

Dr. James Hansen's Keynote Address

Thanks very much and thanks for letting me come and speak and interact with you. The public has so many problems understanding climate change because they don't have the time or the information to understand the issues that are involved. I think we need the religious community to help the public understand the moral implications of what we're doing to the planet.

During the last two or three years, when I've given talks, and in the book that I wrote last year - *Storms of My Grandchildren*, I talk about the gap between what is understood about global warming by the scientific community, and what is known by the people who need to know, and that is the public.

There is a tremendous gap between what is understood by science and what is known by the public. The difficulty stems partly from the inertia of the earth. The earth is a huge body. The ocean is four kilometers deep. It takes the earth time to respond to the insults and to the forces that humans are applying to the earth. As a result the warming that we will get from gases that we have already added to the atmosphere, only about half of the warming has materialized so far. The other half is still in the pipeline, and it's going to occur over coming decades even without any additional gases.

We can understand the problem better by looking at of the earth's history of climate changes in the past, and seeing how the earth has responded to changes in atmospheric conditions. We know that there are tipping points which can push the climate system far enough so that the dynamics of the system begin to take over and proceed out of our control.

Consider, for example, the polar ice sheets. Once an ice sheet reaches a point where it's begun to disintegrate, then it doesn't matter what you do to the gases after that because it's going to continue under its own dynamics. You can't tie a rope around an ice sheet which is more than a mile thick. Once it begins to move, then it's too late.

Consider the species on the planet. As we drive some of them to extinction, and put pressure on the remaining species by continual shifting of climate zones, then other things put pressure on the species. You can reach a point, because of the interdependence of one species upon another, where ecosystems begin to collapse. Then you've reached again a tipping point where it is really too late to make corrections.

So if we want to preserve creation, we have to avoid passing those tipping points. The reason I wrote the book was to try to reduce that gap between what is known and what is popularly understood. But in fact, that gap has widened remarkably in just the last six months. The science has become clearer, yet the public's recognition of the situation has become poorer. Many of the public now think that global warming is a hoax because of the deliberate efforts of those who prefer to do 'business as usual,' and have mounted very successful efforts aimed at confusing the public.

Let me first comment about the science. When I wrote the book, there were still some loose ends in the science which have since become much clearer. One of the things that I talk about is the planet's energy imbalance. We know that the greenhouse gases in the atmosphere cause the heat radiation to space to be reduced.



Dr. James Hansen speaking at the National Religious Coalition on Creation Care's 2010 Prayer Breakfast

They're like a blanket to help keep in the earth's heat. And that's why the temperature rises. The temperature rises until it reaches a point that the planet can again radiate the same amount of energy that it is getting from the Sun. Well, we had expected, based on the amount of greenhouse gases and how they were increasing, that the planet should be out of balance by about $\frac{3}{4}$ of a watt per square meter.

But over the last few years, the measurements have been showing most of this energy, this imbalance, is going into the ocean. So to make very precise measurements of the ocean's temperature, you can see how much the planet is out of balance. And it looked like it was out of balance by about a $\frac{1}{2}$ a watt instead of $\frac{3}{4}$ of a watt. So I discussed in the book some possible reasons why it's a little different. Beginning several years ago, a couple of thousand of Argo ocean profiling floats were distributed around the world's oceans. Every so often, these floats yo-yo down in the ocean with an instrument package that measures the temperature of the ocean, and then yo-yo back up. These yo-yos can go all the way down to two kilometers. A few months ago, they published the results of these measurements. It turns out the planet is out of balance by about $\frac{3}{4}$ of a watt. The main implication of this imbalance is if you want to restore the planet's energy balance, which is what you need to do in order to stabilize the planet, you have to reduce CO₂ from its present level of close to 390 ppm back to 330 ppm.

Now there are other things you can change too. There are some other things that humans are producing, such as methane and black soot. If we reduce those, then the CO₂ may have to go back to only the order of 350 ppm. That has become a lot clearer in the last six months. Another thing that's very important is the stability of the ice sheets. As we warm the ocean, it melts tongues of ice that come off the ice sheets into the ocean, they're called ice shelves. As those ice shelves melt, that allows the ice sheets to move the ice streams more rapidly into the ocean and discharge icebergs into the ocean more rapidly. At the time I wrote the book, I could only say we began to get very precise measurements of the mass of these ice sheets from a satellite called GRACE. It measures the gravitational field of the earth with such a high precision that you can

determine the mass of the Greenland ice sheet very accurately, and the Antarctic ice sheet very accurately. In my book I stated that Greenland was losing mass at the rate of about 200 cubic kilometers per year. Similarly Antarctica loses about 100 cubic kilometers per year. Recently, that gravity satellite gave us an update with a couple of more years of data. We can now see not only the rate of losing mass but how that rate is changing. At the beginning of these measurements in 2002 Greenland was losing mass at about 150 cubic kilometers per year, but it is now close to 300. And in the case of Antarctica, it was about 75, now it is about 150. So the rate of loss has approximately doubled over the last eight years. That's the kind of response on a nonlinear system. If it begins to collapse, it will go faster and faster. And so again, it confirms our concern about this potential nonlinearity.

Finally, at the time I wrote the book, the energy coming from the Sun goes through these natural cycles of ten to twelve years. Sun spots come and go in that periodicity of magnetic fields on the Sun. But last year, the Sun had been remaining in the deepest and longest solar minimum that has occurred during a period of which we have been measuring the Sun very accurately from satellite, which is from the 1970's to the present. In my book I state that the Sun could remain without Sun spots, the way it did in Galileo's time for a few decades. That was during the little ice age. In addition to humans there are natural ways to change the climate and the brightness of the Sun is one of those factors. And if it did stay down, that's the equivalent of decreasing CO₂. We can compare very precisely the forcing due to the Sun versus the human made forcing due to carbon dioxide. And to stay down at that minimum, it's equivalent to 7 years increase of CO₂ the way we're increasing it now. So it would have given us a little reprieve of several years. Well, now the Sun spots have started to reappear. So that reprieve of a few years is not something we can count on. The Sun is now coming back in its cycle.

Another thing I'd like to convey to you is what I've learned during the past couple of decades about the importance of scientists connecting dots all the way from the science to the implications for the public and the policy makers. I testified to Congress in the nineteen eighties about global warming and said that it was beginning to occur. I testified again in 1988 and 1989. Then I decided to get out of the business of talking to the public because it seemed to me that you could just give the scientific results and then hope that the appropriate policies would follow. In any case I did not feel that I was the right messenger. I'm not a public speaker. There are people like my friends, Steve Schneider and Michael Oppenheimer, who are very articulate and they even enjoy the process of communicating with the public. So when I got requests, I referred them to Steve or Michael. I decided I was going to go back to the laboratory and just do science, which I think that I do well.

In 2004, by that time I had two grandchildren. I realized this 'gap' existed and it was continuing to grow; and the government was not taking actions that were effective. Furthermore, the government even discouraged scientists from communicating to the public. So I decided I was going to give one talk in which I would try to lay out the sciences implications very clearly. And because I had begun to think that I did not want my grandchildren to say that their grandfather understood what was happening, but never made it clear. Because I know very well, by the time my grandchildren are older, these climatic changes will be obvious. They will wonder why in the world somebody didn't do something about this when they had the evidence. Their actions just continued right along the same path. What I realized was that you have to connect the dots all the way to the implications.

The first obvious implication which was being ignored is the fact that if you look at how much carbon there is in oil, how much there is in gas, how much there is in coal, then what you see is that if we're going to get the atmospheric composition to be in the safe range, we need to do something. We know that we've already used a large fraction of the oil and the gas. And the amounts of those are limited. We know that those are going to be used because they're owned by Saudi Arabia and Russia. We've already got our infrastructure set up. They are going to sell that oil. Even if we weren't going to buy it, they'd use it themselves. But we could solve the problem if we decide that we were going to leave the coal in the ground.

That's why I ended up going to West Virginia. I was trying to draw attention to the fact that the biggest problem and solution is to say, "Okay, let's move on to the clean energy future...beyond fossil fuels." Let's do it sooner. Let's just leave the coal in the ground.

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Let's phase out coal over the next 20 years, and that will allow us to get back to 350 ppm. What I found was that although leaders were all saying the right words about "We have a planet in peril, we've got to solve this problem," they weren't working to solve the problem--even the greenest countries in the world. I wrote a letter to the Prime Minister of the United Kingdom, and to the Chancellor of Germany because at that time under the Bush Administration, it was clear, we weren't going to get any action here. But they could get started by saying, "We're going to phase out coal." But what I found was that those countries were just building more and more coal fired power plants. Although their words are the right words, their actions are completely inconsistent with that. In fact, what I realized further, you've actually got to go even one dot further. And that is to understand that as long as fossil fuels are the cheapest form of energy, we're going to continue to use them.

Another example of how business as usual continues, the United States recently signed an agreement with Canada to build a pipeline to carry tar-sands oil to the United States. When I talk about oil, gas and coal, there's another thing called unconventional fossil fuels, such as tar-shale and tar-sands. Those are even dirtier fuels than coal. If we're going to get back to 350 ppm, we have to not only leave coal in the ground but we have to say that we're not going to use these other dirty fossil fuels. But the corporations and governments are going to fight to use them. That will continue to be the case as long as fossil fuels are the cheapest form of energy. So the only way that we can solve the problem is to begin to put a rising price on carbon emissions.

Fossil fuels are the cheapest form of energy only because we've partially subsidized them. We have not made them pay for the damage that they do to human health. There's a huge cost associated with the air and water pollution due to the arsenic and mercury that comes off of coal. More than 100,000 people per year are dying from pollution from fossil fuels. In addition, there's an even a bigger cost, and that's the one that will be borne by our children and our grandchildren, from the impacts on the environment and future climate events. It only makes sense to attach those costs to the fuel. So we should have a gradually rising price. It needs to be over a period of time so people can have a chance to make their adjustments. If the business community knows that this price is rising, that will give rise to innovations in clean energy, energy efficiency, and energy sources that do not produce carbon dioxide.

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But what we see instead are attempts to solve the problem in some tricky way. The Kyoto Protocol is an example of the concept of "cap and trade" offsets. These are completely ineffectual. In fact, emissions were going up 1 ½ percent per year before the Kyoto protocol. After that, they went up by 3 percent per year, because there was no real constraint. As long as fossil fuel are the cheapest form of energy, we're going to continue to use them. So you need an honest approach that says that. That's why, although you may not want to recommend specific measures, that the cap and trade and offsets bills that have been talked about by Waxman, Markey, Boxer, and Kerry won't solve the problem. These are all good people and the strongest environmentalists we have in Congress. Yet they're proposing bills that won't solve the problem.

There was actually a very potentially attractive bill that was suggested by Senator Cantwell. The Cantwell bill has some improvements over the Boxer-Kerry bill mainly by adding a dividend. In the Waxman-Markey, or the Boxer-Kerry bills, most of the money is collected and put a cap on the emissions from fossil fuels. Then Congress decides how to use that money. I think it makes much more sense that the money that is collected will be distributed to the public. The public would be able to deal with their increased prices by buying the best and more efficient vehicles for their homes, etc. But the best bill, in my opinion, is the John Larson bill, which is a simple, honest, \$15 per ton fee for carbon dioxide collected at the mine or well-head or the port of entry for all the fossil fuels, oil, gas and coal. If that were coupled with what I call a dividend, or a green check, where that money is then distributed to the public, that would be a good bill. Larson's bill has that fee, rising \$10 per ton per year. By 2020, this approach would actually reduce emissions by about 30 percent. That's a real reduction. But it requires a real price on carbon emissions. To accomplish this, we need to have leaders who will stand up and explain this to the public. That's what we were hoping for with the change of administration.

This is why this situation is so relevant to religious leaders. This is a moral issue. It's analogous to the situation where Churchill stood up and made clear the situation with Nazism. Lincoln also stood up and opposed slavery on moral grounds. Climate change is analogous to those moral situations. We need to make this clear to the public which doesn't yet understand. That's why I think your help may make this clear. That's why it is so important to do it.

Thank you.