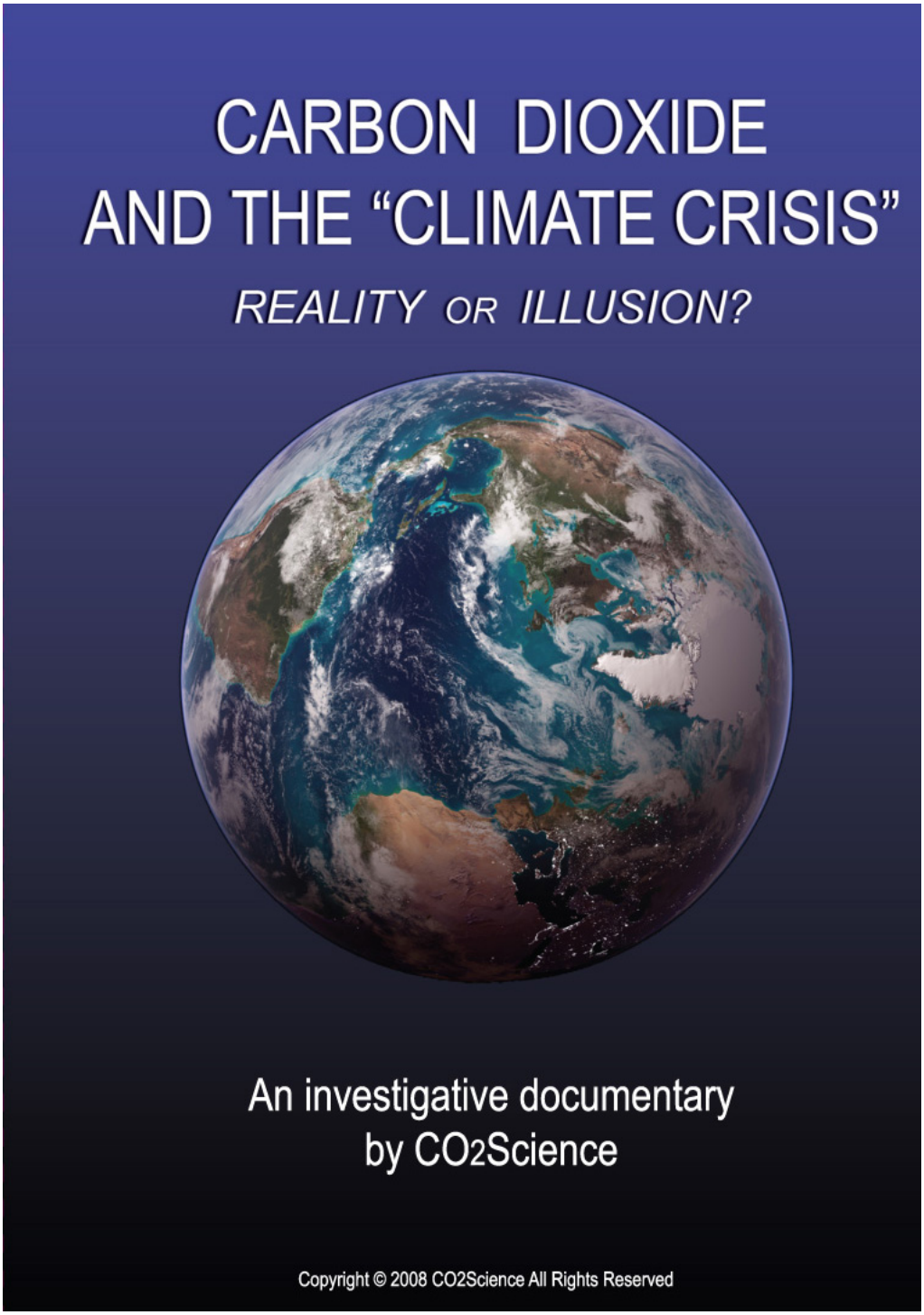
DVD VIDEO TRANSCRIPT WITH PEER-REVIEWED SCIENTIFIC REFERENCES



INTRODUCTION

Al Gore
We are facing a planetary emergency.

John McCain
Climate change is taking place, and it is largely due to human activities which have generated greenhouse gas emissions.

Al Gore
We've literally changed the radiative balance between the earth and the sun.

Barbara Boxer
Global warming poses a serious threat to the world that we know.

Al Gore
More CO_2 means warmer temperatures.

Barbara Boxer
We can expect future catastrophic impacts like more sea level rise, more extreme weather events of all kinds, damage to coral reefs and fisheries which we've already seen, and negative impacts on food production and water supplies.

Al Gore
It's real, we're causing it, mainly.

Hillary Clinton
We can't disregard scientific research, we can't suppress scientific evidence, we can't manipulate scientific advice, we can't politicize scientific panels.

Al Gore
This is a challenge to our moral imagination.

John McCain
Time is not on our side, we must act.

Al Gore
I think that we ought to have an immediate freeze on CO_2 emissions.

Barbara Boxer
We need to act soon, before we reach a tipping point when irreversible changes occur.

Craig Idso
Hello. I'm Craig Idso, Chairman of the Center for the Study of Carbon Dioxide and Global Change. As you have just witnessed in the preceding scenes, talk surrounding *global warming* has reached a frenzied pitch.

On one side of the debate, many scientists, politicians and even religious leaders are sounding alarm bells. These *climate alarmists*, as they have come to be known, insist that humanity's carbon dioxide or CO_2 emissions must be drastically reduced if we are to avoid a global catastrophe of epic proportions, including skyrocketing air temperatures, melting polar ice caps, rapidly rising sea levels, submerged coastal lowlands, numerous species extinctions, and more frequent and stronger droughts, floods and hurricanes.

On the other side of the fence, an ever-growing number of *climate skeptics* contend that rising atmospheric CO_2 concentrations will have little, if any, negative impacts on earth's climate, while actually providing a host of environmental *benefits*, including increased vegetative productivity nearly everywhere on earth, greatly enhanced plant water use efficiency, and elevated yields of essentially all agricultural crops.

Each side is *adamant* that it is correct, and the other is wrong. So who is one to believe?

In what follows, we hope to provide you with what you will need to at least *begin* to cut through much of the hype and hyperbole surrounding the global warming issue. The information we present comes from interviews with scientists who have been involved in the debate, as well as from pertinent research papers published in mainstream scientific journals, the latter of which are the very best sources we possess for discovering the facts that are needed to resolve the controversy. We begin with a brief discussion of what it is that has led to all of the concern about carbon dioxide and global warming, namely, *climate models*.

CLIMATE MODELS

Craig Idso
Because the earth-ocean-atmosphere system is so vast and complex, it is impossible to conduct a small-scale experiment that reveals how the world's climate will change as the air's CO_2 content continues to rise. As a result, scientists *estimate* its response using computer models that define a "virtual" earth-ocean-atmosphere system. To be of any validity, however, these models must incorporate all of the many physical, chemical and biological processes that influence climate in the real world. And they must do so *correctly*.

So how do the models perform in this regard?

Chris de Freitas
The global climate models are really quite blunt instruments. They're next to, they're next to useless for prediction.

Tim Patterson
The biggest problem I see is the mass of parameterization that has to go on with these models. And for example, the difficulty with clouds, dealing with things like clouds;

they can't deal with it. They can't really deal with water vapor. So there's various sorts of parameters in there -- that I think are very significant parts of the climate system -- that just get left out.

John Christy
When it comes to climate models, it's hard to know where to start in terms of finding inadequacies. And, you know, to be just open and fair about this, you have to start somewhere if you want to model the system; and models have been quite helpful in terms of short-range weather forecasts, and telling us what's going to happen specifically in many ways that helps our lives and makes us better. But those processes go haywire after a week or two in the weather forecast models. And think about trying to extend, and they're many analogies here for the long range forecast, that the processes that go haywire in the short term forecast models are also embedded within the long range forecast models. And so having faith in a hundred-year prediction is something that takes a lot of faith.

Robert Balling
We spend billions of dollars a year to construct models and at first glance, I mean they seem very sophisticated: high resolution, appear to resolve countless variables. And then if you go to the library and really read about the models, you find out they're not so good with the way they handle clouds, not very good with the way they handle the interaction of the ocean and the atmosphere; and you find out they're not very good with the precipitation patterns, and they're not very good with surface water balance and energy balance. And then you find out there are fudge factors; and maybe they're not handling the ice as well as they could. You find out basically there are many problems that are well noted.

Tim Patterson
I would think that it's the old adage: "garbage in, garbage out." So, that they're very expensive, these climate models; but it doesn't matter how much money you spend on these things if at the end of the day the results are not accurate. Just because, just because they're giving an output, you're not exactly going to rely on it.

Craig Idso
Clearly, the scientists from whom we have just heard are less than enthusiastic about the climate modeling enterprise as it stands today. But these scientists come from the ranks of the *climate skeptics*. What do researchers who generally *support* the climate-alarmist point of view have to say about the subject?

Some interesting observations have been made by Stephen Schneider,[1] who has explained how "uncertainties compound through a series of modeling steps," where "uncertainties in emissions scenarios feed into uncertainties in carbon-cycle modeling, which feed into uncertainties in climate modeling, which drive an even larger range of uncertain climate impacts." This same phenomenon also occurs as *faulty approximations* and even *outright errors* cascade through layer upon layer of computer calculations, growing ever larger as

they go, much like the proverbial *snowball*, which grows ever more massive as it hurtles down the mountainside.

In addition to this problem, two other climate researchers[2] have indicated that "current models include only a limited set of the necessary components." Think about that, and ask yourself this: How can a model, which includes only a *limited* set of *necessary* components, lay any claim at all to being a valid representation of the real world?

Then there's the problem of *model validation*.

John Christy
You know, one of the things I'm critical of when I think about climate modeling and verification exercises I've seen, is that there will be someone that runs a climate model and then says "look how it compares with the global temperature of the last hundred years." Well here's why that is not science.

There are really only a few changes in the global temperature over the last hundred and fifty years, there's sort of this rise to 1940, this plateauing or falling to 1975 or so, and then a rise since then, so it's like three things that a modeler has to get right, only three. So it's pretty easy how to figure out how to make three things happen with a climate model. You have a climate model that warms, and then you can put in something like aerosols starting around World War II, and that will cause it to cool; and then you put in more greenhouse gases and take away some of the aerosols perhaps, and then cause it to warm. So is that very difficult to do? And so I think calling some of these things climate model "validation situations" is not accurate in a scientific framework.

Craig Idso
Essentially agreeing on this point is another group of researchers,[3] who state that "care should be taken not to over-interpret good agreement between climate models and past observed global mean warming," *because*, as they continue, "with large uncertainties in climate forcings, especially that due to aerosols, agreement when models include all the most important anthropogenic and natural forcings could be obtained fortuitously as a result of … balancing too much (or too little) greenhouse gas warming by too much (or too little) aerosol cooling."

Another sorry state of affairs is described by UK climate modeler Paul Williams[4] of the University of Reading's Centre for Global Atmospheric Modeling, who has written that "the major difficulty of climate modeling stems from the coexistence of climatological phenomena on a vast range of scales," and he states that "the full spectrum of spatial and temporal scales exhibited by the climate system will not be resolvable by models for decades, if ever."

On this point, the world's climate skeptics could not be in better agreement with him.

John Christy

There's a lot we don't know, and when it comes to the climate system, everyone should be very skeptical because the system is so complicated, and can do a number of different things, that we just don't believe things like climate models are tools that are at a point that tell us a whole lot about the long-term future.

Robert Balling
I can't imagine the day would ever come where we would argue that the models are so wonderful. I mean, fifty years from now people will see the models of today as very primitive, and then they'll see their own models as developing, and it's very much in their interest, of course, to say that we need more work. I mean if you said that we're done with the models, there's a lot of people out of work all of a sudden.

John Christy
We are taking on faith the notion that this model is so complete, has every component so perfectly interrelated, that it is going to tell us the truth about the temperature in the future and about the climate in the future. I know how climate, I should say, the climate system is so complex, I can't imagine any model coming close to being able to replicate what it actually does

Craig Idso
In light of these several observations, it should be abundantly clear that we need to look elsewhere than to climate models in order to evaluate the climatic significance of future increases that could occur in the air's CO_2 content, as well as to determine the cause or *causes* of the global warming of the past century or so. Consequently, we turn our attention to a consideration of *earth's climatic history*.

EARTH'S CLIMATIC HISTORY

Craig Idso
In an attempt to depict earth's current temperature as being extremely *high* and, therefore, extremely *dangerous*, climate alarmists typically contend that the planet is currently warmer than it has been at any other time over the past one to two thousand years.[5,6] In fact, James Hansen[7] -- who is perhaps the world's leading scientific figure on the climate-alarmist side of the global warming debate -- has said of a certain location in the Western Equatorial Pacific that "this critical ocean region, and probably the planet as a whole, is approximately as warm now as at the Holocene maximum and within ~1°C of the maximum temperature of the past million years."

Is there any compelling reason to believe these claims about *the entire planet?*

Fred Singer

The idea that the 20th Century is the warmest in the last thousand years doesn't tell you, again, what the cause is. It's just something they tell people to make them believe that something is going on.

Robert Balling
In terms of this recent warming, over the most, I'll say the last three decades, there are people who call it unprecedented. And yet if you go back and look at the temperature record from 1910 to 1940, we've had about the same amount of warming. And if you then believe the proxy reconstructions, it's very likely we had warming at least this great, at least at this rate, a thousand years ago. And we can see a tremendous literature on variations that occurred at the end of the last ice age where the temperature of the earth may have gone up and down in decades far more that what we've seen. So when I look at the warming of the most recent three decades, I'm not looking at it at all as unprecedented.

John Christy
When I hear the statement "unprecedented," I always kind of chuckle to myself, because you can always find a situation in the past that was more extreme than the one you're considering.

Craig Idso
Yes, contrary to a host of climate-alarmist *contentions*, a multitude of real-world data suggests something *vastly* different from what people like Al Gore and James Hansen are trying to tell us about the nature of earth's present warmth.

Tim Ball
If you look at, even with the ice core record of 420,000 years that Jouzel and others produced, it shows you that the last interglacial was warmer than this one, and that was 120,000 years ago. And then you can go back 320,000 years to the previous interglacial and it clearly was warmer.

Craig Idso
Even in *their own paper*, Hansen and his colleagues present data from the Indian Ocean that indicate surface temperatures there some 125,000 years ago, during the prior interglacial, were about 0.75°C *warmer* than they are currently. Likewise, based on data obtained from the Vostok ice core in Antarctica, another of their graphs suggests that temperatures during that earlier period were about 1.8°C warmer than they are now; while data from two sites in the Eastern Equatorial Pacific indicate it was approximately 2.3 to 4.0°C warmer. What is more, a well-known study of the Vostok ice core[8] indicates that large periods of *all four* of the interglacials that preceded the current one were more than 2°C warmer than the peak warmth of the current interglacial.

But we don't have to go nearly so far back in time to demonstrate the *non*-uniqueness of current temperatures.

Tim Patterson

A lot of people don't realize that we are in the middle of a glacial age. And in the last couple of million years there have been thirty three major glaciations occur. So we've just finished one. We are in what's called an interglacial, which lasts about 15,000 years or so. The peak of our interglacial was during something called the Climate Optimum, which was about five to six thousand years ago. And they called it the Climate Optimum, when it was still politically correct to do so, because that was when the major civilizations developed. The Fertile Crescent was a fertile crescent with ample precipitation and so on. So that was probably some 2 to 3 degrees Celsius warmer than it is at the present time. So we're on, very much, on the downside.

George Taylor
The people that study long-term dynamics of the climate, the geologists, the astronomers, and the geophysicists and so on suggest that the warmest time of the Holocene, the period we're in now, occurred about 5,000 years ago. And generally speaking, there has been a decline in temperature since then; and that suggests that as we have seen in the past, that this warm interglacial is likely to end at some point. My fearless forecast for the next several thousand years is it's going to get a lot colder than it is right now. And I would love it if conditions stayed the way they are right now. Then again, that's the way people always are. I think we always assume that right now we're living in the perfect conditions and if it gets warmer or cooler it's a bad thing; but it's always gotten warmer or cooler, because climate always varies on a variety of scales and will continue to do so regardless of what we do.

Craig Idso
Returning again to Hansen and company's *own paper*, of the five sea surface temperature records they display, three of them indicate the mid-Holocene was warmer than it is today. But we needn't go back to even the mid-Holocene to encounter warmer-than-present temperatures, as the Medieval Warm Period, centered on about AD 1100, had *lots* of them.

Robert Balling
There probably are at least a hundred articles that have appeared in the last ten years, from all over the world, showing evidence -- proxy evidence -- that a thousand years ago the earth's temperature was at least as high as, if not higher than, what we have today.

Willie Soon
We're not able to only find conditions happening in Northern Europe, as some would claim that this, "oh this is only a regional phenomenon." It's not true. No, no, no, no. We find the condition in the U.S. southwest, you know, drought conditions. We find it in South American forests. We find it in New Zealand.

Wibjörn Karlén
We have the Indians in Yucatan Peninsula. You can see it in the Africa records in the stalagmites.

Robert Balling

And then you find records from other parts of the world. And once you put this together you think it sure looks like the world was warmer a thousand years ago than it is today.

Craig Idso
And so it likely was. In fact, *every single week* since 1 Feb 2006, we have featured on our website a different peer-reviewed scientific journal article that testifies to the reality of this several-centuries-long period of notable warmth.

The figure you are now viewing, for example, illustrates that the Medieval Warm Period occurred on *all seven of earth's continents*; and for those studies represented by the *blue circles*, where *qualitative* temperature data are available, the peak warmth of the Medieval Warm Period has been determined to have *exceeded* that of the Current Warm Period in over 90% of the identified cases, while for the studies represented by *red squares*, where *quantitative* data are available, the peak warmth of the Medieval Warm Period has been determined to have exceeded that of the Current Warm Period by an average of approximately 0.75°C.

So what's the point we're trying to make here? It is simply this. Today's temperatures are definitely *not* the highest of the past one to two thousand years, nor are they the highest of the current interglacial, nor are they even *close* to rivaling the peak warmth of the past *million* years, in clear contradiction of what Hansen and other climate alarmists claim. Furthermore, during the Medieval Warm Period the air's CO_2 concentration was about 100 parts per million *less* than it is today, *demonstrating* that it is not at all unusual to have warmer temperatures than those of the present, even with much less CO_2 in the air. Consequently, it is our opinion that whatever *natural phenomenon* caused the superior warmth of the Medieval Warm Period -- as well as the warmth of similar century-scale warm intervals that preceded it -- it is *that* phenomenon that has been responsible for earth's recovery from the global chill of the Little Ice Age and the development of the beneficent climate we enjoy today.

But can today's climate really be called *beneficent*? … especially when Al Gore[28,29] and James Hansen,[30] as well as most of the world's other climate alarmists, claim that severe weather phenomena -- including droughts, floods and hurricanes -- have *all* become both more *frequent* and more *severe* in response to what they wrongly characterize as the "unprecedented" global warming of the past century. But is this really the case?

EXTREME WEATHER EVENTS

Madhav Khandekar
Yes, there are pockets of drought and they will always be with us. My contention is that even if we reduce the CO_2 in the atmosphere by 50 or 60 percent, we will still have droughts over North America in the future, we will still have drought over the Sahara region of Africa, we will still have drought in the northwestern parts of India, which is

my home country, or which is my original country. And I think that drought patterns will always be there in some part of the world. Whether they are human activity driven remains to be seen, but more and more studies seem to point out that these are natural cycles and they have nothing to do with human activity or anthropogenic increase of carbon dioxide.

Robert Balling
We could talk about the fear of drought. And there is a fear that we have entered some new megadrought, and we may have. However, if we look back in time there were even bigger droughts that occurred in the Little Ice Age, and there were even bigger droughts that occurred in the Medieval Warm Period. So if I thought the earth was about to cool and I had overwhelming evidence that the earth was about to cool, I'd still predict big droughts in the southwest because I know there were megadroughts in the past during the coldest periods. So, this becomes far too easy. Any day I could find a drought somewhere. And because of that I could say, well, look at all the droughts that are occurring around the world. I don't think any drought pattern seen today is different from the drought patterns we've seen in the past.

Craig Idso
Yes, it's one thing to *claim* earth's weather has worsened; but it's quite another thing to *prove* it. Nevertheless, with climate alarmists contending that both droughts *and* floods become more frequent and severe in response to global warming, one might think that with "both bases covered," so to speak, there is no way they could fail to see at least *one* of their predictions vindicated. Yet, even here their projections widely miss the mark.

A case in point is provided by a turn-of-the-century study[31] of the streamflow records of 78 rivers geographically distributed throughout the greater Asia-Pacific region. Over the period 1936 to 1988, this work revealed that *minimum* river discharges were *unchanged* in 53% of the cases investigated; and where trends did exist, 62% of them were *upward*, indicative of *less drought*. Likewise, *maximum* river discharges were *also* unchanged in more than three-fourths of the cases investigated; but where trends did exist, 72% of them were *downward*, indicative of *less flooding*. Consequently, there was a simultaneous *decrease* in both drought *and* flood conditions, which is something that has also been observed in many other streams and rivers.[32-36]

Sherwood Idso
Additional light on the subject is provided by a radically different type of study that focuses on *soil* conditions. It was conducted by a team of five researchers led by Alan Robock,[37] who pulled together what they describe as "the longest data set of observed soil moisture available in the world." This data set covered the period 1958-2002, and was obtained from 141 stations scattered throughout the Ukraine. It indicated, in their words, that "even though for the entire period there is a small upward trend in temperature and a downward trend in summer precipitation, the soil moisture still has an upward trend for both winter and summer cereals."

Even more impressive is the fact that this phenomenon has been widely observed throughout the earth, as similar results were obtained by an *eight*-member team led by Robock.[38] This study utilized soil moisture data from over *600* stations located in several different countries and climate zones, including the former Soviet Union, China, Mongolia, India and the United States. In this study, as in the previous one, it was again determined, and I quote from them, that "in contrast to predictions of summer desiccation with increasing temperatures, for the stations with the longest records, summer soil moisture in the top one meter has increased while temperatures have risen."

Craig Idso
In light of these many real-world observations, it is abundantly clear that "one of the gravest threats of global warming," to quote Robock's five-member research team, has not only *utterly failed to materialize*, it has actually become *less* of a threat, and over a period of time (1958-2002) in which earth's atmospheric CO_2 concentration rose to levels not seen for hundreds of thousands, if not *millions*, of years.

But what about *hurricanes*?

John Christy
Hurricanes will happen, because they've always happened. And they have not increased in severity or in frequency. We've looked at many, many years of data, 150 years of data, and in some cases there are data going back to 1750, and there's actually a downward trend in those data. So we don't see this catastrophe arising from hurricanes increasing and so on.

Bill Gray
They have shown that from 1975 to 1990, in that fifteen-year period, there were fewer major storms in the various global basins, fewer category 4 and 5 storms (the most intense ones), than there've been since 1990 to 2005. There were more, by almost one and a half times more, a big pick up of major storms. However, there've been a lot of news reports written on this, and they've implied that this is due to global warming. As global warming's come in, it hasn't changed the frequency of the weaker storms, but the intense ones have gotten more intense with time. Well that's just not true, because the satellite data we had in the other global basins wasn't good enough from 1975 to 1990 that they could tell the difference. I visited every global tropical storm center as a survey reporter for the World Meteorological Organization in the late '70s, and I saw what every station had. Many of them didn't have satellite data, or if they had a satellite it didn't work, it needed maintenance. And the people working in there could not, weren't trained, weren't experienced enough to determine whether a storm was a category 4 or 5. So the number of reports of these 4 or 5 storms was just much less in that earlier 15 years from 1975 to 1990 than it was from 1990 to 2005. So they took so many reports in this 15-year period and so many reports here, the curve was up, things must be getting worse. That's fiction. They have not gotten worse. Going back, reanalyzing data, looking at landfall, using other information, a colleague of mine, Phillip Klotzbach, has done this work; and all the global basins, and he's shown that things have not gotten worse.

David Legates
Globally we see local fluctuations. The Atlantic basin seems to have gone into an active phase. The far Pacific, the western Pacific, seems to have actually gone into a senescent phase, and the four other basins seem to show no change whatsoever. If this were a global warming signal, what we should see is an increase in storminess in all six hurricane basins. We really don't see that. So it really says it's much more natural variability that is playing a role here than climate change.

Craig Idso
Nevertheless, and in spite of what you have just heard, there have been dramatic claims of late that there has been a sizeable increase in the frequency and intensity of hurricanes, due *specifically* to the global warming of the latter part of the 20th century.[39,40] However, these assertions are *highly debatable*, and they have been *seriously challenged* in many peer-reviewed papers in numerous scientific journals.[41-51] The preponderance of these analyses clearly indicate that the warmth of the past few decades can *not* be conclusively demonstrated to have led to more numerous and/or stronger tropical cyclones. Although increasing warmth may well lead to more frequent and violent hurricanes in the *virtual* world within which climate *modelers* ply their trade, on the very *real* planet upon which *we* reside, there is as yet *no convincing evidence* for such a relationship.

ICE SHEET DISINTEGRATION

Craig Idso
Changing gears somewhat, we proceed to a consideration of concerns about Greenland and Antarctic Ice Sheet disintegrations. In his book, *An Inconvenient Truth*,[28] Al Gore states that "if Greenland melted or broke up and slipped into the sea -- or if half of Greenland and half of Antarctica melted or broke up and slipped into the sea, sea levels worldwide would increase by between 18 and 20 feet." This catastrophic scenario was hyped even higher, and made to appear more imminent, by James Hansen in his U.S. House of Representatives testimony,[30] wherein he stated "there is increasing realization that sea level rise this century may be measured in meters if we follow business-as-usual fossil fuel emissions."

So what do climate *skeptics* have to say about Greenland melting, or breaking up and slipping into the sea?

John Christy
The testimony of Dr. Hansen revolves around a simple point that Greenland needs to melt in the next 100 years. And so, he happens to believe that there is a trigger that is very, has a very low threshold, that we're going to get to that trigger very soon. Greenland just melts rapidly and sea levels rise about 20 feet in the next hundred years.

Richard Lindzen

Everything has a finite probability; it might be one in a trillion. But, you know, this is where Al Gore and Jim Hansen have really decided to part company with the IPCC, with the ice sheet community, with the specialists, none of whom can see how this can happen. But Al Gore, in what I sometimes refer to as the "revenge of the 'C' student," can see beyond what any scientist can see, and he has an acolyte in Jim Hansen.

John Christy
Yes, there's evidence for much warmer periods in the past. But, in fact, in this current interglacial, the past 10,000 years or so, even just in this period it's been much warmer, especially in the Arctic, than it is now; and we did not have this massive melt off of Greenland. And we're talking about a period of *4,000 years* -- not a hundred years, but 4,000 years of much warmer temperatures, and Greenland survived just fine. And so that catastrophic view will catch a headline, will make a great movie and so on. We just don't have the science and evidence to support such a notion.

Craig Idso
With respect to the *Antarctic* Ice Sheet in the *Southern* Hemisphere, climate skeptics are even *more* adamant in their views about its stability.

John Christy
What we find in Antarctica is that the temperature has actually fallen.

Pat Michaels
Those records show no temperature change or a cooling, depending upon the way you average the data from the mid-1960s to now. In other words, the last 40 years in Antarctica do not show a warming.

Chris de Freitas
But Antarctica, which is a massive continent, is building up ice and cooling in most parts. And that is an uncontroversial fact now, and the IPCC's most recent report confirms that, which shows you there must be a greater truth there, because the IPCC is very much more inclined towards scary scenarios.

Robert Balling
It is so darn cold down there that a little bit of warming just doesn't have an impact. So the IPCC, right in the Executive Summary, says Antarctica is expected to thicken, not retreat. And yet we see never-ending images of some block of ice coming away from the Peninsula as if that's evidence of global warming. That is absolutely silly. Now, again, if you bring this up in the wrong circles, get ready to die on a cross, but that is the reality. And forever I challenge people to just go read the IPCC Executive Summary, or the Summary for Policymakers; and I think they will walk away from that experience shocked at the things the IPCC really says.

Craig Idso
So who is one to believe? … the climate *alarmists* or the climate *skeptics*? In order to make a rational decision, we have to know what the bulk of the scientific studies of the

subject suggest. A good synopsis of this body of evidence is provided in the 16 March 2007 issue of *Science* by Shepherd and Wingham,[52] who review what is known about sea-level contributions arising from wastage of the Antarctic and Greenland Ice Sheets, focusing on the results of 14 different satellite-based estimates of the imbalances of the polar ice sheets that have been derived since 1998. These studies have been of three major types -- standard mass budget analyses, altimetry measurements of ice-sheet volume changes, and measurements of the ice sheets' changing gravitational attraction -- and they have yielded a diversity of values, ranging from an implied sea-level *rise* of 1.0 mm/year to a sea-level *fall* of 0.15 mm/year. Based on their evaluation of these diverse findings, the two researchers conclude that the current "best estimate" of the contribution of polar ice wastage to global sea level change is indeed a *rise*, but of only 0.35 *milli*meters per year, which over a *century* amounts to *less than an inch and a half*, as opposed to the several *meters* suggested by Hansen. And still *other* types of ice sheet studies imply essentially the same thing.[53-56]

So what do actual *sea level data* reveal?

SEA LEVEL TRENDS

James Hansen
"Sea level is already rising at a rate of 3.5 cm per decade and the rate is accelerating"

Craig Idso
Oh *really*? Well, we shall see.

Chris de Freitas
Sea level is rising as we rebound and recover from the last ice age, but the rate of increase hasn't increased. There's been no acceleration

George Taylor
Sea level has been rising for more than 15,000 years. Fifteen thousand years ago at the end of the ice age, the sea level was about 400 feet lower than it is now. And it's because so much of the ice was over the continents in ice sheets that were a mile thick. But as the ice age went away and conditions began to warm up, the ice melted and sea level has risen. And it hasn't stopped rising. If we look over the span of the 15,000 years, what we see is an accelerated rise that began to level off a few thousand years ago.

Robert Balling
The rate of sea level rise has been not steady, but close to steady, for about 8,000 years; and there are variations from that rise that have been linked to anything and everything. However, the articles I've seen up to the recent period have suggested there's no acceleration in sea level rise. That was the IPCC assessment in 2001, that no acceleration had occurred in the rate of sea level rise. But if you notice the 2007 report, they do

suggest that the most recent period has a very slightly greater increase in sea level rise than the previous period. And if you were to go follow up on that, you'll quickly realize that depending on what date you start that calculation and end that calculation, you can make any assessment you want. So I don't think there's an acceleration in sea level rise.

In fact, there was an article out only a year or so ago showing that sea level rise varies considerably; and there were even periods recently where we would go several years with no sea level rise. Then we'd actually see a decline in sea level rise and then it would elevate back up. Like everything else, it sounds so simple: the world's warming, ice sheets are melting, sea level's rising. You go look in the literature of sea level rise, you'll find out that's a very complicated story.

Fred Singer
Sea level is my specialty, and I've been paying a lot of attention to that. It's a very amusing story. The IPCC reports, and we've analyzed all four of them, have lowered their estimates from report to report. We actually have a graph of that, that shows that every report shows a lower future estimate of sea level rise. Maybe they're learning something. However, Jim Hansen is not learning anything. His numbers have become weird. The last thing I've seen from him is an email he sent to *Globe and Mail* in Toronto, in which he predicts a 25-meter rise by the year 2100. That's 82 feet, 82 feet of sea level rise. If you work it, out that's nearly a foot a year, *nearly a foot a year!* How does that compare with reality? Reality is about 2 mm per year, which is less than a tenth of an inch. It just boggles the mind.

Craig Idso
So where does Hansen get his mind-boggling ideas? The answer can be summed up in a single word: *Poseidon*.

Madhav Khandekar
Yes, I realize that some of the satellite data, or what is known as the Poseidon satellite, which measures the sea level surface very carefully, and I am told some altimeter records, they show a certain amount of rise; and I think they have estimated that in the last 15 years the sea level has been rising at a rate of about 2.5 to 2.8 mm per year. But this may be just a short-term rise. I think when you take a long period record like 50 to 100 years, I think it becomes more and more clear that there is no escalated sea level rise.

Craig Idso
With respect to Hansen's claim of a recent significant increase in global sea-level rate-of-rise, Lombard *et al*.[57] note that the larger sea level trends from 1993 to 2003 derived from Topex/Poseidon altimetry data are "mainly caused by thermal expansion," and are "very likely a non-permanent feature." Consequently, they conclude that "we simply cannot extrapolate sea level into the past or the future using satellite altimetry alone." Hence, it is to long-term *coastal tide gauge records* that we *must* turn for a proper evaluation of the claim that the rate of sea level rise is accelerating.

Sherwood Idso

Holgate and Woodworth[58] derived a mean global sea level history from 177 coastal tide gauge records spanning the period 1955-1998, which Holgate[59] extended back in time another half-century by demonstrating that the combination of nine much *longer* tide gauge records was similar enough to the 177-site record, over the period of the two data sets' overlap, to warrant the use of the nine-station record as a reasonable representation of mean *global* sea level for the much longer 1904-2003 period.

Craig Idso
This history is represented by the wavering black line in the figure you are now viewing; and based on that history, Holgate calculated that the mean rate of global sea level rise was "larger in the early part of the last century (2.03 mm/year 1904-1953), in comparison with the latter part of the century (1.45 mm/year 1954-2003)."

Sherwood Idso
Another way of thinking about Holgate's century-long sea level history is suggested by the blue curve I have fit to it, which indicates that mean global sea level may have been rising ever more slowly with the passage of time throughout the entire last hundred years. In any event, and whichever way one looks at Holgate's findings, the nine select tide gauge records indicate that the mean rate of global sea level rise has *not* accelerated over the recent past. In fact, it likely has done just the *opposite* -- in clear contradiction of climate-alarmist claims to the contrary.

Craig Idso
Augmenting the findings of Holgate are those of Jevrejeva *et al*.,[60] who derived long-term sea level trends for 12 large ocean regions, which they *combined* to produce the mean *global* sea level curve depicted in *this* figure. With respect to what they describe as "the discussion on whether sea level rise is accelerating," their results pretty much answer the question in the *negative*; and in further support of this conclusion, they note that Church *et al*.[61] have pointed out that "with decadal variability in the computed global mean sea level" -- such as is evident in this mean global sea level *rate-of-rise* figure developed by Jevrejeva *et al*. -- "it is not possible to detect a significant increase in the rate of sea level rise over the period 1950-2000."

Sherwood Idso
These observations lead me to wonder why late 20th-century global warming -- which climate alarmists describe as having been *unprecedented* over the past two *millennia* or more -- *barely makes a* ***ripple*** in the global sea level data of the two figures we have just seen. And I am even *more* intrigued about the matter in light of the fact that the warming that brought an end to the Little Ice Age ***is*** readily apparent in the *first*, and even the *second*, of the three upward-trending segments of Jevrejeva *et al*.'s global sea level rate-of-rise history.

Likewise, I am perplexed by the fact that although the atmosphere's CO_2 concentration rose at a rate over the last half of the 20th century that was *three and a half times* ***greater*** than the rate at which it rose over the *first* half of the century, the mean global ***sea level*** rate-of-rise did ***not*** trend upwards after 1950, nor has it *subsequently* exceeded its pre-

1950 rate-of-rise. Clearly, therefore, something is very, very *wrong* with the climate-alarmist theory espoused by the likes of Al Gore and James Hansen.

Craig Idso
But that's not *all* that is giving them problems. They also have the embarrassment of what's recently been happening to atmospheric methane concentrations.

ATMOSPHERIC METHANE

Craig Idso
Among the seemingly never-ending list of anxieties about global warming is the concern that rising temperatures will induce rapid melting of Arctic permafrost and release long-sequestered carbon back to the atmosphere as CO_2 and methane, possibly freeing enough of the gases at a sufficiently rapid rate to rival more *direct* anthropogenic emissions and leading to a significant amplification of global warming. What is more, as stated by Al Gore in his testimony before the U.S. Senate: "New evidence shows that it may be even worse than we thought," because "methane is leaking from the Siberian permafrost at five times the predicted levels" and "methane is 23 times as potent a greenhouse gas as carbon dioxide and there are billions of tons underneath the permafrost."

So, is this hypothesis correct? And has the process already been set in motion -- and with a *vengeance* -- as Al Gore suggests?

George Taylor
Now there's not as much methane in the atmosphere, but it had been rising and most policy people and scientists ten years ago said it was rising because of human activities and it was likely to keep rising. Some people even suggested that methane was more important than CO_2.

Pat Michaels
Well, every scientist who did global warming saw an increase in methane, a pretty strong linear increase in methane, from the early 20th century on, and assumed that it was something people were doing, and because people were doing it, that it would continue to increase and increase and increase. And it's a pretty powerful greenhouse gas. It's responsible for, I think in the mid-20th century, about 30 or 40 percent of projected warming. These first projections were made around 1980. Around 1980, the increase in the rate of methane stabilized. Then it began to drop, so that by the time that we get to the early 21st century, there are three years in which the methane concentration of the atmosphere actually dropped below what it was in the year before. If it isn't dropping, it's stabilized. And if you want to ask me why, I'll tell you the three most important words in life are not "I love you," they are "I don't know!" Nor does anyone else, but it stopped.

Fred Singer
I frankly don't understand why it has stopped increasing. It's a mystery; has not been solved. According to my considerations it should go with population growth, and population is still growing.

Craig Idso
Yes, in spite of the loudness of the claims of Al Gore and his minions, the real world of nature seems little impressed with their pronouncements, as does a growing number of scientists; for after rising rapidly subsequent to the start of the Industrial Revolution, the atmosphere's methane concentration has been rising ever more slowly, especially during the supposedly "unprecedented warming" of the last few decades. In fact, since the beginning of the 21st century, the atmosphere's methane concentration has actually *stabilized* -- ceasing to rise any further -- as indicated by data provided by a team of seven scientists,[62] which we have plotted in the figure you are now viewing.

Why are these observations so important? Because there is a widely-held belief[62] that "atmospheric methane's contribution to anthropogenic climate forcing is about half that of CO_2 when direct and indirect components to its forcing are summed," and because all projections of future climate proffered by the IPCC[63] are based upon increasing atmospheric methane for at least the next three decades, many of which scenarios project large increases throughout the entire 21st century. But as you've just seen, reality is *much* different, and such observations have been verified by a number of researchers in subsequent studies.[64-65,70-72]

Nevertheless, and in spite of *all* of the many *real-world observations* supportive of either a *flat* or a *soon-to-be-declining* trend in atmospheric methane concentration, James Hansen contends, in his U.S. House of Representatives testimony,[30] that "greenhouse gases" -- of which methane stands next in importance to CO_2 -- "are skyrocketing," which statement is truly unfathomable, coming from a scientist of his supposed caliber. Yet, he's not the *only* one ignoring reality.

Pat Michaels
Yes, the United Nations projections for the 21st century in their just released 2007 report all have methane increasing. There is one version where it begins to level off around 2050 or something like that, but in most every projection it just continues to increase, even thought it's not.

Fred Singer
They have not yet taken account of the fact that methane increase has stopped. So they're still predicting the rate of increase that has been observed in the past. That obviously is wrong.

Craig Idso
Shifting from primarily *climatic* concerns to those of a predominantly *biological* nature, we next explore the climate-alarmist contention that CO_2-induced global warming will lead to massive extinctions of both plants and animals, on land and in the sea.

LAND AND OCEAN EXTINCTIONS

Craig Idso
Turning once again to the U.S. House of Representatives testimony of James Hansen,[30] we find him claiming that "continued business-as-usual greenhouse gas emissions threaten many ecosystems," and contending even more ominously that "very little additional forcing is needed ... to cause the extermination of a large fraction of plant and animal species." But where is the evidence for these claims?

Robert Balling
There are always going to be winners and losers. I mean if you look at the long history of the earth, plants and animals have come and gone, and come and gone, and it's very likely that will continue. But will there be some mass extinction? I can't believe there would be. Every time I hear about some polar bear or about some butterfly or some bird, I always wonder, so how did they survive the eons that they had to survive? I mean these animals, let's face it, have had to live through ice ages, they've lived through a Medieval Warm Period. They had to live through this Younger Dryas period when the temperature of the earth seemed highly unstable. They all made it somehow. And I believe in the future, that they'll make it again, and that the temperature rise were talking about will undoubtedly impact some ecosystem negatively, but overall I think the evidence is overwhelming that the elevated CO_2 will have positive effects for the biosphere, and that many plants and animals will reap benefits from a slightly warmer world and a place that has more CO_2. So I don't buy into this, all this extinction that's going to occur. It just doesn't seem like the earth would evolve to be so fragile. It strikes me that the earth would evolve and be robust, and that the plants and animals have gone through a lot in the eons they've been here, and they're up to the task of a degree or two of warming that might be in their future.

Fred Michel
And what bothers me in terms of the whole wildlife issue, well, the ecological issue, again I'm not a biologist, but when you look at the proliferation of species and the diversity that we have, it increases when you have warmer temperatures. You can look at it from what kind of ecosystems we have in the Arctic versus what we have in the tropics. The diversity of species is higher in the tropics than it is in the Arctic. Same type of thing when you go from a cold glacial period to a warm interglacial period. So for people to be saying that we're going to lose all these species, we're going to lose our diversification, no; we'll probably have other species filling those niches that are created, and we'll probably end up with a larger diversity of species.

Craig Idso
Nevertheless, *Hansen* says that "animals and plants migrate as climate changes," and so they do, *sometimes*; but he *adds* that in response to *global warming*, and I quote, "polar

species can be pushed off the planet, as they have no place else to go," and that "life in alpine regions ... is similarly in danger of being pushed off the planet." Well, the idea *sounds* logical enough, but is there any *evidence* that such things really happen in the real world? Has any of the vegetation there been "pushed off the planet" in response to the supposedly unprecedented warming of the 20th century?

Keith Idso

A team of three researchers[75] investigated this climate-alarmist scenario in July and August of 2003 by resurveying the floristic composition of the uppermost ten meters of ten mountain summits in the Swiss Alps, applying the same methodology used in earlier surveys that were conducted there in 1905[76] and 1985.[77] This analysis covered the bulk of the Little Ice Age-to-Current Warm Period transition; and it revealed that plants of many species had indeed marched up the sides of the mountains as the earth had warmed. Of even greater significance, however, was the fact that *not a single mountain-top species* was "pushed off the planet." As a result, between 1905 and 1985 the mean number of species observed on the ten mountaintops rose by 86%, while by 2003 it had risen by a whopping 138%, providing, in the words of the researchers who conducted the work, "an enrichment of the overall summit plant diversity."

Sherwood Idso

Another pertinent study was conducted by Kullman,[78] who analyzed altitudinal shifts in the ranges of alpine and subalpine plants during the past century, when air temperatures rose by about 1°C in the mountains of west-central Sweden. This work revealed that since the early 20th century, as he describes it, alpine and subalpine plant species "have shifted upslope by [an] average [of] 200 m." Most importantly, however, he too reports that "no species have yet become extinct from the highest elevations," and he adds that his results "converge with observations in other high-mountain regions worldwide," in support of which statement he cites the results of six additional studies.[79-84]

Craig Idso

Coming down from the mountaintop and peering into the sea, we investigate another extinction scenario promoted by climate alarmists. For some time now they have been predicting that the ongoing rise in the atmosphere's CO_2 concentration will raise havoc with earth's coral reefs and other calcifying organisms, by acidifying the world's oceans and lowering the calcium carbonate saturation state of seawater, which they contend will make it more difficult for such creatures to produce their calcium carbonate skeletons.[85] Hansen claims this phenomenon will lead to the "destruction of coral reefs and other ocean life." However, there is no compelling reason to believe that these entities will be significantly harmed -- much less *destroyed* -- by this phenomenon; for just like the CO_2-induced global warming concept, the CO_2-induced acidification of the world's oceans concept -- and especially its ancillary *deadly consequences* -- is based upon physical-chemical effects that ignore important *biological* phenomena.

So what's the story here? Is there any real-world evidence that can be cited in support of Hansen's strident claims? Climate alarmists certainly make it *appear* such exists, but a

little scientific sleuthing reveals nothing of substance in this regard. In fact, it actually suggests just the *opposite*.

Keith Idso
In a study of calcification rates of massive *Porites* coral colonies found throughout Australia's Great Barrier Reef (GBR), Lough and Barnes[86] added data from Hawaii[87,88] and Thailand[89] to extend the sea surface temperature (SST) range they personally investigated. This analysis indicated that calcification rates were linearly related to temperature in such a way that a 1°C *rise* in average annual SST actually *increased* average annual calcification rate by 0.33 g per cm^2 per year."

Noting that their results "allow assessment of possible impacts of global climate change on coral reef ecosystems," Lough and Barnes further determined that between the two 50-year periods 1880-1929 and 1930-1979, there was a calcification *increase* of 0.06 g per cm^2 per year. And they say that "this increase of ~4% in calcification rate conflicts with the estimated decrease in coral calcification rate of 6-14% over the same time period suggested by Kleypas *et al*.[90] as a response to changes in ocean chemistry." Even more stunning was their observation that between the two 20-year periods 1903-1922 and 1979-1998, the warming-induced *increase* in calcification was about *12%* in the *central* GBR, about *20%* in the *southern* GBR, and as much as *50%* to the *south* of the GBR. And in light of these *real-world observations*, and in stark contrast to the predictions of Hansen and Kleypas *et al*.,[90] the two researchers concluded that coral calcification rates "may have already significantly increased along the GBR in response to global climate change."

Sherwood Idso
Two other scientists[91] investigated the subject via data obtained from a massive *Porites* coral on the French Polynesian island of Moorea. This effort revealed that a 1°C increase in water temperature increased coral calcification rate by 4.5%, leading them to state that "instead of a 6-14% decline in calcification over the past 100 years [as] computed by the Kleypas group, the calcification has increased."

Keith Idso
At about the same time, yet another scientist[92] developed a relationship between coral calcification rates and annual average SSTs based on data collected from colonies of the reef-building coral *Montastraea annularis* at twelve locations in the Gulf of Mexico and the Caribbean Sea. This work revealed that the mean calcification rate in the Gulf of Mexico increased 0.55 g per cm^2 per year for each 1°C temperature increase, while in the Caribbean Sea it increased 0.58 g per cm^2 per year, which result is nearly *twice as great* as that obtained by Lough and Barnes for *Porites* corals. And further pooling these data with those obtained for still other coral species at Belize,[93] the U.S. Virgin Islands,[94] and the Netherlands Antilles,[95] he obtained a more all-inclusive relationship of ~0.5 g per cm^2 per year for each 1°C increase in annual average SST.

Sherwood Idso

To these papers can be added many others[96-101] that also depict increasing rates of coral calcification in the face of rising temperatures and atmospheric CO_2 concentrations. As for *why* this is the way earth's corals respond, McNeil *et al*.[102] say that "observed increases in coral reef calcification with ocean warming are most likely due to an enhancement in coral metabolism and/or increases in photosynthetic rates of their symbiotic algae," as we have consistently stated on our website when noting, over and over, that coral calcification is a *biologically-driven* process that can overcome physical-chemical limitations, which in the *absence of life* would appear to be insurmountable.

Keith Idso
One more reason for not believing that the ongoing rise in the atmosphere's CO_2 content will lead to reduced oceanic pH in the vicinity of the world's coral reefs, and thereby lower their calcification rates, is that the same phenomenon that powers the twin processes of coral calcification and phytoplanktonic growth -- namely, photosynthesis -- tends to *increase* the pH of marine waters.[103-108] And this phenomenon has been shown to have the ability to dramatically increase the pH of the world's marine bays, lagoons and tidal pools,[103,104,107,108] as well as significantly enhance the surface-water pH of areas as large as the North Sea.[105]

Sherwood Idso
Another research team[109] determined the original growth rates of long-dead Quaternary corals found in limestone deposits of islands in the Wakatobi Marine National Park of Indonesia, after which they compared them to the growth rates of present-day corals of the same genera living in the same area. This work revealed that the Quaternary corals appeared to have grown "in a comparable environment to modern reefs," except, of course, for the air's CO_2 concentration, which is currently higher than it has been at any other time throughout the entire Quaternary, which covers the past 1.8 million years. Interestingly, their measurements indicated that the radial growth rates of the modern corals were 31% *greater* than those of their ancient predecessors in the case of *Porites* species, and *34% greater* in the case of *Favites* species.

Craig Idso
Clearly, the impact of the historical increase in the atmosphere's CO_2 concentration on the corals in question has not been as catastrophically negative as climate alarmists suggest it should have been. In fact, the increase in the CO_2 content of the modern atmosphere appears to *not have been negative* ***at all***. In fact, it appears to have been *positive*.

Up to this point, we have focused all of our attention on refuting the major negative consequences of the CO_2-induced global warming hypothesis, *demonstrating* that these "doomsday scenarios" are largely unsubstantiated and typically blown way out of proportion, compared to whatever *sliver of reality* they might possibly contain, such that the ongoing rise in the air's CO_2 content is portrayed by the likes of Al Gore and James Hansen as the *absolute worst thing* that could ever happen to the earth. What these people *fail* to tell you, however, is that there's an *equally* horrific, but much more *real* danger awaiting the earth, if the air's CO_2 content is *not* allowed to continue to rise.

FEEDING HUMANITY

Craig Idso

How much land can ten billion people spare for nature? This provocative question was posed by Paul Waggoner[110] in an essay where he explored the tension that exists between the need for land to grow the crops that sustain mankind, and the need for land to support the natural ecosystems that sustain all other creatures. This challenge of meeting our future food needs, while not destroying the rest of the terrestrial biosphere in the process, was also stressed by Huang *et al*.,[111] who note that humans "have encroached on almost all of the world's frontiers, leaving little new land that is cultivatable." And because of humanity's usurpation of this most basic of natural resources, Peter Raven[112] stated in his 2002 Presidential Address to the American Association for the Advancement of Science that "species-area relationships, taken worldwide in relation to habitat destruction, lead to projections of the loss of fully two-thirds of all species on earth by the end of this century."

In a more detailed analysis of the nature and implications of this impending "global land-grab" -- which moved it closer to the present by a full half-century -- Tilman *et al*.[113] concluded that the task of meeting the *doubled world food demand*, which they calculated would exist in the year 2050, would likely exact a toll that "may rival climate change in environmental and societal impacts." But how could something so *catastrophic* manifest itself so *soon*?

Keith Idso

Tilman and his nine collaborators note that at the end of the 20th century mankind was already appropriating "more than a third of the production of terrestrial ecosystems and about half of usable freshwaters." Now, think of *doubling* those figures, in order to meet the doubled global food demand Tilman *et al*. foresee for the year 2050. The results suggest that *a mere four decades from now* mankind will be appropriating more than *two thirds* of terrestrial ecosystem production, as well as *all* of the planet's remaining usable freshwater, a problem that has also been forseen by Wallace.[114]

Sherwood Idso

In terms of *land* devoted to agriculture, Tilman *et al*. calculate a much less ominous 18% increase by the year 2050. However, because most developed countries are projected to withdraw large areas of land from farming over the next few decades, the loss of natural ecosystems to crops and pastures in *developing* countries will amount to about *half* of their remaining suitable land, which would, in the words of the Tilman team, "represent the worldwide loss of natural ecosystems larger than the United States." What is more, they say that these land usurpations "could lead to the loss of about a third of remaining tropical and temperate forests, savannas, and grasslands." And in a worrisome reflection

upon the consequences of these land-use changes, they remind us that "species extinction is an irreversible impact of habitat destruction."

Craig Idso
So what can be done to avoid this horrific situation?

Keith Idso
In a subsequent analysis, Tilman and a *second* group of coauthors[115] pretty much stated the obvious when writing that "raising yields on existing farmland is essential for 'saving land for nature'," and they proposed a strategy to achieve this goal that focuses on three essential efforts: increasing crop yield per unit of *land area*, increasing crop yield per unit of *nutrients applied*, and increasing crop yield per unit of *water used*. In this regard, however, Tilman and his *first* set of collaborators had already concluded that "even the best available technologies, fully deployed, cannot prevent many of the forecasted problems." This was also the conclusion of a study we conducted,[116] wherein we found that although "expected advances in agricultural technology and expertise will significantly increase the food production potential of many countries and regions," these advances "will not increase production fast enough to meet the demands of the even faster-growing human population of the planet."

Craig Idso
So how can we prevent this unthinkable catastrophe from occurring, when it has been concluded by highly-credentialed researchers, writing in the most prestigious scientific journals, that the earth possesses insufficient land and freshwater resources to forestall it, as things stand currently?

Indur Goklany
The way we deal with that is to reduce agriculture's use of land and water. And the way we do that is we make agriculture more productive per unit of land, per acre of land, and per liter of water. And that is something if we were to do, it would make nature more resilient. And that's how we can help nature adapt. And when we do that we get a lot of "core benefits," which is a fancy way of saying ancillary benefits that will help human beings. So you can, for example, if we increase the productivity of agriculture with respect to either land or water, one of the things that it will provide us, it will provide us with more food on less land. Well let me tell you, more food is the first thing we need if you want to reduce hunger. More food means lower prices. Lower prices mean fewer people go hungry because they can't afford it. That is the best distribution for getting food to people. It works even better than government moving food from place to place, and this way we can kill two birds with one stone. We can benefit nature and we can benefit humanity.

Chris de Freitas
One of the ironies about issues surrounding carbon dioxide, carbon dioxide is not a pollutant. There's no way in a month of Sundays that carbon dioxide is a bad thing. In fact, carbon dioxide is like oxygen for plants. It's food. Plants use carbon dioxide and convert it into solid carbon, if you like, *biomass*. And the level of carbon dioxide in the

atmosphere, the current level, is well below the optimum level for plants. In fact, commercial greenhouse users inject carbon dioxide into their greenhouses. So from a plant's point of view, an increase in carbon dioxide up to a doubling, round about between 800 or 900 ppm, which is over twice what we currently have, is a good thing, because plant growth would be enhanced. And the plants that benefit most are the ones that are suffering, the plants that are nutrient-stressed or water-stressed.

Ross McKittrick
It's very important to remember that CO_2 is not a pollutant. It's not sulfur dioxide, it's not soot, it's not carbon monoxide. It's a natural part of the atmosphere, it's part of our own respiration, and it's plant food.

Craig Idso
Yes! Although the task of adequately feeding humanity some four decades from now may seem next to impossible to accomplish without stealing from nature most of the farmable land and freshwater resources on the face of the planet, *it can be done*; for we have a powerful ally in the ongoing rise in the atmosphere's CO_2 concentration that *can provide* what we can't.

So how does it work?

Keith Idso
Since atmospheric CO_2 is the basic "food" of nearly all plants, the more of it there is in the air, the better they function and the more productive they become. For a 300-ppm increase in the atmosphere's CO_2 concentration, for example, the productivity of earth's herbaceous plants rises by something on the order of 30%,[117,118] while the productivity of its woody plants rises by something on the order of 50%.[119,120] Consequently, as the air's CO_2 content continues to rise, so too will the productive capacity or *land-use efficiency* of the planet continue to rise, as the *aerial fertilization effect* of the upward-trending atmospheric CO_2 concentration boosts the growth rates and biomass production of nearly all plants in nearly all places.

Sherwood Idso
Elevated atmospheric CO_2 concentrations also increase plant *nutrient-use efficiency* in general -- and *nitrogen-use efficiency* in particular -- as well as plant *water-use efficiency*, as may be verified by perusing the many reviews of scientific journal articles dealing with these topics that are archived in our website's Subject Index. Consequently, with respect to fostering *all three* of the plant physiological phenomena that Tilman *et al*. contend are needed to prevent the catastrophic consequences they otherwise foresee just a few short decades from now, a continuation of the current upward trend in the air's CO_2 content would appear to be, not just *good*, but ***essential***.

Craig Idso
In the case we are considering here, the degree of crop yield enhancement likely to be provided by the increase in atmospheric CO_2 concentration expected to occur over the first half of the 21st century has been calculated[116] to be *sufficient* -- but only by the

slightest of margins -- to compensate for the huge differential that would otherwise be expected to prevail between the supply and demand for food earmarked for human consumption in the year 2050. Consequently, not interfering with the natural course of technological development, that is to say, not mandating reductions in anthropogenic CO_2 emissions, would appear to be the *only way* we will ever be able to produce sufficient agricultural commodities to support the human population of the globe just a few short decades from now *without the taking of unconscionable amounts of land and freshwater resources from nature and decimating the biosphere in the process*.

But are we the only people who think this way? Of course not.

Indur Goklany
One of the arguments that has been made with respect to adaptation is that human beings can adapt but natural systems cannot. And, you know, that's a very good point. But I think it is also possible for human beings to ensure that natural systems become more resilient. What am I talking about? The greatest threat for terrestrial biodiversity is the fact that human beings are using land for agriculture. The greatest threat for freshwater biodiversity is that human beings are using water for agriculture. So agriculture and its use of land and water are the greatest threats for biodiversity in general.

John Christy
You know when people think about carbon dioxide there are so many upsides, so many good benefits from the fact that it is in the atmosphere, that the notion of adapting to climate change seems like a pretty easy prospect given the benefits that energy has brought to our lives and the extra CO_2 has done for the biosphere. In fact, because CO_2 was much higher in the past, I've seen one presentation in particular that the world was almost going into CO_2 starvation during this current epoch. And, were it not for the extra CO_2 that the humans have put back into the atmosphere, and I like to say put back into the atmosphere because that's accurate, that there would have been more stress placed upon the plant world, and certainly on food production for people.

CONCLUDING REMARKS

Craig Idso
Before concluding our presentation, it is important to note that near the conclusion of his testimony to the U.S. Senate, Al Gore declared that "this is a moral moment." So also in his testimony to the U.S. House of Representatives did James Hansen declare that we cannot shrink from our moral responsibilities to "preserve the planet for future generations." In these sentiments, both the politician and the scientist are correct. But we have to ask ourselves: *what*, exactly, *is* the *moral thing to do*?

Sherwood Idso

Can any amount of ethical training *alone*, or any amount of *religious* training alone, tell us how to act in light of the two opposing views we have discussed today? The answer is a resounding ***No!*** -- for until one knows the *truth* of what scientists are trying to discover about the subjects in question, one cannot act in a truly moral fashion.

Consider, for example, the fact that climate alarmists contend that morality *dictates* that we dramatically reduce our CO_2 emissions in order to prevent an unprecedented warming of the globe that they claim will lead to innumerable species extinctions, but that ***we*** suggest that morality dictates that we ***not*** interfere with anthropogenic CO_2 emissions, because they will *not* cause significant global warming, and because they are actually *needed* to ***prevent*** the extinctions of innumerable plant and animal species.

Craig Idso
And that is why it is so very important for *everyone* to carefully consider *all* of the hard-won *scientific evidence* pertaining to these subjects. One has to know which of these diametrically-opposed worldviews is correct. *Nothing else matters.* Funding sources, ideologies, politics -- even the climate-alarmist self-proclaimed *scientific consensus*, for which the 2007 Nobel Peace Prize was awarded -- they *all* fade into insignificance when confronted with *real-world observations* of the many phenomena in question, ***or*** when confronted with the *lack* of evidence for these things. Consequently, to be *truly* moral demands that we strive to evaluate the pertinent facts of the matters in question, that we might thereby decide which of the two opposing views -- that of the climate alarmists or that of the climate skeptics -- comes *closest* to what each of us deems to be the *truth*.

Sherwood Idso
Clearly, *morality* cannot operate in a vacuum devoid of *knowledge*. Only when we *know the truth* -- and better make that the *whole* truth -- can we act in a truly moral way. And that is why we have produced this DVD, to help you focus on what is actually *known* about carbon dioxide and global change, and to help you identify what is mere *speculation*, however complex or sophisticated that speculation might be. We hope our efforts may have been of some help to you in drawing your own conclusions about these very important matters.

Calvin Beisner
Good stewardship is not founded upon falsehood. The issue is not what feels good. The issue is not what makes me feel good. It's not motivation or anything else. People with fine motives are on both sides of this. The issue is what's true; what is best supported by the scientific data, not by counting votes, which really has no place in science. Science is not a matter of consensus, it's a matter of evidence.

John Christy
When people talk about the moral issue of controlling carbon dioxide emissions, I say: "Yes, that's right; it *is* a moral issue." In 1900, the energy technology of the day supported 56 billion human-life years. That's 1.6 billion people times 35 years life expectancy -- 56 billion human-life years. The average person lived to 35. Now, the

energy technology supports about 450 billion human-life years. That is an 8-fold increase in the experience of human life; and that is a *spectacular achievement*.

I am a grandfather now; and when my little grandson runs up and hugs me around the knees, I am experiencing something in human life that 100 years ago the average person could not, at all. And so this experience of human life that's been granted to us by energy technology is tremendous and wonderful. Therefore, the moral issue here is that we should provide for people who do not have it, *energy*, so that they can experience life that is safer, that is healthier, and that is longer. *That's* the moral issue.

Craig Idso
And *we can do it* … and we can simultaneously *preserve the world of nature*, with the *help* of what we often call the "elixir of life" -- *carbon dioxide*.

SHORT INTERLUDE

Craig Idso
In closing, we hope that you have found the information we have presented in this DVD to be of help to you in your quest for the truth, and that you will share what you have learned with others.

Because of the many and varied aspects of the global warming debate, we could only discuss a few of them in this *introductory presentation*, and at that only briefly. Hence, we'd like to direct you to our website, www.co2science.org, where you can access a transcript of this DVD that provides complete citations for the 120 scientific journal articles that are the sources of the information described in the footnoted statements.

In the not-too-distant future, you will also be able to order *new* DVDs at our website. These presentations will be devoted to a number of related subjects, where we will be able to address the pertinent science in much more detail. In the meantime, you may peruse the vast collection of written materials we have archived in our Subject Index, which pertain to a wide range of relevant topics.

REFERENCES

1. Schneider, S.H. 2001. What is "dangerous" climate change? *Nature* **411**: 17-19.

2. O'Neill, A. and Steenman-Clark, L. 2002. The computational challenges of Earth-system science. *Philosophical Transactions of the Royal Society, Series A* **360**: 1267-1275.

3. Stott, P.A., Mitchell, J.F.B., Allen, M.R., Delworth, T.L., Gregory, J.M., Meehl, G.A. and Santer, B.D. 2006. Observational constraints on past attributable warming and predictions of future global warming. *Journal of Climate* **19**: 3055-3069.

4. Williams, P.D. 2005. Modeling climate change: the role of unresolved processes. *Philosophical Transactions of the Royal Society, Series A* **363**: 2931-2946.

5. Mann, M.E., Bradley, R.S. and Hughes, M.K. 1999. Northern Hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations. *Geophysical Research Letters* **26**: 759-762.

6. Mann, M.E. and Jones, P.D. 2003. Global surface temperatures over the past two millennia. *Geophysical Research Letters* **30**: 10.1029/2003GL017814.

7. Hansen, J., Sato, M., Ruedy, R., Lo, K., Lea, D.W. and Medina-Elizade, M. 2006. Global temperature change. *Proceedings of the National Academy of Sciences USA* **103**: 14,288-14,293.

8. Petit, J.R., Jouzel, J., Raynaud, D., Barkov, N.I., Barnola, J.-M., Basile, I., Bender, M., Chappellaz, J., Davis, M., Delaygue, G., Delmotte, M., Kotlyakov, V.M., Legrand, M., Lipenkov, V.Y., Lorius, C., Pepin, L., Ritz, C., Saltzman, E., and Stievenard, M. 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature* **399**: 429-436.

9. Bernabo, J.C. and Webb III, T. 1977. Changing patterns in the Holocene pollen record of northeastern North America: A mapped summary. *Quaternary Research* **8**: 64-96.

10. Wijmstra, T.A. 1978. Paleobotany and climatic change. In: *Climatic Change*, J. Gribbin (Ed.), Cambridge University Press, New York, NY.

11. Davis, M.B., Spear, R.W. and Shane, L.C.K. 1980. Holocene climate of New England. *Quaternary Research* **14**: 240-250.

12. Ritchie, J.C., Cwynar, L.C. and Spear, R.W. 1983. Evidence from north-west Canada for an early Holocene Milankovitch thermal maximum. *Nature* **305**: 126-128.

13. Overpeck, J.T. 1985. A pollen study of a late Quaternary peat bog, south-central Adirondack Mountains, New York. *Geological Society of America Bulletin* **96**: 145-154.

14. Kearney, M.S. and Luckman, B.H. 1983. Holocene timberline fluctuations in Jasper National Park, Alberta. *Science* **221**: 261-263.

15. Hope, G.S., Peterson, J.A., Radok, U. and Allison, I. 1976. *The Equatorial Glaciers of New Guinea*. Balkema, Rotterdam.

16. Porter, S.C. and Orombelli, G. 1985. Glacial concentration during the middle Holocene in the western Italian Alps: Evidence and implications. *Geology* **13**: 296-298.

17. Webb, T., Bartlein, P.J. and Kutzbach, J.E. 1987. Climatic change in eastern North America during the past 18,000 years: Comparisons of pollen data with model results. In: *North America and Adjacent Oceans During the Last Deglaciation*, W.F. Ruddiman and H.E. Wright, Jr. (Eds.), *The Geology of North America*, v. K-3. Geological Society of America, Boulder, CO, pp. 447-462.

18. COHMAP Members. 1988. Climatic changes of the last 18,000 years: Observations and model simulations. *Science* **241**: 1043-1052.

19. Bartlein, P.J., Webb, T., III. and Fleri, E. 1984. Holocene climatic change in the northern Midwest: Pollen-derived estimates. *Quaternary Research* **22**: 361-374.

20. Webb, T. 1985. Holocene palynology and climate. In: *Paleoclimate Analysis and Modeling*, A.D. Hecht (Ed.), Wiley-Interscience, New York, NY, pp. 163-196.

21. Huntley, B. and Prentice, C. 1988. July temperatures in Europe from pollen data 6000 years before present. *Science* **241**: 687-690.

22. Velitchko, A.A. and Klimanov, V.A. 1990. Climatic zonality of the northern hemisphere 5 or 6 thousand years B.P. *Proceedings of the USSR Academy of Sciences, Geographical Series*, **5**: 38-52.

23. Korotky, A.M., Pletnev, S.P., Pushkar, V.S., Grebennikova, T.A., Raszhigaeva, N.T., Sahebgareeva, E.D. and Mohova, L.M. 1988. *Development of Natural Environment of the Southern Soviet Far East (Late Pleistocene-Holocene).* Nauka, Moscow, USSR.

24. Taira, K. 1975. Temperature variation of the "Kuroshio" and crustal movements in eastern and southeastern Asia 7000 years B.P. *Palaeogeography, Palaeoclimatology, Palaeoecology* **17**: 333-338.

25. Raymo, M.E., Ganley, K., Carter, S., Oppo, D.W. and McManus, J. 1998. Millennial-scale climate instability during the early Pleistocene epoch. *Nature* **392**: 699-702.

26. Oppo, D.W., McManus, J.F. and Cullen, J.L. 1998. Abrupt climate events 500,000 to 340,000 years ago: Evidence from subpolar North Atlantic sediments. *Science* **279**: 1335-1338.

27. McManus, J.F., Oppo, D.W. and Cullen, J.L. 1999. A 0.5-million-year record of millennial-scale climate variability in the North Atlantic. *Science* **283**: 971-974.

28. Gore, A. 2006. *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. Roldale, Emmaus, PA, USA.

29. Gore, A. 2007. Testimony of the Honorable Al Gore before the United States Senate Environment & Public Works Committee, presented 21 March 2007.

30. Hansen, J. 2007. Testimony of James E. Hansen before the United States House of Representatives Select Committee of Energy Independence and Global Warming entitled "Dangerous Human-Made Interference with Climate," presented 26 April 2007.

31. Cluis, D. and Laberge, C. 2001. Climate change and trend detection in selected rivers within the Asia-Pacific region. *Water International* **26**: 411-424.

32. Knox, J.C. 2001. Agricultural influence on landscape sensitivity in the Upper Mississippi River Valley. *Catena* **42**: 193-224.

33. Molnar, P. and Ramirez, J.A. 2001. Recent trends in precipitation and streamflow in the Rio Puerco Basin. *Journal of Climate* **14**: 2317-2328.

34. Novotny, E.V. and Stefan, H.G. 2006. Stream flow in Minnesota: Indicator of climate change. *Journal of Hydrology* **334**: 319-333.

35. Lins, H.F. and Slack, J.R. 1999. Streamflow trends in the United States. *Geophysical Research Letters* **26**: 227-230.

36. Douglas, E.M., Vogel, R.M. and Kroll, C.N. 2000. Trends in floods and low flows in the United States: impact of spatial correlation. *Journal of Hydrology* **240**: 90-105.

37. Robock, A., Mu, M., Vinnikov, K., Trofimova, I.V. and Adamenko, T.I. 2005. Forty-five years of observed soil moisture in the Ukraine: No summer desiccation (yet). *Geophysical Research Letters* **32**: 10.1029/2004GL021914.

38. Robock, A., Vinnikov, K.Y., Srinivasan, G., Entin, J.K., Hollinger, S.E., Speranskaya, N.A., Liu, S. and Namkhai, A. 2000. The global soil moisture data bank. *Bulletin of the American Meteorological Society* **81**: 1281-1299.

39. Emanuel, K. 2005. Increasing destructiveness of tropical cyclones over the past 30 years. *Nature* **436**: 686-688.

40. Webster, P.J., Holland, G.J., Curry, J.A. and Chang, H.-R. 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. *Science* **309**: 1844-1846.

41. Klotzbach, P.J. 2006. Trends in global tropical cyclone activity over the past twenty years (1986-2005). *Geophysical Research Letters* **33**: 10.1029/2006GL025881.

42. Landsea, C.W., Harper, B.A., Hoarau, K. and Knaff, J.A. 2006. Can we detect trends in extreme tropical cyclones? *Science* **313**: 252-254.

43. Landsea, C.W. 2005. Hurricanes and global warming. *Nature* **438:** 10.1038/nature04477.

44. Chan, J.C.L. 2006. Comment on "Changes in tropical cyclone number, duration, and intensity in a warming environment." *Science* **322**: 1713-1713b.

45. Kossin, J.P., Knapp, K.R., Vimont, D.J., Murnane, R.J. and Harper, B.A. 2007. A globally consistent reanalysis of hurricane variability and trends. *Geophysical Research Letters* **34**: 10.1029/2006GL028836.

46. Ren, F., Wu, G., Dong, W., Wang, X., Wang, Y., Ai, W. and Li, W. 2006. Changes in tropical cyclone precipitation over China. *Geophysical Research Letters* **33**: 10.1029/2006GL027951.

47. Li, Y., Wang, X., Yu, R. and Qin, Z. 2007. Analysis and prognosis of tropical cyclone genesis over the western North Pacific on the background of global warming. *Acta Oceanologica Sinica* **26**: 23-34.

48. Donnelly, J.P. and Woodruff, J.D. 2007. Intense hurricane activity over the past 5,000 years controlled by El Niño and the West African Monsoon. *Nature* **447**: 465-468.

49. Garcia-Herrera, R., Gimeno, L., Ribera, P. and Hernandez, E. 2005. New records of Atlantic hurricanes from Spanish documentary sources. *Journal of Geophysical Research* **110**: 1-7.

50. Nyberg, J., Malmgren, B.A., Winter, A., Jury, M.R., Kilbourne, K.H. and Quinn, T.M. 2007. Low Atlantic hurricane activity in the 1970s and 1980s compared to the past 270 years. *Nature* **447**: 698-701.

51. Nott, J., Haig, J., Neil, H. and Gillieson, D. 2007. Greater frequency variability of landfalling tropical cyclones at centennial compared to seasonal and decadal scales. *Earth and Planetary Science Letters* **255**: 367-372.

52. Shepherd, A. and Wingham, D. 2007. Recent sea-level contributions of the Antarctic and Greenland Ice Sheets. *Science* **315**: 1529-1532.

53. Howat, I.M., Joughin, I. and Scambos, T.A. 2007. Rapid changes in ice discharge from Greenland outlet glaciers. *Science* **315**: 1559-1561.

54. Anandakrishnan, S., Catania, G.A., Alley, R.B. and Horgan, H.J. 2007. Discovery of till deposition at the grounding line of Whillans Ice Stream. *Science* **315**: 1835-1838.

55. Alley, R.B., Anandakrishnan, S., Dupont, T.K., Parizek, B.R. and Pollard, D. 2007. Effect of sedimentation on ice-sheet grounding-line stability. *Science* **315**: 1838-1841.

56. Anderson, J.B. 2007. Ice sheet stability and sea-level rise. *Science* **315**: 1803-1804.

57. Lombard, A., Cazenave, A., Le Traon, P.-Y. and Ishii, M. 2005. Contribution of thermal expansion to present-day sea-level change revisited. *Global and Planetary Change* **47**: 1-16.

58. Holgate, S.J. and Woodworth, P.L. 2004. Evidence for enhanced coastal sea level rise during the 1990s. *Geophysical Research Letters* **31**: 10.1029/2004GL019626.

59. Holgate, S.J. 2007. On the decadal rates of sea level change during the twentieth century. *Geophysical Research Letters* **34**: 10.1029/2006GL028492.

60. Jevrejeva, S., Grinsted, A., Moore, J.C. and Holgate, S. 2006. Nonlinear trends and multiyear cycles in sea level records. *Journal of Geophysical Research* **111**: 10.1029/2005JC003229.

61. Church, J.A., White, N.J., Coleman, R., Lambert, K. and Mitrovica, J.X. 2004. Estimates of the regional distribution of sea level rise over the 1950-2000 period. *Journal of Climate* **17**: 2609-2625.

62. Dlugokencky, E.J., Houweling, S., Bruhwiler, L., Masarie, K.A., Lang, P.M., Miller, J.B. and Tans, P.P. 2003. Atmospheric methane levels off: Temporary pause or a new steady-state? *Geophysical Research Letters* **30**: 10.1029/2003GL018126.

63. Nakicenovic, N., *et al*. 2000. *IPCC Special Report on Emissions Scenarios*. Cambridge University Press, Cambridge, UK.

64. Khalil, M.A.K., Butenhoff, C.L. and Rasmussen, R.A. 2007. Atmospheric methane: Trends and cycles of sources and sinks. *Environmental Science & Technology* 10.1021/es061791t.

65. Simpson, I.J., Blake, D.R. and Rowland, F.S. 2002. Implications of the recent fluctuations in the growth rate of tropospheric methane. *Geophysical Research Letters* **29**: 10.1029/2001GL014521.

66. Bekki, S., Law, K.S. and Pyle, J.A. 1994. Effect of ozone depletion on atmospheric CH_4 and CO concentrations. *Nature* **371**: 595-597.

67. Dlugokencky, E.J., Dutton, E.G., Novelli, P.C., Tans, P.P., Masarie, K.A., Lantz, K.O. and Madronich, S. 1996. Changes in CH_4 and CO growth rates after the eruption of Mt. Pinatubo and their link with changes in tropical tropospheric UV flux. *Geophysical Research Letters* **23**: 2761-2764.

68. Lowe, D.C., Manning, M.R., Brailsford, G.W. and Bromley, A.M. 1997. The 1991-1992 atmospheric methane anomaly: Southern hemisphere ^{13}C decrease and growth rate fluctuations. *Geophysical Research Letters* **24**: 857-860.

69. Dlugokencky, E.J., Walter, B.P., Masarie, K.A., Lang, P.M. and Kasischke, E.S. 2001. Measurements of an anomalous global methane increase during 1998. *Geophysical Research Letters* **28**: 499-502.

70. Dlugokencky, E.J., Masarie, K.A., Lang, P.M. and Tans, P.P. 1998. Continuing decline in the growth rate of the atmospheric methane burden. *Nature* **393**: 447-450.

71. Francey, R.J., Manning, M.R., Allison, C.E., Coram, S.A., Etheridge, D.M., Langenfelds, R.L., Lowe, D.C. and Steele, L.P. 1999. A history of $\delta^{13}C$ in atmospheric CH4 from the Cape Grim Air Archive and Antarctic firn air. *Journal of Geophysical Research* **104**: 23,631-23,643.

72. Lassey, K.R., Lowe, D.C. and Manning, M.R. 2000. The trend in atmospheric methane $\delta^{13}C$ and implications for constraints on the global methane budget. *Global Biogeochemical Cycles* **14**: 41-49.

73. Jurik, T.W., Weber, J.A. and Gates, D.M. 1984. Short-term effects of CO_2 on gas exchange of leaves of bigtooth aspen (*Populus grandidentata*) in the field. *Plant Physiology* **75**: 1022-1026.

74. Idso, K.E. and Idso, S.B. 1994. Plant responses to atmospheric CO_2 enrichment in the face of environmental constraints: a review of the past 10 years' research. *Agricultural and Forest Meteorology* **69**: 153-203.

75. Walther, G.-R., Beissner, S. and Burga, C.A. 2005. Trends in the upward shift of alpine plants. *Journal of Vegetation Science* **16**: 541-548.

76. Rubel, E. 1912. *Pflanzengeographische Monographie des Berninagebietes*. Engelmann, Leipzig, DE.

77. Hofer, H.R. 1992. Veranderungen in der Vegetation von 14 Gipfeln des Berninagebietes zwischen 1905 und 1985. *Ber. Geobot. Inst. Eidgenoss. Tech. Hochsch. Stift. Rubel Zur* **58**: 39-54.

78. Kullman, L. 2007. Long-term geobotanical observations of climate change impacts in the Scandes of West-Central Sweden. *Nordic Journal of Botany* **24**: 445-467.

79. Grabherr, G., Gottfried, M. and Pauli, H. 1994. Climate effects on mountain plants. *Nature* **369**: 448.

80. Keller, F., Kienast, F. and Beniston, M. 2000. Evidence of response of vegetation to environmental change on high-elevation sites in the Swiss Alps. *Regional Environmental Change* **1**: 70-77.

81. Kullman, L. 2002. Rapid recent range-margin rise of tree and shrub species in the Swedish Scandes. *Journal of Ecology* **90**: 68-77.

82. Klanderud, K. and Birks, H.J.B. 2003. Recent increases in species richness and shifts in altitudinal distributions of Norwegian mountain plants. *Holocene* **13**: 1-6.

83. Virtanen, R., Eskelinen, A. and Gaare, E. 2003. Long-term changes in alpine plant communities in Norway and Finland. In: Nagy, L., Grabherr, G., Korner, C. and Thompson, D.B.A. (Eds.), *Alpine Biodiversity in Europe*. Springer, Berlin, Germany, pp. 411-422.

84. Lacoul, P. and Freedman, B. 2006. Recent observation of a proliferation of *Ranunculus trichophyllus* Chaix. in high-altitude lakes of Mount Everest Region. *Arctic, Antarctic and Alpine Research* **38**: 394-398.

85. Orr, J.C., Fabry, V.J., Aumont, O., Bopp, L., Doney, S.C., Feely, R.A., Gnanadesikan, A., Gruber, N., Ishida, A., Joos, F., Key, R.M., Lindsay, K., Maier-Reimer, E., Matear, R., Monfray, P., Mouchet, A., Najjar, R.G., Plattner, G.-K., Rodgers, K.B., Sabine, C.L., Sarmiento, J.L., Schlitzer, R., Slater, R.D., Totterdell, I.J., Weirig, M.-F., Yamanaka, Y. and Yool, A. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature* **437**: 681-686.

86. Lough, J.M. and Barnes, D.J. 2000. Experimental controls on growth of the massive coral *Porites*. *Journal of Experimental and Marine Biology and Ecology* **245**: 225-243.

87. Grigg, R.W. 1981. Coral reef development at high latitudes in Hawaii. In: *Proceedings of the Fourth International Coral Reef Symposium*, Manila, Vol. 1: 687-693.

88. Grigg, R.W. 1997. Paleoceanography of coral reefs in the Hawaiian-Emperor Chain - revisited. *Coral Reefs* **16**: S33-S38.

89. Scoffin, T.P., Tudhope, A.W., Brown, B.E., Chansang, H. and Cheeney, R.F. 1992. Patterns and possible environmental controls of skeletogenesis of *Porites lutea*, South Thailand. *Coral Reefs* **11**: 1-11.

90. Kleypas, J.A., Buddemeier, R.W., Archer, D., Gattuso, J-P., Langdon, C., and Opdyke, B.N. 1999. Geochemical consequences of increased atmospheric carbon dioxide on coral reefs. *Science* **284**: 118-120.

91. Bessat, F. and Buigues, D. 2001. Two centuries of variation in coral growth in a massive *Porites* colony from Moorea (French Polynesia): a response of ocean-atmosphere variability from south central Pacific. *Palaeogeography, Palaeoclimatology, Palaeoecology* **175**: 381-392.

92. Carricart-Ganivet, J.P. 2004. Sea surface temperature and the growth of the West Atlantic reef-building coral *Montastraea annularis*. *Journal of Experimental Marine Biology and Ecology* **302**: 249-260.

93. Graus, R.R. and Macintyre, I.G. 1982. Variation in growth forms of the reef coral *Montastrea annularis* (Ellis and Solander): a quantitative evaluation of growth response to light distribution using computer simulation. In: Rutzler, K. and Macintyre, I.G. (Eds.), *The Atlantic Barrier Reef Ecosystem at Carrie Bow Cay, Belize*. Smithsonian Institution Press, Washington, DC, pp. 441-464.

94. Dodge, R.E. and Brass, G.W. 1984. Skeletal extension, density and calcification of the reef coral, *Montastrea annularis*: St. Croix, U.S. Virgin Islands. *Bulletin of Marine Science* **34**: 288-307.

95. Bosscher, H. 1993. Computerized tomography and skeletal density of coral skeletons. *Coral Reefs* **12**: 97-103.

96. Clausen, C.D. and Roth, A.A. 1975. Effect of temperature and temperature adaptation on calcification rate in the hematypic *Pocillopora damicornis*. *Marine Biology* **33**: 93-100.

97. Coles, S.L. and Jokiel, P.L. 1977. Effects of temperature on photosynthesis and respiration in hermatypic corals. *Marine Biology* **43**: 209-216.

98. Kajiwara, K., Nagai, A. and Ueno, S. 1995. Examination of the effect of temperature, light intensity and zooxanthellae concentration on calcification and photosynthesis of scleractinian coral *Acropora pulchra*. *J. School Mar. Sci. Technol.* **40**: 95-103.

99. Nie, B., Chen, T., Liang, M., Wang, Y., Zhong, J. and Zhu, Y. 1997. Relationship between coral growth rate and sea surface temperature in the northern part of South China Sea. *Sci. China Ser. D* **40**: 173-182.

100. Reynaud-Vaganay, S., Gattuso, J.P., Cuif, J.P., Jaubert, J. and Juillet-Leclerc, A. 1999. A novel culture technique for scleractinian corals: Application to investigate changes in skeletal $\delta^{18}O$ as a function of temperature. *Marine Ecology Progress Series* **180**: 121-130.

101. Reynaud, S., Ferrier-Pages, C., Boisson, F., Allemand, D. and Fairbanks, R.G. 2004. Effect of light and temperature on calcification and strontium uptake in the scleractinian coral *Acropora verweyi*. *Marine Ecology Progress Series* **279**: 105-112.

102. McNeil, B.I., Matear, R.J. and Barnes, D.J. 2004. Coral reef calcification and climate change: The effect of ocean warming. *Geophysical Research Letters* **31**: 10.1029/2004GL021541.

103. Gnaiger, E., Gluth, G. and Weiser, W. 1978. pH fluctuations in an intertidal beach in Bermuda. *Limnology and Oceanography* **23**: 851-857.

104. Santhanam, R., Srinivasan, A., Ramadhas, V. and Devaraj, M. 1994. Impact of *Trichodesmium* bloom on the plankton and productivity in the Tuticorin bay, southeast coast of India. *Indian Journal of Marine Science* **23**: 27-30.

105. Brussaard, C.P.D., Gast, G.J., van Duyl, F.C. and Riegman, R. 1996. Impact of phytoplankton bloom magnitude on a pelagic microbial food web. *Marine Ecology Progress Series* **144**: 211-221.

106. Lindholm, T. and Nummelin, C. 1999. Red tide of the dinoflagellate *Heterocapsa triquetra* (Dinophyta) in a ferry-mixed coastal inlet. *Hydrobiologia* **393**: 245-251.

107. Macedo, M.F., Duarte, P., Mendes, P. and Ferreira, G. 2001. Annual variation of environmental variables, phytoplankton species composition and photosynthetic parameters in a coastal lagoon. *Journal of Plankton Research* **23**: 719-732.

108. Hansen, P.J. 2002. The effect of high pH on the growth and survival of marine phytoplankton: implications for species succession. *Aquatic Microbiology and Ecology* **28**: 279-288.

109. Crabbe, M.J.C., Wilson, M.E.J. and Smith, D.J. 2006. Quaternary corals from reefs in the Wakatobi Marine National Park, SE Sulawesi, Indonesia, show similar growth rates to modern corals from the same area. *Journal of Quaternary Science* **21**: 803-809.

110. Waggoner, P.E. 1995. How much land can ten billion people spare for nature? Does technology make a difference? *Technology in Society* **17**: 17-34.

111. Huang, J., Pray, C. and Rozelle, S. 2002. Enhancing the crops to feed the poor. *Nature* **418**: 678-684.

112. Raven, P.H. 2002. Science, sustainability, and the human prospect. *Science* **297**: 954-959.

113. Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Schindler, D., Schlesinger, W.H., Simberloff, D. and Swackhamer, D. 2001. Forecasting agriculturally driven global environmental change. *Science* **292**: 281-284.

114. Wallace, J.S. 2000. Increasing agricultural water use efficiency to meet future food production. *Agriculture, Ecosystems & Environment* **82**: 105-119.

115. Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. and Polasky, S. 2002. Agricultural sustainability and intensive production practices. *Nature* **418**: 671-677.

116. Idso, C.D. and Idso, K.E. 2000. Forecasting world food supplies: The impact of the rising atmospheric CO_2 concentration. *Technology* **7S**: 33-55.

117. Kimball, B.A. 1983. Carbon dioxide and agricultural yield: An assemblage and analysis of 430 prior observations. *Agronomy Journal* **75**: 779-788.

118. Idso, K.E. and Idso, S.B. 1994. Plant responses to atmospheric CO_2 enrichment in the face of environmental constraints: a review of the past 10 years' research. *Agricultural and Forest Meteorology* **69**: 153-203.

119. Saxe, H., Ellsworth, D.S. and Heath, J. 1998. Tree and forest functioning in an enriched CO_2 atmosphere. *New Phytologist* **139**: 395-436.

120. Kimball, B.A., Idso, S.B., Johnson, S. and Rillig, M.C. 2007. Seventeen years of carbon dioxide enrichment of sour orange trees: final results. *Global Change Biology* **13**: 2171-2183.