

MIT Open Access Articles

Straight Talk about Climate Change

The MIT Faculty has made this article openly available. **Please share** how this access benefits you. Your story matters.

Citation: Lindzen, Richard. "Straight Talk About Climate Change." *Academic Questions* 30, no. 4 (November 30, 2017): 419–432.

As Published: <http://dx.doi.org/10.1007/s12129-017-9669-x>

Publisher: Springer US

Persistent URL: <http://hdl.handle.net/1721.1/115153>

Version: Author's final manuscript: final author's manuscript post peer review, without publisher's formatting or copy editing

Terms of use: Creative Commons Attribution-Noncommercial-Share Alike



UNSETTLED SCIENCE

Straight Talk about Climate Change

Richard Lindzen

Richard Lindzen is Alfred P. Sloan Professor of Atmospheric Sciences, Emeritus, at the Massachusetts Institute of Technology and a Distinguished Senior Fellow at the Cato Institute; rlindzen@mit.edu. This paper is adapted from “Some Thoughts on the Public Discourse over Climate Change,” posted on *Merion West* on April 15, 2017.

For over thirty years, I have given talks on the science of climate change. When, however, I speak to a nonexpert audience, and attempt to explain such matters as climate sensitivity, the relation of global mean temperature anomaly to extreme weather, the fact that warming has decreased profoundly for the past eighteen years, etc., it is obvious that the audience’s eyes are glazing over. Although I present evidence as to why the issue is not a catastrophe and may likely be beneficial, the response is puzzlement. I am typically asked how this is possible. After all, 97 percent of scientists agree, several of the hottest years on record have occurred during the past eighteen years, all sorts of extremes have become more common, polar bears are disappearing, Arctic ice is melting, etc. In brief, there is overwhelming evidence of warming, according to the alarmists. I tend to be surprised that anyone could get away with such sophistry and even downright dishonesty, but, unfortunately, many of my listeners believe it. I will try to explain why such claims are evidence of the dishonesty of the alarmist position.

The 97 Percent Meme

This claim is actually a come-down from the 1988 claim printed on the cover of *Newsweek* that *all* scientists agree. In either case, the claim is meant to satisfy the nonexpert that he has no need to understand the science. Mere agreement with the 97 percent will indicate that one is a supporter of science and superior to anyone denying disaster. This actually satisfies a psychological need for many people.

The claim is made by a number of individuals and there are a number of ways in which it is presented. A thorough debunking has been presented in the *Wall Street Journal* by Joseph Bast and Roy Spencer.¹ One of the dodges is to poll scientists about whether they agree that CO₂ levels in the atmosphere have increased, that the Earth has been warming (albeit only a little), and that man has played some part in this. This is something almost all of us can agree on, but which has no obvious implication of danger. Nonetheless, this is portrayed as support for catastrophism.

Other dodges involve looking at a large number of abstracts where only a few actually deal with danger. If, among these few, 97 percent support catastrophism, the 97 percent is presented as pertaining to the totality of abstracts. One of my favorites is the recent claim in the *Christian Science Monitor* (a once respected and influential newspaper): “For the record, of the nearly 70,000 peer-reviewed articles on global warming published in 2013 and 2014, four

¹Joseph Bast and Roy Spencer, “The Myth of the Climate Change ‘97%,’” *Wall Street Journal*, May 26, 2014, <https://www.wsj.com/articles/joseph-bast-and-roy-spencer-the-myth-of-the-climate-change-97-1401145980?tesla=y>.

authors rejected the idea that humans are the main drivers of climate change.”² I don’t think that it takes an expert to recognize that this claim is a bizarre fantasy for many obvious reasons. Even the body created by the UN to provide “authoritative” assessments of manmade climate change, the United Nations Intergovernmental Panel on Climate Change, generally referred to as the IPCC, doesn’t agree with the claim.

Despite all of this, I am somewhat surprised that it was necessary to use the various shenanigans described above in order to arrive at the 97 percent figure. Since this issue fully emerged in public almost thirty years ago—and was instantly incorporated into the catechism of political correctness—there has been a huge increase in government funding of the area, and that funding has been predicated on the premise of climate catastrophism. By now, most of the people working in this area have entered it in response to this funding. Note that governments essentially have a monopoly over the funding. I would expect that the recipients of such funds would feel obligated to support the seriousness of the problem. Certainly, opposition would be a suicidal career move for a young academic. Perhaps the studies simply needed to phrase their questions properly to achieve levels of agreement for alarm that would be large enough, though perhaps not as large as was required for the 97 percent meme, especially if the respondents were allowed to remain anonymous.

²Charlie Wood, “How Climate Skeptics Are Trying to Influence 200,000 Science Teachers,” *Christian Science Monitor*, March 30, 2017, <http://www.csmonitor.com/Science/2017/0330/How-climate-skeptics-are-trying-to-influence-200-000-science-teachers?cmpid=TW>.

The “Warmest Years on Record” Meme

This simple claim covers a myriad of misconceptions. Under these circumstances, it is sometimes difficult to know where to begin. As in any demonization project, it starts with the ridiculous presumption that any warming whatsoever (and, for that matter, any increase in CO₂) is bad, and proof of worse to come. We know that neither of these presumptions is true. People retire to the Sun Belt rather than to the Arctic. CO₂ is pumped into greenhouses to enhance plant growth. The emphasis on “warmest years on record” appears to have been a response to the observation that the warming episode from about 1978 to 1998 appeared to have ceased and temperatures have remained almost constant since 1998. Of course, if 1998 was the hottest year on record, all the subsequent years will also be among the hottest years on record, since the temperature leveled off at that year and continued into the subsequent years—all of which are now as hot as the record year of 1998. None of this contradicts the fact that the warming (i.e., the increase of temperature) has ceased. Yet, somehow, many people have been led to believe that both statements cannot be simultaneously true. At best, this assumes a very substantial level of public gullibility. The potential importance of the so-called pause (for all we know, this might not be a pause, and the temperature might even cool) is never mentioned and rarely understood. Its existence means that there is something that is at least comparable to anthropogenic forcing. However, the IPCC attribution of most of the recent, and only the recent, warming episode to man depends on the assumption in models that no such competitive process exists.

The focus on the temperature record is worth delving into a bit. What exactly is this temperature that is being considered? It certainly can't be the average surface temperature. Averaging temperatures from places as disparate as Death Valley and Mount Everest is hardly more meaningful than averaging phone numbers in a telephone book (for those who still

remember phone books). What is done instead is to average what are called “temperature anomalies.” Here, one takes thirty-year averages at each station and records the deviations from this average. These are referred to as “anomalies” and it is the anomalies that are averaged over the globe. The only attempt I know of to illustrate the steps in this process was made by the late Stan Grotch at the Lawrence Livermore Laboratory in California. Figure 1a shows the scatter plot of the station anomalies. Figure 1b then shows the result of averaging these anomalies. Most scientists would conclude that there is a remarkable degree of cancellation and that the result is almost complete cancellation. However, instead, one stretches the temperature scale by almost a factor of ten so as to make the minuscule changes in figure 1b look more significant.

Figure 1a

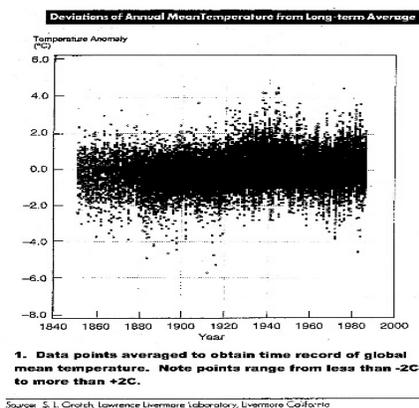
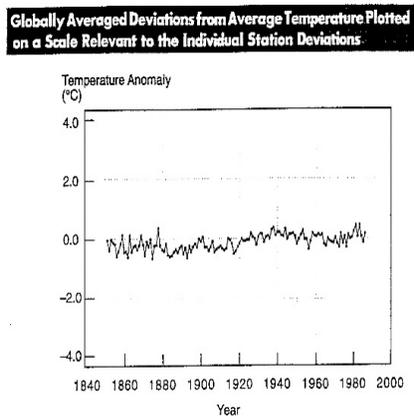
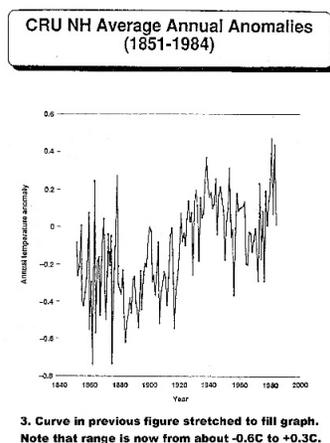


Figure 1b

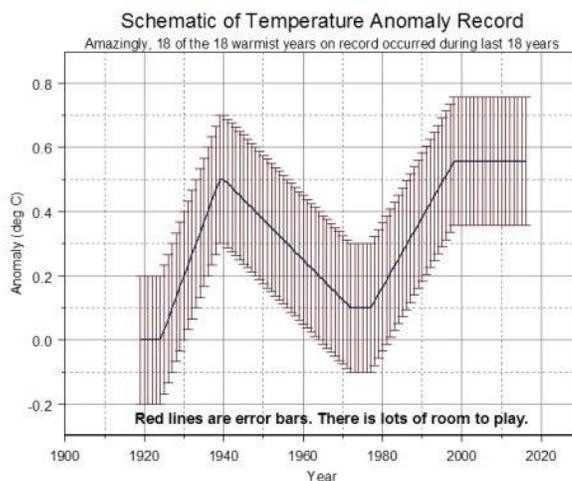


The result is shown in figure 1c, which shows the measurements done by the Climate Research Unit in the Northern Hemisphere.

Figure 1c



There is quite a lot of random noise in figure 1c, and this noise is a pretty good indication of the uncertainty of the analysis (roughly $\pm 0.2\text{C}$). The usual presentations show something considerably smoother. Sometimes this is the result of smoothing the record with something called “running means,” where each point is the average over some number of years before and after the year at issue. It is also the case that Grotch used data from land-based stations from the UK Meteorological Office. Including data from the ocean leads to smoother-looking series, but the absolute accuracy of the data is unknown given that ocean data mixes very different measurement techniques (buckets in old ship data, ship intakes after World War I, satellite measurements of skin temperature—which is quite different from surface temperature—and buoy data). These issues are summarized in figure 2, which presents an idealized schematic of the temperature record and its uncertainty.

Figure 2

We see very clearly that because the rise ceases in 1998, this implies that eighteen of the eighteen warmest years on record (for the schematic presentation) have occurred during the last eighteen years. We also see that the uncertainty together with the smallness of the changes offers ample scope for adjustments that dramatically alter the appearance of the record (note that uncertainty is rarely indicated on such graphs).

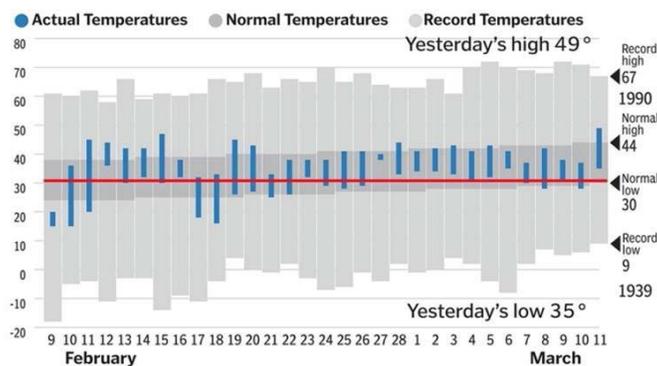
At this point, one is likely to run into arguments over the minutia of the temperature record, but this would simply amount to muddying the waters. Nothing can alter the fact that the changes under consideration are small.

Of course, “small” is relative. Consider three measures of smallness.

Figure 3 shows the variations in temperature in Boston over a one-month period. The black vertical bars show the actual range of temperatures for each day. The dark gray bars show the climatological range of temperatures for that date, and the light gray bars show the range between the record-breaking low and record-breaking high for that date. In the middle is a black horizontal line. The width of that line corresponds to the range of temperature in the global mean temperature anomaly record for the past 175 years. This shows that the temperature change

under consideration is small compared to our routine sensual experience. Keep this in mind when someone claims to “feel” global warming.

Figure 3

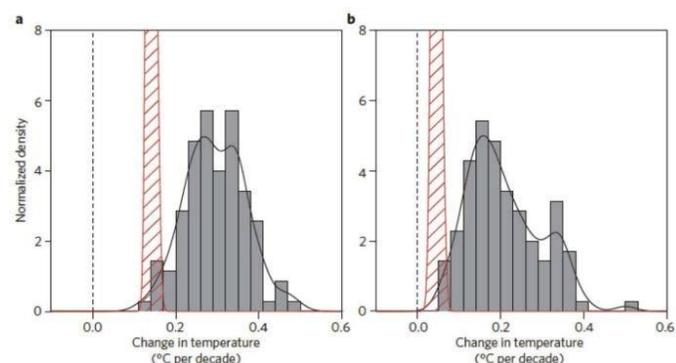


The next measure is how the observed change compares with what we might expect from greenhouse warming. Now, CO₂ is not the only anthropogenic greenhouse gas. When all of them are included, the IPCC finds that we are just about at the greenhouse forcing of climate that one expects from a doubling of CO₂, and the temperature increase has been about 0.8C. “Sensitivity,” by convention, generally refers to the temperature increase produced by a doubling of CO₂ when the system reaches equilibrium. If man’s emissions are responsible for all of the temperature change over that past sixty years, this still points to a lower sensitivity than is produced by the least sensitive models (which claim to have sensitivities of from 1.5 to 4.5C for a doubling of CO₂). And the lower sensitivities are understood to be unproblematic. However, the IPCC only claims man is responsible for most of the warming. The sensitivity might then be much lower. Of course, the situation is not quite so simple, but calculations do show that for higher sensitivities one has to cancel some (and often quite a lot) of the greenhouse forcing with what was assumed to be unknown aerosol cooling in order for the models to remain consistent with past

observations. (A recent *Bulletin of the American Meteorological Society* article points out that there are, in fact, quite a number of arbitrary adjustments made to models in order to get some agreement with the past record.)³ As the aerosol forcing becomes less uncertain, we see that high sensitivities have become untenable. This is entirely consistent with the fact that virtually all models used to predict “dangerous” warming over-predict observed warming after the “calibration” periods, where the models have been tuned to match the observations.

That is to say, observed warming is small compared to what the models upon which concerns are based are predicting. This is illustrated in figure 4.

Figure 4



Note: Hatched bar represents observations. Gray bars show the distribution of model predictions. The right panel is for the period 1998–2012. The left panel is for the period 1993–2012, showing that starting before the El Niño year of 1998 negligibly impacts the result.

³Frédéric Hourdin et al., “The Art and Science of Climate Model Tuning,” *Bulletin of the American Meteorological Society* 98, no. 3 (March 2017),

<http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00135.1>.

As mentioned, uncertainties allow for substantial adjustments in the temperature record. One rather infamous case involved the National Oceanic and Atmospheric Administration's adjustments in a paper by Thomas Karl et al. that replaced the pause with continued warming, thus suggesting that the warming had not ceased.⁴ But it was easy to show that, even with this adjustment, models continued to show more warming than even the "adjusted" time series showed, meaning that the models were still greatly exaggerating the warming that was observed.⁵ Moreover, most papers since have rejected Karl et al.'s adjustment (which coincidentally came out with much publicity just before the November 2015 Paris climate conference).

The third measure is somewhat different. Instead of arguing that the change is not small, it argues that the change is "unprecedented." This is Michael Mann's infamous "hockey stick." Here, Mann used tree rings from bristle cone pines to estimate Northern Hemisphere temperatures back hundreds of years.⁶

This was done by calibrating the tree ring data with surface observations for a thirty-year

⁴Thomas R. Karl et al., "Possible Artifacts of Data Biases in the Recent Global Surface Warming Hiatus," *Science* 348, no. 6242 (June 26, 2015): 1469–72.

⁵Patrick J. Michaels, Richard Lindzen, and Paul C. Knappenberger, "Is There No 'Hiatus' in Global Warming after All?" *Cato at Liberty* (blog), Cato Institute, June 4, 2015, <https://www.cato.org/blog/there-no-hiatus-global-warming-after-all>.

⁶See Ross R. McKittrick, "The Mann et al. Northern Hemisphere 'Hockey Stick' Climate Index: A Tale of Due Diligence," in *Shattered Consensus: The True State of Global Warming*, ed. Patrick Michaels (Lanham, MD: Rowman and Littlefield, 2006), 20–49.

period and using this calibration to estimate temperatures in the distant past in order to eliminate the Medieval Warm Period. Climate alarmists wish to eliminate the Medieval Warm Period since it demonstrates that warming periods have occurred in the past, before man caused carbon increase. Indeed, this reconstruction showed flat temperatures for the past thousand years. The usual test for such a procedure would be to see how the calibration worked for observations *after* the calibration period. Unfortunately, those results failed to show the warming found in the surface data. The solution was starkly simple and stupid. The tree ring record was cut off at the end of the calibration period and replaced by the actual surface record. In the Climategate e-mails (Climategate refers to a huge release of e-mails from various scientists supporting alarm where the suppression of opposing views, the intimidation of editors, the manipulation of data, etc., were all discussed), this was referred to as “Mann’s trick.”

The whole point of examining the three measures of smallness above is to make clear that we are not concerned with warming per se, but with how much warming. It is essential to avoid the tendency among environmentalists to regard anything that may be bad in large quantities as something to be avoided at any level however small. Small warming is, in fact, likely to be beneficial on many counts. If you have assimilated the discussion above, you should be able to analyze media presentations such as *Time*’s “Climate Change Deniers Have President Trump’s Ear. But Now They Want Results”⁷ to see that, amidst all the rhetoric, author Justin Worland is pretty much saying nothing while even misrepresenting what the IPCC says.

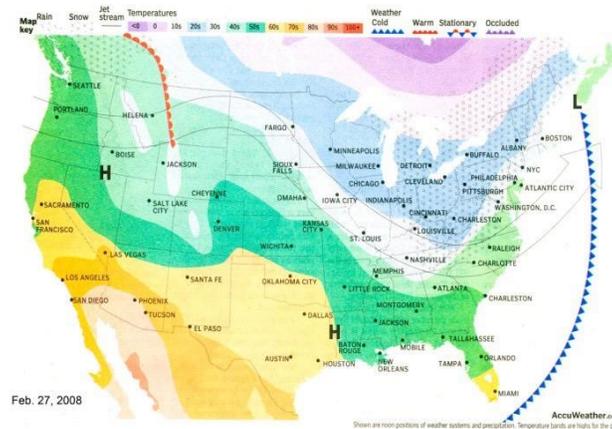
⁷Justin Worland, “Climate Change Deniers Have President Trump’s Ear. But Now They Want Results,” *Time*, April 12, 2017, <http://time.com/4712153/climate-change-deniers-donald-trump-epa-global-warming>.

The Extreme Weather Meme

Every line weather forecaster knows that extreme events occur someplace nearly every day. The present temptation to attribute these normally occurring events to climate change is patently dishonest. University of Colorado Boulder professor Roger Pielke Jr. actually wrote a book detailing the fact that there is no increasing trend in virtually any extreme event (including tornados, hurricanes, droughts, floods, etc.) with some actually decreasing.⁸ Even the IPCC acknowledges that there is no basis for attributing such events to anthropogenic climate change.

The situation with respect to extreme temperatures actually contradicts not just observations but basic meteorological theory. Figure 5 shows a map of temperatures for North America on February 27, 2008. Extreme temperatures at any location occur when air motions carry air from the coldest or warmest points on the map. Now, in a warmer climate, it is expected that the temperature difference between the tropics and the high latitudes will decrease.

Figure 5: Temperature Map for North America



⁸Roger A. Pielke Jr., *The Rightful Place of Science: Disasters and Climate Change* (Charleston, SC: Consortium for Science, Policy & Outcomes, 2014).

Thus the range of possible extremes will be reduced. More important is that the motions that carry these temperatures arise from a process called “baroclinic instability,” and this instability derives from the magnitude of the aforementioned temperature difference. Thus, in a warmer world, these winds will be weaker and less capable of carrying extreme temperatures to remote locations. Claims of greater extremes in temperature simply ignore the basic physics, and rely, for their acceptance, on the ignorance of the audience.

The claims of extreme weather transcend the usual use of misleading claims. They often amount to claims for the exact opposite of what is actually occurring. The object of the claims is simply to be as scary as possible, and if that requires claiming the opposite of the true situation, so be it.

Sea Level Rise

Globally averaged sea level appears to have been rising at the rate of about six inches a century for thousands of years. Until the advent of satellites, sea level was essentially measured with tide gauges, which measure the sea level relative to the land level. Unfortunately, the land level is also changing, and as K.O. Emery and David G. Aubrey note, tectonics are the major source of change at many locations.⁹ In 1979 we began to use satellites to measure actual sea level. The results were surprisingly close to the previous tide gauge estimates, but slightly higher, and as Carl Wunsch, Rui M. Ponte, and Patrick Heimbach show in “Decadal Trends in Sea Level Patterns: 1993–2004,” we are in no position to argue that small differences from

⁹K.O. Emery and David G. Aubrey, *Sea Levels, Land Levels, and Tide Gauges* (New York: Springer-Verlag, 1991).

changing methodologies represent acceleration.¹⁰

Regardless, the changes are small compared to claims that suggest disastrous changes. However, even in the early 1980s advocates of warming alarm such as the late Stephen H. Schneider, professor of environmental biology and global change at Stanford University, argued that sea level would be an easily appreciated scare tactic. The fact that people from Al Gore to Susan Solomon (the former head of the IPCC's Scientific Assessment) have invested heavily in ocean front property supports the notion that the issue is propagandistic rather than scientific.

Arctic Sea Ice

Satellites have been observing Arctic (and Antarctic) sea ice since 1979. Every year there is a pronounced annual cycle where the almost complete winter coverage is much reduced each summer. During this period there has been a noticeable downtrend in summer ice in the Arctic (with the opposite behavior in the Antarctic), though in recent years the coverage appears to have stabilized. In terms of climate change, forty years is a rather short interval. Still, there have been the inevitable attempts to extrapolate short-period trends, which have led to claims that the Arctic should have already reached ice-free conditions. Extrapolating short-term trends is obviously inappropriate. Extrapolating surface temperature changes from dawn to dusk would lead to a boiling climate in days. This would be silly. The extrapolation of Arctic summer ice coverage looks to be comparably silly. Moreover, although the satellite coverage is immensely

¹⁰Carl Wunsch, Rui M. Ponte, and Patrick Heimbach, "Decadal Trends in Sea Level Patterns: 1993–2004," *Journal of Climate* (December 2007),

<http://journals.ametsoc.org/doi/abs/10.1175/2007JCLI1840.1>.

better than what was previously available, the data is far from perfect. The satellites can confuse ice topped with melt water with ice-free regions. In addition, temperature might not be the main cause of reduced sea ice coverage. Summer ice tends to be fragile, and changing winds play an important role in blowing ice out of the Arctic sea. Associating changing summer sea ice coverage with climate change is, itself, dubious. Existing climate models hardly unambiguously predict the observed behavior. Predictions for 2100 range from no change to complete disappearance. Thus, it cannot be said that sea ice behavior confirms any plausible prediction.

It is sometimes noted that concerns for disappearing Arctic sea ice were issued in 1922,¹¹ suggesting that such behavior is not unique to the present. The data used at that time came from the neighborhood of Spitsbergen, southeast of the Arctic Ocean and north of Norway. A marine biologist and climate campaigner, Tom Goreau, has argued that what was described was a local phenomenon, but despite this claim, the evidence presented is far from conclusive.¹² Among other things, Goreau was selective in his choice of “evidence.”

All one can say at this point is that the behavior of Arctic sea ice represents one of the numerous interesting phenomena that Earth presents us with, and for which neither the understanding nor the needed records exist. It probably pays to note that melting sea ice does not

¹¹George Nicholas Ifft, “The Changing Arctic,” *Monthly Weather Review* (NOAA archives), November 1922, <https://docs.lib.noaa.gov/rescue/mwr/050/mwr-050-11-0589a.pdf>.

¹²Tom Goreau, “Long Term Arctic Ice Trends and Global Warming,” Global Coral Reef Alliance, January 8, 2010, <http://www.globalcoral.org/oldgcra/LONG%20TERM%20ARCTIC%20ICE%20TRENDS%20AND%20GLOBAL%20WARMING.1.pdf>.

contribute to sea level rise. Moreover, man has long dreamt of the opening of this Northwest Passage, a sea route to the Pacific through the Arctic Ocean. It is curious that this is now viewed with alarm. Of course, as H.L. Mencken observed, “The whole aim of practical politics is to keep the populace alarmed (and hence clamorous to be led to safety) by an endless series of hobgoblins, most of them imaginary.” The environmentalist movement has elevated this aim well beyond what Mencken noted.

Polar Bear Meme

I suspect that Al Gore undertook considerable focus group research to determine the remarkable effectiveness of the notion that climate change would endanger polar bears. His use of an obviously Photoshopped picture of a pathetic polar bear on an ice float suggests this. As Susan Crockford, a specialist in polar bear evolution, points out, there had indeed been a significant decrease in polar bear population in the past due to hunting and before that due to commercial exploitation of polar bear fur. This has led to successful protective measures and sufficient recovery of polar bear population, so that hunting is again permitted.¹³ There is no evidence that changes in summer sea ice have had any adverse impact on polar bear population, and, given that polar bears can swim for over a hundred miles, there seems to be little reason to suppose that it would. Nonetheless, for the small community of polar bear experts, the climate-

¹³Markus Dyck et al., *2016 Aerial Survey of the Western Hudson Bay Polar Bear Sub-Population: Final Report* (Igloolik, NU: Nunavut Department of Environment, Wildlife Research Section, 2017), https://polarbearsociety.files.wordpress.com/2017/09/western-hudson-bay-pb-2016-population-assessment_gn-report_27-june-2017.pdf.

related concerns have presented an obvious attraction.

Ocean Acidification

This is again one of those obscure claims that sounds scary but doesn't stand up to scrutiny. Ever since the acid rain scare of the 1970s, the public responds with alarm to anything with the word "acid" in it. Ph (potential of hydrogen) is a measure of acidity on a scale from 0 to 14; values greater than 7 are basic and less than 7 acid. In point of fact, the ocean is basic rather than acidic; that is, its ph is always appreciably higher than 7. There is no possibility of increasing levels of atmospheric CO₂ bringing it down to 7, and the purported changes simply refer to making the ocean a bit less basic. However, a more correct description would lack the scare component. As usual, there is so much wrong with this claim that it would take a fairly long article to go over it all. I recommend readers to Frontier Centre for Public Policy senior fellow Patrick Moore's "Ocean 'Acidification' Alarmism in Perspective."¹⁴

Death of Coral Reefs

The alleged death of coral reefs is partly linked to the acidification issue described above, and that linkage is almost opposite to what is commonly claimed. There is also the matter of warming per se leading to coral bleaching. A typical alarmist presentation is "Global Warming and Recurrent Mass Bleaching of Corals," by Terry P. Hughes et al., which appears in the March

¹⁴Patrick Moore, "Ocean 'Acidification' Alarmism in Perspective," Frontier Centre for Public Policy, November 2015, <https://fcpp.org/wp-content/uploads/2015/11/Moore-Ocean-Acidification-Alarmism.pdf>.

16, 2017, *Nature*.¹⁵

The reasoned response to this paper is provided in Jim Steele's "Falling Sea Level: The Critical Factor in 2016 Great Barrier Reef Bleaching!"¹⁶ As Steele, emeritus lecturer in biology at San Francisco State University, points out, bleaching has common causes other than warming and is far from a death sentence for corals, which have a substantial capacity to recover.

Global Warming as the Cause of Everything

As we see from all of the above, there is a tendency to blame everything unpleasant on global warming. The absurd extent of this tendency is illustrated in "A Complete List of Things Caused by Global Warming," posted on *Number Watch*.¹⁷ That hasn't stopped the EPA from using such stuff to claim large health benefits for its climate change policies. Moreover, I fear

¹⁵Terry P. Hughes et al., "Global Warming and Recurrent Mass Bleaching of Corals," *Nature* 543 (March 16, 2017), 373–77,

<http://www.nature.com/nature/journal/v543/n7645/full/nature21707.html?foxtrotcallback=true>.

¹⁶Jim Steele, "Falling Sea Level: The Critical Factor in 2016 Great Barrier Reef Bleaching!" *Landscapes and Cycles: An Environmentalist's Journey to Climate Skepticism*, April 5, 2017, <http://landscapesandcycles.net/falling-sea-level--bleached-great-barrier-reef.html>. See also James Delingpole's "Only Gullible Fools Believe that the Great Barrier Reef Is Dying," *Breitbart*, April 10, 2017, <http://www.breitbart.com/big-government/2017/04/10/delingpole-gullible-fools-believe-great-barrier-reef-dying/>, which is a bit polemical, but essentially correct.

¹⁷"A Complete List of Things Caused by Global Warming," *Number Watch*, March 5, 2012, <http://www.numberwatch.co.uk/warmlist.htm>.

that with so many claims, there is always the next question, “What about...?”

Hardly anyone has the time and energy to deal with the huge number of claims. Fortunately, most are self-evidently absurd. *Nation* magazine recently came up with what is a bit of a champion in this regard: “The Other Poison Gas Killing Syrians: Carbon Dioxide Emissions.”¹⁸ CO₂, it should be noted, is hardly poisonous. On the contrary, it is essential for life on our planet and levels as high as 5000 ppm are considered safe on our submarines and on the space station (current atmospheric levels are around 400 ppm, while indoor levels, due to our breathing, can be much higher).

The *Nation* article is typical in that it makes many bizarre claims in a brief space, among them that a runaway greenhouse effect on Venus led to temperatures hot enough to melt lead. Of course, no one can claim that Earth is subject to such a runaway, but even on Venus, the hot surface depends primarily on the closeness of Venus to the sun and the existence of a dense sulfuric acid cloud covering the planet. Relatedly, Mars, which also has much more CO₂ than Earth, is much further from the sun and very cold. But as we have seen many times already, such matters are mere details when one is in the business of scaring the public.

Conclusion

The accumulation of false and/or misleading claims is often referred to as “overwhelming evidence” of forthcoming catastrophe. Without these claims, one might legitimately ask whether

¹⁸Juan Cole, “The Other Poison Gas Killing Syrians: Carbon Dioxide Emissions,” *Nation*, April 18, 2017, <https://www.thenation.com/article/the-other-poison-gas-killing-syrians-carbon-dioxide-emissions/>.

there is any evidence at all.

Despite this, climate change has been the alleged motivation for enacting numerous policies, which, for the most part, seem to have done more harm than the purported climate change,¹⁹ and have the obvious capacity to do much more. Perhaps the best that can be said for these efforts to combat climate change is that they are acknowledged to have little impact on either CO₂ levels or temperatures despite their immense cost. This is relatively good news, since there is ample evidence that increases in both are likely to be beneficial, although the immense waste of money is not.

I haven't spent much time on the details of the science, but there is one thing that should spark skepticism in any intelligent reader. Consider what the climate system actually is. This system consists in two turbulent fluids interacting with each other. They are on a rotating planet that is differentially heated by the sun. A vital constituent of the atmospheric component is water in the liquid, solid, and vapor phases, and the changes in phase have vast energetic ramifications. The energy budget of this system involves the absorption and reemission of about 200 watts per square meter. Doubling CO₂ involves a 2 percent perturbation to this budget. So do minor changes in clouds, ocean circulations, and other features, and such changes are common. In this complex multifactor system, what is the likelihood that the climate (which itself consists of many variables and not just globally averaged temperature anomalies) is controlled by a 2 percent perturbation in the energy budget due to just one of the numerous variables, namely CO₂?

¹⁹Christopher Booker, "Every Climate Initiative Imposed on Us by Politicians Has Ended in Disaster," *Global Warming Policy Forum*, August 4, 2017, <http://www.thegwpf.com/every-climate-initiative-imposed-on-us-by-politicians-has-ended-in-disaster>.

Believing this is pretty close to believing in magic. Instead, we are told that it is believing in “science.” Such a claim should be a tip-off that something is amiss. After all, science is a mode of inquiry rather than a belief structure.