Global Warming Skepticism for Busy People

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Contents

Preface

"We find that whole communities suddenly fix their minds upon one object, and go mad in its pursuit; that millions of people become simultaneously impressed with one delusion, and run after it, till their

attention is caught by some new folly more captivating than the first."—Charles Mackay, in *Extraordinary Popular Delusions and the Madness of Crowds* (1841)

While science and technology have progressed rapidly in the last 200 years, human nature has changed very little. In 2008 I published the *New York Times* best-selling book *Climate Confusion*. At that time the global warming debate was already contentious, yet most people were open to reason based upon the evidence.

Today it's worse. Rampant "fake news," decreasing scientific literacy, and increasing political polarization have led to what was mere confusion over the global warming issue to degrade into what Scottish journalist Charles Mackay in 1841 called a "popular delusion." The number of natural events allegedly caused by human-caused carbon dioxide (CO2) emissions from fossil fuel burning has exploded, with virtually every observed change in nature being blamed on the coal, petroleum, and natural gas we burn to meet most of the energy needs of humanity. An enterprising person in the UK used to maintain a list of the hundreds of effects allegedly caused by global warming. Many were contradictory, *more snow* and *less snow*; *more hurricanes* and *fewer hurricanes*; *more Antarctic ice* and *less Antarctic ice*; *forest decline* and *forest expansion*.

Those of us fighting against this silliness used to be able to count on the freedom of the internet to allow us to provide some balance through websites and blogs. All one had to do was an internet search to find "skeptical" or "contrarian" views. Unfortunately, in 2018 Google down-ranked many skeptical websites in an attempt to counter "fake science." It also attached links to more mainstream web sources on YouTube videos posted by skeptics.

In fact, at this writing, the first ten results from a Google search on the phrase "climate skepticism" are for web pages arguing *against* it. This bias is making it increasingly difficult for open-minded citizens to access the full spectrum of views on the subject so they can become better informed.

While Google is worried about fake science in skeptical YouTube videos, it apparently has no trouble with Bill Nye's faked global-

warming-in-a-jar experiment in his video entitled "Climate 101 with Bill Nye," which from its description is meant to "stand up for reality."

As will be described later, it is not possible to demonstrate the atmospheric warming effects of CO2 in a laboratory by putting CO2 and a thermometer in a jar. The climate research community knows that. Nevertheless, I hear no complaints from the mainstream scientific community, and Google has put no disclaimer or links to explanations of this deception on the Bill Nye video. Apparently, fake science is acceptable as long as it supports a politically correct point of view.

While websites touting the most ridiculous and outlandish claims about global warming continue to be embraced by Google, scientific research increasingly supports the view that the climate change problem isn't as serious as originally feared. But you wouldn't know that based upon what you read from news outlets and social media. "If it bleeds, it leads" in news reporting, and any good news about global warming is not likely to be covered by the media. Instead, a small group of activist scientists and politicians (with complicit news media) continue to fuel an increasingly shrill and exaggerated narrative of impending doom and warnings of a future "hothouse Earth," despite the lack of convincing evidence to support their extremist claims.

Scientists like me who do not dispute some human influence on climate are called "climate deniers," degrading the scientific debate and feeding the biases of extremists. While hundreds of millions of dollars flow from wealthy donors like George Soros, Tom Steyer, and even the U.S. government into environmental activist organizations supporting alarmist websites and advocacy groups, petroleum companies spend very little money on such efforts. They don't need to because consumers will continue to buy their products. The hydrocarbon fuel industry knows wind and solar energy are still too impractical and too expensive to meet more than a small fraction of humanity's energy needs.

The public remains largely skeptical of apocalyptic scenarios. While Al Gore has stated, "*the climate crisis is now the biggest existential challenge humanity has ever faced*", the most recent (2018) Gallup poll of issues most worrisome to Americans revealed that only 2% of 1,033 adults polled listed any issue under "Environment/Pollution" as their top concern. The reason is that people do not actually see the effects of

climate change in their lives. Yes, they see hurricanes, tornadoes, floods, droughts, wildfires, and snowstorms, but these events have always happened and always will. Satellite data over the last 40 years suggest that global warming of the atmosphere has progressed at a snail's pace, +0.13 C per decade, with no attendant increase in severe weather events. Surface warming has been somewhat greater but is still too weak for anyone to notice in a lifetime.

Even that modest rate of warming might not be entirely our fault. The potential role of Mother Nature in recent warming has been little studied and so is simply assumed to be virtually non-existent. As we will see, claims of a human fingerprint on recent warming are at best unproven, at worst untrue; global warming is manifested in the same way, whether human-caused or natural.

This book is partly in response to the many requests I get for a single go-to reference to the "skeptical" position on climate change. Unfortunately, not all skeptical scientists agree on the reality, magnitude, causes, and consequences of climate change, so I cannot speak for them all. I am considered a "lukewarmer:" a believer that billions of people can have some warming influence on the climate system, but that our influence is rather small and probably benign.

I accept some of the science underpinning the theory of anthropogenic (human-caused) global warming (AGW), but as they say, the devil is in the details. The physics underlying global warming predictions strongly supports a small warming tendency, but theories about that warming being magnified to worrisome levels are much less certain.

The forecast of serious climate change impacts does not depend upon the well-known physics of most atmospheric processes; it instead depends upon poorly known and obscure "feedback" processes. Despite our lack of knowledge of them, those feedbacks will determine whether human-caused climate change is relatively benign, catastrophic, or something in between. This uncertainty allows alarmists to cite the "possibility" of extreme scenarios as serious science when the scenarios are better described as science fiction.

Thus, in a very real sense, catastrophic climate change is a matter of faith—not science. Another way to phrase it is, the scientific support for

a small portion of predicted warming is pretty good, while for strong warming it is extremely speculative.

Over the years I have given hundreds of TV and radio interviews, lectures, and congressional testimonies. I've always strived to simplify the message and reduce it to its basic components. This book represents my latest attempt at accomplishing that. In some sense it is an updated version of my first book, *Climate Confusion*. I will cover the basic issues one needs to understand to be sufficiently knowledgeable on the subject to discuss it with others and to influence the government regarding environmental regulations and energy policy. I will assume the reader has a minimum level of science education, and I'll use real-world analogies to illustrate possibly difficult points.

My hope is that this short book will provide you not only a summary of the most important science to make you a better-informed citizen, but also the basic physical concepts to keep in mind when confronting new warnings of gloom and doom. I want you to be able to think critically, rather than just recite scientific findings. I have tried to address what I consider to be the most important evidences supporting a skeptical view on climate change. I might have left out a few, which can be quickly remedied with later editions.

I hope you will find it enlightening and useful.

1. Overview of the Reasons for Skepticism

There are good reasons to be skeptical of the theory that humans have caused all (or even most) of any recent increase in global average temperature. The science of climate change is exceedingly complex and uncertain. There is historical evidence of natural warm events in the past 2,000 years, and natural climate change could be responsible for much of recent warming. Since we do not understand the causes of natural climate change, climate science papers and proposals are heavily biased toward the assumption of human causation. The news media are only

interested in covering predictions of doom, which further amplifies the bias.

“There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.”
— Mark Twain, *Life on the Mississippi*

1.1 Not all science is created equal

Science has led to many remarkable discoveries and technological innovations. Nevertheless, I agree with Mark Twain: some science is shaky, at best.

As an example of well-established science, the gravitational force has been quantified well enough to make accurate predictions of when a full moon will occur 100 years in advance. We have perfected the art of rocket propulsion, guidance and communication systems, robotics, and digital imaging to the point where we can send rovers to Mars that transmit beautiful color images of the Martian landscape back to Earth.

Smart phones are a miracle of modern science and technology. Many scientific discoveries have enabled us to invent a little gadget we can carry in a pocket that allows us to communicate with each other instantly across the globe, enjoy our favorite movies or music, see exactly where we are on Earth with the help of GPS satellites, and have access to most of the accumulated knowledge of humankind. This is an invention that seemed inconceivable only fifty years ago.

These are just a few of the successes that give science a good reputation.

Yet some scientific problems are exceedingly difficult and slow to progress. The main scientific concern over climate change has been that increasing levels of greenhouse gases in the atmosphere (mainly carbon dioxide, CO2) primarily from humanity’s burning of fossil fuels, is causing global-average warming. To the extent warming is occurring, one might also be concerned about changes in weather patterns, the frequency and intensity of storms, droughts, etc.

But the complexity of weather (and thus climate, or time-averaged weather) makes scientific progress exceedingly slow and uncertain. Yes, we understand pretty well how climate *on average* operates, but

the potential causes of climate *change* are entirely debatable. Some fields of science involve such extreme complexity that we might never have satisfactory answers to outstanding questions. It is when scientists in such areas claim unwarranted confidence that science gets a bad reputation, even as it did in Mark Twain's day.

It is often said that science is self-correcting, and that eventually the scientific establishment gets closer to the truth. In general, I believe this to be true. But it can take decades for progress and self-correction to occur. And, as we shall see, meddling by political influences can actually retard progress.

In a Reason.com article entitled "Most Scientific Findings are Wrong or Useless", Ron Bailey lists numerous examples and studies that have concluded that the scientific literature is littered with junk. Many published studies have been shown to be non-reproducible, especially in medical fields.

Peer review is a useful, but not foolproof, way to ensure that good science gets funded and published. Unfortunately, as scientists become more specialized, there are fewer and fewer scientists in each specialty qualified to provide peer review of research proposals and publications. This leads to either (1) reviewers simply having to assume authors know what they are talking about (I have been in that position as a reviewer many times), or (2) only a small group of researchers continually reviewing each other's work, which leads to groupthink and a lack of innovation. To illustrate the sad state of peer review, hoax papers have even been published—after peer review.

While publication of bad science is one problem, another is the active suppression of good science. This has been happening for many years in climate research, where papers submitted for publication by skeptics are rejected outright for what would be only minor objections if they were in alarmist papers. When one study of which I was a co-author was peer reviewed and published in the journal *Remote Sensing*, the editor of that journal resigned under pressure. His resignation was most likely forced by a single influential alarmist scientist who had financial leverage over the editor's funding. Our paper was never retracted for its content, and I continue to stand by the science it contained. But because our findings did not support the global warming consensus

view, someone had to be punished for letting the paper pass peer review.

I have even had papers rejected for publication where I could demonstrate the reviewers did not read them. How did I know? The reviewers raised objections to issues not even contained in the papers! Journal editors usually do not have time to read every paper, so they just go along with reviewers' conclusions and recommendations.

Skeptics' complaints of biased peer review used to be considered sour grapes. Then people became believers after the unauthorized release of thousands of emails from the University of East Anglia (UEA) in November 2009, an event dubbed "Climategate." The emails revealed just how cutthroat a core group of influential alarmist climate scientists had become. For example, Phil Jones of UEA wrote to Michael Mann (of Hockey Stick fame) in an email labeled "HIGHLY CONFIDENTIAL:"

"I can't see either of these papers being in the next IPCC report. Kevin [Trenberth] and I will keep them out somehow—even if we have to redefine what the peer review literature is!"

This behavior was no surprise to those of us in the skeptic community trying to get papers published and research proposals funded.

The suppression of alternative views exists in other fields, too. It wasn't until relatively recently that medical science finally accepted that peptic ulcers have a bacterial basis. Australian researchers Barry Marshall and Robin Warren were shunned by their peers for years because of their theory, yet were ultimately awarded the 2005 Nobel Prize in Physiology or Medicine. It boggles my mind that modern medicine had millions of patients to study and had not solved the ulcer problem many decades ago, yet global warming has only one patient (the Earth) to study, allegedly with a slight fever, and we are expected to believe science has the correct diagnosis even though there is abundant evidence the Earth has had fevers before?

How could thinking people *not* be skeptical when it comes to the outlandish claims we receive from the news media? The failure of

scientists' predictions is especially widespread in the environmental sciences. Enhanced melting of Arctic sea ice in the summer was supposed to decimate polar bear populations, yet there has been no evidence of a decline in their numbers. (Polar bears were once the "poster child" for global warming, but Al Gore's latest movie *An Inconvenient Sequel* did not even mention them.) Snow was supposed to be a thing of the past, yet we continue to have snowy winters.

Paul Ehrlich's 1968 book *The Population Bomb* was wildly successful—and wildly wrong in its prediction of widespread famine and death in the 1970s due to human population growth supposedly outpacing our ability to grow food. Exactly the opposite happened. Humans are now better fed than ever before, and in countries where nutrition is still poor, the problem is almost always the result of bad economic policies.

Many scientists claim the diagnosis of the cause of global warming is obvious and can be found in basic physical principles. If basic physical principles can explain all of the global-average warming, as the climate consensus claims, then how do we account for the following?

All of the accumulated warming of the climate system since the 1950s, including the deep oceans, was caused by a global energy imbalance of 1 part in 600; yet modern science does not know, with a precision approaching 1 part in 100, ANY of the natural energy flows in and out of the climate system. It is simply assumed that the tiny energy imbalance—and thus warming—was caused by humans.

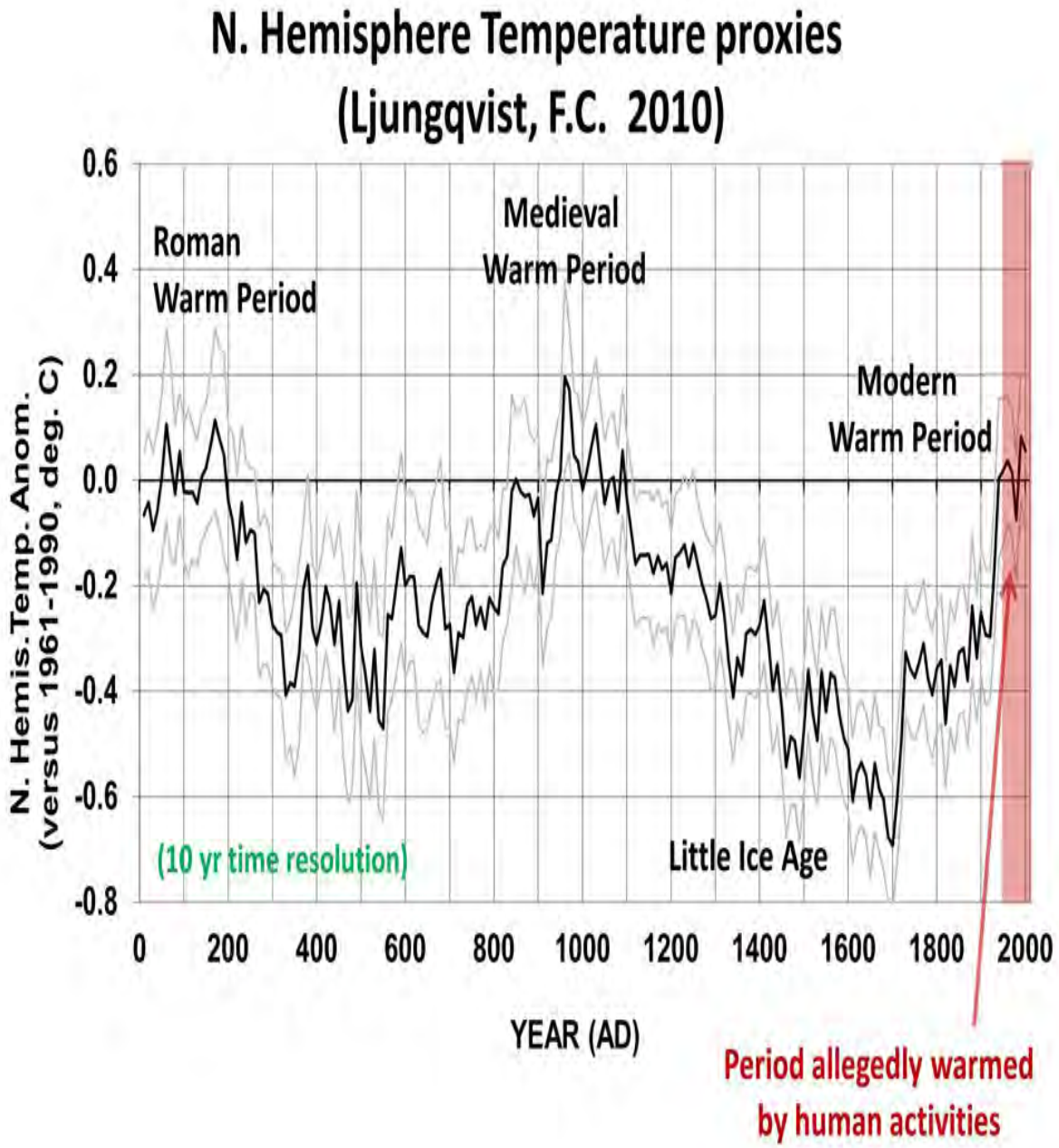
I'm not claiming that increasing CO2 isn't involved at all in recent warming. I'm saying we really can't know with any level of confidence *how much* of recent warming has been caused by humans.

And as we will see, even if the fraction of warming that is human-caused is 100%, the rate of warming is hardly alarming.

So when we talk about "science," remember that not all of science is created equal. When it comes to climate change, there is a large element of faith involved in claims of human causation. Anthropogenic Global Warming (AGW) has become the new religion of the environmental sciences.

1.2 Evidence of natural climate change

We skeptics point out that other explanations are also possible for recent warmth, especially since warm periods have existed in the past, even during recorded human history. As seen in the following plot of estimated temperature changes over the last 2,000 years, change (whether warming or cooling) seems to be the norm rather than the exception. The light grey traces represent the statistical uncertainty in the estimates.



The plot shows that the Northern Hemisphere has been warming irregularly for over 300 years as we came out of the Little Ice Age. The historical evidence for this is abundant, as detailed in Hubert H. Lamb's famous book *Climate, History and the Modern World*. While the above plot suggests substantial warming since the 1600s, humans cannot be blamed for any significant amount of warming until after about 1950, which is when atmospheric CO2 concentrations began to increase markedly. So, how is it that warming from about 1700 to 1950 was natural, but warming since 1950 isn't?

As we will see later, proxy evidence for long-term variations in Arctic sea ice supports this reconstruction of natural multi-century variations in the climate system. Recent warming of the Arctic and the recession of glaciers there are often pointed to as "canary in the coal mine" evidence for human causation, yet multiple glaciers in Alaska and western Canada are revealing tree stumps as they recede—which means it was warmer before they formed than it was at least until very recently. For example, the receding Mendenhall Glacier in Alaska has uncovered tree stumps carbon dated to 1,000 to 2,000 years old:

Warming In the Arctic is Revealing Evidence of Natural Climate Change

Tree stumps (dated to be 1,000-2,000 years old) at the terminus of receding Mendenhall Glacier (Alaska) reveal that glaciers change naturally on long time scales, and that there have been periods of Arctic warmth before.

Obviously, previous episodes of warmth in Alaska were prolonged enough for mature forests to grow, and the timing appears to coincide roughly with the Roman Warm Period and Medieval Warm Period.

No one really knows what causes natural climate change, although there are several theories. There is clearly a need for second opinions … and a healthy dose of skepticism when scientists claim they are certain humans are to blame.

1.3 Climate models do not simulate natural climate change

Computerized climate models, often containing hundreds of thousands of lines of computer code, provide the quantitative basis for proposed reductions in carbon dioxide emissions to limit global warming. But one of the dirty little secrets of the climate modeling business is that models cannot reproduce natural climate change. In fact, when those models are constructed, they are adjusted so they do *not* produce any natural climate change. Any long-term temperature trend is considered to be what modelers call spurious model "drift" and is programmed out, based upon the assumption that the climate system doesn't change naturally on the time scale of hundreds of years.

Since climate modelers don't understand the cause of natural climate cycles, let alone be able to model them, they revert to what they do know: Humans are producing carbon dioxide from fossil fuel burning, and we know CO2 is a "greenhouse gas" (discussed later). So it's easy to blame CO2 for recent warming, especially when you can't think of any other causes.

So, we have this curious situation where models that cannot simulate natural climate change, but are programmed to be dominated by human-induced climate change, are used as "proof" that only humans can cause climate change. This is an example of circular reasoning, or a tautology. Modelers point to their models as evidence of what they assumed to begin with.

Since models cannot produce natural climate change, it's OK to be skeptical of models being used to prove human-caused climate change. Diagnosing the causes of warming is not rocket science—it is much, much more difficult. While some scientists might make dire predictions

because they genuinely care about global warming and believe in it, their lack of professionalism and their track record of failed predictions make them an embarrassment to the scientific community. They are a modern example of why Mark Twain, over 100 years ago, distrusted science.

1.4 Extraordinary claims should require extraordinary evidence

I've been performing research on weather or climate for nearly forty years. During that time I've witnessed the topic of global warming transition from a minor field of study to one that now permeates nearly every aspect of research in the environmental sciences. It is taught in the public schools, and it is blamed for virtually everything imaginable: Wars. Sex changes in lizards. More snow and less snow. More rain and less rain. Colder winters and warmer winters. Most recently, a paper in the *Proceedings of the National Academy of Sciences* (PNAS) was published that claimed that we could be headed towards a "hothouse Earth" as a result of climate tipping points that the extra CO2 will push us past. It drew on no new science, just speculation.

Newsweek published an article on September 3, 2018 entitled *Climate Change is about to Transform Earth into an Unrecognizable, Alien Landscape*.

When it comes to such extremist claims that climate change will kill and displace millions of people, cause massive crop failures and the collapse of the Greenland and Antarctic ice sheets, etc., we should embrace skepticism. Such extraordinary claims should require extraordinary evidence to back them up. Skepticism shows we are capable of independent, critical thought. Since much of peer-reviewed and published science ends up being wrong anyway, it seems to me that being skeptical of scientific theories is the logical initial position to take. Scientists *should* be skeptical, and this is especially true of forecasts of environmental catastrophe.

1.5 Claims of global warming theory are exaggerated

While this short book goes into greater detail, here is a quick summary of the main points supporting what I consider to be healthy skepticism when it comes to predictions of climate doom. Some of what follows is pretty well established fact, and some represents my opinions. Many skeptics will have somewhat different opinions from mine. Climate-change research is still in its infancy, and there are many possible explanations for climate change.

The theory that human-caused greenhouse gas emissions (primarily carbon dioxide) will cause dangerous levels of global warming, increased storminess, and significantly accelerated sea level rise is, in my opinion, mostly wrong.

While basic physics suggests that increasing CO2 should cause some amount of long-term warming of the surface and lower atmosphere, the magnitude of warming is very uncertain because we don't know how weather elements such as clouds will react to either magnify or reduce the warming. Determining these indirect "feedbacks" is the focus of continuing research.

The skeptical position that global warming is largely a non-problem is supported by the fact that the predicted changes have not occurred:

- **Atmospheric warming since 1979 has progressed at only about 50% the rate expected by computerized climate models.**

- **Surface warming since the late 1800s, plus recent warming of the deep oceans, is also consistent with warming being only 50% of what climate models predict.**

- **It is possible that some of the warming is natural, in which case the difference between model projections of human-caused warming and actual observed warming is even greater, and hence the risk from human-caused warming is even smaller.**

- **There is little to no evidence of increased storminess or any other changes in weather outside the range of natural variability.**

- **Global sea-level rise continues to be slow (about 1 inch per decade), mostly a continuation of natural rise that has been measured since the mid-1800s. The potential human enhancement of that rise since 1950 has been about 0.3 inch per decade.**

This is why climate change routinely ranks near or at the bottom of the periodic Gallup Poll surveys of Americans' environmental concerns, including the most recent (2018) poll. Despite alarmist rhetoric, people don't actually see climate change occurring in their lives. Global warming is too weak for people to actually feel in their lifetimes. Even the viewers of politically left-leaning MSNBC seem to be rather uninterested; commentator Chris Hayes tweeted on July 24, 2018, "*almost without exception, every single time we've covered [climate change] it's been a palpable ratings killer.*"

We do indeed see storms, droughts, wildfires, floods, heat waves, cold waves, hurricanes, and tornadoes, but these events have always occurred. In some cases they were even worse in centuries past. The modern-day blaming of weather events on human-caused climate change in news reports is, at a minimum, intellectually lazy, and is probably more aptly described as journalistic malpractice and fearmongering. Admittedly, some in the science community have enabled this feeding frenzy.

Why then does it seem to so many like our weather is getting worse? It is partly because alarmism pervades the news on an almost daily basis. "If it bleeds, it leads," and any new science that suggests climate change might be benign or even beneficial is not very newsworthy. The news media tend to report only the direst predictions. I stopped watching The Weather Channel over a decade ago because of its increasing obsession with disasters and extremist global warming predictions.

For example, which of these is more likely to be reported: that a tornado that just hit some town was the worst in that town's history, or that some other town hasn't had a destructive tornado in its history at all? Obviously, the former will be reported. With the global reach of modern news increasing each year, reporting of only weather disasters

gives the illusion that weather is worsening, despite objective evidence to the contrary.

Pundits like Al Gore, Neil deGrasse Tyson, and Bill Nye "the Science Guy" then further exaggerate what is reported. Next, public school teachers repeat all of the misinformation to their students, relying on textbooks written by poorly informed authors, many with only a superficial knowledge of science. Alarmist theories are presented as fact. Is it any wonder our young people grow up believing humans are destroying the Earth?

"Because *Science*!" is today's mantra, expressing at the same time both our reliance upon science and our credulity when listening to the pundits of modern pop science. So, it is easy to see why a huge disconnect might exist between what most of the public has been led to believe and what can be convincingly demonstrated with evidence.

Climate science is exceedingly complex, probably much more complex than even the climate research community realizes. It is too easy to get lost in the weeds on the scientific details, and as a result the public tends to throw up its collective hands and just assume the consensus of the experts is probably correct. But as I will show, **what the consensus—the *real scientific* consensus—represents is rather unremarkable and is far removed from the global warming Armageddon that is often portrayed.**

2. The Five Big Questions

In order for global warming to be a problem serious enough for us to address through changes in energy policy, a series of five questions must be answered in the affirmative. If any one of them is the weak link, the chain is broken. It is not obvious that any one of five questions can be answered "yes."

This chapter is very short, but very important. There are five main questions which must be answered in the affirmative before energy policy changes to fight global warming should even be considered:

1) Is warming and associated climate change mostly human-caused?

2) Is the human-caused portion of warming and associated climate change large enough to be damaging?

3) Do the climate models we use for proposed energy policies accurately predict climate change?

4) Would the proposed policy changes substantially reduce climate change and resulting damage?

5) Would the policy changes do more good than harm to humanity?

The answers to all five questions need to be “yes” in order to make substantial changes to our energy policies beyond what free market forces dictate. Yet, it is not obvious to me that the answer to any of the five questions is “yes.”

Note that, even if the science of climate change were settled, that would not necessarily demand policy action. When we weigh the costs versus benefits of proposed policy changes, the issue becomes murky and the future policy course is not at all obvious.

While I am most interested in the scientific debate, here is the main reason why I choose to speak out on the subject, even when it would be easier for me professionally to abandon my skepticism and join the scientific consensus:

Poverty kills, and forcing people to use more expensive energy will worsen poverty.

Yes, fossil fuels are probably a finite resource. But as they become scarcer, their price will rise, and other sources of energy will become economically competitive. Innovation will lead to new energy technologies. Because everything humans do requires energy, energy demand *will* lead to energy supply.

But we cannot discover new energy technologies by government mandate.

3. Skepticism versus Alarmism

Global warming skeptics and alarmists have a wide spectrum of views regarding climate change and energy policy. In contrast, the media narrative is that people are either believers or deniers of scientific fact. This is a gross misrepresentation of the science and damaging to reasoned debate.

"*Never discuss politics or religion in polite company*"—author unknown.

As a matter of social etiquette, discussion of religion or politics was once considered taboo since it too often led to heated disagreements. I would be tempted to add "global warming" to the list, but the categories of "politics" and "religion" already have global warming covered.

The battle between skeptics and alarmists (as I will call them) has been raging for decades, and is usually less than polite. While science is claimed to be the focus of the debate, political and religious leanings often provide the fuel, and science is used as a weapon.

Or sometimes, weapons are used as a weapon. On the weekend of the 2017 "March for Science," seven shots were fired from the street into the university building where my colleague John Christy (another skeptic) and I work, all clustered near John's office. The timing of the incident and location of the bullet holes were no accident. Based upon the shell casings found, the gun was aimed through trees to hit a specific portion of the building; most of the rest of the building is unobstructed by trees, and would have been a much easier target for someone just wanting to randomly use the side of a building for target practice.

Over the years many of us skeptics have received hate mail, even threats of violence. To be fair, the same has happened to outspoken alarmist climate scientists, too. Everyone likes to invoke science to support her case ("Because *Science*!"), but don't like it when others do the same to support an opposing point of view.

There is no formal definition of a skeptic or alarmist when it comes to people's views on climate change. For example, the two groups might mostly agree on the science, but disagree on whether something should be done about energy policy to try to fix the problem. Or, they might disagree on the science, but agree on the policy changes. Usually,

though, they disagree to varying degrees on both the science and the policy.

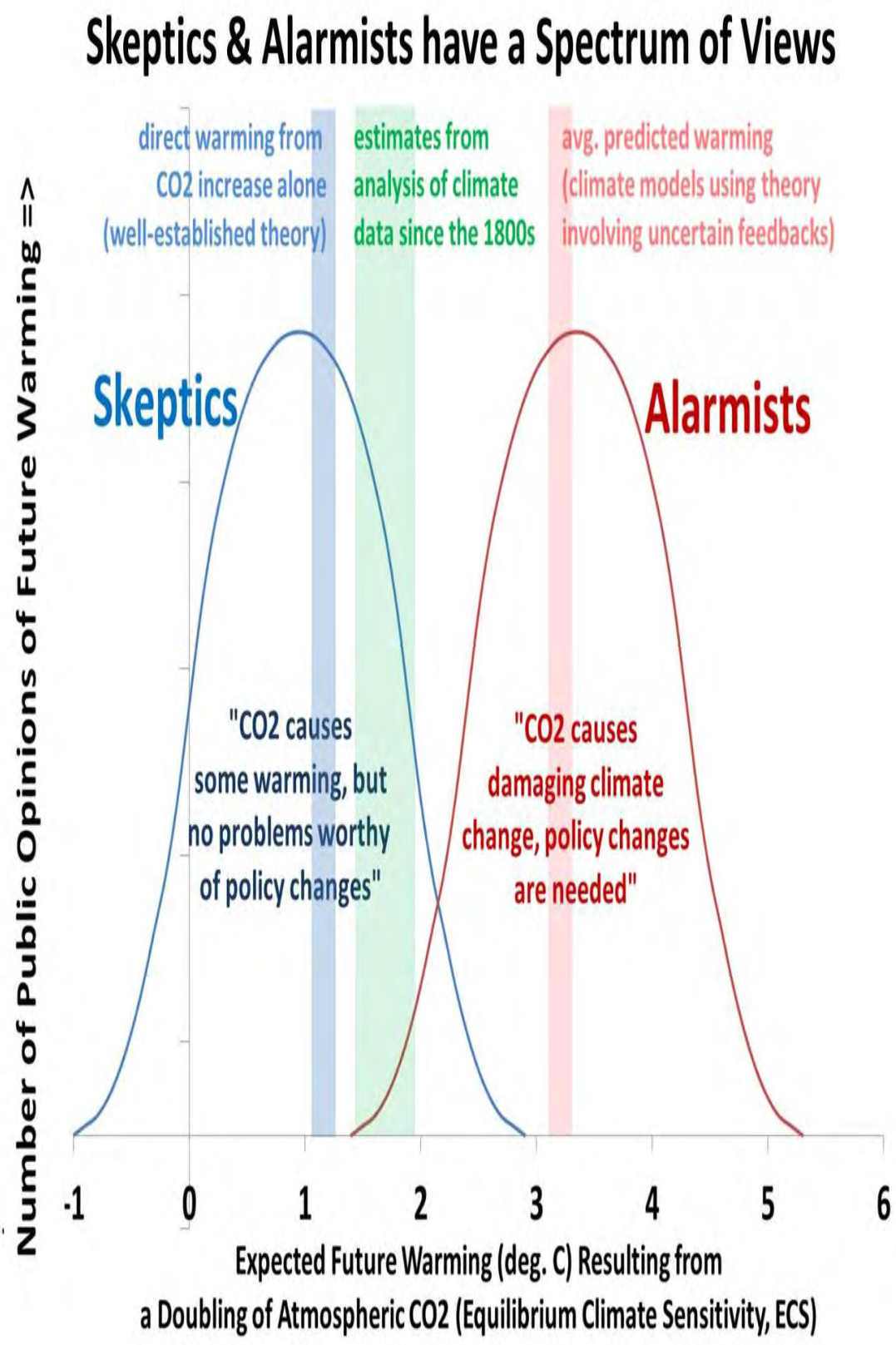
Let's start with my position on some of the most pertinent issues. I am not a denier of climate change. Climate has always changed, and always will. I am not even a denier that some (or maybe even most) of recent warming is due to humans. (As we will see, when you run the numbers, this leads to rather unremarkable predictions for future temperatures.)

I don't really care where our energy comes from as long as it is abundant and affordable enough to meet humanity's needs and allow us to prosper, while minimizing societal harm.

Furthermore, I am not paid by big business or any political organization to do climate research, or to say things I do not believe. I don't care if the CEOs of all petroleum companies eventually decide global warming is a serious problem and that we must do something about it. Their opinions do not affect me or influence me.

After a quarter century working in climate research, I've developed some sense of the spectrum of the public's views on climate change. Formal surveys of public opinion on global warming are pretty useless, because they are phrased too generally or ambiguously, such as "Do you believe in global warming?" I decided to illustrate this spectrum with the following graph containing two bell curves. This presentation is semi-quantitative at best, and represents my perception of public opinions on the subject.

It portrays skeptics and alarmists as having a range of opinions on how serious global warming and associated climate change will be, as well as a range of opinions on what (if anything) we should do about it. I did not attempt to fit all of the issues and nuanced views into the chart, because it would be too cluttered. I'm sure some skeptics and alarmists would disagree with some of the details; the chart simply represents my appraisal of public opinions today.


Skeptics & Alarmists have a Spectrum of Views
direct warming from CO2 increase alone (well-established theory)
estimates from analysis of climate data since the 1800s
avg. predicted warming (climate models using theory involving uncertain feedbacks)
Skeptics
Alarmists
"CO2 causes some warming, but no problems worthy of policy changes"
"CO2 causes damaging climate change, policy changes are needed"
Number of Public Opinions of Future Warming =>
-1
0
1
2
3
4
5
6
Expected Future Warming (deg. C) Resulting from a Doubling of Atmospheric CO2 (Equilibrium Climate Sensitivity, ECS)

I made the two bell curves equal in area because I believe the public is roughly evenly divided on the subject; if the curves only included climate scientists, the skeptic's bell curve would be shorter, since there are fewer skeptical than alarmist scientists.

Generally speaking, skeptics (the blue curve) think that human-caused global warming is weak. A few even believe more CO2 will cool the climate system. But most skeptics believe we have some warming influence on the climate system, with little to no effect on storminess, and the net impact being small, benign, or maybe even beneficial.

Skeptics also tend to believe there is little that can be done to substantially reduce fossil fuel use even if we wanted to because renewable energy technologies are generally too expensive, too intermittent, need fossil fuels as a backup, and not deployable on a large scale.

Alarmists (the red curve) generally believe in larger amounts of warming, probably 2 to 4 times the warming most skeptics believe, with serious consequences for life on Earth. Alarmists tend to claim we can make substantial reductions in harm by steering away from fossil fuels and toward renewables such as solar and wind energy.

Note I have also indicated in the above chart the amount of warming predicted from only a doubling of CO2 with no changes in the climate system other than temperature (about 1.2 deg. C, a widely-accepted calculation from theory); the average warming predicted across all climate models (also theoretical, about 3.2 deg. C, much more uncertain); and the range of warming suggested from simple energy budget studies of the observed rate of surface warming and deep-ocean warming (about 1.5 to 2 deg. C).

As a general rule, alarmists tend to believe climate model predictions. Skeptics tend to believe observation-based studies.

This is merely my personal evaluation of public opinion, which in turn is largely guided by what people learn from the news media and a variety of climate-themed blogs and books. Others will no doubt disagree with some aspects of my portrayal of skeptics and alarmists. There will always be exceptions to the general rules I have proposed.

My point is that the two schools of thought are not at opposing extremes, as is often portrayed by the media that would have you believe there are only realists who believe global warming is a critical

problem that must be solved, and deniers who don't. Not only is this incorrect, but the two bell curves of popular opinion overlap somewhat, which means some skeptics actually share some of the beliefs of alarmists.

For example, Bjorn Lomborg (author of *The Skeptical Environmentalist*) would probably represent the far right tail of the skeptic (blue) bell curve, since he generally believes the scientific consensus on global warming (substantial and even harmful warming), but thinks that adaptation to a warmer world would be better for humanity, due to the immense cost of forcing reliance on expensive solar and wind energy.

Conversely, at the far left end of the alarmist (red) bell curve would be those who are willing to admit that warming from doubling of atmospheric CO2 might well be relatively weak, but that there will be serious consequences for agriculture and life on Earth as we push the climate system even a short distance away from some presumably optimum temperature. Such people believe the climate system is fragile, that climate has remained stable for thousands of years, and that "tipping points" might be exceeded at relatively modest temperature increases with, say, much worse storms and expanding droughts. They claim we should not be meddling with the climate system at all. They (as well as most other alarmists) also tend to believe the only thing standing in the way of widespread adoption of renewable energy is corporate greed, and that moving toward "clean energy" is smart and a good insurance policy, no matter how much warming is forecast.

What about the offensive term "denier" used in reference to skeptics? I consider it to be both insulting, due to its obvious allusion to Holocaust deniers, and a gross exaggeration. The earliest direct comparison between skeptics and Holocaust deniers I could find from a mainstream journalist was in 2007:

"*I would like to say we're at a point where global warming is impossible to deny. Let's just say that global warming deniers are now on a par with Holocaust deniers, though one denies the past and the other denies the present and future.*"—Ellen Goodman, *Boston Globe*, February 9, 2007

Note that when Ellen Goodman said “global warming,” she probably intended for you to infer she meant “human-caused dangerous global warming that we must do something about.” This is a common mistake (or intentional tactic?) of journalists who, in a rush to meet a deadline, learn little of the underlying issues.

Calling someone a denier is somewhat like invoking the term “Nazi” when disagreeing with opponents. Unless there are genuine similarities to the policies or tactics of the National Socialist German Workers' Party, it is simply over the top, unnecessary, and reveals a lack of critical thinking skills.

After tiring of years of being called a denier, I wrote a blog post (“Time to bush back against the global warming Nazis”, Feb. 20, 2014) pointing out that the policies of many global warming alarmists were actually much closer to the Nazi Party than anything we “deniers” advocated. I was hoping to get alarmists to stop using such misleading rhetoric by pointing out their hypocrisy.

This drew an immediate rebuke from the Anti-Defamation League in Atlanta, which claimed offense at my supposedly casual use of the term “Nazi.” I quickly pointed out the ADL’s hypocrisy in criticizing me (“Hypocrisy at the Anti-Defamation League?”) since they turned a blind eye to years of the “denier” label (including explicit comparisons to Holocaust deniers) being pinned on skeptics. The resulting comments at the ADL website were almost unanimously supportive of my position, and the ADL made no further public comment on the matter.

To summarize, the public debate over climate change isn’t an “either-or” proposition, with people believing in either global warming so catastrophic that it demands policy action now, or a “denial” than humans have any effect on climate at all. Both sides have a range of views on the subject, and sometimes even agree on either the science or on proposed changes in energy policy to reduce reliance on fossil fuels.

4. The Unholy Alliance: Politics and Science

For 30 years, global warming research has been biased by the assumption of human causation, which helps maintain the careers and livelihoods of scientists, politicians, bureaucrats, and even some corporations. Without human causation, efforts to control the weather—and human behavior—become unnecessary.

"*Today, the solitary inventor, tinkering in his shop, has been overshadowed by task forces of scientists in laboratories and testing fields …. Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity …. We must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.*"—Dwight Eisenhower, U.S. President, 1961 Farewell Address.

"It is difficult to get a man to understand something, when his salary depends upon his not understanding it."—Upton Sinclair

I dislike the fact I feel compelled to address politics, but in order to understand the present state of the supposed consensus on climate science, we must understand how we got where we are.

Almost all climate-change research is funded by government. That means you, the taxpayer. While there might be isolated exceptions I'm not aware of, no climate research that I know of is funded by coal companies, petroleum companies, or Big Business. Claims to the contrary by Al Gore and environmentalists are simply wrong. Even if a few examples do exist, the private donations and taxpayer dollars flowing into environmental groups to advance the global warming alarmist agenda far exceed those going to oppose it. Al Gore likes to say his fight against the fossil fuel industry is "speaking truth to power", but I think "speaking power to truth" is more accurate.

Petroleum companies don't have to defend their product; they know that people will still need petroleum for a long time to come, whether it causes climate change or not. I don't recall ever seeing a TV commercial by Big Oil defending fossil fuel use against the claims of environmentalists.

Government has been on the global warming bandwagon from the beginning. If young climate researchers today are trying to build their careers, their chances of getting proposals funded by the U.S. Government are directly proportional to how seriously they portray the threat of global warming. If their research proposal themes are instead skeptical of human-caused climate change, their chances of getting funded are greatly reduced.

This is why the average age of skeptical, credentialed climate scientists today is around 60 or 70 years. We are well established in our careers, are nearing or in retirement, and don't really care if the science community does not like the result of our accumulated knowledge and wisdom. But in order for young researchers to build a career, they must go along to get along. You will not build a career in climate research if you are a skeptic, unless you remain in the closet.

Why would the government care how much a young aspiring scientist believes in human-caused climate change? Isn't the government the source of unbiased funding of scientific research? Yes, as long as the research topic has no political or public policy impact. But it would be difficult to imagine a scientific issue having more policy and economic impact than climate change. Why would we expect government-funded science to be apolitical when it is ultimately overseen by elected officials and political appointees?

As seen in the above quote, in his 1961 farewell address to the nation President Eisenhower warned us of the dangers of the trend toward government-sponsored science. When politicians have the ultimate say over who gets money for what reason, you can suspect that political motivations and desired policy outcomes will inevitably result in biased research. Additionally, Eisenhower pointed out that scientists eager to keep the funds flowing might take control of public policy to benefit their own careers.

As an ex-employee of the federal government (NASA), I can say from experience that many government employees are under constant pressure to stay relevant to the desires of the taxpayers and voters, who in turn influence Congress regarding how the public's money is spent. Unlike some other countries (like Japan), which have long funding horizons, every year the threat of cancelled research programs

looms over U.S. funding agencies, as the political winds change and new programs crop up and compete for a slice of the same revenue pie.

In such a fiscal environment, what could be better than a research focus that addresses a problem that is very long term—100 years or more—and potentially threatens life as we know it? Global warming is the ultimate cash cow for climate researchers.

As long as the global warming "problem" exists, billions of dollars of research funds can be extracted from Congress, which then supports the careers of scientists inside and outside of government. The bigger the perceived problem, the more money agencies like NASA, NOAA, DOE, EPA, and NSF can get.

Programs (and employee numbers) expand in proportion to available funds. If funds dry up, careers end.

For long-lived problems like global warming, a few of the scientists rise to the top as charismatic public spokespersons for why many billions of dollars should be spent on pet projects. Interestingly, relatively few of these pundits have degrees in the atmospheric sciences. They often come from other fields of research. It's easy to become an expert in generalities and sound bites when you never had to learn all of the details, assumptions, and uncertainties.

The benefits of alarmism are not only for the scientists and the government agencies overseeing scientific programs. If the eventual solution to the researched "problem" is through increased government regulation of the private sector, there is justification for even more government involvement and thus job security within agencies, such as the Environmental Protection Agency (EPA), that are in the business of regulation. They are constantly dreaming up new regulations, or tightening up existing ones even more than before. By congressional mandate, that's their job: to reduce pollution no matter the unintended consequences and cost to society.

In short, the modern scientific community is in bed with government, working on mutually-desired outcomes and helping each other to stay in business—and in office.

This is not a conspiracy theory, it is just the way government works. I used to be part of that system, helping to convince Congress we should spend billions of dollars to develop a system of NASA Earth-monitoring satellites (what used to be called "Mission to Planet Earth"). *I'm not*

saying this wasn't a good investment for the country; I'm saying the motivation for the investment is not unbiased. And once a long-term government program is started, it is very difficult to stop.

The United States has spent approximately $100 billion on climate-change research in the last few decades. The proposed energy policies that are guided by the science involve trillions of dollars of economic impact and will determine financial winners and losers far into the future.

This is why I bring up politics in a book about the science of global warming skepticism. Virtually all funding of climate science comes from government, so government has a vested policy and career interest in the outcome of that research, which then leads to bias. In climate research, you cannot separate the funding from desired political and policy outcomes.

Climate change science and politics are inseparable, with mutually-supporting influence flowing in both directions. There is financial incentive on the part of researchers and political incentive for those politicians who are driving the global warming gravy train—and in both cases, the incentive is to err on the side of alarmism. The stakes are too high to let the search for scientific truth proceed uncontrolled. One of the most prominent examples of this unholy alliance is Al Gore, who profited quite nicely from trading in carbon credits as he applied political pressure on Congress to support a carbon trading system.

But doesn't the science support human causation in climate change? Yes, in the sense that warming is roughly *consistent with* human causation. But warming can also be consistent with natural causes. Or, more likely, some combination of human and natural influences is involved. As I mentioned previously, *the warming of the climate system since the 1950s was caused by a global energy imbalance of only 1 part in 600, yet none of the underlying natural energy flows in and out of the ocean and atmosphere are known to anywhere near that level of accuracy.*

If government pays scientists to find only evidence of a human impact on climate, scientists will do their best to find that evidence. That is the situation today. But if government paid scientists to find natural causes of climate change, scientists would probably find increasing evidence for that, too. Unfortunately, very little of research funding goes toward

understanding natural causes of climate change. This is a situation Congress could help correct during the appropriations process, but so far has not.

Does this mean that scientists and government funding managers are part of a scam? I don't believe so. In my experience, most scientists and funding managers in climate-change research are believers and dedicated to the cause. After all, who wouldn't want to be part of Saving the Earth? Any misgivings some might have they keep to themselves, or are only revealed in highly technical discussions in meetings and at scientific conferences. Only after retiring from government service have a few government managers spoken out in support of the skeptical cause, for example NASA Headquarters' John Theon.

In contrast to scientists and funding managers, politicians promoting the climate alarmist cause are probably somewhat more opportunistic than ideological, and are working toward policy change futures to which they have decided to hitch their wagons.

But very few if any of these people could defend their beliefs with much more than platitudes (our children deserve a cleaner environment; we need to get away from fossil fuels anyway), a few catch phrases they heard somewhere (we are melting the Arctic ice cap and killing polar bears), and appeals to authority (97% of scientists agree). Their knowledge of climate change science is a mile wide, but only inches deep.

In my experience, even in the climate research community only a small fraction of scientists have the breadth and depth of knowledge to understand the weakness involved in the average climate model prediction of 3 deg. C warming as a result of doubling atmospheric CO2. Most of the climate research community is just along for the ride, assuming some other scientists know what they are talking about. And, whether they know it or not, they are participating in a politically motivated transformation of the global economy which will give more power to governments at the expense of the citizens.

Next we will examine the supposed scientific consensus on climate change.

5. How Could 97% of Scientists Be Wrong?

According to a widely publicized survey, 97% of published science papers support the view that recent warming is mostly human caused. But in contrast to the way the 97% narrative is usually expressed, only a very small fraction of published studies actually involved research into how much of recent warming has been due to human activities. Instead, the papers simply assume human causation. Therefore, the high level of agreement is rather meaningless since it merely represents groupthink rather than independent analysis and opinion.

"The greatest scientists in history are great precisely because they broke with the consensus. There is no such thing as consensus science. If it's consensus, it isn't science. If it's science, it isn't consensus. Period."—Michael Crichton, M.D., author, director, producer

"*If I were wrong*, *one would be enough."*—Albert Einstein, upon hearing a book was published entitled *"A Hundred Authors against Einstein"*

Consensus in science can be useful—but it is far from decisive. For example, I suspect that at least 97% of the medical profession used to believe that peptic ulcers were due to too much spicy food or stress. Yet they were wrong, and two rogue Australian researchers were right about their theory of a bacterial basis for ulcers, paving the way for widespread use of antibiotics for their treatment.

Climate change is much more complex than peptic ulcers. Nevertheless, that complexity has not kept most scientists from claiming that a consensus exists on the cause of climate change.

There is little doubt that popular opinion among scientists leans in the alarmist direction. One of the most influential recent studies relating to global warming was a simple survey of the climate change literature by

John Cook and associates, who examined the abstracts of published climate research papers. Their introduction states,

"We examined a large sample of the scientific literature on global Climate Change, published over a 21 year period, in order to determine the level of scientific consensus that human activity is very likely causing most of the current GW (anthropogenic global warming, or AGW)."

Significantly, this statement they were doing a survey on is a core conclusion of the United Nations Intergovernmental Panel on Climate Change (IPCC), periodic reports from which guide U.S. energy policy. In their most recent (5^{th}) report, the IPCC concluded that humanity's greenhouse gas emissions "*are extremely likely to have been the dominant cause of the observed warming since the mid-20^{th} century*."

The survey paper by Cook *et al.* found that 97% of published paper abstracts supported the consensus, and has been widely praised—and criticized. Those praising it claim the result should silence skeptics, and that it proves the overwhelming scientific support for the IPCC's conclusions.

But subsequent analysis has revealed that the papers surveyed (many of which were not even climate-science studies) merely had to acknowledge, or even simply not dispute, that a consensus exists in order to be counted as "endorsing" the consensus. Those that explicitly endorsed the consensus as stated above amounted to less than 1%, not 97%.

So, the Cook *et al.* study was a rather meaningless exercise, yet it is being misrepresented as some sort of validation that independent scientists have come to independent conclusions based upon independent examination of the evidence that humans are largely to blame for global warming.

I'm not going to go into further detail of the criticisms of the survey study here; others have already done that, such as this critique by former Director of the National Hurricane Center, Dr. Neil Frank. A more direct survey of the opinions of over 4,000 members of the American Meteorological Society found that 67% believe warming is happening and is mostly human-caused.

My point about the 97% study is so important, I want to repeat it. Just because a research paper *assumes* warming is mostly human caused is not independent evidence for human causation. Very few of the thousands of published studies (I'd guess less than a dozen) actually try to quantify the proportion of natural versus human causation. They are not independent tests of the theory; the authors are simply assuming that what others have published is correct. They are the result of a community whose members wear blinders, exist within an echo chamber, and are subject to widespread groupthink.

In reality, the vast majority of climate research studies performed in recent decades address a wide variety of issues peripheral to the global warming debate, say, the impact of climate model-predicted future warming on droughts or floods or storminess in some specific region. As such, they do not actually set out to determine whether more than 50% of recent warming was human-caused. They simply take this as a given, a profession of faith in the Church of Global Warming, and assume climate models are reliable predictors of future reality.

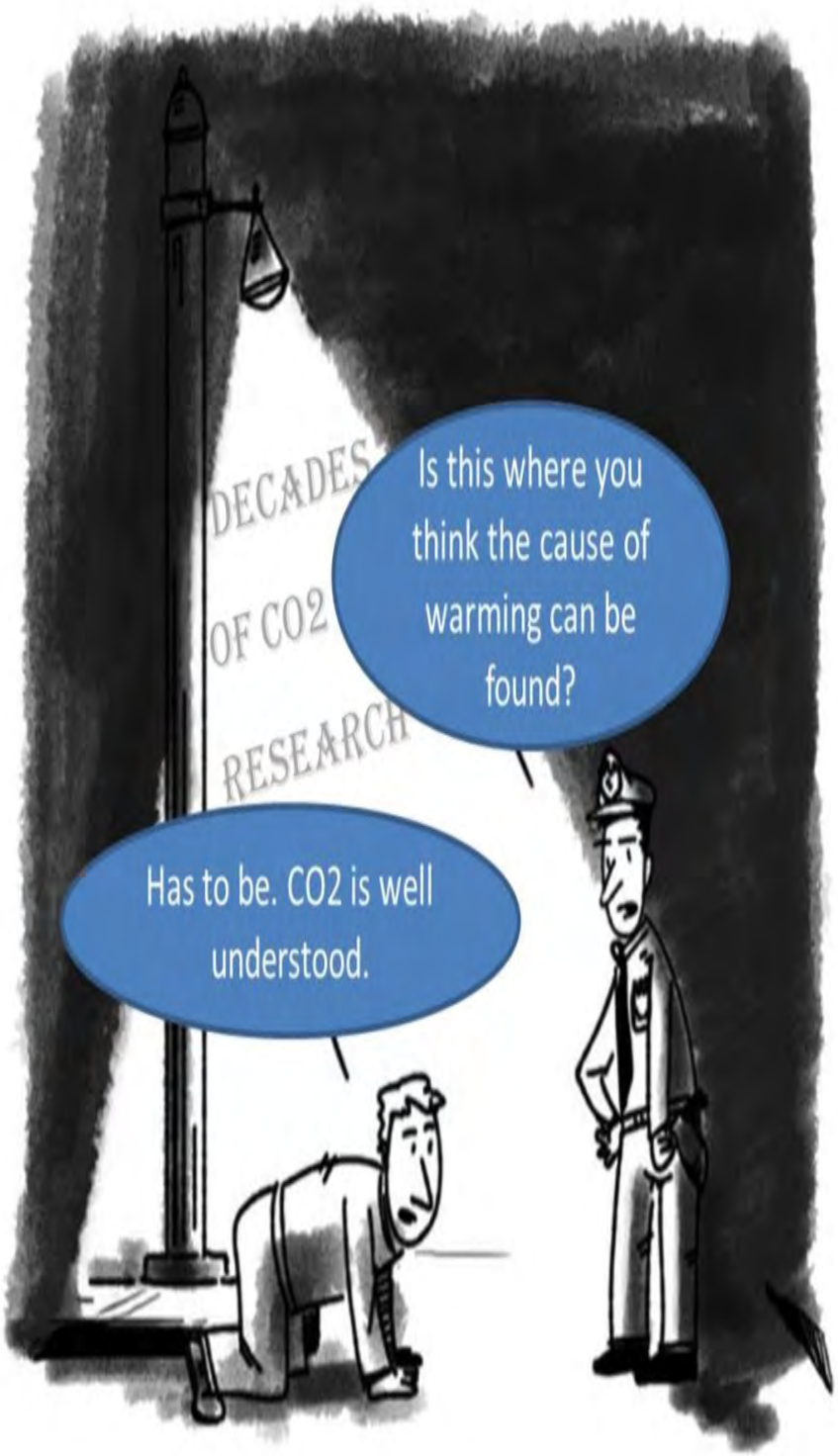
Why don't more papers tackle the thorny issue of determining how much of warming is natural versus anthropogenic? For at least three reasons:

1) We cannot separate human from natural causes of warming (there are no human fingerprints).

2) We have only a poor understanding of natural causes of climate change.

3) We cannot compute how strong human-caused warming is from first physical principles (the climate sensitivity problem, discussed later).

So, since we don't have any other easy options, we conclude CO2 must be to blame since it is a greenhouse gas and it is increasing. This is like the old story of the man who lost something on a dark street, and is looking for it under the only available streetlight. The item he lost could be anywhere, but he is looking near the streetlight because it's the only place he has enough light to see. This has been called the "streetlight effect":


DECADES
OF CO2
RESEARCH
Is this where you think the cause of warming can be found?
Has to be. CO2 is well understood.

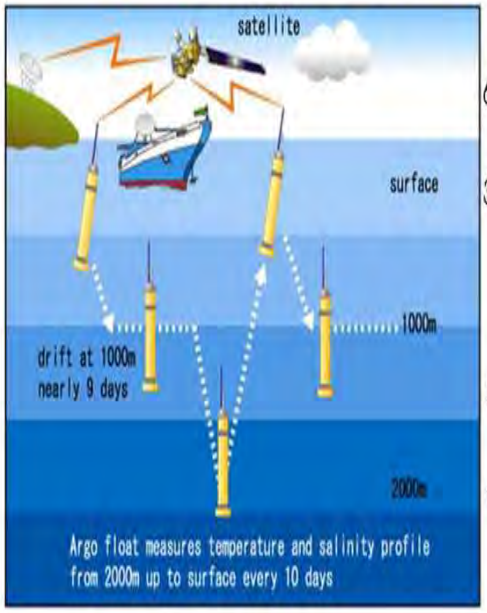
Carbon dioxide is the only cause of global warming researchers choose to see because it's something we understand relatively well in terms of its ability to change the radiative energy flows through the atmosphere. We even have Earth-orbiting satellites that exploit how CO2 absorbs and emits infrared radiation so that we can measure the temperature profile of the atmosphere, data from which are input into weather prediction models to help improve your daily weather forecast. This satellite technology has been operating for forty years.

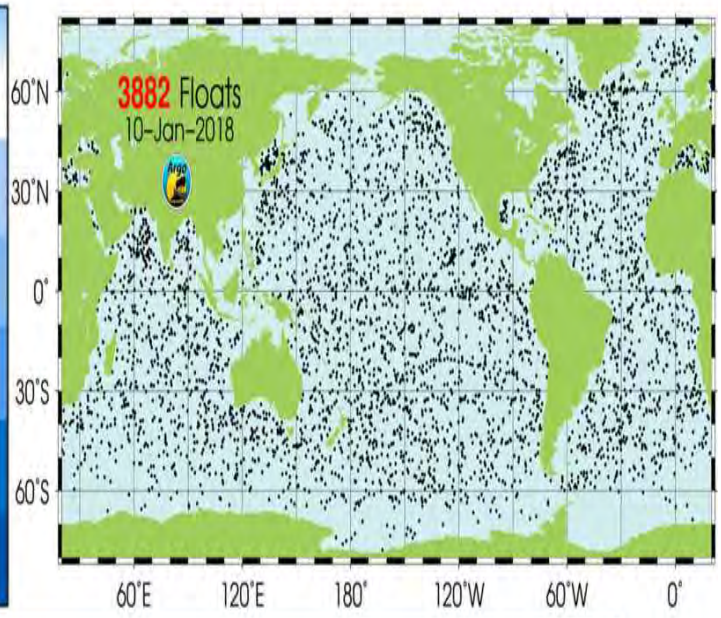
In contrast to the CO2-based theory, natural climate change is largely not understood, unpredictable, and so researchers don't look there for causes of warming. Generally speaking, unless a cause of warming (or cooling) can be quantified, it cannot be included in climate models. The physics of CO2 can be included because it has been quantified; the uncertain causes of natural climate change have not.

As discussed earlier, when the computer models were built, they were adjusted to actually prevent simulation of any long-term climate change. If the models projected any long-term natural climate change (which they all did in the beginning), this was assumed to be spurious "drift" and was adjusted out of the model. Indeed, the model-induced change probably was spurious, because none of the energy flows in and out of the climate system are known to the accuracy needed to keep a climate model from drifting too warm or too cold.

But that doesn't mean natural climate change doesn't exist in the real climate system. And how would a modeler even recognize real natural climate change in their model, when any long-term change naturally arising from the model is removed at the outset?

As I have already mentioned, the warming of the global oceans since the 1950s represents an energy imbalance in the climate system of only 1 part in 600, and none of the natural energy flows are known to anywhere near that level of accuracy. The energy imbalance appears to have increased since 2005 at which point we had more complete coverage of the global oceans with thousands of deep-diving probes. Since then there has been about 0.04 deg. C of warming (2005 through 2017) representing a 1 in 260 energy imbalance, which is still much smaller than the accuracy of known natural energy flows.


satellite
surface
1000m
drift at 1000m
nearly 9 days
2000m
Argo float measures temperature and salinity profile
from 2000m up to surface every 10 days


3882 Floats
10-Jan-2018
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30°N
0°
30°S
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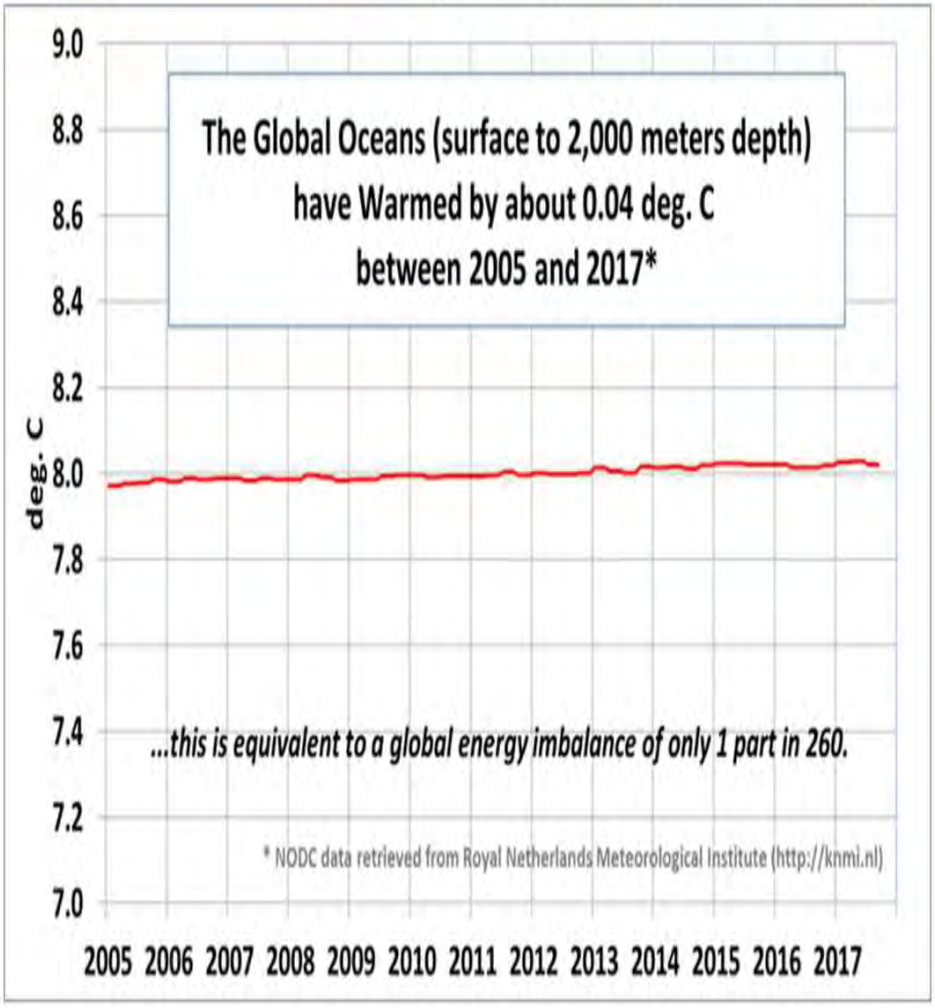
60°E
120°E
180°
120°W
60°W
0°


The Global Oceans (surface to 2,000 meters depth)
have Warmed by about 0.04 deg. C
between 2005 and 2017*
deg. C
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
...this is equivalent to a global energy imbalance of only 1 part in 260.
* NODC data retrieved from Royal Netherlands Meteorological Institute (http://knmi.nl)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

So, the models are simply adjusted to produce an unchanging climate, even though there is abundant historical temperature proxy evidence that the climate system has routinely experienced periods of warming and cooling on century time scales.

Then the models are forced away from energy equilibrium with increasing CO2, which causes warming in them. The claim is that the models then prove human causation. Well, if they have been adjusted to prevent century time scale natural climate change then they certainly would only produce human-caused climate change, wouldn't they?

Most scientists working in climate research are unaware of the circularity of the human causation argument. They assume someone else knows the details, has the explanation, and simply repeat the party line. The 97% consensus in the surveyed climate literature represents a statement of faith, the product of group-think, or the result of recitation of what the community believes by authors who are not trying to test those beliefs.

If it is ever discovered that global warming has been partly or mostly caused by nature, it will not be accepted as a result of 97% of the papers saying it is so; it will be the result of only a handful of papers, which present convincing evidence that conflicts with the current consensus. As was the case of two Australian scientists and peptic ulcers, or Einstein and his Theory of Relativity, the evidence from only very few papers ended up being too overwhelming for the scientific establishment to ignore. Only then does the consensus change.

There's one other problem with the 97% claim: it represents agreement on something that is hardly cause for alarm. Even I, as a skeptic, could be considered to be a part of the 97% since I believe (but cannot prove) that at least one-half of recent warming is probably human-caused. It could be less than 50%, too, but from what we know at this point I'd lean toward greater than 50%. No one really knows; I'm simply making an educated guess based upon incomplete knowledge. But later I will show that even if *all* warming over the last 100+ years was human caused, the level of warming is inconsistent with the IPCC's climate models' predictions of future warming. So, again, the 97% agreement (which we have seen doesn't really exist except as a meme) is on something rather benign, and possibly even beneficial.

I've often said that even if we had perfect measurements of the climate system, there can still be disagreements about causation. Measurements are critically important, but seldom do they prove cause and effect. There is a very cleverly crafted (and very convincing) video on YouTube that supposedly demonstrates that the only way to explain warming over the last century is to include human greenhouse gas emissions. It shows that changes in sunlight intensity can't be the reason (true). Ozone changes can't be blamed (true). Only when climate modelers add in human influences (greenhouse gas warming and aerosol cooling) do the model calculations roughly agree with the observations.

While the demonstration is effective, it is largely a result of statistical curve fitting, and ignores a number of potential natural sources of warming. The famous physicist John von Neumann, who helped pioneer numerical weather prediction methods still used today in your daily weather forecast, once said, "*With four parameters I can fit an elephant, and with five I can make him wiggle his trunk*." Yes, greenhouse gases could be the cause of warming. But models do not include the natural climate cycles we see in nature. Since models don't handle natural climate change well, researchers turn to what they know much better—Increasing CO2. Thousands of researchers, over 30 years, spending billions of dollars, have tried to fit their theory to the observed temperature data—an answer which they knew ahead of time! Is it any wonder they can now produce a good fit between their models and temperature observations since the 1950s? They have certainly had enough practice.

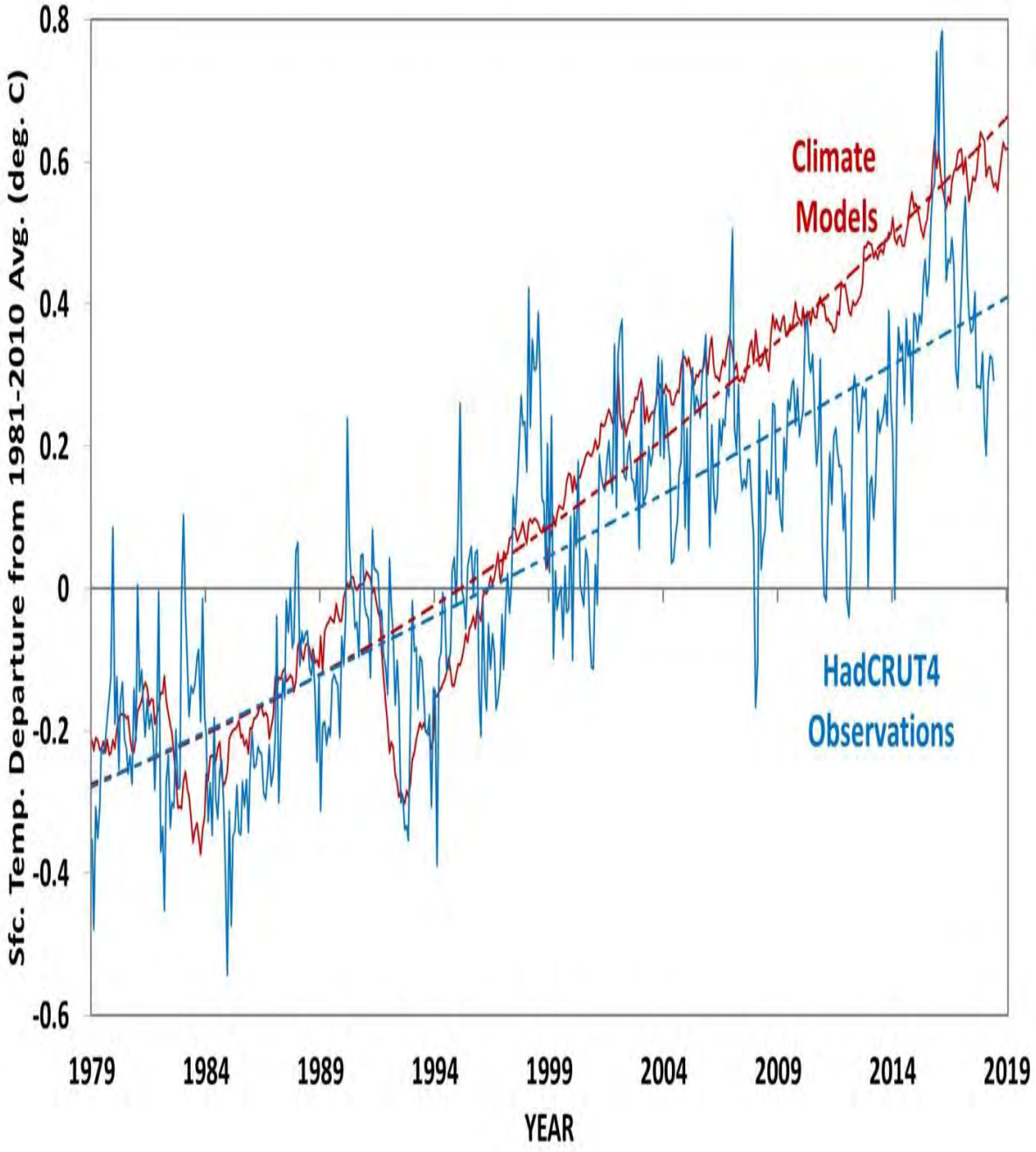
As will be discussed in more detail later, the computerized climate models they use are endlessly adjustable for many poorly known variables, which they then tune (curve fitting) to get better agreement with the observations. When the past rate of warming did not fit the CO2 theory (e.g., the weak cooling period from the 1940s to the 1970s), the modelers assumed human caused aerosol pollution was to blame, and put that into the models to create a better fit. (Note how human causation is always invoked to explain climate change, even when it's to explain temporary cooling).

While modelers often claim their models are based upon known physical principles, I can guarantee you that without prior knowledge of

the global temperature record climate modelers would not be able to explain the temperature variations and warming over the last 100 years from first principles. Their success is a glorified exercise in curve-fitting that assumes human influence as the primary, if not only, cause of warming.

Even with all of that practice at modeling of past climate change, how well do climate models reproduce the last 40 years of observed global-average warming of surface temperatures? The following plot shows the average of all models tracked by the IPCC versus the HadCRUT4 surface temperature dataset through June of 2018.

IPCC Climate Model Projections of Global Average Surface Warming are Increasingly Diverging from the Observations



Over the near-forty year period, the models warmed 35% faster than the observations, and in the most recent 20 years they have warmed 50% faster. Later we will see that global satellite measurements of atmospheric temperatures reveal even a larger discrepancy over 40 years. Clearly there is an increasing discrepancy between climate models and the real world, and yet the "consensus" is based largely upon the models. Most scientists who subscribe to the consensus are probably unaware of this increasing disagreement between the models they profess faith in and the surface temperature observations (which they also profess faith in).

It is often claimed to be part of the consensus that we see the human fingerprints of warming in the climate system. But there are no fingerprints of human-caused warming. Warming due to any cause (say, a slight global decrease in cloudiness, or a slight reduction in the overturning of the oceans, or an increase in atmospheric CO2) would be stronger over land than ocean; strongest at high northern latitudes; likely increase with height in the atmosphere; and would cause an increase in atmospheric total water vapor. These are all features of warming due to any cause, not just a human cause. Again, this is an issue most adherents to the consensus are unaware of; they instead are aware of published research supposedly addressing "human fingerprints" of warming when in fact such papers cannot distinguish natural from anthropogenic warming.

My claim is sometimes countered with one exception: Observed cooling of the stratosphere in recent decades might indeed be a fingerprint of increasing CO2 (as we will see later, greenhouse gases cool the upper atmosphere). *But cooling isn't warming*. The physics of the weather-free stratosphere is much simpler than here in the troposphere where we live and where weather occurs.

Despite its relative meaninglessness, the 97% meme has been exceedingly successful as a talking point supporting the alarmist position. It is invoked by global warming alarmists to support anything the person invoking it desires. "Lies, damned lies, and statistics"; even if the statistic is correct, beware of a statistic being presented as proof of something when in fact it is not. Numbers often become statistical *non sequiturs*, presented as support for cause-and-effect conclusions that do not logically follow from the numbers quoted.

6. What is the Greenhouse Effect?

Any planetary atmosphere with gases that absorb and emit infrared radiation will have a greenhouse effect, causing the lower atmosphere and surface to be warmer (and upper atmosphere to be cooler) than if those gases did not exist. The greenhouse effect can be thought of as a radiative blanket, which not only keeps the Earth's surface warm enough to support life, but also causes most of what we call "weather." You can see the greenhouse effect yourself with a handheld infrared thermometer. It has been calculated from theory that our CO2 emissions have enhanced the natural greenhouse effect by about 1% to 2% compared to pre-industrial times.

Global warming theory starts with the Earth's natural greenhouse effect, which we are presumably enhancing from our burning of fossil fuels. It's not the waste heat from fuel burning that is the culprit, which has been computed to have a trivially small influence on global-average temperatures; it's the effect of the extra CO2 on the Earth's ability to naturally cool itself to outer space.

There are trace gases in the atmosphere (primarily water vapor, and to a lesser extent carbon dioxide and methane) that keep the Earth's surface warmer than if those gases did not exist. They perform their magic simply because they are very good absorbers and emitters of infrared (IR) radiation, and so influence energy flows and thus temperatures throughout the atmosphere. Our burning of fossil fuels produces CO2, the primary component of global warming predictions, which has increased the strength of the Earth's natural greenhouse effect by a theoretically calculated 1% to 2%.

Unlike sunlight, which has only a single source, these flows of IR radiation are originating from everywhere in the atmosphere, all the time, day and night, and are being absorbed everywhere, too. This is part of what makes the greenhouse effect so difficult to describe in simple terms.

It has been calculated that without greenhouse gases the Earth might be perpetually ice-covered, even in the tropics. The warming influence has been termed the greenhouse effect because it's somewhat like a greenhouse in which plants are grown in enhanced warmth where heat loss is reduced by the roof and walls. The analogy isn't all that bad, because the roof of a glass-covered greenhouse absorbs and emits IR radiation, just as the atmosphere does, and the enclosed greenhouse inhibits the loss of warm air to the outside, which is how the strength of the greenhouse effect was originally calculated (without heat loss from warm air parcels rising from the surface). That original calculation of the radiative greenhouse effect by Manabe & Strickler in 1964 (downloadable paper here) resulted in a mind-boggling 88 deg. C (158 deg. F) of surface warming compared to if the Earth had no greenhouse gases. A nice end-to-end basic summary of what goes into such calculations can be downloaded in this slideshow. The oft-cited 33 deg. C greenhouse effect you might be familiar with is after convective weather processes have cooled the surface, resulting in the temperatures we observe today. As such, the 33 deg. C number is not actually a measure of the strength of the Earth's greenhouse effect as is usually claimed; 88 deg. C is (although both calculations involve very questionable assumptions).

I decided to include a discussion of the greenhouse effect because you will find some skeptics who claim the greenhouse effect doesn't really exist, since it depends upon a cold atmosphere making the warm surface of the Earth even warmer. It is claimed this is a violation of the 2nd Law of Thermodynamics, which says heat flow must be from warm temperature to cold temperature, not the other way around.

But the 2nd Law isn't really violated, and in my many debates with some of these people, I came up with what I think is the easiest, do-it-yourself demonstration of the greenhouse effect. You can observe the greenhouse effect with a simple handheld infrared thermometer, available for less than $100.

These instruments detect very subtle temperature differences across a thermopile within the instrument in response to IR radiation passing in and out of an IR-transparent lens when you point the thermometer at an object. If you point the IR thermometer straight up on a clear day (or night), the temperature reading will be quite cold. This is because the

upper atmosphere is cold. The thermopile loses IR energy toward the sky, causing the sky side of the detector to slowly cool to a lower temperature. The thermometer is calibrated to estimate the temperature of what it's pointed at based upon the resulting small change in temperature contrast across the thermopile within the instrument.

If you then point the IR thermometer away from a vertical direction, say halfway toward the horizon, (or at a cloud, which also contributes to the greenhouse effect), it will read a warmer temperature. That warmer temperature is caused by an increased greenhouse effect on the thermopile within the thermometer. The oblique view of the sky compared to when it was pointing straight up involves a longer “path length” of atmosphere and is the same as increasing the amount of greenhouse gases if the thermometer was pointed straight up. (A similar increased path length effect occurs when we look at the setting sun, with more aerosols in the atmosphere dimming the sun’s brightness compared to when the sun is overhead).

How does this demonstrate the greenhouse effect? The IR thermometer’s indicated temperature warmed from the increased greenhouse effect that exists when looking through more greenhouse gases at an oblique angle compared to looking straight up. This warming occurs despite the fact that the temperature of the sky is lower than the ambient temperature where the thermometer is, in seeming violation of the 2nd Law of Thermodynamics.

The surface of the Earth, everywhere, is experiencing the effect measured by the IR thermometer, all the time, day and night. Infrared radiation emitted by the atmosphere down to the surface helps keep the surface warmer than if the atmosphere did not emit (and absorb) IR radiation. The 2nd Law of Thermodynamics is not violated because the *net* flow of IR radiation is still from the surface upward (from higher to lower temperature). But the atmosphere emitting some IR energy downward reduces the net loss of radiant energy by the Earth to outer space, causing warmer temperatures than if greenhouse gases did not exist.

The strength of the gaseous greenhouse effect is actually underrepresented by an IR thermometer because the thermometer’s detector is tuned to only observe at IR wavelengths where greenhouse effects are a minimum, say from 8 to 14 microns. But those wavelengths still have some weak sensitivity to water vapor and carbon dioxide.

In the simplest terms, the greenhouse effect is a radiative blanket surrounding Earth, reducing the rate at which the climate system cools

to outer space, thus keeping surface temperatures warmer than they would otherwise be.

Global warming theory says that the Earth's natural greenhouse effect is becoming slightly stronger due to our burning of fossil fuels, which adds carbon dioxide to the atmosphere. CO2 is a minor atmospheric constituent, now amounting to only 4 molecules out of every 10,000 of air, up from 3 out of 10,000 about a century ago. Again, the increase has been calculated to have enhanced the Earth's natural greenhouse effect by only about 1 or 2 percent. That calculation is a theoretical one; it cannot be verified experimentally. It is the result of measurements (example downloadable here) of how much CO2 absorbs radiation at different infrared wavelengths, data from which refines the rather detailed and complex radiative absorption theory of gases. That theory is then put into a computer program to see how radiative flows of energy up and down through the atmosphere affect the atmospheric temperature profile.

If all that seems complicated, it is. The net effect is this: **any atmosphere with greenhouse gases will be warmer near the surface, and colder at high altitudes, than if those gases were not present.** The same would be true if you put a blanket over your body on a cold night... the inside surface of the blanket gets warmer and the outside surface of the blanket gets colder than just a thin layer of clothing would be. With a blanket, the mechanism of heat transfer is different (conduction versus radiation), but the temperature result is the same.

While it would be nice if we could test the theory of global warming with an experiment involving more CO2 in a laboratory setting, this isn't possible. The atmospheric greenhouse effect only exists over substantial depths of the atmosphere, where the temperature decreases with height. Nevertheless, Bill Nye the Science Guy claimed to have demonstrated the "greenhouse effect in a jar" to support Al Gore's Climate Reality Project in a video entitled *Climate 101*. The video claims to have measured a temperature increase in a glass jar filled with CO2, compared to one filled with air, while both are illuminated with bright lamps.

But meteorologist Anthony Watts cleverly showed that the results of the experiment portrayed in the video were fabricated. In fact, If Bill Nye and Al Gore understood the greenhouse effect they wouldn't have even attempted something doomed to fail. A glass jar is totally opaque to infrared radiation already, and such a small sample of even pure CO2 will have essentially no impact on temperature within the jar. Even a tiny difference in the thickness of the two jars in the experiment, or differences in the heating of the jars with separate lamps, would overwhelm any effects from one jar containing CO2 versus the other jar containing air.

There are additional problems with the experimental setup I won't go into here. I've found other YouTube videos where school students or teachers use a similar setup as a science project. **The experiment cannot succeed.** For Al Gore and Bill Nye to pass off such a clear deception as part of something called the "Climate Reality Project" speaks volumes about the continuing attempts to influence public opinion, even if you have to fake it.

Where is the outrage from the science community over misleading the public with a fraudulent video that has been viewed almost a half-million times over the last seven years? There was no outrage, because the climate science community, Al Gore, and Bill Nye are all on the same team.

Despite all its complexity, and the relative difficulty in demonstrating its existence, the greenhouse effect does indeed exist. Sometimes I'm asked how something occupying such a small fraction of the atmosphere (0.04%) can have such a significant effect. It's because each CO2 molecule undergoes billions of collisions with other atmospheric molecules every second, which allows CO2 to warm (or cool) all of the other molecules. So, if a CO2 molecule temporarily warms (or cools) from the gain (or loss) of infrared energy, it communicates this change with the surrounding air molecules (mostly nitrogen and oxygen) that it collides with. This happens very rapidly, with the collisions happening at least 10,000 times faster than the time it takes for a temporarily "warmed" CO2 molecule to lose its extra energy by radiating it away.

The greenhouse effect does even more, something even most climate experts don't realize: **it creates weather.** Because the

greenhouse effect both warms the surface and cools the upper atmosphere, it greatly destabilizes the atmosphere (makes the temperature fall off very strongly with height), causing warm air to rise and cold air to sink, creating clouds and precipitation and high and low pressure areas and wind. If the upper atmosphere could not cool from the loss of IR energy to outer space, these convective air currents (and thus "weather") would largely cease. Without the greenhouse effect, not only would the Earth be too cold to support life as we know it, but also weather as we know it would not exist. In short, the greenhouse effect is our friend, providing us not only warmth, but also precipitation and all other elements of weather.

Given these facts, we can say that the warming influence of the greenhouse effect and the cooling influence of weather processes are continually fighting against each other in terms of their effect on surface temperature. The greenhouse effect is continuously trying to make the surface unbearably hot, and weather processes are continuously cooling the surface, "short-circuiting" most of that potential greenhouse warming. The heat absorbed by air at the surface is transported upward through convective air currents, which in turn causes cloud and precipitation systems to form.

Why am I going into so much detail about the greenhouse effect? Partly because so many skeptics claim it does not exist. But I am also emphasizing it because I do not accept the premise that the greenhouse effect is a bad thing. The greenhouse effect, including its generation of weather, is probably necessary for life to exist on Earth. Of course, a large part of this process depends upon the existence of water, which helps cool the surface through evaporation and "short circuits" much of the 88 deg. C of potential greenhouse warming, reducing it to the observed 33 deg. C or so of surface warming.

In my opinion, the basic theory behind our 1-2% enhancement of the Earth's greenhouse effect from CO2 emissions is reasonably sound. **But this doesn't mean increasing CO2 is going to have a dramatic effect on temperature or storminess.**

Some alarmists point to the extreme temperatures on Venus as proof of how dangerous an enhanced greenhouse effect can be. But the comparison is totally misplaced. Venus has over 210,000 times as much CO2 in its atmosphere as does the Earth, and it will take at least

several more decades before we even double (2x) the pre-Industrial concentration of atmospheric CO2, which is a far cry from 210,000x. It's like comparing the weight of an average car (which can crush you) to the weight of 3 pennies (which you won't even notice in your pocket).

The big question is: How much warming can be expected from increasing CO2? To answer that, we must first discuss what causes temperature change in general.

7. What Causes Temperature Change?

A temperature change in any object is the result of an imbalance between rates of energy gain and energy loss by that object. This is true of the human body, a pot of water on the stove, a car engine, etc. For the Earth's atmosphere-ocean climate system as a whole, global warming (or cooling) can be caused by changing anything that impacts energy gain or loss between Earth, the sun, and outer space. What forces the changes can be either external to the normal operation of the climate system (e.g., changes in the sun, collision with an asteroid, volcanoes, human greenhouse gas emissions), or internal to it (e.g., chaotic fluctuations in oceanic and atmospheric circulations, including changes in the slow rate of overturning of the cold deep and warm surface waters of the oceans). These latter, internal factors are usually ignored by the climate research community, even though they, too, can cause global warming (or cooling).

It is non-controversial to say that the temperature of anything is the result of a balance between energy gain and energy loss. It doesn't matter whether we are discussing a car engine, a house, the human body, a pot of water on the stove, the Sun, the Moon, or Earth's climate system. While everyone agrees the dominant source of energy for our climate system is the Sun (99.97%, while geothermal is 0.03%), energy loss is just as important as energy gain when determining temperature. The amount of sunlight absorbed by the Earth does not, by itself,

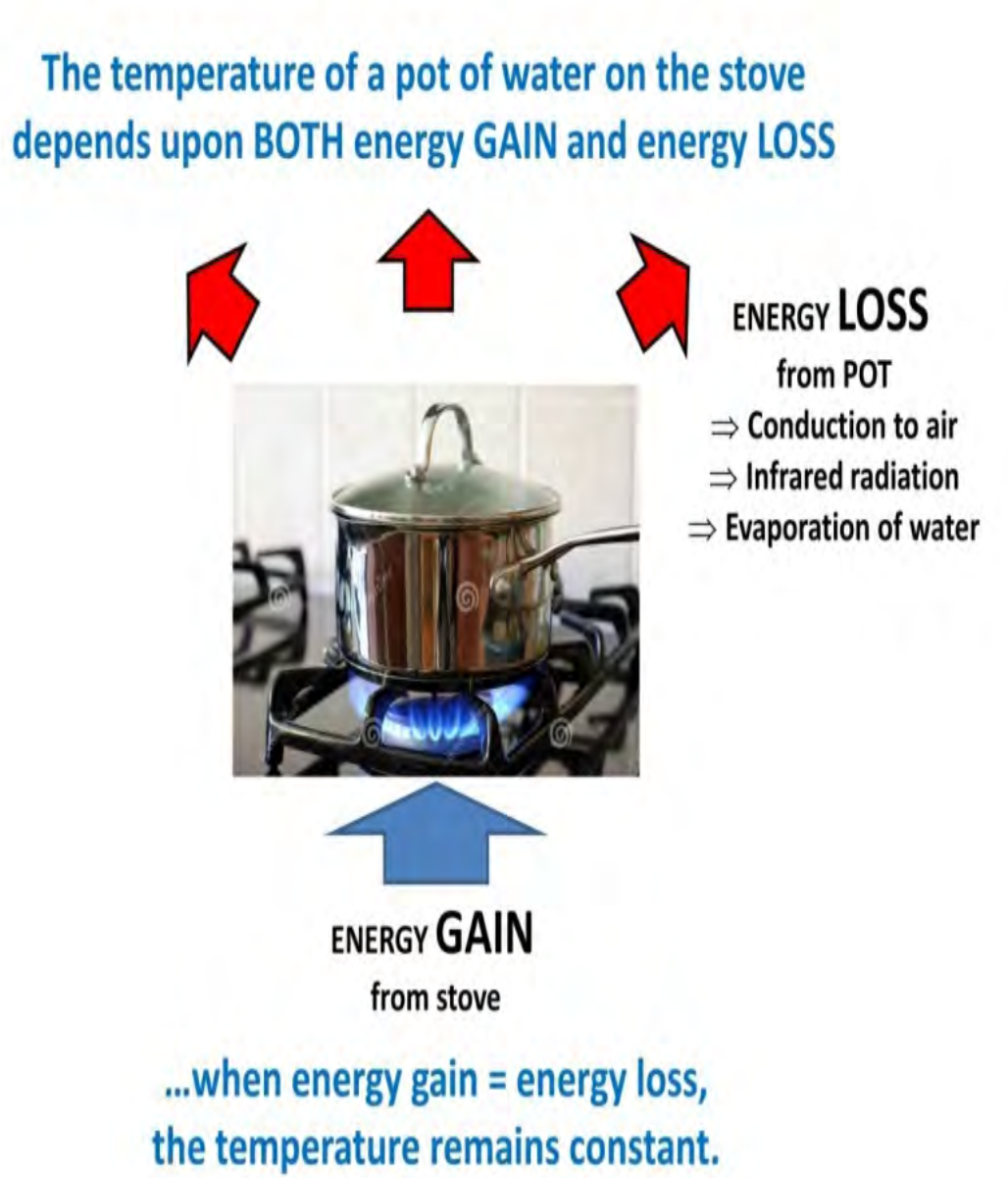
determine the temperature of the climate system; it is only part of the story.

7.1 External forcing of temperature change

The IPCC thinks of global climate change almost exclusively in terms of “external” forcing. This means a change that is not caused by the climate system itself, such as would occur with internal climate cycles. While temperature change is always the result of an energy imbalance, let’s first examine examples of externally-forced changes in energy balance.

Imagine the analogy of an open pot of water over a gas flame on a stove set on “low.” The water will eventually reach an equilibrium temperature where the rate of energy loss by the warm pot to its surroundings equals the rate of energy gain from the stove. The most obvious way to increase its temperature is to turn up the flame on the stove (analogous to turning up the sun’s brightness).

But how might we increase the water temperature without turning up the stove? By placing a lid on the pot of water. This reduces the rate of energy loss by the pot, causing its temperature to rise until the energy loss by the pot once again equals the rate of energy gain from the flame. This is analogous to increasing the Earth’s greenhouse effect. It is considered an “external” forcing of the climate system because it did not originate from the natural operation of the climate system itself.

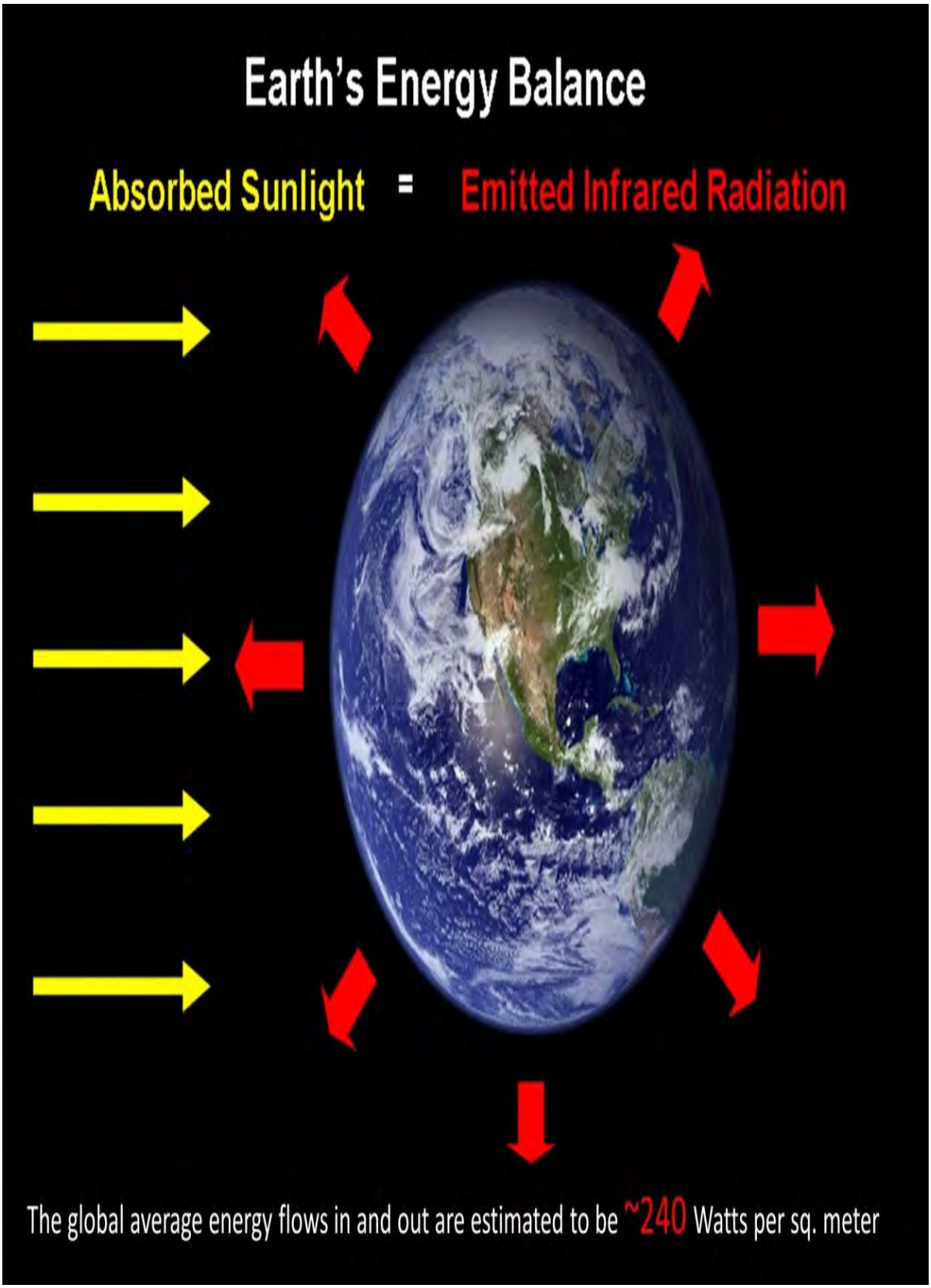


Similarly, putting on a heavier coat in the winter will make your skin warmer than wearing a light jacket. The coat doesn't make you warmer by increasing energy gain, but by reducing energy loss. Again, such a change is external to your body.

For some reason, we are more conditioned to think about energy gains than energy loss when it comes to temperature. When we face the sun, we are aware of the energy gained by the sun warming our skin; we are less aware of the processes that keep our skin from getting too hot, such as conduction of heat from our warm skin to the cooler air,

evaporation of water from our skin, and loss of infrared energy to the cooler surroundings.

In the case of the global climate system, energy gain is from the sun; energy loss is from infrared (heat) radiation emitted to outer space. Global warming from a slightly enhanced greenhouse effect is the result of reducing the rate of infrared energy loss to outer space.


Earth's Energy Balance
Absorbed Sunlight = Emitted Infrared Radiation
The global average energy flows in and out are estimated to be ~240 Watts per sq. meter

These are all examples of how changing the rate of energy loss from an object will change the object's temperature, even if the rate of energy input into the object remains the same.

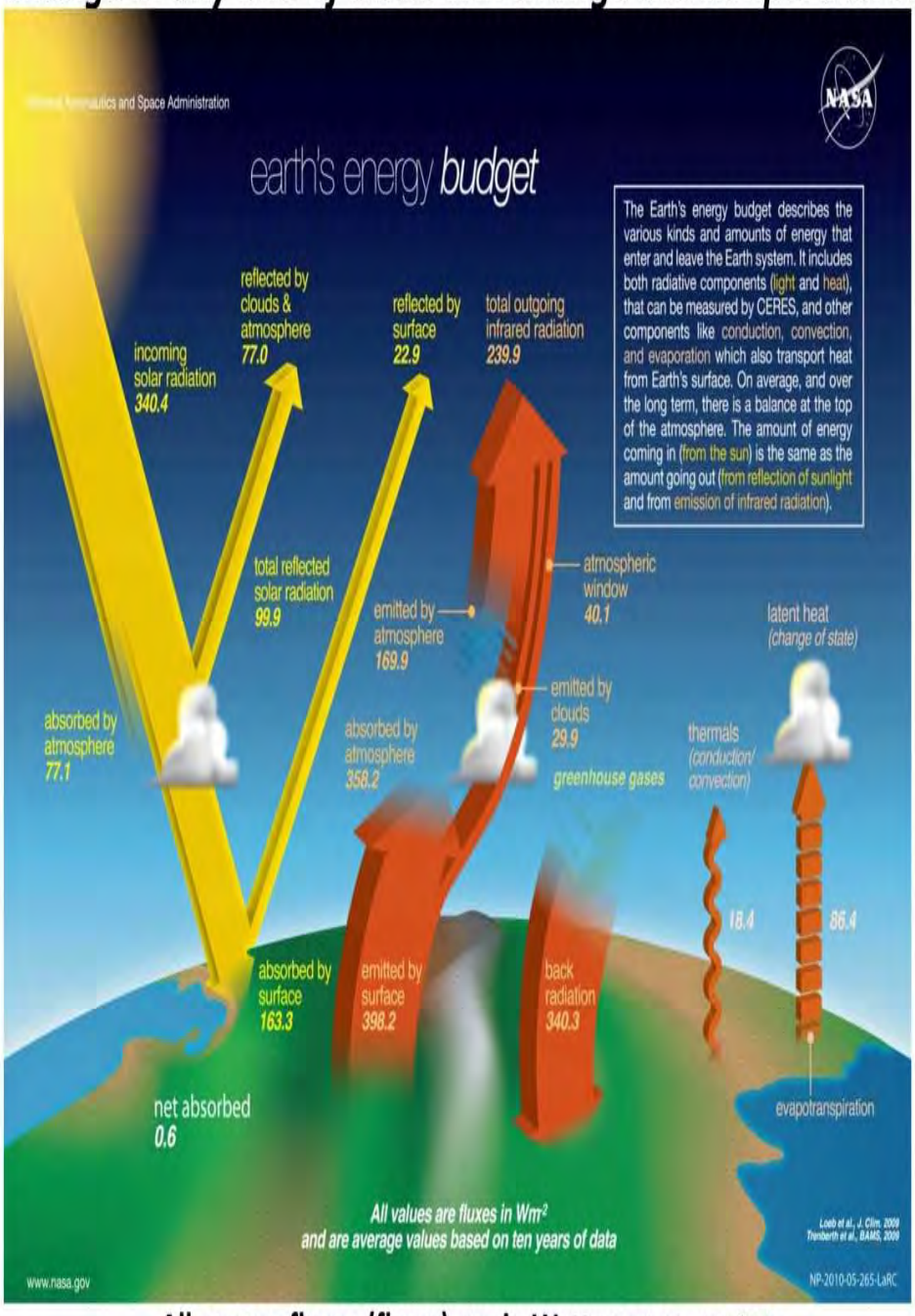
Now let's look at the components of Earth's energy balance. As the above image shows, it has been calculated from a variety of data that the Earth, on average, absorbs about 240 Watts per sq. meter (W/m2) of sunlight. This is a long-term global average across day and night, and all latitudes and longitudes. Obviously, during the daytime in the tropics, the value can be much larger—as much as 1,000 W/m2 with the sun directly overhead. At night, anywhere—from the tropics to the poles—it is essentially zero. But the long-term average value of absorbed sunlight is estimated to be about 240 W/m2.

In order for global temperatures to remain roughly constant, the Earth must be in energy balance, which means it must lose energy at the same rate (240 W/m2) as it gains it from absorbed sunlight. It does this primarily through emission of IR (infrared) radiation to outer space. This is occurring everywhere, day and night, and the rate of emission goes up rapidly with temperature (this is why you feel IR radiation from a hot fire or stove).

This big picture of absorbed sunlight equaling emitted infrared radiation can be broken down into various components. The following energy budget diagram shows the global average estimates of the various energy flows in and out of the climate system, with yellow arrows representing solar energy flows, red arrows infrared energy flows, and the orange arrows to the right representing convective heat loss from the surface by evaporation and warm air rising, both of which heat the atmosphere.

Components of Earth's Average Energy Balance

a change in any one of these will change the temperature!



All energy fluxes (flows) are in Watts per sq. meter.

(1 Watt = 1 Joule per second of energy transfer; a 2,000 calorie daily diet contains 8,373,600 Joules)

The intensities of these average energy flows have all been estimated from a variety of data sources, and as has been already discussed, *the uncertainty in each of these flows is larger than the theoretically calculated energy imbalance due to increasing CO2 that is allegedly causing recent warming, which is now approximately 1 W/m2*.

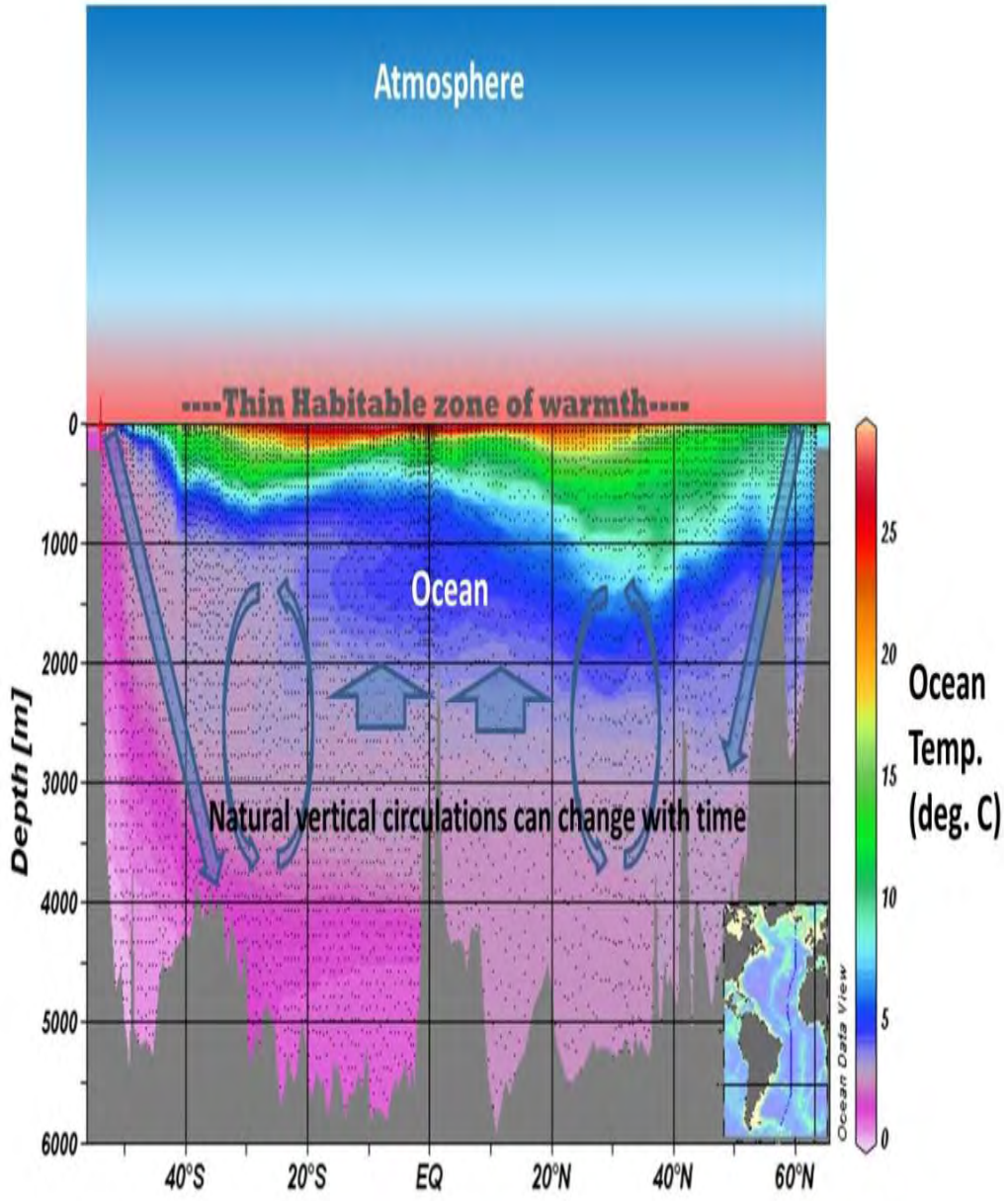
7.2 Internal forcing of temperature change

The part of climate change that science knows very little about is related to the fact that the climate is a “nonlinear dynamical system,” capable of undergoing changes all by itself, without any externally imposed energy imbalances.

How could chaotic changes in the circulations of the ocean and atmosphere cause global warming (or cooling)? The main reason is found in the ocean. Many people don’t realize that the average temperature of the global oceans over their full depth (which contain most of the mass of the climate system) is very cold, around 4 deg. C (about 39 deg. F), and it is only warm near the surface. Over many thousands of years the oceans have filled up with cold water generated in the polar regions, where frigid air and evaporation cause surface waters to become cold, salty, and thus more dense, forcing them to sink.

The result, as shown in the following illustration (which includes actual ocean temperature measurements), is that we live in a very thin zone of warmth, between the cold ocean depths and the cold upper atmosphere.

Chaotic changes in deep-ocean circulation can cause global warming (or cooling) without any external forcing at all.



All of that sinking cold water must be exactly matched by an equal amount of upwelling water elsewhere, which leads to a very slow overturning of the global oceans. In fact, the oceans are continually overturning due to a variety of processes, including wind-driven mixing, tidal flows over bottom topography, variations in density from regional differences in evaporation and precipitation, etc. This is important for climate change because any variation in the rate of overturning of the ocean will cause global warming or global cooling at the surface, owing to the huge temperature contrast between the surface waters and deep waters. Since the ocean is a nonlinear dynamical system, as is the atmosphere, chaotic (so unpredictable as to appear random) changes in any of these processes can result in climate change, without any forcing from the sun, CO2, or any other external influence.

For example, during El Niño, there is a reduction (slowdown) in the overturning of the upper 100–200 meters of the tropical Pacific Ocean. By keeping the same waters near the surface where they absorb energy from the Sun for a longer time, this allows them to become warmer than average, since their mixing with cold deeper waters is reduced, which then affects temperatures almost everywhere on Earth. The opposite happens during La Niña, when the exchange between warm surface waters and cooler deeper waters is enhanced (accelerated), and global-average coolness results in the atmosphere.

It is entirely possible for longer time scale (centuries to millennia) variations in the overturning of the oceans to exist, too, which might well have contributed to events like the Medieval Warm Period and the Little Ice Age. We really don't know the extent to which these have happened in the past, and there is very little (if any) funded research into the problem of internally generated climate variability compared to CO2.

These facts are never mentioned in the slick websites and YouTube videos that claim to "prove" that humans are responsible for recent warming. Those rely on the general ignorance of the public by telling only one side of the story, portraying carbon dioxide as the principal control knob for climate change. Just how important is the chaotic nature of the climate system? Important enough that the IPCC said in its Third Assessment Report (2001), "*The climate system is a coupled non-linear chaotic system, and therefore the long-term prediction of future climate states is not possible.*" But most climate alarmists seem

not to have gotten that message, and even the IPCC authors seem to have forgotten the words they wrote nearly two decades ago.

Yes, CO2 is an important part of the climate system, and an increase in CO2 likely has some warming influence on surface temperature. But it's wrong to characterize CO2 as "carbon pollution". Next, let's examine what is also understood -- the known direct benefits of more CO2 for photosynthesis and thus for life on Earth.

8. The Good News about Increasing CO2

Carbon dioxide, like oxygen, is necessary for life on Earth to exist. Despite the necessity of CO2 for life, there is 500 times more O2 than CO2 in our atmosphere. This makes CO2 an extremely valuable "trace gas" whose increase over the last 100 years in absolute terms has been very small (about 1 part per 10,000 parts air). Increasing CO2 has led to "global greening" and has no doubt enhanced global agricultural productivity.

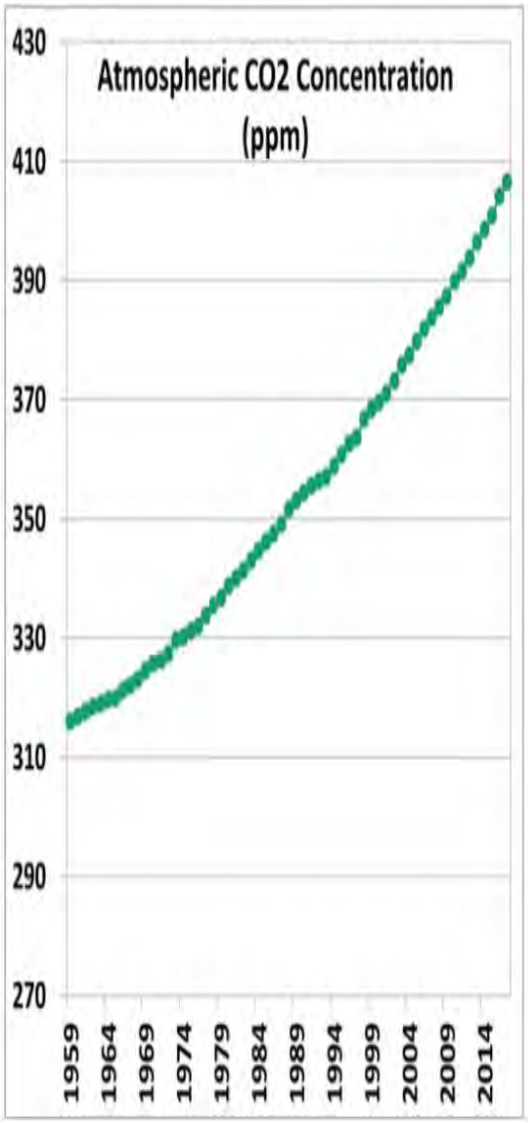
Since pre-industrial times, the atmospheric concentration of CO2 has increased from an estimated 275 parts per million (0.0275%) to 410 ppm (0.041%) today. This is a whopping 50% increase in relative terms, but small in absolute terms (about 1 part in 10,000 of the atmosphere as a whole).

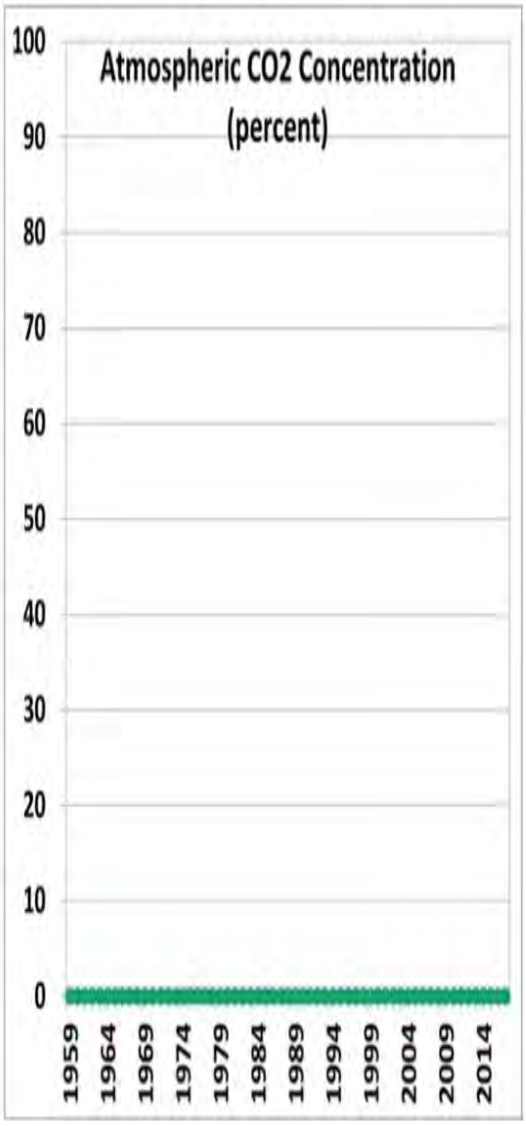
It has even been claimed that atmospheric CO2 is now at its highest level in 800,000 years of Earth history.

Pretty alarming, right?

Well, statistics can be correct, but manipulated to mislead people about dangers. Here are two plots of the CO2 increase at Mauna Loa, Hawaii, which has the longest record of CO2 monitoring. Both plots are correct, but the one on the left appears much more dramatic because the total vertical scale represents only 0.016% of the atmosphere. On a scale of 0-100% of the atmosphere (right plot) the increase in CO2 is not even discernible.

While the amount of CO2 in the atmosphere has experienced a large increase in relative terms, in absolute terms it still occupies only a tiny fraction.



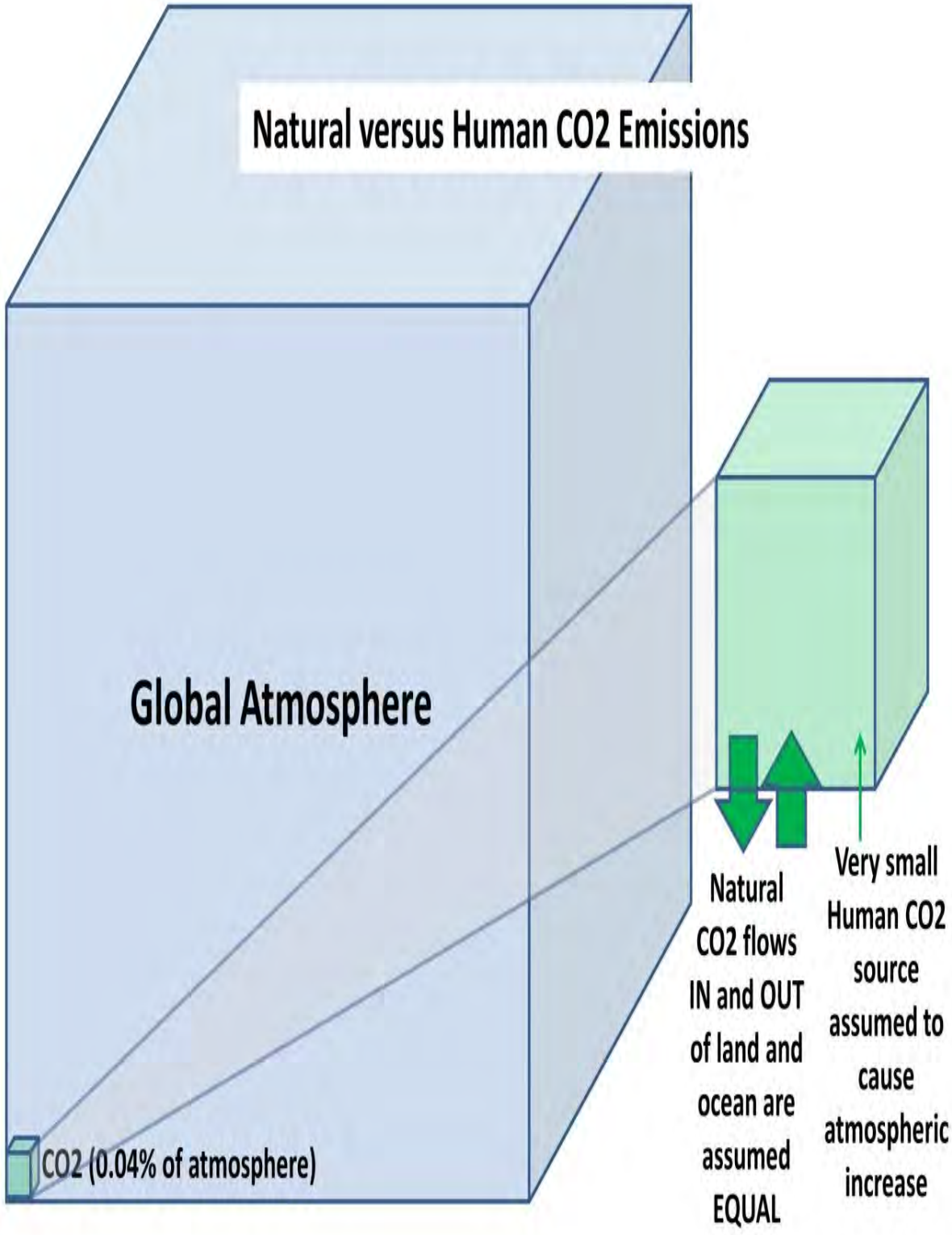


This is not meant to imply that the increase in CO2 has no effect. I'm just illustrating how graphs can be manipulated to make a small effect seem very large (or very small). The same trick is often used when plotting global temperatures; a relatively small increase can be made to look very dramatic. Just because we have the technology to monitor a trace gas in the atmosphere and plot its increase on an expanded scale on a graph is not necessarily evidence that something bad is happening. I have exchanged emails several times with someone who has been genuinely distraught over the increase in atmospheric CO2, believing it will make it dangerous for us to breathe, even though indoor air we breathe routinely has two to three times the CO2 content of outdoor air.

Both oxygen (O2) and carbon dioxide (CO2) are necessary for life to exist on Earth. Plants are the start of the food chain on land and in the ocean, and photosynthesis requires CO2 in order to occur. Despite the necessity of both carbon dioxide and oxygen for life, there is over 500 times as much oxygen in the atmosphere as there is carbon dioxide! This is an amazing disparity between two gases that are both essential for life. CO2 levels below 200 ppm are considered barely sufficient for modern plants to survive, and pre-industrial levels were not much higher than that, down around 275 ppm. It remains somewhat of a mystery how plants survived the Ice Ages, when CO2 levels were estimated to have been as low as 150 ppm. I have had a plant physiologist tell me that it is almost like plants have been starved from a lack of CO2, and now that we are putting more CO2 back into the atmosphere, life is breathing more freely.

Some skeptics claim that human CO2 emissions can't be the reason for the atmospheric rise in CO2 because nature emits about 20 to 30 times as much CO2 as humans do. Strictly speaking, this statistic is true. But nature also absorbs 20 to 30 times as much CO2 as we emit. In other words, nature is believed to be in balance in terms of how much CO2 is emitted from the surface (mainly through decaying vegetation) versus how much is absorbed through the surface (mainly through growing vegetation). This is all part of the natural carbon cycle.

Let's look at it in pictorial form. The very small fraction of our atmosphere that is CO2 has natural exchanges with the surface that are much larger than the human source.


Natural versus Human CO2 Emissions
Global Atmosphere
CO2 (0.04% of atmosphere)
Natural CO2 flows IN and OUT of land and ocean are assumed EQUAL
Very small Human CO2 source assumed to cause atmospheric increase

But even though the natural source of CO2 is 20 to 30 times as large as that from fossil fuel use, it is assumed to be in balance with an equally large sink of CO2 ("sink" is the opposite of "source"), with no net effect on atmospheric CO2 concentration in the long term, say, over hundreds of years. So our drip-drip-dripping of CO2 from the burning of fossil fuels is assumed to be the cause of all of the atmospheric increase.

How do we know the large natural flows of CO2 in and out of the Earth's surface are in balance? We don't. Like the Earth's energy balance and the causes of recent warming, it is simply assumed nature was in balance before humans arrived on the scene. Sound familiar?

We do know that, on a year-to-year basis at least, the natural flows are sometimes out of balance by quite a lot. For example, the growth rate of atmospheric CO2 varies considerably depending on whether an El Niño is in progress in the Pacific Ocean (leading to more CO2 accumulation in the atmosphere), or a La Niña (which removes extra CO2 from the atmosphere). During a particularly strong La Niña year, the surface absorbs the equivalent of virtually all the CO2 produced by humans during that year. During a strong El Niño year, the surface emits more CO2 than it absorbs, by an amount that rivals the anthropogenic source.

So we know there are large natural changes in CO2 on a year-to-year basis. What we don't know is whether there are any significant imbalances causing a net natural source on the time scales of climate change, that is, decades to centuries. It's possible some of the global CO2 increase is natural. We simply don't know. (Contrary to popular opinion, volcanoes, massive as they may be, appear to be a trivially small source of CO2 compared with fossil fuels and non-volcanic natural sources.)

So, if we really don't know whether nature is in balance regarding sources and sinks of CO2, and so whether some of the recent CO2 rise is natural, why is that rise blamed on humans?

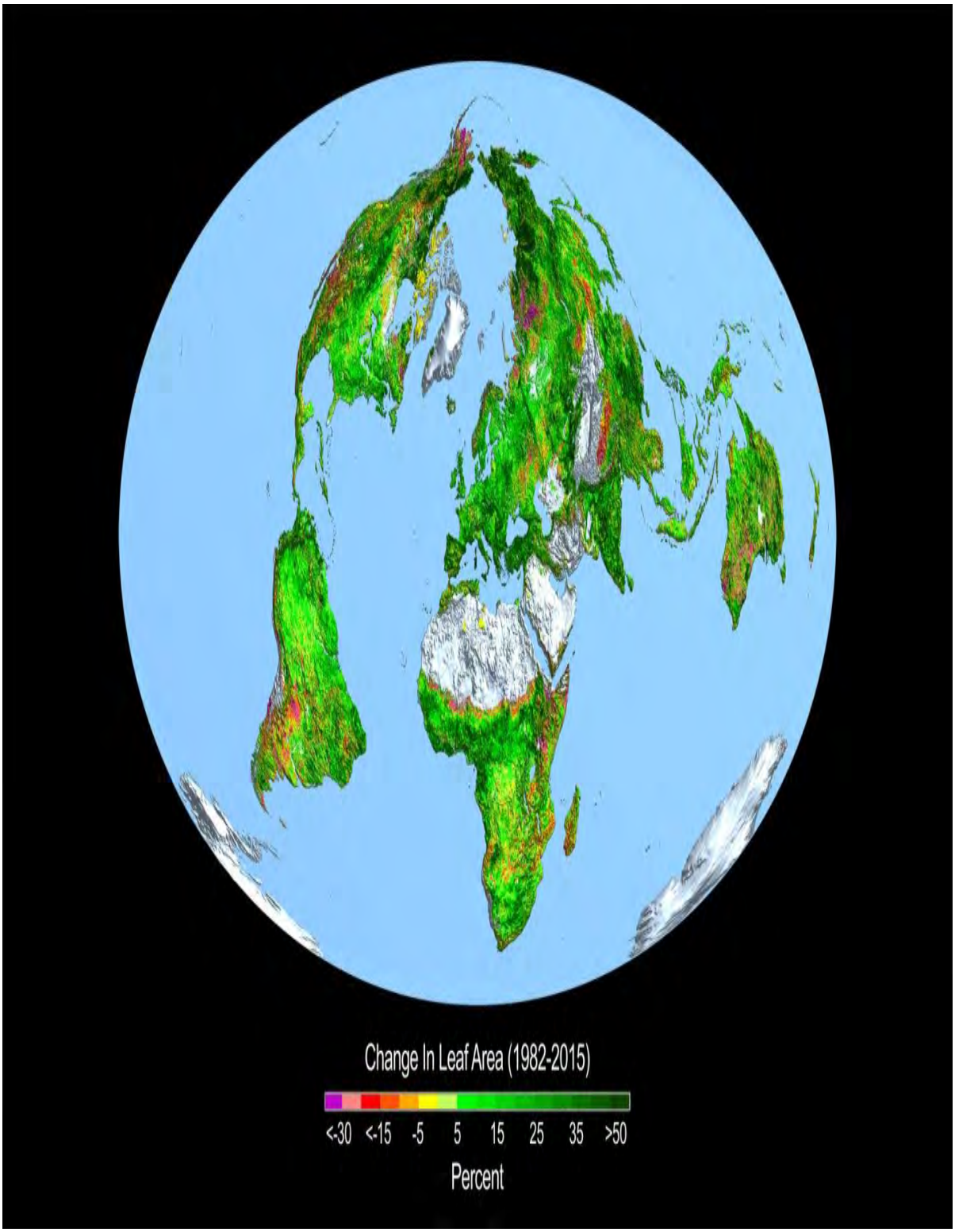
The reason is that anthropogenic sources emit twice as much CO2 as is needed to explain the measured atmospheric increase. The other half of what we produce is absorbed by the biosphere.

This does not prove that all of the CO2 increase is human-caused. Some small fraction of it might be natural. But it would be hard to

imagine that nature absorbs all of the CO2 humans produce, and yet is responsible for the entire observed rise in atmospheric CO2.

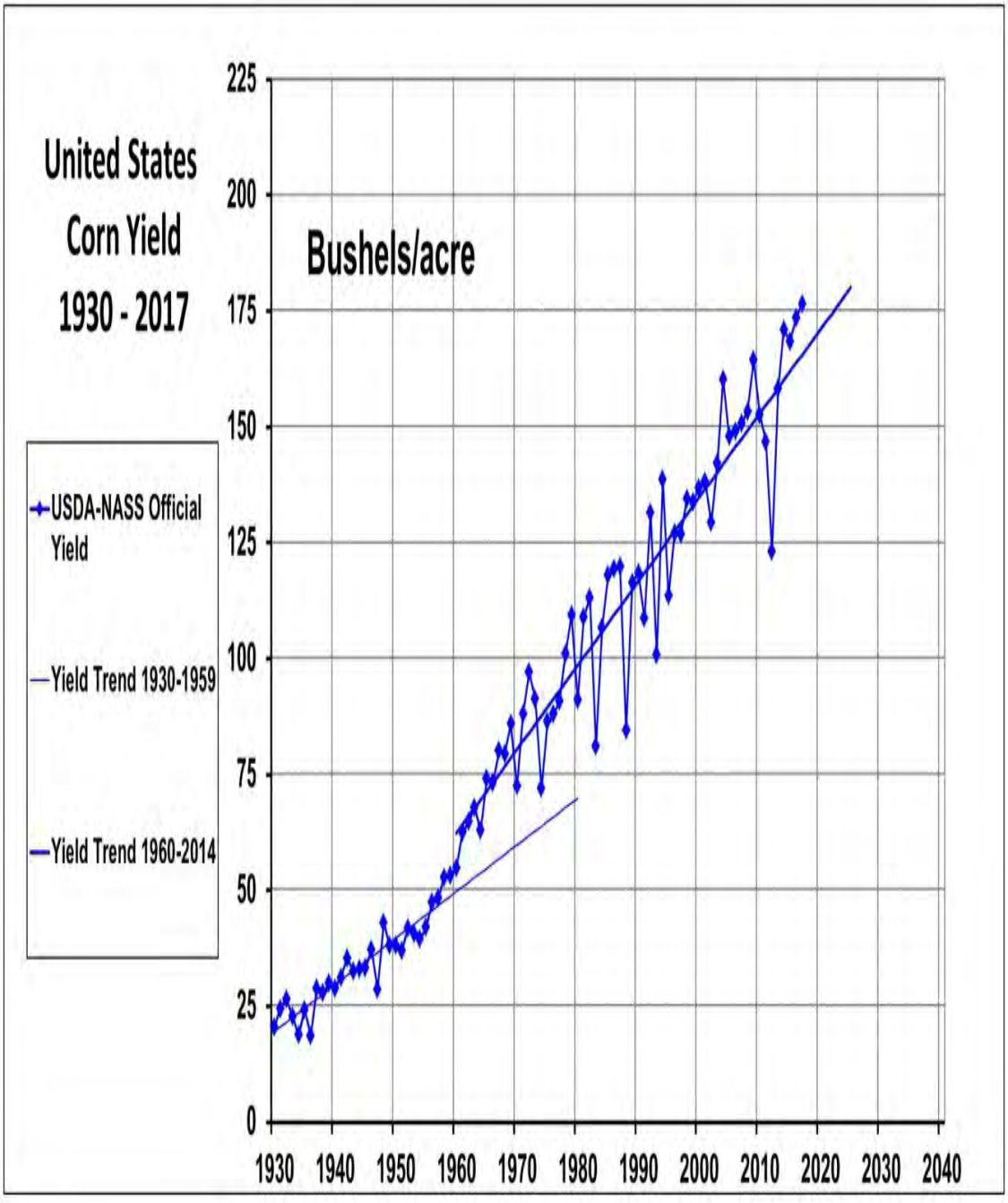
I believe it is very likely that most of the increase is dominated by fossil fuel use (cement production is also a large source). But even if humans are responsible for atmospheric CO2 being the highest in millions of years, you should be skeptical of what that means as a practical matter. It could be a net benefit, given the necessity of CO2 for life on Earth and the exceedingly small amount of it at present (410 parts per million, or 0.041%, as of 2018). Given that the lower bound at which much of plant life would "starve" from a lack of CO2 is estimated to be 150 to 200 ppm, and that most plants thrive on much higher levels of CO2—in the 1,000–5,000 parts per million range, we should consider the possibility that we are helping nature, which was nearing the point of starvation during the last Ice Age.

In fact, there is now considerable evidence from satellites flying since the 1980s that the Earth is experiencing a "global greening" trend from more atmospheric CO2, as seen in the following image derived by NASA from satellite data.



It has been documented through hundreds of studies that more CO2 leads to better plant growth through a direct fertilization effect, increased drought tolerance, and better water use efficiency.

What about the effects on agriculture? To the extent that some amount of warming could be bad for some crops, this is being offset by the positive effects of more CO2, as well as continued hybridization of plants and improved farming practices, to improve food production.
In the U.S. corn belt, crop yields have been increasing at a fairly steady rate after all of the various influences (positive and negative) come into play. Since the 1930s, yields have increased seven-fold.



Yield increases have also occurred all over the world in soybeans, wheat, and rice. Humans adapt and improve their techniques and technologies. Craig Idso at CO2science.org has calculated that some $3.2 trillion worth of crop production since 1960 came simply from the direct effects of CO2 on crop health.

Admittedly, if climate changed too much and too fast, it is conceivable that agricultural yields in growing areas could stop increasing. But so far there are no signs that this is occurring. While some will claim that more CO2 might make some food somewhat less nutritious, such predictions ignore the big picture: more CO2 increases plant growth, drought tolerance, and water use efficiency, making all foods more abundant and hence more affordable, enabling even the poor to gain the nutrition they need by consuming a little more of one food or substituting another, better source.

Remember what Paul Ehrlich predicted in his 1968 book, *The Population Bomb*: that most of humanity would have died out by now because population growth would far outrun agricultural production. Instead, agricultural production has risen faster than population, it continues to increase, and even the U.N. predicts that population growth will slow greatly late in the 21st Century. People (and agriculture) adapt. Be wary of prophets of doom. We do not have an agricultural crisis developing.

If you remain uncomfortable about the idea that we are altering our environment at all, remember that all forms of life alter their environment. The existence of trees also alters the global environment, with the result that some forms of vegetation are not nearly as abundant since tree canopies steal so much of their sunlight. If trees have the right to alter the global environment, even reducing the prevalence of some forms of life, why should humans not have the same right? The answer to that might be religious or philosophical, but it is not scientific. We should be skeptical of the assumption almost everyone makes: that we have no right to alter the global environment.

It is not obvious to me that our emissions of a life-giving gas are necessarily a bad thing. I know that this goes against most of what people have been told, but there is abundant evidence that more CO2 might be, on the whole, a good thing for life on Earth. At a minimum, the benefits of increasing CO2 need to be part of the public debate. I

donate some of my time to an organization called the CO2 Coalition that advances the benefits of more CO2 for humanity.

Next, let's examine what the consensus says about global warming.

9. The U.N. IPCC Consensus: Government-Funded Biased Science

Organized by the United Nations and propelled forward by scientists willing to play by bureaucrats' rules, climate-change forecasts are based mostly upon massively complex and expensive computerized climate models that assume that climate does not change naturally. Despite billions of dollars invested, the models' predicted magnitude of warming in response to a doubling of CO2 remains as uncertain as it was 30 years ago, ranging over a factor of three: 1.5 to 4.5 deg. C.

"One has to free oneself from the illusion that international climate policy is environmental policy … we redistribute de facto the world's wealth by climate policy."—United Nations climate official Ottmar Edenhofer

"This is probably the most difficult task we have ever given ourselves, which is to intentionally transform the economic development model for the first time in human history." —United Nations Framework Convention on Climate Change Executive Secretary Christiana Figueres

Most of the scientific debate over global warming is not over whether humans have any influence on climate at all. It's over the magnitude of that influence. With almost 8 billion people in the world, it would be hard

to imagine we have no impact on weather and climate whatsoever. The question is, how much impact do we have?

Generally speaking, skeptics are not skeptical of any human influence. We are skeptical of (1) the size of the influence, (2) whether it presents any substantial danger, and (3) whether doing something about it with current alternative energy technologies would do more good than harm.

The climate consensus says the human influence is strong, even dangerous, and that nature is incapable of causing the changes we see. Skeptics, in contrast, think natural climate fluctuations and cycles might well dominate over human-caused changes—or, at least, that the science is too uncertain to know with any level of confidence how large the human influence is. Given the evidence in the previous chapter, it is possible that increasing CO2 might well be good for life on Earth even if there is some modest warming.

The climate consensus comes from the international body formed in 1988 to bring together many of the world's physical scientists to determine the human contribution to climate change. That body is the United Nations Intergovernmental Panel on Climate Change (IPCC). The IPCC is closely connected to the international environmental treaty called the United Nations Framework Convention on Climate Change (FCCC). A simplified timeline of the various and continuing major events in the UNFCCC process and the U.S. involvement in it can be seen here.

While the IPCC originally included a wide range of scientific opinions, it has gradually evolved to include almost exclusively those scientists who believe in the narrative of dangerous anthropogenic global warming. The IPCC is heavily influenced by political representatives who help make sure that what the scientists write in the periodic IPCC reports (we have had five, and the sixth is in preparation) is consistent with political and energy policy goals. Those like me who lean toward the skeptical side are either not invited to participate, participated in the past but are no longer invited, or have resigned from the process because they consider it biased.

So why do all of the countries of the world support the IPCC process? Do they all believe in dangerous global warming? Most countries participate because they hope to receive large transfers of wealth from

the minority of developed nations, which are responsible for global prosperity. These poorer countries are part of what are euphemistically called the "Annex II" countries, which represent about 80% of the countries which have signed the UNFCCC.

It should come as no surprise that the IPCC is a source of biased scientific information. Admittedly, the extensive IPCC reports written by the scientists (which virtually no one reads) are only mildly alarmist in tone, and they often include caveats and uncertainties. It is the relatively brief *Summary for Policymakers* which accompanies the report that is more biased, offering only a very human-centric view of climate change. While the reports are circulated for reviewers' comments before they are released, substantive criticisms from skeptical scientists are simply glossed over and usually dismissed as being without merit.

As the "Climategate" emails revealed, a few of the more prominent and influential IPCC scientists have been known to manipulate data and interfere with the peer review process to keep skeptical papers out of scientific journals. The same is true of the scientific reports that come out of the IPCC. The person who claimed responsibility for Climategate listed his serious concerns about the IPCC process in explaining why he made the emails public, concerns I echo here.

It was not always the case that the IPCC promoted biased science. Before 1995, the wider scientific establishment held sway in the wording of the IPCC reports. But political forces in 1995 thrust a young U.S. Government scientist named Ben Santer into the role of rewriting what scientists already agreed to, leading to a much more alarmist tone in the *IPCC 1995* report. The political pressure seems to have originated with Under Secretary of State for Global Affairs Tim Wirth and/or Vice President Al Gore. You can read more about this seminal change of the IPCC from being science-driven to policy-driven here, and about the resulting firestorm of criticism. The change to a more alarmist tone in the 1995 report has held sway up to the present.

My point is, you should not think that the IPCC is made up of unbiased scientists. And some of the government representatives within the IPCC occasionally let it slip why they are in the game. Such admissions seldom get much attention from the news media — conspiracies are apparently acceptable if they are for the global good.

Despite the way in which the global climate modeling community has been co-opted by government funding, political influence, bureaucrats, and activist scientists, climate modeling is a necessary endeavor if we are ever to have useful estimates of future climate change. So how close is the IPCC to solving the scientific problem?

Despite many climate modeling groups around the world spending billions of taxpayers' dollars on the effort, the IPCC amazingly is just as uncertain about the magnitude of the problem as it was 30 years ago. It still places the most likely warming amount in the range 1.5 to 4.5 deg. C as the eventual response to a doubling of atmospheric CO2, "2xCO2" (we are now about 50% of the way there). That's a factor of three range in uncertainty.

And, I will note, continuing uncertainty leads to job security. If the IPCC said, "Okay, now we're certain: warming from 2xCO2 will be 3.1 deg. C," its job would be finished—and so would it its funding.

This 1.5–4.5 deg. C warming response to 2xCO2 is called the Earth's "equilibrium climate sensitivity" (ECS) and is the holy grail of climate research. The greater the climate sensitivity, the worse will be the presumed impacts of global warming.

Of course, one could legitimately ask, just what temperature would life on Earth prefer to have? If we examine the relative abundance of life in the tropics versus the polar regions, we might guess that life on Earth would prefer warmth over cold. As far as humans are concerned, the Medieval Warm Period (also called the Medieval Climate Optimum) of 1,000 years ago was preferable to the cold, misery, disease, and crop failures of the Little Ice Age that occurred several centuries ago.

The question "what global temperature is optimum?" has no simple answer. I am only mentioning it because, at least in a scientific sense, the assumption that whatever the temperature was before humans came along, or before we industrialized, is the preferred temperature is a religious or philosophical view, not a scientific one. In general, though, I would say that at least somewhat warmer is better.

Yet, some scientists simply assume that any human influence on climate is necessarily "bad." I find that point of view to be presumptuous and unscientific.

It is self-evident that the amount of human-caused warming in response to a doubling of CO2 is of great importance. If it is only 1 deg.

C, then it is in the realm of natural climate variability, largely benign in impact, or possibly even beneficial. If it is 5 deg. C, we will likely have problems.

Next, let's see how the official warming predictions of the IPCC have fared.

10. Climate Models Exaggerate Recent Warming

The climate models used to justify changes in energy policy produce twice as much atmospheric warming as has been observed since 1979 by satellites, weather balloons, and "reanalysis" assessments of a variety of global weather data.

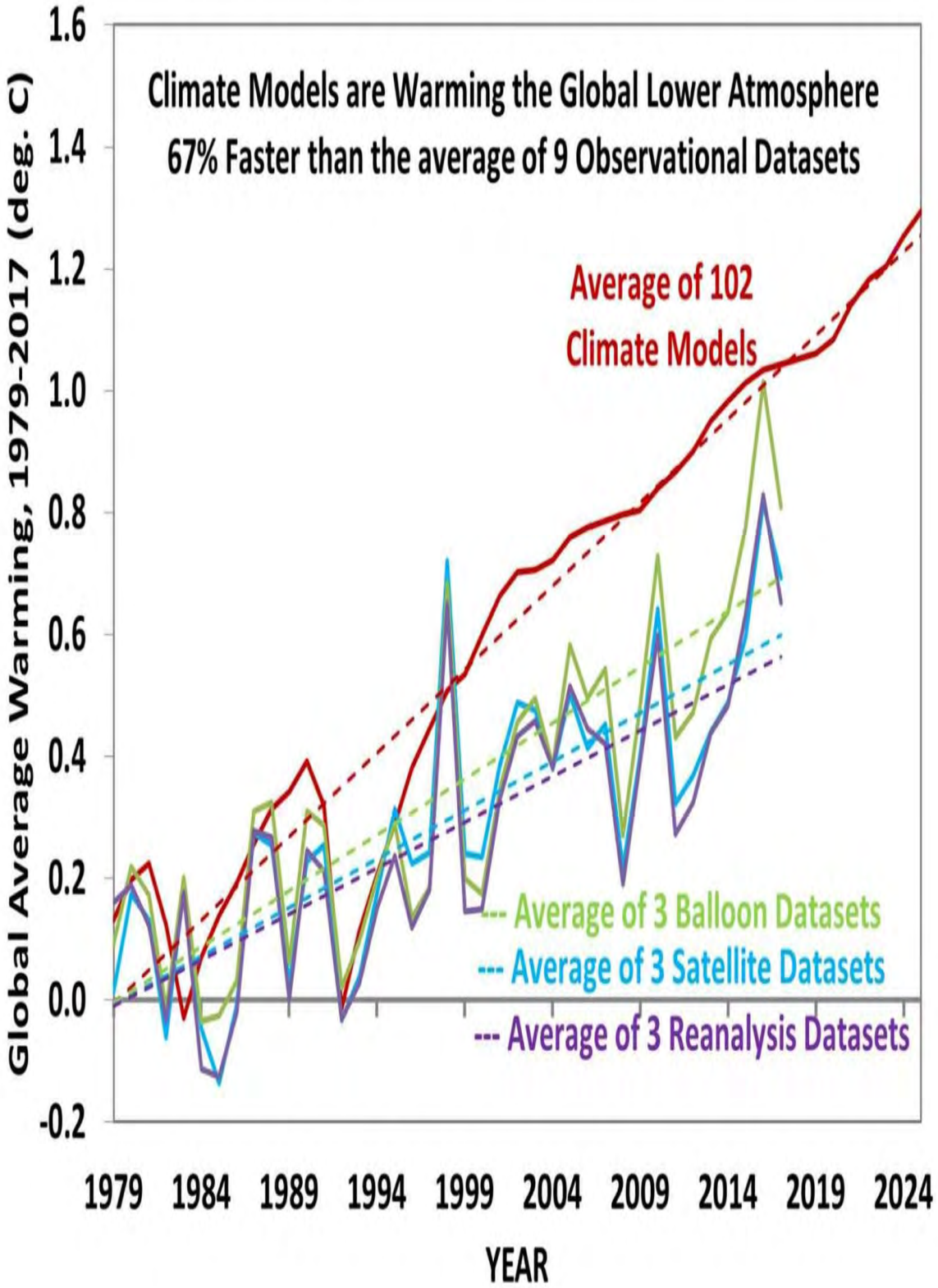
It would be difficult to overstate the importance of climate models to energy policy. All energy policy decisions ultimately depend upon the climate model projections reviewed and reported on by the UN IPCC.

And, if you have not been following the global warming debate in recent years, you might be surprised to find that, regardless what has caused it, warming of the atmosphere in the last forty years has only been progressing at about half the rate predicted by the climate models.

This is based upon temperature measurements from our most geographically comprehensive measurement system, Earth-orbiting satellites, which measure the average temperature of the deep-troposphere (where all of our weather occurs) based upon microwave emissions from oxygen in the atmosphere. Unlike surface-based thermometers, satellites are unaffected by spurious, localized warming from the urban heat island effect, and they measure nearly everywhere on Earth every day, except for small areas around the poles.

In the following graph we see that weather balloons and multi-sensor "reanalysis" projects agree with the satellites: the climate models are warming the atmosphere too much… 67% too much if we average all 9 observational datasets together. All of the curves are plotted so their linear trend lines intersect in 1979, which is the most statistically useful

way to see how long-term warming has been progressing during the climate monitoring satellite age which began in 1979. (The discrepancy between models and observations in the tropics [not shown] is even greater, about a factor of 2.)


Climate Models are Warming the Global Lower Atmosphere
67% Faster than the average of 9 Observational Datasets
Average of 102
Climate Models
--- Average of 3 Balloon Datasets
--- Average of 3 Satellite Datasets
--- Average of 3 Reanalysis Datasets
Global Average Warming, 1979-2017 (deg. C)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1979
1984
1989
1994
1999
2004
2009
2014
2019
2024
YEAR

The deep-layer temperature measurements are a more robust indicator of what the global climate system is doing than are surface-based thermometer measurements. The surface-based measurements are more susceptible to myriad processes that can affect near-surface temperature (typical siting for thermometers is at 2m height), or just below the ocean surface from ships and buoys.

Some alarmists have objected to plotting the data this way, saying that the disagreement between models and observations is somehow exaggerated by having the different datasets trend lines start in 1979. They claim the data should all be plotted versus their long-term average. I strongly disagree. That is an attempt to hide the discrepancy between models and observations by splitting it into two parts, reducing the excess model warmth in the later years by making the models too cool in the early years. But it does not change the discrepancy in the long-term trends, which is the main issue when it comes to global warming. Only the trends answer the question, how fast have the models been warming compared to the observations?

Another objection to using deep-layer atmospheric temperatures is that the surface is where humans live, and so the deep atmosphere isn't that important. Yet, those who raise such objections still point to the deep oceans (where the temperature rise is measured in hundredths of a degree) as one of the most important indicators of global warming. How many humans live in the deep oceans?

The atmosphere responds to what happens at the surface, and also affects the surface, and it is the only portion of the climate system we can make global measurements of with almost no gaps in coverage. Again I will say, deep-atmospheric temperatures are a more robust indicator of global warming than are surface thermometer measurements.

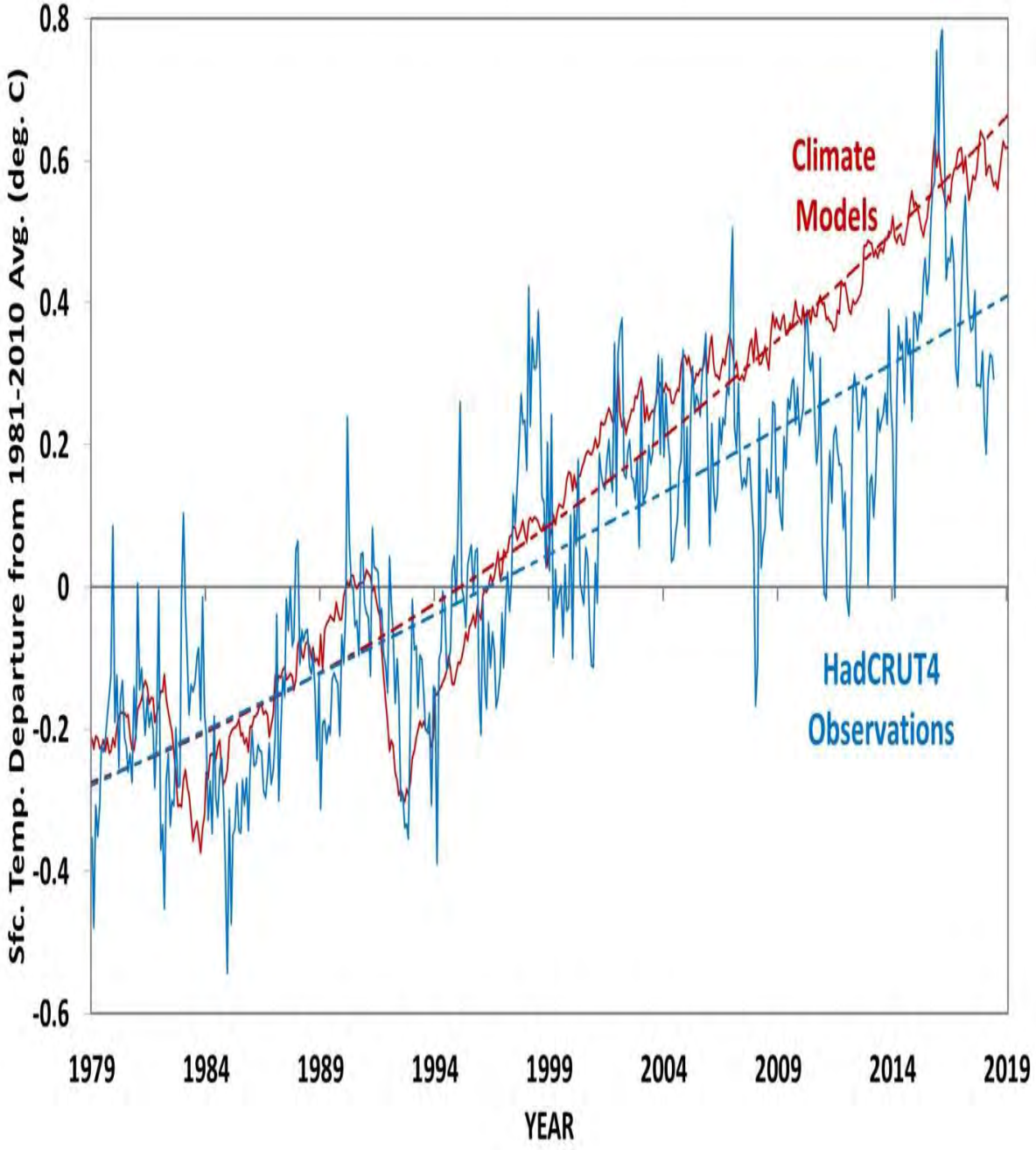
It should be remembered that, no matter what part of the climate system we measure, the temperature changes associated with climate change are relatively small. None of the temperature observation systems is perfect, and none was designed to measure the global warming signal, which in the air is generally around +0.2 deg. C per decade (less for satellites, more from thermometers). While the satellite data need adjustments for changes in satellite altitude and the time of day at which they observe, these adjustments are usually very small

(hundredths of a degree C). In contrast, surface thermometer data adjustments are usually measured in tenths of degrees C, if not larger. The weather balloon data have undergone sensor and data processing changes over the years. The reanalysis datasets contain a wide variety of data, the sources of which change over time. None of the systems are perfect for climate monitoring, and all require adjustments.

That the models have disagreed with three observational dataset types for many years now is rather remarkable when we consider that *the modelers knew what the observations showed before they ran their models*. They can adjust, tune, and tinker with uncertain approximations of, say, clouds to get a wide variety of outputs. They can choose the model runs they think look most like the observed data for submission to the IPCC. And still the models overshoot the observed rates of past atmospheric warming. Why?

Why would the modelers not adjust their models to better agree with observations? Part of the reason is that the modelers focus much of their effort on matching not the atmospheric temperature, but the surface thermometer data, which do not show as large a discrepancy with models as do the deep-layer atmospheric temperatures. The discrepancy between models and observations is not quite as large for surface temperature, but even for that most familiar of climate change metrics the disagreement seems to be growing. In the following plot (which I also showed previously), the models produce about 35% more rapid warming than the observations over the last 40 years, growing to about 50% more rapid warming in the most recent 20 years (1999-2018):

IPCC Climate Model Projections of Global Average Surface Warming are Increasingly Diverging from the Observations



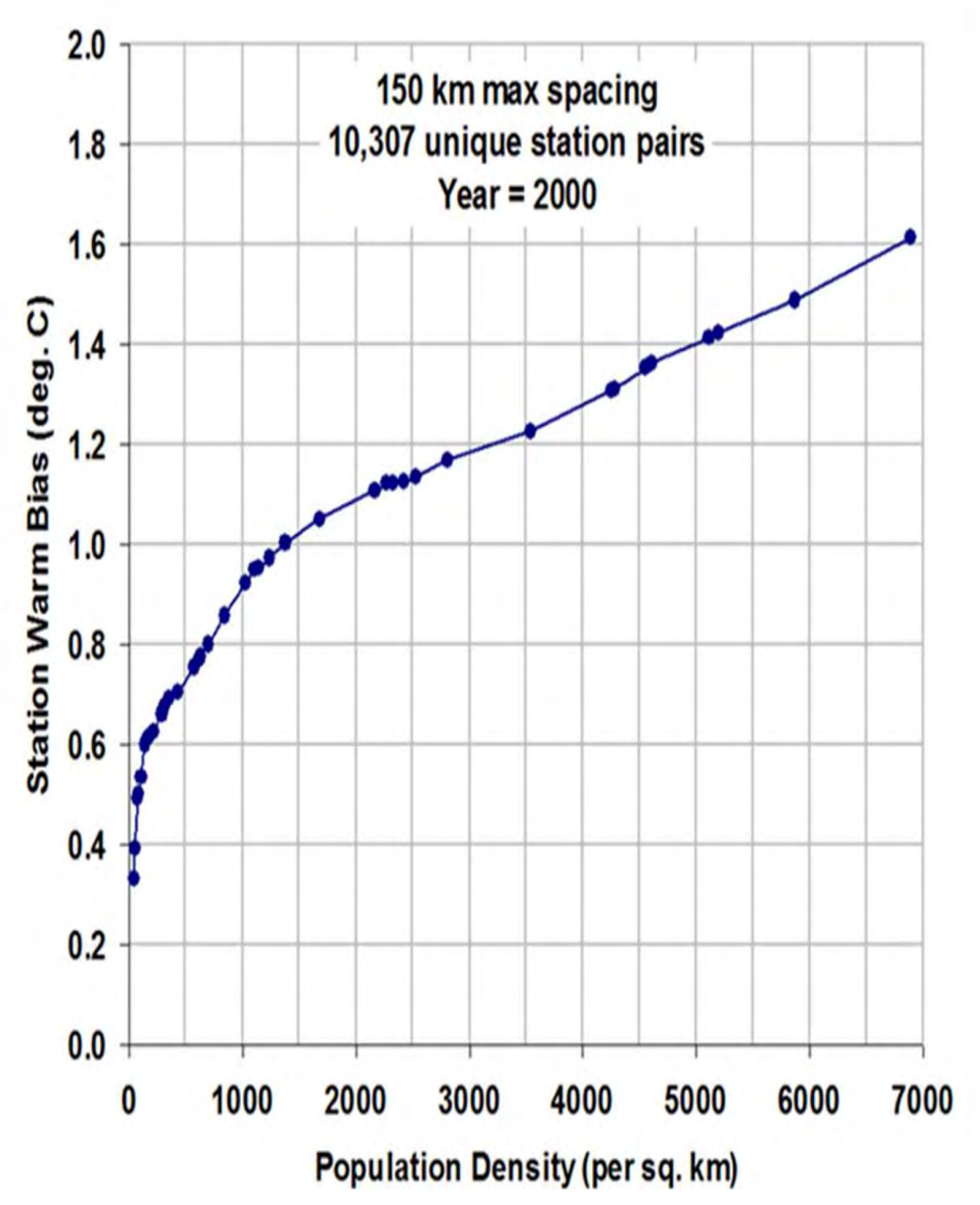
In this plot I have aligned the models with the observations early in the period so that you can see that, even if we assume the models and observations agreed in the early 1980s, the warming in the models is unrealistically accelerating over time.

It remains to be seen whether the modelers will adjust their models to produce less warming, and so agree better with observations. I doubt that will happen, however, since so many of the stakeholders in this business depend upon global warming being a serious problem. The models are what are being relied upon for proposed changes in energy policy; the observations are, apparently, a mere curiosity.

One can also ask: how good are the near-surface temperature measurements we are relying on for monitoring global warming? The surface thermometer data have rather incomplete geographic coverage compared to the satellites, and skeptics have some concern that spurious warming from heat sources near the thermometers has not been properly removed. For example, Anthony Watts and co-authors reported that if only those U.S. stations with the most natural exposure were used to compute U.S. temperature trends, the warming was *reduced by over 50%* compared to NOAA's official analysis of all of the data. Thus, in my opinion, just how much land warming has occurred is not a solved problem.

That urban areas cause warmer temperatures than their rural surroundings is a daily experience of many of us, and most thermometers are sited where there are many manmade structures. The spurious effect is nonlinear, with the greatest warming (per population increase) occurring at the lowest population densities. This was demonstrated by T.R. Oke in his original 1973 study of the Urban Heat Island (UHI) effect, although the nonlinearity was not obvious since his graphs used a logarithmic scale, which made the data points form a line. Here I show the nonlinear effect with my own analysis of global land thermometer data from 2000 data, which shows that a population density of only 100 persons per square kilometer produces an average warm bias of 0.5 deg. C compared to completely rural conditions:

Closely spaced stations report different temperatures depending upon their population density. This Urban Heat Island effect can spuriously exaggerate global warming estimates.



How much of an effect could this have on estimates of global warming over the last 100+ years? Since 1850, global population has increased over six-fold. If we were to consider the global warming estimates made from thermometer data since the 1800s when population densities were considerably lower, we could easily suspect that at least 0.5 deg. C of spurious UHI warming would be quite common, which is about one-half of the land-based global warming reported since that time.

I'm not claiming that there hasn't been warming over the last century. I'm claiming it is probably exaggerated in the observations due to the Urban Heat Island effect. The UHI effect is difficult to adjust for because we do not have much information on local population densities at thermometer sites extending back 100 years or more. Besides, population density is not necessarily the best proxy for the UHI effect anyway. Even if there was constant population in recent decades, increasing wealth in the more prosperous countries leads to more infrastructure and spurious sources of heat over time, such as from air conditioning units, more pavement, more cars, and more buildings.

But even if we assume the thermometer data have no spurious warming trend, we still see a divergence between models and observations. To the extent that spurious local sources of warming have corrupted the observations, their trend discrepancy versus the models will be even larger.

In any event, the period since 1979 is relatively brief in climate terms, and we have omitted a very important component of the climate system when it comes to understanding the degree and causes of global warming—the deep oceans. If possible, it is better to examine considerably longer periods of time, and include what has happened to deep-ocean temperatures, to determine the accuracy of climate model predictions and determine whether they are producing too much future warming. As we will see, when we examine (1) surface warming since the late 1800s, (2) deep-ocean warming in more recent years, and (3) even assume all of the warming is human-caused, the climate sensitivity we diagnose is only about half of what the models produce.

11. Warming since the 1800s Suggests Climate Models are Too Sensitive

Observational estimates of surface and deep-ocean warming over the last 100 years yield a climate sensitivity that is only 50% of that produced by the IPCC climate models. This means the models are likely predicting future warming estimates that are 2 times too large. If nature is responsible for some of the past warming, model estimates of future warming will have even greater errors.

While the IPCC models produce a range of 1.5 to 4.5 deg. C of eventual warming from a doubling of atmospheric CO2 (the equilibrium climate sensitivity), the ECS can be estimated directly from observed changes over the last century in three quantities: (1) the global average surface temperature, (2) how much extra heat has been absorbed by the ocean, and (3) the "forcings" of the climate system (primarily increasing CO2, anthropogenic aerosol pollution, and volcanic eruptions), which are assumed to be causing the temperature changes. This kind of study is considered an "energy budget" estimate.

The most recent (2018) study by Lewis and Curry in *Journal of Climate* of this observational determination of equilibrium climate sensitivity is based upon differencing these three variables between two averaging periods: 1869 to 1882, and 2007 to 2016. The periods chosen are mainly to avoid the uncertain forcing due to major volcanic eruptions.

They arrived at 1.5 deg. C for the diagnosed ECS, that is, the total warming eventually resulting from a doubling of atmospheric CO2. This is right at the lower limit of the IPCC's ECS range of 1.5 to 4.5 deg. C, and is less than half of the average warming produced by the IPCC climate models.

It would be difficult to overstate the importance of this finding. It doesn't matter how many billions of dollars and thousands of scientists that have been invested in the climate modeling effort, if Mother Nature indicates you're wrong, you should probably not ignore her.

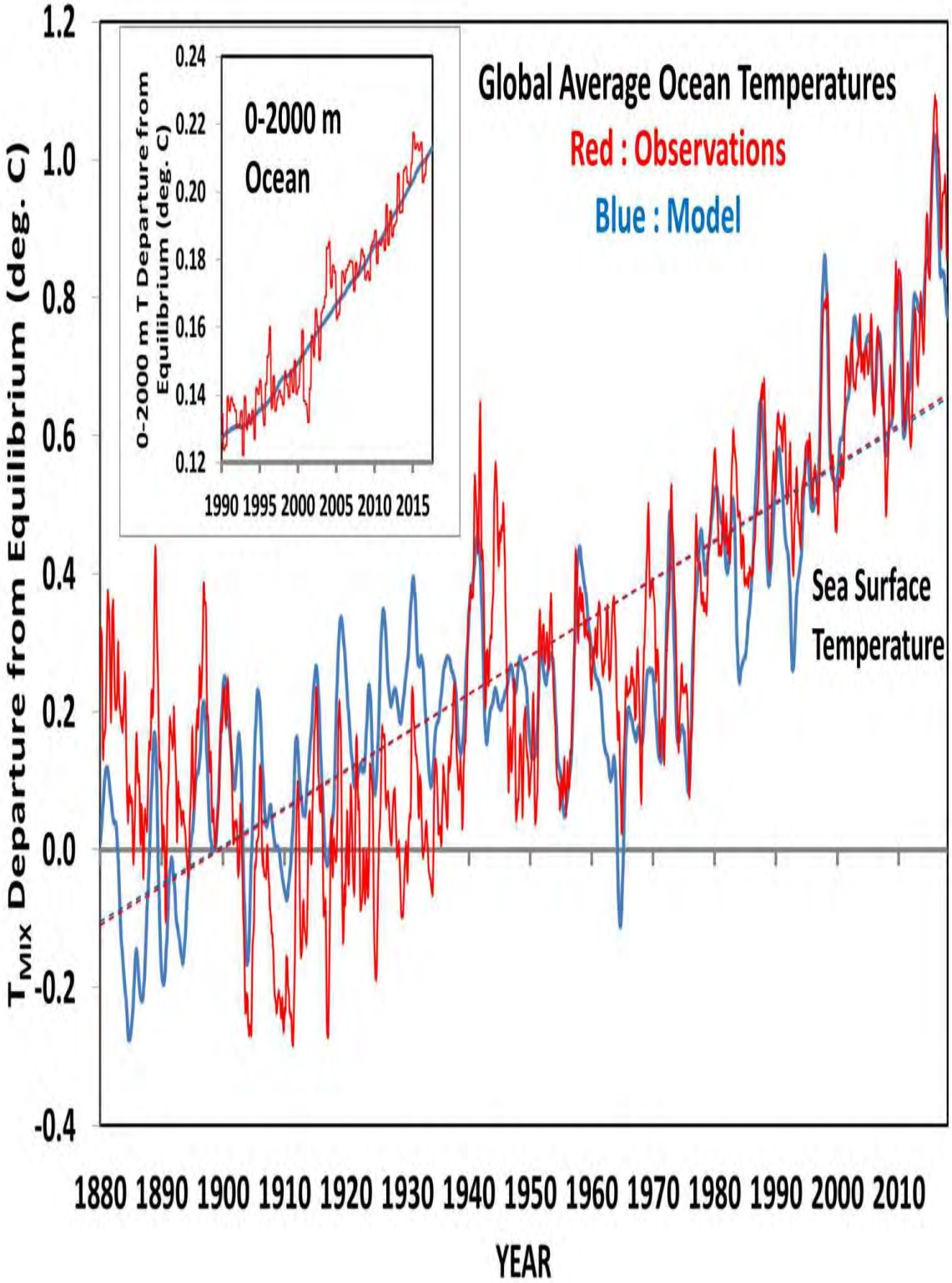
The observational estimate is not without uncertainties, but it turns out climate models are limited by those same uncertainties. For example, we really don't know what the temperature of the deep ocean was during 1869–1882. That can only be assumed. We really don't know how any of the periods were affected by natural climate change. We also are not sure of the assumed anthropogenic forcings, with aerosol pollution (which causes cooling) being the most uncertain. But these uncertainties are common to both the models and the observational diagnosis of climate sensitivity with an energy budget analysis, so neither the model estimate nor the observational estimate has an advantage in this regard.

What the energy budget estimate has as its advantage is that *it must agree with the observations*, which we have seen the models (so far) do not. The bottom line is that, when we look at long–term warming of the atmosphere and ocean and use the same assumed forcings as the climate models use, the most recent published study deduces a climate sensitivity much less than the climate models produce.

Skeptics consider such an observational estimate to be the most accurate way to estimate climate sensitivity, since it does not depend upon a wide variety of additional approximations and assumptions that the climate models require. It is based upon what has actually happened in the climate system, not simulations of what happened from a model.

I have taken these energy budget calculations of the difference between two time periods a step further using a simple time-dependent energy balance model, restricted to the global oceans, that tries to replicate the temperature variations from 1880 to the present. It adds the observed timing of historical El Niño and La Niña events, optimizing the model inputs to best match the observed rate of ocean surface warming, deep-ocean warming, and satellite measurements of Earth's radiative energy budget.

While not yet accepted for publication, the method gives good agreement between the simple model and observations, with an equilibrium climate sensitivity of 1.75 deg. C. This is seen in the following plot, where the red curves represent observations (globally averaged sea surface temperature or deep-ocean temperature), and the blue curves show my model-produced estimates of the same.


Global Average Ocean Temperatures
Red : Observations
Blue : Model
Sea Surface Temperature
0-2000 m Ocean
0-2000 m T Departure from Equilibrium (deg. C)
0.24
0.22
0.20
0.18
0.16
0.14
0.12
1990 1995 2000 2005 2010 2015
T_{MIX} Departure from Equilibrium (deg. C)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
YEAR

To some extent this actually is an experiment in “curve fitting,” but using a model that is required to match a variety of observations, including the satellite observed effect of El Niño and La Niña on the Earth radiative energy budget. In effect it attempts to answer the question, “If we assume the same climate forcings as the IPCC (including increasing CO2), but add in the observed history of El Niño and La Niña activity, what climate sensitivity provides the best match between the model and observations?”

The resulting climate sensitivity number (1.75 deg. C) I diagnosed from this simple model is near the lower end of the IPCC’s 1.5 to 4.5 deg. C expected range of climate sensitivity, and a little above the 1.5 deg. C published result mentioned above. In contrast, the average warming produced across all IPCC models in response to a doubling of CO2 is 3.2 deg. C, so about twice what the observations are suggesting.

So, once again, we see that the models are off by a factor of about 2. If you wish to ignore my results because they are unpublished, fine; then you are left with the published study of Lewis and Curry, which reveals an even larger problem with the climate models.

And even that ECS estimate assumes all warming since the late 1800s was due to humans! If some portion of past warming was due to Mother Nature (from coming out of the Little Ice Age), future warming from 2xCO2 will be even less.

So, I believe the climate models guiding energy policy decisions are not yet up to the task. They produce too much warming and are inconsistent with simple energy budget considerations applied to observed rates of warming of the Earth’s surface and deep oceans. That the IPCC, politicians, Al Gore, environmental groups, the media, and various other pundits continue to push a more alarmist view of the science has been difficult for skeptical scientists like me to understand, because the observational evidence is against them—not us.

They are the ones denying the data of climate change.

12. How the Reliance on IPCC Climate Models Affects You

Climate models exhibit little skill in predicting what impacts people: changes in climate where they live. The U.S. Environmental Protection Agency (EPA) nevertheless has used the climate models to decide that increasing CO2 presents a danger to human health and welfare, justifying regulations that will make energy more expensive. This will lead to greater poverty, and poverty kills. Despite this fact, lawsuits will continue to be brought against the fossil fuel industry, with exaggerated claims of damage despite the fact that all CO2 produced by the U.S. will have an unmeasurable effect on global temperatures by 2100.

Despite my criticism of climate models, I believe models are a necessary tool in climate research. They are important for helping to answer questions about complex systems like our climate. But that does not mean that the current crop of models is ready for prime time. And yet, their predictions are guiding energy policy in the U.S. and abroad.

In any other field of science or engineering, models with errors so large that they can be demonstrated to be off by a factor of two would not be used for major policy decisions. Because of their errors, I also believe current model projections should not be allowed as evidence in a court of law, even though a majority of climate scientists believe in them. This would follow the so-called *Daubert* standard, which attorney Brooks Harlow and I addressed in *Energy Law Journal*. While it is unlikely any judge would disallow evidence from models supported by a majority of climate scientists, I must ask: Would the expert predictions of astrologers be allowed in court, if all astrologers agreed their astrology made useful predictions?

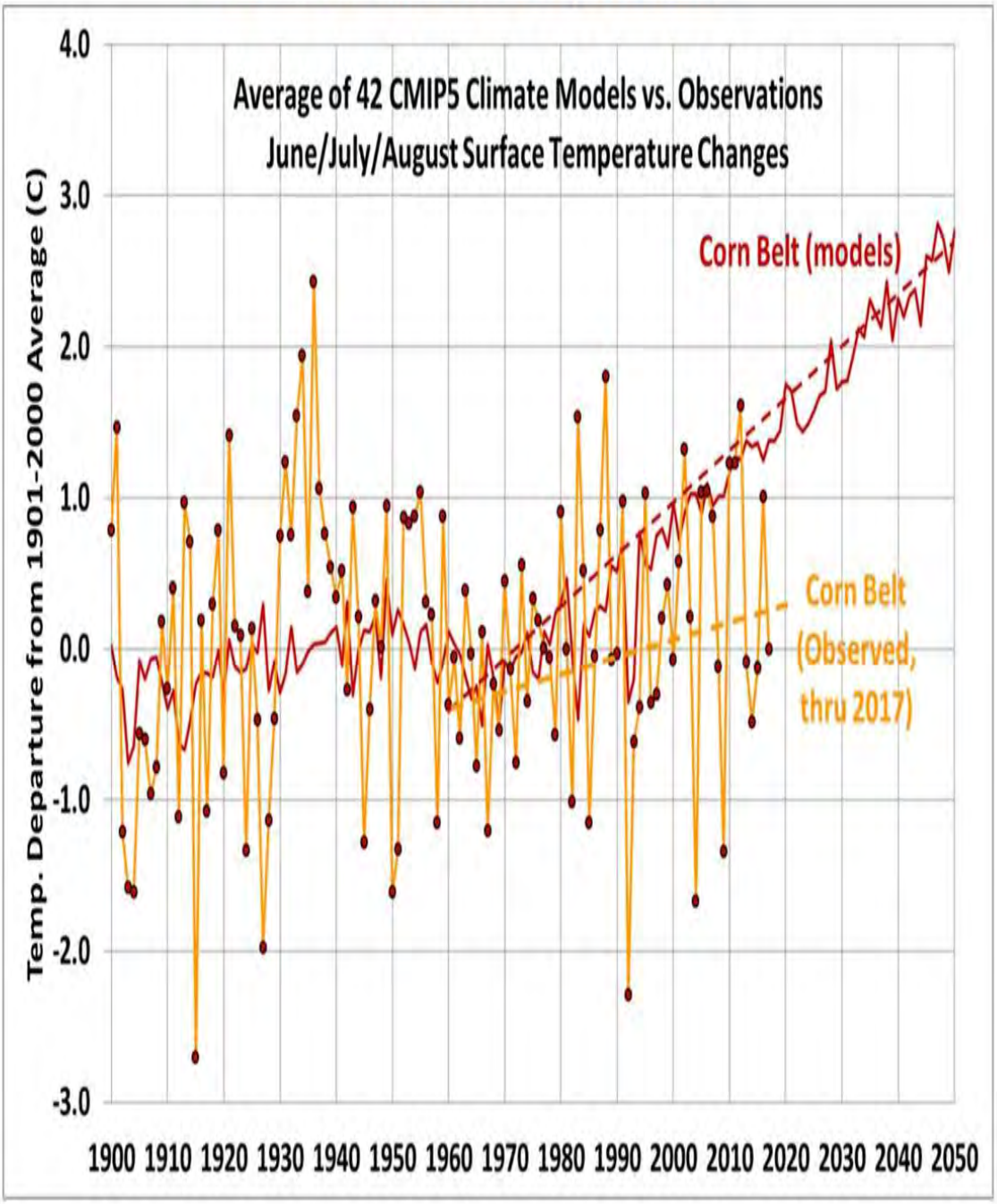
We must be clear about what models can and cannot do. The models do produce reasonably realistic looking *average* weather patterns, seasons, ocean circulations, etc. But they do not succeed in what their main purpose is: to produce useful predictions of how average weather will *change in the future*. That is a much more difficult problem. In my

opinion, modelers defending their models because of the many things they do well (average weather) while diverting attention from their failure to predict what we are most interested in (climate change) is a form of “bait and switch.”

12.1 Regional model predictions have little skill

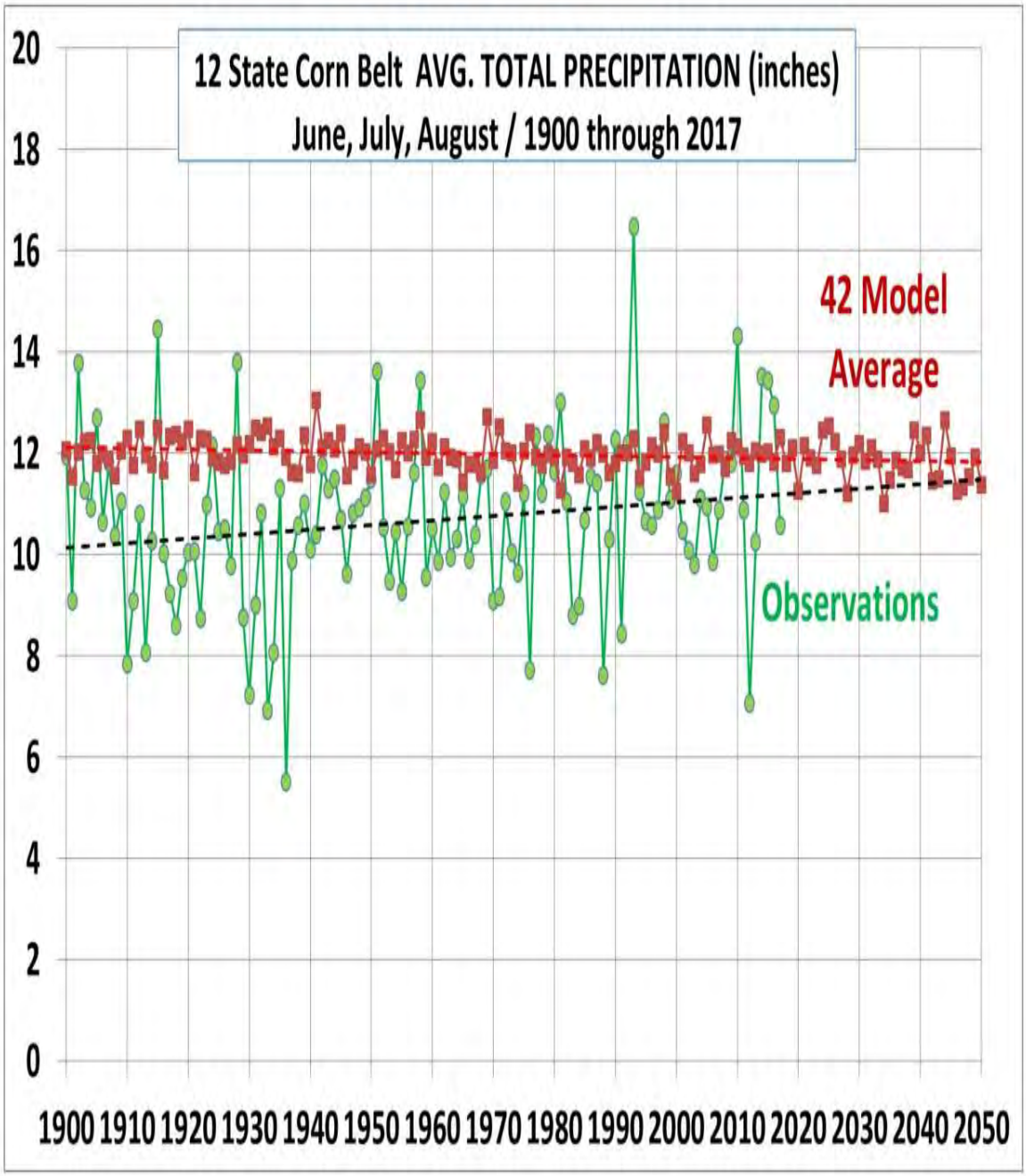
If model projections are poor for global average conditions, they are even worse on a regional basis, which is where it really matters to people. For example, here is the average climate model prediction for summer surface temperatures in the U.S. Midwest Corn Belt compared to what has actually happened through 2017 as reported by NOAA. We can see that, since 1960, the models have produced warming almost three times what was actually observed.

Since 1960, the U.S. Corn Belt has not warmed nearly as fast as climate models have predicted.



A similar plot for Corn Belt precipitation shows that (like temperature) there is a lot of natural variability in growing season precipitation, but the long-term trend to slightly drier conditions predicted by models has yet to materialize. In fact, given the huge natural year-to-year variability, it's not obvious we will recognize a small drying trend even if it occurs over the next several decades. Farmers are accustomed to large year-to-year changes in weather, and the larger the natural variability, the more difficult it is to detect any underlying long-term trend.

There is no sign of reduced summer rainfall in the U.S. Corn Belt



Despite the lack of observational evidence, the public is routinely presented with news reports about climate change being "worse than we thought." The latest weather disaster is presented as more proof that humans are destroying the Earth, and that something must be done about it. (Later I will demonstrate that severe weather events have not increased.) Droughts are presented as the worst ever, supposedly in support of climate models and scientists' forecasts.

Most of the sensationalist climate claims you see are 97% hype. Or maybe I should say "97%-hype." Yet, the climate models are still relied upon by the IPCC for advancing the international Paris Agreement, and in the U.S. the EPA's CO2 Endangerment Finding (EF) and Clean Power Plan (CPP).

12.2 The EPA's Endangerment Finding

There is no environmental regulatory process with the potential for so much governmental mischief and overreach as the EPA's CO2 Endangerment Finding (EF). The EF was the EPA's decision that increasing CO2 levels in the atmosphere from burning of fossil fuels are a threat to human health and welfare, which then paves the way for the EPA to potentially regulate all use of fossil fuels. The EPA has largely neglected the positive effects of abundant and inexpensive energy on advancing humanity's prosperity, health, and longevity, while exaggerating the supposed threats of harm.

Once the EPA made the Endangerment Finding, it was virtually obligated by law to regulate CO2 emissions. The Clean Power Plan was the EPA's attempt to force the closure of coal-fired power plants by limiting their CO2 emissions to a level that was technologically and financially unattainable. President Trump ended the CPP, and has proposed replacing it with the Affordable Clean Energy (ACE) rule, which will allow the individual states to have more say on phasing out coal-fired power plants.

Unfortunately, ACE continues the Endangerment Finding's unproven premise that increasing CO2 concentrations are a threat to human health and welfare. There is little appetite in Washington to overturn or rescind the EF, mostly because any attempts to do so would be met with howls of protest from the environmental lobby which would

characterize it as giving in to Big Oil interests, an assault on the environment, etc. The “97% of scientists agree” meme would be trotted out as proof that Neanderthal politicians don’t care about your children and grandchildren.

12.3 Expensive energy kills

Wind and solar energy are presented as technologies that can save us from fossil fuels. I personally don’t care where our energy comes from, as long as it is abundant enough to provide for humanity’s needs, inexpensive enough so that people do not die in poverty because they can no longer afford goods and services (including heat to protect them in winter and air conditioning to protect them in summer) due to high energy prices, and limit negative impacts on the environment. (It is not possible for humans to have no impact on the environment.)

Europe has implemented rather stringent goals for renewable energy in recent years, such as for wind and solar power. Partly as a result, the average annual electricity bill in the UK rose by over 50% from 2003 to 2012. Another estimate (Eurostat and U.S. Energy Information Administration data) put the increase between 2005 and 2014 at 133% for the UK. On April 30, 2015, the UK’s *Independent* reported that fuel poverty killed 15,000 people during the winter of 2014–15.

I hope that someday we will have renewable energy sources that meet those goals. But in the meantime we must still rely mostly on fossil fuels. Doing anything else sacrifices real lives today in exchange for theoretical lives in the future.

No one can demonstrate that anyone has ever been killed by human-caused climate change, but poverty causes premature deaths every day.

Part of the utility of fossil fuels derives from their very high energy densities compared to renewable sources, and they are more widely deployable and practical. They do not require large diversion of land area, and do not require the sun to shine or the wind to blow. While use of renewables is increasing rapidly in a relative sense, this is only due to the overwhelming subsidy advantage they enjoy (per kilowatt-hour of energy produced), as seen in the following chart.

*FEDERAL SUBSIDIES FOR VARIOUS ENERGY SOURCES NORMALIZED TO ENERGY PRODUCED FOR 2010, 2013, 2016 AND PROJECTED FOR 2019

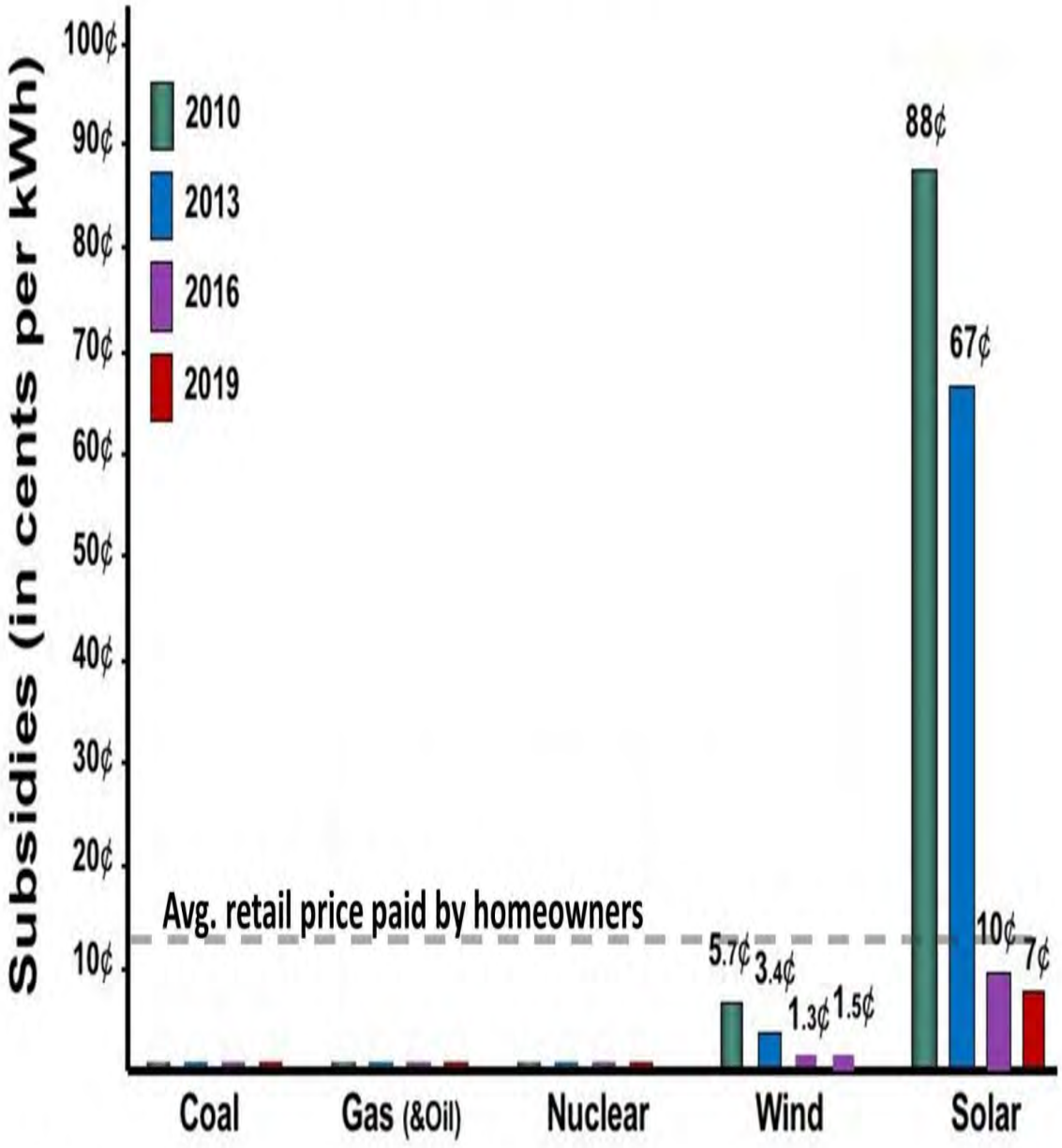


Chart modified from Forbes.com based upon data from Univ. of Texas

Because global demand for energy is rising even faster, it is unlikely they will amount to more than 20% of global energy needs in the coming decades as the demand for energy outpaces the ability of renewables to meet that demand. Once renewables are cost-competitive, special interests won't need to campaign for them; they will happen naturally, due to free-market forces.

As long as climate model projections of the future are assumed to be accurate, and CO2 is assumed to be "pollution" rather than necessary for life, the long expensive march toward de-carbonization of the global economy will continue. Without affordable replacements for fossil fuels, the result of forcing expensive energy on humanity will be increasing poverty, and poverty is the leading cause of premature death in the world.

12.4 Juliana v. United States: Climate trial of the century

No matter what the scientific or economic arguments are, the courts are often used as a last resort to institute change when public opinion and the legislative process do not produce the results some desire.

As of August 2018 there were over 1,000 lawsuits pending in the U.S. claiming damages from anthropogenic climate change. The number is growing rapidly. In late October 2018 the U.S. District Court in Eugene, Oregon, will hear the *Juliana v. United States* case, where 21 children are suing the United States Government for allowing carbon dioxide to continue to be released into the atmosphere, despite the government having "known" that continued CO2 emissions would cause "dangerous climate change." The Trump Administration's last-ditch effort to have the U. S Supreme Court intervene and stop the trial failed on July 30, 2018.

Chief Judge Ann Aiken, U.S. District Court for Oregon, has allotted a full 50 days for the *Juliana* trial. She clearly has an interest in the case, and I suspect has a philosophical bias toward ruling for the plaintiffs. A decision for the plaintiffs would then be appealed, and the case might not be settled until it reaches the U.S. Supreme Court.

Legal arguments I have read suggest that it is most likely that one of the courts will rule that this issue is inappropriate for the judicial branch

of government, and it needs to be settled by the President or Congress, but who knows?

There is no better example of global warming alarmism than the scientific claims made in this lawsuit. The claims are no doubt due to the involvement of James Hansen, now retired from NASA and the modern godfather of global warming alarmism. For whatever reason, Dr. Hansen has chosen an extremist narrative for his beliefs about climate change. As stated in the lawsuit introduction as originally filed against the Obama Administration in September, 2015:

"For over fifty years, the United States of America has known that carbon dioxide ("CO2") pollution from burning fossil fuels was causing global warming and dangerous climate change, and that continuing to burn fossil fuels would destabilize the climate system on which present and future generations of our nation depend for their wellbeing and survival."

As we have seen, the claim that increasing CO2 concentrations in the atmosphere are "destabilizing" the climate system and threatening our "survival" cannot be supported. In fact, the overall result of a CO2-enriched atmosphere is likely to be more beneficial than harmful. Unfortunately, the desire of a few climate scientists for attention has led to gross exaggerations to be spread by the news media, movies, TV documentaries, and various forms of social media.

And now, lawsuits throughout the country are blaming all manner of life's misfortunes and unfulfilled expectations on human-caused climate change. The *Juliana* lawsuit, if ruled for and successfully upheld on appeal, has the potential to fundamentally change life as we know it in the United States. It would compel the federal government to force our society to do what is, technologically, virtually impossible: drastically reduce CO2 emissions without causing widespread suffering and increases in poverty. Ironically, the *Juliana* plaintiffs are suing partly on the claim that changes in our environment are depriving them of their constitutional guarantees to "life, liberty, and property," despite the fact

that a much greater deprivation of these constitutional rights would be caused by reducing our use of fossil fuels.

While I am not a lawyer, I hope that the Department of Justice lawyers defending the case will consider at least three main points.

First, Dr. Hansen's exaggerated claims are outside the mainstream of climate science.

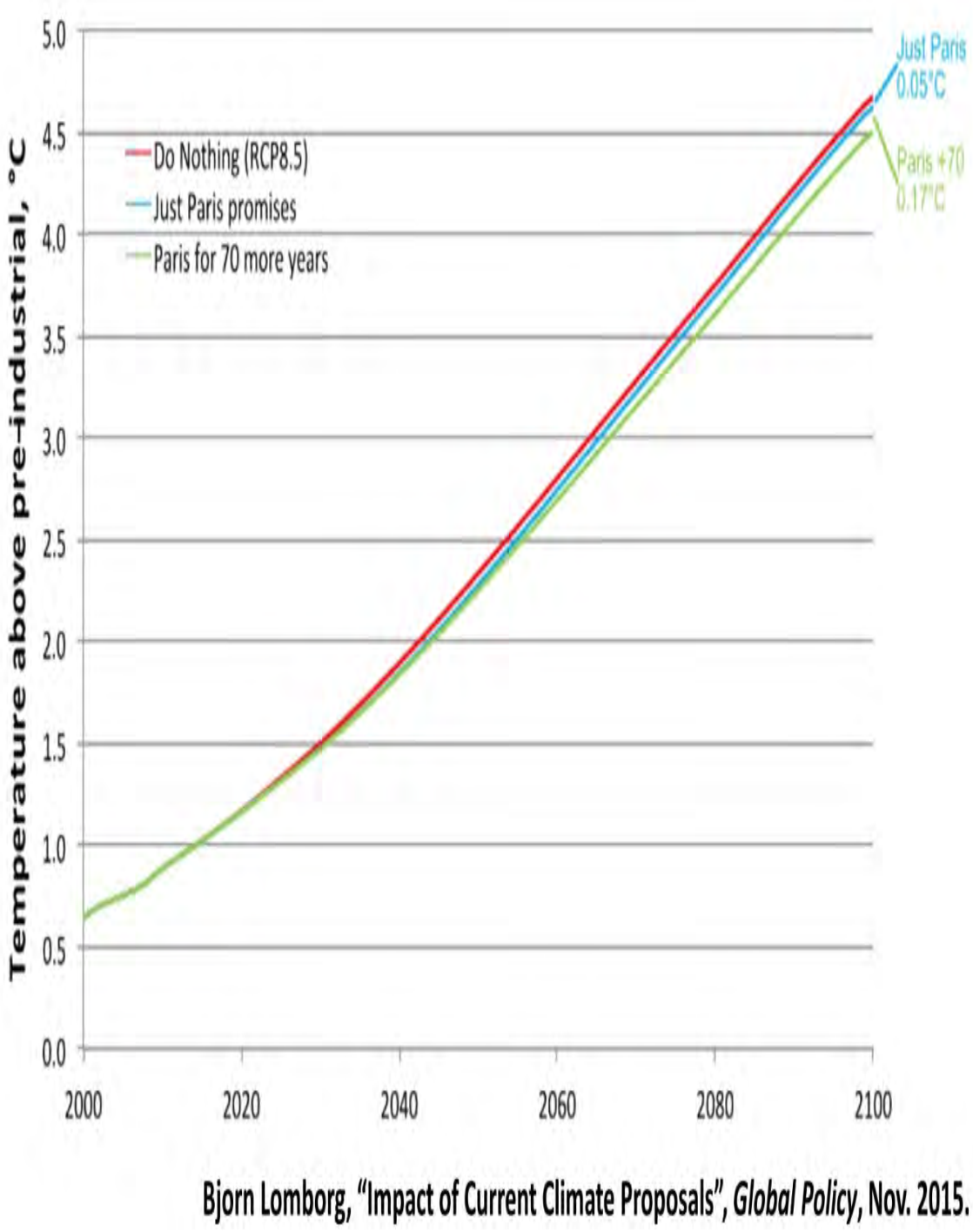
Second, forcing massive reductions in fossil fuel use in the U.S would require much more expensive forms of energy (which are also intermittent), which will in turn cause premature deaths, reductions in liberty, and deprivations in property from what amounts to government-mandated increases in poverty. It would do irreparable harm to society, causing worse ills than the plaintiffs are asking relief from.

Third, what would be gained by such action? It has long been known that even if all CO2 emissions in the U.S. could be halted, the effect on global temperatures by the end of the 21st Century would be unmeasurable, approximately a 0.1 deg. C reduction in future warming. Thus, greatly reducing U.S. CO2 emissions would be all economic pain for no measurable climate gain.

12.5 The Paris Agreement: All pain for no gain

The December 2015 Paris Agreement is an outgrowth of the United Nations continuing efforts to reduce CO2 emissions, and to limit future warming to less than 2 deg. C. Like all UN agreements over the years related to global warming, though, the media hype over their success far exceeds the reality.

Much of what was agreed to in the Paris Agreement constitutes "business as usual" for most of the industrialized world. Bjorn Lomborg (the "skeptical environmentalist") computed and published just how much the Paris Agreement would reduce future temperatures. Even assuming high climate sensitivity, and assuming that the Paris Agreement commitments from countries were extended 70 years beyond the initial commitments, the resulting reduction in future temperatures would be a statistically unmeasurable 0.17 deg. C over the next 80 years.



A few of the signatory countries have since announced even bolder plans for emissions reductions. For example, France will ban all gas and diesel vehicles by 2040 and no longer use coal to produce electricity after 2022. As the human and economic costs of such efforts

are gradually realized, it seems unlikely that such goals will be ever met.

13. Why is Warming Not Progressing as Predicted?

Climate models probably over-predict warming because they produce too much positive feedback, which is necessary for high climate sensitivity. The small amount of direct warming from a doubling of CO2 (a little over 1 deg. C) is magnified by about a factor of three in climate models due to warming-induced changes in clouds and water vapor, while the observations suggest there is little magnification at all.

If we take the Lewis and Curry (2018) conclusions based upon surface warming since the 1800s and more recent measurements of deep-ocean warming at face value, there are a few possible reasons why warming is not progressing as fast as climate models say it should be:

1) The climate system is not very sensitive to our CO2 emissions (my preferred theory).

2) The climate system is very sensitive, but the human forcing of climate is not (yet) as strong as has been assumed (one IPCC theory).

3) The climate system is very sensitive, but some natural climate fluctuation has caused temporary cooling, which is offsetting some of the human-caused warming, and strong warming will eventually occur (another IPCC theory).

The last two of these three possibilities still allow for accelerated warming in the future. Since this book is about the skeptics' position, I will mainly address the first explanation: that the climate system isn't very sensitive to our CO2 emissions.

To review, the direct warming effect of doubling atmospheric CO2 (which can only be calculated from theory) is agreed by nearly everyone to be about 1 deg. C, maybe slightly more. To get substantially more

warming than that requires positive feedbacks in the climate system, which amplify that small amount of direct warming into a much larger amount of indirect warming, before the climate system eventually warms so much that it restores global energy balance through emission of more IR radiation to outer space.

The positive feedback processes contained in climate models are very uncertain, yet are responsible for most (about 2/3) of the warming the models produce.

While the models are indeed mostly made up of fundamental physical principles that are pretty well established, it is these few poorly known feedback processes that determine how serious the global warming problem will be. Out of hundreds of thousands of lines of computer code making up the models, it could be that only a few lines of code representing very uncertain assumptions about the climate system are mainly responsible for producing too much warming.

This is why I call the climate research community's defense of current climate models as "bait and switch". The well-understood basic physical principles the models are built on produce only about 1 deg. C of warming in response to 2xCO2, while the additional 2 deg. C of warming they produce from positive feedbacks is very speculative. They sell you on the well understood physics supporting the 1 deg. C of direct warming, but then switch to the full 3 degrees of warming the models produce as similarly reliable.

How clouds might change with warming (cloud feedback) is particularly uncertain, a fact that is admitted by modelers. The climate models cannot include the actual physics of cloud formation and dissipation because computers are not nearly fast enough to be run with the fine detail contained in clouds. In fact, we don't even understand some of the microphysical details of what happens in clouds, preventing us from modelling them even if computers were fast enough.

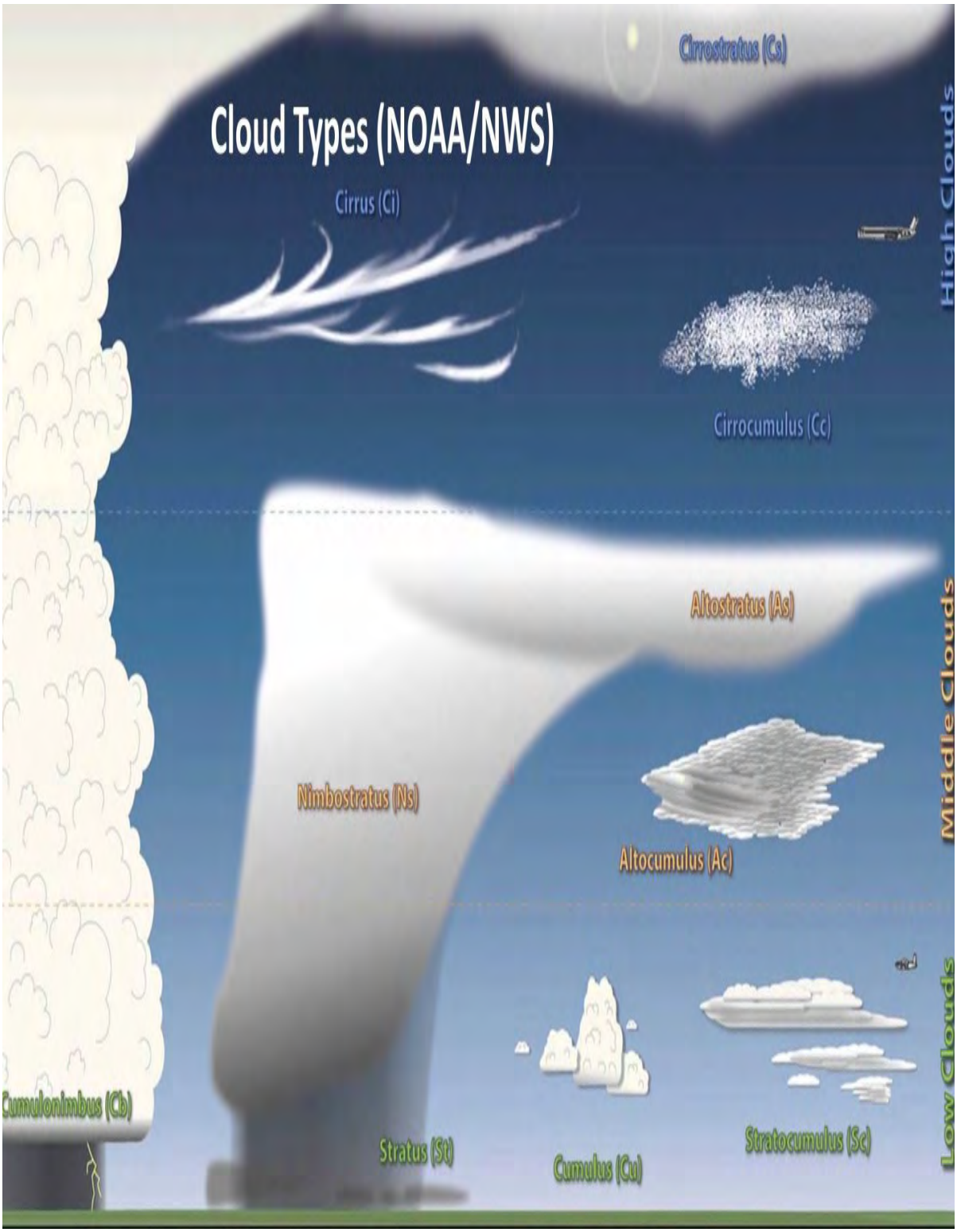
Instead, clouds are crudely "parameterized" with greatly simplified statistical relationships between what's happening on the finest (but still large) spatial scales contained in the models (typically 100 km or so) and the scale the clouds occupy in the real world, often 1-10 km or so. So, for example, even though we know a cloud cannot form unless the relative humidity of air reaches 100%, the humidity at which climate

models begin to form clouds is closer to 85%, and the clouds are then assumed to occupy a portion of the smallest grid cell the model can resolve. This is an extremely simplified approximation of what happens in nature.

Now, such approximations are not necessarily a recipe for failure. But changing that humidity threshold for cloud formation to a slightly different value can substantially change the modeled cloud cover, and thus the modeled climate. The tuning of parameterizations to achieve a fairly realistic average climate is deemed to be entirely acceptable by the climate modeling community, and to some extent it is acceptable—for explaining *today's* climate. But what if a different tuning is needed for a climate that is, say, 1 deg. C warmer? Models are tuned for *today's* climate, not future climate. That is one of the many uncertainties in the myriad assumptions that make up climate models but are seldom mentioned to the public.

We already know that the net effect of all types of clouds taken together is to cool the global climate system. Clouds are the Earth's sunshade. While clouds also have a greenhouse warming effect, their bigger effect is to cool the climate by reflecting sunlight back to outer space. So will warming from more CO2 cause clouds, on average, to increase or decrease? No one knows. Clouds are immensely complex, especially if they produce precipitation, and they are only crudely represented in computerized climate models.

If low-altitude clouds (cumulus, stratus) increase with warming, then more sunlight will be reflected back out to space, offsetting the modest warming effect of more CO2. But if those clouds decrease, warming would be amplified.



In contrast, the effect of a change in high altitude (cirrus and cirrostratus) clouds goes in the opposite direction. If cirrus clouds increase with warming, their greenhouse effect (which is larger than

their sunlight reflection effect) will increase, enhancing warming. But if cirrus clouds decrease, warming will decrease.

What about the Earth's main greenhouse gas, water vapor? Since warming would likely increase the total amount of water vapor in the atmosphere, there is widespread belief that this will enhance warming from more CO2, approximately doubling the 1 deg. C direct warming effect of 2xCO2. This process of enhanced warming is called positive water vapor feedback.

But I don't believe the positive water vapor effect is as strong as is assumed. The processes controlling water vapor are much more complex than is usually admitted, and certainly more complex than is contained in climate models. While low-altitude water vapor will almost certainly increase with warming, a warmer atmosphere makes more efficient rainfall systems, which in turn reduce the amount of water vapor left over to moisten the cloud-free areas at higher altitudes. As a result, the total amount of water vapor in the troposphere (where our weather occurs) can increase, but the water vapor feedback could still be very weak, or even negative, because the very low amounts of vapor in the upper troposphere are more critical to feedback than the large amounts of vapor near the surface. To my knowledge this effect (changing the precipitation efficiency with temperature) is not included in climate models, although researchers are becoming increasingly aware of its importance (e.g. Zhao *et al.*, 2014 *Journal of Climate*; Mauritsen & Stevens, 2015 *Nature Geoscience*).

The issue is not a new one. Skeptical MIT scientist Richard Lindzen discussed it in 1990 ("Some Coolness Concerning Global Warming," *Bulletin of the AMS*), as did Renno, Emanuel, and Stone in 1994 (*Journal of Geophysical Research*), and Danny Braswell and I in 1997 ("How Dry is the Tropical Free Troposphere? Implications for Global Warming Theory," in *Bulletin of the AMS*). Nevertheless, if an issue isn't understood, it has a history of being ignored, downplayed, or even swept under the rug.

What do the observations say about water vapor feedback? Weather balloon data since the 1950s—a period of general warming—suggest upper atmospheric drying might have actually occurred, partly or mostly cancelling out the warming effect on water vapor feedback of low-altitude moistening. The climate models do not produce such behavior

because their cloud and precipitation processes are quite crude. Yet, the possibility of such a change is critical to warming predictions being made by the models.

So, the possibility that warming from increasing CO2 will be minimal is very real, especially since nature has already revealed to us that the climate system has not warmed as much as expected. But we don't really know just yet. In the meantime, modelers stick to the assumption that climate sensitivity is high. It is their last refuge to ensure continued funding, because only in the case of high climate sensitivity does global warming become a serious enough threat to justify continued large expenditures on climate-change research.

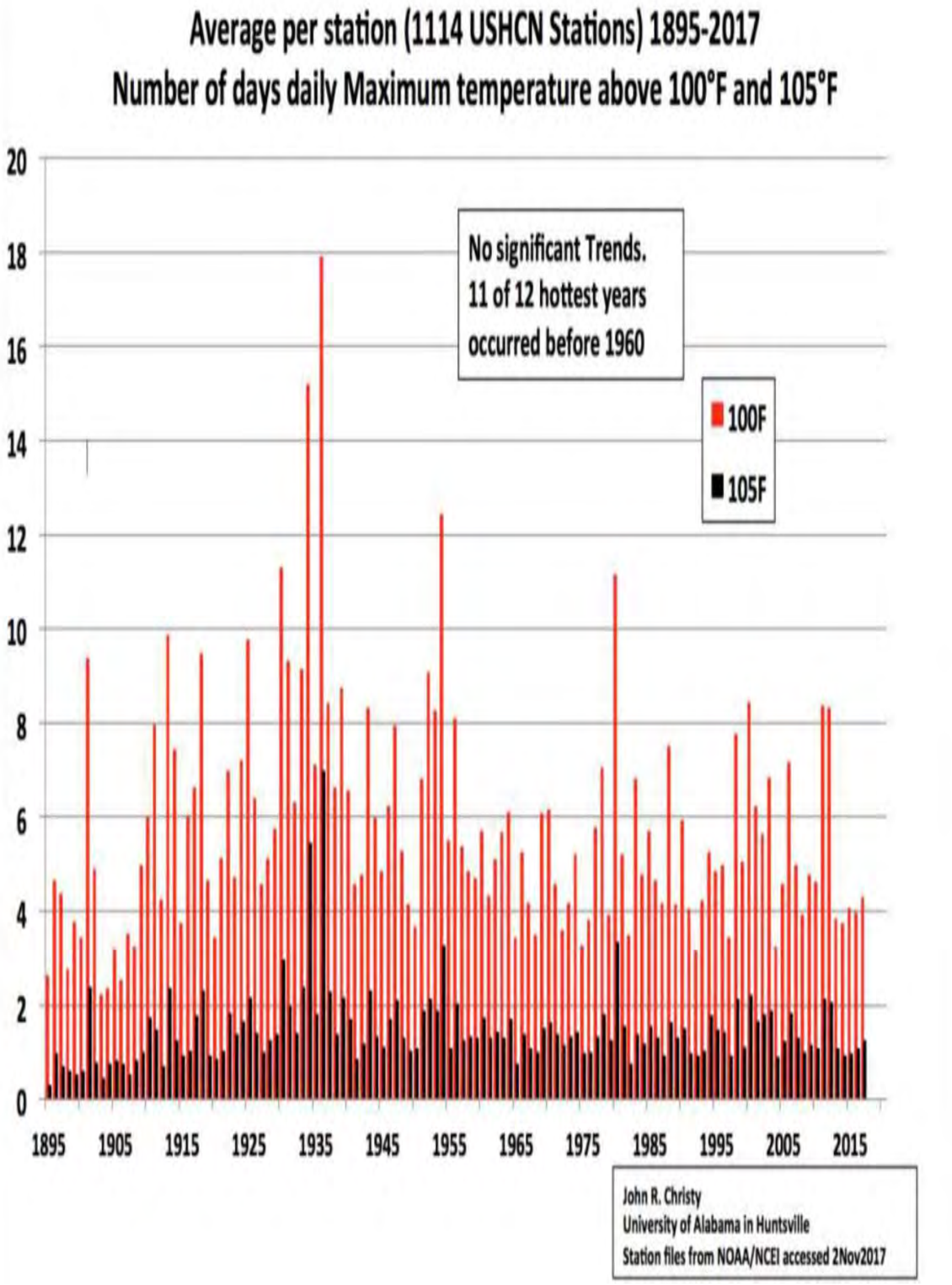
14. Refuting Common Climate Delusions

It would be difficult to address the myriad claims of climate alarmists—there are simply too many of them. Here I will address the most common ones: heatwaves; droughts & floods; storminess (including tornadoes, hurricanes, and storm damages); wildfires; sea level rise; Arctic sea ice melting; Antarctic ice sheet melting; and ocean acidification. Depending upon the subject, we will see that there is little or no reason to believe there are long-term changes occurring that are outside the realm of natural variability.

14.1 U.S. heatwaves have not increased

We have already examined the fact that there has been a small increase in global average temperature. As a consequence, we might expect that extreme heat events should also have increased. But when we examine the details, the story becomes less clear.

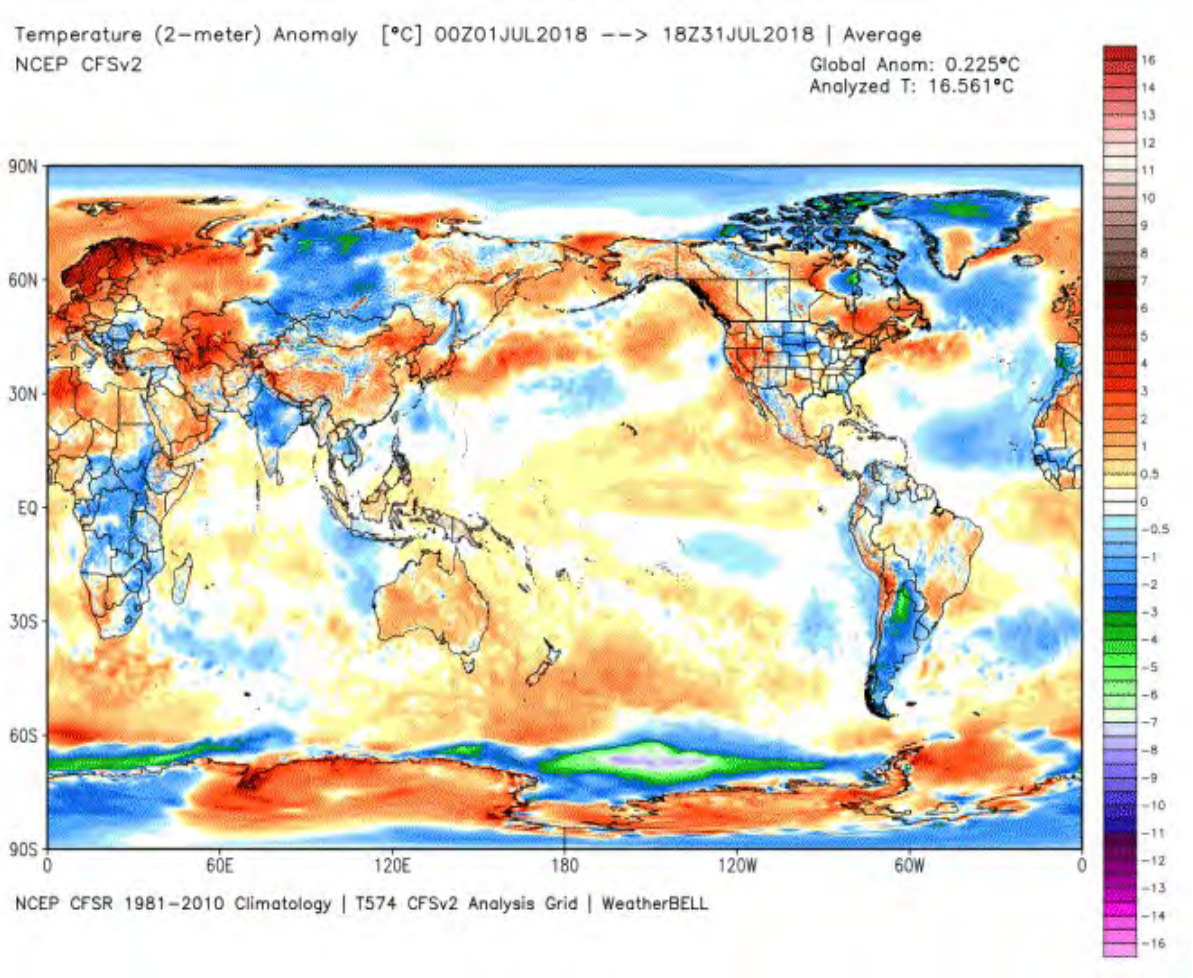
In the United States, official NOAA data reveal that the number of station-days that have experienced temperatures over 100 and 105 deg. F have not changed substantially in the last 100+ years:


Average per station (1114 USHCN Stations) 1895-2017
Number of days daily Maximum temperature above 100°F and 105°F
No significant Trends.
11 of 12 hottest years
occurred before 1960
100F
105F
20
18
16
14
12
10
8
6
4
2
0
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
John R. Christy
University of Alabama in Huntsville
Station files from NOAA/NCEI accessed 2Nov2017

As can be seen, the Dust Bowl days of the 1930s stand out as having more days with extreme heat, but otherwise there has been no obvious long-term trend in the number of days with excessive heat.

Heatwaves in the summer tend to be reported on more in the news than unusually cool summer temperatures, so there is a reporting bias in the media regarding heat waves. Even though both can be occurring in different parts of the country at the same time, it is the excessive heat that will be reported.

As a recent example, the media reported excessive heat during July 2018 in much of Europe and the western U.S., but a global plot of temperature departures from the 1981–2010 average shows that there were anomalously cool areas as well (graphic courtesy of http://weatherbell.com):

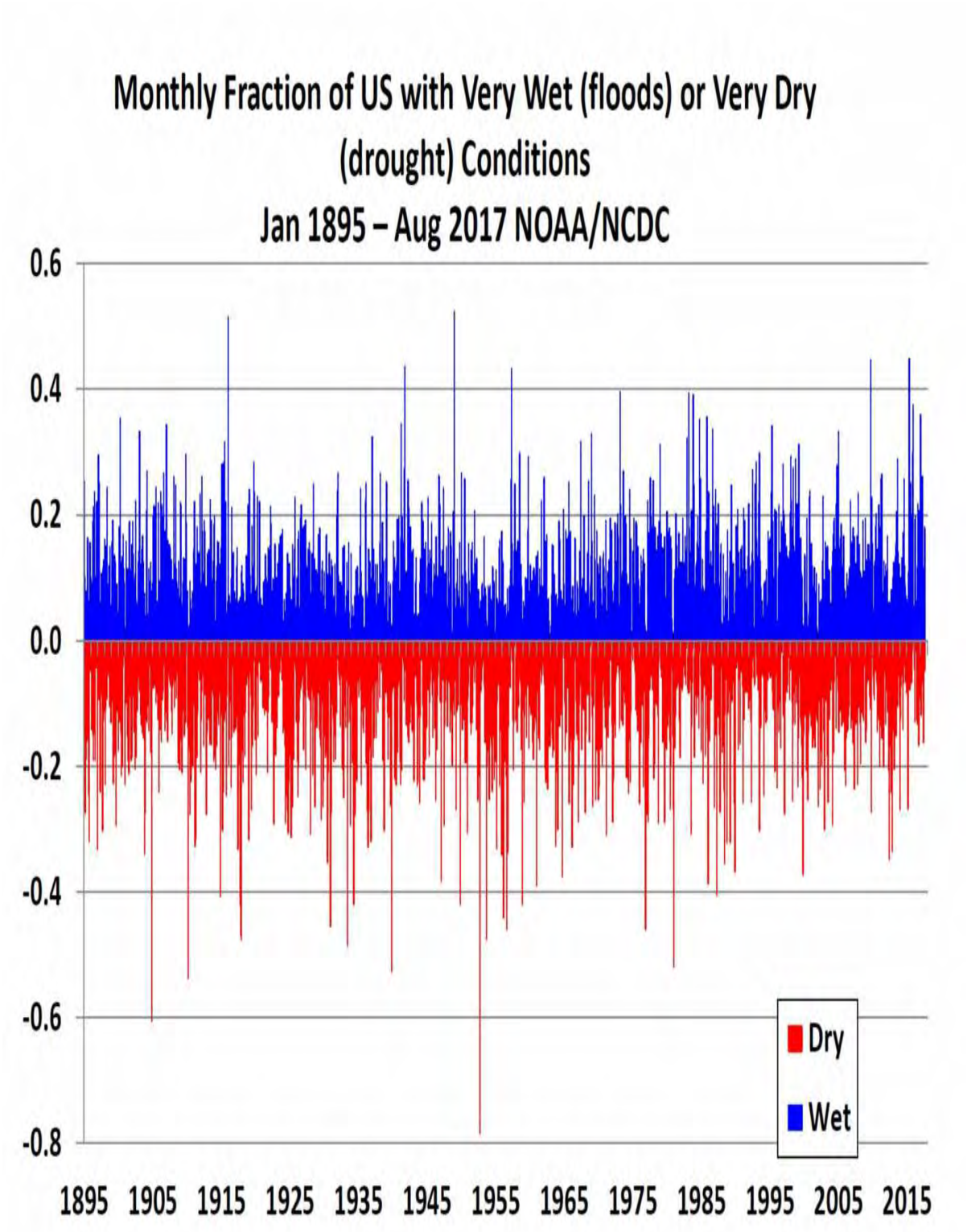


The global average was about 0.23 deg. C above the 30-year average, which is too small for anyone to actually feel and indicates that

the cool areas approximately cancelled out the warm areas in the global average. This is fairly typical, as weather flow patterns that cause warmer than normal conditions in one region also cause cooler than normal conditions in adjacent regions. For example, anomalous warmth in the western U.S will usually correspond to anomalous coolness somewhere in the eastern U.S., and *vice versa*. It's just weather, not climate change.

14.2 U.S. droughts and floods have not increased

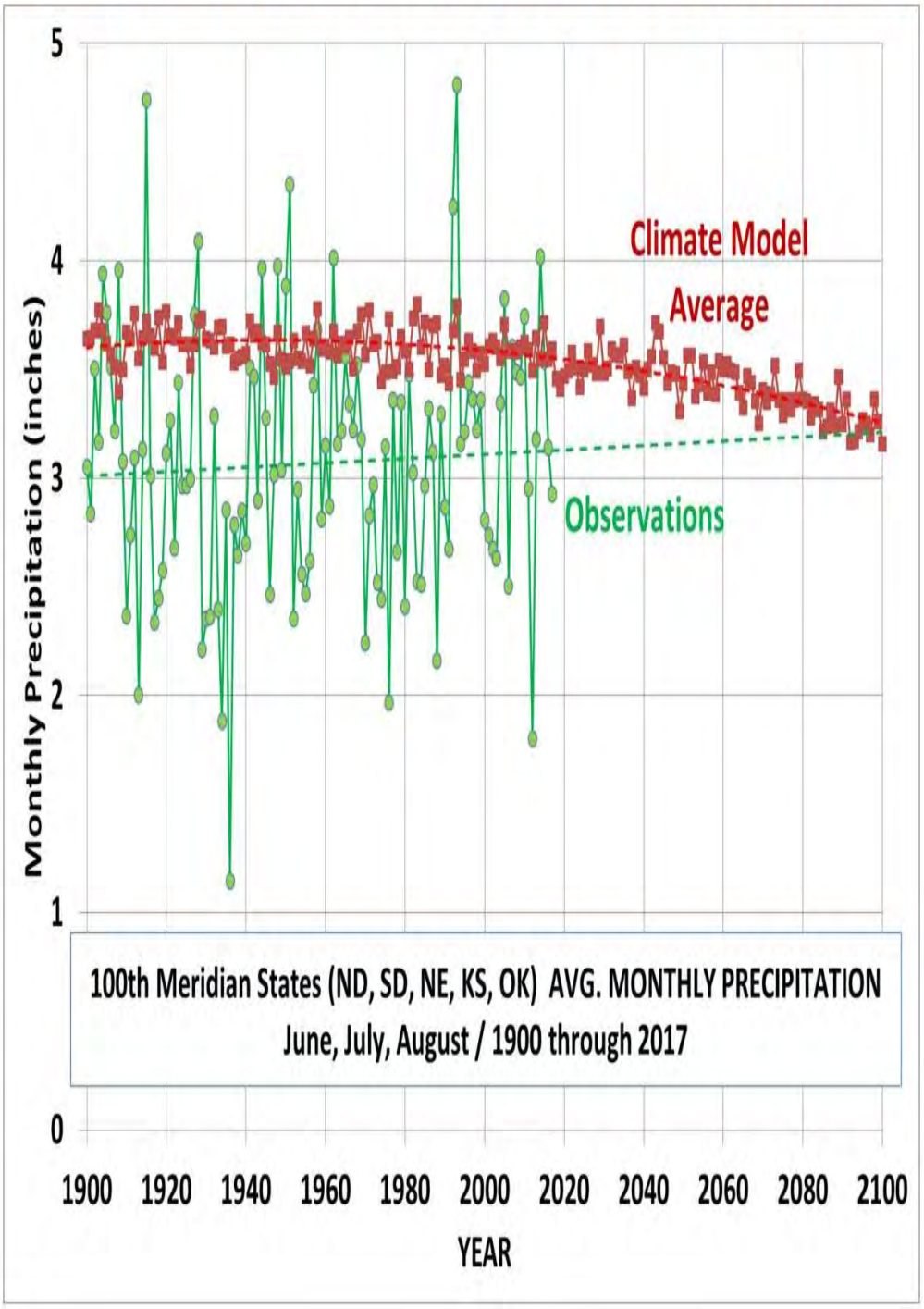
NOAA also monitors the area of the United States experiencing floods or drought conditions. As in the case of weather stations reporting excessive heat, a plot of these areas by month over the last 100+ years reveals no obvious long-term trends in the fraction of the U.S. covered by very wet conditions or by drought:


Monthly Fraction of US with Very Wet (floods) or Very Dry (drought) Conditions
Jan 1895 – Aug 2017 NOAA/NCDC
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
Dry
Wet

A recent example of fake climate news was the claim that the 100th parallel climatological dividing line between the dry West and rainy East in the United States has moved eastward as drought slowly overtakes the agricultural belt. This has not happened; the official precipitation data from NOAA shows that no such change has occurred; it is just another prediction from models which have, so far, failed:

Fake Climate News:

The U.S. 100th Meridian climate boundary has NOT grown drier



Another claim is that heavy rain events have increased dramatically, by as much as 50%. While I would indeed expect some increase in precipitation overall in a slightly warmer world, the claim is based upon misleading statistics. In the Fourth National Climate Assessment (2017, USGCRP), it is claimed that there has been a 4% increase in U.S. precipitation over the period 1901–2015. First of all, this increase is partly because the very dry Dust Bowl days of the 1930s make recent years seem slightly wetter in comparison. Nevertheless, even without the anomalous Dust Bowl drought being included in the analysis I could still believe there has been 2–3% increase in total precipitation over the last century. This is hardly alarming and is consistent with what we would expect in a slightly warmer world.

What might cause more alarm is the National Assessment's claim that the heaviest 2-day rainfall events have increased substantially. But this is because certain *thresholds* of heavy precipitation were used, which leads to an exaggerated change due to a statistical sleight of hand. As an example, let's say that for some given location there used to be on average only one 5 inch rainfall (or greater) every 10 years. Then in some later decade there were three 5+ inch rainfall events. One might then claim there has been a tripling of the heaviest rainfall events.

But this doesn't mean that there used to be only one heavy rain event and now there are three. Instead, the three heaviest rainfall events might have been 4.85, 4.92, and 5.13 inches previously (so, one event exceeding 5 inches), and now they are 5.01, 5.16, and 5.25 inches, so, three events exceeding 5 inches. There were still three very heavy rainfall events in both the earlier decade and later decade, but their total amount of rainfall in this case went up by only 3.5%. To claim that the frequency of the heaviest rainfall events has tripled in such a case is clearly misleading, which is a common tactic among climate alarmists. Most people do not realize the ambiguity in such claims and so infer something that was not actually stated.

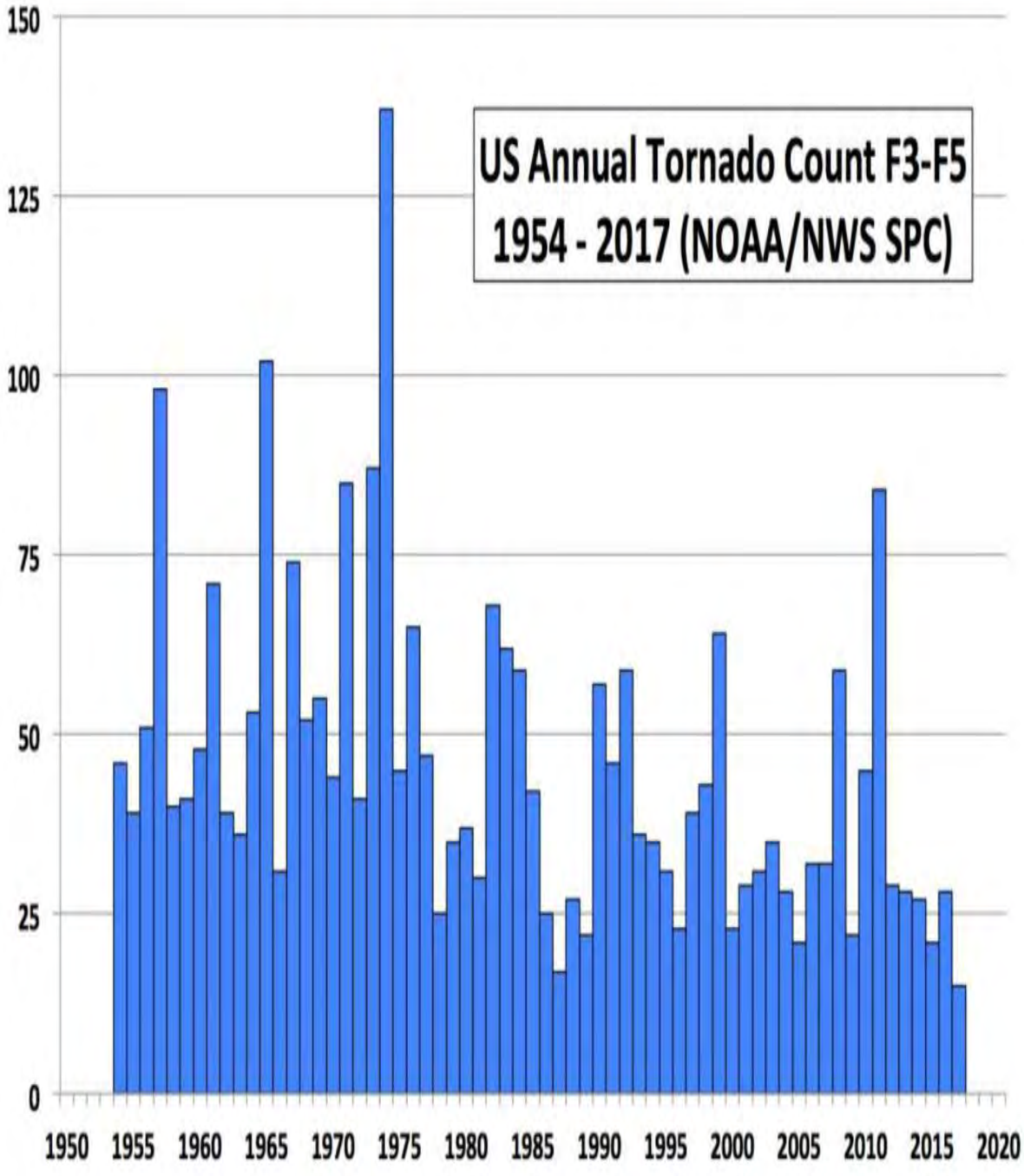
14.3 Storminess has not increased

My primary training is in meteorology (Ph.D.). I consider myself most knowledgeable of day-to-day weather, with an emphasis on satellite observations. Many years ago I passed National Weather Service

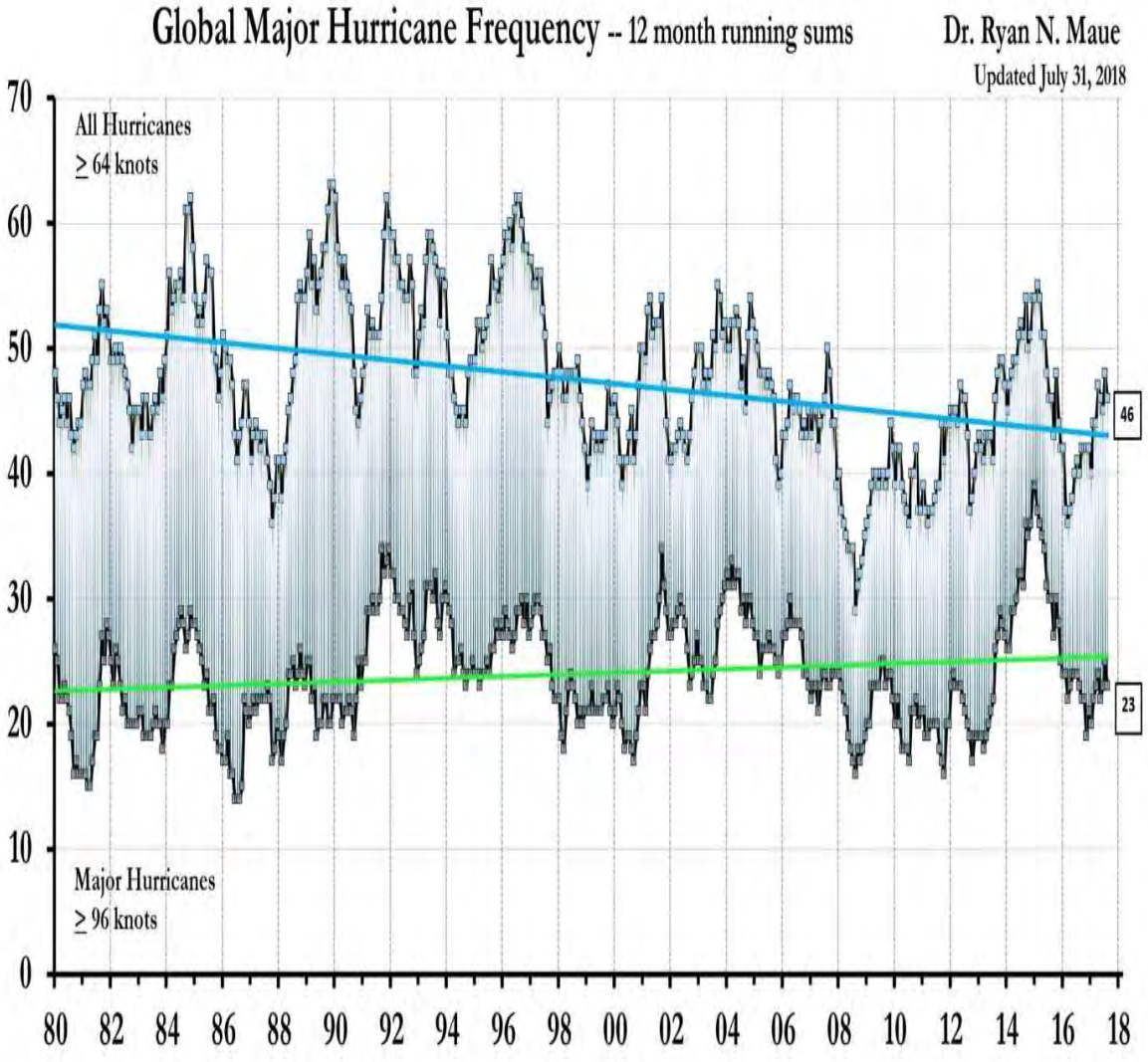
certification exams in weather observation, something I doubt few if any alarmist climate scientists have done. I've published peer-reviewed papers on how to monitor weather, severe thunderstorms, and hurricane intensity from space.

In my professional opinion there is no good evidence that weather has gotten more severe in recent decades. In fact, for strong to severe tornadoes in the U.S. (which is the global hotspot for tornado activity), the weather has grown quieter.

Decrease in Strong to Severe Tornadoes in the U.S. since the 1950s



For hurricanes, there are large fluctuations in global activity from year to year and decade to decade, with no obvious long-term increase:


Global Major Hurricane Frequency -- 12 month running sums
Dr. Ryan N. Maue
Updated July 31, 2018
All Hurricanes
≥ 64 knots
Major Hurricanes
≥ 96 knots
46
23
70
60
50
40
30
20
10
0
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
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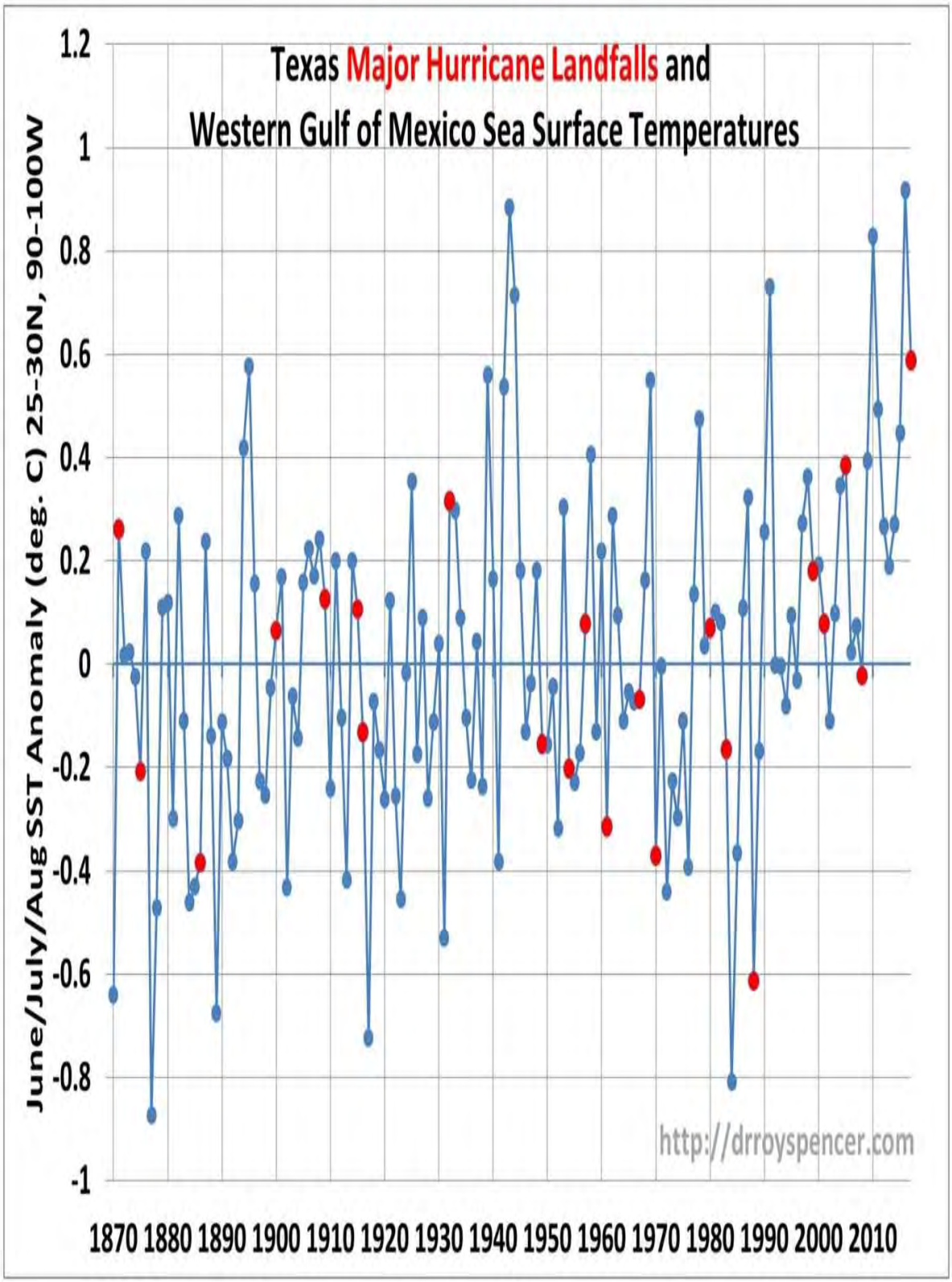
12
14
16
18

Only if we look at the strongest hurricanes (over 96 knots maximum sustained wind speeds) is there some evidence of a long-term upward global trend, maybe 10% in the last 40+ years, but it is unknown whether this is just a statistical artifact of very noisy data, long-term natural variability, or human influence.

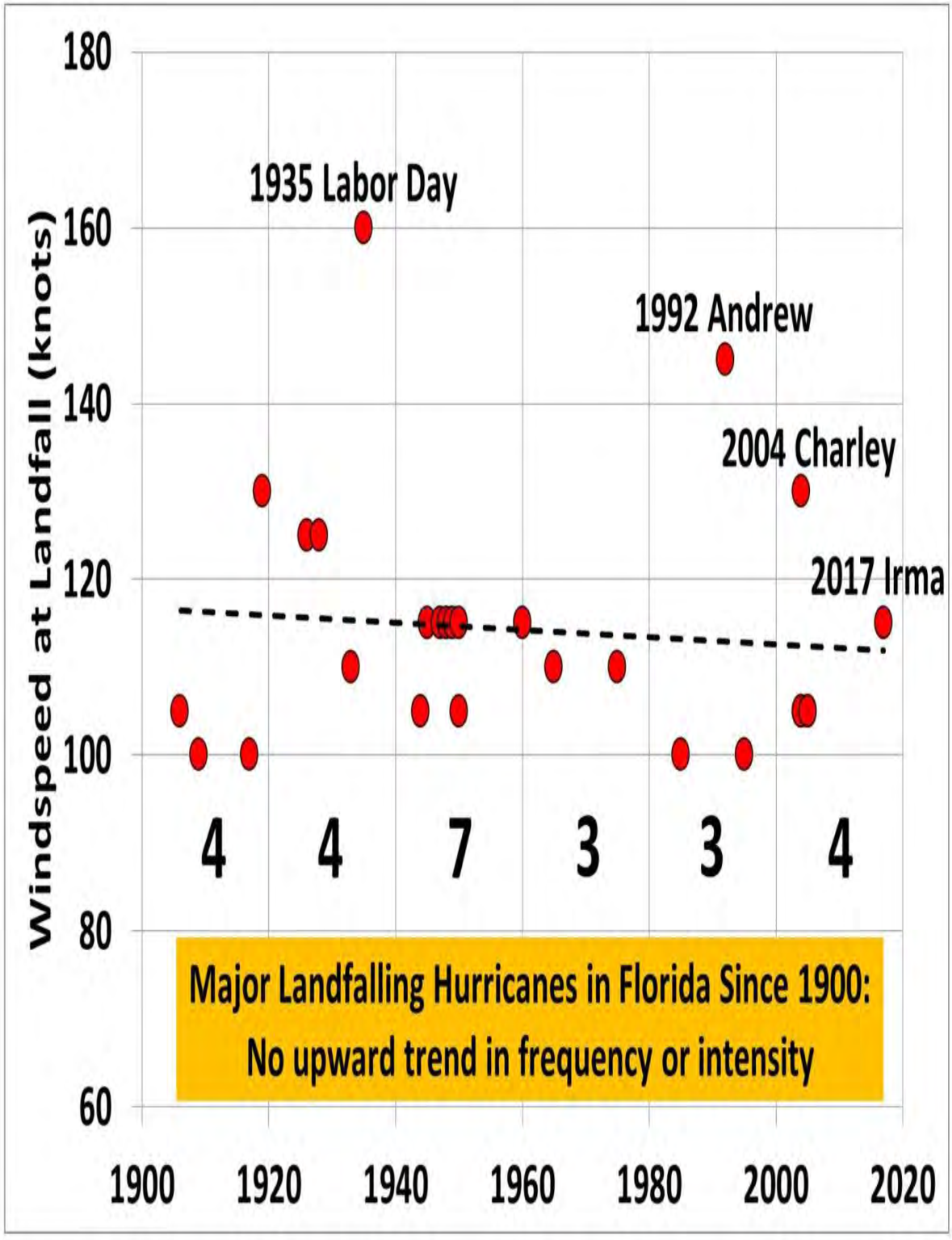
In the U.S., there is evidence from Gulf of Mexico coastal lake bottom sediments of super-hurricane storm surges 1,000 to 3,800 years ago that have not been rivaled in the modern historical record. The strongest hurricane to strike New England occurred on August 25, 1635, only fifteen years after the Mayflower arrived and the Massachusetts Bay Colony was established, with 14 to 22 feet of storm surge. Few people are aware of this epic meteorological event, yet millions of people know of relatively weak (Category 1) Hurricane Sandy, which hit New York City and Long Island (a densely populated area) from the worst possible direction and at the worst possible time (high tide), doing major flood damage with a total water surge of 14 feet at Battery Park.

The 2017 Hurricane Harvey flooding disaster in Houston was not the result of global warming, but of an unusually slow-moving tropical cyclone centered over a major metropolitan area that has experienced extensive land subsidence of 3 to 9 feet, reducing the ability of rivers to quickly remove the excess rainfall. If we examine all major (Category 3 and higher) hurricane strikes in Texas since 1870 and how they compare to the warmth of the Gulf of Mexico waters, we find that half of them have occurred when water temperatures were below average, and half were during above-average water temperature:


Texas Major Hurricane Landfalls and
Western Gulf of Mexico Sea Surface Temperatures
June/July/Aug SST Anomaly (deg. C) 25-30N, 90-100W
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
http://drroyspencer.com

Thus, it would be difficult to claim that warming of the Gulf of Mexico is causing major hurricanes to become more frequent along the Texas coast.

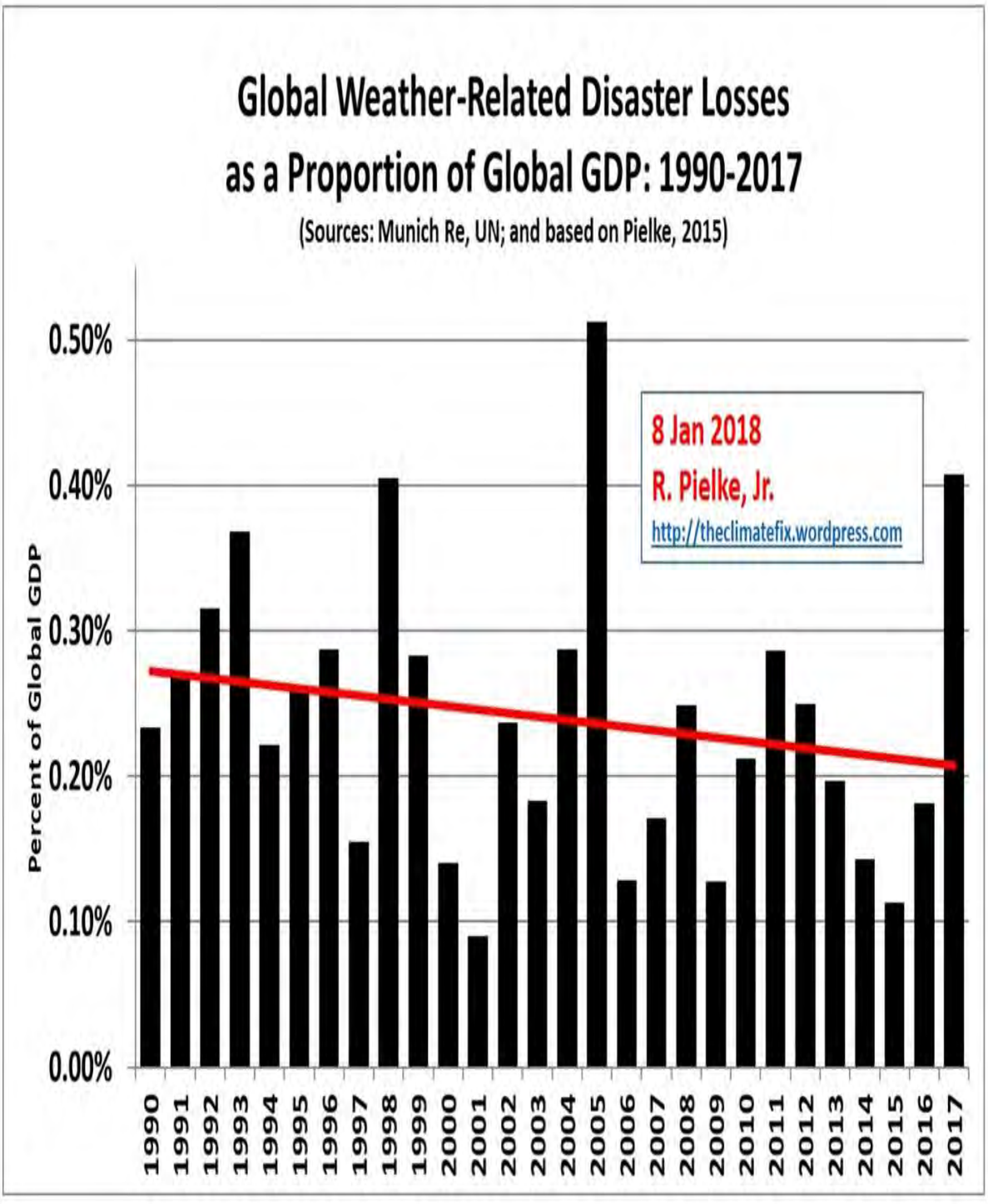
Florida also had a major hurricane strike in 2017 (Irma), but again we find that the long-term trend does not support alarm. The number and intensity of major hurricanes have, if anything, gone down in Florida:


Windspeed at Landfall (knots)
180
160
140
120
100
80
60
1900
1920
1940
1960
1980
2000
2020
1935 Labor Day
1992 Andrew
2004 Charley
2017 Irma
4
4
7
3
3
4
Major Landfalling Hurricanes in Florida Since 1900:
No upward trend in frequency or intensity

The media coverage of Hurricane Irma was breathlessly apocalyptic, yet where were the media reports that 2017 represented the end of an unprecedented 11-year hiatus in major hurricane landfalls for the U.S.? If it isn't a disaster, it's not news. This is why we need to examine objective evidence before we believe the claims of journalists operating on deadlines.

The only evidence I've seen of a long-term change in severe weather (which is still uncertain) is that there might be some evidence for an increase in the frequency of the heaviest rainfall events. This remains uncertain because the increase might just be the result of a change in rainfall measurement technology in the early 1990s. Nevertheless, to the extent there has been some warming, one would expect a shift toward somewhat more precipitation.

What has definitely increased is monetary storm damage. But this is not from worsening weather. It is because as population and wealth increase we build more infrastructure subject to damage, especially in hurricane-prone areas like the U.S. Gulf and Atlantic coasts. So, even if the number and intensity of hurricanes remained the same year after year, hurricane-related damages would continue to increase. Researcher Roger Pielke, Jr., has adjusted for the effect of increased prosperity and found that, as a proportion of GDP, storm-related damage has actually decreased in recent decades:


Global Weather-Related Disaster Losses
as a Proportion of Global GDP: 1990-2017
(Sources: Munich Re, UN; and based on Pielke, 2015)
Percent of Global GDP
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
8 Jan 2018
R. Pielke, Jr.
http://theclimatefix.wordpress.com
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

By the way, look again at that vertical axis. It doesn't list 10, 20, 30, 40, or 50 percent, but 0.1, 0.2, 0.3, 0.4, and 0.5 percent. That is, although the extent of damage done by a hurricane where it hits built-up areas may be enormous for those areas, on a global scale the total damage done by all hurricanes in a single year since 1990 has only once topped one-half percent of the value of everything produced in the world in that year—let alone of the enormous amount of wealth, many times more than annual production, accumulated up to now. It's easy, when we look at localized destruction, to think of it in apocalyptic, Armageddon-like terms, but if we stand back and look at the big picture, that's not very realistic thinking.

Severe weather is notoriously variable, year-to-year and decade-to-decade, for reasons we cannot predict and sometimes don't even understand. Such variability is normal for weather. But what is also normal is people's tendency to respond to severe weather in irrational ways. If your small town is destroyed by a tornado for the first time in 100 years, you are more likely to consider the possibility that anthropogenic climate change is responsible. There are always a handful of scientists who are willing to tell reporters they believe there is such a connection. The situation is little different from expert economists who routinely diagnose and predict what is going on in the economy, sometimes coming to totally opposite conclusions.

But what if your town hasn't been hit by a major tornado since it was founded in the 1800s? Who will be alarmed by that, and blame it on climate change? Where are the reporters interviewing people and doing news stories on climate change causing fewer destructive tornadoes?

It doesn't happen. It's not newsworthy.

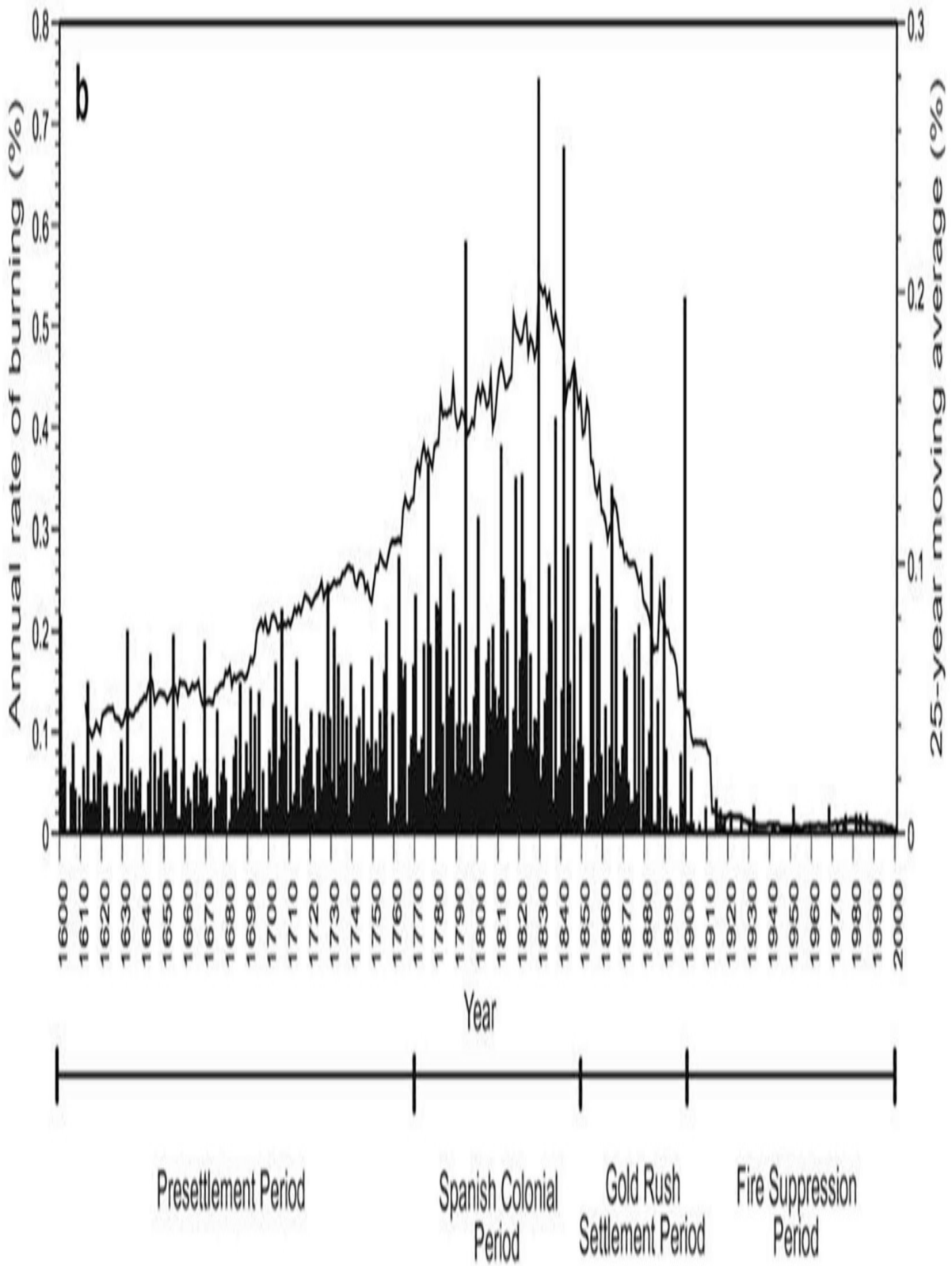
And as a result, our perception of worsening weather is reinforced.

14.4 Wildfires have not worsened

Wildfires have always occurred naturally. Native Americans used to set them on purpose for hunting. The biggest factor controlling the prevalence of wildfires, though, is land management practices. If you live in a region like the American West, where the winter season is rainy with growing vegetation and the summer is characterized by drought, it

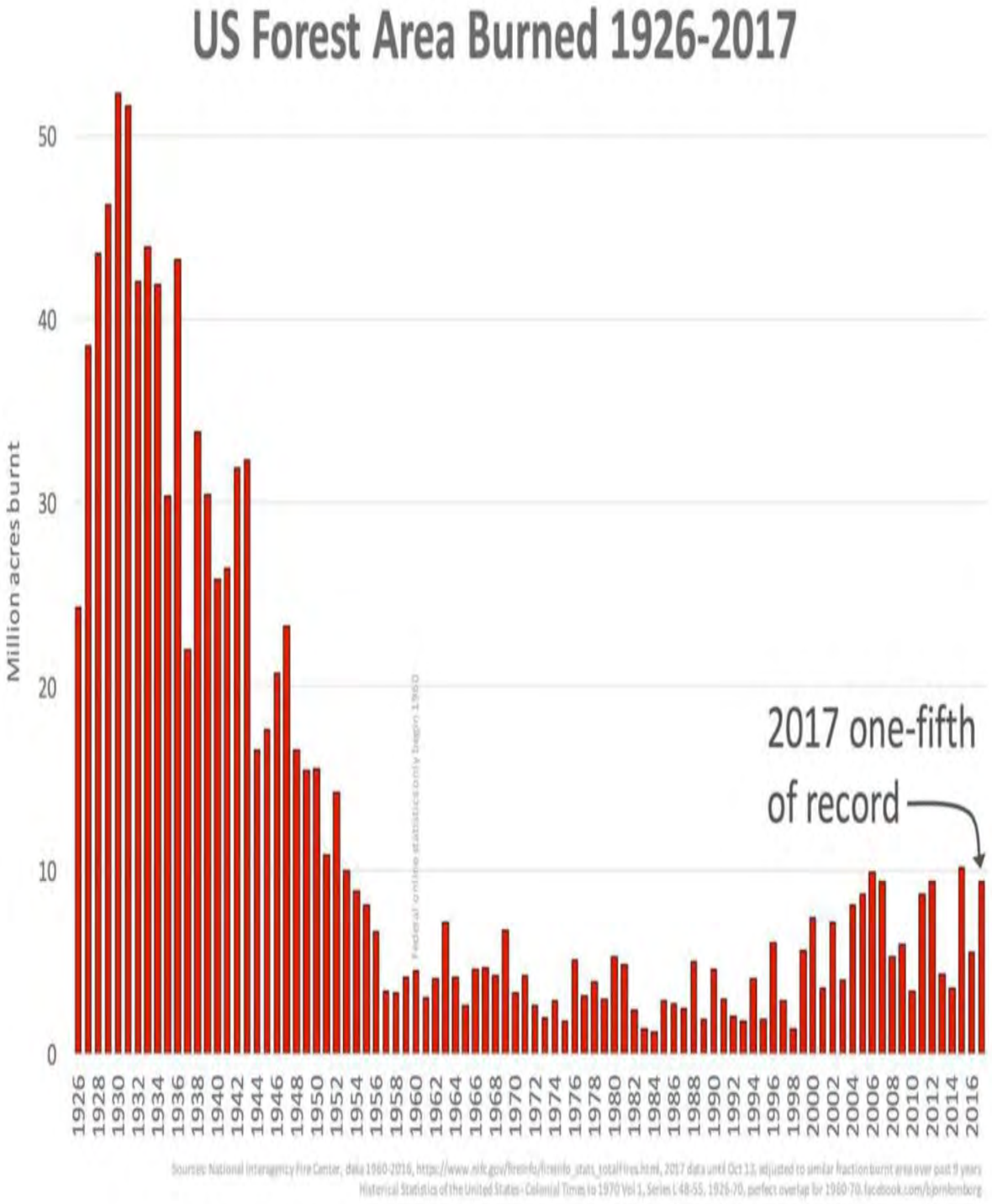
is natural for woody fuel to build up year after year. Unless this dry wood is cleared, it is only a matter of time before it burns, whether from a dry lightning strike, a windstorm taking down power lines, a campfire, or arson. As humans continue to build into rural areas, the risk of humans starting fires—and having their houses destroyed—increases.

Land management practices are known to have a huge influence on wildfire activity. This can be clearly seen in the case of Yosemite National Park, where wildfires were common before the 1900s, after which active suppression of fires was instituted:


b
Annual rate of burning (%)
25-year moving average (%)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.3
0.2
0.1
0
1600
1610
1620
1630
1640
1650
1660
1670
1680
1690
1700
1710
1720
1730
1740
1750
1760
1770
1780
1790
1800
1810
1820
1830
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year
Presettlement Period
Spanish Colonial Period
Gold Rush Settlement Period
Fire Suppression Period

What happens when fires are suppressed? All of the naturally occurring dead wood builds up over the years, leading to an increasing threat of catastrophic fires. Concerns of environmentalists, especially those who are preservationists, often cause such mismanagement since some people don't like to see forest areas cleared or controlled burns charring the landscape. But without such management practices, the danger of catastrophic, uncontrollable fires rises year after year.

For the U.S as a whole, wildfire activity looks similar to the Yosemite data, with the initiation of fire suppression by the Forest Service during the early 20th Century being quite noticeable:


US Forest Area Burned 1926-2017
Million acres burnt
50
40
30
20
10
0
2017 one-fifth
of record
Federal online statistics only begin 1960
1926 1928 1930 1932 1934 1936 1938 1940 1942 1944 1946 1948 1950 1952 1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Sources: National Interagency Fire Center, data 1960-2016, https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html, 2017 data until Oct 13, adjusted to similar fraction burnt area over past 9 years
Historical Statistics of the United States - Colonial Times to 1970 Vol 1, Series L 48-55, 1926-70, perfect overlap for 1960-70. facebook.com/bjornlomborg

Regarding global wildfire activity, a 2016 study by Doerr and Santin published in the *Philosophical Transactions of the Royal Society B*, stated:

"… many consider wildfire as an accelerating problem, with widely held perceptions both in the media and scientific papers of increasing fire occurrence, severity and resulting losses. However, important exceptions aside, the quantitative evidence available does not support these perceived overall trends. Instead, global area burned appears to have overall declined over past decades, and there is increasing evidence that there is less fire in the global landscape today than centuries ago. Regarding fire severity, limited data are available. For the western USA, they indicate little change overall, and also that area burned at high severity has overall declined compared to pre-European settlement."

If you are the one whose house burns in a wildfire, these facts give little consolation. But we should place the blame for wildfires where it belongs, whether that is misguided forest management practices, improper maintenance of electric utility lines, arson, or simply the natural forces of weather—not on global warming.

14.5 The human component of sea-level rise is probably small

At any given coastal location, sea-level rise (like weather) is affected by many things:

- natural subsidence of the land (for example, as is occurring in Miami Beach, Norfolk, New Orleans, and Galveston);

- weather patterns changing the prevailing wind and sea-level pressure patterns (some ocean areas have sea level as much as 30 to 40 inches higher than other areas, due to wind-driven ocean circulation);

- tidal variations from the sun's and moon's gravity;

- localized storm surge, both tropical and extratropical;

- changes in glaciers, especially the Greenland and Antarctic ice sheets;

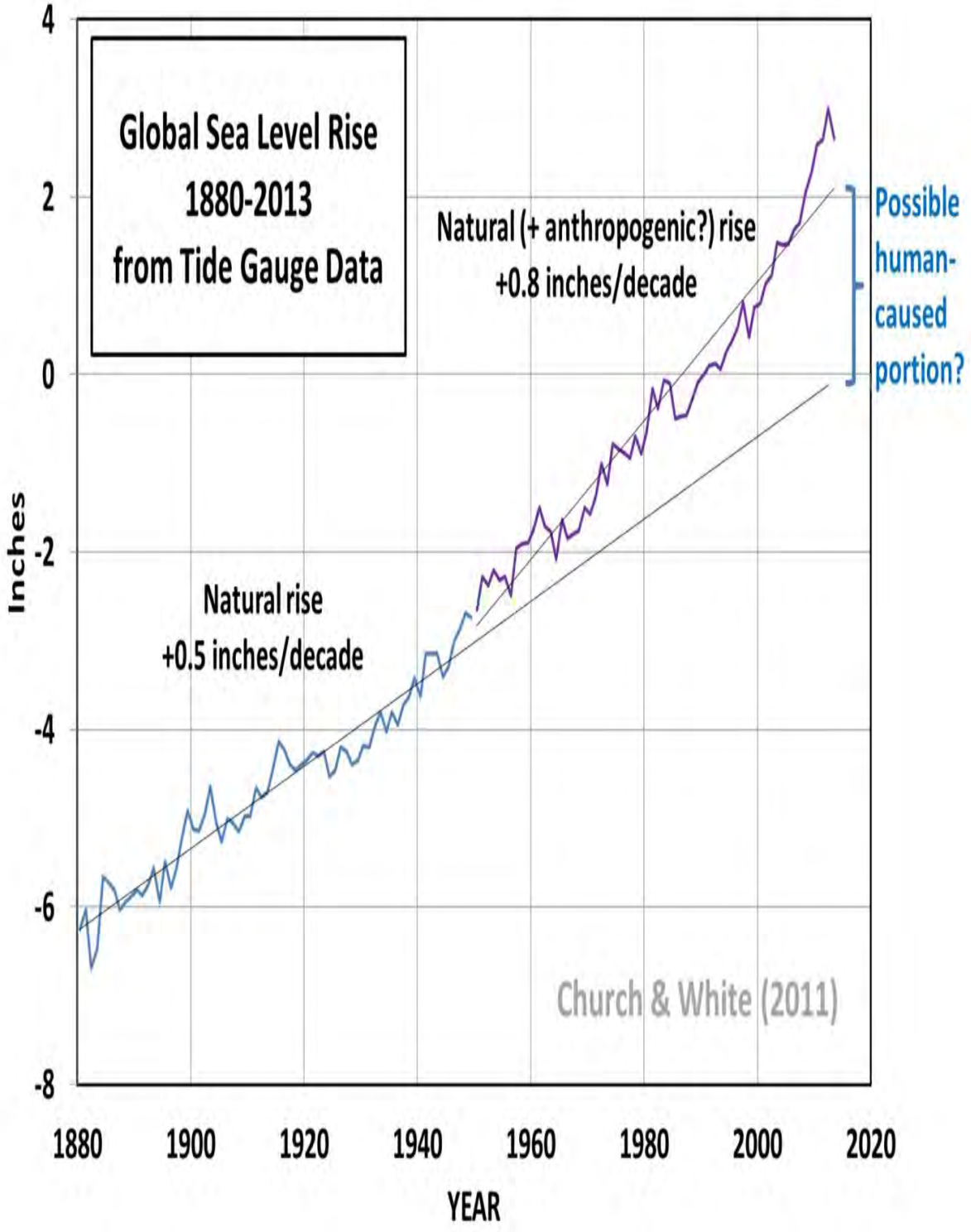
- changes in the storage of precipitation on land and in river runoff;

- slow sea-level rise since the end of the last ice age;

- and, finally, thermal expansion from warming.

Our most consistent record of sea-level data is from tide gauges, which measure local sea level at coastal locations. These are not ideal because the ones with long-term records are geographically sparse, but they still represent a “gold standard” of quality and provide a record of sufficient length to construct global average sea levels since about 1855.

One of the most widely-referenced tide gauge records by alarmists is that of Church & White (2011), which is plotted in the following graph and updated through 2013.


Global Sea Level Rise
1880-2013
from Tide Gauge Data
Natural (+ anthropogenic?) rise
+0.8 inches/decade
Natural rise
+0.5 inches/decade
Possible human-caused portion?
Church & White (2011)
Inches
YEAR
4
2
0
-2
-4
-6
-8
1880
1900
1920
1940
1960
1980
2000
2020

I have split the record into two parts: before and after 1950. This is because humanity had not emitted a substantial amount of CO2 into the atmosphere before that time; even the IPCC mentions this date for the start of substantial human influence. So, it is reasonable to assume the natural rate of rise (0.5 inches per decade) would have continued, and that the recent increase above that since 1950 is at least partly due to humans.

The difference in the rate of rise in these two periods is about +0.3 inch per decade, which is what we might attribute to human activities if we assume 100% of the recent warming and glacial melt (the two main contributors to global sea level rise) was due to humans.

That is only about 1 inch every 30 years, a very small number.

If someone objects that there were human emissions of CO2 prior to 1950, I can change the date to 1920, redo the calculations, and the results are virtually the same for the calculated influence of humans on sea-level rise.

Only time will tell if the acceleration continues; there are natural decadal time-scale changes in sea-level rise, and we should not extrapolate what has been happening recently too far into the future, given the poor state of knowledge of natural variations. The role of nature in sea-level change will continue to remain uncertain. Simply assuming that humans are responsible for any recent acceleration in sea-level rise does not make it so. Yes, warming of the climate system might be expected to cause sea-level rise, but that doesn't mean that humans are responsible for the warming.

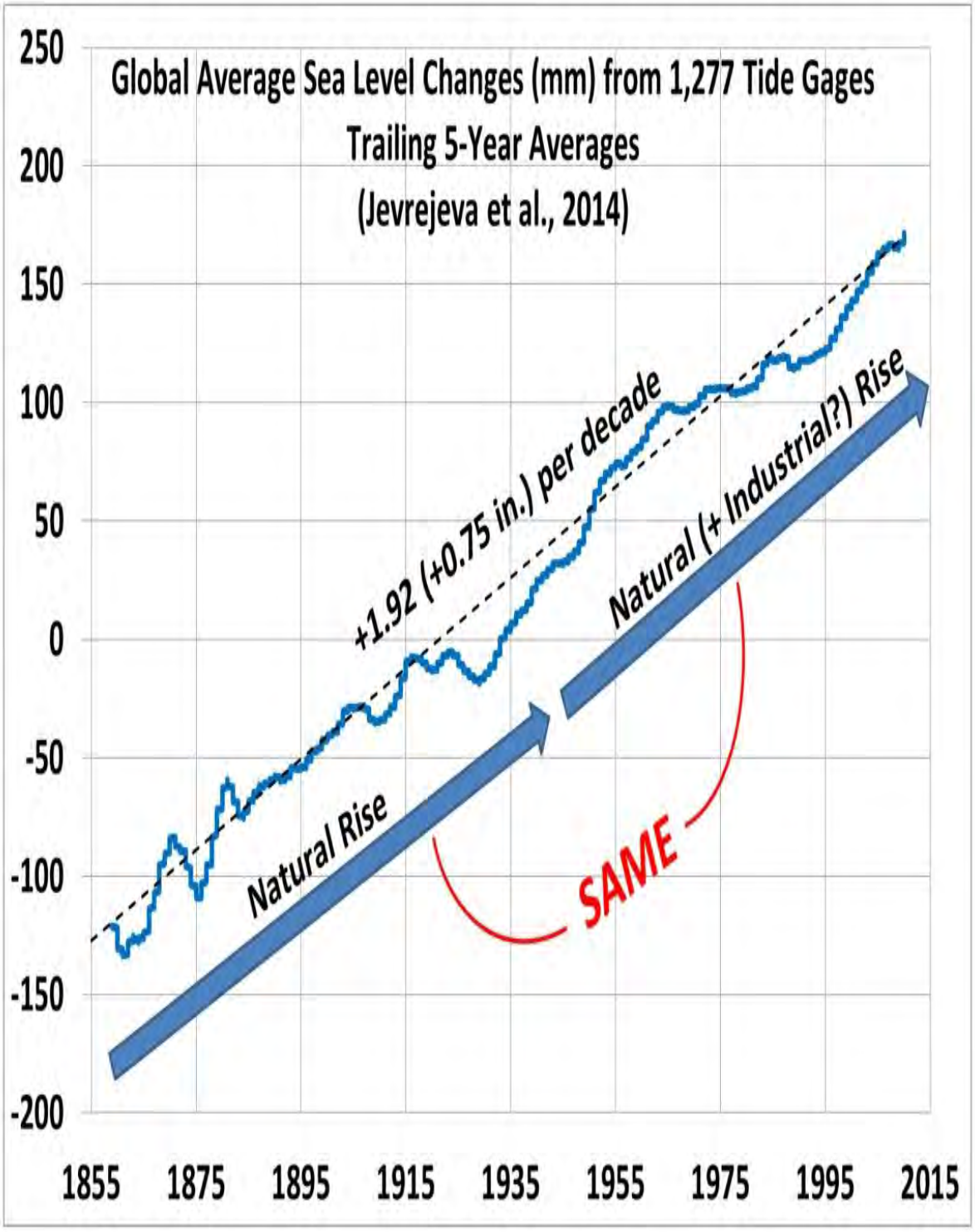
Note that the natural portion of sea-level rise is never mentioned in news reports, which typically imply all sea-level rise is our fault. The fact is that most sea-level rise is natural, and our contribution to it has been rather small so far.

Just like our uncertainty about what caused the Little Ice Age and our emergence from it during the 1700s and 1800s, researchers are still having difficulty explaining why sea level was rising for at least 100 years before humans could be blamed. This is one more piece of evidence that climate changes naturally.

I have not included sea-level data from satellites because that record is relatively short (only since 1993) and the data are continually being

revised with rather large and uncertain adjustments. In any event, the satellite data are generally consistent with the above plot.

Alternatively, I could have used a different analysis of tide gauge data (Jevrejeva *et al.*, 2014) that doesn't show any acceleration in sea-level rise at all:


Global Average Sea Level Changes (mm) from 1,277 Tide Gages
Trailing 5-Year Averages
(Jevrejeva et al., 2014)
250
200
150
100
50
0
-50
-100
-150
-200
1855
1875
1895
1915
1935
1955
1975
1995
2015
+1.92 (+0.75 in.) per decade
Natural (+ Industrial?) Rise
Natural Rise
SAME

In that case, one might argue there has been no acceleration of sea-level rise. But instead, I wanted to use the data most referenced by alarmists to illustrate that, even if sea-level rise has accelerated, and 100% of that acceleration is due to humans, that anthropogenic contribution (1 inch every 30 years) is hardly alarming compared to Mother Nature's contribution (3 inches every 30 years).

So, when you see news reports that sea-level rise is our fault, remember that sea level has been rising naturally for over 150 years and only in the last 50 years has there been any evidence it has accelerated. And even if 100% of the recent enhancement of the rise is due to humans, it amounts to only about 1 inch every 30 years.

Given that sea level has been rising anyway, it would have to be part of long-term coastal planning. One way to think about that is to compare the cost of mitigation with long-term economic production. Back in 1988 Max Singer wrote in his book *Passage to a Human World: the Dynamics of Creating Global Wealth* that, as could be inferred from average annual GDP growth rates, half the world's total capital (physical wealth accumulated from the dawn of humanity) as of then had been created in only the previous 25 years. A small fraction of total capital lies in areas that could, with sea level rising at 1 inch per decade, be underwater in a hundred years, but much of that capital can be moved, and much of what can't can be protected by sea walls and dikes—as has been done in the Netherlands for over 400 years. The small remaining part that cannot be moved or protected would constitute but a tiny percentage of annual global GDP, not a monumental loss to humanity.

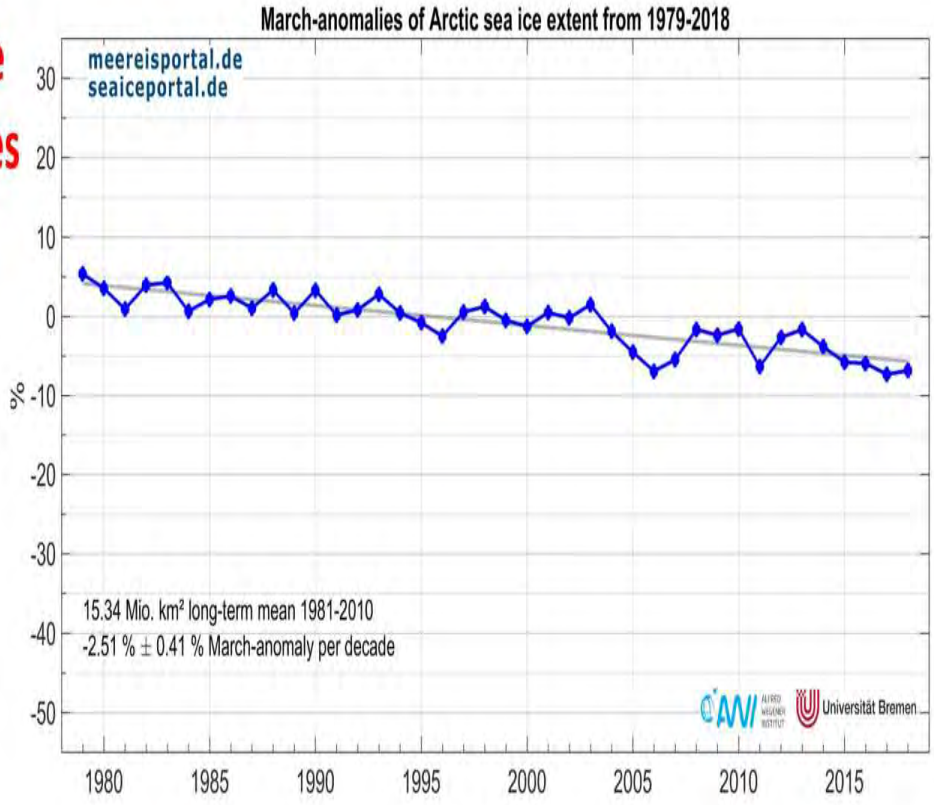
14.6 Arctic sea-ice cover was lower in the past

Accurate measurements of sea ice in the Arctic Ocean have only existed since 1979, with the launch of Earth-orbiting satellites carrying microwave radiometers that can look through persistent cloudy areas to measure the extent of ice. I know something about the issue because I was the U.S. Science Team leader for NASA on one of the instruments that performed this function. Since 1979, a number of satellites launched sequentially have allowed a continuous sea ice record to be

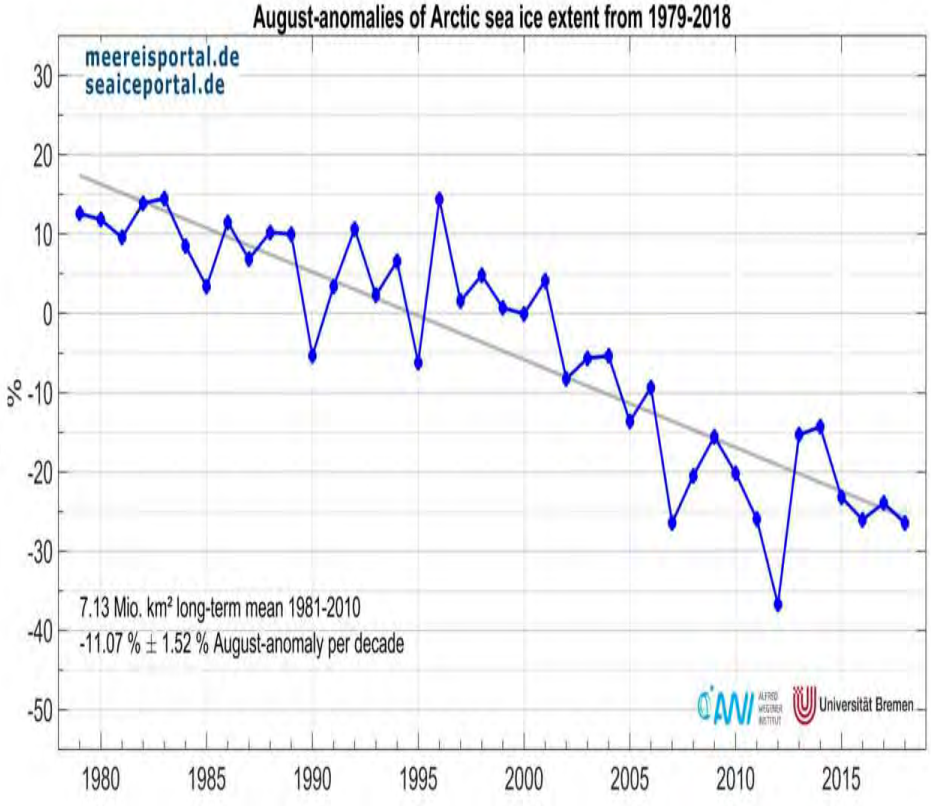
constructed which has revealed a decrease in sea-ice cover, especially during the summer melt season.

Arctic Sea Ice Extent changes 1979-2018

March:
-2.5% / decade



August:
-11.1% / decade



This is qualitatively consistent with both surface thermometer and satellite measurements that suggest the greatest rate of atmospheric warming in recent decades has been in the far northern latitudes. (The long-term trend in sea ice around Antarctica has not changed much during this period of time, consistent with our satellite measurements of essentially no long-term temperature change there.)

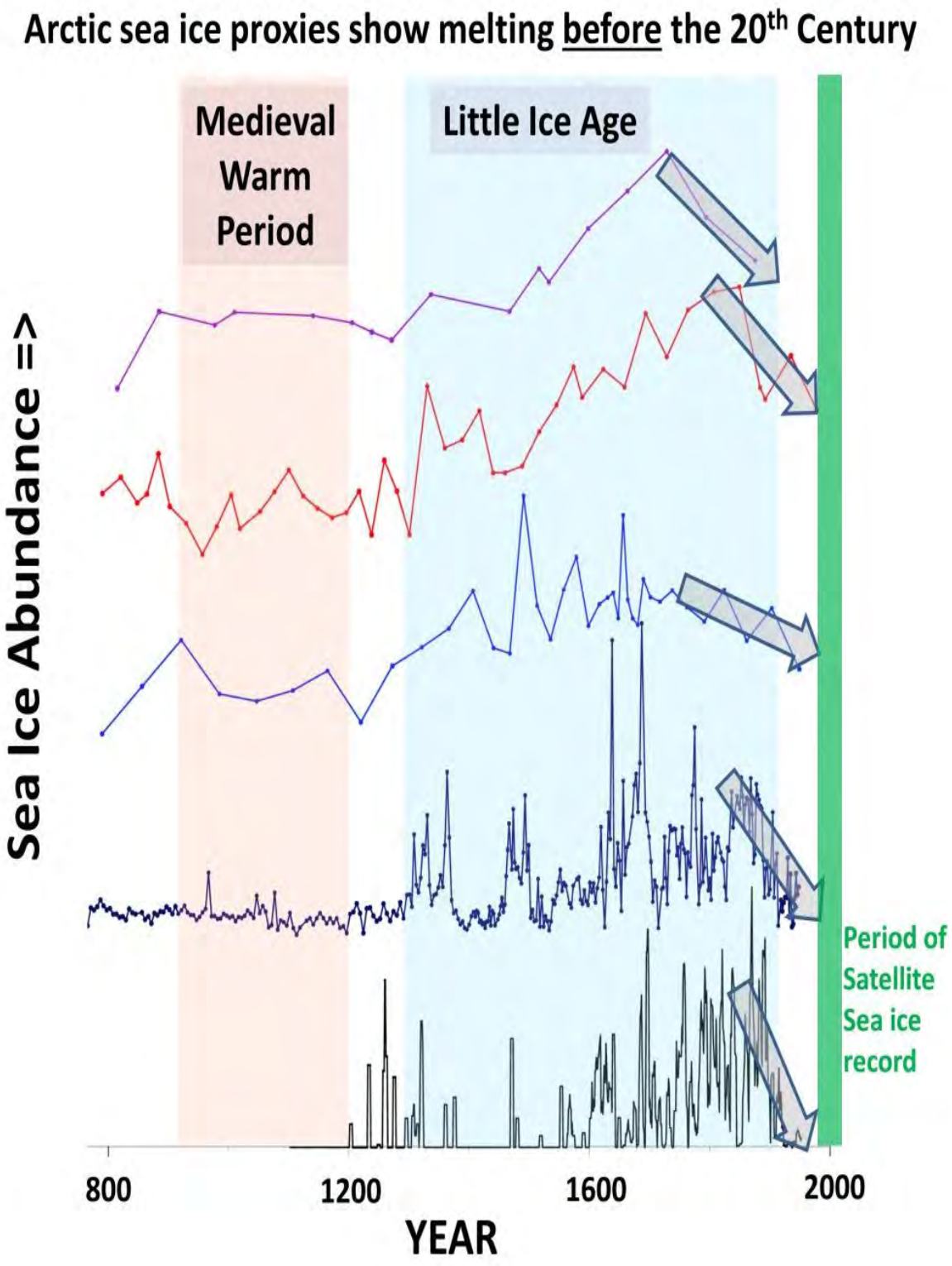
The Arctic warming was widely assumed to be negatively impacting polar bear populations, but a thorough and heavily referenced report in 2018 by Susan Crockford suggests that there has been no decline in polar bear numbers or health. Even Al Gore's latest movie released in 2017, *An Inconvenient Sequel*, dropped any mention of polar bears.

But what is the cause of the Arctic warming? The Arctic and Antarctic are particularly sensitive to natural fluctuations in atmospheric and oceanic circulation. Heat transport from low latitudes is what keeps the polar regions from getting much colder than they already are, and if that heat transport increases, the poles will warm, or if the transport declines the poles will cool. On a month-to-month basis, Arctic temperature in the winter can vary widely, depending upon this natural "venting" of chilled polar air and its replacement with more temperate air masses from the south. If there are long-term variations in ocean and atmospheric circulation, there can be changes in Arctic temperatures.

The original expert reference on Arctic sea ice was published in 1940 by the Russian oceanographer N.N. Zubov. In his book *Arctic Ice*, Zubov described unprecedented levels of Arctic warming during the 1920s and 1930s, well before humans could be blamed. The changes included receding of glaciers, a rise of air temperature, a rise in temperature of Atlantic water which enters the Arctic basin, a decrease in ice abundance, changes in biology with fish ranging farther north and species appearing where they had formerly not been found before, and ship navigation possible farther north than ever before. Zubov emphasized, "Still more remarkable is the fact that the warming of the Arctic is not confined to any particular region."

Today such changes would have been blamed on our CO2 emission, yet this was well before humanity could have played a role. Clearly, the Arctic experiences large changes without the help of humans. This is just one more example of how premature the claims of an obvious human influence on climate really are.

An emerging area of research that involves ocean sediment evidence for algae that grows in sea ice is allowing new insights into the geographic extent of Artic sea ice, possibly extending back thousands of years. Analysis of this and other proxies of Arctic sea ice provide a fairly consistent picture that sea ice cover was lower during the Medieval Warm Period, and then increased substantially during the Little Ice Age. The following graph is adapted from Fig. 5 of a 2016 study by Cabedo-Sanz *et al.* in *Quaternary Science Reviews,* and shows a variety of indirect estimates of Arctic sea ice, offset vertically for clarity.


Arctic sea ice proxies show melting before the 20th Century
Medieval Warm Period
Little Ice Age
Sea Ice Abundance =>
Period of Satellite Sea ice record
800
1200
1600
2000
YEAR

The bottom curve in this graph represents actual visual observations of the extent of sea ice from the coast of Iceland extending back to A.D. 1150. All of these proxy estimates of Arctic sea ice extent support the proxy measurements of Northern Hemisphere surface temperatures discussed earlier. Significantly, they show (1) that Arctic sea ice was declining naturally since 1900 or earlier, which was before humans could be blamed, and (2) that sea ice was low during the Medieval Warm Period of ~1,000 years ago, just as it is during the modern satellite record, a period represented by the green line.

Thus, the Arctic sea ice changes which are reported in the news media since 1979 represent a very brief period of time (40 years) compared to the 1,200 years of sea ice variations in the above graph. During that time, the available evidence suggests large natural variations in Arctic sea ice, with a peak roughly coinciding with the start of the Industrial Revolution and the end of the Little Ice Age.

So, once again, we see that what is claimed to be evidence of a human impact on climate is much less obvious when we examine the historical evidence of natural fluctuations in the climate system. This does not actually prove that humans are not the cause of recent warmth, but it certainly reduces confidence in claims of human causation for the changes we see today.

14.7 The Antarctic ice sheet isn't collapsing

One of the best examples of climate porn is the alarmist news coverage of the Antarctic ice sheet collapsing. Just picking one at random out of dozens of news reports in 2018, *Business Insider* published an article entitled, *Antarctica is melting faster than anyone thought, and we're not ready for the sea level rise that's coming*, which announced, "Experts think that if we don't get climate change under control quickly, ice sheets in West Antarctica could collapse, leading to rapid sea level rise around the globe."

If the Antarctic ice sheet were to melt completely, the resulting amount of sea-level rise would be an astounding 200 feet. Fears of ice sheet collapse arise whenever a piece of one of the ice shelves circling Antarctica breaks off and floats off into the Southern Ocean. There are

44 named Antarctic ice shelves, and they attach to about 44% of the Antarctic coastline.

Ice shelves are not static structures; they are naturally and continually flowing out to sea. Snow falling on Antarctica year-round slowly sinks under the force of gravity. This causes the ice to spread outward, feeding the shelves, which gradually flow outward away from the underlying continent supporting the ice sheet. Eventually, these shelves fracture and portions break off. This represents part of the natural cycle of ice gain and ice loss experienced by all glaciers on Earth, and it involves very long periods of time, typically centuries.

The question is, are ice shelves breaking off more frequently now than in the past? No one knows, because we would need measurements extending back many centuries, and those measurements do not exist. As recently as June 15, 2018, leading NASA glaciologist Jay Zwally told *The Daily Caller* that he believes the Antarctic ice sheet is currently in balance, with gains from increased snowfall offsetting losses from melting of the base of the western Antarctic ice sheet. His statement countered a paper published in the prestigious journal *Nature* at about the same time that claimed a net loss of ice—but only enough to add 0.02 inch to global annual sea level rise. So, even if the *Nature* study ends up being correct, the change is small, and it's not even obvious that Mother Nature isn't the one to blame. The Antarctic and Greenland ice sheets are dynamic systems, slowly evolving over centuries to millennia, and it would be surprising if they always contained the same amount of ice.

14.8 Ocean acidification isn't destroying sea life

While technically not a component of climate change, the claim that increasing CO2 levels in the atmosphere will cause a degradation of marine life due to "ocean acidification," a small lowering of ocean pH, is worth addressing here. Keep in mind that a substance is "acidic" if its pH is under 7, and "alkaline" if its pH is over 7; the scale runs 0 to 14; and each full step down from 7 indicates that the substance is 10 times more acidic, while each step up from 7 indicates that it is 10 times more alkaline. As extra CO2 is dissolved in the ocean, carbonic acid is formed, which then lowers ocean pH, at least initially. "Ocean

acidification" is somewhat of a misnomer since, while the oceans' average pH has declined from an estimated 8.2 a couple hundred years ago to an estimated 8.1 today, they're still alkaline, not acid. No model projections I am aware of predict the oceans becoming acidic, with a pH of less than 7.0. Even the above estimates of current and past average ocean pH are suspect, because pH varies a lot regionally, and actual measurements of pH remain sparse even today and were nonexistent during pre-industrial times.

Experiments have been performed where various forms of marine life have been subjected to decreases in pH. The initial studies found negative effects on calcified shells. But my understanding is that those studies did not actually address what is happening in the real world (adding CO2 to ocean water). They instead involved laboratory experiments where the acidity of water samples was increased by adding hydrochloric acid.

It should not come as a surprise that there is a difference between CO2 dissolved in water and hydrochloric acid. Marine life, like vegetation on land, uses carbon from CO2 to help grow lifeforms. Jim Steele, director emeritus of the Sierra Nevada Field Campus, San Francisco State University, has stated:

"… all ocean acidification models are deeply flawed, based on an incorrect assumption that CO2 enters the ocean and is then transported like an inert tracer. But CO2 is not inert! When CO2 first invades sunlit surface waters, it indeed dissolves into 3 forms of inorganic carbon (DIC) and lowers pH. But in contrast to those models, DIC is rapidly assimilated into particulate organic carbon via photosynthesis, which raises pH. Particulate organic carbon (alive or dead) is heavy, and if not consumed and recycled, it sinks. For millions of years, this process created and maintained a DIC/pH gradient with high pH/low DIC near the surface and low pH/higher DIC at depth."

While I do not have the marine chemistry or biochemistry background to have an expert opinion on this subject, my understanding is that an increasing number of studies with more realistic laboratory experiments are now showing that shelled organisms actually benefit from more dissolved CO2 in the ocean. I would recommend that those interested

in the subject start with Dr. Steele's March 1, 2017 blog post. Also, a literature survey of hundreds of scientific papers on the biological effects on increasing CO2 on marine life is maintained at http://co2science.org. The bottom line of that survey is that modest decreases in the pH of the oceans, even if they do occur, might well be a net benefit for marine life.

Conclusions

I have outlined what I consider to be the most compelling evidences that human-caused global warming and associated climate change are largely a non-problem. I have covered the "skeptics'" position from my point of view; other skeptics will disagree with me on some of my arguments. That's fine. Climate change is a relatively young area of scientific study, and it is one in which uncertainty remains for some obscure but critically important details. Most of the physics used to predict climate change can be right, yet the final prediction can be seriously in error.

None of the energy flows in and out of the climate system are known accurately enough to say how much of recent warming has been human-caused versus natural. The warming of the deep oceans since 2005 is equivalent to a tiny energy imbalance, 1 part in 260, and yet we don't know any of the natural energy flows to a precision of better than 1 in 100.

Observed warming of the climate system (including the deep ocean) has been shown from energy budget studies to be consistent with low climate sensitivity, suggesting less than 2 deg. C of eventual warming resulting from a doubling of atmospheric CO2. If some of the warming has been naturally caused – a possibility officially admitted to by the IPCC - then climate sensitivity will likely be below 1.5 deg. C.

Note that since these temperature changes (1.5 to 2 deg. C warming) are the actual UN goals for limiting future warming, those goals might well have already been met, simply because the climate system is not as sensitive to increasing CO2 as climate models suggest. It will be at least the 2060s before we reach 2xCO2, and technological

advancements by then might have already reduced out CO2 emissions substantially. But even if we later exceed that “2xCO2” level of CO2 concentration in the atmosphere (550 ppm, versus ~275 ppm during the pre-industrial era), low climate sensitivity at a minimum means we have more time to come up with alternative energy technologies.

In contrast to the alarmist stories you read in the news media, note that such a weak level of warming is even consistent with the main conclusion of the IPCC, which is that humanity’s greenhouse gas emissions “*are extremely likely to have been the dominant cause of the observed warming since the mid-20th century*.” It is possible for this statement to be strictly true, and yet for climate sensitivity to be below 1 deg. C, in which case no one would be terribly alarmed. This shows how the “consensus of scientists” on warming has been conflated with agreement that disaster is imminent, when in fact there is abundant evidence that does not support alarmist conclusions.

This point is so important it bears repeating. **The core conclusion of the U.N. IPCC (about warming since 1950 being mostly human caused) can be entirely accurate, and yet the global warming threat can be virtually non-existent. The IPCC has become a master at instilling maximum alarm without supplying convincing reason for alarm. Alarm is instead based upon very speculative science which so far has little to no observational support.**

The IPCC habitually ignores evidence (such as that presented in this book) that does not support its alarmist narrative. The climate models that predict over 3 deg. C of average warming have been shown to be biased toward both assumed human causation and high climate sensitivity. While modelling is a necessary part of analyzing complex physical problems like climate, none of the natural energy flows in the climate system are known accurately enough to say that our 1–2% enhancement of the greenhouse effect is the dominant cause of recent warming. In other words, we do not know the physics of climate system responses to warming well enough to blame most of the warming on human activities.

Human causation is simply assumed.

The models are designed with the assumption that the climate system was in natural balance before the Industrial Revolution, despite historical evidence to the contrary. They only produce human-caused

climate change because that is the way they are designed. This is in spite of abundant evidence of past warm episodes, such as 1,000- to 2,000-year-old tree stumps being uncovered by receding glaciers; temperature proxy evidence for the Roman and Medieval Warm Periods covering that same time frame; and Arctic sea ice proxy evidence for a natural decrease in sea ice starting well before humans could be blamed. Natural warming since the Little Ice Age of a few hundred years ago is simply ignored in the design of climate models, since we do not know what caused it.

Simply put, the computerized climate models support human causation of climate change because that's what they assume from the outset. They are an example of circular reasoning.

There is little to no evidence of long-term increases in heat waves, droughts, or floods. Wildfire activity has, if anything, decreased, even though poor land management practices are now making some areas more vulnerable to wildfires even without climate change.

Contrary to popular perception and new reports, there is little to no evidence of increased storminess resulting from climate change. This includes tornadoes and hurricanes. Long-term increases in monetary storm damages have indeed occurred, but are due to increasing development, not worsening weather.

Sea level has been rising naturally since at least the mid-1800s, well before humans could be blamed. Land subsidence in some areas (e.g. Norfolk, Miami, Galveston-Houston, New Orleans) would result in increasing flooding problems even without *any* sea-level rise, let alone human-induced sea-level rise causing thermal expansion of the oceans. Some evidence for recent acceleration of sea-level rise might support human causation, but the magnitude of the human component since 1950 has been only 1 inch every 30 years.

Ocean acidification is now looking like a non-problem, as the evidence builds that sea life prefers somewhat more CO2, just as vegetation on land does.

Given that CO2 is necessary for life on Earth, yet had been at dangerously low levels for thousands of years, the scientific community needs to stop accepting the premise that more CO2 in the atmosphere is necessarily a bad thing. Global greening has been observed by satellites over the last few decades, which is during the period of most

rapid rises in atmospheric CO2. The benefits of increasing CO2 to agriculture have been calculated to be in the trillions of dollars. Crop yields continue to break records around the world, due to a combination of human ingenuity and the direct effects of CO2 on plant growth and water use efficiency.

Much of this evidence is not known by our citizens, who are largely misinformed by a news media that favors alarmist stories. The scientific community is, in general, biased toward alarmism in order to maintain careers and support desired governmental energy policies.

Only when the public becomes informed based upon evidence from *both* sides of the debate can we expect to make rational policy decisions. I hope my brief treatment of these subjects provides a step in that direction.

THE END

Table of Contents