II. Science

Prof. William Happer in *The New York Symposium*

The World Needs More Carbon Dioxide

Princeton University Professor Emeritus of Physics William Happer gave this presentation and discussion Jan. 19, 2024, on the "New York Symposium" *weekly webcast of Diane Sare, LaRouche independent candidate for U.S. Senate from New York State.*

The discussion has been edited, and subheads added; not all of Professor Happer's slides are shown. The full original "New York Symposium" *video interview is here.*

Diane Sare: Welcome to the "New York Symposium with Diane Sare." I'm Diane Sare. And tonight, I'm very pleased to have Professor William Happer, who is a Professor Emeritus of Physics at Princeton University. He's an expert on some of these matters. And I also would like to say that participation in my symposium does not constitute endorsement of my campaign or any campaign. And my guests and I may often have disagreements. So, the opinions expressed by us are our own. And with that, I am very glad to have you here, professor. And please go ahead.

Prof. Wiliam Happer: Well, thank you very much, Diane. This is a part of a talk that I gave a few months ago in Australia. Australia, like most of the civilized world, is plagued by climate hysterics. So, let's talk about that a little bit.

What we're facing today is yet another misguided crusade. Human society has been plagued by crusades as long as we have records. And most crusades end badly. The reason for the crusade is very seldom really what is said about the crusade. For example, the Crusades to the Middle East, in the medieval times were not really about saving the True Cross. It was about power. It was about money. It was about anything but true religion. But it was disguised as true religion.

And today we have a crusade against carbon dioxide (CO_2), supposedly a pollutant. You hear about "carbon pollution." I scratch my head and I wonder what they're talking about because all of life is made of carbon. Carbon is *the* fundamental part of life. And yet somehow the mainstream media has managed to convince many people that *they* are causing carbon pollution….

Sare for Senate

Prof. William Happer

How Earth Is Heated and Cooled

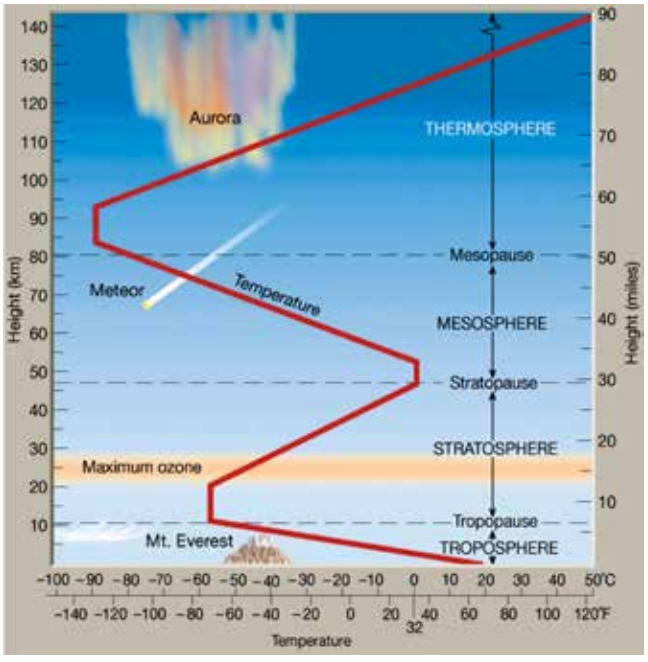
Now I'm going to give a little bit of science background; I'm a physicist, it's hard to resist.

When I gave this talk in Australia, I wanted to use a local example. The highest point of Australia is not much higher than 1.5 km above Melbourne, and it's quite a bit colder there. It's 10° centigrade colder at Hotel Kosciuszko than it is in Melbourne. And so that means that the cooling rate per kilometer is about 6.6 degrees….

What you notice is that anywhere on Earth, the temperature on the ground rapidly decreases as you go up. (See Diagram, "Hotel Kosciuszko...") That's why you go to the mountains in the Summer to try to keep cool. And this decrease is on the order of 6.5° per kilometer of altitude. It's quite a bit, but that continues only to 10 or 12 km [altitude] in temperate latitudes where we live. Then the temperature stabilizes, and goes up again. This atmosphere is what allows us to keep warm from heating from the Sun…. If you don't have some way to get rid of the solar heat that's warming the ground, then, the ground will overheat. So, the

Hotel Kosciuszko at 1.5 km averages about 10°C colder than Melbourne at 0 km.

Lapse rate = 10°C / 1.5 km = 6.6°C / km



Source: Lutgens and Tarbuck, The Atmosphere, 2001.

Thermal structure of the atmosphere.

temperature we live in is a balance between the Sun heating the ground, and the ground cooling.

The ground cools for two main reasons. One is where we live, in the troposphere. When the Sun is shining, the air is turning up and down, up and down, just like hot air balloons rising and falling, rising and falling. So, much of the heat where we live is carried away by convection. But at this 10 or 12 km I mentioned, comes the tropopause—the convection stops. So everywhere above here, the heat is carried by radiation, which can penetrate all the way out into space and dump the excess heat from the Sun.

Radiation and convection are affected by the amount of CO_2 in the atmosphere and other greenhouse gases. I should say, most of the atmosphere is not a greenhouse gas. It's nitrogen, and it's oxygen, which is completely transparent to the Sun and transparent to the thermal energy that is radiated from the surface and the lower atmosphere. Water vapor and CO_2, the major greenhouse gases, are transparent to the Sun, but they're not transparent to thermal radiation. So, they limit the cooling of the Earth, and we should say, thank God for greenhouse gases, because it's what makes the surface of the Earth warm enough to live on. Without them, it would be much too cold. We would live on a frozen Earth, and there would be no life….

So there is no single temperature of the Earth. And so crazy slogans like, "keeping the temperature from rising 1.5°," mean absolutely nothing….

[According to the well-known formula involving the Stefan-Boltzmann Constant] the increase in temperature from doubling CO_2 will be one quarter of a percent of the absolute temperature. That's less than 1° Centigrade. You can't get around this. This was known right from the beginning. Fifty years ago, 100 years ago, it was well known that the direct effects of large changes of CO_2 almost don't make any difference.

So, what's going on? What's going on is: The Alarm Establishment has invoked huge positive feedbacks from water vapor in order to greatly increase the direct effects of CO_2 (See slide, "Positive Feedback"). So, I sometimes joke that it's affirmative action for CO_2. CO_2 is not a very potent greenhouse gas, and so it needs some help to even be noticeable!

Most Natural Feedbacks Are Negative

You know, this positive feedback [from water vapor—ed.] is very unusual.

Most feedbacks in nature are negative, and that

POSITIVE FEEDBACK

- 0.71 C is not enough warming to justify a climate emergency!
- What to do?
- Invoke huge positive feedbacks from water vapor, clouds, whatever sounds plausible to increase predicted warming to 3 C or more from doubling CO_2.
- Affirmative action for CO_2!

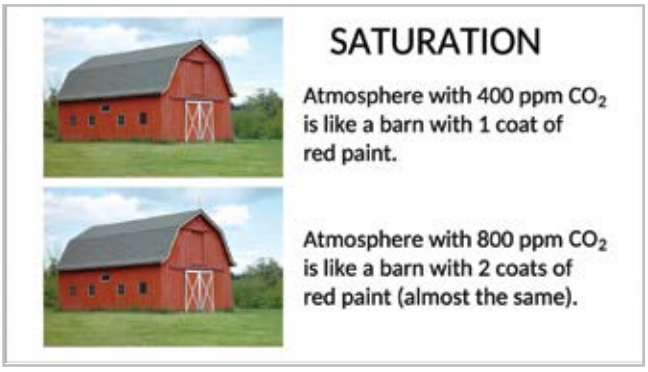
Problem: most natural feedbacks are negative:
Le Chatelier's Principle

When a simple system in thermodynamic equilibrium is subjected to a change in concentration, temperature, volume, or pressure, (1) the system changes to a new equilibrium, and (2) this change partly counteracts the applied change.

Henry Louis Le Chatelier

is so widespread that it even has a special name. It's called Le Chatelier's Principle (See slide, "Le Chatelier's Principle"). So, if the climate system has a positive feedback, it's very anomalous. Most other natural systems have negative feedbacks. So most likely the warming from doubling CO_2 will be less than the 0.7° [Centigrade] that we calculated, if it's like other feedbacks in nature.

The problem is that the CO_2 that's in the atmosphere already is like a coat of paint. If you put a good coat of red paint on a barn, it'll look nice and red. But if you think that's not enough paint and you want to double the amount of paint, like doubling CO_2, if you put a second coat of paint on the barn, it'll look just the same, because the first coat of paint is just good



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enough. There's a maximum amount of pigment that is needed, and if you add more than that, you're simply wasting your money. That's the situation with CO_2. The effects of CO_2 are heavily saturated, just like two coats of paint is no better than one coat of paint….

Less CO_2 Today than Plants Want

Okay. Now I have one more message I'd like to put out, so we'll have time for discussion later. And that is that more CO_2 not only will make almost no difference to climate, but it will be a very significant *benefit* to life, to agriculture and forestry.

The slide ["More CO_2 will be a very significant benefit"] shows a field of soybeans. When I'm giving a talk, I often give a little quiz. I ask, "How do you know that this is genetically modified soybeans?" Every now and then, there's some smart person in the audience who raises their hand and says, "Because there are no weeds." And that's right. This is Roundup Ready soybeans. You can spray them with a herbicide which kills all the weeds. And the soybeans are okay. You get a

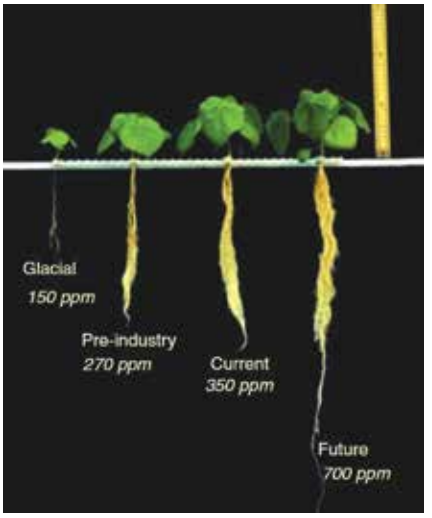
South Carolina Dept. of Agriculture

much better crop without the weeds competing with the soybeans. One of the things that has made food products so cheap, is that. The cleverness of farmers and seed breeders and others in the agricultural industry has just enormously increased agricultural production.

This is one example. Here's what happens if you add more CO_2 to a growing plant. This is a laboratory experiment with a weed. This is velvetleaf. If you're a gardener, you probably have to pull that out of your garden. I do, in New Jersey. This is a common weed, and it grows better with more CO_2. But so does corn. So do beans, so does lettuce. Any plant that is exposed to more CO_2, grows better than one exposed to less CO_2.

This slide ["All Plants Grow Better with More CO_2"] shows plant responses to levels of CO_2. At glacial levels, plants almost die. This picture was made a few years ago when CO_2 levels were 350 [parts per million, ppm]. But as you go up, there's no end in sight. More CO_2 greatly increases plant productivity. Now there are two main reasons for that. Let me review them.

The first and the most important is that plants need less water if there's more CO_2. And the reason for that, I'll show in a later slide. But plants have to make an engineering trade-off between getting enough CO_2 through holes in their leaf, and leaking water back through the same holes. More CO_2 means that plants grow leaves that have fewer holes in them and don't waste much water. There's a more subtle reason: Plants today lose about 25% of their potential efficiency because of photorespiration—that there's so little CO_2 in



All plants grow better with more CO_2 in the air!

Representative plants of Abutilon theophrasti (C_3) grown at glacial through future [CO_2] levels. All plants were 14 days old and were grown under similar water, light, and nutrient conditions. These plants were photographed during a study by Dippery et al. (1995). (Photograph is courtesy of Anne Hartley, Florida Gulf Coast University.)

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the air today compared to what plants are used to, that instead of using CO_2, plants will, by mistake, use oxygen; and instead of making good things, they make bad things, like hydrogen peroxide, ammonia—things that really are not good for the plant. And so the plant has to devote a lot of effort to countering this photorespiration problem.

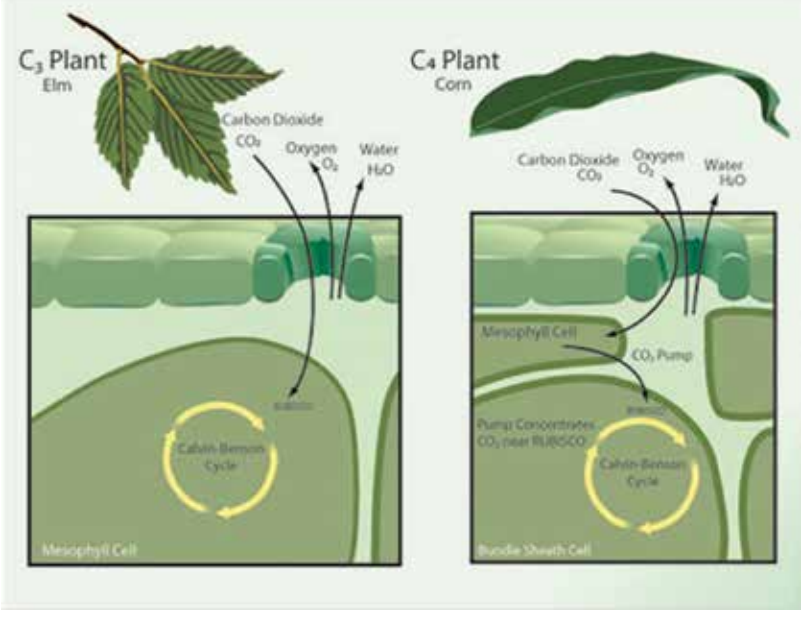
"The Two Main Photosynthetic Pathways" is the basic idea of a plant. The plant has to get CO_2 through the air. It can't get it through the roots. It gets water through the roots, fertilizers through the roots. But all CO_2 has to come through holes in the leaf; and through the same holes, oxygen that's generated by photosynthesis goes back into the air as much as possible, and water vapor leaks back into the air. Typically, 100 water molecules come out of this hole for every CO_2 that comes in. So this is a very leaky and wasteful system for water. So if plants are stressed for water—and over most of the world they are; if you're not in a greenhouse or in tropical rainforest, water is a big problem—the low CO_2 levels have fostered the development of another photosynthetic pathway. Most plants follow this C_3 pathway. It's called that in honor of [Melvin] Calvin, the scientist at Berkeley who worked out all of the photosynthetic pathways back in the 1940s and '50s.

[But] C_4 plants are able to cope with lower amounts of CO_2, like we have today. Examples of C_4 plants are corn and sugar cane. They're important, but, they're a minority. Both types of plants, C_3 and C_4, do much better if there's more CO_2 in the air.

Two main reasons more CO_2 helps plants:

- Plants need less water if there is more CO_2;
- There is less harmful photorespiration with more CO_2. Today C_3 plants lose about 25% of their potential photosynthetic potential due to photorespiration.

The Two Main Photosynthetic Pathways

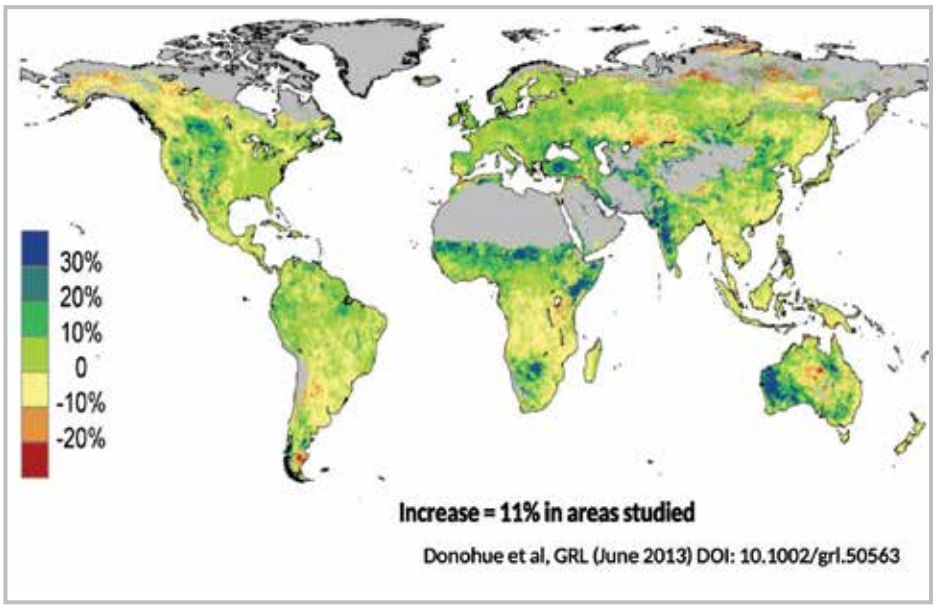


X/BiologyExams4U

I mentioned photorespiration. This may be a little too detailed, but the most abundant protein in the world is called RuBisCO. By weight, this is by far the largest. And that's natural because it's the thing that allows green plants to fix carbon dioxide and convert it into sugar—combining carbon dioxide and water and using energy from the Sun to make sugar. And the machinery that does that is this enzyme RuBisCO.

But RuBisCO was designed when there was no oxygen in the air. And so, by bad luck, it's poisoned by oxygen. Times like today, when there's very little CO_2 compared to geological norms and plenty of oxygen, about 25% of the time, this little machine, instead of doing what it's

Global Greening from CO_2 Fertilization: 1982-2010



supposed to and making sugar, makes things like hydrogen peroxide and oxygen, just by mistake. Plants know about this problem, and they spend a lot of biological energy coping with this.

If you double the CO_2 concentration, then you halve the number of these harmful oxygenation effects…. The map ["Global Greening from CO_2 Fertilization: 1982–2010"] shows satellite pictures of chlorophyll. You can see that the entire world since 1982, to 2010 when this picture was made—and it's even better today—is getting greener and greener. Most of this is from CO_2 fertilization. You can see the fertilization is most important in drier parts of the globe, the dry western United States and Canada, the Sahel in North Africa, the dry western parts of Australia, the Deccan Plateau in India. So, thank God for more CO_2. It's been a major factor in the *increase* in agricultural productivity!

I hope that in our discussion we can talk about some of the causes—how it is possible that CO_2, which is a major benefit to life, has been demonized….

Why should we care? Those of you listening to this, you should care about this, because it's not like astrology. You shouldn't care if people waste their money on horoscopes. It's not going to harm you. It's not going to harm the economy. But if people are carried away with climate hysteria, it will cause enormous harm eventually. So, I'll close with a quote from Dietrich Bonhoeffer:

If I see a madman driving a car into a group of innocent bystanders, then I can't simply wait for the catastrophe and then comfort the wounded and bury the dead. I must try to wrestle the steering wheel out of the hands of the driver.

Many of you know, Dietrich was one of the very few brave clergymen who opposed Hitler and the Nazis. He was doubly brave because he refused to leave his native land of Germany, and he refused to shut up, and so he continued to criticize the atrocities of the Nazi Party. And, alas, he was hung [at Flossenbürg Concentration Camp in 1945—ed.] before it was possible for the allies to rescue him, but he did a lot of good in the meantime.

Questions and Dialogue: What Young People Think

Sare: Okay. Great. Maybe Jason [Ross, Science Advisor to the Schiller Institute—ed.] can join us. I thought I would actually let Jason begin with some thoughts and comments and responses, and then go back to you. Jason?

Jason Ross: Well, I really want to thank Professor Happer for that fantastic presentation…. I think there's a lot of things to take from that. To me, I just think about how all—encompassing this CO_2—or more broadly, this climate issue—has become in discussions all around the world. A couple of days ago, I was speaking with a young woman in Afghanistan who was working on education programs there, to get around some of the difficulties with educating women, and also just education in general in that country, to aid in its development. Among the courses proposed, where she's looking for outside mentors to help her program, she mentioned environmental issues…. We talked about it, and I said, "I don't really think that this should be a priority; CO_2 obviously shouldn't be a priority for a country like Afghanistan at present: Focus on development first." She

understood that, but it's in the air and it's everywhere….

The case that Dr. Happer put forward is very clear, and it is a message that should be gotten across, broadly. I've noticed a lot of people recognize that there's something rotten in the state of climate science. They'll try to avoid the tough issues by simply saying that it's better to invest in improving our climate mastery, than to invest in trying to prevent climate change by stopping CO_2. But the level that's needed, I think, is really what we were able to experience here tonight—going directly at the scientific issue, and seeing that, truly, the emperor has no clothes here.

Prof. Happer: Jason, I thank you for that. A big part of the problem, especially with young people, is that they need a cause that's bigger than themselves. Some of them used to get it from religion. Many don't anymore. "What am I here for? Why am I living? Why am I? I'd like to do something that's significant." And so, of course, they're grasping for things, and, they've been given this phony cause, of saving the planet from CO_2. It's really disgraceful because you have all this enthusiasm. They want to do something good. And instead of doing something good, they're doing something just completely crazed.

This happened during the real Crusades. Disreputable people wandered around Northern Europe, Germany, and France in particular; and they recruited a Children's Crusade [1212 A.D.—ed.], to save the True Cross. And so the poor children went marching off to Palestine. Almost none survived; most of them were killed. But the entrepreneurs who organized this made a lot of money, right? So, not everybody was disappointed with the results. And that's happening today, too, I'm sure. Many, many people are profiting just obscenely from the climate hysteria.

I think that CO_2 will cause a little bit of warming. I just told you; my estimate is, if you double it, it'll be about 0.7°C. If the climate is like other systems, there will be negative feedback. So maybe it's 0.4° or 0.5°.

Ross: Sure. And in terms of achieving political ends, if you have a goal of preventing development or undoing development; if you'd much rather have a country that has a lot of raw materials remain in a poorer state, so that it's less able to assert its sovereignty over those resources, or move up the value chain and do more of transforming those resources into higher level products; and you'd rather just get the raw materials; then preventing development is a fantastic way of achieving that.

Just to reflect on what you just said about how people *do* want a mission, that's true. And how that's perverted with this phony thing. It makes me think about the extent to which a positive vision of the future has to be part of the antidote to taking on the CO_2 myth. There are truly wonderful things that young people *could* be devoting themselves to. We've got a whole universe out there to explore. We've got secrets of the atom that we haven't figured out yet. We've got poverty in the world to eliminate through development. There are a lot of actually useful missions that that young people could profitably, and happily, and meaningfully take on with their lives.

Why Is Less CO_2 a Problem?

Sare: I'd like to bring up a comment and ask you, professor, how *you* would respond. Someone writes, "It's undeniable that human activity causes climate change. The question is how much?" What would you say to that?

Prof. Happer: Well, I guess I would agree with that. I mean, I think that CO_2 will cause a little bit of warming. I just told you; my estimate is, if you double it, it'll be about 0.7°C. If the climate is like other systems, there will be negative feedback. So maybe it's 0.4° or 0.5°. That would be the normal guess.

Sare: Why shouldn't we panic about that?

Prof. Happer: Why shouldn't you panic about a half a degree? Well, look around, people my age. None of us ever moved to Canada. We moved to Mexico or Florida or Texas. Warmer is better.

Sare: You were saying that having less CO_2 creates a stress on plants and causes them to need more water.

The elm leaf in 1850 had 30% or 40% more holes than it does today. It doesn't need as many holes today because there's more CO_2. So, it's losing less water today than it did in 1850. This is all very, very solid stuff, there's just no question that it's happening.

Prof. Happer: Right.

Sare: Where are we getting less CO_2? Is that a problem? And why is that happening?

Prof. Happer: Look at the geological record of CO_2, which you can infer from various proxies, for the last million years or so. Look at bubbles in the Antarctic ice and measure the fraction of CO_2 in the bubbles. You'll find that it fluctuates up and down with the glacial cycles. If you go much further into the past—tens of millions of years—there are other ways to estimate how much CO_2 is there. And so, over most of geological history, CO_2 concentrations have been four or five or six times greater than they are now—measured in several thousand parts per million, not 400 ppm. We're just over 400 ppm now, and that's way, way less than most plants prefer. Greenhouse operators, for example….

Sare: So, you're saying that there used to be a lot more CO_2 in the air?

Prof. Happer: Oh, of course. That's common knowledge to geologists, at least. Maybe not to Al Gore!

If you talk about the social cost of carbon, which lots of people do; if you're honest about it, the social cost is *negative*, because more CO_2 increases agricultural productivity; it's having essentially no effect on climate; and so the net result is a *benefit* to humanity.

If we could get all the CO_2 out of the air and go back to 280 parts per million—pre-industrial levels, we would lose 30 to 40% of agricultural productivity. So, a good fraction of the world would starve to death. So, just feeding the current world population is completely dependent on the increases of CO_2 we've had! There are other factors too. Use of fertilizer has been very important, better seed varieties, but CO_2 has been at least as important as all the rest of those.

Ross: I think it's interesting that what William brought up, about thinking through how the shortage of CO_2 means that plants have to lose more water to get in the amount [of CO_2] that they need. I'm just thinking about the deserts, the map that you showed about the increase in agricultural output due to CO_2. In large parts of the Earth there's hardly any plant life at all. Desalination and these kinds of things are, in my mind, a big part of being able to improve that. But it's really interesting to think about how transforming the CO_2 level in the atmosphere will allow plants to colonize areas that would have been too arid for them at lower levels.

Prof. Happer: Well, that's being observed, Jason. There's not much doubt that that's happening. Look at photographs, for example, of the American West that were taken 150 years ago when the daguerreotypes were just being developed. Then photograph the same area today. It's much greener today than it was in the old photographs. Or you can look at, say, botanical specimens in museums that were collected in the year 1850; and an elm leaf, for example, like the one I showed. You can count the little holes in the leaf, and then you compare it to a leaf today. And you notice that the elm leaf in 1850 had 30 or 40% more holes than it does today. It doesn't need as many holes today because there's more CO_2. So, it's losing less water today than it did in 1850. This is all very, very solid stuff, there's just no question that it's happening.

Ross: One of the museums in San Francisco had an exhibit about the impact of CO_2 on plant growth. The portion of the exhibit was called "Our Itchy Future," because they specifically said, "Oh, poison ivy grows much better when there's more CO_2."

Prof. Happer: It does! It does; but so does wheat and corn. Not everybody, you know, dislikes poison ivy. My wife's parents have a little farm, and their horses just love poison ivy. That's the first thing they eat; I wouldn't dare, but they seem to love it.

What Else Affects Climate?

Sare: Maybe we should talk a little bit about what affects climate more than CO_2.

Prof. Happer: Well, that's a good point, Diane. I think this sort of manic fixation on CO_2 has set back real climate science by 50 years, maybe more. Until the 1980s or '90s, there was a small community of very good people who were studying climate. They were honest, they were imaginative, they were self-critical. They didn't have very much money. And they got many

answers right, with not very much support.

And then money started pouring in from Washington to reinforce the idea that there was an emergency. And so, it was a sort of a Gresham's Law. All of a sudden there was this money to be had. It didn't matter whether you were smart or dumb, you could get the money as long as you promised to come up with some alarming so-called scientific results.

And so, we've got a whole community now that has been degraded, I would say. It's not just climate, it's happened in other areas, too. I'm sure you're familiar with the problems in biomedical research, where most papers, you can't reproduce them, they're not true.

But it's been very bad for climate, and it's been very bad for the science of the field.

My personal view is that [Earth's climate] almost certainly has something to do with the Sun; but the Sun is very subtle. It may not be directly the heat from the Sun. It could well be something to do with the solar magnetic fields affecting cosmic rays. We could have worked a lot of this stuff out faster if we hadn't wasted so much resources on this clearly inadequate dogma that there's only one control knob for climate and that's CO_2. It's just so absurd because *nothing* else in the world has just one control knob. This would be the first time ever if that were the case. Everything has many, many influences acting at the same time, and it's very hard to disentangle one from the other.

And that's true of climate, too. I'm sure greenhouse gases cause a little bit of warming, but they're not the major warming effects, because we've seen warming just as fast as this—even greater—back, say, in the Year 1,000 [A.D.], when it got so warm in Greenland that you could farm it. The Norse settled there, they bought farms, they produced barley and hay and sheep and shipped them back to Iceland and Norway. Two hundred years later, climate took a turn for the worse. Worse, meaning it got colder, right? In general, cold is bad and warming is good. They got frozen out eventually. You can't farm Greenland now. It's still too cold…. These things happen naturally, and they're big [changes], much bigger than the warming we've seen today. Instead of honestly trying to find out why, and, learning better how to cope with it, we've wasted all of this time in hysteria over CO_2.

Ross: I'd actually like to get your take, delving a little more into the role of the Sun. I've been really interested in the cosmo-climatology, the work of Nir Shaviv and others on how the Sun's changing intensity could modulate the impact of cosmic rays acting to cause the formation of clouds. Is that something that you've looked into much?

Prof. Happer: Yes, I have tremendous respect for Nir Shaviv and his colleague Hendrik Svensmark from Denmark. Against all odds, they have made great progress here. And the evidence that they show is very persuasive. You can see very tight correlations between solar activity and the climate. It's much, much better than any correlation with CO_2, where there's practically no correlation. So maybe that's a straw man to fight against. But it's actually pretty good.

I think they're on to something. There are others too, who have alternate theories of how the Sun might affect the climate. But, look out any day. It's the Sun that keeps us warm. Well, we get a tiny amount of heat from geothermal heat, from under our feet. But that's a thousand times less than we get from the Sun. So, it's just not enough to be very important. Except in very special cases.

CO_2 and Arid Regions

Sare: Someone's asking what would be the effect on global CO_2 levels of large-scale irrigation of arid, and large desert areas. What if we started just getting a bunch of water into dry areas? Would that affect the CO_2 level?

Prof. Happer: Well, it's pretty hard to localize CO_2 in any economical way because the Earth's atmosphere is a big place. Whatever CO_2 we release or China releases, it mixes with the air all over the world right away. I think any increases in CO_2, though, will help with arid regions of the world. Agriculture there will improve, yields will improve.

Actually, surprisingly, it's not just dry land. One of the reasons for the fantastic fisheries off the coasts Peru and Ecuador is the upwelling of nutrients, including CO_2. The water that is sucked up from the Humboldt Current there is loaded with CO_2. That's one of the reasons the plants are doing better there. It's another fertilization effect. Nitrate is important. Phosphate is important, but CO_2 is not trivial.

Everything about CO_2 is good. We have 40,000 parts per million of CO_2 in our blood. If you have less than that, it's a real problem. There are clinical syndromes.

Go into a cornfield on any day, by 3:00 in the afternoon if there's no wind, the CO_2 has been sucked out of the air. There's not enough CO_2 for the corn to continue to grow! It's a very dramatic effect. It's also true in the water. By mid-afternoon, in productive seawater or ponds, most of the CO_2 has been used up. That's quite dangerous, actually, for fish farmers, because the CO_2 in the fish farm neutralizes some of the alkalinity that the fish produce—the fish pee ammonia. After a while, a fish pond gets quite basic; it's a little bit like Drano. If the CO_2 was not there to neutralize the alkalinity, it would eventually kill the fish. And that happens, so if you use up all the CO_2—which occurs because of the rapid growth of plants, they just use it up, and the alkalinity goes way up to 9 or 10—your whole crop of catfish die.

Everything about CO_2 is good. We have 40,000 parts per million of CO_2 in our blood. If you have less than that, it's a real problem. There are clinical syndromes.

Sare: If we grew a gigantic new rainforest, would we be using up too much CO_2?

Prof. Happer: Well, now, forests clearly suck up a lot of CO_2, because every Spring, CO_2 levels, especially in the Northern Hemisphere, where there's a lot of land, plummet; they drop by 10, 15, 20 parts per million from early spring to late fall. That's because of the growth of plants in the North. If the Winter didn't come to let them begin to decompose, what you say could happen. We could use up all of the CO_2 and plant life would come to an end.

My friend and colleague Patrick Moore, who was one of the founders of Greenpeace Canada, keeps making the point that, maybe humans have come along just in time to save life on Earth by finally burning some of the fossil fuels which have sequestered CO_2 for so long that it's beginning to be dangerous for plant life….

CO_2 and Plant Transpiration

Sare: Does the reduction in water vapor—this question comes from someone watching—released from plants offset the global warming potential of the increase in CO_2? I think he seems to be asking, is there not some kind of equilibrium where, if you have more CO_2, the plants release less water, which is another warming gas, so maybe you wouldn't get any warming change?

Prof. Happer: Well, that's a good point. Transpiration from plants will decrease a little bit if you add more CO_2 because of the fewer holes in the leaf that we mentioned. I don't think that that will make that much of a difference, because a good fraction of the water in the atmosphere comes from the oceans. It's 70% of the Earth's surface. More CO_2 is not going to make much difference there. Land, too. Much of the water vapor comes from moist soil. That won't be affected very much by transpiration through the leaves. But it will be an effect. Almost everything's an effect at some level. The question is, how big is it? And, should you worry about it, or will it be good, even?

Maybe humans have come along just in time to save life on Earth by finally burning some of the fossil fuels which have sequestered CO_2 for so long that it's beginning to be dangerous for plant life.

Sare: Well, that's the really optimistic thing: there's so much we don't know. At least I find that optimistic. It would be really boring if we knew everything. Why would we be here?

Prof. Happer: Well, Diane, I have to apologize. My internet connection is not the greatest. And had it not been for the snowstorm, I would have taken this from my office. But where's global warming when you need it?

Sare: Well, I want to really thank you for joining me this evening. I think the presentation was very helpful. I hope the people watching will circulate it. The graphics were clear and the discussion excellent. So thank you, both Jason and Dr. Happer. I hope we do this again. And I hope that the world shapes up so we can have more conversations about these matters, and not about who's dying, where, and what weapons we shouldn't be sending someone.

Prof. Happer: I agree with you.