MELTDOWN

The Predictable Distortion of Global Warming by Scientists, Politicians, and the Media

Patrick J. Michaels

CATO
INSTITUTE
Washington, D.C.

Contents

2. An Introduction to Global Warming

Global warming is real, and human beings have something to do with it. We don't have everything to do with it; but we can't stop it, and we couldn't even slow it down enough to measure our efforts if we tried.

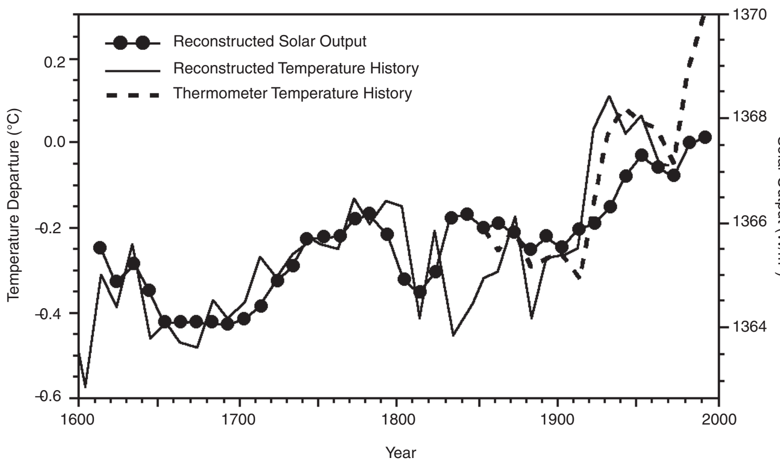
Figure 2.1 is a chart of various estimates of planetary temperature going back to 1610. That signal date marks Galileo's invention of the telescope. One of the first things Galileo used it for was to view the sun. (That he didn't immediately go blind is testimony to his wisdom: he knew to project the image rather than to look at it directly.) Every few months or weeks he noticed that a black spot, or a few of them, would appear on the sun's surface.

Whether a person believed in an earth-centered universe or a heliocentric one (a view of Jupiter and its moons soon convinced Galileo of the latter), everyone pretty much agreed that the sun warmed the earth. So the appearance of black spots became a curiosity worth recording: Would a darker sun create a cooler planet?

We now know that the opposite is true. A sun with many spots is a hotter sun because the dark regions are surrounded by larger, whiter areas that are more energetic than the quiescent state. Since that discovery, myriad scientists have matched the earth's temperature to the output of the sun. This isn't exactly rocket science. If there were no match, the basic theory of climatology would be wrong, a theory that simply states that the sun is the cause of our climate.

A review of sunspot records is one way to back-calculate the earth's temperature before the general use of thermometers, which dates back to the mid-1800s. But there are other climate ''proxies.'' The width of tree rings, for example, is related to total rainfall and summer temperature. Plants leave fragments, including long-lasting pollen, in the bottom of lakes, and shallow lakes ''turn over'' every year, creating annual striations, called varves, that can be counted back in time. Shifts in pollen assemblages trapped in varves from

Figure 2.1



The dotted line is the output of the sun, as measured by sunspots, and the solid line is a reconstruction of temperature histories. The dashed line is the temperature measured by ground-based thermometers. Until the mid- to late 20th century, it was the sun that drove most climate change.

SOURCE: Lean and Rind, 1998.

boreal (spruce, fir, birch—the "north woods" complex) to oak and pine, for example, would characterize a warming climate.

Checking one type of back-calculation against another lends credence to both. For instance, the tree-ring records, shown as the solid line in Figure 2.1, can be matched against the sun's output. The correspondence is quite good. Both records in turn can be compared with the thermometric era (dashed line), and the mutual correspondence is again very good until somewhere around 1970. At that point, the surface thermometer record begins to diverge wildly from the solar history.

Something happened. But what? Why didn't the divergence between solar-derived and greenhouse-enhanced temperatures begin earlier?

First, the early increments of CO_2 were relatively small. After accounting for the known constellation of greenhouse-enhancing gases, only about a third of the total enhancement had taken place by 1950.

THE GREENHOUSE EFFECT

In the absence of an atmosphere, it's pretty easy to calculate the temperature of the earth-atmosphere system. All you need to know is the amount of radiation that the earth intercepts from the sun and the amount that it reflects from its nonblack surface. That number works out to about −17°C (+1.4°F).

But obviously, that's not the correct surface temperature. In large part, that's because the gases in our atmosphere selectively absorb some of the sun's incoming radiation as well as another fraction of the heat emanating from the sun-warmed earth. Those molecules, such as oxygen, water vapor, and carbon dioxide, ultimately release that energy, preferentially warming some layers of the atmosphere at the expense of cooling elsewhere.

Carbon dioxide and water vapor are especially adept in absorbing the heat of the earth's surface. When they release (or "reradiate") that energy, they do so either upward (out to space) or back down. That increase in "downwelling" radiation is what, among other things, keeps the surface of the planet warmer than its temperature would be without an atmosphere. This differential warming is known as the "greenhouse effect," an analogy to a greenhouse, an enclosure that is warmer than the surrounding environment because of different radiational characteristics.

We have known all of this since 1872, following pioneering experiments by British physicist John Tyndall. And since at least 1895, we have known that human beings were increasing the concentration of one minor greenhouse gas—carbon dioxide (CO_2)—largely through the combustion of fuel stored under or at the earth's surface: peat, coal, oil, and natural gas.

The relative roles in surface warming of water vapor vs. carbon dioxide are approximately 10 to 1, which is why CO_2 is considered a "minor" greenhouse enhancer. But if an increment of CO_2 slightly warms the surface, then the vapor pressure of water over the vast oceans of the planet also increases slightly, raising the amount of water vapor in the air. That "positive feedback" is much harder to quantify than it is to qualify, and it is one of the reasons that so many computer simulations of climate give so many different forecasts for 21st-century warming.

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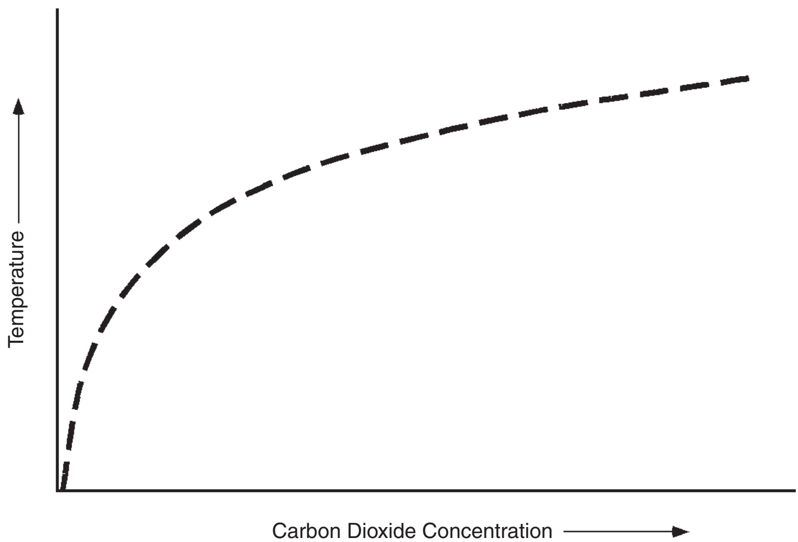
Of course, there are also other greenhouse gases that result from human activity. Methane (CH_4) is especially potent, and it is thought to currently exert an additional warming increment amounting to about 25 percent of the current greenhouse enhancement due to CO_2. Chlorofluorocarbons (CFCs), largely used as refrigerants, have been phased out because of their relation to stratospheric ozone depletion, and concentrations are beginning to drop; but they provide another increment—roughly 10 percent—over the CO_2 fraction. And there are a whole host of other, far more minor greenhouse enhancers that people can produce.

Second, it takes time for the ocean to warm. Consider an analogous experiment: heating a large pot of water by adding infrared energy (i.e., turning on an electric stove). Water has a certain ''heat capacity,'' which is to say it requires a certain amount of energy to raise its temperature a degree. That energy has to be supplied. Water also has a ''lag'' between the burner-water interface—the bottom of the big pot and the top. The temperature of the entire stovetop ''ocean'' will only equilibrate after all the heat has been mixed, through vertical currents or through deep horizontal motions. In reality, that pan of water—our ocean—averages miles in depth, and in spots is 35,000 feet (seven miles) deep. Even warming the top few thousand feet takes decades.

Consequently, the combination of slowly increasing the greenhouse effect and a tremendously ''fly-wheeled'' ocean with massive thermal inertia delays the onset of warming for some time.

Is the warming that began around 1970 largely a result of greenhouse changes? That's a testable hypothesis, and one I looked at very carefully in a paper I published with three colleagues in the journal *Climate Research.* It had to do with the known physics of greenhouse gases and temperature. Early experiments had demonstrated that the response of temperature to carbon dioxide is a logarithm (Figure 2.2), meaning that warming begins to damp off as carbon dioxide increases. Another greenhouse gas, water vapor, absorbs much of the same type of radiation and therefore acts much the same. That similarity has an important implication.

Figure 2.2



The response of temperature to a change in a given greenhouse gas is logarithmic, meaning that it damps off at increasing concentrations.

If we could find a place in which there is very little water vapor and there was very little CO_2 (before humans burned much fossil fuel), then adding CO_2 to that atmosphere should produce a rapid warming because the temperature response is on the rapidly ascending portion of the greenhouse-response logarithm (see Figure 2.2).

Siberia, in the dead of winter, is an ideal test case. January temperatures hover around −40°C or F (at that temperature, they're one and the same). As a result, the atmosphere has virtually no water vapor. It's been all frozen out. Only an infinitesimal number of molecules evaporate from the snowy and icy surface.

It turns out that by far the largest warmings on Earth are occurring in Siberian winter, just as greenhouse theory predicts (see Figure 2.3 in color insert). And further, we were able to ''prove'' the greenhouse influence: The more cold and dry air there was, the more it warmed. If the air was moist and cold, there was little if any warming. In the summer we could also run the experiment where the same theory would predict maximum warming in the driest places. Indeed, where adequate data existed, the largest warmings were in or near the Sahara Desert.

So that's the signature of greenhouse warming: a disproportionate warming of dry air. And that signature appears to have begun in the early 1970s. That's when the divergence from the solar temperature begins, and the differential warm-up of the dry air, mainly in Siberia, takes off. That's the recent past, but what about the future?

The Nature of Climate Projections

In 1896, Swedish physicist Svante Arrhenius published the first paper predicting how much the earth's surface would warm from changing concentrations of atmospheric carbon dioxide; his forecasts appeared in the journal *Philosophical Transactions*.

Arrhenius calculated the following:

- A doubling of the background concentration of CO_2 would lead to a net average surface warming of about 5°C (9°F).
- The warming would be greater in winter than in summer, more in the Northern Hemisphere than in the Southern.
- Nights would warm relative to days.
- Warming would be enhanced at high latitudes.

His projections remain remarkable to this day, if only because of their resemblance to the output of current computer models of climate, known collectively as general circulation models (GCMs). Although the median GCM projections for the ''sensitivity'' of surface-to-doubled CO_2 tend to run at about 3°C (5.4°F), or 60 percent less than Arrhenius's original projections, their geographical, seasonal, and daily distributions of projected warming are remarkably similar.

Why do we need a computer to do what Arrhenius did with a pencil and paper? Arrhenius was calculating expected climate response to a ''step change,'' or an instantaneous doubling of atmospheric CO_2. Note that he never said *when* the temperature change would take place, or how fast it would occur. The answer to those questions, among others, requires much more sophisticated computation because they result from slowly changing atmospheric conditions rather than the unrealistic step change.

In addition, and perhaps more important, Arrhenius' planet was a nondynamic sphere where the atmosphere had no obvious interaction with the surface constitution. In reality, we know that changing climate yields changed ecosystems, and, in turn, those alterations change the energetics of the planetary surface. As an extreme example, consider the difference between the dry, hot Sahara desert and the tropical rainforest. The latter cycles tremendous amounts of moisture into the atmosphere, holding down daytime temperatures and warming the nights. The desert behaves in completely opposite fashion.

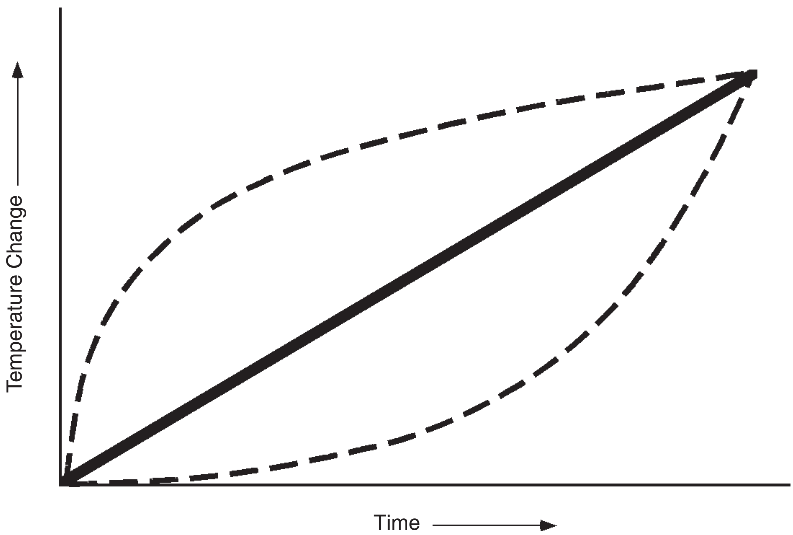
Recall that greenhouse effect warmings tend to take place primarily in the driest air. Consequently, you might expect either an expansion or an increased intensity of desertification.

On the other hand, by warming winters and nights preferentially to summers and days, greenhouse warming lengthens the growing season—the time between the last frost of spring and the first frost of autumn. The period in between is the time in which plants actively produce green matter, so global warming is likely, simply from its temperature effect, to make the planet greener, ''everything else being equal.'' There's ample evidence that this type of greening is already occurring, as Boston University scientist Ranja Myneni has articulated in several published papers.

Of course, everything else is never ''equal''—making that phrase the largest and most common form of scientific subterfuge. A computer climate model attempts, where possible, to correct for that fact by dynamically changing climate and vegetation. In other words, increased rainfall in some areas, coupled with longer growing seasons, may lead to increased greening, while decreased rainfall in others may lead to browning.

That all seems well and good on the surface, but in fact a computer model is only as good as its understanding of the dynamic process that it must simulate. As an example, we really don't have a very good understanding of the basic flow of carbon dioxide through the atmosphere. After a molecule of fossil carbon is burned, how long does it take before it is ultimately sequestered back in the earth? That depends on assumptions about the rate of uptake by plants, which means their response to weather and climate. It also depends on the rate of decay of dead plant matter littering the world's forest floors. For all those processes, rate estimates vary widely. As a result, the estimates for the ''atmospheric lifetime'' of a newly released molecule of CO_2 vary from 25 to 150 years, depending what you think is ''equal.''

Figure 2.4



The combination of an exponential increase in carbon dioxide, coupled to a logarithmic response, can be a straight line. As shown in Figure 2.5 (see color insert), climate models converge on this solution.

Climate models do, however, retain a series of core beliefs. One, you may recall, is that the response of temperature to increments of carbon dioxide is logarithmic, meaning that it begins to damp off as concentrations increase. That means that the first increments of carbon dioxide create the greatest warming.

All climate models also assume that the growth rate of carbon dioxide in the atmosphere is exponential, at 1 percent per year (a gross overestimate) meaning that it is going into the atmosphere at ever-increasing rates. The models hold that the CO_2 itself will not damp off, but will rise in concentration forever and ever. That turns out to be a highly questionable assumption, one that may have dramatic implications for future climate change.

However, the interaction of a logarithmic response of temperature to carbon dioxide, coupled to an exponential increase, as shown in Figure 2.4, can easily combine to a straight line.

This behavior is especially apparent in studies known as CMIPs, or Climate Model Intercomparison Projects. Figure 2.5 (see color insert), taken from the first CMIP study, dramatically shows this behavior. (A second study, CMIP-II, added additional complication but essentially gave the same result as shown in Figure 2.6 in the color insert).

So the question becomes this: Which, if any, of these straight lines is correct?

Analogy to Weather Forecasting Models

Environmental conservatives often argue that ''weather forecasting models aren't reliable after a week, so why should climate models for the next 100 years be better?'' That argument is convenient, but fallacious.

The fallacy: Weather forecasting and climate forecasting models, while retaining much of the same mathematics, are designed to respond to different types of change.

The weather forecasting model is designed to calculate internal changes in the atmosphere given a base external condition, which is the observed weather on a given day. Because of a combination of computational limitations and random behavior, these models run up against a mathematical ''wall'' around 10 to 14 days out, where the predicted weather patterns, as specified by high- and low-pressure systems and large-scale circulations like the jet stream, no more resemble reality than a pattern that could be randomly picked out of a sample of thousands of days.

In the long-range climate model, or GCM, it is the external conditions that change, as forced by an alteration in the atmosphere's natural greenhouse effect. GCMs then interact this initial alteration with other consequent changes in the atmosphere, such as the vertical distribution of temperature, which in turn produces more ''weather-like'' effects such as rainfall. In their most sophisticated incarnations, the accumulated weather changes then drive additional alterations at the earth's surface, like the transformation of deserts into forests and vice versa.

As a result, it's unfair to say that climate models must fail because we can't forecast day-to-day weather; what they are attempting is not the same. Rather, they are only trying to predict ''aggregate'' weather forced by changes in the base atmosphere, which is to say, alterations of the greenhouse effect.

Even so, that is where the climate models fall down—in the ''aggregate'' weather and its consequences. As one example of many, consider the finding of University of Delaware climatologist David Legates, who has demonstrated that the aggregate precipitation produced by GCMs can easily be off by 50 percent, depending upon location. That GCM precipitation is then used as input to a model for vegetation change, but it is in error. Further, the relationship between precipitation and vegetation is not all that clear—some equally wet and warm environments have radically different vegetation, depending upon other factors, including soil, drainage, and seasonality of precipitation.

The multiplying mess becomes obvious: Because each of these interacting processes is only partially understood, the mathematics for each depends on the choice of the modeling team. As a result, different GCMs produce different patterns, rates, and distributions of warming resulting from human alteration of the atmosphere.

Is there a way to adjudicate this mess? Absolutely, and it involves the same process that confronts weather forecasters when the models for tomorrow diverge from each other. The solution? Look out the window! Literally.

That's exactly what they must do. On any given day, there are about a dozen different weather forecasting models applicable to the United States. Sometimes they are pretty unanimous, but other times they diverge wildly and produce forecasts with radically different implications.

Such a problem often crops up in winter along the Atlantic Coast. The coastal bend from Georgia to North Carolina is a prime breeding ground for strong low-pressure systems because of its proximity to tropical water (east of the Gulf Stream, as close as 50 miles to shore) and to cold air sliding down from Canada. When the jet stream gets in the right orientation, powerful cyclones, known locally as Northeasters, can spin up in a matter of hours, with serious weather consequences.

Virtually every major snowstorm in the Raleigh-Boston corridor is a result of a Northeaster, and the typical band of heavy, disruptive snow is often less than 100 miles wide. Consequently, when the position of the storm in weather forecasting models diverges by more than that distance—a common occurrence—the forecaster confronts a vexing and serious problem: which one to believe, the one that buries Washington, D.C., or the one that says all the action will be out to sea?

That's when the forecaster literally does ''look out the window'' (or at least at the window of the computer screen) to see which of the many models has handled the *past* 24 hours the best, or which one has handled the last similar situation the best. Unless there's some other compelling reason, that model becomes the model of choice for tomorrow's weather forecast.

Ditto for the climate models. Having established a greenhouse warming for several decades, owing to the strong preference for warming of the cold dry air in Siberia and North America, we can simply take the observed warming, which itself has been highly linear, and project it onto the other forecasts. It becomes very clear that, unless the central tendency for linearity (funded by about $20 billion in climate science research over the years) is dead wrong, then we already know the warming rate to a very small error.

As a result, scientists know quite precisely how much the climate will warm in the policy-foreseeable future of 50 years, a modest three quarters of a degree (°C) (1.4°F) (see Figures 2.5, 2.6, and 2.7 in color insert). NASA's James Hansen, whom many credit with lighting the fire over the greenhouse issue with his incendiary 1988 congressional testimony, wrote this in the *Proceedings of the National Academy of Sciences* in 2001:

> Future global warming can be predicted much more accurately than is generally realized . . . we predict additional warming in the next 50 years of ¾°C ± ¼°C, a warming rate of 0.15°C ± 0.05°C per decade.

In that paper, Hansen says that ''much of the warming of the next 50 years'' will result from emissions already in the atmosphere. With regard to future emissions, he generally extrapolates current trends detailed later in this chapter. One greenhouse gas, methane, is assumed to decline slightly because its trend has already changed from upwards to steady. He assumes the same growth in carbon dioxide that has caused most of the current warming rate. His lower limit for warming, 0.5°C (0.9°F), results from ''possible additional downward pressure [on carbon dioxide emissions] caused by climate change.''

In fact, this is almost certainly impossible. As has been demonstrated by numerous scientists, the Kyoto Protocol on climate change, if adhered to by every signatory (including the United States) would only reduce surface temperature by .07°C (.13°F) in fifty years. But even this will not happen, as none of the signatories are currently expected to meet the Protocol's modest emissions reductions.

The warming rate given both by Hansen and by the observed trends is about four times less than the lurid top figure widely trumpeted by the United Nations in its 2001 compendium on climate change and repeated ad infinitum in the press. Why wasn't it front-page news that the scientist who was responsible for much of the global warming furor was now predicting, with high confidence, only a modest warming? Hansen went on to write the following in the online journal *Natural Science*:

> Emphasis on extreme scenarios may have been appropriate at one time, when the public and decision-makers were relatively unaware of the global warming issue. Now, however, the need is for demonstrably objective climate . . . scenarios consistent with what is realistic under current conditions.

With that remarkable statement, Hansen declared that scientists exaggerating to draw public attention to global warming was just fine.

GLOBAL WARMING AND EL NIÑO

One current belief in climate science (which has recently been challenged in an important doctoral thesis by Oliver Frauenfeld at the University of Virginia) is that the biggest weather-maker on the planet is a large oscillation in the tropical Pacific Ocean known colloquially as ''El Niño,'' but more accurately as ''ENSO,'' or the El Niño-Southern Oscillation.

ENSO is certainly one of the major climatic seesaws in the world. Usually, easterly trade winds diverge warm surface water away from the coast of South America, resulting in an upwelling pool of cold water that fuels a fertile anchovy fishery and attendant avian diversity. The pattern is so persistent that sea level in the Western Pacific is usually a foot or two higher than in the east.

The easterly trade winds, literally the largest wind circulation on earth, for reasons that are still speculative, suddenly drop

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or even reverse direction over the Tropical Pacific. Disrupting the biggest pattern of atmospheric flow that there is affects a lot of weather around the world. This is what happens during an ENSO.

For example, ENSO causes rain in Southern California and tends to dry out the normally soaked Pacific Northwest. By limiting the upwelling of cold water over a huge area off the coast of South America, ENSO events spike planetary temperature. It's most likely that whatever year sets the next ''record'' for planetary warmth will also be an El Niño year. The current recordholder for surface temperature, 1998, had a whopper El Niño, one of the two or three biggest in the last 100 years.

Science is pretty equivocal about whether global warming will increase, decrease, or do nothing about El Niño frequency or magnitude. Because the 1990s were globally warm and because El Niños were a bit more persistent than average, some federal scientists (perhaps pleasing Vice President Gore) attempted to link the two. (Gore visited Florida in 1998 and blamed the large wildfires on El Niño, saying it was a glimpse of what global warming would do to the Sunshine State). But that type of government-science rhetoric seems to have cooled with a return to a more typical El Niño frequency and a Republican president.

Whether or not El Niños increase or decrease because of global warming, the fact is that they have appeared every few years for most of the last 50 million years or so (at least) and, in the span of geologic time, they are about as common as a sunrise. Life goes on and adapts to El Niño cycles as surely as it does to the rhythm of the sun.

The Intergovernmental Panel on Climate Change and Emissions Projections for Greenhouse Gases

Projections of future warming from greenhouse gases largely depend on how much carbon dioxide is produced by the respiration of our civilization. For years, the unchallenged prognosticator of these concentrations has been the United Nations.

In 1988, the UN established the Intergovernmental Panel on Climate Change (IPCC), which describes itself as ''an intergovernmental mechanism aimed at providing the basis for the development of a realistic and effective internationally accepted strategy for addressing climate change.''

The IPCC conducts occasional ''assessments'' of the state of climate science, producing one assessment in 1990, another report as a supplement for the Rio Earth Summit in 1992, and subsequent assessments in 1996 and 2002. Those slick, massive volumes are the product of hundreds of scientists and a larger community of reviewers. They include analyses of past climate behavior, projections of future greenhouse gas emission projections, and forecasts of future climate. (The nature of the IPCC is discussed at length in my 2000 book, *The Satanic Gases*, which should be consulted for more detailed information.)

Briefly, the IPCC is as much a collection of government bureaucrats as it is of working scientists. In *The Satanic Gases*, my coauthor, Robert Balling, and I determined that only about 33 percent of the 200+ ''lead authors'' are in fact climate scientists. Consequently, the ''consensus'' that these documents achieve is in fact determined by a majority opinion that is not necessarily formally trained in the subject matter. Nor are the IPCC ''assessments'' ''peer-reviewed'' in the proper sense.

Normal peer review is a straightforward process. A scientist sends a paper to a major journal, where it is assigned to one of many editors. The editor then sends the manuscript out for review, and the authors must respond. If the reviews are sufficiently critical (as they often are, given that the vast majority of scientific papers are rejected), the paper cannot be published until the points at issue are addressed or rebutted. (At least that's the way it's supposed to work. In reality, editors can and do dramatically increase—or decrease—the likelihood of a manuscript's publication by judicious selection of reviewers and acceptance or rejection of critical comments. It happens all the time, and under duress, I will be happy to show anyone an e-mail from a major journal editor proudly telling me how she does it.)

That's not the way the so-called ''peer review'' works in the IPCC process. Instead, the selfsame authors of the report decide which reviews to respond to. Many are completely ignored. The result? Tremendous imbalances.

One example, from the 1996 *Assessment*, concerns satellite measurements of temperatures. Those measures are truly global, compared with the rather sparse ground thermometer network, and, at the time, they had shown no warming trend since they had begun in 1979. (Since then, there has been a slight but significant trend established—in large part because of the huge warming spike induced by the 1998 El Niño—yet still far beneath what most computer models have projected for global warming.)

The satellite data are obviously very important, in large part because they are at such variance with ground-measured temperature trends; they were especially so at the time of the 1996 *Assessment*. Yet, in the ''Policymakers Summary,'' a section that is probably the only one most policy wonks (and many journalists) will read, there is not one mention of the word ''satellite.'' In other words, the so-called ''consensus of scientists'' had decided by so-called ''consensus'' that the satellite temperatures' inconsistency with ground temperature should not be revealed to the policy world.

The satellite-ground temperature discrepancy is just one example of willful neglect or exaggeration by the scientific community; there are plenty of others.

It shouldn't be surprising, therefore, that a similar dynamic is at play with the IPCC's projections of future carbon dioxide emissions. The IPCC's projections of future emissions are based on what they call ''storylines,'' or seemingly self-consistent projections of future development. There are six:

> ''A1.'' The A1 family includes three scenarios: According to the IPCC, ''The A1 storyline and scenario family describes a world of very rapid economic growth, global population that peaks in midcentury and declines thereafter, and the rapid introduction of new and efficient technologies.'' The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), nonfossil energy sources (A1T), or a balance across all sources (A1B).
>
> ''A2.'' The IPCC states that ''the underlying theme is self-reliance and preservation of local identities. . . . Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.'' (Author's note: It's a pretty good guess that this one is simply wrong!)

> ''B1.'' ''The B1 storyline and scenario family describes a convergent world with the same global population that peaks in midcentury and declines thereafter, as in the A1 storyline, but with rapid change of economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies.''
>
> ''B2.'' ''The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability.''

Someone could write a rather large book criticizing the IPCC's storyline approach. Nonetheless, Figure 2.8 (see color insert) gives the range of UN temperature projections of warming for the next 100 years as a result of these storylines. That range is from 1.4°C (2.5°F) to 5.8°C (10.4°F).

The enormity of this range is disturbing, because it is actually *larger* than the range published in the first IPCC science compendium back in 1990, which was 1.5°C to 4.5°C. The implication is that 12 years and tens of billions of dollars of research funding has resulted in more, not less, uncertainty.

Is that the case? What is the most likely temperature rise, and who can help us to comprehend 245 predictions? For this we look to Stanford University's Steve Schneider. There is little to argue with in his analysis of the absurdly large range of temperature scenarios projected by the IPCC. Writing in the May 3, 2001, edition of *Nature*, Schneider provides insight into the relative *improbability* of the IPCC's high projections of future temperature in a doubled-CO_2 world.

First, a word of explanation: The IPCC's huge temperature range came about when 35 different levels of potential anthropogenic (human-caused) emissions were run through a climate model tuned to seven different climate ''sensitivities.'' A ''sensitivity'' represents a climate model's prediction as to how much things will warm given a doubling of earth's atmospheric carbon dioxide concentration. The exercise resulted in 245 different temperature predictions ranging between 1.4°C and 5.8°C. Are all equally likely?

A rise of 5.8°C undoubtedly would result in severe consequences. But is it as probable as a rise of 1.4°C, which is a warming that many economists, including the notable Robert Mendelssohn, believes will be a net benefit? A reading of the IPCC on this point provides little or no guidance. Its *Special Report on Emission Scenarios* stipulates, ''No judgment is offered in the Report as to the preference for any of the scenarios and they are not assigned probabilities of occurrence. . . . '' The vaunted *Summary for Policymakers* asserts, ''All [scenarios] should be considered equally sound.''

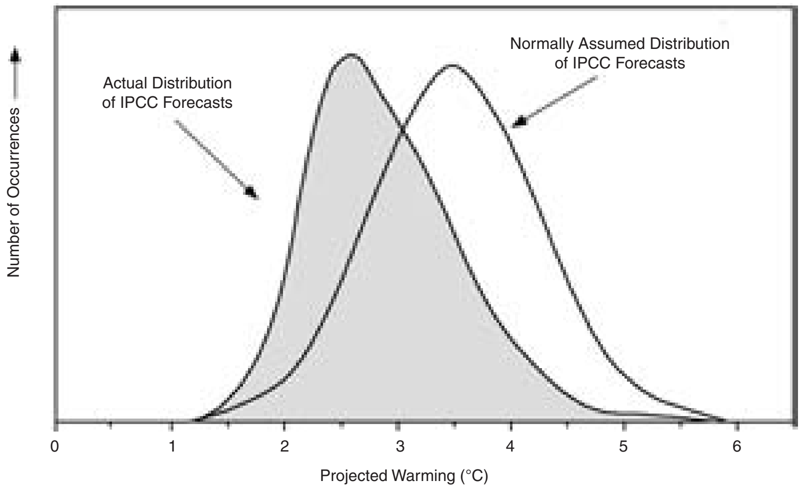
Schneider's explanation? The IPCC, he wrote, was unwilling to assign individual probabilities to its outcomes, ''in an attempt to avoid endless disputes'' among the participants in a scenario development meeting that he attended and where he unsuccessfully argued for their inclusion as a way of providing scientific credibility.

Because the IPCC refuses to present anything more than a range—as opposed to an actual *distribution* of the 245 possibilities—no one is able to assess whether a prediction of 5.8°C is a single ''outlier'' or is accompanied by other forecasts that are nearly as high. Without that kind of information, readers are forced to assume that the 245 forecasts fall into a ''normal distribution'' (picture a bell-shaped curve) with an average value of 3.6°C, midway between, being the most common prediction (Figure 2.9). In such a distribution, half the values would be above the mean and half below it. But that assumption is wrong, as Schneider shows.

When Schneider plots the actual distribution of warming forecasts, he finds it is significantly skewed toward the *low end*. In other words, the IPCC's ''average'' value is in fact higher than the value represented by the average of all the forecasts. Instead of half the forecasts predicting temperatures higher than 3.6°C, only about a quarter do. Amazingly, just under 50 percent come in at less than 2.5°C, meaning that, absent any further guidance from the IPCC (e.g., their assessment of probability), it is much more likely that future global warming would fall nearer the low end of the IPCC range, 1.4°C, rather than the high end. The IPCC has known that all along, yet they've let a hysterical environmental and popular press run with apocalyptic scenarios touting the huge 5.8°C (10.4°F) warming. And where was the news coverage of Schneider's analysis? Virtually nonexistent.

In wanting us to believe the reason the IPCC hasn't taken a stand on a preferred value of warming for the next hundred years is that they want to ''avoid endless disputes,'' we now reasonably can conclude that the IPCC prefers to play up the possibility of disastrous climate change—the very thing Schneider says scientists are wont to do when discussing climate change (see Chapter 11).

Figure 2.9



Given the amount of information available from the IPCC in its *Third Assessment Report*, it would be logical to assume the distribution of predictions of future warming would be best represented as a bell-shaped curve. That type of curve would result in an average value of 3.6°C (6.5°F), with half the forecasts being warmer and half cooler. Instead, we now know the *actual* distribution is strongly skewed toward the lower end. The result is an average of 2.2°C (4.0°F), nearly 1.5°C (2.7°F) cooler than the IPCC has led the world to believe.

SOURCE: Schneider, *Nature*, 2001.

Reality vs. Emissions Projections

Recall that both the climate models and the United Nations Intergovernmental Panel on Climate Change generally assume that the change in greenhouse gases is an exponential function, that is, one of constantly increasing slope. That notion accrues largely from the assumption that global population must grow exponentially and that everyone desires an American (energy-intensive) lifestyle. Those assumptions ignore a lot of reality.

Population projections have dropped dramatically in recent years. As recently as 1980, the UN predicted a global population of 15 billion in 2050, an increase of approximately 9 billion from today's population. Its most recent estimate for 2050 is now 9 billion, or an increase of only 3 billion from today, and a net reduction of the projected increase by 67 percent.

One reason for this drop is the spread of wealth and industrialization throughout much of the world. It is well known (though people differ about the mechanism) that per capita wealth and number of children have a very strong inverse correlation: The richer you are, the more likely you are to have few children. As a result, wealthy nations without large immigration pressures, such as many western European countries, now project population levels in 2050 that are at or below today's levels. The United States would be approaching this situation, too, except for its tremendous immigration, which largely comprises individuals far beneath the national median in wealth, who consequently have a higher than average expected fecundity.

Another development has been the stabilization of carbon dioxide use per capita since much of the world (Africa and a few nations excepted) has transitioned from undeveloped to developing and developed economies. Since the early 1980s, carbon dioxide emissions per capita have become constant or have actually declined. Figure 2.10 (see color insert) shows emissions per capita since 1950, as well as a simple curved trend analysis. The correspondence between the two, indicating that an actual statistically significant decline in per capita emissions is occurring, is a remarkable 94 percent.

If the combined trends of a progressive lowering of future population estimates and a decreased per capita carbon dioxide use continue, then the increase in atmospheric carbon dioxide is likely to be in a transition from exponential (constantly increasing growth rates) to a linear (constant) growth rate.

Has that trend already begun? One way to test it is with a statistical analysis.

It is an easy exercise to analyze whether trends in atmospheric carbon dioxide are increasing exponentially, which the UN assumed to be the most likely scenario, or are merely linear. One way is to pass a linear trend through the data, and then see whether changing that to an exponential function results in a better ''fit'' of the data, which means a more accurate analysis of the observed increase.

So, let's start in, say, the last 10 years (1993–2002) and run a straight line through the data. Is making it curve upward, in exponential fashion, more realistic? The computer answers a resounding *no*: There is no significant exponential increase that explains more than the straight line. How about beginning in 1992? No. 1991, 1990, 1989, no, no, and no. In fact, we would have to go back to the 1974–2002 period, almost three decades, before there is evidence of significant exponential upward curvature in the concentration of atmospheric carbon dioxide.

Therefore, the assumption used for future behavior by every climate model (and therefore every climate modeler), which is an exponential growth of 1 percent per year, hasn't been right for three decades. The climate modeling community *must* know better! But instead, it chooses to be literally 30 years behind the power curve of reality on the issue of atmospheric carbon dioxide concentration. In fact, only one major modeler, the same James Hansen who first drew attention to this issue, has acknowledged this problem and, accordingly, has dramatically dropped his forecasts of warming.

The observed behavior of per capita carbon dioxide vs. reality is a stark example of the exaggeration of global warming, in which the climatological modeling community and the UN's IPCC continues to assume something that is obviously wrong.

Enormous Implications

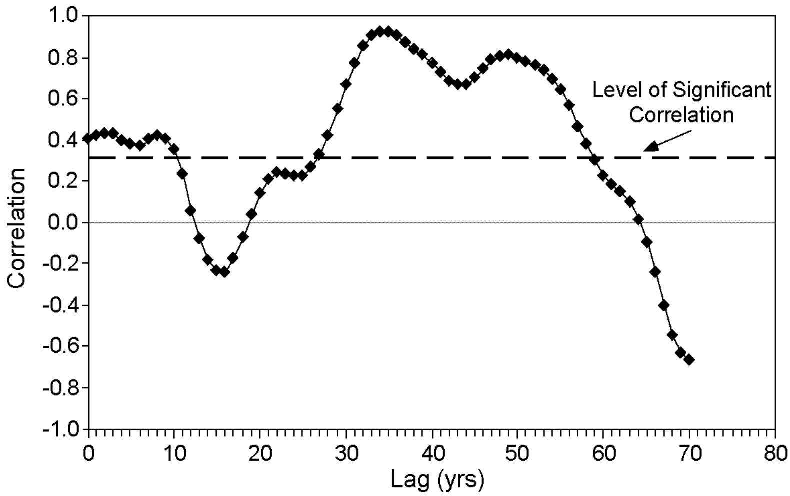
The implications of this erroneous assumption are staggering. After all, a constant greenhouse warming trend actually *requires* an exponential (ever-increasing rate) change in atmospheric carbon dioxide. Yet that exponential behavior appears to have ceased nearly 30 years ago! Will global warming therefore slow down in coming decades?

When? The answer may lie in the ocean.

In 2000, oceanographer Syd Levitus demonstrated that warming is now detectable in the top 10,000 feet of much of the world's oceans. One question that has always troubled climatologists is how long it takes a change in the atmosphere and near-surface temperatures to be reflected in that deeper ocean.

To get a handle on this, we could compare temperatures in the thin oceanic surface layer with those in the deep (10,000-foot) column. There has to be some type of lag, and that lag can help to define how long it takes overall temperature to come to grips with what humans are doing to the atmosphere.

Figure 2.11



Correlation between surface ocean temperatures and those in the surface-to-10,000-foot depth. The correlation reaches a maximum at around 35 to 40 years. A correlation of ±0.3 is not statistically significant, while ±1.0 is a perfect match between the two sets of data.

Figure 2.11 shows the correlation between global sea-surface temperatures and those from depths of zero to 10,000 feet. Statistical significance is barely achieved in the first 10 years, and then the correlation actually drops to insignificant through about 30 years. Going further back, roughly 35 to 40 years, the correlation between surface and deep ocean temperatures reaches a profound maximum.

This tells us how long it will take for the rate of temperature increase to respond to a damping of the carbon dioxide increase from exponential to linear, which began about 30 years ago (and still has yet to be acknowledged by many scientists!). The peak in the "lag correlation" at 35 to 40 years is strongly suggestive that, contrary to what you have read in every popular account of global warming, the modest rate of surface warming may begin to *decline* in a decade or so. If it occurs, the decline in rate will be slight and will take a decade or two to even be noticed, but that is what results from these observations.

Another View of Emissions Projections

London's *Economist*, which has generally been pretty strident about global warming, hewing to the IPCC line, published a devastating series of articles beginning February 13, 2003, about the UN's approach to future emissions. Ian Castles and Davis Henderson were quite plain that the IPCC was as far behind the times in the economic analyses accompanying its warming ''storylines'' as it was on the emissions of per capita carbon dioxide. Castles and Henderson indicate that, had the IPCC used currently accepted methods, the resulting warming would be considerably less than what it is currently projecting.

Those two seem to know what they're talking about. Castles was president of the International Association of Official Statistics (a section of the International Statistical Institute), head of the Australian Department of Finance from 1979 to 1986, and the Australian Statistician from 1986 to 1994. Henderson was formerly the chief economist of the Organization for Economic Cooperation and Development (OECD) and is now with the Westminster Business School. Both have been involved in developing appropriate methods for comparing the economy of one country with that of another—a difficult task with different monetary units, standards of living, and the variety of goods and materials produced under different currencies.

There are two customary ways of making such comparisons: The first and simplest is to convert the gross domestic product (GDP) of each country into a universal standard (U.S. dollars) based on the going market exchange (MEX) rate. That is the method the IPCC uses. However, the method suffers from many weaknesses—so many, in fact, that the UN's own Statistical Commission has concluded that using MEX rates results in ''material errors,'' errors that leave the reader with a fundamentally distorted view of the phenomenon being described.

The preferred method is Purchasing Power Parity (PPP). PPP basically compares the cost of the same basket of goods in two different countries. The PPP approach gives a better means of comparison than simply relying on exchange rates, which may fluctuate rapidly and vary from application to application (e.g., tourist rates, bank rates, foreign trade, black market).

Castles and Henderson insist the IPCC should have used the PPP method, and indeed the IPCC now admits as much (after pressure from Castles and Henderson), claiming that its use of MEX rates ''was done in full recognition of the fact that the preferred measure of wealth and poverty is to adjust GDP using the purchasing power parity estimates. . . . The reason the SRES report [the report detailing the storylines] adopted a market-based GDP is [that] most greenhouse gas emissions models in the peer-reviewed literature . . . are run based on market GDP.''

Okay. And if all the other climate modelers jumped off a cliff, would the IPCC do it too?

As Castles pointed out in a presentation to an IPCC Experts Panel in Amsterdam in January 2003, the IPCC statement seems to claim that certain comparisons between rich and poor countries that are integral to developing the emissions scenarios ''were known to be misleading at the time they were made.''

Using the MEX rate greatly underestimates the current purchasing power of developing countries and therefore leads to unrealistic future growth rates to make up for that initial inequality. For instance, in the B1 storyline, the GDP of developing countries is forecast to rise 65 times between 1990 and 2100. Using PPP for the same calculation results in a rise of just over 24 times, admittedly still a nearly impossible scenario, but nevertheless, one that is about 2.5 times lower than that using the MEX approach.

Even so, translating either of these figures into carbon dioxide emissions is tricky, as shown by the recent decline in global emissions per person. Even calculating the number of people that will be on earth 50 years from now is a big problem. But, at least according to current (and questionable) logic, emissions will rise with wealth, despite the fact that per capita emissions *and* population projections themselves are both dropping.

It is possible to perform a rough calculation of the effect of using PPP vs. MEX techniques on global temperature projections for the next 100 years. If we adjust the IPCC's six storylines appropriately using IPCC's own climate model as shown in Figure 2.12 (see color insert), the projected temperature rise by the year 2100 is reduced by about 0.5°C, a reduction of about 15 percent with slight variation among the scenarios. But, as shown in Figure 2.7, the UN's projections in general vastly overestimate future warming.

Problems with the IPCC projections don't stop there. Castles and Henderson point out that the future 100-year growth rates of developing countries the IPCC used in its most conservative scenarios are in many instances far greater than has ever been observed by any country in history, resulting in improbable (if not downright *impossible*) scenarios.

Here's a good one: Under the IPCC's B1 scenario family (the family of scenarios that include the lowest CO_2 emissions in 2100), in the year 2100, all of the following countries are projected to have a higher per capita GDP than the United States: Germany, Italy, France, Japan, Russia, the Baltic States, South Korea, North Korea, Malaysia, Singapore, Hong Kong, South Africa, Libya, Algeria, Tunisia, Saudi Arabia, Israel, Turkey, and Argentina. Sound likely?

Currently, the United States ranks second in the world, only behind Luxembourg, in this measure of personal wealth.

The work of Castles and Henderson clearly illustrates that the economic savvy of the IPCC is very weak. Further, as we have seen in this chapter, IPCC's scenarios of dramatic warming require the continuation of an exponential increase in carbon dioxide that stopped a quarter-century ago.

All this inevitable exaggeration results from the culture of modern science, where competition for tax monies requires histrionic proposals, engenders a political response, and rewards scientists for going along with the charade. How bad is it? The rest of this book provides the graphic evidence. Readers who think science is a ''pure'' process, governed by logic and tempered by experiment, are in for a rude awakening.