

Hurricanes and Global Warming News Conference

Center for Health and Global Environment
Harvard Medical School
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Verbatim Transcript

Moderator (Scott Edward Stapf, The Hastings Group): Good afternoon. Welcome to this tele-news event sponsored by the Center for Health and Global Environment at Harvard Medical School. The purpose of today's tele-news event is to look at the connection between hurricane activity, global warming, and what may lie ahead. You'll be hearing from four speakers today, four experts. Before we introduce them as a group and then individually, I'd like the operator to explain how the Q&A period will work.

Operator: During the question and answer session, if you would like to indicate a question please press star and then one on your touchtone phone. If you decide to remove yourself, press star and then 2 but during the question and answer session press * star and then one. Please limit yourself to one question and a single follow up.

Moderator: And we will invite the operator back on the line at the conclusion of the statements by the four speakers so that you can hear those instructions again as we move into the Q&A period.

As I indicated, you will be hearing from four speakers today. I'm going to go through them as a group first and then individually as they deliver their brief opening statements. First speaker today will be Paul Epstein, M.D., Associate Director of the Center for Health and the Global Environment at Harvard Medical School. Our second speaker will be Jim McCarthy, who is professor of Biological Oceanography at Harvard University and the former co-chair of the impacts group of the Intergovernmental Panel on Climate Change, the IPCC. You'll also be hearing today from our third speaker, whose name is Matthias Weber, senior vice president and chief property underwriter of the U.S. Direct Americas Division of Swiss Re. Our fourth and final speaker today will be Kevin Trenberth, who is head of the climate analysis section of the National Center for Atmospheric Research in Boulder, Colorado. He's also convening lead author of the 2007 Intergovernmental Panel on Climate Change, IPCC report.

Again, our first speaker today, Dr. Paul Epstein, Associate Director of the Center for Health and Global Environment at Harvard Medical School.

Epstein: Thank you Scott. Yes, I'm Paul Epstein. I'm a medical doctor trained in tropical public health and Associate Director for the Center for Health and Global Environment at Harvard Medical School.

I'm going to try to be brief and give a little overview on the trends as well as the public health impacts of what we're seeing and the center is sponsoring this briefing today

because of the growing concern among a number of experts about the potential for climate change, global warming, to promote more extreme weather events in the future and intense hurricanes. Four things we know are true from the IPCC, the first intergovernmental [corrects himself] 2001 Intergovernmental Panel on Climate Change. We know the climate is changing. Two, that humans are having an influence. Three, biological systems are responding on all continents, and weather is becoming more extreme. This alone, these statements, tell us that by deduction we've got to understand all events that we are seeing in terms of climate change and natural variability. We cannot isolate one event and say "Oh, this is natural. This is climate." Everything is a function. I know this may sound new and heretical but that's the conclusion that climate and baseline is changing.

Since 2001, we know a lot more about the system. We know more about the deep ocean warming throughout the world. We know that surface pressures and winds are affected and polar winds are affected so that gradients are set up and so that storms can become more intense and are seeing these swings back and forth from dry periods to wet, et cetera. For Americans in the Southeast—Florida, Texas—this can be devastating; for Haiti, we've seen the impacts already this year. In terms of the direct public health impact of the lives lost in the U.S. alone, these hurricanes killed 128 people. We know that throughout the Caribbean over thousands, particularly in Haiti. We know Granada has been devastated. Their [indiscernible] is a loss so this is about development and poverty and ripples through the economy back to health. It means that this year's unusually intense period of destructive weather activity of four hurricanes hitting the U.S. in a five-week period could be a harbinger of even more extremes to come.

Now, in the past—now why do I say that? In the past decade we've seen unprecedented set of events worldwide that have taken lives and left clusters of diseases. Extremes of all types. So as we look at these hurricanes we have to see the context of more extreme events. Hurricane Mitch in '98 in Honduras, Mozambique floods in 2000, and then the pace quickens in 2003 with 21[-000] to 35,000 deaths. Then this May we had 172 tornados in the U.S., five feet of rain in 36 hours—this is in Haiti, which later got hit again in September. So the context is that weather patterns are changing, the character of the system is changing. We're seeing this greater variance and variability. Variance from the scientific prospective is often a nuisance of the noise in the system. It is becoming a signal of how this system is behaving and it is not stable and we can project more of these kinds of extremes.

I'm going to close with that. I think that we're going to look at some of the dynamics behind this. We're going to look at the events themselves. We're going to look at the costs of these events and then I urge us to come back in the end to discuss some of what [sic] our sense of how these systems might be restabilized. So I turn now to my friend Jim McCarthy of the Intergovernmental Panel of Climate Change.

McCarthy: Yes, Jim McCarthy here, professor of Oceanography at Harvard University and as mentioned in the introduction co-chair of the Intergovernmental Panel on Climate Change Working Group 2 on impacts in the last assessment, which concluded its work in

2001—actually published our report in 2001 [on] work that was completed the year before. As Dr. Epstein has said, the Intergovernmental Panel on Climate change reports have established, based upon scientific findings, a very clear pattern in how the earth's temperature is changing. We know that the earth's temperature and precipitation patterns are changing as a result of changes—not only those attributable to natural variability but also attributable to the greenhouse gas condition that's accumulating in our atmosphere.

On every continent it is now evident that there are impacts from these changes in temperature and precipitation and while some of those changes, some of those impacts, rather, are seen as positive, many of them are negative and disruptive. We see this in every aspect of natural ecosystems, but also in human socio-economic systems.

Now, one of the conclusions that was reached in the Intergovernmental Panel on Climate Change four years ago now, which brought a new sense of urgency to this, is that we are seeing these patterns that Dr. Epstein referred to in terms of extreme events. We found that the data over the last several decades show that we have higher maximum temperatures or hot days, more heat waves over nearly all land areas and the projections for climate in the future show that is very likely to continue. In addition, there are increasingly intense precipitation events. Many of these we have just heard reference to, but similarly the projections for the future show that this is going to become increasingly common.

Now, over the last four years I think that the general message of the IPCC has become rather well accepted and when you only look at recent high profile coverage in *Business Week* in August or the *National Geographic* in September or just today, the *USA [TODAY]* editorial to recognize that whether or not the earth's climate is changing at the hand of humankind is really not a matter of substantive debate today. The one aspect of this ongoing climate change that continues to receive less attention than it deserves is how the warmer world will lead to more extremes in weather and particularly these heavy precipitation events, extreme wind events, and more hot, dry periods as well.

In these last four years since the work of the IPCC was last concluded, we have seen changes in climate that in many instances we thought were rather unlikely for the near future, but we knew were of high consequence if they did occur. But in the last four years we have seen some of these become increasingly likely. For example, the rate at which ice is being lost in Greenland. The loss of ice shells in the Antarctic. And also changes in ocean circulation. And while these changes may seem distant from our own shores and to be perhaps not terribly relevant in our own everyday lives, they're really important components of the interactive climate system and they should serve as a wake-up call.

What we're seeing in climate, in climate now, is that all species on planet earth, including our own and our socio-economic systems that have evolved to climate, to the earth as known, are now having to adapt to a new climate. And while for some species, including our own, there may be simple, straightforward adaptation strategies, in others we know that will not be so simple. The premise that earth's climate is changing at the hand of humankind and that there are negative consequences to this is gaining wider acceptance.

The really serious consequences of more variable weather are only now beginning to register, as decision makers are pondering the magnitude of the lost lives, livelihood, and property in the recent extreme weather disasters that were summarized by Dr. Epstein over the last five to ten years. And I'll conclude my remarks there. Thank you.

Moderator: That was the opening statement of Jim McCarthy, professor of biological oceanography at Harvard University and the former co-chair of the impacts group of the Intergovernmental Panel on Climate change. He was preceded by Dr. Paul Epstein, Associate Director of the Center for Health and the Global Environment at Harvard Medical School. Our third of four speakers today is Matthias Weber Senior Vice President and Chief Property Underwriter of the U.S. Direct Americas division of Swiss Re.

Weber: Thank you Scott. This is Matthias Webber speaking. I am going to talk about this year's 2004 hurricane occurrences in the U.S. and in the Pacific, especially focusing on Japan. In the U.S., it's the first time since 1886 that we had four hurricanes affecting a single state in one and the same season. Charley, Frances, Ivan, and Jeanne all hit the mainland or at least affected the state of Florida. Alone in the state of Florida more than 22% of all the homes were affected, by at least one of those hurricanes, which resulted in a loss. We have still roughly 15,000 loss adjusters adjusting losses alone in the state of Florida. Outside of Florida, there are some more of those. A total of more than 2 million claims alone occurred in Florida. But if you had a comparison you probably remember Hurricane Andrew, which also hit mainland Florida in 1992. Hurricane Andrew created some 700,000 claims. The series of those four hurricanes I was referring to, resulted in at least three times as many losses. It usually takes about three hours to half a day on average to settle a claim, which means a good claim settler can settle 2 to 3 claims. If you do the math you will realize that it takes about 100—that every claim settler has about 140 claims to settle, which means it takes about 3 to 4 months to take care of all those claims.

Specific example: typically when hurricanes devastate a region it results in a so-called post-loss inflation, and this has technically happened in Florida. Replacing a roof now costs about three times as much before these hurricanes happened. The modeling firms of the U.S., they made estimates about what can the series of these four hurricanes cost alone to the U.S.; the published range is somewhere between 20 and 25 billion [dollars] U.S. There are actually a number of people who suspect that this range could go up as a result of the fact that the modeling firms cannot take everything into account, which contributes to the total loss. "Everything" includes, for instance, losses caused by water; that's extremely difficult to model. Mold losses are also right now not part of these models. However, mold has happened and will happen as a result of these hurricanes, and there are also one or two additional reasons why some people believe that the range of between 20 and 25 billion might actually ultimately be exceeded. So far the industry in the U.S., the insurance center in the insurance industry has announced something like close to 20 billion U.S. dollars. We expect that a little bit more will follow. As a reminder, Swiss Re—we also have losses, of course. It's part of our job to take risk and

now it's part of our job to pay for those losses. Our combined loss of the four hurricanes which made landfall in the U.S. amounts to 640 million U.S. dollars.

Please let me say some sentences with respect to the situation in the Pacific, especially around Japan. Japan has seen the most active hurricane or typhoon season—hurricane in the U.S. is the same as a typhoon in Japan—so Japan has seen the most active typhoon season since 1970. 1970 is the time the year when complete records start to exist. Ten tropical cyclones or typhoons have been affecting Japan so far, resulting in a total insured loss of somewhere between 5 to 7 billion U.S. This frequency has never been seen before and one reason why this frequency is above average is the sea surface temperature around the island of Japan is above average and has been above average in 2004. As a result of the fact that the sea surface temperature is a little bit higher than usually, we expect that the tropical cyclone season in Japan this year will last probably one month longer than usual. Swiss Re has announced that the total incurred loss in Japan of 110 million U.S. dollars. This concludes my opening remarks.

Moderator: That was the opening statement of Matthias Webber, senior vice president and chief property underwriter of the U.S. Direct Americas division of Swiss Re. Our fourth and final speaker today before the Q&A period is Kevin Trenberth, head of the climate analysis section of the National Center for Atmospheric Research in Boulder, Colorado. Mr. Trenberth also is a convening lead author of the 2007 Intergovernmental panel on Climate Change report.

Trenberth: It's still morning here, but good day to everyone. This is Kevin Trenberth from NCAR, the National Center for Atmospheric Research. I might add also that I was a lead author on the 2001 IPCC report for Working Group One, which deals with the science of climate change, and in fact I was involved in developing some of the information that is in that report dealing with hurricanes.

Let me focus then on the science of climate change and the physical aspects of the climate change that are going on. The first key point, as Jim McCarthy said, is that the atmospheric composition is changing due to human activities. There's a buildup of carbon dioxide; it's around 31, 32% higher than pre-industrial levels. Global warming is happening and there is a lot of evidence for that, as others have already stated, and the global mean temperature is increasing.

One thing I would pick on, in particular, is that global sea level has risen about an inch and a quarter in the past ten years. This is good information—the first time we've had global information from satellites using a process called altimetry. Now most of this rise in sea level is due to expansion of the ocean as it warms up, and maybe 20 to 35% is from melting of glaciers. So the sea surface temperature is rising globally. It's been about 1 degree Fahrenheit over the 20th century and it's risen in particular in recent times in the Atlantic and other regions, of course, that affect hurricanes. At the same time, water vapor amounts have increased and the empirical evidence suggests that water vapor in the atmosphere goes up about 10% [7% overall] for every degree Celsius—or say about 2 degrees Fahrenheit—increase in sea surface temperature in the atmosphere. And of

course this is the fuel for the hurricanes and it also means that the hurricanes end up dropping a lot more precipitation and rainfall as a result. And so the environment in which these hurricanes form is changing and it's changing in ways that provide more fuel for them through the water vapor and the changes in sea surface temperature.

And another example aside from the ones over near Japan is that on late March 2004 there was a hurricane in the South Atlantic off the coast of Brazil. This was the first of its kind and it's clear evidence that things are changing.

In general, the changes in the tropics are such that more storm activity is favored, but it's very difficult to say whether or not these are going to be individual thunderstorms or hurricanes. And in general throughout the United States in the 20th century there was an increase in heavy rainfall events of about 7% and very heavy events, which is the top 1% of all events, were up about 20% in the 20th century. And so this is an indication that in general rainfall events are apt to increase.

There are several factors that go into making hurricanes. They're really a collective of thunderstorms and they need a disturbance that hangs together. And we are not able to say what global warming is likely to do to that, and so there could be a trade off between individual thunderstorms versus actual hurricanes. It also requires—this actually requires a favorable atmospheric circulation. This relates to things like whether the wind will blow it apart or wind shear will cause it to collapse before the hurricane actually forms. And we can't say anything really about the tracks which make the hurricanes hit the U.S. or miss the U.S.—whether they [make] landfall or not. What we can say is that the high sea surface temperatures of water vapor make for more intense storms and so this is consistent with the evidence that we're seeing. And so this is the main link with global warming that we can establish at the current time.

And so this is supported also by the modeling evidence and the theoretical evidence. There was a certain amount of activity regarding a paper that came out recently by a group headed by Tom Knutson at the Geophysical Fluid Dynamics Laboratory—*laboratory* for those of you, if I say it in American. And that supports the idea that indeed hurricanes are apt to become more intense in the future. So a key consequence, I think, is certainly perhaps increased damage from winds, but I think the biggest consequence is likely to be more heavy rains and flooding. And so it wasn't just Florida, but it was all the way up the eastern seaboard, for instance, that had flooding events in association with these recent hurricanes. And with that I will open it up for questions, I guess.

Moderator: Yes that was the opening statement of Kevin Trenberth head of Climate Analysis section, National Center for Atmospheric Research in Boulder, Colorado. At this point, we are going to move into the question and answer portion of today's tele-news event. I'd like to invite the operator back on the line to explain once again how it is that you can participate in the Q&A period.

Operator: If you would like to ask a question please press star and then one on a touchtone phone. If you decide to remove yourself from the question list please press star and then two. Please limit yourself to one question and a single follow-up. If you need to ask an additional question please know you may always press star and then one to rejoin the queue.

Moderator: Operator, let's proceed with our first question at this time.

Operator: The first question is from Patrick O'Driscoll of *USA TODAY*.

Patrick O'Driscoll, USA TODAY: Yes, hello. This is a question for either Paul or Kevin. Is what you're saying now much of a departure from what the IPCC report said three years ago, four years ago?

Epstein: Kevin, you want to start?

Trenberth: This is Kevin Trenberth from NCAR. I think the evidence is mounting as Jim McCarthy suggested, and I refer to the hurricane off of the coast of Brazil. You heard also from Matthias that there is unprecedented activity out in parts of the Pacific, the far western Pacific, and now we have a series of seasons, very vigorous seasons ever since 1995. Let's see, I think seven of those—seven of the last ten years—has been above normal in terms of hurricanes. So this kind of evidence is pointing more in the direction that these extremes are occurring and are having a real impact on society.

Epstein: If I just second that and say—yes, we know these things as of 2001, but now we've learned a lot more. Ruth Curry at Woods Hole [Oceanographic Institution] has published a paper showing that the tropics in general are becoming warmer and saltier as they evaporate and we're seeing changes towards the poles of fresher and cooler water. So there's a dynamic in the Atlantic Ocean, it's the same thing with all the oceans in terms of changes in this distribution of heat and salt. And so that creates a belt out of which these hurricanes can be fueled. In general we're seeing more outliers, and that's what I was describing—more events that are even greater than one or two standard deviations from the mean. Like the heat wave last summer, like this state of hurricanes—

Trenberth: By last summer, Paul, you're referring to Europe, I think?

Epstein: Yes, in Europe, 2003—which was way beyond where model projections of what doubling of CO₂ would do to temperatures and mortality results. It was 18 degrees Fahrenheit greater than long-term averages and the number of deaths extreme and wildfires and the heart failures. So we're seeing outliers and as Matthias

Weber has described we're seeing not only clustering of problems in particular places, as I've described, but many problems occurring across the globe now at the same time. That's what's increasingly important to the insurance and reinsurance industry.

McCarthy: Jim McCarthy here. I would just like to make one additional comment. Jim McCarthy, Harvard University. I think one way to answer that question is, what we're seeing is happening more quickly than had been projected just four or five years ago, and that's true of the rate of ice loss in Greenland, the rate of loss of ice in Antarctica, but also the extreme events. And if you look at the data the four of the last six years are now the warmest years on record. So, as we look ahead and we anticipate these changes, the temptation is to think that they'll be smooth changes. But if anything they're accelerating and they are more irregular than we had thought likely and therefore more disruptive.

Moderator: Is there a follow-up question there?

O'Driscoll: Just a brief one. Again, for many of you, for laypeople out here who may look at this and say, "Well, couldn't you chalk this up to just natural variation and deviation?" I mean, it's an awfully short period of time we're talking about here where we've seen these admittedly extreme changes. What's to say that it won't revert in coming years?

Trenberth: Well, this is Kevin Trenberth at NCAR. That's a very good point, and certainly in the Atlantic there's no guarantee that this is going to continue, because in the Atlantic there is large, natural decade-to-decade variability in hurricane activity and we know the way in which the ocean works in the Atlantic is that it's apt to favor this kind of thing. There will be on and off periods. But at the same time within that, now superimposed on that natural variability, is also this longer-term trend that we associate with global warming. Even a year-to-year basis—there can be a year with more hurricanes or fewer hurricanes, depending on things like El Niño events in the tropical Pacific. And indeed, as we've had more hurricanes in the Atlantic in recent years, there have actually been fewer hurricanes in the far Eastern Pacific—you know, off of the west coast of Mexico and so on—and so there is a competition around the tropics as to where hurricanes tend to occur, and this natural variability is certainly going to continue.

Weber: I would like to add something here. This is Matthias Weber, Swiss Re speaking. You probably recognize my accent. We believe it is actually impossible to associate a single event such as Hurricane Charley, or even a series of events such as the series we have seen this year, to a climate change trend. Which means we can't just look at the four hurricanes we have seen and forget about the rest and conclusively say 'climate change is going on,' but we also cannot say the opposite. And we therefore as a company, Swiss Re, we take climate change very seriously and the possibility that it could affect the hurricane activity in the future with respect to both frequency and severity.

Moderator: Our next question, operator?

Operator: Yes, the next question is from Usha McFarling of the *Los Angeles Times*.

Usha McFarling, *Los Angeles Times*: Hi, I think my question is for Dr. Trenberth. Elaborating on that last question, I'm just—can you be clear, are you—I know in the Knutson paper they are talking about perhaps increases of 5% of wind speed in 80 years,

but this stuff doesn't seem to imply that what we saw in Florida may be due to climate change because of warmer sea surface temps. And I'm wondering—the hurricane researchers are saying what happened in Florida, they don't believe is linked to climate change—it's definitely more that decadal variability and just bad luck with the tracking of storms towards Florida instead of out to sea or elsewhere. So, maybe if you could be clear on what—what are we saying here? Are we saying that what we saw in Florida may be an indication on what's in the future, or are people implying that perhaps Florida was caused by climate change and we're already seeing the changes now instead of 80 years from now? Thank you.

Trenberth: Yes, this is Kevin Trenberth at NCAR. That's a very good question, and I think one of the reasons we've got this press conference is to perhaps try to add a little bit to other statements that have been made by hurricane forecasters. Now as I mentioned before, there is a lot of natural variability and decadal variability in hurricanes, and as Matthias mentioned it's impossible in fact for researchers to tie an individual hurricane or even four hurricanes to global warming as such. But as we have—several—all of us have mentioned, there is a much larger pattern going on and it's not just in the Atlantic but in the western Pacific and it's also other rainfall events, severe weather events across the United States, and so on. And so it's part of a larger pattern which is consistent with the sorts of things we expect with global warming. With global warming a lot of the heat goes into driving the hydrological cycle, evaporating moisture, putting moisture into the atmosphere, which then gets rained out and there's more moisture lying around. Then the rain events tend to be heavier. And at the same time in places where it's not raining, there is more evaporation and so the droughts tend to be stronger as well. And so ironically you can have stronger rainfall events and stronger droughts at exactly the same time and caused by the same phenomenon. And of course we're well aware that there's a major drought going on in the southwestern parts of the country. And so, it's just larger context that we thought was missing and needed to be brought to bear to indicate that this is a real risk and it's something we are going to have to deal with as we move into the future.

McCarthy: Jim McCarthy here, Harvard University. Just to add to that point, Kevin mentioned earlier that there is no way of forecasting tracks and just as nobody remembers the tropical storms named A and B, but we remember Charley, and we don't remember D and E, but we remember Frances, and so on and then Ivan and Jeanne on down the line. Many, many of the storms that arise will go little-noticed and indeed anyone who's in one location forecasting hurricanes is looking largely at the exposure of that particular location. The sense that there is a larger picture, and the sense that it's consistent with the projections that come from the scenarios of climate models for the reasons that Kevin has articulated—the hydrological cycle of the energy that arises from that—is really what we think has been missed in these more general dismissive statements.

Epstein: If I could just add a bit here, Paul Epstein, I think this context of the trends and the kinds of events I mentioned—tornadoes, because we've had, as I mentioned, 247 in September; 47 is the average for September, 172 in May—we're seeing more of these kinds of events and furthermore, what Kevin's comments help us understand is that we can understand the dynamics under them. They're making sense in terms of the warming

of the ocean, drying out of land. As surfaces of the ocean and the land heat up it changes the pressure and the pressure gradients that's changing wind speeds. As I mentioned, we're now seeing increased wind speeds around both poles. So we're seeing some changes in temperature and pressure and pressure gradients and wind and weather patterns that are consistent with the changes we know to be associated with warming of the ocean and climate change.

Moderator: Our next question, operator?

Operator: The next question is from Juliet Eilperin of the *Washington Post*.

Juliet Eilperin, *Washington Post*: Hi, I'm sorry, this is for Kevin. I think you mentioned it briefly, but I just wanted to check again. Can you just explain the dynamics when sea temperature, sea surface temperatures, rise, then water vapor is increased? In other words there is more water evaporating and how does that shift the dynamics again? Can you just go over that one more time?

Trenberth: Certainly. Well, we know from a very fundamental physical law that as you warm up the atmosphere it can hold more moisture and so if you keep the relative humidity constant then for every 1 degree—I'm sorry this is in Celsius—1 degree Celsius there's a 7% increase in the water-holding capacity. Now empirically, when we look at what's going on over the North Atlantic, for every 1 degree Celsius increase in sea surface temperature it's actually about a 10% increase in the water vapor in the lowest 20,000 feet of the atmosphere. So we take the column integral, it's not just the humidity of the surface we're looking at, but also throughout the lower part of the atmosphere. And so that has gone up by about 5%, for instance, in the last fifteen years from the very good measurements that we've got now over the ocean from an instrument called the—well, it's a microwave instrument—and so the water-holding capacity goes up and the empirical evidence suggests that the actual amount of moisture in the atmosphere goes up, and this is, of course, the fuel for any thunderstorms and tropical storms.

Epstein: Paul Epstein. As I learned from Kevin you've got a push-pull on the water cycle. As water warms, the oceans warm, they evaporate faster. As the atmosphere warms, it can hold more water vapor. So water is warming, water vapor's rising, and ice is melting. These are the three parts of the hydrological cycle that are changing.

Moderator: Is there a follow-up question?

Eilperin: Well, the one thing is, I know Tom Knutson actually in an interview recently with the Post raised an issue of—who you mentioned—raised the issue that he didn't see a strong link between global warming—I'm just wondering—and the hurricanes that just happened in Florida. And again, I just wonder how that fits into your analysis or again, to you, do you see this as 'that's a narrow question' whereas again you're addressing this broader worldwide phenomenon?

Trenberth: Yes, certainly. If you just look at what's going on in the Atlantic the record has a lot of variability from year to year. Some of that's associated with El Niño—this is Kevin Trenberth from NCAR again—and also there's this decadal variability which may well be associated with things like this thermohaline circulation. That was the change in circulation throughout the Atlantic that was a key in the movie called "The Day After Tomorrow." And so that's a form of natural variability, but it may well also be affected by global warming. And if you simply take that narrow view, then it's very hard to find a global warming signature in the record. And we're suggesting here that maybe the main signature is not so much in the frequency, the number of hurricanes, but rather more in the intensity of hurricanes and the very heavy rainfall events. Certainly there is a very clear signature in the United States, and east of the Rockies in particular, where heavy rainfall events are increasing and a good fraction, a fraction, of those are associated with hurricane events.

McCarthy: Jim McCarthy here. Just to add another point. It's also apparent that some of the people who have been quoted saying they don't see any connection here are also not people who have really been involved in the studies of the largest-scale patterns of change. And, in fact, some of them have publicly said that they don't believe that ice is actually melting in the Arctic and the like. So I think one has to be careful to find out on what grounds these positions are being based and I think what we're trying to say today is that there is a very consistent story here. If someone says, "Well, I don't think hurricanes are caused by climate change or by global warming and, oh by the way, I don't believe in global warming either," that's another perspective you would want to see in its entirety and not just as a fragment.

Moderator: Our next question, operator?

Operator: Yes, the next question is from Chris Crisler of *Florida Today*.

Chris Crisler, *Florida Today*: Yes, thank you very much. We're rather hurricane-centered down here as you might imagine, and given—you do seem to be talking about a broader trend than perhaps an increase in more extreme events. So, I just want to clarify—you can't be more specific about, say, number of storms, but storms we do get might be more intense, and you can't be more specific about tracks necessarily at this point.

Trenberth: This is Kevin Trenberth at NCAR. One of the things that we did say in the 2001 report is that certainly the environment in the tropics becomes one which favors more storm activity in a general sense, but it's very difficult for us given our current knowledge to say whether it's going to be a whole lot of individual thunderstorms or a collective of thunderstorms where they get organized into a tropical storm or a hurricane. And it could be that as we move into the future that we end up with a whole lot of thunderstorms, but of course Florida gets a lot of thunderstorm activity as well, and so you can also expect that kind of thing, as well.

Crisler: Okay, thank you.

Moderator: Our next question, operator?

Operator: From Alex Lane of the *New Jersey Star-Ledger*.

Alex Lane, *New Jersey Star-Ledger*: Hi, just curious as to whether there's any financial relationship between the researchers and Swiss Re?

Epstein: Full disclosure is—our center is getting support from Swiss Re to look at the health, ecological, and economic dimensions of climate change and so we're actively interacting with them to figure out what the health and what the life and health and property and casualties all adds up for economics starting from the impacts on our health. So full disclosure—yes, we are collaborating, trying to understand the system.

Trenberth: Hey Paul, this is Kevin. How do you do this? I would like some money, but no, I don't have any funds from Swiss Re or any other insurance company [laugh].

Epstein: I would say, they're funding us as an independent study.

Lane: Does Swiss Re have any stake in the hurricanes being attributed to global warming?

Epstein: Well, I think as Matthias has said, since the early '90s Swiss Re has taken climate change seriously, has accepted it, has accepted the conclusions of the IPCC and is seeing the costs of extreme events rise, from \$4 billion a year in the 80's to \$40 billion in the '90s. They went to \$55 billion in 2002, \$60 billion in 2003 and now—the first figures were '99 dollars—they're looking at, as the UN has pronounced this potential for \$150 billion a year loss from extreme weather. Yes, we're living near coasts; yes, things cost more; but there are many more extreme events occurring, and they are taking this seriously as the physical and the biological impacts. I'd also say that they were in the forefront of looking for the opportunities for their own business of how to promote solutions that—about clean energy and decreasing vulnerability to climate, to reduce their risks.

Weber: Can I add something here? This is again the Swiss guy speaking, the Swiss Re property underwriter. The question was, "Does Swiss Re have any stake in the hurricanes?" The answer is, of course, yes. We are the second largest insurer in the world and such whenever a natural catastrophe happens somewhere in the world, be it in Japan or in the U.S., we are paying a fair share of the losses caused by whatever the event is as long as the event is an insured loss. We also recognize that there is a certain degree of uncertainty around the implications coming from climate change, so we do not believe that the scientific community right now has all the answers to all possible questions, but we as a company, we say we cannot really wait until uncertainty turns into certainty, because if you do this then it could be too late. And therefore we think it is very important to help contribute, that this uncertainty of knowledge turns into certainty as

quick as possible, and as such we feel we have a certain obligation to contribute to events—contribute to it with our knowledge and contribute to it also financially.

Epstein: And if I could say briefly—Paul Epstein—if anyone wants to know more about this study I would be glad to provide information. We're looking at implications of disease as a result of climate change on trade, travel, tourism, the events themselves, and the climate of investment and—beyond life and health and property and casualty—the stability of markets and the security of investments. So, there's a broad look, that the Swiss Reinsurance is really out in the lead in looking at these long-term implications.

Moderator: Our next question Operator?

Operator: It's from Chris Joyce of National Public Radio.

Chris Joyce, National Public Radio: Hi, I may be missing some nuanced information here, but I'm not hearing any particularly new data. I'm hearing references to hurricanes that happened five weeks ago and to a paper in September and then for the references to the 2001 IPCC report, and I'm just wondering, why have you all come together at this particular moment to talk about this? Obviously something occurred to you that you felt the need to come together and remind the world about what is happening with global warming and I wonder what those reasons might be.

McCarthy: Well I'll take one cut at that. Jim McCarthy here, Harvard University. I think that several of us who have spent the last several years looking at these larger pictures were surprised by some of the statements appearing in the press. Again, as I suggested earlier, in cases attributed to people who either are not, have not been involved or have shown interest in these larger studies, but who have also at times even said that they don't, for example, believe that the Arctic is losing ice today. These statements were very local in perspective and didn't have the benefit of the larger picture that so much occupies our lives both as researchers in this field and as teachers, and as we begin talking with other people through groups like the Center for Health and the Global Environment at Harvard Medical School, people like Kevin, others, it appeared that within our community there was a lot of surprise that this possible relationship that we're discussing seemed to have been buried by a number of stories in the press.

Epstein: Jumping in here. One paper I wrote—I'll gladly send you—by Jim McCarthy and myself, [is] about to come out about this issue of climate stability and systems and the susceptibility to surprises in shifts. That's a new conceptual way of looking at the system. But I want to put my public health prevention hat on for a moment as a public health person and say that we are also looking at prevention. And frankly, the relief that the government, the administration has come up with now—\$11.7 billion for the hurricane, 2.7 for the drought-plagued plains—these are patch-up, downstream measures to intervene on events that are occurring that we see a pattern of tremendous increase, and we see no attempt to deal with the upstream drivers. I will leave it at that. I think you understand what I'm saying, that we would like to see attention to this problem of climate

change and not just payouts for the damage that ultimately falls on the tax dollars of citizens.

Weber: This is Matthias Weber, Swiss Re, jumping in. [The] question we have just heard implies that one single event happens and then the scientists all come together, might come together, and say this is a result of climate change or indicates that climate change is going on. I would like to repeat because it's so important for me to do it. It is not scientific to say one single event such as one single hurricane is a result of climate change. One really needs to look at the whole picture and look at everything which is going on for a number of years, and such a time to talk and think about climate change and its impact is always a good time.

Epstein: And one other—Paul Epstein-Chris Joyce, if you do mention my political statement or anybody else, please attribute it to me and it's from us at the Center for Health and Global Environment. I don't want to be speaking for everyone.

Moderator: Our next question, operator?

Operator: The next question is from Alexandra Witze from the *Dallas Morning News*.

Alexandra Witze, *Dallas Morning News*: Thanks. I wanted to ask either Dr. Trenberth or McCarthy to talk a little bit about the role of El Niño and how that feeds into all this. I know there hasn't been a significant El Niño in the last couple of years, and if we were to have a big one develop in the next few years, how would that help you to understand the role that all this plays into climate change and hurricane frequency [indiscernible]?

Trenberth: This is Kevin Trenberth at NCAR. Indeed, throughout the tropics there tends to be a bit of a competition as to where the main actions occur and you can have a couple of major centers of action around the tropics, but if you have a major El Niño and the activity shifts east of the [International] Date Line, say from the Date Line toward the coast, then that activity tends to have a suppression effect in the Atlantic. It changes the winds in the Atlantic, the wind shear changes, and the environment is no longer as favorable for any of the disturbances that come off of Africa to form as hurricanes. And so with a big El Niño during the hurricane season, during the summer season, the Atlantic hurricanes tend to be suppressed. So, it does depend on a couple of things. It depends on the timing—I mean, the big El Niño events are more common in the northern winter rather than the northern summer and so it depends whether they can continue and extend that influence. There is a weak El Niño going on right now, but at the moment the atmosphere has not really gotten on board with that. It hasn't responded. The main tropical activity is still west of the Date Line and this is, of course, is consistent also with a lot of the typhoons forming out in that region, and that's far enough away that it doesn't have a big influence on the Atlantic. But on the other hand there has been a suppression of activity in the eastern Pacific at the same time, and so in this case the Atlantic is winning out over the eastern Pacific and there is a negative correlation between those two reasons. Did I answer the question?

Witze: Yes. I guess I was just wondering in terms of the level of understanding, how desperate are you for a really nice whopping big El Niño to come along? [laughs]

Trenberth: Well, you know the whole question of how El Niño has changed with climate change is a very interesting question, it's a very important research question; it's one that we have not solved. It's one that was highlighted in the last IPCC and is going to probably be highlighted again in the next IPCC. It relates to our ability to simulate El Niños in climate models, and they have things that look a bit like El Niños but in some respects they're not as, quite as, quite the same as the ones that occur in nature. And so anything we can say from climate models tends to be compromised a little bit by evidently some lack of complete understanding of exactly how these things work. It does look to me like—I think there's a number of papers which have been published, which suggest—that El Niño is a response of the tropical Pacific to a buildup of heat and what it's doing is trying to get rid of that heat. And so the heat spreads across the Pacific and then goes into higher latitudes. It comes up the western coast of the United States, then goes down into the Southern Hemisphere and it also goes into the atmosphere and there is a mini-global warming in the atmosphere following an El Niño. And as a result 1998 is still the warmest year on record following the big El Niño event that we had then. And so if there's more global warming and the Pacific starts to warm up, it's likely to have a consequence for El Niños in some fashion. And indeed in the last 25 years there have in general been more and bigger El Niños, but since they only occur about every four years or something like that on average, you have to try and adopt a long-term and large-scale perspective in order to really look at the statistics. And as I say, it's still a research question.

Witze: Thank you

Moderator: Our next question Operator?

Operator: It's from Abhi Raghunathan, *Naples Daily News*.

Abhi Raghunathan, *Naples Daily News*: Hi, this is Abhi Raghunathan at the Naples Daily News in Florida. The National Oceanic and Atmospheric Administration, NOAA, has publicly stated that global warming and climate change have had insignificant to no impact on this year's hurricane season. Were they one of the groups you were referring to earlier when you said that some of the quotes you read in papers came from those with limited perspective?

McCarthy: This is Jim McCarthy. I presume you're directing that to me. No, I'm not aware of the NOAA statement. Kevin referred earlier to a publication that has been influential in the kind of discussion we're having right now which came from NOAA scientists, but I was referring to pieces that had come my way, largely op-ed pieces in newspapers throughout the East Coast, where either from the direct effect or the aftermath of these recent storms these opinions have been voiced. Kevin, you might want to comment on the NOAA piece if you're familiar with it. I'm not.

Trenberth: I have not been aware of any official NOAA statement on this position one way or another.

Raghunathan: I guess NOAA said that the entire sort of rise in the Atlantic sea surface temperature by 1 degree was entirely sort of contributable to a natural historic system funneling warmer-than-normal water to the Atlantic this year.

Epstein: Paul Epstein. I don't know if it was NOAA or Jim O'Brien, Gary Sharp—there was a statement about that from some scientist. William Gray has been skeptic on this whole issue of deep ocean warming and climate change for a long time. I think that the issue really is, as Kevin was laying out, how do we understand the natural variability like El Niño/Southern Oscillation, the North Atlantic Oscillation, the Pacific Decadal Oscillation, the monsoon. We're seeing—we hadn't talked about the floods in China, Vietnam, Thailand and so on—we're seeing changes in the monsoons because of warming over land and melting of the Himalayas and as well warming of the Indian Ocean. All of these [remainder of response lost due to tape change]

Moderator: Brown here and we are reaching the one-hour mark, which is just about the limit for time that we have today. I understand that there are a number of people who are queued up who have questions. We're going to talk in another minute about how you can make sure those questions get answered. We do have time for one remaining question.

Epstein: Do we want to go on for 10 or 15 minutes?

Moderator: We actually do have an actual physical time limit here, but let's ask—let's have one more question asked. Then we'll go through the details about how individuals with additional questions, follow-up questions, can make sure they get responded to. Operator?

Operator: The last question is from Dennis O'Brien of the *Baltimore Sun*.

Dennis O'Brien, *Baltimore Sun*: What should be done to prevent or reduce damages from this stuff?

Trenberth: Well, this is Kevin Trenberth. I can start the ball rolling, although perhaps Jim McCarthy is best qualified to answer this. Certainly, one of the things is the buildup in vulnerable areas. Especially areas like New Orleans are just going to be—I mean, it's amazing they haven't been hit thus far, and sooner or later a big one is going to come along in the right place and since they're below sea level in a lot of areas it's just going to cause a lot of devastation. And so there's a lot of very vulnerable areas where prudent—in fact, Matthias may well want to comment more on this—this is a case where reducing vulnerability and whether taxpayers around the nation should be subsidizing people to build in areas where they shouldn't be building in the first place, and so that's one aspect of things. Another aspect of things is certainly related to the overall climate change, and this relates to the buildup of greenhouse gases and the fact that this is very likely to continue. It relates to a number of other aspects. The lack of participation of the current

administration in the Kyoto Protocol—the Kyoto Protocol now seems likely to go into effect, which is one of the international strategies for trying to help slow down and mitigate some aspects of climate change—and whether or not the U.S. should be doing more in this area. A number of people, including myself, think that we should be doing more in playing a stronger leadership role in this, since the U.S. is indeed a major contributor to the increases in greenhouse gases in the atmosphere, but there's a number of aspects to this question, and let me with that turn it over to Jim.

McCarthy: Jim McCarthy here, Harvard University. I'll comment briefly, but we should probably give Matthias the last word on this. If we were to just look back about a decade ago to the way people talked about problems like this, we would often hear a debate as to whether it made more sense to take some of the actions Kevin just referred to—that is, slow the rate of growth of greenhouse gases and attempt to diminish the likelihood of some of these changes in climate—or whether we should just let them come and be prepared to adapt. One of the realizations of the late '90s work that is summarized in the IPCC documents is that that's not a choice we can make any longer. We have embarked upon a path and are now at a point where these impacts are all about us and will continue to arise. Many of them negative, some perhaps positive. There certainly are some positive ones, but it's the negative ones we are talking about today that are so disruptive to lives, livelihood, and property, and indeed much of what we have done in the way we have used our habitable areas has contributed to this. Dr. Epstein mentioned earlier the situation in Haiti. Well, we know that on one island two nations have managed their land very differently and you see the destructive power of a hurricane on one being vastly more costly in terms of lives and property than on the other. So, back to Kevin's point, we should look carefully at the areas where we have vulnerabilities and where we could, with wise uses of land and other resources, diminish the likelihood of the effects of increasing sea level and additional storminess.

But I wouldn't want to sign off without saying that I completely concur with Kevin that in part it's the slow realization that we are facing a seriously changing climate now and that we should take all action we can to slow this rate of change. And that takes us back as Kevin suggested to the source term for greenhouse gases, and it's a realization that has come increasingly not only in the scientific community but to heads of state around the world and we hope that that discussion continues. But I think Matthias probably is the one who can best comment on these vulnerabilities.

Weber: Okay, Matthias Weber, Swiss Re. Since [it is] time for the last word, I think Jim and Kevin already addressed that issue from more of a [indiscernible] approach. They explained what can be done on the global basis. I would like to do the opposite and talk about individual houses, individual risks, especially with respect to hurricanes. 1992, when Hurricane Andrew made landfall in Florida, this was not only a surprise to many people, this was also a shock and brought the whole insurance industry to a state of turmoil and actually initiated a number of changes. And one of the [changes] which happened is that in many counties of Florida, as a result or consequence of Hurricane Andrew, building codes were discussed and adjusted and on average these building codes were consequently [indiscernible] the homes which were built after 1994, that's when the

majority of the building codes came into effect. This is actually very, very good and for me as a representative of an insurance company I will say I'm very pleased to be able to tell you it actually works. These building codes are doing what they are supposed to do. We see that the buildings which were built after 1994 behaved better in some places—significantly better—than the older, older buildings which were not yet subject to these building codes. And I can tell you—and I'm sure you understand that I cannot give you names, but I can tell you—some of your clients, some insurance companies actually give discounts to insureds [sic] which have a home built to the new, more restrictive building codes. Thank you.

Moderator: Paul, I don't know if you have any final thoughts that you had to offer.

Epstein: I just—clearly we've talked about different levels of responses here, and early warning systems can be crucial for underdeveloped countries. They've gotta improve. Vulnerability, as Jim has said—deforestation, for energy use as well as other uses, is a key thing to reduce vulnerability—but I second the issue of primary prevention. And how we do this so that we can really make an investment in our common future and make this a win-win for the environment and the economy is the simultaneous equation we have to solve. And I welcome the corporations and nongovernmentals [sic] and scientists and UN agencies all coming together to figure out this global problem.

Moderator: You've been listening to a tele-news event sponsored by the Center for Health and the Global Environment at Harvard Medical School.

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