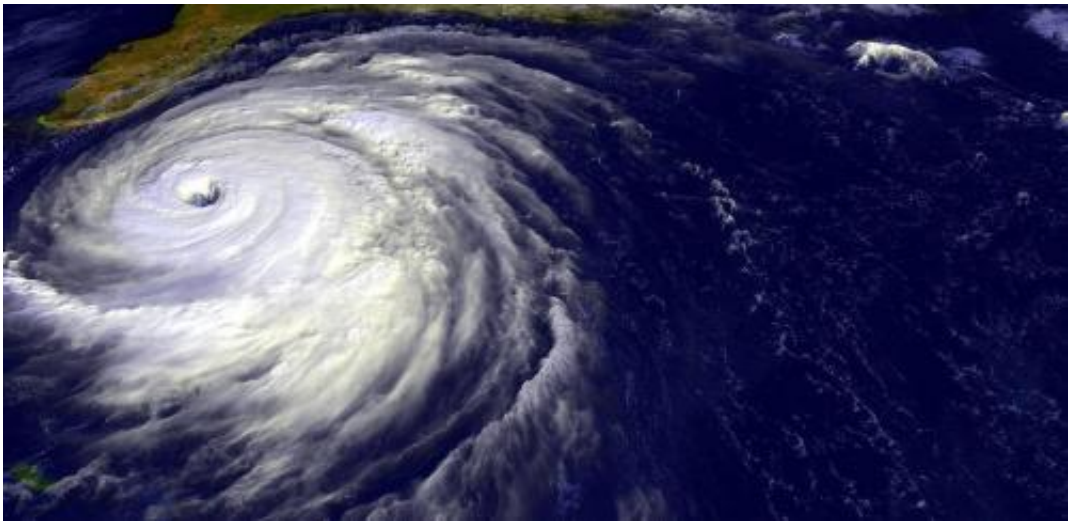
From hurricanes to death threats, atmospheric science explained

February 19 2014, by Kerry Emanuel



Hurricane Jeanne about to hit the US.

Kerry Emanuel, professor of atmospheric science at the Massachusetts Institute of Technology answered questions posed by the public on Reddit. The Conversation has curated the highlights.

Weather

With computer predictions getting better every day, will there be no need for meteorologists by 2050?

Weather forecasts have demonstrably improved over the past half-century or so, but as Lorenz demonstrated, there is a fundamental limit to how far out one can make a forecast. We think this fundamental limit is at about two weeks.

But faster computers have allowed us to do something we could not do just 20 years ago or so, that is quantify the uncertainty in each individual forecast. This is done by running ensembles of computer models, or ensembles within just one model but starting from slightly different, but equally plausible, initial states. These slight differences in models or initial conditions typically amplify with time, but do so at different rates at different times and places. The divergence yields a measure of uncertainty.

What impact do hurricanes have on the climate? Is there a limit on how large hurricanes can get on earth?

First, hurricanes vigorously stir the uppermost 100-200 metres of the ocean, bringing cold water to the surface and pumping warm water downward. We think, based on basic physics and computer model simulations, that this can induce ocean currents that transport heat laterally and thereby affect climate.

Second, there is some indication that hurricanes (and cloud clusters in general) dry out the atmosphere, and this could have climate impacts. But this is very early, tentative work.

There is a theoretical limit which is around 1000km for the storm's outer dimension. There is also a limit on wind speed which in the present climate, in the hottest parts of the tropical oceans, is about 300kmph. (This limit comes from equating dissipation of wind energy to its

thermodynamic generation in hurricanes.)

Media takes it as a given that storms have gotten worse. What do you use to define the severity of weather? What does research show over a long period of time?

We do see some signals in open-ocean hurricane statistics, but since only about one in three Atlantic hurricanes makes landfall in the US, and these do damage over a tiny fraction of their lifetimes, the record of landfalling storms is too short to see any climate signals, save perhaps for El Niño-related signals. We do not expect to see a global warming signal in US hurricane damage for some decades.

In the UK right now we're having the exact sort of extreme weather event that was predicted back in the 1990s. Lots of wind and rain. What is the most likely outlook for the next few decades here?

It is very hard to attribute individual events, or even groups of events, to climate change. This is simply a matter of statistics. We usually need long records to detect climate signals. There are also natural, long-period fluctuations of the North Atlantic climate that modulate rainfall in places like the UK.

Can the extreme cold snaps (like the "polar vortex") be attributed to climate change? Could we see more of those as Earth warms?

The cold snaps many of us have been experiencing this winter are

extreme only by the standards of the last decade or two; in most places there were worse extremes further back in history. I have no idea how climate change might affect these, but my intuition is that there will be fewer, or less extreme, cold snaps as the planet warms.

Climate change

What's the primary basis for segregating the effects of human-induced climate change vs natural occurring climate changes?

The primary objective here is to try to quantify the character of natural variability though the instrumental record of climate, through paleoclimate evidence (for example, ice cores), and in computer models that run for long periods of time without any change in climate forcing (that is, constant sunlight and greenhouse gases).

The second strand is to quantify the signal also by looking at observations, by understanding the theory of radiative and convective heat transfer, and by using models subject to various kinds of forcing change.

What do you think of Guy McPherson, who is very pessimistic about avoiding a 4°C increase in global temperature, which is considered to be the point when we may see runaway increase in temperature?

In my view, the only good way to look at this is to view it as a problem of risk. By its very definition, risk is probabilistic. The consensus view of global temperature increase over the next century is a curve with a peak in the 2-4°C range, but a non-trivial tail at higher temperatures.

The most probable outcome (at least on the 100-year timescale) has risks that are probably manageable, but as Marty Weitzman at Harvard University has pointed out, we need to pay attention to the tail of the risk distribution, because the economic and societal risks can be very large there. Scientists by nature are conservative and do not like to talk about what might happen in the tail, but we do need to think carefully about tail risk as part of our overall assessment of the risk.

In your professional opinion, can geo-engineering help humanity slow or control the effects of climate change?

As a purely technical matter, almost certainly yes, we can alter climate change through geo-engineering. Whether it is at all advisable, given the associated risks and known side-effects, is another question, and it is probably politically impossible. Also, there are strong risks, for example the acidification of the oceans owing to increases in dissolved CO_2, that are not addressed by current geo-engineering proposals.

What, if anything, can we do as normal citizens of the world to help with research efforts on climate change?

Check out Climate-at-home, where you can volunteer your computer to do calculations to help climate modellers.

Are changes caused to the climate due to human intervention permanent?

This is an important question. If we were to completely stop CO_2 emissions, the concentrations of CO_2 would fall of at first fairly rapidly (tens of years) but then much more slowly, taking a thousand years or

more to return to pre-industrial levels. So unless we find an economical way to extract CO_2 from the atmosphere, we are stuck with human-induced climate change for a long time.

Many of us in climate science or paleoclimate, even as grad students, receive unsolicited messages ranging from admonishment to death threats. Can you offer any advice? Where does our obligation to the media end?

I think (and hope) that the worst of the threats are over for climate scientists, and you should not let such threats discourage you from engaging in the very vibrant curiosity-driven research in our field.

As far as communication goes, in my view we are most effective when we talk directly to people about our work. Where possible, avoid going through the media who often have agendas that have little to do with truth finding.

What do you say to those people who say that climate change is a hoax?

All I can say to this is that I try to get people to look at this as a problem of risk. But most risk problems we are used to dealing with (for example, the risk that our house might burn down) confront problems that may develop in our own lifetimes. We are less used to thinking about risk to future generations. We have to intelligently weigh climate risks (and possible benefits) against the risks (and possible benefits) of any actions we might contemplate to deal with climate change.

We have to get away from binary thinking – climate change will be

either an apocalypse or nothing to worry about; solutions will either be a complete panacea or not work at all. I do think this is actually the way most people think about the problem of climate change.

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