

A Call to Truth, Prudence, and Protection of the Poor 2014: The Case against Harmful Climate Change Policies Gets Stronger

David R. Legates¹ and G. Cornelis van Kooten²

The Cornwall Alliance for the Stewardship of Creation
Burke, Virginia
September 2014

Epigram

The greatest threat to the alleviation of the structural poverty of the Third World is the continuing campaign by western governments, egged on by some climate scientists and green activists, to curb greenhouse emissions, primarily the CO₂ from burning fossil fuels. ...

[I]t is mankind's use of the mineral energy stored in nature's gift of fossil fuels ... accompanying the slowly rolling Industrial Revolution, [that] allowed the ascent from structural poverty which had scarred humankind for millennia.

To put a limit on the use of fossil fuels without adequate economically viable alternatives is to condemn the Third World to perpetual structural poverty.

—Deepak Lal, *Poverty and Progress:
Realities and Myths about Global Poverty*

¹ David R. Legates, Ph.D., is Professor of Climatology at the University of Delaware, Newark, DE.

² G. Cornelis van Kooten, Ph.D., is Professor of Economics and Research Chair in Environmental Studies and Climate, University of Victoria, BC, Canada.

Introduction: Why Climate Policy Matters to Evangelical Christians

E. Calvin Beisner³
Founder and National Spokesman, Cornwall Alliance

On June 2, 2014, the United States Environmental Protection Agency (EPA) proposed a new rule requiring a 30% reduction in carbon dioxide (CO₂) emissions from existing power plants by 2030. Compliance is estimated to cost about \$50 billion per year, the loss of about \$1,200 per year in income for the average family of four, and the loss of about 600,000 jobs. Is that a good idea, or a bad one?

Assuming that CO₂ warms the atmosphere as much as EPA (depending on the U.N. Intergovernmental Panel on Climate Change [IPCC]) claims, the “benefits” of compliance include, even according to EPA itself, a hypothetically calculable but observationally indiscernible 0.02°C reduction in global average temperature by the end of this century, which would have no discernible impact on human or other life on the planet. If CO₂’s warming effect is actually much less, then the indiscernibly small global temperature reduction will be even smaller.

Despite rising emissions and atmospheric concentration of CO₂, global surface temperature stopped rising in 1995 (19 years ago), and lower tropospheric temperature stopped rising some 16 to 26 years ago (McKittrick 2014b; Monckton 2014). This has led many climate scientists around the world to reduce their estimates of “climate sensitivity”— how much average global atmospheric surface temperature will rise in response to doubled concentration of atmospheric CO₂ (NIPCC 2013a, pp. 6, 9; NIPCC 2013b, pp. 24–29; Lewis and Crok 2013, p. 9; see discussions of many similar studies at Curry 2014). IPCC estimates climate sensitivity at 1.5°C to 4.5°C, but that estimate is based on computer climate models that failed to predict the absence of warming since 1995 and predicted, on average, four times as much warming as actually occurred from 1979 to the present. It is therefore not credible. Newer, *observationally based* estimates have ranges like 0.3°C to 1.0°C (NIPCC 2013a, p. 7) or 1.25°C to 3.0°C with a best estimate of 1.75°C (Lewis and Crok 2013, p. 9). Further, “No empirical evidence exists to support the assertion that a planetary warming of 2°C would be net ecologically or economically damaging” (NIPCC 2013a, p. 10).

In any case, EPA itself says the reduced CO₂ emissions will provide no direct health benefits. Yet EPA claims the rule will still benefit Americans’ health because reducing CO₂ emissions will have the side effect of reducing emissions of nitrous oxides, sulfur dioxide, and fine particulate matter, the last of which can cause or exacerbate upper respiratory diseases like asthma. (It makes this claim despite the fact that asthma rates have risen while particulate pollution has fallen). But regulations already exist to control those emissions, and by law those

³ E. Calvin Beisner, Ph.D., taught theology and ethics at Knox Theological Seminary (2000–2008) and interdisciplinary studies at Covenant College (1992–2000) before founding the Cornwall Alliance in 2005.

regulations are supposed to be sufficient to bring those emissions to a level necessary to protect the public health with adequate margin for safety. So if EPA justifies the new CO₂ regulations by appealing to their indirect effect on other emissions, one of three things follows:

1. EPA is admitting that its already-in-place regulations of those other emissions do not achieve what the law requires them to achieve. (If that is the case, then the proper solution is not to regulate CO₂ emissions but to tighten regulation on the other emissions.)
2. Or, as the American Enterprise Institute's Ben Zycher (2014) puts it, EPA is "double-counting the health benefits from other regulations already in force."
3. Or, again as Zycher puts it, EPA is "assuming further health benefits from reducing pollution levels that already are lower than those at which the epidemiological analyses suggest no adverse effects."

That sets up an unpleasant dilemma for EPA: We are breaking the law by not doing our job. Or we are liars. Or we are imposing lots of pain for no gain. Maybe it's all three.

In addition, implementing the rule would harm most Americans, especially the poor. A study by scholars at the Massachusetts Institute of Technology (Rausch et al. 2009) found that a policy imposing a CO₂ tax or cap-and-trade regime (and the new EPA rule allows states to use either or both) would impose higher costs on states that currently get more of their energy from fossil fuels and lower costs on those that currently get less. The MIT study predicted: "Differences in costs among regions are driven by differences in CO₂ intensity of electricity production, the presence of energy producing and energy intensive industry, and income levels."

Rich people tend to be able to afford more expensive things than poor people. That includes energy. The lower you push CO₂ emissions, the more expensive it is to generate electricity, and consequently, the poorer you are, the less likely you are to choose more expensive energy sources.

Not surprisingly, states that have chosen to push their CO₂ emissions down already—California, the Pacific Coast, New England, and New York—are rich (and "Blue") states. They averaged \$46,954 per capita in income in 2012, one-tenth more than the national average. Key states not pushing their CO₂ emissions down yet are poorer (and "Red") states: South Central States, Texas, and Mountain States, which averaged \$36,854 per capita in income, 14% lower than the national average and more than a fifth lower than the states with CO₂ reduction policies already in place.

Because the poor spend a higher percentage of their incomes on energy in the first place, an increase in energy prices—which EPA's new rule would cause—will cause disproportionately heavy harm to them, ironically functioning as if it were a regressive tax (taxing the poor at higher rates than the rich). Consider examples from a few states, according to data from the U.S. Department of Energy's Energy Information Agency (America's Power 2014):

- Although on average Colorado families spent just 8% of their after-tax incomes on energy in 2013, the 879,000 Colorado families with income under \$50,000 per year spent an average of 17%—more than twice as much—of their after-tax incomes on energy, and the 128,000 families earning under \$10,000 per year 57%—more than seven times as much as the average family. For the average family, a 10% increase in energy prices would push energy costs to 8.8% of after-tax income; for the family earning under \$10,000, that same increase in energy prices would push energy costs to a crushing 62.3%.

- While on average Florida families spent just 10% of their after-tax incomes on energy in 2013, the 3.9 million Florida households with annual income under \$50,000 spent an average of 19% of their after-tax income on energy, and the 587,000 families earning under \$10,000 per year spent 68%—nearly seven times the average. For the average family, a 10% increase in energy prices would push energy costs to 11% of after-tax income; for the family earning under \$10,000, that same increase in energy prices would push energy costs to 74.6%.
- The average Iowa family spent 11% of after-tax income on energy in 2013. The 600,000 Iowa families with under \$50,000 in annual income spent on average 19% of their after-tax income on energy, while 80,000 Iowa families with annual incomes under \$10,000 spent on average 69%—more than six times the average. For the average family, a 10% increase in energy prices would push energy costs to 12.1% of after-tax income; for the family earning under \$10,000, that same increase in energy prices would push energy costs to 75.9%.

Data for these three and twelve other states are summarized in Table 1.

Table 1: Energy Spending by State Source: EIA	Average % of Family After-tax Income Spent on Energy		# Families Earning Under \$50,000/yr	Average % of Family After-tax Income Spent on Energy		# Families Earning Under \$10,000/yr	Average % of Family After-tax Income Spent on Energy	
	2013	+ 10%		2013	+ 10%		2013	+10%
Arizona	10.0	11.0	1,200,000	18.0	19.8	189,000	68.0	74.6
Colorado	8.0	8.8	879,000	17.0	18.7	128,000	57.0	62.3
Florida	10.0	11.0	3,900,000	19.0	20.9	587,000	68.0	74.6
Georgia	13.0	14.3	1,800,000	24.0	26.4	329,000	86.0	94.6
Indiana	11.0	12.1	1,300,000	19.0	20.9	188,000	71.0	78.1
Iowa	11.0	12.1	600,000	19.0	20.9	80,000	69.0	75.9
Kansas	10.0	11.0	550,000	19.0	20.9	72,000	76.0	83.6
Maryland	9.0	9.9	750,000	21.0	22.1	115,000	70.0	77.0
Michigan	11.0	12.1	2,000,000	20.0	22.0	332,000	73.0	80.3
Mississippi	13.0	14.3	677,000	22.0	24.2	133,000	77.0	84.7
North Carolina	11.0	12.1	2,000,000	20.0	22.0	325,000	70.0	77.0
Ohio	11.0	12.1	2,400,000	20.0	22.0	387,000	72.0	79.2
Pennsylvania	10.0	11.0	2,400,000	19.0	20.9	357,000	72.0	79.2
Virginia	9.0	9.9	1,200,000	20.0	22.0	185,000	71.0	77.1
West Virginia	12.0	13.2	439,000	20.0	22.0	79,000	70.0	77.0

To comprehend the impact of EPA's proposed new rule on America's poor, just imagine what it would be like to have to spend three-fourths of your household income on energy, leaving only one-fourth for food, clothing, shelter, transportation, health care, education, and everything else combined.

In three previous major papers,

- *An Examination of the Scientific, Ethical, and Theological Implications of Climate Change Policy* (2005), by Roy W. Spencer, Paul K. Driessen, and E. Calvin Beisner;
- *A Call to Truth, Prudence, and Protection of the Poor: An Evangelical Response to Global Warming* (2006), by E. Calvin Beisner, Paul K. Driessen, Ross R. McKittrick, and Roy W. Spencer; and
- *A Renewed Call to Truth, Prudence and Protection of the Poor: An Evangelical Examination of the Theology, Science, and Economics of Global Warming* (2010), by lead authors Craig

C. Mitchell, Roy W. Spencer, David R. Legates, G. Cornelis van Kooten, E. Calvin Beisner, and Pete Geddes, plus 23 reviewers,

the Cornwall Alliance has presented strong evidence that climate change is mostly natural, that human contribution to it is small and is not now and will not become dangerous, and that efforts to combat it by mandatory reductions in CO₂ emissions, which can be accomplished only by switching from abundant, affordable, reliable fossil fuels as a major energy source to diffuse, expensive, unreliable “renewable” sources like wind and solar will make no significant reduction in future global temperatures, bring no significant benefits to human health or other life on earth, and cause serious harm to America’s and the world’s poor.

In the five years since our *Renewed Call to Truth*, important developments in the science of climate change have strengthened the case for all of those conclusions. Among them:

- “Climategate”—the release of thousands of emails plus computer programs and documentation from the Climatic Research Unit of the University of East Anglia, first in 2009 and with many thousands more in 2011—revealed that a small cadre of climate scientists at the core of IPCC had been exaggerating data, fabricating data, suppressing contrary data, intimidating researchers whose conclusions undermined the case for global warming alarmism, corrupting the peer review process, and bullying editors of science journals (even forcing the resignation of one) if they published articles that called alarmism into question (McKittrick 2011; Montford 2010b). Contrary to mainstream media reports and claims by the principals in Climategate, official investigations did not exonerate the principal actors in the scandal (McKittrick 2010; Montford 2010a).
- This was followed by the discovery that IPCC’s Fourth Assessment Report (2007) had violated its own rules by using high percentages of non-refereed sources (Laframboise 2011), some of them leading to a large number of false claims in that Report about rapidly mounting climate-change damage that IPCC eventually had to retract.
- The Nongovernmental International Panel on Climate Change (NIPCC) released *Climate Change Reconsidered* (2009), the first of its massive reports rivaling those of IPCC but unsullied by the political priorities of the governments whose political representatives heavily shaped IPCC’s reports. That volume was followed first by NIPCC’s *Climate Change Reconsidered: 2011 Interim Report of the Nongovernmental International Panel on Climate Change* (2011) and then by *Climate Change Reconsidered II: Physical Science* (2013) and *Climate Change Reconsidered II: Biological Impacts* (2014), with a third volume, on adaptation and mitigation, now in the works. NIPCC’s work earned the admiration of leading scholars on scientific publication who, despite their own bias in favor of IPCC’s more alarmist conclusions, compared it favorably with IPCC’s (Jankó, Móricz, and Vancsó 2014).
- As discussed above, contrary to predictions by over 95% of the computer climate models on which IPCC relies, observed global temperatures failed to rise from 1995 to 2014. The stark contrast between the model projections and the real-world observations effectively invalidates the models, which are the sole basis of fears of catastrophic anthropogenic warming.

Last, and with devastating implications for the case that rising CO₂ plays even a bit part in recent global warming, was the appearance in July 2014, in the highly respected technical journal *Environmetrics*, of new analysis of climate data showing that after adjusting for the

Pacific Climate Shift in 1977, associated with a shift in the Pacific Decadal Oscillation from negative to positive and clearly observed in weather balloon temperature records, *the data show no warming trend whatsoever for the tropical troposphere from 1958 through 2012* (McKittrick and Vogelsang 2014). As lead author McKittrick summarized it (McKittrick 2014) (emphasis added):

- All climate *models* but one characterize the 1958–2012 interval as having a significant upward trend in temperatures. Allowing for a late-1970s step change has basically no effect in model-generated series. Half the climate models yield a small positive step and half a small negative step, but all except two still report a large, positive and significant trend around it. Indeed in half the cases the trend becomes even larger once we allow for the step change. In the GCM [Global Climate Model] ensemble mean there is no step-change in the late 1970s, just a large, uninterrupted and significant upward trend.
- Over the same interval, when we do not control for a step change in the observations, we find significant upward trends in tropical LT [Lower Troposphere] and MT [Mid Troposphere] temperatures, though the average *observed* trend is significantly smaller than the average *modeled* trend.
- When we allow for a late-1970s step change in each radiosonde series, all three assign most of the post-1958 increase in both the LT and MT to the step change, and the trend slopes become essentially zero.
- Climate *models* project much more warming over the 1958–2012 interval than was observed in either the LT or MT layer, and the inconsistency is statistically significant whether or not we allow for a step-change, but when we allow for a shift term the models are rejected at smaller significance levels. ...
- Over the 55-years from 1958 to 2012, climate models not only significantly over-predict observed warming in the tropical troposphere, but they represent it in a fundamentally different way than is observed. *Models represent the interval as a smooth upward trend with no step-change. The observations, however, assign all the warming to a single step-change in the late 1970s coinciding with a known event (the Pacific Climate Shift), and identify no significant trend before or after.* In my opinion the simplest and most likely interpretation of these results is that climate models, on average, fail to replicate whatever process yielded the step-change in the late 1970s and they significantly overstate the overall atmospheric response to rising CO₂ levels.

Because, according to the models, the tropical troposphere (which contains about half of Earth's atmosphere) is supposed to warm faster than any other part in response to rising CO₂, this implies that there has been no general warming trend for the entire atmosphere over that period, either. McKittrick is working on a follow-up article that will deal with data for the entire atmosphere (personal communication, August 25, 2014).

These findings are consistent with an important aspect of the Biblical worldview: As the product of infinitely wise design, omnipotent creation, and faithful sustaining (Genesis 1:1–31; 8:21–22), Earth is robust, resilient, self-regulating, and self-correcting. (In more scientific terms, this means it is dominated more by negative feedback mechanisms, which reduce the effect of new forcings, rather than positive feedback mechanisms, which magnify them.) Thus, while Earth and its subsystems, including the climate system, are susceptible to damage by ignorant or malicious human action, God's wise design and faithful sustaining make these natural systems

more likely—as confirmed by widespread scientific observation—to respond in ways that suppress and correct that damage than magnify it catastrophically. (Again in more scientific terms, runaway “positive feedback loops” producing catastrophic results from relatively small initial changes are unlikely.)

The authors of the two chapters of this paper are not only fully credentialed, veteran university researchers and professors in the academic disciplines relevant to their contributions but also evangelical Christians committed to glorifying God through responsible stewardship of the earth.

In Chapter 1, climatologist Dr. David R. Legates rehearses the scientific evidence that CO₂'s impact on global temperature is much smaller than IPCC and other alarmists claim, and that there is no persuasive scientific evidence that human emissions of CO₂ have caused, or in the foreseeable future will cause, dangerous global warming.

In Chapter 2, environmental economist Dr. G. Cornelis “Kees” van Kooten rehearses the economic evidence that policies to fight global warming by reducing CO₂ emissions by switching from fossil fuels to wind, solar, and other “renewable” sources will do far more harm than good to the world’s poor.

For evangelical Christians, who take seriously the Bible’s emphasis on protecting the vulnerable from harm (Psalm 12:5; 35:10; 41:1; 72:4, 12; Proverbs 31:9; Galatians 2:10), these two chapters and the information above provide compelling evidence that to protect the poor, we must oppose such policies and instead support policies that simultaneously reflect responsible environmental stewardship (Genesis 1:28; 2:15), make energy and all its benefits more affordable, and so free the poor to rise out of poverty. To take this position is not to suggest that we may abuse the earth or any of its ecological systems. It is to conclude, instead, that what some people consider an abuse of the earth (obtaining energy from fossil fuels and so adding CO₂ to the atmosphere) is not an abuse of the earth but is instead a vitally important way of improving human wellbeing.

The Cornwall Alliance offers this paper in support of a new declaration, “Protect the Poor: Ten Reasons to Oppose Harmful Climate Change Policies,” and encourages our evangelical Christian brothers and sisters to join us in endorsing it and to share it with others, including political representatives at national, state, and local levels.

References

- America’s Power, 2014. *State Energy Costs for Families*. <http://americaspower.org/federal-issues/state-energy-cost-for-families>
- Ball, Tim, 2014. *The Deliberate Corruption of Climate Science*. Mount Vernon, WA: Stairway Press.
- Curry, Judith, 2014. “Climate Etc., Category Archives: Sensitivity & Feedbacks.” JudithCurry.com. <http://judithcurry.com/category/sensitivity-feedbacks/>
- Jankó, Ferenc, Norbert Móricz, and Judit Papp Vancsó, 2014. “Reviewing the Climate Change Reviewers: Exploring Controversy through Report References and Citations,” *Geoforum* 56 (2014) 17–34. <http://www.sciencedirect.com/science/article/pii/S0016718514001389>
- Laframboise, Donna, 2011. *The Delinquent Teenager Who Was Mistaken for the World’s Top Climate Expert*. Downey, CA: Avenue Press.
- Lal, Deepak, 2013. *Poverty and Progress: Realities and Myths about Global Poverty*. Washington, D.C.: Cato Institute.
- Lewis, Nicholas, and Marcel Crok, 2014. *A Sensitive Matter: How the IPCC Buried Evidence Showing Good News about Global Warming*. London: Global Warming Policy Foundation. <http://www.thegwpcf.org/content/uploads/2014/02/A-Sensitive-Matter-Foreword-inc.pdf>

- McKittrick, Ross R., 2010. “Understanding the Climategate Inquiries.”
http://www.rossmckittrick.com/uploads/4/8/0/8/4808045/rmck_climategate.pdf
- McKittrick, Ross R., 2011. “Bias in the Peer Review Process: A Cautionary and Personal Account,” in *Climate Coup*, edited by Patrick J. Michaels. Washington D.C.: Cato Institute.
http://www.rossmckittrick.com/uploads/4/8/0/8/4808045/gatekeeping_chapter.pdf
- McKittrick, Ross R., 2014a. “New Paper by McKittrick and Vogelsang Comparing Models and Observations in the Tropical Troposphere,” WattsUpWithThat.com, July 24. <http://climateaudit.org/2014/07/24/new-paper-by-mckittrick-and-vogelsang-comparing-models-and-observations-in-the-tropical-troposphere/>
- McKittrick, Ross R., 2014b. “HAC-Robust Measurement of the Duration of a Trendless Subsample in a Global Climate Time Series,” *Open Journal of Statistics*, 4, 527–535. <http://dx.doi.org/10.4236/ojs.2014.47050>
- McKittrick, Ross R., and Timothy J. Vogelsang, 2014. “HAC robust trend comparisons among climate series with possible level shifts,” *Environmetrics*. DOI 10.1002/env.2294.
<http://onlinelibrary.wiley.com/doi/10.1002/env.2294/pdf>
- Monckton, Christopher, 2014a. “Global Temperature Update—Still no global warming for 17 years and 10 months,” WattsUpWithThat.com, August 2. <http://wattsupwiththat.com/2014/08/02/global-temperature-update-still-no-global-warming-for-17-years-10-months/>
- Monckton, Christopher, 2014b. “Global Temperature Update—No global warming for 17 years 11 months,” WattsUpWithThat.com, September 4. <http://wattsupwiththat.com/2014/09/04/global-temperature-update-no-global-warming-for-17-years-11-months/>
- Montford, A.W., 2010a. *The Climategate Inquiries*. London: Global Warming Policy Foundation, GWPF Report 1. http://heartland.org/sites/all/modules/custom/heartland_migration/files/pdfs/28547.pdf
- Montford, A.W., 2010b. *The Hockey Stick Illusion: Climategate and the Corruption of Science*. London: Stacey International.
- NIPCC, 2009. *Climate Change Reconsidered*. Edited by Craig D. Idso and S. Fred Singer. Chicago: Heartland Institute/Nongovernmental International Panel on Climate Change.
<http://www.nipccreport.org/reports/2009/pdf/CCR2009FullReport.pdf>
- NIPCC, 2011. *Climate Change Reconsidered: 2011 Interim Report of the Nongovernmental International Panel on Climate Change*. Edited by Craig D. Idso, Robert M. Carter, and S. Fred Singer. Chicago: Heartland Institute. <http://www.nipccreport.org/reports/2011/pdf/2011NIPCCinterimreport.pdf>
- NIPCC, 2013a. *Climate Change Reconsidered II: Physical Science, Summary for Policymakers*. Edited by Craig D. Idso, Robert N. Carter, and S. Fred Singer. Chicago: Heartland Institute/Nongovernmental International Panel on Climate Change. <http://heartland.org/media-library/pdfs/CCR-II/Summary-for-Policymakers.pdf>
- NIPCC, 2013b. *Climate Change Reconsidered II: Physical Science*. Edited by Craig D. Idso, Robert N. Carter, and S. Fred Singer. Chicago: Heartland Institute/Nongovernmental International Panel on Climate Change.
<http://heartland.org/media-library/pdfs/CCR-II/CCR-II-Full.pdf>
- NIPCC, 2014. *Climate Change Reconsidered II: Biological Impacts*. Edited by Craig D. Idso, Sherwood Idso, Robert M. Carter, and S. Fred Singer. Chicago: Heartland Institute. <http://heartland.org/media-library/pdfs/CCR-IIb/Full-Report.pdf>
- Rausch, Sebastian, et al., 2009. *Distributional Impacts of a U.S. Greenhouse Gas Policy: A General Equilibrium Analysis of Carbon Pricing*. Cambridge, MA: Massachusetts Institute of Technology Joint Program on the Science and Policy of Global Change, November.
<http://globalchange.mit.edu/files/document/MITJSPGCRpt182.pdf>
- Zycher, Benjamin, 2014. “Obama and the EPA: It’s about rewarding friends and punishing enemies,” *Los Angeles Times*, June 9. <http://www.latimes.com/opinion/op-ed/la-oe-zycher-epa-global-warming-20140610-story.html>

Chapter 1

Greenhouse Gases and Warming of the Earth

David R. Legates
Professor of Climatology
University of Delaware, Newark, Delaware, USA

Few controversies have received greater attention around the world in the last twenty years than that over global warming. Some think it threatens the very survival of the human race, others that it is little or nothing to worry about—and there are many intermediate positions. What is a well-informed, faithful Christian perspective?

At the outset, let us define what the debate is *not* about. The debate is not about whether our climate is changing; indeed, it always has changed on timescales ranging from decades to millennia. It is not about whether humans can influence the Earth's climate; they certainly do. It is not about whether global air temperatures have risen over the past 160 years; they have. The real questions that define this debate are: (1) To what extent are humans responsible for the climate change we see? (2) What are the future consequences of climate change, from both natural and anthropogenic sources? (3) How should we respond? This paper focuses on the first question and provides implications for the second and third.

The Definition of “Climate”

Historically, the definition of “climate” as “average weather” has given the impression to many that climate is not dynamic and is little more than a statistical summary. This has led to the erroneous belief that climate should not change and that any change in climate must be adverse. Climate itself has been oversimplified by statements such as “the Earth's atmosphere acts like a blanket” or that “carbon dioxide causes the Earth to heat like the windows of a car on a hot afternoon.” Both reduce the atmosphere to only its radiative properties and ignore the effect of atmospheric motions (both horizontally and vertically) and the evaporation of water on the climate.

One definition of “climate” is long-term behavior of the atmosphere. But that assumes that the atmosphere is independent from the rest of the environment. The study of climate, climatology, is a holistic endeavor which includes interactions between the Sun, the Earth's atmosphere and oceans, its surface characteristics, and even its inhabitants—including, most notably, vegetation and humans—on longer timescales. It is a very complex area of scientific inquiry since it encompasses many different processes operating on time scales that often exceed human lifespans or modern recordkeeping.

In the early days of modeling, much of the focus was based largely on the energy budget (*i.e.*, incoming and outgoing electromagnetic radiation). Simple zero-dimensional (Earth as a

point in space) or one-dimensional (Earth has only Pole-to-Equator variations) models average over the un-modeled horizontal and vertical patterns. Even as two-dimensional models (including both latitude and altitude) were being developed, the understanding of the energy budget was more complete than other processes such as large-scale cloud formation and spatial gradients. Thus, climate modelers gave more attention and assigned more impact to the energy budget and the changes over time due to atmospheric molecules like carbon dioxide and methane than the more complex interrelationships with climate driven by the most important greenhouse gas, water vapor.

Water exists on Earth in all three phases—solid, liquid, and gas—and it transitions through these three phases relatively easily, affecting the energy budget through the movement of evaporated water, changes in the reflected solar energy by becoming ice and snow, and variations in the solar and heat energy distribution by the formation of clouds as it condenses. Thus, water is the most important greenhouse gas in the atmosphere, and, since its phase changes involve the creation and dissipation of clouds, ice sheets, and sea ice, it is the most difficult to model correctly.

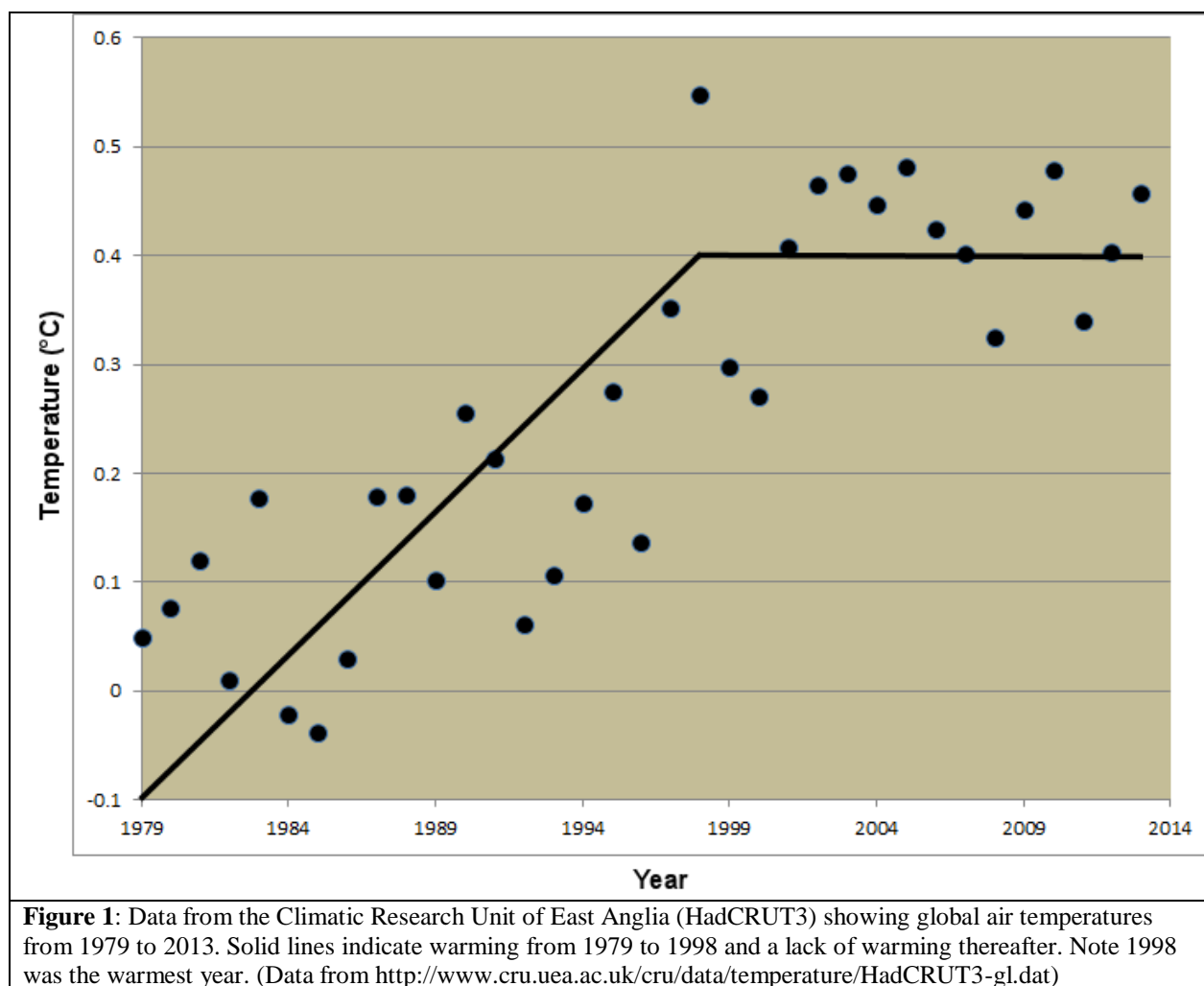
One cannot begin to understand how utterly complex our climate system is. Processes occur on a variety of space and time scales, many of which are far below the spatial and temporal resolution of most climate models. Water changes phase and passes from ice sheets and sea ice, to liquid water in the oceans, lakes, streams, and groundwater, and to water vapor in the atmosphere. Condensed moisture in the atmosphere can be either solid or liquid and creates clouds that affect both the incoming solar radiation and outgoing heat energy. As Legates (2014) discusses in more detail, precipitation is the Achilles' Heel of climate modeling: "... anything that is modeled incorrectly in a climate model will adversely affect the simulation of every other variable ... [and] incorrect simulations of the precipitation/condensation process necessarily will adversely affect the simulation of other aspects of the energy balance [of the model]." Currently, climate models simulate precipitation poorly since they generate rain too frequently with too little moisture (*i.e.*, light showers every day over most of the planet) do not exhibit the full range of precipitation-forming mechanisms that have been observed. Legates (2014) demonstrated that these impacts are not trivial—an error of only 0.1 inch in simulating liquid rainfall is equivalent to the energy required to heat the entire troposphere by 1.4°F, and models exhibit differences between the simulated and observed precipitation that can exceed 0.1 inch per day.

In this light, this paper will examine how climate model simulations of globally averaged air temperature trends grossly overestimate the observational data and provide some insight as to why. Overestimate of the climate model sensitivity to greenhouse gases and the general over-reliance on greenhouse gases as the predominant climate forcing mechanism both serve to yield greater-than-observed responses to changes in atmospheric greenhouse gas concentrations.

Climate Model Estimates of Warming

Every report issued by the United Nations Intergovernmental Panel on Climate Change (IPCC) focuses on the simulations by climate models (or so-called three-dimensional Atmosphere-Ocean General Circulation Models) to provide projections of future climate change. Results of these models are fundamental to assessing climate change resulting from a number of different scenarios projecting future greenhouse gas concentrations. Reliability of these models can only be assessed by how well they have simulated the past climate and how likely they are able to represent climate change in the future. For CMIP5 (the Coupled Model Intercomparison

Project, Phase 5), which evaluated the models used in the Fifth IPCC Assessment Report, more than twenty of these models were used to simulate the warming from 1979 through 2013. This period saw a rise in global temperatures beginning in 1979 and peaking in 1998 (an unusually warm year due to an unusually strong El Niño) with a plateau at a lower temperature for approximately the last 15 years (Figure 1). Over this period, nearly all climate models overestimated the observed trend in global air temperature (Figures 2 and 3), with only a couple of models having an average that was lower than the observed trend (plotted under the term “singleton” on Figure 2). In fairness to the climate models, natural fluctuations are difficult to predict, as many internal climate fluctuations (like the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation) are not well represented.



In the Fifth Assessment report, the assertion is that the models overestimate the temperature trend for the period from 1998 to 2012 but underestimate it between 1984 and 1998, so that the overall trend between from 1951 to 2012 is well simulated. But this illustrates a fundamental flaw in the climate models: namely, that they achieve a reasonable result for the wrong reasons. Models are usually tuned to match observational data (which by definition are from the past), so the “reasonable simulation” since 1951 is explicitly forced. The fact that they cannot simulate fluctuations in the climate on time scales of about fifteen years, however,

implies that their response is not appropriately driven by the climate forcings (natural and anthropogenic greenhouse gases plus other natural factors like solar and ocean current cycles) applied to them. If they cannot adequately resolve multi-decadal climate variability in the observational record, how can they possibly simulate the future for the next fifty to one hundred years?

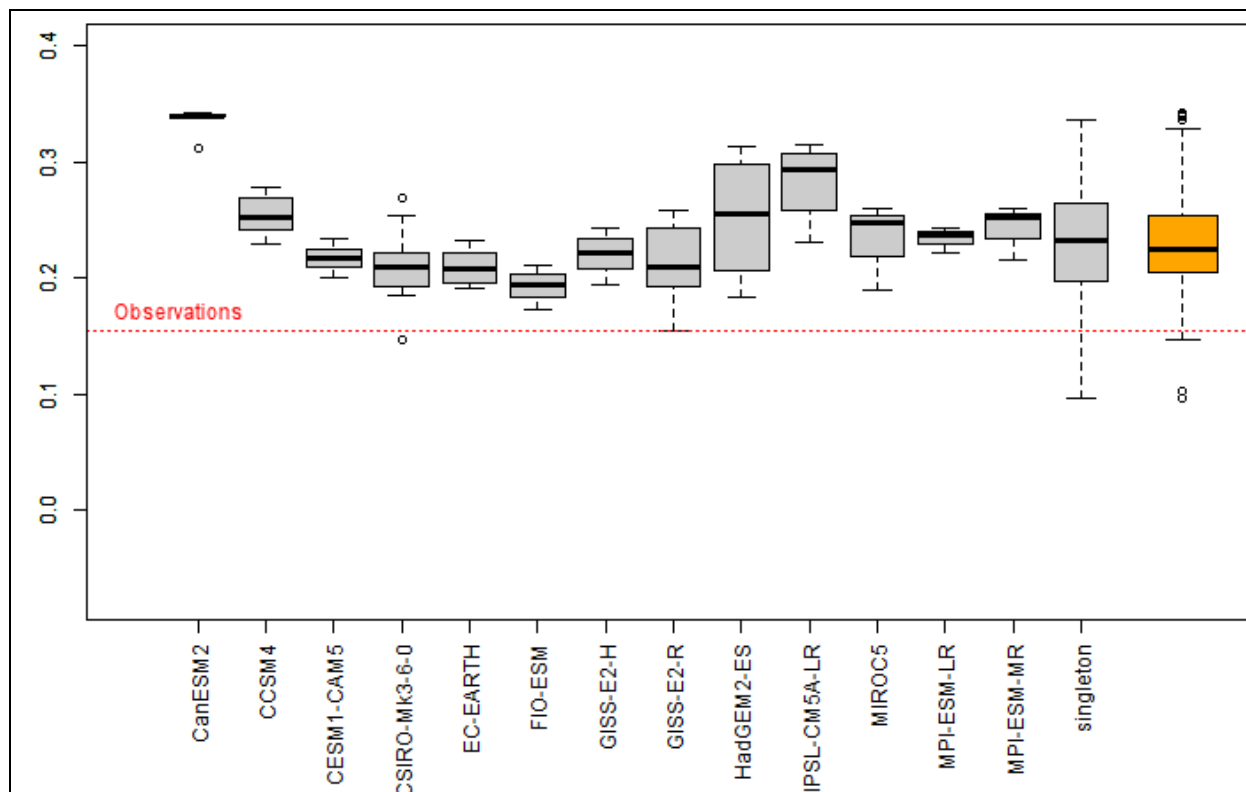
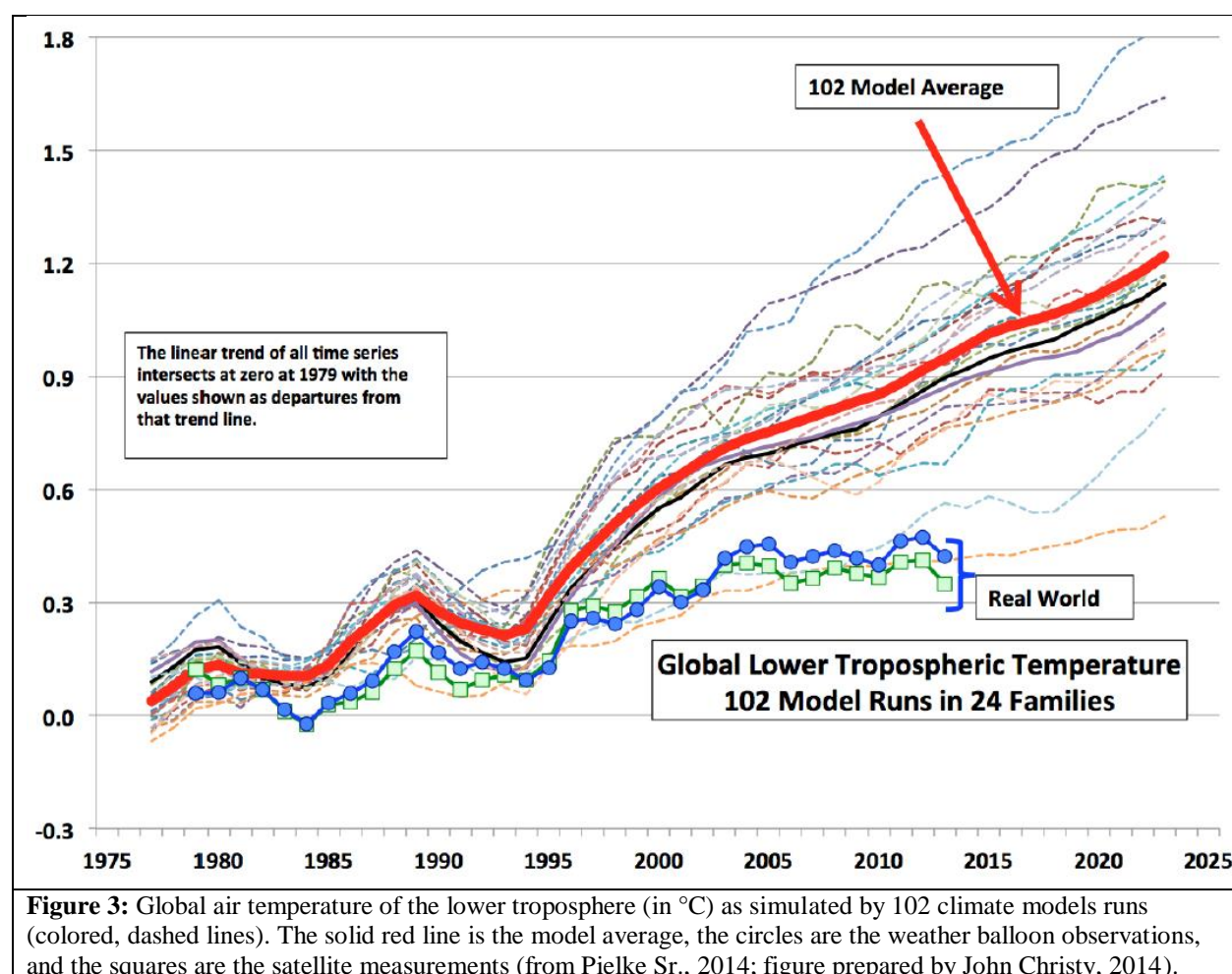


Figure 2: Temperature trends ($^{\circ}\text{C}$ per decade) for the 109 CMIP5 climate model simulations from 1979 to 2013. Models run more than once are plotted with a boxplot to indicate the median value (solid line), the central 50% (gray box – 25% of model runs are greater than the top of the box and 25% are less than the bottom of the box), and the 95% confidence intervals of the model runs (the dashed vertical lines connecting the small horizontal bars). Small circles represent results from the more extreme model runs. Models with only one simulation are agglomerated into the group marked “singleton”; the composite of all model runs is given in the orange boxplot. The horizontal red line indicates the trend from the observational data of the HadCRUT4 (Climate Research Unit, University of East Anglia, Norwich UK) database (Graph extracted from Lewis and Crok, 2014, and <http://climateaudit.org/2013/09/24/two-minutes-to-midnight/>)

In a recent paper, McKittrick and Vogelsang (2014) argued that for the tropical troposphere (TT), climate model prognostications exhibit a relatively constant upward trend with far too much warming over the period from 1958 to 2012 relative to observations from ground-based stations and weather balloon measurements. Moreover, the authors show that the data exhibit a “jump-discontinuity” around 1977 due to the Great Climate Shift (Seidel and Lanzante, 2004; Tsonis *et al.*, 2007) with no statistically significant trend before or after 1977. The lack of model efficacy in the TT is of critical importance because the TT is the location of the strongest feedbacks, the highest input of solar radiation, and the highest concentration of water vapor (Soden and Held, 2006). The importance of their finding is twofold: First, it uncovers a substantial disconnect between the TT as observed (from weather balloons and satellites) and the

TT as depicted by climate models, which purport to simulate the Earth’s climate. Second, it underscores the over-sensitivity of the models in simulating the effect of greenhouse gases. This paper and others that preceded it have raised substantial questions regarding the effect of carbon dioxide on human-induced climate change.

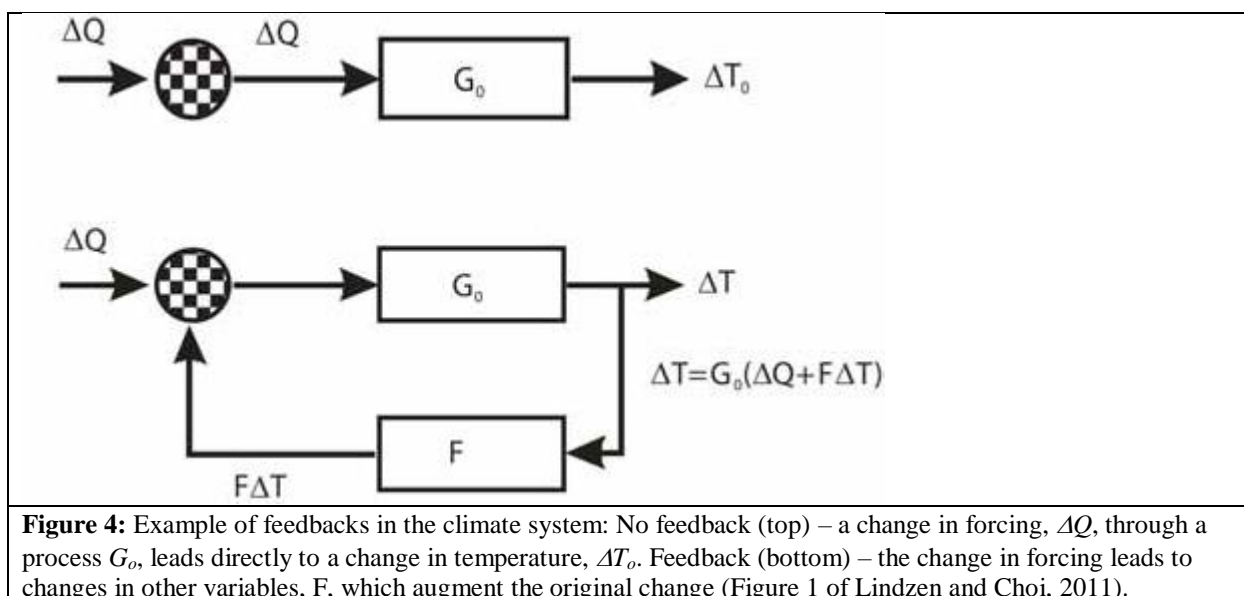
So why do the models tend to “run hot”? As Monckton *et al.* (2014) and others demonstrate, the equilibrium climate sensitivity of the models to greenhouse gas forcing exceeds observational estimates because the IPCC uses the mean of the observed temperature changes rather than calculating the average of the temperature response to changing greenhouse gases; that is, the assumption is that *all* temperature change can be attributed to greenhouse gases (see Roe, 2009). The key to answering this question, therefore, lies in the inherent temperature-feedback response to greenhouse gas forcing implied by each model. The range of this value determined from the CMIP5 models is significantly larger than it should be. Consequently, models tend to be more sensitive to changes in greenhouse gases and, when the models are forced by changes in greenhouse gas concentrations since 1950, they overestimate the changes in global air temperature.



Equilibrium Climate Sensitivity and the Transient Climate Response

Equilibrium climate sensitivity—the temperature response to a doubling of greenhouse gases ($^{\circ}\text{C}$ per doubling of carbon dioxide) relative to pre-industrial levels, when the Earth reaches an equilibrium temperature, the equilibrium involving the ocean-atmosphere system but not including melting of ice sheets or vegetative responses (Bindoff *et al.*, 2013)—is a key to understanding the limitations in model simulations of the temperature response to greenhouse gas forcing. Therefore, it makes sense to investigate it further. The warming will not occur immediately, and the warming over shorter periods is called the *transient climate response*.

It can be demonstrated that a doubling of carbon dioxide results in an increase of only about 1.0 to 1.2°C *in the absence of feedbacks* (see Torn and Harte, 2006; IPCC, 2007; Lindzen and Choi, 2011; Wilson and Gea-Banacloche, 2012). That is, if everything else were held constant, the global increase in air temperature would be about 1.0 to 1.2°C for a doubling of carbon dioxide. Feedbacks, the concept that a change in one variable can, by its effect on other variables that in turn affect the first, cause a greater (positive feedback) or diminished (negative feedback) change in that same variable, are prevalent in the climate system (see Figure 4). The IPCC asserts that a doubling of carbon dioxide will result in a much greater increase in global air temperature as a result of a net positive feedback in the climate system (*i.e.*, the effect of doubling will be greater due to other factors that will enhance the warming). Climate models are the tools by which the effect of these feedback processes are evaluated.



When these feedbacks are considered, the IPCC Fifth Assessment Report suggests a 90% level of confidence that the climate sensitivity lies between 1.2°C and 5.3°C (Bindoff *et al.*, 2013). However, they argue the upper limit is reduced to 3.6°C when a different (*i.e.*, Bayesian) method of statistics is used or to as low as 2.2°C when more data are included. However, the IPCC concludes “with *high confidence* that [equilibrium climate sensitivity] is *likely* in the range [of] 1.5°C to 4.5°C ” and adds, “feedbacks can lead to different, probably larger, warming than indicated ... on very long time scales” (italics in original; see Figure 5).

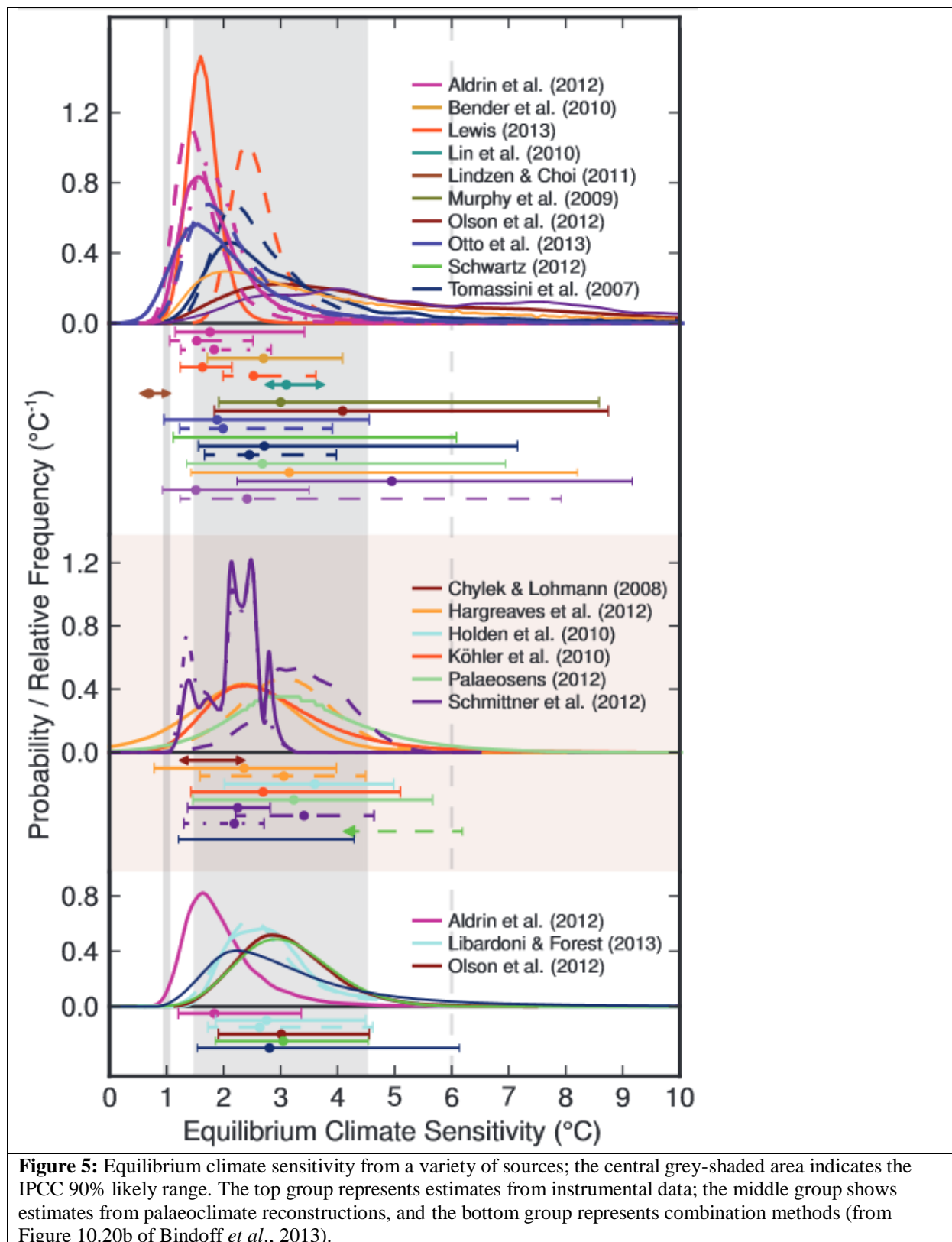
Recent research, however, has demonstrated that instead of a net positive feedback, the feedbacks are more likely to be negative. Idso (1998) documents a number of studies that suggest

a doubling of atmospheric carbon dioxide concentrations would raise the mean global air temperature by only 0.4°C. But Idso goes on to argue that even this modest estimate of warming may be too high due to a number of cooling factors and the carbon dioxide enrichment of the biosphere. As the tropics are important to climate variability and sensitivity, Spencer *et al.* (2007) investigated their impact on climate sensitivity. They found that the “increase in longwave cooling is traced to decreasing coverage by ice clouds”; in essence showing that a strong negative feedback exists whereby warming leads to a decreased coverage of high ice clouds, which, in turn, allows more heat energy to radiate to space. This supports the Lindzen *et al.* (2001) hypothesis of the Earth’s *adaptive infrared iris*. Using satellite estimates from the Earth Radiation Budget Experiment (ERBE), Lindzen and Choi (2009; 2011) concluded that outgoing heat energy increases with increasing sea surface temperatures, thereby providing a strong negative feedback and lower climate sensitivity. Bates (2012) further diagnosed that climate models overestimate the tropical feedback because they overestimate the positive feedback in the tropics, which is exacerbated by the poleward transport of heat.

The impact of the Spencer *et al.* (2007) and Lindzen and Choi (2009; 2011) studies was further quantified by Spencer and Braswell (2014). Using a simple one-dimensional climate model, they expanded on this earlier research to conclude that “feedbacks are largely concentrated in the tropics” and that the net effect of all feedbacks is negative, resulting in an estimate of equilibrium climate sensitivity of 1.3°C. If the model is driven by only anthropogenic and volcanic forcings, climate sensitivities were slightly less than those suggested by climate models. Their research was to consider ocean temperature changes, driven by the El Niño/Southern Oscillation (ENSO cycle), as an additional forcing of climate variability. Thus, Spencer and Braswell (2014) conclude “only with the inclusion of ENSO related radiative forcing ... could the lag relationship between satellite measured global oceanic radiative flux variations ... be reasonably well reproduced.” This implies that the observed climate sensitivity is driven by a larger proportion of ocean temperature fluctuations than argued by the IPCC (Bindoff *et al.*, 2013), which suggests that the IPCC overstates climate sensitivity to carbon dioxide changes.

Here is how it works. Before a warming (El Niño) event, cloud cover in the tropics *decreases*, allowing more solar radiation to reach the Earth’s surface. Conversely, cloud cover *increases* before a cooling (La Niña) event, thereby allowing less solar radiation to reach the Earth’s surface. This accounts for about one-third of the change in sea surface temperature. Since the cloud changes precede the warming or cooling (by about nine months), they are a cause of, and not a response to, the change in sea surface temperature.

However, the climate is never in equilibrium. The response to changes in forcing mechanisms is likely to be delayed. Thus, it is important to evaluate the transient climate response to added carbon dioxide. By the IPCC’s (2007) definition, the transient climate response is “the global annual mean surface air temperature change (with respect to a “control” run) averaged over a 20-year period centered at the time of carbon dioxide doubling in a 1% yr⁻¹ compound carbon dioxide increase scenario.” The transient response is necessarily less than the equilibrium sensitivity due to the delay in realizing the equilibrium response because of ocean heat storage.



The IPCC Fifth Assessment Report suggests with high confidence (“very likely”) that the transient climate response lies between 1°C and 2.5°C and that it is extremely unlikely it exceeds 3°C (Bindoff *et al.*, 2013). By contrast, the IPCC Fourth Assessment Report determined that the transient climate response was “very likely” to lie between 1°C and 3°C. However, this wide range covers the response of all of the CMIP5 climate models (Figure 6). Lewis and Crok (2014) argue that from the IPCC report, a best estimate of between 1.3° and 1.4°C can be determined.

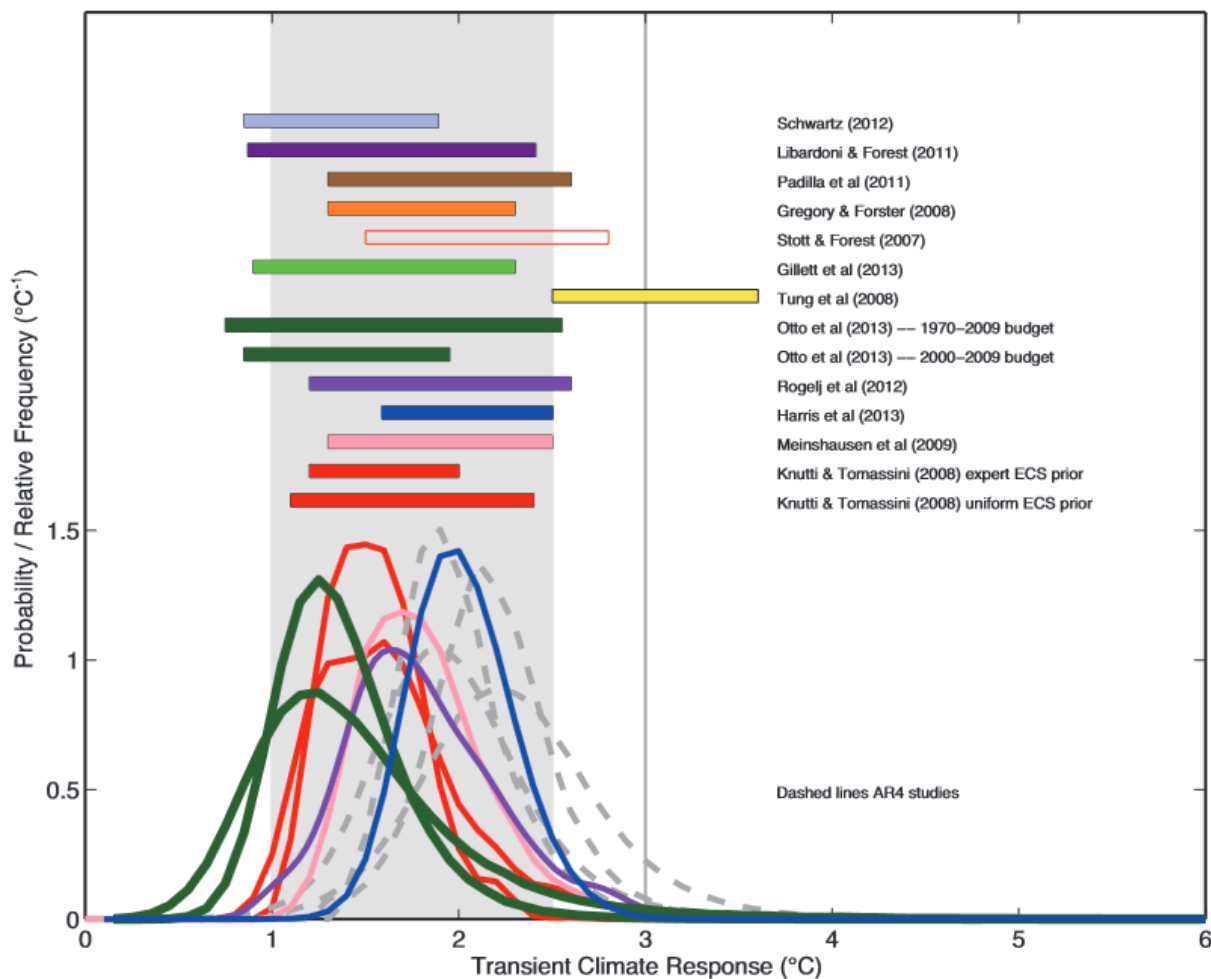


Figure 6: Examples of the distribution of the transient climate response from a number of sources; the central grey-shaded area indicates the IPCC 90% “very likely” range (from Figure 10.20a of Bindoff *et al.*, 2013).

Important studies more recent than those considered in the IPCC Fifth Assessment Report (2013) suggest strongly that the transient climate response lies near the low end of the range proffered by the IPCC. Schwartz (2012) used radiation transfer models and six data sets to estimate the forcing generated by greenhouse gases and aerosols over the Twentieth Century. He concluded that while the equilibrium sensitivities were commensurate with the IPCC specified range, the transient climate sensitivity ranged only from $0.86^{\circ}\text{C} \pm 0.04^{\circ}\text{C}$ to $1.91^{\circ}\text{C} \pm 0.15^{\circ}\text{C}$. Gillett *et al.* (2013) used a different dataset to evaluate the observed transient climate sensitivity and found a range from 0.7°C to 2.0°C . Similarly, Otto *et al.* (2013) used an assessment of the global energy budget and concluded that the best estimate of the transient climate response from 1970 to 2009 is 1.4°C with a range between 0.7°C and 2.5°C . This compares well with data from

the 1990s (1.6°C, 0.9 to 3.1°C) and from the latest decade (1.3°C, 0.9 to 2.0°C), although they argue that “because the most recent estimate has the strongest forcing and is less affected by the eruption of Mount Pinatubo in 1991, it is arguably the most reliable.” Figure 7 shows the average of these estimates along with their best estimate. These three analyses are quite robust, using more data than were available before.

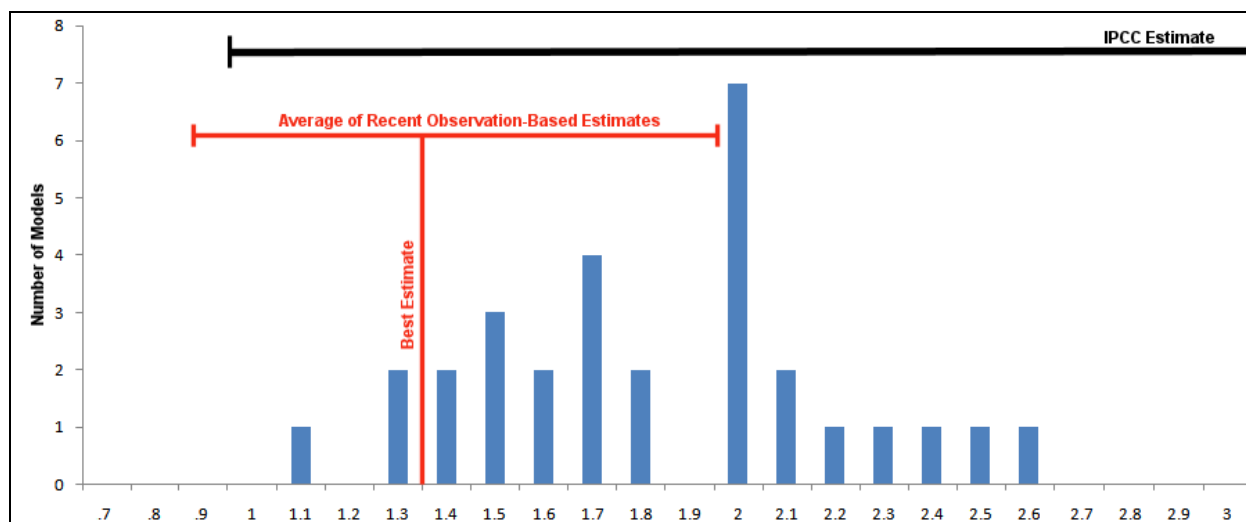


Figure 7: Transient climate response for thirty CMIP5 climate models (blue bars) compared with the best estimates from observational data (red line). From Figure 6 of Lewis and Crok (2014).

However, climate models yield substantially larger values of the transient climate response. A plot of the values obtained from the thirty CMIP5 climate models (Figure 7) show that while they are consistent with the IPCC estimate (derived from these models), they as a group tend to overestimate the transient climate response. Their values are, on average, about one third higher than the best estimate from observations. Again, the reason for this over-sensitivity is directly attributable to the assumption that all forcing over the observational record is due to carbon dioxide; as we have seen, variability in tropical clouds leading to increased ocean temperatures in the tropics can account for about a third of the observed warming, which implies that attributing all of the warming to increased carbon dioxide is mistaken and leads to overstating climate sensitivity.

Global Warming—Natural or Human-Induced?

In its Summary for Policymakers, the IPCC Fifth Assessment Report (2013) states “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia ... the atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.” The report suggests that natural processes play only a very small role in recent climate change and that the increase in greenhouse gases due to human sources is responsible for the “observed” climate disruption (a direct rise in global air temperatures with a concomitant change in precipitation and other climate variables and extremes—the enhanced greenhouse effect) and the dangerous scenarios that are posited for the future.

The rationale for anthropogenic global warming can be understood better by examining the Earth's energy budget. Of the total energy arriving at the top⁴ of the Earth's atmosphere, about 47% is absorbed by the Earth's surface while the atmosphere absorbs about 23% (Figure 8). While increases in greenhouse gases (*e.g.*, water vapor, carbon dioxide, and methane) have relatively little effect on the solar portion of the Earth's energy budget, they are strong absorbers of the outgoing longwave energy (*i.e.*, heat energy) emitted from Earth's surface toward space and are responsible for the "loop" between surface radiation and the atmospheric radiation absorbed by the surface (Figure 8). Note that about 90% of the outgoing longwave energy emitted from the surface is absorbed by the atmosphere. Thus, the Earth's atmosphere is relatively transparent to incoming solar radiation but relatively opaque to outgoing longwave (heat) energy.

At the heart of anthropogenic greenhouse-gas-induced global warming is the climate sensitivity issue discussed earlier. As greenhouse gases increase, more outgoing longwave energy should be absorbed by the atmosphere. However, the climate responds in numerous ways, and changes to greenhouse gases necessarily result in changes to other portions of the climate system including clouds and melting polar ice. Thus, the discussion really focuses on how much of an increase in global air temperature results from the increase in greenhouse gases.

In particular, those who expect anthropogenic global warming to be large and dangerous argue that the net feedbacks are positive. Warming leads to a greater potential for water vapor in the atmosphere (at saturation, the amount of water vapor in the atmosphere increases exponentially with increasing air temperature), which, because water vapor is the most important greenhouse gas, enhances the warming. Warmer temperatures lead to melting of polar ice, which uncovers darker land and open water, which absorb more heat and thereby enhance the warming. Clouds clearly are the wildcards in this scenario, because they affect both the absorption of longwave radiation (particularly at night) and the reflection of energy from the Sun during the day.

⁴ The top of the atmosphere is an academic construct and does not really exist; the atmosphere becomes thinner with altitude until it disappears. Scientists use this concept to separate energy in space from energy that is absorbed, reflected, or transmitted by the atmosphere.

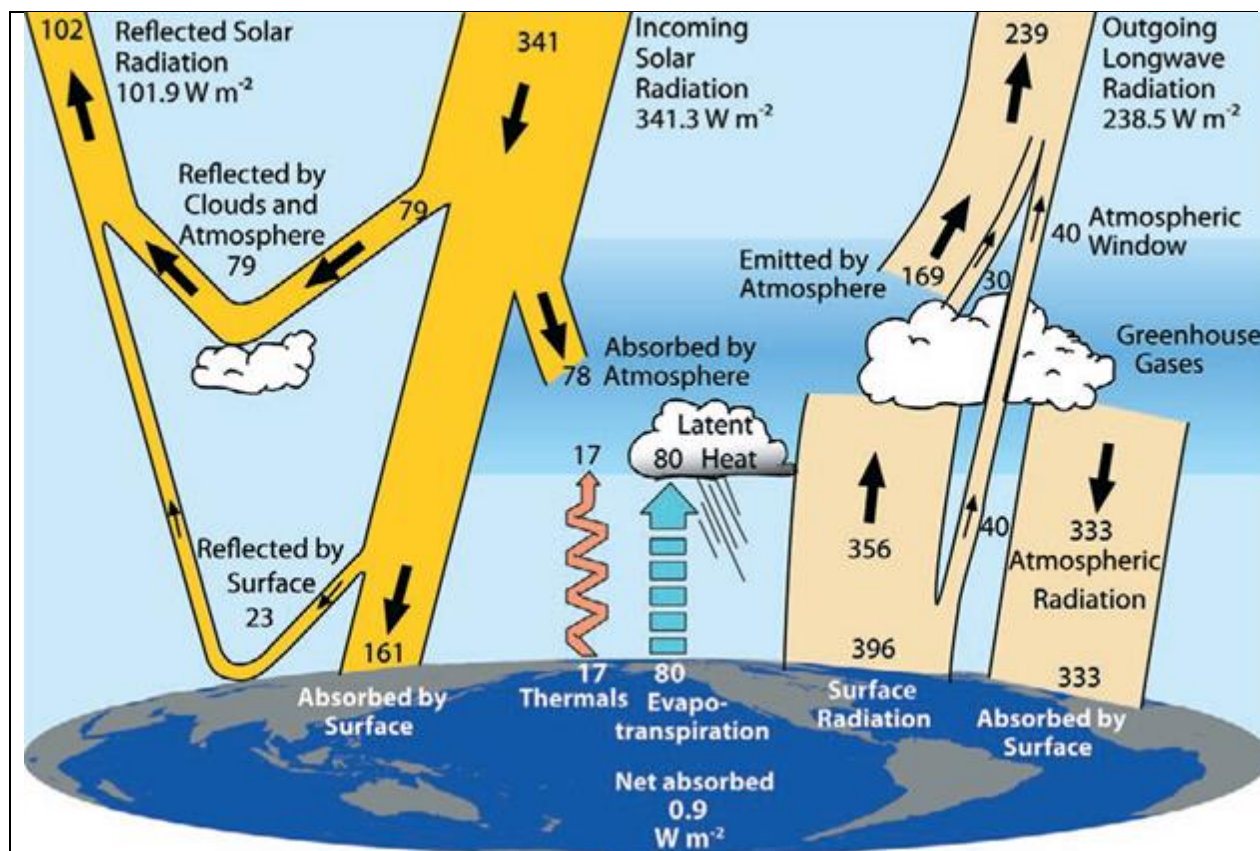


Figure 8: The mean annual energy budget for the Earth; units are in Watts per square meter and the arrows show the relative magnitude of each energy flow (from Trenberth *et al.*, 2009).

Aside from greenhouse gases, humans also affect the climate in a variety of other ways. It has long been known that an urban heat island effect exists (Figure 9)—that cities are warmer than the suburbs, which, in turn, are warmer than the surrounding rural areas (Landsberg and Maisel, 1972; Imhoff *et al.*, 2010). The problem lies in the fact that most weather stations were moved from downtown locations to the newly formed airports located in the rural areas outside of cities in the late 1940s and 1950s. Since then, urbanization has led to a substantial warming signal in our weather station network as sprawling cities have grown to encompass airports (see, for example, the history of Dulles Airport in Washington, D.C.). Urbanization also has led to changes in floods and droughts. Consider Talleyville, Delaware ($39.8089^{\circ}N$, $75.5489^{\circ}W$), where seventy years of changes in the landscape have led to a dramatically different environment (Figure 10). Trees and farmland have been replaced by a large suburban area. Droughts are more frequent, not because climate (including rainfall rates) has changed but because there are more people with an increased demand for water. Floods, too, are more frequent, again not because of climate change but because the concrete and asphalt leads to urban street flooding, which allows the rainwater to flow more efficiently into the nearby Brandywine Creek. Similarly, effects in coastal regions have been observed as a result of tourism, agriculture, and other human activities.

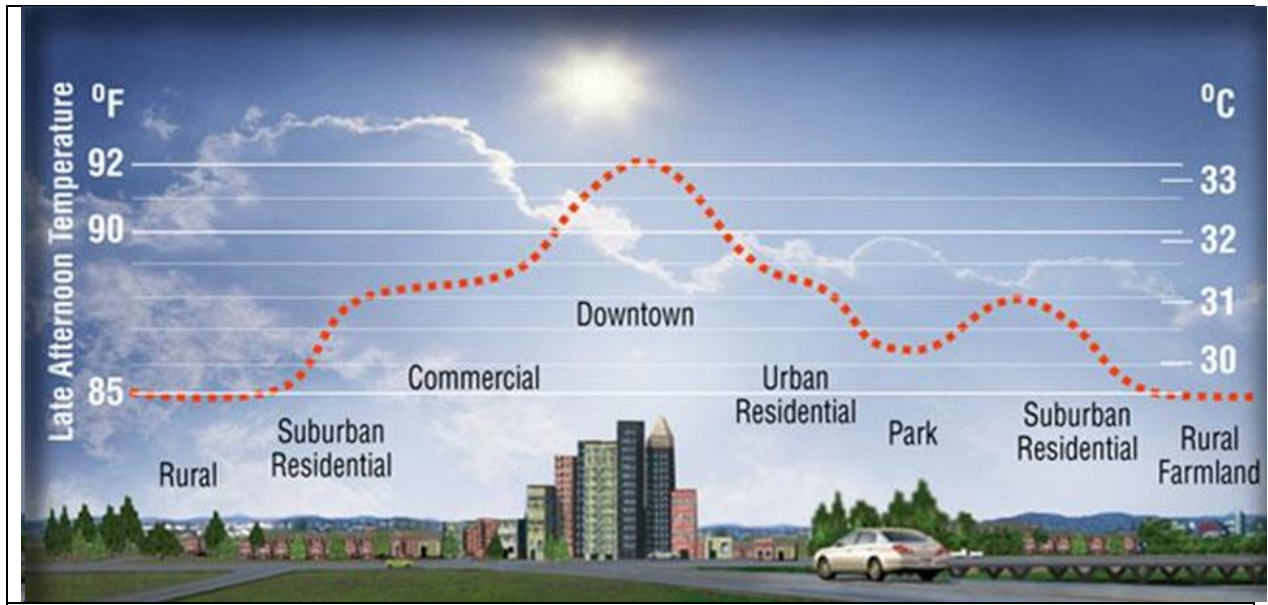


Figure 9: Hypothetical air temperature distribution for a cross-section through an urban area (from <http://heatisland.lbl.gov/>).

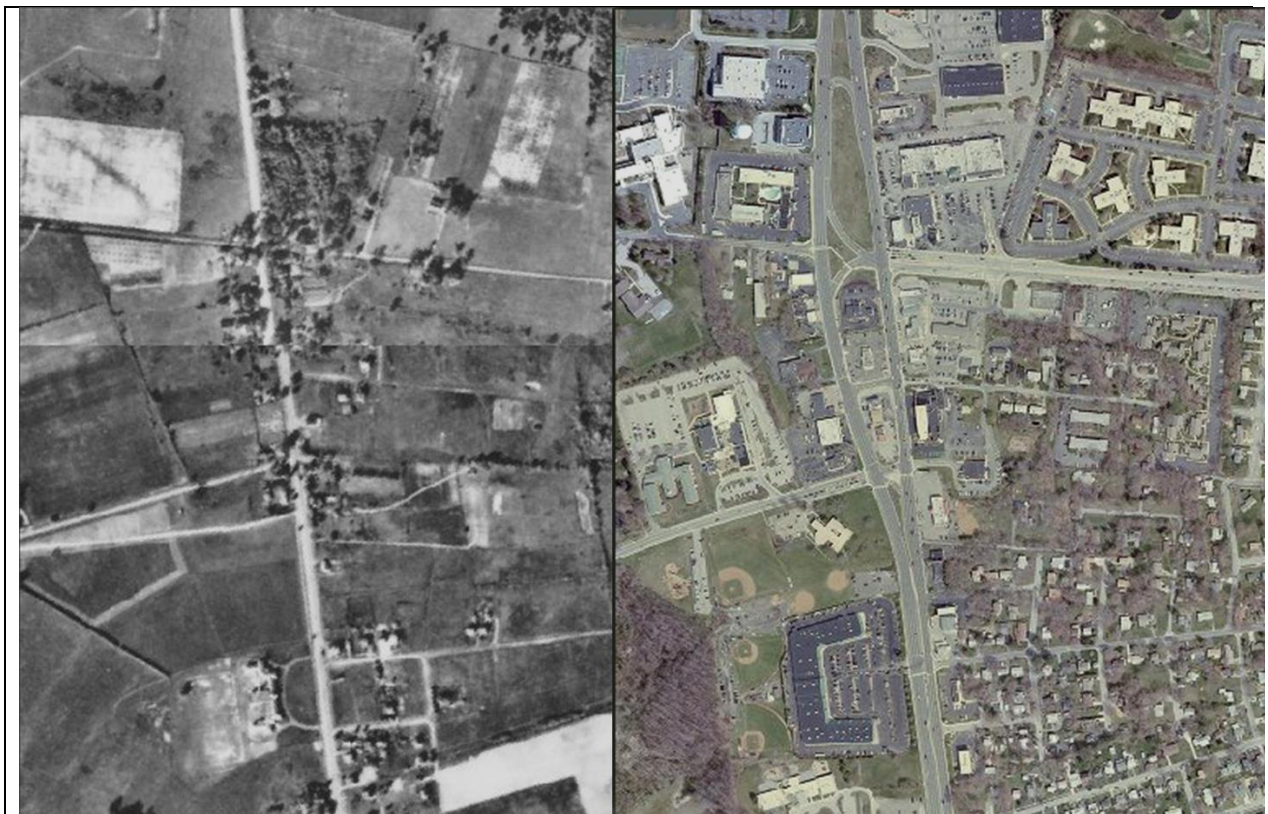


Figure 10: Talleyville, Delaware in 1937 (left) and 2007 (right).

Humans also have deforested large portions of developing countries (such as Brazil and Indonesia) and afforested other areas (such as the Eastern United States). In addition to the change in carbon dioxide from changing forested areas, forests generally are darker than the underlying land surface and so absorb more incoming solar energy. The forest canopy keeps the

surface cooler, however, and when the forests are removed, surface temperature tends to increase (Mahmood *et al.*, 2014). Moreover, changing concentrations of atmospheric aerosols (solid or liquid particles suspended in the atmosphere), tropospheric ozone and other pollutants, and even jet concentration trails (contrails, which consist of water vapor) also are attributable to human activity. It has been argued, for example, that the transient climate sensitivity to ozone and aerosols is “substantially greater” than the transient climate sensitivity to carbon dioxide (Shindell, 2014), and much interest has been generated over “global dimming” due to aerosols, pollutants, and contrails.

However, the climate has changed on a variety of timescales simply as a result of natural fluctuations and external forcings. As virtually all energy on the Earth arises from the Sun, it stands to reason that the Sun is a factor in climate change, both directly (due to fluctuations in solar output) and indirectly (through variability in Sun-Earth geometry). The Sun is a variable star, and its output changes on a variety of time scales from multidecades to millennia (see Soon and Legates, 2013; Soon *et al.*, 2014). To estimate total solar irradiance (*i.e.*, the 341.3 Wm^{-2} number in Figure 7), a number of different indices are considered, including the equatorial solar rotation rate, sunspot activity (*i.e.*, the number of sunspots and the number of sunspots without umbrae—the dark, central part of a sunspot), and the length and decay rate of the sunspot cycle (Hoyt and Schatten, 1993; Fontenla *et al.*, 2011; 2014). The Sun was more active during the Medieval Warm Period (*circa* 1075–1240 A.D.) and declined in intensity during the Spörer (*circa* 1420–1530 A.D.), Maunder (*circa* 1645–1715 A.D.), and Dalton (*circa* 1790–1820 A.D.) solar minima, the overall period largely coincident with the Little Ice Age. Recently, the Sun has become more intense, although some scientists are concerned that total solar irradiance has decreased during the last cycle, which might lead to cooling on Earth (Solheim *et al.*, 2012; Velasco Herrera *et al.*, 2014). Although solar irradiance has varied from about 340 to 342 Watts per square meter over just the last 150 years (Fontenla *et al.*, 2014), total solar irradiance explains very well the variability in (1) Arctic air temperatures (Soon, 2005), (2) tropical Atlantic Ocean sea surface temperatures (Soon, 2009), and (3) the Northern Hemisphere Equator-to-Pole air temperature gradient (Soon and Legates, 2013) over the last century (Figure 11).

Milutin Milanković, a Serbian astronomer, codified the impact of changes in Sun-Earth geometry into a series of three variables known as Milankovitch variables. These variables include (1) eccentricity (*i.e.*, the departure of the Earth’s orbit from that of a perfect circle) which varies at a period of about 100,000 years due to gravitational interaction with Jupiter and, to a lesser extent, Saturn, (2) obliquity (*i.e.*, the angle of the Earth’s axial tilt with respect to the plane of the Earth’s orbit) which varies at a period of about 41,000 years due to the “wobble” of the Earth (like a spinning top), and (3) precession (*i.e.*, the pattern of perihelion, the Earth’s closest approach to the Sun, as its occurrence progresses through the seasons) which varies at a period of about 26,000 years due to tidal forces from the Sun and the Moon. While these variables operate on time-scales much longer than those of changing anthropogenic greenhouse gas concentrations and they are not sufficient to explain the entire variability in climate throughout Earth’s history, they are nevertheless important climate change variables.

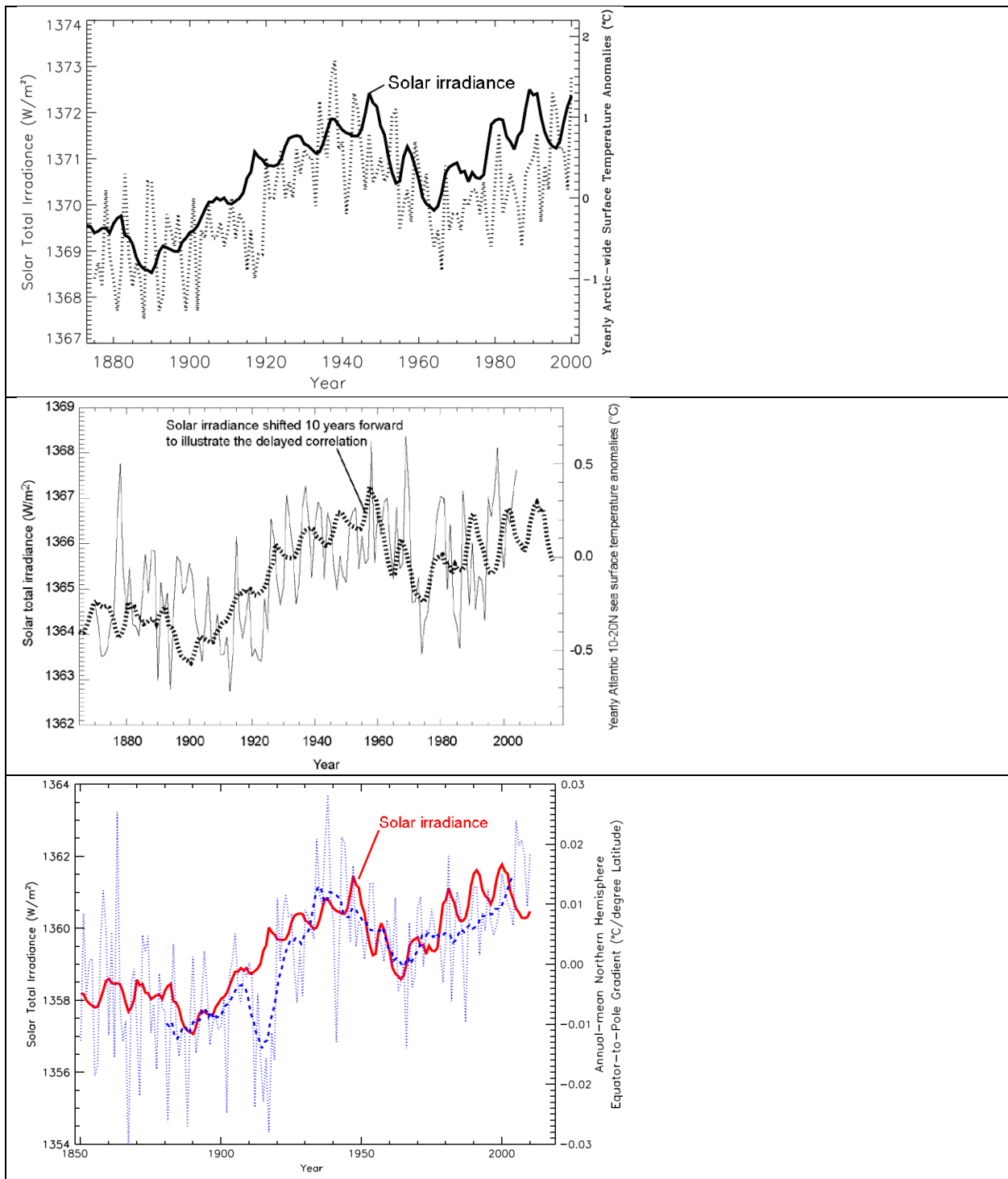


Figure 11: Total solar irradiance (identified on each plot) versus (a) Arctic-wide surface air temperature anomalies (dotted line; adapted from Soon, 2005), (b) tropical Atlantic Ocean (10°N-20°N) sea surface temperature anomalies (thin solid line; Soon, 2009), and (c) the annual mean Northern Hemisphere Equator-to-Pole air temperature gradient (dotted blue lines with smoothing; adapted from Soon and Legates, 2013). Total solar irradiance here is presented as the solar constant, which is four times the value shown on Figure 8.

A final possibility regarding natural climate variability arises from internal variations of the climate system itself. The oceans and the atmosphere never reach a state of equilibrium, and

they often toggle or “oscillate” from one solution to another. A well-known example is the ocean warming/cooling in the central Pacific Ocean called El Niño/La Niña. It is coupled with an oscillation of pressures between central Australia and the central Pacific Ocean called the Southern Oscillation, such that the combined events are referred to as ENSO events. There are many others including the Pacific Decadal Oscillation (PDO) in the northern Pacific and the Atlantic Multidecadal Oscillation (AMO) in the northern Atlantic. Both have been linked to rainfall and droughts in the United States (Enfield *et al.*, 2001; McCabe *et al.*, 2004; 2008), and the AMO is responsible for multidecadal-scale variations in Atlantic tropical cyclone activity (Goldenberg *et al.*, 2001; Zhang and Delworth, 2006) as well as rainfall in the African Sahel region and the Indian Subcontinent (Zhang and Delworth, 2006). In essence, variability in the AMO is related to the migration of warm, equatorial waters poleward via surface ocean currents (primarily the Gulf Stream), where they then cool and so sink into the deep ocean at the high-latitude convection regions around the northern North Atlantic Ocean, from whence they flow back to the south—the whole process called the Thermohaline [heat/salt] Circulation. Warm phases of the AMO represent more poleward transport of energy, whereas cold phases represent less.

Climate oscillations are not limited to the oceans, however. The atmosphere also undergoes these oscillations of atmospheric pressure, such as the North Atlantic Oscillation (NAO) and the Pacific/North American Teleconnection Pattern (PNA). These phenomena often affect winter weather conditions in North America and Europe. In addition, the atmosphere exhibits a type of “thermostatic control” (Sud *et al.*, 1999) whereby changes in cloud cover in the tropics serve to maintain a relatively constant sea surface temperature. This idea, developed by Lindzen *et al.* (2001) into the “adaptive infrared iris” theory, argues that as the sea surface temperature of the eastern Pacific Ocean increases, the upper-level cirrus cloud coverage decreases, allowing more longwave energy (“heat”) to escape to space and thus cooling the surface. Spencer *et al.* (2008) corroborated this theory, which Lindzen and Choi (2011) later extended to include a similar response for the entire tropics.

The key question surrounding the climate change debate is, “To what extent is carbon dioxide responsible for climate changes, in light of these other natural sources of climate variability?” Given the research cited here, the climate system appears to be highly resilient, and the large values of climate sensitivity to greenhouse gases suggested by the climate models are not difficult to reconcile with real-world observations. Lewis and Crok (2014) conclude their survey of the relevant peer-reviewed literature by saying that the “observationally-based “likely” range [of equilibrium climate sensitivity] could be 1.25–3.0°C, with a best estimate of 1.75°C.” The Nongovernmental International Panel on Climate Change (NIPCC) (Idso *et al.*, 2013) concludes its similar survey by saying, “Climate models generally assume a climate sensitivity of 3°C for a doubling of carbon dioxide above preindustrial values, whereas meteorological observations are consistent with a sensitivity of 1°C or less.” Either of these conclusions is more defensible than the IPCC’s 1.5°C–4.5°C range, and both suggest that there is less need, if any, to mitigate future warming by reducing emissions of carbon dioxide, particularly in light of the high costs of doing so—costs that will fall particularly on the world’s poor. Climate variability is largely driven by natural, external forcings and internal fluctuations of the climate system. Although the effect of greenhouse gases cannot be ignored, it does appear that greenhouse gases are relatively minor players in observed changes to our climate. In addition, anthropogenic changes other than greenhouse gases can cause large changes to the local environment but often serve to mask the actual effect of these gases.

Summary

As Christians, we are exhorted both to “Test all things, hold fast what is good” (1 Thessalonians 5:21) and to be good stewards of our environment (Genesis 1:26–28; 2:15)—especially when millions on the planet are without clean water, adequate sanitation, and affordable energy. We certainly do not want to squander precious resources or harm our environment, but neither do we want to waste our time and efforts to “solve” non-problems. An examination of the science shows that the sensitivity of our planet to greenhouse gases is not as large as the climate models indicate, and, indeed, higher levels of carbon dioxide are beneficial to life on Earth, since plants grow better in response to more carbon dioxide. Climate change is both natural and human-induced and has always occurred, since climate is not simply “average weather”; it is dynamic and variable. The evidence shows that much of the climate variability we see is attributable to natural climate fluctuations with a small contribution of rising global air temperatures due to changes in anthropogenic carbon dioxide concentrations.

Proponents of efforts to mitigate climate change often appeal to the “Precautionary Principle,” which was set forth in Principle #15 of the Rio Declaration in 1992: “In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities ... where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” In light of that, we are urged to take draconian action to avert climate change even if scientific proof that a problem exists is lacking or the efficacy of recommended remedies is unproven. But we must also remember the Corollary to the Precautionary Principle: “Action to abate climate change, either natural or human-induced, shall not be taken until it can be demonstrated that the proposed response will (1) effect a positive remedy to the issue at hand and (2) not have adverse impacts that will create new problems or exacerbate existing ones.” We believe attempts to reduce climate change will increase the cost of providing electricity to the over 1 billion people in the world who now lack it, thus prolonging their dependence on wood, dried dung, and other biomass as principal heating and cooking fuels, which in turn causes hundreds of millions of upper respiratory diseases and over 4 million premature deaths annually in the developing world, primarily among women and young children (World Health Organization, 2014). We cannot forget the world’s poorest citizens, who will be the hardest hit by the severe energy restrictions imposed by climate “stabilization” efforts.

References

- Bindoff, N.L., P.A. Stott, K.M. AchutaRao, M.R. Allen, N. Gillett, *et al.* (2013). Detection and attribution of climate change: From global to regional. In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [T.F., Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, *et al.* (eds.)]. Cambridge University Press, Cambridge, UK.
- Enfield, D.B., A.M. Mestas-Núñez, and P.J. Trimble (2001). The Atlantic multidecadal oscillation and its relationship to rainfall and river flows in the continental U.S. *Geophysical Research Letters*, **28**:2077-2080.
- Fontenla, J.M., J. Harder, W. Livingston, M. Snow, and T. Woods (2011). High-resolution solar spectral irradiance from extreme ultraviolet to far infrared. *Journal of Geophysical Research*, **116**, D20108.
- Fontenla, J.M., E. Landi, M. Snow, and T. Woods (2014). Far- and extreme-UV solar spectral irradiance and radiance from simplified atmospheric physical models. *Solar Physics*, **289**:515-544.
- Gillett, N.B., V.K. Arora, D. Matthews, and M.R. Allen (2013). Constraining the ratio of global warming to cumulative CO₂ emissions using CMIP5 simulations. *Journal of Climate*, **26**:6844-6858.

- Goldenberg, S.B., C.W. Landsea, A.M. Mestas-Nuñez, and W.M. Gray (2001). The recent increase in Atlantic hurricane activity: Causes and implications. *Science*, **293**:474-479.
- Hoyt, D.V., and K.H. Schatten (1993). A discussion of plausible solar irradiance variations, 1700-1992. *Journal of Geophysical Research*, **98**(A11):18,895-18,906.
- Idso, C.D., R.M. Carter, S.F. Singer, *et al.* (2013). *Climate Change Reconsidered II: Physical Science—Summary for Policymakers*. Report of the Nongovernmental International Panel on Climate Change.
- Idso, S.B. (1998). CO₂-induced global warming: A skeptic's view of potential climate change. *Climate Research*, **10**:69-82.
- Imhoff, M.L., P. Zhang, R.E. Wolfe, and L. Bounoua (2010). Remote sensing of the urban heat island effect across biomes in the continental USA. *Remote Sensing of Environment*, **114**:504-513.
- Intergovernmental Panel on Climate Change (2007). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK and New York NY (USA).
- Intergovernmental Panel on Climate Change (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK and New York NY (USA).
- Landsberg, H.E., and T.N. Maisel (1972). Micrometeorological observations in an area of urban growth. *Boundary Layer Meteorology*, **2**:365-370.
- Legates, D.R. (2014). Precipitation: The *Achilles' Heel* of climate models? *Energy & Environment*, forthcoming.
- Lewis, N., and M. Crok (2014). *A Sensitive Matter: How the IPCC buried evidence showing good news about global warming*. The Global Warming Policy Foundation, GWPF Report 13, London, UK.
- Lindzen, R.S., and Y.-S. Choi (2009). On the determination of climate feedbacks from ERBE data. *Geophysical Research Letters*, **36**, L16705.
- Lindzen, R.S., and Y.-S. Choi (2011). On the observational determination of climate sensitivity and its implications. *Asia-Pacific Journal of Atmospheric Science*, **47**:377-390.
- Lindzen, R.S., M.-D. Chou, and A.Y. Hou (2001). Does the Earth have an adaptive infrared iris? *Bulletin of the American Meteorological Society*, **82**:417-432.
- Mahmood, R., R.A.S. Pielke, *et al.* (2014). Land cover changes and their biogeophysical effects on climate. *International Journal of Climatology*, **34**:929-953.
- McCabe, G.J., M.A. Palecki, and J.L. Betancourt (2004). Pacific and Atlantic Ocean influences on multidecadal drought frequency in the United States. *Proceedings of the National Academy of Sciences*, **101**(12), 4136-4141.
- McCabe, G.J., J.L. Betancourt, S.T. Gray, M.A. Palecki, and H.G. Hidalgo (2008). Associations of multi-decadal sea-surface temperature variability with US drought. *Quaternary International*, **188**:31-40.
- McKittrick, R.R., and T.J. Vogelsang (2014). HAC robust trend comparisons among climate series with possible level shifts. *Environmetrics*, in press.
- Monckton, C. of Brenchley, W. Soon, D.R. Legates, and W. Briggs (2014). Why models run hot: Results from an irreducibly simple climate model. *Chinese Science Bulletin*, submitted.
- Otto, A., F.E.L. Otto, O. Boucher, J. Church, G. Hegerl, *et al.* (2013). Energy budget constraints on climate response. *Nature Geoscience*, **6**:415-416.
- Pielke, R.A. Sr. (2014). Testimony to the U.S. House Committee on Science, Space and Technology, May 29, 2014.
- Roe, G. (2009). Feedbacks, timescales, and seeing red. *Annual Review of Earth and Planetary Sciences*, **37**:93-115.
- Schwartz, S.E. (2012). Determination of Earth's transient and equilibrium climate sensitivities from observations over the Twentieth Century: Strong dependence on assumed forcing. *Surveys in Geophysics*, **33**(3-4):745-777.
- Seidel, D.J., and J.R. Lanzante (2004). An assessment of three alternatives to linear trends for characterizing global atmospheric temperature changes. *Journal of Geophysical Research*, **109**(D14108).
- Shindell, D.T. (2014). Inhomogeneous forcing and transient climate sensitivity. *Nature Climate Change*, **4**(4):274-277.
- Soden, B.J., and I.M. Held (2006). An assessment of climate feedbacks in coupled ocean-atmosphere models. *Journal of Climate*, **19**(14):3354-3360.
- Solheim, J.-E., K. Stordahl, and O. Humlum (2012). The long sunspot cycle 23 predicts a significant temperature decrease in cycle 24. *Journal of Atmospheric and Solar-Terrestrial Physics*, **80**:267-284.
- Soon, W. (2005). Variable solar irradiance as a plausible agent for multidecadal variations in the Arctic-wide surface air temperature record of the past 130 years. *Geophysical Research Letters*, **32**(L16712).

- Soon, W. (2009). Solar Arctic-mediated climate variation on multidecadal to centennial timescales: Empirical evidence, mechanistic explanation, and testable consequences. *Physical Geography*, **30**(2):144-184.
- Soon, W., and D.R. Legates (2013). Solar irradiance modulation of Equator-to-Pole (Arctic) temperature gradients: Empirical evidence for climate variation on multi-decadal timescales. *Journal of Atmospheric and Solar-Terrestrial Physics*, **93**(1):45-56.
- Soon, W., V.M. Velasco Herrera, *et al.* (2014). A review of Holocene solar-linked climatic variation on centennial to millennial timescales: Physical processes, interpretative frameworks and a new multiple cross-wavelet transform algorithm. *Earth-Science Reviews*, **134**:1-15.
- Spencer, R.W., and W.D. Braswell (2014). The role of ENSO in global ocean temperature changes during 1955-2011 simulated with a 1D climate model. *Asia-Pacific Journal of Atmospheric Science*, **50**(2):229-237.
- Spencer, R.W., W.D. Braswell, J.R. Christy, and J. Hnilo (2007). Cloud and radiation budget changes associated with tropical intraseasonal oscillations. *Geophysical Research Letters*, **34**, L15707.
- Sud, Y.C., G.K. Walker, and K.-M. Lau (1999). Mechanisms regulating deep moist convection and sea-surface temperatures in the tropics. *Geophysical Research Letters*, **26**(8):1019-1022.
- Torn, M.S., and J. Harte (2006). Missing feedbacks, asymmetric uncertainties, and the underestimation of future warming. *Geophysical Research Letters*, **33**, L10703.
- Tsonis, A.A., K.L. Swanson, and S. Kravtsov (2007). A new dynamical mechanism for major climate shifts. *Geophysical Research Letters*, **34**(L13705).
- Trenberth, K.E., J.T. Fasullo, and J.T. Kiehl (2009). Earth's global energy budget. *Bulletin of the American Meteorological Society*, **90**(3):311-323.
- Velasco Herrera, V.M., B. Mendoza, and G. Velasco Herrera (2014). Reconstruction and prediction of the total solar irradiance: From the Medieval Warm Period to the 21st Century. *New Astronomy*, forthcoming.
- Wilson, D.J., and J. Gea-Banacloche (2012). Simple model to estimate the contribution of atmospheric CO₂ to the Earth's greenhouse effect. *American Journal of Physics*, **80**(4):306-315.
- World Health Organization (2014). "Household air pollution and health," Fact Sheet No. 292.
- Zhang, R., and T.L. Delworth (2006). Impact of Atlantic multidecadal oscillations on India/Sahel rainfall and Atlantic hurricanes. *Geophysical Research Letters*, **33**, L17712.

Chapter 2

Climate Policy, Economics, and the Poor

G. Cornelis van Kooten, Ph.D.

Professor of Economics and Canada Research Chair in Environmental Studies
University of Victoria, Victoria, British Columbia, Canada

I was a reluctant contributing author of the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4)—reluctant because, after having been a reviewer of the Third Assessment Report (TAR), putting in quite a bit of time and then being totally ignored, I viewed the process as too political. I contributed to a chapter (Forestry) on mitigation in AR4 because I had written some of the seminal papers (van Kooten et al. 1995, 2004; van Kooten and Sohngen 2007). In our discussions pertaining to the chapter, several authors made some strong points against the use of terrestrial carbon sequestration for mitigating climate change, because the related forest activities were considered a waste of money, leading to corruption, and actually providing disincentives to countries and large emitters to reduce CO₂ emissions (see van Kooten 2013), although these views did not appear in the chapter.

My early work on climate problems focused primarily on forestry, both in terms of adaptation and mitigation, from the perspective of a forest/agricultural economist and forest management specialist since 1985. I am familiar with large nonlinear models, how they can be solved, problems with interpretation, etc. I have built and solved (and not solved) forest management and land-use models with millions of equations (e.g., van Kooten et al. 2014). These models are extremely sensitive to starting conditions and the parameters one employs. I subsequently wrote a book in 2004 entitled *Climate Change Economics: Why International Accords Fail*, based on my experience in dealing with forest carbon offsets and Canada's attempt to base more than a third of its Kyoto target CO₂ reductions on carbon sequestration (van Kooten 2004).

I first looked at the broader problem of climate change when, in 2007, I was asked to teach climate economics in a new Climate Studies minor in the Faculty of Social Sciences at my university. My efforts culminated in a book for the course, *Climate Change, Climate Science and Economics: Prospects for an Alternative Energy Future* (van Kooten 2013). I was influenced to write the book because of attacks on my person and subsequent discussions with Dr. Ross McKittrick, now Professor of Economics and Chair in Sustainable Commerce at the University of Guelph, on whose Ph.D. committee I had served. By now I have encountered a significant number of scientists and others who have been personally attacked and even threatened with violence for their contrarian views on climate change, and even more scientists who have such views but keep them to themselves. Indeed, there are likely as many on my own university campus who are skeptical about the human origins of supposed global warming as there are who support the so-called consensus—though my university is noted for its climate scientists who

assert anthropogenic origins of global warming.

In preparation for my course, I read much of what McKittrick had written (McKittrick 2011; McKittrick and Michaels 2007; McKittrick and Nierenberg 2010; McKittrick and Vogelsang 2014), read books and material on climate modeling (e.g., McGuffie and Henderson-Sellers 2009; Pruppacher and Klett 1997; Spencer 2010), read the papers supporting the infamous “hockey stick” graph, constructed my own paleoclimatic, instrumental, and satellite temperature series, examined data on CO₂ emissions, studied up on energy, and read many, many other papers and books related to climate change. I talked to statisticians, mathematicians, and physicists. (I also have a B.Sc. in Physics.) I came away with the feeling that the IPCC story was not the only one out there. Closer research led me to question certain shibboleths, and it was when I got closer to the truth that I began to encounter opposition.

The problem is simply this: If you want to determine appropriate economic policy for addressing climate change—the costs and benefits of whether to mitigate climate change—you need to know something about the science of climate change. What follows is a brief discussion of my findings and how they affect economic policy recommendations. (For further details on the science of climate change, see climatologist Dr. David Legates’s section of this joint paper, and the science sections, by climatologist Dr. Roy W. Spencer and Dr. Legates, in the Cornwall Alliance’s previous two major papers, *A Call to Truth, Prudence, and Protection of the Poor: An Evangelical Response to Global Warming* (Beisner et al. 2005) and *A Renewed Call to Truth, Prudence, and Protection of the Poor: An Evangelical Examination of the Theology, Science, and Economics of Global Warming* (Mitchell et al. 2010). Here I raise only issues that specifically contributed to the development of my views on the economics of climate policy.)

Climate Change Science and Economics

Finding Anthropogenic Climate Change

The IPCC is charged with understanding the risk underlying human-caused climate change from the perspective of the latest available science. Therefore, its priority is to discover the extent to which humans are responsible for climate change, and only secondarily the best means to mitigate humanity’s role in causing climate change. Of course, the latter of these presupposes that climate change is both anthropogenic and bad. In that case, a third task of climate research is to determine the cost of permitting climate change to continue unabated. Lastly, and only as an afterthought, does the IPCC examine possible strategies for adapting to climate change, although, as indicated below, the best strategy may well be to do nothing about climate change itself but rather to focus on reducing global poverty by encouraging economic growth, thus enabling people to adapt successfully. Economic growth can only occur if those living in developing countries have access to abundant and inexpensive energy (e.g., see Prins et al. 2010). Unfortunately, given the current mandate of the IPCC, natural causes of climate change are generally ignored, despite being the proverbial “elephant in the room.”

The IPCC’s Third Assessment Report relied heavily on the “hockey stick” graph to make the case that humans were responsible for global warming. That graph depicts global temperatures as remaining relatively constant over a period of 1,500 to 2,000 years (or even longer), followed by a rapid rise beginning in the 20th century. The long period of constant temperatures constitutes the “shaft,” and the recent temperature increase the “blade” of the hockey stick. The climate scientists did away with the Medieval Warm Period (MWP) and Little

Ice Age (LIA), explaining them as local phenomena despite anthropological and other evidence to the contrary (Singer and Avery 2007). Some scientists, committing the causal fallacy of *post hoc, ergo propter hoc* (after this, therefore because of this), concluded from the correlation between rising emissions and concentrations of atmospheric CO₂ and rising temperature that human emissions of CO₂ caused the temperature increase. It seemed not to matter that the increase in temperatures and the rise in atmospheric CO₂ concentration were weakly correlated, so there was no straightforward cause and effect.

But a more sinister plot appeared in the hockey stick story. The hockey stick relied on a “trick,” namely, ending paleoclimatic temperature proxies (reconstructions based on lake sediment, ice core, and tree ring data) in the 1970s and switching to instrumental surface temperature data for the post-1970s period. Why was this done? It was done to ensure that the temperature increase appeared to be unabated—to hide the fact that the paleoclimatic proxies *declined* after 1970. This meant that the authors of the graph were comparing apples and oranges. It also undermined their faith in the reliability of the paleoclimatic proxies for the pre-1970 period; if they were not to be believed for post-1970, why for pre-1970? I had discovered the “hide the decline” on my own, and, while puzzling over it, found that others had also found it (including most notably Richard Muller of UC Berkeley, who is a noted anthropogenic climate change proponent).

The hockey stick was a very clever device for showing the supposed link between human activity and temperatures. The concentration of CO₂ in the atmosphere was flat until it began to rise at the time of the Industrial Revolution. If temperatures were shown to follow the same trend, then, presto, you apparently had found the human link to climate change. Unfortunately, as I demonstrate elsewhere, the science underlying the hockey stick is shoddy at best (van Kooten 2013, pp.71–95; see also Wegman et al. 2006; National Research Council 2006; McIntyre and McKittrick 2005).

The 2007 Fourth Assessment Report (AR4) no longer relied on the hockey stick to make the case that warming was the result of human activities. Rather, AR4 relied on the results of climate models themselves. The justification is provided on p. 684 of the Physical Science Basis volume. In Figure 9.5 of the report, two simulations are provided. The first consists of 19 temperature simulations from five climate models for the period 1900–2005 with only natural forcings included. The second consists of 58 simulations from 14 climate models for the same period, but now including both the natural and anthropogenic forcings. The ensemble of mean temperatures in the second case (which includes the anthropogenic forcings) tracks actual average global temperatures relatively closely, while modeled mean temperatures without anthropogenic forcings are below actual mean temperatures for 1900–2005. The IPCC concludes that this is clear evidence that human emissions of CO₂ are driving temperature increase. The same approach was subsequently used in the 2013 Fifth Assessment Report (AR5).

There are some problems with this approach. Outcomes from one set of model runs are compared to outcomes from another set of model runs. In my view, such a comparison is not valid. First, outcomes from two different sets of climate models are used in making the comparison. Further, by parameterizing (assigning ad hoc values to) enough variables it is always possible to get models to reproduce, fairly closely, a known, targeted set of data. What the modelers have not been able to show is that the ad hoc values they have assigned are accurate representations of the real world. This is problematic because models that track the past tolerably well are usually poor at predicting the future. This is evidenced in the case of climate change by the fact that models that have been parameterized to track past temperatures have not been able

to forecast future temperatures with any degree of accuracy. This is shown by the large deviation between model projections of future temperatures and real-world observations for the period 1979 to 2014 (Figure 1). However, in the AR4 and AR5 reports, even the parameterized models used to illustrate the impact of anthropogenic forcings are different. Thus, the IPCC case that warming is human caused is scientifically highly suspect.

But the use of models to demonstrate that humans are responsible for climate change is simply bad science. As noted by the Institute of Forecasters in a forensic audit of climate models (see van Kooten 2013, pp. 140–142), the climate models have never been validated and are simply unreliable. For example, McKittrick (personal communication) found that, with the exception of three climate models, they tended to perform rather badly. The only three to track/predict temperatures reasonably well were the National Center for Atmospheric Research (NCAR), Russian, and Chinese models.

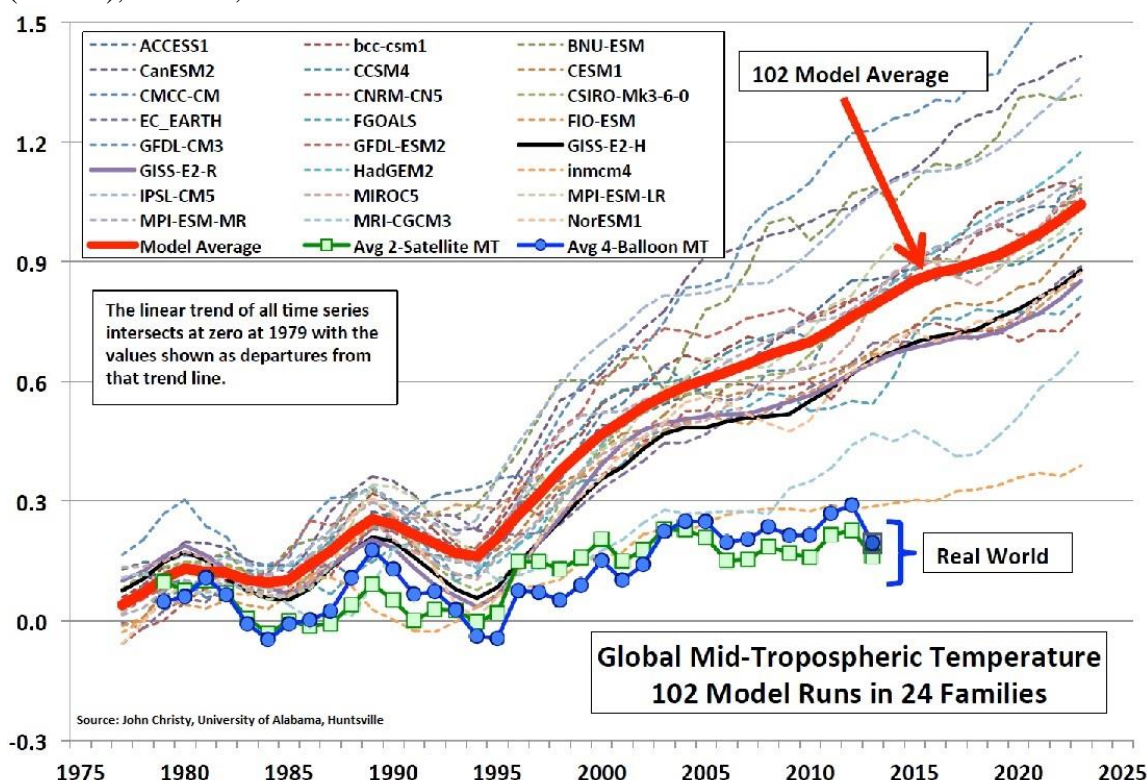


Figure 1: Global Mid-Tropospheric Temperature 102 Model Runs in 24 Families. Model runs versus observed temperatures. The 102-model average projected temperature anomaly is roughly 4 times higher than observed temperatures at present, ran well above observations consistently from the early 1980s, has never come close since 1997, and completely failed to forecast the absence of observed warming over the past decade.

Rather than recognizing the shortcomings of their models, climate modelers used the same approach to make claims about the increasing intensity of storms, rainfall events, etc., though empirical evidence indicates that storm events have been on the decline. Even the IPCC acknowledges this. In its 2012 special report on extreme weather events it said, “There is low confidence in any observed long-term (i.e., 40 years or more) increases in tropical cyclone activity (i.e., intensity, frequency, duration), after accounting for past changes in observing capabilities” (IPCC 2012, p.7). In AR5, the IPCC notes: “Current data sets indicate no significant observed trends in global tropical cyclone frequency over the past century and it remains uncertain whether any reported long-term increases in tropical cyclone frequency are robust,

after accounting for past changes in observing capabilities Current data sets indicate no significant observed trends in global tropical cyclone frequency over the past century and it remains uncertain whether any reported long-term increases in tropical cyclone frequency are robust, after accounting for past changes in observing capabilities In summary, confidence in large scale changes in the intensity of extreme extratropical cyclones since 1900 is low” (IPCC 2013, pp. 216, 220).

By hyping storms, the media drew attention to phenomena that have little to do with actual climate change. One such storm was “Superstorm” Sandy, which struck New York and New Jersey in October 2013, having combined with a strong Nor’easter. Was Sandy bigger or stronger because of global warming? In strength, Sandy never exceeded Category 3 (out of 5) and was actually no longer a hurricane but only a post-tropical storm when it made landfall at Atlantic City. The *diameter* (not strength) of Sandy’s wind field was greater than any Atlantic hurricane in recorded history—but only by about 3%—and for this measure “recorded history” reaches back only to 1988 (Masters 2013). Except for its large front and damage to unprotected coastal areas that had been built up over the last decades, Sandy did not really pack as much punch as a typical hurricane. Nonetheless, some people claimed that higher sea levels driven by recent, anthropogenic global warming (AGW) made the storm surge worse than it otherwise would have been. Yet land subsidence and natural sea level rise, both happening since the end of the Ice Age, account for the apparent sea level rise at Battery Park in New York City (Hansen 2013). In fact, Sandy’s “storm surge was likely surpassed in the New England hurricanes of 1635 and 1638” and “at least seven hurricanes of intensity sufficient to produce storm surge” greater than three meters “made landfall in southern New England in the past 700” years (Middleton 2012). All seven occurred prior to 1960—before the period the IPCC claims human activities directly caused global warming. In 1821, at low tide and with sea level a foot lower than today, a Category 3 hurricane brought a 13.9-foot storm surge to New York City (Horn 2012). The same storm today, hitting at high tide, would have caused much greater flooding than Sandy.

Interestingly, Dutch commentators warned beforehand that Sandy could be particularly nasty because it would hit at high tide, during a full moon (which made the tide higher than normal), and, most important, in coastal locations of New York and New Jersey that (unlike the Netherlands with its dikes) had no infrastructural defenses. Indeed, parts of New York City are built on former marshlands that previously served to protect New York from storm surges. However, government policies had incentivized people to live in the path of potential storms, which is one reason Sandy caused \$65 billion in damages: citizens determined that the benefits of living in vulnerable regions exceeded potential costs, in part because government was expected to come to the rescue if the insurance companies did not (as it did).

My point here, however, is simply this: You cannot base predictions on models that are not validated by *observational data*, even if they are validated *against each other*. While the models do indeed include a lot of well-known physical equations, they also contain a lot of ad hoc parameters (such as the climate sensitivity parameter) and information based on weak empirical foundations. Further, models are nonlinear, difficult to solve, and with no guarantee that any solution is anything more than a local optimum (or attractor). In other words, a numerical solution to a climate model could get trapped at a local point (as it often does), and an entirely different solution can be found simply by slightly changing one or more of the model parameters, or even one of the many starting values (e.g., initial concentration of water vapor in a certain region of the model) needed by the computer to start the algorithm for finding a solution. In many cases, the highly nonlinear equations in the models need to be linearized around some

point near where the model builders expect the solution to lie, because the nonlinearities are too complex for even a high-powered computer to find a numerical solution.

Climate Sensitivity

One of the many parameters in the model that the modeler needs to set is the climate sensitivity. Climate sensitivity refers to the expected increase in temperature from a doubling of the atmospheric concentration of CO₂. In climate models it is the critical, climate sensitivity parameter that converts atmospheric CO₂ into temperature increases. Values of the climate sensitivity parameter used by the IPCC have ranged from a high of 4.5°C to as low as 2.5°C to 3.0°C. While earlier IPCC reports were much more assertive about the size of the climate sensitivity parameter, stating a likely range of 2.0°C to 4.5°C with a best estimate of 3.0°C, the more recent AR5 report is much less certain about climate sensitivity, reducing its lower likely bound to 1.5°C and offering no best estimate. Yet, the IPCC expressed greater confidence that global warming is anthropogenic in nature than ever before; as of 2013, the IPCC is 95% certain that warming is caused by humans, up from 90% in 2007, 66% in 2001 and only 50% in 1996. These certainty values are frightening for the simple reason that they are mere speculation and not based on science. Probability ought to decline as a result of the material reported in AR5, not increase.

Recent studies by Schwartz (2007), Spencer et al. (2007), Spencer and Braswell (2008), Spencer (2008), and Lindzen and Choi (2009) point to a much, much lower value of the climate sensitivity parameter, more likely closer to 0.5°C. The argument hinges on the role of feedbacks. If increases in atmospheric CO₂ increase water vapor in the atmosphere without increasing cloud formation, then there is a positive feedback that serves to amplify the initial warming. However, if increased water vapor leads to increased cloud cover, there is a negative feedback caused by the cloud albedo (reflectivity—reflecting solar radiation back into space before it can warm Earth’s surface). This offsets the initial increase in warming caused by CO₂ rather than amplifying it. Thus the good news is that *empirical* evidence, as opposed to theoretical models, shows that climate sensitivity to CO₂ is much less than originally anticipated, with a “new observationally-based ‘likely’ range [of] ... 1.25–3.0°C, with a best estimate of 1.75°C” (Lewis and Crok 2014).

Natural Causes

Based on discussions with astrophysicists and their writings (van Kooten 2013, pp.158–165), I am convinced that cyclical changes in solar activities, cosmic rays originating in deep space, and ocean currents (Pacific Decadal Oscillation, Atlantic Multidecadal Oscillation, North Atlantic Oscillation, etc.) are perhaps a better explanation of changing temperatures and possible global warming than CO₂. While increased CO₂ in the atmosphere certainly warms the Earth, it needs to be amplified through water vapor before it leads to significant warming. However, there are serious questions regarding the role of water vapor, cloud formation, and so on. These issues remain to be resolved, and it is not clear whether and to what extent cloud feedbacks enhance or reduce the initial warming. Articles supporting both sides of this debate continue to appear in the refereed literature.

The reason climate modelers do not like the MWP is that humans were not a factor in causing it. It could not be explained by higher levels of atmospheric CO₂. Any climate model

worth considering would not only need to predict observed temperatures over a long period, but also provide an explanation of the MWP. But the climate models do not appear capable of either. They do not provide an adequate explanation of the MWP, nor can they explain the current 17+ years with no temperature increase despite steadily rising CO₂ levels (Monckton 2014). The most common explanation—that the heat is hiding in the deep oceans (since sea surface temperatures have not risen)—is less persuasive given increasing evidence pointing to natural causes. Further, this line of reasoning leads to doubts about the state of climate science as it relates to AGW. The AGW story warns of an impending catastrophe if there is a rapid and large increase in the atmospheric temperature at the Earth's surface, but it says nothing of an impending catastrophe should there be an increase in the total energy content of the lithosphere / hydrosphere / cryosphere / atmosphere / biosphere. To argue that the temperature increase has not happened because the energy is hidden in the deep oceans is really to concede that there is something wrong with the way energy systems are modeled.

Damages

The benefits of mitigating climate change are the damages purportedly prevented. What are the expected damages from global warming? The list of potential damages that global warming proponents flag includes sea level rise, more frequent and more intense storms, increased risk of disease, heat waves and drought, loss of biodiversity, climate refugees and increased international tensions, and even psychological damage. Upon investigating the potential damage from each of these possible “effects,” one is struck by two things. First, many are simply non-existent. There is no evidence that storm frequency or intensity is increasing. Rather, the available observational evidence suggests that, despite several prominent storms such as Sandy, the incidence and accumulated energy of storms have actually declined over the period of alleged AGW (Figures 2 and 3) (Maue 2014; see also above).

While damages from various storm events have increased over time, this cannot be attributed to more frequent or severe storms. Instead, storm damages have increased because more people and property are in harm's way (Pielke 2014) (Figure 4).

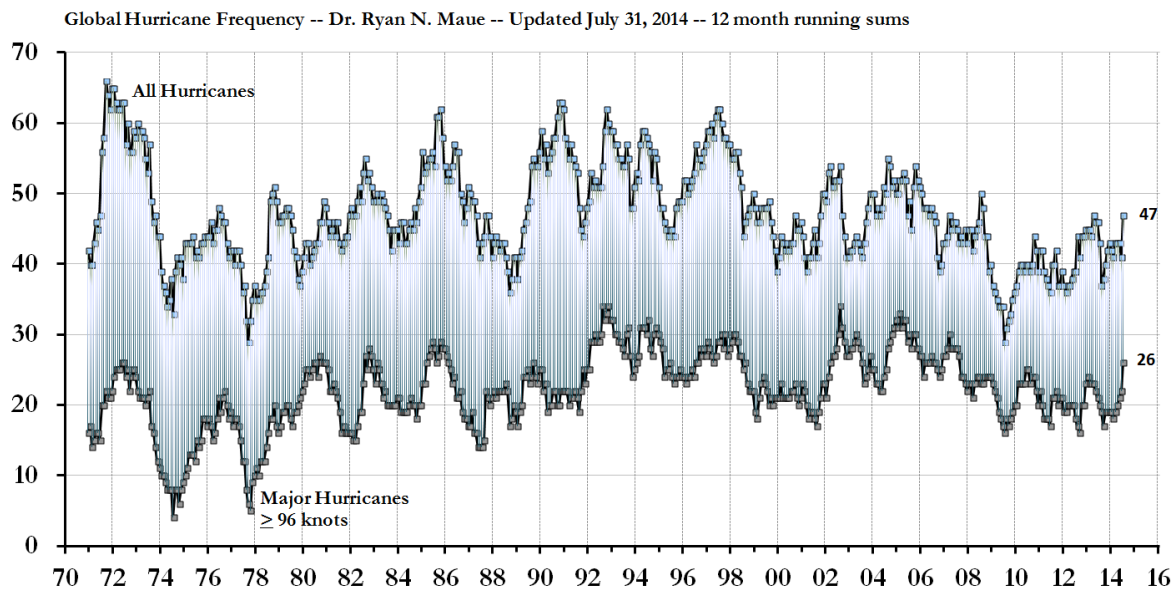


Figure 2: Global Hurricane Frequency (all & major) -- 12-month running sums. The top time series is the number of global tropical cyclones that reached at least hurricane-force (maximum lifetime wind speed exceeds 64-knots). The bottom time series is the number of global tropical cyclones that reached major hurricane strength (96-knots+). Adapted from Maue (2011) GRL.

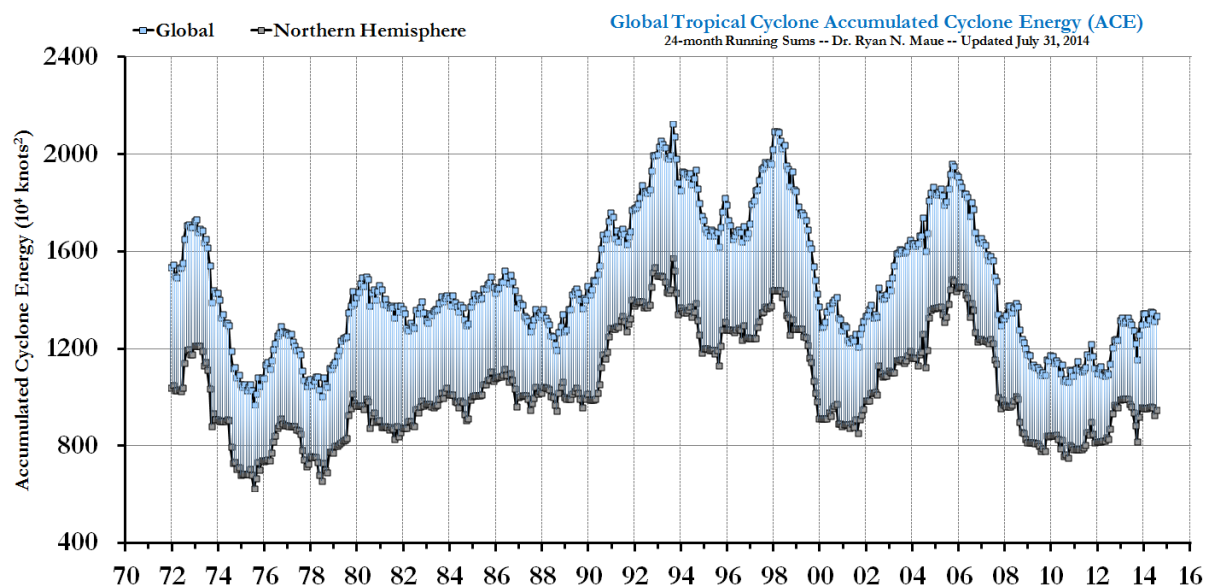


Figure 3: Last 4-decades of Global and Northern Hemisphere Accumulated Cyclone Energy: 24 month running sums. Note that the year indicated represents the value of ACE through the previous 24-months for the Northern Hemisphere (bottom line/gray boxes) and the entire global (top line/blue boxes). The area in between represents the Southern Hemisphere total ACE.

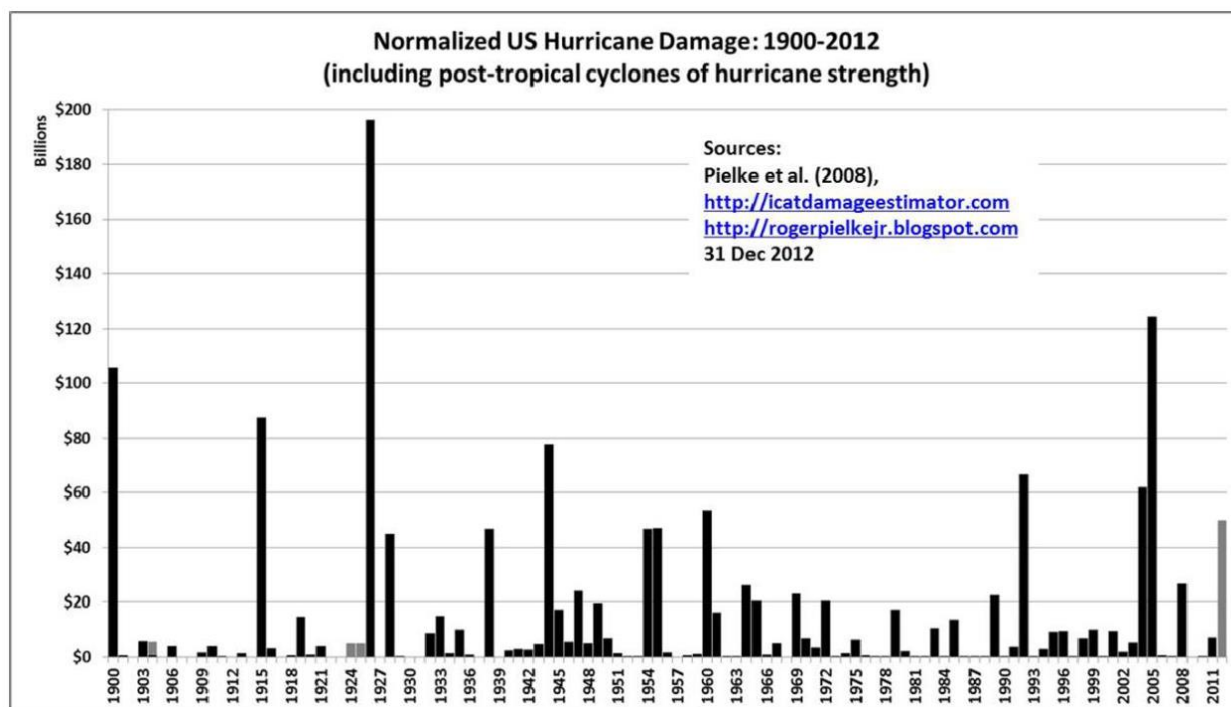


Figure 4: Normalized U.S. Hurricane Damage: 1900–2012. This indexes hurricane damage by adjusting for economic and population growth.

Nor is there evidence to indicate that climate change is causing sea levels to rise, although one might expect this if oceans expand as a result of warming. But without evidence, one is left to speculate, which is unscientific.

With regard to health concerns, these are best considered a red herring. The most frequently cited example concerns malaria, which hypothetically would spread as tropical temperatures shifted poleward. But malaria (like dengue fever) is not a tropical disease but a disease of poverty (Reiter 1998, 2005). Indeed, it had appeared in Europe and North America as recently as the 1960s and was eradicated in these regions through mosquito control and public health efforts, and the greatest malaria outbreak in modern times occurred in Siberia—not noted for its tropical climate—in the 1920s and 1930s, infecting 9.5 million and killing over 600,000 (Manguin et al. 2008, p. 244). Effective vector control and, as the current *Ebola* outbreak indicates, the quality of health care are more important than climate in prevention of disease. The health of the globe’s population would best be served by economic development that lifts people out of poverty (as discussed below).

The remaining categories are interesting but even more controversial. Increasing atmospheric CO₂ improves agricultural productivity, enabling crops to better utilize nutrients including water, thereby making them less susceptible to drought. While droughts might increase in some regions of the globe, overall a warmer atmosphere will hold more moisture leading to increased rainfall. However, some argue that, as temperatures continue to rise beyond an increase of 2°C, the CO₂-fertilization effect will be offset by too much heat, while precipitation will evaporate before it hits the ground. These arguments are accepted with no empirical support. The only *empirical* evidence points to increased crop yields as atmospheric CO₂ increases and to declines in the incidence and prevalence of droughts as temperatures rise. Although using very crude methods to estimate benefits, one author estimated that the increases in atmospheric CO₂

since 1960 added \$3.2 trillion in crop value, and projected rising CO₂ to add nearly \$10 trillion more from 2014 to 2050 (Idso 2013, p. 3). Likewise, mortality from cold weather exceeds that from hot weather so that, as global climate warms, deaths due to temperature extremes actually decline.

Biodiversity loss is difficult to measure, and its value more so (van Kooten and Bulte 2000, pp.270-307). Indeed, the methods used to determine nonmarket values, which play prominently in Nicolas Stern's (2007) evaluation of the costs and benefits of mitigating climate change, have recently come under severe criticism. Nobel Laureate Daniel Kahneman and colleagues have argued that, despite many efforts, proponents of nonmarket methods have not been able to overcome the problems associated with soliciting people's preferences about environmental goods and services, including biodiversity (see Kahneman 2011; Kahneman and Tversky 1979, 1984). Indeed, nonmarket valuation methods are at odds with neoclassical economic theory and cost-benefit analysis (Hausman 2012). This applies not only to biodiversity, but to environmental economics more broadly as the damages avoided by reducing pollution, for example, are estimated using the same techniques. Polar bears are the poster child of biologists—the harbinger apparently of climate change's negative impact on biodiversity. Yet, polar bear populations seem to be increasing, and not decreasing as a result of declining sea ice (Crockford 2013, 2014).

Finally, I cannot determine how one might determine the psychological costs associated with climate change. If climate change refers to the normal vagaries of weather, I might understand what this means. I too am upset when it is supposed to be sunny and warm but it rains. It is important to remember, however, that “climate change” is not something related to greater frequency, incidence, and unpredictability of storm events; rather, it refers to the *gradual rise in average global temperatures*. Any other interpretation is speculation, not science. How might the gradual increase in average global temperature cause psychological stress or damage? And, in light of the previous paragraph, how might one measure such damage in monetary terms so that it could be included in the calculation of the social cost of carbon (as discussed below)?

Likewise, with one exception of an individual from an island administered by New Zealand, who was granted permission to stay in New Zealand on the basis of rising sea level, it is highly unlikely that there will be an increase in climate refugees. This would be particularly true if incomes in the least developed world do rise to the extent IPCC's emission scenarios, used in climate models, assume—and without that rise in incomes, CO₂ emissions are lower than IPCC projects, which entails, on IPCC's assumptions, that temperatures, and everything alleged to depend on them, will change less, too (van Kooten 2013, pp. 106–110).

Economic Evaluation

There is a great deal of uncertainty regarding the extent of future climate change. If the climate sensitivity parameter is 0.5°C to 1.5°C rather than 2.5°C to 4.5°C, then the threat of climate change has essentially disappeared, and it would make little sense to implement expensive climate mitigation strategies. Likewise, if natural causes trump anthropogenic ones as the culprit behind global warming, then there is little that can be done to prevent warming. Again, no action should be taken beyond what might make sense for other reasons. Further, since climate models are highly unreliable and unable to predict with any accuracy, it makes sense that about all we have to deal with are speculative scenarios of future climate, some of which might even be plausible. There is not much to go on, so policy should proceed in small steps.

Therefore, *if* we should do anything (and that is not certain), it makes sense to rely on a simple tax that might vary over time as more information becomes available, rather than change the structure of the economy through regulations and carbon trading that is open to corruption (Pindyck 2013; Prins et al. 2010; van Kooten and de Vries 2013; van Kooten et al. 2014).

From an economic standpoint, a carbon tax should be set equal to the social cost of carbon, which, in turn, is determined by the relationship between economic damages and atmospheric levels of CO₂ (not temperature!)—the social cost of carbon is the cost supposedly imposed on global society when one additional metric ton of CO₂ (tCO₂) is added to the atmosphere. There is no such relation; as noted earlier, temperatures are only weakly correlated with CO₂, but it is temperature that economists use to determine economic damages, which in turn are used to determine the social cost of carbon. For example, Yale University’s William Nordhaus is arguably the most notable climate economist in the world. His well-known and oft-used DICE model employs a simple functional relation between economic damage and global temperature (Nordhaus and Boyer 2000). Yet, the damages he can best justify must be primarily nonmarket in nature. Given the work by Kahneman (2011) and Hausman’s (2012) critique of nonmarket valuation, the very idea of a social cost of carbon is suspect. The policy maker is then left to muddle through. As part of this muddling through, the most rational policy that economists can agree upon is a carbon tax that raises funds for technological research and development, incentivizes greater energy conservation, but does the least harm to the economy, and picks no winners or losers among energy technologies.

If We *Must* Try to Mitigate Global Warming, What Is the Best Policy?

Nordhaus has certainly not been afraid to make the case for a carbon tax, particularly advocating a tax that rises gradually as atmospheric concentrations of carbon dioxide increase. The tax is designed to increase in response to the supposed increase in damages from rising CO₂ levels.

The Case for a Carbon Tax

Nordhaus (2010) argues that the “desirable features of any tax are that it raises revenues in a manner that has minimal distortionary effect on the economy and reinforces other objectives of national policy.” A carbon tax is particularly relevant because it can be used to raise revenues to tackle the burgeoning U.S. debt. A carbon tax has the following advantages:

- It has the potential to raise substantial revenue.
- It is well understood.
- It increases economic efficiency as it tackles undesirable CO₂ emissions.
- It has potential health benefits, because reducing emissions of CO₂ will also reduce emissions of other harmful pollutants, assuming nothing else changes.
- It displaces regulatory inefficiencies associated with attempts to regulate greenhouse gas emissions, and useless subsidies to produce ethanol or protect standing forests, for example, when both these policies have been shown to have little or no impact on overall greenhouse gas emissions (due to release of other greenhouse gases and/or leakages).
- A carbon tax can be harmonized across countries, reducing overall distortions.
- A tax can enable the U.S. to meet international CO₂-emission reduction targets.

- A carbon tax is preferred to emissions trading because it captures the economic rents that are lost to government when a grandfathered cap-and-trade scheme, reduces transaction costs associated with emissions trading, and it leads to fewer opportunities for corruption.

Some of the claims that Nordhaus makes in favor of a carbon tax, such as “substantial public health benefits,” are determined using the aforementioned nonmarket techniques. Nordhaus’s calculations regarding the ideal tax ramp and budget implications are derived from his DICE model and are provided in Table 1 below. The present value of the tax revenues over the period to 2030 is 15% (discounted at 5%) of 2010 GDP, or 35% if discounted over the period to 2050. Therefore, the carbon tax can be expected to make a significant contribution to reducing the U.S. budget deficit and debt.

Table 1: Ideal Carbon Tax Ramp and Budgetary Implications for the United States

Year	Tax rate (\$/t CO ₂)	Revenues (2010 \$×10 ⁹)	Year	Tax rate (\$/t CO ₂)	Revenues (2010 × 10 ⁹)
2005	0.00	0 (0.0%)	2025	63.00	282 (0.9%)
2015	25.00	123 (0.6%)	2030	89.80	386 (1.0%)
2020	39.70	184 (0.7%)	2035	128.10	528 (1.1%)

Notes: Adapted from Nordhaus (2010). Results assume inflation and real GDP growth of 2.5%. Revenues as a proportion of GDP are provided in parentheses.

The Adverse Aspects of a Carbon Tax

Nordhaus also makes the case that the income re-distributional effects of a carbon tax are minimal, or at least no worse than those associated with a value-added tax or payroll tax for social security purposes. The average household in the U.S. consumes 12,000 kilowatt hours (kWh) of electricity annually and pays an average of 10¢ per kWh. If this power is generated solely by coal-fired plants, Nordhaus argues the annual cost to a household would rise in 2015 from \$1200 to \$1500, or by 25% (\$300).

However, using Nordhaus’s data and CO₂ release by fuel type, I calculate that a carbon tax of \$25 per tCO₂ would increase the price that a household pays for electricity by 150%, or from \$1200 to \$3000 annually (assuming no reduction in use). The price of gasoline would rise by 15.1%, adding nearly 14¢ to a gallon of gasoline, not the 7¢ indicated by Nordhaus.

If governments are determined to try to mitigate global warming by reducing CO₂ emissions, a carbon tax is probably the best instrument that governments have in their policy arsenal. Yet, based on PEW surveys (Pew Research 2010) and a survey by *The Economist* (July 4, 2009, pp. 24-25) that indicated the majority of people would oppose climate change mitigation policies if these cost them \$175 or more per year, it is unlikely that citizens would willingly accept a carbon tax. Rather, they would view it as another attempt on the part of politicians to pay for wrongheaded policies related to the 2008–2009 financial crisis, and perhaps financing of the Iraq and Afghanistan wars, which led to the growing U.S. debt.

In an effort to get serious about climate change, the leaders of the largest eight countries

(G8) meeting in L'Aquila, Italy, agreed on July 8, 2009 to limit the increase in global average temperature to no more than 2°C above pre-industrial levels. To attain this, they set “the goal of achieving at least a 50% reduction of global emissions by 2050” with “developed countries reducing their aggregated domestic emissions by 80% or more” compared to 1990 (Schiermeir 2009). There is no way for the United States, Europe or any country to meet this target and retain anything remotely close to its present standard of living. Reductions in CO₂ on that scale are simply not achievable without severely impoverishing people. The last time the United States had CO₂ emissions that were 80% below 1990 levels was around 1905, when it had under a fifth as many people as it has now, and their average income was about 13% of what it is now (Figure 5) (Goklany 2012, p.375).

Even emission reductions of as little as 25% would be difficult and costly to achieve. They would require huge investments in nuclear power generation, massive changes in transportation infrastructure, and impressive technical breakthroughs in everything from biofuels to battery technology.

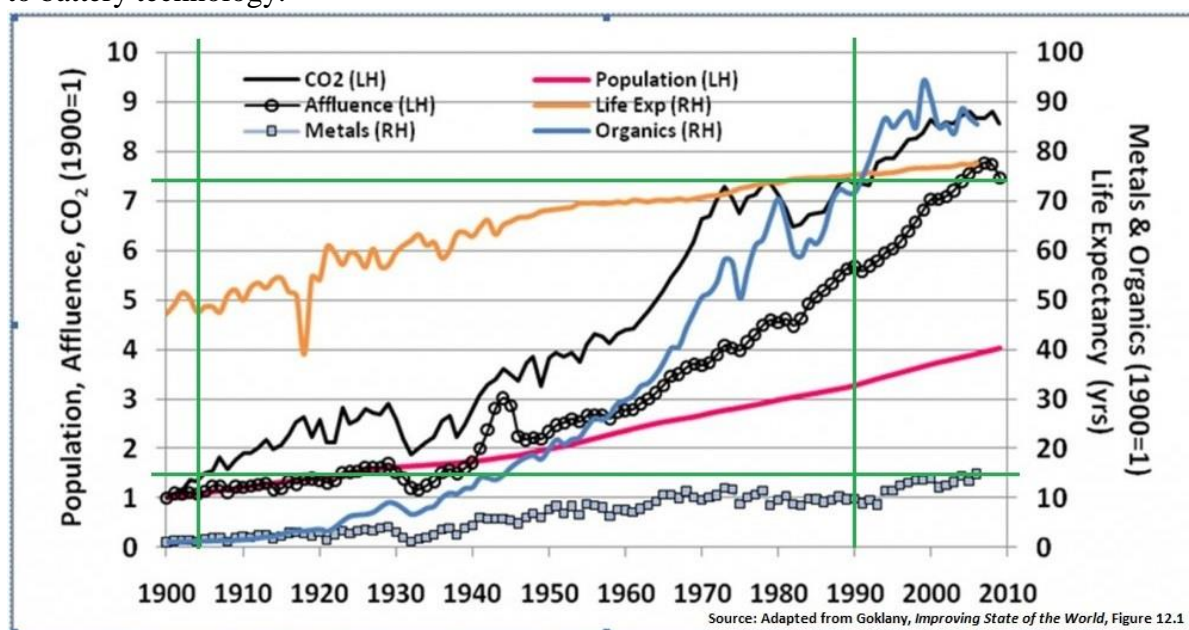


Figure 5: Population, affluence, CO₂ emissions, metals & organics use, and life expectancy, 1900–2010. The vertical and horizontal green lines mark CO₂ emission levels in 1905 and 1990. Achieving 80% reduction from 1990 levels would require returning to 1905 levels.

Yet, even if the developed countries are successful in reducing their emissions of greenhouse gases, the impact on climate change will be small. Growth in emissions by developing countries, especially China and India, will easily and quickly exceed any reduction in emissions by rich countries. This is evident in Figure 6, which shows CO₂ emissions from energy use for selected countries or regions. Fossil fuels are abundant, ubiquitous and inexpensive relative to alternative energy sources; therefore, any country would be foolish to impair its economy by large-scale efforts to abandon them. It is evident that it does not matter what rich countries do to reduce their emissions of carbon dioxide. Their efforts will have no impact on climate change, but they will have an adverse impact on their own citizens. Whether AGW is real or not, whether the climate model projections are accurate or not, fossil fuels will continue to be the major driver of economic growth and wealth into the foreseeable future. But efforts to contain CO₂ emissions could curtail global poverty alleviation, perpetuating poverty and

attendant high rates of disease and premature death and leading to a more unstable world.

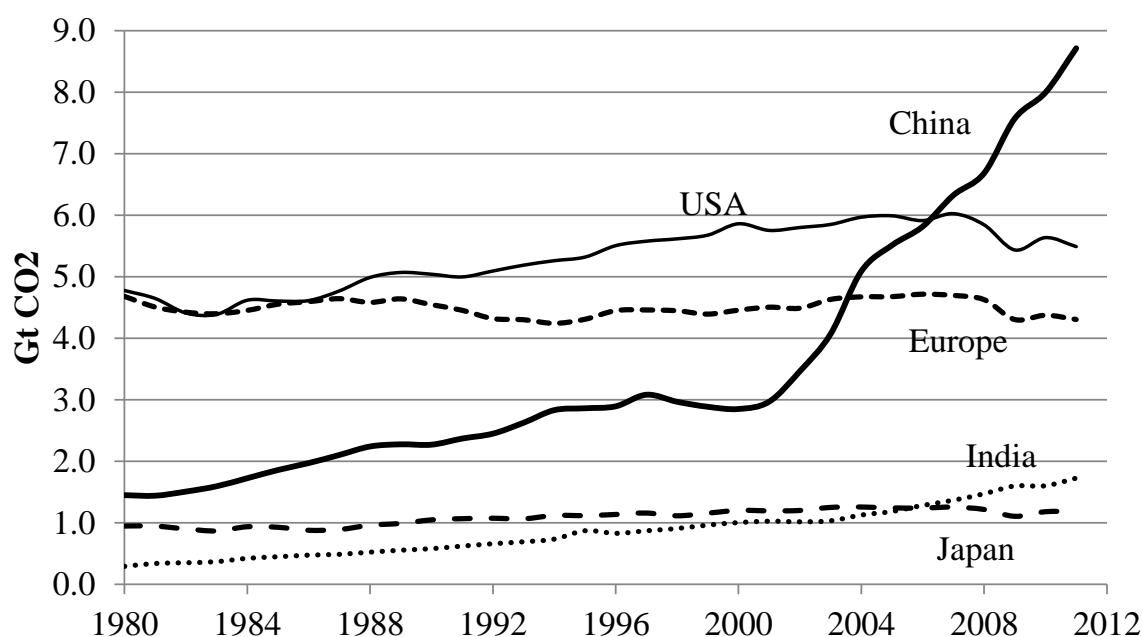


Figure 6: Carbon dioxide emissions from energy, selected countries/regions, 1980–2011

Source: <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8>

Generation of Electricity: Nuclear and Renewable Options

The capacity to produce electricity continues to increase unabated as the economies of China, India, Brazil, and other developing countries rapidly expand, and rich countries increase their need for electricity to facilitate digital storage and the electric automobile. There is no way to stop energy consumption from growing, as this would put a halt to the march out of global poverty and reduce standards of living even in rich countries. The growth in electricity production has been and continues to be powered by fossil fuels, particularly coal, despite wishes to the contrary. Global coal use is expected to rise by 1.1% annually over the next twenty years; an annual growth of 1.6% in developing countries is expected to be offset by a decline of 0.9% per year in the OECD countries. The reduction in coal use in the OECD will be mainly offset by a 1.2% annual increase in natural gas for power generation, while natural gas consumption is expected to increase 1.7% per year globally.

Renewable energy is also expected to become more important in the future, particularly in rich countries. Power generated from renewable energy sources is expected to grow by 5.8% annually in OECD countries (albeit from a much smaller base than other sources), while nuclear generation is expected to decline slightly and hydropower is expected to expand slightly. Yet, because CO₂ emission reduction targets are so ambitious, there has been a renewed discussion in some quarters about the role of nuclear power in meeting CO₂ emission reduction targets. Indeed, a California study concluded that it would not be possible to meet that state's ambitious emissions reduction targets without major investments in nuclear power. Nonetheless, recent concerns related to the failure of the Fukushima Daiichi nuclear power plant in Japan to withstand an earthquake and tsunami have reduced society's already low confidence in the safety of nuclear power—despite the fact that no deaths resulted from radiation released from the plant. As a result, Germany has quietly invested in new coal power plants to retain base-load capacity.

Another result is that renewable sources of electrical generation, such as wind, are viewed by many as a better alternative to fossil fuel sources of energy for safely generating electricity and reducing CO₂ emissions.

Yet wind poses many challenges for electrical system operators. Wind speeds vary considerably and sometimes unexpectedly within an hour, throughout the day or season, and even from year to year. The intermittent nature of wind requires that wind generation be supplemented by fast-ramping backup generation from open-cycle gas turbine (OCGT) or diesel power plants. This results in significant CO₂ emissions from these plants due to more frequent starts and stops and operation at less than optimal capacity. This problem is exacerbated by inadequate transmission capacity. The ability to store power could alleviate some of the intermittency problems, but batteries are simply not up to the task at the enormous scale needed. However, an ability to store power generated intermittently, whether from wind, solar, wave, or tidal action, behind hydroelectric dams, which are also relatively fast ramping, can compensate for some of the intermittency.

Nuclear power plants are an alternative means for reducing CO₂ emissions from electricity generation. They have high capacity factors and other operating characteristics that allow them to substitute for coal-fired and closed-cycle gas turbine (CCGT) base-load facilities that meet the bulk of a system's load. An MIT study (Deutsch et al. 2009) recommends that, if significant reductions in global CO₂ emissions are needed to stabilize the climate, installed capacity will need to increase from the current 100 GW to 300 GW in the United States by 2050 and from 340 GW to 1000 GW globally. But these are ambitious targets.

From an environmental standpoint, wind and nuclear energy have several drawbacks. Wind turbines are visually unappealing, turbine noise could have a negative impact on health, and wind farms kill many birds, including raptors and species at risk. Because wind farms are scattered across the landscape, the costs of transmission lines and associated externalities (people do not want to live near transmission lines) increase the cost of their use. However, disposal and transportation of nuclear waste, and fears associated with a potential nuclear accident, terrorist attack, and nuclear proliferation are major drawbacks of nuclear power.

In research with my graduate students, we developed simple and more complex models of electricity grids (van Kooten 2012; van Kooten et al. 2013). Because market incentives are considered more efficient than regulation, we employed a carbon tax to incentivize decommissioning of coal-fired generating capacity and new investments in renewable energy (wind and biomass in our model), as well as investments in nuclear, natural gas, and "clean" coal (CCS). In our analyses, we assume increasing penalizing of fossil fuel production of electricity.

The focus was on the Alberta electricity system because it has a high proportion of fossil fuel generating assets, the reduction or elimination of which would result in substantial CO₂ savings. Further, there is the potential to link to British Columbia via an existing transmission intertie. The advantage of the interprovincial intertie is that BC is dominated by large-scale hydroelectric assets, so that wind power generated in Alberta can be stored easily in BC reservoirs. Currently most of Alberta's electricity needs are met by plants that burn coal or natural gas, with minor production from hydroelectric, biomass, and, more recently, wind sources. In response to an increasing load and growing environmentalism related to the high CO₂ emissions from oil sands production, wind and nuclear alternatives to coal and natural gas are increasingly seen as viable options.

Consider first the case where no investment in nuclear power is permitted. Then, when we increase the carbon tax to \$50 per metric ton of CO₂ (tCO₂) or higher, coal plants begin to be

de-commissioned and more wind is added to the system. As the carbon tax is ratcheted upwards from \$50 to \$200 per tCO₂, coal generation is immediately abandoned and replaced entirely by wind and natural gas. There is also activity along the intertie to BC: Any excess wind output produced during low peak hours is sold to BC (at a low price) and stored behind BC hydro dams. During peak hours, the Alberta system operator will “buy back” hydroelectricity from BC as needed (i.e., depending on available wind output at the time), albeit at a higher price than it sold that power to begin with.

Interestingly, while a lot of wind capacity is added to the system, investment in gas capacity begins to rival that of the coal capacity that was displaced. Indeed, despite huge investments in added wind generating capacity, the increase in gas generating capacity equals that of the coal capacity that is displaced. Why? Base-load power previously produced by coal is replaced by natural gas capacity, but additional natural gas capacity is also installed to backstop rapid fluctuations in wind output over and beyond what can be handled through exchange with the British Columbia system.

By replacing coal-fired power with a combination of wind and natural gas capacity, CO₂ emissions in Alberta can be reduced, by about 55% to 65%, depending on assumptions regarding the capacity of the intertie between Alberta and BC (i.e., the ability to store and recover intermittent wind power). These are significant reductions, but they can be partly attributed to ideal trade conditions, a potentially unacceptable carbon tax, and the installation of 5,000 wind turbines of 2.3-MW capacity across the southern Alberta landscape—bringing environmental problems of their own in terms of aesthetics, health, and avian mortality. Indeed, the Dutch government requires companies to pay €3,000 (nearly \$4,000) per wind turbine as compensation to local municipalities, although residents are lobbying for much more.

When investments in nuclear power plants are allowed along with wind and natural gas, coal is again driven out of the model. However, there is no investment in new wind turbines (beyond those already in place). Rather, nuclear power and natural gas replace coal-fired capacity almost one-for-one at carbon prices of \$150/tCO₂ or less; at a higher carbon tax, some of the original natural gas capacity is actually decommissioned with nuclear capacity entirely replacing coal, but only if the transmission capacity of the intertie to BC is increased.

Nuclear power plants operate at a very low cost, but cannot be ramped up or down. Hence, they are best used as base-load plants. While enhanced storage of electricity through a larger capacity intertie to BC is meant to mitigate intermittency associated with wind power, nuclear power can take advantage of this storage to make it a more attractive option than wind. But the main reason why nuclear outcompetes wind, despite its extremely high construction and decommissioning costs, relates to the amount of natural gas capacity required. With wind, natural gas generating capacity increases in lock-step with increases in the installed capacity of wind despite the availability of storing intermittent energy elsewhere. Thus, while carbon taxes could potentially incentivize CO₂ emission reductions of upwards of 65% when wind and gas replace coal as an energy source, emissions could be reduced by 90% or more if nuclear energy were permitted in the same system.

The research indicates that similar emission reductions are potentially available in Nova Scotia once their power grid is linked to Newfoundland. However, such savings can only be expected in systems that currently rely heavily on fossil-fuel generation, especially coal—it is like picking low-hanging fruit. However, others have likewise found that nuclear power is preferred to wind and other renewables (e.g., see article “Sun, Wind and Drain” in *The Economist*, July 26, 2014).

Do Energy Companies Promote Skeptical Research?

Many advocates of alarm over AGW charge that energy companies support skeptical climate research. Yet this puzzles me. The amount of money these private companies have contributed to skeptics' research is miniscule compared with the billions of dollars spent every year by governments to fund AGW research. Indeed, the energy companies have contributed more to the "convinced" global warming folks and IPCC scientists than to the skeptics. What people fail to realize is that the oil and, particularly, coal companies could be the main beneficiaries of permit trading that involves grandfathering of permits. Energy companies will reap a huge windfall in that case, while their energy sales are not about to collapse, as there is nothing else on the horizon. They will spin off divisions to scoop up renewable energy subsidies, and—the biggest windfall of all—they will benefit the most from emissions trading: they will receive free but valuable emission permits under so-called cap-and-trade. Why would they support research that might threaten this gravy train?

The point is this: the mad scramble to implement policy to mitigate climate change has led to an orgy of rent seeking and corruption in the renewable energy sector that, along with the huge debts governments are piling up (partly because of ill-founded climate policies), will aid and abet climate change if it is indeed of human origins. And, in all of this, it is the poorest and most vulnerable people in society who are harmed the most.

U.S. Climate Policy in a Broader Economic Policy Context

The United States has long been spending beyond its means. This is partly the result of globalization. As indicated in Figure 7, the U.S. began to run a large balance of payments deficit after about 1990, especially with the emerging countries—most particularly China but also India. Normally, a trade deficit leads to the devaluation of the country's currency. However, in the U.S. case, the emerging countries were able to prevent their currencies from appreciating relative to the U.S. dollar (thereby increasing the price of their exports in the U.S.) by purchasing U.S. Treasury Bills. The U.S. government sold T-bills to finance huge budgetary deficits resulting from increased military expenditures (especially after 2001), spending on social programs, bailouts of banks, and so on. In essence, the emerging countries were subsidizing profligate consumer spending by Americans (Prasad 2014).

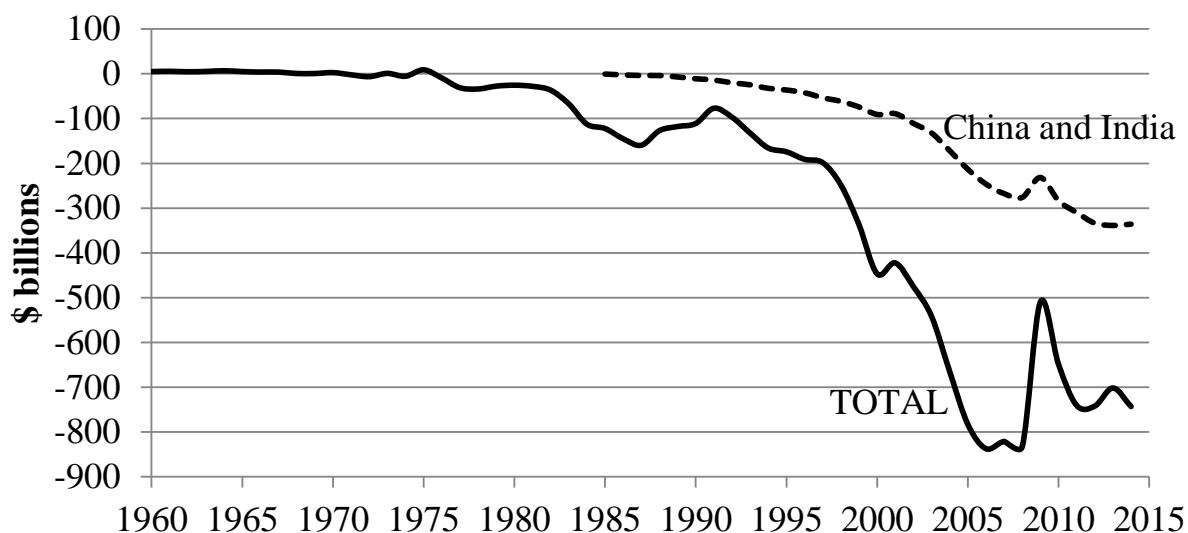


Figure 7: United States Trade Deficits on a Balance of Payments Basis, Total and China plus India, 1960–2014

What had taken place in the United States during the past several decades was a radical shift in the structure of the U.S. economy. As noted by Smith (2012), globalization and the pursuit of increasing efficiency led to a shift in U.S. manufacturing off-shore (mainly to China), thereby reducing CO₂ emissions at the expense of economic resilience. As jobs were lost and taxes kept low in an effort to promote investment and create jobs, government deficit spending was needed to prevent the economy from going into recession. As a result, the U.S. currently is in a unique dilemma not faced by other nations. Its massive debt and obligations (mainly government pension obligations) are denominated in U.S. dollars and held by emerging countries as well as developed ones. The only way out is to deflate the U.S. dollar relative to the other currencies, but this would have consequences on the emerging nations that would be greater than any economic consequences these countries might otherwise face (say, as a result of severe efforts to mitigate global warming).

While Americans and consumers in other rich countries have benefitted greatly from cheap products, they have come at the expense of increased CO₂ emissions in the exporting countries. In Figure 8, I provide a crude estimate of the extent to which the United States has been able to offshore its CO₂ emissions. Rather than producing goods domestically, these are produced in countries that employ more energy per unit of output. I estimate that U.S. has been able to reduce its domestic CO₂ emissions by perhaps 16% as a result of shifting manufacturing to other countries. This aspect of climate policy is ignored by policy makers.

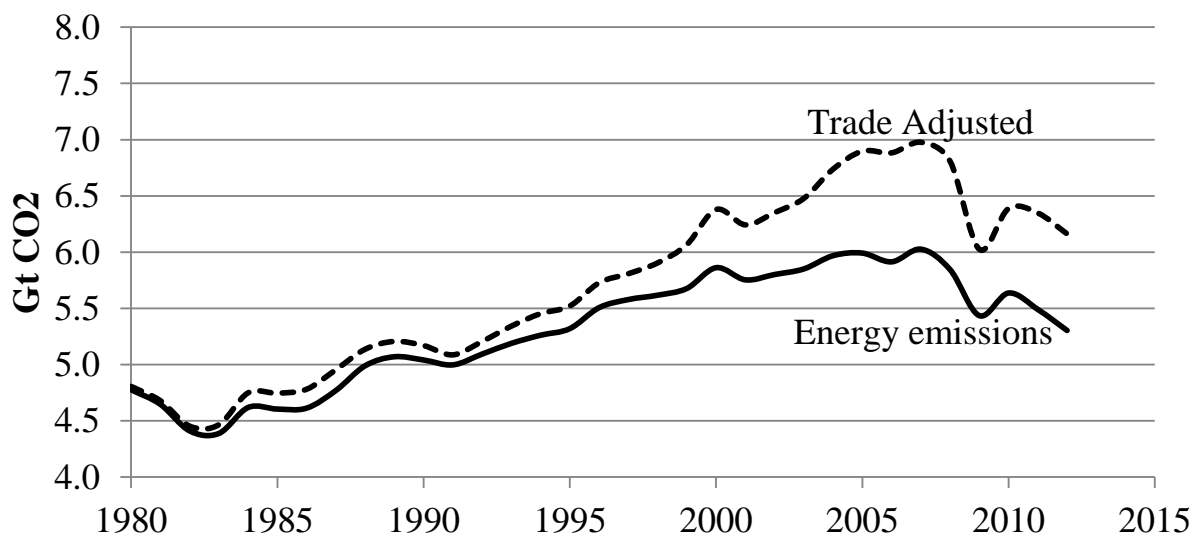


Figure 8: Domestic and Trade Adjusted Carbon Dioxide Emissions from Energy Use, United States, 1980–2012

Which Harms the Poor More—Climate Change or Climate Policy?

Many climate scientists argue that we need to mitigate global warming because otherwise it will be the poor who will be hurt the most. Apparently these scientists do not understand their own models. They do not appear to understand that economic models of the energy sector are used to determine the emission scenarios that drive the climate models. This is an extraordinarily important point to understand, so it bears some explanation.

The energy sector models the climate scientists use to drive their emission scenarios, which in turn drive their CO₂ concentration projections, which in turn drive their temperature projections, which in turn drive their impact projections, are themselves based on assumptions regarding population and economic growth, and, importantly, the convergence of per capita incomes between rich and poor countries. In short, greater economic development for the world's poorer countries leads to greater CO₂ emissions and, according to the models, greater warming and greater impacts. Reduce that economic growth, and you reduce the emissions, the temperatures, and the impacts. In other words, emission scenarios are driven by assumptions regarding the rate at which poverty is reduced or eliminated globally. Projections from climate models are based on the rates of poverty reduction, with the highest ('worst') temperature projections resulting when the poorest people in the world increase their incomes from \$246 (measured in real 1990 USD) to \$49,000 per year (approximately equal to U.S. GDP per capita in 2014) by the end of the 21st century. The lowest expected rise in the per capita income of the poorest people will see them earning \$3,850 annually, which though obviously not so much as the highest temperature scenario is still some 15 times more than now. It follows that what the advocates of AGW mitigation prescribe, because mitigation can only be achieved to the extent that economic growth is reduced, is to reduce global warming by trapping the world's poor in their poverty.

Given the underlying foundations of the climate predictions, the only realistic policy if one is truly interested in the wellbeing of poor people is to permit them to get rich, while allowing the climate to warm. There are huge benefits to health and every other measure one cares to choose when one becomes rich. For example, "Superstorm" Sandy resulted in the deaths

of some 120 people; if it had struck a very poor country (such as the typhoon that struck the Philippines in December 2012), it would have led to a death toll measured in the thousands. Rich people can cope not only with natural catastrophes but also with different climates—from the Arctic Circle to the Equator, from Death Valley to the Amazon rainforest—better than poor people. Adequate wealth more than outweighs any damage from climate change (Goklany 2008, 2009).

The underlying assumption in the IPCC climate models leads to the following conclusion: Rising CO₂ emissions are, for the most part, a side effect of alleviating global poverty. To mitigate climate change one needs to force the vast majority of humankind to continue living in abject poverty. Preventing climate change does not help the poor, it dooms them! Poverty simply kills more people than climate. Climate policy experts often say that fossil fuels are both too cheap and too expensive: too cheap, because they impose a global externality (a cost not borne by the user but imposed on others) by way of CO₂ emissions that lead to climate change, but too expensive, because many poor people are unable to pay for the energy they need to enable them to escape poverty (Prins et al. 2010).

The UN Dilemma

The United Nations is confronted with a *huge dilemma*: We can pursue the rich world's environmental climate objective only by denying developing countries the cheap energy needed for economic development. There are sufficient fossil fuels that can be made available cheaply enough to drive economic development of the least developed nations. The problem is not lack of resources; it is the obstacles that both rich and poor countries put in the way of exploration, development, transportation, and distribution of energy. Rich countries block exploitation of all sorts of natural resources on the grounds of their potential adverse environmental impacts, while poor governance, corruption, and failure of the rule of law hinder all aspects of the energy supply chain, resulting in huge waste. Sources of energy are plentiful enough to drive economic development, and they can be made available at low cost to developing countries. The problems are a lack of will to do so and the fact that the energy sources are hydrocarbons.

The Economist (September 25, 2010) also published a lead article pertaining to the UN's Millennium Development Goals (MDGs) that, among other targets, aim by 2015 to halve the number of people living below \$1.25 per day. That and other MDG targets seem to be within reach because of economic growth in China. Despite this, many people continue to live in abject poverty. Interestingly, the UN's MDGs do not talk about economic development, but economic growth is pretty well the only way to meet the MDG's targets. And economic development cannot occur without energy—vast amounts of which are required when we consider that one-quarter to one-third of the world's population lacks access to electricity. High-quality, high-density energy, which can currently only be found in fossil fuels, is also needed so that they can live decent lives rather than having to die prematurely from pollutants associated with low-density forms of energy, such as burning of crop residues, peat, etc. It would be immoral to deny the poor the ability to develop by curtailing their access to cheap energy.

The dilemma is of course that, through the United Nations, the rich countries have agreed to pursue policies of economic development in poor countries, so that their standards of living converge to those of the developed world. But they have also agreed, via the UN Framework Convention on Climate Change (UNFCCC), to de-carbonize the global economy. These objectives are incompatible. China and India recognize this all too well, which is why they refuse

to allow rich countries to seduce them into limiting their greenhouse gas emissions.

Heads in the Sand: The Ostrich Effect

What has been the response of the developing countries to the aforementioned dilemma? Surprisingly, rather than focus efforts on helping poor countries access sources of energy to enable the economic growth required to adapt to the negative effects of climate change, rich countries are acting as if there is no dilemma whatsoever. They are ramping up efforts to de-carbonize their own economies while continuing to threaten and cajole developing countries into doing the same. The developing countries have simply rejected such efforts, continuing to expand their energy consumption and CO₂ emissions as fast as they can. China is in the forefront, with India coming on and others likely to follow in the not-too-distant future.

Consider the evidence. Given lack of adequate data on CO₂ emissions by country, in Figure 9, I provide a graph of coal consumption for selected industrial countries. Coal is primarily used for generating electricity and making steel. Coal consumption by the U.S., Russia, and Japan has remained relatively flat over the period 1990–2009, while that of Germany declined slightly, mainly because of unification and the closing of inefficient coal-fired power plants and steel factories in the eastern part of the country. Indian consumption has risen slowly and should overtake U.S. consumption within the next several years. However, Chinese consumption of coal has increased some threefold since 2000. The same picture emerges if you take CO₂ emissions from energy consumption, as noted in conjunction with Figure 6.

It is also clear that, no matter what rich western countries are doing about CO₂ emissions, global emissions of CO₂ will continue to rise inexorably. Nothing the Americans, the Europeans, or the Japanese do can prevent global warming.

Consider this: In just over two years, the increase in Chinese emissions of CO₂ from coal generation alone exceeds the emissions of greenhouse gases, measured in CO₂ equivalence, of the entire Canadian economy. China adds some 1000 MW of installed coal-fired generating capacity every week, and Chinese consumption of coal in 2009 exceeded the total consumption of Germany, Russia, India, Japan and the United States combined. Despite this, China's generating capacity lags that of the United States by more than 30 percent, although total generation of electricity lags that of the U.S. by only about 20 percent, because the U.S. imports electricity from its neighbor, Canada, while China has no such option.

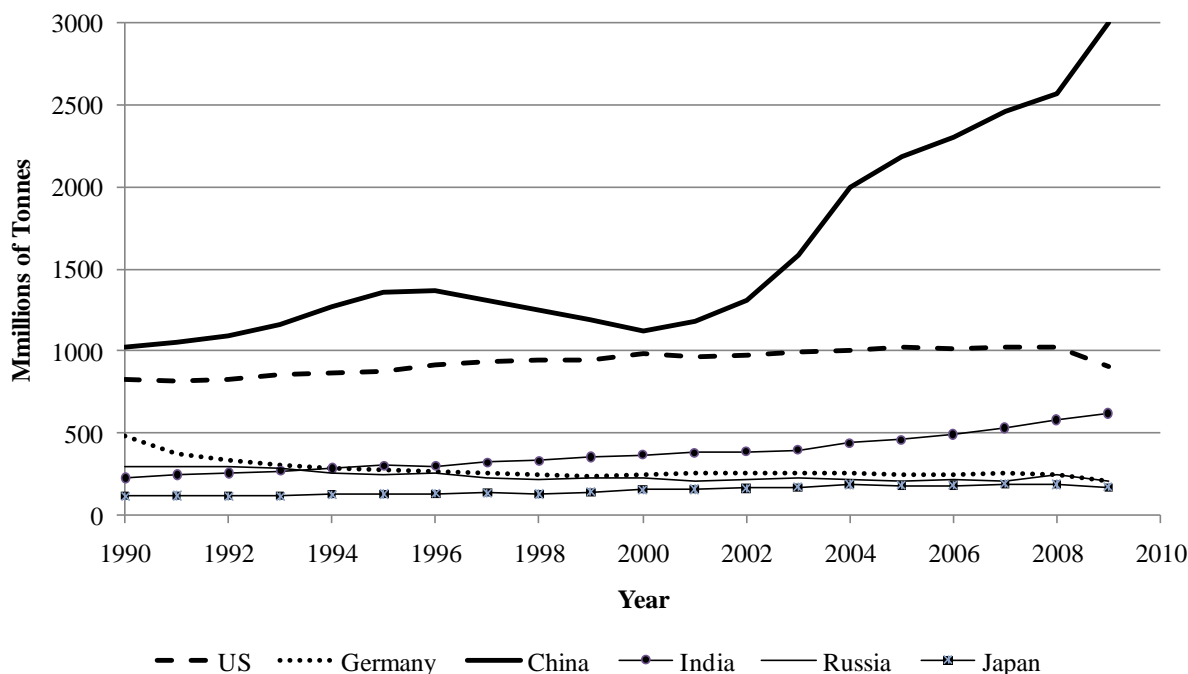


Figure 9: Coal Consumption, Selected Countries, 1990–2009

The response of rich nations has been to stick to the ill-advised UN FCCC Kyoto process as the roadmap to follow, and attempt to impose it upon the rest of the globe. In Europe, countries originally agreed to a binding target that requires 20% of total energy to come from renewable sources by 2020. In early 2014, the European Commission proposed to extend the renewable energy target to 27% of total energy production by 2030. In the United States, the Environmental Protection Agency recently indicated it would require new coal plants to have carbon capture and storage (CCS) capability, or otherwise achieve a particularly low carbon-intensity performance standard. The construction cost of CCS-capable plants is prohibitive, while the CCS process increases the energy required to produce electricity by some 28%. However, it is the risk that captured CO₂ could be released that will most likely prevent CCS from getting off the ground. The sudden release of a large amount of CO₂ from a storage site could lead to loss of life. It would result in a cloud of CO₂ that would hug the ground, because it is heavier than air, suffocating all air-breathing life that it enveloped. This happened when an underwater landslide apparently released a massive amount of volcanically generated CO₂ that had been trapped beneath Lake Nyos, Cameroon, in 1986, instantly killing 1,700 people and 3,500 livestock. (Stager 1987) So, to provide alternatives to fossil fuels, many jurisdictions are providing large subsidies to incentivize wind, solar, and other forms of renewable, non-nuclear energy.

Granted that none of these programs, even collectively, can significantly reduce climate change, why do governments continue to pursue them? One reason is the mistaken notion that these large subsidies will lead to greater employment and the development of a renewable energy sector that is a global leader. Every country believes it will be the global leader in the development of wind turbines or solar panels. However, research indicates that public funds directed at the renewable energy sector actually reduce employment by crowding out private sector investment or public infrastructural investments elsewhere in the economy (e.g., investments in transportation infrastructure that reduce costs of moving goods and people)

(Álvarez et al. 2009; Morriss et al. 2009).

The other reason for pursuing the Kyoto roadmap comes from environmental groups and the media, which together have convinced politicians to do something about reducing greenhouse gas emissions and the so-called carbon footprint. But doing something, anything, is not always wise. Economists have long known that governments cannot pick winners and, worse, government subsidies can lock in technologies that become a hindrance to more efficient energy use rather than a solution.

Conclusion

The Economist (September 25, 2010, p. 117) reported that, in 2009, 1.44 billion people lacked access to electricity, and all but three million of those lived outside the rich, developed countries. Worse yet, some 2.7 billion still cook their food on inefficient stoves that use dung, crop residues, and fuel wood. It is estimated that perhaps 2 million people die prematurely each year because of health problems associated with biomass-burning stoves (p. 72). Collection of biomass for burning occupies much time (mainly of women and children) that could otherwise be used to produce wealth, robs cropland of important nutrients that can only partly be replaced by artificial fertilizers from offsite, and causes deforestation.

One-quarter to one-third of the world's population—1.75 billion to 2.33 billion people—need access to electricity and high-density energy such as currently can be provided only from fossil and nuclear fuels, so that they can live decent lives and have some hope that their children will lead a better life than they. Again, it would be immoral to deny the poor the ability to develop by curtailing their access to abundant, affordable, reliable energy, all in pursuit of an environmental objective that only interests one billion rich people.

References

- Álvarez, G.C., R.M. Jara, J.R.R. Julián and J.I.G. Bielsa, 2009. Study of the Effects on Employment of Public Aid to Renewable Energy Sources. Lessons from the Spanish Renewables Bubble. Madrid: Universidad Rey Juan Carlos. <http://www.juandemariana.org/pdf/090327-employment-public-aid-renewable.pdf>. 43pp.
- Beisner, E.C., P.K. Driessen, R. McKittrick and R.W. Spencer, 2005. *A Call to Truth, Prudence, and Protection of the Poor: An Evangelical Response to Global Warming*. Burke, VA: Cornwall Alliance for the Stewardship of Creation. <http://www.cornwallalliance.org/docs/a-call-to-truth-prudence-and-protection-of-the-poor.pdf>.
- Crockford, S., 2013. *Ten Good Reasons Not to Worry about Polar Bears*. London: Global Warming Policy Foundation.
- Crockford, S., 2014. *Dodgy new clarification of global polar bear population estimate (yes, another)*. Posted August 5 at: <http://polarbearsandscience.com/>
- Deutsch, J.M., C.W. Forsberg, A.C. Kadak, M.S. Kazimi, E.J. Moniz, J.E. Parsons, Y. Du and L. Pierpoint, 2009. *Update of the MIT 2003 Future of Nuclear Power. An Interdisciplinary MIT Study*. Cambridge, MA: Massachusetts Institute of Technology. 18pp.
- Goklany, I.M., 2008. What to do about climate change *Policy Analysis Paper No. 609, February 5* (pp. 27). Washington, DC: CATO Institute.
- Goklany, I.M., 2009. Is Climate Change the 'Defining Challenge of our Age'? *Energy & Environment* 20(3): 279-302.
- Goklany, I.M., 2012. *The Improving State of the World: Why We're Living Longer, Healthier, More Comfortable Lives on a Cleaner Planet*. Washington, D.C.: Cato Institute.
- Hansen, K., 2013. "From the Scientific Urban Legend Department: 'AGW Sea Level Rise Made Sandy More Destructive,'" *WattsUpWithThat.com*, September 19. <http://wattsupwiththat.com/2013/09/19/from-the-scientific-urban-legend-department-agw-sea-level-rise-made-sandy-more-destructive/>.
- Hausman, J., 2012. Contingent Valuation: From Dubious to Hopeless, *Journal of Economic Perspectives* 26(4): 43-56.

- Horn, A., 2012. "Was Hurricane Sandy a Sign of the 'New Normal'?" *Energy Tribune*, November 2. <http://www.energytribune.com/64549/hurricane-sandy#sthash.s6CkecPY.M0oBr0rL.dpbs>.
- Idso, C., 2013. *The Positive Externalities of Carbon Dioxide: Estimating the Monetary Benefits of Rising Atmospheric CO₂ Concentrations on Global Food Production*. Tempe, AZ: Center for the Study of Carbon Dioxide and Global Change. <http://www.co2science.org/education/reports/co2benefits/MonetaryBenefitsofRisingCO2onGlobalFoodProduction.pdf>.
- Intergovernmental Panel on Climate Change, 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Summary for Policymakers*. Cambridge: Cambridge University Press.
- Intergovernmental Panel on Climate Change, 2013. *Climate Change 2013: The Physical Science Basis*. Cambridge: Cambridge University Press.
- Kahneman, D., 2011. *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.
- Kahneman, D. and A. Tversky, 1979. Prospect Theory: An Analysis of Decision under Risk, *Econometrica* 47: 263-291.
- Kahneman, D. and A. Tversky, 1984. Choices, Values, and Frames, *American Psychologist* 34: 341-350.
- Lewis, N. and M. Crok, 2014. *Oversensitive. How the IPCC Hid the Good News on Global Warming*. London: Global Warming Policy Foundation.
- Lindzen, R.S., and Y.-S. Choi, 2009. On the Determination of Climate Feedbacks from ERBE Data, *Geophysical Research Letters*, Online at <http://www.leif.org/EOS/2009GL039628-pip.pdf>.
- Manguin, S., P. Carnevale, and J. Mouchet, 2008. *Biodiversity of Malaria in the World*. Surrey, UK: John Libbey Eurotext Limited.
- Masters, J., 2013. "NHC upgrades Sandy to a Cat 3 in reanalysis, affirms changes needed for warnings," *Weather Underground*. <http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2349>.
- Maue, R., 2014. "Global Tropical Cyclone Activity." *WeatherBell.com*. Updated July 31, 2014. <http://models.weatherbell.com/tropical.php>.
- McGuffie, K. and A. Henderson-Sellers, 2009. *A Climate Modeling Primer* 3rd ed. Chichester, UK: John Wiley & Sons.
- McIntyre, S., and R.R. McKittrick, 2005. "The M&M Critique of the MBH98 Northern Hemisphere Climate Index: Update and Implications," *Energy and Environment* 16(1) pp. 69–100.
- McKittrick, R.R., 2011. *What Is Wrong With The IPCC? Proposals for Radical Reform*. London: Global Warming Policy Foundation, November.
- McKittrick, R.R. and P.J. Michaels, 2007. Quantifying the Influence of Anthropogenic Surface Processes and Inhomogeneities on Gridded Global Climate data, *Journal of Geophysical Research*, 112, D24S09, doi:10.1029/2007JD008465.
- McKittrick, R.R. and N. Nierenberg, 2010. Socioeconomic Signals in Climate Data, *Journal of Economic and Social Measurement* 35(3,4): 149-175.
- McKittrick, R.R. and T. Vogelsang, 2014. HAC-Robust Trend Comparisons among Climate Series with Possible Level Shifts, *Environmetrics* DOI: 10.1002/env.2294.
- Middleton, D., 2012. "Hurricane Sandy's 'Unprecedented' Storm Surge," *WattsUpWithThat.com*, November 1. <http://wattsupwiththat.com/2012/11/01/hurricane-sandys-unprecedented-storm-surge/>.
- Mitchell, C.V., et al., 2010. *A Renewed Call to Truth, Prudence, and Protection of the Poor: An Evangelical Examination of the Theology, Science, and Economics of Global Warming*. Burke, VA: Cornwall Alliance for the Stewardship of Creation. <http://www.cornwallalliance.org/docs/a-renewed-call-to-truth-prudence-and-protection-of-the-poor.pdf>.
- Monckton, C., 2014. "Global Temperature Update—Still no global warming for 17 years 10 months." *WattsUpWithThat.com*. <http://wattsupwiththat.com/2014/08/02/global-temperature-update-still-no-global-warming-for-17-years-10-months/>.
- Morriss, A.P., W.T. Bogart, A. Dorchak and R.E. Meiners, 2009. Green Jobs Myth. University of Illinois Law and Economics Research Paper Series No. LE09-001. 97pp. Available at: <http://ssrn.com/abstract=1358423> (viewed August 21, 2014)
- National Research Council, 2006. *Surface Temperature Reconstructions for the Last 2,000 Years*. Washington, DC: The National Academies Press.
- Nordhaus, W.D., 2010. Carbon Taxes to Move toward Fiscal Sustainability, *The Economists' Voice* (September). Retrieved from www.bepress.com/ev

- Nordhaus, W.D. and J. Boyer, 2000. *Warming the World. Economic Models of Global Warming*. Cambridge, MA: The MIT Press.
- Pew Research Center for the People & the Press, 2010. "Public's Priorities for 2010: Economy, Jobs, Terrorism." Pew Research Center, January 26. <http://www.people-press.org/2010/01/25/publics-priorities-for-2010-economy-jobs-terrorism/>.
- Pielke Jr., R., 2014. "Disasters Cost More than Ever—But Not Because of Climate Change." *FiveThirtyEightScience*, March 19. <http://fivethirtyeight.com/features/disasters-cost-more-than-ever-but-not-because-of-climate-change/>.
- Pindyck, R.S., 2013. Climate Change Policy. What do the Models Tell Us? *Journal of Economic Literature* 51(3): 860-872.
- Prasad, E.S., 2014. *The Dollar Trap. How the U.S. Dollar Tightened its Grip on Global Finance*. Princeton, NJ: Princeton University Press.
- Prins, G., I. Galiana, C. Green, R. Grundmann, M. Hulme, A. Korhola, F. Laird, T. Nordhaus, R.A. Pielke Jr., S. Rayner, D. Sarewitz, M. Shellenberger, N. Stehr and H. Tezuka, 2010. *The Hartwell Paper: A New Direction for Climate Policy after the Crash of 2009*. May (pp. 42). London, UK: Institute for Science, Innovation & Society, University of Oxford; LSE Mackinder Programme, London School of Economics and Political Science.
- Pruppacher, H. R. and J.D. Klett, 1997. *Microphysics of clouds and precipitation. Second revised and enlarged edition with an introduction to cloud chemistry and cloud electricity*. Dordrecht, NL: Kluwer Academic Publishers.
- Reiter, P., 1998. "Global Warming and Vector-Borne Disease: Is Warmer Sicker?" Washington, D.C.: Competitive Enterprise Institute, July 28. <http://cei.org/news-letters-cooler-heads-digest/global-warming-and-vector-borne-disease-warmer-sicker>.
- Reiter, P., 2005. "The IPCC and Technical Information. Example: Impacts on Human Health," Memorandum to U.K. Parliament Select Committee on Economic Affairs, March 31. <http://www.publications.parliament.uk/pa/ld200506/ldselect/ldeconaf/12/12we21.htm>.
- Schiermeir, Q., 2009. "G8 leaders fail to agree on carbon cuts before 2050," *Nature*, doi:10.1038/news.2009.660.
- Schwartz, S. E., 2007. Heat Capacity, Time Constant, and Sensitivity of the Earth's Climate System, *Journal of Geophysical Research* 112, doi:10.1029/2007JD008746.
- Singer, S. F., and D.T. Avery, 2007. *Unstoppable Global Warming Every 1,500 Years*. 2d ed. Lanham, MD: Rowman & Littlefield.
- Smith, H., 2012. *Who Stole the American Dream?* New York: Random House.
- Spencer, Roy W., 2008. Global Warming as a Natural Response to Cloud Changes Associated with the Pacific Decadal Oscillation (PDO), <accessed August 13, 2009> online at <http://www.drroyspencer.com/research-articles/global-warming-as-a-natural-response/>
- Spencer, R.W., 2010. *The Great Global Warming Blunder*. New York, NY: Encounter Books.
- Spencer, R.W., and W.D. Braswell, 2008. Potential Biases in Feedback Diagnosis from Observational Data: A Simple Model Demonstration, *Journal of Climate* 21(February): 5624-5628.
- Spencer, R.W., W.D. Braswell, J.R. Christy and J. Hnilo, 2007. Cloud and Radiation Budget Changes Associated with Tropical Intraseasonal Oscillations, *Geophysical Research Letters* vol. 34, L15707.
- Stager, C., 1987. "Silent Death at Cameroon's Killer Lake," *National Geographic*, 172 (3) (September): 404-420.
- Stern, N., 2007. *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press.
- van Kooten, G.C., 2004. *Climate Change Economics: Why International Accords Fail*. Cheltenham, UK: Edward Elgar. 167pp.
- van Kooten, G.C., 2012. Natural Gas, Wind and Nuclear Options for Generating Electricity in a Carbon Constrained World. REPA Working Paper 2012-01. May. Victoria: University of Victoria. Available at: <http://web.uvic.ca/~repa/publications.htm>
- van Kooten, G.C., 2013. *Climate Change, Climate Science and Economics: Prospects for an Alternative Energy Future*. Dordrecht, NL: Springer. 466pp.
- van Kooten, G.C. and B. Sohngen, 2007. Economics of Forest Carbon Sinks: A Review, *International Review of Environmental & Resource Economics* 1(3): 237-269.
- van Kooten, G.C. and E.H. Bulte, 2000. *The Economics of Nature: Managing Biological Assets*. Oxford, UK: Blackwell Publishers. 512pp.
- van Kooten, G.C. and F.P. de Vries, 2013. Carbon Offsets. Chapter 165 in *Encyclopedia of Energy, Natural Resource and Environmental Economics* edited by J. Shogren. Amsterdam, NL: Elsevier.

- van Kooten, G. Cornelis, Timothy N. Bogle and Frans P. de Vries, 2014. Forest Carbon Offsets Revisited: Shedding Light on Darkwoods, *Forest Science* 60: <http://dx.doi.org/10.5849/forsci.13-183>.
- van Kooten, G.C., C. Johnston and L. Wong, 2013. Wind versus Nuclear Options for Generating Electricity in a Carbon-Constrained World: Strategizing in an Energy-Rich Economy, *American J Agricultural Economics* 95(2): 505-511.
- van Kooten, G.C., A.J. Eagle, J. Manley and T. Smolak, 2004. How Costly are Carbon Offsets? A Meta-analysis of Carbon Forest Sinks, *Environmental Science & Policy* 7(4): 239-251.
- van Kooten, G.C., C.S. Binkley and G. Delcourt, 1995. Effect of Carbon Taxes and Subsidies on Optimal Forest Rotation Age and Supply of Carbon Services, *American Journal of Agricultural Economics* 77(2): 365-374.
- Wegman, E.J., D.W. Scott, and Y.H. Said, 2006. "Ad Hoc Committee Report on the 'Hockey Stick' Global Climate Reconstruction," presented to the U.S. House of Representatives Committee on Energy and Commerce and Subcommittee on Oversight and Investigations. <http://www.uoguelph.ca/~rmckitri/research/WegmanReport.pdf>.

Concluding Declaration

Protect the Poor: Ten Reasons to Oppose Harmful Climate Change Policies

As governments consider far-reaching, costly policies to mitigate human contribution to global warming, Christian leaders need to become well informed of the scientific, economic, and ethical debates surrounding the issue.

Consistent with the findings of *A Call to Truth, Prudence, and Protection of the Poor 2014: The Case against Harmful Climate Policies Gets Stronger*, we believe:

1. As the product of infinitely wise design, omnipotent creation, and faithful sustaining (Genesis 1:1–31; 8:21–22), Earth is robust, resilient, self-regulating, and self-correcting. Although Earth and its subsystems, including the climate system, are susceptible to some damage by ignorant or malicious human action, God’s wise design and faithful sustaining make these natural systems more likely—as confirmed by widespread scientific observation—to respond in ways that suppress and correct that damage than magnify it catastrophically.
2. Earth’s temperature naturally warms and cools cyclically throughout time, and warmer periods are typically more conducive to human thriving than colder periods.
3. While human addition of greenhouse gases, particularly carbon dioxide (CO₂), to the atmosphere may slightly raise atmospheric temperatures, observational studies indicate that the climate system responds more in ways that suppress than in ways that amplify CO₂’s effect on temperature, implying a relatively small and benign rather than large and dangerous warming effect.
4. Empirical studies indicate that natural cycles outweigh human influences in producing the cycles of global warming and cooling, not only in the distant past but also recently.
5. Computer climate models, over 95% of which point toward greater warming than has been observed during the period of rapid CO₂ increase, do not justify belief that human influences have come to outweigh natural influences, or fears that human-caused warming will be large and dangerous.
6. Rising atmospheric CO₂ benefits all life on Earth by improving plant growth and crop yields, making food more abundant and affordable, helping the poor most of all.
7. Abundant, affordable, reliable energy, most of it now and in the foreseeable future provided by burning fossil fuels, which are the primary source of CO₂ emissions, is indispensable to lifting and keeping people out of poverty.
8. Mandatory reductions in CO₂ emissions, pursued to prevent dangerous global warming, would have little or no discernible impact on global temperatures, but would greatly increase the price of energy and therefore of everything else. Such policies would put more people at greater risk than the warming they are intended to prevent, because they would slow, stop, or even reverse the economic growth that enables people to adapt to all climates. They would also harm the poor more than the wealthy, and would harm them more than the small amount of warming they might prevent.
9. In developed countries, the poor spend a higher percentage of their income on energy than others, so rising energy prices, driven by mandated shifts from abundant, affordable, reliable

fossil fuels to diffuse, expensive, intermittent “Green” energy, will in effect be regressive taxes—taxing the poor at higher rates than the rich.

10. In developing countries, billions of the poor desperately need to replace dirty, inefficient cooking and heating fuels, pollution from which causes hundreds of millions of illnesses and about 4 million premature deaths every year, mostly among women and young children. To demand that they forgo the use of inexpensive fossil fuels and depend on expensive wind, solar, and other “Green” fuels to meet that need is to condemn them to more generations of poverty and the high rates of disease and premature death that accompany it.

A Call to Action

In light of these facts,

1. We call on Christians to practice creation stewardship out of love for God and love for our neighbors—especially the poor.
2. We call on Christian leaders to study the issues and embrace sound scientific, economic, and ethical thinking on creation stewardship, particularly climate change.
3. We call on political leaders to abandon fruitless and harmful policies to control global temperature and instead adopt policies that simultaneously reflect responsible environmental stewardship, make energy and all its benefits more affordable, and so free the poor to rise out of poverty.

Endorsement

(Endorsement period is over.)

While our signatures express our endorsement only of this Declaration and do not imply agreement with every point in *A Call to Truth, Prudence, and Protection of the Poor 2014: The Case against Harmful Climate Policies Gets Stronger*, we believe that document provides ample justification for it. We call on scholars, experts, leaders, and citizens to join us in signing this declaration to protect the poor from harmful climate change policies.

[Click to view a list of all endorsers.](#)

[Click to view a list of notable endorsers by specialty.](#)