Dr. William Happer

How To Think About Climate Change

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Schiller Institute

Dr. William Happer

Thank you very much for the invitation.

My original title for this presentation was, "How Do You Think About Climate Change?" My response: the best way to think about what's happening with the climate frenzy in Europe and the United States today, is that it's very much like the medieval Crusades. It's cloaked in supposed science, but the science there is not really science; it's no more science than the motives of the Crusades were to promote the teachings of Jesus Christ. There were many motives in the Crusades. Very few of them were terribly noble; and that's true of climate today. It's not easy to know what's in someone else's head, but it's definitely not to save the planet.

This would not matter, if it did not have big implications for the average person. I personally don't believe in astrology, but it's perfectly OK to me for newspapers to publish a horoscope every day. I wouldn't waste my time on them, but if someone else wants to do it, that's fine. The difference is, the government is not promoting astrology. But the government *is* promoting climate hysteria. Here's a quote from the climate bigshot in Massachusetts, about a month ago, [speaking] to an environmental group. Let me read it to you—David Ismay:

> So let me say that again: 60% of our emissions that need to be reduced come from you, the person across the street, the senior on fixed income, right?… There's no bad guy left, at least in Massachusetts, to point the finger at [he's talking about Exxon or Peabody Coal] to turn the screws on, and you know, to break their wills, so they stop emitting. That's you. We have to break your will. Right? I can't even say that publicly.

Most Americans don't like having their will broken by some two-bit bureaucrat. And Mr. Ismay wants this to gain publicly—well, he was at least forced to resign [as the state's undersecretary for climate change], so that shows there's some virtue left in the American system. But I have to admire him for speaking so frankly, so my hat's off to him for telling the truth.

Let me start by saying the climate frenzy is really based on bait and switch. Supposedly it's based on saving the environment. Nobody wants a bad environment. I don't; I'm sure none of you want a bad environ-

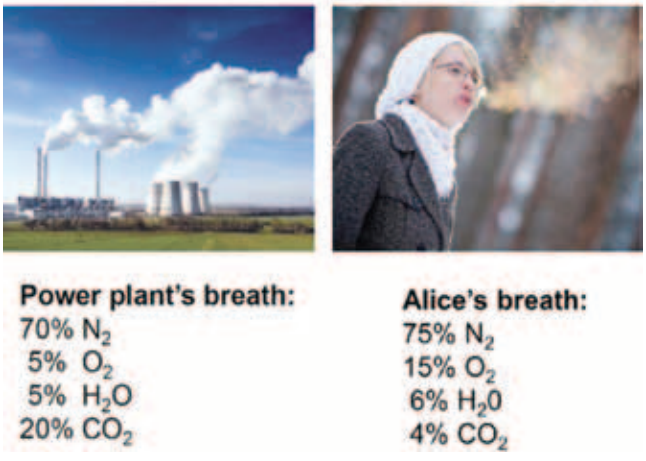
FIGURE 1

Real Air Pollution in Shanghai

Courtesy of William Happer

FIGURE 2

C02 Is Not a Pollutant



ment. **Figure 1** is a picture of Shanghai on a smoggy day: You can just barely see the bottle-opener building through the smog back there. This is real pollution—but this is not CO_2, nitrous oxide, or methane. You can't see those gases at all. They're completely transparent. This pollution is partly due to combustion of coal, but it's also due to burning rice fields, and it's also due to dust blowing off the Gobi Desert in the spring. Environmentalists have very effectively confused this situation, which nobody wants, with the emissions of CO_2, which, as I will mention a little bit later, are almost certainly good for the planet.

CO_2 is a completely natural part of life. (See **Figure 2**.) When we breathe [out], our breath is 4% CO_2, 6% water; there's a fair amount of oxygen left—that's why you can give mouth-to-mouth resuscitation with your own breath to help someone; and essentially all the nitrogen is left that you breathed in. Nitrogen is completely inert, in people at least.

Now, that's really not that different, even semi-quantitatively, to the output of a power plant that's been well-designed, where you strip out all of the smoke and the sulfur and the oxides of nitrogen; it puts out about the same amount of water vapor, it puts out a bit more CO_2, four times more CO_2, and correspondingly less oxygen, because it burns up most of the oxygen in the gas stream. But it's quite similar to our own breath. A good number to remember is that each of us exhales about two pounds of carbon dioxide a day. That's a lot of carbon dioxide if you multiply by 8 billion people.

I'm going to say perhaps more about science, and this is going to be a little bit more like a university lecture than perhaps it should be, but it's important that you understand the science, and also understand that the science does not support the "fact" that there's a "climate emergency," or a "climate crisis," as we often hear claimed.

The first thing to remember is that the thing that keeps us warm, really, is the Sun. (See **Figure 3**.) The Sun shines mostly near the Equator; that's where, most of the time, it's nearly overhead, although surprisingly the maximum sunlight is over the poles in mid-summer, when the Sun just never sets. But on average, or yearly average, the Earth is most heated near the Equator. A lot of that heat is transported north to the polar regions by

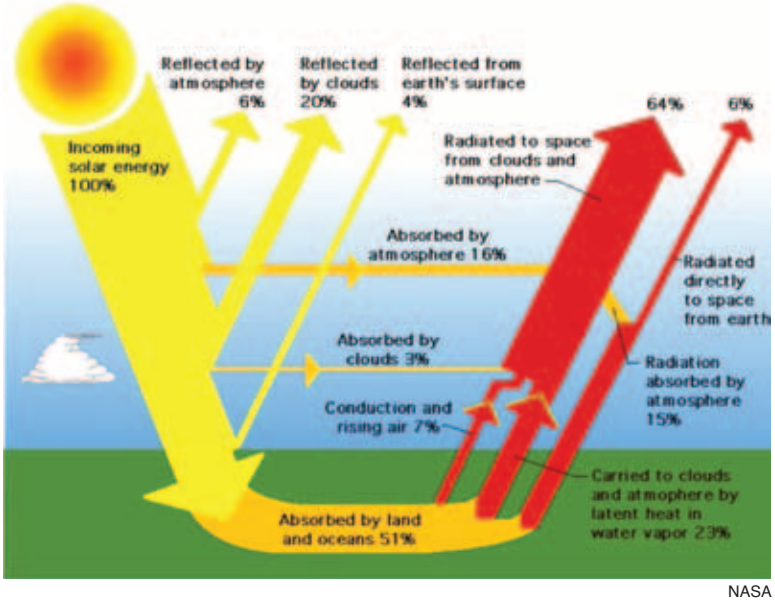
FIGURE 3

NASA/Apollo 17 crew

Atmospheric and oceanic circulation transports heat from the equator to the poles. Cloud formations seen from space make some of the atmospheric circulation directly visible.

FIGURE 4

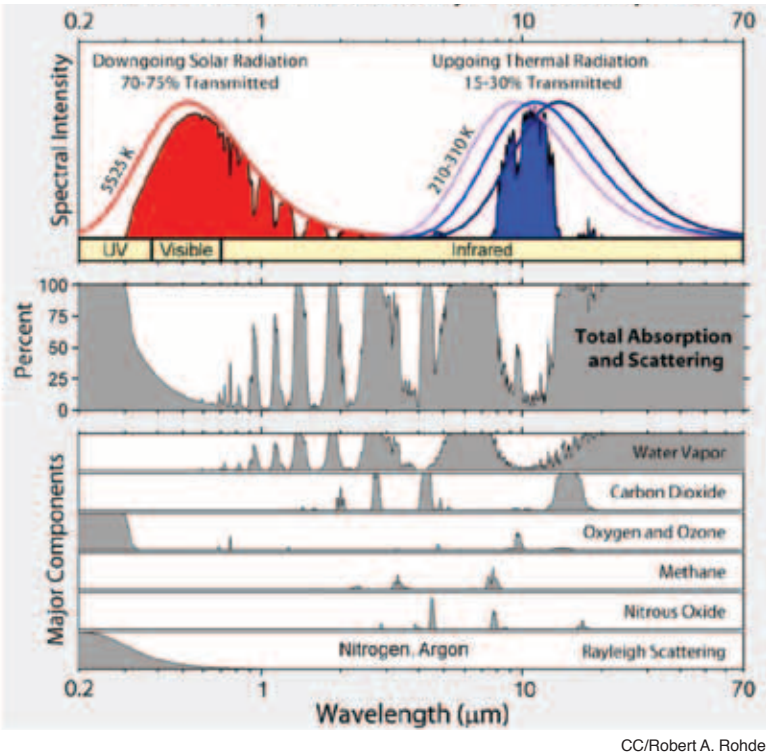
Earth's Energy Budget



NASA

FIGURE 5

Radiation Transmitted by the Atmosphere



CC/Robert A. Rohde

the oceans and by the atmosphere, and all of that heat is radiated back into space. The only way the Earth can get rid of the heat from the Sun is by radiating the heat back as infrared radiation into cold space. So the Earth glows in the dark, very much like a coal in a fire, and that glowing is what keeps us cool. There's nothing to convect or to conduct heat away from the Earth, once you get into outer space.

Figure 4 is a little NASA viewgraph. It's certainly semi-quantitatively correct, which shows the heating by the Sun, this yellow beam coming down on the left. About 30% of that is reflected back into space without producing any heat, by clouds, by reflection off the ground, and 70% is converted to heat, which has to be released back into space. Near the ground, the flux of heat going back to space is largely carried by convection, not by radiation. It's rising moist air; it's the same thing that sail-plane pilots ride on, thermals going up—they're carrying a lot of heat, especially if it's moist air with all the latent heat. But as you get higher and higher in the atmosphere, there's less and less convection and more and more of the heat flux is carried by radiation, so by the time you reach the top of the atmosphere, say 100 km, it's all radiation; there's practically no convective heat transfer left.

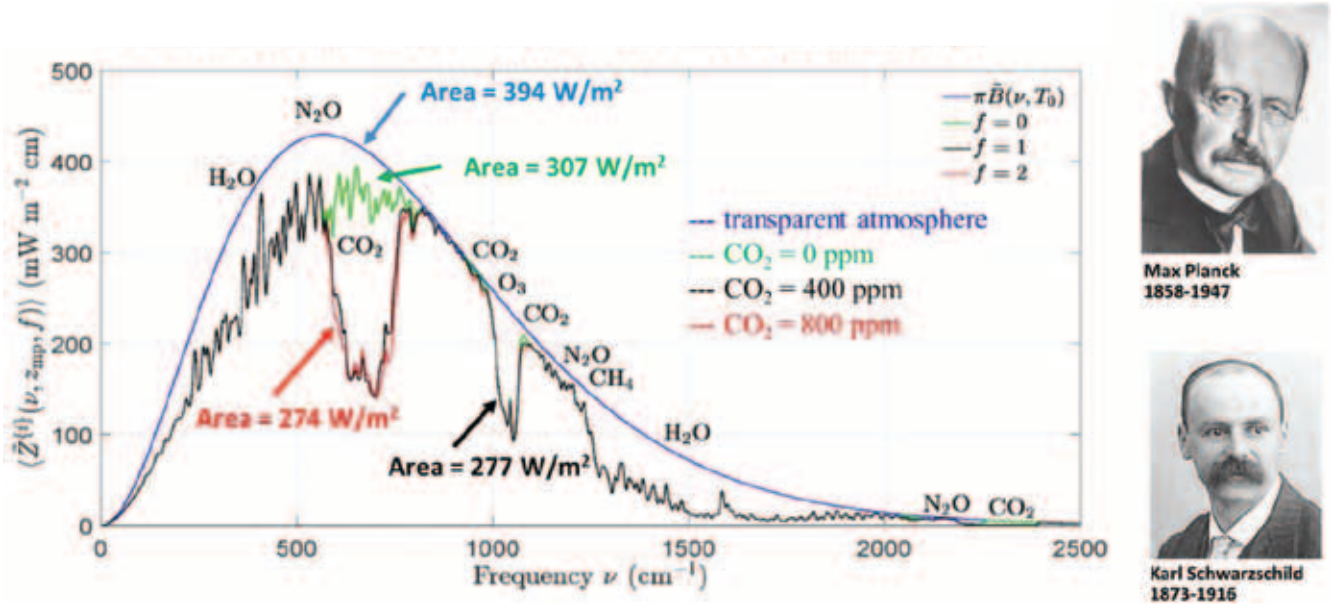
So the 800-pound gorilla in all of this is not greenhouse gases, it's not clouds, it is the Sun. The Sun controls our climate.

So, why all the excitement about carbon dioxide? So-called "carbon pollution." It's amazing that they get away with that word "carbon pollution," because carbon dioxide is not pollution at all! But the point is that these gases actually do absorb some of the thermal radiation and they re-radiate the radiation, and gases that are transparent to visible light, but which are partially opaque to the thermal radiation that cools the Earth, these are called "greenhouse gases." And so the greenhouse gases hinder somewhat the cooling of the Earth, and therefore make the surface a little bit warmer than it otherwise would be if there were no greenhouse gases.

Figure 5 shows the various greenhouse gases in Earth's atmosphere. By far the most important is water vapor, which is the third panel down; you can see water vapor absorbs most of the thermal radiation, which

FIGURE 6

Even a Doubling of CO_2 Would Make Little Difference



From William Happer, citing W.V. Wijngaarden and W. Happer, "Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases." *arXiv: Atmospheric and Oceanic Physics* (2020).

is the radiation on the right side of this chart. Left to right is the wavelength of the radiation, so the blue curves correspond to thermal radiation from the Earth; the red curve on the left is the heating radiation from the Sun, which is in the visible, near-infrared and ultraviolet.

So *water vapor is the most important greenhouse gas,* and if you add clouds, which act much the same way, water really dominates the greenhouse effect of the Earth. The second, and a rather distant second, is carbon dioxide, which is shown on the fourth panel down. You see it absorb some of the same radiation that water does. And other greenhouse gases—ozone, methane, nitrous oxide—are really down in the noise: they don't make very much difference.

Greenhouse gases were discovered by an Anglo-Irish physicist, John Tyndall, in the 1850s. Tyndall and many other scientists who have looked at that since then, are quite convinced that we should thank the Almighty for greenhouse gases: They keep the Earth warm enough to live in. Here's the comment by Tyndall himself, about the importance of water vapor greenhouse gas in Britain:

> Aqueous vapor is a blanket, more necessary to the vegetable life of England than clothing is to man. Remove for a single summer night the aqueous vapor from the air which overspreads this country, and you would assuredly destroy every plant capable of being destroyed by a freezing temperature. The warmth of our fields and gardens would pour itself unrequited into space, and the Sun would rise upon an island held fast in the iron grip of frost.

This is actually very good science: Tyndall got it right, and somehow we've forgotten that in the years that have passed since 1875.

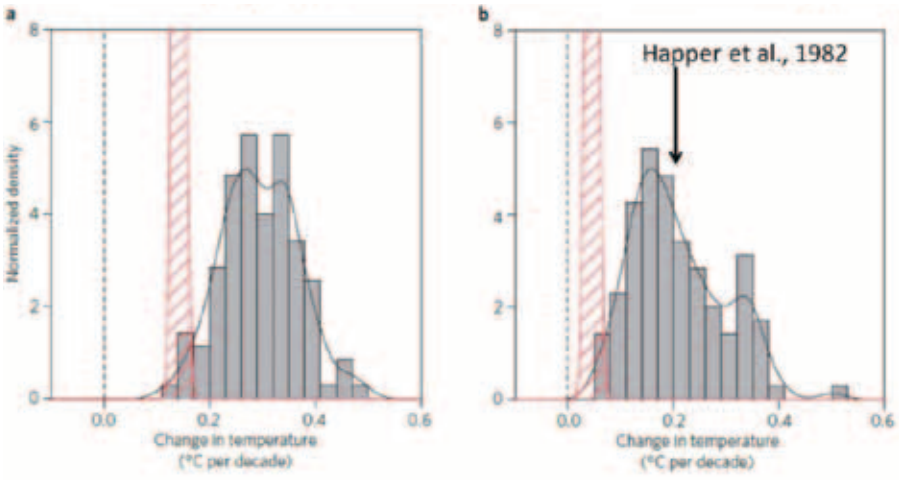
Figure 6 is perhaps the most important I'm going to show you. It's worth taking a little time to talk about it. On the right are two very eminent physicists: The top is Max Planck, the discoverer of quantum mechanics, trying to figure out how it is that radiation works. Why does the wavelength distribution of radiation look the way it does? We knew the way it looked by the time he started his work by the late 1800s, early 1900s. And in solving that seemingly intractable problem—it had all sorts of paradoxes in classical physics—he invented quantum mechanics.

So quantum mechanics came from solving the radiation transfer problem. It didn't come from particle accelerators or from radioactivity; it came from thermal radiation.

Below Planck is Karl Schwarzschild, who is a little bit younger than Max Planck, and tragically died during World War I on the Russian front—not from Russian bullets, but from a horrible autoimmune disease which

FIGURE 7

Modelled Warming (Gray) Is Much Larger Than Observed Warming (Red)



From William Happer, citing John C. Fyfe, et al., a commentary in *Nature Climate Change*, Vol. 3, Sept. 2013, p. 767

got worse while he was in the service and eventually killed him.

But turning now from these personalities to the picture, the smooth, envelope curve, blue curve on my chart here, is Planck's radiation curve. So that's the prediction of how much Earth would radiate to space if there were no greenhouse gases.

The area under that curve, as pointed out in the graph is 394 W/m^2 [watts per square meter of surface area], that's the radiation pouring out into cold space. And if you look from satellites, that is not what you observe. You do not observe Planck's curve when you look down on the Earth. Instead what you see is the black, jagged curve below with all sorts of wiggles in it. I call that the "Schwarzschild curve" after Karl Schwarzschild, who was the first to show how to calculate that curve, rather model it. He got it absolutely right. He was an amazing guy: God knows what he would have done if he had survived. He was the first to write down, for example, an analytic solution to Einstein's General Relativity equations—absolutely astonishing.

According to Schwarzschild, you get this jagged black curve. The area under the jagged black curve, the radiation the Earth really radiates into space, is 277 W/m^2 [watts per square meter of surface area], compared to almost 400 W/m^2 if there were no greenhouse gases. So there's a substantial decrease in the cooling of the Earth due to greenhouse gases. And thank God for that: That's what keeps us warm enough to live on Earth.

This is actually a model, but the experimental data look the same. If you double the CO_2 concentrations, you go from the black curve to the red curve. But the red curve hardly differs from the black curve. It's only in the CO_2 [frequency] band where there's a slight difference, and just about everywhere else, it's all the same. And so, going from current CO_2 (a little over 400 parts per million), to double that (to a little over 800 ppm), takes you from the black curve to the red curve and decreases the cooling radiation by 277 minus 274, or 3 W/m^2. Think about that: We are talking about giving up our freedoms, giving up our liberties, giving up meat, every pursuit of happiness you can imagine because of the difference between the black and the red curve on this graph!

And supposedly this causes a climate emergency. Does this look like an emergency to you? No! It's *not* an emergency! And if you put in more quantitative details, it's very hard to see how any rational person with any gray matter left could consider this to be a "climate emergency."

Remember that doubling CO_2, adding twice as much as we have now, almost makes no difference—almost makes no difference. So please don't forget this curve, the next time you talk with an alarmist. Most of them probably won't understand it, but I can guarantee you, it's rock-solid physics.

All right, let me finish: We're basing all of the alarm on models. **Figure 7** shows modeled predictions of warming per decade. The panel on the left side is for 20 years. The panel on the right is for 10 years. In the panel on the right, I made some of the first predictions—I have to confess—in a book I co-authored in 1982. My predictions of warming were way off, just like everybody else's. I was sort of in the middle of the pack.

The actual warming is the red bars. The warming per decade in the last 10 years, was something like 0.1° per decade. If you're taking 20 years, maybe 0.15°; it fluctuates, decade to decade.

The predictions are the gray bars: The predictions are two, three, four times greater than what's being observed. Yet, we're making policy decisions, wrenching policy decisions, based on predictions that don't work.

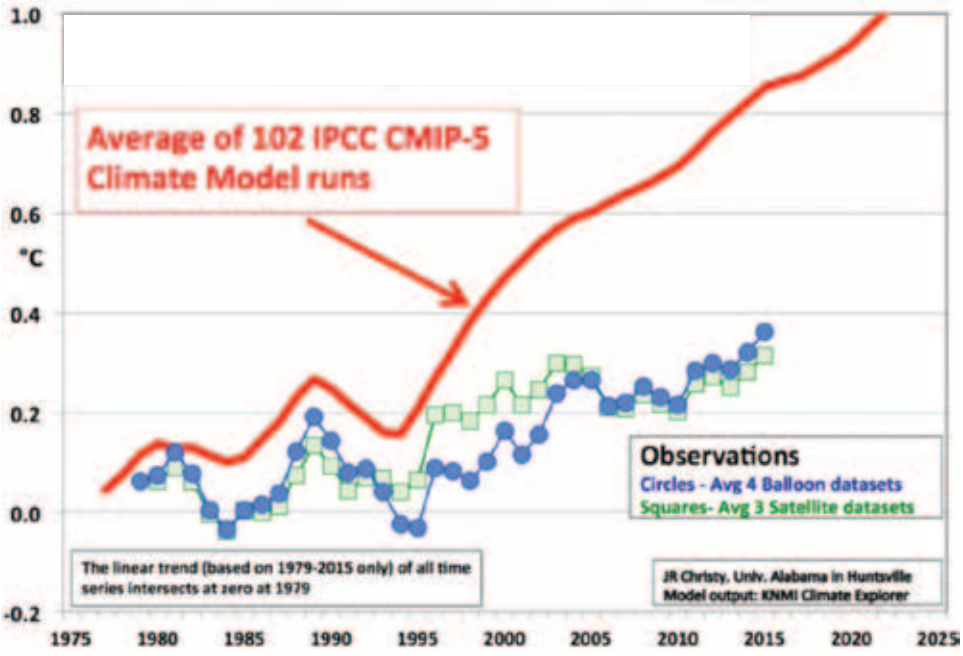
Figure 8 is a nice chart due to John Christy at the

University of Alabama–Huntsville, which shows the same information in a different way. He's taken all of the climate models that were indicated by the gray histogram bars in Figure 7, and averaged them to get this red curve. The red curve is the predicted temperature versus year, starting about 1975 and going through 2025 for the predictions. Below are the actual measurements.

The measurements from balloons that rise up through the air—and there are thousands launched every day for weather—and by satellites looking down, are nearly in agreement with each other. None of these readings is even close to the model predictions which are being used by climate alarmists to enslave the world.

FIGURE 8

Modelled Warming Is Much Larger Than Observed Warming

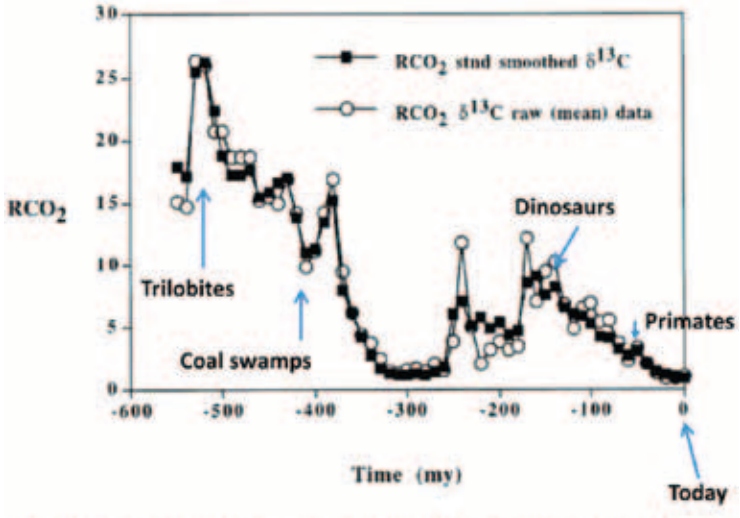


And why? Well, we have seen that CO_2 doesn't cause very much warming, so that's not an issue, and it's certainly not at an unprecedented level today. **Figure 9** shows the relative amounts of CO_2 since the Cambrian era, 540 million years ago. This is called the Phanerozoic. Over most of this time, CO_2 levels in the vertical scale on the left, were 5 times, 10 times what they are today. And life flourished. Every type of plant and animal was doing very well, including our primate ancestors, 60, 70, 80 million years ago: They lived in two or three times more CO_2 than we have today; they did just fine! So CO_2 is not a problem. It's not a pollutant, it's not a poison.

FIGURE 9

The Earth Has Been in a CO_2 Famine for Several Tens of Millions of Years

RCO_2= past CO_2 / today's CO_2

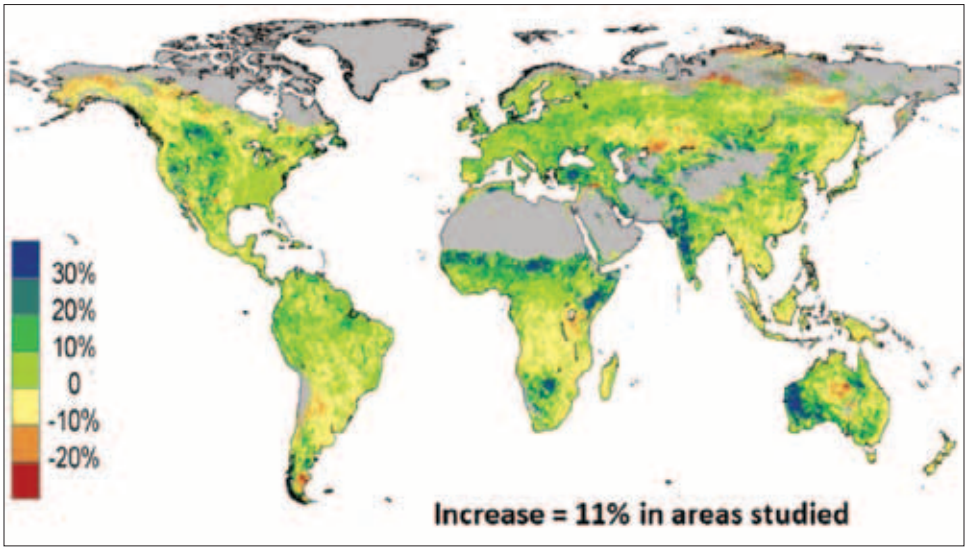


R. A. Berner and Z. Kothavala, Geocarb III: A Revised Model of Atmospheric CO_2 over Phanerozoic Time, American Journal of Science, V. 301, pp. 182-204 (2001)

Furthermore, I think many of you are aware that CO_2 *really* helps plants to grow. **Figure 10** shows the greening of the Earth. You've probably heard about "desertification" due to CO_2 emissions. It's just the opposite. CO_2 emissions are actually greening the Earth, especially in arid regions. The figure shows significant greening of the Sahel, just south of the Sahara Desert in Africa; significant greening of the dry, western parts of the United States; significant greening of the dry western side of Australia. And this is because, as you add more CO_2 to the air, plants are able to grow with less water, so this is greatly expanding the areas of the Earth where plants can grow successfully, compared to 100 years ago, when we were

FIGURE 10

Global Greening from CO_2 Fertilization: 1982-2010



From William Happer, citing courtesy of R.J. Donohue.

in a really serious CO_2 famine.

Figure 11 shows a controlled experiment where—this is Sherwood Idso, showing how experimental pine trees grew in ambient CO_2 [far left, 385 ppm], I think this was about 15, 20 years ago—a little more CO_2 [535 ppm], more CO_2 [685 ppm], still more CO_2 [835 ppm]. Every type of plant where you do this experiment, the plants grow better, you get better fruit, you get better flowers, if you add CO_2. This is not lost on commercial greenhouse operators, many of whom fill their greenhouses with two or three times more CO_2 than is in the outside air. So CO_2, far from being a pollutant, is benefitting our planet.

Your colleagues will say, "Well, that's what you say, but 97% of scientists don't agree with you. They all believe that this is a climate emergency." There are several answers you should make to this:

First of all, science is not determined by voting. You don't vote on the law of gravity or on the laws of quantum mechanics. You determine that they're true because they agree with observation and experiment. Many, many scientific consensuses have been wrong. This is one of my favorites, because I lived through it when I was a student: People just guffawed when you said that the continents drift. Well, yeah, there was this crazy German, Alfred Wegener, who pointed out that South America and Africa fit together like a jigsaw puzzle if you imagined that they could move over the surface of the Earth. But everyone scoffed at this, and even more if you pointed out fossils of similar species, plants, and animals on adjacent parts of the continents if you were to fit them together. Very, very persuasive evidence!

And yet, no one believed him. An easy way to get tenure in 1940 or early 1950s, was to write a nasty thesis about Wegener's continental drift, and you were immediately promoted. But—Wegener was right, and the consensus was wrong. And there are many other examples of this. Maybe we can talk about some in the question-and-answer sessions.

Let me conclude by saying that policies to slow CO_2 emissions are based on flawed computer models. They exaggerate warming by factors of 2 or 3, and on the basis of these flawed models, we're being asked to do horrendous things to our liberty, to our standard of living, to the planet—we cover the planet with huge flocks of windmills and ugly black solar panels, on the basis of models that don't work.

And the second point is that more CO_2 is an overall benefit, with enormous benefits to agriculture and forestry. So limiting CO_2 not only does no good, it's actually harmful. We should really have the courage to do *nothing* about CO_2 emissions. There's *nothing* that needs to be done about CO_2 itself.

Thank you very much.

FIGURE 11

Is CO_2 Plant Food?

Dr. Craig Idso