WEST VIRGINIA
LAW REVIEW

Volume 116 Spring 2014 Issue 3
ENERGY AND SUSTAINABILITY ISSUE

UNRINGING THE BELL: TIME FOR EPA TO RECONSIDER ITS GREENHOUSE GAS ENDANGERMENT FINDING

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I. INTRODUCTION

One of the most controversial and most consequential actions by the Environmental Protection Agency ("EPA") was its declaration that anthropogenic emissions of six well-mixed greenhouse[1] gases ("GHGs")[2] are

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[1] The greenhouse effect is a bit of a misnomer. Rather than preventing convection of warm air into space, as the glass of a greenhouse prevents heat from leaving the building, GHGs "absorb and reradiate in all directions outgoing, infrared radiation that would otherwise directly escape into space." CLIMATE CHANGE DIV., OFFICE OF ATMOSPHERIC PROGRAMS, U.S. ENVTL. PROT. AGENCY, TECHNICAL SUPPORT DOCUMENT FOR ENDANGERMENT AND CAUSE OR

pollutants subject to regulation under the Clean Air Act ("CAA"). That determination, expressed in EPA's "Endangerment Finding,"[3] was based on a belief that GHG emissions are causing climate change that poses a danger to human health and the environment. EPA's Endangerment Finding ("Endagerment Finding" or "Finding") was supported by a Technical Support Document[4] ("TSD") that set forth the scientific basis for its decision.

Two unavoidable facts weigh heavily against the Endangerment Finding. Worldwide temperatures have plateaued for the last 16 or 17 years, while GHG levels have continued to rise. This directly contradicts the basic theory of those who claim that GHGs are driving climate change by increasing temperatures, and undercuts the very foundation of the Endangerment Finding.

In the last four years, these and other data, along with continuing scientific research, have called the Endangerment Finding into question. The current state of the science is such that EPA should reconsider its Endangerment Finding in an open, transparent fashion that invites widespread participation and independent review from a variety of scientific disciplines. EPA should introduce a higher level of scientific rigor that sets standards for evaluating the effect of increasing GHGs and should develop metrics for fairly evaluating whether those effects pose a danger to Americans.

This Article will provide a brief background of the history of GHG regulation, leading up to the Supreme Court's anticipated ruling in the Spring of 2014 on GHG regulation.[5] A discussion of the scientific basis for EPA's Endangerment Finding will follow, along with a critique of the reasons cited by EPA as the basis for the Finding. The final Part will present some steps EPA might take to introduce more clarity and accountability into the debate over the extent and nature of the effects of GHGs.

CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER SECTION 202(A) OF THE CLEAN AIR ACT 23 (2009), *available at* [hereinafter TSD] http://permanent.access.gpo.gov/gpo34148/Endangerment_TSD.pdf.

2 Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

3 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009) [hereinafter Endangerment Finding] (to be codified at 40 C.F.R. ch. 1).

4 TSD, *supra* note 1.

5 SUPREME COURT, ORDER LIST: 571 U.S. 2–3 (Oct. 15, 2013), *available at* http://www.supremecourt.gov/orders/courtorders/101513zor_4g25.pdf [hereinafter ORDER LIST] (granting certiorari to *Utility Air Regulatory Group v. EPA*, *Am. Chemistry Council v. EPA*, *Energy-Intensive Mfrs. Working Group on Greenhouse Gas Regulation v. EPA*, *Se. Legal Found. v. EPA*, *Texas v. EPA*, and *Chamber of Commerce v. EPA*, and consolidating the cases).

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II. EPA'S REGULATION OF GREENHOUSE GASES

A. Petitions for Rulemaking Pursuant to Clean Air Act Section 202

On October 20, 1999, 19 organizations jointly petitioned EPA to regulate emissions of carbon dioxide ("CO_2"), methane ("CH_4"), nitrous oxide ("N_2O"), and hydrofluorocarbons ("HFCs") from new motor vehicles and new motor vehicle engines under Section 202 of the Clean Air Act.[6] Section 202(a)(1) authorizes EPA to regulate emissions of air pollutants from motor vehicles:

> The Administrator shall by regulation prescribe (and from time to time revise) in accordance with the provisions of this section, standards applicable to the emission of any air pollutant from any class or classes of new motor vehicle or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.[7]

The petitioners claimed that GHGs "meet the CAA's broad statutory definition of 'air pollutant,'"[8] and that "U.S. mobile sources are responsible for a significant amount of greenhouse gas emissions."[9] Citing the United Nations Intergovernmental Panel on Climate Change ("IPCC")[10] for the proposition that

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6 Petition for Rulemaking and Collateral Relief Seeking the Regulation of Greenhouse Gas Emissions from New Motor Vehicles under § 202 of the Clean Air Act, Int'l Ctr. For Tech. Assessment v. Browner (Oct. 20, 1999) [hereinafter Petition for Rulemaking], *available at* http://www.ciel.org/Publications/greenhouse_petition_EPA.pdf. Although not the primary sources of GHGs, mobile source (e.g., cars and trucks) regulation provided the simplest avenue for bringing GHGs within the ambit of Clean Air Act regulation. Had the petitioning organizations asked EPA to develop a National Ambient Air Quality Standard for GHGs, EPA would have faced the daunting task of developing air quality criteria. By asking for regulation of GHGs under the mobile source provisions of the CAA, all that the organizations needed to do was to convince EPA (or a court) that GHGs are an air pollutant. Once that was established, controls for GHGs from mobile sources were compelled and, under EPA's interpretation of the CAA, controls for GHGs from stationary sources were required as well. As noted later in this Article, the United States Supreme Court is considering whether regulation of GHGs from mobile sources compels EPA to regulate GHGs from other sources as well. *See infra* Part II.C.

7 42 U.S.C. § 7521(a)(1) (2012).

8 Petition for Rulemaking, *supra* note 6, at 10.

9 *Id.* at 8.

10 The Intergovernmental Panel on Climate change was created by the United Nations Environment Programme and the World Meteorological Organization ("WMO") in 1988. It is open to all member countries of the U.N. and WMO, and "reviews and assesses the most recent scientific, technical, and socio-economic information produced worldwide relevant to the

GHG emissions "are significantly accelerating" global warming,[11] the petitioners asserted that such warming posed a serious danger to both the public health and the public welfare.[12] The petitioners therefore urged EPA to "make a precautionary decision to regulate pollutants" despite any scientific uncertainty, and to fulfill its "mandatory duty to regulate greenhouse gas emissions from new motor vehicles under § 202(a)(1) of the CAA."[13]

After four years consideration, EPA issued its Notice of Denial of Petition for Rulemaking on September 8, 2003.[14] EPA concluded that "the CAA does not authorize EPA to regulate for global climate change purposes, and accordingly that CO_2 and other GHGs cannot be considered 'air pollutants' subject to the CAA's regulatory provisions for any contribution they may make to global climate change."[15] Among other reasons EPA gave for its decision was the substantial scientific uncertainty regarding "the causes, extent and significance of climate change and the potential options for addressing it."[16] As such, regulating GHGs under Section 202(a) would be an "inefficient, piecemeal approach to addressing the climate change issue."[17] EPA also rejected the notion that regulating GHGs under the Clean Air Act's National Ambient Air Quality Standards ("NAAQS") program[18] was a viable alternative,

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understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters." *Organization*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, http://www.ipcc.ch/organization/organization.shtml#.UxXyTWeYbct (last visited Mar. 1, 2014).

11 Petition for Rulemaking, *supra* note 6, at 7.

12 *Id.* at 14.

13 *Id.* at 9.

14 Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. 52,922 (Sept. 8, 2003).

15 *Id.* at 52,925.

16 *Id.* at 52,931.

17 *Id.*

18 42 U.S.C. §§ 7408–7409 (2012). This program authorizes EPA to regulate

> each air pollutant— (A) emissions of which, in [the Administrator's] judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare; (B) the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and (C) for which air quality criteria had not been issued before December 31, 1970 but for which [the Administrator] plans to issue air quality criteria under this section.

42 U.S.C. § 7408(a)(1). Currently, there are six "criteria" air pollutants regulated under this section: sulfur dioxide, particulate matter, carbon monoxide, ground level ozone, nitrogen oxides, and lead. 40 C.F.R. §§ 50.4–50.18 (2013). Once a criteria air pollutant has been added to the list, EPA "must issue criteria for that pollutant that summarize the scientific knowledge about it, publish information about techniques to control the pollutant and—simultaneously with the issuance of the criteria—propose primary and secondary ambient air quality standards for later

as "[u]nique and basic aspects of the presence of key GHGs in the atmosphere make the NAAQS system fundamentally ill-suited to addressing these gases in relation to global change."[19]

B. Massachusetts v. EPA

EPA's rejection was not the end of the matter, however. "[T]welve states, three cities, an American territory, and numerous environmental organizations" challenged EPA's decision before the U.S. Court of Appeals for the District of Columbia Circuit in *Massachusetts v. EPA*.[20] On July 15, 2005, the D.C. Circuit affirmed EPA's decision, holding that, in view of scientific and policy considerations, the "EPA Administrator properly exercised his discretion under § 202(a)(1) in denying the petition for rulemaking." [21]

The U.S. Supreme Court reversed the D.C. Circuit's judgment on April 2, 2007, in *Massachusetts v. EPA*.[22] The Court held that the Clean Air Act's definition of "air pollutant" was broad enough to encompass GHGs[23] and that, "[i]f EPA makes a finding of endangerment, the Clean Air Act requires the agency to regulate emissions of the deleterious pollutant from new motor vehicles."[24] As a final point, the Court dismissed the notion that scientific uncertainty precluded EPA from making a judgment under Section 202(a):

> Nor can EPA avoid its statutory obligation by noting the uncertainty surrounding various features of climate change and concluding that it would therefore be better not to regulate at

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promulgation." Craig N. Oren, *When Must EPA Set Ambient Air Quality Standards? Looking Back at* NRDC v. Train, 30 UCLA J. ENVTL. L. & POL'Y 157, 166 (2012); *see also* 42 U.S.C. §§ 7409(a)(2), 7409(b). The NAAQS prescribe the maximum amount of each air pollutant that can be present in the ambient air in a given time period. Primary NAAQS are those "which the Administrator judges are necessary, with an adequate margin of safety, to protect the public health." 40 C.F.R. § 50.2(b) (2013); *see also* 42 U.S.C. § 7409(b)(1). Secondary NAAQS are those "which the Administrator judges are necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant." 40 C.F.R. § 50.2(b); *see also* 42 U.S.C. § 7409(b)(2).

19 Control of Emissions from New Highway Vehicles and Engines, 68 Fed. Reg. at 52,927; *see also* Craig N. Oren, *Is the Clean Air Act at a Crossroads?*, 40 ENVTL. L. 1231, 1246–49 (2010) (discussing the difficulties of establishing NAAQS for GHGs). One could speculate that this is the reason that the petitioners targeted Section 202(a) as a means of regulating GHGs—it was the path of least resistance.

20 415 F.3d 50, 53 (D.C. Cir. 2005).

21 *Id.* at 58.

22 549 U.S. 497 (2007).

23 *Id.* at 532.

24 *Id.* at 533.

> this time. If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so. That EPA would prefer not to regulate greenhouse gases because of some residual uncertainty . . . is irrelevant. The statutory question is whether sufficient information exists to make an endangerment finding.[25]

Thus, the Court remanded the case back to EPA.[26]

C. GHG Rulemakings Following Massachusetts v. EPA

In response to the U.S. Supreme Court's decision in *Massachusetts v. EPA*, EPA promulgated its "Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act" as a Final Rule on December 15, 2009.[27] EPA announced that "[p]ursuant to CAA section 202(a), the Administrator finds that greenhouse gases in the atmosphere may reasonably be anticipated both to endanger public health and to endanger public welfare."[28] Additionally, "emissions of well-mixed greenhouse gases from the transportation sources covered under CAA section 202(a) contribute to the total greenhouse gas air pollution, and thus to the climate change problem, which is reasonably anticipated to endanger public health and welfare."[29] In short, EPA decided that GHGs have been increasing in the atmosphere as a result of anthropogenic activity; that temperatures have been rising for at least the last 100 years; that the latter is likely being caused by the former; and that the effects of the GHG emissions, and any concomitant warming, will be, on the whole, bad for mankind and the environment. Consequently, mobile source emissions of GHGs would be subject to regulation.

About the time that EPA issued the Endangerment Finding, hundreds of hacked emails from the Climate Research Unit at East Anglia University were released, which raised significant questions about possible ethical lapses and the scientific rigor of many of the scientists who were warning of catastrophic changes as a result of GHG emissions.[30] These and other concerns

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25 *Id.* at 534.

26 *Id.* at 535.

27 Endangerment Finding, 74 Fed. Reg. 66,496 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

28 *Id.* at 66,497.

29 *Id.* at 66,499.

30 Fred Pearce, *Climate Change Emails Between Scientists Reveal Flaws in Peer Review*, GUARDIAN (U.K.) (Feb. 2, 2010), http://www.theguardian.com/environment/2010/feb/02/hacked-climate-emails-flaws-peer-review.

about the data relied upon by EPA in issuing the Endangerment Finding led to the filing of ten petitions for reconsideration, which EPA rejected.[31]

1. The Timing Rule

The ramifications of the Endangerment Finding extended beyond mobile sources, because EPA takes the position that air pollutants from mobile sources regulated under Section 202(a) also must be regulated under the PSD permitting program for stationary sources.[32] In its "Timing Rule," EPA explained its reasoning and announced that GHGs emitted from stationary sources would also be regulated under the Clean Air Act's Prevention of Significant Deterioration of Air Quality ("PSD") permitting program in Title I of the Clean Air Act.[33] Under PSD, new or modified "major stationary sources" which produce or may potentially produce emissions of "any regulated NSR pollutant" above a certain threshold require a pre-construction permit.[34] Stationary sources are required to install the "best available control technology" for that type of source.[35] Accordingly, GHGs would officially be "subject to regulation" on the date that the Tailpipe Rule was set to take effect for mobile sources, thus triggering requirements for stationary sources as well under PSD and Title V.[36]

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[31] EPA's Denial of the Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 75 Fed. Reg. 49,556 (Aug. 13, 2010) [hereinafter Denial of Petitions] (to be codified at 40 C.F.R. ch. 1).

[32] Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs, 75 Fed. Reg. 17,004 (Apr. 2, 2010) [hereinafter Timing Rule] (to be codified at 40 C.F.R. pts. 50, 51, 70, 71). In the Timing Rule, EPA used the same reasoning to justify regulation of GHGs under Title V of the Clean Air Act. This program requires sources which produce or may potentially produce emissions of "any air pollutant" above a certain threshold to obtain an operating permit. Such permits "assure[] compliance . . . with all [Clean Air Act] requirements," including those under the PSD program. 40 C.F.R. § 70.1(b) (2013).

[33] Timing Rule, 75 Fed. Reg. at 17012–23. It is this issue that the Supreme Court has agreed to decide during its current term.

[34] AIR QUALITY PROD. DIV., OFFICE OF AIR QUALITY PLANNING STANDARDS, U.S. ENVTL. PROT. AGENCY, PSD AND TITLE V PERMITTING GUIDANCE FOR GREENHOUSE GASES 6–7 (2011) [hereinafter Permitting Guidance], *available at* http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf.

[35] *See generally id.* at 17–44.

[36] *Id.* at 3 (explaining that EPA's Light-Duty Vehicle Rule, also known as the "Tailpipe Rule," see *infra* note 37, was set to take effect on January 2, 2011).

2. The Tailpipe Rule

On May 7, 2010, EPA issued the "Tailpipe Rule," establishing GHG emission standards for mobile sources "as part of its efforts to expeditiously respond to the Supreme Court's nearly three year old ruling."[37] Among other things, EPA established carbon dioxide emissions standards for cars and trucks built for model years 2012 through 2016.[38]

3. The Tailoring Rule

Having previously determined that GHGs would be regulated under the PSD and Title V stationary source permitting programs on the date the Tailpipe Rule went into effect, EPA's "Tailoring Rule"[39] then tried to ameliorate the anticipated ramifications of those actions. EPA acknowledged that the potential effects of regulating GHGs from stationary sources included "greatly increasing the number of required permits, imposing undue costs on small sources [of GHGs], overwhelming the resources of permitting authorities, and severely impairing the functioning of the programs."[40] GHGs, especially carbon dioxide, are so ubiquitous that the number of major sources that emit 100 or 250 tons[41] of GHGs, particularly carbon dioxide, runs into the millions, a potential permitting burden that the states and EPA could not handle.[42] To

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[37] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25,324, 25,402 (May 7, 2010) [hereinafter Tailpipe Rule] (to be codified at 40 C.F.R. pts. 85, 86, 600). This was a joint rulemaking with the Department of Transportation's National Highway Traffic Safety Administration setting Corporate Average Fuel Economy (CAFÉ) Standards for cars and light duty trucks.

[38] Tailpipe Rule, 75 Fed. Reg. at 25,329–30 ("In this notice, EPA . . . is setting national CO_2 emissions standards for light-duty vehicles under section 202(a) of the Clean Air Act . . . [that] will require these vehicles to meet an estimated combined average emissions level of 250 grams/mile of CO_2 in model year 2016.").

[39] Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) [hereinafter Tailoring Rule] (to be codified at 40 C.F.R. pts. 51, 52, 70, 71).

[40] *Id.*

[41] The level of emissions which qualify a source as "major" depend on whether or not the source falls in one of the categories specified in 40 C.F.R. § 51.166(b)(1)(i)(a) (2013) or 40 C.F.R. § 52.21(b)(1)(i)(a) (2013).

[42] EPA, FINAL RULE: PREVENTION OF SIGNIFICANT DETERIORATION AND TITLE V GREENHOUSE GAS TAILORING RULE, FACT SHEET 1 (2010) [hereinafter FACT SHEET], *available at* http://www.epa.gov/NSR/documents/20100413fs.pdf ("Without this tailoring rule, the lower emissions thresholds would take effect automatically for GHGs on January 2, 2011. PSD and title V requirements at these thresholds would lead to dramatic increases in the number of required permits—tens of thousands of PSD permits and millions of title V permits.").

reduce the pool of potential permittees, EPA pulled from its hat various legal doctrines that, in EPA's view, allowed it to "tailor[] the applicability criteria that determine which GHG emission sources become subject to the PSD and Title V programs."[43] In short, EPA elected to only regulate large GHG sources, and effectively modified the definition of a "major source" in order to do so.[44]

Ten petitions were submitted to EPA by affected companies, industrial associations and states that challenged the Endangerment Finding, the Tailoring Rule, and the Timing Rule. The petitions were denied via a Notice issued on August 13, 2010.[45] Many of these petitioners then sought judicial review in the U.S. Court of Appeals for the District of Columbia Circuit, which affirmed the Rules on June 26, 2012.[46]

No fewer than nine petitions for writs of certiorari were subsequently filed with the U.S. Supreme Court,[47] all taking issue with the "cascading series of greenhouse gas-related rules and regulations."[48] The nine petitioners objected to various aspects of the Endangerment Finding, the Timing and Tailoring Rules, and challenged the D.C. Circuit's decision affirming the Endangerment Finding on a number of grounds. However, a common refrain in several petitions was that EPA's scientific basis was utterly lacking, rendering the Endangerment Finding (and the subsequent rulemakings) irrational.[49]

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43 Tailoring Rule, 75 Fed. Reg. at 31,516 (June 3, 2010).

44 *See* FACT SHEET, *supra* note 42, at 1. The levels at which regulation began were phased in over time, but initially they were set at 75,000 tons per year of CO_2 (carbon dioxide equivalent) for sources that otherwise were subject to PSD permitting, and later were extended to regulation of new sources of 100,000 tons per year CO_2. *Id.*

45 Denial of Petitions, 75 Fed. Reg. 49,556 (Aug. 13, 2010) (to be codified at 40 C.F.R. ch. 1).

46 Coal. for Responsible Regulation v. EPA, 684 F.3d 102 (D.C. Cir. 2012).

47 Petition for Writ of Certiorari, Chamber of Commerce of U.S. v. EPA, No. 12-1272, 2013 WL 1752521 (Apr. 19, 2013); Petition for Writ of Certiorari, Se. Legal Found., Inc. v. EPA, No. 12-1268, 2013 WL 1751482 (Apr. 19, 2013); Petition for Writ of Certiorari, Texas v. EPA, (Apr. 19, 2013), *available at* http://washingtonpropertylawyer.typepad.com/GHG_Rule_SCOTUS_Review/Cert_Petitions/Texas.pdf; Petition for Writ of Certiorari, American Chemistry Council v. EPA, No. 12-1248, 2013 WL 1697570 (Apr. 18, 2013); Petition for Writ of Certiorari, Coal. for Responsible Regulation, Inc. v. EPA, No. 12-1253, 2013 WL 1697572 (Apr. 17 2013); Petition for Writ of Certiorari, Energy-Intensive Mfrs. Working Group on Greenhouse Gas Regulation v. EPA, No. 12-1254, 2013 WL 1697573 (Apr. 17, 2013); Petition for Writ of Certiorari, Pac. Legal Found. v. EPA, No. 12-1153, 2013 WL 1177276 (Mar. 20, 2013); Petition for Writ of Certiorari, Utility Air Regulatory Group v. EPA, No. 12-1146, 2013 WL 1191182 (Mar. 20, 2013); Petition for Writ of Certiorari, Virginia v. EPA, No. 12-1152, 2013 WL 1177275 (Mar. 20, 2013).

48 *Coal. for Responsible Regulation*, 684 F.3d at 114.

49 *See, e.g.*, Petition for Writ of Certiorari, Se. Legal Foundation v. EPA, 2013 WL 1751482 (Apr. 19, 2013) at *10–17 (arguing that the Endangerment Finding should fail because "EPA's

Following its October 15, 2013, conference, the U.S. Supreme Court granted certiorari for six of the nine petitions.[50] The Court indicated that it would limit its review to the sole question of "[w]hether EPA permissibly determined that its regulation of greenhouse gas emissions from new motor vehicles triggered permitting requirements under the Clean Air Act for stationary sources that emit greenhouse gases."[51] The Court will consider the legal question of whether regulation of GHGs as a mobile source automatically makes them regulated pollutants for stationary sources, but will not take action to address the scientific conclusions underlying the Endangerment Finding.

III. KEY ASPECTS OF THE ENDANGERMENT FINDING

A. Basis for the Endangerment Finding and Standard of Decision

Regulation of GHGs has been justified by EPA's premise, expressed in the Endangerment Finding, that greenhouse gases have caused temperatures to rise around the earth. EPA states flatly that "[w]arming of the climate system is unequivocal"[52] and that "[i]t is also well established that [GHGs] can exert a warming effect on the climate by trapping in heat that would otherwise escape to space."[53] Moreover, "[a]ll three [global temperature datasets developed by NOAA, NASA, and the United Kingdom's Hadley Center] show an unambiguous warming trend over the past 100 years."[54]

While an increase in temperatures over the last 100 or more years or so is fairly widely acknowledged,[55] the attribution of that increase to GHGs is a

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three lines of evidence are either weak and equivocal or outright invalid"); Petition for Writ of Certiorari, Pac. Legal Found. v. EPA, 2013 WL 1177276 (Mar. 20, 2013) at *5–8 (arguing that EPA ignored its statutory duty to submit its Endangerment Finding to the Science Advisory Board for peer review); Petition for Writ of Certiorari, Virginia v. EPA, 2013 WL 1177275 (Mar. 20, 2013) at *19–26 (arguing that EPA "failed to observe basic information quality standards" by relying on an unreliable report by the IPCC to make its Endangerment Finding).

50 *See* ORDER LIST, *supra* note 5.

51 *Id.* at 3.

52 Endangerment Finding, 74 Fed. Reg. 66,496, 66,517 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

53 *Id.*

54 *Id.*

55 *See, e.g.*, *How much has the global temperature risen in the last 100 years?*, UNIV. CORP. FOR ATMOSPHERIC RESEARCH, https://www2.ucar.edu/climate/faq/how-much-has-global-temperature-risen-last-100-years (last visited Mar. 1, 2014); Phil Jones, Colin Harpham, & Mike Salmon, *Temperature Data*, UNIV. OF EAST ANGLIA'S CLIMATIC RESEARCH UNIT, http://www.cru.uea.ac.uk/cru/data/temperature/ (last updated Jan. 2013). However, the extent of the temperature increase is still debated. For example, the temperature datasets relied on by EPA have been modified, with the modifications primarily reducing pre-1940s temperatures and

subject of greater dispute. Correlation is not causation,[56] as the mere rise in temperatures at a time of rising GHGs is not proof that the former is caused by the latter. Some scientific evidence is needed to tie the rise of GHGs to the increase in temperatures. EPA found that proof in three lines of evidence:

> [Its] basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors and other human impacts . . . indirect, historical estimates of past climate changes that suggest that the changes in global surface temperatures over the last several decades are unusual . . . [and] computer-based climate models. . . .[57]

In weighing these categories of evidence and reaching a decision on whether to regulate GHGs from mobile sources, EPA decided it did not have to wait for scientific certainty as to whether GHGs were driving climate change.

> Because scientific knowledge is constantly evolving, the Administrator may be called upon to make decisions while recognizing the uncertainties and limitations of the data or information available, as risks to public health or welfare may involve the frontiers of scientific or medical knowledge. At the

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increasing temperatures after 1950 to show an upward trend in modified temperatures, rather than a cooling trend or no-trend for raw temperatures. *See* Steven Goddard, *Uncorrupted US Temperature Data Showed Cooling From 1930 To 1999*, REAL SCIENCE, http://stevengoddard.wordpress.com/2012/06/11/uncorrupted-us-temperature-data-showed-cooling-from-1930-to-1999/ (last visited Mar. 1, 2014). One of those, the National Oceanic and Atmospheric Administration (NOAA) U.S. dataset, has been adjusted such that "[t]he cumulative effect of all adjustments is approximately a one-half degree Fahrenheit warming in the annual time series over a 50-year period from the 1940s until the last decade of the century." *See United States Historical Climatology Network*, NAT'L CLIMATIC DATA CTR., http://www.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html#QUAL (last updated Mar. 16, 2010). The British Meteorological Office Hadley Centre and the Climatic Research Unit at the University of East Anglia have also adjusted their data. *Met. Office Hadley Centre and Climatic Research Unit HadCRUT4 and CRUTEM4 Temperature Data Sets Adjusted/Corrected/Updated. . . Can You Guess The Impact?*, WATTS UP WITH THAT? (May 12, 2013), http://wattsupwiththat.com/2013/05/12/met-office-hadley-centre-and-climatic-research-unit-hadcrut4-and-crutem4-temperature-data-sets-adjustedcorrectedupdated-can-you-guess-the-impact/.

[56] Spurious relationships between datasets can be found everywhere. *See* Ky Harlin, *The 10 Most Bizarre Correlations*, BUZZFEED (Apr. 11, 2013, 9:56 AM), http://www.buzzfeed.com/kjh2110/the-10-most-bizarre-correlations. Among the examples cited are a close relationship between the reduction of pirates and the increase in global warming, and between Mexican lemon imports and highway deaths. *Id.*

[57] Endangerment Finding, 74 Fed. Reg. at 66,518.

> same time, the Administrator must exercise reasoned decision making, and avoid speculative inquiries.[58]

Furthermore, EPA did not have to conclude that GHGs posed a significant risk of harm,[59] nor did it need to find that mobile source control measures would prevent a substantial part of the danger posed by GHGs.[60] EPA stated that "Congress intentionally adopted a precautionary and preventative approach" under the Clean Air Act[61] and decided that it only needed to find some risk of harm that was related in some way to GHG emissions.[62] Nor did EPA have to weigh the costs of mitigation against the cost of GHG emission reductions.[63]

In short, in concluding that increased GHGs were causing higher world temperatures, EPA felt it did not need to wait for scientific certainty establishing that connection; it did not need to establish a significant relationship between GHGs and temperature; it could act upon a showing of some risk of harm of an unquantified amount; and it did not have to consider whether the cost of GHG controls would exceed the cost of adapting to higher temperatures. Whether EPA was correct or not in describing the standard for regulating GHGs in this fashion is debatable, but it is clearly a bar that could be fairly easily crossed.

B. Scientific Review of the Endangerment Finding

Given the remarkable latitude that is given to EPA to designate air pollutants, it is all the more important to apply rigorous scientific scrutiny to the evidence of climate change. Unhappily, that did not occur in the case of the Endangerment Finding.

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58 *Id.* at 66,505–06.

59 *Id.* at 66,508 ("c. The Administrator Does Not Need To Find There Is Significant Risk of Harm").

60 *Id.* at 66,507–09.

61 *Id.* at 66,507.

62 EPA's position is somewhat inconsistent with the decision in *Ethyl Corp. v. EPA*, 541 F.2d 1 (D.C. Cir. 1976), in which the D.C. Circuit determined that the "will endanger" language of § 211(c)(1)(a) of the Clean Air Act is precautionary in nature and "evidence of potential harm as well as actual harm comes within the purview of that term." 541 F.2d at 14, 17. However, in that case the Court agreed with EPA that endangerment must present "a significant risk of harm," in contrast to EPA's conclusion in the Endangerment Finding that demonstrating a significant risk of harm from GHGs wasn't required. *Id.* at 12.

63 Endangerment Finding, 74 Fed. Reg. at 66,509 ("[T]he issues of risk of harm and severity of harm if it were to occur are separate from the issues of the economic impacts of any resulting regulatory provisions. . . .").

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LAW REVIEW

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ENERGY AND SUSTAINABILITY ISSUE

While EPA has the authority to make a public policy (i.e., not purely scientific) decision regarding regulation of GHGs, it is not an unconstrained choice.[64] EPA still has the obligation to closely scrutinize scientific information, including careful evaluation of differing views, and then EPA must weigh the resulting information rationally.[65] It can be aided in this process by its Science Advisory Board ("SAB")[66] which can provide technical help.

In preparing the Endangerment Finding and the TSD, EPA did not perform its own research to establish a causal relationship between rising GHGs and dangerous climatic conditions, nor did it consult with the SAB. It relied primarily upon the reports and conclusions of three organizations[67]: the Intergovernmental Panel on Climate Change ("IPCC"), the U.S. Global Climate

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[64] Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub. L. No. 106-554, § 515, 114 Stat. 2763 (2000); H.R. 5658, 106th Cong. (2000), ("the Data Quality Act") directed the Office of Management and Budget ("OMB") to develop guidelines that "provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility and integrity of information (including statistical information) disseminated by Federal agencies." Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub. L. No. 106-554, 114 Stat. 2763A–154 (2001). Each federal agency was to apply the OMB's guidelines in the development of its own implementation guidelines that would meet the OMB's requirements. The OMB's guidelines were published at 67 Fed. Reg. 369 (Jan. 3, 2002) and republished in corrected version in 67 Fed. Reg. 8452 (Feb. 22, 2002). OMB later expanded on this initial guidance in its Final Information Quality Bulletin for Peer Review, issued December 16, 2004 and published at 70 Fed. Reg. 2664 (Jan. 14, 2005) [hereinafter Peer Review Bulletin].

[65] EPA has issued several documents in order to comply with the Data Quality Act and OMB's guidelines. *See, e.g.*, OFFICE OF ENVTL. INFO., U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR ENSURING AND MAXIMIZING THE QUALITY, OBJECTIVITY, UTILITY, AND INTEGRITY OF INFORMATION DISSEMINATED BY THE ENVIRONMENTAL PROTECTION AGENCY (2002), *available at* http://www.epa.gov/QUALITY/informationguidelines/documents/EPA_InfoQualityGuidelines.pdf; OFFICE OF POLICY, ECON. AND INNOVATION, U.S. ENVTL. PROT. AGENCY, EPA'S ACTION DEVELOPMENT PROCESS (Nov. 2006), *available at* http://www.epa.gov/rfa/documents/Guidance-RegFlexAct.pdf; SCI. POLICY COUNCIL, U.S. ENVTL. PROT. AGENCY, A SUMMARY OF GENERAL ASSESSMENT FACTORS FOR EVALUATING THE QUALITY OF SCIENTIFIC AND TECHNICAL INFORMATION (2003); SCI. POLICY COUNCIL, U.S. ENVTL. PROT. AGENCY, PEER REVIEW HANDBOOK, (3rd ed. 2006), *available at* http://www.epa.gov/peerreview/pdfs/peer_review_handbook_2012.pdf. The history of the development of data quality assurance procedures and guidelines at EPA is explained in the OIG Report, *infra* note 71, at 1–11.

[66] The SAB was created by Congress in 1978 and given a "broad mandate to advise [EPA] on technical matters." *EPA Science Advisory Board*, U.S. ENVTL. PROT. AGENCY, http://yosemite.epa.gov/sab/sabpeople.nsf/webcommittees/BOARD (last visited Mar. 1, 2014).

[67] Endangerment Finding, 74 Fed. Reg. at 66,496–97. Another short summary of the reports from these three organizations can be found in the OIG Report, *infra* note 71, at 2–4.

Research Program ("USGCRP"),[68] and the National Research Council.[69] Of these, the IPCC[70] was the most prominent, and was referred to most frequently.

Due to concerns that EPA had not met the requirements of the Data Quality Act, EPA's Office of Inspector General was asked to conduct a review of the process that EPA used in making its Endangerment Finding.[71] More specifically, the OIG was asked "to determine whether EPA followed key federal and Agency regulations and policies in obtaining, developing, and reviewing the technical data used to make and support its greenhouse gas endangerment finding."[72] The OIG concluded that EPA, in preparing the TSD, did not comply with the data quality requirements mandated for a highly influential scientific assessment[73] that are mandated by the Office of Management and Budget's "Final Information Quality Bulletin for Peer Review."[74]

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[68] For the USGCRP reports for 2001 and 2009, and the draft report for 2013, see *USGCRP Publications*, U.S. GLOBAL CHANGE RES. PROGRAM, http://www.globalchange.gov/resources/reports (last visited Mar. 1, 2014).

[69] For the prepublication copy of the National Research Council's "America's Climate Choices: Panel on Advancing the Science of Climate Change," see NAT'L RESEARCH COUNCIL, ADVANCING THE SCIENCES OF CLIMATE CHANGE (2010), *available at* http://dge.stanford.edu/labs/caldeiralab/Caldeira_research/pdf/ACC_Science_2010.pdf.

[70] *See Organization*, *supra* note 10. The IPCC was created in 1988 by the United Nations Environment Programme and the World Meteorological Organization "to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts." *Id.* It works primarily through its periodic Assessment Reports, the most recent of which (the Fifth Assessment Report, or AR5) is currently being finalized. *Activities*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/activities/activities.shtml (last visited Mar. 1, 2014). In a curious process, the Summary for Policymakers is released before the final report is issued. *Id.* "The Summary for Policymakers of the Working Group I contribution to the Fifth Assessment Report was approved, and the full report accepted, by the IPCC on 27 September 2013. The finalized version of the Summary for Policymakers was published on 11 November 2013." INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, http://www.ipcc.ch/ (last visited Mar. 1, 2014).

[71] OFFICE OF INSPECTOR GEN., ENVTL. PROT. AGENCY, PROCEDURAL REVIEW OF EPA'S GREENHOUSE GASES ENDANGERMENT FINDING DATA QUALITY PROCESSES (2011), *available at* http://www.epa.gov/oig/reports/2011/20110926-11-P-0702.pdf [hereinafter OIG Report].

[72] *Id.* at 1.

[73] In its summary, the OIG stated, "[W]e recommend that EPA (1) revise its *Peer Review Handbook* to accurately reflect OMB requirements for peer review of highly scientific assessments, (2) instruct program offices to state in proposed and final rules whether the action is supported by influential scientific information or a highly influential scientific assessment, and (3) revise its assessment factors guidance to establish minimum review and documentation requirements for assessing and accepting data from other organizations." *Id.* at At a Glance.

[74] OIG REPORT, *supra* note 71, at 19.

EPA's response to the OIG report was telling. It defended its failure to comply with its own Data Quality Act guidance on the grounds that the Endangerment Finding was not a highly influential scientific assessment[75] because "[n]o *weighing* of information, data and studies occurred in the TSD. That had already occurred in the underlying assessments, where the scientific synthesis occurred and where the state of the science was assessed."[76] By conceding that its TSD, and therefore its Endangerment Finding, was not a scientific assessment, EPA avoided having to characterize the TSD as highly influential, which it surely would have been compelled to do. It would be difficult to imagine a conclusion with more far-reaching effects, including social cost or novel and controversial subject, than a conclusion that emissions of carbon dioxide and other GHGs should be regulated.[77] EPA and other agencies have designated much less important studies as highly influential scientific assessments.[78]

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[75] The OIG Report stated, "In our opinion, the TSD was a highly influential scientific assessment because EPA weighed the strength of the available science by its choices of information, data, studies, and conclusions included in and excluded from the TSD." *Id.* at At a Glance. The OMB defines a scientific assessment as "an evaluation of a body of scientific or technical knowledge which typically synthesizes multiple factual inputs, data, models, assumptions and/or applies best professional judgment to bridge uncertainties in the available information." *Id.* at 6–7. A "highly influential scientific assessment" is one that could have an impact of greater "than $500 million in any year on either the public or private sector, or is novel, controversial or precedent setting, or has significant interagency interest." *Id.* at 7.

[76] *Id.* at 54 (emphasis in original). EPA believed that its TSD was not a highly influential scientific assessment, but was "influential scientific information." *Id.*

[77] This point was made by, among others, Steve McIntyre in his highly-regarded Climate Audit blog. *See* Steve McIntyre, *EPA: The Endangerment Finding Was Not a "Highly Influential Scientific Assessment,"* CLIMATE AUDIT (Oct. 4, 2011, 12:17 PM), http://climateaudit.org/2011/10/04/epa-the-endangerment-finding-was-not-a-highly-influential-scientific-assessment/.

[78] *See, e.g.*, *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay Alaska (First External Review Draft)*, U.S. ENVTL. PROT. AGENCY, http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=241743 (last visited Mar. 1, 2014) (designating as "highly influential" the Bristol Bay assessment); *Peer Review Agenda*, U.S. ENVTL. PROT. AGENCY, http://cfpub.epa.gov/si/si_public_pr_agenda.cfm (last visited Mar. 1, 2014) (listing "IRIS Toxicological Review of Acrylonitrile (2011 External Review Draft)" among Highly Influential Scientific Assessments); *see also OMB Information Quality Peer Review Agenda*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/od/science/quality/support/peer-review.htm (last visited Mar. 1, 2014) (listing "Criteria for a Recommended Standard: 1-Bromopane" and "Current Intelligence Bulletin: Neurological Effects of Manganese exposure to Welders" among Highly Influential Scientific Assessments). None of these would begin to compare in scope with an assessment of whether GHGs were changing the planet's climate in the manner that EPA described in its Endangerment Finding, or the effects on the economy from the GHG regulations EPA was promulgating.

EPA also took the position that the Endangerment Finding did not require full peer review because the studies on which it relied had already been peer reviewed.[79] In the case of the IPCC Assessment Reports, that is a dubious proposition, at best, given the manner in which the reports are put together.[80] Peer review is not a guarantee of academic rigor or reliable conclusions.[81] In fact, the field of climate research has its fair share of tribalism, turf protection and inappropriate efforts to squelch publication of opposing views.[82] The Climategate[83] emails revealed the behind-the-scenes efforts by some climate scientists to promote policy at the expense of science. For example, Phil Jones, a leading advocate of the theory of rapid warming from GHG emissions, wrote to Dr. Michael Mann, author of the infamous "hockey stick" chart,[84] regarding global warming skeptics' papers that "I can't see either of these papers being in the next IPCC report. Kevin [Trenberth] and I will keep them out somehow – even if we have to redefine what peer review literature is!" [85] At the time the email was written, Jones and Trenberth had recently been appointed as joint

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79 OIG REPORT, *supra* note 71, at 54.

80 For an account of some of the questionable practices of the IPCC in developing its Assessment Reports, see DONNA LAFRAMBOISE, THE DELINQUENT TEENAGER WHO WAS MISTAKEN FOR THE WORLD'S TOP CLIMATE EXPERT (2011).

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> Publication in a refereed scientific journal may mean that adequate peer review has been performed. However, the intensity of peer review is highly variable across journals. There will be cases in which an agency determines that a more rigorous or transparent review process is necessary. For instance, an agency may determine a particular journal review process did not address questions (e.g., the extent of uncertainty inherent in a finding) that the agency determines should be addressed before disseminating that information. As such, prior peer review and publication is not by itself sufficient grounds for determining that no further review is necessary.

Peer Review Bulletin, 70 Fed. Reg. 2664, 2671 (Jan. 14, 2005).

82 *See* Pearce, *supra* note 30.

83 "Climategate" is the name that has been given to the release of emails from the University of East Anglia's Climate Research Unit by an unknown hacker that revealed behind-the-scenes efforts to advance the theory of global warming. *See Climatic Research Unit Email Controversy*, WIKIPEDIA.COM, http://en.wikipedia.org/wiki/Climatic_Research_Unit_email_controversy (last visited Mar. 2, 2014).

84 The creation and defense of the "hockey stick" chart, which has served as the iconic symbol of out-of-control twentieth century warming, is an example of the attempts by some climate researchers to circle the wagons to defend questionable research rather than confront questions of methodology and data. *See generally* A.W. MONTFORD, THE HOCKEY STICK ILLUSION: CLIMATEGATE AND THE CORRUPTION OF SCIENCE (2010).

85 Pearce, *supra* note 30 (alteration in original).

lead authors for a key chapter in the IPCC's AR4[86] and were in a perfect position to influence the IPCC's conclusions.

The Inspector General's report that EPA had not complied with its Data Quality Act requirements, and the evident tendency of some in the climate science community to try to obstruct the development and dissemination of scientific evidence that cast doubt on the theory of global warming, would be irrelevant if there were no significant evidence that the Endangerment Finding was wrong. However, since the Finding was issued, more and more information has come to light which should compel a reconsideration of the Endangerment Finding.

IV. PROBLEMS THAT HAVE DEVELOPED WITH THE ENDANGERMENT FINDING

As noted above, EPA's Endangerment Finding was based on (1) "basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors and other human impacts . . . [(2)] indirect, historical estimates of past climate changes that suggest that the changes in global surface temperatures over the last several decades are unusual . . . [and (3)] computer-based climate models."[87] These are the bases EPA uses for connecting dangerous climate change to anthropogenic activity. Yet further along, EPA makes this startling admission: "Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature changes. **However, directly attributing specific regional changes in climate to emissions of greenhouse gases from human activities is difficult**, especially for precipitation."[88]

If EPA is certain that changes to regional climate is occurring, but cannot attribute the climate change to GHGs, on a regional basis or otherwise, how can it find that GHGs are a danger? This lack of certainty as to the cause of global warming should be kept in mind when examining EPA's lines of evidence.

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86 *Id.*

87 Endangerment Finding, 74 Fed. Reg. 66,496, 66,518 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1); *see also* U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 19 (2009), *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf (citing the same three categories of proof).

88 Endangerment Finding, 74 Fed. Reg. at 66,518 (emphasis added).

A. EPA's Understanding of Physical Processes Is Incomplete

EPA could not have issued the Endangerment Finding without confidence that the scientists they cited and relied upon in the TSD have a well-developed understanding of the physical processes that create weather and climate, and therefore could reliably tie weather and climate changes to the effects of increasing GHGs. Those scientists believe there has been an increase of air and ocean temperatures over the past 100 years, with resulting widespread melting of snow and ice and increased sea levels, and further believe that the rise in temperature is due to anthropogenic GHGs.[89] According to the scientists EPA relied upon, temperatures are expected to continue to warm, with more intense heat waves, precipitation, and hurricanes, and the sea level is expected to increase, all due to GHG emissions.[90]

However, although GHGs continue to rise, many of these supposedly inevitable climate changes are not occurring. This failure of the world to react as expected to higher GHG levels suggests that the basic physical processes that comprise the climate may not be as well-understood as EPA had thought. An example of EPA's lack of understanding of the "basic physical understanding of the effects of changing concentrations of greenhouse gases, natural factors and other human impacts on the climate system" is the divergence between its theoretical understanding of the effects of GHG increases on temperature and actual data.[91] GHGs should be causing higher temperatures in the places where they are absorbing energy from the earth and radiating it back, so one would expect to see temperatures rising in the upper troposphere, then in the lower troposphere, then on the surface.[92] Atmospheric temperature databases show that those temperatures are essentially flat while

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89 TSD, *supra* note 1, at ES-2.

90 *Id.* at ES-4.

91 Of course, the ability to understand the data, and make predictions based upon it, assumes that it is accurate in the first place.

> A new data set of middle- and upper-stratospheric temperatures based on reprocessing of satellite radiances provides a view of stratospheric climate change during the period 1979–2005 that is strikingly different from that provided by earlier data sets. The new data call into question our understanding of observed stratospheric temperature trends and our ability to test simulations of the stratospheric response to emissions of greenhouse gases and ozone-depleting substances.

David W.J. Thompson et al., *The Mystery of Recent Stratosphere Temperature Trends*, 491 NATURE 692, 692 (2012), *available at* http://www.arl.noaa.gov/documents/JournalPDFs/ThompsonEtal.Nature2012.pdf.

92 *See* Donald Rapp, *Tropospheric and Surface Temperatures*, CLIMATE ETC. (Oct. 29, 2011), http://judithcurry.com/2011/10/29/tropospheric-and-surface-temperatures.

GHGs rise.[93] The failure of tropospheric temperatures to rise with the increase in GHGs calls into question any attempt to ascribe temperature increases or decreases to changes in GHG levels.

The four years since the Endangerment Finding have seen the development of more data that undercuts EPA's or anyone's ability to assert a full and complete understanding of the natural physical processes that control the earth's climate. The following are examples of a few of the physical processes that EPA relied upon for support in the Endangerment Finding, and contradictory evidence that calls EPA's conclusions into question.

Extreme weather. One of the primary indicia of climate change advanced by EPA was the increased frequency and cost of unusual storm events.[94] While that is an assertion that is frequently made following unusual weather events, it is no longer a position advocated widely by researchers[95] and scientific publications.[96] Even the IPCC has agreed that there has been no demonstration of a relationship between global warming and wildfires, rainfall, storms, hurricanes, and other extreme events. The IPCC AR5 Summary for Policymakers noted that there are

> no significant observed trends in global tropical cyclone frequency over the past century. . . . [T]here continues to be a lack of evidence and thus low confidence regarding the sign of the trend in the magnitude and/or frequency of floods on a global scale. . . . [T]here is low confidence in observed trends in small-scale severe weather phenomena such as hail and thunderstorms because of historical data inhomogeneities and inadequacies in monitoring systems . . . . [T]here is not enough evidence at present to suggest more than low confidence in a global-scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th century due to lack of

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93 *See generally* Brief of Scientists and Economists as Amici Curiae Supporting of Petitioner SE. Legal Found. & State Petitioners, Utility Air Regulatory Group v. EPA, Nos. 12-1146, 12-1152, 12-1153, 12-1248, 12-1254, 12-1268, 12-1269, 12-1272, 2013 WL 6805691 (U.S. 2013).

94 Endangerment Finding, 74 Fed. Reg. 66,496, 66,526 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1) ("The evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events.").

95 *See, e.g.*, *Clean Air Act: Risk from Greenhouse Gas Emissions: Hearing Before the S. Comm. on Env't & Pub. Works*, 107th Cong. 87–94 (2002) (statement of Dr. Roger Pielke, Jr., Assoc. Professor, Ctr. For Sci. & Tech. Policy Research, Univ. of Colorado).

96 *Extreme Weather: Better Models are Needed Before Exceptional Events can be Reliably Linked to Global Warming*, 489 NATURE 335, 335–36 (Sept. 19, 2012), *available at* http://www.nature.com/news/extreme-weather-1.11428.

> direct observations, geographical inconsistencies in the trends, and dependencies of inferred trends on the index choice.[97]

In fact, the United States is still in the longest major (i.e., Category 3, 4 or 5) hurricane "drought" since recordkeeping began at the turn of the twentieth century.[98]

Even EPA admitted that the IPCC found no clear trend in the number of tropical cyclones, or small-scale phenomena such as thunderstorms, tornadoes, hail, lightning and dust storms.[99] In the United States, there has been no greater incidence of drought except in the West and Southwest, and EPA agreed that is attributable to multidecadal fluctuations.[100] In fact, over the past 2,000 years, drought in North America was "more frequent, longer, or geographically more extensive. . . than during the 20th Century."[101] The Endangerment Finding is replete with observations of alleged climate changes, without showing a connection between them and GHG increases or warming temperatures, or even showing that they are outside the range of past climate norms. [102]

Sea level rise. In the Endangerment Finding, EPA announced that "[t]here is strong evidence that global sea level gradually rose in the twentieth century and is currently rising at an increased rate."[103] The rise in sea level over 100 years or more is widely acknowledged; the attribution of this rise to GHGs and the rate of the rise is the subject of considerable disagreement, as sea levels are affected by many factors.[104] There is significant evidence that there has

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97 Roger Pielke, Jr., *Coverage of Extreme Events in the IPCC AR5*, ROGER PIELKE JR.'S BLOG (Oct. 3, 2013, 3:40 PM), http://rogerpielkejr.blogspot.com/2013/10/coverage-of-extreme-events-in-ipcc-ar5.html.

98 Roger Pielke, Jr., *Updated Major Huricane Drought Figure*, ROGER PIELKE JR.'S BLOG (Sept. 9, 2013, 10:48 AM), http://rogerpielkejr.blogspot.com/2013/09/updated-major-hurricane-drought-figure.html.

99 TSD, *supra* note 1, at 44.

100 *Id.* at 45.

101 *Id.* (internal citations omitted).

102 *See id.* at 38–44 (discussing observations in changes in glacial movement, freeze and thaw dates, biological systems changes and hydrosphere changes without any indication that the changes are unprecedented in the historical, not to say geologic, past).

103 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,518 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1). On a global level, sea level rise can be attributed to a number of factors, such as groundwater de-watering, ice melting, and the thermal expansion of the oceans. TSD, *supra* note 1, at 36.

104 "Seasonal weather patterns, variations in the Earth's declination, changes in coastal and ocean circulation, anthropogenic influences (such as dredging), vertical land motion, and the El Niño Southern Oscillation are just a few of the many factors influencing changes in sea level

been no acceleration in sea level rise since GHGs began to increase; in fact, the evidence points to a *deceleration* in sea level rise while GHGs rose in the twentieth century.[105] The average rate of sea level rise of about 1.7 mm/year for the past 110 years[106] is consistent with the rate from 2005 until 2012 of 1.6 mm/year,[107] indicating that short term trends (allegedly resulting from increased GHGs and higher temperatures) are matching long term trends (which began before GHGs or temperatures climbed significantly).[108] At that rate, sea level would rise about .16 meters, or about six inches, by 2100. In short, significant changes in sea level that are predicted by the IPCC based on models and speculation are not being borne out by actual data.[109] As can be seen in the following chart, the rate of sea level rise in the latter half of the twentieth century, when GHG levels and temperatures were higher, is approximately the same as before that time, when both were lower:[110]

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over time." *Frequently Asked Questions: Tides & Currents*, NAT'L OCEANIC & ATMOSPHERIC ADMINISTRATION (Oct. 15, 2013), http://www.tidesandcurrents.noaa.gov/est/faq. The TSD notes that in some areas, such as the eastern Pacific and western Indian Ocean, sea levels are falling. TSD, *supra* note 1, at 36.

105 "Our analyses do not indicate acceleration in sea level in U.S. tide gauge records during the 20th century. Instead, for each time period we consider, the records show small decelerations that are consistent with a number of earlier studies of worldwide-gauge records." J.R. Houston & R.G. Dean, *Sea-Level Acceleration Based on U.S. Tide Gauges and Extensions of Previous Global-Gauge Analyses*, 27 J. COASTAL RES. 409, 416 (2011), *available at* http://www.jcronline.org/doi/abs/10.2112/JCOASTRES-D-10-00157.1.

106 O. Baur et al., *Continental Mass Change from GRACE over 2002–2011 and Its Impact on Sea Level*, 87 J. GEODESY 117 (2013), *available at* http://link.springer.com/article/10.1007/s00190-012-0583-2; D.P. Chambers et al., *Is There a 60-Year Oscillation in Global Mean Sea Level?*, GEOPHYSICAL RES. LETTERS, Sept. 2012, at 1, *available at* http://onlinelibrary.wiley.com/doi/10.1029/2012GL052885/abstract.

107 ERIC LEULIETTE, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., THE BUDGET OF RECENT GLOBAL SEA LEVEL RISE 2005–2012 8, tbl.1 (2012), *available at* http://ibis.grdl.noaa.gov/SAT/SeaLevelRise/documents/NOAA_NESDIS_Sea_Level_Rise_Budget_Report_2012.pdf.

108 *See, e.g.*, B.D. Hamlington et al., *Contribution of the Pacific Decadal Oscillation to Global Mean Sea Level Trends*, 40 GEOPHYSICAL RES. LETTERS 5171, 5171–75 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/grl.50950/abstract (setting forth their conclusion that accounting for the natural fluctuation in Pacific Decadal Oscillation reduces the perceived acceleration in sea level over the past 60 years).

109 J.M. Gregory et al., *2013: Twentieth Century Global-Mean Sea Level Rise: Is the Whole Greater than the Sum of the Parts?*, 26 J. CLIMATE 4476, 4476 (2013). The authors concluded that sea level rise was constant in the twentieth century, and that future predictions of seal level rise assume a relationship between climate change and sea level rise that has not been established in the twentieth century data. *Id.*

110 *See infra* Part IV.B for a comparison of temperature rises with GHG levels in the twentieth century.

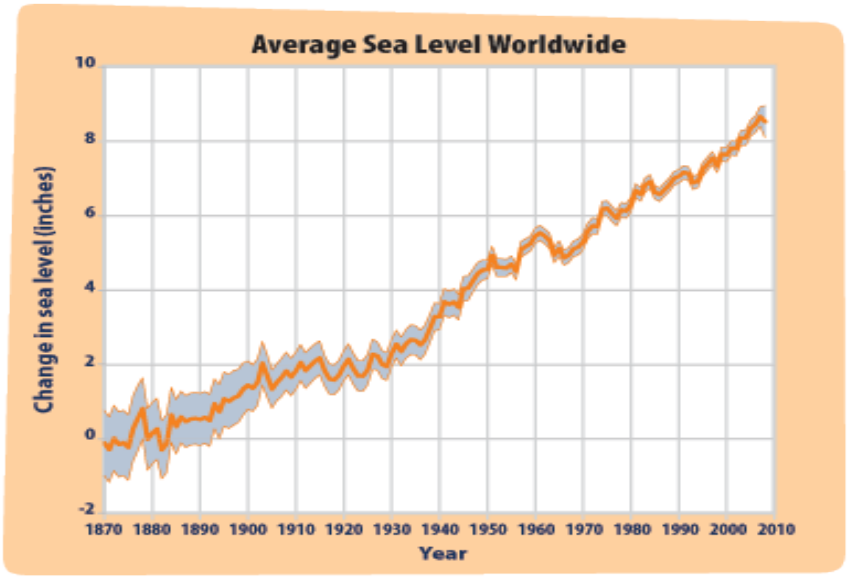

Figure 1: A Student's Guide to Global Climate Change[111]

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[111] *A Student's Guide to Global Climate Change: Rising Sea Level*, EPA, http://epa.gov/climatestudents/impacts/signs/sea-level.html (last updated July 25, 2013).

Sea ice. EPA states that Arctic ice is being reduced, at a size and speed "that is highly anomalous relative to the previous few thousands of years."[112] This is somewhat misleading, as Arctic ice has only been precisely measured by satellites since 1979. Before that time, anecdotal and historical evidence suggests that there were many times when Arctic ice was significantly reduced, and probably at lower levels than today.[113] Predictions that Arctic ice would disappear by the summer of 2013[114] proved to be spectacularly wrong, as Arctic ice extent was an average of 5.3 million square kilometers at its yearly low in September,[115] while the level of Antarctic sea ice was at a record high.[116] The sea ice record from northern Greenland showed that multi-year sea ice reached a minimum between about 8,500 to 6,000 years ago, and that variations in sea-ice cover are likely related to large scale natural atmospheric anomalies such as the Arctic Oscillation.[117]

Ocean acidification.[118] According to EPA, "[o]cean carbon dioxide uptake has lowered the average ocean pH (increased the acidity) level

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[112] Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,518 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

[113] *See* Tony Brown, *Historic Variations in Arctic Sea Ice. Part II: 1920–1950*, JUDITHCURRY.COM (Apr. 10, 2013), http://judithcurry.com/2013/04/10/historic-variations-in-arctic-sea-ice-part-ii-1920-1950/ (citations omitted) (noting sources that support this proposition). As noted in the TSD, "a slightly longer warm period [in the Arctic], almost as warm as the present, was also observed from the late 1920's to early 1950's." TSD, *supra* note 1, at 27.

[114] Ed Driscoll, *Yet Another Final Countdown Expires*, PJMEDIA.COM (Dec. 14, 2013, 3:12 PM), http://pjmedia.com/eddriscoll/2013/12/14/yet-another-final-countdown-expires/; Al Gore, among others, predicted that arctic sea ice would disappear by 2013. *See* Jonathan Amos, *Artic Summers Ice-Free "by 2013,"* BBC NEWS (Dec. 12, 2007, 10:40 GMT), http://news.bbc.co.uk/2/hi/science/nature/7139797.stm.

[115] *See Sea Ice Index*, NATIONAL SNOW & ICE DATA CENTER., http://nsidc.org/data/seaice_index/ (last visited Feb. 25, 2014).

[116] Press Release, National Snow & Ice Data Center, *Arctic Sea Ice Avoids Last Year's Record Low; Antarctic Sea Ice Edges Our Last Year's High* (Oct. 3, 2013), *available at* http://nsidc.org/news/press/2013_minimum_final.html; Jason Samenow, *Antarctic Sea Ice Hit 35-Year Record High Saturday*, WASHINGTON POST (Sept. 23, 2013), http://www.washingtonpost.com/blogs/capital-weather-gang/wp/2013/09/23/antarctic-sea-ice-hit-35-year-record-high-saturday/.

[117] Svend Funder et al., *A 10,000-Year Record of Arctic Ocean Sea-Ice Variability—View from the Beach*, 333 SCI. MAG., Aug. 2011, at 747.

[118] While lowering the pH of the ocean is widely referred to as "acidification," and though we have used that term in this Article, the seas are basic in pH, about eight, and are not anywhere near moving to the acid side of the pH scale. *See Ocean Acidity*, EPA.GOV, http://www.epa.gov/climatechange/science/indicators/oceans/acidity.html (last visited Feb. 25, 2014).

approximately .1 since 1750. Consequences for marine ecosystems may include reduced calcification by shell-forming organisms, and in the longer term, the dissolution of carbonate sediments."[119] It is questionable whether such a small change in pH[120] can be accurately measured[121] on a worldwide basis over a 260 year period, given the absence of reliable data from pre-Industrial Revolution times until very recently.[122] Even if that small change has occurred, its effect is unclear, in light of daily changes in ocean reef systems of as much as one unit pH.[123] Furthermore, increased absorption of CO_2 in the sea may not interfere with growth or the ability of mollusks to grow calcified shells[124] and may actually increase shell-building potential.[125] The IPCC predicts a further change

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[119] Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,518 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

[120] The first use of pH was by Soren Peder Lauritz Sorenson in 1909. *Soren Sorensen Introduces the pH Scale*, HUMAN TOUCH OF CHEMISTRY, http://humantouchofchemistry.com/soren-sorensen-introduces-the-ph-scale.htm (last visited Mar. 4, 2014). Consequently, there are no direct, contemporaneous measurements of pH before that time, and researchers must rely on proxies to estimate pH levels.

[121] At present, there is still no reliable method of measuring pH on a worldwide basis, as demonstrated by the Wendy Schmidt Ocean Health XPrize, which is being offered to encourage development of "pH sensor technology that will affordably, accurately and efficiently measure ocean chemistry from its shallowest waters . . . to its deepest depths." *Overview*, WENDY SCHMIDT OCEAN HEALTH XPRIZE, http://oceanhealth.xprize.org/competition-details/overview (last visited Feb. 25, 2014). The website notes that "our ability to measure, and thus respond to, changes in ocean pH is hampered by a lack of tools for ocean sensing. This competition will incentivize the creation of breakthrough pH sensors, and ultimately the value of monitoring and understanding our ocean broadly." *Id.*

[122] EPA's "Ocean Acidity" webpage has information on oceanic carbon dioxide and acidity levels going back to only 1983. *Ocean Acidity*, *supra* note 118.

[123] Carles Pelejero, Presentation at the Workshop on Paleo-ocean Acidification and Carbon Cycle Perturbation Events: Coral Reefs and Ocean pH: Modern pH Variability and Paleo-Reconstructions for the Recent Past (Aug. 26–28, 2010) (slides used in presentation available at http://pages-142.unibe.ch/science/paloa/talks/Catalina_Carles_SN.pdf).

[124] Nongovernmental International Panel on Climate Change, *How Blue Mussels Tolerate Seawater of High CO_2 Partial Pressure*, CLIMATE CHANGE RECONSIDERED, http://nipccreport.org/articles/2013/aug/28aug2013a2.html (last visited Feb. 25, 2014) (citing J. Thomsen et al., *Food Availability Outweighs Ocean Acidification Effects in Juvenile Mytilus Edulis: Laboratory and Field Experiments*, 19 GLOBAL CHANGE BIOLOGY 1017 (2013)).

[125] In a striking finding that raises new questions about carbon dioxide's (CO2) impact on marine life, Woods Hole Oceanographic Institution (WHOI) scientists report that some shell-building creatures—such as crabs, shrimp and lobsters—unexpectedly build more shell when exposed to ocean acidification caused by elevated levels of atmospheric carbon dioxide (CO2).

in ocean pH of another .06 to .32 units by 2100,[126] but daily pH levels already swing by that amount in many near-shore ocean environments,[127] and monthly swings of up to 1.43 units ocean-wide already occur naturally. [128]

As the previous examples show, it is often difficult to accurately project future climate changes, based solely on knowledge of the basic physical properties of GHGs. The following chart[129] was adapted from the most recent IPCC report, the AR5,[130] and sets out some of the scenarios that the IPCC had included among the risks of climate change, but are now less likely to occur:

Change in Climate System Component	**Projected Likelihood of Twenty-First Century Change**
Atlantic MOC collapse	*Very unlikely* that the AMOC will undergo a rapid transition *(high confidence)*

In CO2-rich Environment, Some Ocean Dwellers Increase Shell Production, WOODS HOLE OCEANOGRAPHIC INSTITUTION (Dec. 1, 2009), http://www.whoi.edu/page.do?pid=7545&tid=282&cid=63809.

126 "Earth System Models project a global increase in ocean acidification for all RCP scenarios. The corresponding decrease in surface ocean pH by the end of 21st century is in the range 18 of 0.06 to 0.07 for RCP2.6, 0.14 to 0.15 for RCP4.5, 0.20 to 0.21 for RCP6.0, and 0.30 to 0.32 for RCP8.5." INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013, THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS 25 (2013), *available at* http://www.ipcc.ch/report/ar5/wg1/docs/WGIAR5_SPM_brochure_en.pdf.

127 "Coastal ecosystems that are characterized by kelp forests encounter daily pH fluctuations, driven by photosynthesis and respiration, which are larger than pH changes owing to ocean acidification (OA) projected for surface ocean waters by 2100." Christopher Cornwall, *Diurnal Fluctuations in Seawater pH Influence the Response of a Calcifying Macroalga to Ocean Acidification*, 7 PROCEEDINGS ROYAL SOC'Y B., Dec. 2013, at 1772, *available at* http://rspb.royalsocietypublishing.org/content/280/1772/20132201.abstract.

128 "Here, we present a compilation of continuous, high-resolution time series of upper ocean pH, collected using autonomous sensors, over a variety of ecosystems ranging from polar to tropical, open-ocean to coastal, kelp forest to coral reef. These observations reveal a continuum of month-long pH variability with standard deviations from 0.004 to 0.277 and ranges spanning 0.024 to 1.430 pH units."

Gretchen E. Hoffman et al., *High-Frequency Dynamics of Ocean pH: A Multi-Ecosystem Comparison*, 6 PLOS ONE 1 (2011), *available at* http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0028983.

129 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FIFTH ASSESSMENT REPORT, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 1115, tbl.12.4 (2013), *available at* http://www.ipcc.ch/report/ar5/wg1/#.Uw_AHfldUXs.

130 *See generally id.*

Ice sheet collapse	*Exceptionally unlikely* that either Greenland or West Antarctic Ice sheets will suffer near-complete disintegration *(high confidence)*
Permafrost carbon release	Possible that permafrost will become a net source of atmospheric greenhouse gases *(low confidence)*
Clathrate methane release	*Very unlikely* that methane from clathrates will undergo catastrophic release *(high confidence)*
Tropical forests dieback	*Low confidence* in projections of the collapse of large areas of tropical forest
Boreal forests dieback	*Low confidence* in projections of the collapse of large areas of boreal forest
Disappearance of summer Arctic sea ice	*Likely* that the Arctic Ocean becomes nearly ice-free in September before mid-century under high forcing scenarios such as RCP8.5 *(medium confidence)*
Long-term droughts	*Low confidence* in projections of changes in the frequency and duration of megadroughts
Monsoonal circulation	*Low confidence* in projections of a collapse in monsoon circulations

Clearly many of the dangers that were foretold have failed to occur.[131]

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[131] The only risk that is deemed of even medium likelihood, the complete loss of arctic sea ice, has not panned out to date. Further, it poses a questionable risk of harm, as an ice-free Arctic improves shipping opportunities, and low ice conditions in recent years in the Arctic have not depressed polar bear numbers, which continue to hold steady or grow. Caroline Graham, *The Poster Boys of Climate Change Thrive in the Icy Arctic: Polar Bears Defy Concerns About Their Extinction*, DAILY MAIL ONLINE (Sept. 28, 2013), http://www.dailymail.co.uk/news/article-2436882/The-poster-boys-climate-change-thrive-icy-Arctic-Polar-bears-defy-concerns-extinction.html; Susan J. Crockford, *Polar Bears Have Not Been Harmed by Sea Ice Declines in Summer—the Evidence*, POLAR BEARS SCIENCE (Aug. 18, 2013),

B. There Is No Clear Evidence That Changes in Global Surface Temperatures over the Last Several Decades Are Unusual.

The second leg of the stool that EPA relied upon to prove that GHGs are contributing to dangerous warming is evidence that the recent warming (i.e., in the last half of the twentieth century) is unprecedented, at a time GHG levels have also been rising.[132] All three datasets relied upon by EPA, those kept by the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, and University of East Anglia's Hadley Center, showed a rise in temperatures in the previous 30 years, and that "[e]ight of the 10 warmest years on record have occurred since 2001."[133] This is not surprising, given that temperatures had risen for over a century, and then plateaued. In such a temperature record, one would expect to see that each of the years during that plateau would be close to the record year. The greater surprise is that, with GHGs increasing, temperatures have stopped rising, and in some datasets have even begun a small fall.[134]

EPA dismissed "comments suggesting global temperatures have stopped warming,"[135] stating that

> [w]hile there have not been strong trends over the last seven to ten years in global surface temperature or lower troposphere temperatures measured by satellites, this pause in warming should not be interpreted as a sign that the Earth is cooling or that the science supporting continued warming is in error. Year-to-year variability in natural weather and climate patterns make it impossible to draw any conclusions about whether the climate system is warming or cooling from such a limited analysis. Historical data indicate short-term trends in long-term time series occasionally run counter to the overall trend.[136]

EPA is correct in stating that a short term trend of flat or declining temperatures does not necessarily preclude a resumption of warming. But EPA fails to explain why the pause has happened—something that it should be able

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http://polarbearscience.com/2013/08/18/polar-bears-have-not-been-harmed-by-sea-ice-declines-in-summer-the-evidence/.

132 Endangerment Finding, 74 Fed. Reg. 66,496, 66,517–18 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

133 *Id.* at 66,517.

134 *See, e.g.*, *Global Land-Ocean Temperature Index*, NASA.GOV, http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif (last visited March 5, 2014).

135 Endangerment Finding, 74 Fed. Reg. at 66,522.

136 *Id.* at 66,522.

to do if it has a good understanding of the climate, and the effect anthropogenic increases in GHGs have on temperature.[137] Nor does EPA identify the point at which it would concede that flat or declining temperatures (presently seventeen years and counting, using the Hadley CRU record)[138] have extended long enough to conclude that increasing temperatures are no longer a sufficient justification for the Endangerment Finding.

More importantly, the thermometer record from the recent past does not lend any credence to EPA's position that temperatures in the last half of the twentieth century,[139] at a time of significant GHG increases, were unusual. In fact, the temperature increases of the second half of the twentieth century were matched, or exceeded, in the first half of that century, when GHG levels were lower and were growing slowly. CO_2 emissions increased 15 ppm between 1900 and 1950 (295.8 ppm to 310.7 ppm),[140] while from 1950 to 2000 there was a 61 ppm increase of CO_2 (310.7 ppm to 371.6 ppm).[141] Despite this four-fold difference in the rate of CO_2 growth, an examination of the temperature records maintained by the National Oceanic and Atmospheric Administration

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137 Even proponents of anthropogenic climate change theory could not ignore the cessation of temperature increases, and when faced with the pause, questioned the data instead of their models.

> The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't. The CERES data published in the August BAMS 09 supplement on 2008 shows there should be even more warming: but the data are surely wrong. Our observing system is inadequate.

See Tom Moriarty, *Kevin Trenberth's REAL Travesty*, CLIMATESANITY (Nov. 24, 2009), http://climatesanity.wordpress.com/2009/11/24/kevin-trenberths-real-travesty/ (quoting the email in full).

138 David Rose, *Met Office Proof that Global Warming Is Still "on Pause" as Climate Summit Confirms Global Temperature has Stopped Rising*, DAILY MAIL ONLINE (Sept. 28, 2013), http://www.dailymail.co.uk/news/article-2436710/Met-office-proof-global-warming-pause-climate-summit-confirms-global-temperature-stopped-rising.html.

139 EPA chose 1750 as the start of the industrial period, and 250 ppm as the level of CO_2. EPA may be correct that 1750 is a reasonable year from which to date the onset of the Industrial Revolution; it is not of much relevance in tying carbon dioxide emissions to industrial activities or temperature increases. Carbon dioxide and other GHGs did not begin to increase substantially until the second half of the twentieth century. *See, e.g.*, D.M. ETHERIDGE ET AL., COMMONWEALTH SCIENTIFIC & INDUS. RESEARCH ORG., HISTORICAL CO_2 RECORD FROM THE LAW DOME DE08, DE-08-2 AND DSS ICE CORES (1998), *available at* http://cdiac.ornl.gov/ftp/trends/co2/lawdome.combined.dat (showing levels of CO_2 at 295 ppm in 1900, 150 years after EPA's start date).

140 *Id.*

141 *Id*. (stating the 1950 measurement); C.D. KEELING ET AL., SCRIPPS INST. OF OCEANOGRAPHY, EXCHANGES OF ATMOSPHERIC CO2 AND 13CO2 WITH THE TERRESTRIAL BIOSPHERE AND OCEANS FROM 1978 TO 2000 (2001), *available at* http://scrippsco2.ucsd.edu/data/in_situ_co2/monthly_mlo.csv (stating the 2000 measurement).

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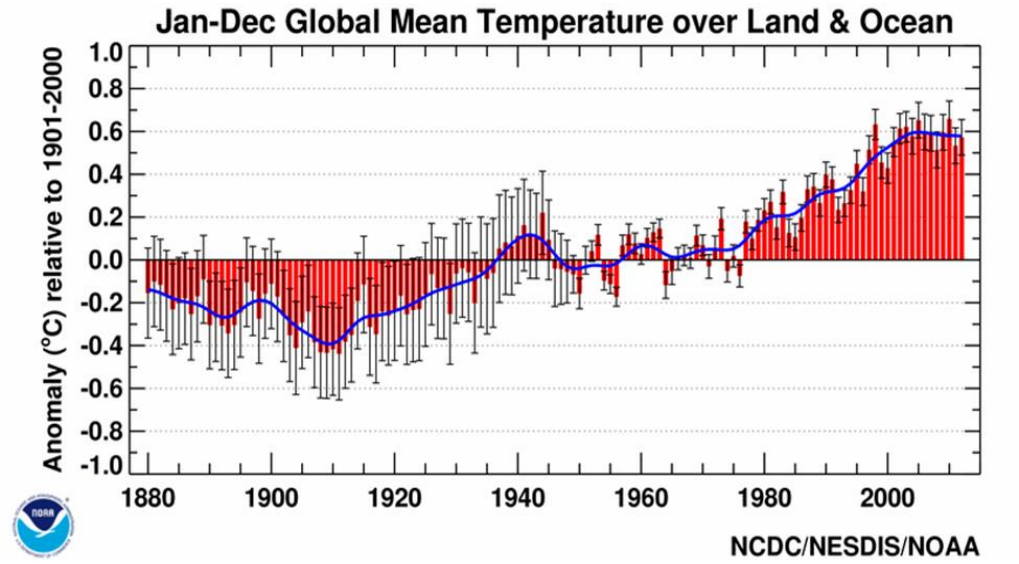
show two similar (approximately .5 degree Celsius) step changes in temperatures, one from about 1910–1940, and one from about 1970–2000, separated by a period of flat or declining temperatures.[142] The similarity in the temperature increase in 1910–1940 and 1970–2000 at a time of significantly different CO_2 levels, suggests a lack of correlation between temperature and CO_2 levels, and does not support EPA's contention that temperature increases were unusual in the second half of the twentieth century.[143]



[142] EPA noted these two step changes in temperature between the 1910s and 1940s, and from the 1970s to the end of 2006. TSD, *supra* note 1, at 27.

[143] *How Much has the Global Temperature Risen in the Last 100 Years?*, UNIV. CORP. ATMOSPHERIC RESEARCH, https://www2.ucar.edu/climate/faq/how-much-has-global-temperature-risen-last-100-years (last visited Feb. 27, 2014).

Figure 2: Global Mean Temperature over Land & Ocean

Nor is there any reason to believe that today's temperatures are unusually warm compared to the past 10,000 years. As reliable thermometer temperature records do not exist for more than a few hundred years, and then only in limited parts of the world, and GHG levels have only been measured fairly recently,[144] proxies must be used to estimate past temperatures. For example, cores extracted from glaciers, tree rings, sediments in lakebeds, speleothems,[145] and other substitutes are used to approximate past temperatures. Caution must be used in drawing conclusions from these sort of proxy records[146] because accurate correlation between the studied material and changing temperatures or climate has yet to be conclusively demonstrated.[147]

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[144] Regular direct measurements of CO_2 levels in the atmosphere began in the late 1950s. Jet Propulsion Lab., Cal. Inst. of Tech., *A Brief History of CO2 Measurements*, NASA, http://airs.jpl.nasa.gov/story_archive/Measuring_CO2_from_Space/History_CO2_Measurements / (last visited Feb. 27, 2014). Before that time, levels of CO2, and other GHGs, can only be measured in certain substances or organisms, or by measuring certain things. Timothy Casey, *Climate Change Catastrophes in Critical Thinking*, CONSULTING GEOLOGIST, http://climate.geologist-1011.net/ (last visited Feb. 27, 2014) (oxygen isotope ratios in ancient and current marine organisms); Christopher Readinger, *Ice Core Proxy Methods for Tracking Climate Change*, CSA DISCOVERY GUIDES (Feb. 2006), http://www.csa.com/discoveryguides/icecore/review.php (air trapped in glacial ice); *The CO2 Record in Plant Fossils*, PLANT FOSSILS OF W. VA., http://www.geocraft.com/WVFossils/stomata.html (last visited Feb. 27, 2014) (size and appearance of leaf stomata).

[145] Speleothems are mineral deposits like stalactites and stalagmites that accrete slowly over many years, often in layers that can reveal the date of deposition and the characteristics of the environment at the time of deposition. *See Speleothem*, NAT'L CLIMATIC DATA CTR., http://www.ncdc.noaa.gov/data-access/paleoclimatology-data/datasets/speleothem (last visited Feb. 27, 2014).

[146]

> Predicting historic temperatures based on tree rings, ice cores, and other natural proxies is a difficult endeavor. The relationship between proxies and temperature is weak and the number of proxies is far larger than the number of target data points. Furthermore, the data contain complex spatial and temporal dependence structures which are not easily captured with simple models. In this paper, we assess the reliability of such reconstructions and their statistical significance against various null models. We find that the proxies do not predict temperature significantly better than random series generated independently of temperature. Furthermore, various model specifications that perform similarly at predicting temperature produce extremely different historical backcasts. Finally, the proxies seem unable to forecast the high levels of and sharp run-up in temperature in the 1990s either in-sample or from contiguous holdout blocks, thus casting doubt on their

To the extent that proxy studies are deemed reliable indicators of past temperatures, they do not generally support the contention that temperature increases over the past half century have been unusual or have been driven by higher GHG levels. Long-term ice core data from Antarctica[148] shows a close relationship between CO_2 and temperature over the past 800,000 years, but one in which CO_2 rises *after* temperatures rise,[149] which would seem to eliminate CO_2 rise as a cause of historical global temperature increases. It also suggests that rising CO_2 levels do not create inexorable positive feedback loops that drive temperatures higher; if they did, one would not expect temperature and CO_2 levels to rise and fall as they have.

Put in historical context, there is no reason to believe that the temperature increases in the past fifty years are exceptional.[150] In fact, there have likely been several times in the last 10,000 years when temperatures were warmer than today. For example, EPA acknowledges that there were warm conditions around 1000 A.D., the Medieval Warm Period,[151] then makes the statement that "the warmth of the last half century is unusual in at least the

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> ability to predict such phenomena if in fact they occurred several hundred years ago.

Blakeley B. McShane & Abraham J. Wyner, *A Statistical Analysis of Multiple Temperature Proxies: Are Reconstructions of Surface Temperatures over the last 1000 Years Reliable?*, 5 ANNALS APPLIED STAT. 1, 5 (2011), *available at* http://projecteuclid.org/euclid.aoas/1300715170.

147 *See, e.g.*, Chuan-Chou Shen et al., *Testing the Annual Nature of Speleothem Banding*, 3 SCI. REP. 1, 1 (2013), *available at* http://www.nature.com/srep/2013/130916/srep02633/full/srep02633.html ("The irregular formation of missing and false bands in this example indicates that the assumption of annual speleothem laminae in a climate reconstruction should be approached carefully without a robust absolute-dated chronology.").

148 Andy Extance, *Global View Answers Ice Age CO2 Puzzle*, SIMPLE CLIMATE (Apr. 4, 2012), http://simpleclimate.wordpress.com/2012/04/04/global-view-answers-ice-age-co2-puzzle/ (see chart).

149 Recent studies suggest that CO_2 increases lag behind temperature increases by at least 200 years. William Ferguson, *Ice Core Data Help Solve a Global Warming Mystery*, SCIENTIFIC AMERICAN (Mar. 1, 2013), http://www.scientificamerican.com/article/ice-core-data-help-solve/.

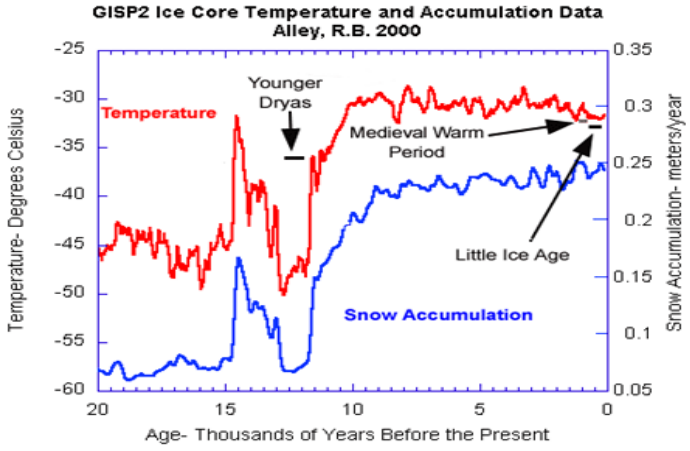
150 > Earth's climate has both cooled and warmed independent of its atmospheric CO_2 concentration, revealing the true inability of carbon dioxide to drive climate change throughout the Holocene. Conditions as warm as, or warmer than, the present have persisted across the Holocene for decades and centuries even though the atmosphere's CO_2 concentration remained approximately 30 percent lower than it is today.

NONGOVERNMENTAL INT'L PANEL ON CLIMATE CHANGE, CLIMATE CHANGE RECONSIDERED II: PHYSICAL SCIENCE 349 (2013), *available at* http://heartland.org/media-library/pdfs/CCR-II/Chapter-4-Temperature.pdf.

151 TSD, *supra* note 1, at 31.

previous 1,300 years."[152] In the next sentence, EPA cautions that uncertainty as to world temperatures is significant prior to 1600.[153]

EPA's uncertainty about historical temperatures is in sharp contrast to the conclusions of many researchers. The regional and worldwide nature of the Medieval Warm Period, with temperatures as warm as, or warmer than, the present, has been widely supported.[154] In addition to the Medieval Warm Period, there are other periods, such as the Minoan and Roman Warm Periods, that were warmer than today, such that current temperatures are well within historic averages.[155] This chart, drawn from Greenland GISP2 ice core data, shows temperatures for the past 10,000 years in Greenland have been significantly higher than the present:[156]



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152 *Id.* at 32 (

153 That unc k" graph that was develo n Period and showed a as been challenged as b note 84; Stephen McInty *Database and Northern H* l (2003), *available at* http f.

154 *See, e.g.,* ` *0 Years*, 342 S(*at* http://www.scie

> We show that water masses linked to North Pacific and Antarctic intermediate waters were warmer by 2.1 ± 0.4°C and 1.5 ± 0.4°C, respectively, during the middle Holocene Thermal Maximum than over the past century. Both water masses were ~0.9°C warmer during the Medieval Warm period than during the Little Ice Age and ~0.65° warmer than in recent decades. Although documented changes in global surface temperatures during the Holocene and Common era are relatively small, the concomitant changes in [ocean heat content] are large.

Id.; *see also* C. Loehle, *A 2000-Year Global Temperature Reconstruction Based on Non-Treering Proxies*, 18 ENERGY & ENV'T 1049, 1049 (2007), *available at* http://www.drroyspencer.com/wp-content/uploads/Loehle-2000-year-non-treering-temp-reconstruction-Energy-and-Environment.pdf (offering proxy support for a Medieval Warm Period).

155 Weichao Wu et al., *Sea Surface Temperature Variability in Southern Okinawa Trough During Last 2700 Years*, GEOPHYSICAL RES. LETTERS, July 2012, at 1, *available at* http://www.agu.org/pubs/crossref/pip/2012GL052749.shtml#content ("Despite an increase since 1850 AD, the mean [sea surface temperature] in the 20th century is still within the range of natural variability during the past 2700 years.").

156 Richard B. Alley, *The Younger Dryas Cold Interval as Viewed from Central Greenland*, 19 QUATERNARY SCI. REVS. 213, 213 (2003), *available at* http://www.ncdc.noaa.gov/paleo/pubs/alley2000/alley2000.html.

Figure 3: Ice Core Tempeature and Accumulation Data

These past warmer temperatures, at a time of lower GHG levels, establish that the former can naturally rise independently of the latter, which suggests that something other than GHGs may have caused the late twentieth century warming.

C. Computer-based Climate Models Cannot Reliably Attribute Climate Change to Higher GHG Levels.

The third line of evidence EPA is relying upon, the computer models,[157] is crucial to the Endangerment Finding; it would be fair to say that there could be no Finding without them. As discussed above, there is no direct evidence that increasing GHGs in the latter half of the twentieth century caused warming during that period, and there is insufficient historical evidence to conclude that the temperature rise (or any other climate change) in the last half of the twentieth century is unprecedented. It is only the computer models that can tie GHG increases to climate change, by adjusting the GHGs in the models and considering the results. However, 17 years of flat temperatures from 1996 until the present,[158] a hiatus that was unpredicted by the models, suggests that they do not accurately replicate the earth's climate, and therefore are not useful for predicting future climate change.

Climate models are computer programs that attempt to replicate the earth's weather system by programming in all or many of the various physical

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[157] Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,518 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

[158] *See* Rose, *supra* note 138.

processes that control the climate.[159] The earth is marked off into grids, with each individual grid cell representing a certain area of the earth's surface. [160] (In complex models, tens of thousands of cells are used, each with an area about the size of Connecticut.)[161] For each cell, information is keyed in, such as surface pressure, wind temperature, humidity and rainfall,[162] positive and negative feedbacks,[163] and other factors. The computer is instructed as to how these factors influence one another within the cell and within neighboring cells in response to changes in solar radiation or GHGs.[164] Where the scale of the cells will not allow for accurate representation of these various physical conditions, parameters,[165] or approximations of the conditions, are used to simplify their operations.[166]

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159 Climate models are derived from fundamental physical laws (such as Newton's laws of motion), which are then subjected to physical approximations appropriate for the large-scale climate system, and then further approximated through mathematical discretization. Computational constraints restrict the resolution that is possible in the discretized equations, and some representation of the large-scale impacts of unresolved processes is required (the parameterization problem).

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC CLIMATE CHANGE 2007: WORKING GROUP I: THE PHYSICAL SCIENCE BASIS 596 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter8.pdf. A brief description of climate modeling can be derived from a number of websites that explain climate models in laymen's terms. *See, e.g.*, *General Circulation Model*, WIKIPEDIA, http://en.wikipedia.org/wiki/Global_climate_model (last visited Feb. 28, 2014); *Climate Modeling 101*, NAT'L ACAD. SCI., http://nas-sites.org/climatemodeling/ (last visited Feb. 28, 2014); *What is a GCM?*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, http://www.ipcc-data.org/guidelines/pages/gcm_guide.html (last visited Feb. 28, 2014); *Climate Models*, WORLD METROLOGICAL ORG., https://www.wmo.int/pages/themes/climate/climate_models.php (last visited Feb. 28, 2014).

160 *Climate Modeling 101*, *supra* note 159.

161 *Id.*

162 *Climate Models*, *supra* note 159.

163 "Feedbacks are defined as processes in the climate system (such as a change in water vapor concentrations) that can either amplify or dampen a system's initial response to relative forcing changes." TSD, *supra* note 1, at 26. For example, if a model assumes that GHG increases will lead to more water vapor, which in turn produces its own greenhouse effect, the GHGs are said to generate a positive feedback. Roy Spencer, *How Do Climate Models Work?*, ROY SPENCER, PH. D. (July 13, 2009), http://www.drroyspencer.com/2009/07/how-do-climate-models-work. Dr. Spencer is a Principal Research Scientist at the University of Alabama in Huntsville, and the U.S. Science Team leader for the Advanced Microwave Scanning Radiometer on NASA's Aqua satellite.

164 Spencer, *supra* note 163.

165 There are certain physical processes that act at a scale much smaller than the characteristic grid interval (e.g. clouds and turbulence). And if the complete physics of these processes, for example, clouds, were to be computed explicitly at each time step and at every grid-point, the huge amount of data

By changing the operating parameters, the modelers attempt to discover what might happen to the climate if one or more of the operating conditions (e.g. the amount of sunlight striking the earth, changes in water vapor concentrations, increases in GHGs) are changed. The effects of these changes are referred to as "forcings."[167] One of the principal goals of climate models is to determine the earth's sensitivity[168] to an increase of GHGs, often stated in terms of the increase in temperature each time the level of CO_2 in the atmosphere doubles.

As one might expect, the models can be extraordinarily complex,[169] and to be accurate they would have to reflect an almost perfect understanding of the climate system. That, unfortunately, is not the case, and models start at a

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> produced would swamp the computer. These processes cannot be eliminated, so simplifying equations are developed to represent the gross effect of the many small-scale processes within a grid cell as accurately as possible. This approach is called parameterization.

Climate Models, *supra* note 159.

166 > The climate system includes a variety of physical processes, such as cloud processes, radiative processes and boundary-layer processes, which interact with each other on many temporal and spatial scales. Due to the limited resolutions of the models, many of these processes are not resolved adequately by the model grid and must therefore be parameterized. The differences between parameterizations are an important reason why climate model results differ.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC CLIMATE CHANGE 2007, *supra* note 159, at 596.

167 *See generally* NONGOVERNMENTAL INT'L PANEL ON CLIMATE CHANGE, *supra* note 150.

168 "Climate sensitivity is a metric used to characterize the response of the global climate system to a given forcing. It is broadly defined as the equilibrium global mean surface temperature change following a doubling of CO_2 concentration." INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC CLIMATE CHANGE 2007, *supra* note 159, at 629; *see also* Gavin Schmidt, *On Sensitivity: Part I*, REALCLIMATE (Jan. 3, 2013), http://www.realclimate.org/index.php/archives/2013/01/on-sensitivity-part-i/ (Dr. Gavin Schmidt discussing the report in some detail); Judith Curry, *Climate Sensitivity in the AR5 SOD*, CLIMATE ETC. (Dec. 19, 2012), http://judithcurry.com/2012/12/19/climate-sensitivity-in-the-ar5-sod/ (Dr. Judith Curry discussing climate sensitivity in the AR5).

169 Model complexity is not, in and of itself, a guarantor of greater utility.

> Reto Knutti . . . advocates more work on quantifying uncertainties in climate modelling, so that different models can be compared. "A prediction with a model that we don't understand is dangerous, and a prediction without error bars is useless," he told me. Although complex models rarely help in this regard, he noted "a tendency to make models ever more complicated. People build the most complicated model they can think of, include everything, then run it once on the largest computer with the highest resolution they can afford, then wonder how to interpret the results."

Jon Turney, *A Model World*, AEON (Dec. 16, 2013), *available at* http://aeon.co/magazine/world-views/should-we-trust-scientific-models-to-tell-us-what-to-do/. Mr. Turney's article is a thoughtful discussion of the value of, and uncertainties presented by, computer modeling.

disadvantage in accurately reproducing the effects of changes in forcing (whether the forcing agent is GHGs or otherwise)[170] because the natural processes affecting climate are poorly understood, or at least not properly represented in the models.[171] Many natural climatological features have a periodicity, or natural fluctuation, that is only now being noticed and studied.[172]

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[170] The IPCC acknowledges the difficulty of getting accurate results from models:

> [M]any physical processes, such as those related to clouds, also occur at smaller scales and cannot be properly modelled. Instead, their known properties must be averaged over the larger scale in a technique known as parameterization. This is one source of uncertainty in GCM-based simulations of future climate. Others relate to the simulation of various feedback mechanisms in models concerning, for example, water vapor and warming, clouds and radiation, ocean circulation and ice and snow albedo. For this reason, GCMs may simulate quite different responses to the same forcing, simply because of the way certain processes and feedbacks are modelled.

What is a GCM?, *supra* note 159.

[171] *See, e.g.*, John Turner et al., *An Initial Assessment of Antarctic Sea Ice Extent in the CMIP5 Models*, 26 J. CLIMATE 1473, 1473 (2013), *available at* http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00068.1 (suggesting that the climate models do not accurately portray the processes that are causing the increased sea ice). From the Abstract: "The negative [sea ice extent] trends in most of the model runs over 1979–2005 are a continuation of an earlier decline, suggesting that the processes responsible for the observed increase over the last 30 years are not being simulated correctly." *Id.*; *see also* Alfredo Ruiz-Barradas et al., *The Atlantic Multidecadal Oscillation in Twentieth Century Climate Simulations: Uneven Progress from CMIP3 to CMIP5*, 41 CLIMATE DYNAMICS 3301, 3301 (2013), *available at* http://link.springer.com/article/10.1007%2Fs00382-013-1810-0 ("Decadal variability in the climate system from the Atlantic Multidecadal Oscillation (AMO) is one of the major sources of variability at this temporal scale that climate models must properly incorporate because of its climate impact . . . . Variability of the AMO in the 10–20/70–80 year ranges is overestimated/underestimated in the models and the variability in the 10–20 year range increases in three of the models from the CMIP3 to the CMIP5 versions. Spatial variability and correlation of the AMO regressed precipitation and SST anomalies in summer and fall indicate that models are not up to the task of simulating the AMO impact on the hydroclimate over the neighboring continents.").

[172] *See, e.g.*, Chambers, *supra* note 106; Marcia Glaze Wyatt and Judith A. Curry, *Role for Eurasian Arctic Shelf Sea Ice in a Secularly Varying Hemispheric Climate Signal During the 20th Century*, CLIMATE DYNAMICS (Sept. 10, 2013), http://curryja.files.wordpress.com/2013/10/stadium-wave1.pdf. Judith Curry sums the article up in the following manner:

> A new paper published in the journal *Climate Dynamics* suggests that this "unpredictable climate variability" behaves in a more predictable way than previously assumed. The paper's authors, Marcia Wyatt and Judith Curry, point to the so-called "stadium-wave" signal that propagates like the cheer at sporting events whereby sections of sports fans seated in a stadium stand and sit as a "wave" propagates through the audience. In like manner, the "stadium wave" climate signal propagates across the Northern Hemisphere through a network of ocean, ice, and atmospheric circulation regimes that self-organize into a collective tempo.

Developing an accurate climate model would require the ability to understand and accurately calculate the effect of natural fluctuations in, for example, natural temperature and climate cycles like the Pacific Decadal Oscillation[173] and the Atlantic Multi-decadal Oscillation ("AMO"),[174] as well as GHG re-radiation,[175] solar radiation,[176] cloud formation,[177] water vapor levels,[178] land

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Judith Curry, *The Stadium Wave*, CLIMATE ETC. (Oct. 10, 2013), http://judithcurry.com/2013/10/10/the-stadium-wave/.

[173] The Pacific Decadal Oscillation is a warming and cooling of the Pacific with phases lasting about 30 years. *See generally Pacific Decadal Oscillation*, GLOBAL WARMING SCI. (Mar. 2, 2011), http://www.appinsys.com/GlobalWarming/PDO.htm. Some have suggested that the fact that the Pacific is heading in a cooling phase is one of the reasons for the plateau of world temperatures. *See* Yu Kosaka & Shang-Ping Xie, *Recent Global-warming Hiatus Tied to Equatorial Pacific Surface Cooling*, NATURE (Aug. 28, 2013), *available at* http://www.nature.com/nature/journal/vaop/ncurrent/full/nature12534.html; *see also* Chris R. de Freitas and John D. McLean, *Update of the Chronology of Natural Signals in the Near-Surface Mean Global Temperature Record and the Southern Oscillation Index*, 4 INT'L J. GEOSCIENCES 234, 234 (2013), *available at* http://www.scirp.org/journal/PaperInformation.aspx?paperID=27382&.

[174] The Atlantic Multi-Decadal Oscillation (AMO) is a fluctuation in de-trended sea surface temperatures in the North Atlantic Ocean. It was identified in 2000 and the AMO index was defined in 2001 as the 10-year running mean of the de-trended Atlantic SST anomalies north of the equator. *Atlantic Multidecadal Oscillation*, GLOBAL WARMING SCI. (Jan. 3, 2010), http://www.appinsys.com/globalwarming/AMO.htm.

[175] As a purely theoretical matter, increases in CO_2 drive increases in temperature through reradiation, but not in a linear fashion. The cumulative temperature effect of CO_2 is logarithmic, with the rate of re-radiation (and therefore the rate of temperature increases) decreasing as the concentration of CO_2 rises. Roy Spencer, *On the Relative Contribution of Carbon Dioxide to the Earth's Greenhouse Effect*, ROY SPENCER, PH. D. (Sept. 10, 2010), http://www.drroyspencer.com/2010/09/on-the-relative-contribution-of-carbon-dioxide-to-the-earth%E2%80%99s-greenhouse-effect/.

> This is because the more CO_2 there is in the atmosphere, the more "saturated" the CO_2-portion of the greenhouse effect becomes, a well-known feature that has a standard simplified, logarithmic formula for its computation. Everyone already knows about this mostly saturated condition relative to the radiative effect of carbon dioxide – even the IPCC. Adding more and more CO_2 causes incrementally less and less warming.

Id.

[176] Changes in the sun's radiation may not by itself be sufficient to drive temperature changes seen in the last half century, but there may be a connection between the climate and solar cycles that may hinge on some unknown feedback mechanism that is triggered by solar activity. Tony Phillips, *Solar Variability and Terrestrial Climate*, NASA (Jan. 8, 2013), http://science.nasa.gov/science-news/science-at-nasa/2013/08jan_sunclimate (discussing recent studies in the area); NONGOVERNMENTAL INT'L PANEL ON CLIMATE CHANGE, *supra* note 150, at 247.

[177] "Realistic parametrizations of cloud processes are a prerequisite for reliable current and future climate simulation." INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC CLIMATE CHANGE 2007, *supra* note 159, at 601; *see also Identifying Robust Cloud Feedbacks in*

use changes, aerosols,[179] volcanic activity,[180] and many other factors.[181] The models must not only consider all these factors individually, but calculate their effects on one another. The result is a large degree of uncertainty in the climate models,[182] reducing their reliability.[183]

The uncertainties that are the present in the climate models are exemplified by their treatment of water vapor and clouds.[184] Heating from

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Observations and Models, PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON, http://www-pcmdi.llnl.gov/projects/cloud_feedbacks (last visited Mar. 1, 2014) ("For more than 30 years, scientists have known that the inability to predict how clouds will respond to a climate change hinders a confident prediction of the magnitude of global warming resulting from a given increase in greenhouse gases. As a result, we are not able to confidently identify the magnitude of carbon emission reductions necessary to avoid dangerous anthropogenic interference in the climate system. Thus it is imperative to perform research aimed at reducing the uncertainty range associated with the response of clouds to a warming of the planet, also known as the 'cloud feedback.'").

178 *See generally* C.I. Garfinkel et al., *Temperature Trends in the Tropical Upper Troposphere and Lower Stratosphere: Connections with Sea Surface Temperatures and Implications for Water Vapor and Ozone*, 118 J. GEOPHYSICAL RES.: ATMOSPHERES 9658 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50772/abstract;jsessionid=F5E72EA0EFFD854D9524122181B5C6D8.f04t04.

179 Aerosols, the minute liquid or solid particles that are suspended in the atmosphere, present one of the great uncertainties in climate modeling. For an explanation of aerosols and their effects, see Gunnar Myhre et al., *Aerosols and Their Relation to Global Climate and Climate Sensitivity*, NATURE EDUC. KNOWLEDGE, www.nature.com/scitable/knowledge/library/aerosols-and-their-relation-to-global-climate-102215345 (last visited Apr. 3, 2014).

180 Volcanic emissions of sulfur dioxide, which is converted to sulfuric acid, can result in the formation of aerosols that block incoming radiation, cooling the earth. *Volcanic Gases and Climate Change Overview*, USGS, http://volcanoes.usgs.gov/hazards/gas/climate.php (last visited Mar. 1, 2014). However, emissions from volcanoes, both on land and under the ocean, may also contribute significant amounts of CO_2 to the air. *See* Timothy Casey, *Volcanic Carbon Dioxide*, CONSULTING GEOLOGIST (Dec. 11, 2011), http://carbon-budget.geologist-1011.net.

181 For a description of some of these natural variations in climate, the causes of which are unknown, see the World Meteorological Organization's explanation of Significant Natural Climate Fluctuations. *Significant Natural Climate Fluctuations*, WORLD METEOROLOGICAL ORG., http://www.wmo.int/pages/themes/climate/significant_natural_climate_fluctuations.php (last visited Mar. 1, 2014).

182 *See generally* J.A. Curry et al., *Climate Science and the Uncertainty Monster*, 92 AM. METEOROLOGICAL SOC'Y 1667, 1667 (2011), *available at* http://journals.ametsoc.org/doi/pdf/10.1175/2011BAMS3139.1.

183 An excellent discussion of global climate models and their deficiencies can be found at Climate Change Reconsidered II: Physical Science, Chapter 1. *See* NONGOVERNMENTAL INTERNATIONAL PANEL ON CLIMATE CHANGE, *supra* note 150, at 1.

184 Clouds remain one of the least understood and most poorly simulated parameters in climate models. *See, e.g.*, Xiuhong Chen et al., *Non-Negligible effects of Cloud Vertical Overlapping Assumptions on Longwave Spectral Fingerprinting Studies*, 118 J. GEOPHYSICAL

GHGs would be expected to generate more atmospheric water vapor,[185] as a warmer atmosphere can carry more water. Water vapor is itself a GHG,[186] and has a greater warming effect in its totality than does carbon dioxide. Water vapor also can form clouds, which may reflect incoming solar radiation[187] and

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RES. ATMOSPHERES 7309, 7309 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50562/abstract. The paper has been summarized as follows:

> A new paper published in the *Journal of Geophysical Research-Atmospheres* finds that models must take into account not only the presence or absence of clouds but also how clouds are stacked vertically. The authors find that changes in vertical stacking of clouds can change radiative forcing assumptions by a factor of two [100%]. However, state of the art climate models do not take vertical stacking into consideration, and most global datasets of cloudiness also do not contain this information.

New Paper Finds Cloud Assumptions in Climate Models Could Be Incorrect by Factor of 2, HOCKEY SCHTICK (Aug. 30, 2013), http://hockeyschtick.blogspot.com/2013/08/new-paper-finds-cloud-assumptions-in.html.

[185] While one might expect increased water vapor in the atmosphere as a result of warmer temperatures, that may not be the case, at least in the upper atmosphere, according to NASA satellite data. Ken Gregory, *Water Vapor Decline Cools the Earth: NASA Satellite Data*, FRIENDS OF SCI. (Mar. 4, 2013), http://www.friendsofscience.org/assets/documents/NVAP_March2013.pdf.

> Climate models predict upper atmosphere moistening which triples the greenhouse effect from man-made carbon dioxide emissions. The new satellite data from the NASA water vapor project shows declining upper atmosphere water vapor during the period 1988 to 2001 . . . . Changes in water vapor are linked to temperature trends in the upper atmosphere. Both satellite data and radiosonde data confirm the absence of any tropical upper atmosphere temperature amplification, contrary to IPCC theory.

Id.

[186] Much of the temperature rise predicted by the IPCC models arises from a belief that water vapor will increase along with global temperatures and will contribute to an ever greater degree of runaway global warming referred to as "positive feedback." *Introduction: What Are Greenhouse Gases?*, NAT'L CLIMATIC DATA CTR., http://www.ncdc.noaa.gov/cmb-faq/greenhouse-gases.php (last visited Mar. 1, 2014).

> Water Vapor is the most abundant greenhouse gas in the atmosphere, which is why it is addressed here first. However, changes in its concentration is also considered to be a result of climate *feedbacks* related to the warming of the atmosphere rather than a direct result of industrialization. The feedback loop in which water is involved is critically important to projecting future climate change, but as yet is still fairly poorly measured and understood.

Id.

[187] "Clouds are responsible for about 55% of the sunlight that is reflected into space. Clouds alone roughly double Earth's albedo, from 0.15 (no clouds) to 0.31 (including clouds). In short, clouds are the predominant means by which incoming sunlight is reflected back out into space." Julia Genyuk, *Global Warming, Clouds, and Albedo: Feedback Loops*, WINDOWS TO THE UNIVERSE (Sept. 26, 2013), http://www.windows2universe.org/earth/climate/warming_clouds_albedo_feedback.html.

therefore act to cool the planet, or inhibit heat radiation from the surface and conserve heat.[188] Given these potentially opposing effects, it would seem to be of prime importance to understand exactly the effects of clouds and water vapor and their interrelationship. Yet even the staunchest defenders of computer climate models concede that the effects of water vapor and clouds are poorly understood[189] and that current models are not particularly good at representing their effects. The IPCC has admitted that

> [t]he quantification of cloud and convective effects in models, and of aerosol-cloud interactions, continues to be a challenge. Climate models are incorporating more of the relevant processes than at the time of AR4, but confidence in the representation of these processes remains low. Cloud and aerosol properties vary at scales significantly smaller than those resolved in climate models, and cloud-scale processes respond in nuanced ways at these scales. Until subgrid-scale parameterizations of clouds and aerosol-cloud interactions are able to address these issues, model estimates of aerosol-cloud interactions and their radiative effects will carry large uncertainties.[190]

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188 Water vapor "intercepts" about 32% to 59% (36% to 66% times 89.7%) of the outgoing infrared. Clouds "intercept" about 17% to 27% (19% to 30% times 89.7%) of the outgoing infrared. Water vapor plus cloud droplets combine to "intercept" about 59% to 76% (66% to 85% times 89.7%) of the outgoing longwave radiation. The bottom line? Water vapor and clouds are important contributors to the greenhouse effect, and an increase in the amount of water vapor in the air or of the amount of cloud coverage will exert a powerful influence on climate.

Id.

189 As a greenhouse gas, the higher concentration of water vapor is . . . able to absorb more thermal IR energy radiated from the Earth, thus further warming the atmosphere. The warmer atmosphere can then hold more water vapor and so on and so on. This is referred to as a "positive feedback loop." However, huge scientific uncertainty exists in defining the extent and importance of this feedback loop. As water vapor increases in the atmosphere, more of it will eventually also condense into clouds, which are more able to reflect incoming solar radiation (thus allowing less energy to reach the Earth's surface and heat it up). The future monitoring of atmospheric processes involving water vapor will be critical to fully understand the feedbacks in the climate system leading to global climate change. As yet, though the basics of the hydrological cycle are fairly well understood, *we have very little comprehension of the complexity of the feedback loops*.

Introduction: What are Greenhouse Gases?, *supra* note 186 (emphasis added).

190 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, WORKING GROUP I CONTRIBUTION TO THE IPCC FIFTH ASSESSMENT REPORT CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 25–

It should come as no surprise that these climate models, which are subject to "large uncertainties" regarding the most basic climatic physical processes, have proven to be ineffective at predicting the extent and even the direction of world temperature changes. The models are at present incapable of accurately identifying and accounting for the effects of natural and anthropogenic forcings so as to arrive at a reasonably accurate prediction of what world temperatures would be without an increase in GHGs.[191] The models' unsuitability for that task is demonstrated by their collective inability to accurately account for the observed temperature patterns over the past 15 years. The climate models relied upon by the IPCC have consistently overestimated actual temperature increases, and have failed to predict that, for at least the past 15 years, the world's temperatures have been essentially flat.[192]

The effect over time of overestimating temperatures is demonstrated in the following "spaghetti graph" of the climate models' outputs, compared to physical temperature record.[193] The lines are computer predictions of future temperatures, while the circles and squares are actual temperature anomaly measurements over the same period.

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45 (2013), *available at* http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter07.pdf.

191 As support for its belief that models are accurately reproducing the effects of increased GHGs on the climate, EPA reported that temperature increases of the past half century cannot be modeled without forcing from anthropogenic factors. Endangered and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66519 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1). What that means is that the climate modelers cannot duplicate the last half century increase using the natural inputs *as the modelers understand them*. However, it is just as likely that the computer modelers have improperly calculated natural effects. If, for example, natural climatic fluctuations such as the PDO and AMO were the cause of the late twentieth century warming, but the modelers underestimated their effects and erroneously ascribed the increased warming to feedbacks from rising GHGs, then the models will be correct only as long as the AMO and PDO remain in a warm cycle. Once those natural oscillations go negative, temperatures could drop even though GHGs rise.

192 *The Recent Pause in Warming*, U.K. METEOROLOGICAL OFFICE (Sept. 30, 2013), http://www.metoffice.gov.uk/research/news/recent-pause-in-warming ("July 2013-Global mean surface temperatures rose rapidly from the 1970s, but have been relatively flat over the most recent 15 years to 2013. This has prompted speculation that human induced global warming is no longer happening, or at least will be much smaller than predicted. Others maintain that this is a temporary pause and that temperatures will again rise at rates seen previously.").

193 Roy Spencer, *STILL Epic Fail: 73 Climate Models vs. Measurements, Running 5-Year Means*, ROY SPENCER, PH. D. (June 6, 2013), http://www.drroyspencer.com/2013/06/still-epic-fail-73-climate-models-vs-measurements-running-5-year-means. For those interested in following the predictions of a specific climate model, the graph is found at Dr. Spencer's website in color.

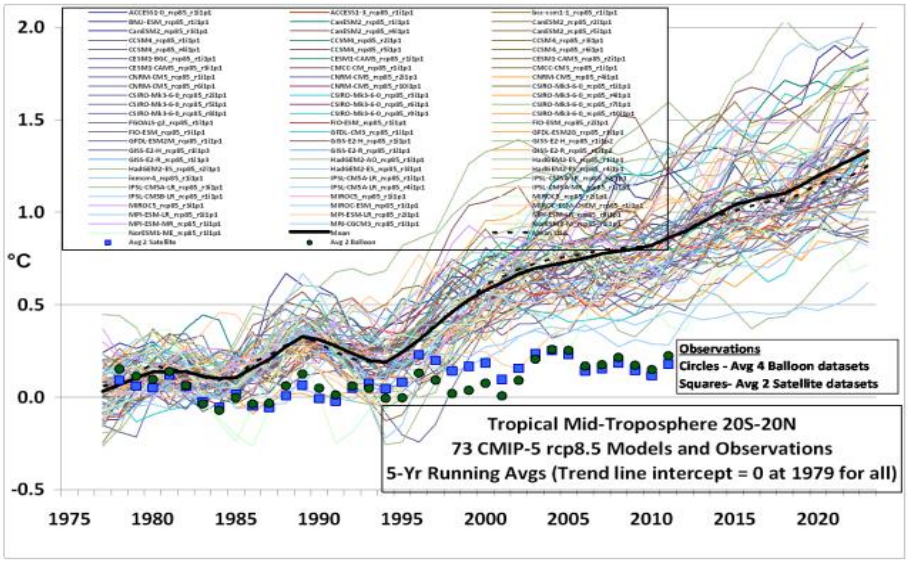

Figure 4: Computer Models v. Physical Temperature Record Comparison

Note that the models overestimate actual temperatures, most by a significant amount.

For whatever reason they are failing, the models are not doing a good job of simulating the climatic processes at work on the earth. And having done a demonstrably poor job at that simulation, there is no reason to believe that they have accurately identified GHGs as the cause of the late twentieth century warming. They provide no reliable support for the Endangerment Finding.

V. RECONSIDERING THE ENDANGERMENT FINDING

The effect of increased levels of GHGs on the earth's climate, and the danger, if any, they pose are matters of great contention.[194] Partisans on both

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[194] The disagreement between the two sides is often unnecessarily exacerbated by the inaccurate labels that are assigned to one side or the other. For example, the lead author of this Article falls into a category of persons frequently described as global warming/climate change "skeptics," yet he is not skeptical of evidence: that the world is somewhat warmer over the past 100 years; that GHG levels have increased during that time; or that the latter could have contributed to some degree to the former. He does question: whether the relation between increased temperature and GHGs is significant, compared to natural changes that have occurred

sides cite studies and data in support of their positions, and it is fair to say that neither camp can completely prove or disprove the possible effect of increased GHGs in the earth's atmosphere.[195] However, one thing that is certain is that, over the four years since the Endangerment Finding was made, substantial new evidence has been developed. EPA should seize the opportunity to re-evaluate the evidence, as it noted in 2009: "EPA recognizes the potential importance of new scientific research, and the value of an ongoing process to take more recent science into account."[196] EPA has the opportunity and resources to become an honest broker in the often contentious climate change debate by setting reasonable standards for evaluating and interpreting data. If it does so, it should focus on a couple of matters.

One improvement EPA could bring to the climate debate is in the development of better data collection, retention, and evaluation tools. The results of scientific studies often are not subject to validation because the underlying data has been lost[197] or was never available. EPA could announce that no study or finding would be relied upon by the agency in reaching any public policy decision unless full and complete data sets are archived, methods of data manipulation are fully described, and both data and methods are made available to the public.[198] American environmental policy should be made on

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and will occur; whether the ill effects of higher temperatures and CO_2 have been overstated, and whether they outweigh the positive effects; and whether the cure for GHG-related global temperature increases, such as higher fossil fuel prices, is worse than the disease, especially for poor, energy-deprived people around the world.

195 EPA has responded to many of the points made by the authors in this article, and to many of the objections raised by others. *See generally* EPA's Denial of Petitions to Reconsider the Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 75 Fed. Reg. 49,556 (Aug. 13, 2010) (to be codified at 40 C.F.R. ch. 1).

196 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496, 66,511 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. 1).

197 Timothy Vines et al., *The Availability of Research Data Declines Rapidly with Article Age*, 24 CURRENT BIOLOGY 94, 94 (2013), *available at* http://www.cell.com/current-biology/abstract/S0960-9822(13)01400-0?script=true. The authors note the reluctance of some researchers to share data, as well as the loss of archived data, and even the email addresses of the researchers, over a period of two to twenty-two years, and urge mandatory data sharing via public archives. *Id.*

198 One of the valuable scientific developments of recent times is the capacity of the internet to allow citizen scientists to work collaboratively on issues of common interest, including climate studies, and to quickly point out potential flaws in data and ideas, to refine hypotheses, and test theories in real time. Websites such as Watts Up With That, http://wattsupwiththat.com; Climate Audit, http://climateaudit.org; Lucia's Blackboard, http://rankexploits.com/musings; RealClimate, http://www.realclimate.org; and Climate Etc., http://judithcurry.com, provide opportunities for those with an interest in climate matters to engage with one another in a (usually) open and freewheeling fashion.

the basis of studies that are of the highest caliber and that are susceptible to replication by others.[199]

Closer scrutiny should be given to climate models, their calibration and development, and their interpretation. EPA should fully evaluate the reliability of the models, particularly when even model proponents agree that there are significant difficulties with replicating the behavior and effects of aerosols, clouds, and other key physical processes. The predictive capacities of climate models, particularly their estimations of climate sensitivity, are demonstrably poor at present, and no climate model should be relied upon to forecast future climate change until it has been proven reliable, at least in the near term. Greater knowledge of earth science is needed before there can be any confidence in the model results, and EPA should acknowledge that "the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming."[200]

The most important task for EPA is to provide a rationale for finding that GHGs pose a danger to society. EPA devoted a large portion of the Endangerment Finding to explaining why it could regulate GHGs without quantifying the extent of GHG contributions to climate change[201] or the problems posed by climate change.[202] EPA has said that section 202(a) of the CAA is precautionary in nature, and that it does not need to find that control measures would prevent at least a substantial part of the danger under

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199 The Science Advisory Board is an example of the scholarly bodies that could advise EPA on developing processes and procedures for evaluating the tremendous amount of climate science data that is presently being developed, and for developing standards for fairly evaluating that data. The SAB's charge includes the following:

> Reviewing the quality and relevance of the scientific and technical information being used or proposed as the basis for Agency regulations . . . reviewing generic approaches to regulatory science, including guidelines governing the use of scientific and technical information in regulatory decisions, and critiquing such analytic methods as mathematical modelling . . . [and] advising the Agency on broad scientific matters in science, technology, social and economic issues. . . .

EPA Science Advisory Board, *supra* note 66.

200 Massachusetts v. EPA, 549 U.S. 497, 534 (2007).

201 EPA concluded that it is "reasonable for EPA to decline to establish a 'bright line objective test of contribution.'" Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. at 66,542 (quoting Catawba Cnty. v. EPA, 571 F.3d 20, 39 (D.C. Cir. 2009)). EPA rejected the argument that it "must provide some basis for determining de minimis amounts that fall below the threshold of 'contributing' to the endangerment of public health and welfare under CAA section 202(a)." *Id.* at 66,541.

202 *Id.* at 66,541–42.

consideration, or that the danger posed by GHGs would be significant.[203] But it does have to find a danger, and as it becomes more apparent that temperatures are fluctuating within a range that is not unprecedented, it becomes more difficult to say that a danger exists.[204] If current temperatures, and expected increases, are within historical norms, then deciding on an optimal temperature to try to achieve is effectively benefitting some species and ecosystems while punishing others. Which environmental changes would be considered favorable changes, and which negative, and what weight would be assigned them in a balancing test? EPA acknowledged that there are positive aspects of climate change, such as favorable effects on agricultural production,[205] but glossed over them in favor of emphasizing negative changes. One would like to be assured that the overall effects of increased GHGs and temperatures would be negative before concluding that there has been an endangerment.[206]

The best analysis of endangerment may be more a matter of metaphysics than physics. We know that temperatures and GHGs, especially CO_2, have fluctuated naturally over time, and have been both higher and lower than the present. Even in the recent past (i.e., the last 10,000 years) there is clear evidence of temperatures that were warmer than the present, and probably higher than are predicted for the future, if we use the most reliable climate models. If so, it is difficult to conclude that an increased Earth temperature in the twenty-first century presents a danger, even if GHG forcings contribute to that increase. Both a cooler and warmer Earth are natural conditions. In light of that fact, how does EPA decide which state of nature is acceptable, and which is dangerous?

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203 *Id.* at 66,506–09.

204 For example, at least one study has concluded that a temperature rise of even two degrees Celsius would have negligible effects on welfare. Richard S.J. Tol, *The Economic Effects of Climate Change*, 23 J. ECON. PERSP. 29, 29 (2009), *available at* http://www.econ.yale.edu/~nordhaus/homepage/documents/Tol_impacts_JEP_2009.pdf.

205 "Elevated carbon dioxide concentrations can have a stimulatory effect on grain and oilseed crop yield, as may modest temperature increases and a longer growing season that results." Endangerment Finding, 74 Fed. Reg. at 66,531; *see also* Bruce A. Kimball, *Carbon Dioxide and Agricultural Yield: An Assemblage and Analysis of 430 Prior Observations*, 75 AGRONOMY J. 779, 779 (1983); Bruce A. Kimball, *Seventeen Years of Carbon Dioxide Enrichment of Sour Orange Trees: Final Results*, 13 GLOBAL CHANGE BIOLOGY 2171, 2171 (2007).

206 Similarly, as part of any endangerment analysis, EPA should also look at the costs of its actions in terms of the effect on the national economy and on U.S. citizens. Limiting fossil fuel use, and substituting more expensive alternative fuels, has important implications in this country and abroad. The danger posed by limiting growth, by curtailing use of the least expensive energy, could be far greater than the limited, perhaps vanishingly small, costs imposed by temperature increases due to GHGs.

Perhaps it is unreasonable to expect that a U.S. President who is so firmly committed to redressing climate change that he told a nominating convention that his election would one day be seen by future generations as "the moment when the rise of the oceans began to slow and our planet began to heal"[207] will ever agree to reconsider evidence contradicting the Endangerment Finding. But the growing body of evidence that GHGs are not driving dangerous climate change will provide ample opportunity for another administration to reach a different, and scientifically supportable, conclusion.

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[207] Barack Obama, *Remarks on Winning the Democratic National Nomination*, YOUTUBE (June 4, 2008), http://www.youtube.com/watch?v=u2pZSvq9bto.