

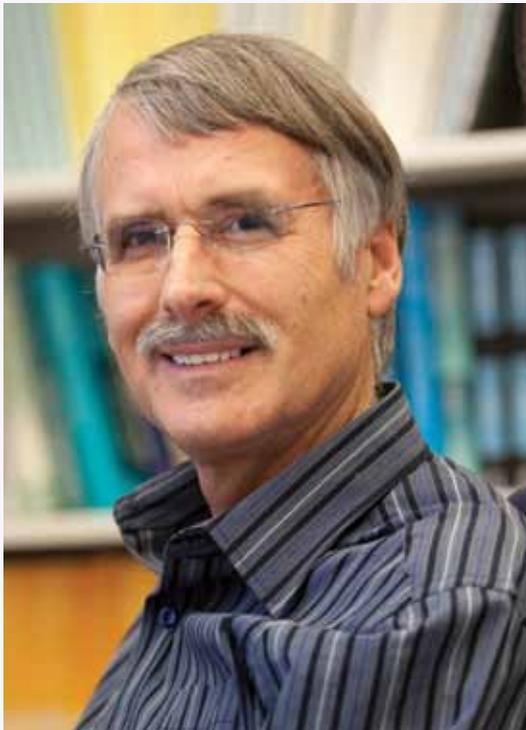
Eyes on the Atmosphere

KEVIN TRENBERTH, PhD

Distinguished Senior Scientist

National Center for Atmospheric Research, Climate Analysis Section

Kevin Trenberth has led an extraordinarily active and distinguished career as an atmospheric scientist. He is a Fellow of the American Meteorological Society, the American Association for the Advancement of Science, and the American Geophysical Union, and an Honorary Fellow of the New Zealand Royal Society. Dr. Trenberth has served as lead author and a coordinating lead author for three Intergovernmental Panel on Climate Change (IPCC) scientific assessments, and, as a member of the IPCC, shared the 2007 Nobel Peace Prize. In addition, he has served on the Joint Scientific Committee of the World Climate Research Programme (WCRP) and chaired the WCRP Observation and Assimilation Panel. He now chairs the Global Energy and Water Exchanges Program scientific steering group.



The senior scientist as a young man

I grew up in New Zealand and went to college at University of Canterbury in Christchurch. I did a math honors degree, which focused on applied mathematics and included courses in quantum mechanics, relativity, mechanics, and fluid dynamics. Rather than an interest in weather, it was an interest in understanding how fluids work—and in particular the atmosphere, which is a fluid—that led me into meteorology.

After I finished my degree, I joined the New Zealand Meteorological

Service and won a research fellowship to study in the United States. The condition was that for every year I was away, I had to work in the Meteorological Service for a year. So I returned after earning my PhD at MIT, but then came back to the U.S. to work as an associate professor at the University of Illinois at Urbana-Champaign. I had been planning just to

take a sabbatical but instead ended up leaving to work at NCAR [the National Center for Atmospheric Research].

Patterns and variations

By the time I came to NCAR, I had already written some of the very early papers on the El Niño phenomenon, a climate pattern in which changes in the ocean subsequently influence patterns in the atmosphere. It turns out that El Niño is a very important factor in New Zealand's weather and its variability from one year to the next.

When I came to NCAR, I worked on a program to help develop a national and then international program to predict the El Niño phenomenon. This program was called TOGA (Tropical Oceans Global Atmosphere), and its goal was to track and predict global climate phenomenon on the scale of months to years. My work eventually became broader, encompassing not just El Niño but other patterns related to interannual climate variations, including droughts and floods, related to irregular changes in ocean-atmosphere interactions.

Natural variability, intensified

In 1988, Jim Hansen [head of the NASA Goddard Institute for Space Studies] went before Congress and testified that the very hot weather and drought in the Midwest that year, which caused about \$40 billion in damage, was a result of global warming. The same year, a couple of colleagues and I published a paper in *Science* that said this weather was really more related to the La Niña pattern that occurred at the time: fairly cool conditions changed the heating patterns in the atmosphere and set up a wave pattern that in this case favored this drought across the United States. It was a fairly unique circumstance.

But Hansen's testimony did raise the question in my mind of what role global warming was playing in the drought. Subsequently, we have come to understand that while drought itself tends to be caused by a natural variability, the *intensity* of the drought is related to global warming. The drought lasts longer. It is more severe. Heat waves and an increased risk of wildfires go along with that.

In the golden age

To improve our climate models, we need to build data sets that are continuous over time. This is a big challenge with space-based observations: satellites last for about five years, and then a new instrument goes up on a new satellite. The question is how to relate today's measurements to those that were made 20 years ago with other instruments, or that will be made 20 years from now. It is very difficult to make all these data compatible. It requires reprocessing all the old satellite data with our current technology so we can know that any changes we see are not simply a result of a change in the instrument.

I just led a major review of the challenges to the observing system, and even with its current limitations, I think we may now be in the golden age of Earth observations. Because of budget cuts, it's expected that there will be a decline in the number of Earth observing satellites by 2020. This is especially scary when you consider events like Superstorm Sandy. Space-based satellite information played a key role in helping to inform decision makers as to what was happening, well before the event.

Chance and change

Most of what happened with Sandy was weather—and a large chance element, in the way in which what started out as a hurricane blended with what started out as a snowstorm in Colorado that moved east. They combined to make this hybrid storm very intense, with hurricane force winds over a very large region, much bigger than the size of a normal hurricane. That can happen purely by chance.

But global warming played a role. It very likely made the storm a bit stronger and more intense than it otherwise would have been. Extra energy, warmer oceans, and extra moisture in the atmosphere lead to heavier rainfalls. All of those things—along with the higher sea level, which added to the storm surge—are aspects of global warming.

We need to talk

The next IPCC assessment report is due out in 2013. In some respects, I think we should have done things differently this time. In the last report [in 2007], we said that global warming is unequivocal, that there is no doubt that it is here, and that it is very likely due to human activity. How can you go much beyond that?

What is really needed now are more regular updates every year as to what is happening in the climate system and what it means for the future. This could be part of the role of what you might call a climate service, which NOAA has actually proposed. But the politicization of the term "climate" has really hurt the prospects of forming a climate service as well as our ability to do updates and



planning on a more routine basis.

The role of climate scientists is to try to understand, as best we can, what is going on and why and what it means for the future. The role of politics should be in deciding what to do about it. There are a number of options: we can try to prevent things from happening, we can live with the consequences, or we can plan for the consequences. Unfortunately, those things aren't being discussed adequately at the moment.

Speaking for science

My work got caught up in politics because of this thing called "Climategate," where a whole bunch of IPCC scientists' emails, including mine, were stolen. I've seen a number of papers that have been published since that time—important papers with regard to climate science. But as soon as the paper comes out, the authors get an angry backlash from a number of deniers. Some of my fellow scientists—and I would say too many of them—have responded by withdrawing into the ivory tower. I've made the decision to go in the other direction, and that is to speak out. Along with about 150 other scientists, I'm a member of the Climate Science Rapid Response Team, a group that tries to correct misinformation about climate science that gets into the media.

What kind of planet

I am hopeful that amazing things could happen if the right kinds of "carrots and sticks" can be put in place. With incentives to reduce carbon emissions and for us to become more energy efficient, I believe technology will advance in ways that enable us to meet the problems and aid adaptation to climate change while setting us on a road to a more sustainable future. We should all ask, "What kind of a planet should we leave our grandchildren?" and act accordingly. **i**