

Appendix

Climate Change Is Real

What is the fundamental situation with climate change? Is it actually happening? Are human beings causing it? How much of climate science is truly reliable enough for us to accept?

This appendix is designed to help readers work through initial questions about climate science. It will rely in part on the background research and in part on common sense. I will organize it in reply to various objections in the hope that it will respond to the kinds of misgivings readers may have, or questions they have heard, about the basics of our situation.

The first objection is this: *It isn't real*. A fully “skeptical” response would suggest, right from the start, that global warming is not happening and that in consequence there is no need for us to worry about the effects of climate change; we can put the entire subject aside and get on with the rest of our lives.

Right on the face of it, this position is wildly implausible. “Skeptics” like to suggest that the science on climate change is unsettled, that there are many grounds for doubt, that the current consensus among researchers is full of holes. But in fact, there is virtually no serious dissent from this consensus among qualified specialists in the relevant fields, specialists who are doing good research recognized as such by their peers.

Because of the controversy about climate change, several scholars have surveyed publications in the field to see how many scientists are raising doubts about the basic consensus, and they repeatedly find that the number of qualified dissidents is extremely small. One recent study examined research by scholars who have published at least twenty articles on the topic and ranked them by the number of articles they have published. They concluded that only one of the top fifty relevant scientists, only three of the top one hundred, and only five of the top two hundred

are “unconvinced by the evidence.” These findings closely match surveys of expert scientists, 97 percent of whom state that they share the consensus view. Although there are dissidents from that view, they are primarily scientists in other fields, scholars no longer doing active research, journalists, or laymen—in short, people who do not have as clear a knowledge of contemporary research as those centrally in the relevant fields.¹⁵⁶

A series of similar reviews of the literature have taken place over many years and inevitably point to the same result.¹⁵⁷ Yet a significant portion of the public continues to think that scientists are still in doubt about global warming. Researchers on climate change are of course acutely aware of public attitudes and are highly motivated to correct this false impression. Accordingly, organizations of scientists in several dozen nations and in specialties all across climate change science have issued clear, strong declarations on climate change.¹⁵⁸

What’s more, given the urgency of this research for public policy analysis, the international community has organized the Intergovernmental Panel on Climate Change (IPCC) to summarize contemporary science every few years for public consumption. The scientific portions of each IPCC report are written by scientists and the summary portions by others for the benefit of government officials around the world. Scientists of various persuasions complain that the IPCC reports omit important aspects of their research, whether by ignoring important questions about the consensus view or by refusing to endorse the most alarming recent research.¹⁵⁹ Such complaints are inevitable about any document that strives to capture the most representative views within a vast field of knowledge. It’s also inevitable that a document this immense and complex will contain at least minor errors. No human enterprise is infallible. But it does not follow that the entire consensus is therefore incorrect.

“Skeptics” nevertheless insist that the consensus view is unconvincing or false. Some of those who repudiate this view argue that most researchers act from venal motives, from the attempt to comply with the wishes of power-hungry bureaucrats, well-funded public agencies, and other parties offering money, power, and fame to scientists who endorse the mainstream view. Perhaps the most vocal advocate for this argument is the MIT atmospheric scientist Richard Lindzen, who scorns what he calls the fraudulence and hysteria of the consensus.¹⁶⁰ But the notion

that researchers benefit from a conspiracy, that they collude with those in power and with each other for mutual benefit, flies in the face of reality. It can hardly explain why scientists in so many different nations around the world, in such a wide variety of disciplines, and with so many contrasting relationships to funding agencies agree on the basic claims. The world of climate change science is far too large and complex for such a conspiracy to work.

This refusal to accept the validity of the overwhelming majority of scientific findings is not really motivated by skepticism but by a distorting, self-flattering tale about the lone wolf who defies The Man, who goes up against The Establishment and beats it at its own game. It calls out to the contrarian streak in all of us, our love of the tiny, heroic minority that exposes the foolishness of the mindless drones in power. This sensational scenario is splashed across the title pages of countless books promising to enlighten readers about the climate change conspiracy, the hysteria and fraud of those supporting the consensus view, or the science “they” don’t want you to know. Although ninety-seven of the top one hundred scientists accept the idea of human-caused climate change and only three scientists raise doubts, “skeptics” clearly want us to believe that these three lonely researchers—and *only these three*—are correct. Doing so may be especially foolish, for it’s not clear whether those three even agree with each other or are assured that an alternative paradigm is necessarily correct. Their doubts about the dominant view may be motivated by hesitation rather than defiance. Nevertheless, “skeptics” capitalize on that hesitation, hoping that it can justify repudiating the reality of climate change outright, as if the refusal to accept the consensus view is a sufficient reason to commit to an alternative. It’s clear that the position of heroic opposition hardly qualifies as a cautious, deliberative, and truly *skeptical* viewpoint: it is actually much more like a risky, defiant, and absolute *faith*—a faith that simply *knows* that climate change cannot be real.

This idealization of the contrarian scientist collapses as soon as one examines the science carefully. For one thing, researchers have been examining climate change with special intensity for the last couple of decades, and the ideas of the dissenters have of course received serious attention during that time. The more carefully researchers look at dissenters’ objections and replicate earlier studies to correct for possible errors

and flaws, the more accurate and persuasive their findings become and the firmer the basis for the overall consensus. The drift in climate science over time has been toward *greater*, not lesser, conviction. Each succeeding IPCC report indicates as much, for the statements on the likelihood that climate change is caused by human activity have become increasingly confident. The Third Assessment (2001) was still somewhat hesitant: “There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.” The Fourth Assessment (2007), however, was much stronger, stating, “Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations,” with “very likely” elsewhere defined as a likelihood of 90 through 99 percent.¹⁶¹

Nevertheless, some “skeptical” observers are unimpressed—or have evolved new ways to contest the consensus. Recently, contrarians have begun to concede that climate change is real and is caused by human beings, but insist that it will do far less damage than is claimed—and that with our current technology we can’t address the problem to any serious extent anyway. In effect, they have changed their tactics, pretending to accept the basic science but finding yet another way to dispute its significance. This new style of resistance may be found in a wide range of “skeptical” writings, the best example of which—and one that I will discuss here—may well be a book by Patrick J. Michaels and Robert C. Balling, Jr.

Michaels and Balling hold that the virtual unanimity of the consensus results from the institutional structure of science. The nature of publication in the sciences, they argue, tends to exclude negative findings (those that find no correlation between variables or no statistically significant results), creating an intrinsic bias in favor of any prevalent theory, including the consensus view. Moreover, in their interpretation of the operations of normal scientific research, scientists who adhere to a reigning paradigm tend to exclude alternative views. Finally, following the tenets of “public choice theory,” which holds that people tend to choose political and economic options that promise “more” rather than “less,” preferring big claims over small ones, they argue that a systematic bias pervades

decisions about publication, public funding, and career advancement in the field.¹⁶²

These authors draw on credible ideas about how science operates, but they do not apply those ideas to the climate change controversy with sufficient care. In the context of that controversy, research that undermines the prevailing view would be a *positive* finding, for it *would* establish a statistically significant result. The IPCC incorporates many findings of this kind, taking care to list many instances where research suggests that certain factors may not be causing climate change, or at least not through any clearly demonstrated mechanism (for example, atmospheric aerosols), and that certain consequences one might expect, such as the thinning of ice over the East Antarctic landmass, are not taking place.

Furthermore, researchers do not operate as if they are so many sheep; they take delight when they encounter convincing arguments to the contrary, when they see data that upsets the established view in the field. Scientists are interested in examining the dominant research paradigm, to be sure, but they also know that it can be more important and groundbreaking to create a new one. Most of the major reputations in science are made when a researcher finds something genuinely different from what has gone before, shifting the general orientation of the field in a new direction.

Finally, the claim that the consensus view is not credible is itself an example of “more” rather than “less,” for it inevitably gets an outsize share of public attention. To suggest that people would prefer *not* to hear a “skeptical” viewpoint simply ignores the public—and scientific—response, since the public is just as interested in a contrary view as in the consensus. The popularity of “skeptical” books—including the one Michaels and Balling themselves wrote—exemplifies that pattern.

The relatively cogent ideas put forward by Michaels and Balling are more apparently responsible—and thus ultimately more devious—than Lindzen’s charge of a climate change conspiracy. But at least Lindzen attempts to explain what might motivate a conspiracy at all: a wish to corner the market on public funding for research. The problem with his theory is that it’s difficult to see why scientists would conspire to give the world such consistently bad news. If they might be tempted (according to this theory) by the promise of more grant money, nearly everything else

in their lives would tell them to *disprove* the consensus. Do any of us—outside of hardcore disaster freaks—really have incentives to *accept* climate change? We enjoy our lives as they are, and typically we would like to be more wealthy, consume more energy, travel greater distances more often, and contribute to and benefit from steadily increasing economic growth. Nearly everyone from the poorest to the most wealthy likes the idea of an ever increasing abundance—an abundance, of course, that with current technology also implies an increasing emission of greenhouse gases. Who, exactly, wants to bother with rebooting the industrial capacity at the basis of all this abundance? For most of us, climate change is the *last* thing we want to see happen. Our lives would be much easier and more casual, far more relaxed and enjoyable, if we didn't have to worry about it at all. *Nearly all the incentives are on the side of the contrarians.*

Follow the money. If the entire global economic system is on one side, and a handful of granting agencies is (hypothetically) on the other, which one wins? In the face of such an immense tide of longing for more wealth, the conspiracy of a handful of scientists for their own self-interest would soon be swept away. But that's assuming scientists would ever wish to participate in this scheme in the first place. Scientists are people too: their assumptions, training, laboratories, and institutions are fully bound up with the technologies of an advanced industrial society and thus with the very economic systems that are also causing climate change. What they are discovering, in short, is inconvenient to *them* as people, too. In fact, it is *especially* inconvenient to them, for a change in our industrial economies would affect their technical labor quite directly. It's ludicrous to imagine that they are concocting the tale of climate change for personal benefit. On the contrary, they are laying out findings that the entire international community would rather *not* accept. Instead of denouncing them as conspirators, we should see them as reluctantly discovering and investigating something that even *they* might prefer were not true.

Given the enormous incentives for all of us *not* to accept the science of climate change, it would be much more plausible to ponder whether the small group of dissenters is concocting *their* science for personal benefit. Dissenters, after all, have the entire world potentially with them, especially business-oriented groups such as the U.S. Chamber of Commerce, which continually pressures the U.S. Congress to take as mild a course

of action as possible, and corporate advocates for the fossil-fuel industry, who of course dread the thought that the world might eventually wean itself of oil. One might expect such groups—which ultimately represent some aspect of consumer preference in which we are all implicated—to put their weight behind denying or dismissing climate change science, and indeed some of them have already done so. As James Hoggan demonstrates in his book, *Climate Cover-Up*, starting around 1991, businesses such as the Western Fuels Association and the National Coal Association funded a massive public relations campaign to distort the science, mislead the public, and delay the adoption of public policies meant to address the problem. In a parallel effort, the Exxon corporation created groups to funnel support to various conservative “think tanks” for similar purposes.¹⁶³ This effort had significant results: one study showed that over 92 percent of English-language books expressing skepticism about climate change between 1972 and 2005 were “published by conservative think tanks, written by authors affiliated with those think tanks, or both.”¹⁶⁴ A good example is the aforementioned book by Michaels and Balling, which was published by the Cato Institute, the well-known conservative think tank in Washington, D.C. Through these and associated efforts, national business associations and major fossil-fuel corporations successfully persuaded mainstream media outlets that there was a credible debate about climate change, with genuinely accomplished scientists on “both sides” of the question.¹⁶⁵

In doing so, these groups relied on a sophisticated strategy that they and others had long used in postwar America. In this instance, as in others, they relied on the gap between how scientists and the public see uncertainty. Scientists seek out areas where knowledge is not settled in order to refine and deepen their understanding, whereas the public often confuses that level of uncertainty with doubt on the basic facts themselves. As the historians of science Naomi Oreskes and Erik M. Conway show in their devastating book, *Merchants of Doubt*, since World War II conservative obstructionists have relied on a small number of scientists to exploit this gap and create the perception of doubt again and again. Climate change is only one of the most recent instances in a long sequence of public policy questions in which doctrinaire opponents of action have set aside a solid scientific consensus in the name of a supposed uncertainty. Over the

decades, these “merchants of doubt” have suggested there really was no strict link between smoking and a host of health problems, industrial air pollution and the problem of acid rain, or CFCs and the growing ozone hole over the Antarctic. They sought to undermine research showing how an exchange of nuclear warheads could lead to nuclear winter, and in recent years have even suggested that the ban on DDT was a mistake. All these campaigns took roughly the same shape, and all were effective in shaping public opinion: they show that once you suggest that a consensus position is “bad science,” prompting responsible scientists to reply and defend research in the field, you create a public debate where there is none to speak of within the scientific community itself, produce the impression of uncertainty, and thus create the basis for inaction. The situation today around climate change is no different.¹⁶⁶

At one point a few years ago, however, many of the “skeptics” behind these efforts abandoned their intransigence. Frank Luntz, the Republican pollster, spinmeister, and leading participant in a public relations campaign against action on climate change, recanted his “skeptical” views in 2006, and in 2008 or so Exxon stopped funding the group behind most of that campaign’s activities.¹⁶⁷ Around the same time, President George W. Bush, who doubted whether human activities are contributing to global warming and whose White House had often doctored statements about climate change by scientists working for the federal government, spoke of the urgent need to take steps to “confront the serious challenge of global climate change” in his 2007 State of the Union message.¹⁶⁸ By this point, the increasing confidence of climate change science was beginning to change even resistant minds.

Despite the tendency of even well-known public figures to recant or soften their resistance to action, a portion of the public remains unconvinced and is likely to stick with that position, no matter what scientists or policy professionals might say. This group, generally associated with the Republican party, is now *permanently* committed to a “skeptical” position, despite the partial change of heart by leaders as prominent as former President Bush. Candidates for office as Republicans are now virtually required to deny the human contributions to climate change if they are to receive the support of voters in that party, whatever the evidence may show. Apparently, “conservatives” are not terribly interested

in conserving the planet, even though the preservation of cherished traditions—the core of the conservative position—will be impossible if we don't also conserve the environments we live in.

By now, “skeptical” opinion has very little going for it: the scientific research doesn't support it, its leading spokespeople have been largely discredited, many of its former leaders have recanted or altered their positions, and a vast majority subscribes to the consensus view. Nevertheless, as a result many contrarians hold to their views with greater intransigence. No doubt a certain lazy style of media coverage—which continues to speak of “both sides” of a so-called “debate”—helps sustain this degree of public misperception. But media coverage alone cannot account for that deep resistance. The ferocity of the rhetoric attacking climate change scientists, the hostility to all the suggestions for how to address the problem, and the general intolerance for the concerns of environmental justice suggest that something else is at stake.

For some lay “skeptics,” the idea of climate change undermines the belief that God protects and sustains his creation. Acknowledging the consensus view would require giving up a particular version of the theology of creation. In another version of this resistance, Lindzen is reluctant to give up his belief that nature is intrinsically capable of balancing out its own systems.¹⁶⁹ For other “skeptics,” the consensus poses a threat to the notion of individual liberty guaranteed by the U.S. Constitution, and the prospect that the government might take action to decrease our emissions smacks to them of an unwarranted intrusion into our private lives. This position amounts to a civil religion in which liberty trumps all other concerns, including the “general welfare” of the Preamble to that very Constitution. People committed to these fundamental positions have ample motive to seize upon the least doubt regarding the consensus to justify their “skepticism.” Clearly, what is at stake for them goes much further than a reading of the science. (I discuss these aspects of the debate in depth in chapters four and twelve.)

Linked to these deep sources of resistance is another: a suspicion of the political and cultural power of experts. For good reasons, common people around the world instinctively mistrust the power of highly educated people, whatever their profession, to understand and govern them. The inevitable failure of those in the governing class to reflect on

the sources of their authority, as well as the willingness of those in that class to intrude into long established ways, to scoff at folk wisdom and received cultural values, and to demand compliance with the latest form of social improvement, have always been more than a little offensive, even if expert knowledge has often brought real benefits to common people. Popular ambivalence over expertise is deep, for it is intrinsic to the vexed relation between people of different social classes and different ways of seeing the world. Yet this ambivalence is not a feature only of certain social classes; it is present in nearly anyone who secretly defies doctor's orders, follows an unhealthy diet, or finds a purely scientific definition of the world and the human mind limiting.

For all these reasons, the attempt to persuade "skeptics" through the endless rehearsal of scientific findings does not get at their real concerns. The conversation must take up questions about our bedrock values. In the end, a person fully committed to the "skeptical" position may simply resist the authority of science as such or acknowledge it only insofar as it complies with more important loyalties. But those who dismiss such "skepticism" too readily may also miss something essential, for none of us is truly free of the impulse to resort to similarly intransigent, and often unacknowledged, loyalties. We all have abundant reasons to evade the implications of climate change; we all on some level feel a deep surprise and resistance. In reflecting on the intransigence of the "skeptics," then, we would do well to consider our own convenient evasions, our own hesitation to take the transformation in the world seriously.

The outright denial that climate change is taking place is only the most overt form of evading its claims. There is an entire series of increasingly subtle denials of what researchers have found, each of which is instructive. Perhaps the next version of resistance arises in someone who doesn't wish to be so harsh in repudiating the science but doesn't want to accept it, either. Even if the "skeptics" are wrong to be so stubborn, a person might think, they are right to point out how much we still don't know about the Earth's climate. Accordingly, in this view *there is simply too much uncertainty in the science for us to act now.*

Hesitation of this kind is ordinarily a good thing. In fact, the position of so-called "skeptics" betrays the promise of a *genuine* skepticism. A truly cautious dissent from the claim that human beings are causing climate

change is beneficial to the public, for it forces researchers to account for their way of gathering and analyzing data much more carefully and to sharpen their research methods as well. Even the research—not the rhetoric—of contrarian scientists such as Lindzen who cultivate the lone wolf persona continues to benefit climate research today, for his challenge to the consensus view helps it sharpen its own account of climate change and prevent it from becoming too uncritical of its findings. Such contrarian viewpoints serve an important public function. Because the news is so bad, and has such a huge potential impact on our lives, it's only natural that we'd resist it with everything we've got—and force the experts to listen to a wide range of objections and doubts. Making researchers defend their findings is a good thing: there is no reason to let their work influence our lives until they make a case that is truly convincing. Skepticism here, as in so many walks of life, can be a real boon.

But skepticism of *this* sort is non-dogmatic, open-minded, and curious; when it is true to itself, it hesitates to endorse *any* of the findings outright, including the work of contrarian scientists. (Nor would it, like Lindzen, describe those who accept the consensus as venal or hysterical.) This kind of skepticism, in fact, permeates the scientific community; it is the lifeblood of research, its motivating force. No self-respecting researcher could get up in the morning without the perpetual suspicion that earlier work in the field was incomplete, that there are huge gaps in existing knowledge, and that another angle might reveal more. Because of this attitude, the statements about climate change that scientists give to the public even today are not declarations of absolute faith but carefully phrased descriptions of a plausible scenario, descriptions that have probability and hesitation built into them as a matter of course.

Such doubts are not present merely out of habit, merely because scientists just can't commit. On the contrary, it's quite clear that there are, in fact, vast gaps in our knowledge. Nobody really understands what causes clouds to form, what effect climate change might have in creating more or fewer of them, and whether the ability of clouds to reflect potentially warming sunlight back into space may increase or decrease in the future (and thus affect the planet's warming in some manner).¹⁷⁰ Furthermore, the computer models that predict future warming are not yet capable of describing the incredibly complex, dynamic systems of the planet with

utter accuracy, and as a result there is no firm consensus on exactly how much warming a certain level of atmospheric carbon dioxide would cause. Specialists in each field related to climate change studies can easily add to this list.

Yet those specialists have also declared their conviction that global warming is happening and is being caused by human beings. We can only conclude that for them *this* much is certain; the uncertainties arise in how to *describe* some of the mechanisms by which warming takes place, in *how much* warming might take place under certain circumstances, and what *exact* consequences might emerge in the course of time.¹⁷¹ The limitations in our knowledge do not undercut the fundamental reality that we are changing Earth's climate in an unprecedented way. The consensus position, in short, is now seen as so elementary, so difficult to dispute, that it is taken for granted by scientists in the field, who have moved on to examine other questions.

But the hesitation with regard to certainty nevertheless does reveal something crucial about our current dilemma. After all, very few of us have ever been asked to assess the state of scientific expertise before making up our minds about something central to our lives. We're not used to being in this position. What's more, while scientists live with uncertainty as part of their profession, we laymen typically think in a different way: we want clear, concise answers and ask our politicians, journalists, and leading figures to supply them as often as possible. We don't like the mismatch between scientific caution and our everyday demand for clarity. Our dissatisfaction with the scientific response to our demand for certainty comes out of this mismatch.

But it's worth asking whether our defensiveness on climate makes sense. Do we truly seek certainty in every area of our own lives? For example, do we buy fire insurance only if we know for *sure* we'll need it down the line? When we go on a trip, do we take only those items we can *prove* we'll need? As a nation, do we demand military preparedness only if we know *precisely* what other forces will threaten us—and when they will do so?

When we think about our situation in this light, it's pretty clear that insisting on total certainty about climate change before we act gets everything backwards. What would you do if you were told that if you drove

down a particular street at a certain hour, you'd face a 1 to 10 percent chance you'd have a terrible accident? Very few of us would take that chance. Those who insist on certainty, however, suggest that if there is somewhere between a 90 and 99 percent chance of a crash, we should *still* go down that road. After all, there is still a small chance we'd make it through without injury.

Such a response is ludicrous. When faced with the possibility of major harm, most sane adults would want to play it safe, to have an out, a Plan B, or at least good insurance and excellent medical care. We aren't simply indifferent if there is a high likelihood something horrible will happen to us. Yet in the climate change debate, we've managed to get the whole thing upside down. A supposed uncertainty in the science has covered up a far more frightening uncertainty about our futures: are we going to make it through the next few decades in good shape? Do we actually *have* a future? *That's* the real uncertainty we should face, and if we think about it in *those* terms, our answer gets obvious very fast.

The question is not whether scientists have absolute proof that human beings are causing climate change. The core question is instead whether we are sure we are *not* putting our own lives and futures into doubt by how we live, especially by how we emit greenhouse gases. Even if you think the science on this subject could be sharper, you have to admit it's already telling a pretty dire tale. Just hanging out until the consensus is even stronger isn't very smart.

But wait a minute, another person might object, *global warming is real, but we aren't the cause*. Earth's climate has changed dramatically over its history, thanks to any number of natural causes; our present moment is no exception. For us to attribute climate change to ourselves is merely a sign of our own arrogance. We live on an unstable planet, this person might say; there's nothing we can do about that fact. The cyclic changes in distance between the Earth and sun, the changes in the tilt of the polar axes, and variations in the brightness of the sun all change the amount of sunlight entering the atmosphere, alter the planet's warmth, and over time lead to immense changes in climate.

This objection has a great deal behind it. Research has in fact demonstrated, for example, that the slight changes in solar intensity (due to sunspots and changes in the sun's brightness) have enormous effects

on temperature and climate systems and that these variations are routine events over the vast stretches of the planet's history. But because those factors are relevant, scientists have worked hard to take them into account. Looking into this very question, scientists found that an increase in solar radiation caused the rise in temperatures up to the 1940s and that a decrease in that intensity—possibly along with the release of aerosols into the atmosphere, which may counteract warming—led to the global cooling from the 1940s to the 1970s. But average sunspot activity has not increased since then, while global temperatures have risen at a good pace, suggesting that solar intensity is not in fact a primary factor in the global warming of recent decades.¹⁷² The current change in temperature is anomalous, is taking place far more quickly than in the past, and is primarily caused by human activities.

But this direct response to the objection may not do it justice. Evidently, many people feel that if climate change has happened before, we shouldn't get too upset if it is happening again. This attitude may motivate responses to charts showing how much temperatures have risen since the late 1970s: for some observers, if current temperatures remain within the zone of temperature variation familiar in the planet's history, what we see today is by definition *not* anomalous and thus not a source of concern.¹⁷³ As a result, if they can show that current temperatures really aren't higher today than they were at some point in the past, they feel they have refuted the consensus view.

But this logic just doesn't hold true. If we say for the sake of argument that the planet may have been this warm or even warmer in the very distant past, that fact does not mean that the current warming is "natural," part of the ordinary course of things. Nonhuman causes may have led to great warming in another era; it doesn't follow that the current warming is "natural," too.

This answer is already a sufficient response. But it is interesting to try a thought experiment as well—to take the contrarian objection at its word and see what happens. Suppose that the current warming is "natural," that it is entirely the result of forces entirely outside our control. Does it really follow that we have nothing to worry about? Rather than helping us dismiss climate change, this argument only *reinforces* the problem—and makes it even *harder* for us to do anything about it.

This position is ultimately quite puzzling. It's just not plausible to assume that if sometime in Earth's history it was as warm as it is today, we can relax. For hundreds of thousands of years, Earth's average temperatures have varied widely, far more than most of us learned in science classes. Until recently, in fact, the history of Earth's climate had barely registered in the popular mind. A good look at charts of temperatures over the past 70,000 years or so—not to mention the last 600,000 years—will certainly get one's attention: the lines on those charts bounce around far more than one might initially have thought, slowing down into relative stability only in the very recent past, in the 10,000 years or so since the most recent Ice Age—the period geologists call the Holocene.¹⁷⁴ Civilization as we know it arose on a planet pretty much with its current characteristics. In this rather brief, exceptional period, the Earth's climate has created conditions that are ideal for certain kinds of human activities to flourish. "Nature" for us is highly specific, very recent, and quite vulnerable. Even for the first several thousand years after the Ice Age, we lived in mobile hunter-gatherer communities and could adapt to new conditions by changing our habitat. But with the rise and spread of the great sedentary, built civilizations, we are now rooted in specific places, much less flexible, and deeply reliant on the endurance of our familiar landscapes. The return of an Ice Age or the coming of a fully tropical planet, both with ample precedent in Earth's history, would be an immense danger to our way of life. Nothing we are used to, and no aspect of contemporary civilization, would be the same if Earth entered one of these scenarios. Rather than allowing us to dismiss the danger of climate change, then, this version of "skepticism" only makes clearer how fragile civilization is, how recent and potentially temporary.

If we are merely caught in yet another climatic shift, we must still imagine how to cope. For the most part, those who claim that climate change is not caused by human activities fight against efforts to do anything substantial about our situation. Such a position is indeed consistent with their sense that human action is not the cause of recent warming. But if that warming is taking place and we can do nothing about it, then how should we face the coming decades?

Anybody who actually believes that the current warming is entirely natural should pause and think about the consequences of that claim. If it

is true, then our attempts to reduce our contributions to climate change will have no effect and our future is truly bleak. Such a person should also be very interested in reflecting—at least in some fashion—on what it is like to live in a world with a disappearing future. The thought experiment in imagining this alternative rendition of our present dilemma ultimately takes us right back to the central questions of this book.

Very well, one might say, *climate change is real and is caused by human beings, but the rise in temperatures isn't that great—not enough for us to worry about.* Some observers argue that if we gather data about Earth's temperatures more carefully, for example by filtering out the “urban heat effect” (the drift toward higher temperatures caused by urban encroachment into areas where weather data is collected), we'd find that the Earth simply isn't warming as much as we thought.¹⁷⁵

At first, this sounds like an intriguing objection. What if the data about warming is exaggerated? On this score, skeptical inquiry is justified: shouldn't we be fairly certain that we measure global temperature shifts accurately if we are to have a clue in understanding the present biosphere?

Richard A. Muller of the University of California at Berkeley found enough flaws in previous studies of global temperatures that he led a research team in examining the entire question. As a result of this effort, he published an opinion piece in July, 2012, that began, “Call me a converted skeptic.” Taking up a series of objections raised by climate change skeptics (regarding the urban heat effect, faulty data selection, and human bias) and subjecting them all to a comprehensive statistical analysis, that team ultimately found that none of these objections held true—and that the emission of greenhouse gases has indeed forced an increase in global temperatures of two and one half degrees Fahrenheit over the past 250 years and of one and one half degrees over the past fifty.¹⁷⁶ That group further found that no explanation other than human activity better accounted for this rise in temperatures—not even a change in solar intensity. Such a serious, apparently neutral, and thorough examination of the question should remove most doubts on this score.

But it's also important to recognize that objecting to the reality of climate change on this basis misses the point. It looks for certainty in how we *measure* climate change rather than thinking about its *results*. The best

response to this objection is to try out another thought experiment. Let's say this objection is correct: what follows?

The answer is immediate and quite damning. Evidently, the rise in temperature, however high or low, is already having surprising effects. As I mentioned in the first pages of this book, the sea ice in the Arctic—and the methane clathrates on an Arctic continental shelf—are both melting far more quickly than scientists predicted just a few years ago, suggesting that the effect of the warming we've already experienced is more severe than we recently suspected. If such massive Earth systems can transform so greatly and so soon, the rise in the planet's average temperature, whatever the precise numbers might be, are enough to get our attention. Is it really wise to keep disputing how to gather temperature data for another decade or so and let the world's ecosystems just take care of themselves?

There is very little doubt that we have a serious problem on our hands. Scientists have arrived at an overwhelming, nearly unanimous consensus that we're causing climate change and that it is already causing devastating changes to Earth's living systems. The fact that our knowledge about how it works is not yet absolute should not encourage us to ignore it for the time being, since the very great uncertainty about whether we'll have a future dramatically outweighs the relatively technical uncertainties in our knowledge. The fundamentals of climate change science, in short, tell us that this problem is real.

Notes

156. William R. L. Anderegg and others, "Expert credibility in climate change," *Proceedings of the National Academy of Sciences of the United States of America*, volume 107, number 27 (June 21, 2010), 12107–12109, doi:10.1073/pnas.1003187107.
157. For a widely cited early example, see Naomi Oreskes, "The Scientific Consensus on Climate Change," *Science*, volume 306, number 5702 (December 3, 2004), 1686, doi:10.1126/science.1103618.
158. For a representative attempt by scientists to demonstrate their sense of the urgency of the crisis and the need for public action, see the National Academies' joint statement, "Climate change and the transformation of energy technologies for a low carbon future," May 2009, available online as a pdf document.

159. For a representative complaint about the IPCC from a “skeptical” perspective, see the discussion of Christopher Landsea’s experience as a contributor to the second IPCC report (1995) in Lawrence Solomon, *The Deniers: The World-Renowned Scientists Who Stood Up Against Global Warming Hysteria, Political Persecution, and Fraud* (Richard Vigilante Books, 2010), 29–36. For a complaint from those who argue the IPCC is too cautious, see the account of new assessments of the Greenland ice sheet by Richard Schlesinger and others in Fred Pearce, *With Speed and Violence: Why Scientists Fear Tipping Points in Climate Change* (Boston: Beacon Press, 2007), 39–45, 145–46; see also Glenn Scherer, “Eight examples of where the IPCC has missed the mark on its predictions and projections,” *The Daily Climate*, December 6, 2012, <http://www.dailyclimate.org/tdc-newsroom/2012/12/ipcc-prediction-fact-check>.
160. For a representative statement, see Richard S. Lindzen, “Resisting Climate Hysteria: A Case Against Precipitous Climate Action,” <http://www.quadrant.org.au/blogs/doomed-planet/2009/07/resisting-climate-hysteria>.
161. See the IPCC Third Assessment Report, Working Group I: The Scientific Basis, Summary for Policymakers, page three, initial portal available at http://www.grida.no/publications/other/ipcc_tar/, and the IPCC Fourth Assessment Report, Working Group I: The Scientific Basis, Summary for Policymakers, Understanding and Attributing Climate Change, http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspmp-understanding-and.html.
162. Patrick J. Michaels and Robert C. Balling, Jr., *Climate of Extremes: Global Warming Science They Don’t Want You to Know* (Washington, D.C.: Cato Institute, 2009), 195–209.
163. For a discussion of both efforts, see James Hoggan, *Climate Cover-up: The Crusade to Deny Global Warming* (Berkeley: Greystone Books, 2009), 31–87.
164. Hoggan, *Climate Cover-up*, 81.
165. For another, particularly devastating treatment of these corporately funded efforts to discredit climate change science, see George Monbiot, *Heat: How to Stop the Planet from Burning* (Cambridge, Massachusetts: South End Press, 2009), 20–42.
166. Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York: Bloomsbury Press, 2010).
167. On Luntz, see Hoggan, *Climate Cover-up*, 72; on Exxon, see Hoggan, 84.
168. President George W. Bush, State of the Union Address, January 23, 2007, <http://georgewbush-whitehouse.archives.gov/news/releases/2007/01/20070123-2.html>.

169. Hansen, *Storms of My Grandchildren*, 55. On the uncertainties surrounding clouds and climate change, see Fred Pearce, *With Speed and Violence: Why Scientists Fear Tipping Points in Climate Change* (Boston: Beacon Press, 2007), 105–114.
170. For a balanced statement that combines an endorsement of the mainstream view with a strong sense of its limitations, see Claire L. Parkinson, *Coming Climate Crisis? Consider the Past, Beware of the Big Fix* (New York: Rowman & Littlefield, 2010). On these dimensions of uncertainty see Michael Oppenheimer and others, “The Limits of Consensus,” *Science*, volume 317, number 5844 (September 14, 2007), 1505–1506, doi:10.1126/science.1144831, and the letter in response by Susan Solomon and others, “A Closer Look at the IPCC Report,” *Science*, volume 319, number 5862 (January 25, 2008), 409–410, doi:10.1126/science.319.5862.409c.
171. Spencer R. Weart, *The Discovery of Global Warming*, revised and expanded edition (Cambridge: Harvard University Press, 2008), 167–68. For a representative research article on the influence of solar irradiation, volcanic activity, aerosols, and greenhouse gases on global temperatures, see Thomas J. Crowley, “Causes of Climate Change Over the Past 1000 Years,” *Science*, volume 289, number 5477, (July 14, 2000), 270–77, doi:10.1126/science.289.5477.270.
172. For a skeptical view of the famous “hockey stick” chart and related topics, see Solomon, *The Deniers*, 9–21; 57–74. For a representative mainstream account of the Michael Mann controversy, see Fred Pearce, *With Speed and Violence*, 204–209.
173. For good examples of such charts, see Richard B. Alley, *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future* (Princeton: Princeton University Press, 2000), 123, and Wallace S. Broecker and Robert Kunzig, *Fixing Climate: What Past Climate Changes Reveal About the Current Threat—And How to Counter It* (New York: Hill and Wang, 2008), 118.
174. Michaels and Balling, *Climate of Extremes*, 58–64.
175. Richard A. Muller, “The Conversion of a Climate Change Skeptic,” *The New York Times*, July 28, 2012, http://www.nytimes.com/2012/07/30/opinion/the-conversion-of-a-climate-change-skeptic.html?pagewanted=all&_r=0. For the full research behind Muller’s statement, see the papers at Berkeley Earth Inc., <http://berkeleyearth.org/>.