I'm Paul Loikith, a meteorologist and a climate scientist from Portland State University, I study extreme temperature and precipitation events in observations and climate models. Ask me anything!

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Abstract

Extreme temperature and precipitation events are often driven by unusual patterns in atmospheric circulation such as strong high and low pressure systems. Learning about these large-scale meteorological patterns improves our understanding of the physical mechanisms that cause extremes at local scales. Furthermore, because most climate models are challenged at resolving extremes at local scales, we can use the associated large-scale patterns as a way to analyze extremes in all climate models. In the Portland State University Climate Science Lab, one of our main focus areas is on gaining a better understanding of the driving large-scale patterns behind extremes in the historical record. This understanding gives us an observational foundation to evaluate climate model skill and assess projections of future changes in the conditions associated with extreme event. I will be back at 3 pm ET (12 pm PT) to answer your questions, Ask me anything!

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PAUL_LOIKITH R/SCIENCE

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Hi Paul, I'm in a graduate climate science department down the valley at Oregon State. I am wondering if you can comment on the rather extreme winter and summer we've had this year, specifically the two large snowstorms and the ~110 deg heat wave that recently occurred. Is there an agreed upon explanation for the anomalous weather events? Did any climate models forecast these extreme seasons with any meaningful accuracy?

Also, just because I'm curious, where do these two seasons fall in the historical record of extreme events in the Willammette Valley?

Thanks!

kniezgo

We have had some extreme weather this past year! Besides the recent heatwave, we had a record wet February (in Portland), several winter storms in December and January including a major snowstorm in the Portland metro the 2nd week in January, and the 2nd wettest October on record (also in Portland). There are a lot of components to what causes these events, including persistent unusual patterns in atmospheric circulation. The recent heat wave was caused by a combination of inland high pressure which inhibited onshore winds from the ocean which cool the air, combined with sinking air under an upper level high pressure which warms as it sinks. Certainly weather forecast models were able to predict some of these events, but climate models are more geared towards projecting long term trends in mean climate rather than individual events or even seasons. The Portland snowstorm in January, was not well-forecast and part of the reason was likely the small scale nature of the intense snow band that set up over the city. Putting these seasons into climate perspective, winter 2016-17 (Dec Jan Feb) was the 15th coldest but only the 88th wettest out of 122 years in the Willamette Valley. The summer

isn't quite over yet so we won't know until September where it ranks.

What got you interested in the sciences, and what is your favorite weather-realated movie?

Gralkor

I was always excited by and interested in weather and that was my path into meteorology and climate science. It still fascinates me and keeps me curious. I guess my favorite weather movie would be Twister...

Thanks for coming to talk with us! I'm curious about your data collection strategies. What kinds of data do you gather--is it all remote, or is some of it local/on-the-ground? Do you ever rush to a location because something unusual is happening?

asbruckman

I don't actually do any data collection. The data I use is all freely available via the web. There is a vast amount of observational and climate model data archived online for scientists to use and analyze. The data is collected from satellites and weather stations around the globe and compiled into datasets provided via the web.

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I think you are probably referring to the hypothesis that global warming could shut down what is called the thermohaline circulation in that Atlantic. This would cause the Gulf Stream in the Atlantic to stop transporting warm water towards Europe and cool the northern hemisphere. This is, however, very unlikely to happen and not a risk at all in the foreseeable future.

Weather effects of climate change are presented in the media as evidence of climate change. My Q: are there more of these extreme weather effects on average or are theses events receiving more media coverage?

Zaluiha

If you look globally over time, extreme events are becoming more common, in some cases. This is most true for extreme heat events. However, the distinction between weather and climate is important here. Weather variability is always going on and just because an event seems so extreme to you, it doesn't necessarily mean the event was caused by climate change. There is a growing area of research called detection and attribution analysis which uses statistics to determine whether an event was likely influenced by human activity or if it was in the range of natural variability. Most detection and attribution results show that heat waves have a detectable human signal, some extreme precipitation events do too, but other events become a little more noise in the current climate.

How did you get into your field of study? I also want to be a climate scientist and will be majoring in environmental science. I'm not sure if this was the right decision. Thanks!

UkeGod

I was really into weather as a kid and it was an easy decision to go to college for meteorology. After undergrad, I decided I was also interested in climate and wanted to study weather and climate in grad school. I think majoring in environmental science is perfectly fine if you plan to pursue climate science! Depending on what you want to study, a fair amount of math and physics is required; however, climate science covers a wide range of topics and disciplines and there are many routes to enter the field.

How much impact has the use and deployment of concrete for roads, parking lots, buildings, etc. affected the climate? We often are being told it's CO2, but that can't be the only factor. Thanks for the AMA!

v27v

Warming at the global scale is due almost entirely to increases in greenhouse gases. At urban scales, dark surfaces (which absorb more solar energy) do absorb a lot of heat and retain that heat into the night causing something called the "urban heat island." There are small impacts on climate caused by changes in land cover due to deforestation, but in some cases this causes a cooling since agricultural fields are more reflective than dark forests.

Are there any first-order physical processes in mid-latitude extreme temperatures that dominate the human-caused climate change trends (projected or already observed)?

I'm thinking of something along the lines of lower equator-pole temperature gradient leading to decreased baroclinicity of the jet stream leading to less extremes. I'm aware there are probably holes in that logic but do you find it useful in your work to break things down into conceptual models like that?

aClimateScientist

This is a great question and a topic of ongoing research! There is some thought that a reduction in the pole to equator temperature gradient would result in a more meandering jet stream which could lead to more extremes, both warm and cold. Other studies have shown that this is not likely the case. This isn't an area of research that I am involved in, so I hesitate to comment definitively on which is right, and I think the community is still working this out. One thing that is for certain is that regardless the cold outbreaks will be less cold and warm outbreak much warmer in the future.

Hello, thanks for the AMA!

So I have a few questions :

1) When starts the differentiation between weather and climate? Is it the time frame, the scale?

2) What kind of time frames can be expect for relevant climate predictions? 10 years, 20, 30, 100?

3) What are the most extreme climate changes you've witnessed during your research? Where did they take place?

4) How can we communicate about climate change so that people out there understand the stakes? How do you explain your job and findings to people who have zero scientific background?

5) We often see misleading titles in mainstream news outlet about climate change consensus, what is the consensus on climate change then?

6) If you study extreme phenomenons, how do you gather data? I believe you can't teleport to places and be there every time! How do you then compare that data so it's useable and understandable and not just a bunch of recordings of extreme conditions?

Thanks a lot!

DiogenicOrder

1. Weather can be thought of as the state of the atmosphere at any given time and climate is the average of the weather. The difference between the two as far as time scales goes can be a bit fuzzy, but here are a few ways I like to think of it. Weather is what you dress for, climate is what you buy your close for. Weather is what you get, climate is what you expect.
5 The scientific consensus on climate change is unanimous and has been for a very long time. There is no question that human emissions of greenhouse gases are warming the planet, the remaining questions are in the details. For example: What does global warming mean for changes in precipitation where you live? How will wind patterns change? Where will extreme heat waves become more extreme fastest?
6 Climate data comes in many digital formats that are freely available via the web. This data comes from many sources including satellite measurements, weather stations, ships, buoys and airplanes. This data is then processed into a bunch of useable products for the public and scientific community to use and is available in many different datasets produced by many different groups around the world.

By the end of the 21st century will we be seeing the effects of global warming?

TheRepenstein

We are already witnessing the effects of global warming today through increased mean temperature, more frequent and severe heatwaves, some changes to extreme precipitation, and rising sea levels to name a few. By the end of the 21st century, the climate will be fundamentally different than it is today in many respects.

Hi. Modeling Question.

You wrote: Learning about these large-scale meteorological patterns improves our understanding of the physical mechanisms that cause extremes at local scales.

Question: I'm curious to know about the ways mechanisms can be determined from computational models. Can you describe the model briefly, e.g. number/type of parameters and equations, solver, etc? And then describe the approach taken to elucidate physical mechanisms?

Another Question: I model cardiovascular circulation which involves equilibrium and homeostasis. These principles are used to develop/justify equations that characterize function. What are the underlying principles involved in atmospheric circulation? I assume it's not equilibrium and homeostasis.

Thanks in advance.

doxic4

Great question. The climate models that I use are numerical computer models that are based on the basic equations of the atmosphere. We provide the model with “radiative forcing” which is essentially the balance between incoming and outgoing energy from the sun on Earth and the models then simulate the climate. While the primary variables that the models produce directly are temperature,

wind, humidity, and pressure, we can use these values to derive other important variables based on physics. So if I wanted to know what wind pattern is associated with snowstorms in Boston, I can get this information from any climate model by identifying which days had snowstorms and compiling an average of the wind patterns for all of those days. Atmospheric circulation is driven by differences in atmospheric pressure which are driven by differences in temperature. If you have higher pressure next to lower pressure, wind will blow from the higher pressure to the lower pressure in an attempt to correct the imbalance in air mass.

Hi Paul, if you had to guess, what percentage would you apply to anthropocentric climate change versus natural variability? Do events like the past Maunder Minimum get reflected in our current climate models? Can you comment on the overall skill of the climate models? Cheers.

JimmySmoot

Nearly all the observed global warming over the past several decades is due to human produced emissions of greenhouse gases. The Earth's temperature can only change over long periods of time due to a change in the balance between incoming and outgoing solar energy. Greenhouse gases reduce the amount of energy going directly out to space and causes the planet to warm. Changes in the solar cycle can change the amount of energy coming to Earth, but these changes are small compared with what greenhouse gases are able to do, and they last for relatively short periods of time. Climate models are outstanding tools for helping us learn the impact changes in solar output can have on climate, such as the Maunder Minimum, and that is one way we are confident that it is the changes caused by greenhouse gases that are warming the planet. As far as climate model skill...climate models are tools that scientists use to help us understand how the climate responds to changes in the amount of energy in the system. Climate models do an excellent job at reproducing observed global warming when provided with observed changes in greenhouse gases. They also reproduce many of key atmosphere and ocean climate patterns very well and in many cases can capture important variability even at the weather scale. All models of course are imperfect, but they are very skillful at helping us understand what causes changes in the climate and how large those changes would be if we altered the greenhouse effect further.

Hi Paul!

What's the worst case scenario with overlapping extreme events? Like, how hot can it get in a heat wave during a drought in the mddle of a very hot summer? For how long?

Thanks.

HQJMVF

One of the worst case scenarios for extreme heat is when it is combined with high humidity. This makes it more difficult for the human body to cool itself through sweating. There is some concern that the wet bulb temperature (the temperature that air would cool to if you saturated it with water through evaporation) may go above the human body temperature in some parts of the world. At this point humans cannot survive! That is worst case scenario and not something most parts of the world have to worry about any time soon. This paper has some interesting info on it.
http://advances.sciencemag.org/content/3/8/e1603322