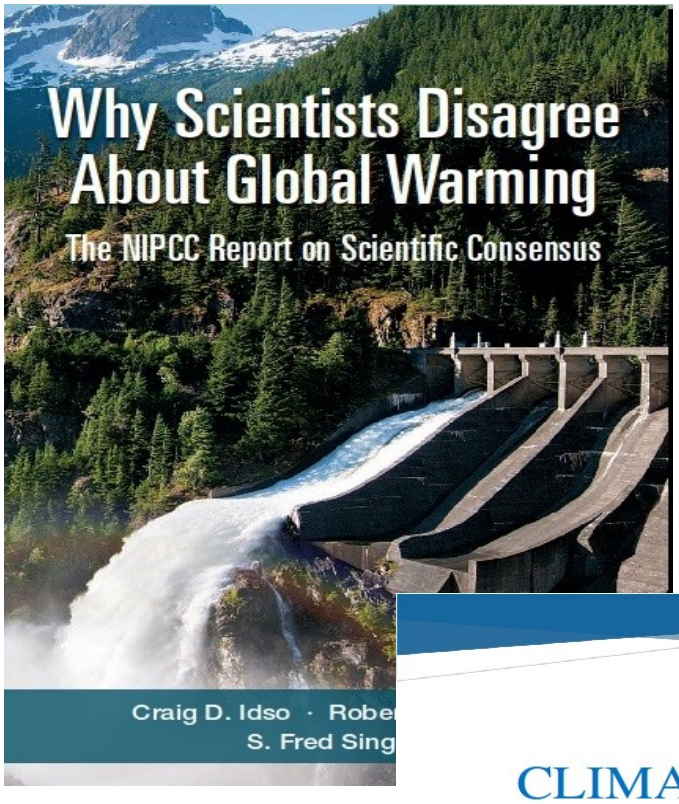
Climate Change an Update 2019



28/05/2019 What I Learned about Climate Change: The Science is not Settled – Medium

What I Learned about Climate Change: The Science is not Settled

David Siegel Follow
Oct 15, 2015 · 38 min read

- *David Siegel*

CLIMATE CHANGE PRIMER

What you need to know
A clear and concise explanation about climate change and global warming.

Dr. D. Michael Shafer
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Warm Heart Environmental Program

Environmental Effects of Increased Atmospheric Carbon Dioxid

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ABSTRACT A review of the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide leads to the conclusion that increases during the 20th and early 21st centuries have produced no deleterious effects upon Earth's weather and climate. Increased carbon dioxide has, however, markedly increased plant growth. Predictions of harmful climatic effects due to future increases in hydrocarbon use and minor greenhouse gases like CO_2 do not conform to current experimental knowledge. The environmental effects of rapid expansion of the nuclear and hydrocarbon energy industries are discussed.

SUMMARY

Political leaders gathered in Kyoto, Japan, in December 1997 to consider a world treaty restricting human production of "greenhouse gases," chiefly carbon dioxide (CO_2). They feared that CO_2 would result in "human-caused global warming" – hypothetical severe increases in Earth's temperatures, with disastrous environmental consequences. During the past 10 years, many political efforts have been made to force worldwide agreement to the Kyoto treaty.

When we reviewed this subject in 1998 (1,2), existing satellite records were short and were centered on a period of changing intermediate temperature trends. Additional experimental data have now been obtained, so better answers to the questions raised by the hypothesis of "human-caused global warming" are now available.

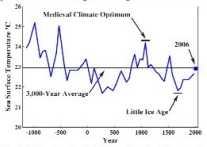

Figure 1: Surface temperatures in the Sargasso Sea, a 2 million square mile region of the Atlantic Ocean, with time resolution of 50 to 100 years and ending in 1975, as determined by isotope ratios of marine organism remains in sediment at the bottom of the sea (3). The horizontal line is the average temperature for this 3,000-year period. The Little Ice Age and Medieval Climate Optimum were naturally occurring, extended intervals of climate departures from the mean. A value of 0.25 °C, which is the change in Sargasso Sea temperature between 1975 and 2006, has been added to the 1975 data in order to provide a 2006 temperature value.

The average temperature of the Earth has varied within a range of about 3°C during the past 3,000 years. It is currently increasing as the Earth recovers from a period that is known as the Little Ice Age, as shown in Figure 1. George Washington and his army were at Valley Forge during the coldest era in 1,500 years, but even then the temperature was only about 1° Centigrade below the 3,000-year average.

The most recent part of this warming period is reflected by short-

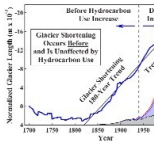

Figure 2: Average length of 169 glaciers from 1700 to 2

pal source of melt energy is solar radiation. Variations i
length are primarily due to temperature and precipitation
trend lags the temperature increase by about 20 years,
6-fold increase in hydrocarbon use (7) over more than a
Hydrocarbon use could not have caused this shortening

ening of world glaciers, as shown in Figure 2. (
lengthen and shorten in delayed correlation with
ing trends. Shortening lags temperature by about 20
rent warming trend began in about 1800.

Atmospheric temperature is regulated by the sun
in activity as shown in Figure 3; by the greenhou
caused by atmospheric water vapor (H_2O); and by
that are more poorly understood. While major gas
substantially warms the Earth, minor greenhouse g

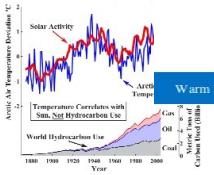

Figure 3: Arctic surface air temperature compared with total solar irradiance as measured by sunspot cycle amplitude, sunspot cycle length, solar equatorial rotation rate, fraction of penumbral spots, and decay rate of the 11-year sunspot cycle (8,9). Solar irradiance correlates well with Arctic temperature, while hydrocarbon use (7) does not correlate.

Journal of American Physicians and Surgeons (2007) **12**, 79-90.

11/17/2016 The rise and fall of the Hockey Stick

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A Sceptical Mind

having doubts about global warming

The rise and fall of the Hockey Stick

The rise of the so called *Hockey Stick graph* is pivotal to the story of the rise of the alarm about man made global warming.

The fall of the Hockey Stick graph is pivotal to the rise of scepticism about man made global warming.

Here is the story of the rise and fall of the Hockey Stick.

The Background

A central and critical plank of the alarmist global warming case is that the current phase of warming that started in the late 19th century is unprecedented.

Why is this claim so important?

Because if a similar or greater warming phase has occurred in the *very recent past*, before human CO2 emissions had caused CO2 levels to rise, then clearly any such recent warming must have been natural and was not caused by CO2. And if any recent similar warming phase was natural then clearly the current phase of warming could also be a natural phenomena.

If the current phase of warming could be natural then those arguing that it was primarily caused by human CO2 emissions would have to prove their hypothesis. *And this is something they cannot do.*

The only "proof" that CO2 is currently forcing up global temperatures is the claim that the current warming is somehow unusual, unique and unnatural. *That's the total argument for CO2 forcing.* Something unprecedented is happening to the climate and CO2 is the only candidate for what is causing this unique phenomena.

Its certainly true that the well understood physics of CO2 in the atmosphere demonstrates (see "CO2 the basic facts")that CO2 is indeed a greenhouse gas and will have a warming impact. No one disputes that. *The issue is what is the scale of impact that this CO2 warming is having on the overall climate system. Is the effect of the CO2 so big that it can drive the temperature of the whole planet up in a way that is big enough to actually alter the climate?*

This is a much harder question to answer because no one has a model of the total climate system that actually works and which verifiably produces even remotely accurate forecasts about climate trends.

So without a working model of the total climate system the only way to "prove" that CO2 is driving climate change is to prove that something truly unique is happening to the climate, that there is unprecedented warming occurring, and and then propose man made CO2 change as the only candidate as the cause of this 'unprecedented' warming.

http://a-sceptical-mind.com/the-rise-and-fall-of-the-hockey-stick 1/9

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What I Learned about Climate Change: The Science is not Settled

David Siegel Follow
Oct 15, 2015 · 38 min read

- *David Siegel*

THIS ESSAY, written in 2015 (with a few updated links), has had over 220,000 views. Please link to ClimateCurious.com. Welcome new readers from my *Interview with Barack Obama*. Enjoy!

What is your position on the climate-change debate? What would it take to change your mind?

If the answer is *It would take a ton of evidence to change my mind, because my understanding is that the science is settled, and we need to get going on this important issue,* that's what I thought, too. This is my story.

More than thirty years ago, I became vegan because I believed it was healthier (it's not), and I've stayed vegan because I believe it's better for the environment (it is). I haven't owned a car in ten years. I love animals; I'll gladly fly halfway around the world to take photos of them in their natural habitats. I'm a Democrat: **I think governments play a key role in helping preserve our environment for the future in the most cost-effective way possible.** Over the years, I built a set of assumptions: that Al Gore was right about global warming, that he was the David going up against the industrial Goliath. In 1993, I even wrote a book about it.

Recently, a friend challenged those assumptions. At first, I was annoyed, because I thought the science really was settled. As I started to look at the data and read about climate science, I was surprised, then shocked. As I learned more, I changed my mind. I now think there probably is no climate crisis and that the focus on CO2 takes funding and attention from critical environmental problems. I'll start by making ten short statements that should challenge your assumptions and then back them up with an essay.

1 Weather is not climate. There are no studies showing a conclusive link between global warming and increased frequency or intensity of storms, droughts, floods, cold or heat waves. The increase in storms is simply a result of improved measurement methods. There has been no real increase.

2 Natural variation in weather and climate is tremendous. Most of what people call "global warming" is natural, not man-made. The earth *is* warming, but not quickly, not much, and not lately.

3 There is tremendous uncertainty as to how the climate really works. Climate models are not yet skillful; predictions are unresolved.

4 New research shows fluctuations in energy from the sun correlate very strongly with changes in earth's temperature, better than CO2 levels.

5 CO2 has very little to do with it. All the decarbonization we can do isn't going to change the climate much.

6 There is no such thing as "carbon pollution." Carbon dioxide is coming out of your nose right now; it is not a poisonous gas. CO2 concentrations in previous eras have been many times higher than they are today.

7 Sea level will probably continue to rise—not quickly, and not much. Researchers have found no link between CO2 and sea level.

8 The Arctic experiences natural variation as well, with some years warmer earlier than others. Polar bear numbers are up, not down. They have more to do with hunting permits than CO2*.

9 No one has demonstrated any unnatural damage to reef or marine systems. Additional man-made CO2 will not likely harm oceans, reef systems, or marine life. Fish are mostly threatened by people, who eat them. Reefs are more threatened by sunscreen than by CO2.

10 The Intergovernmental Panel on Climate Change and others are pursuing a political agenda and a PR campaign, not scientific inquiry. There's a tremendous amount of trickery going on under the surface*.

Could this possibly be right? Is it heresy, or critical thinking—or both? If I've upset or confused you, let me guide you through my journey.

I won't present all the science. Instead, my goal is to give you a platform for investigating the other side of the debate, so you can form your own opinion. I have noted important and quick reads with an asterisk*—if you have time for further study, start with those videos and documents. Here are the sections:

7. **Summary**
8. **What Do You Think?**

This nine-thousand-word essay represents over 400 hours of research boiled down into a half-hour reading experience, with links to 250+ carefully chosen documents and videos. I'm building the argument from the bottom up, so take your time and see if it makes sense. Along the way, I'll list five "smoking guns" that I think make the argument for decarbonization unsupportable. Before we dive in, I want to talk about …

My journey into critical thinking has taught me to **hold strong opinions loosely**. I've been more wrong in my life than I thought was possible. Now I try to put my reactions aside and look at all the evidence before coming to a conclusion.

Policy always involves politics. Governments often make policy decisions by starting with a social objective and then bring in the "facts" to justify the goal (think of the Vietnam war, the Iraq war, Prohibition, the War on Drugs, and others). We shouldn't be surprised to find social agendas driving at least some of the "science" of global warming.

In addition, studies show that **political beliefs cloud our ability to process information**. Strong political beliefs can cause us to look at one side of an issue and ignore the evidence. We should try to avoid shortcuts and look directly at the data.

Forecasts are mental constructs; they are not properties of the physical world. Forecasts are tools, not truth. In most cases, the size of the error bars (uncertainty) around the number is more important than the number itself.

Consensus is not an argument for any scientific principle. Many important scientists toiled alone to make discoveries that were less than

popular. One key paper can be worth more than thousands of papers reinforcing a myth. The claim that 97 percent of scientists believe in man-made global warming is one such myth. Almost all scientists expect a small man-made contribution to warming, so the claim is misleading.

Metastudies are important. One key paper can be a breakthrough, but there are very few of those. A better source of information is properly done metastudies (reviews of all the literature on a topic) conducted by qualified statisticians. They help find the signal in the noise.

There is a big climate conference coming up in Paris in December, 2015. Diplomats will debate the merits of an agreement that promises to steer hundreds of billions of dollars toward reducing carbon emissions, mostly in large developing countries. Is it based on sound science? Let's ask four hard questions and see what we can learn …

1. **What are the natural drivers of temperature and its variability?**
2. **What does the projected natural increase in temperature mean for the environment and people?**
3. **What does the increase in greenhouse gases from human activity mean for oceans, environment, animals, habitats, and humanity?**
4. **Is Decarbonation the Right Solution?**

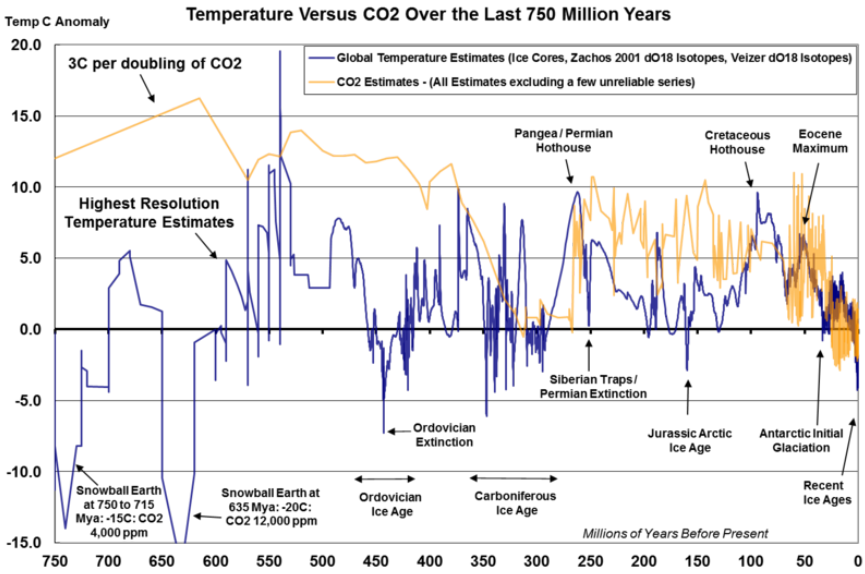
Let's look with fresh eyes and see what we can learn.

1. What are the natural drivers of temperature and its variability?

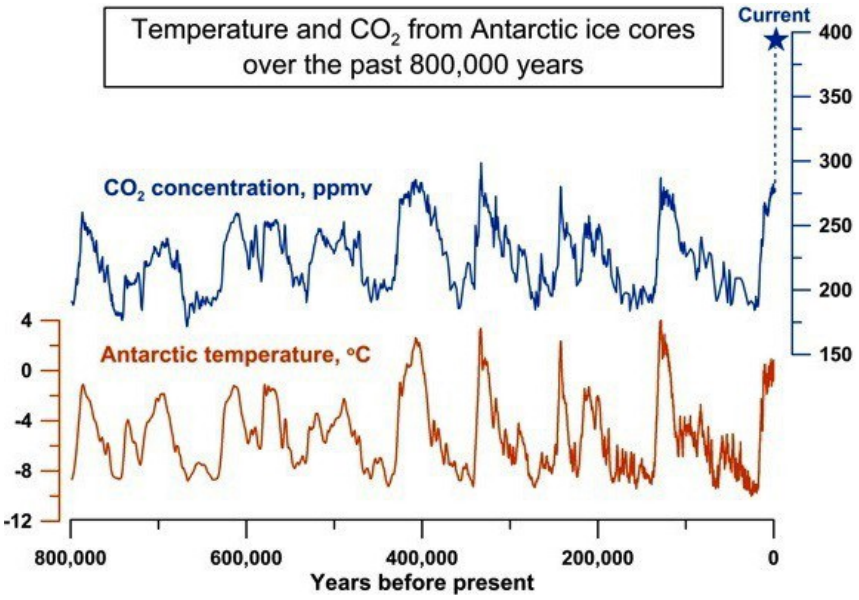
Incoming solar radiation is the primary driver of temperature. A second factor is the atmosphere, which traps heat and reflects some of it back to earth. Other factors play smaller roles. I'll start with the familiar greenhouse-gas model and then present a more accurate picture based on solar activity.

The Greenhouse Effect

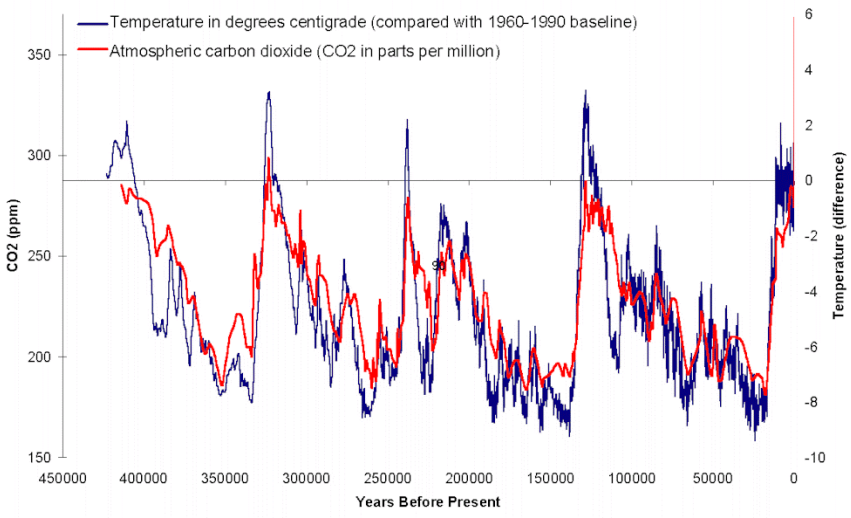
In this section, I focus on CO2 because it's regarded as the main greenhouse gas after water vapor. Looking at the 750-million-year graph below, we see some extreme cold periods, then warm epochs punctuated by ice ages, **all while CO2 (yellow) was far above what it is today**. There is almost no correlation between temperature and carbon dioxide until about ten million years ago.



Starting around a million years ago, the curves start to sync up, and we see a pretty definitive supercycle of about 100,000 years for both:

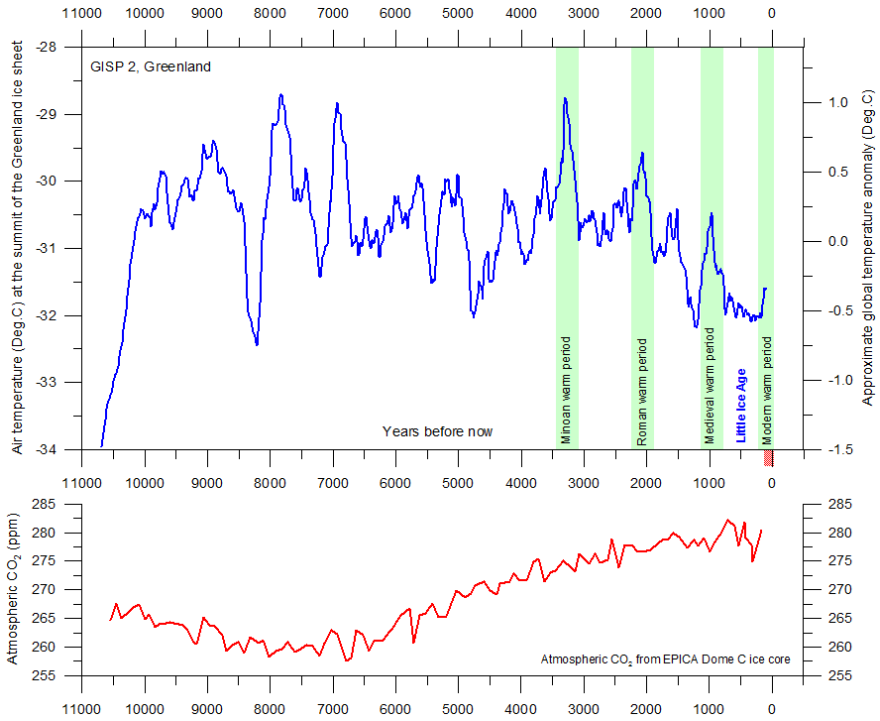


Think about that: CO2 had *no correlation* with temperature for more than 2 billion years, and now it's *causing* temperature to rise? *Something's* going on, but what? Let's zoom in:



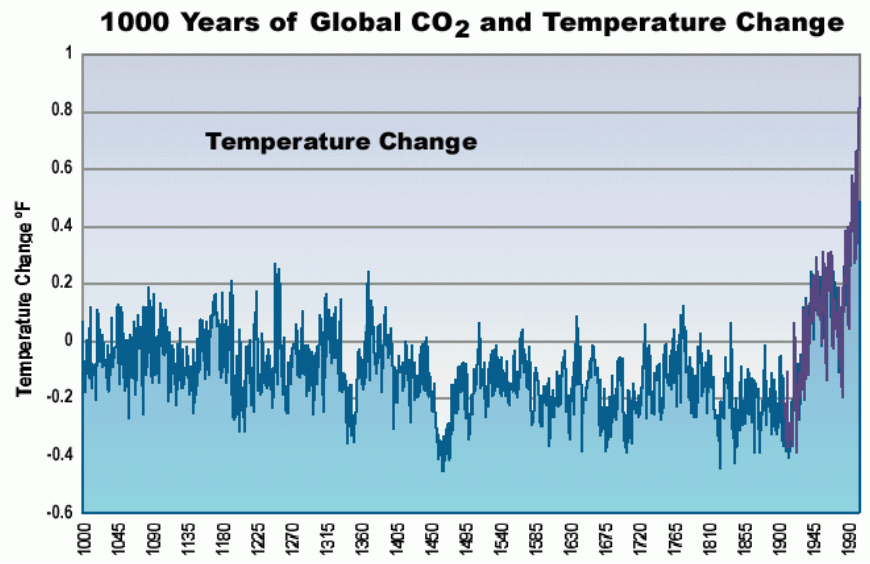
Notice that temperature generally changes *first*, and CO2 changes some 800+ years later. Blue line to the left, red line to the right. This is called the temperature lag—an inconvenient truth for CO2-warming enthusiasts; it's well known but not well understood. **It could easily be a complex relationship, but CO2 changes do not initially cause historical temperature changes.**

On a shorter time scale, we start to get some perspective:



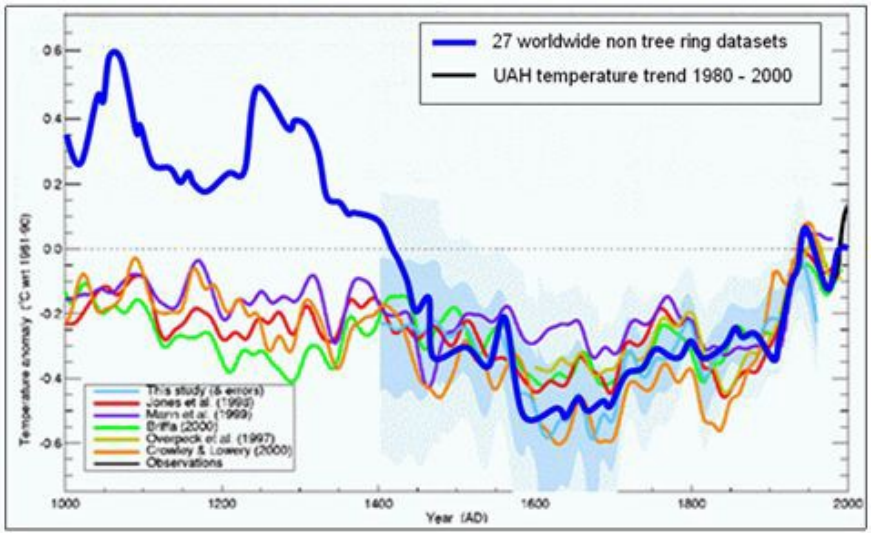
At this scale of 11,000 years, it doesn't seem like CO2 is "driving" temperature. We are in the middle of an upswing coming out of the Little Ice Age, but there is also an overall cooling trend.

Before the twentieth century, there was plenty of temperature variability, and it continues today. If you have heard about the hockey-stick controversy, it's about whether this graph created by Michael Mann, which Al Gore likes to stand in front of on a scissor lift, represents reality:



It doesn't. Despite what you read on Wikipedia, **this graph was manufactured by carefully cherrypicking the data from tree rings**.

Looking at tree rings is about the least accurate way to measure ancient temperatures. Better methods involve looking at drilled ice and sediment cores. Using those methods, we see a pronounced period *warmer than today* from 1000 to 1300 AD, called the Medieval Warm Period, and then the Little Ice Age about 400 years ago (same time period as above):



This single issue invalidates many of Al Gore's claims* and undermines the IPCC's predictions of man-made CO2 catastrophe. (You'll find a list of relevant studies at CO2Science.org*.)

[Update 2018:] There is a very good video showing how NASA has been "warming" their data and that today's NASA data doesn't agree at all with their data from 2000. I highly recommend watching:

Smoking gun #1: The Hockey Stick is Wrong; The Medieval warming period was real and worldwide.

If you look in GeoRef, the bibliography for publications in geology, you will find 485 papers on the Medieval Warm Period and 1,413 on the Little Ice Age. So the total number of papers in the geologic literature is 1,900. And we're expected to believe that one curve [based on] tree rings is going to overturn all of those 1,900 papers?

— Don Easterbrook —

Once I understood that the IPCC was playing games, I realized I had a lot of work to do to uncover the rest of the story. It starts with data manipulation.

Where Does the Data Come From?
For the last 80 years, we have far more accurate ways of recording temperature, so the far right hand side of the graph above should come from direct measurements. Weather stations that gather this data differ in quality and consistency, especially over decades as the areas around them develop. A large-scale reassessment of all US weather stations from 1979 to 2008 carefully divided the stations into five classes, from best quality (I) to worst (V). For this period of time, they calculated the per-decade average temperature increases, and found:

- **Class I and II only (most accurate): 0.155 C**
- **Class III, IV, and V sites only: 0.248 C**
- **NOAA 2015 "adjusted" calculation: 0.309 C**

What does that tell you? NOAA is "adjusting" their data to increase warming figures far out of the realm of possibility. The IPCC relies mostly on NOAA data and other similarly adjusted data, which conveniently provides an instant doubling of temperature increase, making all the graphs much steeper after 1980.

The science is extremely complex and uncertain. **If you have blind faith in the wrong numbers, you're going to jump to the wrong conclusions.** Anthony Watts has carefully reviewed NOAA's data and

found unscientific manipulation. Watch this 15-minute video* and decide for yourself*:

NOAA continues to "adjust" their data, manufacturing graphs that support the cause.

Smoking gun #2: Government agencies have rigged climate data to support man-made global warming.

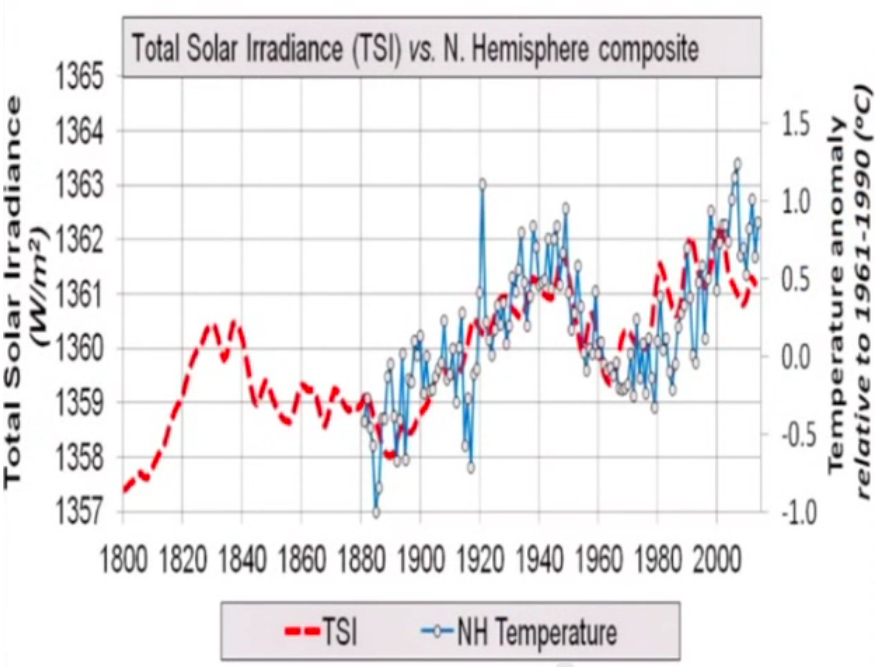
Note: It's easy to find nonscientific articles and videos that "prove" the hockey stick has been validated by updated research and that the sun's energy doesn't fluctuate. However, one central tenet of journalism is that you can't fact-check a source by asking the source, and that's exactly what most journalists are doing. To fact-check the IPCC, look at the peer-reviewed literature written by scientists who are *not* in the IPCC.

That's the greenhouse-gas theory. Now on to more recent research.

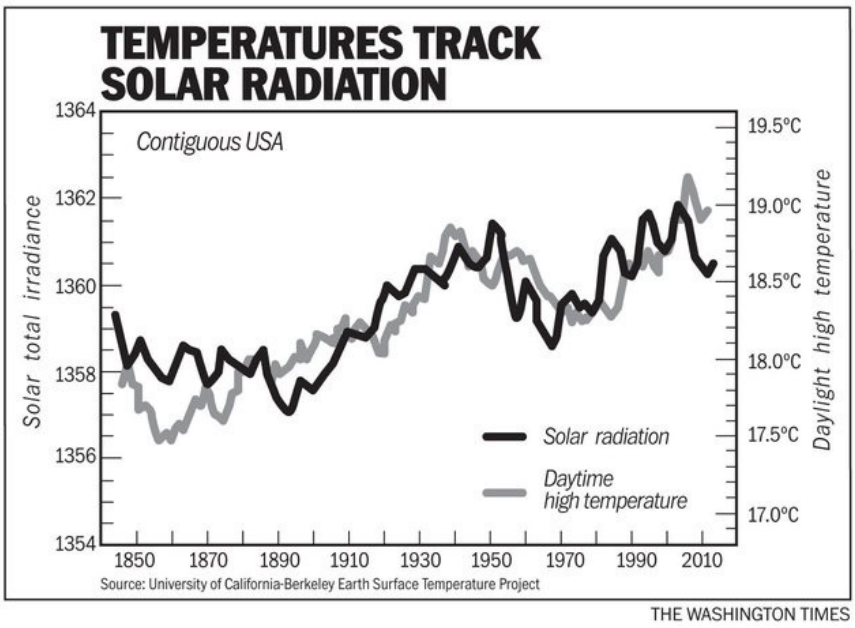
Solar Forcing
Many solar variables contribute to the variance we see in temperature: distance, orbit cycles, axis tilt, magnetic fields, sunspots, solar wind, cosmic rays, the passage of earth through our galaxy, etc. Even though the total *energy* coming from the Sun is nearly constant, a) those tiny fluctuations can make a difference, and b) there are many other factors that can and do change. In particular, magnetic field changes can have

significant influence on the shape of the jet stream, and that can influence cloud formation.

Willie Soon, a solar physicist, showed that the tiny variations in incoming solar radiation can have a more direct effect on temperature than CO2 does, but it takes very sensitive measurements and careful analysis to see the signal. Willie and his team first did many months of inspecting data from weather stations in the Northern Hemisphere*, throwing out spurious and made-up measurements, to put an accurate temperature picture together (blue line):



Then they plotted total solar irradiation (TSI) and found a very good first-order correlation, much better than with CO2. The graph above is probably the most accurate picture we have for that time period. Below is a similar exercise for the United States:



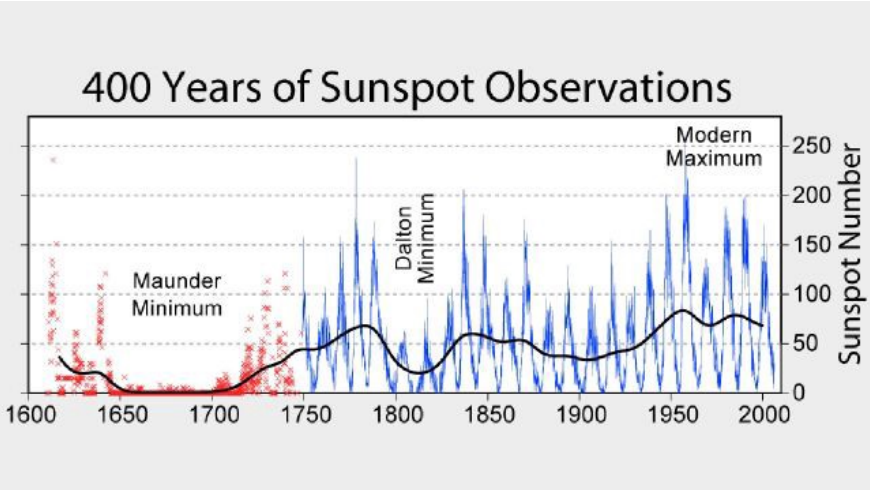
Note that this graph accurately shows the most recent cooling trend since 1998 without any hand waving.

Smoking gun #3: Solar fluctuations correlate better with observed temperature fluctuations.

Not only do fluctuations in solar energy drive changes in climate, the oceans react to increases in solar energy by generating clouds that help regulate temperature. **Since 2013, much research has been aimed at constructing a more accurate picture of past temperature/solar radiation correlation and developing a realistic solar-driven climate prediction model*, taking the greenhouse effect into account.**

Sunspots

Sunspots fluctuate in roughly 11-year cycles. It's complicated, but in general these cycles show a moderate amount of correlation with temperature. The period of no sunspot activity 400 years ago corresponds to the Little Ice Age, when winters were significantly colder than they are today.

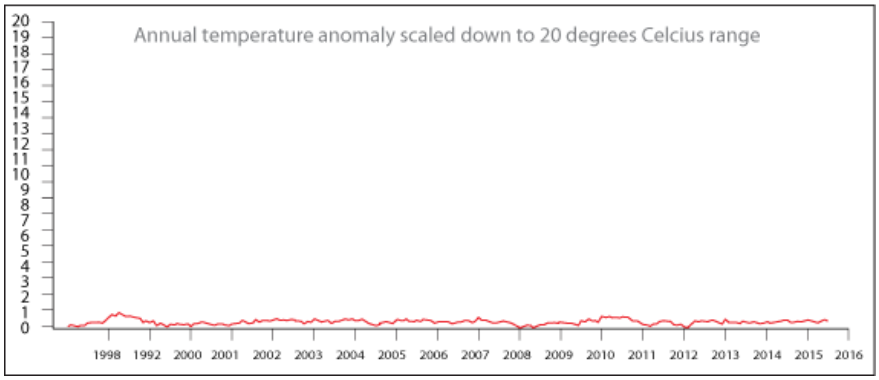


The current cycle peaked in 2014. Solar experts speculate that the next cycle, which starts in 2020, will have fewer sunspots. If that turns out to be true, temperatures could be heading down, rather than up. Reactions to this cooling prediction range from "unlikely," to "plausible," to "probable." Whatever mechanism causes sunspots could be part of the picture, but there are several different solar cycles, different research approaches, and competing theories. They are converging, but it's a complex work in progress. A single predictive model is still years or decades away.

Hottest Year on Record?

When you hear claims of this year being "the hottest year on record," you should understand that 1922, 1998, and 2010 were also extremely hot, and the El Niños were extreme then as well. That's not a trend; that's a local peak. Look at the last 18 years from satellite data:

How many peaks do you see that are higher than this year's? Now look at the scale—it's *one degree* Celsius from top to bottom. To give you a sense of how up and down this really is, I traced the graph above and put it in perspective of the 20 degrees C (36 degrees F) we might experience *in a single day*:



Same data, different perspective. Can you see the hottest year on record now? In any given year, several weather stations will record dramatic "all time highs" with no effect on global temperatures.

Research has uncovered more complexity than was previously appreciated. Researchers are unable to balance all the fluxes of the global carbon cycle over the period 1800 to the present, and different mathematical models give results that are difficult to reconcile.

— Oak Ridge National Laboratory —

No one knows what will really happen. We can't see the future. We know CO2 is increasing relentlessly, yet temperatures are not. **If you believe in the IPCC models, then you *need* worldwide temperatures to start going up, and soon. A few more hurricanes wouldn't hurt, either.** If you agree that solar activity primarily drives climate changes, then you will probably agree with the current scientific consensus outside the IPCC and with the conclusions of a recent metastudy on temperature forecasts: **one degree C of warming this century, plus or minus one degree**. That's the 90%-confidence prediction at this point, but there's always a chance that they are wrong, or that things will change unexpectedly. We'll know a lot more in another twenty years or so.

2. What does the projected natural increase in temperature mean for the environment and people?

Sea level won't likely rise in response to increased CO2. For starters, sea level rises and falls more than people think. Global mean sea level rose about 15 cm (6 inches) in the twentieth century. The IPCC models predicted higher levels by now, but researchers have found no link between CO2 and sea level. Sea level rises linearly; the rate of rise is not increasing. Any rise so far is very much in line with natural factors, not man-made. Estimates range from 5-20 cm (2–8 inches) of sea level rise (naturally) by the end of this century.

Reef systems and marine life will not likely be harmed by additional CO2. Researchers use tank experiments and computer models to predict doom and gloom (this approach is full of errors). Recent observations show that the Great Barrier Reef has been bleaching and recovering naturally for hundreds of years. Despite what you read in the press, **no one has yet seen any verifiable signs of manmade CO2 effects, or even pollution.** Coral bleaching is a natural phenomenon caused by temperature changes, especially in El Niño and La Niña years—it's been going on forever. Live reef experiments have shown that coral polyps adapt well to changes in pH, but sunscreen is toxic. Furthermore, a recent metastudy found no evidence of harm due to "ocean acidification" and no likely harm in the future. **If you care about ocean life, stop eating it!** Stop developers from replacing estuaries, wetlands, and mangrove swamps with condos. And please stop eating shrimp immediately.

Freak storms are a far bigger threat. Again, storms are *not* caused by global warming. Over the next hundred years, as our population reaches nine billion or so, *we should expect extreme events to have catastrophic consequences around the globe as a result of massive-scale urbanization and natural variance* . Damage figures will rise significantly as we build larger cities on the coasts and expensive buildings with sea views. Don't be fooled by graphs showing rising damage figures—they are guaranteed! The science is settled on this—even the IPCC admits that none of it is driven by CO2.

Let's talk about polar bears. The health and numbers of the Arctic's 19 polar bear populations are in very good shape, better than in decades*. Mitch Taylor, who has studied polar bears for over 30 years, says populations are increasing and very resilient. Each year at least 600 polar bears are shot, killed, and eaten by hunters—did your favorite news source tell you that? Arctic sea ice grows and shrinks by *an area almost the size of the continental United States every six months*. As the planet gently warms, the overall trend for slightly less ice each year continues; all the animals who live there have been dealing with this kind of fluctuation for millions of years. International fishing and seal hunting quotas have more to do with polar bear numbers than temperature does.

Furthermore, Greenland is not melting into the sea because of global warming. Greenland's temperature fluctuates all by itself and always has.

Far from the land of polar bears, we hear tales of extreme temperatures melting Antarctic ice sheets the size of Wyoming. Despite the fact that glaciers fall into the ocean dramatically each year, Antarctica's ice is actually increasing (reason: it snows in Antarctica, but snowfall doesn't make good news footage). Imagine a time-lapse movie of Antarctica over the past million years or more: we see huge amounts of ice accumulating, moving, dropping into the sea, over and over. We shouldn't be surprised to watch the Larsen B ice shelf fall into the sea—it should take extraordinary evidence to convince us that this is not natural. To think Antarctica should stay the same as it was when we were children is to commit the error of base-rate neglect. Remember this: **the Arctic is losing a bit of ice each year, and the Antarctic is gaining a bit. Not much. And not quickly.**

If you smell something, say something.
— Jon Stewart —

If the worst isn't going to happen, a small rise in temperature should benefit society. CO2 helps plants grow. Excessive cold kills far more people than excessive heat does.

3. What does the increase in greenhouse gases mean for oceans, environment, animals, habitats, and humanity?

This is the domain of climate models. I could write twenty pages, but I'll summarize my research:

1. According to Bob Tisdale, a researcher I respect after reading his book *Climate Models Fail*, the IPCC models simply aren't skillful. They failed to predict the past twenty years, they don't realistically model the cloud response, and there is simply too much uncertainty about the inputs to get decent outputs.

2. NASA GISS, in realizing that global temperatures refuse to conform to their models, has said that the increase in heat is trapped in the oceans. This bit of model trickery also does not stand up to careful analysis.

3. The IPCC models are falsifiable—if temperature doesn't go up over the next ten years or so, we will have to agree that the IPCC models are, and always were, dead wrong. It is not looking good.

4. According to J Scott Armstrong, **all climate models so far don't meet the minimum criteria for a skillful forecast**. He has testified before congress on climate forecasts, polar-bear counts, and other misconceptions. Here is his 15-minute talk:

Armstrong and other modeling experts say the simple "no change" prediction is often far superior to a complex one with many independent variables. **In that case, we can predict about another one-degree C rise for this century, and another 3–7 centimeters of gradual sea-level rise.**

Smoking Gun #4: Rigged Inputs and Wrong Assumptions About Feedback Lead to Computer Model Failure.

Correlation is not Causation

Killer storms. Bee colony collapse. Mosquito-borne diseases. Ticks heading south for the winter. Heat-related deaths. Arctic lobster populations. Algae blooms. Global temperatures. These things may or may not be increasing, but let's assume they are. Atmospheric carbon dioxide is also increasing. So are the number of toilets made every year and the number of vinyl records sold. When a particular scientist issues

a press release describing the future collapse of ecosystems, I recommend asking **"What evidence do you have?"** When they say something we can see today is due to "anthropogenic global warming," they are saying that the *extra* 120 parts per million of CO2 in the atmosphere—about 30% of the total—are *causing* the phenomenon right now, as opposed to *all other possible natural explanations, including variance*. I recommend asking, **"How can you be sure?"** Just because we haven't seen something in the past century doesn't mean it wasn't going to occur anyway.

This is the scientific method—ask hard questions, develop hypotheses, and try to disprove them. Not only do we need better models, we need to be empirical, not hysterical. We need to look at the data and separate the signal from the noise. The majority of single papers showing research results are simply wrong. To get a better picture of scientific findings, one of the best tools is the metastudy.

Smoking Gun #5: All metastudies so far disagree with the IPCC projections.

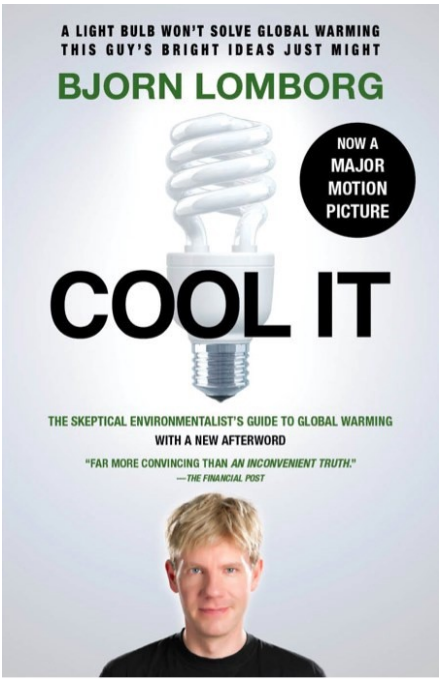
We only have two so far, but they are significant: one on temperature, and one on ocean acidification. Anyone who claims otherwise is going to have to explain why his/her claim invalidates the metastudies. That's a lot to ask, but this is the level of proof science demands.

4. Is decarbonization the right solution?

Okay, but even if there's a lot of uncertainty, what about the small possibility that something *really bad* could happen? Shouldn't we put money and resources into doing *something*, just as an insurance policy?

We could, but we have to balance that against buying other things with the same money and effort*. Right now, some ecosystems are fragile and threatened by humanity, while many others are already repairing themselves*. The focus on CO2 may be misplaced. It's not the CO2 that causes choking smog in Los Angeles, it's the rest of the mix that comes from the power plant and out of exhaust pipes. It's the fact that China needs to build a new city the size of Phoenix *every month* for the next 15 years. More people are eating a western diet, contributing to deforestation and wasting resources. Overfishing is a crisis in progress. This and much more is actually happening today, not in a computer model.

The Bush administration held up the Kyoto agreement, yet they spent trillions on a war based on no verifiable evidence to prevent a future that was never going to happen. Should we really do the exact opposite?



Enter Bjorn Lomborg, the "skeptical environmentalist," who has spent his mediagenic career trying to prioritize our efforts to save the earth and humans along with it. According to his calculations, the EU's goal of spending $250 billion *per year* until the end of the century will result in—and this is not a typo—0.1 degree lower temperatures.

Lomborg's book, *Cool It*, and movie of the same name, are excellent (though for some reason he believes the IPCC projections). He says we *should* switch to renewable sources of energy, but for the right reasons at the right price.

That's my attempt to answer the four questions. For a good summary, see Nir Shaviv's paper or Bob Tisdale's excellent ebook. In the next three sections, I'll quickly list people not to listen to and why, then I'll list people I think we can trust.

This section is a guide to the IPCC and people sounding the alarm of impending climate doom.

The Intergovernmental Panel on Climate Change

The "mainstream climatologist" view is generally embodied by the

IPCC. In 2007, the IPCC shared the Nobel Prize with Al Gore. Once I started to learn about the IPCC and the people who have left it and why, I started to question their motivations. The big shift came when I read a book called *The Delinquent Teenager Who Was Mistaken for the World's Top Climate Expert* by Donna LaFramboise, detailing the methods and motivations of the IPCC. I highly recommend reading Laframboise's book*; here are a few highlights:

- The IPCC operates in secrecy, leaves out critical pieces of data, relies too heavily on unproven measuring schemes, and tends to make unsupported sensationalist claims that support a politically-motivated, pre-determined agenda.
- Chris Landsea, a hurricane expert, resigned from the IPCC after a lead author for the IPCC and its chairman claimed that there would be more intense and more frequent storms as a result of man-made greenhouse gases. In his resignation letter, he wrote ***"I personally cannot in good faith continue to contribute to a process that I view as both being motivated by pre-conceived agendas and being scientifically unsound."***
- There is a growing list of scientists who have resigned from the IPCC* on the grounds that *"**scientific conclusions are re-written by politicians and presented to the public as valid science."***
- The IPCC claims to only use peer-reviewed papers from respected journals, but as Laframboise and a team of volunteers showed, **thirty percent of the source material—more than 5,000 articles—for the IPCC reports is not peer-reviewed**, and some of it is Greenpeace literature and press releases.
- Here is a list of more than one thousand published peer-reviewed papers questioning the science behind the IPCC reports.
- There is a growing list of distinguished climatologists who find no evidence for significant human-induced warming.
- The IPCC deliberately manipulates the peer-review process at the top journals*.

Because the IPCC narrative is so dominant, speaking up has consequences. A few people have put their careers on the line to defend scientific principles, several have been targeted by Greenpeace and others, while many scientists have simply played the game to win positions, research grants, publication, and lucrative consulting and side contracts.

Wikipedia
Unfortunately, Wikipedia can't be trusted on climate issues, thanks to the efforts of people who constantly maintain the alarmist message. While this sounds incredible, it's far more common than people think. PR firms focus their efforts on Wikipedia articles because they rank high in search results. For climate change, the action is particularly fierce. This is called sock puppetry. One study confirms that political topics are carefully tended and defended.

So I did an experiment. I added a single sentence to one section of Michael Mann's Wikipedia page. Here it is with my sentence highlighted:

Hockey stick controversy [edit]

Main article: Hockey stick controversy

Figures based on the northern hemisphere mean temperatures graph from MBH99 were prominently featured in the IPCC Third Assessment Report of 2001, and became the focus of controversy when some individuals and groups disputed the data and methodology of this reconstruction.[29]

The 2006 North Report published by the United States National Academy of Sciences endorsed the MBH studies with a few reservations. The principal component analysis methodology had a small tendency to bias results so was not recommended, but it had little influence on the final reconstructions, and other methods produced similar results.[30][31] Mann has said his findings have been "independently verified by independent teams using alternative methods and alternative data sources."[32] More than two dozen reconstructions, using various statistical methods and combinations of proxy records, support the broad consensus shown in the original hockey stick graph, with variations in how flat the pre-20th century "shaft" appears.[33][34] Independently, a research project looking only at peer-reviewed studies continues to find strong evidence for the Medieval Warming Period. [35]

I timed it. **It took *five minutes* for the page to go back the way it was before.** You can try this yourself on any of thousands of climate-related Wikipedia pages.

Realclimate.org
Set up by a PR firm and run by IPCC core elite, the site claims to bring a fair and balanced view of the debate. They don't allow dissenting comments. This piece describes their tactics and gives several references. One of their founders, William Connolley, known as "the climate doctor," was once banned by Wikipedia from continually revising thousands of climate-related pages, though he is now back on Wikipedia updating pages at a furious pace.

There are dozens of sites designed to promote global warming, demote skeptics, confuse the public, and get to the top of Google searches. An example is SkepticalScience.com, run by a former cartoonist who optimizes the content to dominate search engine rankings.

NASA and NOAA
As director of **NASA's Goddard Institute for Space Studies** (GISS)

from 1981 to 2013, James Hansen kept his team pumping out papers and articles to help evangelize his views, even though his predictions keep turning out to be wrong. Hansen's former boss, Dr. John S. Theon, now joins the ranks of many ex-NASA employees who believe Hansen is wrong. Fortunately, things are starting to change. NASA recently acknowledged this important paper showing how even tiny changes in the sun's output has dramatic effects on the earth's temperature*.

The **National Oceanic and Atmospheric Administration** follows NASA's lead in manufacturing data to suit the agenda. Did you know that NASA, NOAA, and the National Science Foundation together split *about a billion dollars of a $2 billion US annual budget spend on climate-change research*? Anthony Watts and others have shown the NOAA data to be strongly biased to support a global-warming scare.

Unfortunately, you can't trust Nature or Science magazines, either. Like many of today's peer-reviewed journals, they show strong publication bias. Dr. Marcia McNutt, chief editor of *Science*, is the latest in a long line of activist editors. They won't publish any scientific findings that go against their agenda.

> *The "Climategate" [stolen and revealed] e-mails indicate concerted efforts [by IPCC insiders] to reshape the peer-review process by managing and coordinating reviews of individual papers, by putting pressure on journal editors and editorial boards, by seeking to stack editorial boards with like-minded colleagues, by arranging boycotts of journals, and through other unprofessional actions.*
>
> — Roger Pielke Jr., *The Climate Fix: What Scientists and Politicians Won't Tell You About Global Warming*

Al Gore

Gore built a PR business around decarbonizing the energy industry to save us from a looming apocalypse. The poster for his film depicts a factory with a (Southern hemisphere) tropical storm coming out of the smoke stack. He predicted an Arctic Ocean free of ice, more intense storms, a malaria epidemic, and many more invented plagues that haven't and likely won't come true.

Barack Obama

I wish I could say that Obama—whom I voted for twice—is calm, cool, and collected on climate change, but he's far too hot under the collar. He is dedicated to reducing carbon emissions and has built his faith-based initiative into the national security agenda. On the campaign trail, Hillary Clinton sees decarbonization as a vote-getter.

MoveOn.org
This effective political action group seems to have swallowed an entire bottle of Hansen/Gore pills, even though they are supposed to help Americans "move on" and do what really matters.

Greenpeace
Greenpeace takes extremely complex issues and boils them down to a single slogan that promotes their agenda. Though they are usually wrong, they use simple messages, daring acts of vandalism, and paid street canvassers to raise money. Patrick Moore, a founder, now says, "I fear an intellectual Gulag with Greenpeace as my prison guards."

Like most people, we'd like to see the world a better place, which in this context translates into our working to reduce the risk of potentially disastrous climate change. To do that we have to get some broad-based support, to capture the public's imagination. That, of course, entails getting loads of media coverage. So we have to offer up scary scenarios, make simplified, dramatic statements, and make little mention of any doubts we might have.

— Stephen Schneider, climate scientist —

The Mainstream Press CNN, the BBC, and the mainstream networks all buy the decarbonization agenda without question. *The Atlantic*, *New York Times*, *Scientific American*, *National Geographic*, *Slate*, *The LA Times*, *and* *Rolling Stone* **all turned down my request to publish this essay**. Fair and balanced? They *never* publish opposing views or research by respected scientists. Look at TED.com's climate page—not a single dissenting voice (they don't want to piss off Al Gore—he's a big draw at the conferences). **It's sad that only FOX News is on the other side of this debate, since they are also politically motivated and can't possibly understand the science.**

How did things get this far out over the edge of reason? It helps to understand the history: In the 1950s, Roger Revelle and David Keeling documented the rise of CO2 in the atmosphere and came to the

reasonable conclusion that it *could* have an impact on climate later. In the 1960s, Revelle taught undergraduate student Al Gore about climate science. In 1967, James Hansen went to work at NASA's Goddard Institute for Space Studies doing climate modeling and other things. In the early 1980s, the green movement was gathering momentum. Temperatures had been rising steadily since the early Sixties. **Hansen, who was by then running GISS, simply extrapolated twenty years of recent warming far into the future and saw the apocalypse coming.**

The Critical Year

In June of 1988, Hansen testified before Congress, saying that *"the evidence is pretty strong that the greenhouse effect is here."* **As 1988 was a strong el-niño year, it was easy to point to the thermometer and talk about hottest year on record.** That same year, the IPCC was created. It was also 1988 when Al Gore set up the Senate Science, Technology, and Space Committee, famously choosing the hottest day of the year and making sure the room was *not* air-conditioned for the first meeting, and Gore became the chief warming promoter.

In that same year, Revelle wrote two letters to congress saying *"My own personal belief is that we should wait another ten or twenty years to really be convinced that the greenhouse effect is going to be important for human beings, in both positive and negative ways."*

But Hansen was building an ideological platform. His people at NASA assembled confirming data, and by the mid-Nineties enough environmentalists had taken senior positions to really get the ball rolling. They quickly discovered they could use fearful and dramatic imagery to raise funds—nothing like a crisis to get people to open their checkbooks. News organizations sold more copies when they ran stories of doom and gloom—the more immediate the threat, the better.

Think tanks, NGOs, universities, the alternative power industry, consultants, government agencies, magazines, and others switched from scientific inquiry to rent seeking. Academics need to get their work published; an IPCC paper is a career mover, while publishing a paper finding no warming isn't. The IPCC has an aggressive outreach/communications plan that has plenty of staffers. It's a classic case of manufacturing consent.

I worked at NASA GISS in the early 1980s, when Jim Hansen was building the Global Climate Model. Despite the fact that today's computers run billions of times faster, the assumptions upon assumptions baked into millions of lines of FORTRAN code do not inspire confidence.
— Former NASA GISS programmer —

It's Not the Message, it's the Messenger

The master consent-maker is a man you probably haven't heard of: David Fenton. Fenton Communications is the leading "social change" PR firm. They are driven by their passionate belief that they are saving the planet and changing the world. Fenton is a charming man of the same vintage as James Hanson. He and his team have worked tirelessly to promote a few good causes that were substantiated by scientific research and many more causes that were not. His magic is powerful. He can put an image of polar bears on the cover of TIME Magazine. His firm is responsible for the propaganda sites RealClimate.org and IPCCFacts.org (an oxymoron), and probably for much Wikipedia manipulation. He has worked for Al Gore and the UN for at least the past twenty years. How many PR firms can claim they got a Nobel Prize for their clients?

Fenton's powerful network, drives the image and credibility of the IPCC, so people automatically delegate their opinion without digging further. Fenton's strategy: *it's not about the message, it's about the messenger.* Use brand names to promote the cause and attack skeptics with name calling, law suits, and character assassination.

Aside from a pile of leaked and embarrassing emails in 2009, and the chair of the IPCC stepping down under charges of sexually harassing a female researcher, the PR machine is working smoothly. Michael Mann has 30,000 Twitter followers (I'd love to know how he got them). The New York Times encourages the use of Nazi/genocidal language in describing skeptics. The word "denier" lumps legitimate skeptics with wing nuts like Rush Limbaugh. Even the Pope has shuffled into the CO2 spotlight, hurting the very people he vows to protect. James Hansen is now at Columbia University promoting a huge decarbonization campaign. The goal is now to produce a climate deal in Paris later this year, which now seems likely, but will probably be impossible to implement.

To sum up: a common statistical error called **the law of small numbers** led James Hansen to start a worldwide movement. He got help from a number of same-age cronies, took advantage of public fear and laziness, and now steers trillions of dollars via the budgets and

subsidies of many governments toward decarbonization, undermining real environmental progress.

Just to be fair, both sides of the debate suffer from confirmation bias*. I am as guilty as anyone. It is complex, it's not "settled," and it makes sense to look for more evidence before we jump to conclusions.

Now I'll list the protagonists—people I think accurately represent the other side of the climate debate. This is a biased list—**I'm curating for you, leaving out a lot of names on purpose**. Almost all these "deniers" have PhDs (many with peer-reviewed papers), or have received significant praise for journalistic integrity.

Warren Meyer
An expert in forecasting of complex systems, his blog is widely read. He's written a simple primer on the Climate Debate and produced an excellent video, Catastrophe Denied*.

Judith Curry
A professor of climatology at Georgia Institute of Technology, Curry changed from mainstream to skeptic after looking at the evidence. She testified before Congress in April 2015* and has many strong YouTube videos explaining the political nature of the debate. See her excellent home page.

If you prefer reading, try the text of her speech to the House of Lords in London.

Matt Ridley
A very respected science writer has written a short essay on why he calls himself a climate lukewarmer*. Ridley's essay, The Climate Wars' Damage to Science*, should be one of the first things you read after finishing this one. Here's an excerpt:

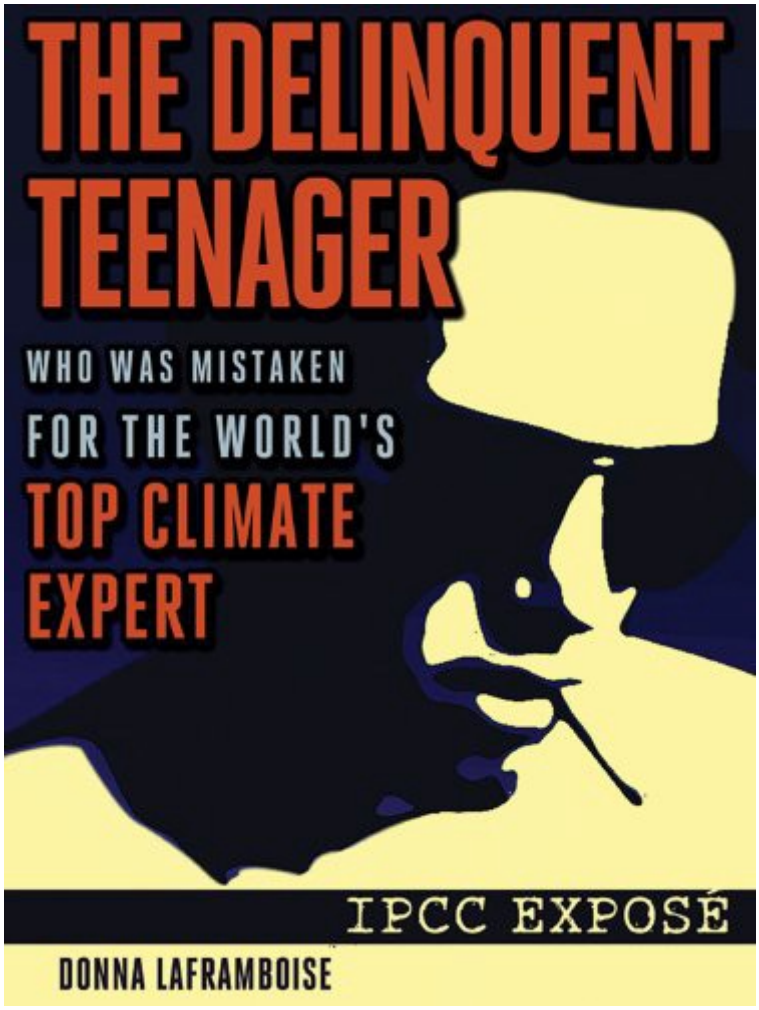
> *Look what happened to a butterfly ecologist named Camille Parmesan when she published a paper on "Climate and Species Range" that blamed climate change for threatening the Edith checkerspot butterfly with extinction in California by driving its range northward. The paper was cited more than 500 times, she was invited to speak at the White House and she was asked to contribute to the IPCC's third assessment report.*

> *Unfortunately, distinguished ecologist Jim Steele found fault with her conclusion: there had been more local extinctions in the southern part of the butterfly's range due to urban development than in the north, so only the statistical averages moved north, not the butterflies. There was no correlated local change in temperature anyway, and the butterflies have since recovered throughout their range. Parmesan's paper continues to be cited as evidence of climate change. Steele meanwhile is derided as a "denier".*

Anthony Watts: a former meteorologist who specializes in temperature measurement, his blog is technical but popular. He has a Paleoclimate reference page with many good graphs of temperature history, he has formed an impressive group to measure and categorize weather stations, and he carefully debunks Al Gore's claim that you can reproduce the greenhouse effect in a jar. His web site hosts an open

debate on facts, figures, and scientific findings. I recommend his mailing list.

Donna Laframboise
A journalist whose exposé of the IPCC, *The Delinquent Teenager Who Was Mistaken for the World's Top Climate Expert** will remove your faith in the United Nations and the IPCC. If you are passionate about saving the environment, this book should be at the top of your list.



Bob Tisdale: You can read his blog, or his book, *Climate Models Fail*. If your belief is based on the supposed accuracy of UN climate models, you'll change your belief after reading his book. His latest epic work is a free ebook taking you gently through all the arguments.

Jim Peacock, an ex-NASA engineer, has gathered a group of ex-NASA people at TheRightClimateStuff.com; they have produced their own independent report on the state of human-induced climate change.

Craig Idso produces a site full of peer-reviewed findings at CO2Science.org*. He has written *Climate Change Reconsidered*, and

CO2, Global Warming, and Coral Reefs, and is featured in many videos. Idso is also a lead author on the alternative *Nongovernmental International Panel on Climate Change*. Their new book, *Why Scientists Disagree about Global Warming*, is available for free at climatechangereconsidered.org.

Steve McIntyre's talk on paleoclimatology recounts the ClimateGate story (in which IPCC emails were leaked) from his perspective as a participant. His web site is very technical and a particular pain point for the IPCC.

Robert M Carter is a paleontologist, stratigrapher, and geologist who was fired for being critical of the mainstream stance on climate change. Here's a good short talk on YouTube* where he separates the signal from the noise:

William Happer is a physicist at Princeton. His testimony before congress is worth watching. He says, "*I, and many other scientists, think the warming will be small compared to the natural fluctuations in the earth's temperature.*"

Richard Lindzen is professor emeritus of atmospheric sciences at MIT and former contributing member of the IPCC. His bio is impressive. In a video interview*, he explains that many people simply don't understand natural variance and have confused it with a made-up catastrophe. His paper on the distortion and misuse of science in the name of climate change is important.

Nir Shaviv is a solar scientist with a good clear introduction to the science*.

Jason Scott Johnson, director of the University of Pennsylvania's Program on Law, Environment, and the Economy, has written an excellent "cross-examination" of the IPCC and reveals "what seem to be systematic patterns and practices that diverge from, and problems that impede, the application of basic scientific methods in establishment climate science."

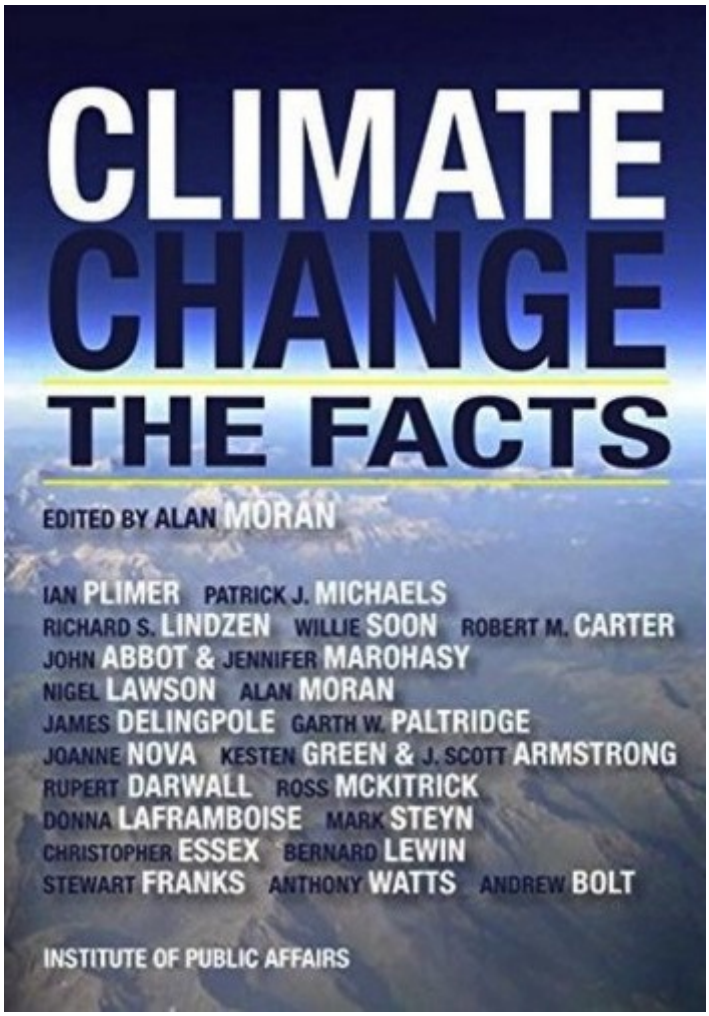
Michael Crichton, the late author, summed it up to Charlie Rose.*

Joanne Nova is a journalist in Australia. Her excellent blog is full of clear, concise reports on current topics in climate science. See her 2009 ebook, *Climate Money*.

J. Scott Armstrong, an expert in forecasting at the Wharton School of Business, teaches proper forecasting techniques. He cofounded PublicPolicyForecasting.com to give government agencies better forecasting tools. In his testimony before congress, he gives the IPCC model forecasts a failing grade.

The Breakthrough Institute takes a practical approach to finding technical solutions without penalizing the world's poorest nations. Read their excellent report on climate pragmatism: *Our High Energy Planet**.

Willie Soon is a solar physicist who has become a target of Greenpeace. His chapter in *Climate Change, The Facts** convinced me that solar variations are largely responsible for earth's temperature changes*.

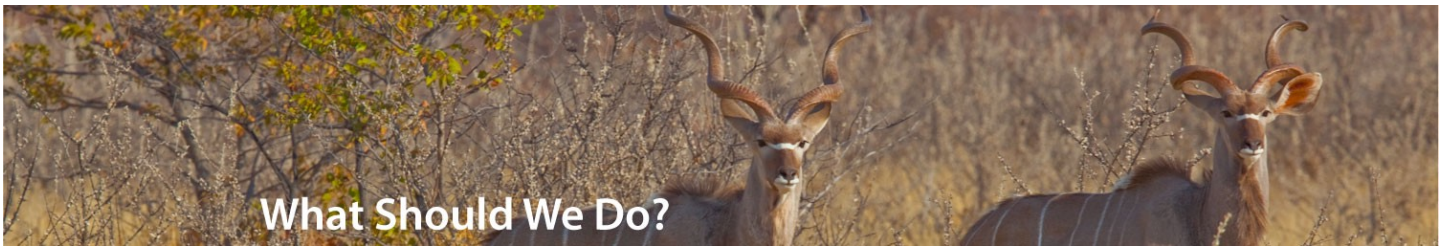


Some researchers here are funded by the Heartland Institute. I believe these people would quit if they felt pressure to do anything other than authentic science and trying to get the word out.

The idea of climate change should be seen as an intellectual resource around which our … identities and projects can form and take shape. We need to ask not what we can do for climate change, but to ask what climate change can do for us.

— Mike Hulme, professor of climate and culture —

Think about how you formed your opinion about climate change. Was it based on reading research papers, or was it from the popular press, movies, and stories? When it comes to the science, how much faith do you really have in the IPCC models? In tank experiments? In tree rings? In CO2 as the biggest threat to mankind since Hitler?



If we care about the environment, **we shouldn't be spending hundreds of billions of dollars on things that don't work**. Here are my suggestions:

Educate ourselves. This takes effort, but if it's the defining issue of this century—if climate change can modify your behavior, direct your tax money, and tell you whom to vote for, it makes sense to spend some of your time learning more*. This rabbit hole is astonishingly deep—it takes time to learn what's really going on. If you read/watch the * items and still have questions, please contact me, and I'll do my best to answer: david@businessagilityworkshop.com.

Call for the dismissal of the IPCC, UNFCC, and the UNSDSN. These organizations are doing more harm than good, putting politics ahead of science. We must effectively make them ineffective.

At the head (HQ/Secretariat level), however, logic has not always worked and the operation becomes an international fiefdom selected through political maneuvers rather than scientific leadership. Noncommunicative, illogical, and even quirky decisions seem to be par. … I believe this needs a clean sweep to revitalize the IPCC.
— IPCC member scientist —

Stop the carbon credits. There are perverse incentives to set up carbon credit markets, and they distract from the main goals of improving the lives of people and the environment. Thankfully, most carbon markets are already tanking by themselves.

Fund proper metastudies. We simply don't have good metastudies of the literature. We have one on temperature* and one on ocean acidification*, both of which support my conclusions here, but we need more. Since we are spending hundreds of billions each year on decarbonization, our first priority should be to allocate $10m to a systematic literature review done by metastudy specialists, not by politicians, climatologists, or magazines.

Clean up smoke emissions. Coal-based energy can be cleaned up, but we're spending the majority of our money trying to figure out how to capture the carbon rather than all the bad stuff. Let's go after smog, which kills at least 3 million people every year, and indoor air pollution, which kills at least 4 million people a year. Not only do we have good technology now, support of this market will drive more innovation and lower prices.

Provide affordable energy for all. We could use some of the decarbonization budget to build energy infrastructure in developing countries that have none. Alternatives like solar are not getting close to replacing power plants, but they certainly have their place. Wind energy has its own problems. We will be burning fossil fuels for the foreseeable future—let's do it right and help lift billions out of poverty.

Invest in adaptation. Sea level is going to rise no matter what, but not quickly and not much. Regional water shortages and powerful storms are real threats that are here today. We should prepare for those threats now and pursue practical solutions to medium-term problems.

Invest in better medium-range forecasts. One of the most sensible suggestions I have heard: if we had good forecasts 2–3 months out, we could better prepare for disastrous weather events.

Invest in next-generation nuclear power. We will build thousands of power plants this century. Most of the money we're planning to spend on decarbonization should go into producing the next generation of nuclear reactors. Fourth-generation molten-salt nuclear reactors will be safer, cleaner, and more cost-efficient.

Reach Out to Corporations. Many companies support decarbonization, spending billions of dollars that could be invested in new solutions. A commitment to nuclear power might be less popular but better for all.

Use the Paris climate conference to get the word out. There's a big PR event coming up in December. Undoubtedly, there will be another emotional film with apocalyptic images. The WWF has already started:

It's serious. The (money) stakes are higher than you might think. Science has nothing to do with it—this is about strengthening the decarbonization lobby. Hillary Clinton and John Kerry will magically pop up. Shabby-chic celebrities will photobomb the event, trying to look good doing good. The only thing that can stop this train is brand names speaking out, raising doubts, promoting more sensible solutions.

Reach out to the press. Mainstream publications have already decided the issue. I challenge a media-studies organization, like the Pew Research Center, to look hard at the issues and create a report that guides editors toward a more neutral and inclusive tone. A group like the Science Media Centre should take their own advice and look critically at climate science and wrongheaded claims.

Reach out to people you know. I realize you don't want to be seen as a climate "denier." Take it a step at a time. Ask questions. Send links to this article to friends, family, and people you know. You can just say *"Hey, can you please read this and tell me what you think?"* Use the hashtag **#climatecurious** to get your Twitter followers to come check it out.

Talk with educators. Think of kids who are truly concerned and want to do something for the planet. Their text books predict a scary, hellish future. If everyone who reads this can get one teacher to start questioning the dogma, we may have a chance to start teaching children to be critical thinkers and investigate for themselves.

In the renewable energy industry, anyone questioning the 'settled' science is a heretic. Many privately say they must go along with the doomsday conclusions or lose customers and possibly lose their business. We want renewables to win, but not as a result of lies and deceit.

— Anonymous member of the renewable industry —

Reach out to prominent liberals. If you know Bill Gates, Jeff Skoll, Mike Bloomberg, Gwyneth Paltrow, George Clooney, Leo DiCaprio, @ev, Matt Damon, Angelina Jolie, Taylor Swift, Michael Moore, Laurie David, @vkhosla, @johndoerr, or others interested in the climate issue, please send him/her to this page. We have to face the issue of fear and intimidation. Can you imagine Matt Damon holding a press conference to say he's now a climate skeptic? **Bring this up at a Beverly Hills cocktail party and you're going to lose friends faster than you can say "vaccination."** What if Hillary Clinton told a reporter she's "not so sure" about climate change?

But think about the choice we make *not* to look into this issue. Can we really afford to let the decarbonization lobby hijack our priorities, when so much else needs to be done at a critical time for the environment?

I'm not asking you to "get involved." I'm asking you to investigate and talk about it. **Your active questions and conversations will do the job.** I invite anyone who has read this to contact me to just spend some time learning and talking about how we can help open minds. Jon Stewart—I'd like to talk with you. Gates Foundation— I have a proposal for you. My email is david@businessagilityworkshop.com.

I'm still vegan. I still want to help people, animals, and the environment. I'm still a Democrat. **But I now believe that Al Gore, the United Nations, and many trusted institutions are Goliath—crisscrossing the globe in private jets selling the Chicken-Little climate narrative at any cost—and the Davids are the lone scientists and bloggers who are just trying to uncover the facts.**

Changing your mind this much is like getting a tattoo removed, but I feel like I'm seeing more clearly. **The earth *is* warming, but not quickly, not much, and not lately.**

I guess the main thing that convinced me to doubt Al Gore & the IPCC was partially the increasing number of PhD scientists who have changed their views and become more vocal about the science. It wasn partially the many peer-reviewed papers debunking the claims of the IPCC. And it was the metastudies—if the IPCC is right, why do the metastudies disagree? So far, we only have two, but they are significant:

- **Temperature:** "Corrected for publication bias, the bulk of the literature is consistent with climate sensitivity lying between 1.4 and 2.3 degrees Celsius."
- **Oceans:** "… marine biota may be more resistant to ocean acidification than expected."

Besides, even if it were all true, we're wasting our money and energy on decarbonization. It's not going to change anything. If people like Bjorn Lomborg realize that the IPCC narrative is probably wrong, then we could start setting priorities guided by experiments, evidence, and efficacy.

Finally, I keep in mind that **skeptics have nothing to prove**. They are trying—as Richard Feynman would if he were alive today—to *disprove* the claims made by people who should welcome the scrutiny. Yes, some skeptics are too extreme and have their own agenda. But the very essence of science is at stake. In the skeptic movement, I see people asking hard questions, challenging the status-quo, downloading the data, and changing their minds when they get new information.

> ***The problem with the world is that fools and fanatics are so certain of themselves, and wiser people are full of doubts.***
>
> — **Bertrand Russell** —

I expect some personal backlash for writing this (it's already happened), and of course I am not paid by and have no financial interest in either side of the debate. I simply care and want to be part of the solution, not part of the problem. I sympathize with people who have lost their jobs, can't get their research funded, have had papers

rejected, have been investigated, accounts hacked, and harassed—it's really happening, and it's costing all of us dearly.

Understanding this gives us hope—by using the money and effort we are currently dedicating to reducing carbon emissions, we can have a huge impact today *and* tomorrow. So let's get on with it: there are hundreds of things more important than decarbonizing and not a moment to lose.

If you don't agree with my conclusions, please fill out the survey so I can record your vote**.** You can see the survey results if you're interested.

If you do agree, if this essay has changed your view, or if you're a liberal who believes we should delete decarbonization, send people here, spend time on the web sites I've mentioned, and start conversations with people you know.

Want to Write Me?
Please don't send me your list of reasons I'm wrong and the Earth is going to Hell in a hand basket unless we decarbonize. You can leave comments at the page for this essay on Wattsupwiththat.com. I welcome thoughtful email discussions with those who have read this (the answer to your question is probably here somewhere already) and media interviews.

Thanks
My thanks to Kevin Dick, Richard Lindzen, Willie Soon, Brian Wu, and Rob Siegel for helpful comments as I was writing this.

The Story Continues
I don't have time to update this page, but I recently (March 2017)

discovered an excellent video on polar bears I think everyone should see and share:

Polar Bear Scare Unmasked

News
November 10, 2015: I am flattered by a big response to this essay written by well-meaning decarbonistas Josh Halpern, Greg Laden, Collin Maessen, Miriam O'Brien, Ken Rice, and Michael Tobis. In return, two people have helped me respond. One is by Tim Hunter, who bravely defended my essay against this ad-hominous attack. The other is by me and Bob Johnson. If you read the attack piece, be sure to see the two rebuttals.

Spread The Word
I appreciate any help in getting this to mainstream journalists. Try this tweet for your followers and see what they say:

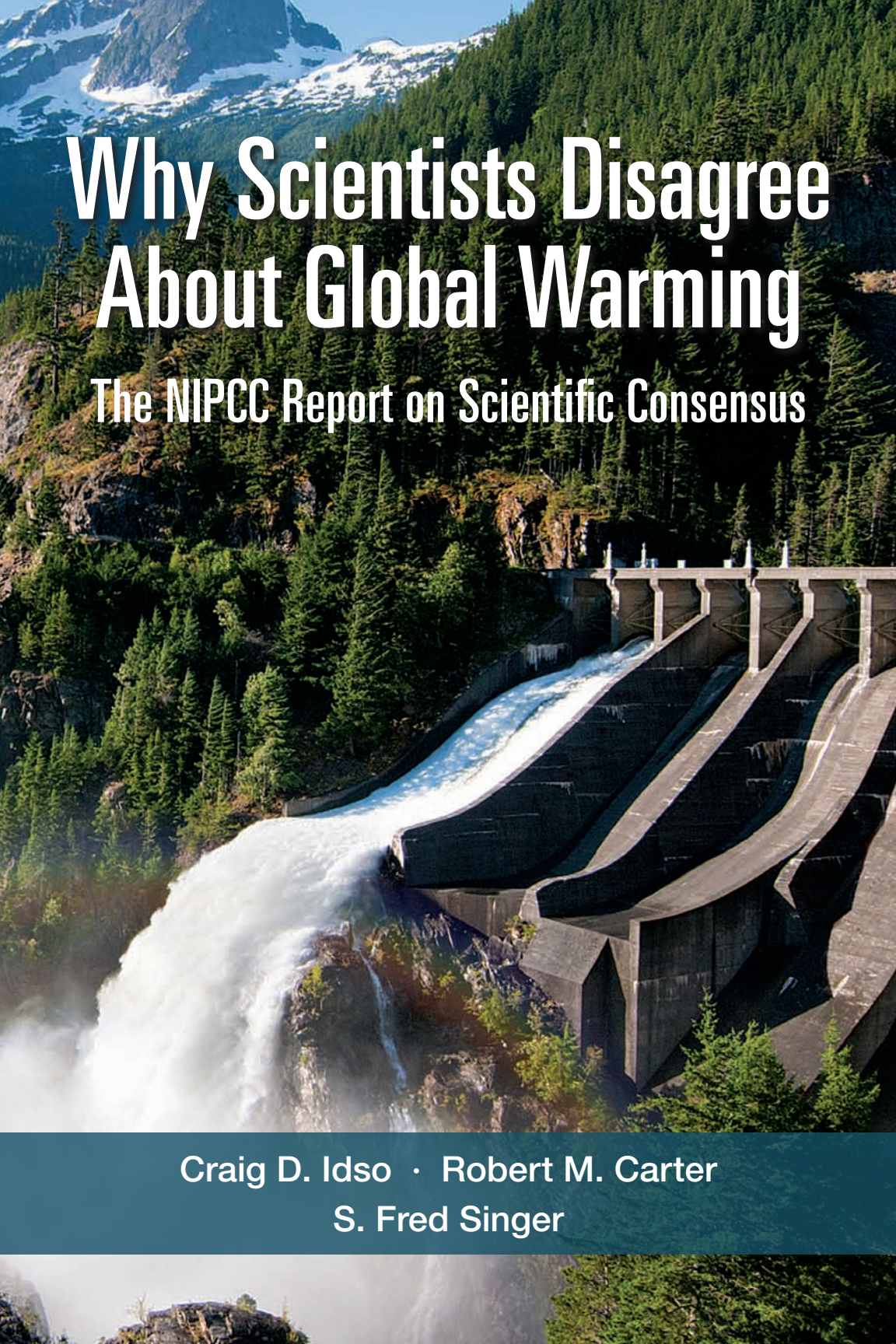
@Pullnews asks hard questions about climate change, read and tell me what you think: http://climatecurious.com #climatecurious

Feel free to connect to me on LinkedIn.

Please like/recommend this essay. Every click helps.

David Siegel is CEO of Twenty Thirty AG, a blockchain innovation community

Next: *People Don't Click*



Why Scientists Disagree About Global Warming

The NIPCC Report on Scientific Consensus

Craig D. Idso · Robert M. Carter
S. Fred Singer

Praise for past reports by the
Nongovernmental International Panel on Climate Change

Climate Change Reconsidered is a comprehensive, multidisciplinary compilation of technical papers covering a very large variety of important topics that will be appreciated by all who desire reliable, up-to-date information.

— Larry Bell, endowed professor and director
Sasakawa International Center for Space
Architecture at the University of Houston

Many will treat *Climate Change Reconsidered* as a highly authoritative source of reference. It is in particular a standing rebuke to all those alarmists who deny the existence of hard science supporting the sceptical case. ... Given the increasing realisation that climate mitigation efforts are creating an economic crisis, and increasing popular scepticism about the alarmist scenario, this is a timely publication, and a key resource for all of us who are arguing for common sense.

— Roger Helmer
Member of the European Parliament

The 2011 edition of *Climate Change Reconsidered* is a quite extraordinary achievement. It should put to rest once and for all any notion that "the science is settled" on the subject of global warming, or that humanity and our planet face an imminent manmade climate change disaster.

— Paul Driessen
Author, *Eco-Imperialism*

I fully support the efforts of the Nongovernmental International Panel on Climate Change (NIPCC) and publication of its latest report, *Climate Change Reconsidered II: Physical Science*, to help the general public to understand the reality of global climate change.

— Kumar Raina
Former Deputy Director General
Geological Survey of India

I've been waiting for this book for twenty years. It was a long wait, but I'm not disappointed. *Climate Change Reconsidered* is a *tour de force*.

— E. Calvin Beisner, Ph.D.
National Spokesman, Cornwall Alliance for the Stewardship of Creation

Highly informative, *Climate Change Reconsidered* ought to be required reading for scientists, journalists, policymakers, teachers, and students. It is an eye-opening read for everyone else (concerned citizens, taxpayers, etc.).

— William Mellberg
Author, *Moon Missions*

[T]here are several chapters in the NIPCC report that are substantially more thorough and comprehensive than the IPCC treatment, including 5 (Solar variability and climate cycles), 7 (Biological effects of carbon dioxide enrichment), 8 (Species extinction) and 9 (Human health effects). Further, the NIPCC's regional approach to analyzing extreme events and historical and paleo records of temperature, rainfall, streamflow, glaciers, sea ice, and sea-level rise is commendable and frankly more informative than the global analyses provided by the IPCC.

— Dr. Judith Curry, professor and chair
School of Earth and Atmospheric Sciences
Georgia Institute of Technology

NIPCC's CCR-II report should open the eyes of world leaders who have fallen prey to the scandalous climate dictates by the IPCC. People are already suffering the consequences of sub-prime financial instruments. Let them not suffer more from IPCC's sub-prime climate science and models. That is the stark message of the NIPCC's CCR-II report.

— M.I. Bhat, formerly professor and head
Department of Geology and Geophysics
University of Kashmir, India

Climate Change Reconsidered is a comprehensive, authoritative, and definitive reply to the IPCC reports.

— Dr. Gerrit van der Lingen
Christchurch, New Zealand

I was glad to see that a new report was coming from the NIPCC. The work of this group of scientists to present the evidence for natural climate warming and climate change is an essential counter-balance to the biased reporting of the IPCC. They have brought to focus a range of peer-reviewed publications showing that natural forces have in the past and continue today to dominate the climate signal. Considering the recent evidence that climate models have failed to predict the flattening of the global temperature curve, and that global warming seems to have ended some 15 years ago, the work of the NIPCC is particularly important.

— Ian Clark, professor, Department of Earth Sciences
University of Ottawa, Canada

Library shelves are cluttered with books on global warming. The problem is identifying which ones are worth reading. The NIPCC's CCR-II report is one of these. Its coverage of the topic is comprehensive without being superficial. It sorts through conflicting claims made by scientists and highlights mounting evidence that climate sensitivity to carbon dioxide increase is lower than climate models have until now assumed.

— Chris de Freitas, School of Environment
The University of Auckland, New Zealand

The CCR-II report correctly explains that most of the reports on global warming and its impacts on sea-level rise, ice melts, glacial retreats, impact on crop production, extreme weather events, rainfall changes, etc. have not properly considered factors such as physical impacts of human activities, natural variability in climate, lopsided models used in the prediction of production estimates, etc. There is a need to look into these phenomena at local and regional scales before sensationalization of global warming-related studies.

— S. Jeevananda Reddy
Former Chief Technical Advisor
United Nations World Meteorological Organization

The claim by the UN IPCC that "global sea level is rising at an enhanced rate and swamping tropical coral atolls" does NOT agree with observational facts, and must hence be discarded as a serious disinformation. This is well taken in the CCR-II report.

— Nils-Axel Mörner, emeritus professor
Paleogeophysics & Geodynamics
Stockholm University, Sweden

Climate Change Reconsidered is simply the most comprehensive documentation of the case against climate alarmism ever produced. Basing policy on the scientifically incomplete and internally inconsistent reports of the UN's Intergovernmental Panel on Climate Change is no longer controversial – *Climate Change Reconsidered* shows that it is absolutely foolhardy, and anyone doing so is risking humiliation. It is a must-read for anyone who is accountable to the public, and it needs to be taken very, very seriously.

— Patrick J. Michaels, Director
Center for the Study of Science, Cato Institute

CCR-II provides scientists, policy makers and other interested parties information related to the current state of knowledge in atmospheric studies. Rather than coming from a pre-determined politicized position that is typical of the IPCC, the NIPCC constrains itself to the scientific process so as to provide objective information. If we (scientists) are honest, we understand that the study of atmospheric processes/dynamics is in its infancy. Consequently, the work of the NIPCC and its most recent report is very important. It is time to move away from politicized science back to science – this is what NIPCC is demonstrating by example.

— Bruce Borders, professor of Forest Biometrics
Warnell School of Forestry and Natural Resources
University of Georgia

Why Scientists Disagree About Global Warming

The NIPCC Report
on Scientific Consensus

Craig D. Idso, Robert M. Carter, S. Fred Singer

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NONGOVERNMENTAL INTERNATIONAL PANEL
ON CLIMATE CHANGE

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Contents

Preface

The global warming debate is one of the most consequential public policy debates taking place in the world today. Billions of dollars have been spent in the name of preventing global warming or mitigating the human impact on Earth's climate. Governments are negotiating treaties that would require trillions of dollars more to be spent in the years ahead.

A frequent claim in the debate is that a "consensus" or even "overwhelming consensus" of scientists embrace the more alarming end of the spectrum of scientific projections of future climate change. Politicians including President Barack Obama and government agencies including the National Aeronautics and Space Administration (NASA) claim "97 percent of scientists agree" that climate change is both man-made and dangerous.

As the authors of this book explain, the claim of "scientific consensus" on the causes and consequences of climate change is without merit. There is no survey or study showing "consensus" on any of the most important scientific issues in the climate change debate. On the contrary, there is extensive evidence of scientific disagreement about many of the most important issues that must be resolved before the hypothesis of dangerous man-made global warming can be validated.

Other authors have refuted the claim of a "scientific consensus" about global warming. This book is different in that it comprehensively and specifically rebuts the surveys and studies used to support claims of a consensus. It then summarizes evidence showing disagreement, identifies four reasons why scientists disagree about global warming, and then provides a detailed survey of the physical science of global warming based

on the authors' previous work.

This book is based on a chapter in a forthcoming much larger examination of the climate change debate to be titled *Climate Change Reconsidered II: Benefits and Costs of Fossil Fuels.* That volume will finish the three-volume *Climate Change Reconsidered II* series, totaling some 3,000 pages and reporting the findings of more than 4,000 peer-reviewed articles on climate change.

This book and the larger volume that will follow it are produced by the Nongovernmental International Panel on Climate Change (NIPCC), an international panel of scientists and scholars who came together to understand the causes and consequences of climate change. NIPCC has no formal attachment to or sponsorship from any government or government agency. It also receives no corporate funding for its activities.

NIPCC seeks to objectively analyze and interpret data and facts without conforming to any specific agenda. This organizational structure and purpose stand in contrast to those of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which is government -sponsored, politically motivated, and predisposed to believing that dangerous human-related global warming is a problem in need of a UN solution.

This volume, like past NIPCC reports, is edited and published by the staff of The Heartland Institute, a national nonprofit research and educational organization newly relocated from Chicago to suburban Arlington Heights, Illinois. The authors wish to acknowledge and thank Joseph L. Bast and Diane C. Bast, Heartland's seemingly tireless editing duo, for their help in getting this chapter ready for release before the rest of the volume in which it will eventually appear.

Craig D. Idso, Ph.D.
Chairman
Center for the Study of Carbon Dioxide and Global Change (USA)

Robert M. Carter, Ph.D.
Emeritus Fellow
Institute of Public Affairs Australia)

S. Fred Singer, Ph. D.
Chairman
Science and Environmental Policy Project (USA)

Key Findings

Key findings of this book include the following:

No Consensus

- The most important fact about climate science, often overlooked, is that scientists disagree about the environmental impacts of the combustion of fossil fuels on the global climate.

- The articles and surveys most commonly cited as showing support for a "scientific consensus" in favor of the catastrophic man-made global warming hypothesis are without exception methodologically flawed and often deliberately misleading.

- There is no survey or study showing "consensus" on the most important scientific issues in the climate change debate.

- Extensive survey data show deep disagreement among scientists on scientific issues that must be resolved before the man-made global warming hypothesis can be validated. Many prominent experts and probably most working scientists disagree with the claims made by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

Why Scientists Disagree

- Climate is an interdisciplinary subject requiring insights from many fields of study. Very few scholars have mastery of more than one or two of these disciplines.

- Fundamental uncertainties arise from insufficient observational evidence, disagreements over how to interpret data, and how to set the parameters of models.

- IPCC, created to find and disseminate research finding a human impact on global climate, is not a credible source. It is agenda-driven, a political rather than scientific body, and some allege it is corrupt.

- Climate scientists, like all humans, can be biased. Origins of bias include careerism, grant-seeking, political views, and confirmation bias.

Scientific Method vs. Political Science

- The hypothesis implicit in all IPCC writings, though rarely explicitly stated, is that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions.

- The null hypothesis is that currently observed changes in global climate indices and the physical environment, as well as current changes in animal and plant characteristics, are the result of natural variability.

- In contradiction of the scientific method, IPCC assumes its implicit hypothesis is correct and that its only duty is to collect evidence and make plausible arguments in the hypothesis's favor.

Flawed Projections

- IPCC and virtually all the governments of the world depend on global climate models (GCMs) to forecast the effects of human-related greenhouse gas emissions on the climate.

- GCMs systematically over-estimate the sensitivity of climate to carbon dioxide (CO_2), many known forcings and feedbacks are poorly modeled, and modelers exclude forcings and feedbacks that run counter to their mission to find a human influence on climate.

- NIPCC estimates a doubling of CO_2 from pre-industrial levels (from 280 to 560 ppm) would likely produce a temperature forcing of 3.7 Wm^{-2} in the lower atmosphere, for about ~1°C of *prima facie* warming.

- Four specific forecasts made by GCMs have been falsified by real-world data from a wide variety of sources. In particular, there has been no global warming for some 18 years.

False Postulates

- Neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside normal natural variability.

- The late twentieth century warm peak was of no greater magnitude than previous peaks caused entirely by natural forcings and feedbacks.

- Historically, increases in atmospheric CO_2 follow increases in temperature, they did not precede them. Therefore, CO_2 levels could not have forced temperatures to rise.

- Solar forcings are not too small to explain twentieth century warming. In fact, their effect could be equal to or greater than the effect of CO_2 in the atmosphere.

- A warming of 2°C or more during the twenty-first century would probably not be harmful, on balance, because many areas of the world would benefit from or adjust to climate change.

Unreliable Circumstantial Evidence

- Melting of Arctic sea ice and polar icecaps is not occurring at "unnatural" rates and does not constitute evidence of a human impact on the climate.

- Best available data show sea-level rise is not accelerating. Local and regional sea levels continue to exhibit typical natural variability – in some places rising and in others falling.

- The link between warming and drought is weak, and by some measures drought decreased over the twentieth century. Changes in the hydrosphere of this type are regionally highly variable and show a closer correlation with multidecadal climate rhythmicity than they do with global temperature.

- No convincing relationship has been established between warming over the past 100 years and increases in extreme weather events.

Meteorological science suggests just the opposite: A warmer world will see milder weather patterns.

- No evidence exists that current changes in Arctic permafrost are other than natural or are likely to cause a climate catastrophe by releasing methane into the atmosphere.

Policy Implications

- Rather than rely exclusively on IPCC for scientific advice, policymakers should seek out advice from independent, nongovernment organizations and scientists who are free of financial and political conflicts of interest.

- Individual nations should take charge of setting their own climate policies based upon the hazards that apply to their particular geography, geology, weather, and culture.

- Rather than invest scarce world resources in a quixotic campaign based on politicized and unreliable science, world leaders would do well to turn their attention to the real problems their people and their planet face.

Introduction

Probably the most widely repeated claim in the debate over global warming is that "97 percent of scientists agree" that climate change is man-made and dangerous. This claim is not only false, but its presence in the debate is an insult to science.

As the size of recent reports by the alarmist Intergovernmental Panel on Climate Change (IPCC) and its skeptical counterpart, the Nongovernmental International Panel on Climate (NIPCC) suggest, climate science is a complex and highly technical subject, making simplistic claims about what "all" or "most" scientists believe necessarily misleading. Regrettably, this hasn't prevented various politicians and activists from proclaiming a "scientific consensus" or even "overwhelming scientific consensus" that human activities are responsible for observed climate changes in recent decades and could have "catastrophic" effects in the future.

The claim that "97 percent of scientists agree" appears on the websites of government agencies such as the U.S. National Aeronautics and Space Administration (NASA, 2015) and even respected scientific organizations such as the American Association for the Advancement of Science (AAAS, n.d.), yet such claims are either false or meaningless.

Chapter 1 debunks surveys and abstract-counting exercises that allege to have found a "scientific consensus" in favor of the man-made global warming hypothesis and reports surveys that found no consensus on the most important issues in the debate. Chapter 2 explains why scientists disagree, finding the sources of disagreement in the interdisciplinary character of the issue, fundamental uncertainties concerning climate

science, the failure of IPCC to be an independent and reliable source of research on the subject, and bias among researchers.

Chapter 3 explains the scientific method and contrasts it with the methodology used by IPCC and appeals to the "precautionary principle." Chapter 4 describes flaws in how IPCC uses global climate models to make projections about present and future climate changes and reports the findings of superior models that foresee much less global warming and even cooling. Chapter 5 critiques five postulates or assumptions that underlie IPCC's work, and Chapter 6 critiques five key pieces of circumstantial evidence relied on by IPCC. Chapter 7 reports the policy implications of these findings, and a brief summary and conclusion end this book.

Chapters 1 and 2 are based on previously published work by Joseph Bast (Bast, 2010, 2012, 2013; Bast and Spencer, 2014) that has been revised for this publication. Chapters 3 to 7 are based on the *Summary for Policymakers* of *Climate Change Reconsidered II: Physical Science*, an earlier volume in the same series as the present book produced by the Nongovernmental International Panel on Climate Change (NIPCC) (Idso, Carter, and Singer, 2014). Although brief, this summary of climate science is based on an exhaustive review of the scientific literature. Lead authors Craig D. Idso, Robert M. Carter, and S. Fred Singer worked with a team of some 50 scientists to produce a 1,200-page report that is comprehensive, objective, and faithful to the scientific method. It mirrors and rebuts IPCC's Working Group 1 and Working Group 2 contributions to IPCC's 2014 *Fifth Assessment Report,* or AR5 (IPCC, 2014). Like IPCC reports, NIPCC reports cite thousands of articles appearing in peer-reviewed science journals relevant to the subject of human-induced climate change.

NIPCC authors paid special attention to research that was either overlooked by IPCC or contains data, discussion, or implications arguing against IPCC's claim that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions. Most notably, NIPCC's authors say IPCC has exaggerated the amount of warming likely to occur if the concentration of atmospheric CO_2 were to double, and such warming as occurs is likely to be modest and cause no net harm to the global environment or to human well-being. The principal findings from *CCR-II: Physical Science* are summarized in Figure 1.

Figure 1
Summary of NIPCC's Findings on Physical Science

- Atmospheric carbon dioxide (CO_2) is a mild greenhouse gas that exerts a diminishing warming effect as its concentration increases.

- Doubling the concentration of atmospheric CO_2 from its pre-industrial level, in the absence of other forcings and feedbacks, would likely cause a warming of ~0.3 to 1.1°C, almost 50 percent of which must already have occurred.

- A few tenths of a degree of additional warming, should it occur, would not represent a climate crisis.

- Model outputs published in successive IPCC reports since 1990 project a doubling of CO_2 could cause warming of up to 6°C by 2100. Instead, global warming ceased around the end of the twentieth century and was followed (since 1997) by 16 years of stable temperature.

- Over recent geological time, Earth's temperature has fluctuated naturally between about +4°C and -6°C with respect to twentieth century temperature. A warming of 2°C above today, should it occur, falls within the bounds of natural variability.

- Though a future warming of 2°C would cause geographically varied ecological responses, no evidence exists that those changes would be net harmful to the global environment or to human well-being.

- At the current level of ~400 ppm we still live in a CO_2-starved world. Atmospheric levels 15 times greater existed during the Cambrian Period (about 550 million years ago) without known adverse effects.

- The overall warming since about 1860 corresponds to a recovery from the Little Ice Age modulated by natural multidecadal cycles driven by ocean-atmosphere oscillations, or by solar variations at the de Vries (~208 year) and Gleissberg (~80 year) and shorter periodicities.

- Earth has not warmed significantly for the past 18 years despite an 8 percent increase in atmospheric CO_2, which represents 34 percent of all extra CO_2 added to the atmosphere since the start of the industrial revolution.

- No close correlation exists between temperature variation over the past 150 years and human-related CO_2 emissions. The parallelism of temperature and CO_2 increase between about 1980 and 2000 AD could be due to chance and does not necessarily indicate causation.

- The causes of historic global warming remain uncertain, but significant correlations exist between climate patterning and multidecadal variation and solar activity over the past few hundred years.

- Forward projections of solar cyclicity imply the next few decades may be marked by global cooling rather than warming, despite continuing CO_2 emissions.

Source: Idso, C.D., Carter, R.M., Singer, S.F. 2013. Executive Summary, *Climate Change Reconsidered II: Physical Science.* Chicago, IL: The Heartland Institute.

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1

No Consensus

Key findings of this chapter include the following:

- The most important fact about climate science, often overlooked, is that scientists disagree about the environmental impacts of the combustion of fossil fuels on the global climate.

- The articles and surveys most commonly cited as showing support for a "scientific consensus" in favor of the catastrophic man-made global warming hypothesis are without exception methodologically flawed and often deliberately misleading.

- There is no survey or study showing "consensus" on the most important scientific issues in the climate change debate.

- Extensive survey data show deep disagreement among scientists on scientific issues that must be resolved before the man-made global warming hypothesis can be validated. Many prominent experts and probably most working scientists disagree with the claims made by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

Why Debate Consensus?

Environmental activists and their allies in the media often characterize climate science as an "overwhelming consensus" in favor of a single view

that is sometimes challenged by a tiny minority of scientists funded by the fossil fuel industry to "sow doubt" or otherwise emphasize the absence of certainty on key aspects of the debate (Hoggan and Littlemore, 2009; Oreskes and Conway, 2010; Mann, 2012; Prothero, 2013). This popular narrative grossly over-simplifies the issue while libeling scientists who question the alleged consensus (Cook, 2014). This section reveals scientists do, in fact, disagree on the causes and consequences of climate change.

In May 2014, Secretary of State John Kerry warned graduating students at Boston College of the "crippling consequences" of climate change. "Ninety-seven percent of the world's scientists tell us this is urgent," he added (Kerry, 2014). Three days earlier, President Obama tweeted that "Ninety-seven percent of scientists agree: #climate change is real, man-made and dangerous" (Obama, 2014). What is the basis of these claims?

The most influential statement of this alleged consensus appears in the *Summary for Policymakers* of the *Fifth Assessment Report* (AR5) from the Intergovernmental Panel on Climate Change (IPCC): "It is extremely likely (95%+ certainty) that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period" (IPCC, 2013, p. 17).

In a "synthesis report" produced the following year, IPCC went further, claiming "Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks" (IPCC, 2014, p. 8). In that same report, IPCC expresses skepticism that even reducing emissions will make a difference: "Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases" (p. 16).

The media uncritically reported IPCC's claims with headlines such as "New Climate Change Report Warns of Dire Consequences" (Howard, 2014) and "Panel's Warning on Climate Risk: Worst Is Yet to Come"

(Gillis, 2014).

What evidence is there for a "scientific consensus" on the causes and consequences of climate change? What do scientists really say? Any inquiry along these lines must begin by questioning the legitimacy of the question. Science does not advance by consensus or a show of hands. Disagreement is the rule and consensus is the exception in most academic disciplines. This is because science is a process leading to ever-greater certainty, necessarily implying that what is accepted as true today will likely not be accepted as true tomorrow. As Albert Einstein famously once said, "No amount of experimentation can ever prove me right; a single experiment can prove me wrong" (Einstein, 1996).

Still, claims of a "scientific consensus" cloud the current debate on climate change. Many people, scientists included, refuse to believe scientists and other experts, even scholars eminent in the field, simply because they are said to represent minority views in the science community. So what do the surveys and studies reveal?

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Flawed Surveys

Claims of a "scientific consensus" on the causes and consequences of climate rely on a handful of essays reporting the results of surveys or efforts to count the number of articles published in peer-reviewed journals that appear to endorse or reject the positions of IPCC. As this section reveals, these surveys and abstract-counting exercises are deeply flawed and do not support the claims of those who cite them.

Oreskes, 2004

The most frequently cited source for a "consensus of scientists" is a 2004 essay for the journal *Science* written by science historian Naomi Oreskes (Oreskes, 2004). Oreskes reported examining abstracts from 928 papers reported by the Institute for Scientific Information database published in scientific journals from 1993 and 2003, using the key words "global climate change." Although not a scientist, she concluded 75 percent of the abstracts either implicitly or explicitly supported IPCC's view that human activities were responsible for most of the observed warming over the previous 50 years while none directly dissented.

Oreskes' essay, which was not peer-reviewed, became the basis of a book, *Merchants of Doubt* (Oreskes and Conway, 2010), an academic career built on claiming that global warming "deniers" are a tiny minority within the scientific community, and even a movie based on her book released in 2015. Her claims were repeated in former Vice President Al Gore's movie, *An Inconvenient Truth*, and in his book with the same title (Gore, 2006).

It is now widely agreed Oreskes did not distinguish between articles that acknowledged or assumed some human impact on climate, however small, and articles that supported IPCC's more specific claim that human emissions are responsible for more than 50 percent of the global warming observed during the past 50 years. The abstracts often are silent on the matter, and Oreskes apparently made no effort to go beyond those abstracts. Her definition of consensus also is silent on whether man-made climate change is dangerous or benign, a rather important point in the debate.

Oreskes' literature review inexplicably overlooked hundreds of articles by prominent global warming skeptics including John Christy, Sherwood Idso, Richard Lindzen, and Patrick Michaels. More than 1,350 such articles (including articles published after Oreskes' study was completed) are now identified in an online bibliography (Popular Technology.net, 2014).

Oreskes' methodology was flawed by assuming a nonscientist could determine the findings of scientific research by quickly reading abstracts of published papers. Indeed, even trained climate scientists are unable to do so because abstracts routinely do not accurately reflect their articles' findings. According to In-Uck Park *et al.* in research published in *Nature* in 2014 (Park *et al.*, 2014), abstracts routinely overstate or exaggerate research findings and contain claims that are irrelevant to the underlying research. The authors found "a mismatch between the claims made in the abstracts, and the strength of evidence for those claims based on a neutral analysis of the data, consistent with the occurrence of herding." They note abstracts often are loaded with "keywords" to ensure they are picked up by search engines and thus cited by other researchers.

Oreskes' methodology is further flawed, as are all the other surveys and abstract-counting exercises discussed in this section, by surveying the opinions and writings of scientists and often nonscientists who may write about climate but are by no means experts on or even casually familiar with the science dealing with attribution – that is, attributing a specific climate effect (such as a temperature increase) to a specific cause (such as rising

CO_2 levels). Most articles simply reference or assume to be true the claims of IPCC and then go on to address a different topic, such as the effect of ambient temperature on the life-cycle of frogs, say, or correlations between temperature and outbreaks of influenza. Attribution is the issue the surveys ask about, but they ask people who have never studied the issue. The number of scientists actually knowledgeable about this aspect of the debate may be fewer than 100 in the world. Several are prominent skeptics (John Christy, Richard Lindzen, Patrick Michaels, and Roy Spencer, to name only four) and many others may be.

Monckton (2007) finds numerous other errors in Oreskes' essay including her use of the search term "global climate change" instead of "climate change," which resulted in her finding fewer than one-thirteenth of the estimated corpus of scientific papers on climate change over the stated period. Monckton also points out Oreskes never stated how many of the 928 abstracts she reviewed actually endorsed her limited definition of "consensus."

Medical researcher Klaus-Martin Schulte used the same database and search terms as Oreskes to examine papers published from 2004 to February 2007 and found fewer than half endorsed the "consensus" and only 7 percent did so explicitly (Schulte, 2008). His study is described in more detail below.

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Doran and Zimmerman, 2009

In 2009, a paper by Maggie Kendall Zimmerman, at the time a student at the University of Illinois, and her master's thesis advisor Peter Doran was published in *EOS*. They claimed "97 percent of climate scientists agree" that mean global temperatures have risen since before the 1800s and that humans are a significant contributing factor (Doran and Zimmerman, 2009). This study, too, has been debunked.

The researchers sent a two-minute online survey to 10,257 Earth scientists working for universities and government research agencies, generating responses from 3,146 people. Solomon (2010) observed, "The two researchers started by altogether excluding from their survey the thousands of scientists most likely to think that the Sun, or planetary movements, might have something to do with climate on Earth – out were the solar scientists, space scientists, cosmologists, physicists, meteorologists and astronomers. That left the 10,257 scientists in disciplines like geology, oceanography, paleontology, and geochemistry that were somehow deemed more worthy of being included in the consensus. The two researchers also decided that scientific accomplishment should not be a factor in who could answer – those surveyed were determined by their place of employment (an academic or a governmental institution). Neither was academic qualification a factor – about 1,000 of those surveyed did not have a Ph.D., some didn't even have a master's diploma." Only 5 percent of respondents self-identified as climate scientists.

Even worse than the sample size, the bias shown in its selection, and the low response rate, though, is the irrelevance of the questions asked in the survey to the debate taking place about climate change. The survey asked two questions:

"Q1. When compared with pre-1800s levels, do you think that mean global temperatures have generally risen, fallen, or remained relatively

constant?

Q2. Do you think human activity is a significant contributing factor in changing mean global temperatures?"

Overall, 90 percent of respondents answered "risen" to question 1 and 82 percent answered "yes" to question 2. The authors get their fraudulent "97 percent of climate scientists believe" sound bite by focusing on only 79 scientists who responded and "listed climate science as their area of expertise and who also have published more than 50 percent of their recent peer-reviewed papers on the subject of climate change."

Most skeptics of man-made global warming would answer those two questions the same way as alarmists would. At issue is not whether the climate warmed since the Little Ice Age or whether there is a human impact on climate, but whether the warming is unusual in rate or magnitude; whether that part of it attributable to human causes is likely to be beneficial or harmful on net and by how much; and whether the benefits of reducing human carbon dioxide emissions – i.e., reducing the use of fossil fuels – would outweigh the costs, so as to justify public policies aimed at reducing those emissions. The survey is silent on these questions.

The survey by Doran and Zimmerman fails to produce evidence that would back up claims of a "scientific consensus" about the causes or consequences of climate change. They simply asked the wrong people the wrong questions. The "98 percent" figure so often attributed to their survey refers to the opinions of only 79 climate scientists, hardly a representative sample of scientific opinion.

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Anderegg *et al.*, 2010

William R. Love Anderegg, then a student at Stanford University, used

Google Scholar to identify the views of the most prolific writers on climate change. He claimed to find "(i) 97–98% of the climate researchers most actively publishing in the field support the tenets of ACC [anthropogenic climate change] outlined by the Intergovernmental Panel on Climate Change, and (ii) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers" (Anderegg *et al.*, 2010). This college paper was published in *Proceedings of the National Academy of Sciences*, thanks to the addition of three academics as coauthors.

This is not a survey of scientists, whether "all scientists" or specifically climate scientists. Instead, Anderegg simply counted the number of articles he found on the Internet published in academic journals by 908 scientists. This counting exercise is the same flawed methodology utilized by Oreskes, falsely assuming abstracts of papers accurately reflect their findings. Further, Anderegg did not determine how many of these authors believe global warming is harmful or that the science is sufficiently established to be the basis for public policy. Anyone who cites this study in defense of these views is mistaken.

Anderegg *et al.* also didn't count as "skeptics" the scientists whose work exposes gaps in the man-made global warming theory or contradicts claims that climate change will be catastrophic. Avery (2007) identified several hundred scientists who fall into this category, even though some profess to "believe" in global warming.

Looking past the flashy "97–98%" claim, Anderegg *et al.* found the average skeptic has been published about half as frequently as the average alarmist (60 versus 119 articles). Most of this difference was driven by the hyper-productivity of a handful of alarmist climate scientists: The 50 most prolific alarmists were published an average of 408 times, versus only 89 times for the skeptics. The extraordinary publication rate of alarmists should raise a red flag. It is unlikely these scientists actually participated in most of the experiments or research contained in articles bearing their names.

The difference in productivity between alarmists and skeptics can be explained by several factors other than merit:

- Publication bias – articles that "find something," such as a statistically significant correlation that might suggest causation, are much more likely to get published than those that do not;

- Heavy government funding of the search for one result but little or no funding for other results – the U.S. government alone paid $64 billion to climate researchers during the four years from 2010 to 2013, virtually all of it explicitly assuming or intended to find a human impact on climate and virtually nothing on the possibility of natural causes of climate change (Butos and McQuade, 2015, Table 2, p. 178);

- Resumé padding – it is increasingly common for academic articles on climate change to have multiple and even a dozen or more authors, inflating the number of times a researcher can claim to have been published (Hotz, 2015). Adding a previously published researcher's name to the work of more junior researchers helps ensure approval by peer reviewers (as was the case, ironically, with Anderegg *et al.*);

- Differences in the age and academic status of global warming alarmists versus skeptics – climate scientists who are skeptics tend to be older and more are emeritus than their counterparts on the alarmist side; skeptics are under less pressure and often are simply less eager to publish.

So what, exactly, did Anderegg *et al.* discover? That a small clique of climate alarmists had their names added to hundreds of articles published in academic journals, something that probably would have been impossible or judged unethical just a decade or two ago. Anderegg *et al.* simply assert those "top 50" are more credible than scientists who publish less, but they make no effort to prove this and there is ample evidence they are not (Solomon, 2008). Once again, the authors did not ask if authors believe global warming is a serious problem or if science is sufficiently established to be the basis for public policy. Anyone who cites this study as evidence of scientific support for such views is misrepresenting the paper.

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Cook *et al.*, 2013

In 2013, a paper by John Cook, an Australia-based blogger, and some of his friends published in *Environmental Research Letters* claimed their review of the abstracts of peer-reviewed papers from 1991 to 2011 found 97 percent of those that stated a position explicitly or implicitly suggested human activity is responsible for some warming (Cook *et al.*, 2013). This exercise in abstract-counting doesn't support the alarmist claim that climate change is both man-made and dangerous, and it doesn't even support IPCC's claim that a majority of global warming in the twentieth century was man-made.

This study was quickly debunked by Legates *et al.* (2013) in a paper published in *Science & Education.* Legates *et al.* found "just 0.03 percent endorsement of the standard definition of consensus: that most warming since 1950 is anthropogenic." They found "only 41 papers – 0.3 percent of all 11,944 abstracts or 1.0 percent of the 4,014 expressing an opinion, and not 97.1 percent – had been found to endorse the standard or quantitative hypothesis."

Scientists whose work questions the consensus, including Craig Idso, Nils-Axel Mörner, Nicola Scafetta, and Nir J. Shaviv, protested that Cook misrepresented their work (Popular Technology.net, 2013).

Richard Tol, a lead author of the United Nations' IPCC reports, said of the Cook report, "the sample of papers does not represent the literature. That is, the main finding of the paper is incorrect, invalid and unrepresentative" (Tol, 2013). On a blog of *The Guardian*, a British

newspaper that had reported on the Cook report, Tol explained: "Cook's sample is not representative. Any conclusion they draw is not about 'the literature' but rather about the papers they happened to find. Most of the papers they studied are not about climate change and its causes, but many were taken as evidence nonetheless. Papers on carbon taxes naturally assume that carbon dioxide emissions cause global warming – but assumptions are not conclusions. Cook's claim of an increasing consensus over time is entirely due to an increase of the number of irrelevant papers that Cook and Co. mistook for evidence" (Tol, 2014).

Montford (2013) produced a blistering critique of Cook *et al*. in a report produced for the Global Warming Policy Foundation. He reveals the authors were marketing the expected results of the paper before the research itself was conducted; changed the definition of an endorsement of the global warming hypothesis mid-stream when it became apparent the abstracts they were reviewing did not support their original (IPCC-based) definition; and gave guidance to the volunteers recruited to read and score abstracts "suggest[ing] that an abstract containing the words 'Emissions of a broad range of greenhouse gases of varying lifetimes contribute to global climate change' should be taken as explicit but unquantified endorsement of the consensus. Clearly the phrase quoted could imply any level of human contribution to warming." Montford concludes "the consensus referred to is trivial" since the paper "said nothing about global warming being dangerous" and that "the project was not a scientific investigation to determine the extent of agreement on global warming, but a public relations exercise."

A group of Canadian retired Earth and atmospheric scientists called Friends of Science produced a report in 2014 that reviewed the four surveys and abstract-counting exercises summarized above (Friends of Science, 2014). The scientists searched the papers for the percentage of respondents or abstracts that explicitly agree with IPCC's declaration that human activity is responsible for more than half of observed warming. They found Oreskes found only 1.2 percent agreement; Doran and Zimmerman, 3.4 percent; Anderegg *et al.*, 66 percent; and Cook *et al.*, 0.54 percent. They conclude, "The purpose of the 97% claim lies in the psychological sciences, not in climate science. A 97% consensus claim is merely a 'social proof' – a powerful psychological motivator intended to make the public comply with the herd; to not be the 'odd man out.' Friends of Science deconstruction of these surveys shows there is no 97% consensus on

human-caused global warming as claimed in these studies. None of these studies indicate any agreement with a catastrophic view of human-caused global warming" (p. 4).

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Evidence of Lack of Consensus

In contrast to the studies described above, which try but fail to find a consensus in support of the claim that global warming is man-made and dangerous, many authors and surveys have found widespread disagreement or even that a majority of scientists oppose the alleged consensus. These surveys and studies generally suffer the same methodological errors as afflict the ones described above, but they suggest that even playing by the alarmists' rules, the results demonstrate disagreement rather than consensus.

Klaus-Martin Schulte, 2008

Schulte (2008), a practicing physician, observed, "Recently, patients alarmed by the tone of media reports and political speeches on climate change have been voicing distress, for fear of the imagined consequences of anthropogenic 'global warming.'" Concern that his patients were experiencing unnecessary stress "prompted me to review the literature available on 'climate change and health' via PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez)" and then to attempt to replicate Oreskes' 2004 report.

"In the present study," Schulte wrote, "Oreskes' research was brought up to date by using the same search term on the same database to identify abstracts of 539 scientific papers published between 2004 and mid-February 2007." According to Schulte, "The results show a tripling of the mean annual publication rate for papers using the search term 'global climate change', and, at the same time, a significant movement of scientific opinion away from the apparently unanimous consensus which Oreskes had found in the learned journals from 1993 to 2003. Remarkably, the proportion of papers explicitly or implicitly rejecting the consensus has risen from zero in the period 1993–2003 to almost 6% since 2004. Six papers reject the consensus outright."

Schulte also found "Though Oreskes did not state how many of the papers she reviewed explicitly endorsed the consensus that human greenhouse-gas emissions are responsible for more than half of the past 50 years' warming, only 7% of the more recent papers reviewed here were explicit in endorsing the consensus even in the strictly limited sense she had defined. The proportion of papers that now explicitly or implicitly endorse

the consensus has fallen from 75% to 45%."

Schulte's findings demonstrate that if Oreskes' methodology were correct and her findings for the period 1993 to 2003 accurate, then scientific publications in the more recent period of 2004–2007 show a strong tendency away from the consensus Oreskes claimed to have found. We can doubt the utility of the methodology used by both Oreskes and Schulte but recognize that the same methodology applied during two time periods reveals a significant shift from consensus to open debate on the causes of climate change.

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Dennis Bray and Hans von Storch, 1996, 2003, 2008, 2010

Surveys by German scientists Dennis Bray and Hans von Storch conducted in 1996, 2003, 2008, and 2010 consistently found climate scientists have deep doubts about the reliability of the science underlying claims of man-made climate change (Bray and von Storch, 2007; Bray and von Storch, 2008; Bray and von Storch, 2010). This finding is seldom reported because the authors repeatedly portray their findings as supporting, as Bray wrote in 2010, "three dimensions of consensus, as it pertains to climate change science: 1. manifestation, 2. attribution, and 3. legitimation" (Bray, 2010). They do not.

One question in Bray and von Storch's latest survey (2010) asked scientists to grade, on a scale from 1 = "very inadequate" to 7 = "very adequate," the "data availability for climate change analysis." On this very important question, more respondents said "very inadequate" (1 or 2) than "very adequate" (6 or 7), with most responses ranging between 3 and 5.

Bray and von Storch summarized their survey results using a series of graphs plotting responses to each question. In their latest survey, 54 graphs show responses to questions addressing scientific issues as opposed to opinions about IPCC, where journalists tend to get their information, personal identification with environmental causes, etc. About a third show more skepticism than confidence, a third show more confidence than

skepticism, and a third suggest equal amounts of skepticism and confidence.

For example, more scientists said "very inadequate" (1 or 2) than "very adequate" (6 or 7) when asked "How well do atmospheric models deal with the influence of clouds?" and "How well do atmospheric models deal with precipitation?" and "How well do atmospheric models deal with atmospheric convection?" and "The ability of global climate models to model sea-level rise for the next 50 years" and "The ability of global climate models to model extreme events for the next 10 years." These are not arcane or trivial matters in the climate debate.

Unfortunately, the Bray and von Storch surveys also show disagreement and outright skepticism about the underlying science of climate change don't prevent most scientists from expressing their opinion that man-made global warming is occurring and is a serious problem. On those questions, the distribution skews away from uncertainty and toward confidence. Observing this contradiction in their 1996 survey, Bray and von Storch described it as "an empirical example of 'postnormal science,'" the willingness to endorse a perceived consensus despite knowledge of contradictory scientific knowledge when the risks are perceived as being great (Bray and von Storch, 1999). Others might refer to this as cognitive dissonance, holding two contradictory opinions at the same time, or "herding," the well-documented tendency of academics facing uncertainty to ignore research that questions a perceived consensus position in order to advance their careers (Baddeleya, 2013).

On their face, Bray and von Storch's results should be easy to interpret. For at least a third of the questions asked, more scientists aren't satisfied than are with the quality of data, reliability of models, or predictions about future climate conditions. For another third, there is as much skepticism as there is strong confidence. Most scientists are somewhere in the middle, somewhat convinced that man-made climate change is occurring but concerned about lack of data and other fundamental uncertainties, far from the "95%+ certainty" claimed by IPCC.

Bray and von Storch are very coy in reporting and admitting the amount of disagreement their surveys find on the basic science of global warming, suggesting they have succumbed to the very cognitive dissonance they once described. But their data clearly reveal a truth: There is no scientific consensus.

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Verheggen *et al.*, 2014, 2015

Verheggen *et al.* (2014) and Strengers, Verheggen, and Vringer (2015) reported the results of a survey they conducted in 2012 of contributors to IPCC reports, authors of articles appearing in scientific literature, and signers of petitions on global warming (but apparently not the Global Warming Petition Project, described below). By the authors' own admission, "signatories of public statements disapproving of mainstream climate science … amounts to less than 5% of the total number of respondents," suggesting the sample is heavily biased toward pro-"consensus" views. Nevertheless, this survey found fewer than half of respondents agreed with IPCC's most recent claims.

A total of 7,555 authors were contacted and 1,868 questionnaires were returned, for a response rate of 29 percent. The authors asked specifically about agreement or disagreement with IPCC's claim in its *Fifth Assessment*

Report (AR5) that it is "virtually certain" or "extremely likely" that net anthropogenic activities are responsible for more than half of the observed increase in global average temperatures in the past 50 years.

When asked "What fraction of global warming since the mid 20th century can be attributed to human induced increases in atmospheric greenhouse gas (GHG) concentrations?", 64 percent chose fractions of 51 percent or more, indicating agreement with IPCC AR5. (Strengers, Verheggen, and Vringer, 2015, Figure 1a.1) When those who chose fractions of 51 percent or more were asked, "What confidence level would you ascribe to your estimate that the anthropogenic GHG warming is more than 50%?", 65 percent said it was "virtually certain" or "extremely likely," the language used by IPCC to characterize its level of confidence (*Ibid.*, Figure 1b).

The math is pretty simple: Two-thirds of the authors in this survey – a sample heavily biased toward IPCC's point of view by including virtually all its editors and contributors – agreed with IPCC on the impact of human emissions on the climate, and two-thirds of those who agreed were as confident as IPCC in that finding. Sixty-five percent of 64 percent is 41.6 percent, so fewer than half of the survey's respondents support IPCC. More precisely – since some responses were difficult to interpret – 42.6 percent (797 of 1,868) of respondents were highly confident that more than 50 percent of the warming is human-caused.

This survey shows IPCC's position on global warming is the minority perspective in this part of the science community. Since the sample was heavily biased toward contributors to IPCC reports and academics most likely to publish, one can assume a survey of a larger universe of scientists would reveal even less support for IPCC's position.

Like Bray and von Storch (2010) discussed above, and Stenhouse *et al.*, (2014) discussed below, Verheggen *et al.* seem embarrassed by their findings and hide them in tables in a report issued a year after their original publication rather than explain them in the text of their peer-reviewed article. It took the efforts of a blogger to call attention to the real data (Fabius Maximus, 2015). Once again, the data reveal no scientific consensus.

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Surveys of Meteorologists and Environmental Professionals

The American Meteorological Society (AMS) reported in 2013 that only 52 percent of AMS members who responded to its survey reported believing the warming of the past 150 years was man-made (Stenhouse *et al.*, 2014). The finding was reported in a table on the last page of the pre-publication version of the paper and was not even mentioned in the body of the peer-reviewed article.

From an earlier publication of the survey's results (Maibach *et al.*, 2012) it appears 76 percent of those who believe in man-made global warming also believe it is "very harmful" or "somewhat harmful," so it appears 39.5 percent of AMS members responding to the survey say they believe man-made global warming could be dangerous. Once again, this

finding doesn't appear in the peer-reviewed article.

Questions asked in the AMS survey reveal political ideology is the strongest or second strongest factor in determining a scientist's position on global warming. But the published report doesn't reveal whether all or just nearly all of the AMS members who believe man-made global warming is dangerous self-identify as being liberals. In light of the numbers presented above, this appears likely.

Other surveys of meteorologists also found a majority oppose the alleged consensus (Taylor, 2010a, 2010b). A 2006 survey of scientists in the U.S. conducted by the National Registry of Environmental Professionals, for example, found 41 percent disagreed the planet's recent warmth "can be, in large part, attributed to human activity," and 71 percent disagreed recent hurricane activity is significantly attributable to human activity (Taylor, 2007).

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Global Warming Petition Project

The Global Warming Petition Project (2015) is a statement about the causes

and consequences of climate change signed by 31,478 American scientists, including 9,021 with Ph.D.s. The full statement reads:

> We urge the United States government to reject the global warming agreement that was written in Kyoto, Japan in December, 1997, and any other similar proposals. The proposed limits on greenhouse gases would harm the environment, hinder the advance of science and technology, and damage the health and welfare of mankind.
>
> There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate. Moreover, there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the Earth.

This is a remarkably strong statement of dissent from the perspective advanced by IPCC. The fact that more than ten times as many scientists have signed it as are alleged to have "participated" in some way or another in the research, writing, and review of IPCC's *Fourth Assessment Report* is very significant. These scientists actually endorse the statement that appears above. By contrast, fewer than 100 of the scientists (and nonscientists) who are listed in the appendices to IPCC reports actually participated in the writing of the all important *Summary for Policymakers* or the editing of the final report to comply with the summary, and therefore could be said to endorse the main findings of that report.

The Global Warming Petition Project has been criticized for including names of suspected nonscientists, including names submitted by environmental activists for the purpose of discrediting the petition. But the organizers of the project painstakingly reconfirmed the authenticity of the names in 2007, and a complete directory of those names appeared as an appendix to *Climate Change Reconsidered: Report of the Nongovernmental International Panel on Climate Change (NIPCC)*, published in 2009 (Idso and Singer, 2009). For more information about The Petition Project, including the text of the letter endorsing it written by the late Dr. Frederick Seitz, past president of the National Academy of Sciences and president emeritus of Rockefeller University, visit the project's Web site at www.petitionproject.org.

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Admissions of Lack of Consensus

Even prominent "alarmists" in the climate change debate admit there is no consensus. Phil Jones, director of the Climatic Research Unit at the University of East Anglia, when asked if the debate on climate change is over, told the BBC, "I don't believe the vast majority of climate scientists think this. This is not my view" (BBC News, 2010). When asked, "Do you agree that according to the global temperature record used by IPCC, the rates of global warming from 1860–1880, 1910–1940 and 1975– 1998 were identical?" Jones replied,

> Temperature data for the period 1860-1880 are more uncertain, because of sparser coverage, than for later periods in the 20th Century. The 1860-1880 period is also only 21 years in length. As for the two periods 1910-40 and 1975-1998 the warming rates are not statistically significantly different (see numbers below).
>
> I have also included the trend over the period 1975 to 2009, which has a very similar trend to the period 1975-1998.
>
> So, in answer to the question, the warming rates for all 4 periods are similar and not statistically significantly different from each other.

Finally, when asked "Do you agree that from 1995 to the present there has been no statistically-significant global warming" he answered "yes." Jones' replies contradict claims made by IPCC.

Mike Hulme, also a professor at the University of East Anglia and a contributor to IPCC reports, wrote in 2009: "What is causing climate change? By how much is warming likely to accelerate? What level of

warming is dangerous? – represent just three of a number of contested or uncertain areas of knowledge about climate change" (Hulme, 2009, p. 75). He admits "Uncertainty pervades scientific predictions about the future performance of global and regional climates. And uncertainties multiply when considering all the consequences that might follow from such changes in climate" (p. 83). On the subject of IPCC's credibility, he admits it is "governed by a Bureau consisting of selected governmental representatives, thus ensuring that the Panel's work was clearly seen to be serving the needs of government and policy. The Panel was not to be a self-governing body of independent scientists" (p. 95). All this is exactly what IPCC critics have been saying for years.

* * *

As this summary makes apparent, there is no survey or study that supports the claim of a scientific consensus that global warming is both man-made and a problem, and ample evidence to the contrary. There is no scientific consensus on global warming.

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2

Why Scientists Disagree

Key findings in this section include the following:

- Climate is an interdisciplinary subject requiring insights from many fields. Very few scholars have mastery of more than one or two of these disciplines.

- Fundamental uncertainties arise from insufficient observational evidence, disagreements over how to interpret data, and how to set the parameters of models.

- The United Nations' Intergovernmental International Panel on Climate Change (IPCC), created to find and disseminate research finding a human impact on global climate, is not a credible source. It is agenda-driven, a political rather than scientific body, and some allege it is corrupt.

- Climate scientists, like all humans, can be biased. Origins of bias include careerism, grant-seeking, political views, and confirmation bias.

Conflict of Disciplines

Climate is an interdisciplinary subject requiring insights from many fields. Very few scholars have mastery of more than one or two of these disciplines.

One reason disagreement among those participating in the climate change debate may be sharper and sometimes more personal than is observed in debates on other topics is because climate is an interdisciplinary subject requiring insights from astronomy, biology, botany, cosmology, economics, geochemistry, geology, history, oceanography, paleontology, physics, and scientific forecasting and statistics, among other disciplines. Very few scholars in the field have mastery of more than one or two of these disciplines.

Richard S. Lindzen, an atmospheric physicist at MIT, observed, "Outside any given specialty, there are few – including scientists – who can distinguish one scientist from another, and this leaves a great deal of latitude for advocates and politicians to invent their own 'experts.' … In effect, once political action is anticipated, the supporting scientific position is given a certain status whereby objections are reckoned to represent mere uncertainty, while scientific expertise is strongly discounted" (Lindzen, 1996, p. 98).

When an expert in one field, say physics, presents an estimate of the climate's sensitivity to rising carbon dioxide levels, an expert in another field, say biology, can quickly challenge his understanding of the carbon cycle, whereby huge volumes of carbon dioxide are added to and removed from the atmosphere. Unless the physicist is intimately familiar with the literature on the impact of rising levels of CO_2 on photosynthesis, plant growth, and carbon sequestration by plants and aquatic creatures, he or she is missing the bigger picture and is likely to be wrong. But so too will the biologist miss the "big picture" if he or she doesn't understand the transfer of energy at the top of the atmosphere and how the effects of CO_2 change logarithmically as its concentration rises.

Geologists view time in millennia and eons and are aware of huge fluctuations in both global temperatures and carbon dioxide concentrations in the atmosphere, with the two often moving in different directions. They scoff at physicists and botanists who express concern over a historically tiny increase in carbon dioxide concentrations of 100 parts per million and a half-degree C increase in temperature over the course of a century. But how many geologists understand the impact of even relatively small changes in temperature or humidity on the range and health of some plants and animals?

Economists are likely to ask if the benefits of trying to "stop" global warming outweigh the benefits of providing clean water or electricity to

billions of people living in terrible poverty. If not, wouldn't it be wiser – better for humanity and perhaps even wildlife – to focus on helping people today become more prosperous and consequently more concerned about protecting the environment and able to afford to adapt to changes in weather regardless of their causes? But do economists properly value the contribution of ecological systems to human welfare, or apply properly the discount rates they use to measure costs and benefits that occur far in the future?

Simon (1999) observed another consequence of this tunnel vision. Scientists are often optimistic about the safety of the environment when it relates to subjects encompassing their own area of research and expertise, but are pessimistic about risks outside their range of expertise. Simon wrote:

> This phenomenon is apparent everywhere. Physicians know about the extraordinary progress in medicine that they fully expect to continue, but they can't believe in the same sort of progress in natural resources. Geologists know about the progress in natural resources that pushes down their prices, but they worry about food. Even worse, some of those who are most optimistic about their own areas point with alarm to other issues to promote their own initiatives. The motive is sometimes self-interest (pp. 47–8).

The climate change debate resembles the famous tale of a group of blind men touching various parts of an elephant, each arriving at a very different idea of what it is like: to one it is like a tree, to another, a snake, and to a third, a wall. A wise man tells the group, "You are all right. An elephant has all the features you mentioned." But how many physicists, geologists, biologists, and economists want to be told they are missing "the big picture" or that their earnest concern and good research aren't enough to describe a complex phenomenon, and therefore not a reliable guide to making decisions about what mankind should do? Few indeed.

This source of disagreement seems obvious but is seldom discussed. Scientists (both physical scientists and social scientists) make assertions and predictions claiming high degrees of confidence, a term with precise meaning in science but turned into an empty tool of rhetoric by IPCC and its allies, that are wholly unjustified given their training and ignorance of large parts of the vast literature regarding climate.

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Scientific Uncertainties

Fundamental uncertainties arise from insufficient observational evidence, disagreements over how to interpret data, and how to set the parameters of models.

The claim that human activities are causing or will cause catastrophic global warming or climate is a rebuttable hypothesis, not a scientific theory and certainly not the "consensus" view of the science community. The human impact on climate remains a puzzle. As Bony *et al.* wrote in 2015, "Fundamental puzzles of climate science remain unsolved because of our limited understanding of how clouds, circulation and climate interact" (abstract).

Reporting in *Nature* on Bony's study, Quirin Schiermeier wrote, "There is a misconception that the major challenges in physical climate science are settled. 'That's absolutely not true,' says Sandrine Bony, a climate researcher at the Laboratory of Dynamic Meteorology in Paris. 'In fact, essential physical aspects of climate change are poorly understood'" (Schiermeier, 2015, p. 140). Schiermeier goes on to write, "large uncertainties persist in 'climate sensitivity,' the increase in average global temperature caused by a given rise in the concentration of carbon dioxide," citing Bjorn Stevens, a director at the Max Planck Institute for Meteorology in Hamburg, Germany (*Ibid.*). Bony has also identified uncertainty in climate science in the journal *Science* (Stevens and Bony, 2013).

The first volume in the *Climate Change Reconsidered II* series cited thousands of peer-reviewed articles and studies revealing the extensive uncertainty acknowledged by Bony *et al.* Since the *Summary for Policymakers* of that volume appears below (Chapters 3 to 7), there is no need to summarize its findings here. Instead, it is useful to ponder the views of two prominent climate scientists whose scientific contributions to the

debate are widely acknowledged.

Richard S. Lindzen, quoted earlier, is one of the world's most distinguished atmospheric physicists. According to the biography on MIT's website, "he has developed models for the Earth's climate with specific concern for the stability of the ice caps, the sensitivity to increases in CO_2, the origin of the 100,000 year cycle in glaciation, and the maintenance of regional variations in climate. Prof. Lindzen is a recipient of the AMS's Meisinger, and Charney Awards, the AGU's Macelwane Medal, and the Leo Huss Walin Prize. He is a member of the National Academy of Sciences, and the Norwegian Academy of Sciences and Letters, and a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Sciences, the American Geophysical Union and the American Meteorological Society.

"Lindzen is a corresponding member of the NAS Committee on Human Rights, and has been a member of the NRC Board on Atmospheric Sciences and Climate and the Council of the AMS. He has also been a consultant to the Global Modeling and Simulation Group at NASA's Goddard Space Flight Center, and a Distinguished Visiting Scientist at California Institute of Technology's Jet Propulsion Laboratory." He received his Ph.D. from Harvard University in 1964.

According to Lindzen (1996), there are three principal areas of uncertainty in climate science:

- "First, the basic greenhouse process is not simple. In particular, it is not merely a matter of the bases that absorb heat radiation – greenhouse gases – keeping the earth warm. If it were, the natural greenhouse would be about four times more effective than it actually is. …

- "Second, the most important greenhouse gas in the atmosphere is water vapor. … Roughly speaking, changes in relative humidity on the order of 1.3 to 4 percent are equivalent to the effect of doubling carbon dioxide. Our measurement uncertainty for trends in water vapor is in excess of 10 percent, and once again, model errors are known to substantially exceed measurement errors in a very systematic way.

- "Third, the direct impact of doubling carbon dioxide on the earth's temperature is rather small: on the order of .3 degrees C. Larger predictions depend on positive feedbacks… [T]hose factors arise from models with errors in those factors."

"[T]here is very little argument about the above points," Lindzen wrote. "They are, for the most part, textbook material showing that there are errors and uncertainties in physical processes central to model predictions that are an order of magnitude greater than the climate forcing due to a putative doubling of carbon dioxide. There is, nonetheless, argument over whether the above points mean that the predicted significant response to increased carbon dioxide is without meaningful basis. Here there is disagreement" (pp. 86–7). For Lindzen's more recent views (which are similar) see Lindzen (2012).

A second recognized authority is Judith Curry, a professor and former chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Her Ph.D. in geophysical sciences is from the University of Chicago and she served for three decades on the faculties of the University of Wisconsin-Madison, Purdue, Penn State, University of Colorado-Boulder, and since 2002 at the Georgia Institute of Technology. She is an elected fellow of the American Geophysical Union and councilor and fellow of the American Meteorological Society.

Curry delivered a speech on June 15, 2015 to the British House of Lords. Titled "State of the climate debate in the U.S.," the prepared text of her remarks is available online (Curry, 2015). Curry wrote, "there is widespread agreement" on three basic tenets: "Surface temperatures have increased since 1880, humans are adding carbon dioxide to the atmosphere, [and] carbon dioxide and other greenhouse gases have a warming effect on the planet." However, she wrote, "there is disagreement about the most consequential issues," which she lists as the following:

- "Whether the warming since 1950 has been dominated by human causes
- "How much the planet will warm in the 21st century
- "Whether warming is 'dangerous'
- "Whether we can afford to radically reduce CO_2 emissions, and whether reduction will improve the climate"

Observing the "growing divergence between models and observations," she poses three questions:

- "Are climate models too sensitive to greenhouse forcing?

- "Is the modeled treatment of natural climate variability inadequate?
- "Are climate model projections of 21st century warming too high?"

After observing surveys show most scientists seem to accept IPCC's claims, she wrote, "Nevertheless, a great deal of uncertainty remains, and there is plenty of room for disagreement. So why do scientists disagree?" She gives five possible reasons:

- "Insufficient observational evidence
- "Disagreement about the value of different classes of evidence
- "Disagreement about the appropriate logical framework for linking and assessing the evidence
- "Assessments of areas of ambiguity & ignorance
- "And finally, the politicization of the science can torque the science in politically desired directions."

"None of the most consequential scientific uncertainties are going to be resolved any time soon," Curry wrote. "[T]here is a great deal of work still to do to understand climate change. And there is a growing realization that unpredictable natural climate variability is important."

All of this concurs with the findings of NIPCC and was documented at great length in *Climate Change Reconsidered II: Physical Science* and *Climate Change Reconsidered II: Biological Impacts* (Idso *et al.*, 2013; Idso *et al.*, 2014).

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Failure of IPCC

The Intergovernmental Panel on Climate Change (IPCC), created to find and disseminate research finding a human impact on global climate, is not a credible source. It is agenda-driven, a political rather than scientific body, and some allege it is corrupt.

According to Bray (2010), "In terms of providing future projection[s] of the global climate, the most significant player in setting the agenda is the Intergovernmental Panel on Climate Change (IPCC). It is typically assumed that IPCC, consisting of some 2500 climate scientists, after weighing the evidence, arrived at a consensus that global temperatures are rising and the most plausible cause is anthropogenic in nature." As this section will explain, that assumption is wrong.

Prior to the mid-1980s very few climate scientists believed man-made climate change was a problem. This non-alarmist "consensus" on the causes and consequences of climate change included nearly all the leading climate scientists in the world, including Roger Revelle, often identified as one of the first scientists to "sound the alarm" over man-made global warming (Solomon, 2008; Singer, Revelle and Starr, 1992).

Most of the reports purporting to show a "consensus" beginning in the 1980s came from and continue to come from committees funded by government agencies tasked with finding a new problem to address or by

liberal foundations with little or no scientific expertise (Darwall, 2013; Carlin, 2015; Moore *et al.*, 2014). These committees, one of which was IPCC, often produced reports making increasingly bold and confident assertions about future climate impacts, but they invariably included statements admitting deep scientific uncertainty (Weart, 2015). Reports of IPCC, including drafts of the latest *Fifth Assessment Report*, are replete with examples of this pattern.

It is common for committees seeking consensus reports to include qualifications and admissions of uncertainty and even publish dissenting reports by committee members. This common practice had an unintended result in the climate debate. Politicians, environmental activists, and rent-seeking corporations in the renewable energy industry began to routinely quote IPCC's alarming claims and predictions shorn of the important qualifying statements expressing deep doubts and reservations. Rather than protest this mishandling of its work, IPCC encouraged it by producing Summaries for Policymakers that edit away or attempt to hide qualifying statements. IPCC news releases have become more and more alarmist over time until they are indistinguishable from the news releases and newsletters of environmental groups. In fact, many of those IPCC news releases were written or strongly influenced by professional environmental activists who had effectively taken over the organization.

Some climate scientists spoke out early and forcefully against this corruption of science (Idso, 1982; Landsberg, 1984; Idso, 1989; Singer, 1989; Jastrow, Nierenberg, and Seitz, 1990; Balling, 1992; Michaels, 1992) but their voices were difficult to hear amid a steady drumbeat of doomsday forecasts produced by environmentalists and their allies in the mainstream media.

Perhaps the most conspicuous and consequential example of this practice occurred in 2006 in the form of a movie titled *An Inconvenient Truth*, produced by former Vice President Al Gore, and Gore's book with the same title (Gore, 2006). The movie earned Gore a Nobel Peace Prize (shared with IPCC), yet it made so many unsubstantiated claims and over-the-top predictions it was declared "propaganda" by a UK judge and schools there were ordered to give students a study guide identifying and correcting its errors before showing the movie (*Dimmock* v. *Secretary of State for Education and Skills*, 2007).

The principal source cited in Gore's movie and book, and arguably the reason it was well-received by much of the science community, was IPCC.

There is no evidence IPCC ever complained about the misrepresentation of its report in the film or asked for corrections. Despite documentation of the film's and book's many flaws (e.g., Lewis, 2007), Gore has never revised the book or even acknowledged the errors.

IPCC's reliability was crippled at birth, mandated by the UN Framework Convention on Climate Change (UNFCCC) to define climate change as human-caused climate change and to disregard naturally caused climate change. Since natural climate change is at the very center of the debate over whether human activity is influencing the climate and by how much, this essentially predetermined IPCC's conclusions. Tasked with finding a human impact on climate and calling on the nations of the world to do something about it, IPCC pursued its mission with fierce dedication.

IPCC's reports have been subjected to withering criticism by scientists and authors almost too numerous to count, including even high-profile editors and contributors to its reports (Seitz, 1996; Lindzen, 2012; Tol, 2014; Stavins, 2014) and no fewer than six rigorously researched books by one climate scientist, Patrick Michaels, former president of the American Association of State Climatologists, former program chair for the Committee on Applied Climatology of the American Meteorological Society, and a research professor of Environmental Sciences at University of Virginia for 30 years (Michaels, 1992, 2000, 2005a, 2005b, 2009, 2011). Michaels also was a contributing author and is a reviewer of IPCC's reports. Besides Michaels, see Singer (1999); Essex and McKitrick (2003); McIntyre and McKitrick (2005); Green and Armstrong (2007); Green, Armstrong, and Soon (2009); Pielke, R. (2010); Carter (2010); Bell (2011); and Vahrenholt and Lüning (2015).

Others have pointed out IPCC's heavy reliance on environmental advocacy groups in the compilation of its official reports, using their personnel as lead authors and incorporating their publications – even newsletters – as source material (Laframboise, 2011). Scientists who participated in the latest IPCC report (AR5) described the process of producing the *Summary for Policymakers* as "exceptionally frustrating" and "one of the most extraordinary experiences of my academic life" (*Economist*, 2014).

Criticism hasn't come only from individual scientists. *Nature*, a prominent science journal, editorialized in 2013: "[I]t is time to rethink the IPCC. The organization deserves thanks and respect from all who care about the principle of evidence-based policy-making, but the current report

should be its last mega-assessment." After describing the "exponential" growth of its reports and "truly breathtaking array of data" IPCC reports offer, the editors wrote, "Unfortunately, one thing that has not changed is that scientists cannot say with any certainty what rate of warming might be expected, or what effects humanity might want to prepare for, hedge against or avoid at all costs. In particular, the temperature range of the warming that would result from a doubling of atmospheric carbon dioxide levels is expected to be judged as 1.5– 4.5ºC in next week's report – wider than in the last assessment and exactly what it was in the report of 1990. … Absent from next week's report, for instance, is recent and ongoing research on the rate of warming and what is – or is not – behind the plateau in average global temperatures that the world has experienced during the past 15 years. These questions have important policy implications, and the IPCC is the right body to answer them. But it need not wait six years to do so" (*Nature*, 2013).

In 2014, a reporter for *Science*, published by the American Association for the Advancement of Science (AAAS), reported on political interference with IPCC's *Fifth Assessment Report*: "Although the underlying technical report from WGIII was accepted by the IPCC, final, heated negotiations among scientific authors and diplomats led to a substantial deletion of figures and text from the influential 'Summary for Policymakers' (SPM). … [S]ome fear that this redaction of content marks an overstepping of political interests, raising questions about division of labor between scientists and policy-makers and the need for new strategies in assessing complex science. Others argue that SPM should explicitly be coproduced with governments" (Wible, 2014). The subtitle of the article is "Did the 'Summary for Policymakers' become a summary by policy-makers?"

Later in 2014, after release of the Working Group III contribution to the Fifth Assessment Report, *Nature* reported critics "find the key conclusions unsurprising and short of detail. They say that the document sidesteps any hint of what specific countries, or groups of countries, should do to move towards clean energy systems. … Some researchers have long argued for a more pragmatic and diversified approach to climate change" (Schiermeier, 2014, p. 298).

Particularly harsh criticism of IPCC has come from the Amsterdam-based InterAcademy Council (IAC), which is made up of the presidents of many of the world's national science academies, the very academies defenders of IPCC often say endorse IPCC's findings. IAC

conducted a thorough audit of IPCC in 2010 (IAC, 2010). Among its findings:

> *Fake confidence intervals:* The IAC was highly critical of IPCC's method of assigning "confidence" levels to its forecasts, singling out "…the many statements in the Working Group II Summary for Policymakers that are assigned high confidence but are based on little evidence. Moreover, the apparent need to include statements of 'high confidence' (i.e., an 8 out of 10 chance of being correct) in the Summary for Policymakers led authors to make many vaguely defined statements that are difficult to refute, therefore making them of 'high confidence.' Such statements have little value" (p. 61).
>
> *Use of gray-sources:* Too much reliance on unpublished and non-peer-reviewed sources (p. 63). Three sections of the IPCC's 2001 climate assessment cited peer-reviewed material only 36 percent, 59 percent, and 84 percent of the time.
>
> *Political interference:* Line-by-line editing of the summaries for policymakers during "grueling Plenary session that lasts several days, usually culminating in an all-night meeting. Scientists and government representatives who responded to the Committee's questionnaire suggested changes to reduce opportunities for political interference with the scientific results…" (p. 64).
>
> *The use of secret data:* "An unwillingness to share data with critics and enquirers and poor procedures to respond to freedom-of-information requests were the main problems uncovered in some of the controversies surrounding IPCC (Russell *et al.*, 2010; PBL, 2010). Poor access to data inhibits users' ability to check the quality of the data used and to verify the conclusions drawn…" (p. 68).
>
> *Selection of contributors is politicized:* Politicians decide which scientists are allowed to participate in the writing and review process: "political considerations are given more weight than scientific qualifications" (p. 14).
>
> *Chapter authors exclude opposing views:* "Equally important is

> combating confirmation bias—the tendency of authors to place too much weight on their own views relative to other views (Jonas *et al.*, 2001). As pointed out to the Committee by a presenter and some questionnaire respondents, alternative views are not always cited in a chapter if the Lead Authors do not agree with them..." (p. 18).
>
> *Need for independent review:* "Although implementing the above recommendations would greatly strengthen the review process, it would not make the review process truly independent because the Working Group Co-chairs, who have overall responsibility for the preparation of the reports, are also responsible for selecting Review Editors. To be independent, the selection of Review Editors would have to be made by an individual or group not engaged in writing the report, and Review Editors would report directly to that individual or group (NRC, 1998, 2002)" (p. 21).

This is a damning critique. IPCC misrepresents its findings, does not properly peer review its reports, the selection of scientists who participate is politicized, the summary for policymakers is the product of late-night negotiations among governments and is not written by scientists, and more. The quotations above and the reference below are to a publicly circulated draft of IAC's final report, still available online (see reference). The final report was heavily edited to water down and perhaps hide the extent of problems uncovered by the investigators, itself evidence of still more misconduct. The report received virtually no press attention in the United States.

In 2012, IPCC issued a news release saying in part, "IPCC's 32nd session in Busan, Republic of Korea, in October 2010, adopted most of the IAC recommendations, and set up Task Groups to work on their implementation" (IPCC, 2012). One key recommendation, that a new Executive Committee be created that would include "three independent members," was almost comically disregarded: the committee was created, but all three slots were filled with IPCC employees (Laframboise, 2013). It is doubtful whether any other changes made at that time would have meaningfully affected the *Fifth Assessment Report*, which was already largely written. Media accounts of the release of AR5 once again told of late-night sessions with politicians and advocacy group representatives rewriting the *Summary for Policymakers*.

In conclusion, it is difficult to understand why IPCC reports still command the respect of anyone in the climate debate. They are political documents, not balanced or accurate summaries of the current state of climate science. They cannot provide reliable guidance to policymakers, economists, and climate scientists who put their trust in them.

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Bias

Climate scientists, like all humans, can be biased. Origins of bias include careerism, grant-seeking, political views, and confirmation bias.

Bias is another reason for disagreement among scientists and other writers on climate change. Scientists, no less than other human beings, bring their personal beliefs and interests to their work and sometimes make decisions based on them that direct their attention away from research findings that would contradict their opinions. Bias is often unconscious or overcome by professional ethics, but sometimes it leads to outright corruption.

Park *et al*. (2013), in a paper published in *Nature*, summarized research on publication bias, careerism, data fabrication, and fraud to explain how scientists converge on false conclusions. They write, "Here we show that even when scientists are motivated to promote the truth, their behaviour may be influenced, and even dominated, by information gleaned from their peers' behaviour, rather than by their personal dispositions. This phenomenon, known as herding, subjects the scientific community to an inherent risk of converging on an incorrect answer and raises the possibility that, under certain conditions, science may not be self-correcting."

Freedman (2010) identified a long list of reasons why experts are so often wrong, including pandering to audiences or clients, lack of oversight, reliance on flawed evidence provided by others, and failure to take into account important confounding variables.

John P.A. Ioannidis, professor of medicine and of health research and policy at Stanford University School of Medicine and a professor of statistics at Stanford University School of Humanities and Sciences, in a series of articles published in journals including the *Journal of the American Medical Association* (JAMA), revealed most published research in the health care field cannot be replicated or is likely to be contradicted by later publications (Ioannidis, 2005a, 2005b; Ioannidis and Trikalinos, 2005; Ioannidis, 2012). His most frequently cited work is titled "Why most published research findings are false."

Ioannidis's work generated widespread awareness that peer review is no guarantee of the accuracy or value of a research paper. In fact, he found that the likelihood of research being contradicted was highest with the most prestigious journals including *Nature, Science,* and *JAMA.* Springer, a major publisher of science journals, recently announced it was removing 16

papers it had published that were generated by a computer program called SCIgen that were simply gibberish (*Nature*, 2014). Much to their credit, these journals and academic institutions claim to be engaged in considerable soul-searching and efforts to reform a peer-review process that is plainly broken.

This controversy has particular relevance to the climate change debate due to "Climategate," the release of emails exchanged by prominent climate scientists discussing efforts to exclude global warming skeptics from journals, punish editors who allowed skeptics' articles to appear, stonewall requests for original data, manipulate data, and rush into publication articles refuting or attempting to discredit scientists who disagree with IPCC's findings (Montford, 2010; Sussman, 2010; Michaels, 2011, chapter 2). The scandal received little press attention in the United States. Journals such as *Nature* take the scandal over peer-review corruption seriously when it involves other topics (Ferguson *et al.*, 2014), but are curiously silent about its occurrence in the climate change literature.

Scientists, especially those in charge of large research projects and laboratories, have a financial incentive to seek more funding for their programs. They are not immune to having tunnel vision regarding the importance of their work and employment. Each believes his or her mission is more significant and essential relative to other budget priorities.

To obtain funding (and more funding), it helps scientists immensely to have the public – and thus Congress and potentially private funders – worried about the critical nature of the problems they study. This incentive makes it less likely researchers will interpret existing knowledge or present their findings in a way that reduces public concern (Lichter and Rothman, 1999; Kellow, 2007; Kabat, 2008). As a result, scientists often gravitate toward emphasizing worst-case scenarios, though there may be ample evidence to the contrary. This bias of alarmism knows no political bounds, affecting both liberal Democrats and conservative Republicans (Berezow and Campbell, 2012; Lindzen, 2012).

Alarmists in the climate debate seem to recognize only one possible source of bias, and that is funding from "the fossil fuel industry." The accusation permeates any conversation of the subject, perhaps second only to the "consensus" claim, and the two are often paired, as in "only scientists paid by the fossil fuel industry dispute the overwhelming scientific consensus." The accusation doesn't work for many reasons:

- There has never been any evidence of a climate scientist accepting money from industry to take a position or change his or her position in the climate debate (Cook, 2014);

- Vanishingly few global warming skeptics have ever been paid by the fossil fuel industry. Certainly not more than a tiny fraction of the 31,478 American scientists who signed the Global Warming Petition or the thousands of meteorologists and climate scientists reported in Chapter 1 who tell survey-takers they do not agree with IPCC;

- Funding of alarmists by government agencies, liberal foundations, environmental advocacy groups, and the alternative energy industry exceeds funding from the fossil fuel industry by two, three, or even four orders of magnitude (Butos and McQuade, 2015). Does government and interest-group funding of alarmists not also have a "corrupting" influence on its recipients?

- The most prominent organizations supporting global warming skepticism get little if any money from the fossil fuel industry. Their support comes overwhelmingly from individuals (and their foundations) motivated by concern over the apparent corruption of science taking place and the enormous costs it is imposing on the public.

In the text of her speech to the British House of Lords cited earlier, climate scientist Judith Curry wrote, "I am very concerned that climate science is becoming biased owing to biases in federal funding priorities and the institutionalization by professional societies of a particular ideology related to climate change. Many scientists, and institutions that support science, are becoming advocates for UN climate policies, which is leading scientists into overconfidence in their assessments and public statements and into failures to respond to genuine criticisms of the scientific consensus. In short, the climate science establishment has become intolerant to disagreement and debate, and is attempting to marginalize and de-legitimize dissent as corrupt or ignorant" (Curry, 2015).

Money probably isn't what motivates Mike Hulme, now professor of climate and culture in the Department of Geography at King's College

London. He was formerly professor of climate change in the School of Environmental Sciences at the University of East Anglia, a contributor to IPCC reports, and author of *Why We Disagree About Climate Change* (Hulme, 2009). Hulme was cited earlier in Chapter 1 admitting to great uncertainties in climate science, yet he eagerly endorses and promotes IPCC's claims. Why does he do that?

In his book, Hulme calls climate change "a classic example of ... 'post-normal science,'" which he defines (quoting Silvio Funtowicz and Jerry Ravetz) as "the application of science to public issues where 'facts are uncertain, values in dispute, stakes high and decisions urgent.'" Issues that fall into this category, he says, are no longer subject to the cardinal requirements of true science: skepticism, universalism, communalism, and disinterestedness. Instead of experimentation and open debate, post-normal science says "consensus" brought about by deliberation among experts determines what is true, or at least true enough for the time being to direct public policy decisions.

The merits and demerits of post-normal science can be debated, but it undoubtedly has one consequence of significance in the climate change debate: scientists are no longer responsible for actually doing science themselves, such as testing hypotheses, studying data, and confronting data or theories that contradict the "consensus" position. Scientists simply "sign onto" IPCC's latest report and are free to indulge their political biases. Hulme is quite open about his. He wrote, "The idea of climate change should be seen as an intellectual resource around which our collective and personal identities and projects can form and take shape. We need to ask not what we can do for climate change, but to ask what climate change can do for us" (p. 326).

In his book, Hulme says "because the idea of climate change is so plastic, it can be deployed across many of our human projects and can serve many of our psychological, ethical, and spiritual needs." Hulme describes himself as a social-democrat so his needs include sustainable development, income redistribution, population control, and social justice. By focusing on these "needs," how can Hulme objectively evaluate the anthropogenic global warming hypothesis?

Like the late Stephen Schneider, who once said "to reduce the risk of potentially disastrous climate change … we need to get some broad based support, to capture the public's imagination. That, of course, means getting loads of media coverage. So we have to offer up scary scenarios, make

simplified, dramatic statements, and make little mention of any doubts we might have" (Schneider, 1989), Hulme wrote, "We will continue to create and tell new stories about climate change and mobilise them in support of our projects." He suggests his fellow global warming alarmists promote four "myths," which he labels Lamenting Eden, Presaging Apocalypse, Constructing Babel, and Celebrating Jubilee.

This is unusual behavior for a scientist and disturbing for one working at high levels in IPCC. When Hulme talks about climate science, is he telling us the truth or one of his "myths"?

* * *

While it would be ideal if scientists could be relied upon to deliver the unvarnished truth about complex scientific matters to governments and voters, the truth is they almost always fall short. Ignorance of research outside their area of specialization, reliance on flawed authorities, bias, and outright corruption all contribute to unwarranted alarmism in the climate change debate.

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3

Scientific Method vs. Political Science

Key findings of this section include the following:

- The hypothesis implicit in all IPCC writings, though rarely explicitly stated, is that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions.

- The null hypothesis is that currently observed changes in global climate indices and the physical environment, as well as current changes in animal and plant characteristics, are the result of natural variability.

- In contradiction of the scientific method, IPCC assumes its implicit hypothesis is correct and that its only duty is to collect evidence and make plausible arguments in the hypothesis's favor.

The Missing Null Hypothesis

Although IPCC's reports are voluminous and their arguments impressively persistent, it is legitimate to ask whether that makes them good science. In order to conduct an investigation, scientists must first formulate a falsifiable hypothesis to test. The hypothesis implicit in all IPCC writings, though rarely explicitly stated, is that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions.

In considering any such hypothesis, an alternative and null hypothesis must be entertained, which is the simplest hypothesis consistent with the known facts. Regarding global warming, the null hypothesis is that currently observed changes in global climate indices and the physical environment are the result of natural variability. To invalidate this null hypothesis requires, at a minimum, direct evidence of human causation of specified changes that lie outside usual, natural variability. Unless and until such evidence is adduced, the null hypothesis is assumed to be correct.

Science does not advance by consensus, a show of hands, or even persuasion. It advances by individual scientists proposing testable hypotheses, examining data to see if they disprove a hypothesis, and making those data available to other unbiased researchers to see if they arrive at similar conclusions. Disagreement is the rule and consensus is the exception in most academic disciplines. This is because science is a process leading to ever-greater certainty, necessarily implying that what is accepted as true today will likely not be accepted as true tomorrow. Albert Einstein was absolutely right when he said, "No amount of experimentation can ever prove me right; a single experiment can prove me wrong" (Einstein, 1996).

In contradiction of the scientific method, IPCC assumes its implicit hypothesis is correct and that its only duty is to collect evidence and make plausible arguments in the hypothesis's favor. One probable reason for this behavior is that the United Nations protocol under which IPCC operates defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations, 1994, Article 1.2). Not surprisingly, directing attention to only the effects of human greenhouse gas emissions has resulted in IPCC failing to provide a thorough analysis of climate change.

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Models, Postulates, and Circumstantial Evidence

IPCC offers three lines of reasoning in defense of its hypothesis: global climate model projections, a series of postulates or assumptions, and appeals to circumstantial evidence. The specific arguments are summarized in Figure 2.

Figure 2
IPCC's Three Lines of Argument

Global Climate Model Projections

IPCC modelers assume Global Climate Models (GCMs) are based on a perfect knowledge of all climate forcings and feedbacks. They then assert:

- A doubling of atmospheric CO_2 would cause warming of up to 6°C.
- Human-related CO_2 emissions caused an atmospheric warming of at least 0.3°C over the past 15 years.
- Enhanced warming (a "hot spot") should exist in the upper troposphere in tropical regions.
- Both poles should have warmed faster than the rest of Earth during the late twentieth century.

Postulates

Postulates are statements that assume the truth of an underlying fact that has not been independently confirmed or proven. IPCC postulates:

- The warming of the twentieth century cannot be explained by natural variability.
- The late twentieth century warm peak was of greater magnitude than previous natural peaks.
- Increases in atmospheric CO_2 precede, and then force, parallel increases in temperature.
- Solar forcings are too small to explain twentieth century warming.
- A future warming of 2°C or more would be net harmful to the

biosphere and human well-being.

Circumstantial Evidence

Circumstantial evidence does not bear directly on the matter in dispute but refers to circumstances from which the occurrence of the fact might be inferred. IPCC cites the following circumstantial evidence:

- Unusual melting is occurring in mountain glaciers, Arctic sea ice, and polar icecaps.
- Global sea level is rising at an enhanced rate and swamping tropical coral atolls.
- Droughts, floods, and monsoon variability and intensity are increasing.
- Global warming is leading to more, or more intense, wildfires, rainfall, storms, hurricanes, and other extreme weather events.
- Unusual melting of Boreal permafrost or sub-seabed gas hydrates is causing warming due to methane release.

Source: Summary for Policymakers, *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

All three lines of reasoning depart from proper scientific methodology. Global climate models produce meaningful results only if we assume we already know perfectly how the global climate works, and most climate scientists say we do not (Bray and von Storch, 2010; Strengers, Verheggen, and Vringer, 2015). Moreover, it is widely recognized that climate models are not designed to produce predictions of future climate but rather what-if projections of many alternative possible futures (Trenberth, 2009).

Postulates, commonly defined as "something suggested or assumed as true as the basis for reasoning, discussion, or belief," can stimulate relevant observations or experiments but more often are merely assertions that are difficult or impossible to test (Kahneman, 2011). IPCC expresses "great confidence" and even "extreme confidence" in its assumptions, but it cannot apply a statistical confidence level because they are statements of opinion and not of fact. This is not the scientific method.

Circumstantial evidence, or observations, in science are useful primarily to falsify hypotheses and cannot prove one is correct (Popper, 1965, p. vii). It is relatively easy to assemble reams of "evidence" in favor of a point of view or opinion while ignoring inconvenient facts that would contradict it, a phenomenon called "confirmation bias." The only way to avoid confirmation bias is independent review of a scientist's work by other scientists who do not have a professional, reputational, or financial stake in whether the hypothesis is confirmed or disproven. As documented in Chapter 2, this sort of review is conspicuously absent in the climate change debate. Those who attempt to exercise it find themselves demonized, their work summarily rejected by academic journals, and worse.

Facing such criticism of its methodology and a lack of compelling evidence of dangerous warming, IPCC's defenders often invoke the precautionary principle. The principle states: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (United Nations, 1992, Principle 15). This is a sociological precept rather than a scientific one and lacks the intellectual rigor necessary for use in policy formulation (Goklany, 2001).

The hypothesis of human-caused global warming comes up short not merely of "full scientific certainty" but of reasonable certainty or even plausibility. The weight of evidence now leans heavily against the theory. Invoking the precautionary principle does not lower the required threshold for evidence to be regarded as valid nor does it answer the most important questions about the causes and consequences of climate change. Scientific principles acknowledge the supremacy of experiment and observation and do not bow to instinctive feelings of alarm or claims of a supposed scientific "consensus" (Legates *et al.*, 2013). The formulation of effective public environmental policy must be rooted in evidence-based science, not an over-abundance of precaution (More and Vita-More, 2013; U.K. House of Commons Science and Technology Committee, 2006).

Contradictions about methodology and the verity of claimed facts make it difficult for unprejudiced lay persons to judge for themselves where the truth actually lies in the global warming debate. This is one of the primary reasons why politicians and commentators rely so heavily on supposedly authoritative statements issued by one side or another in the public discussion. Arguing from authority, however, is the antithesis of the scientific method. Attempting to stifle debate by appealing to authority

hinders rather than helps scientific progress and understanding.

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4

Flawed Projections

Key findings in this section include the following:

- The United Nations' Intergovernmental Panel on Climate Change (IPCC) and virtually all the governments of the world depend on global climate models (GCMs) to forecast the effects of human-related greenhouse gas emissions on the climate.

- GCMs systematically over-estimate the sensitivity of climate to carbon dioxide (CO_2), many known forcings and feedbacks are poorly modeled, and modelers exclude forcings and feedbacks that run counter to their mission to find a human influence on climate.

- The Nongovernmental International Panel on Climate Change (NIPCC) estimates a doubling of CO_2 from pre-industrial levels (from 280 to 560 ppm) would likely produce a temperature forcing of 3.7 Wm^{-2} in the lower atmosphere, for about ~1°C of *prima facie* warming.

- Four specific forecasts made by GCMs have been falsified by real-world data from a wide variety of sources. In particular, there has been no global warming for some 18 years.

Why Computer Models Are Flawed

In contrast to the scientific method, IPCC and virtually all national

governments in the world rely on computer models, called global climate models or GCMs, to represent speculative thought experiments by modellers who often lack a detailed understanding of underlying processes. The results of GCMs are only as reliable as the data and theories "fed" into them, which scientists widely recognize as being seriously deficient. If natural climate forcings and feedback are not perfectly understood, then GCMs become little more than an exercise in curve-fitting, or changing parameters until the outcomes match the modeller's expectations. As John von Neumann is reported to have once said, "with four parameters I can fit an elephant, and with five I can make him wiggle his trunk" (Dyson, 2004).

The science literature is replete with admissions by leading climate modellers that forcings and feedback are not sufficiently well understood, that data are insufficient or too unreliable, and that computer power is insufficient to resolve important climate processes. Many important elements of the climate system, including atmospheric pressure, wind, clouds, temperature, precipitation, ocean currents, sea ice, and permafrost, cannot be properly simulated by the current generation of models.

The major known deficiencies include model calibration, non-linear model behavior, and the omission of important natural climate-related variability. Model calibration is faulty as it assumes all temperature rise since the start of the industrial revolution has resulted from human CO_2 emissions. In reality, major human-related emissions commenced only in the mid-twentieth century.

More facts about climate models and their limitations reported in Chapter 1 of *Climate Change Reconsidered-II: Physical Science* are reported in Figure 3.

Figure 3
Key Facts about Global Climate Models

- Climate models generally assume a climate sensitivity of 3°C for a doubling of CO_2 above preindustrial values, whereas meteorological observations are consistent with a sensitivity of 1°C or less.

- Climate models underestimate surface evaporation caused by increased temperature by a factor of 3, resulting in a consequential under-estimation of global precipitation.

- Climate models inadequately represent aerosol-induced changes in infrared (IR) radiation, despite studies showing different mineral aerosols (for equal loadings) can cause differences in surface IR flux between 7 and 25 Wm^{-2}.

- Deterministic climate models have inherent properties that make dynamic predictability impossible; introduction of techniques to deal with this (notably parameterization) introduces bias into model projections.

- Limitations in computing power restrict climate models from resolving important climate processes; low-resolution models fail to capture many important regional and lesser-scale phenomena such as clouds.

- Model calibration is faulty, as it assumes all temperature rise since the start of the industrial revolution has resulted from human CO_2 emissions; in reality, major human-related emissions commenced only in the mid-twentieth century.

- Non-linear climate models exhibit chaotic behavior. As a result, individual simulations ("runs") may show differing trend values.

- Internal climate oscillations (AMO, PDO, etc.) are major features of the historic temperature record; climate models do not even attempt to simulate them.

- Climate models fail to incorporate the effects of variations in solar magnetic field or in the flux of cosmic rays, both of which are known to significantly affect climate.

Source: "Chapter 1. Global Climate Models and Their Limitations," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Forcings and Feedbacks

The discussion in the previous section of why global climate models are flawed included references to some of the forcings and feedbacks that are poorly modeled and likely to make models unreliable. In many of these cases, climate scientists are substituting opinions or best guesses for data. As serious as that problem is, it is made worse by the exclusion of forcings and feedbacks that are well documented in the scientific literature. Many of these run counter to the goal of many modelers to find a human influence on climate and so are ignored.

Among the forcings and feedbacks IPCC has failed to take into account are increases in low-level clouds in response to enhanced atmospheric water vapor, ocean emissions of dimethyl sulfide (DMS), and the presence and total cooling effect of both natural and industrial aerosols. These processes and others are likely to offset most or even all of any warming caused by rising CO_2 concentrations. Figure 4 summarizes these and other findings about forcings and feedbacks appearing in Chapter 2 of *Climate Change Reconsidered-II: Physical Science.*

Figure 4
Key Facts about Temperature Forcings and Feedbacks

- A doubling of CO_2 from pre-industrial levels (from 280 to 560 ppm) would likely produce a temperature forcing of 3.7 Wm^{-2} in the lower atmosphere, for about ~1°C of *prima facie* warming.

- IPCC models stress the importance of positive feedback from increasing water vapor and thereby project warming of ~3–6°C, whereas empirical data indicate an order of magnitude less warming of ~0.3–1.0°C.

- In ice core samples, changes in temperature precede parallel changes in atmospheric CO_2 by several hundred years; also, temperature and CO_2 are uncoupled through lengthy portions of the historical and geological records; therefore CO_2 cannot be the primary forcing agent for most temperature changes.

- Atmospheric methane (CH_4) levels for the past two decades fall well below the values projected by IPCC in its assessment reports. IPCC's temperature projections incorporate these inflated CH_4 estimates and need downward revision accordingly.

- The thawing of permafrost or submarine gas hydrates is not likely to emit dangerous amounts of methane at current rates of warming.

- Nitrous oxide (N_2O) emissions are expected to fall as CO_2 concentrations and temperatures rise, indicating it acts as a negative climate feedback.

- Other negative feedbacks on climate sensitivity that are either discounted or underestimated by IPCC include increases in low-level clouds in response to enhanced atmospheric water vapor, increases in ocean emissions of dimethyl sulfide (DMS), and the presence and total cooling effect of both natural and industrial aerosols.

Source: "Chapter 2. Forcings and Feedbacks," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Yet another deficiency in GCMs is that non-linear climate models exhibit chaotic behavior. As a result, individual simulations ("runs") may show differing trend values (Singer, 2013b). Internal climate oscillations (Atlantic Multidecadal Oscillation (AMO), Pacific Decadal Oscillation (PDO), etc.) are major features of the historic temperature record, yet GCMs do not even attempt to simulate them. Similarly, the models fail to incorporate the effects of variations in solar magnetic field or in the flux of cosmic rays, both phenomena known to significantly affect climate.

We conclude the current generation of GCMs is unable to make accurate projections of climate even 10 years ahead, let alone the 100-year period that has been adopted by policy planners. The output of such models should therefore not be used to guide public policy formulation until they have been validated and shown to have predictive value.

Failed Forecasts

Four specific forecasts made by GCMs have been falsified by real-world data from a wide variety of sources:

Failed Forecast #1: A doubling of atmospheric CO_2 would cause warming between 3°C and 6°C.

The increase in radiative forcing produced by a doubling of atmospheric CO_2 is generally agreed to be 3.7 Wm^{-2}. Equating this forcing to temperature requires taking account of both positive and negative feedbacks. IPCC models incorporate a strong positive feedback from increasing water vapor but exclude negative feedbacks such as a concomitant increase in low-level clouds – hence they project a warming effect of 3°C or more.

IPCC ignores mounting evidence that climate sensitivity to CO_2 is much lower than its models assume (Spencer and Braswell, 2008; Lindzen and Choi, 2011). Monkton *et al.* cited 27 peer-reviewed articles "that report climate sensitivity to be below current central estimates" (Monckton *et al.*, 2015). Their list of sources appears in Figure 5.

Figure 5
Research Finding Climate Sensitivity Is Less than Assumed by IPCC

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Source: Monckton, C., Soon, W. W-H., Legates, D.R., and Briggs, W.M. 2015. Keeping it simple: the value of an irreducibly simple climate model. *Science Bulletin* **60:** 15, 1378–1390, footnotes 7 to 33.

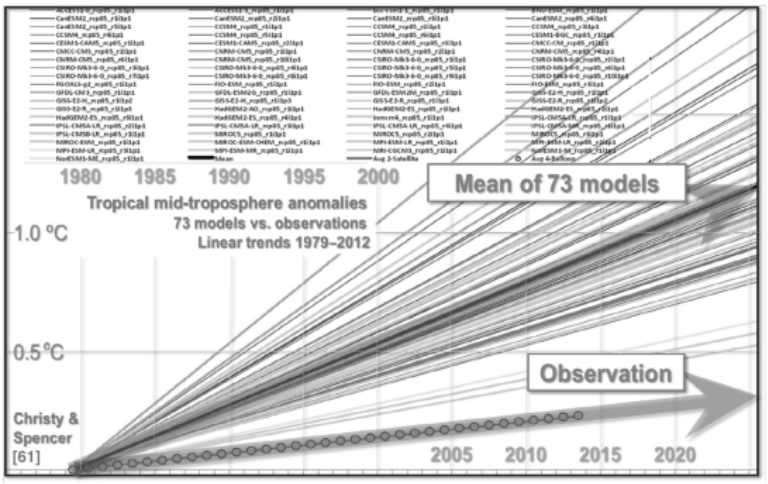
Failed Forecast #2: CO_2 caused an atmospheric warming of at least 0.3°C over the past 15 years.

The global climate models relied on by IPCC predicted an atmospheric warming of at least 0.3ºC during the first 15 years of the twenty-first century, but temperatures did not rise at all during that period. Figure 6 shows global temperatures from 1997 to 2015, based on satellite data compiled and reported by Remote Sensing Systems and interpreted by Monckton *et al.* (2015). They show a trend of -0.01ºC from January 1997 to June 2015. Figure 7 vividly portrays the failure of GCMs to hindcast this trend.

Figure 6
RSS Monthly Global Mean Lower-troposphere Temperature Anomalies, January 1997 to June 2015

Source: Monckton *et al.*, 2015. Data from Mears and Wentz, 2009.

Figure 7. Linear Trends on Tropical Mid-troposphere Temperature Anomalies Projected by 73 Models and Measured by Two Coincident Observational Datasets, 1979–2012



Source: Monckton *et al.*, 2015.

The absence of a warming trend for more than 15 years invalidates GCMs based on IPCC's assumptions regarding climate sensitivity to carbon dioxide. In its 2008 *State of the Climate* report, the National Oceanic and Atmospheric Administration (NOAA) reported, "Near zero and even negative trends are common for intervals of a decade or less in the simulations, due to the models internal climate variability. The simulations rule out (at the 95% level) zero trends for intervals of 15 yr or more, suggesting that an observed absence of warming of this duration is needed to create a discrepancy with the expected present-day warming rate" (Knight *et al.*, 2009). This "discrepancy" now exists, indeed now extends to 18 years without warming, and the models have been invalidated.

IPCC's authors compare the output of unforced (and incomplete) models with a dataset that represents twentieth century global temperature (HadCRUT, British Meteorological Office). Finding a greater warming trend in the dataset than in model projections, the false conclusion is then drawn that this "excess" warming must be caused by human-related

greenhouse forcing. In reality, no excess warming has been demonstrated, first because this line of argument assumes models have perfect knowledge, information, and power, which they do not, and second, because a wide variety of datasets other than the HadCRUT global air temperature curve favored by IPCC do not exhibit a warming trend during the second half of the twentieth century. See Figure 8.

Figure 8
Lack of Evidence for Rising Temperatures

The difference in surface temperatures between 1942–1995 and 1979–97, as registered by datasets that represent land, oceanic, and atmospheric locations.

LAND SURFACE	Global (IPCC, HadCRUT)	+0.5° C
	United States (GISS)	~zero
OCEAN	Sea surface temperature (SST)[1]	~zero
	SST Hadley NMAT	~zero
ATMOSPHERE	Satellite MSU (1979–1997)	~zero
	Hadley radiosondes (1979–97)	~zero
PROXIES	Mostly land surface temperature[2]	~zero

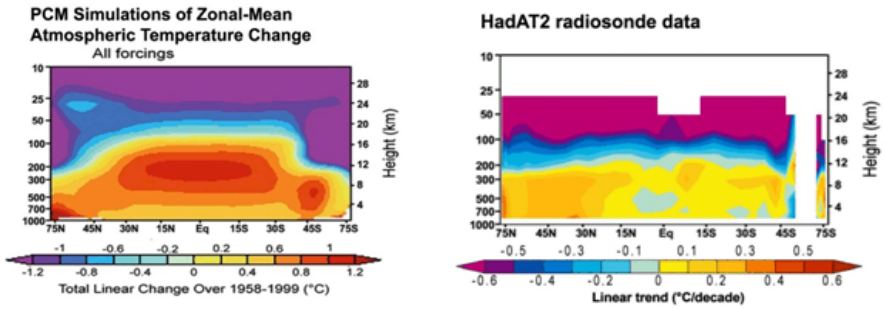
Unless otherwise indicated, data are drawn from the nominated government agencies.

Sources: [1] Gouretski *et al.*, 2012; [2] Anderson *et al.*, 2013.

Failed Forecast #3: A Thermal Hot Spot Should Exist in the Upper Troposphere in Tropical Regions

Observations from both weather balloon radiosondes and satellite MSU sensors show the opposite, with either flat or decreasing warming trends with increasing height in the troposphere (Douglass *et al.*, 2007; Singer, 2011; Singer, 2013a). In Figure 9, the image on the left is model simulations of temperature trends in the tropical mid-troposphere, as shown in figure 1.3F from a report by the U.S. Climate Change Science Program (Karl *et al.*, 2006). The image shows a "hot spot" should occur in the upper troposphere in tropical regions. The image on the right is figure 5.7E from the same source. It shows observed temperatures based on radiosonde data by the Hadley Centre and are in good agreement with the corresponding U.S. analyses. The observed data do not show the temperature rise in the tropical mid-troposphere forecast by the model.

Figure 9
Greenhouse-model-predicted Temperature Trends Versus Latitude and Altitude Versus Observed Temperature Trends



Source: Karl *et al.*, 2006, pp. 25, 116.

Failed Forecast #4: Both Polar Regions Should Have Warmed Faster than the Rest of Earth During the Late Twentieth Century

Late-twentieth century warming occurred in many Arctic locations and also over a limited area of the West Antarctic Peninsula, but the large polar East Antarctic Ice Sheet has been cooling since at least the 1950s (O'Donnell *et al.*, 2010). More data and commentary on this appears in Chapter 6.

* * *

In general, GCMs perform poorly when their projections are assessed against empirical data. In their comprehensive report of an extensive test of contemporary climate models, Idso and Idso write, "we find (and document) a total of 2,418 failures of today's top-tier climate models to accurately hindcast a whole host of climatological phenomena. And with this extremely poor record of success, one must greatly wonder how it is that anyone would believe what the climate models of today project about earth's climate of tomorrow, i.e., a few decades to a century or more from now" (Idso and Idso, 2015).

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5

False Postulates

Key findings in this section include the following:

- Neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside normal natural variability.
- The late twentieth century warm peak was of no greater magnitude than previous peaks caused entirely by natural forcings and feedbacks.
- Historically, increases in atmospheric CO_2 followed increases in temperature, they did not precede them. Therefore, CO_2 levels could not have forced temperatures to rise.
- Solar forcings are not too small to explain twentieth century warming. In fact, their effect could be equal to or greater than the effect of CO_2 in the atmosphere.
- A warming of 2°C or more during the twenty-first century would probably not be harmful, on balance, because many areas of the world would benefit from or adjust to climate change.

Figure 2 in Chapter 3 identified five postulates at the base of IPCC's claim that global warming has resulted, or will result, from anthropogenic greenhouse gas emissions. All five are readily refuted by real-world observations.

Modern Warming Is Not Unnatural

IPCC's first false postulate is that the warming of the twentieth century cannot be explained by natural variability. But temperature records contain natural climate rhythms that are not well summarized or defined by fitting straight lines through arbitrary portions of a fundamentally rhythmic, non-stationary data plot. In particular, linear fitting fails to take account of meteorological-oceanographical-solar variations that are well established to occur at multidecadal and millennial time scales.

Even assuming, wrongly, that global temperatures would have been unchanging in the absence of man-made greenhouse gas emissions, the correctness of IPCC's assertion depends upon the period of time considered (Davis and Bohling, 2001). For example, temperatures have been cooling since 8,000 and 2,000 years ago; warming since 20,000 years ago, and also since 1850 and since 1979; and static (no net warming or cooling) between 700 BC and 150 AD and since 1997 AD.

Global warming during the twentieth century occurred in two pulses, between 1910–1940 and 1975–2000, at gentle rates of a little over 1.5°C/century (British Meteorological Office, 2013). In contrast, natural warming at some individual meteorological stations during the 1920s proceeded at high rates of up to 4°C/decade or more (Chylek *et al.*, 2004). The first period (1910–1940) represents rates of global warming that are fully natural (having occurred prior to the major build-up of greenhouse gases in the atmosphere), whereas measurements made during the late twentieth century warming are likely exaggerated by inadequate correction for the urban heat island effect (DeLaat and Maurellis, 2004; McKitrick and Michaels, 2004, 2007).

Modern Warming Is Not Unprecedented

IPCC's second false postulate is that the late twentieth century warm peak was of greater magnitude than previous natural peaks. Comparison of modern and ancient rates of natural temperature change is difficult because of the lack of direct measurements available prior to 1850. However, high-quality proxy temperature records from the Greenland ice core for the past 10,000 years demonstrate a natural range of warming and cooling rates between +2.5 and -2.5 °C/century (Alley, 2000; Carter, 2010, p. 46, figure

7), significantly greater than rates measured for Greenland or the globe during the twentieth century.

Glaciological and recent geological records contain numerous examples of ancient temperatures up to 3°C or more warmer than the peak reported at the end of the twentieth century. During the Holocene, such warmer peaks included the Egyptian, Minoan, Roman, and Medieval warm periods (Alley, 2000). During the Pleistocene, warmer peaks were associated with interglacial oxygen isotope stages 5, 9, 11, and 31 (Lisiecki and Raymo, 2005). During the Late Miocene and Early Pliocene (6–3 million years ago) temperature consistently attained values 2–3°C above twentieth century values (Zachos *et al.*, 2001).

Figure 10 summarizes these and other findings about surface temperatures that appear in Chapter 4 of *Climate Change Reconsidered-II: Physical Science.*

Figure 10
Key Facts about Surface Temperature

- Whether today's global surface temperature is seen to be part of a warming trend depends upon the time period considered.

- Over (climatic) time scales of many thousand years, temperature is cooling; over the historical (meteorological) time scale of the past century temperature has warmed. Over the past 18 years, there has been no net warming despite an increase in atmospheric CO_2 of 8 percent – which represents 34 percent of all human-related CO_2 emissions released to the atmosphere since the industrial revolution.

- Given an atmospheric mixing time of ~1 year, the facts just related represent a test of the dangerous warming hypothesis, which test it fails.

- Based upon the HadCRUT dataset favored by IPCC, two phases of warming occurred during the twentieth century, between 1910–1940 and 1979–2000, at similar rates of a little over 1.5°C/century. The early twentieth century warming preceded major industrial carbon dioxide emissions and must be natural; warming during the second (*prima facie,* similar) period might incorporate a small human-related carbon dioxide

effect, but warming might also be inflated by urban heat island effects.

- Other temperature datasets fail to record the late twentieth century warming seen in the HadCRUT dataset.

- There was nothing unusual about either the magnitude or rate of the late twentieth century warming pulses represented on the HadCRUT record, both falling well within the envelope of known, previous natural variations.

- No empirical evidence exists to support the assertion that a planetary warming of 2°C would be net ecologically or economically damaging.

Source: "Chapter 4. Observations: Temperatures," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

CO_2 Does Not Lead Temperature

IPCC's third false postulate is that increases in atmospheric CO_2 precede, and then force, parallel increases in temperature. The remarkable (and at first blush, synchronous) parallelism that exists between rhythmic fluctuations in ancient atmospheric temperature and atmospheric CO_2 levels was first detected in polar ice core samples analyzed during the 1970s. From the early 1990s onward, however, higher-resolution sampling has repeatedly shown these historic temperature changes precede the parallel changes in CO_2 by several hundred years or more (Mudelsee, 2001; Monnin *et al.*, 2001; Caillon *et al.*, 2003; Siegenthaler *et al.*, 2005). A similar relationship of temperature change leading CO_2 change (in this case by several months) also characterizes the much shorter seasonal cyclicity manifest in Hawaiian and other meteorological measurements (Kuo *et al.*, 1990).

In such circumstances, changing levels of CO_2 cannot be driving changes in temperature, but must either be themselves stimulated by temperature change, or be co-varying with temperature in response to

changes in another (at this stage unknown) variable.

Solar Influence Is Not Minimal

IPCC's fourth false postulate is that solar forcings are too small to explain twentieth century warming. Having concluded solar forcing alone is inadequate to account for twentieth century warming, IPCC authors infer CO_2 must be responsible for the remainder. Nonetheless, observations indicate variations occur in total ocean–atmospheric meridional heat transport and that these variations are driven by changes in solar radiation rooted in the intrinsic variability of the Sun's magnetic activity (Soon and Legates, 2013).

Incoming solar radiation is most often expressed as Total Solar Insolation (TSI), a measure derived from multi-proxy measures of solar activity (Hoyt and Schatten, 1993; extended and re-scaled by Willson, 2011; Scafetta and Willson, 2013). The newest estimates, from satellite-borne ACRIM-3 measurements, indicate TSI ranged between 1360 and 1363 Wm-2 between 1979 and 2011, the variability of ~3 Wm-2 occurring in parallel with the 11-year sunspot cycle. Larger changes in TSI are also known to occur in parallel with climatic change over longer time scales. For instance, Shapiro *et al.* (2011) estimated the TSI change between the Maunder Minimum and current conditions may have been as large as 6 Wm-2.

Temperature records from circum-Arctic regions of the Northern Hemisphere show a close correlation with TSI over the past 150 years, with both measures conforming to the ~60–70 year multidecadal cycle. In contrast, the measured steady rise of CO_2 emissions over the same period shows little correlation with the strong multidecadal (and shorter) ups and downs of surface temperature around the world.

Finally, IPCC ignores x-ray, ultraviolet, and magnetic flux variation, the latter having particularly important implications for the modulation of galactic cosmic ray influx and low cloud formation (Svensmark, 1998; Kirkby, *et al.*, 2011). Figure 11 summarizes these and other findings about solar forcings from Chapter 3 of *Climate Change Reconsidered II: Physical Science*.

Figure 11
Key Facts about Solar Forcing

- Evidence is accruing that changes in Earth's surface temperature are largely driven by variations in solar activity. Examples of solar-controlled climate change epochs include the Medieval Warm Period, Little Ice Age, and Early Twentieth Century (1910–1940) Warm Period.

- The Sun may have contributed as much as 66 percent of the observed twentieth century warming, and perhaps more.

- Strong empirical correlations have been reported from around the world between solar variability and climate indices including temperature, precipitation, droughts, floods, streamflow, and monsoons.

- IPCC models do not incorporate important solar factors such as fluctuations in magnetic intensity and overestimate the role of human-related CO_2 forcing.

- IPCC fails to consider the importance of the demonstrated empirical relationship between solar activity, the ingress of galactic cosmic rays, and the formation of low clouds.

- The respective importance of the Sun and CO_2 in forcing Earth's climate remains unresolved; current climate models fail to account for a plethora of known Sun-climate connections.

- The recently quiet Sun and extrapolation of solar cycle patterns into the future suggest a planetary cooling may occur over the next few decades.

Source: "Chapter 3. Solar Forcing of Climate," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Warming Would Not Be Harmful

IPCC's fifth false postulate is that warming of 2°C above today's temperature would be harmful. The suggestion that 2°C of warming would be harmful was coined at a conference organized by the British Meteorological Office in 2005 (DEFRA, 2005). The particular value of 2°C is entirely arbitrary and was proposed by the World Wildlife Fund, an environmental advocacy group, as a political expediency rather than as an informed scientific opinion. The target was set in response to concern that politicians would not initiate policy actions to reduce CO_2 emissions unless they were given a specific (and low) quantitative temperature target to aim for.

Multiple lines of evidence suggest a 2°C rise in temperature would not be harmful to the biosphere. The period termed the Holocene Climatic Optimum (c. 8,000 ybp) was 2–3°C warmer than today (Alley, 2000), and the planet attained similar temperatures for several million years during the Miocene and Pliocene (Zachos *et al.*, 2001). Biodiversity is encouraged by warmer rather than colder temperatures (Idso and Idso, 2009), and higher temperatures and elevated CO_2 greatly stimulate the growth of most plants (Idso and Idso, 2011).

Despite its widespread adoption by environmental NGOs, lobbyists, and governments, no empirical evidence exists to substantiate the claim that 2°C of warming presents a threat to planetary ecologies or human well-being. Nor can any convincing case be made that a warming will be more economically costly than an equivalent cooling (either of which could occur for natural reasons), since any planetary change of 2°C magnitude in temperature would result in complex local and regional changes, some being of economic or environmental benefit and others being harmful.

* * *

We conclude neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside normal natural variability, nor was it in any way unusual compared to earlier episodes in Earth's climatic history. Furthermore, solar forcings of temperature change are likely more important than is currently recognized, and evidence is lacking that a 2°C increase in temperature (of whatever cause) would be globally harmful.

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6

Unreliable Circumstantial Evidence

Key points in this chapter include the following:

- Melting of Arctic sea ice and polar icecaps is not occurring at "unnatural" rates and does not constitute evidence of a human impact on climate.

- Best available data show sea-level rise is not accelerating. Local and regional sea levels continue to exhibit typical natural variability – in some places rising and in others falling.

- The link between warming and drought is weak, and by some measures drought has decreased over the twentieth century. Changes in the hydrosphere of this type are regionally highly variable and show a closer correlation with multidecadal climate rhythmicity than they do with global temperature.

- No convincing relationship has been established between warming over the past 100 years and increases in extreme weather events. Meteorological science suggests just the opposite: A warmer world will see more mild weather patterns.

- No evidence exists that current changes in Arctic permafrost are other than natural or are likely to cause a climate catastrophe by releasing

methane into the atmosphere.

Introduction

IPCC's third line of reasoning, summarized in Figure 2 in Chapter 3, consists of circumstantial evidence regarding natural phenomena known to vary with temperature. The examples IPCC chooses to report invariably point to a negative impact on plant and animal life and human well-being. When claims are made that such phenomena are the result of anthropogenic global warming, almost invariably at least one of the following three requirements of scientific confidence is lacking:

(1) *Correlation does not establish causation.* Correlation of, say, a declining number of polar bears and a rising temperature does not establish causation between one and the other, for it is not at all unusual for two things to co-vary in parallel with other forcing factors.

(2) *Control for natural variability.* We live on a dynamic planet in which all aspects of the physical and biological environment are in a constant state of flux for reasons that are entirely natural (including, of course, temperature change). It is wrong to assume no changes would occur in the absence of the human presence. Climate, for example, will be different in 100 years regardless of what humans do or don't do.

(3) *Local temperature records that confirm warming*. Many studies of the impact of climate change on wildlife simply assume temperatures have risen, extreme weather events are more frequent, etc., without establishing that the relevant local temperature records conform to the postulated simple long-term warming trend.

All five of IPCC's claims relying on circumstantial evidence listed in Figure 2 in Chapter 3 are refutable.

Melting Ice

IPCC claims unusual melting is occurring in mountain glaciers, Arctic sea

ice, and polar icecaps. But what melting is occurring in mountain glaciers, Arctic sea ice, and polar icecaps is not occurring at "unnatural" rates and does not constitute evidence of a human impact on the climate. Both the Greenland (Johannessen *et al.*, 2005; Zwally *et al.*, 2005) and Antarctic (Zwally and Giovinetto, 2011) icecaps are close to balance. The global area of sea ice today is similar to that first measured by satellite observation in 1979 (Humlum, 2013) and significantly exceeds the ice cover present in former, warmer times.

Valley glaciers wax and wane on multidecadal, centennial, and millennial time-scales, and no evidence exists that their present, varied behavior falls outside long-term norms or is related to human-related CO_2 emissions (Easterbrook, 2011). Figure 12 summarizes the findings of Chapter 5 of *Climate Change Reconsidered-II: Physical Science* regarding glaciers, sea ice, and polar icecaps.

Figure 12
Key Facts about the Cryosphere

- Satellite and airborne geophysical datasets used to quantify the global ice budget are short and the methods involved in their infancy, but results to date suggest both the Greenland and Antarctic Ice Caps are close to balance.

- Deep ice cores from Antarctica and Greenland show climate change occurs as both major glacial-interglacial cycles and as shorter decadal and centennial events with high rates of warming and cooling, including abrupt temperature steps.

- Observed changes in temperature, snowfall, ice flow speed, glacial extent, and iceberg calving in both Greenland and Antarctica appear to lie within the limits of natural climate variation.

- Global sea-ice cover remains similar in area to that at the start of satellite observations in 1979, with ice shrinkage in the Arctic Ocean since then being offset by growth around Antarctica.

- During the past 25,000 years (late Pleistocene and Holocene) glaciers

around the world have fluctuated broadly in concert with changing climate, at times shrinking to positions and volumes smaller than today.

- This fact notwithstanding, mountain glaciers around the world show a wide variety of responses to local climate variation and do not respond to global temperature change in a simple, uniform way.

- Tropical mountain glaciers in both South America and Africa have retreated in the past 100 years because of reduced precipitation and increased solar radiation; some glaciers elsewhere also have retreated since the end of the Little Ice Age.

- The data on global glacial history and ice mass balance do not support the claims made by IPCC that CO_2 emissions are causing most glaciers today to retreat and melt.

Source: "Chapter 5. Observations: The Cryosphere," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Sea-Level Rise

IPCC claims global sea level is rising at an enhanced rate and swamping tropical coral atolls. But the best available data show sea-level rise is not accelerating (Houston and Dean, 2011). The global average sea level continues to increase at its long-term rate of 1–2 mm/year globally (Wöppelmann *et al.*, 2009). Local and regional sea levels continue to exhibit typical natural variability – in some places rising and in others falling. Unusual sea-level rise is therefore not drowning Pacific coral islands, nor are the islands being abandoned by "climate refugees."

The best available data show dynamic variations in Pacific sea level vary in accord with El Niño-La Niña cycles, superimposed on a natural long-term eustatic rise (Australian Bureau of Meteorology, 2011). Island coastal flooding results not from sea-level rise, but from spring tides or storm surges in combination with development pressures such as borrow pit digging or groundwater withdrawal. Persons emigrating from the islands are

doing so for social and economic reasons rather than in response to environmental threat.

Another claim concerning the effect of climate change on oceans is that increases in freshwater runoff into the oceans will disrupt the global thermohaline circulation system. But the range of natural fluctuation in the global ocean circulation system has yet to be fully delineated (Srokosz *et al.*, 2012). Research to date shows no evidence for changes that lie outside previous natural variability, nor for any malign influence from increases in human-related CO_2 emissions. See Figure 13 for more findings about climate change and oceans from Chapter 6 of *Climate Change Reconsidered II: Physical Science.*

Figure 13
Key Facts about Oceans

- Knowledge of local sea-level change is vital for coastal management; such change occurs at widely variable rates around the world, typically between about +5 and -5 mm/year.

- Global (eustatic) sea level, knowledge of which has only limited use for coastal management, rose at an average rate of between 1 and 2 mm/year over the past century.

- Satellite altimeter studies of sea-level change indicate rates of global rise since 1993 of more than 3 mm/year, but complexities of processing and the infancy of the method preclude viewing this result as secure.

- Rates of global sea-level change vary in decadal and multidecadal ways and show neither recent acceleration nor any simple relationship with increasing CO_2 emissions.

- Pacific coral atolls are not being drowned by extra sea-level rise; rather, atoll shorelines are affected by direct weather and infrequent high tide events, ENSO sea-level variations, and impacts of increasing human populations.

- Extra sea-level rise due to heat expansion (thermosteric rise) is also unlikely given that the Argo buoy network shows no significant ocean warming over the past nine years (Knox and Douglass, 2010).

- Though the range of natural variation has yet to be fully described, evidence is lacking for any recent changes in global ocean circulation that lie outside natural variation or were forced by human CO_2 emissions.

Source: "Chapter 6. Observations: The Hydrosphere," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Droughts, Floods, and Monsoons

IPCC claims droughts, floods, and monsoon variability and intensity are increasing. But the link between warming and drought is weak, and pan evaporation (a measurement that responds to the effects of several climate elements) decreased over the twentieth century (Roderick *et al.*, 2009). Huntington (2008) concluded on a globally averaged basis precipitation over land increased by about 2 percent over the period 1900–1998. However, changes in the hydrosphere of this type are regionally highly variable and show a closer correlation with multidecadal climate rhythmicity than they do with global temperature (Zanchettin *et al.*, 2008).

Monsoon intensity correlates with variations in solar activity rather than increases in atmospheric CO_2, and both the South American and Asian monsoons became more active during the cold Little Ice Age and less active during the Medieval Warm Period (Vuille *et al.*, 2012), suggesting there would be less volatility if the world becomes warmer. See Figure 14 for more facts about monsoons, droughts, and floods presented in Chapter 6 of *Climate Change Reconsidered II: Physical Science.*

Figure 14
Key Facts about Monsoons, Droughts, and Floods

- Little evidence exists for an overall increase in global precipitation during the twentieth century independent of natural multidecadal climate rhythmicity.

- Monsoon precipitation did not become more variable or intense during late twentieth century warming; instead, precipitation responded mostly to variations in solar activity.

- South American and Asian monsoons were more active during the cold Little Ice Age and less active during the Medieval Warm Period. Neither global nor local changes in streamflow have been linked to CO_2 emissions.

- The relationship between drought and global warming is weak, since severe droughts occurred during both the Medieval Warm Period and the Little Ice Age.

Source: "Chapter 6. Observations: The Hydrosphere," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Extreme Weather

IPCC does not object when persons, such as former U.S. Vice President Al Gore, cite its reports in support of claims that global warming is leading to more, or more intense, wildfires, rainfall, storms, hurricanes, and other extreme weather events. IPCC's latest Summary for Policymakers is filled with vivid warnings of this kind, even though in 2012 an IPCC report acknowledged that a relationship between global warming and wildfires, rainfall, storms, hurricanes, and other extreme weather events has not been demonstrated (IPCC, 2012).

In no case has a convincing relationship been established between warming over the past 100 years and increases in any of these extreme weather events (Alexander *et al.*, 2006; Khandekar, 2013; Pielke, Jr., 2014). Instead, the number and intensity of extreme events vary, and they wax and wane from one place to another and often in parallel with natural decadal or multidecadal climate oscillations. Basic meteorological science suggests a warmer world would experience fewer storms and weather extremes, as indeed has been the case in recent years.

Figure 15 summarizes key facts on this subject presented in Chapter 7 of *Climate Change Reconsidered-II: Physical Science.*

Figure 15
Key Facts about Extreme Weather Events

- Air temperature variability decreases as mean air temperature rises, on all time scales.

- Therefore the claim that global warming will lead to more extremes of climate and weather, including of temperature itself, seems theoretically unsound; the claim is also unsupported by empirical evidence.

- Although specific regions have experienced significant changes in the intensity or number of extreme events over the twentieth century, for the globe as a whole no relationship exists between such events and global warming over the past 100 years.

- Observations from across the planet demonstrate that droughts have not become more extreme or erratic in response to global warming. In most cases, the worst droughts in recorded meteorological history were much milder than droughts that occurred periodically during much colder times.

- There is little to no evidence that precipitation will become more variable and intense in a warming world; indeed some observations show just the opposite.

- There has been no significant increase in either the frequency or intensity of stormy weather in the modern era.

- Despite the supposedly "unprecedented" warming of the twentieth century, there has been no increase in the intensity or frequency of tropical cyclones globally or in any of the specific ocean basins.

- The commonly held perception that twentieth century warming was accompanied by an increase in extreme weather events is a misconception fostered by excessive media attention and has no basis in facts.

Source: "Chapter 7. Observations: Extreme Weather," *Climate Change Reconsidered II: Physical Science* (Chicago, IL: The Heartland Institute, 2013).

Thawing Permafrost

IPCC claims unusual thawing of Boreal permafrost or sub-seabed gas hydrates is causing warming due to methane release. It is true that over historic time, methane concentration has increased from about 700 ppb in the eighteenth century to the current level of near 1,800 ppb. However, the increase in methane concentration levelled off between 1998 and 2006 at around 1,750 ppb, which may reflect measures taken at that time to stem leakage from wells, pipelines, and distribution facilities (Quirk, 2010). More recently, since about 2007, methane concentrations have started to increase again, possibly due to a combination of leaks from new shale gas drilling and Arctic permafrost decline.

The contribution of increased methane to radiation forcing since the eighteenth century is estimated to be only 0.7 Wm^{-2}, which is small. And in any case, no evidence exists that current changes in Arctic permafrost are other than natural. Most of Earth's gas hydrates occur at low saturations and in sediments at such great depths below the seafloor or onshore permafrost that they will barely be affected by warming over even one thousand years.

* * *

We conclude no unambiguous evidence exists for adverse changes to the global environment caused by human-related CO_2 emissions. In particular, the cryosphere is not melting at an enhanced rate; sea-level rise is not accelerating; no systematic changes have been documented in evaporation or rainfall or in the magnitude or intensity of extreme meteorological events; and an increased release of methane into the atmosphere from permafrost or sub-seabed gas hydrates is unlikely.

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7

Policy Implications

Key findings in this section include the following:

- Rather than rely exclusively on IPCC for scientific advice, policymakers should seek out advice from independent, nongovernment organizations and scientists who are free of financial and political conflicts of interest.

- Individual nations should take charge of setting their own climate policies based upon the hazards that apply to their particular geography, geology, weather, and culture.

- Rather than invest scarce world resources in a quixotic campaign based on politicized and unreliable science, world leaders would do well to turn their attention to the real problems their people and their planet face.

To date, most government signatories to the UN's Framework Convention on Climate Change have deferred to the monopoly advice of IPCC in setting their national climate change policies. More than 20 years since IPCC began its work in 1988, it is now evident this approach has been mistaken. One result has been the expenditure of hundreds of billions of dollars implementing energy policies that now appear to have been unnecessary, or at least ill-timed and ineffective.

Rather than rely exclusively on IPCC for scientific advice,

policymakers should seek out advice from independent, nongovernment organizations and scientists who are free of financial and political conflicts of interest. The Chinese Academy of Sciences took an important step in this direction by translating and publishing an abridged edition of the first two volumes in NIPCC's Climate Change Reconsidered series (CAS, 2013).

Climate change, whether man-made or not, is a global phenomenon with very different effects on different parts of the world (Tol, 2011). Individual nations should take charge of setting their own climate policies based upon the hazards that apply to their particular geography, geology, weather, and culture – as India has started to do by setting up an advisory Indian Network on Comprehensive Climate Change Assessment (INCCCA) (Nelson, 2010).

The theoretical hazard of dangerous human-caused global warming is but one small part of a much wider climate hazard – extreme natural weather and climatic events that Nature intermittently presents us with, and always will (Carter, 2010). The 2005 Hurricane Katrina disaster in the United States, the 2007 floods in the United Kingdom, and the tragic bushfires in Australia in 2009 demonstrate the governments of even advanced, wealthy countries are often inadequately prepared for climate-related disasters of natural origin.

Climate change as a natural hazard is as much a geological as a meteorological issue. Geological hazards are mostly dealt with by providing civil defense authorities and the public with accurate, evidence-based information regarding events such as earthquakes, volcanic eruptions, tsunamis, storms, and floods (which represent climatic as well as weather events), and then planning to mitigate and adapt to the effects when such events occur.

The idea that there can be a one-size-fits-all global solution to address future climate change, such as recommended by the United Nations in the past, fails to deal with real climate and climate-related hazards. It also turned climate change into a political issue long before the science was sufficiently advanced to inform policymakers. A better path forward was suggested by Ronald Brunner and Amanda Lynch: "We need to use adaptive governance to produce response programs that cope with hazardous climate events as they happen, and that encourage diversity and innovation in the search for solutions. In such a fashion, the highly contentious 'global warming' problem can be recast into an issue in which every culture and community around the world has an inherent interest"

(Brunner and Lynch, 2010).

There is some evidence world leaders are reconsidering past decisions. India, China, Russia, and other countries are making it clear they will not blindly follow the path of reducing the use of fossil fuels in the vain hope of having an almost indiscernible effect on climate some time in the twenty-second or twenty-third centuries. A writer for *Nature*, commenting on the upcoming Conference of the Parties (COP-21) of the UN Framework Convention on Climate Change, reported in May 2015, "The negotiations' goal has become what is politically possible, not what is environmentally desirable. Gone is a focus on establishing a global, 'top down' target for stabilizing emissions of a carbon budget that is legally binding. The Paris meeting will focus on voluntary 'bottom up' commitments by individual states to reduce emissions. The global climate target is being watered down in the hope of getting any agreement in Paris. The 2ºC warming limit need only be kept 'within reach.' The possibility of using 'ratcheting mechanisms' keeps hopes alive of more ambitious policies, but such systems are unlikely to achieve the desired outcomes. Strict measuring, reporting and verification mechanisms are yet to be agreed" (Geden, 2015, p. 27).

Michael Levi, a senior fellow for the Council on Foreign Relations, wrote in June 2015 about the changing expectations of world leaders. His points in brief: (1) Developed countries are no longer pushing for binding emissions reduction commitments, whether for themselves or developing countries; (2) the emphasis has shifted from reducing emissions in order to mitigate future climate change to helping nations adapt to whatever the future climate might look like; (3) the goals declared at the UN's next meeting (in Paris in December 2015) will be too far in the future to matter to anyone; and (4) the widely discussed pledge of giving developing countries $100 billion a year is going to consist largely of relabeling foreign aid and private funding already going to those countries (Levi, 2015).

If Geden's and Levi's observations are true, this is all very good news indeed. The world appears to be backing away from a disaster of its own making, caused by lobbyists and campaigners and interest groups steering public policy in the wrong direction.

Policymakers should recognize that the human impact on the global climate remains a scientific puzzle, perhaps the most difficult one science has ever faced. The scientific debate is far from over. Despite appeals to a "scientific consensus" and claims from even the president of the United

States that "climate change is real, man-made, and dangerous," the truth is we simply don't know if climate change is a problem that needs to be addressed. The best available evidence points in a different direction: The human impact on climate is small relative to natural variability, perhaps too small to be measured. Rather than invest scarce world resources in a quixotic campaign based on politicized and unreliable science, world leaders would do well to turn their attention to the real problems their people and their planet face.

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Conclusion

The most important fact about climate science, often overlooked, is that scientists disagree about the environmental impacts of the combustion of fossil fuels on the global climate. There is no survey or study showing "consensus" on the most important scientific issues, despite frequent claims by advocates to the contrary.

Scientists disagree about the causes and consequences of climate for several reasons. Climate is an interdisciplinary subject requiring insights from many fields. Very few scholars have mastery of more than one or two of these disciplines. Fundamental uncertainties arise from insufficient observational evidence, disagreements over how to interpret data, and how to set the parameters of models. The Intergovernmental Panel on Climate Change (IPCC), created to find and disseminate research finding a human impact on global climate, is not a credible source. It is agenda-driven, a political rather than scientific body, and some allege it is corrupt. Finally, climate scientists, like all humans, can be biased. Origins of bias include careerism, grant-seeking, political views, and confirmation bias.

Probably the only "consensus" among climate scientists is that human activities can have an effect on local climate and that the sum of such local effects could hypothetically rise to the level of an observable global signal. The key questions to be answered, however, are whether the human global signal is large enough to be measured and if it is, does it represent, or is it likely to become, a dangerous change outside the range of natural variability? On these questions, an energetic scientific debate is taking place on the pages of peer-reviewed science journals.

In contradiction of the scientific method, IPCC assumes its implicit hypothesis – that dangerous global warming is resulting, or will result, from human-related greenhouse gas emissions – is correct and that its only duty is to collect evidence and make plausible arguments in the hypothesis's favor. It simply ignores the alternative and null hypothesis, amply supported by empirical research, that currently observed changes in global climate indices and the physical environment are the result of natural variability.

The results of the global climate models (GCMs) relied on by IPCC are only as reliable as the data and theories "fed" into them. Most climate scientists agree those data are seriously deficient and IPCC's estimate for climate sensitivity to CO_2 is too high. We estimate a doubling of CO_2 from pre-industrial levels (from 280 to 560 ppm) would likely produce a temperature forcing of 3.7 Wm^{-2} in the lower atmosphere, for about ~1°C of *prima facie* warming. The recently quiet Sun and extrapolation of solar cycle patterns into the future suggest a planetary cooling may occur over the next few decades.

In a similar fashion, all five of IPCC's postulates, or assumptions, are readily refuted by real-world observations, and all five of IPCC's claims relying on circumstantial evidence are refutable. For example, in contrast to IPCC's alarmism, we find neither the rate nor the magnitude of the reported late twentieth century surface warming (1979–2000) lay outside normal natural variability, nor was it in any way unusual compared to earlier episodes in Earth's climatic history. In any case, such evidence cannot be invoked to "prove" a hypothesis, but only to disprove one. IPCC has failed to refute the null hypothesis that currently observed changes in global climate indices and the physical environment are the result of natural variability.

Rather than rely exclusively on IPCC for scientific advice, policymakers should seek out advice from independent, nongovernment organizations and scientists who are free of financial and political conflicts of interest. NIPCC's conclusion, drawn from its extensive review of the scientific evidence, is that any human global climate impact is within the background variability of the natural climate system and is not dangerous.

In the face of such facts, the most prudent climate policy is to prepare for and adapt to extreme climate events and changes regardless of their origin. Adaptive planning for future hazardous climate events and change should be tailored to provide responses to the known rates, magnitudes, and risks of natural change. Once in place, these same plans will provide an adequate response to any human-caused change that may or may not emerge.

Policymakers should resist pressure from lobby groups to silence scientists who question the authority of IPCC to claim to speak for "climate science." The distinguished British biologist Conrad Waddington wrote in 1941,

> It is … important that scientists must be ready for their pet theories to turn out to be wrong. Science as a whole certainly cannot allow its judgment about facts to be distorted by ideas of what ought to be true, or what one may hope to be true (Waddington, 1941).

This prescient statement merits careful examination by those who continue to assert the fashionable belief, in the face of strong empirical evidence to the contrary, that human CO_2 emissions are going to cause dangerous global warming.

Reference

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About the Authors

Dr. Craig D. Idso is founder and chairman of the Center for the Study of Carbon Dioxide and Global Change. Since 1998, he has been the editor and chief contributor to the online magazine CO2 Science. He is the author of several books, including *The Many Benefits of Atmospheric CO2 Enrichment* (2011) and *CO2, Global Warming and Coral Reefs* (2009). He earned a Ph.D. in geography from Arizona State University, where he lectured in meteorology and was a faculty researcher in the Office of Climatology.

Dr. Robert M. Carter is a stratigrapher and marine geologist with degrees from the University of Otago (New Zealand) and University of Cambridge (England). He is the author of *Climate: The Counter Consensus* (2010) and *Taxing Air: Facts and Fallacies about Climate Change* (2013). Carter's professional service includes terms as head of the Geology Department, James Cook University, chairman of the Earth Sciences Panel of the Australian Research Council, chairman of the national Marine Science and Technologies Committee, and director of the Australian Office of the Ocean Drilling Program. He is currently an emeritus fellow of the Institute of Public Affairs (Melbourne).

Dr. S. Fred Singer is one of the most distinguished atmospheric physicists in the United States. He established and served as the first director of the U.S. Weather Satellite Service, no part of the National oceanic and Atmospheric Administration (NOAA), and earned a U.S. Department of Commerce Gold Medal Award for his technical leadership He is coauthor, with Dennis T. Avery, of *Unstoppable Global Warming Every 1,500 Years* (2007, second ed. 2008) and many other books. Dr. Singer served as professor of environmental sciences at the University of Virginia, Charlottesville, VA (1971–94) and is founder and chairman of the nonprofit Science and Environmental Policy Project. He earned a Ph.D. in physics from Princeton University.

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Heartland has a full-time staff of 35. Joseph Bast is cofounder, president, and CEO. Dr. Herbert Walberg is chairman of the 10-member Board of Directors. Approximately 250 academics participate in the peer review of its publications and more than 175 elected officials pay annual dues to serve on its Legislative Forum.

Heartland has a long and distinguished history of defending freedom. We are widely regarded as a leading voice in national and international debates over budgets and taxes, environmental protection, health care, school reform, and constitutional reform. Five centers at The Heartland Institute conduct original research to find new ways to solve problems, turn good ideas into practical proposals for policy change, and then effectively promote those proposals to policymakers and the public.

For more information, visit our website at www.heartland.org, call 312/377-4000, or visit us at 3939 North Wilke Road, Arlington Heights, Illinois.

CLIMATE CHANGE PRIMER

What you need to know

A clear and concise explanation about climate change and global warming.

Dr. D. Michael Shafer
info@warmheartworldwide.org

About NIPCC

The Nongovernmental International Panel on Climate Change (NIPCC) is what its name suggests: an international panel of nongovernment scientists and scholars who have come together to understand the causes and consequences of climate change. Because we are not predisposed to believe climate change is caused by human greenhouse gas emissions, we are able to look at evidence the Intergovernmental Panel on Climate Change (IPCC) ignores. Because we do not work for any governments, we are not biased toward the assumption that greater government activity is necessary.

NIPCC traces its roots to a meeting in Milan in 2003 organized by the Science and Environmental Policy Project (SEPP), a nonprofit research and education organization based in Arlington, Virginia. SEPP, in turn, was founded in 1990 by Dr. S. Fred Singer, an atmospheric physicist, and incorporated in 1992 following Dr. Singer's retirement from the University of Virginia. NIPCC is currently a joint project of SEPP, The Heartland Institute, and the Center for the Study of Carbon Dioxide and Global Change.

NIPCC has produced eight reports to date:

Nature, Not Human Activity, Rules the Climate
Climate Change Reconsidered: The 2009 Report of the Nongovernmental International Panel on Climate Change (NIPCC)
Climate Change Reconsidered: 2011 Interim Report
Climate Change Reconsidered II: Physical Science
Climate Change Reconsidered II: Biological Impacts
Scientific Critique of IPCC's 2013 'Summary for Policymakers'
Commentary and Analysis on the Whitehead & Associates 2014 NSW Sea-Level Report
Why Scientists Disagree About Global Warming

These publications and more information about NIPCC are available at www.climatechangereconsidered.org.

$14.95

"Probably the most widely repeated claim in the debate over global warming is that '97% of scientists agree' that climate change is man-made and dangerous. This claim is not only false, but its presence in the debate is an insult to science."

With these words, the distinguished authors of *Why We Disagree About Global Warming: The NIPCC Report on Scientific Consensus* begin a detailed analysis of one of the most controversial topics of the day. Do most scientists agree on the causes and consequences of climate change? Is it really only a small fringe of the scientific community that believes global warming is not a crisis?

The authors make a compelling case against claims of a scientific consensus. The purported proof of such a consensus consists of sloppy research by nonscientists, college students, and a highly partisan Australian blogger. Surveys of climate scientists, even those heavily biased in favor of climate alarmism, find extensive disagreement on the underlying science and doubts about its reliability.

Why do scientists disagree? The authors point to four reasons: a conflict among scientists in different and often competing disciplines; fundamental scientific uncertainties concerning how the global climate responds to the human presence; failure of the United Nations' Intergovernmental Panel on Climate Change (IPCC) to provide objective guidance to the complex science; and bias among researchers.

What does the science actually say about global warming? The authors offer a succinct summary of the real science of climate change based on their previously published comprehensive review of climate science in a volume titled *Climate Change Reconsidered II: Physical Science.* They recommend policymakers resist pressure from lobby groups to silence scientists who question the authority of IPCC to claim to speak for "climate science." They conclude with a quotation from the distinguished British biologist Conrad Waddington:

> *It is … important that scientists must be ready for their pet theories to turn out to be wrong. Science as a whole certainly cannot allow its judgment about facts to be distorted by ideas of what ought to be true, or what one may hope to be true.*

CRAIG D. IDSO, Ph.D., a climatologist, is one of the world's leading experts on the effects of carbon dioxide on plant and animal life and is chairman of the Center for the Study of Carbon Dioxide and Global Change.

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Preface

"May you live in interesting times" has always had an ominous ring to it, today perhaps more so than any time in recent memory.

When this Primer was written, there seemed to be a growing consensus among the developed and developing countries of the world that climate change constituted a real and imminent danger and demanded immediate action.

Today, the United States has withdrawn from the Paris Accords, and the executive agencies of the United States government have closed down climate change research, and even banned the use of the term "climate change" in emails and on websites.

This situation poses problems for me as the author of this Primer and for the Primer itself.

On the one hand, as a social scientist trained in empirical scientific methodology, I personally find the arguments for both greenhouse gas driven global warming (that in turn drives climate change) and for human causality increasingly compelling.

I have yet to see contradictory data that has not yielded to further research and I have been impressed by the growing robustness of climate change models and their ability to account for new, highly diverse data.

On the other hand, as you will see as you peruse the Primer, I have used many graphics drawn from such US agencies as the Department of Agriculture (USDA), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA).

I have also provided many links to their once extensive reference guides to, for example, the impact of atmospheric warming on crop yields, greenhouse gases, satellite imagery and the effects of ocean acidification.

Many of these images are now orphaned and many of these links are now dead as these sites have been closed down. No other country in the world possesses the scientific resources that these agencies possess and so many long-term observation projects have gone dark.

So, where does this leave us?

My personal sense is pretty much where we were when I wrote the Primer. Donald Trump has profoundly upset a lot of environmentalists. He has also upset a lot of Americans with economic vision who are unhappy to see the future of the environmental industries ceded to China.

But the bottom line, as they say, is the bottom line: coal, despite Mr. Trump's best efforts to hold back development, is history and oil is rapidly moving in the same direction – not for environmental, but for cost reasons.

And while the United States government may be trying to dig in its heels and deny climate change, most state and municipal governments have recognized that man-made or not, floods and fires, hurricanes and heat are getting out of hand and need to be addressed.

Who wouldn't want to have a self-powered house that tops up the car, too? Hell, who wouldn't want to breathe clean air? Know that the water is clean? That there will be unpoisoned food tomorrow? That it will not be necessary to mobilize the military behind defensive walls to fight off hordes of the hot and hungry from the developing world?

What do I think is going to happen?

People always ask me that. To be honest, my answer depends largely on how my day is going.

I will always tell you that my neighbors here in rural Thailand and all those like them in the developing world are going to suffer a lot, no matter how the story turns out.

Last summer – 2016 – we suffered through seven weeks of temperatures over 42º C (about 105º F). You try to imagine what it was like to prepare hard, clay soil for planting in heat like that.

Crop yields are falling; pest pressure is rising on crops; rains are unpredictable and torrential when they come; malaria is back with a vengeance and dengue is now year around. No one's likely to show up with help.

But as for the world as a whole?

Part of me says that we are already past the tipping point, that the processes of change have already gone so far that sooner rather than later the oceans will rise six meters, millions of people will first be displaced and then die of starvation, that the global economy will collapse as the world's industrial and transportation facilities drown.

Part of me says that drowning, like hanging, concentrates the mind, that the moment will come when surviving finally becomes enough of a priority that we really do something about it.

Your guess is as good as mine.

For the moment, however, you will have to make do with this Primer, which really is just that, a Primer.

Do not expect new revelations or bursts of clarity. "Climate Change Primer: What You Need To Know", is just that, the real basics explained in layperson's words.

At the end, you will find a bit of my social scientist's best effort to explain, in simple terms, how it is that we have accomplished so little to deal with climate change – indeed, even to reach agreement that climate change is happening.

Otherwise, the Primer is simply an exercise in organizing and simplifying the vast amount of highly complex information out there that most people can make neither heads nor tails of.

I hope it serves you well.

Michael Shafer
A.Phrao Chiang Mai Thailand
December, 2017

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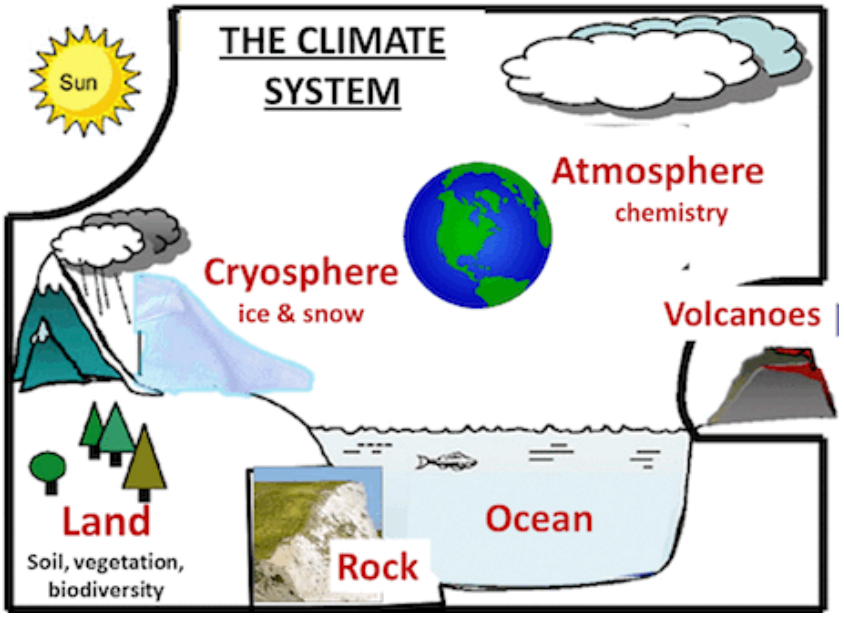
Climate Change Primer

Dr. D. Michael Shafer. Warm Heart Environmental Program

What is climate change?

Climate change refers to significant, long-term changes in the global climate. The global climate is the connected system of sun, earth and oceans, wind, rain and snow, forests, deserts and savannas, and everything people do, too.



(Source: US Environmental Protection Agency)

The climate of a place, say New York, can be described as its rainfall, changing temperatures during the year and so on.

But the global climate is more than the "average" of the climates of specific places. A description of the global climate includes how, for example, the rising temperature of the Pacific feeds typhoons which blow harder, drop more rain and cause more damage, but also shifts global ocean currents that melt Antarctica ice which slowly makes sea level rise until New York will be under water. It is this systemic connectedness that makes global climate change so important and so complicate.

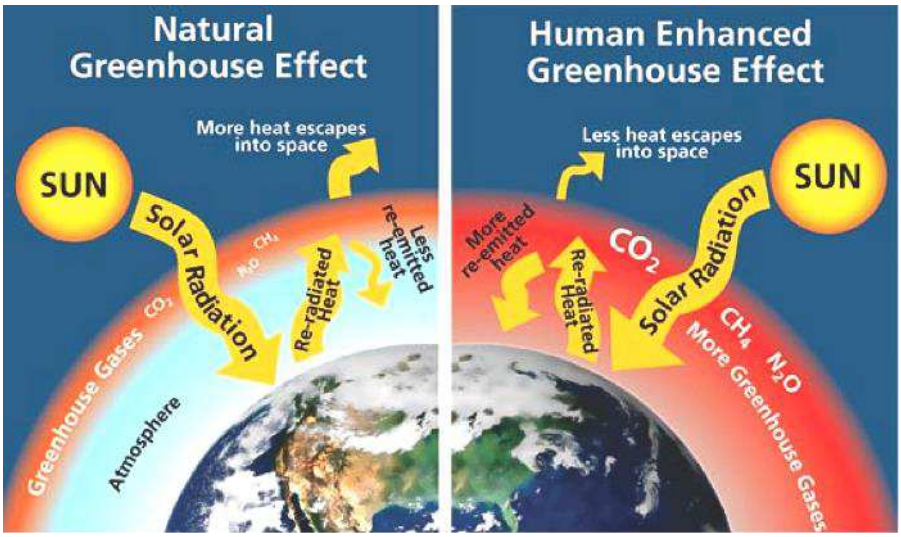
What is global warming?

Global warming is the slow increase in the average temperature of the earth's lower atmosphere because an increased amount of the energy (heat) striking the earth from the sun is being trapped in the atmosphere and not radiated out into space.

The earth's atmosphere has always acted like a greenhouse to capture the sun's heat, ensuring that the earth has enjoyed temperatures that permitted the emergence of life forms as we know them, including humans.

Without our atmospheric greenhouse the earth would be very cold. Global warming, however, is the equivalent of a greenhouse with high efficiency reflective glass installed the wrong way around.

So much heat is being kept inside greenhouse earth that the temperature of the earth is going up faster than at any previous time in history. NASA provides an excellent course module on the science of global warming.



(Source: Center for Climate and Energy Solutions)

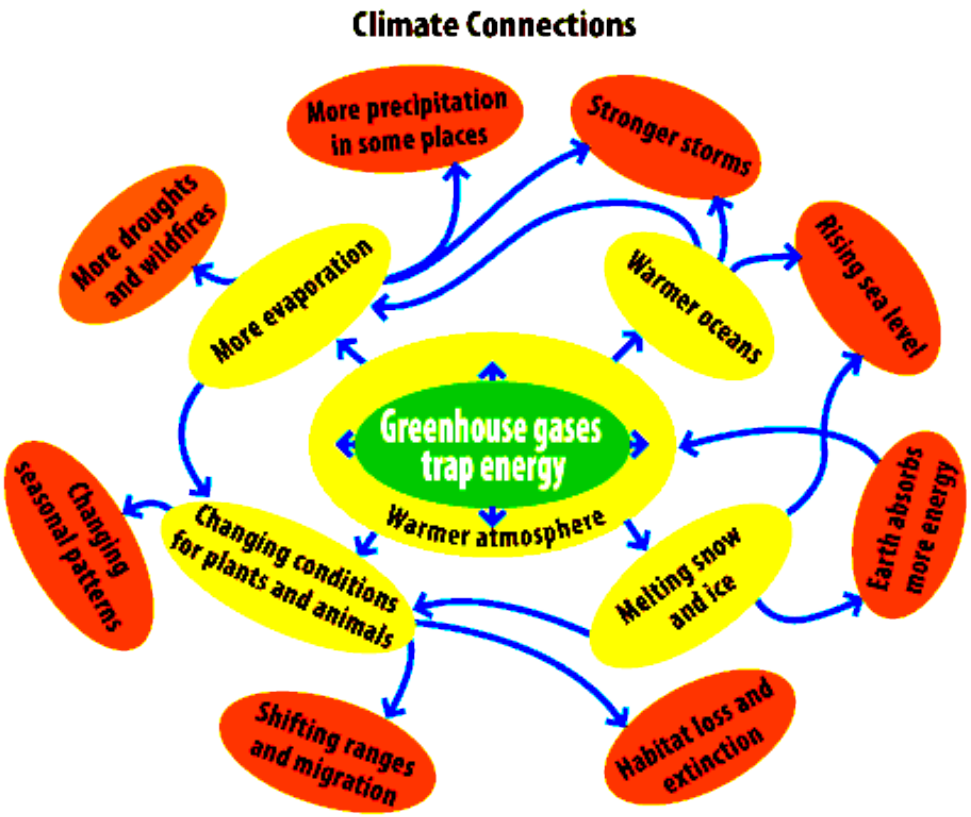
How does global warming drive climate change?

Heat is energy and when you add energy to any system changes occur.

Because all systems in the global climate system are connected, adding heat energy causes the global climate as a whole to change.

Much of the world is covered with ocean which heats up. When the ocean heats up, more water evaporates into clouds.

Where storms like hurricanes and typhoons are forming, the result is more energy-intensive storms.



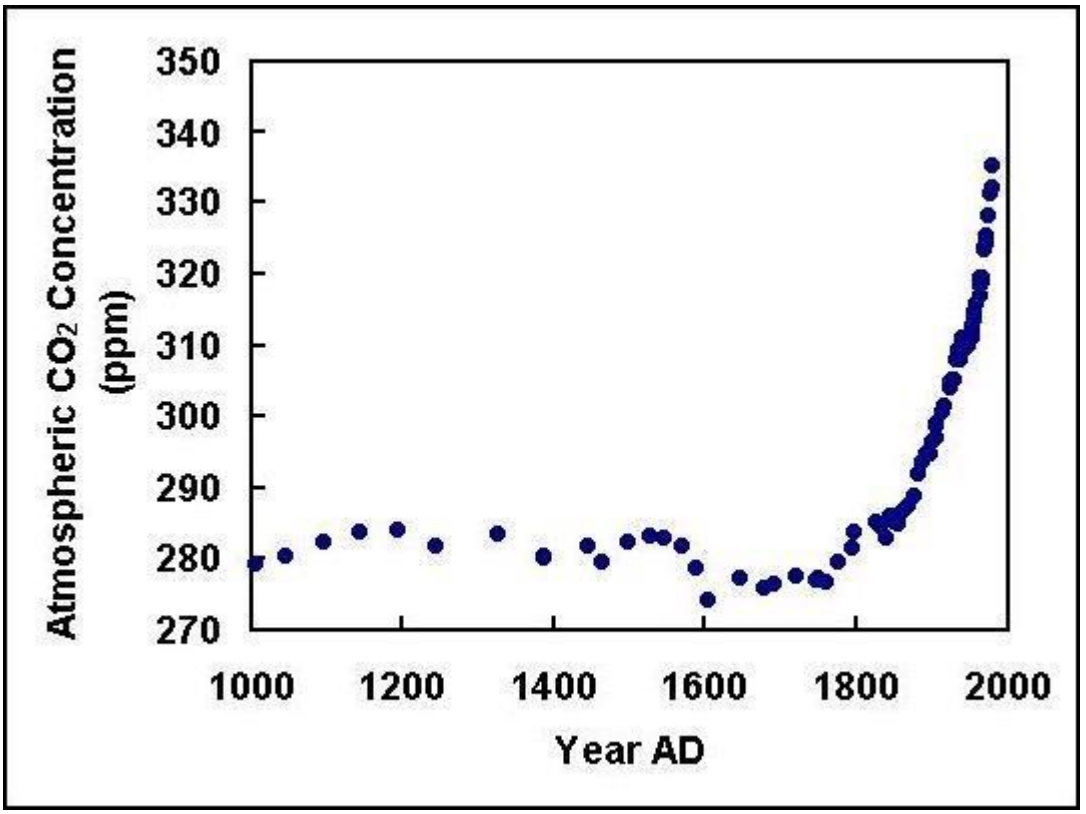
A warmer atmosphere makes glaciers and mountain snow packs, the Polar ice cap, and the great ice shield jutting off of Antarctica melt raising sea levels.

Changes in temperature change the great patterns of wind that bring the monsoons in Asia and rain and snow around the world, making drought and unpredictable weather more common. This is why scientists have stopped focusing just on global warming and now focus on the larger topic of climate change.

What causes global warming?

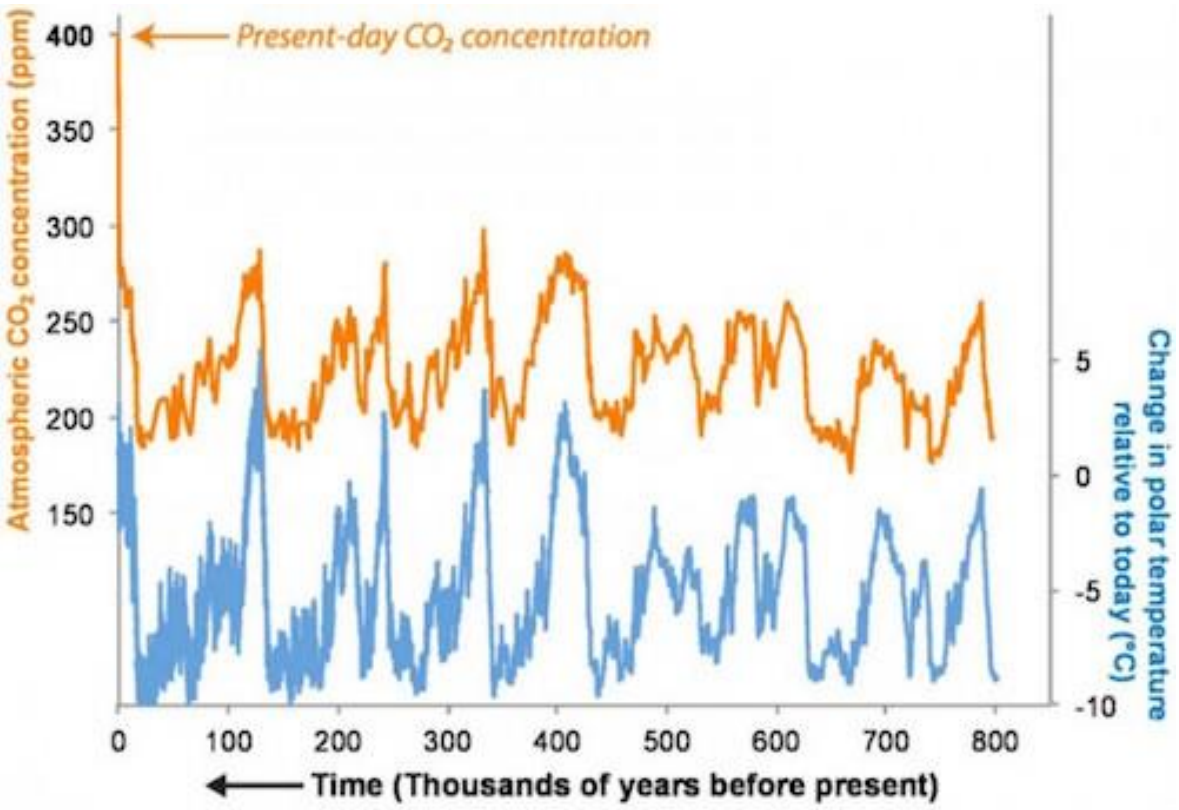
Scientists attribute current atmospheric warming to human activities that have increased the amount of carbon containing gases in the upper atmosphere and to increased amounts of tiny particles in the lower atmosphere. (NASA offers a good course module on "The Carbon Question.")

Specifically, gases released primarily by the burning of fossil fuels and the tiny particles produced by incomplete burning trap the sun's energy in the atmosphere.



(Source: EARSI)

Scientists call these gases "greenhouse gases" (GHGs) because they act like the wrong way reflective glass in our global green house. Scientists call the tiny particles 'black carbon' (you call it soot or smoke) and attribute their warming effect to the fact that the resulting layer of black particles in the lower atmosphere absorbs heat like a black blanket.



(Source: State of the Planet)

Scientists date the beginning of the current warming trend to the end of the 18th or beginning of the 19th century when coal first came into common use.

This warming trend has accelerated as we have increased our use of fossil fuels to include gasoline, diesel, kerosene and natural gas, as well as the petrochemicals (plastics, pharmaceuticals, fertilizers) we now make from oil.

Scientists attribute the current warming trend to the use of fossil fuels because using them releases into the atmosphere stores of carbon that were sequestered (buried) millions of years ago. The addition of this "old" carbon to the world's current stock of carbon, scientists have concluded, is what is warming our earth.

What are the most important greenhouse gases (GHGs)?

The most common and most talked about GHG is CO2 or carbon dioxide. In fact, because it is so common, use it as the measure of gases that warm the atmosphere. Methane, another important GHG, for example, is 28-36 times as warming as CO2 when in the upper atmosphere (USEPA GWP – Global Warming Potential – estimate over 100 years), therefore, 1 ton of methane = 28-36 tons eCO2 or CO2 equivalents.

The most commonly discussed GHGs are:

- CO2 or carbon dioxide is produced any time something is burned. It is the most common GHG, constituting by some measures almost 55% of total long-term GHGs. It is used as a marker by the United States Environmental Protection Agency, for example, because of its ubiquity. It is assigned a GWP or Global Warming Potential of 1.
- Methane or CH4 is produced in many combustion processes and also by anaerobic decomposition, for example, in flooded rice paddies, pig and cow stomachs, and pig manure ponds. Methane breaks down in approximately 10 years, but is a precursor of ozone, itself an important GHG. CH4 has a GWP of 28-36.
- Nitrous oxide, or paren (laughing gas), NO/N2O or simply NOx is a byproduct of fertilizer production and use, other industrial processes and the combustion of certain materials. Nitrous oxide lasts a very long time in the atmosphere, but at the 100 year point of comparison to CO2, its GWP is 265-298.
- Fluorinated gases were created as replacements for ozone depleting refrigerants, but have proved to be both extremely long lasting and extremely warming GHGs. They have no natural sources, but are entirely manmade. At the 100 year point of comparison, their GWPs range from 1,800 to 8,000 and some variants top 10,000.
- Sulphur hexafluoride or SF6 is used for specialized medical purposes, but primarily in what are called dielectric materials, especially dielectric liquids. These are used as insulators in high voltage applications such as transformers and grid switching gear. SF6 will last thousands of years in the upper atmosphere and has a GWP of 22,800.

What is black carbon and how does it cause global warming?

Black carbon (BC) is tiny particles of carbon released as a result of the incomplete combustion of fossil fuels, biofuels and biomass.

These particles are extremely small, ranging from 10 µm (micrometers, PM10), the size of a single bacterium to less than 2.5 µm (PM2.5), one thirtieth the width of a human hair and small enough to pass through the walls of the human lung and into the blood stream.

Although black carbon – think of the plume of smoke from a chimney or a fire – falls out of the lower atmosphere in days, while it is suspended in the air, it absorbs the sun's heat millions of times more effectively than CO_2. When wind carries BC over snow, glaciers or ice caps where it falls out onto the white, normally reflective surface, it is particularly damaging because it contributes directly to melting. Overall, BC is considered the second biggest contributor to global warming after CO_2.

Further reading:

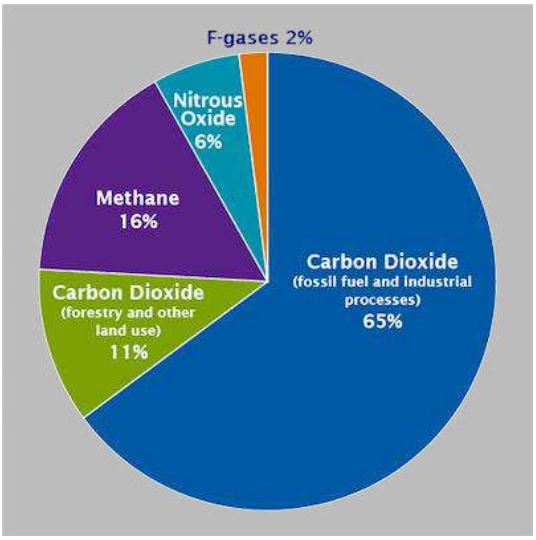
An Analysis of Black Carbon Mitigation as a Response to Climate Change

What are the most important sources of GHGs and black carbon?

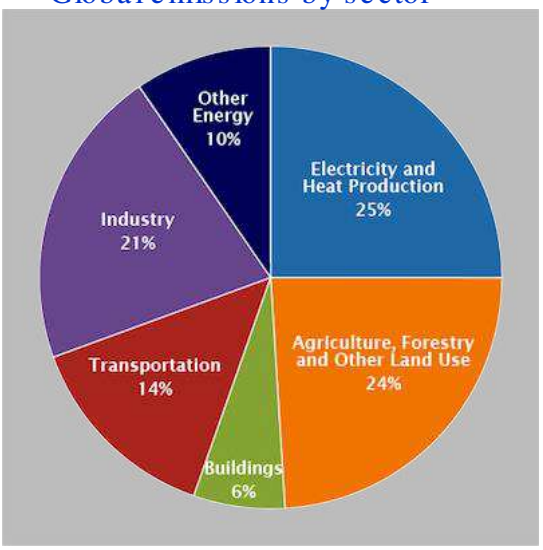
Fossil fuel and related uses of coal and petroleum are the most important sources of GHGs and black carbon (power generation, industry, transportation, buildings).

Agriculture is the second most important source (animals (cows and pigs), feed production, chemical intensive food production, and flooded paddy rice production, as well as deforestation driven by the desire to expand cultivated areas). (New studies suggest that agriculture is the largest contributor of particulate emissions in the US and other developed agricultural countries.)

Global emissions by gas

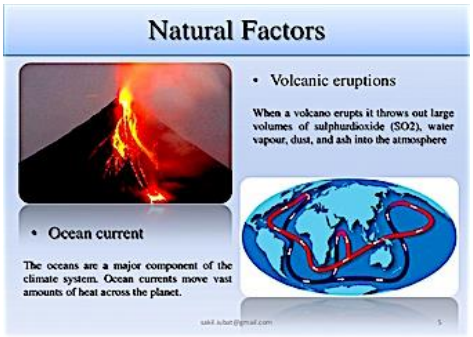


Global emissions by sector



(Source: US Environmental Protection Agency)

Natural sources of GHGs and black carbon include forest fires, savanna fires and volcanos.



(Source: Slide Share)

What evidence do we have of climate change?

The most compelling evidence scientists have of climate change is long term data relating atmospheric CO2 levels and global temperature, sea level, the expanse of ice, the fossil record and the distribution of species.

This data, which goes back millions of years, shows a strong correlation between CO2 levels and temperature. Recent data shows a trend of increasing temperature and rising CO2 levels beginning in the early 19th century.

Because all parts of the global climate are connected, scientists have been able to create models of how changes caused by heating should work their way through the entire system and appear in different areas, for example, sea level, intemperate weather, the movement of fish species in the ocean.

Testing whether or not predicted changes have occurred is an important way to verify underlying theory. This can be done in two ways.

First, it is possible to load a model with historical data and ask: how well does this model predict what we know happened? NASA and other scientific agencies have done this and found that the models work well.

A second way to test is to use the model to predict upcoming changes and then to see if emerging reality fits. It is possible to track the rapid retreat of glaciers and observe the summer melting of the Polar Ice Cap. Sea levels are rising measurably, the temperature of the world's oceans is demonstrably rising and consequently many fish species are moving to follow waters that are the right temperature for them.

Correlating these changes to the timing of rises in CO2 levels and temperature suggests relationship. NASA provides a good visual tool for viewing these relational models "in action".

In specific instances, for example, CO2 levels, temperature and ocean pH, the chemical processes are traceable proving direct causal connection.

Do all scientists agree that climate change is occurring and is caused by human activity?

No.

Despite the apparent consensus among scientists, NGOs, international organizations, policy makers and the media, there are respected scientists who remain "climate sceptics," that is, who doubt that the overall theory of human induced global climate change is correct, or that the observed phenomena demonstrate conclusively that it is, or that the observed phenomena are anything out of the ordinary (viewed in the time frame of "earth history").

It is important to separate these scientists from 'sceptics' who have a financial interest in denying climate change. These people have been important in framing the climate change debate in the United States and the position of the United States government on the issue of climate change. Their success has little to do with alternative science, however, and everything to do with the permeability of the US political process to the influence of such actors.

It is also important to separate these scientists from the ignorant and people who do not understand evidence-based science. Such people are simply uninformed or misinformed, make such ignorant statements as "it's just a theory" or cite isolated facts as if they mattered. Their numbers have made this group politically powerful in the US, but their ignorance sidelines them in the global debate.

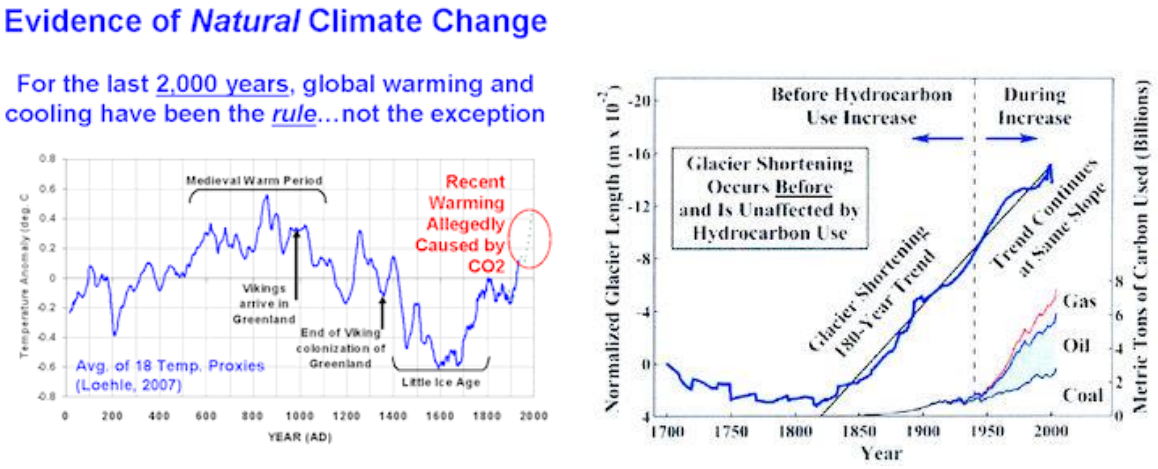
Climate sceptics fall into three camps: those like Freeman Dyson, Bjorn Lomborg and Kiminori Itoh who acknowledge climate change, but think that carbon-based theory and current models are too simplistic to capture such a complex process; those like Ivar Giaever who think that the data is too thin to support such bold claims; and those like Will Happer who contend that the nice analogy of a greenhouse does not apply and that CO2 is too insignificant to be the culprit.

An article prepared to accompany a petition urging the US not to sign global climate accords reviews each of the main contentions of climate change scientists and presents data suggesting that each is wrong.

The authors of the article cite data, for example, that suggests that the earth's temperature today is essentially at the 3,000-year average global temperature, while during the Medieval period, long before the use of fossil fuels, temperatures were 24º C higher.

In a similar vein, they cite data to suggest that glacier shortening began in the early 19th century, 25 years before the start of intensive fossil fuel use.

For a more recent web piece by a well-informed, non-scientist sceptic, see David Siegel, "What I learned about climate change: The science is not settled."



(Source: GWReview)

What has been the result of disagreement among scientists?

Science does not exist in a vacuum.

Scientists have strong beliefs about the world they live in and personal agendas.

The people who manage the funding agencies, companies, political action groups, political parties and NGOs that pay for their research also have ideological and organizational agendas.

When talking about disagreements among scientists, it is therefore important to distinguish between scientific contests between different theories, models and data sets, and the shouting matches among nonscientists who use science for their own purposes.

The key result of disagreements among scientists has been more science.

Where climate-sceptics have challenged climate scientists' time frames, data and theories, the climate change scientists have retested the climate-sceptics' data and claims, retested and improved their own data and reworked their models and theories.

Every time they return with improved results, the climate-sceptics do the same thing.

To date, the ongoing research suggests that the climate change models are better and improving rapidly, but the continued contest demonstrates the living nature of the scientific process.

Outside of the scientific world, however, ignorance of the facts and of science itself have created a free-for-all.

Fringe environmental groups, rightwing internet blogs, politicians of all stripes

have spread falsehoods far and wide or distorted the truth to serve their own ends. Beware three particular versions of "science" abuse:

- At the start of "My cause is so critically important that a little exaggeration/a few lies are no sin": This is the most common version indulged in equally by left and right. Environmentalists feel that "life on earth" or whatever is worth any price; the hard right believes that the "climate myth" is simply another internationalist plot to impose government control on free people – whose freedom must be protected at all costs. In both cases, attention to the truth takes a back seat.

- "The sky is falling" - "Oh, give me a break": Here the divide is between the doomsayers ("Climate Change Impacts Could Collapse Civilization by 2040") and the perpetually disengaged ("Americans don't worry much about climate"). The doomsayers will find any excuse to believe the worst; the "whatevers" see no reason for concern about anything. To put these contending positions in context and observe the misuse of science in action, remember, first, the 1970s and the gloom that surrounded the impending exhaustion of world oil resources that led to a policy of "pump America dry first" and then, second, the "oh, give me a break" reaction to the efforts that ultimately led to the 1970 Clean Air and Water Act.

- "They only believe in/deny climate change because they are [dumb, insane, evil, deluded, godless, terrorists…]: This is such a common type of "argument" that it must be mentioned, although it is so illogical an "explanation" that it is hard to consider. Most people learned in primary school that such ad homonym attacks do not constitute compelling refutations, but such assertions form such an essential part of what passes for global "public discourse" today that it bears repeating that any such contention only bears tossing out.

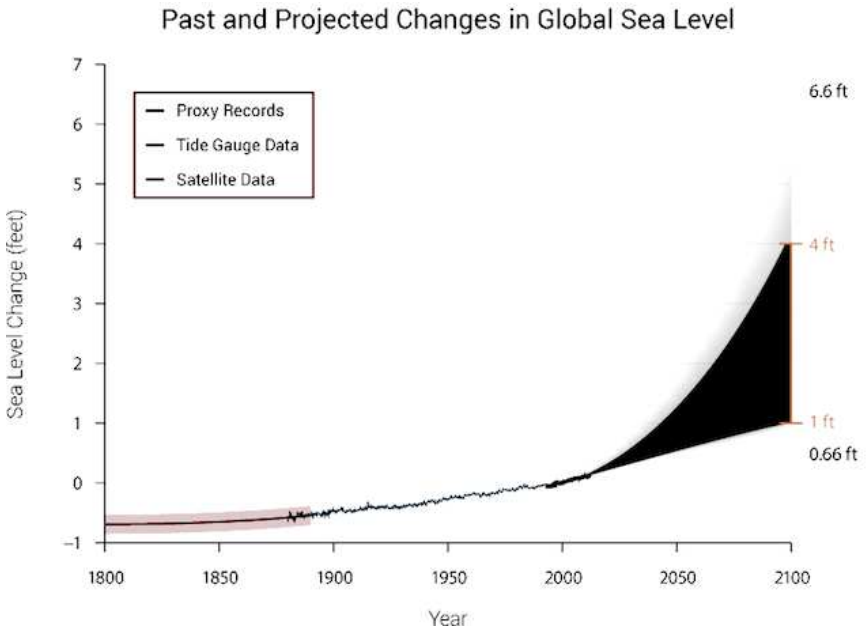
What impacts does climate change have?

Because the global climate is a connected system, the impacts of climate change are felt everywhere. Among the most important impact are:

- Rising sea levels: Average sea level around the world rose about 8 inches (20 cm) in the past 100 years; climate scientists expect it to rise more and more rapidly in the next 100 years.

  Coastal cities such as New York are already seeing an increased number of flooding events and by 2050 many such cities may require sea walls to survive. Estimates vary, but conservatively sea levels are expected to rise 1 to 4 feet (30 to 100 cm), enough to flood many small Pacific island states (Vanatu), famous beach resorts (Hilton Head) and coastal cities (Bangkok, Boston).

  If the Greenland ice cap and/or the Antarctic ice shelf collapses, sea levels could rise by as much as 20 ft (6 m), inundating, for example, large parts of Florida, the Gulf Coast, New Orleans and Houston.



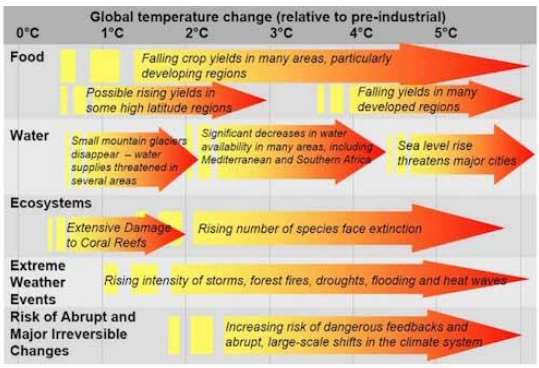
(Source: National Climate Assessment)

- Melting ice: Projections suggest that within the next 100 years, if not sooner, the world's glaciers will have disappeared, as will the Polar ice cap, and the huge Antarctic ice shelf, Greenland may be green again, and snow will have become a rare phenomenon at what are now the world's most popular ski resorts. To view an interactive map of changing polar ice coverage, 1979-2015, click here.

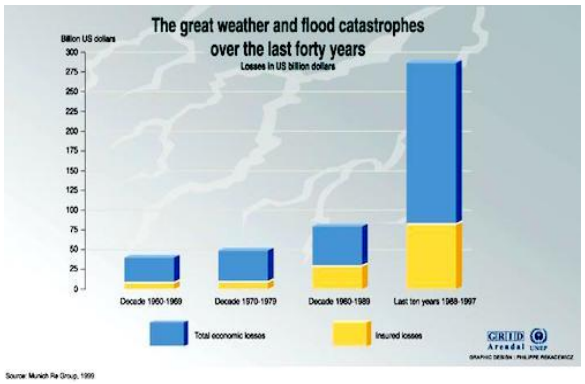
- Torrential downpours and more powerful storms: While the specific conditions that produce rainfall will not change, the amount of water in the atmosphere will increase producing violent downpours instead of steady showers when it does rain.

  Hurricanes and typhoons will increase in power, and flooding will become more common.

  Anyone in the United States who has tried to buy storm and flood insurance in the past few years knows that the insurance industry is completely convinced that climate change is raising sea levels and increasing the number of major storms and floods. (To understand the insurance industry's thinking on the subject, consider the chart below compiled by Munich Re-Insurance.)



(Source: Environmental Change @ Western)



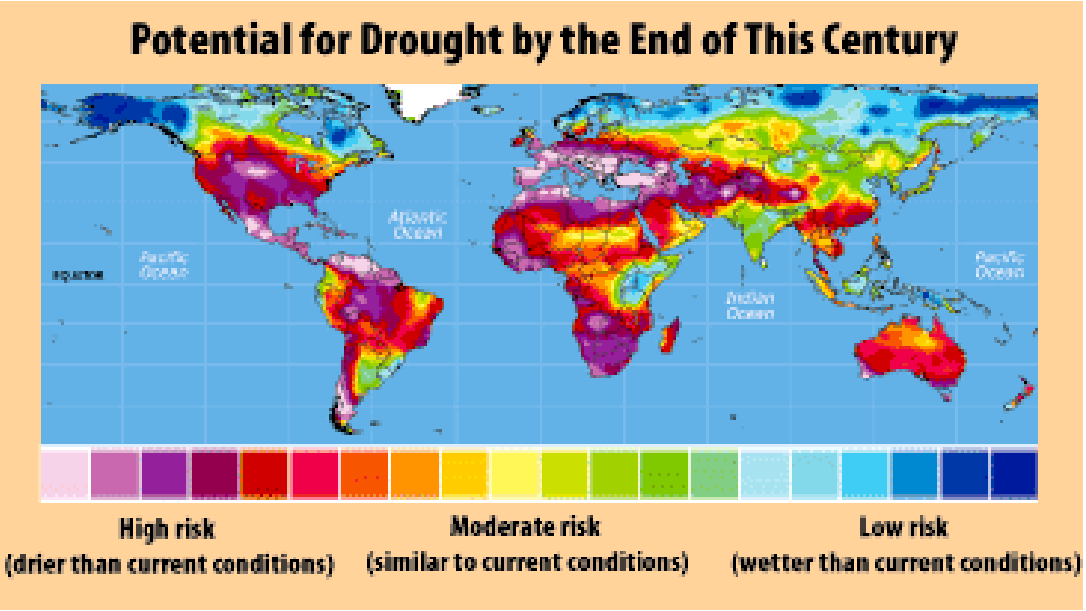
(Source: Munich RE)

- Heatwaves and droughts: Despite downpours in some places, droughts and prolonged heatwaves will become common.

  Rising temperatures are hardly surprising, although they do not mean that some parts of the world will not "enjoy" record cold temperatures and terrible winter storms. (Heating disturbs the entire global weather system and can shift cold upper air currents as well as hot dry ones. Single snowballs and snowstorms do not make climate change refutations.)

  Increasingly, however, hot, dry places will get hotter and drier, and places that were once temperate and had regular rainfall will become much hotter and much drier.

  The string of record high temperature years and the record number of global droughts of the past decade will become the norm, not the surprise that they have seemed.



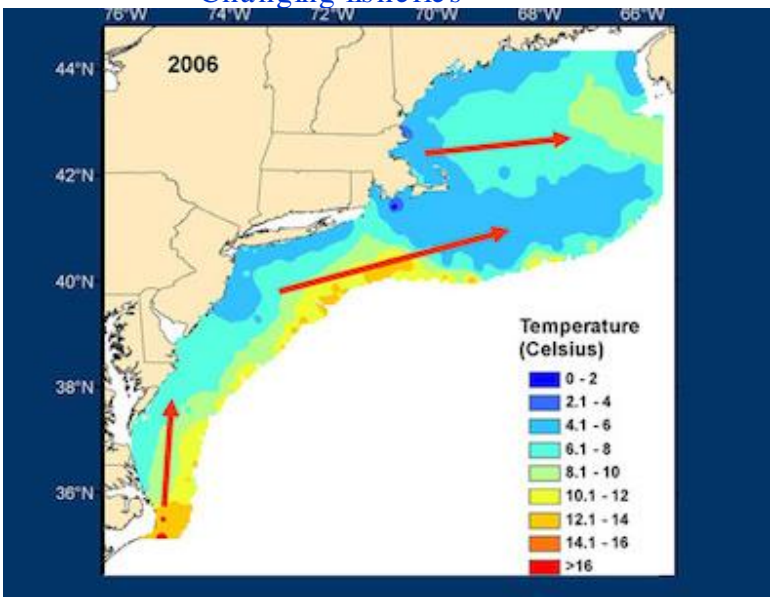
(Source: EPA adopted from Dai, Drought Under Global Warming)

- Changing ecosystems: As the world warms, entire ecosystems will move.

  Already rising temperatures at the equator have pushed such staple crops as rice north into once cooler areas, many fish species have migrated long distances to stay in waters that are the proper temperature for them.

  In once colder waters, this may increase fishermen's catches; in warmer waters, it may eliminate fishing; in many places, such as on the East Coast of the US, it will require fishermen to go further to reach fishing grounds.

Changing fisheries



(Source: NOAA Fisheries)

Farmers in temperate zones are finding drier conditions difficult for crops such as corn and wheat, and once prime growing zones are now threatened.

Some areas may see complete ecological change. In California and on the East Coast, for example, warming will soon fundamentally change the forests; in Europe, hundreds of plants species will disappear and hundreds more will move thousands of miles.

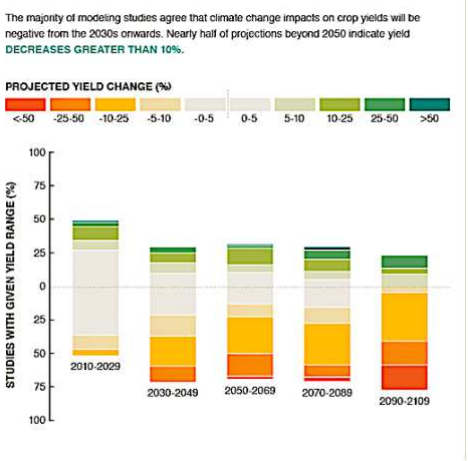
- Reduced food security: One of the most striking impacts of rising temperatures is felt in global agriculture, although these impacts are felt very differently in the largely temperate developed world and in the more tropical developing world. Different crops grow best at quite specific temperatures and when those temperatures change, their productivity changes significantly.

  In North America, for example, rising temperatures may reduce corn and wheat productivity in the US mid-west, but expand production and productivity north of the border in Canada.

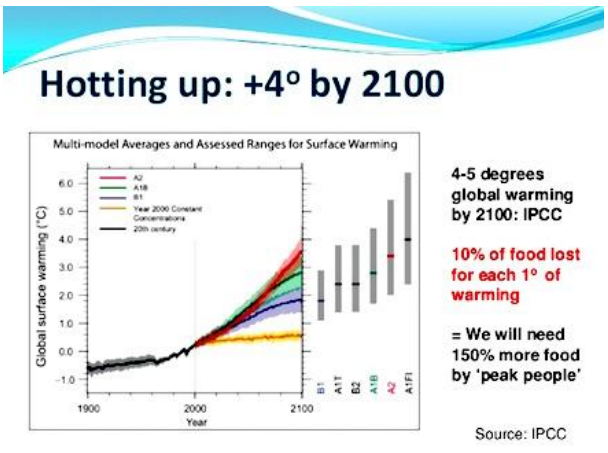
  The productivity of rice, the staple food of more than one third of the world's population, declines 10% with every 1º C increase in temperature.

  Past climate induced problems have been offset by major advances in rice technology and ever larger applications of fertilizer; expectations are that in Thailand, the world's largest exporter of rice, however, future increases in temperatures may reduce production 25% by 2050.

  At the same time, global population models suggest that developing world will add 3 billion people by 2050 and that developing world food producers must double staple food crop production by then simply to maintain current levels of food consumption.



(Source: Climate Impacts)

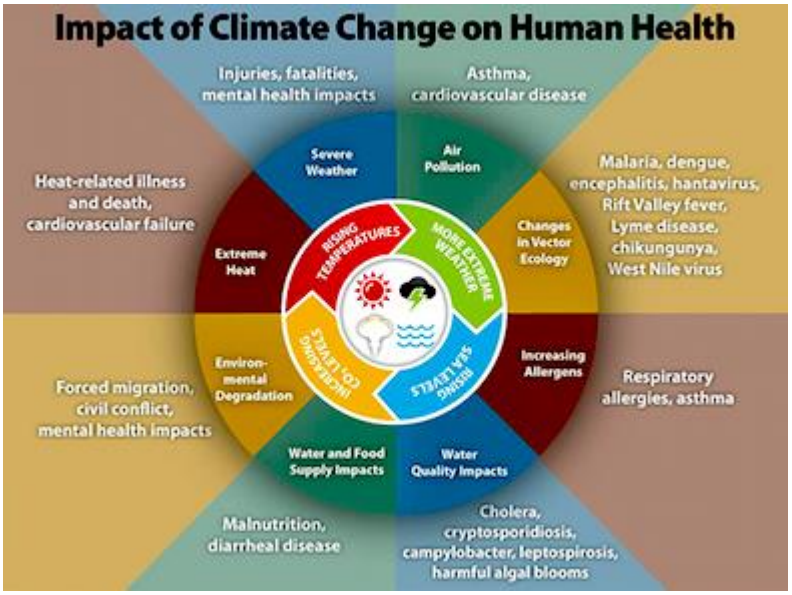


(Source: Slideshare)

- Pests and disease: Rising temperatures favor agricultural pests, diseases and disease vectors. Pest populations are on the rise and illnesses once found only in limited, tropical areas are now becoming endemic in much wider zones.

  In Southeast Asia, for example, where malaria had been reduced to a wet season only disease in most areas, it is again endemic almost everywhere year around.

  Likewise, dengue fever, once largely confined to tropical areas, has become endemic to the entire region.



(Source: CDC)

Increased temperatures also increase the reproduction rates of microbes and insects, speeding up the rate at which they develop resistance to control measures and drugs (a problem already observed with malaria in Southeast Asia).

- Ocean acidification: Rising temperature and rising CO2 levels are making the world's oceans more acidic (lowering their pH). More acidic sea water damages the ability of sea creatures to make shells. Shelled species, tiny and large, are the base of the ocean food pyramid and their loss threatens the food producing potential of the oceans.
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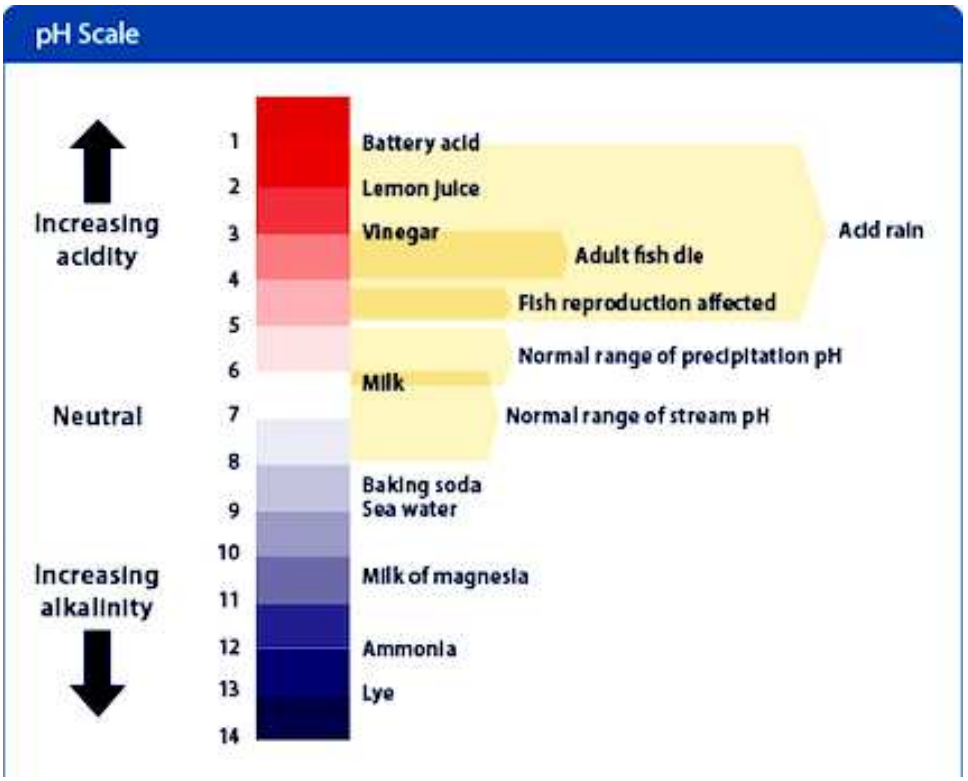
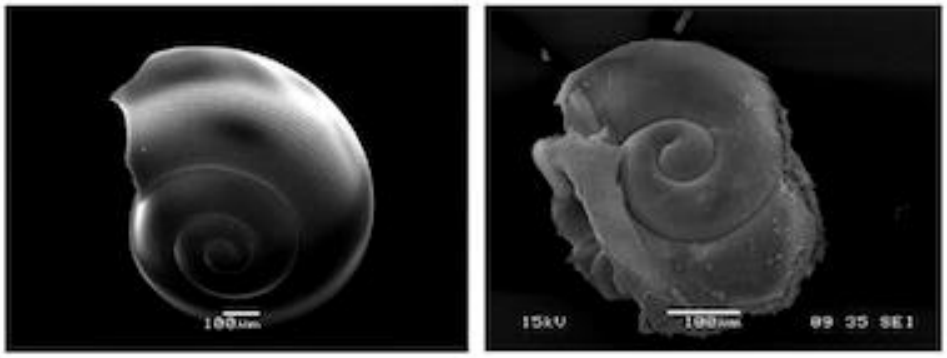


(Source: Environmental Protection Agency)

Shells Dissolve in Acidified Ocean Water



(Source: National Climate Assessment)

What have we done to manage climate change?

To date, the effort to manage climate change has been a matter of high level diplomatic negotiations involving states and international organizations with a loud, but largely excluded fringe of NGOs, business groups, and minor political actors.

The logic for this is that global climate change affects us all, but individual countries can manage only the activities that take place within their borders; to confront a global problem, we need a global solution. As the United Nations history of these negotiations begins:

> ***"Climate change is a global challenge and requires a global solution. Greenhouse gas emissions have the same impact on the atmosphere whether they originate in Washington, London or Beijing. Consequently, action by one country to reduce emissions will do little to slow global warming unless other countries act as well. Ultimately, an effective strategy will require commitments and action by all the major emitting countries."***

The global effort to manage climate change has been organized through what is called the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was launched at the 1992 Rio Earth Summit to achieve GHG concentrations ***"at a level that would prevent dangerous anthropogenic interference with the climate system".***

It also set voluntary GHG emissions reductions that countries did not meet.

With the failure of the Rio initiatives, the then 191 signatories to the UNFCCC agreed to meet in Kyoto in 1997 to establish a more stringent regime.

The resulting Kyoto Protocol created a global trading system for carbon credits and binding GHG reductions for ratifying countries. (The US did not sign; China and India were exempt as developing countries.)

(Source: European Council)

So-called Conferences of the Parties (COPs) were held almost annually thereafter in places such as The Hague, Cancun and Doha without progress being made. (Following the failure of the 2012 Doha meetings, the un-renewed Kyoto carbon trading system collapsed.)

In 2016, COP 21 in Paris finally resulted in major advances. The agreement reaffirmed a commitment to reduce emissions, set a 2º C warming limit target, emphasized mandatory reductions by developed countries, called upon developing countries to contribute, created a fund to compensate climate change losers and reestablished a Kyoto-style clean development mechanism and carbon trading system. Paris makes no provisions for the reduction of emissions from agriculture and largely ignores the developing world. The US has still not ratified the treaty.

(Source: Wikipedia)

Why has it been so difficult to manage climate change?

Managing climate change has been difficult for two, related reasons: climate change management is viewed as expensive and it poses what we call a collective action problem.

- **Why managing climate change seems so expensive**

  When business and politicians talk about climate change, the first thing they mention is cost.

  If you start from the status quo today, adding CO2 removing equipment to a coal power plant is expensive – but only if you do not value the environment.

  When you buy coal for a power plant, you pay for a limited resource and the cost of supplying it to you. Today, when you dump the GHGs and black carbon from burning coal into the air, you pay nothing.

  But a clean atmosphere is a limited resource; the atmosphere will absorb only so much GHGs and black carbon before it is not clean, at which point it is costly to clean it.

  Logically, there is no reason why businesses that pay for a scarce resource like coal as an input should not pay for a scarce resource like the environment as a disposal site.

  This is called “costing” or “accounting” the environment. If the environment is included among the basic costs of doing business that all businesses plan into their profit and loss statements, then “managing climate change” would no longer be an expensive extra. It would be a standard cost of doing business.

  Today, however, no one values the environment and, therefore, environmental expenses are considered “extras” and so expensive, not expenses.

What is a collective action problem?

Collective action problems arise when all of the members of a large group enjoy a resource equally – say clean air – but protecting that resource must be paid for by each group member.

When such situations arise – especially when the cost of protection is high – each member really, really wants his/her neighbors to pay and to avoid paying him/herself. Each person's thinking is simple: "I'm just one person. If I don't contribute, it won't make any difference to the total amount of money raised, but it will save me money – and I will still get to breathe clean air!
In our case, everyone enjoys a world which is not too hot and the climate is normal, but who wants to pay to change our dependence on cars and trucks and plastics and and and? So what happens?

Where there are collective action problems there are collective action failures – and the higher the cost to each actor, the more likely the actor is to "free ride" – that is, to welch on his/her commitment and hope that others will pay (which they don't for the same reason).

In the case of climate change management, as in all such cases, collective action failure means that all of us end up with less of what we want – an end to climate change.

What does this portend for the current process?

Don't hold your breath.

Slowing global and domestic growth, rising global and domestic divisions, especially the increasingly strident "us first" tone of domestic politics worldwide, and increasingly unsure leaders everywhere do not bode well for the kind of strong leadership by a small group of critical players necessary to overcome collective action problems.

- Learn more

  Many authors – academics, clerics, diplomats – have written on why progress toward a meaningful climate change treaty has been so slow, difficult and ultimately disappointing.

  You might want to start with a few of the following. None of the articles or authors are well known, but each comes to the subject from a different perspective – the Pontificate, a Nordic think tank, an Ecosocialist blog, an academic journal, a German magazine – and applies very different analytic tools.

  What is interesting is that beneath all of their differences (not least of jargon), all of these authors come to essentially the same conclusion for the same reasons.

  Scott Barrett
  A. Vilma and H. van Aselt
  C. Williams
  Jon Hovi, Tora Skodvin, and Stine Aaker
  Oliver Geden

What more can we do to manage climate change?

It is clear that even if the international community manages to make further progress, it has a long way to go before it has exhausted its current agenda of negotiated restrictions on carbon emissions.

It should also be clear that even with unimaginably successful negotiations, restrictions on carbon emissions will not do the job.

To be blunt: there is too much carbon in the atmosphere and existing technology – cars, factories, airplanes, ships, buildings – will continue to emit huge amounts more into the foreseeable future.

The only thing to do is to reduce the amount of atmospheric carbon.

There are many experiments underway to find ways to do this.

So far, only a few processes show promise.

While different in many ways, these processes are similar in one critical way: they all remove carbon from the atmosphere by converting it into an inert form that can be sequestered permanently, that is, returned to a form where, like the fossil carbon forms, it is truly out of sight, out of mind and out of the atmosphere – forever.

New techniques for doing this are remarkably simple chemically, but the innovations in business modeling to make them work are complex. In Iceland, for example, scientists have demonstrated that CO2 pumped underground into porous basalt formations will quickly turn to stone. (Ten percent of continental land and the entire seabed are basalt; the technology already costs less than one half as much as current (and unreliable) underground sequestration techniques.)

Another technology passes air across a huge surface of flowing alkali bath to capture CO2 so that it can then be converted to pellets. (Unfortunately, because CO2 is just 0.04% of the air, meaningful systems will have to be huge and much more efficient.)

In each case, and in those of many other possible technologies, the issues are not scientific, but how to scale production cost-effectively.

The second method of sequestration is at least 4,000 years old: biochar production.

The "pyrolysis" of biomass, or heating it to high temperatures (450º-750º C) in the absence of oxygen produces a pure form of carbon known as "biochar."

From a global climate change point of view, biochar production has great potential as it eliminates all of the black carbon and long-term GHGs from biomass burning, and is carbon negative.

Estimates of sequestration rates vary, but by atomic weight, the production of 1 ton of biochar permanently removes 3 tons of CO2 from the atmosphere, as well as 6 kilograms of particulates and large amounts of NOx and SO2.

Widespread biochar production in the developing world where most agricultural waste is field burned would annually remove millions of tons of CO2 from the atmosphere, and eliminate millions of tons of black carbon and GHGs.

What impacts will climate change have in the developing world?

Climate change affects the entire globe; its impacts are more pronounced in the developing world than in the developed world.

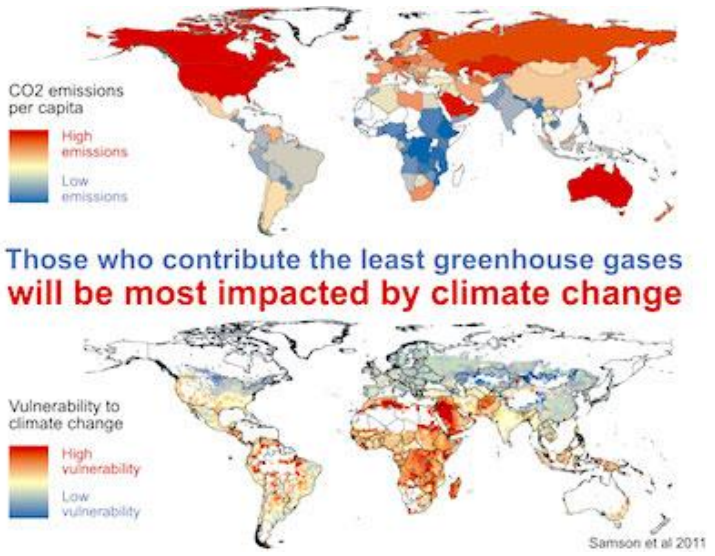
In fact, ironically, although most of the human activity that produces climate change occurs in the developed world, many of climate changes' effects will actually be beneficial in the developed world.

In the short- and middle-term, for example, climate change will likely increase fish and agricultural yields where populations are small and shrinking and productivity is highest.

Climate change's impacts in the developing world will be almost exclusively negative, often terribly so.

As K. Smith tartly observed in 2008:

"The rich will find their world to be more expensive, inconvenient, uncomfortable, disrupted and colourless; in general, more unpleasant and unpredictable, perhaps greatly so. The poor will die."

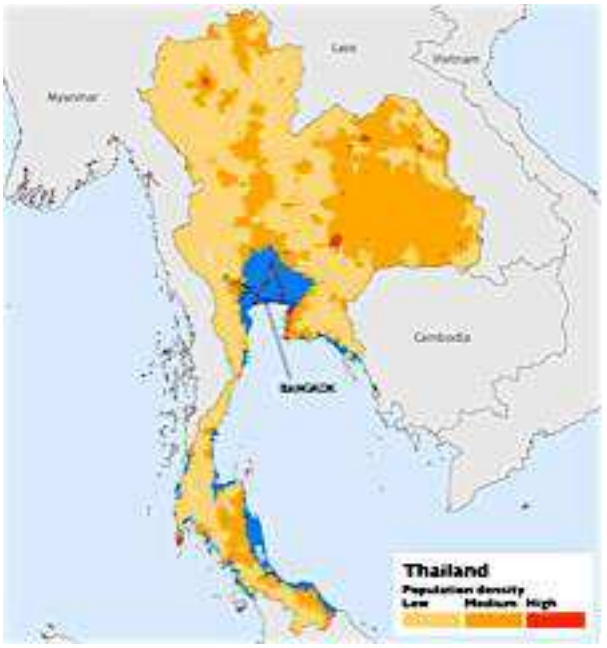


(Source: J. Samson et al., Geographic disparities and moral hazards in the predicted impacts of climate change on human populations)

In the developing world:

Sea rise is expected entirely to submerge a number of small, island countries, and to flood coastal spawning grounds for many staple marine resources, as well as low-lying capital cities, commercial agriculture, transportation and power generation infrastructure and tourism investments.

Thailand sea rise



Torrential downpours and devastating storms will increase large-scale damage to fields, homes, businesses, transportation and power systems and industry in countries without the financial or human capital resources to respond.

Heatwaves and droughts will increase pressure on already fragile power, healthcare, water and sewage systems, as well as reducing countries' ability to feed themselves or export agricultural products.

Heat will also become an increasingly important killer, especially of the very young and the old. The handful of deaths during the European heatwave of 2003 resulted in a storm of press outrage that this could happen in the developed world.

In 2016, sections of North Thailand suffered two straight months of temperatures of 105º F (44º C) without air conditioning, cooling centers, public health or hospital support.

No one counted the dead, but there is no question that across the tropical developing world heat will become a major killer.

In the developing world, *changing ecosystems* seem to result almost exclusively in the loss of important food species, for example of fish and staple crops, and the increase of malign species such as disease vectors.

A study published in *Nature*, a leading scientific journal, provides data that suggest that climate change related phenomena have killed 150,000 people annually for the past 30 years, and that numbers will increase.

The authors contend that included in the death count should be those killed by, for example, heat induced cardio-vascular attacks, as well as those killed by malnutrition resulting from climate change induced crop failures, most of them, needless to say, live in the global South.

Food security, already shaky, is crumbling under rising temperatures and related climate changes.

Major staple crops are declining in productivity, while unlike in the developed countries, there are no new, more tropical staples to move in to take their places. Rising population combined with declining productivity, increasing incidence of drought and storms is increasingly leaving developing countries vulnerable of food shortfalls.

Rising temperatures increase the reproduction rates of *pests* and so shorten the time required for insects and plant pathogens to develop resistance to control regimes. For a review of many of the different ways in which climate change affects pests, see JH Porter et al.

Diseases, like pests, develop more rapidly in the heat and so do their insect vectors. Moreover, with climate change, the range of critical vectors – mosquitos, for example, vectors for dengue, encephalitis, malaria, West Nile and Zika – all expand putting larger and larger populations at risk.

Ongoing *ocean acidification* threatens more and more small shell fish, which form the broad base of the ocean food chain. Ultimately, this will threaten the entire ocean population and so the critical protein source for a third of the people on earth and a major industry.

Can we adapt to the negative impacts of climate change?

Yes. What happens in any given region, country or district, or how a given farmer or fisherman responds to the challenges can make a huge difference.

Scientific, technological and extension resources in the developed world, for example, combined with highly educated and well-resourced farmers makes adaptation fast and easy. Developing world farmers, too, can adapt. They have, for example, fundamentally changed how they farm over the past 50 years, largely on their own. (Aid agencies and government ministries will contest this observation, but out in the field, there is little evidence that aid agency or government extension programs have reached very deep.

Farmers have learned through imitation and judicious borrowing, not training and wholesale adoption.) The same problems that have constrained very small farmers and fishermen for the past 50 years will also inhibit their ability to adapt to rapid climate change. They have no financial cushion and so are risk constrained; they have little access to new techniques and materials; they lack the capital to invest in big changes to farming or fishing practice, however much they might like to make such changes; and they have no outside support. They are on their own to observe, understand and develop responses to climate change.

More generally, a country's capacity to respond will be a function of income, technological capacity, extent, type and variability of vulnerability and, not least, ruling elite interest in acting. (It is not simply that the developed world will look to itself first; ruling elites everywhere are ruling elites because they can shift benefits to themselves and costs to the poor.)

What can we do in the developing world to slow climate change?

Countries in the developing world can make two major contributions to slowing climate change:

(1) They can pursue smart development, avoiding the worst mistakes of the developed world; and

(2) They can reduce – even reverse – their one major contribution to climate change: unsustainable agriculture practices.

What can the developing world do to avoid the mistakes of the developed world?

Look first at the primary sources of the GHGs that cause global warming: Power generation (25%); industry (21%); transportation (14%); and buildings (6%).

Power
Most power is generated in the developed world, much using old, dirty technology and carried long distances over inefficient power grids. Developing countries have the opportunity to build entirely new, distributed generation power systems that require no grids and use nonpolluting technologies.

Industry
Building greenfield industrial economies, developing countries have the opportunity to cost the environment and construct with nonpolluting technologies.

Transportation
Not yet entirely dependent upon massive road-based transportation infrastructures, developing countries have the opportunity to design efficient, low-cost, high volume transportation systems to serve cities and industrial centers, and to use policy incentives to discourage personal automobile ownership and construct high quality public transportation systems.

And because so much existing building stock must be replaced in short order, developing countries have the opportunity to build efficiency into individual structures and to design urban areas for high density, high energy efficiency living.

Excellent models already exist in China, Korea and Singapore, and even the medium-term cost savings are so great that not investing to do better than the developed world today is foolish.

How can the developing world reduce its own impact on climate change?

Improve agriculture. Globally, agriculture accounts for approximately one third of total GHG and black carbon emissions; the developing world, however, produces a disproportionate amount of this total – Asia and Africa between them producing 59% of the total.

While developed country contributions have dropped as a result of reduced biomass burning and reduced agrochemical use per unit, developing country contributions have risen. (In 1990, for example, Europe's contribution was 21% and Asia's 38%; today, Europe contributes 12% and Asia 44%.)

Three immediate steps stand out.

First, rice production in the developing world, largely in Asia, which grows 90% of the world's rice, needs to switch from flooded paddy propagation to SRI (system for rice intensification) techniques.

This will largely eliminate the tremendous amount of methane produced by anaerobic decomposition in flooded paddies that alone contributes 10% of global GHGs annually.

Second, developing countries need to control the practice of the open field burning of agricultural wastes (rice straw, corn stalks), which annually contributes millions of tons of eCO2 and black carbon to global warming.

Third, developing countries need to develop aggressive national programs to promote the transformation of field wastes into biochar, which will sequester millions of tons of CO2 annually and eliminate both particulate and GHG emissions, while adsorbing NOx and other fertilizer derives emissions if added to soil.

What are the prospects that such policies will be adopted?

Low to middling. At issue are not scientific, technical or even cost considerations. The issues are, as everywhere, political.

The international climate change regime sits very lightly on developing countries and with few exceptions there is no domestic ground swell of support for environmental initiatives.

This allows rulers of any stripe to prioritize other, more pressing short-term concerns over abstract environmental programs with long-term pay-offs.

Where tax systems rely heavily on customs duties and/or sales taxes, for example, governments often seize the popular populist option of incentives to encourage car ownership.

Where elites are uncertain about their tenure in office, quick (and lucrative) deals with big utilities or mining companies are understandably tempting, whatever their climate change consequences. (Does this sound familiar? How long did it take Britain to close down coal mining? Why is coal mining still pushing presidential candidates around in the US? Why does even China concede ground to coal operators?)

What does the likely failure of these efforts suggest about the global effort to stop climate change?

Here it is possible to see why countries free ride in the global effort to manage climate change causing the collective action failures that have left us looking at climate disaster.

Leaders lack international incentives to act in politically costly ways and face powerful domestic incentives to do other, more politically pressing things.

But do not leap to the conclusion that developing world leaders are the problem or are in some way special.

The crisis of our times is not the result of tin pot dictators misbehaving.

Don't leave these final sections of our primer thinking that the rulers of the developing world are merely ignorant or misinformed or corrupt or the tools of malign outside actors.

Talk to them and you will find that they are generally very well informed.

Talk to folks in the know and you will find that, yes, they are corrupt by your standard and, yes, outside actors ply them with all sorts of temptations.

But that said, you will also discover that their actions are seldom easily explained by the blandishments of their almost always frustrated "corrupters".

Think about what you learn when listening in on local politics and you will discern a very familiar political logic, the stay-in-power logic.

These guys got to power by knowing how to mix-and-match, how to appease-and-pay. Every one of them has his or her ideals and everyone has his or her agenda – but everyone knows that the quickest way to kill a long-term goal is to blow a short-term necessity.

Is this really a developing world phenomena?

Think of American presidents who have left a real legacy. They were not nice guys. They were connivers. They played even their closest friends and allies. They were tricky.

But FDR left us Social Security.

And Richard Nixon left us Medicare. Barak Obama left us The Affordable Care Act.

And Clinton, Bush, Obama – no American president to date has signed a global climate change accord.

What does all of this suggest about your becoming a climate change maker?

Start by embracing three things: (1) no one's opinion is stupid; (2) nothing about the process is or will ever be simple; and (3) everyone you confront has really good reasons for doing what they do.

If you can't respect the opposition, deal with complexity or recognize that what you want may not be first on everyone's wish list, get out of the business now!

About the author

Dr. D. Michael Shafer is the Director and Co-founder of Warm Heart Worldwide, a US non-profit working in Thailand.

About Warm Heart

Warm Heart offers an education and training program to local farming families on the benefits of sustainable farming practices, and the environmental impact.

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Environmental Effects of Increased Atmospheric Carbon Dioxide

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ABSTRACT A review of the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide leads to the conclusion that increases during the 20th and early 21st centuries have produced no deleterious effects upon Earth's weather and climate. Increased carbon dioxide has, however, markedly increased plant growth. Predictions of harmful climatic effects due to future increases in hydrocarbon use and minor greenhouse gases like CO_2 do not conform to current experimental knowledge. The environmental effects of rapid expansion of the nuclear and hydrocarbon energy industries are discussed.

SUMMARY

Political leaders gathered in Kyoto, Japan, in December 1997 to consider a world treaty restricting human production of "greenhouse gases," chiefly carbon dioxide (CO_2). They feared that CO_2 would result in "human-caused global warming" – hypothetical severe increases in Earth's temperatures, with disastrous environmental consequences. During the past 10 years, many political efforts have been made to force worldwide agreement to the Kyoto treaty.

When we reviewed this subject in 1998 (1,2), existing satellite records were short and were centered on a period of changing intermediate temperature trends. Additional experimental data have now been obtained, so better answers to the questions raised by the hypothesis of "human-caused global warming" are now available.

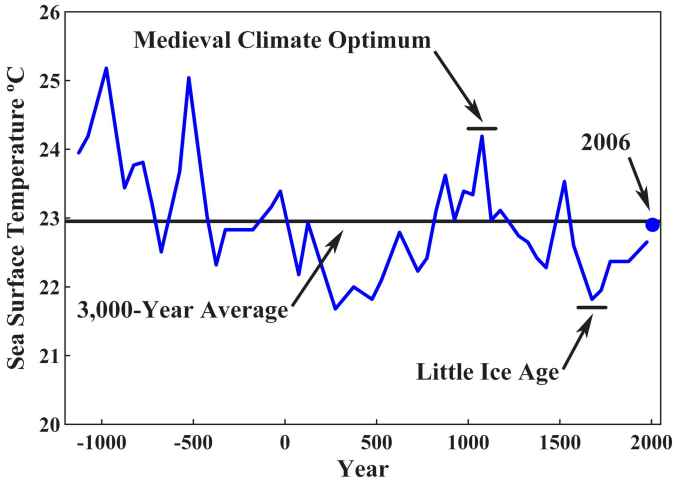

Figure 1: Surface temperatures in the Sargasso Sea, a 2 million square mile region of the Atlantic Ocean, with time resolution of 50 to 100 years and ending in 1975, as determined by isotope ratios of marine organism remains in sediment at the bottom of the sea (3). The horizontal line is the average temperature for this 3,000-year period. The Little Ice Age and Medieval Climate Optimum were naturally occurring, extended intervals of climate departures from the mean. A value of 0.25 °C, which is the change in Sargasso Sea temperature between 1975 and 2006, has been added to the 1975 data in order to provide a 2006 temperature value.

The average temperature of the Earth has varied within a range of about 3°C during the past 3,000 years. It is currently increasing as the Earth recovers from a period that is known as the Little Ice Age, as shown in Figure 1. George Washington and his army were at Valley Forge during the coldest era in 1,500 years, but even then the temperature was only about 1° Centigrade below the 3,000-year average.

The most recent part of this warming period is reflected by shortening of world glaciers, as shown in Figure 2. Glaciers regularly lengthen and shorten in delayed correlation with cooling and warming trends. Shortening lags temperature by about 20 years, so the current warming trend began in about 1800.

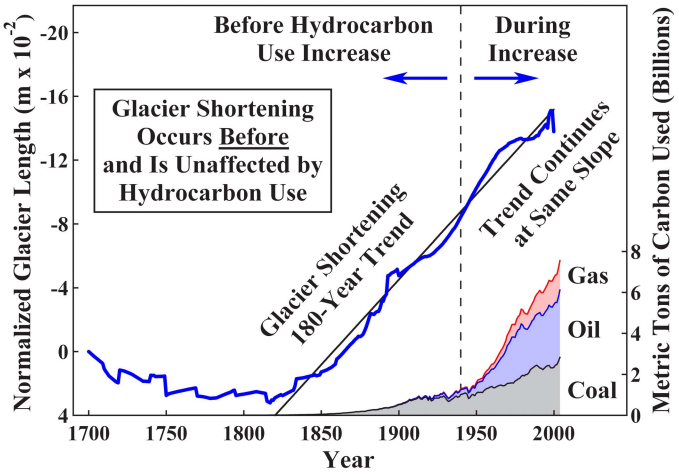

Figure 2: Average length of 169 glaciers from 1700 to 2000 (4). The principal source of melt energy is solar radiation. Variations in glacier mass and length are primarily due to temperature and precipitation (5,6). This melting trend lags the temperature increase by about 20 years, so it predates the 6-fold increase in hydrocarbon use (7) even more than shown in the figure. Hydrocarbon use could not have caused this shortening trend.

Atmospheric temperature is regulated by the sun, which fluctuates in activity as shown in Figure 3; by the greenhouse effect, largely caused by atmospheric water vapor (H_2O); and by other phenomena that are more poorly understood. While major greenhouse gas H_2O substantially warms the Earth, minor greenhouse gases such as CO_2

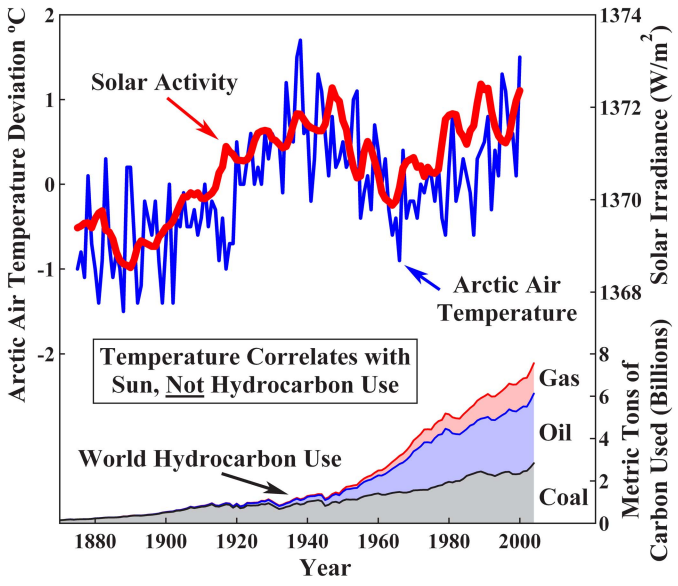

Figure 3: Arctic surface air temperature compared with total solar irradiance as measured by sunspot cycle amplitude, sunspot cycle length, solar equatorial rotation rate, fraction of penumbral spots, and decay rate of the 11-year sunspot cycle (8,9). Solar irradiance correlates well with Arctic temperature, while hydrocarbon use (7) does not correlate.

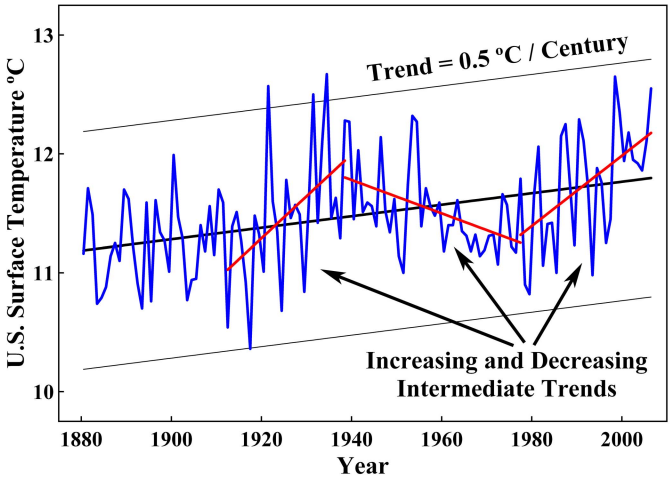

Figure 4: Annual mean surface temperatures in the contiguous United States between 1880 and 2006 (10). The slope of the least-squares trend line for this 127-year record is 0.5 ºC per century.

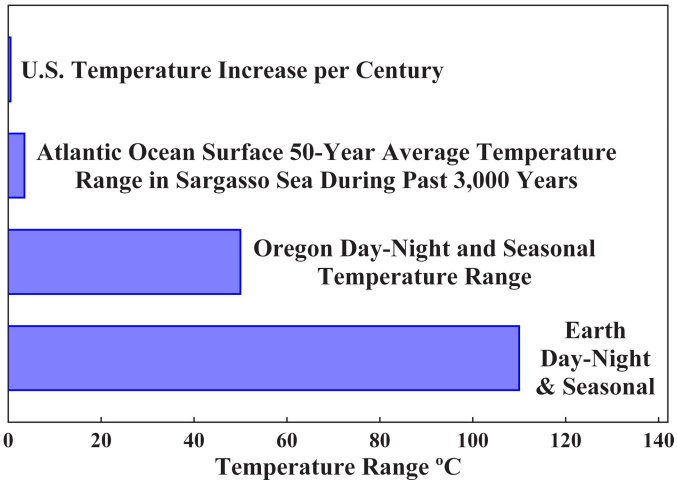

Figure 6: Comparison between the current U.S. temperature change per century, the 3,000-year temperature range in Figure 1, seasonal and diurnal range in Oregon, and seasonal and diurnal range throughout the Earth.

have little effect, as shown in Figures 2 and 3. The 6-fold increase in hydrocarbon use since 1940 has had no noticeable effect on atmospheric temperature or on the trend in glacier length.

While Figure 1 is illustrative of most geographical locations, there is great variability of temperature records with location and regional climate. Comprehensive surveys of published temperature records confirm the principal features of Figure 1, including the fact that the current Earth temperature is approximately 1 °C lower than that during the Medieval Climate Optimum 1,000 years ago (11,12).

Surface temperatures in the United States during the past century reflect this natural warming trend and its correlation with solar activity, as shown in Figures 4 and 5. Compiled U.S. surface temperatures have increased about 0.5 °C per century, which is consistent with other historical values of 0.4 to 0.5 °C per century during the recovery from the Little Ice Age (13-17). This temperature change is slight as compared with other natural variations, as shown in Figure 6. Three intermediate trends are evident, including the decreasing trend used to justify fears of "global cooling" in the 1970s.

Between 1900 and 2000, on absolute scales of solar irradiance and degrees Kelvin, solar activity increased 0.19%, while a 0.5 °C temperature change is 0.21%. This is in good agreement with estimates that Earth's temperature would be reduced by 0.6 °C through particulate blocking of the sun by 0.2% (18).

Solar activity and U.S. surface temperature are closely correlated, as shown in Figure 5, but U.S. surface temperature and world hydrocarbon use are not correlated, as shown in Figure 13.

The U.S. temperature trend is so slight that, were the temperature change which has taken place during the 20th and 21st centuries to occur in an ordinary room, most of the people in the room would be unaware of it.

During the current period of recovery from the Little Ice Age, the U.S. climate has improved somewhat, with more rainfall, fewer tornados, and no increase in hurricane activity, as illustrated in Figures 7 to 10. Sea level has trended upward for the past 150 years at a rate of 7 inches per century, with 3 intermediate uptrends and 2 periods of no increase as shown in Figure 11. These features are confirmed by the glacier record as shown in Figure 12. If this trend continues as

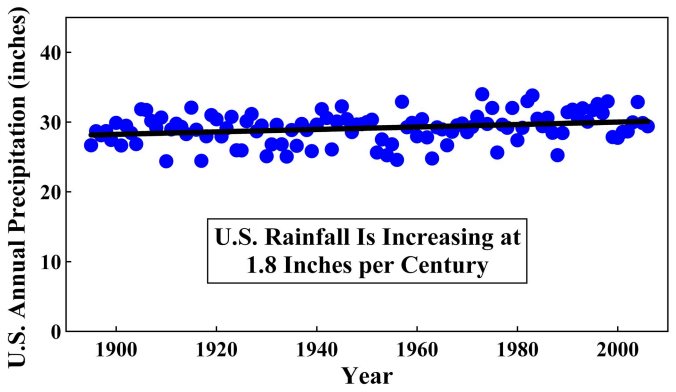

Figure 7: Annual precipitation in the contiguous 48 United States between 1895 and 2006. U.S. National Climatic Data Center, U.S. Department of Commerce 2006 Climate Review (20). The trend shows an increase in rainfall of 1.8 inches per century – approximately 6% per century.

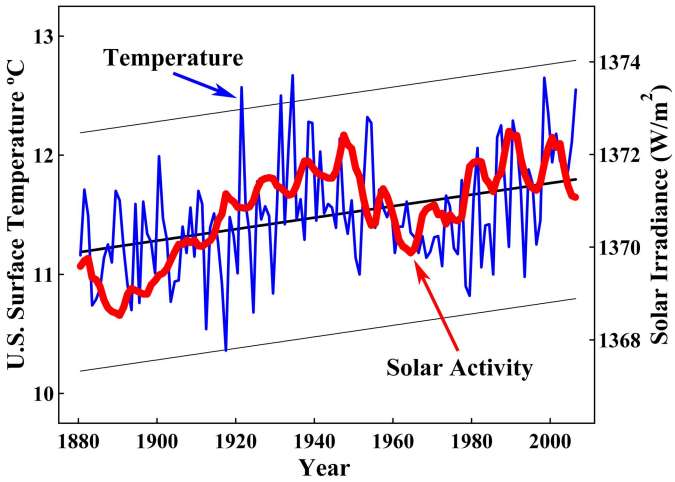

Figure 5: U.S. surface temperature from Figure 4 as compared with total solar irradiance (19) from Figure 3.

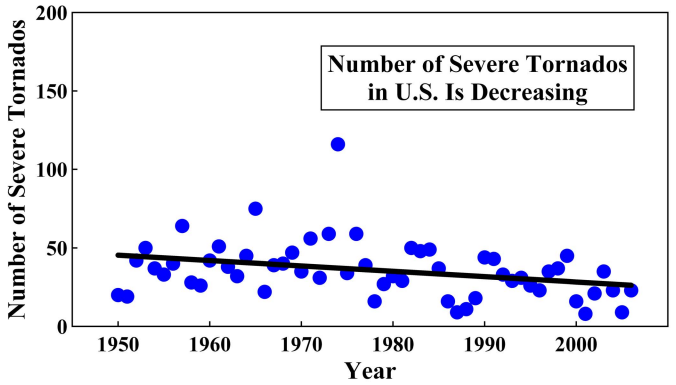

Figure 8: Annual number of strong-to-violent category F3 to F5 tornados during the March-to-August tornado season in the U.S. between 1950 and 2006. U.S. National Climatic Data Center, U.S. Department of Commerce 2006 Climate Review (20). During this period, world hydrocarbon use increased 6-fold, while violent tornado frequency decreased by 43%.

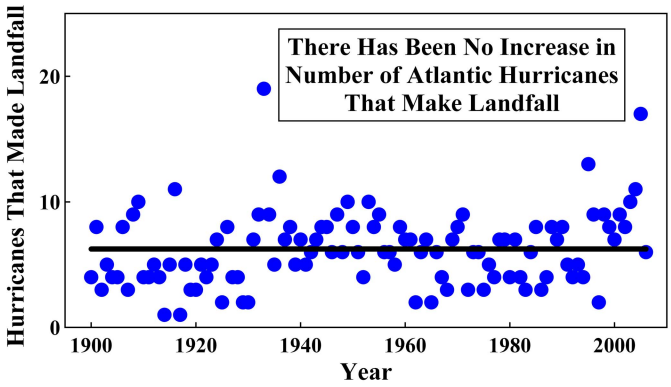

Figure 9: Annual number of Atlantic hurricanes that made landfall between 1900 and 2006 (21). Line is drawn at mean value.

did that prior to the Medieval Climate Optimum, sea level would be expected to rise about 1 foot during the next 200 years.

As shown in Figures 2, 11, and 12, the trends in glacier shortening and sea level rise began a century ***before*** the 60-year 6-fold increase in hydrocarbon use, and have not changed during that increase. Hydrocarbon use could not have caused these trends.

During the past 50 years, atmospheric CO_2 has increased by 22%. Much of that CO_2 increase is attributable to the 6-fold increase in human use of hydrocarbon energy. Figures 2, 3, 11, 12, and 13 show, however, that human use of hydrocarbons has not caused the observed increases in temperature.

The increase in atmospheric carbon dioxide has, however, had a substantial environmental effect. Atmospheric CO_2 fertilizes plants. Higher CO_2 enables plants to grow faster and larger and to live in drier climates. Plants provide food for animals, which are thereby also enhanced. The extent and diversity of plant and animal life have both increased substantially during the past half-century. Increased temperature has also mildly stimulated plant growth.

Does a catastrophic amplification of these trends with damaging climatological consequences lie ahead? There are no experimental data that suggest this. There is also no experimentally validated theoretical evidence of such an amplification.

Predictions of catastrophic global warming are based on computer climate modeling, a branch of science still in its infancy. The empirical evidence – actual measurements of Earth's temperature and climate – shows no man-made warming trend. Indeed, during four of the seven decades since 1940 when average CO_2 levels steadily increased, U.S. average temperatures were actually decreasing.

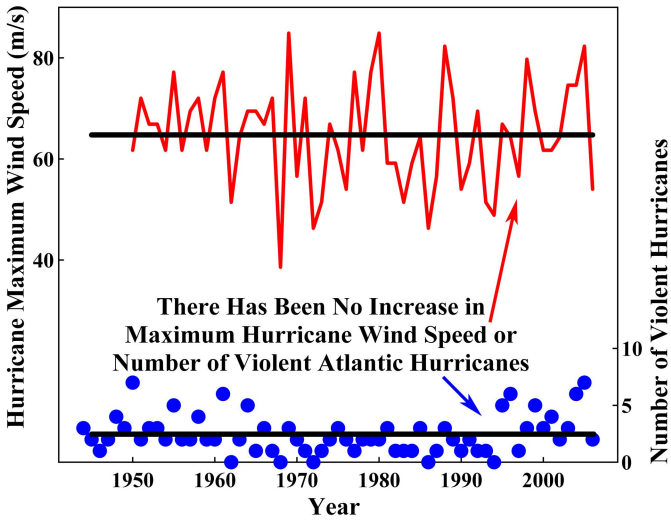

Figure 10: Annual number of violent hurricanes and maximum attained wind speed during those hurricanes in the Atlantic Ocean between 1944 and 2006 (22,23). There is no upward trend in either of these records. During this period, world hydrocarbon use increased 6-fold. Lines are mean values.

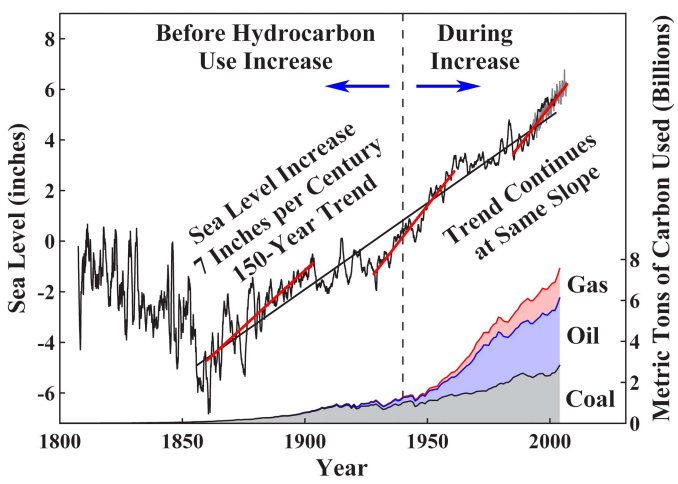

Figure 11: Global sea level measured by surface gauges between 1807 and 2002 (24) and by satellite between 1993 and 2006 (25). Satellite measurements are shown in gray and agree with tide gauge measurements. The overall trend is an increase of 7 inches per century. Intermediate trends are 9, 0, 12, 0, and 12 inches per century, respectively. This trend lags the temperature increase, so it predates the increase in hydrocarbon use even more than is shown. It is unaffected by the very large increase in hydrocarbon use.

While CO_2 levels have increased substantially and are expected to continue doing so and humans have been responsible for part of this increase, the effect on the environment has been benign.

There is, however, one very dangerous possibility.

Our industrial and technological civilization depends upon abundant, low-cost energy. This civilization has already brought unprecedented prosperity to the people of the more developed nations. Billions of people in the less developed nations are now lifting themselves from poverty by adopting this technology.

Hydrocarbons are essential sources of energy to sustain and extend prosperity. This is especially true of the developing nations, where available capital and technology are insufficient to meet rapidly increasing energy needs without extensive use of hydrocarbon fuels. If, through misunderstanding of the underlying science and through misguided public fear and hysteria, mankind significantly rations and restricts the use of hydrocarbons, the worldwide increase in prosperity will stop. The result would be vast human suffering and the loss of hundreds of millions of human lives. Moreover, the prosperity of those in the developed countries would be greatly reduced.

Mild ordinary natural increases in the Earth's temperature have occurred during the past two to three centuries. These have resulted in some improvements in overall climate and also some changes in

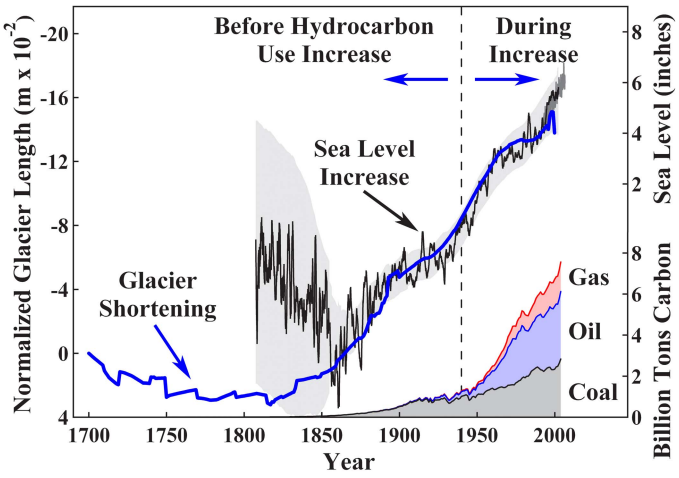

Figure 12: Glacier shortening (4) and sea level rise (24,25). Gray area designates estimated range of error in the sea level record. These measurements lag air temperature increases by about 20 years. So, the trends began more than a century before increases in hydrocarbon use.

the landscape, such as a reduction in glacier lengths and increased vegetation in colder areas. Far greater changes have occurred during the time that all current species of animals and plants have been on the Earth. The relative population sizes of the species and their geographical distributions vary as they adapt to changing conditions.

The temperature of the Earth is continuing its process of fluctuation in correlation with variations in natural phenomena. Mankind, meanwhile, is moving some of the carbon in coal, oil, and natural gas from below ground to the atmosphere and surface, where it is available for conversion into living things. We are living in an increasingly lush environment of plants and animals as a result. This is an unexpected and wonderful gift from the Industrial Revolution.

ATMOSPHERIC AND SURFACE TEMPERATURES

Atmospheric and surface temperatures have been recovering from an unusually cold period. During the time between 200 and 500 years ago, the Earth was experiencing the "Little Ice Age." It had descended into this relatively cool period from a warm interval about 1,000 years ago known as the "Medieval Climate Optimum." This is shown in Figure 1 for the Sargasso Sea.

During the Medieval Climate Optimum, temperatures were warm enough to allow the colonization of Greenland. These colonies were abandoned after the onset of colder temperatures. For the past 200 to 300 years, Earth temperatures have been gradually recovering (26). Sargasso Sea temperatures are now approximately equal to the average for the previous 3,000 years.

The historical record does not contain any report of "global warming" catastrophes, even though temperatures have been higher than they are now during much of the last three millennia.

The 3,000-year range of temperatures in the Sargasso Sea is typical of most places. Temperature records vary widely with geographical location as a result of climatological characteristics unique to those specific regions, so an "average" Earth temperature is less meaningful than individual records (27). So called "global" or "hemispheric" averages contain errors created by averaging systematically different aspects of unique geographical regions and by inclusion of regions where temperature records are unreliable.

Three key features of the temperature record – the Medieval Climate Optimum, the Little Ice Age, and the Not-Unusual-Temperature of the 20th century – have been verified by a review of local temperature and temperature-correlated records throughout the world (11), as summarized in Table 1. Each record was scored with respect to those queries to which it applied. The experimental and historical literature definitively confirms the primary features of Figure 1.

Most geographical locations experienced both the Medieval Climate Optimum and the Little Ice Age – and most locations did not

Table 1: Query	Yes	No	Yes/No	Two-Tailed Probability
Warm Climatic Anomaly 800-1300 A.D.?	**88**	2	7	> 99.99
Cold Climatic Anomaly 1300-1900 A.D.?	**105**	2	2	> 99.99
20th Century Warmest in Individual Record?	7	**64**	14	< 0.0001

Table 1: Comprehensive review of all instances in which temperature or temperature-correlated records from localities throughout the world permit answers to queries concerning the existence of the Medieval Climate Optimum, the Little Ice Age, and an unusually warm anomaly in the 20th century (11). The compiled and tabulated answers confirm the three principal features of the Sargasso Sea record shown in Figure 1. The probability that the answer to the query in column 1 is "yes" is given in column 5.

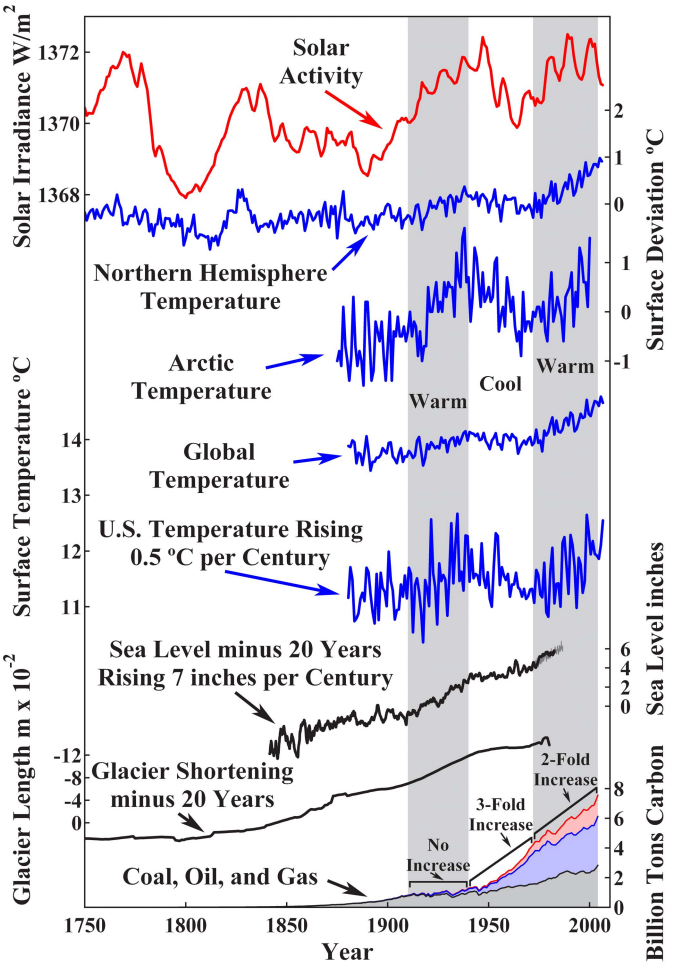

Figure 13: Seven independent records – solar activity (9); Northern Hemisphere, (13), Arctic (28), global (10), and U.S. (10) annual surface air temperatures; sea level (24,25); and glacier length (4) – all qualitatively confirm each other by exhibiting three intermediate trends – warmer, cooler, and warmer. Sea level and glacier length are shown minus 20 years, correcting for their 20-year lag of atmospheric temperature. Solar activity, Northern Hemisphere temperature, and glacier lengths show a low in about 1800.

Hydrocarbon use (7) is uncorrelated with temperature. Temperature rose for a century before significant hydrocarbon use. Temperature rose between 1910 and 1940, while hydrocarbon use was almost unchanged. Temperature then fell between 1940 and 1972, while hydrocarbon use rose by 330%. Also, the 150 to 200-year slopes of the sea level and glacier trends were unchanged by the very large increase in hydrocarbon use after 1940.

experience temperatures that were unusually warm during the 20th century. A review of 23 quantitative records has demonstrated that mean and median world temperatures in 2006 were, on average, approximately 1 °C or 2 °F cooler than in the Medieval Period (12).

World glacier length (4) and world sea level (24,25) measurements provide records of the recent cycle of recovery. Warmer temperatures diminish glaciers and cause sea level to rise because of decreased ocean water density and other factors.

These measurements show that the trend of 7 inches per century increase in sea level and the shortening trend in average glacier length both began a century before 1940, yet 84% of total human annual hydrocarbon use occurred only after 1940. Moreover, neither of these trends has accelerated during the period between 1940 and 2007, while hydrocarbon use increased 6-fold. Sea level and glacier records are offset by about 20 years because of the delay between temperature rise and glacier and sea level change.

If the natural trend in sea level increase continues for another two centuries as did the temperature rise in the Sargasso Sea as the Earth entered the Medieval Warm Period, sea level would be expected to rise about 1 foot between the years 2000 and 2200. Both the sea level and glacier trends – and the temperature trend that they reflect – are

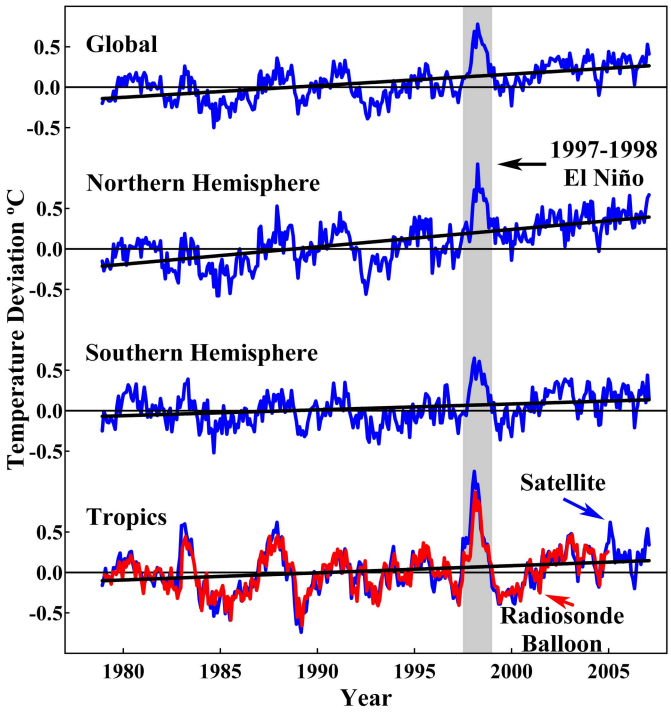

Figure 14: Satellite microwave sounding unit (blue) measurements of tropospheric temperatures in the Northern Hemisphere between 0 and 82.5 N, Southern Hemisphere between 0 and 82.5 S, tropics between 20S and 20N, and the globe between 82.5N and 82.5S between 1979 and 2007 (29), and radiosonde balloon (red) measurements in the tropics (29). The balloon measurements confirm the satellite technique (29-31). The warming anomaly in 1997-1998 (gray) was caused by El Niño, which, like the overall trends, is unrelated to CO_2 (32).

unrelated to hydrocarbon use. A further doubling of world hydrocarbon use would not change these trends.

Figure 12 shows the close correlation between the sea level and glacier records, which further validates both records and the duration and character of the temperature change that gave rise to them.

Figure 4 shows the annual temperature in the United States during the past 127 years. This record has an upward trend of 0.5 ºC per century. Global and Northern Hemisphere surface temperature records shown in Figure 13 trend upward at 0.6 ºC per century. These records are, however, biased toward higher temperatures in several ways. For example, they preferentially use data near populated areas (33), where heat island effects are prevalent, as illustrated in Figure 15. A trend of 0.5 ºC per century is more representative (13-17).

The U.S. temperature record has two intermediate uptrends of comparable magnitude, one occurring before the 6-fold increase in hydrocarbon use and one during it. Between these two is an intermediate temperature downtrend, which led in the 1970s to fears of an impending new ice age. This decrease in temperature occurred during a period in which hydrocarbon use increased 3-fold.

Seven independent records – solar irradiance; Arctic, Northern Hemisphere, global, and U.S. annual average surface air temperatures; sea level; and glacier length – all exhibit these three intermediate trends, as shown in Figure 13. These trends confirm one another. Solar irradiance correlates with them. Hydrocarbon use does not.

The intermediate uptrend in temperature between 1980 and 2006 shown in Figure 13 is similar to that shown in Figure 14 for balloon and satellite tropospheric measurements. This trend is more pronounced in the Northern Hemisphere than in the Southern. Contrary to the CO_2 warming climate models, however, tropospheric temperatures are not rising faster than surface temperatures.

Figure 6 illustrates the magnitudes of these temperature changes by comparing the 0.5 ºC per century temperature change as the Earth recovers from the Little Ice Age, the range of 50-year averaged Atlantic ocean surface temperatures in the Sargasso Sea over the past 3,000 years, the range of day-night and seasonal variation on average in Oregon, and the range of day-night and seasonal variation over the whole Earth. The two-century-long temperature change is small.

Tropospheric temperatures measured by satellite give comprehensive geographic coverage. Even the satellite measurements, however, contain short and medium-term fluctuations greater than the slight warming trends calculated from them. The calculated trends vary significantly as a function of the most recent fluctuations and the lengths of the data sets, which are short.

Figure 3 shows the latter part of the period of warming from the Little Ice Age in greater detail by means of Arctic air temperature as compared with solar irradiance, as does Figure 5 for U.S. surface temperature. There is a close correlation between solar activity and temperature and none between hydrocarbon use and temperature. Several other studies over a wide variety of time intervals have found similar correlations between climate and solar activity (15, 34-39).

Figure 3 also illustrates the uncertainties introduced by limited time records. If the Arctic air temperature data before 1920 were not available, essentially no uptrend would be observed.

This observed variation in solar activity is typical of stars close in size and age to the sun (40). The current warming trends on Mars (41), Jupiter (42), Neptune (43,44), Neptune's moon Triton (45), and Pluto (46-48) may result, in part, from similar relations to the sun and its activity – like those that are warming the Earth.

Hydrocarbon use and atmospheric CO_2 do not correlate with the observed temperatures. Solar activity correlates quite well. Correlation does not prove causality, but non-correlation proves non-causality. Human hydrocarbon use is not measurably warming the earth. Moreover, there is a robust theoretical and empirical model for solar warming and cooling of the Earth (8,19,49,50). The experimental data do not prove that solar activity is the only phenomenon responsible for substantial Earth temperature fluctuations, but they do show that human hydrocarbon use is not among those phenomena.

The overall experimental record is self-consistent. The Earth has been warming as it recovers from the Little Ice Age at an average rate of about 0.5 ºC per century. Fluctuations within this temperature trend include periods of more rapid increase and also periods of temperature decrease. These fluctuations correlate well with concomitant fluctuations in the activity of the sun. Neither the trends nor the fluctuations within the trends correlate with hydrocarbon use. Sea level and glacier length reveal three intermediate uptrends and two downtrends since 1800, as does solar activity. These trends are climatically benign and result from natural processes.

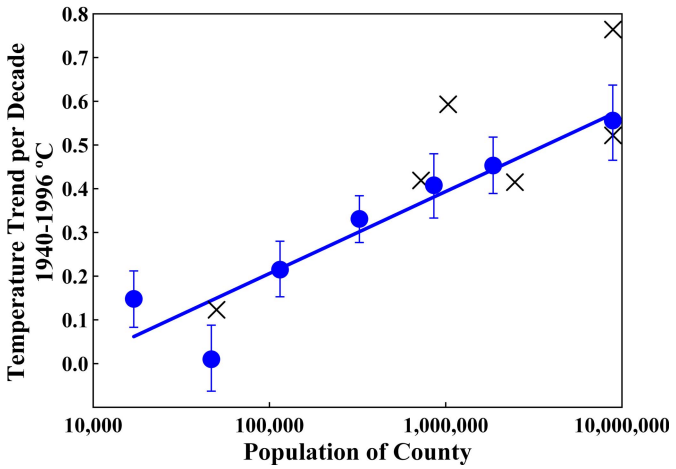

Figure 15: Surface temperature trends for 1940 to 1996 from 107 measuring stations in 49 California counties (51,52). The trends were combined for counties of similar population and plotted with the standard errors of their means. The six measuring stations in Los Angeles County were used to calculate the standard error of that county, which is plotted at a population of 8.9 million. The "urban heat island effect" on surface measurements is evident. The straight line is a least-squares fit to the closed circles. The points marked "X" are the six unadjusted station records selected by NASA GISS (53-55) for use in their estimate of global surface temperatures. Such selections make NASA GISS temperatures too high.

ATMOSPHERIC CARBON DIOXIDE

The concentration of CO_2 in Earth's atmosphere has increased during the past century, as shown in Figure 17. The magnitude of this atmospheric increase is currently about 4 gigatons (Gt C) of carbon per year. Total human industrial CO_2 production, primarily from use of coal, oil, and natural gas and the production of cement, is currently about 8 Gt C per year (7,56,57). Humans also exhale about 0.6 Gt C per year, which has been sequestered by plants from atmospheric CO_2. Office air concentrations often exceed 1,000 ppm CO_2.

To put these figures in perspective, it is estimated that the atmosphere contains 780 Gt C; the surface ocean contains 1,000 Gt C; vegetation, soils, and detritus contain 2,000 Gt C; and the intermediate and deep oceans contain 38,000 Gt C, as CO_2 or CO_2 hydration products. Each year, the surface ocean and atmosphere exchange an estimated 90 Gt C; vegetation and the atmosphere, 100 Gt C; marine biota and the surface ocean, 50 Gt C; and the surface ocean and the intermediate and deep oceans, 40 Gt C (56,57).

So great are the magnitudes of these reservoirs, the rates of exchange between them, and the uncertainties of these estimated numbers that the sources of the recent rise in atmospheric CO_2 have not been determined with certainty (58,59). Atmospheric concentrations of CO_2 are reported to have varied widely over geological time, with peaks, according to some estimates, some 20-fold higher than at present and lows at approximately 200 ppm (60-62).

Ice-core records are reported to show seven extended periods during 650,000 years in which CO_2, methane (CH_4), and temperature increased and then decreased (63-65). Ice-core records contain substantial uncertainties (58), so these correlations are imprecise.

In all seven glacial and interglacial cycles, the reported changes in CO_2 and CH_4 lagged the temperature changes and could not, therefore, have caused them (66). These fluctuations probably involved temperature-caused changes in oceanic and terrestrial CO_2 and CH_4 content. More recent CO_2 fluctuations also lag temperature (67,68).

In 1957, Revelle and Seuss (69) estimated that temperature-caused out-gassing of ocean CO_2 would increase atmospheric

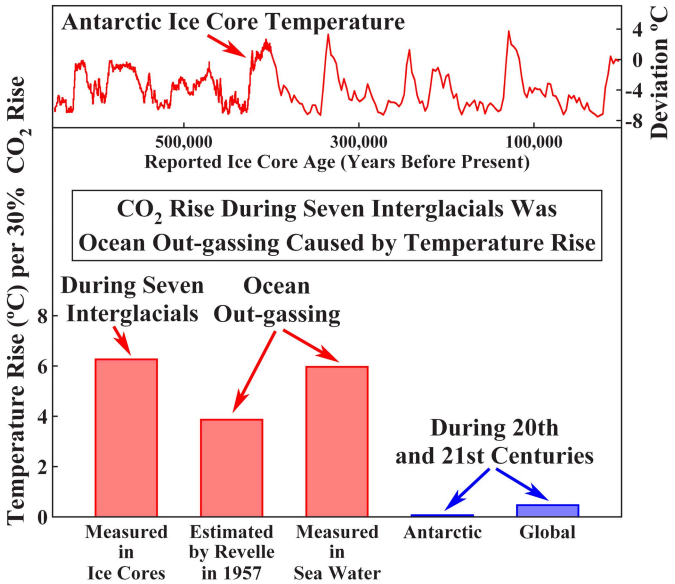

Figure 16: Temperature rise versus CO_2 rise from seven ice-core measured interglacial periods (63-65); from calculations (69) and measurements (70) of sea water out-gassing; and as measured during the 20th and 21st centuries (10,72). The interglacial temperature increases caused the CO_2 rises through release of ocean CO_2. The CO_2 rises did not cause the temperature rises.

In addition to the agreement between the out-gassing estimates and measurements, this conclusion is also verified by the small temperature rise during the 20th and 21st centuries. If the CO_2 versus temperature correlation during the seven interglacials had been caused by CO_2 greenhouse warming, then the temperature rise per CO_2 rise would have been as high during the 20th and 21st centuries as it was during the seven interglacial periods.

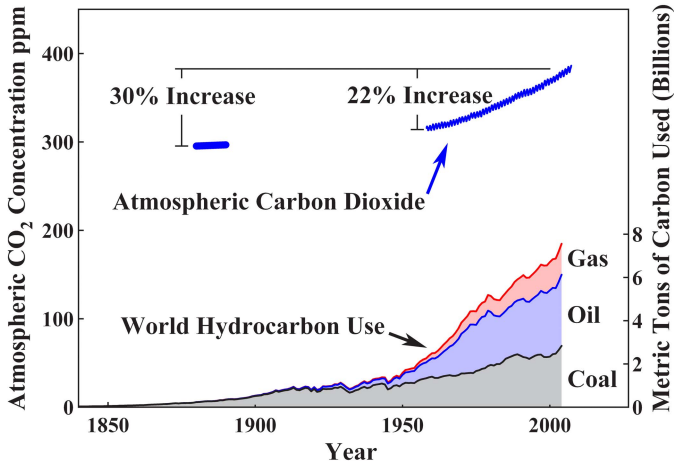

Figure 17: Atmospheric CO_2 concentrations in parts per million by volume, ppm, measured spectrophotometrically at Mauna Loa, Hawaii, between 1958 and 2007. These measurements agree well with those at other locations (71). Data before 1958 are from ice cores and chemical analyses, which have substantial experimental uncertainties. We have used 295 ppm for the period 1880 to 1890, which is an average of the available estimates. About 0.6 Gt C of CO_2 is produced annually by human respiration and often leads to concentrations exceeding 1,000 ppm in public buildings. Atmospheric CO_2 has increased 22% since 1958 and about 30% since 1880.

CO_2 by about 7% per °C temperature rise. The reported change during the seven interglacials of the 650,000-year ice core record is about 5% per °C (63), which agrees with the out-gassing calculation.

Between 1900 and 2006, Antarctic CO_2 increased 30% per 0.1 °C temperature change (72), and world CO_2 increased 30% per 0.5 °C. In addition to ocean out-gassing, CO_2 from human use of hydrocarbons is a new source. Neither this new source nor the older natural CO_2 sources are causing atmospheric temperature to change.

The hypothesis that the CO_2 rise during the interglacials caused the temperature to rise requires an increase of about 6 °C per 30% rise in CO_2 as seen in the ice core record. If this hypothesis were correct, Earth temperatures would have risen about 6 °C between 1900 and 2006, rather than the rise of between 0.1 °C and 0.5 °C, which actually occurred. This difference is illustrated in Figure 16.

The 650,000-year ice-core record does not, therefore, agree with the hypothesis of "human-caused global warming," and, in fact, provides empirical evidence that invalidates this hypothesis.

Carbon dioxide has a very short residence time in the atmosphere. Beginning with the 7 to 10-year half-time of CO_2 in the atmosphere estimated by Revelle and Seuss (69), there were 36 estimates of the atmospheric CO_2 half-time based upon experimental measurements published between 1957 and 1992 (59). These range between 2 and 25 years, with a mean of 7.5, a median of 7.6, and an upper range average of about 10. Of the 36 values, 33 are 10 years or less.

Many of these estimates are from the decrease in atmospheric carbon 14 after cessation of atmospheric nuclear weapons testing, which provides a reliable half-time. There is no experimental evidence to support computer model estimates (73) of a CO_2 atmospheric "lifetime" of 300 years or more.

Human production of 8 Gt C per year of CO_2 is negligible as compared with the 40,000 Gt C residing in the oceans and biosphere. At ultimate equilibrium, human-produced CO_2 will have an insignificant effect on the amounts in the various reservoirs. The rates of approach to equilibrium are, however, slow enough that human use creates a transient atmospheric increase.

In any case, the sources and amounts of CO_2 in the atmosphere are of secondary importance to the hypothesis of "human-caused global warming." It is human burning of coal, oil, and natural gas that is at issue. CO_2 is merely an intermediate in a hypothetical mechanism by which this "human-caused global warming" is said to take place. The amount of atmospheric CO_2 does have profound environmental effects on plant and animal populations (74) and diversity, as is discussed below.

CLIMATE CHANGE

While the average temperature change taking place as the Earth recovers from the Little Ice Age is so slight that it is difficult to discern, its environmental effects are measurable. Glacier shortening and the 7 inches per century rise in sea level are examples. There are additional climate changes that are correlated with this rise in temperature and may be caused by it.

Greenland, for example, is beginning to turn green again, as it was 1,000 years ago during the Medieval Climate Optimum (11). Arctic sea ice is decreasing somewhat (75), but Antarctic ice is not decreasing and may be increasing, due to increased snow (76-79).

In the United States, rainfall is increasing at about 1.8 inches per century, and the number of severe tornados is decreasing, as shown in Figures 7 and 8. If world temperatures continue to rise at the current rate, they will reach those of the Medieval Climate Optimum about 2 centuries from now. Historical reports of that period record the growing of warm weather crops in localities too cold for that purpose today, so it is to be expected that the area of more temperate climate will expand as it did then. This is already being observed, as studies at higher altitudes have reported increases in amount and diversity of plant and animal life by more than 50% (12,80).

Atmospheric temperature is increasing more in the Northern Hemisphere than in the Southern, with intermediate periods of increase and decrease in the overall trends.

There has been no increase in frequency or severity of Atlantic hurricanes during the period of 6-fold increase in hydrocarbon use, as is illustrated in Figures 9 and 10. Numbers of violent hurricanes vary greatly from year to year and are no greater now than they were 50 years ago. Similarly, maximum wind speeds have not increased.

All of the observed climate changes are gradual, moderate, and entirely within the bounds of ordinary natural changes that have occurred during the benign period of the past few thousand years.

There is no indication whatever in the experimental data that an abrupt or remarkable change in any of the ordinary natural climate variables is beginning or will begin to take place.

GLOBAL WARMING HYPOTHESIS

The greenhouse effect amplifies solar warming of the earth. Greenhouse gases such as H_2O, CO_2, and CH_4 in the Earth's atmosphere, through combined convective readjustments and the radiative blanketing effect, essentially decrease the net escape of terrestrial thermal infrared radiation. Increasing CO_2, therefore, effectively increases radiative energy input to the Earth's atmosphere. The path of this radiative input is complex. It is redistributed, both vertically and horizontally, by various physical processes, including advection, convection, and diffusion in the atmosphere and ocean.

When an increase in CO_2 increases the radiative input to the atmosphere, how and in which direction does the atmosphere respond? Hypotheses about this response differ and are schematically shown in Figure 18. Without the water-vapor greenhouse effect, the Earth would be about 14 ºC cooler (81). The radiative contribution of doubling atmospheric CO_2 is minor, but this radiative greenhouse effect is treated quite differently by different climate hypotheses. The hypotheses that the IPCC (82,83) has chosen to adopt predict that the effect of CO_2 is amplified by the atmosphere, especially by water vapor, to produce a large temperature increase. Other hypotheses, shown as hypothesis 2, predict the opposite – that the atmospheric response will counteract the CO_2 increase and result in insignificant changes in global temperature (81,84,85,91,92). The experimental evidence, as described above, favors hypothesis 2. While CO_2 has increased substantially, its effect on temperature has been so slight that it has not been experimentally detected.

The computer climate models upon which "human-caused global warming" is based have substantial uncertainties and are markedly unreliable. This is not surprising, since the climate is a coupled,

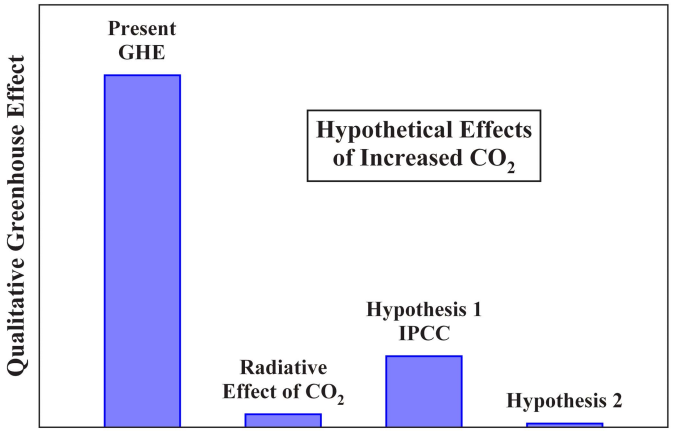

Figure 18: Qualitative illustration of greenhouse warming. "Present GHE" is the current greenhouse effect from all atmospheric phenomena. "Radiative effect of CO_2" is the added greenhouse radiative effect from doubling CO_2 without consideration of other atmospheric components. "Hypothesis 1 IPCC" is the hypothetical amplification effect assumed by IPCC. "Hypothesis 2" is the hypothetical moderation effect.

non-linear dynamical system. It is very complex. Figure 19 illustrates the difficulties by comparing the radiative CO_2 greenhouse effect with correction factors and uncertainties in some of the parameters in the computer climate calculations. Other factors, too, such as the chemical and climatic influence of volcanoes, cannot now be reliably computer modeled.

In effect, an experiment has been performed on the Earth during the past half-century – an experiment that includes all of the complex factors and feedback effects that determine the Earth's temperature and climate. Since 1940, hydrocarbon use has risen 6-fold. Yet, this rise has had no effect on the temperature trends, which have continued their cycle of recovery from the Little Ice Age in close correlation with increasing solar activity.

Not only has the global warming hypothesis failed experimental tests, it is theoretically flawed as well. It can reasonably be argued that cooling from negative physical and biological feedbacks to greenhouse gases nullifies the slight initial temperature rise (84,86).

The reasons for this failure of the computer climate models are subjects of scientific debate (87). For example, water vapor is the largest contributor to the overall greenhouse effect (88). It has been suggested that the climate models treat feedbacks from clouds, water vapor, and related hydrology incorrectly (85,89-92).

The global warming hypothesis with respect to CO_2 is not based upon the radiative properties of CO_2 itself, which is a very weak greenhouse gas. It is based upon a small initial increase in temperature caused by CO_2 and a large theoretical amplification of that temperature increase, primarily through increased evaporation of H_2O, a

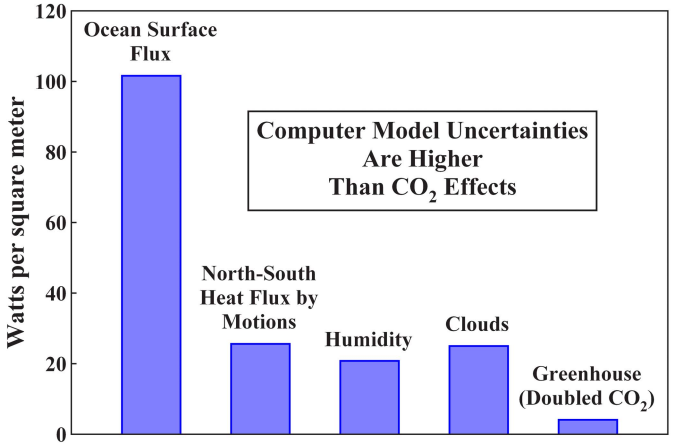

Figure 19: The radiative greenhouse effect of doubling the concentration of atmospheric CO_2 (right bar) as compared with four of the uncertainties in the computer climate models (87,93).

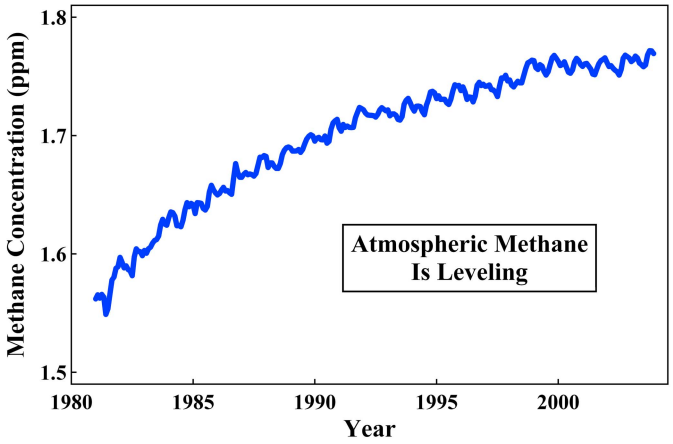

Figure 20: Global atmospheric methane concentration in parts per million between 1982 and 2004 (94).

strong greenhouse gas. Any comparable temperature increase from another cause would produce the same calculated outcome.

Thus, the 3,000-year temperature record illustrated in Figure 1 also provides a test of the computer models. The historical temperature record shows that the Earth has previously warmed far more than could be caused by CO_2 itself. Since these past warming cycles have not initiated water-vapor-mediated atmospheric warming catastrophes, it is evident that weaker effects from CO_2 cannot do so.

Methane is also a minor greenhouse gas. World CH_4 levels are, as shown in Figure 20, leveling off. In the U.S. in 2005, 42% of human-produced methane was from hydrocarbon energy production, 28% from waste management, and 30% from agriculture (95). The total amount of CH_4 produced from these U.S. sources decreased 7% between 1980 and 2005. Moreover, the record shows that, even while methane was increasing, temperature trends were benign.

The "human-caused global warming" – often called the "global warming" – hypothesis depends entirely upon computer model-generated scenarios of the future. There are no empirical records that verify either these models or their flawed predictions (96).

Claims (97) of an epidemic of insect-borne diseases, extensive species extinction, catastrophic flooding of Pacific islands, ocean acidification, increased numbers and severities of hurricanes and tornados, and increased human heat deaths from the 0.5 °C per century temperature rise are not consistent with actual observations. The "human-caused global warming" hypothesis and the computer calculations that support it are in error. They have no empirical support and are invalidated by numerous observations.

WORLD TEMPERATURE CONTROL

World temperature is controlled by natural phenomena. What steps could mankind take if solar activity or other effects began to shift the Earth toward temperatures too cold or too warm for optimum human life?

First, it would be necessary to determine what temperature humans feel is optimum. It is unlikely that the chosen temperature would be exactly that which we have today. Second, we would be fortunate if natural forces were to make the Earth too warm rather than too cold because we can cool the Earth with relative ease. We have no means by which to warm it. Attempting to warm the Earth with addition of CO_2 or to cool the Earth by restrictions of CO_2 and hydrocarbon use would, however, be futile. Neither would work.

Inexpensively blocking the sun by means of particles in the upper atmosphere would be effective. S.S. Penner, A.M. Schneider, and E. M. Kennedy have proposed (98) that the exhaust systems of commercial airliners could be tuned in such a way as to eject particulate sun-blocking material into the upper atmosphere. Later, Edward Teller similarly suggested (18) that particles could be injected into the atmosphere in order to reduce solar heating and cool the Earth. Teller estimated a cost of between $500 million and $1 billion per year for between 1 ºC and 3 ºC of cooling. Both methods use particles so small that they would be invisible from the Earth.

These methods would be effective and economical in blocking solar radiation and reducing atmospheric and surface temperatures. There are other similar proposals (99). World energy rationing, on the other hand, would not work.

The climate of the Earth is now benign. If temperatures become too warm, this can easily be corrected. If they become too cold, we have no means of response – except to maximize nuclear and hydrocarbon energy production and technological advance. This would help humanity adapt and might lead to new mitigation technology.

FERTILIZATION OF PLANTS BY CO_2

How high will the CO_2 concentration of the atmosphere ultimately rise if mankind continues to increase the use of coal, oil, and natural gas? At ultimate equilibrium with the ocean and other reservoirs there will probably be very little increase. The current rise is a non-equilibrium result of the rate of approach to equilibrium.

One reservoir that would moderate the increase is especially important. Plant life provides a large sink for CO_2. Using current knowledge about the increased growth rates of plants and assuming increased CO_2 release as compared to current emissions, it has been estimated that atmospheric CO_2 levels may rise to about 600 ppm before leveling off. At that level, CO_2 absorption by increased Earth biomass is able to absorb about 10 Gt C per year (100). At present, this absorption is estimated to be about 3 Gt C per year (57).

About 30% of this projected rise from 295 to 600 ppm has already taken place, without causing unfavorable climate changes. Moreover, the radiative effects of CO_2 are logarithmic (101,102), so more than 40% of any climatic influences have already occurred.

As atmospheric CO_2 increases, plant growth rates increase. Also, leaves transpire less and lose less water as CO_2 increases, so that plants are able to grow under drier conditions. Animal life, which depends upon plant life for food, increases proportionally.

Figures 21 to 24 show examples of experimentally measured increases in the growth of plants. These examples are representative of a very large research literature on this subject (103-109). As Figure 21 shows, long-lived 1,000- to 2,000-year-old pine trees have shown a sharp increase in growth during the past half-century. Figure 22 shows the 40% increase in the forests of the United States that has

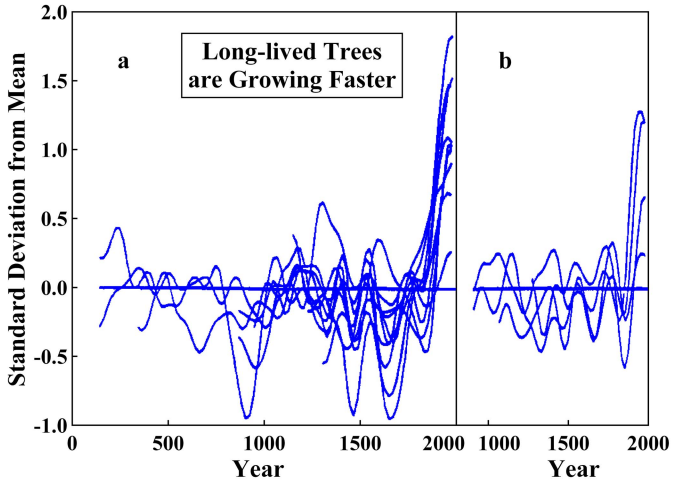

Figure 21: Standard deviation from the mean of tree ring widths for (a) bristlecone pine, limber pine, and fox tail pine in the Great Basin of California, Nevada, and Arizona and (b) bristlecone pine in Colorado (110). Tree ring widths were averaged in 20-year segments and then normalized so that the means of prior tree growth were zero. The deviations from the means are shown in units of standard deviations of those means.

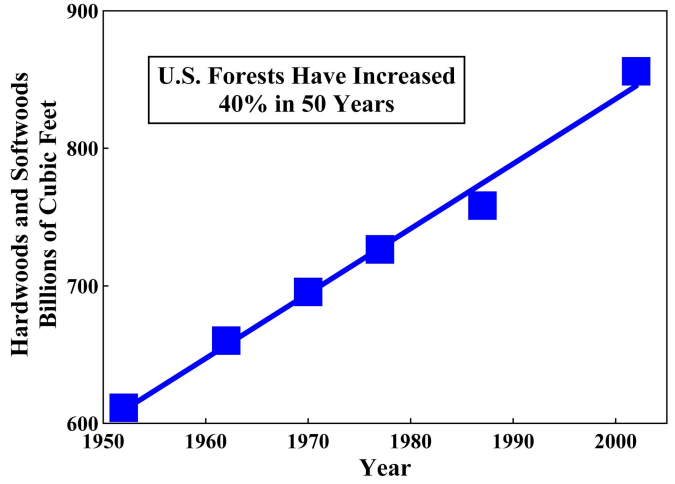

Figure 22: Inventories of standing hardwood and softwood timber in the United States compiled in *Forest Resources of the United States,* 2002, U.S. Department of Agriculture Forest Service (111,112). The linear trend cited in 1998 (1) with an increase of 30% has continued. The increase is now 40%. The amount of U.S. timber is rising almost 1% per year.

taken place since 1950. Much of this increase is due to the increase in atmospheric CO_2 that has already occurred. In addition, it has been reported that Amazonian rain forests are increasing their vegetation by about 900 pounds of carbon per acre per year (113), or approximately 2 tons of biomass per acre per year. Trees respond to CO_2 fertilization more strongly than do most other plants, but all plants respond to some extent.

Since plant response to CO_2 fertilization is nearly linear with respect to CO_2 concentration over the range from 300 to 600 ppm, as seen in Figure 23, experimental measurements at different levels of CO_2 enrichment can be extrapolated. This has been done in Figure 24 in order to illustrate CO_2 growth enhancements calculated for the atmospheric increase of about 88 ppm that has already taken place and those expected from a projected total increase of 305 ppm.

Wheat growth is accelerated by increased atmospheric CO_2, especially under dry conditions. Figure 24 shows the response of wheat grown under wet conditions versus that of wheat stressed by lack of water. The underlying data is from open-field experiments. Wheat was grown in the usual way, but the atmospheric CO_2 concentrations of circular sections of the fields were increased by arrays of computer-controlled equipment that released CO_2 into the air to hold the levels as specified (115,116). Orange and young pine tree growth enhancement (117-119) with two atmospheric CO_2 increases – that which has already occurred since 1885 and that projected for the next two centuries – is also shown. The relative growth enhancement of trees by CO_2 diminishes with age. Figure 24 shows young trees.

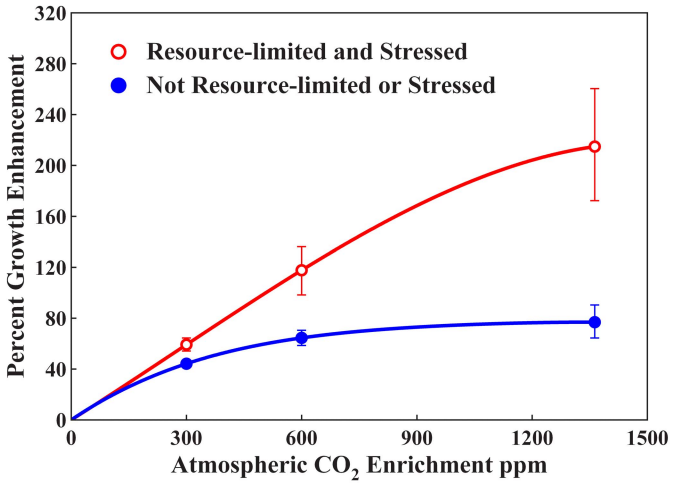

Figure 23: Summary data from 279 published experiments in which plants of all types were grown under paired stressed (open red circles) and unstressed (closed blue circles) conditions (114). There were 208, 50, and 21 sets at 300, 600, and an average of about 1350 ppm CO_2, respectively. The plant mixture in the 279 studies was slightly biased toward plant types that respond less to CO_2 fertilization than does the actual global mixture. Therefore, the figure underestimates the expected global response. CO_2 enrichment also allows plants to grow in drier regions, further increasing the response.

Figure 23 summarizes 279 experiments in which plants of various types were raised under CO_2-enhanced conditions. Plants under stress from less-than-ideal conditions – a common occurrence in nature – respond more to CO_2 fertilization. The selections of species in Figure 23 were biased toward plants that respond less to CO_2 fertilization than does the mixture actually covering the Earth, so Figure 23 underestimates the effects of global CO_2 enhancement.

Clearly, the green revolution in agriculture has already benefitted from CO_2 fertilization, and benefits in the future will be even greater. Animal life is increasing proportionally, as shown by studies of 51 terrestrial (120) and 22 aquatic ecosystems (121). Moreover, as shown by a study of 94 terrestrial ecosystems on all continents except Antarctica (122), species richness – biodiversity – is more positively correlated with productivity – the total quantity of plant life per acre – than with anything else.

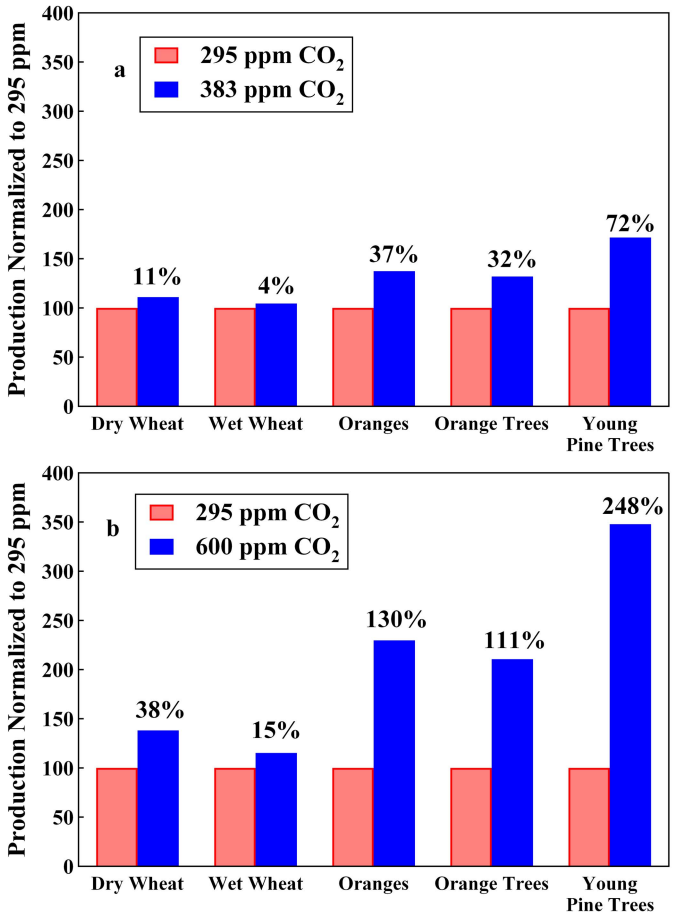

Figure 24: Calculated (1,2) growth rate enhancement of wheat, young orange trees, and very young pine trees already taking place as a result of atmospheric enrichment by CO_2 from 1885 to 2007 (a), and expected as a result of atmospheric enrichment by CO_2 to a level of 600 ppm (b).

Atmospheric CO_2 is required for life by both plants and animals. It is the sole source of carbon in all of the protein, carbohydrate, fat, and other organic molecules of which living things are constructed.

Plants extract carbon from atmospheric CO_2 and are thereby fertilized. Animals obtain their carbon from plants. Without atmospheric CO_2, none of the life we see on Earth would exist.

Water, oxygen, and carbon dioxide are the three most important substances that make life possible.

They are surely not environmental pollutants.

ENVIRONMENT AND ENERGY

The single most important human component in the preservation of the Earth's environment is energy. Industrial conversion of energy into forms that are useful for human activities is the most important aspect of technology. Abundant inexpensive energy is required for the prosperous maintenance of human life and the continued advance of life-enriching technology. People who are prosperous have the wealth required to protect and enhance their natural environment.

Currently, the United States is a net importer of energy as shown in Figure 25. Americans spend about $300 billion per year for imported oil and gas – and an additional amount for military expenses related to those imports.

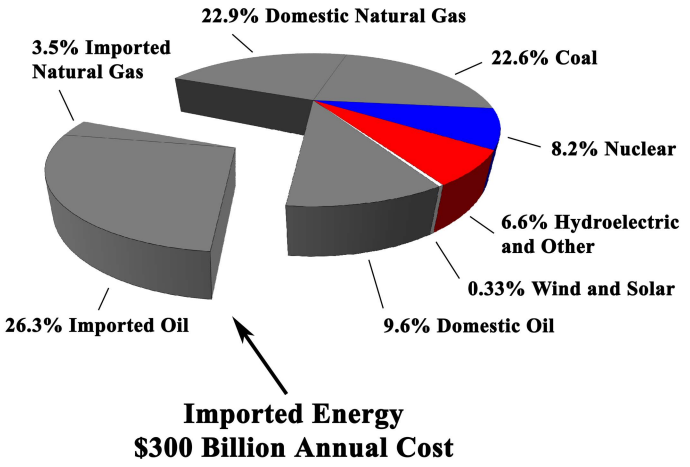

Figure 25: In 2006, the United States obtained 84.9% of its energy from hydrocarbons, 8.2% from nuclear fuels, 2.9% from hydroelectric dams, 2.1% from wood, 0.8% from biofuels, 0.4% from waste, 0.3% from geothermal, and 0.3% from wind and solar radiation. The U.S. uses 21 million barrels of oil per day – 27% from OPEC, 17% from Canada and Mexico, 16% from others, and 40% produced in the U.S. (95). The cost of imported oil and gas at $60 per barrel and $7 per 1,000 ft^3 in 2007 is about $300 billion per year.

Political calls for a reduction of U.S. hydrocarbon use by 90% (123), thereby eliminating 75% of America's energy supply, are obviously impractical. Nor can this 75% of U.S. energy be replaced by alternative "green" sources. Despite enormous tax subsidies over the past 30 years, green sources still provide only 0.3% of U.S. energy.

Yet, the U.S. clearly cannot continue to be a large net importer of energy without losing its economic and industrial strength and its political independence. It should, instead, be a net exporter of energy.

There are three realistic technological paths to American energy independence – increased use of hydrocarbon energy, nuclear energy, or both. There are no climatological impediments to increased use of hydrocarbons, although local environmental effects can and must be accommodated. Nuclear energy is, in fact, less expensive and more environmentally benign than hydrocarbon energy, but it too has been the victim of the politics of fear and claimed disadvantages and dangers that are actually negligible.

For example, the "problem" of high-level "nuclear waste" has been given much attention, but this problem has been politically created by U.S. government barriers to American fuel breeding and reprocessing. Spent nuclear fuel can be recycled into new nuclear fuel. It need not be stored in expensive repositories.

Reactor accidents are also much publicized, but there has never been even one human death associated with an American nuclear reactor incident. By contrast, American dependence on automobiles results in more than 40,000 human deaths per year.

All forms of energy generation, including "green" methods, entail industrial deaths in the mining, manufacture, and transport of resources they require. Nuclear energy requires the smallest amount of such resources (124) and therefore has the lowest risk of deaths.

Estimated relative costs of electrical energy production vary with geographical location and underlying assumptions. Figure 26 shows a recent British study, which is typical. At present, 43% of U.S. energy consumption is used for electricity production.

To be sure, future inventions in energy technology may alter the relative economics of nuclear, hydrocarbon, solar, wind, and other methods of energy generation. These inventions cannot, however, be forced by political fiat, nor can they be wished into existence. Alternatively, "conservation," if practiced so extensively as to be an alternative to hydrocarbon and nuclear power, is merely a politically correct word for "poverty."

The current untenable situation in which the United States is losing $300 billion per year to pay for foreign oil and gas is not the result of failures of government energy production efforts. The U.S. government does not produce energy. Energy is produced by private industry. Why then has energy production thrived abroad while domestic production has stagnated?

This stagnation has been caused by United States government taxation, regulation, and sponsorship of litigation, which has made the U.S. a very unfavorable place to produce energy. In addition, the U.S. government has spent vast sums of tax money subsidizing inferior energy technologies for political purposes.

It is not necessary to discern in advance the best course to follow. Legislative repeal of taxation, regulation, incentives to litigation, and repeal of all subsidies of energy generation industries would stimulate industrial development, wherein competition could then automatically determine the best paths.

Nuclear power is safer, less expensive, and more environmentally benign than hydrocarbon power, so it is probably the better choice for increased energy production. Solid, liquid and gaseous hydrocarbon fuels provide, however, many conveniences, and a national infrastructure to use them is already in place. Oil from shale or coal liquefaction is less expensive than crude oil at current prices, but its ongoing production costs are higher than those for already developed oil fields. There is, therefore, an investment risk that crude oil prices could drop so low that liquefaction plants could not compete. Nuclear energy does not have this disadvantage, since the operating costs of nuclear power plants are very low.

Figure 27 illustrates, as an example, one practical and environmentally sound path to U.S. energy independence. At present 19% of U.S. electricity is produced by 104 nuclear power reactors with an average generating output in 2006 of 870 megawatts per reactor, for a total of about 90 GWe (gigawatts) (125). If this were increased by 560 GWe, nuclear power could fill all current U.S. electricity requirements and have 230 GWe left over for export as electricity or as hydrocarbon fuels replaced or manufactured.

Thus, rather than a $300 billion trade loss, the U.S. would have a $200 billion trade surplus – and installed capacity for future U.S. re-

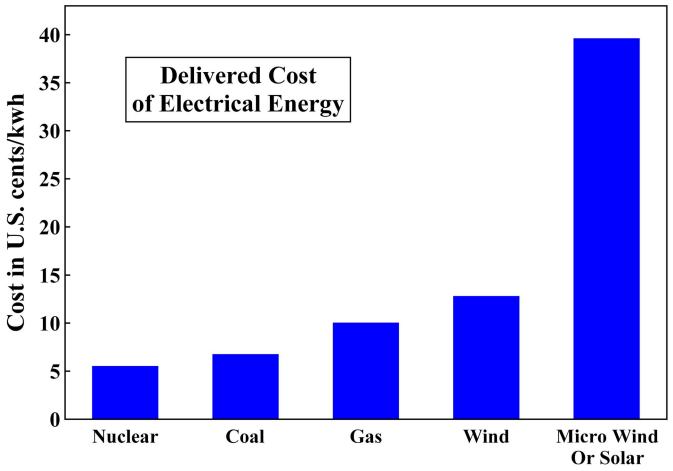

Figure 26: Delivered cost per kilowatt hour of electrical energy in Great Britain in 2006, without CO_2 controls (126). These estimates include all capital and operational expenses for a period of 50 years. Micro wind or solar are units installed for individual homes.

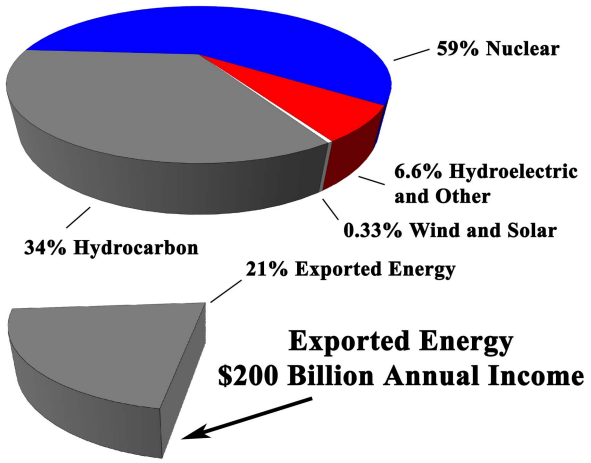

Figure 27: Construction of one Palo Verde installation with 10 reactors in each of the 50 states. Energy trade deficit is reversed by $500 billion per year, resulting in a $200 billion annual surplus. Currently, this solution is not possible owing to misguided government policies, regulations, and taxation and to legal maneuvers available to anti-nuclear activists. These impediments should be legislatively repealed.

quirements. Moreover, if heat from additional nuclear reactors were used for coal liquefaction and gasification, the U.S. would not even need to use its oil resources. The U.S. has about 25% of the world's coal reserves. This heat could also liquify biomass, trash, or other sources of hydrocarbons that might eventually prove practical.

The Palo Verde nuclear power station near Phoenix, Arizona, was originally intended to have 10 nuclear reactors with a generating capacity of 1,243 megawatts each. As a result of public hysteria caused by false information – very similar to the human-caused global warming hysteria being spread today, construction at Palo Verde was stopped with only three operating reactors completed. This installation is sited on 4,000 acres of land and is cooled by waste water from the city of Phoenix, which is a few miles away. An area of 4,000 acres is 6.25 square miles or 2.5 miles square. The power station itself occupies only a small part of this total area.

If just one station like Palo Verde were built in each of the 50 states and each installation included 10 reactors as originally planned for Palo Verde, these plants, operating at the current 90% of design capacity, would produce 560 GWe of electricity. Nuclear technology has advanced substantially since Palo Verde was built, so plants constructed today would be even more reliable and efficient.

Assuming a construction cost of $2.3 billion per 1,200 MWe reactor (127) and 15% economies of scale, the total cost of this entire project would be $1 trillion, or 4 months of the current U.S. federal budget. This is 8% of the annual U.S. gross domestic product. Construction costs could be repaid in just a few years by the capital now spent by the people of the United States for foreign oil and by the change from U.S. import to export of energy.

The 50 nuclear installations might be sited on a population basis. If so, California would have six, while Oregon and Idaho together would have one. In view of the great economic value of these facilities, there would be vigorous competition for them.

In addition to these power plants, the U.S. should build fuel reprocessing capability, so that spent nuclear fuel can be reused. This would lower fuel cost and eliminate the storage of high-level nuclear waste. Fuel for the reactors can be assured for 1,000 years (128) by using both ordinary reactors with high breeding ratios and specific breeder reactors, so that more fuel is produced than consumed.

About 33% of the thermal energy in an ordinary nuclear reactor is converted to electricity. Some new designs are as high as 48%. The heat from a 1,243 MWe reactor can produce 38,000 barrels of coal-derived oil per day (129). With one additional Palo Verde installation in each state for oil production, the yearly output would be at least 7 billion barrels per year with a value, at $60 per barrel, of more than $400 billion per year. This is twice the oil production of Saudi Arabia. Current proven coal reserves of the United States are sufficient to sustain this production for 200 years (128). This liquified coal exceeds the proven oil reserves of the entire world. The reactors could produce gaseous hydrocarbons from coal, too.

The remaining heat from nuclear power plants could warm air or water for use in indoor climate control and other purposes.

Nuclear reactors can also be used to produce hydrogen, instead of oil and gas (130,131). The current cost of production and infrastructure is, however, much higher for hydrogen than for oil and gas. Technological advance reduces cost, but usually not abruptly. A prescient call in 1800 for the world to change from wood to methane would have been impracticably ahead of its time, as may be a call today for an abrupt change from oil and gas to hydrogen. In distinguishing the practical from the futuristic, a free market in energy is absolutely essential.

Surely these are better outcomes than are available through international rationing and taxation of energy as has been recently proposed (82,83,97,123). This nuclear energy example demonstrates that current technology can produce abundant inexpensive energy if it is not politically suppressed.

There need be no vast government program to achieve this goal. It could be reached simply by legislatively removing all taxation, most regulation and litigation, and all subsidies from all forms of energy production in the U.S., thereby allowing the free market to build the most practical mixture of methods of energy generation.

With abundant and inexpensive energy, American industry could be revitalized, and the capital and energy required for further industrial and technological advance could be assured. Also assured would be the continued and increased prosperity of all Americans.

The people of the United States need more low-cost energy, not less. If this energy is produced in the United States, it can not only become a very valuable export, but it can also ensure that American industry remains competitive in world markets and that hoped-for American prosperity continues and grows.

In this hope, Americans are not alone. Across the globe, billions of people in poorer nations are struggling to improve their lives. These people need abundant low-cost energy, which is the currency of technological progress.

In newly developing countries, that energy must come largely from the less technologically complicated hydrocarbon sources. It is a moral imperative that this energy be available. Otherwise, the efforts of these peoples will be in vain, and they will slip backwards into lives of poverty, suffering, and early death.

Energy is the foundation of wealth. Inexpensive energy allows people to do wonderful things. For example, there is concern that it may become difficult to grow sufficient food on the available land. Crops grow more abundantly in a warmer, higher CO_2 environment, so this can mitigate future problems that may arise (12).

Energy provides, however, an even better food insurance plan. Energy-intensive hydroponic greenhouses are 2,000 times more productive per unit land area than are modern American farming methods (132). Therefore, if energy is abundant and inexpensive, there is no practical limit to world food production.

Fresh water is also believed to be in short supply. With plentiful inexpensive energy, sea water desalination can provide essentially unlimited supplies of fresh water.

During the past 200 years, human ingenuity in the use of energy has produced many technological miracles. These advances have markedly increased the quality, quantity, and length of human life. Technologists of the 21st century need abundant, inexpensive energy with which to continue this advance.

Were this bright future to be prevented by world energy rationing, the result would be tragic indeed. In addition to human loss, the Earth's environment would be a major victim of such a mistake. Inexpensive energy is essential to environmental health. Prosperous people have the wealth to spare for environmental preservation and enhancement. Poor, impoverished people do not.

CONCLUSIONS

There are no experimental data to support the hypothesis that increases in human hydrocarbon use or in atmospheric carbon dioxide and other greenhouse gases are causing or can be expected to cause unfavorable changes in global temperatures, weather, or landscape. There is no reason to limit human production of CO_2, CH_4, and other minor greenhouse gases as has been proposed (82,83,97,123).

We also need not worry about environmental calamities even if the current natural warming trend continues. The Earth has been much warmer during the past 3,000 years without catastrophic effects. Warmer weather extends growing seasons and generally improves the habitability of colder regions.

As coal, oil, and natural gas are used to feed and lift from poverty vast numbers of people across the globe, more CO_2 will be released into the atmosphere. This will help to maintain and improve the health, longevity, prosperity, and productivity of all people.

The United States and other countries need to produce more energy, not less. The most practical, economical, and environmentally sound methods available are hydrocarbon and nuclear technologies.

Human use of coal, oil, and natural gas has not harmfully warmed the Earth, and the extrapolation of current trends shows that it will not do so in the foreseeable future. The CO_2 produced does, however, accelerate the growth rates of plants and also permits plants to grow in drier regions. Animal life, which depends upon plants, also flourishes, and the diversity of plant and animal life is increased.

Human activities are producing part of the rise in CO_2 in the atmosphere. Mankind is moving the carbon in coal, oil, and natural gas from below ground to the atmosphere, where it is available for conversion into living things. We are living in an increasingly lush environment of plants and animals as a result of this CO_2 increase. Our children will therefore enjoy an Earth with far more plant and animal life than that with which we now are blessed.

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A Sceptical Mind

having doubts about global warming

The rise and fall of the Hockey Stick

The rise of the so called *Hockey Stick graph* is pivotal to the story of the rise of the alarm about man made global warming.

The fall of the Hockey Stick graph is pivotal to the rise of scepticism about man made global warming.

Here is the story of the rise and fall of the Hockey Stick.

The Background

A central and critical plank of the alarmist global warming case is that the current phase of warming that started in the late 19th century is unprecedented.

Why is this claim so important?

Because if a similar or greater warming phase has occurred in the *very recent past,* before human CO2 emissions had caused CO2 levels to rise, then clearly any such recent warming must have been natural and was not caused by CO2. And if any recent similar warming phase was natural then clearly the current phase of warming could also be a natural phenomena.

If the current phase of warming could be natural then those arguing that it was primarily caused by human CO2 emissions would have to prove their hypothesis. *And this is something they cannot do.*

The only "proof" that CO2 is currently forcing up global temperatures is the claim that the current warming is somehow unusual, unique and unnatural. *That's the total argument for CO2 forcing.* Something unprecedented is happening to the climate and CO2 is the only candidate for what is causing this unique phenomena.

Its certainly true that the well understood physics of CO2 in the atmosphere demonstrates (see "CO2 the basic facts")that CO2 is indeed a greenhouse gas and will have a warming impact. No one disputes that. *The issue is what is the scale of impact that this CO2 warming is having on the overall climate system. Is the effect of the CO2 so big that it can drive the temperature of the whole planet up in a way that is big enough to actually alter the climate?*

This is a much harder question to answer because no one has a model of the total climate system that actually works and which verifiably produces even remotely accurate forecasts about climate trends.

So without a working model of the total climate system the only way to "prove" that CO2 is driving climate change is to prove that something truly unique is happening to the climate, that there is unprecedented warming occurring, and and then propose man made CO2 change as the only candidate as the cause of this 'unprecedented' warming.

The "problem" of the Medieval Warm Period

Until the 1990s there were many, many references in scientific and historical literature to a period labelled the Medieval Warm Period (MWP) lasting from about AD 800–1300. It was followed by a much cooler period termed the Little Ice Age. Based on both temperature reconstructions using proxy measures and voluminous historical references it was accepted that the Medieval Warm Period had been a period when global temperatures were a bit hotter than today's temperatures. Until about the mid-1990s the Medieval Warm Period was for climate researchers an undisputed fact. The existence of the Medieval Warm Period was accepted without question and noted in the first progress report of the IPCC from 1990. On page 202 of that 1990 IPCC report there was the graphic 7c (see below), in which the Medieval Warm Period was portrayed as clearly warmer than the present.

By the time of the second IPCC report in 1995 where for the first time CO2 forcing began to be proposed more prominently as a cause of serious alarm, the Medieval Warm Period was sidelined in the text and narrative. An important way that this was done in the report was to alter the diagram of recent climate history by simply shortening the time period it covered so that it now started after the Medieval Warm Period. All that was shown was the long slow recovery from the Little Ice Age to today's temperatures, i.e. a long period of increasing temperatures. But clearly this was only a short term solution. The way that the Medieval Warm Period dominated the recent climate graph challenged the basic argument for CO2 forcing which was that the late 20th century climate was some how unique. As Jay Overpeck, an IPCC participant said in his email to Professor Deming, "We have to get rid of the Medieval Warm Period".

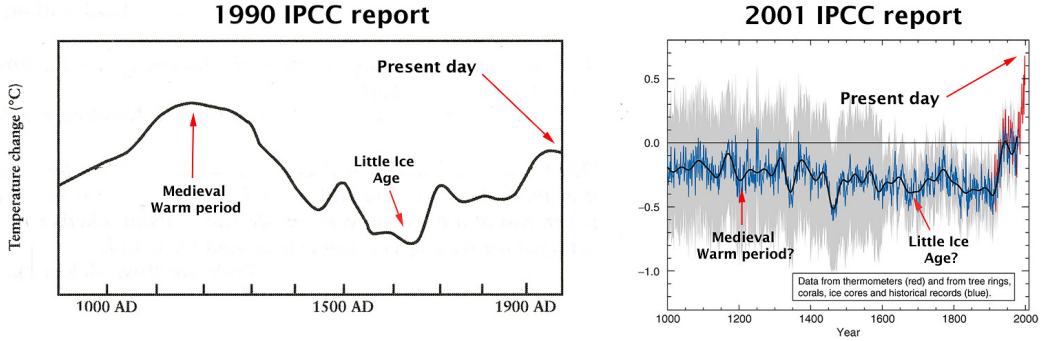
In order to prove CO2 forcing the Medieval Warm Period had to be eliminated.

The Rise of the Hockey Stick

Between the 1995 second IPCC report and the 2001 third IPCC report there was a complete revision in the way that recent climate history was portrayed. The supporters of the theory that CO2 changes were driving temperatures up had succeeded in their goal of eliminating the Medieval Warm Period. This rewriting of climate history and the elimination of the Medieval Warm Period was achieved through the famous Hockey Stick graph.

To understand the scale of the revision that had taken place compare the two graphs below. The one on the left is diagram 7c from page 202 of the 1990 IPCC report in which the Medieval Warm Period was portrayed as clearly warmer than the present. On the right is the Hockey Stick graph from the 2001 IPCC report in which the Medieval Warm Period and the Little Ice Age have all but disappeared and the recent climate history is dominated by a rapid temperature rise in the last 20th century.

Climate change over the past 1000 years as shown by the IPCC



The Hockey Stick Chart

The first blow against the accepted understanding of climate history came in 1995 when the English climatologist Keith Briffa (based at the Climate Research Unit at East Anglia) published in the journal Nature a study with sensational results. According to his studies of tree rings in the Siberian Polar-Ural, there had never been a Medieval Warm Period and the 20th century suddenly appeared as the warmest of the last 1000 years. The most recent part of this study is known as the Yamal study, because of the name of the region it was done in, and it has recently been discredited – see here.

Briffa's work boldly proposed that the 20th Century had experienced the warmest climate of the millennium and this claim was now the central battlefield for the scientific argument about CO2 forcing. This of course ignored the Climatic Optimum (see Happy Holocene) between 5000 and 9000 years ago when temperatures were significantly higher than today but most people (and certainly the media and politicians) actually think that 5000 years is a long time ago so there was no need to undermine the Climatic Optimum in order to win wide public support for the CO2 forcing hypothesis. Hottest in the last 1000 years would do.

Briffa's work had an impact and laid the ground work but the real knock out blow that finally succeeded in eliminating the Medieval Warm Period was a paper published in 1998 in Nature by Mann, Bradley and Hughes entitled, "Global-scale temperature patterns and climate forcing over the past six centuries" (you can download it here). This was the original peer reviewed hockey stick article.

Michael Mann of the Department of Geosciences, University of Massachusetts, who was the primary author of the paper, had in one scientific coup overturned the whole of climate history. Using tree rings as a basis for assessing past temperature changes back to the year 1,000 AD, supplemented by other proxies from more recent centuries, *Mann completely redrew climate history, turning the Medieval Warm Period and Little Ice Age into non-events.* In the new Hockey Stick diagram the Medieval Warm Period and Little Ice Age have disappeared, to be replaced by a largely benign and slightly cooling linear trend in climate until 1900 AD after which the *Mann's new graph showed the temperature shooting up in the 20th century in an apparently anomalous and accelerating fashion.*

In every other science when such a drastic revision of previously accepted knowledge is promulgated, there is considerable debate and initial scepticism, the new theory facing a gauntlet of criticism and intense review. Only if a new idea survives that process does it become broadly accepted by the scientific peer group and the public at large.

This never happened with Mann's `Hockey Stick'. The coup was total, bloodless, and swift as Mann's paper was greeted with a chorus of uncritical approval from the increasingly politically committed supporters of the CO2 greenhouse theory. Within the space of only 12 months, the new theory had become entrenched as a new orthodoxy. The ultimate consummation of the new theory came with the release of the draft of the Third Assessment Report of the IPCC in 2000. Based solely on this new paper from a relatively unknown and young scientist the IPCC could now boldly state:

"It is likely that the rate and duration of the warming of the 20th century is larger than any other time during the last 1,000 years. The 1990s are likely to have been the warmest decade of the millennium in the Northern Hemisphere, and 1998 is likely to have been the warmest year."

Overturning its own previous view in the 1995 report, the IPCC presented the `Hockey Stick' as the new orthodoxy with hardly an apology or explanation for the abrupt U-turn since its 1995 report. The IPCC could show almost no supporting scientific justification because other than Mann's Hockey Stick paper, and Briffa's Siberian tree ring study there was little in the way of research confirming their new line.

The Hockey Stick graph, the new orthodoxy, was blown up to a wall sized display and used as a back drop for the public launch of the 2001 IPCC report.

Within months of the IPCC draft release, the long-awaited draft U.S. `National Assessment' Overview document featured the `Hockey Stick' as the first of many climatic graphs and charts in its report, affirming the crucial importance placed in it by the authors and by the active pro CO2 warming campaign at large. This was now not an esoteric theory about the distant past but rather the core foundation upon which the offensive on global warming was being mounted.

Soon the Hockey Stick was everywhere and with it went the new simple and catchy campaigning slogans "*its hotter now than the last 1000 years!*", "*1998 was the hottest year for a 1000 years!*"

Not long after the 2001 IPCC report the Government of Canada sent the hockey stick to schools across the country, and its famous conclusion about the 1990s being the warmest decade of the millennium was the opening line of a pamphlet sent to every household in Canada to promote the Kyoto Protocol.

Al Gore's Oscar winning and hugely popular film "An Inconvenient Truth" was virtually built around the Hockey Stick (although Gore couldn't resist tweaking it to make it look even more compelling by changing the way the graph data was displayed along the axis so that the temperature trend line it showed looked even steeper and starker).

In the UK the Government announced that the DVD of the "An Inconvenient Truth" would be sent to every school in the country as a teaching aid.

The Hockey Stick seemed to be carrying all before it. Dr Mann was promoted, given a central position in the IPCC and became a star of the media.

And then it all went horribly wrong.

The Fall of the Hockey Stick

In the years immediately after the 2001 IPCC report it seemed as if the sudden adoption of the Hockey Stick model of the earth's recent climate past had created a new orthodoxy which could not be challenged. Even when some scientists quietly worried that the new theory about the past climate had been adopted way too quickly or were unhappy about the way that satellite temperature readings didn't seem to fit the Hockey Stick model or they noticed that new individual proxy studies still seemed to keep showing that the Medieval Warm Period was hotter than today, they mostly stayed silent. They didn't want to be branded as '*deniers*' after all.

Then an unlikely hero emerged in the shape of Stephen McIntyre a retired mineralogist fromToronto. McIntyre is not a scientist or an economist but he does know a lot about statistics, maths and data analysis and he is a curious guy. He didn't start off as a climate sceptic but was just someone interested in the nuts and bolts of these new and apparently exciting ideas about climate change, and he was curious about how the Hockey Stick graph was made and wanted to see if the raw data looked like hockey sticks too. In the Spring of 2003, Stephen McIntyre requested the raw data set used in the Hockey Stick paper from Mann. After some delay Mann arranged provision of a file which he said was the one used in the original 1998 Hockey Stick paper and McIntyre began to look at how Mann had processed all the data from the numerous different proxy studies cited as his source material and how they had been combined to produce the average that was the basis of the famous Hockey Stick shape.

About this time Steve McIntyre linked up with Ross McKitrick a Canadian economist specialising in environmental economics and policy analysis. Together McIntyre and McKitrick began to dig down into the data that Mann had used in his paper and the statistical techniques used to create the single blended average used to make the Hockey Stick. *They immediately began to find problems.*

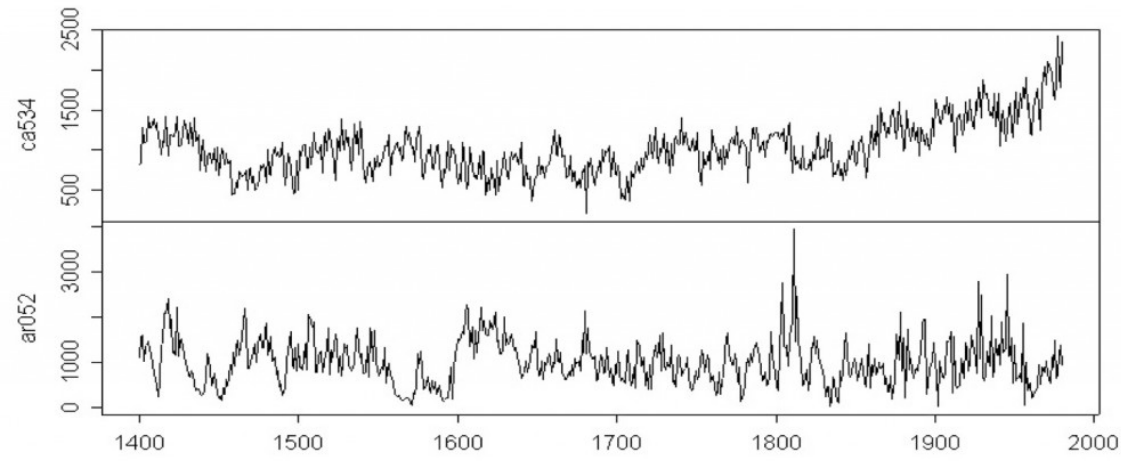
Some of these problems just seemed the sort of errors that are caused by sloppy data handling concerning location

labels, use of obsolete editions, unexplained truncations of available series, etc. Although such errors should have been spotted in the peer review process and they would adversely affect the quality of Mann's conclusions they had a relatively small effect on the final results.

But McIntyre and McKitrick found one major error, an error so big that it invalidated the entire conclusion of the whole paper. *A whopper of an error.*

As we have seen what Mann had done was blend together lots of different proxy studies of the past climate going back a 1000 years and then produced an average of all these studies and a single graph showing the trend. Clearly the validity of the techniques used to blend together and average the different data from the various different studies was absolutely critical as to the validity of the final conclusions reached and the resulting Hockey Stick graph. This sort of blending of data sets is a very common statistical exercise and there are very well established techniques for undertaking such an exercise, these techniques use values that are called 'principal components' (if you want to know a lot more about the technical details then download McKitrick's paper from here). What McIntyre and McKitrick discovered was that *Mann had used very unusual principal component values and the effect of the choice of value used had drastically skewed the outcome* of the blending and averaging exercise. Effectively what Mann's odd statistical techniques did was to select data that had any sort of Hockey Stick shape and hugely increase its weight in the averaging process. *Using Mann's technique it meant that any data was almost certain to produce a spurious Hockey Stick shape.*

Here is an example of the sort of things Mann was doing to the raw date.



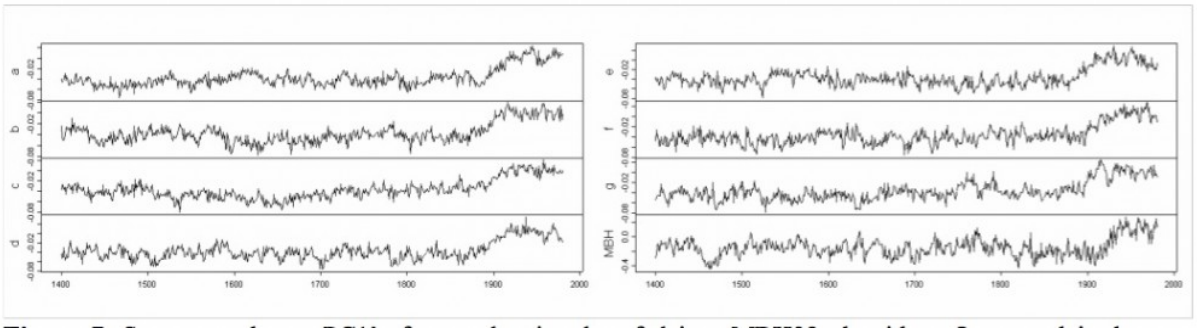
Above are two separate temperature reconstructions running from 1400AD, both use tree rings, one is from California and one is from Arizona. Both were were part of the data used by Mann and included in the Hockey Stick average. The top one shows a temperature up tick at the end in the 20th century like the final Hockey Stick, the other shows a relatively flat temperature for the 20th century. *Mann's statistical trick gives the top series, the one with the desired Hockey Stick shape a weighting in the data that is 390 times that of the bottom series just because it has a Hockey Stick bend at the end.* This means that whatever data is fed into Mann's statistical manipulations is almost bound to produce a Hockey Stick shape whether it is actually in the data or not.

McIntyre and McKitrick then took their critical analysis a step further. When you apply a statistical manipulation to a set of data it is important to make sure that what you doing is not actually distorting the data so much that you are really just creating something new, spurious and false in the numbers. One way to do this is to take the statistical manipulation in question and apply it to several examples of random numbers (sometimes this is called a Red Noise test). To simplify, you use random numbers as input data, then apply the statistical technique you are testing to the

random numbers then if the techniques are sound you should get a set of random numbers coming out the other end of the calculations. There should be no false shape imparted to the random noise by the statistical techniques themselves, if what you get out is random numbers then this would prove that the techniques you were testing were not adding anything artificial to the numbers. This is what McIntyre and McKitrick did using the techniques that Mann had used in the Hockey Stick paper. *And the results were staggering*.

What they found was that 99% of the time you could process random data using Mann's techniques and it would generate a Hockey Stick shape. This meant that Mann's claim that the Hockey Stick graph represented an accurate reconstruction of the past climate was in tatters.

Here are some examples. Below are eight graphs. Seven were made by processing random numbers using Mann's techniques. The eighth is the actual Hockey Stick chart from Mann's paper. *See if you can spot which is which.*



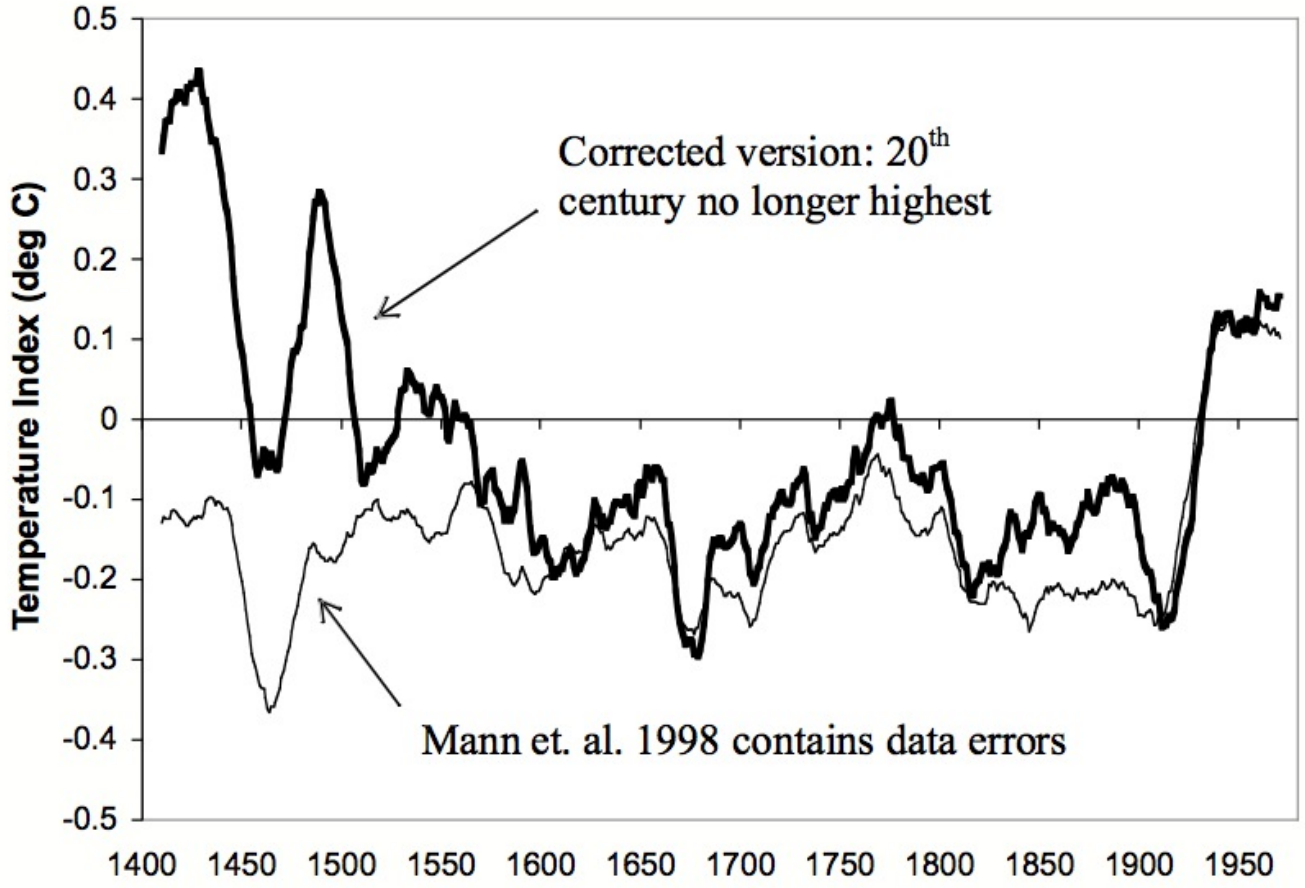
McIntyre and McKitrick submitted a letter to Nature about the serious flaws they had uncovered in the methodology used in the Hockey Stick paper. After a long (8-month) reviewing process Nature notified them that they would not publish it. They concluded it could not be explained in the 500-word limit they were prepared to give McIntyre and McKitrick, and one of the referees said he found the material was quite technical and unlikely to be of interest to the general readers!

Instead of publishing anything from McIntyre and McKitrick explaining the serious errors that they had found Nature allowed Mann to make a coy correction in an on-line Supplement (but not in the printed text itself) where he revealed the nonstandard method he had used, and added the unsupported claim that it did not affect the results.

Eventually in 2003, McIntyre and McKitrick published an article entitled "Corrections to the Mann et al. (1998) Proxy Data Base and Northern Hemisphere Average Temperature Series" in the journal Energy and Environment raising concerns about what they had found in Manns Hockey Stick paper. By this point following further work analysing Mann's paper McIntyre and McKitrick showed that the data mining procedure did not just pull out a random group of proxies, instead it pulled out a single eccentric group of bristlecone pine chronologies published by Graybill and Idso in 1993 called the Sheep Mountain series.The original authors of the bristlecone study have always stressed that these trees are not proper climate proxies, their study was not trying to do a climate reconstruction and that they were surprised that Mann included it in the Hockey Stick data set. McIntyre and McKitrick had discovered that just removing this odd series from Mann's proxy set and then applying Mann's own eccentric statistical averaging caused the Hockey Stick shape to disappear. *This revolutionary new model of the recent climate past was that fragile and it revealed the Hockey Stick graph as just a carefully worked artificial creation.*

In the graph below the dotted line is the original Hockey Stick chart as published by Mann and as adopted and promoted by the IPCC. The solid line shows the past temperature reconstruction if the data used by Mann is averaged using the correct statistical analysis techniques rather than Mann's unconventional ones. A*s can be seen the familiar Medieval Warm Period re-emerges and the 1990s cease to be the hottest of the millennium, that title*

is now claimed by the early 1400s.



In doing this research McIntyre and McKitrick had legitimately accessed Mann's public college web site server in order to get a lot of the source material, and whilst doing this they found the data that provoked them to look at the bristlecone series *in a folder entitled "Censored"*. It seems that Mann had done this very experiment himself and discovered that the climate graph loses its hockey stick shape when the bristlecone series are removed. In so doing he discovered that the hockey stick was not an accurate chart of the recent global climate pattern, it is an artificial creation that hinges on a flawed group of US proxies that are not even valid climate indicators. But Mann did not disclose this fatal weakness of his results, and it only came to light because of McIntyre and McKitrick's laborious efforts.

You can download McKitrick'ss own account of the whole Hockey Stick saga here and this web page compiled by McIntyre and McKitrick has a list of links and documents relating to the Hockey Stick controversy.

Following the publication of McIntyre and McKitrick's critique of Mann's work there was an immediate counter attack by some climatologists who had worked closely with Mann in the past. The attack on McIntyre and McKitrick's critique of Mann's work really boiled down to saying that of course the Hockey Stick disappeared if you stopped using Mann's techniques and that you should carry on using Mann's techniques and then you could get the Hockey Stick back!

Eventually a US senate committee of inquiry was set up under the chairmanship of Edward Wegman a highly respected Professor of mathematics and statistics and in 2006 his report was published. You can download it here.

The report examined the background to Mann's Hockey Stick paper, the paper itself, the critique of it by McIntyre

and McKitrick and took evidence from all the key players. Interestingly Wegman's committee commissioned some original research into how the small world of climatology actually worked. The study of the social networking of the paleoclimatology world showed how closed it was and how often a small group of scientists both co-wrote and peer reviewed each others papers. For work that depended so much on making statistical claims about trends it was noted that it was surprising that no statisticians ever seemed to be involved in either the research work itself or its peer review.

The key finding in the WEgman Report was that "Our committee believes that the assessments that the decade of the 1990s was the hottest decade in a millennium and that 1998 was the hottest year in a millennium cannot be supported by the MBH98/99 [*the technical name of Mann's original Hockey Stick paper*]"

The other conclusions of the Wegman Report are also very interesting; It listed the following conclusions:

Conclusion 1. *The politicization of academic scholarly work leads to confusing public debates. Scholarly papers published in peer reviewed journals are considered the archival record of research. There is usually no requirement to archive supplemental material such as code and data. Consequently, the supplementary material for academic work is often poorly documented and archived and is not sufficiently robust to withstand intense public debate. In the present example there was too much reliance on peer review, which seemed not to be sufficiently independent.*

Conclusion 2. *Sharing of research materials, data, and results is haphazard and often grudgingly done. We were especially struck by Dr. Mann's insistence that the code he developed was his intellectual property and that he could legally hold it personally without disclosing it to peers. When code and data are not shared and methodology is not fully disclosed, peers do not have the ability to replicate the work and thus independent verification is impossible.*

Conclusion 3. *As statisticians, we were struck by the isolation of communities such as the paleoclimate community that rely heavily on statistical methods, yet do not seem to be interacting with the mainstream statistical community. The public policy implications of this debate are financially staggering and yet apparently no independent statistical expertise was sought or used.*

Conclusion 4. *While the paleoclimate reconstruction has gathered much publicity because it reinforces a policy agenda, it does not provide insight and understanding of the physical mechanisms of climate change except to the extent that tree ring, ice cores and such give physical evidence such as the prevalence of green-house gases. What is needed is deeper understanding of the physical mechanisms of climate chang*e.

Generally the response of the IPCC, the supporters of the CO2 hypothesis and the broader coalition of climate campaigners to all this was a cross between a sneer and a yawn, and the Hockey Stick continued to be used widely as a campaigning and propaganda tool.

It is still being used today.

In 2008 the BBC paid for a large truck to tour central London displaying a giant version of Mann's Hockey Stick as part of the promotion of its very pro CO2 warming mini series called "Climate Wars".

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