Scientific Shortcomings in the EPA's Endangerment Finding from Greenhouse Gases

Patrick J. Michaels and Paul C. Knappenberger

On April 24, 2009, the U.S. Environmental Protection Agency issued a finding of "proposed endangerment" from climate change caused by six greenhouse gases, with the largest contributions to warming resulting from emissions of carbon dioxide and methane (EPA 2009a).

The EPA also referred to this document as a "proposed finding" in response to a 2007 decision by the U.S. Supreme Court, *Massachusetts v. EPA*, which empowered the EPA to make such a finding for greenhouse gases under existing law. This was the Court's interpretation of Section 202 (a) of the Clean Air Act Amendments of 1990.

In *Proposed Endangerment*, the EPA requested comments "on the data on which the proposed findings are based, the methodology used in obtaining and analyzing the data, and major legal interpretations and policy considerations underlying the proposed findings" (EPA 2009a: 18890).

We answered the EPA's request in a filing on June 23, 2009 (Michaels, Knappenberger, and Davis 2009). This article details

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some of the most relevant findings in our response. In general, we found that *Proposed Endangerment* suffered from systematic errors that were inevitable, given that the way in which the EPA chose to determine the required background science had to result in both biased and outmoded climate science. In addition, the EPA made grand and sweeping assumptions about human adaptation to climate that are of such illogic as to invalidate the entire study. We believe that these systematic errors call into question any attempt on the EPA's part to subsequently issue regulations on greenhouse gas emissions. Other entities that may use the EPA's document as a basis for emissions reductions will be using similarly incomplete science and be subject to severe and public criticism. This conclusion has obvious implications for upcoming negotiations in Copenhagen in December 2009, on a replacement for the Kyoto Protocol.

The EPA's major systematic errors with regard to science concerned the way in which it provided scientific background for *Proposed Endangerment*. The essence is given in Section III (A), "Approach in Utilizing the Best Available Scientific Information":

> EPA has developed a technical support document which synthesizes major findings from the best available scientific assessments that have gone through rigorous and transparent peer review. The TSD therefore relies most heavily on the major assessment reports of both the Intergovernmental Panel on Climate Change and the U.S. Climate Change Science Program. EPA took this approach rather than conducting a new assessment of the scientific literature [EPA 2009a: 18894].

In doing so, the EPA is ultimately relying on the May 2007, *Fourth Assessment Report* (AR4) of the United Nations' Intergovernmental Panel on Climate Change (IPCC 2007). Given the lead times for publication of that compendium,[1] some of the cited science very well could have been modified, altered, or invalidated in the subsequent period of close to three years between the closing time for AR4 input and *Proposed Endangerment*. The Climate Change Science Program (CCSP) reports consist of a long series of 16 separate documents, with publication dates between 2006 and 2009 (see EPA 2009b).

[1]The IPCC had a late 2005/early 2006 deadline for the publication of new scientific findings to be included in the *Fourth Assessment Report*.

Many of these were contemporary with AR4. CCSP documents, as demonstrated below, relied heavily on AR4, as did the EPA in its technical support document (TSD).

As we will also show, there were multiple instances where both the United Nations' AR4 and the United States' CCSP missed, omitted, ignored, or unfairly dismissed relevant portions of the refereed scientific literature that are highly germane to *Proposed Endangerment*. This is an additive to the problem of the timeliness of AR4 and many of the CCSP reports that the EPA's TSD relied so heavily upon.[2]

None of the compendia upon which the EPA relied make any mention of the concept of "publication bias," which is a natural skewing of professional literature toward "cause and effect" publications. In the case of global warming, the literature that is surveyed in compendia is likely to be overwhelmingly biased toward linkages between climate change and certain effects, even though negative results—no effect—might in fact be scientifically noteworthy. This phenomenon was first defined by Rosenthal (1979) where he described the "file drawer problem," in that research demonstrating negative results tends to be put in the back of a researcher's files because they are inherently more difficult to publish.

Publication bias has been well documented in both the economic and biomedical literature (e.g., de Angelis et al. 2004, Chan et al. 2004) but was first noted in the climatic literature by Michaels (2008). In general, he concluded that publication bias would create biased compendia which, if relied upon for policy (as is the case for *Proposed Endangerment*), would likely overestimate threats from and underestimate immunities to climate change. In this study, we find a disturbing number of omissions of citations in both AR4 and the CCSP foundation documents for *Proposed Endangerment*, consistent with the notion of publication bias.

Stephen Jay Gould described another form of publication bias, which is similar in nature to the normative behavior of science described classically by Thomas Kuhn (1962) in his book, *The Structure of Scientific Revolutions*. Gould (2002: 763) argued that publication bias results from "prejudices arising from hope, cultural expectation, or the definitions of a particular theory [that] dictate

[2]See the Appendix to this article for a sample of important refereed publications that are absent from the AR4, the CCSP documents, and the EPA's TSD, along with their relevance to topics discussed in *Proposed Endangerment*.

only certain kinds of data will be viewed as worthy of publication, or even documentation at all." From the examples we shall give, it is quite clear that *Proposed Endangerment* was not immune to the influence of publication bias.

Another major systematic problem with *Proposed Endangerment* is that it purposefully neglects adaptation both to secular climate and climate change (whether caused by greenhouse gas changes or not). In fact, it is the nature of our species to adapt to climate with clothing, shelter, and social structures. Because it is also natural for climate to *change*, we also adapt to change at the same time. As will be demonstrated below, some of those adaptations in fact result in a society that is *more* resilient to prospective warming caused by greenhouse emissions. The EPA, in a key statement, ignores this, and instead considers adaptation to any climate or climate change as prima facie evidence for negative impacts of greenhouse gases, when in fact such adaptation may immunize society against those negative impacts. The EPA clearly violates this reality when it states:

> However, it is the Administrator's position that the purpose of the endangerment analysis is to assess the risks posed to public health and welfare, rather than to estimate how various adaptation and greenhouse gas mitigation policies may ameliorate or exacerbate any endangerment that exists. Indeed, the presumed need for adaptation and greenhouse gas mitigation to occur to avoid, lessen or delay the risks and impacts associated with human-induced climate change presupposes that there is endangerment to public health or welfare [EPA 2009a: 18894].

We will cite examples where adaptation to natural (as well as anthropogenerated) climate and climate change clearly reduces or in fact may *reverse* endangerment, resulting in improvements in health and welfare despite greenhouse gas induced warming.

Method of Analysis

Our analysis isolates key statements in *Proposed Endangerment* that are either no longer correct, because of changes in global warming science, or are incorrect because of omission of relevant information from the refereed scientific literature. This article offers only a

few examples out of many.[3] However, before that is undertaken, it is important to discuss a major misconception in *Proposed Endangerment* about the documents upon which it is based.

As noted earlier, *Proposed Endangerment* is supported by the EPA's technical support document, which is based upon the CCSP and AR4 reports. As a result, the TSD purports to synthesize "major findings from the best available scientific assessments that have gone through rigorous and transparent peer review" (EPA 2009b).

This is hardly the case. In peer reviewed science, an article, or book, or compilation is submitted to an impartial editor. The editor sends it out to reviewers whose identity is not revealed to the authors. The reviewers comment on the manuscript, recommending acceptance, rejection, or modification.

The editor then sends the reviews, or summarizes them for the authors, asking for changes on the manuscript or response to the review comments as a prerequisite for publication. If the authors do not respond satisfactorily or do not change the manuscript to meet the editor's request, the manuscript is not published.

The IPCC's AR4 clearly does not conform to this model. Instead, compilations of various aspects of climate science, called "zeroeth order," taken from individual contributions of a large number of subspecialists and modified by "coordinating lead authors" (who are chosen by governments rather than by scientists) are sent out for review. The reviewers are *not* anonymous. The lead authors then choose which comments to respond to, and then produce a second draft. There is no independent editor who can demand, upon condition of publication, that certain reviews be either responded to in the text or refuted outside of the text. The EPA is not relying on peer review in the normal scientific sense when it states that the IPCC reports are "peer reviewed."

A similar situation accrues for the CCSP documents. Again, the writers determine which reviews to respond to rather than an editor who is independent of the production process. Finally, the same process applies to the EPA's TSD itself. So it is clear that for the three "foundation" documents cited in *Proposed Endangerment,* their description as "peer reviewed" in no way indicates a review process similar to that which occurs in the traditional refereed scientific literature.

[3]For numerous other examples, see Michaels, Knappenberger, and Davis (2009).

It is noteworthy that every listed reviewer of the TSD is a federal employee who also participated in the production of AR4 and the CCSP. This is hardly independent peer review. The TSD lists 29 authors, of which 9 were involved in AR4 and 13 with CCSP.

Important Errors in *Proposed Endangerment*

Here we give six examples of important errors in *Proposed Endangerment*.

1. Warming Due to Greenhouse Gases Overestimated

Proposed Endangerment confidently attributes "most" of recent warming to change in greenhouse gas concentrations, ignoring recent important scientific papers that, in aggregate, seriously challenge this assertion. According to the EPA study, "The heating effect caused by the human-induced buildup of greenhouse gases in the atmosphere is very likely the cause of most of the observed warming of the last 50 years" (EPA 2009a: 18888).

The reference given in *Proposed Endangerment* is to the IPCC, which implies that this is referring to the IPCC temperature records. Traditionally, the most commonly cited of these is from the Climate Research Unit at the University of East Anglia, a temperature record often referred to as "HadCRUT3" (Brohan et al. 2006). In the last 50 years (1959–2008), the HadCRUT3 data show a rise in global average surface temperature of 0.13°C per decade. However, as much as half of this rise appears to be a result of mistakes in data analysis, which is the implication of an article published in a prominent journal that was ignored in the CCSP background documents (Thompson et al. 2008).

That article (co-authored by several of the same scientists responsible for the compilation of the original temperature dataset[4]) noted that an oft-discussed drop in global surface temperature in the 1940s is apparently an artifact of adjustment of measurements of sea-surface temperature. Compensating for this measurement error has the effect of making the temperatures at the beginning of the last 50-year

[4]P. D. Jones and J. J. Kennedy are co-authors on both Brohan et al. (2006), which describes the surface temperature dataset, as well as on Thompson et al. (2008), which describes the newly found problems with the surface temperature dataset described in Brohan et al. (2006).

period warmer than previously thought and thereby reducing the total warming during this period. Hence, a portion of the net warming thought to be a result of changes in greenhouse gases is in fact a result of error in early measurement techniques. While the net result of the error has yet to be determined, as an updated HadCRUT3 temperature dataset has not yet been published, there has been speculation as to its impact,[5] with some estimates that, once corrected for, the warming rate since the mid-20th century could be reduced by nearly 50 percent (Pielke Jr. 2008).

Foundation documents used by the EPA did not reference work by McKitrick and Michaels (2007), who found a nonurban ("socioeconomic," in their parlance) bias of +0.04°C per decade (beginning in 1979) as a result of land-use, geography, and variables pertaining to data quality. Proportionally adjusting this result for the lower trend in the last half-century, which *must* result from Thompson et al. (2008), lowers warming by an additional 0.02° per decade since 1979.

Similarly, Klotzbach et al. (2009) further document biases in land-based temperature records including "poor exposure of observing sites, effects on temperature trends of concurrent multi-decadal trends in the local surface air humidity, microclimate, non-spatially representative land use change over time, movement of temperature measurements closer to buildings, changes in the turbulent state of the nocturnal boundary layer by surface development and aerosols, and the sampling of temperature data at single heights." They postulate that the net effect of these biases has induced a substantial artificial warming in the land-based surface temperature record.

Additionally, the EPA foundation documents did not reference Pielke Sr. et al. (2007), who found persistent warming biases in the U.S. Historical Climate Network instrumentation citing. This network is one of the most important components of global climate histories.

[5]For example, an article in *The Independent* included a graphic from the U.K.'s Climate Research Unit (the curator of the dataset in question) showing the potential impacts, including the elevation of the temperatures in the mid-20th century (see www.independent.co.uk/environment/climate-change/case-against-climate-change-discredited-by-study-835856.html). S. McIntyre discussed the potential impacts of the temperature correction on his ClimateAudit website (see www.climateaudit.org/?p=3114), as did Roger Pielke Jr. (see sciencepolicy.colorado.edu/prometheus/does-the-ipcc%e2%80%99s-main-conclusion-need-to-be-revisited-4433).

Other research results (in citations absent from the EPA's foundation documents) found that a significant portion of the warming during at least the past three decades has been a result of variations in solar radiation (e.g., Scafetta and West 2007, 2008; Scafetta and Willson 2009). As this is independent of the findings we have previously discussed, addition of this solar impact would have the effect of further lowering the portion of observed warming during the past half-century that can be attributed to greenhouse gas increases.

Further, some important research by Ramanathan and Carmichael (2008) that was referenced in *Proposed Endangerment* was not assimilated into the conclusion that "most of the observed warming of the last 50 years" was caused by human–emitted greenhouse gases. Ramanathan and Carmichael showed that the amount of warming caused by black carbon aerosols (not a greenhouse gas) has been underestimated. When the revised estimates for the degree of warming from black carbon aerosols are accounted for they necessarily reduce the amount of observed warming attributed to greenhouse gases—the total amount of the reduction works out to be approximately 25 percent.

In combination, the above results demonstrate that a key finding in *Proposed Endangerment*—that the buildup of greenhouse gases is very likely to be the cause of most of the observed warming in the last 50 years—is *wrong*.

2. Change in Rates of Sea Level Rise

Another major topic in which findings too recent to be included in *Proposed Endangerment* or its supporting documents have had a major impact on our level of scientific understanding is the rate of observed and future sea level rise. *Proposed Endangerment* states: "There is strong evidence that global sea level . . . is currently rising at an increasing rate" (EPA 2009a: 18898).

But there is a substantial refereed literature, ignored by the AR4 and the CCSP (and thus by *Proposed Endangerment*), questioning whether a recent accelerated sea level rise represents a sustained change or simply short-term variations, or whether we are even able to make such a determination (e.g., Holgate 2007, Wunsch et al. 2007, Willis et al. 2008). Notably, Holgate (2007) concluded from a high-quality set of long-term tide gauge measurements that the rate of sea level rise in recent decades was likely equaled or exceeded

during several occasions within the study period 1904–2003, and that the average rate of sea level rise in the first half of the study period was greater (although not significantly so) than that of the latter half.

Other researchers have found a significant meteorological (as opposed to global warming) influence on the rate of observed sea level rise along the U.S. East Coast (Kolker and Hameed 2007). And perhaps most significantly, research has demonstrated that the calving of Greenland ice sheets is unlikely to dramatically speed up as a result of near-term surface warming (van de Wal et al. 2008, Nick et al. 2009), countering the claims of more rapid sea level rise this century that are made in *Proposed Endangerment*.

None of the above references are in either IPCC AR4 (because of publication deadlines) or the CCSP (because they were ignored), the two "foundation" documents for the TSD that serves as the basis for the *Proposed Endangerment*.

3. Estimates of Future Warming Rates Are Based on Failing Climate Models

Proposed Endangerment bases many of its conclusions upon the future course of climate as projected by climate models used in the IPCC AR4. For example, the EPA study states:

> Future warming over the course of the 21st century, even under scenarios of low emissions growth, is very likely to be greater than observed warming over the past century. . . . Through about 2030, the global warming rate is affected little by the choice of different future emission scenarios, according to IPCC [EPA 2009a: 18899].

However, these climate models are failing—the course of global temperatures thus far in the 21st century *is statistically different* (less than) the projections made by the suite of climate models employed by the IPCC to make climate projections (Michaels et al. 2009). This model failure points to severe deficiencies in the ability of climate models to emulate real-world climate behavior. Models that are unable to simulate known climate behavior cannot produce reliable projections of future climate behavior.

This is readily demonstrated. In recent work (Michaels et al. 2009), we compared the observed global surface temperature trends in recent years to the collective temperature trends projected by the

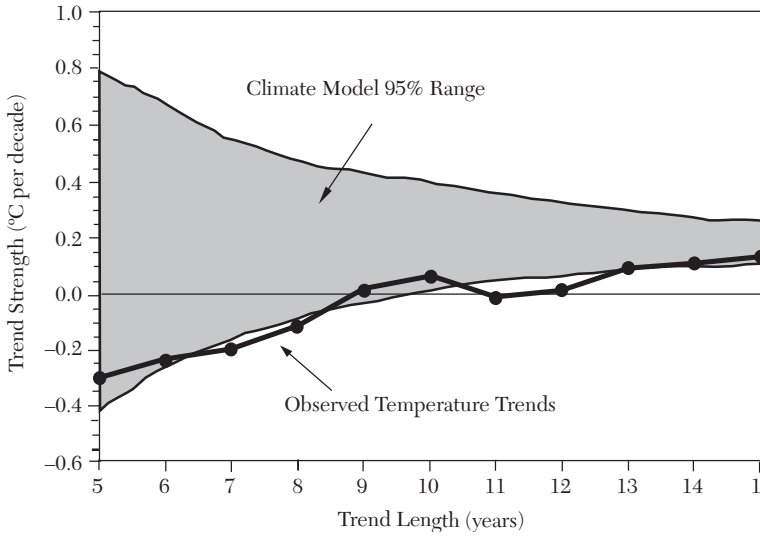
22 models included in the IPCC AR4. The trend in the average global temperature is the most fundamental large-scale climate measure—one that is imperative for models to emulate correctly if they are to accurately model the global climate system. We devised an elementary series of statistical tests aimed at assessing the climate model performance during the longest period possible of overlap between observations and climate model projections—beginning in January 2001.

Taken together, we found that the collective climate model projections were unable to accurately capture the observed trend in global temperatures. The observed trend during the period January 2001 through April 2009 falls well outside of the 95 percent confidence bounds of the model mean trend. Statistically speaking, this signifies that there is a significant difference between the model mean temperature trend and the observed temperature trend—a strong indication that the models and the observations are not representing the same system, in this case, the earth's climate. Since the observations represented reality, the models, therefore, do not.

An additional test was performed to compare the observed trends to climate model projections for trends ranging in length from 5 to 15 years (Michaels 2009). Figure 1 summarizes the comparison of the 95 percent confidence range of the model trends with the observed trend for each trend length from 5 to 15 years (ending in December 2008).[6] Again, the model collective deficiency is evident. The observed trends of length 7, 8, 11, 12, and 13 years all fall below the lower bound of the 95 percent confidence range of all model trends of that length—meaning that the observed trend is statistically significantly different than the collection of model trends for those trend lengths—while the observed trends at the remaining lengths (5, 6, 9, 10, 14, and 15 years) lie very near the lower 95 percent confidence bound. These results point to failed or failing climate models. Consequently, the core models that drive *Proposed Endangerment* are wrong, even if one accepts the temperature record as it stands (that is, without the systematic biases already noted).

[6]The 95 percent confidence range of modeled trends are determined as the mean of the 2.5th and 97.5th percentiles of the ranked distributions of all trends of each length as projected by 22 climate models during the first two decades of the 21st century when run under the IPCC SRES A1B (middle-of-the-road) emissions scenario.

FIGURE 1
THE 95% CONFIDENCE RANGE OF THE TRENDS IN GLOBAL TEMPERATURES PROJECTED BY A COLLECTION OF CLIMATE MODELS, ALONG WITH OBSERVATIONS OF THE SAME QUANTITY



SOURCE: Michaels (2009).

4. Observed Responses of Decreased Mortality to Increased Heat Wave Frequency Have Been Ignored

Proposed Endangerment states:

> There is evidence that unusually hot days and nights and heat waves have become more frequent in the U.S. Severe heat waves are projected to intensify in magnitude and duration over the portions of the U.S. where these events already occur, with likely increases in mortality and morbidity. The populations most sensitive to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and the socially isolated [EPA 2009a: 18901].

However, as shown by a series of papers by Davis et al. (2002, 2003a, 2003b) examining the temporal and spatial patterns of the

relationship between excessive heat and human mortality across the major cities of the United States, the *more* frequent unusually hot days are the *less* sensitive the population is to them. These studies, which were cited in the TSD (EPA 2009b), show that since the mid–1960s, summertime temperatures have increased in major U.S. cities, while at the same time, the mortality rate from extreme heat events has *declined*. Further, the studies show that the population's sensitivity to extreme heat is the *lowest* in those regions of the country that have the *highest* summer temperatures. The locations with the greatest (albeit declining) sensitivity to excessive heat events are generally those regions where the frequency of such events is the lowest (for example, the upper Midwest and Northeast).

An analogous result has been found for Europe (Fouillet et al. 2008). Unexpected heat waves raise the human mortality toll. But, when high summer temperatures become more common, and heat waves become more frequent, the population grows better aware of expected climate conditions and adapts. Note that urban temperatures rise *with* or *without* global warming because of the well-known "urban heat island" effect. This conveniently allows a real-world test of how heat-related mortality changes with warming, even though it is not necessarily from greenhouse-gas changes. The result is obvious adaptation. Consequently, *Proposed Endangerment* is in fact completely unrealistic in eschewing consideration of adaptation, which in this case is provoked by the normal climatic evolution of cities rather than greenhouse-gas emissions.

So, as the unexpected and unusual become more usual and thus more expected, the population becomes better able to respond to them. Therefore, if the projections made in *Proposed Endangerment* (EPA 2009a: 18901) come to pass and "Severe heat waves . . . intensify in magnitude and duration over the portions of the U.S. where these events already occur," history quite clearly demonstrates that they will be met with *declines* in mortality and morbidity—exactly the opposite from the conclusion reached in *Proposed Endangerment*.

5. Large-Scale Agriculture Will Fail because of Global Warming

Proposed Endangerment states:

> CCSP concluded that, with increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress

> more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable [EPA 2009a: 18902].

Yet, U.S. farmers have constantly changed their farming practices—tillage, crop varieties, irrigation, fertilizers, equipment—to produce increasing crop yields over the varying conditions that they face (climate, soil, landscape, etc.). Most of these changes result from on-going technical advances including the development of new crop varieties that produce greater yields and are more resistant to environmental variables, including insects and weeds (Fernandez-Cornejo and Caswell 2006). These improvements are an on-going facet of modern farming and will undoubtedly continue into the future as a changing climate, changing landscape, and changing food consumption patterns place a demand on the farmers of tomorrow. Increases in yields of major crops have occurred concurrent with the climate changes that have occurred across the United States during the past 100 years (Figure 2).

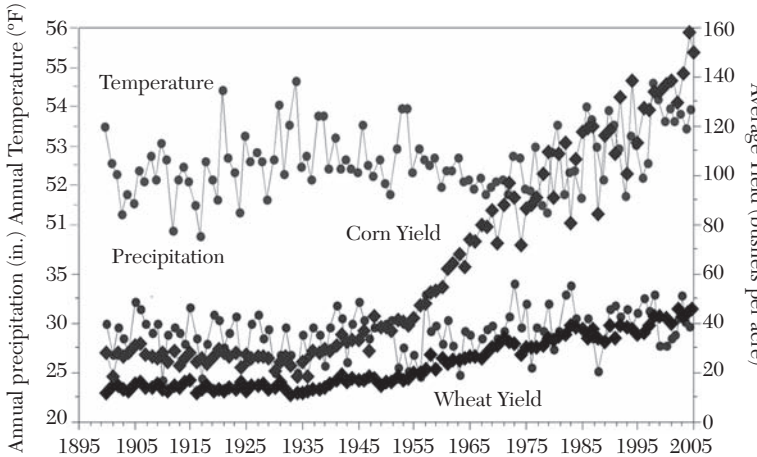
The aerial distribution of major U.S. crops demonstrates the adaptability of American agriculture (USDA 2009). Soybeans are grown from the Gulf of Mexico to the Canadian border. The range of corn is almost as large. If there were substantial warming beyond this large climatic range, there is no doubt that there would be a shift over to other crops that would provide considerable protein and carbohydrate sources under hotter conditions, such as grain sorghum and sugar cane. In general, the U.S. climate is not sufficiently warm to make these economically viable today, which is why they are currently relegated to tropical climates.

6. The Positive Response of Primary Agriculture to the Direct Stimulative Effects of Carbon Dioxide Differentiates It as a Greenhouse Gas

Proposed Endangerment states:

> She [the administrator] proposes to make this finding specifically with respect to six greenhouse gases that together constitute the root of the climate change problem: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride [EPA 2009a: 18886].

FIGURE 2
Historical U.S. Annual Average Yields of Corn and Wheat, along with U.S. Annual Average Temperature and Precipitation



Sources: Crop data available from the U.S. Department of Agriculture's National Agriculture Statistics Service (www.nass.usda.gov/); climate data available from the National Oceanic and Atmospheric Administration's National Climatic Data Center (www.ncdc.noaa.gov).

However, the impacts from carbon dioxide are different in kind from the impacts of the other five greenhouse gases that the EPA proposed to combine into one entity for regulation. Unlike the other gases, CO_2 acts as a plant fertilizer that enhances growth and productivity (Idso and Idso 2001, Norby et al. 2005), increases the efficiency of plant water use allowing more growth using less water (Pospisilova and Catsky 1999, Yoshimoto et al. 2005), and protects plants from the negative impacts of ground level ozone (Poorter and Perez-Soba 2001, Booker et al. 2005). The overall impact from CO_2 increases on agricultural plants is overwhelmingly positive, as has been firmly established in the scientific literature for years (Idso 1989). Growing more productive plants, including forests and crops is surely a net benefit to human health and welfare. Therefore, based upon the unique impact on the planet's plant life, CO_2 should not be grouped with the other five greenhouse gases. It should be treated as

a separate entity, and its role on the public health and welfare gauged independently.

Conclusion

Proposed Endangerment exemplifies the systematic errors that accumulate at the interface between science and policy when policymakers (in this case, the U.S. Environmental Protection Agency) rely upon previously assembled "compendia" of science, such as the IPCC's AR4 report or the CCSP documents. It is particularly dangerous, in the area of global warming, when an entity takes "this approach rather than conducting a new assessment of the scientific literature" (quotation from *Proposed Endangerment* [EPA 2009a: 18894]).

Proposed Endangerment relies on compendia that are subject to Rosenthal's (1979) "publication bias," which results in a skewed scientific literature. Resulting compendia, such as those used by the EPA, are likely to suffer from this bias (Michaels 2008). It is noteworthy that this bias is well documented in disciplines other than climate science. Additionally disturbing are the large number of missing citations that are highly germane to arguments put forth in *Proposed Endangerment* (see the Appendix for a representative listing).

Moreover, the "foundation documents"—the TSD, the AR4, and the CCSP reports—are clearly not "peer reviewed" in any fashion similar to the peer review process for normal scientific publication. Further, the cross-breeding between the authors and reviewers of these reports is appallingly large.

Our examples of areas where *Proposed Endangerment* refused to consider or ignored significant citations from refereed science represent only a small amount of the incomplete science in the EPA's overall document. But, as such, they demonstrate systematic shortcomings in the science backing *Proposed Endangerment*. It is doubtless that this problem will continue to plague the EPA should it propose regulation of greenhouse emissions.

Appendix: A Sample of Relevant Refereed Publications Not Cited in the Climate Change Science Program (CCSP) References, the Fourth Assessment Report (AR4) of the IPCC, or the Technical Support Document (TSD) for *Proposed Endangerment*

de Laat, A. T. J., and Maurellis, A. N. (2006) "Evidence for Influence of Anthropogenic Surface Processes on Lower Tropospheric and Surface Temperature Trends." *International Journal of Climatology* 26: 897–913. (Relevance: Surface temperature trends in recent decades in CCSP and AR4 that serve as the basis for *Proposed Endangerment* are contaminated with nonclimatic signals and are overestimated.)

Douglass, D. H., et al. (2007) "A Comparison of Tropical Temperature Trends with Model Predictions." *International Journal of Climatology:* doi: 10.1002/joc.1651. (Relevance: Modeled and observed patterns of warming are significantly different in a large portion of the upper troposphere, invalidating the models that base *Proposed Endangerment*.)

Dyck, M. G., et al. (2007) "Polar Bears of Western Hudson Bay and Climate Change: Are Warming Spring Air Temperatures the 'Ultimate' Survival Control Factor?" *Ecological Complexity* 4: 73–84. (Relevance: High temperatures in northwest North America are associated with high populations of polar bears, which are central to Inuit culture. This fact obviates some of the concern for Alaskan natives expressed in *Proposed Endangerment*.)

Fouillet, A., et al. (2008) "Has the Impact of Heat Waves on Mortality Changed in France since the European Heat Wave of Summer 2003? A Study of the 2006 Heat Wave." *International Journal of Epidemiology* 37: 309–17, doi: 10.1093/ije/dym253. (Relevance: People easily adapt to urban heat waves, a phenomenon specifically ignored in *Proposed Endangerment*.)

Gerten, D., et al. (2008) "Causes of Change in 20th Century Global River Discharge." *Geophysical Research Letters* 35: L20405, doi: 10.1029/2008GL035258. (Relevance: Secular interdecadal variability in floods caused by heavy precipitation dominates that which might be associated with climate change, compromising the assertions in *Proposed Endangerment*.)

Gosling, S., et al. (2008) "Associations between Elevated Atmospheric Temperature and Human Mortality: A Critical Review of the Literature." *Climate* Change: doi: 10.1007/s10584–008–9441–x. (Relevance: Populations must be adjusted for age distribution before inferring the effects of climate or climate changes, which was not done in *Proposed Endangerment*.)

Hartmann, B., and Wendler, G. (2005) "On the Significance of the 1976 Pacific Climate Shift in the Climatology of Alaska." *Journal of Climate* 18: 4824–39. (Relevance: Alaskan warming is dominated by a single step-change warming, invalidating the models used in *Proposed Endangerment*.)

Holgate, S. J. (2007) "On the Decadal Rates of Sea Level Change during the 20th Century." *Geophysical Research Letters* 34: L01602, doi: 10.1029/2006GL028492. (Relevance: "Accelerations" in sea level rise may be an artifact of data analyses, counter to what is claimed in *Proposed Endangerment*.)

Hu, F. S., et al. (2001) "Pronounced Climatic Variations in Alaska during the Last Two Millennia." *Proceedings of the National Academy of Sciences* 98: 10552–556. (Relevance: The present warm period in Alaska has been equaled on several previous extended occasions in the past 2,000 years and thus is not particularly unusual.)

Hume, J. D., and Schalk, M. (1967) "Shoreline Processes near Barrow Alaska: A Comparison of the Normal and the Catastrophic." *Arctic* 20 (2): 86–103. (Relevance: North Alaskan shorelines have been eroding rapidly with or without global warming and affecting native settlements; *Proposed Endangerment* conflates the erosion with global warming.)

Hume, J. D., et al. (1972) "Short-term Climate Changes and Coastal Erosion, Barrow Alaska." *Arctic* 25 (4): 272–78. (Relevance: North Alaskan shorelines have been eroding rapidly with or without global warming and affecting native settlements; *Proposed Endangerment* conflates the erosion with global warming.)

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Klotzbach, P. J., et al. (2009) "An Alternative Explanation for Differential Temperature Trends at the Surface and in the Lower Troposphere." *Journal of Geophysical Research* (forthcoming). (Relevance: The observed warming in the surface temperature record is contaminated by nonclimatic signals that lead to a warming bias in the global temperature history, meaning that the amount of global temperature rise assigned in *Proposed Endangerment* to anthropogenic greenhouse gas emissions is overestimated.)

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Research 112: D24S09, doi: 10.1029/2007JD008465. (Relevance: Surface temperature trends in recent decades in CCSP and AR4 that serve as the basis for *Proposed Endangerment* are contaminated with nonclimatic signals are are overestimated.)

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Pielke Sr., R. A., et al. (2007) "Documentation of Uncertainties and Biases Associated with Surface Temperature Measurement Sites for Climate Change Assessment." *Bulletin of the American Meteorological Society* 88: 913–28. (Relevance: Persistent warm bias in the U.S. Historical Climate Network stations means that *Proposed Endangerment* has overestimated U.S. warming.)

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Scafetta, N., and West, B. J. (2006) "Phenomenological Solar Contribution to the 1900–2000 Global Surface Warming." *Geophysical Research Letters:* doi: 1029/2005GL025539. (Relevance: Sensitivity of temperature to carbon dioxide may be less than assumed in the models that serve as a basis for *Proposed Endangerment*.)

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Thompson, D. W., et al. (2008) "A Large Discontinuity in the Mid-Twentieth Century in Observed Global-Mean Surface Temperature." *Nature* 453: 646–50. (Relevance: Accounting for this discontinuity reduces warming in the last half-century, which implies a much lower sensitivity of temperature to carbon dioxide than is assumed in the models that back *Proposed Endangerment*.)

van de Wal, R. S., et al. (2008) "Large and Rapid Melt-Induced Velocity Changes in the Ablation Zone of the Greenland Ice Sheet." *Science* 321: 111–13. (Relevance: Rapid changes in ice-stream velocity are transient features rather than permanent inductions of global warming, as is considered "likely" in *Proposed Endangerment*.)

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Wunsch, C., et al. (2007) "Decadal Trends in Sea Level Patterns, 1993–2004." *Journal of Climate* 20: 5889–5911. (Relevance: "Accelerations" in sea level rise may be an artifact of data analyses, counter to what is claimed in *Proposed Endangerment*.)

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