No. 05-1120

In the Supreme Court of the United States

COMMONWEALTH OF MASSACHUSETTS, *et al.*,
Petitioners,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, *et al.*,
Respondents.

On Writ of Certiorari to the United States Court of Appeals for the District of Columbia Circuit

BRIEF OF *AMICI CURIAE* CLIMATE SCIENTISTS DAVID BATTISTI, WILLIAM E. EASTERLING, CHRISTOPHER FIELD, INEZ FUNG, JAMES E. HANSEN, JOHN HARTE, EUGENIA KALNAY, DANIEL KIRK-DAVIDOFF, PAMELA A. MATSON, JAMES C. MCWILLIAMS, MARIO J. MOLINA, JONATHAN T. OVERPECK, F. SHERWOOD ROWLAND, JOELLEN RUSSELL, SCOTT R. SALESKA, EDWARD SARACHIK, JOHN M. WALLACE, AND STEVEN C. WOFSY IN SUPPORT OF PETITIONERS

JOHN C. DERNBACH
WIDENER UNIVERSITY
LAW SCHOOL
3800 VARTAN WAY
HARRISBURG, PA 17106
(717) 541-1933

ROBERT B. MCKINSTRY, JR.*
PENN STATE UNIVERSITY
432 FOREST RESOURCES
BUILDING
UNIVERSITY PARK, PA 16802
(484) 467-3207
* *Counsel of Record*

KIRSTEN H. ENGEL
UNIVERSITY OF ARIZONA
COLLEGE OF LAW
1201 E. SPEEDWAY BLVD.
TUCSON, AZ 85721
(520) 621-5444

STEPHANIE TAI
UNIVERSITY OF WISCONSIN
LAW SCHOOL
957 BASCOM MALL
MADISON, WI 53706
(608) 890-1236

Counsel for Amici Curiae Climate Scientists

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INTEREST OF THE *AMICI CURIAE*[1]

Amici Curiae Climate Scientists are David Battisti, William E. Easterling, Christopher Field, Inez Fung, James E. Hansen, John Harte, Eugenia Kalnay, Daniel Kirk-Davidoff, Pamela A. Matson, James C. McWilliams, Mario J. Molina, Jonathan T. Overpeck, F. Sherwood Rowland, Joellen L. Russell, Scott R. Saleska, Edward Sarachik, John M. Wallace, and Steven C. Wofsy (hereinafter "Climate Scientists").[2] The Climate Scientists are individual climate scientists who are actively involved in research on changes to the Earth's climate that are being caused by anthropogenic emissions of carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons ("greenhouse gases" or "GHGs") and the effects of those changes. Most of these scientists are members of the National Academy of Sciences ("NAS")[3] or Engineering, or have served on one or more of the recent National Academy of Sciences/National Research Council ("NAS/NRC") panels that have

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[1] All parties have consented to the filing of this brief. Pursuant to this Court's Rule 37.6, *Amici* state that no counsel for any party in this case authored this brief in whole or in part, and no person other than *Amici* and their counsel has made a monetary contribution to the preparation and submission of this brief.

[2] The Climate Scientists are appearing in their individual capacity and not as representatives of any institution with which any of them is affiliated. The assertions of science in this brief have been drafted, reviewed and approved by the Climate Scientists, representing a distillation of the conclusions set forth in *Climate Change Science* and other scientific reports cited herein.

[3] "The National Academy of Sciences ("NAS") is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of a charter granted to it in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters." J.A. 140, National Academy of Sciences/National Research Council, Preface to *Climate Change Science: An Analysis of Some Key Questions* (2001) ["*Climate Change Science*" or "NAS/NRC 2001 Report"].

reviewed the state of the science on climate change and the impacts of human activities on climate.[4] The first of these, *Climate Change Science: An Analysis of Some of the Key Questions* ("*Climate Change Science*" or "NAS/NRC 2001)"), was published in 2001 in response to a request from the White House for an assessment of the areas of greater and lesser certainty in climate change science.[5] The second, *Abrupt Climate Change: Inevitable Surprises* ("*Abrupt Climate Change*" or "NAS/NRC 2002") was published one year later. The third, *Surface Temperature Reconstructions for the Last 2,000 Years* ("*Reconstructions*" or "NAS/NRC 2006"), was published this year in response to a request from Congress. The NRC, the Academy's principal operating arm, was formed in 1916 to further scientific and technological knowledge and to advise the federal government. J.A. 140, *preface to Climate Change Science.*

A. Perspective

As practicing scientists who study the earth's climate system, we and many in our profession have long understood that continued human-caused emission of greenhouse gases—primarily carbon dioxide (CO_2), but also methane (CH_4), nitrous oxide (N_2O), and fluorocarbons—would eventually warm the earth's surface. Most were skeptical that we would see strong signs of human-induced climate change in our lifetimes. But by the beginning of this decade, we observed that global temperatures are rising, plant and animal ranges are shifting, glaciers are in retreat globally, and arctic sea ice is retreating. Sea levels are rising and the oceans are becoming more acidic. To the extent that these changes

[4] *Id.*; National Academy of Sciences/National Research Council, *Abrupt Climate Change: Inevitable Surprises* (2002) ["*Abrupt Climate Change*" or "NAS/NRC 2002"]; National Academy of Sciences/ National Research Council, *Surface Temperature Reconstructions for the Last 2,000 Years* (2006) ["NAS/NRC 2006"].

[5] J.A. 213, *Climate Change Science* at 27 (reprinting Letter from John M. Bridgeland & Gary Edson to Bruce Alberts (May 11, 2001)).

result from human alteration of the atmosphere, we know that they are just the first small increment of climate change yet to come if human societies do not curb emissions of greenhouse gases.

The evidence of these changes, though attended by the uncertainty or caveats that appropriately accompany scientific knowledge, is nonetheless so compelling that it has crystallized a remarkable consensus within the scientific community: climate warming is happening, and human activities are very likely a significant causal factor. The nature of this consensus may be obscured in a public debate that sometimes equates consensus with unanimity or complete certainty. We are profoundly troubled by the misunderstanding or misrepresentation of the current state of knowledge of climate change evident in the United States Environmental Protection Agency's ("EPA's") denial of the petition for rulemaking to regulate emissions of greenhouse gases from mobile sources, Pet. App. A59-A93, Control of Emissions From New Highway Vehicles and Engines, 68 Fed. Reg. 52,922, (Sept. 8, 2003), and the subsequent court of appeals review of that action, Pet. App. 1-58, *Massachusetts* v. *EPA*, 415 F.3d 50 (D.C. Cir. 2005).

EPA and the appeals court stated that they considered the NAS/NRC report *Climate Change Science* to be the scientific authority for the decision to deny the petition to regulate. We feel an obligation to inform this Court that they misunderstood or misrepresented the science contained in this report, to correct the public record as to what *Climate Change Science* and subsequent NAS reports say about climate change, and to offer our professional insight on using scientific evidence to judge whether a particular standard for regulatory action is met in the matter of climate change.

B. Background and Experience

Amicus David Battisti is the Tamaki Professor of Atmospheric Sciences at the University of Washington.

He has a Ph.D. from the University of Washington in the field of atmospheric sciences. He has been involved in the field of climate dynamics and climate change since 1984. His research involves climate variability (El Niño, drought in the Sahel, decadal variability in the climate system), paleoclimate (abrupt climate change during the last glacial period), and climate change. He served for three years on the NAS Committee for Climate Research and for six years was co-chair of the U.S. Climate Variability and Predictability Science Steering Committee.

Amicus William E. Easterling is Professor of Geography and Earth System Science at The Pennsylvania State University. He also directs the Penn State Institutes of the Environment. He received his B.S. (1976), M.S. (1980), and Ph.D (1984) degrees in geography from the University of North Carolina at Chapel Hill. Dr. Easterling is an expert on the implications of climate change for global and regional food security, including the potential for agricultural systems to adapt to such change. He has served on several panels and committees of the National Research Council, including chairing the Panel on the Human Dimensions of Seasonal-to-Interannual Climate Variability. He has served on numerous government advisory committees and task forces.

Amicus Christopher Field is the founding director of the Department of Global Ecology of the Carnegie Institution of Washington and Professor of Biological Sciences at Stanford University. He has a Ph.D. from Stanford University in the field of biological sciences. He has been involved in the study of climate change impacts and the global carbon cycle since 1988. He is a member of the NAS.

Amicus Inez Fung is Professor of Atmospheric Science and Co-Director of the Berkeley Institute of the Environment at the University of California ("U.C.") at Berkeley. Dr. Fung received her Sc.D. from the Massachusetts Institute of Technology ("MIT"). Her research expertise is in large scale numerical modeling of biogeochemical cycles and their interaction with climate. Her research also includes climate change, remote sensing

of earth systems, investigations of atmosphere-ocean interactions, and atmosphere-biosphere interactions. She is a member of the NAS and served on the NAS/NRC's Committee on Climate Change Science that reviewed the state of climate science for President Bush and produced *Climate Change Science.*

Amicus James E. Hansen is head of the NASA Goddard Institute for Space Studies. Dr. Hansen received his Ph.D. from the University of Iowa. His research interests include radiative transfer in planetary atmospheres, development of global climate models, current climate trends from observational data, and projections of man's impact on climate. He is a member of the NAS and served on the NAS/NRC's Committee on Climate Change Science that reviewed the state of climate science for President Bush and produced *Climate Change Science.*

Amicus John Harte is a Professor in the Energy and Resources Group and the Ecosystem Sciences Division of the College of Natural Resources at the U.C. Berkeley. He received a B.A. in physics from Harvard University in 1961 and a Ph.D. in theoretical physics from the University of Wisconsin in 1965. He has been involved in the study of earth system science since 1973 and his research currently focuses on the ecological consequences of climate change and the climate consequences of ecological changes. He has served on six different panels of the NAS/NRC.

Amicus Eugenia Kalnay is a Distinguished University Professor at the University of Maryland. Previously, she was Director of the Environmental Modeling Center at the National Weather Service and Head of the Global Modeling Branch at the NASA Goddard Space Flight Center. She has a Ph.D. in meteorology from MIT. Her research expertise is in numerical modeling of the atmosphere, data assimilation and predictability, El Niño prediction, and applications of satellite remote measurements to weather and climate problems. She is a member of the National Academy of Engineering, and has served on many panels of the NAS/NRC.

Amicus Daniel Kirk-Davidoff is an Assistant Professor in the Department of Meteorology at the University of Maryland. He received a Ph.D. in Meteorology from MIT in 1997. He is a climate dynamicist with interests in the stratospheric water vapor budget, paleoclimate modeling, satellite climate monitoring, and the use of satellite data to improve climate models.

Amicus Pamela A. Matson is the Richard and Rhoda Goldman Professor of Environmental Studies at Stanford University. She has been involved in the study of global change for more than 20 years, focusing on land use change, greenhouse gas production from agricultural ecosystems, and interactions of forest and agricultural ecosystems with the atmosphere and water. She has served on the NRC's Board on Global Change, and is currently co-chair of the NAS Roundtable on Science and Technology for Sustainability.

Amicus James C. McWilliams is the Louis Slichter Professor of Earth Sciences at University of California, Los Angeles. He has a Ph.D. from Harvard University in the field of applied mathematics. He has been involved in the study of oceanic and atmospheric circulations and climate since 1970. He is a member of the NAS and a Fellow of the American Geophysical Union. He served on the NAS/NRC's Committee on Climate Change Science that reviewed the state of climate science for President Bush and produced *Climate Change Science*.

Amicus Mario J. Molina is a Professor at the University of California, San Diego (UCSD), with a joint appointment in the Department of Chemistry and Biochemistry and the Scripps Institution of Oceanography. Prior to joining UCSD he was an Institute Professor at MIT. He received a Ph.D. in Physical Chemistry from the University of California, Berkeley. He has been involved in developing our scientific understanding of the chemistry of the stratospheric ozone layer and its susceptibility to human-made perturbations. He was a co-author, with F. Sherwood Rowland, of the 1974 publication in the British journal *Nature*, on the threat to the ozone layer from

chlorofluorocarbon (CFC) gases, and received the 1995 Nobel Prize in Chemistry (with F. Sherwood Rowland and Paul Crutzen) for his "work on atmospheric chemistry, particularly concerning the formation and decomposition of ozone." He has served on the President's Committee of Advisors in Science and Technology, and on many other advisory boards and panels. He is a member of the NAS, the Institute of Medicine, and the Pontifical Academy of Sciences. He has received numerous awards for his scientific work in addition to the 1995 Nobel Prize in Chemistry, including the Tyler Ecology and Energy Prize in 1983 and the UNEP-Sasakawa Award in 1999.

Amicus Jonathan T. Overpeck is a Professor of Geosciences and a Professor of Atmospheric Sciences at the University of Arizona. He has a Ph.D. from Brown University in the field of geological sciences. He has been involved in the study of climate science since 1979. His research focuses on using models and the climate record of the past million years to understand climate variability and future change. He served on the NAS/NRC Committee that reviewed the state of climate science for President Bush and produced *Abrupt Climate Change.*

Amicus F. Sherwood Rowland is the Bren Research Professor of Chemistry and Earth System Science at U.C. Irvine. He has a Ph.D. in Chemistry from the University of Chicago in the field of Physical Chemistry. He was a co-author, with Mario Molina, of the 1974 publication in the British journal *Nature*, on the threat to the ozone layer from CFC gases, and received the 1995 Nobel Prize in Chemistry (with Mario Molina and Paul Crutzen) for his "work on atmospheric chemistry, particularly concerning the formation and decomposition of ozone." He is a member of the NAS and the Institute of Medicine, and is a Foreign Member of the Royal Society (UK). He served for eight years as the Foreign Secretary of the NAS, and has received the Roger Revelle Medal of the American Geophysical Union, and the Debye Award of the American Chemical Society. He has received numerous prizes for his scientific work on the environment including

the Japan Prize in Environmental Science and Technology and the Tyler Prize in Ecology and Energy. He is a member of the Board on Atmospheric Sciences and Climate of the NRC, and served on the NAS/NRC's Committee on Climate Change Science that reviewed the state of climate science for President Bush and produced *Climate Change Science.*

Amicus Joellen L. Russell is an Assistant Professor of Geosciences at the University of Arizona. She received her B.A. in Environmental Geoscience from the Department of Earth and Planetary Sciences at Harvard University in 1993, and her Ph.D. in Oceanography from the Scripps Institution of Oceanography at UCSD in 1999. Her research focuses on biogeochemical dynamics, the interactions between the biological, geological and chemical components of Earth's environment.

Amicus Scott R. Saleska is an Assistant Professor of Ecology and Evolutionary Biology at the University of Arizona. He received a B.S. in Physics from MIT in 1986 and a Ph.D. in Energy and Resources from the U.C. Berkeley in 1998. His research focuses on how climate interacts with plant physiology, demography, and ecological processes to influence or control biogeochemical cycling from local to global scales.

Amicus Edward Sarachik is a professor in the Department of Atmospheric Sciences and an adjunct professor in the School of Oceanography at the University of Washington. He served on the NAS/NRC Committee on Climate Change Science that reviewed the state of climate science for President Bush and produced *Climate Change Science.*

Amicus John M. Wallace is a Professor in the Department of Atmospheric Sciences at the University of Washington. He has a Ph.D. from MIT in the field of meteorology. He has been involved in the study of climate variability and change since 1980 and his research involves El Niño and other patterns of climate variability. He served on the NAS/NRC's Committee on Climate Change Science that reviewed the state of climate science for

President Bush and produced *Climate Change Science*. He is a member of the NAS and served on both the NAS/NRC Committee that produced *Abrupt Climate Change* and the NAS/NRC committee that produced the report *Reconstructions*.

Amicus Steven C. Wofsy is the Abbott Lawrence Rotch Professor of Atmospheric and Environmental Science at Harvard University. He has a Ph.D. in Chemistry from Harvard University and has studied atmospheric science since 1971, concentrating on the processes that control atmospheric chemical composition, climate change, and the global carbon cycle. He has served on the NASA Advisory Council and many other Federal advisory committees, and was a principal author of the U.S. Carbon Cycle Science Plan.

SUMMARY OF ARGUMENT

The science of climate change indicates that increases in greenhouse gases will almost certainly affect global climate and pose risks to human societies**.** The NAS/NRC 2001 report, *Climate Change Science*, comprehensively addressed the centrally relevant questions of climate change science, and unambiguously concluded that Earth's climate is changing in ways that risk significant adverse impacts on public welfare. The NAS/NRC report found strong evidence for anthropogenic causation of recent climate change by emissions of CO_2 and other greenhouse gases, and stated that there is a high probability for much larger human-caused climate changes in the future.

EPA claimed to rely on *Climate Change Science* as its sole scientific authority in denying petitioners' request to regulate GHG emissions under Section 202(a)(1) of the Clean Air Act. However, EPA misrepresented the findings of *Climate Change Science* by selectively quoting statements about uncertainty while ignoring statements of certainty and near-certainty, thus giving the appearance of far more

fundamental uncertainty than stated in the NAS/NRC report. EPA then concluded that "it is inappropriate to regulate GHG emissions from motor vehicles" "until more is understood about the causes, extent, and significance of climate change," implying that there is no risk in waiting for future research, a conclusion sharply inconsistent with the plain language of *Climate Change Science*.

In fact, *Climate Change Science* establishes that there was and is sufficient scientific evidence to enable EPA to make a determination under Section 202 (a)(1) of the Clean Air Act that greenhouse gas emissions "may reasonably be anticipated to endanger public health or welfare." Given the protective standard of environmental regulation that Congress codified in Section 202(a)(1),[6] the scientific evidence of the risks, long time lags, and irreversibility of climate change argue persuasively for prompt regulatory action to restrain emissions of greenhouse gases under the Clean Air Act.

ARGUMENT

I. The Science of Climate Change Indicates that It Is Virtually Certain that Greenhouse Gas Emissions from Human Activities Cause Global Climate Changes, Endangering Human Health and Welfare.

Neither EPA nor the court of appeals correctly applied the science of climate change to the petition for rulemaking. In its report in 2001, *Climate Change Science*, a panel of NAS/NRC unambiguously stated that it is virtually certain[7] that greenhouse gas emissions from

[6] By "protective standard," we refer to measures taken to protect against possible danger or failure. Should EPA regulate GHGs today, the principal effect would be to mitigate harm expected to occur decades hence, not to reduce the impacts of GHGs already emitted.

[7] In our discussion of climate change science, we use the terminology introduced by Intergovernmental Panel on Climate Change Third Assessment Report. Intergovernmental Panel on Climate Change

human activities cause global climate changes. These emissions increase the risk of adverse effects on health and welfare. To aid this Court in understanding the foregoing conclusion, we first clarify what scientific knowledge informs us about anthropogenic climate change.

1. The basic physics underlying the greenhouse effect is firmly established. Two principles in particular are as certain as any phenomena in planetary sciences. First, particular atmospheric gases ("greenhouse gases") absorb radiation that otherwise would be lost to space, and re-radiate it back to the ground. A planet with those gases in its atmosphere is thus warmer at the surface than it would be without them. Second, greater atmospheric concentrations of greenhouse gases, all other things being equal, cause higher temperatures at the surface. The Earth is habitable for its current life forms in part because natural levels of greenhouse gases in the atmosphere warm the surface.

2. Over the last two centuries, it is virtually certain that human activities have increased amounts of important greenhouse gases (primarily CO_2, CH_4, N_2O, and fluorocarbons[8]) in the atmosphere to levels not seen in all

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["IPCC"], *Technical Summary of the Working Group I Report of the Intergovernmental Panel on Climate Change* 28 n.4 (2001) ("In this Technical Summary and in the Summary for Policymakers, the following words have been used where appropriate to indicate judgmental estimates of confidence: virtually certain (greater than 99% chance that a result is true); very likely (90-99% chance); likely (66-90% chance); medium likelihood (33-66% chance); unlikely (10-33% chance); very unlikely (1-10% chance); exceptionally unlikely (less than 1% chance). The reader is referred to individual chapters for more details.").

[8] Water vapor is a greenhouse gas and is an important amplifier of climate change because its atmospheric concentrations tend to increase when the atmosphere and surface waters warm up. Anthropogenic emissions of water vapor to the atmosphere by automobiles and other combustion sources do not significantly affect global atmospheric concentrations of water vapor relative to the natural evaporation and condensation processes, and thus they do not "cause, or contribute," to pollution implicated in anthropogenic climate change. 42 U.S.C. 7521(a)(1) .

of prior human experience, and likely not seen for 3 million years.

3. It is likely or very likely[9] that human-induced increases in these greenhouse gases are already causing global climate to warm. Human activities likely caused most of the approximately 0.6 ºC (1.1 ºF) rise over the 20th century. J.A. 151, *Climate Change Science* at 1. The mean ocean temperature has risen by 0.05 ºC (0.09 ºF), global average sea level has risen by 0.1 to 0.2 meters (1/3 to 2/3 feet) over the 20th century, and snow cover and Arctic ice have decreased by about 10% and 10-15%, respectively, since the late 1960s (when data first became available for this measurement). *Id.* at 16. A variety of other climate factors are changing consistent with warming induced by greenhouse gases. By contrast, we know of no measures of climate on the global scale that indicate cooling.

4. It is virtually certain that what has been observed so far is only the beginning, and that continued greenhouse gas emissions along current trajectories will cause additional warming of the earth system as a whole. The average time for removal from the atmosphere of added carbon dioxide is measured in centuries. It is very likely that such perturbation would cause the rate of surface warming and sea level rise in the 21st century to be substantially larger and faster than that experienced in the 20th century, without precedent in the past 10,000 years.

5. The first sentences of *Climate Change Science* state:

> Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability. Human-induced warming and associated sea level rises are expected to continue through the

[9] See note 7 *supra*.

> 21st century. Secondary effects are suggested by computer model simulations and basic physical reasoning. These include increases in rainfall rates and increased susceptibility of semi-arid regions to drought. The impacts of these changes will be critically dependent on the magnitude of the warming and the rate with which it occurs.

J.A. 151, *Climate Change Science* at 1.

6. Although the general link between increased greenhouse gases in the atmosphere and increased warming of the earth system is virtually certain, the complexity of the climate system means that predictions of specific details that follow from this general link are subject to varying degrees of certainty. Among the more certain predictions are the following:

a. It is likely, based on both models and on data from the ice ages over the last 400,000 years, that if atmospheric carbon dioxide doubled from pre-industrial times, and rose no further, the long-term rise of global average surface temperature (the "climate sensitivity") would be between 1.5 and 4.5 ^{o}C (2.7 - 8.1 ^{o}F). J.A. 166, *Climate Change Science* at 7.

b. In the absence of emissions reductions, however, carbon dioxide concentrations in the atmosphere are very likely to increase to much more than twice pre-industrial values, and the consequent rise in global average temperature during the 21st century, projected to be 1.4 to 5.8 ^{o}C (2.5 to 10.4 ^{o}F), will likely continue to higher values beyond the year 2100. IPCC, *Technical Summary*, at 69.

c. This amount of warming in 6.a and 6.b is very likely to drive melting of arctic ice sheets and further increases in global average sea level by 2100, with continued sea-level rise in the decades and centuries following 2100.

d. The anticipated sea level rise, especially when combined with likely increases in hurricane intensities, would exacerbate storm surges and have direct, negative impacts on health and welfare in the United States, and globally. These negative impacts would be concentrated in

low-lying coastal regions, such as Cape Cod, Massachusetts, the Gulf coast, and southern Florida.

e. Rising temperatures are also likely to lead to increases in extreme weather events (especially heat waves, and associated heat-related deaths) and altered patterns of rainfall (*e.g.*, droughts and floods) that will disrupt natural and agricultural ecosystems, and increase the risk of extinction of animal and plant species.

f. Ocean acidity is very likely to increase by several tenths of a pH unit due to continued uptake of carbon dioxide, and this acidification is likely to cause substantial stress to key marine organisms, and hence to whole marine ecosystems, particularly in cold water regions. Although this is an impact of increasing levels of greenhouse gases, it is not an atmospheric climate change and therefore was not addressed in *Climate Change Science*.

g. Ground level ozone ("smog") levels (and associated risks to human health) are very likely to increase with temperature, especially in the Northeastern United States, where many areas currently experience ozone levels that exceed EPA Clean Air Act standards on hot summer days.

7. The possibilities of the climate changes above have been carefully and extensively assessed, and there is a broad scientific consensus that these changes are likely or very likely. This consensus is clearly expressed in *Climate Change Science*. It is harder to determine how long it may take for these changes to occur, and what the precise magnitude of the impacts may be. The climate system has a great deal of inertia (especially in the ice sheets and oceans), and thus the effects of greenhouse gases already in the atmosphere are delayed. Emissions of GHGs commit the climate to future warming long after release to the atmosphere.

8. Apart from the likely, very likely, and virtually certain gradual climate changes outlined in points 1-7, there is also an as yet unquantifiable probability that continued greenhouse gas emissions will trigger abrupt climate change surprises that could very rapidly impose large impacts on ecosystems and human welfare and

health. The NAS/NRC issued a detailed report (*Abrupt Climate Change*) on this matter in 2002, showing that abrupt climate changes (*e.g.*, large regional cooling or warming, widespread droughts, shifts in hurricane frequency or flood regimes that occur in only a decade or so) are possible because they have happened in the past, at the dawn of human history and before. We do not understand these switches very well, but there is a finite but unknown risk that continued emission of greenhouse gases will trigger a climate change surprise.

9. The science of climate change (including the uncertainties) implies that delay in reducing greenhouse gas emissions will very likely increase the risks to human societies. Early steps to reduce greenhouse gas emissions to levels below current trajectories will certainly reduce the magnitude of climate change that would otherwise be caused. Because of inertia in the climate system, it will be many decades before effects of emission reductions are realized.

10. Delaying reductions in greenhouse gas emissions heightens the risk to human welfare because climate inertia commits us to large-scale, long term (centuries) climate change consequences before the exact nature of those consequences can be known. The heightened risk of delaying emissions reductions is clearly expressed in *Climate Change Science.* J.A. 151-152, *Climate Change Science* at 1.

11. Stratospheric ozone depletion and the Antarctic "ozone hole" illustrate how both surprise and inertia may increase the risks from unmitigated global environmental change. Models predicted that the emission of chlorofluorocarbons (CFCs) and other chlorinated halocarbons by human activities would gradually deplete stratospheric ozone. No model predicted the stratospheric ozone hole in advance of its discovery in the mid-1980s. The reality of ozone depletion turned out to be worse than even the worst-case modeled scenario because none of the models anticipated the novel chemistry of ozone depletion via polar stratospheric clouds above the south (and north)

poles. The CFC phase-out of the 1990s should allow the ozone hole to recover, but it will take about 75 years, a time lag reflecting the long lifetimes of CFCs (inertia preventing recovery). It is noteworthy that early regulation by the United States (beginning in the 1970s, before the ozone hole was discovered) certainly reduced the risks and damages that unfolded in the case of stratospheric ozone depletion.

12. Developments since the NAS/NRC reports of 2001 and 2002 have only reinforced the finding that recent climate changes are "likely mostly due to human activities."[10] J.A. 151, *Climate Change Science* at 1.

a. The five warmest years since pre-industrial times were 1998, 2002, 2003, 2004, and 2005 (2005 is the warmest overall), and the reduction of ice cover in the Arctic has accelerated.[11]

b. A recent NAS/NRC report confirmed temperature trends discussed in *Climate Change Science*, concluding that the global mean surface temperature during the last few

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[10] See, *e.g.*, *Joint Science Academies' Statement: Global Response to Climate Change*, *available at* http://www.nationalacademies.org/onpi/06072005.pdf (June 2005) (signed by the presidents of the national scientific academies in Brazil, Canada, China, France, Germany, India, Italy, Japan, Russia, United Kingdom, and the United States). The *Statement* begins:

> *Climate change is real.* There will always be uncertainty in understanding a system as complex as the world's climate. However there is now strong evidence that significant global warming is occurring. The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities (IPCC 2001). This warming has already led to changes in the Earth's climate.

Id. (emphasis added).

[11] J. Hansen, M. Sato, R. Ruedy, K. Lo, D.W. Lea & M. Medina-Elizade, *Global Temperature Change*, Proc. Natl. Acad. Sci. (forthcoming); J.C. Comiso, *Arctic Warming Signals from Satellite Observations*, 61-3 Weather 70-76 (2006).

decades of the 20th century was higher than any comparable period in the past four centuries, and, likely so, in the past 1000 years. *Reconstructions* at 2, Report in Brief; *id.* at 3.

c. The question of the apparent discrepancy between late 20th century temperature rise at the surface, versus satellite-derived temperatures above the surface, regarded as a puzzle in *Climate Change Science*, has been resolved. A recent comprehensive scientific reevaluation, which corrected errors in the initial satellite estimates, concluded that "all available data sets show that both the surface and the troposphere have warmed." U.S. Climate Change Science Program, *Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences* 1 (Apr. 2006).

II. EPA and the Court of Appeals Mischaracterized the Science of Climate Change, Making It Appear More Uncertain Than It Actually Is.

EPA relied on the NAS/NRC 2001 report, *Climate Change Science,* as the authoritative source of scientific information in its decision to deny the petition for rulemaking. The court of appeals cited no other source than *Climate Change Science* for its conclusion regarding scientific uncertainty. But EPA and the court of appeals mischaracterized the scientific analysis in *Climate Change Science* and arrived at conclusions sharply at variance with the scientific judgments in the report.

To understand the magnitude of their mischaracterization of *Climate Change Science*, one must first examine the nature of scientific uncertainty. Scientific knowledge is developed incrementally, using experiment and observation to test and refine hypotheses. A large part of the work of science is directed towards understanding and quantifying uncertainties. *The goal is to place bounds on future outcomes.* An hypothesis is deemed "virtually certain" if the predicted outcome is expected to occur for

99% or more of repeated trials, "very likely" for 90-99%, and "likely" for 66-90%.[12] Absolute certainty is impossible *in principle* in climate science, as in all fields of science.[13] Moreover, there is only a single "trial" with respect to earth's climate, so strict statistical measures of likelihood cannot be applied. These characteristics of scientific knowledge must be expertly considered, and certainties and uncertainties carefully balanced, when applying the protective approach required for decisions to regulate under the Clean Air Act. However, in its denial of the petition for rulemaking, EPA presented an inexpert and unbalanced discussion, and reached conclusions not supported by the scientific evidence it was purporting to use.

A. EPA's Decision

EPA's decision misrepresented the findings in *Climate Change Science*, which EPA cited as the only source of evidence in its discussion of scientific uncertainty. See Pet. App. 82, 68 Fed. Reg. 52,922, 52,930 (Sept. 8, 2003) ("We rely in this decision on NRC's objective and independent assessment of the relevant science."); *see also id.* (adding that nothing received during the public comment period "causes us to question the validity of the NRC's conclusions"). *Climate Change Science* encompasses both the more certain and the less certain elements of the science, and uncertainties are described explicitly, as is the norm in scientific reports. Thus, it is possible to quote selectively from the report to make the scientific conclusions appear either more or less certain than they actually are.

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[12] See note 7 *supra* .

[13] See Erica Beecher-Monas, *The Heuristics of Intellectual Due Process: A Primer for Triers of Science*, 75 N.Y.U. L. Rev. 1563, 1581 (2000) ("Scientists understand that fluctuations, instability, multiple choices, and limited predictability are inherent at all levels of observation.") (internal quotation marks omitted).

EPA admitted to three important observations about the global climate: (1) that "concentrations of GHGs are increasing in the atmosphere as a result of human activities," *id.* (citing J.A. 170-180, *Climate Change Science* at 9-12), (2) that a "diverse array of evidence points to a warming of global surface air temperatures," *id.* (quoting J.A. 190, *Climate Change Science* at 16), and (3) that "the magnitude of the observed warming is large in comparison to natural variability," Pet. App. A83, 68 Fed. Reg. at 52,930 (quoting J.A. 193, *Climate Change Science* at 17).

However, EPA omitted the essential scientific conclusion that constitutes the core of *Climate Change Science*: that these separate observations are causally linked. This is a fundamental omission. It is as if a summary of Newton's *Principia*—which advanced the theory of gravitation as the common explanation for how apples fall to earth and planets move in the heavens—repeated Newton's description of the motions of apples and planets, but never got around to mentioning gravity. Isaac Newton, *Principia Mathematica Philosophiae Naturalis* (W.A. Kaminski trans., World Scientific 1987) (1729).

EPA in particular omitted mention of the following two pivotal conclusions. First, the NAS report unambiguously links already observed climate warming, and related impacts, damages, and risks, to human emissions of greenhouse gases. "*The changes observed over the last several decades are likely mostly due to human activities*, but we cannot rule out that some significant part of these changes is also a reflection of natural variability." J.A. 151, *Climate Change Science* at 1 (emphasis added). The key conclusion, in the first part of this sentence, is never cited by EPA. Second, after listing a number of impacts and damages that are likely to occur in response to human-caused climate change, *Climate Change Science* states, "Hence national policy decisions made now, and in the longer-term future will influence the extent of any damage suffered by vulnerable human populations and ecosystems later in this century." J.A. 152, *Climate Change*

Science at 1. Remarkably, EPA ignored this scientific judgment, which clearly indicated the panel's concern that dangerous human-caused climate change is likely[14] already underway with larger effects committed for the future, particularly if action should not be taken to limit emissions.

EPA focused instead on a statement in the 2001 report that a "causal linkage between the buildup of greenhouse gases in the atmosphere and the observed climate changes during the 20th century cannot be unequivocally established." J.A. 193, *Climate Change Science* at 17 (cited in Pet. App. A83, 68 Fed. Reg. at 52,930). But EPA was petitioned to initiate rulemaking under Section 202(a)(1) of the Clean Air Act, which requires regulation of motor vehicle pollutants that "may reasonably be *anticipated* to endanger public health or welfare." 42 U.S.C. 7521(a)(1) (emphasis added). It is not required that the link between observed warming and increased greenhouse gas concentrations be "unequivocally established" in order to ascertain whether greenhouse gas emissions "may reasonably be anticipated to harm" human health and welfare under Section 202(a)(1). As noted above, if "unequivocal" means "absolutely certain," this is impossible for climate science, just as absolute certainty is impossible to show for the link between smoking and cancer, or for the links to impacts of many other pollutants that are already regulated under the "reasonably be anticipated to endanger" framework.

EPA also ignored the two-sidedness of scientific uncertainty. Outcomes may turn out better than our best current prediction, but it is just as possible that environmental and health damages will be more severe than best predictions, as happened in the examples of stratospheric ozone depletion (discussed *supra*) and of lead toxicity from automobile emissions (discussed *infra*). Thus, it is wrong to infer that, because a prediction of an

[14] See note 7 *supra*.

undesirable outcome is uncertain, the associated risks are not worth regulating.

EPA's use of selective quotations and its unbalanced treatment of uncertainty allowed it to draw conclusions that are opposed to the actual scientific conclusions of *Climate Change Science*. EPA stated: "Substantial scientific uncertainties limit our ability to assess each of these factors [that contribute to climate change] and to separate out those changes resulting from natural variability from those that are directly the result of increases in anthropogenic GHGs." Pet. App. A84, 86 Fed. Reg. at 52,930. EPA's conclusion, drawn from this statement, was: "Until more is understood about the causes, extent, and significance of climate change and the potential options for addressing it, EPA believes that it is inappropriate to regulate GHG emissions from motor vehicles." Pet. App. A86, 86 Fed. Reg. at 52,931.

EPA's conclusion implies that there is no significant risk in waiting for future studies. This conclusion directly conflicts with the plain language of *Climate Change Science*, the authority that EPA claimed to use. The uncertainties are important, but so are the certainties and near-certainties, and the risks of delaying reductions in GHG emissions. In environmental science generally, and climate science in particular, critical decisions must be made in a timely fashion to protect the health and welfare of the population, without absolute certainty or multiple trials, and without the false luxury of waiting for the damage to be observed.

The need for timely decisions in the presence of uncertainty was recognized explicitly by Congress in crafting the Clean Air Act 202(a)(1). *Climate Change Science* assessed the science holistically and concluded that human-caused climate change had most likely already occurred and that serious future damage was highly probable.

By failing to properly balance scientific knowledge and uncertainties, and to acknowledge the links between GHGs, climate change, and damage to human health and

welfare discussed in *Climate Change Science*, EPA fundamentally distorted the meaning of the report. There is simply no sign in EPA's decision of the strong base of scientific knowledge described in *Climate Change Science*. The core conclusions of *Climate Change Science* (omitted in EPA's discussion) dovetail with the requirements of the Clean Air Act § 202(a)(1). EPA's denial of petition to regulate was based on distortion and misrepresentation of the scientific findings of *Climate Change Science*.

B. Court of Appeals Decision

The court of appeals assumed that EPA has the statutory authority to regulate greenhouse gas emissions from motor vehicles, but decided that EPA had properly exercised its discretion in refusing to regulate these emissions. In upholding EPA's decision, the court of appeals relied on several factors, including scientific uncertainty. Pet. App. 12, *Massachusetts*, 415 F.3d at 57. The court of appeals, relying on EPA's misrepresentation of *Climate Change Science*, also mischaracterizes the findings of the NAS/NRC panel by emphasizing uncertainties in climate change science while failing even to mention the existence of fundamental areas of certainty or consensus. The court then used scientific uncertainty (which it had mischaracterized) as a basis for upholding EPA's decision. Pet. App. 13, *id.* at 58.

Judge Randolph's opinion for the court cites *Climate Change Science* six times, with these citations selected in a way that omits important scientific context. For example, the opinion states, "The National Research Council [NAS/NRC] concluded that 'a causal linkage' between greenhouse gas emissions and global warming 'cannot be unequivocally established,'" excluding the intervening words "between the buildup of greenhouse gases in the atmosphere and the observed climate changes in the 20th century." Pet. App. 12, *id.* at 57. Without the intervening words, the reader is given the false impression that the quote applies to a completely different issue, the *general*

link between greenhouse gas concentrations and global warming. In fact, as we (including those of us who were members of the 2001 NAS/NRC panel) emphasize above, this link is virtually certain, even though uncertainties attach to the exact magnitude and timing of human-induced climate warming.

III. EPA Did Not Apply the Standard of Scientific Evidence Set Forth in the Clean Air Act.

The appropriate legal standard for determining the sufficiency of scientific evidence depends on the legal setting in which a decision is made. Different standards are appropriate in different contexts, such as in civil cases ("preponderance of the evidence"[15]) and criminal cases ("beyond reasonable doubt"[16]).

In this case, the legal standard for the sufficiency of scientific evidence has been established by Congress in Section 202(a)(1) of the Clean Air Act. That section provides:

> 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 vehicles 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*.

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[15] See Dan B. Dobbs, *The Law of Torts* § 19 (2000) ("The plaintiff need not prove that each fact necessary for her prima facie case is certainly true or true beyond a doubt. Instead, she must prove that each fact is more probable than not. Expressed statistically, she must persuade the jury or other trier of fact that the likelihood of each fact in her case exceeds 50%.") (footnote omitted).

[16] *Victor* v. *Nebraska*, 511 U.S. 1, 15 (1994) (requiring fact finder to have "a subjective state of near certitude" to return a guilty verdict); Robert C. Power, *Reasonable and Other Doubts*, 67 Tenn. L. Rev. 45, 51-53 (1999).

42 U.S.C. 7521(a)(1) (emphasis added). The following explains the standard of scientific evidence established under Section 202(a)(1) and how, in fact, the science of climate change meets this standard.

A. Section 202 Requires Reasonable Anticipation of Endangerment to Public Health or Welfare, Not Absolute Scientific Certainty.

The text and purposes of the Clean Air require a conservative approach to protection of public health and welfare. The statute mandates regulation of pollutants that "may reasonably be anticipated to endanger public health or welfare," 42 U.S.C. 7521(a)(1). It does not, and cannot reasonably be read to require complete scientific certainty in order to make a determination.[17]

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[17] The protective approach in Section 202(a)(1) is reinforced and made more explicit for greenhouse gases by a treaty to which the United States is a party, the United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107, *available at* http://unfccc.int/essential_background/convention/background/items/1349.php, which entered into force in 1994, see UNFCCC website at http://unfccc.int/parties_and_observers/parties/items/2228.php. In ratifying the Convention, the parties expressly agreed not to invoke scientific uncertainty as a ground for failing to take regulatory action on greenhouse gases where there is a "threat" of serious damage:

> The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, *lack of full scientific certainty should not be used as a reason for postponing such measures . . . .*"

Id. at Art. 3, ¶ 3 (emphasis added). Ratified treaties, along with the Constitution itself and United States laws, are "the supreme Law of the Land." U.S. CONST. Art. VI, § 2. Thus, an "act of Congress ought never to be construed to violate the law of nations if any other possible construction remains . . ." *Murray* v. *Schooner Charming Betsy*, 6 U.S. 64, 118 (1804); *Weinberger* v. *Rossi*, 456 U.S. 25, 32 (1982); *Hartford Fire Ins. Co.* v. *California*, 509 U.S. 764, 814-815 (1993) (Scalia, J., dissenting); *Spector* v. *Norwegian Cruise Line, Ltd.*, 545 U.S. 119, ___, 125 S.Ct. 2169, 2185 (2005) (Ginsburg, J., concurring).

EPA's decision to regulate lead additives in gasoline illustrates the wisdom of Congress' protective mandate to protect public health and welfare in Clean Air Act § 202(a)(1). In 1973, EPA promulgated final regulations phasing out the use of lead as a gasoline additive. Control of Lead Additives in Gasoline, 38 Fed. Reg. 33,734 (Dec. 6, 1973). It acted under Section 211(c)(1)(A) of the Clean Air Act, which at that time authorized EPA to adopt regulations restricting fuel additives in gasoline if any of their emission products "will endanger the public health or welfare. . . ." 42 U.S.C. 1857f-6c(c)(1)(A), currently codified as amended at 42 U.S.C. 7545(c)(1)(A). In adopting these regulations, EPA found that auto emissions from leaded gasoline presented "a significant risk of harm" to public health. 38 Fed. Reg. at 33,734.

These regulations were promulgated notwithstanding the lack of scientific consensus on whether the target of EPA's regulation—airborne lead from motor vehicles—was correlated with elevated blood lead levels (which cause lead poisoning and irreversible loss of cognitive function), and, if it was, whether airborne lead from burning leaded gasoline was a significant exposure pathway relative to other pathways (e.g. lead-based paint). 38 Fed. Reg. at 33,736.

Nevertheless, EPA promulgated lead regulations in the face of this uncertainty. As the court upholding EPA's decision to regulate recognized, certainty "may be impossible to obtain if the precautionary purpose of the statute is to be served." *Ethyl Corp. v. EPA*, 541 F.2d 1, 28 (D.C. Cir. 1976). The "will endanger" language, the *Ethyl c*ourt said, is triggered when harm is threatened, not simply when it has already occurred. 541 F.2d at 17. This conclusion is supported, the court said, not only by the text and legislative history of the Clean Air Act, but also by EPA's responsibility under the statute: "to protect the public from danger." *Id.* at 24.[18]

[18] The court of appeals in the instant case misread *Ethyl* to support EPA's reliance, in deciding not to regulate motor vehicle greenhouse gas emissions, upon policy considerations unrelated to whether such

This protective interpretation of the Clean Air Act was strengthened and codified by Congress' subsequent amendment of the Section 202(a)(1) to require EPA to regulate where emissions "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare," as opposed to the more narrow wording that the pollution "will endanger" public health or welfare.[19]

The outcome of regulating lead emissions was very significant. After lead was removed from gasoline, blood levels in children and adults dropped faster than anticipated. Blood lead levels decreased from 12.8 μg/dL in the late 1970s to 2.3 μg/dL in 1993 (geometric mean); recent epidemiological studies show that adults who carried the mean blood lead levels of the 1970s suffered an increase in mortality (all causes) exceeding 40%, compared to those having lead levels equal to current mean values.[20] This startling impact could not be determined in the 1970s because the entire population had elevated levels of lead,

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emissions meet the Section 202(a)(1) endangerment standard. *Massachussetts* v. *EPA*, 415 F.3d 57-58. While *Ethyl* approved EPA's authority to make essentially "legislative policy judgments" under statutory language nearly identical to that of Section 202, those judgments were sharply limited to "the relative risks of underprotection as compared to overprotection" and did not encompass such far-flung considerations as whether unilateral regulation of U.S. motor vehicle emissions could weaken efforts to persuade developing countries to reduce their emissions of greenhouse gases. See *Ethyl*, 541 F.2d at 20 (refuting industry's contention that the statute limited EPA to reliance upon specific factual findings). Nothing in the treatment of *Ethyl* by the court of appeals below cast aspersions upon *Ethyl*'s endorsement of a protective interpretation of the Section 202(a)(1) trigger for regulation.

[19] Pub. L. No. 95-95, § 401, 91 Stat. 791 (1977). Congress expressly intended these changes to compel EPA to assess risks and undertake regulatory action under conditions of uncertainty.

[20] Susan E. Schober, Lisa B. Mirel, Barry I. Graubard, Debra J. Brody, & Katherine M. Flegaldoi, *Blood Lead Levels and Death from All Causes, Cardiovascular Disease, and Cancer: Results from the NHANES III Mortality Study*, 10.1289 Envtl. Health Persp. 9123 (2006), *available at* http://www.ehponline.org/members/2006/9123/9123.pdf (last visited Aug. 24, 2006).

and because the studies had not covered a sufficiently long period. Evidently huge impacts on health and welfare accrued even though they could not be demonstrated conclusively when EPA issued its ruling.

The timely EPA action removed lead from fuel at least 10 years before similar steps in Europe. In the United Kingdom, lead removal began in 1993. It has been estimated that removing lead from motor fuels delivered a net societal saving of over $2 billion in the first 10 years in the United Kingdom alone, accounting for mortality changes but not including the costs of loss of cognitive function and other effects of lead intoxication.[21] But while uncontrolled lead emissions continued in Europe and the United Kingdom through the 1980s and early 1990s, the United States was already applying the Clean Air Act's conservative science-based approach to curtail lead emissions, evidently saving many billions of dollars and protecting the health of tens of millions of people, especially children.

B. There Was and Is Sufficient Scientific Evidence to Enable EPA to Make a Determination Under Section 202 of the Clean Air Act that Greenhouse Gas Emissions "May Reasonably Be Anticipated to Endanger Public Health or Welfare."

EPA's decision not to regulate GHG emissions never directly addressed the fundamental question: does the science of climate change support a determination that GHG emissions "may reasonably be anticipated to endanger public health or welfare"? We here explain why, in our professional opinion as climate scientists, the evidence supporting such a determination is compelling.[22]

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[21] Emma J. Hutchinson & Peter J. G. Pearson, *An Evaluation of the Environmental and Health Effects of Vehicle Exhaust Catalysts in the United Kingdom*, 112 (2) Envtl. Health Persp. (Feb. 2004).

[22] We are not asking the Court to make an endangerment determination, as that is properly the role of EPA. This brief provides the Court with the Climate Scientists' expert opinion that evidence

As stated in *Climate Change Science*, "national policy decisions made now and in the longer term future will influence the extent of any damage suffered by vulnerable human populations and ecosystems later in this century." J.A. 152, *Climate Change Science* at 1.

The NAS/NRC report discusses many adverse impacts of anthropogenic climate change, in addition to those discussed *supra*:

> The optimal climate for crops may change, requiring significant regional adaptations. Some models project an increased tendency toward drought over semi-arid regions, such as the U.S. Great Plains. Hydrologic impacts could be significant over the western United States, where much of the water supply is dependent on the amount of snow pack and the timing of the spring runoff. Increased rainfall rates could impact pollution run-off and flood control. With higher sea level, coastal regions could be subject to increased wind and flood damage even if tropical storms do not change in intensity. A significant warming also could have far reaching implications for ecosystems.

J.A. 160-161, *Climate Change Science* at 4.

> Climate is one of a number of factors influencing the incidence of infectious disease. Cold related stress would decline in a warmer climate, while heat stress and smog induced respiratory illnesses in major urban areas would increase, if no adaptation occurred.

J.A. 160*, Climate Change Science* at 4.

> Global warming could well have serious adverse societal and ecological impacts by the end of this century, especially if globally-averaged temperature increases approach the upper end of the IPCC

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exists to support an endangerment finding, so that a remand would not be an empty gesture.

> projections. Even in the more conservative scenarios, the models project temperatures and sea levels that continue to increase well beyond the end of this century, suggesting that assessments that examine only the next 100 years may well underestimate the magnitude of the eventual impacts.

Id., *Climate Change Science* at 4.

These impacts are clearly sufficient to support a finding of "reasonable anticipation" of endangerment. The fact that the *extent* of the damage, or associated time lags, may be greater or less than current projections were not (in the judgment of the NAS/NRC panel) sufficient to cast doubt on the links between GHGs and climate change with its associated risks. That particular impacts may be more or less uncertain, that the economy or public health system might adapt, or that future research may reveal more effective control technologies, are *all* irrelevant to the statutory standard for triggering regulatory action.[23]

Protective considerations are particularly important for greenhouse gases because, as explained in Part I, delaying action to reduce greenhouse gas emissions will certainly result in greater buildup of greenhouse gases in the atmosphere,[24] and thus we commit the earth to long-

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[23] The brief for respondent Utility Air Regulatory Group in opposition to the petition for certiorari suggested that the existence of some benefits from global warming and the economy's ability to adapt to adverse impacts would support a finding of non-endangerment (UARG Br. in Opp. 12-13). In its decision, EPA cited only the existence of scientific uncertainties regarding the extent of the impact and development of new technologies. Pet. App. 82-85, 62 Fed. Reg. at 52,931.

[24] Among the uncertainties that EPA cited was "[t]he fraction of fossil fuel carbon that will remain in the atmosphere and contribute to radiative forcing versus exchange with the oceans or with the land biosphere." Pet. App. 84, 62 Fed. Reg. at 52,930. But that uncertainty is irrelevant to the question as to whether to regulate, because (1) a significant portion of the emissions will accumulate in the atmosphere, (2) to the extent that the emissions are taken up by the oceans they will accumulate there and contribute to acidification and (3) in both cases, waiting will exacerbate the damage. See pt. I, *supra*.

lasting climate change and associated damages decades before these damages can be measured. Reversing the impacts of climate change becomes vastly harder, or impossible, and more expensive as we allow greenhouse gas pollutants to accumulate in the atmosphere. Thus more than enough scientific evidence exists to warrant the conclusion that greenhouse gas emissions "may reasonably be anticipated to endanger public health or welfare" under Section 202(a)(1).

CONCLUSION

For the foregoing reasons, this Court should reverse the decision of the court of appeals.

Respectfully submitted,

JOHN C. DERNBACH
WIDENER UNIVERSITY
LAW SCHOOL
3800 VARTAN WAY
HARRISBURG, PA 17106
(717) 541-1933

ROBERT B. MCKINSTRY, JR.*
PENN STATE UNIVERSITY
432 FOREST RESOURCES
BUILDING
UNIVERSITY PARK, PA 16802
(484) 467-3207
**Counsel of Record*

KIRSTEN H. ENGEL
UNIVERSITY OF ARIZONA
COLLEGE OF LAW
1201 E. SPEEDWAY BLVD.
TUCSON, AZ 85721
(520) 621-5444

STEPHANIE TAI
UNIVERSITY OF WISCONSIN
LAW SCHOOL
957 BASCOM MALL
MADISON, WI 53706
(608) 890-1236

Counsel for Amici Curiae Climate Scientists

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