and has been named one of TIME's 100 Most Influential People and Fortune's 50 World's Greatest Leaders. David Easterling is a Supervisory Physical Scientist with the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA/NCEI) in Asheville, North Carolina. David received his Ph.D. in 1988 from the University of North Carolina at Chapel Hill and served as an Assistant Professor in the Atmospheric Sciences Program, Department of Geography, Indiana University-Bloomington from 1987 to 1990. In 1990 he moved to NOAA's National Climatic Data Center as a climate scientist, He has authored or co-authored more than 90 research articles and book chapters on climate science. David was a Lead Author on the Nobel Prize winning Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, the IPCC Special Report on Climate Extremes, the IPCC Fifth Assessment Report, and a Convening Lead Author for the U.S. Climate Change Science Program (CCSP) Synthesis and Assessment Product (SAP) 3.3 on Climate Extremes. He is a Fellow of the American Meteorological Society, and has been awarded four NOAA Administrator's Awards, and three NOAA Bronze Medals. 3:56 PM (CST) - Hi all, we're jumping into your questions now! David Easterling is joining us on the floor of the American Meteorological Society Annual Meeting, and Katharine Hayhoe is joining us online. We're excited for the discussion! 5:00 PM (CST) - We've just about finished answering most of people's questions. Please feel free to reach out to us if you have any more!

the WINNOWER

REDDIT

We're climate scientists Katharine Hayhoe (Texas Tech) and David Easterling (NOAA/NCEI). Ask us anything about climate change in the United States!

AMMETEOROLOGICALSOC R/SCIENCE

In a year where we experienced record-breaking forest fires, floods, hurricanes, heat waves, and cold spells, one can't help but wonder - in what ways is climate change already impacting American communities? Are the extreme weather events that the US has endured in the recent past indicative of climate change, or are the just a run of bad luck? If they are, how should we expect them to change in the future? But most importantly - how do we communicate the complexities of these answers to the public?
To answer these questions and more, we've assembled a group of scientists who have dedicated significant effort to collaborate with other like-minded researchers and put together documents such as the National Climate Assessment and the Climate Sciences Special Report.
Panelists
Katharine Hayhoe is an atmospheric scientist whose research focuses on understanding what climate change means for people and the places where we live. She is a professor and directs the Climate Science Center at Texas Tech University and has been named one of TIME's 100 Most Influential People and Fortune's 50 World's Greatest Leaders.
David Easterling is a Supervisory Physical Scientist with the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NOAA/NCEI) in Asheville, North Carolina. David received his Ph.D. in 1988 from the University of North Carolina at Chapel Hill and served as an Assistant Professor in the Atmospheric Sciences Program, Department of Geography, Indiana University-Bloomington from 1987 to 1990. In 1990 he moved to NOAA's National Climatic Data Center as a climate scientist, He has authored or co-authored more than 90 research articles and book chapters on climate science. David was a Lead Author on the Nobel Prize winning Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, the IPCC Special Report on Climate Extremes, the IPCC Fifth Assessment Report, and a Convening Lead Author for the U.S. Climate Change Science Program (CCSP) Synthesis and Assessment Product (SAP) 3.3 on Climate Extremes. He is a Fellow of the American Meteorological Society, and has been awarded four NOAA Administrator's Awards, and three NOAA Bronze Medals.
3:56 PM (CST) - Hi all, we're jumping into your questions now! David Easterling is joining us on the floor of the American Meteorological Society Annual Meeting, and Katharine Hayhoe is joining us online. We're excited for the discussion!
5:00 PM (CST) - We've just about finished answering most of people's questions. Please feel free to reach out to us if you have any more!

READ REVIEWS

WRITE A REVIEW

CORRESPONDENCE:

DATE RECEIVED:
January 11, 2018

DOI:
10.15200/winn.151558.88831

ARCHIVED:
January 10, 2018

CITATION:
AmMeteorologicalSoc , r/Science , We're climate scientists Katharine Hayhoe (Texas Tech) and David Easterling (NOAA/NCEI). Ask us anything about climate change in the United States!, *The Winnower* 5:e151558.88831 , 2018 , DOI: 10.15200/winn.151558.88831

Two part question, if you could change one thing to help with climate change, what would it be and I don't mean something as broad as "stop all fossil fuels now!" considering the economic and social ramifications of doing so across the planet while it would be nice are futile right now, and have you ever personally worked with the researchers in Antarctica.

Nivzamora

Hi, Katharine here. If I could realistically change one thing it would be simply to get people to TALK about climate change! Did you know that three-quarters of people living in the US don't hear anyone talk about it more than once or twice a year? The real problem isn't the people who reject the science; it's the fact that most of us think it doesn't matter. And why would we, when no one talks about it??

Why don't we talk about it? Often, because it's either too controversial or it's too depressing--or both. That's why I think it's so important to read up on (1) what's happening and how climate change is affecting us, not just the polar bears but us, in the places where we live, and (2) the amazing solutions that are already happening today – here in Texas where I live, on the other side of the globe in China and India, and many other places around the world – and share them with people.

We have a short Global Weirding episode that talks about this:https://youtu.be/Q48BvprCFr0

I also wrote this article about it: http://foreignpolicy.com/2017/05/31/everyone-believes-in-global-warming-they-just-dont-realize-it/

And sadly, I have not done any research in Antarctica, but I know many who have. Natasja VanGestel from our Texas Tech Climate Science Center is one of them. Here's a description of her work: https://www.depts.ttu.edu/artsandsciences/news/profile-vanGestel.php and a talk she gave to our pub

science series about it: https://www.youtube.com/watch?v=8be-8QHPGpo

Dr Easterling, I understand if you choose not answer this, but I was wondering if you have felt any political pressure on your research from the new administration? Has there been any attempts to silence or sabotage in any way your research? To alter its conclusions?

Finally, do you think the climate change deniers in the administration such as Scott Pruitt and the president himself can be convinced to change their mind or do you think they just choose to deny it for political and/or monetary gain?

ventsyv

I have not felt any pressure to alter any research findings etc. As a matter of fact, in November we released the Climate Science Special Report, Vol 1 of the Fourth National Climate Assessment. Regarding “deniers” I let the science speak for itself, people deny climate change for many reasons.

David Easterling

Is there an estimated cost for 2017 or maybe say, 2010-2017 or something of how much climate change has cost the US?

In the sense that you can't say that Hurricane X was caused by climate change, but you can say Y% of hurricanes probably were, or that hurricanes were Z% more powerful because of it.

AdrianBlake

Katharine here. Dave’s the expert on the costs, so I'll leave that part to him, but in terms of the attribution you are exactly right. We’ve always been at risk from hurricanes; that’s nothing new. What’s new is how climate change exacerbates that risk through rising sea levels, warmer oceans, and more moisture in the atmosphere contributing to heavier rainfall rates.

We have a short Global Weirding episode about this:https://youtu.be/yfkS7LqCMDQ

This NYT piece also lays out what we do and don’t know:
https://www.nytimes.com/2017/08/25/us/hurricane-harvey-climate-change-texas.html

And if you’re looking for an even deeper dive, this chapter from our recent US federal climate science report, that Dave and I co-authored, summarises the very latest science of what we know:
https://science2017.globalchange.gov/chapter/9/

Is there an estimated cost for 2017 or maybe say, 2010-2017 or something of how much climate change has cost the US?

In the sense that you can't say that Hurricane X was caused by climate change, but you can say Y% of hurricanes probably were, or that hurricanes were Z% more powerful because of it.

AdrianBlake

At NOAA we track the number of US weather disasters per year that exceed $1billion in damage costs (CPI adjusted to account for inflation). This is the closest thing we have to tracking climate costs and since 1980 there has been a large increase in the number of events.

As for hurricanes, we can't say an individual hurricane was caused by climate change, there have always been hurricanes. But one newer field of research call event attribution examines individual events, such as Hurricane Harvey, and tries to identify how much of an influence the observed changes in climate have on the event. For Harvey there has been an attributable influence identified in recent research by scientists at Lawrence Berkeley National Labs, mainly due to increased sea surface temperatures in the Gulf of Mexico.

David Easterling

Hi, I live in Puerto Rico currently, Last year was a historic hurricane season, a hurricane cat 3 visited Ireland (hurricane Ophelia) and 2 hurricanes cat 5&5 each 1 week between them pounded the Caribbean

Will warmer seas represent bigger hurricanes, stronger hurricanes or both/neither?

How big or powerful a hurricane could get if earth gets 2 deg Celsius warmer (worst case scenario)?

Are there indications earth will get warmer than 2Celsius or 3.6F before year 2100?

Which parts of the United States will benefit from global warming ?

xirvin

Xirvin, this is Katharine. Thank you for joining us, and I hope you and your family are safe and well. I have many colleagues in PR and have been working on climate adaptation in that region for a long time. It is heartbreaking to see and hear of the continued devastation and suffering.

We all know that there's always been hurricanes – they are a natural risk of living in the Caribbean and along the Gulf Coast. However, hurricanes are powered by warm ocean water: and today, over 90% of the excess heat being trapped inside the earth's climate system as a result of heat-trapping gas emissions is going into the ocean.

So it's no surprise that we see hurricanes intensifying faster than they used to, and that we also see heavier rainfall associated with a given hurricane. Sea level rise increases the risk of coastal flooding from hurricanes. And we also see some evidence (although we need a longer data record to be absolutely sure) that the more intense hurricanes are becoming more common, and in the future we do expect to see more intense, bigger, and longer-lasting hurricanes as the world continues to warm.

We have a short Global Weirding episode about this:https://youtu.be/yfkS7LqCMDQ

This NYT piece also lays out what we do and don't know:
https://www.nytimes.com/2017/08/25/us/hurricane-harvey-climate-change-texas.html

And if you're looking for an even deeper dive, this chapter from our recent US federal climate science report, that Dave and I co-authored, summarises the very latest science of what we know:
https://science2017.globalchange.gov/chapter/9/

In terms of future projections, as our climate science report says, how much climate will change in the future depends primarily on how much heat-trapping gases we produce and how the earth's climate system responds to the giant kick in the pants we are giving it. It is still possible to limit warming this century below 2oC, but we don't have lot of time. If we continue producing carbon the way we have in the past, we have less than 20 years' worth of emissions before we pass the point of no return. If we continue on our current pathway, warming by end of century could reach 5oC.

For more information, see: https://science2017.globalchange.gov/chapter/4/

And lastly, yes: there absolutely are some benefits from climate change, but in just about every area of the world the negative impacts outweigh the benefits. For example, you might think that Arctic people would welcome a little warming. But that warming is thawing the ground their homes and infrastructure is built on, leaving them with nowhere to live. Also, CO2 is plant food, right? But increasing CO2 disproportionately benefits weeds over most food crops, and rising temperatures also increase pest ranges. And many of us from up north would like warmer winters; but we aren't prepared for hotter summers and heavier downpours that come with them.

We talk about the benefits and drawbacks of climate change in more detail in this short global weirding episode on plants: https://youtu.be/CLtFwUTrE4E And this one on people:
https://youtu.be/1SAqdG3gJH0

Another question. Understandably, much of life on earth is sustained in a kind of equilibrium and changing things too quickly might cause many trophic cascades and short term destruction. If we focus on the very long term, would releasing more CO2 into the atmosphere not increase the availability of carbon as a resource for plant growth? If so might that be beneficial for life? If we didn't extract oil would the biologically important molecules on earth just deplete from the Environment over time to become useless oil that is not biologically available?

redditoomanytimes

I have a Global Weirding episode about this!https://youtu.be/CLtFwUTrE4E

Short answer: Plants were already doing just fine with the current climate. If we continue on our current pathway until our fossil fuel resources run out, the earth will survive. Human civilization will not.

How can an average person help?

coolSakura

Thank you for asking this -- I wish it were the top-rated question!

So often we feel like climate change is a giant boulder we need to roll uphill but no one is trying and alone, I can't make a difference.

The reality is that the boulder is already starting to roll downhill. More solar than coal in the US, electric cars taking over the market (Ford won't even be making gas cars in a few years!), China and India leading the world in affordable solar and wind energy, nearly 40% of the US (and the rest of the world) committed to the Paris Agreement – the boulder is already starting to roll down that hill and there are millions of hands helping it on its way. We just need a few more to get it going fast enough.

As an individual, the most important thing we can do is TALK ABOUT IT. Here in the US, very few people do (see my answer above). So why would we think it matters, and why would we imagine that we can fix it, if we never hear anyone talk about it?

We need to educate ourselves on local impacts, positive solutions, and we can amplify our voice by joining an organization that reflects our values and our priorities and reaches out to others who do.

What type of organization? All kinds! For moms (Mom's Clean Air Force), birders (the Audubon does a great job on climate), skiers and snowboarders (Protect our Winters), evangelicals (yes you heard that right – Young Evangelicals for Climate Action, Micah Challenge, the Evangelical Environmental Network, Climate Caretakers to name just a few), Libertarians (Niskanen Institute), advocates for a free market economy (Energy Enterprise Institute), for science (Union of Concerned Scientists), for polar bears (Polar Bears International), and for political change no matter where you fall on the political spectrum (Citizen's Climate Lobby).

Stepping on the carbon scale also helps. Measure your footprint. Figure out where your emissions come from and what you can do to reduce them (Cooler, Smarter is a great book on this topic). Then share that information with others. I love my lightbulbs (I know that's nerdy, but I am obsessive about the wavelength of light in our house, that it's warm but still bright, and LEDs FINALLY let me get it right), I share the mileage from my plug-in hybrid with envious neighbours, we save $$ and improve our health by eating lower down the food chain (it's Texas, so there is still some BBQ in there, but it's not like we need it every week), and the remainder of what I can't reduce, I offset using Climate Stewards (tax-deductible in the US, UK, and Netherlands -> working with people in Ghana, Kenya and Mexico on forestry and clean cookstoves projects).

Here's a facebook post on this I did recently, with links:
https://www.facebook.com/katharine.hayhoe/videos/2426770344214786/

And a few good carbon calculators: US: http://coolclimate.berkeley.edu/calculator Canada: http://www.carbonzero.ca/calculate UK: https://www.carbonfootprint.com/calculator.aspx

I have read study after study suggestion to appeal to a person's life and how climate change will impact them, rather than just stating facts... But what is your best way to combat dumb statements like the President's suggestion that a colder than average New Year's Eve mean the Earth can't possibly be warming?

StormKatcher

Well, it depends on who you are talking to. Sometimes a simple "no" is all you can say, and then walk away. But I have a short Global Weirding video about exactly that ... https://youtu.be/nkMIjbDtdo0

-Katharine

REgarding how to comunicate the impact of climate change I was wondering abou this. Here in Europe in the last 2 years we had both extremely record hot temperatures and record droughts. But a fraction of the population still denies it's happening. What can you do in such cases?

lucaxx85

Some will always reject the science, and more facts -- and even personal experiences! -- will not change their minds.

Those types of people are "dismissives" -- they will dismiss any piece of evidence they are presented with. Arguing with them will get us nowhere, but thankfully even in the US they are less than 10% of the population (though a very vocal 10%).

My short Global Weirding episode on this topic unpacks what the social science has to tell us about why people accept and reject science: https://youtu.be/nkMIjbDtdo0

-- Katharine

Is there a strong connection/correlation between the high number of hurricanes the US experienced this summer and rising global temperatures? Thanks!

neenoibstudent

Nope, the strongest influence of a changing climate on hurricanes is on their rainfall rates and coastal flooding exacerbated by sea level rise, not their frequency.

In the future, on average, we expect increases in the intensity of rainfall associated with hurricanes and more intense, more rapidly intensifying, bigger, and longer-lasting storms. But we don't necessarily expect more frequent ones; in fact, there could even be not as many hurricanes, as other factors that affect hurricane formation (rather than development) are affected by a changing climate.

This short article has a good summary of what we know:
https://www.nytimes.com/2017/08/25/us/hurricane-harvey-climate-change-texas.html

And here is the relevant chapter from our recent US federal climate science report, that Dave and I co-authored: https://science2017.globalchange.gov/chapter/9/

How do you communicate these complexities to corporation heads? How do you measure its usefulness?

j94982

Great question! I (Katharine) don't tackle anyone unless I'm invited to, but I absolutely do make myself available to talk to oil and gas corporations, power companies, cities, water districts, manufacturers, and anyone else who has questions and is interested in a genuine and honest discussion.

Whenever I talk to any group, whether a corporation or not, I try to start by verbalizing and respecting and valuing their interests and their perspectives, then connecting those to climate change. For example: because you are invested in X, why might you care about a changing climate? How will its impacts affect your bottom line? What about mitigation efforts? And how might I help them identify positive ways to move forward and prepare for a different future?

I lay out my approach in brief here, in this little global weirding video on "if I just tell them the facts, they'll get it, right?": https://youtu.be/nkMljbDtdo0

I haven't empirically measured the usefulness of this approach to corporations, although I have received a great deal of useful feedback from them that suggests it works. However, we did measure the effectiveness when applied to evangelical college students (in this case, starting with a Christian perspective on people and the planet, then connecting it to climate change). You can read about that here: https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/aug/28/study-katharine-hayhoe-is-successfully-convincing-doubtful-evangelicals-about-climate-change

In New England we've been experiencing record low temperatures. How does this relate to climate change, and how to you it will affect us in the future if we don't make a change in our environmental policies?

Conserisapp

David here, with climate change we will still have periods of cold weather in the eastern US, and still have snow storms etc. This is natural variability that is always present, but superimposed on the long-term warming trend. This is much like the so-call Hiatus in global temperatures from the late 1990s to about 2014. The last three years have been the warmest on record, so if there was a hiatus it is no longer there.

Regarding the cold in the eastern US this year, there is some research suggesting that the reduction in Arctic sea ice is impacting the upper level winds in the Arctic (the true Polar Vortex) causing them to meander more and having a more wavy pattern than allows blasts of Arctic air to come south. This is still an area of active research.

Not specifically a USA question, but what are the current leading ideas in reversing or minimising harm from ocean acidification

dickymouse1

I (Katharine) am by no means an expert in this area – if you want more info, I'd suggest Ken Caldeira as a great resource – but the bottom line is that we need to (a) stop producing carbon, (b) figure out inexpensive ways to suck it out of the atmosphere before it goes into the ocean, and (c) figure out ways to remove it from ocean water (initial ideas like iron fertilization have not fulfilled their original promise, but that was the idea behind them).

However, I'd like to point out that ocean WARMING is at least an equal if not greater problem. Most of the coral reef devastation? Warming. Shifting marine ecosystems? Warming. Gender shifting in turtles? Warming. Exacerbated by acidification, to be sure. But the warming is a huge problem that we can't lose sight of. Over 90% of the excess heat being trapped inside the climate system as a result of human emissions of heat-trapping gases is going into the ocean, and it's having a huge impact.

I talk about the challenges facing our oceans in this short global weirding episode: https://youtu.be/6iUWGvtssME

And our new Federal climate science report, that Dave and I co-authored, has a good chapter summarizing the latest we know about oceans, including not just warming and acidification but also deoxygenization (!).https://science2017.globalchange.gov/chapter/13/

For David:

I'm a second year graduate student in climate science and one of my dreams is to work on the IPCC. I vaguely know that they open calls for nominating authors but what steps should I take if I want to be an author, and at what point in my career can I start getting involved?

aClimateScientist

I know you intended this for David and he is absolutely the best person to answer this, but I (Katharine) couldn't help laughing when I read this because I HAD THE EXACT SAME AMBITION when I was a second year graduate student. In fact, it was the sum total of my ambitions – I had no others! Which just goes to show: you never know where your career will lead you. I certainly never imagined I'd be talking climate change with Obama and Leo and doing PBS video series and top our PM on a list of the world's greatest leaders all while publishing my regular papers and doing my regular research and teaching students and supervising postdocs and writing NSF proposals -- and in that whole time, never once be an IPCC author! I do still think it is a great ambition to have, and very important work to do, and I would not change a thing if I could go back in time; but don't be discouraged if your engagement ends up leading you in different directions. It's all good.

For David:

I'm a second year graduate student in climate science and one of my dreams is to work on the IPCC. I vaguely know that they open calls for nominating authors but what steps should I take if I want to be an author, and at what point in my career can I start getting involved?

aClimateScientist

David Easterling: Participating in IPCC does take a lot of one's time and early career scientists need to understand that. First you need to develop a research line where you become an acknowledged expert. You don't necessarily have to be well into your career but if you are in a tenure-track position you should talk with your department chair about participation. I have always felt IPCC needs a good mix of younger and more senior scientists so it never hurts to put in a nomination for yourself.

Simple question: Will conditions improve? Complicated answer.

ValenceJaxe

Simple answer: they could. But unless we take deliberate and swift action to ensure they do, they won't. Letting the status quo slide –or, even worse, fighting against our own future to preserve a way of life that has led us into this situation--will yield short-term benefits for a few, but guarantee a more dangerous future for all of us. -Katharine

Is it true that we've moved on from the term "Global Warming" to "Climate Change" and why?

Conflit

Depends who you mean by “we”! We scientists (including both Dave and I) have always used climate change to refer to climate change and global warming to refer to global warming.

What’s the difference? Global warming is simply one of the symptoms of climate change – the increase in the near-surface temperature of the planet -- and to be honest, it’s a symptom that most of us can’t even see or experience. To understand global warming personally, we'd have to be like Rainman (if you remember that old movie) - able to remember the temperature every day at thousands of weather stations around the world and then add up all those numbers and average them year after year then look for trends over time scales of 20-30 years or longer ...

What we are more likely to see and experience with our own eyes is more like “global weirding” -> the normal conditions in the places where we live are getting weirder. Trees blooming out of season; insects and birds (and invasive species) moving poleward; heavy downpours getting stronger; summer heat becoming more frequent and more intense; sea levels rising; and so on.

Here’s a great article on this enduring myth: https://www.skepticalscience.com/climate-change-global-warming.htm

We commonly talk about our carbon budget in terms of CO2, but it seems that methane is less discussed. Do we have any calculations of the available hydroxyl radical budget in the troposphere or stratosphere? To what extent is there a risk of the GWP of methane increasing over time due to methane sinks depleting?

zastari

Ooh thank you for asking! I (Katharine) study methane and agree it is often neglected in the public discussion.

In the scientific discussion, however, we are very aware of the role of other gases in warming the planet.

My MS thesis work was on the topic of how much $$ we could save if we focused on reducing both CH4 and CO2 compared to just CO2, and I also calculated some of the first indirect GWP values for CH4 that take into account the changing chemistry of the troposphere back in the day (we’re talking mid-1990s).

This resource does a great job of breaking down the human-caused increase in radiative forcing by gas: 66% CO2, 18% CH4, 6% N2O, and so on (scroll to the bottom for the data).

https://www.esrl.noaa.gov/gmd/aggi/aggi.html

And in our new Federal climate science report, when we calculate the budget required to give us a 66% chance of meeting the 2oC target, we explicitly include non-CO2 GHGs in the calculation. That is why our budget is 800 GtCeq when other budgets you might see are 1000 GtC -> the larger numbers don’t include other gases (and they should!).

Here’s the relevant chapter: https://science2017.globalchange.gov/chapter/14/

Methane is short-lived, so reductions will have a more immediate impact. Methane is also produced by the biosphere, however, so my greater concern is not so much alterations to atmospheric chemistry that would affect its sink but rather the extent to which warming might affect its natural sources, triggering massive CH4 releases from permafrost, hydrates, wetlands etc.

More on this, here. See in particular the second half of section 15.4, which I wrote: https://science2017.globalchange.gov/chapter/15/

A question I've gotten from a family member:

To what extent does the historical record of atmospheric CO2 concentrations support the idea that CO2 warms the planet? You see a strong historical correlation of CO2 and temperature, but can we rule out an inverted causal relationship? For example, I could imagine that an increase in temperature by an unrelated mechanism might coincidentally increase atmospheric CO2, perhaps through a change in biological processes.

PBJ_ad_astra

I (Katharine) am pretty sure I’ve got the same question from a family member as well. Do you have an Uncle Joe? :)

This is a standard talking point of those who want to cast doubt on the science – that CO2 doesn’t

drive temperature or that it's just a statistical correlation.

The reality is that it's basic physical chemistry: nothing at all to do with statistics or even historical records. We can measure the amount of infrared radiation that CO2 absorbs through its vibrational and rotational bands in a lab. I did it myself as a (not very capable) undergraduate. (It's true: I am all thumbs in the lab. After I'd broken several $500 lenses that summer, my advisor suggested I work on some modeling software.)

With that information, which we've known since the 1850s, it's possible to calculate how much the planet will warm as we increase levels of CO2 in the atmosphere: using physics and chemistry, not statistics. Here is a short video on the amazing history of climate science and what we knew a hundred years ago and more! https://youtu.be/XpqBto89i38

My favourite resource, Skeptical Science, does a great job tackling this question and many more. I love that they provide basic, intermediate, and advanced answers, depending on how deep you want to go, and they also link directly to the original scientific references so they are transparent on where they got the information from.

Here's three of their articles on this topic:

https://www.skepticalscience.com/The-correlation-between-CO2-and-temperature.html

https://www.skepticalscience.com/empirical-evidence-for-co2-enhanced-greenhouse-effect.htm

https://www.skepticalscience.com/co2-temperature-correlation.htm

And I also have two short Global Weirding episodes, explaining how we know this thing is real: https://youtu.be/m50bYJX2i6I

And why, for the first time in the history of the planet, it's not a natural cycle: https://www.youtube.com/watch?v=k5_zpjerQFo

A question I've gotten from a family member:

To what extent does the historical record of atmospheric CO2 concentrations support the idea that CO2 warms the planet? You see a strong historical correlation of CO2 and temperature, but can we rule out an inverted causal relationship? For example, I could imagine that an increase in temperature by an unrelated mechanism might coincidentally increase atmospheric CO2, perhaps through a change in biological processes.

PBJ_ad_astra

The historical record of CO2 is really not the reason climate scientists understand that the climate will warm with increasing CO2. The fact that CO2 and other greenhouse gases absorb and re-emit longwave radiation, thus warming the climate is due to experiments performed by scientists like John Tyndall 150 years ago. He showed this in laboratory experiments. Svante Arrhenius calculated how much the climate should warm with a doubling of CO2 back in the late 1800s and his numbers compare favorably with what climate science thinks today.

David Easterling

If we could start things all over again from say 1900, how much increase in CO2 levels do you feel would have been optimal to stop earth's tipping into the next ice age while also minimizing the damage of a warming planet.

thirteenth_king

This is an interesting question and the only way I can think to answer it would be to run a climate model with increased GHGs and with changes in the solar energy input according to the Milankovich cycles and see what levels of CO2 are needed to offset a coming ice age. The problem is that the ice age is not "due" for tens of thousands of years. Ice ages occur most likely due to the axial tilt changes of the Earth's rotational axis, when the tilt is less there is less difference in summer vs. winter temperatures which lead to a build up of the ice sheets etc. The axial tilt cycle is about 41k years.

David Easterling

If we could start things all over again from say 1900, how much increase in CO2 levels do you feel would have been optimal to stop earth's tipping into the next ice age while also minimizing the damage

of a warming planet.

thirteenth_king

Fascinating question! There is no question that some amount of CO2 emissions from human activities are largely beneficial for human civilization because it is in our best interests to prevent another glacial maximum, which would devastate the global economy and would be nearly certain to lead to massive reduction in human population and quality of life. There is also no question that we have passed that "minimum level" a long time ago, and it is rapidly disappearing in the rear view mirror; and it is likely that level was reached by 1900, if not before.

Bill Ruddiman argues that the development of agriculture over the last few thousand years, with associated emissions from ruminants and rice paddies, coupled with deforestation, was already enough to head it off. This suggests levels as low as 300ppm. Here is his thought-provoking book; a bit dated but still well worth reading: https://www.amazon.com/Plows-Plagues-Petroleum-Control-Princeton/dp/0691173214/

David Archer did a study a while back, connecting a range of cumulative CO2 emissions with how long the next ice age would be delayed. If I am reading Figure 3 correctly (here is the link below so you can check for yourself), cumulative carbon emissions totaling around 300 GtC would have marginally delayed the next ice age and held atmospheric levels below 300. For context, we are currently around 580 GtC or so, measured since the beginning of the Industrial Era. Cumulative emissions around 1000 GtC, as we may reach in the next few decades, would delay the next ice age for well over 100,000 years. Unfortunately he did not look at anything in between.
http://onlinelibrary.wiley.com/doi/10.1029/2004GC000891/full

Two more recent studies find that "model experiments suggest that in the current orbital configuration —which is characterized by a weak minimum in summer insolation—glacial inception would require CO2 concentrations below preindustrial levels of 280 ppmv (refs 2–4). This analogy suggests that the end of the current interglacial would occur within the next 1500 years, if atmospheric CO2 concentrations did not exceed 240±5 ppmv." and (this second paper disagreeing slightly regarding timing though not overall conclusions) "we suggest that glacial inception was narrowly missed before the beginning of the Industrial Revolution. The missed inception can be accounted for by the combined effect of relatively high late-Holocene CO2 concentrations [which Ruddiman would argue were anthropogenic already at that time --KH] and the low orbital eccentricity of the Earth. Additionally, our analysis suggests that even in the absence of human perturbations no substantial build-up of ice sheets would occur within the next several thousand years and that the current interglacial would probably last for another 50,000 years."

https://www.researchgate.net/profile/Helga_Kleiven/publication/239753471_Determining_the_natural_length_of_the_current_interglacial/linl

https://www.nature.com/articles/nature16494

Are you in a position to survey the AMS attendees, informally or otherwise?

If so:

- Who, or what resource, do they know about, that they have gone to for climate change expertise?
- What % of warming so far do they think is human-caused?
- What do they think will be the biggest impacts (up to 3) of climate change, on human societies?
- What do they think will happen after 2100, if CO2 keeps climbing?
- What questions do they have about climate change?
- What questions does the public ask them about climate change?

Are there better questions to ask, in a short survey?

climateincal

Dave has people coming by the booth, so he might be able to do some quick polling! I'd love to hear as well. Here are my (Katharine's) answers:

- Skeptical Science, for answers to all the common myths with links to the original literature; the US National Climate Assessment, for the latest information on climate science and impacts; and there are some excellent books, like "The Thinking Person's Guide to Climate Change", that cover science, impacts, solutions, and policies.

https://www.skepticalscience.com/argument.php?f=taxonomy

https://nca2014.globalchange.gov/

https://www.amazon.com/Thinking-Persons-Guide-Climate-Change/dp/1935704737/

- This one is not an opinion, it's a fact, based on analysis of data. The likely human contribution to observed warming is between 92%–123% and best guess is over 100%. Why? Because, according to natural cycles, we should be cooling right now, not warming.

Here's a short Global Weirding video that unpacks this: https://youtu.be/k5_zpjerQFo

And here's the relevant chapter from our new US federal climate science report: https://science2017.globalchange.gov/chapter/3/

- Impacts --> this depends on where we live. In most parts of the world, climate change is going to get us right in our Achilles' heel. Are we drought-prone? Expect longer, stronger droughts. Are we on low-lying land at risk from coastal flooding? That's going up. Heat waves, heavy precipitation events, wildfires, hurricanes -> we care about a changing climate because it exacerbates the risks we already face today. And what's at risk? Not the future of the planet; it will survive just fine. It's human civilization that's at risk. And so, long-term, my #1 biggest concern is the destabilization of our entire society.

- We have climate model simulations out to 2300 but even basic physics tells us that the further and faster we push the system beyond its natural state, the greater the amount of change and the higher the risk of triggering the type of tipping points that lead to abrupt and potentially irreversible change. In my chapter of our new US federal climate science report, we put future projections into the context of paleoclimates to help us understand what the earth might look like after it had the 100s to 1000s of years it takes to adjust to higher CO2 levels in the atmosphere. It was stark. See section 4.2.3: https://science2017.globalchange.gov/chapter/4/

- On that same theme, I am personally most concerned about the "known unknowns" and even worse, the "unknown unknowns" in the climate system! I talk about it here: http://iopscience.iop.org/article/10.1088/1748-9326/11/12/120202

- What questions does the public ask them about climate change? I get questions every day and I would say the number one question is "isn't this just a natural cycle?" or "hasn't it been warmer before?". Number two is, "can't you just explain the science to [my uncle, friend, colleague, elected representative, president] because surely if they heard the facts they'd change their mind?" Then there's "I'm just one person, is there anything I can do?" and "isn't it too late anyways?". Whenever extreme weather happens, "Was this climate change or not?" And also, "what about China and India?" (not realising that they are beating the pants off the US when it comes to clean energy. We designed our entire Global Warming series around the questions I am asked! Check it out here: http://www.globalweirdingseries.com/

So, climate change is not a future threat anymore but a sad reality. On top of avoiding it getting worse, what can we do to mitigate the impact? On the active defense from extreme events I mean.

Should we build water reservoirs in the plains for when flood happens and save the water for droughts? Should we look into recharging aquifers?

lucaxx85

I (Katharine) work with cities and water managers and infrastructure engineers all the time. We partner together to answer exactly these questions. I'm not an expert in bridge performance or flood plain control, but they are. I can tell them how often we expect past events to recur, and how much stronger they may be. Then can then tell me what they will do to prepare for those impacts! For example:

The city of Chicago is mitigating the effect of future heat waves through green roofs and more reflective surfaces.

The city of Austin is preparing for the impacts on their water supply by developing future projections and then looking at what they can do to prevent evaporation from their reservoirs.

Transportation engineers are trying to figure out how to incorporate climate projections into their long-term design and management procedures. Not easy! But so important.

We need to reduce our emissions to avoid the impacts we can; but we also need to prepare for the impacts we can't avoid.

Any thoughts on abrupt climate change? If that's just doomsayers, is there anything that concerns you in particular?

m4st3rn8

Oh we have thoughts, believe me. These thoughts are what keep me up at night!

Paleoclimate records combined with our physical understanding of the climate system tell us three things. (1) Abrupt changes have occurred in the past. That is a fact. (2) Climate models include some but not all of the processes that are needed to simulate all of these types of changes, and as such are more likely than not to underestimate the magnitude of long-term (millenial-scale) change. (3) We do not yet understand well enough how much forcing (how big a kick, in other words) is required to push the Earth system in part or in whole into a new state, but we don't think we'll be facing a tipping point this century and we do know that the faster we reduce and eventually eliminate our emissions, the more likely it is that we can avoid the worst of these. Conversely, the longer we continue on our current pathway, the greater and the more immediate the risk that such tipping points may be reached becomes. Like smoking and lung cancer.

For a brief overview of the topic, I wrote a short essay on "what surprises lurk within the climate system?" with paleo expert Bob Kopp: http://iopscience.iop.org/article/10.1088/1748-9326/11/12/120202

And for all the gory details, we have an entire chapter in the new US Federal climate science report that Dave and I co-authored on this topic: https://science2017.globalchange.gov/chapter/15/

Many people do not believe that climate change is caused by humans or even that it is happening, do you think that the goal of reducing use of fossil fuels might be better achieved by focusing more on the practically finite nature of oil and the potantial consequences of it's depletion on a huge human population that is inheritantly dependant on oil based energy?

I think it provides a more convincing arguement for those deniers that pushes the same move towards finding clean, renewable alternatives.

redditoomanytimes

If you go to the Yale Climate Opinion Maps, and select any of the questions that have to do with solutions – even “do you support limiting CO2 emissions?” – you will see that the majority of US people support solutions across the entire country, even if they don’t agree with the science.

http://climatecommunication.yale.edu/visualizations-data/ycom-us-2016/

Why would people support reducing CO2 and investing in clean energy if they don’t think humans are changing climate? I don’t know and honestly, I don't care! As long as we can agree that clean energy is good – for the local economy, for air quality, for the job market, for national security, for our pocketbooks – I am fine if someone disagrees with me about the science :)

So yes – we should discuss ALL the benefits of weaning ourselves off an old and dirty way of getting energy that we’ve been using for hundreds of years, and focus on those most relevant to whoever it is we're talking to. When it comes to climate change, all that really matters is what we do, not why we do it. And there’s no rule that says we can only do the right thing for one reason!

Is NOAA “cooking the books” to “normalize” data from the past?

JayRobMoney

At NOAA/NCEI we have worked long and hard to develop high quality data sets. One of the things we do it to test the data for individual observing stations for changes that are due to non-climatic factors, such as a move or instrument change. Sometimes the changes lead to random changes in the data (e.g. suddenly a little warmer or cooler) like when an observing station is moved. Sometimes the changes are systematic (always warming or always cooling) such as when there is a change in the type of instrument being used. We have developed correction methods for these data trying to make them represent the current environment around the observing site back through time. In other words the data should appear like the station has always been in the current location with the current surroundings such as trees, and current instrumentation. Then the variations in the data only represent those cause by the large-scale climate. As for “cooking the books” I’m not even sure what that means, we run the software on the data and whatever comes out at the end is what we use. Some of the corrections actually result in a lessening of trends because we know some changes resulted in warmer temperatures for the same observing conditions.

David Easterling

Is NOAA “cooking the books” to “normalize” data from the past?

JayRobMoney

Here's a short explanation of how we don't even need thermometer data to know that the planet is warming (although of course it is extremely useful!) - Katharine

https://youtu.be/m50bYJX2i6I

I personally don't see the destruction of the earth and the human species as a negative. Is there any valid reasons to change my view?

Survival300

I can't really answer that without more information (and even then I'm not sure I could!). Why do you think that? --Katharine