EXHIBIT 20

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

COMMONWEALTH OF MASSACHUSETTS, et al.,	)	
Petitioners,	)	
v.	)	No. 03-1361
	)	Consolidated with Nos. 03-1362-1368
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY,	)	
Respondent.	)	

DECLARATION OF MICHAEL C. MacCRACKEN

I, MICHAEL C. MacCRACKEN, declare as follows:

1. I received my Bachelor's of Science in Mechanical Engineering from Princeton University in 1964. I then received my Master of Science and Ph.D. degrees in Applied Science from the University of California Davis in 1966 and 1968, respectively. I was elected to the Phi Kappa Phi honorary society at both undergraduate and graduate levels. From 1968 to 2002, I was employed as a physicist at the University of California's Lawrence Livermore National Laboratory (LLNL), where I led a number of scientific projects using numerical models to simulate the effects of transport and industrial emissions on air quality and the response of the climate to a range of natural and human-induced perturbations, including the likely impacts of an increase in the concentrations of greenhouse gases such as carbon dioxide. As a result of these projects, I am the co-author/co-editor of eight books, 22 journal articles, and hundreds of other reports and other notes.

2. From 1993 to 2002, I was on assignment from my permanent position with LLNL to serve as the senior scientist on global change at the Office of the U. S. Global Change

Research Program. In this capacity, I served as the first Executive Director of the Office of the U.S. Global Change Research Program ("USGCRP") from 1993-1997. I was responsible for assisting in the coordination of the global change research programs of ten federal agencies, including the Environmental Protection Agency, the Department of Energy, the National Science Foundation, the National Oceanographic and Atmospheric Administration, NASA, and others. In addition, in my role as senior scientist, I was responsible for keeping up with scientific advances in the field for the USGCRP and assisting the Office of Science and Technology Policy (OSTP) of the Executive Office of the President in summarizing the scientific advances for government leaders.

3. Following my tenure as Executive Director of the Office of the USGCRP, I was appointed Executive Director of the National Assessment Coordination Office, and served from 1997 through 2001 in this role. I led a small staff that had responsibility for coordinating the U.S. National Assessment of the Potential Consequences of Climate Variability and Change (U.S. National Assessment), which was carried out under the auspices of the USGCRP. This responsibility included helping to design and support the overall assessment activity, focusing particularly on ensuring the high quality of the scientific aspects. The U. S. National Assessment was carried out at the direction of the Director of OSTP. The National Assessment brought together the efforts of 20 university-based regional teams, 5 joint university-government scientific teams focused on particular sectors of the economy and natural resources, and a federal advisory committee composed of 12 leading scientists and experts. In addition to participating in and reviewing many of the regional and sectoral activities and reports, I served as an additional lead author and generally contributed to the preparation of the national level reports entitled *Climate Change Impacts on the United States: The Potential Consequences of Climate*

Variability and Change, that were published in 2000 and 2001.[1] I was an additional lead author of the National Assessment's Overview Report, and for the National Assessment's Foundation Report I was one of the lead authors of "Chapter 1: Scenarios for Climate Variability and Change" and "Chapter 12: Potential Consequences of Climate Variability and Change for Native Peoples and Homelands." In my role as Executive Director of the National Assessment Coordination Office, I also prepared Chapter 6 of the U.S. Government's *Climate Action Report 2002*.[2] This report was the U.S. Government's quadrennial national communication under the United Nations Framework Convention on Climate Change; Chapter 6, on impacts and adaptation, incorporated the findings of the National Assessment. In 2002-03, I also assisted the Department of Transportation in the conduct of a workshop on the potential impacts of climate change on transportation.

4. I have served in various capacities in the preparation of the First, Second and Third Assessments of the Intergovernmental Panel on Climate Change (IPCC). For the IPCC's First Assessment Report, which was completed in 1990, I was a contributor to Chapter 5 on "Equilibrium Climate Change—and its Implications for the Future" and Chapter 8 on "Detection of the Greenhouse Effect in the Observations." For the Second Assessment, which was completed in 1995, I was a contributor to Chapter 8 of Working Group I, "Detection of Climate Change and Attribution of Causes," and a lead author of Chapter 25 of Working Group II, "Mitigation: Cross-Sectoral and Other Issues." For the Third Assessment that was completed in 2001, I was a contributing author to Chapter 12 of Working Group I, "Detection of Climate Change and Attribution of Causes." I was a reviewer of various chapters for each of these

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[1] U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change: Overview Report* (2000) and *Foundation Report* (2001). Available from Cambridge University Press.

[2] U.S. Dept. of State, *U.S. Climate Action Report 2002* (U.S. Government Printing Office 2002).

assessment reports and as part of my responsibility for the Office of the U.S. Global Change Research Program, I served as scientific coordinator for the official reviews of the U.S. Government for both the Working Group I and II contributions for the Second and Third IPCC Assessment Reports. I also served as scientific advisor to the U.S. delegation at the plenary meetings of Working Group I for the Second and Third Assessments,[3] contributing to the preparation of the Summary for Policymakers of each assessment. For the IPCC's Fourth Assessment Report to be completed in 2007, I was recently appointed by the leadership of Working Group II to serve as Review Editor for Chapter 14, which will focus on past, ongoing, and future impacts of climate change on North America.

Summary of Opinions

5. The following findings and supporting information are offered as my expert scientific opinion, based on my education, qualifications, experience, and knowledge of the relevant scientific literature. These findings, in my expert opinion, also reflect the strong consensus of opinion among qualified scientific experts involved in climate change research in the U.S. and around the world:

a. The atmospheric concentrations of three important greenhouse gases, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), have been increasing since about 1750 as a result of human activities, principally the combustion of fossil fuel. The higher concentrations of these greenhouse gases enhance the Earth's natural greenhouse effect and exert a warming influence on the Earth's climate. The human-induced increases in the concentrations of CO_2, CH_4, and N_2O are widely considered to be the major factor responsible for the global warming of about 0.6°C (about 1°F) that occurred during the

[3] Held in Madrid, Spain in November 1995 and in Shanghai, China in January 2001. Prior to joining the Office of the USGCRP, I also served as a scientific adviser to the US delegation for consideration of the IPCC Working Group I special report in January 1992 held in Guangzhou, China.

20th century.

b. The most probable scenarios of future greenhouse gas emissions indicate that, in the absence of policy change, atmospheric concentrations of greenhouse gases will continue to rise steadily throughout this century, very likely exceeding concentrations seen over at least the last 10 million years. As a result, global average surface air temperature, which has already increased by about 0.6°C (about 1°F) over the last century, will also continue rising at rates unprecedented in human history. In its Third Assessment Report, averaging across the results of climate models, the IPCC concluded that global surface air temperature is likely to increase by about 0.2 to 0.5°C (about 0.3 to 0.9°F) per decade. By the end of the century, global average surface air temperature is projected to increase by about 2 to 4.5°C over 1990 levels.

c. Important environmental impacts of global warming that have occurred to date include: (i) the warming of the oceans and the increased melting of many mountain glaciers around the world that were the major contributions to the rise in global sea level by 10-20 cm (4 to 8 inches) observed over the past century; (ii) the lengthening of the growing season in mid- and high-latitudes that has contributed to poleward and altitudinal shifts of plant and animal ranges and the declines of some plant and animal populations; and (iii) the thawing of permafrost, and the later freezing and earlier break-up of ice on rivers and lakes.[4]

d. The environmental impacts of projected global warming will include: (i) an increase in sea level at an average rate of about 0.5 to 3.5 inches per decade, reaching 4-35 inches by the end of the century (with the most likely value being, in my expert opinion, near or

[4] Some text is drawn from the IPCC's Third Assessment Report *Climate Change 2001: Impacts, Adaptation and Vulnerability*; Cambridge University Press, page 3.

above the middle of this range); (ii) severe and irreversible changes to important natural ecosystems (e.g., coral reefs, Arctic coastal environments) and geographic features (e.g., forest boundaries, glaciers and ice sheets); and (iii) significant reduction of water storage in winter snowpack in mountainous regions with direct and important economic consequences;

e. Achievable reductions in emissions of CO_2 and other greenhouse gases from U.S. motor vehicles would significantly reduce the build-up in atmospheric concentrations of these gases and delay and moderate many of the adverse impacts of global warming.

The scientific basis for each of these findings is explained in more detail below.

Current State of Scientific Authority on Climate Change

6. Collective scientific understanding of climate change is best represented in major assessment reports that assemble, evaluate and critically summarize the results of thousands of scientific papers and studies that have been written about the many aspects of the climate change issue. These carefully peer reviewed assessment reports present the most authoritative consensus available of the scientific understanding of the effects of human activities on climate, as well as of the potential impacts of climate change on the world and the U.S.

7. In the late 1980s, the international community formed the Intergovernmental Panel on Climate Change (IPCC), which produced a series of major assessments of climate change in 1990, 1995 and 2001.[5] The national academies of science of approximately twenty

[5] The IPCC's First Assessment Report series in 1990 consisted of the following reports: *Scientific Assessment of Climate Change – Report of Working Group I* (Cambridge University Press, UK); *Impacts Assessment of Climate Change – Report of Working Group II* (Australian Government Publishing Service Marketing Section); and *The IPCC Response Strategies – Report of Working Group III* (Island Press, USA). The IPCC's Second Assessment Report Series in 1995 consisted of the following: *Climate Change 1995: The Science of Climate Change; Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*; and *Climate Change 1995: Economic and Social Dimensions of Climate Change* (all available from Cambridge University Press). The IPCC's Third Assessment Report series in 2001 consisted of the following: *Climate Change 2001: Synthesis Report; Climate Change 2001: The Scientific Basis* (Houghton et al. eds., Cambridge Univ. Press 2001)

nations, including the U.S.,[6] recognize the IPCC's 2001 findings as the most authoritative available concerning human-induced changes in climate and associated consequences. As a result of my involvement in the development of these assessments, as summarized in paragraph 4, I have an extensive understanding of the findings of the IPCC reports relating to climate change science and consequent impacts, especially as they relate to the United States.

8. The National Assessment of the Potential Consequences of Climate Variability and Change, undertaken by the U.S. Global Change Research Program (USGCRP) pursuant to Section 106 of the Global Change Research Act of 1990 [Public Law 101-606], is the major assessment most directly focused on the potential impacts of climate change for the United States.[7] As a result of my role as an author and as Executive Director of the office responsible for coordinating preparation of the National Assessment (see paragraph 3), I have a detailed knowledge of the findings of the National Assessment.

9. The U.S. Government also included the findings of the National Assessment in its *Climate Action Report 2002*, the U.S. Government's quadrennial national communication under the United Nations Framework Convention on Climate Change.[8] I prepared Chapter 6 of this report, on impacts and adaptation, in my capacity as Executive Director of the National Assessment Coordination Office of the USGCRP. It is in full agreement with the presentation of the science and impacts contained in the IPCC and National Assessment reports.

(available at http://www.grida.no/climate/ipcc_tar/wg1/index.htm) ("Working Group I report"); *Climate Change 2001: Impacts, Adaptation and Vulnerability* (McCarthy et al. eds., Cambridge Univ. Press 2001) (available at http://www.grida.no/climate/ipcc_tar/wg2/) ("Working Group II report");and *Climate Change 2001: Mitigation* (Pachauri et al. eds., Cambridge Univ. Press 2001) (available at http://www.grida.no/climate/ipcc_tar/wg3/index.htm) ("Working Group III report"). In addition, the IPCC has published many other special reports and documents. See http://www.ipcc.ch/pub/reports.htm.

[6] Natl. Research Council, *Climate Change Science: An Analysis of Some Key Questions*, (Natl. Academies Press 2001).

[7] U.S. Global Change Research Program, *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change: Overview Report* (2000) and *Foundation Report* (2001). Both reports are available from Cambridge University Press.

[8] U.S. Dept. of State, *U.S. Climate Action Report 2002* (U.S. Government Printing Office 2002).

10. The IPCC and NAST assessments carefully indicate the level of confidence and uncertainty that can be associated with the various dimensions of the issue. For example, the IPCC's Third Assessment Report adopted a specific set of terms to address the degree of certainty associated with various findings, with a numerical range of likelihood associated with each term: "In this Summary for Policymakers and in the Technical Summary, 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%); *medium likelihood* (33-66% chance); *unlikely* (10-33% chance); *very unlikely* (1-10% chance); *exceptionally unlikely* (less than 1% chance)."[9] For the U.S. National Assessment, NAST developed a similar lexicon: very likely or very probable, likely or probable, possible, unlikely or some chance, and very unlikely or little chance. My use of these terms in the following paragraphs is consistent with this IPCC and NAST usage.

The Role of Greenhouse Gases in Global Warming

11. Greenhouse gases in the atmosphere absorb about 90% of the solar energy that is radiated upward from the Earth's surface, and then these greenhouse gases re-radiate much of the energy back down to the surface. In this way, the greenhouse gases act in a manner roughly equivalent to adding a blanket over the Earth. The higher the concentrations of greenhouse gases, especially CO_2, CH_4, and N_2O, the greater will be the trapping of heat and the increase in surface temperature.

[9] IPCC Working Group I report, 2004, page 2, footnote 7 [italics in original].

induced a cooling influence over the past 50 years—so the two most important natural influences would have tended to cool the Earth just when it was in fact warming rapidly. The warming has also been larger than could be explained by past natural oscillations in the climate since the end of the last glaciation about 10,000 years ago.

Projections of Changes in Greenhouse Gas Emissions Over the 21st Century

15. Reliable projections of future changes in the climate are most effectively carried out using: (a) climate models that ensure objective and quantitative consideration is given to all relevant processes and factors governing the behavior of the climate system, and (b) emissions scenarios that are based upon the best available projections of how population, economic development, and energy technologies are expected to evolve.

16. Absent changes in policy to reduce greenhouse gas emissions, atmospheric concentrations of these gases are likely to increase at least as much and at least as fast as in recent decades. I base this opinion on internationally accepted quantitative scenarios generated by the IPCC.[13] These scenarios cover a wide range of possible outcomes from now until the end of the 21st century in terms of global population growth, economic development, and energy technologies and rates of use.

17. If annual global emissions of greenhouse gases continue to increase in the next several decades in accordance with these scenarios, there will be significant increases in the atmospheric concentrations of these gases. Under the most plausible energy scenarios, the CO_2 concentration will continue to increase over the coming decades, reaching between two to three times its preindustrial level by the end of this century (for reference, the current concentration is approximately 1.35 times the preindustrial concentration).

[13] IPCC, *Emissions Scenarios*, 2000 (Cambridge Univ. Press 2000) (avail. at http://www.ipcc.ch/pub/sres-e.pdf).

Future Global Warming

18. These increases in concentrations will likely accelerate the rate of warming. In its Third Assessment Report, averaging across the results of climate models, the IPCC concluded that global surface air temperature is likely to increase by about 0.2 to 0.5°C (about 0.3 to 0.9°F) per decade. By the end of the century, global average surface air temperature is projected to increase by about 2 to 4.5°C over 1990 levels. These are projections for changes in the global average surface temperature. Temperature changes over land areas are expected to be greater than over the ocean and temperature changes in mid to high latitudes are expected to exceed changes in low latitudes. Because of this, the IPCC's projection of regional temperature changes indicates larger changes are likely over North America. Warming in the Arctic is projected to be even greater.[14]

19. Overall, this projected temperature increase would be likely to make average conditions by the end of this century warmer than they have been for at least 420,000 years (the period for which ice core data is available).

The Consequences of Future Global Warming

20. This projected temperature increase would have widespread adverse consequences.[15] For the U.S., the National Assessment summarizes key findings for different regions of the country and for different national sectors.[16] The following enumeration of

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[14] IPCC Working Group I report, 2004, at chapter 10.

[15] See IPCC's Third Assessment Report *Climate Change 2001: Impacts, Adaptation and Vulnerability* (McCarthy et al. eds., Cambridge Univ. Press 2001) (available at http://www.grida.no/climate/ipcc_tar/wg2/) ("Working Group II report"). In addition, a database of articles on the likely impacts of climate change for the U.S. and other countries is available at <http://www.climate.org/CI/index.shtml>.

[16] National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States, Overview* (Cambridge Univ. Press 2000) and *Foundation* (Cambridge Univ. Press 2001) (these reports and supporting regional and sectoral reports are available at <http://www.usgcrp.gov/usgcrp/nacc/default.htm>).

conditions focuses mainly on consequences related to human health and the services provided by ecosystems and landscapes within the U.S.

21. ***Increased incidence of high temperatures and extremely high heat index:*** The climate scenarios considered in the U.S. National Assessment were based primarily on model simulations done by two IPCC-accepted models, each running a mid-range scenario for future emissions. These models projected an annual average warming of about 3 to 5°C (about 5 to 9°F) across the U.S. during this century, which would be several times the increase across the U.S. during the 20th century.[17] The change in summertime temperatures, combined with the associated increase in absolute humidity, is projected to cause the 24-hour average heat index (a combined measure of temperature and humidity) for July (as a representative summer month) to increase by at least 6°C (about 10°F) over most of the country by 2100. Changes are projected to be about double this amount in some regions, particularly across the southeastern and south-central U.S. where the summertime heat index is already high. In addition to such changes in the monthly average temperature, the models also project that the length of the very warm season will increase and the occurrence of very high heat index conditions will be expected to be more frequent in more northerly parts of the country where people are not well adapted to such conditions.

22. ***Air quality is likely to be further impaired:*** Without additional control measures, ongoing and projected changes in climate due to global warming are very likely to increase emissions of various pollutants.[18] Higher temperatures caused by global warming will increase

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[17] MacCracken et al., Climate change scenarios for the U.S. National Assessment, **84** *Bulletin of the American Meteorological Society,* 1711 (2003) (<avail. at http://ams.allenpress.com/pdfserv/i1520-0477-084-12-1711.pdf>).

[18] For example, warmer temperature will increase demand for energy (in buildings, cars, etc.) while decreasing the efficiency of combustion processes (in generating plants and in internal combustion engines), leading to the emission of more pollutants; warmer temperatures will increase the release of smog-forming hydrocarbons from oil storage tanks and other storage containers and from forests and vegetation; the increased CO_2 concentration is expected to enhance growth of biomass, which could in some regions provide a larger source of hydrocarbon

the rates of the photochemical reactions that convert smog-forming emissions (volatile organic compounds and oxides of nitrogen) into ozone smog.[19] In addition, unless there is a substantial and compensating tightening of emissions standards on all types of sources, longer warm seasons are very likely to increase the frequency of high ozone concentration episodes and violations of air quality standards.

23. ***Projected warming will also cause significant sea level rise:*** Global warming contributed significantly to the 10 to 20 cm (about 4 to 8 inches) rise in sea level during the 20th century. The meltback of mountain glaciers and warming of the oceans will contribute even more significantly to future sea level rise. The IPCC assessment projects that these factors, and other factors affecting the amount of water stored in reservoirs and underground, will cause sea level to rise by about 9 to 88 cm (about 4 to 35 inches) by 2100, with a central range estimate of 20-70 cm (8-28 inches) that I believe more likely encompasses what will occur. To determine the projected sea level rise at a particular location, the local rate of subsidence or uplift must also be accounted for.

24. ***More frequent and intense extreme weather events:*** The additional energy available from increased average temperature will drive an increase in evaporation, ensuring that more moisture will precipitate out as rain and snow. The increased rate of condensation releases additional energy to the atmosphere and intensifies convective (e.g., thunderstorm-like) motions in the atmosphere. Observations from many countries, including the U.S., indicate that such changes are already evident as a result of the warming during the 20th century, and these

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emissions; warmer temperatures will tend to increase the summertime drying of biomass, making the increased biomass into a larger fuel base for fires and the pollutants that they emit.

[19] As an example, results from the New York Climate and Health project indicate that warmer temperatures significantly increase the likelihood of ozone exceedances in that region. National Assessment Synthesis Team, U.S. Global Change Research Program, *Climate Change Impacts on the United States, Overview* (Cambridge Univ. Press 2000), page 104.

observed trends are very likely to continue, contributing to more frequent flooding and inundation in vulnerable regions. Of particular concern is the potential for an increase in the wind speed and peak rate of precipitation of major tropical cyclones (i.e., hurricanes and typhoons).

25. ***An increase in local flooding and coastal inundation:*** The increase in the frequency and intensity of intense convective rainfall events is likely to increase incidents of localized flooding. The increased wind speed and peak rate of precipitation from hurricanes, along with higher storm surges due to the increase in sea level and in hurricane winds, are likely to cause greater damage and put those in the paths of hurricanes (or along streams and rivers whose levels are raised by hurricanes) at greater risk of physical injury, property damage, and subsequent anguish. Soil compaction, sea level rise and recurrent severe storms are destroying approximately 20-30 square miles of Louisiana wetlands each year. These wetlands serve as the "shock absorber" for storm surges that could inundate New Orleans, significantly enhancing the risk to a major urban population. More frequent flooding and inundation have the potential for developing in other low-lying regions around the country, including along low-lying coastal areas on the Gulf of Maine, Cape Cod, Long Island and the New York metropolitan area and New Jersey, and further south along the Eastern Seaboard. The increased occurrence of very dry conditions not only increases the risk of forest fires that can wipe out homes and communities, but also sets the stage for the subsequent compounding effects of mudslides.

26. ***Climate change will impact water resources:*** More precipitation falling in more intense weather events will increase both flood- and drought-related damage. As soils become saturated, more excess rain will run off into streams and rivers rather than be retained as soil moisture. At the same time, the increased temperatures will cause more rapid evaporation of

31. Based on average emissions over the 1990s, the U.S. was responsible for emitting roughly 22% of the world's fossil fuel emissions during that decade and the U.S. transportation sector (mainly automobiles) was responsible for about 7% of global fossil fuel emissions. Within the U.S., the transportation sector is responsible for approximately 32% of national carbon emissions. The U.S. transportation sector is becoming an increasing share of U.S. emissions due to two trends: overall energy efficiency is improving in the industrial sector while the number of vehicles is growing, and the average emission of CO_2 per vehicle is increasing.[23]

32. Given the large emissions of CO_2 and other greenhouse gases from motor vehicles in the United States and the lead time needed to economically introduce changes into the motor vehicle fleet, emission reductions must be initiated in the near future in order to significantly reduce and delay the impacts of global warming. If the U.S. takes steps to reduce motor vehicle emissions, other countries are very likely to take similar actions regarding their own motor vehicles using technology developed in response to the U.S. program, thereby multiplying the total emission reduction benefit of the U.S. action. This would discernibly and significantly reduce and delay projected adverse consequences of global warming, and greatly improve the likelihood that there would be time for additional development and use of even better technologies. With such efforts, accompanied by progress in limiting other emissions, it would be much more likely that the extent of climate change could ultimately be limited to levels that would avoid the most serious impacts of global warming.

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[23] Chapter 3 (Greenhouse Gas Inventory) in *U.S. Climate Action Report—2002*, pages 26 to 49, Government Printing Office, 2002. Table 3-4 on page 36 summarizes the trends in CO_2 emissions by year and vehicle type; total vehicle emissions increased by 16% from 1990 to 1999. Footnote 14 on page 35 admits that the average miles per gallon achieved by the U.S. highway vehicle fleet decreased in 1998 and 1999 (the latest years for which information is available).

I declare under the penalty of perjury that the foregoing is true and correct.

Executed on June 18, 2004 in Washington, D.C.

Michael C. MacCracken

Michael C. MacCracken

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