Volume 19 | Issue 1 Article 1

2008

Derogating the Precautionary Principle

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VILLANOVA ENVIRONMENTAL LAW JOURNAL

VOLUME XIX 2008 NUMBER 1

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I. INTRODUCTION

A. Assessment and Attribution

In early 2001, the Intergovernmental Panel on Climate Change[1] (IPCC) issued its Third Assessment Report[2] consisting of

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1. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, INTRODUCTION, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), 1 (2004), *available at* http://www.ipcc.ch/about/faq/IPCC%20Introduction.pdf (explaining formation of IPCC). The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly established the IPCC in 1988 in response to growing concerns within the atmospheric sciences community regarding the observation of increasing concentrations of greenhouse gases (GHGs) in the atmosphere. *See id.* GHGs are "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation." United Nations Framework Convention on Climate Change, art. I, May 9, 1992, 31 I.L.M. 849 (UNFCCC).

2. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: SYNTHESIS REPORT (Robert Watson et al. eds., Cambridge University Press 2001) (discussing recent revelations in climate change); *see also* WORKING GROUP I TO THE THIRD ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS (J.T. Houghton et al. eds., Cambridge University Press 2001) (WORKING GROUP I), *available at* http://www.grida.no/climate/ipcc_tar/wg1/index.htm (analyzing scientific data on climate); IPCC, CLIMATE CHANGE 2001: IMPACTS, ADAPTATION, AND VULNERABILITY (James J. McCarthy et al. eds., Cambridge University Press 2001), *available at* http://www.grida.no/climate/ipcc_tar/wg2/index.htm (containing IPCC's Formal Statement concerning impact of climate change); *see also* IPCC, CLIMATE CHANGE 2001: MITIGATION (Tariq Banuri et al. eds., Cambridge University Press 2001), *available at* http://www.ipcc.ch/pub/wg3spm.pdf (discussing climate change mitigation).

three separate parts authored by separate working groups.[3] In the volume of the subsection titled "The Identification of a Human Influence on Climate Change," Working Group I stated the following:

> *Detection* is the process of demonstrating that an observed change is significantly different (in a statistical sense) than can be explained by natural variability. *Attribution* is the process of establishing cause and effect with some defined level of confidence, including the assessment of competing hypotheses.[4] The IPCC's mandate, or its "terms of reference[,]" includes the responsibility "to assess available scientific and socio-economic information on climate change and its impact and on the options for mitigating climate change and adapting to it and . . . to provide, on request, scientific/technical/socio-economic advice to the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change."[5]

The IPCC's mission includes the need to gauge the anthropogenic or human-induced contribution to climate change and its impact, and making a determination whether "a human influence on climate change to date can be identified."[6] To make this determination, the IPCC stresses the importance of being able to eliminate,

3. *See* Robert Watson et al., CLIMATE CHANGE 2001: SYNTHESIS REPORT (2001) (summarizing IPCC's Third Assessment Report). The Third Assessment Report was produced in three volumes, with each Working Group authoring one of those. *See id.* Working Group I was responsible for evaluating the scientific research on climate change; Working Group I authored the first volume, THE SCIENTIFIC BASIS. *See id.* Working Group II was responsible for evaluating the vulnerability of natural and human systems to climate change and produced the second volume, IMPACTS, ADAPTATION, AND VULNERABILITY. *See id.* Working Group III was responsible for evaluating the ability of human society to mitigate the consequences of climate change, and produced the third volume, MITIGATION. *See id.*

4. *See* D. L. Albritton et al., *Technical Summary, in* CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS: CONTRIBUTION OF WORKING GROUP I TO THE THIRD ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE at 55 (emphasis in original) (defining detection and attribution).

5. *See* Working Group I, *supra* note 2, at vii (defining terms for discussion). The IPCC interprets "climate change" as referring to "any change in climate over time, whether due to natural variability or as a result of human activity." *See id.* The UNFCCC, on the other hand, prefers to view climate change as referring to a change of climate that is "attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods." *See* UNFCCC, *supra* note 1, art. I(2), 31 I.L.M. at 851. This article will utilize the IPCC interpretation of the term "climate change" unless specifically noted otherwise in the text or in a footnote.

6. *See* Albritton et al., *supra* note 4, at 55 (discussing IPCC goal of identifying human effects on climate).

with a reasonable degree of confidence, many of the possible alternative (non-anthropogenic) influences on climate change.[7] Specifically, the IPCC states:

> The *attribution* of climate change to anthropogenic causes involves statistical analysis and the careful assessment of multiple lines of evidence to demonstrate, within a prespecified margin of error, that the observed changes are: unlikely to be due entirely to internal variability; consistent with the estimated responses to the given combination of anthropogenic and natural forcing;[8] and not consistent with alternative, physically plausible explanation of recent climate change that exclude important elements of the given combination of forcings.[9]

The IPCC contends it has made substantial headway in attributing recent observable changes in the global mean surface temperature, at least in part, to anthropogenic activity.[10] Despite uncertainties in estimating the extent of the signals from natural climate variation and sulphate aerosols,[11] "almost all studies are nevertheless able to detect the presence of the anthropogenic greenhouse signal[12] in the recent climate record."[13] The IPCC also asserts climate change has negatively impacted many of this planet's environmental systems.[14]

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7. *See id.* at 55-56 (providing IPCC policy for analyzing climate change).

8. *See* WORKING GROUP I, *supra* note 2, at 5, n.8 (defining radiative forcing). The IPCC defines a "forcing," or more formally, a "radiative forcing," as "a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system, and is an index of the importance of the factor as a potential climate change mechanism." *Id.*

9. *See* Albritton et al., *supra* note 4, at 56 (describing reasoning for statistical inferences).

10. *See* James E. Hansen, Head, NASA Goddard Inst. For Space Studies, Address before the Committee on Commerce, Science and Transportation (May 1, 2001), *available at* http://www.hq.nasa.gov/office/legaff/hansen5-1.html (last visited Oct. 24, 2007) (discussing aerosol). "Aerosols tend to increase the number of cloud droplets, thus making the clouds brighter and longer-lived. *All of the aerosol effects have large uncertainty bars, because our measurements are inadequate and our understanding of aerosol processes is limited.*" *Id.* (emphasis added).

11. For a discussion of airborne particles, *see infra* note 53 and accompanying text.

12. For a discussion of the term "signal", *see infra* notes 42-64 and accompanying text.

13. *See* Albritton et al., *supra* note 4, at 59 (analyzing impact of signals provided by recent studies).

14. *See* Stephen Schneider et al., *Overview of Impacts, Adaptation, and Vulnerability to Climate Change, in* McCarthy et al., *supra* note 2, at 83 (stating IPCC belief in negative impact of climate change). "[A]lthough some regions may experience beneficial effects of climate change (e.g., increasing agricultural productivity at

The IPCC began work in earnest in 1988 by establishing the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP) and publishing reports in 1990.[15] The IPCC's mission is to "assess available information on the science of climate change, in particular that arising from human activities, assess the environmental and socioeconomic impacts of climate change, and formulate response strategies."[16] The IPCC's early work helped lead to the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) and the addition of the 1997 Kyoto Protocol[17] to the UNFCCC, both of which demonstrated the global community's commitment to reducing anthropogenic greenhouse gas emissions.[18] Article 3 of the Kyoto Protocol encapsulates these commitments.[19]

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high latitudes), previous IPCC assessments have concluded that net negative climate impacts are more likely in most parts of the world . . . . " *Id.*

15. *See* WORKING GROUP I, *supra* note 2, at vii (listing categories of work products issued by IPCC beginning in 1990).

16. *See* Jose D. G. Miguez, *Equity, Responsibility and Climate Change*, ETHICS, EQUITY AND INT'L NEGOTIATIONS ON CLIMATE CHANGE 9 (Luis Pinguelli-Rosa & Mohan Munasinghe, eds., 2002) (noting IPCC's Fourth Assessment Report is scheduled for publication in 2007). A draft of the Fourth Assessment Report, divided into the three main components of Working Groups I, II, and III, is currently being circulated among national governments. General practice is to gather comments from experts in the climate field. The United States Climate Science Program made the draft available for comment, during a limited time frame, in the United States in the Fall 2005 and Spring and Summer of 2006. A "first-order" draft was opened for comment in Fall 2005, and a "second-order" draft was opened for comment in Spring and Summer of 2006. For further information on the draft Fourth Assessment, *see* United States Climate Change Science Program, *available at* http://www.climatescience.gov/Library/ipcc/wg14ar-review.htm (last visited Oct. 24, 2007) (posting requests to United States Climate Change Technology Program (CCTP) for expert review of different components of draft Fourth Assessment in Federal Register as those components become available for review); *see* Department of State, United States Climate Change Technology Program, Public Notice, 71 Fed Reg. 41, 857 (July 24, 2006) (detailing United States Department of State's receipt of first notification of availability of draft assessment components from IPCC Secretariat); *see also* Jim Giles, *U.S. Posts Sensitive Climate Report for Public Comment*, 441 NATURE 7089, 6 (2006) (expressing early comments on overall thrust of draft Fourth Assessment).

17. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1970, 37 I.L.M. 22 (providing text of Kyoto Protocol). At the first meeting of the Conference of the Parties (COP1) in Berlin in 1995, the parties agreed that the original UNFCCC goal of stabilizing greenhouse gas emissions at the 1990 levels would not produce a concentration "that would prevent dangerous anthropogenic interference with the climate system." *See* UNFCCC, 31 I.L.M. 849, 854 (1992) (providing text of Article 4(2)(b)).

18. *See* David Hunter, James Salzman & Durwood Zaelke, INTERNATIONAL LAW AND POLICY, 590 (2d ed. 2002) (commenting on need for international commitment to establish clear targets and timetables).

19. *See* Kyoto Protocol to the United Nations Framework Convention On Climate Change, Dec. 10, 1970, 37 I.L.M. 22 (providing text of Kyoto Protocol). The Kyoto Protocol states the following:

In later COP meetings, it was prevalently believed that the target reduction level for 1990 was unlikely to be achieved because of the effort required by certain countries. As a result, an agreement was reached allowing deficient countries to offset their greenhouse gas (GHG) emission targets by increasing their biological carbon sequestration through afforestation, reforestation, altering the management of agricultural lands and trading carbon credits.[20] This agreement translated into the biological sequestration reaching an offset of up to eighty percent of the target GHG emission reductions set out in the Kyoto Protocol itself.[21]

Participants in subsequent COPs attempted to ease the requirements for actual GHG reductions in order to induce additional states to ratify the Kyoto Protocol. Despite these easements, the United States continued to object to the protocol.[22] In June 2001, President Bush stated the Kyoto Protocol was "fatally flawed."[23] The United States *was* (and remains) a signatory to the UNFCCC. Article 3 of the UNFCCC states, "[t]he Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects."[24]

> [t]he Parties included in Annex I shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of this Article, with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

Id.

20. *See* United Nations Framework Convention on Climate Change Conference of the Parties, July 16-27, 2001, SECOND PART OF ITS SIXTH SESSION HELD AT BONN, 36, FCCC/CP/2001/5 (Sept. 25, 2001), *available at* http://unfccc.int/resource/docs/cop6secpart/05.pdf (adopting formally agreement during seventh session of COP at Marrakesh in Nov. 2001, after formulating framework of agreement at two-part sixth session of Conference of Parties in Bonn).

21. *See* E. D. Schulze, et al., *The Long Way From Kyoto to Marrakesh: Implications of the Kyoto Protocol Negotiations for Global Ecology*, 8 GLOBAL CHANGE BIOLOGY 505, 513-16 (2002) (interpreting agreements from seventh session of COP).

22. *See* Alexander Gillespie, *Sinks and the Climate Change Regime: The State of Play*, 13 DUKE ENVTL. L. & POL'Y F. 279, 288 (explaining United States dissent). The United States left the Sixth Conference of the Parties (COP6) climate change negotiations at the Hague in October 2006 over the issue of the proper carbon accounting methods to be adopted by Kyoto signatories. *See id.*

23. *See* Press Release, Office of the Press Secretary, President Bush, President Bush Discusses Global Climate Change (June 11, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html (discussing Kyoto Protocol).

24. *See* UNFCCC, *supra* note 1 at 853 (requiring parties to take precautionary measures).

Article 3 demonstrates the United States has indeed intended to institute "precautionary measures" in anticipation of climate change.[25] Unfortunately, these measures have been ineffective. This appraisal of the United States precautionary posture derives from the degree of scientific certainty the United States insists upon before accepting the emission reduction obligations established by the Kyoto Protocol.

Based on Article 3 of the UNFCCC, it appears the United States current precautionary stance is only utilitarian, rather than robust. Current United States policy largely emphasizes cost considerations when weighing different policy responses to possible climate change projections. Article 3 also supports the current position that there is diminished sense of urgency towards climate change. The National Oceanic and Atmospheric Administration announced that mounting scientific evidence suggests anthropogenic activity is making a significant contribution to climate change.[26] The United States responds to this evidence with a strong reliance on adaptation to the effects of climate change, with a lesser reliance on mitigation of the problems (e.g. emission reduction). Through the application of adaptive measures, the current United States administration takes the position that the negative consequences credited to climate change can be held to a manageable level.[27]

The current United States administration concedes climate change is occurring;[28] yet they have adopted a precautionary policy that is ineffective. This Article contends that the United States and the larger global community would be better served if the United

25. *See* Paula Dobriansky, Head, United States Delegation to COP11 (Dec. 7, 2005), *available at* http://www.state.gov/g/rls/rm/2005/57867.htm (last visited Oct. 24, 2007) (enumerating several measures to address climate change question, including Partnership for Clean Fuels and Vehicles, and Partnership for Clean Indoor Air).

26. *See* Press Release, Department of Commerce Press Release, Report Reconciles Atmospheric Temperature Trends (May 2, 2006), *available at* http://www.climatescience.gov/Library/pressreleases/pressrelease2may2006.htm (last visited Oct. 24, 2007) (introducing new evidence that continues to support a substantial human impact on global temperature increases).

27. *See* UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, STRATEGIC PLAN FOR THE U.S. CLIMATE CHANGE SCIENCE PROGRAM, 121 (2003), *available at* http://www.climatescience.gov/Library/stratplan2003/final/ccspstratplan2003-all.pdf (posing research questions that can lead to management strategies for ecosystems).

28. *See* Press Release, Department of Commerce Press Release, Report Reconciles Atmospheric Temperature Trends (May 2, 2006), *available at* http://www.climatescience.gov/Library/pressreleases/pressrelease2may2006.htm (last visited Oct. 24, 2007) (finding no discrepancy between global surface temperature increase compared with higher atmospheric temperature levels).

States adopted a precautionary stance that was no longer weak, utilitarian, and pedestrian, but was instead strong, robust, and expeditious. The current United States precautionary policy is utilitarian and pedestrian because of the administration's perception that the potential consequences of climate change are not imminent. The administration takes the position that the progression toward those consequences will take place in a linear or near-linear fashion. If these projections *do* hold true over time, the present precautionary posture might be justified. In that case, a precautionary posture emphasizing adaptation rather than mitigation should negate severe consequences from climate change. If those projections do not hold, mitigation would have likely been preferable because predominately negative consequences would occur, and regrets and recriminations would then be in order.

This Article argues for a different outlook toward climate change than that currently embraced by the administration. A precautionary posture that is strong, robust, and expeditious would prevent future regrets and recriminations. In adopting such a posture, the United States must abandon the view that substantial reliance on adaptation is a sufficient response to climate change. This type of policy shift would first require an alteration in the current view regarding the pace or velocity of temperature change and the acknowledgment of imminent consequences of climate change. A policy shift of this extent would also require an alteration of the view that non-imminent consequences will be mild for those global regions or individual states able to forge effective adaptive measures.

Part I of this Article outlines the IPCC's argument favoring mitigation as the preferred response to climate change, with adaptive measures to be applied in a complementary fashion. Part I also includes the reasons for the United States rejection of the Kyoto Protocol, as well as arguments from a segment of the scientific and policy communities which counters the IPCC thesis. Part II of this Article argues there is movement away from the current administration's declarations that uncertainty still resides in the science surrounding climate change, and, thus, reason for the United States to agree to the Kyoto Protocol. Part II also shows that despite increasing recognition within the United States government of human activity contributing to climate change, the current administration continues to maintain an inadequate and unjustifiable precautionary posture.

Part III of this Article focuses on different articulations of the precautionary principle and how the principle has been applied in specific international instruments. Part III also characterizes the current United States policy toward climate change as an inadequate application of the precautionary principle. Part IV presents a representative sample of paleoclimatology concerned with abrupt climate change. Part IV additionally argues the evidence in the climatological historical record clearly confirms the occurrence of abrupt climate change. Part IV asserts the occurrence of abrupt climate change historically warrants modifying a central premise of the United States policy on climate change.

B. Forcings

The IPCC's task largely consists of validly attributing climate change to a particular variable.[29] Specifically, this task is to "rule out, with a reasonable degree of confidence,"[30] the notion that the recently observed variation in the climate system is "due entirely to internal variability."[31] Internal variability refers to changes occurring from factors generated within the climate system itself.[32] These changes are to be distinguished from external factors which may also generate climate change.[33] The term climate change merits further elaboration.

Note that a change in climate is a change in the climate *system.* Also note that "[t]he ultimate source energy that drives the climate system is radiation from the sun."[34] About half of the radiation is visible light, and the other half is infrared.[35] More than a third of the solar radiation reaches the earth's surface, which returns heat to the atmosphere, a good portion of which is infrared radiation.[36]

29. *See* IPCC, 2001: CLIMATE CHANGE 2001: THIRD ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SYNTHESIS REPORT 50 (Robert T. Watson, ed., Cambridge University Press 2001) (comparing graphically anthropogenic forcing with natural forcing).

30. For a discussion of what constitutes a reasonable degree of confidence, *see supra* notes 8-10 and accompanying text.

31. For a discussion of "internal variability," *see supra* notes 9-10 and accompanying text.

32. For an overview of the current climate system, *see* WORKING GROUP I, *supra* note 2, at 78 and accompanying text.

33. *See* WORKING GROUP I, *supra* note 2, at 5 and accompanying text (discussing external factors). Summary notes that changes in climate occur when there is internal and external variability of the climate system, where external factors include both natural and anthropogenic. *Id.*

34. *See id.* at 89 (describing radiation from sun and effect on earth).

35. *See id.* (examining electromagnetic spectrum).

36. *See id.* (stating thirty-one percent of solar radiation is immediately reflected by clouds, atmosphere, and earth's surface).

"For a stable climate, a balance is required between incoming solar radiation and the outgoing radiation emitted by the climate system."[37] Greenhouse gases have an important role in maintaining this balance.[38]

An increase in the atmosphere is an important atmospheric phenomenon that produces positive radiative forcings.[39] Greenhouse gases (GHGs), however, are always present in the atmosphere at some level.[40] The presence of GHGs at relatively stable concentrations in the atmosphere over time helps to produce a relatively stable climate that incorporates a *natural* greenhouse effect.[41]

C. Signals

The scientific community, environmental non-governmental organizations (ENGOs), and many national governments are concerned with a relatively recent addition to the natural greenhouse effect.[42] The IPCC said this "addition" is contributed by human activity, or anthropogenic sources.[43] These sources brought about an

37. *See id.* (explaining impact of solar radiation and its movement on climate change group).

38. *See* Houghton et al., *The Climate System: An Overview,* in WORKING GROUP I, *supra* note 2, at 89 (describing natural greenhouse effect as part of energy balance of earth).

39. *See* Kyoto Protocol, *supra* note 19 at 41; *see also* Houghton et al., *The Climate System: An Overview,* in WORKING GROUP I, *supra* note 2, at 95 (labeling stabilization of GHG concentrations as ultimate goal of UNFCCC). The major greenhouse gases are listed in Annex A of the Kyoto Protocol. They are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluroide (SF_6. *Id.*

40. *See* WORKING GROUP I, *supra* note 2, at 39 (describing presence of GHGs in atmosphere for hundreds of thousands of years, and for carbon dioxide, tens of millions of years).

41. *See* Houghton et al., *supra* note 2, at 90 (defining and discussing greenhouse effect). Specifically, the review explains:

> The atmosphere contains several trace gases which absorb and emit infrared radiation. These so-called greenhouse gases absorb infrared radiation, emitted by the Earth's surface, the atmosphere and clouds, except in a transparent part of the spectrum called the 'atmospheric window'. . . they emit in turn infrared radiation in all directions including downward to the Earth's surface. Thus greenhouse gases trap heat within the atmosphere. This mechanism is called the natural greenhouse effect.

Id.

42. *See id.* at 87 (citing IPCC as presenting evidence of human influence on environment).

43. *See id.* (reasoning additional natural greenhouse effect contributed by human activity).

enhanced greenhouse effect by generating an increased level of GHGs in the atmosphere.[44]

In its 1995 Second Assessment Report, the IPCC issued the "now famous words"[45] that "[t]he balance of evidence suggests a discernible human influence on global climate."[46] In its Third Assessment Report, the IPCC added that in the period between the two assessments (1995-2001), progress had been made in the following ways:

> [R]educing uncertainty, particularly with respect to distinguishing and quantifying the magnitude of [climate] responses to different external influences . . . . There are new estimates of the climate response to natural forcing and anthropogenic forcing, and new detection techniques have been applied. Detection and attribution studies consistently find evidence for an anthropogenic *signal* in the climate record of the last 35 to 50 years.[47]

The anthropogenic signal, or forcing, must be differentiated from a natural forcing, and the IPCC recognizes that considerable uncer-

44. *See id.* at 93 (explaining and discussing greenhouse effect). The IPCC provided the following information regarding the concentration of particular GHGs, carbon dioxide, methane, and nitrous oxide, causing major concern.

> The atmospheric concentration of carbon dioxide (CO_2) has increased by 31% since 1750. The present CO_2 concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years. The current rate of increase is unprecedented during at least the past 20,000 years. About three-quarters of the anthropogenic emissions of CO_2 to the atmosphere during the past 20 years is due to fossil fuel burning . . . . The atmospheric concentration of methane (CH_4) has increased by 1060 [parts per billion] (151%) since 1750 and continues to increase. The present CH_4 concentration has not been exceeded during the past 420,000 years . . . Slightly more than half of current CH_4 emissions are anthropogenic (e.g., use of fossil fuels, cattle, rice agriculture and landfills). The atmospheric concentration of nitrous oxide (N_20) has increased by 46 [parts per billion] (17%) since 1750 and continues to increase. The present level of N_2O concentration has not been exceeded during at least the past thousand years. About a third of current N_2O missions are anthropogenic (e.g., agricultural soils, cattle feed lots and chemical industry).

Id. at 7.

45. *See* Prue Taylor, *Heads in the Sand as the Tide Rises: Environmental Ethics and the Law on Climate Change*, 19 UCLA J. ENVT'L. L. & POL'Y 247, 253 (2000/2001) (quoting IPCC regarding human effect).

46. *See* IPCC, *Summary for Policymakers*: THE SCIENCE OF CLIMATE CHANGE, J.T. Houghton et al., CLIMATE CHANGE 1995: SECOND ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 5 (1996) (reporting discernable human effects in climate change).

47. *See* Houghton et al., *supra* note 2, at 10 (emphasis added) (asserting anthropogenic signal provides indication that human activity has detectable impact on climate change, apart from natural external forcings).

tainty remains in any estimate of natural climate variability.[48] Despite this uncertainty, in its Third Assessment Report, the IPCC produced results supporting the conclusion reached in the Second Assessment: "[T]he observed change in global mean, annually averaged temperature over the last century is unlikely to be due entirely to natural fluctuations of the climate system."[49] The issue is identifying the cause of the detected change in climate, which the IPCC terms the "attribution problem."[50] The question of interest is whether the detected change is confidently attributable to human activities. The IPCC believes the answer is yes.[51] Continuing uncertainties exist in how an observed change in climate is statistically significant when compared with a change explained by natural variability (the detection problem).[52] The IPCC notes:

> Uncertainties in other forcings that have been included do not prevent identification of the effect of anthropogenic greenhouse gases over the last 50 years . . . . Studies that distinguish the separate responses to greenhouse gas, sulphate aerosol and natural forcing produce uncertain estimates of the amplitude of the sulphate aerosol and natural signals, but almost all studies are nevertheless able to detect the presence of the anthropogenic greenhouse *signal* in the recent climate record.[53]

A signal is some variation in certain indicators, like ocean or atmospheric temperature, from the background stability of the sys-

48. *See* Houghton et al., *supra* note 2, at 91 (indicating climate system is non-linear and that unpredictable behavior of non-linear systems can never be ruled out).

49. *See id.* at 97 (discussing likelihood that obscured climate changes are caused solely by material changes).

50. *See id.* (stating after detecting climate change, problem of determining cause of change remains).

51. *See* Houghton et al., *Detection of Climate Change and Attribution of Causes*, in WORKING GROUP I, *supra* note 2, at 699 (discussing human activities' impact on climate change).

52. *See* Albritton et al., *supra* note 4, at 55 (defining attribution).

53. *See id.* at 59 (emphasis added) (discussing ability to identify anthropogenic greenhouse signal regardless of other emissions). Sulphate aerosols are airborne microscopic particles which produce a negative cooling forcing. *See id.* Black carbon aerosols are produced through the incomplete burning of fossil fuels and "biomass" burning (generally of forests and grasslands) which tend to warm the climate system. *See id.* A source of natural sulphate aerosols is volcanic activity. *See id.* Anthropogenic sulphate aerosols include organic carbon from fossil fuel burning. *See id.* "The anthropogenic sulphate aerosol forcing, while uncertain, is negative over [the last fifty years] and therefore cannot explain the [observed atmospheric] warming." *But see Summary for Policy Makers*, *supra* note 2, at 9-10 (discrediting argument).

tem.[54] The following factors can cause variations from systemic stability:

> Any human-induced changes in climate will be embedded in a background of natural climatic variation that occur on a whole range of time- and space-scales. Climate variability can occur as a result of natural changes in the forcing of the climate system, for example variations in the strength of the incoming solar radiation and changes in the concentration of aerosols arising from volcanic eruptions . . . . To distinguish anthropogenic climate changes from natural variations, it is necessary to identify the anthropogenic "signal" against the background noise of natural climate variability.[55]

The "signal to noise" problem is the label for distinguishing natural climate variability from variations generated through human activity.[56] This problem centers the debate between different factions within the scientific community and between national governments. Climate variation may be due to external forcings, e.g. solar radiation, or anthropogenic activity, the latter of which can bring about increasing concentrations of greenhouse gases. Thus, the detection and attribution of anthropogenic forcings on climate change presents a statistical "signal to noise" problem.[57]

Although uncertainties remain, the IPCC contends that the "signal to noise" problem has been overcome to some extent.[58] Remaining uncertainties include: (1) the estimates of internal climate variability drawn from models and observations; (2) reconstructions of solar and volcanic forcing which, for the period prior to the last two decades, must rely on limited observational data; and (3) large differences between different models' responses to the same anthropogenic forcing.[59] Finally, the IPCC understood its task "[t]o attribute all or part of recent climate change to human activity," further acknowledging that it "need[s] to demonstrate that alternative explanations, such as pure internal variability or purely natu-

54. *See* Houghton et al., *supra* note 2, at 89 (noting without this stability "system" would not be apparent).

55. *See* Albritton et al., *supra* note 4, at 25 (illustrating factors that may cause variation).

56. *See* Houghton et al., *supra* note 2, at 700 (describing processes of detection and of attribution).

57. *See id.* (offering reasons for variation).

58. *See id.* at 730 (noting uncertainties surrounding problem).

59. *See id.* (listing uncertainties).

rally forced climate change, are unlikely to account for a set of observed changes that can be accounted for by human influence."[60] The IPCC authors fully understood that *unequivocal* attribution of climate change to anthropogenic causes was impossible because conducting controlled experiments with independent variables ("agents of change"), to determine cause and effect, was impossible.[61] The IPCC instead relied on an estimation approach, allowing that:

> [T]o quantify, with associated estimates of uncertainty, how much different factors have contributed to recent observed climate changes. . . [t]he possibility of a confounding explanation can never be ruled out completely, but as successive alternatives are tested and found to be inadequate, it can be seen to become progressively more unlikely."[62]

After several years of concentrated work, the IPCC concluded human activity is the most likely explanation for observed recent climate change.[63] The IPCC notes:

> The observed warming is inconsistent with model estimates of natural climate variability; [t]he observed warming in the latter half of the [Twentieth] century appears to be inconsistent with natural external (solar and volcanic) forcing of the climate system; [a]nthropogenic factors do provide an explanation of [Twentieth] century temperature; [i]t is unlikely that detection studies have mistaken a natural signal for an anthropogenic signal.[64]

Not everyone in the scientific and policy spheres is persuaded by the IPCC's assertions regarding likely anthropogenic causes of climate change. Part II discusses the bases for this skepticism.

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60. *See id.* at 700 (stating what is necessary to attribute change to human conduct).

61. *See* Houghton et al., *supra* note 2, at 700 (describing why attribution is unequivocal).

62. *See id.* at 700-01 (summarizing ICC approach).

63. *See* Albritton et al., *supra* note 4, at 56 (noting that observed changes in climate are consistent with estimated response to combination of anthropogenic and natural forcing).

64. *See* Houghton et al., *supra* note 2, at 730 (noting IPCC's conclusions).

II. AN ABSENCE OF SCIENTIFIC UNANIMITY

A. Dour Skepticism

In June 2001, in response to the IPCC's Third Assessment Report, the current United States administration commissioned the National Academy of Sciences (NAS) to review the Assessment Report and develop a research agenda for the United States scientific community to "reduce uncertainties in climate science."[65] In its report to the administration, the National Research Council (NRC) stated: "[T]he IPCC's conclusion that most of the warming of the last 50 years is likely to have been due to the increase in greenhouse gas concentrations accurately reflects the current thinking of the scientific community on this issue."[66] The NRC took note of the same remaining uncertainties the IPCC highlighted in its Third Assessment Report. The NRC said that uncertainty remained regarding:

> [T]he level of natural variability inherent in the climate system on time scales of decades to centuries; the questionable ability of models to accurately simulate variability on those long time scales; and the degree of confidence that can be placed on reconstructions of global mean temperature over the past millennium based on proxy evidence.[67]

There may be no better example of the uncertainties "confounding" climate change science than the problem of "feedbacks."[68] The United States Department of State Climate Action Report to the UNFCCC in 2002 portrays this phenomenon well.[69] Noted in the Report, for example, is how the response of the cli-

65. *See* UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, *Part I, Overview of the Climate Change Research Initiative, in* DRAFT STRATEGIC PLAN FOR THE CLIMATE CHANGE SCIENCE PROGRAM, 14 (2002), *available at* http://www.climatescience.gov/Library/stratplan2003/draft/ccspstratplan2003-11nov2002.pdf (last visited Oct. 24, 2007) (DRAFT STRATEGIC PLAN) (directing NAS's actions for scientific community).

66. *See* RALPH J. CICERONE ET AL., CLIMATE CHANGE SCIENCE: AN ANALYSIS OF SOME KEY QUESTIONS at 3 (2001). This report is Appendix D of the UNITED STATES DEPT. OF STATE, UNITED STATES CLIMATE ACTION REPORT; THE USA'S 3RD NATIONAL COMMUNICATION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2002) (stating similarity in IPCC's and Scientific Community's thinking), *available at* www.gcrio.org/OnLnDoc/pdf/ClimateChangeScience.pdf.

67. *See id.* at 3 (discussing sources of uncertainty).

68. *See id.* at 6 (noting how climate sensitivity to forcing is significantly impacted by feedbacks such as melting sea ice).

69. *See* CICERONE ET AL., *supra* note 66, at 6 (discussing major factors contributing to climate change).

mate system to atmospheric water vapor amount and clouds is likely responsible for the most significant climate feedbacks.[70]

Despite the identified uncertainties, the NAS agreed "that the observed warming is real and particularly strong within the last twenty years."[71] NAS scientists generally agreed with the assessment from the IPCC's Working Group I that human activity was a contributing cause of climate change, in that an anthropogenic "signal" was detectable among the background "noise" of climate variability.[72] NAS sought to "articulate more clearly the level of confidence that can be ascribed to those assessments and the caveats that need to be attached to them."[73] In 2003, NAS was asked to review the Draft Strategic Plan of the United States Climate Change Science Program,[74] which was issued in November 2002. Though the NAS commended the Plan's call for increased observational capabilities and accelerated research on the carbon cycle, the general evaluation was at best mixed. When asked to determine if the Strategic Plan's goals were clear and appropriate, NAS replied "the document is not a coherent strategic plan, because it lacks most elements of a strategic plan . . . ."[75]

For the purposes of this Article, the most important criticism of the Draft Strategic Plan called for an improved grasp on uncertainties attached to the science of climate change. One NAS criticism of

70. *See id.* at 7 (quoting effects of feedbacks).

71. *See id.* at 3 (noting status of certainty).

72. *See* Houghton et al., *supra* note 2, at 730 (asserting it is unlikely that natural forcing can completely account for observed warming in recent decades).

73. *See* CICERONE ET AL., *supra* note 66, at 1 (explaining NAS goal).

74. *See* UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, *supra* note 65, 14 (discussing history of climate research). The United States Climate Change Science Program (CCSP) was formed in 2002 to coordinate and direct United States efforts in climate change and global change research. *See id.* The CCSP builds upon the decade-old United States Global Change Research 1 Program (GCRP). *See id.* The CCSP incorporates the GCRP and adds a new component-the Climate Change Research Initiative (CCRI) whose primary goal is to "measurably improve the integration of scientific knowledge, *including measures of uncertainty*, into effective decision support systems and resources." *Id.* at 5 (emphasis added). The GCRP was created by the United States Global Change Research Act of 1990, Pub. L. No. 101-606, 104 Stat. 3096-3104 (1990). The CCRI was created in June 2001 to study areas of uncertainty and "to enhance the ongoing research activities of the United States Global Change Research Program (USGCRP)." UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, *supra* note 65, at 15.

75. *See* Committee to Review the United States Climate Change Program Strategic Plan, National Research Council, PLANNING CLIMATE AND GLOBAL CHANGE RESEARCH: A REVIEW OF THE DRAFT UNITED STATES CLIMATE CHANGE PROGRAM STRATEGIC PLAN 54 (National Academy of the Sciences 2003) (NRC, REVIEW OF DRAFT STRATEGIC PLAN). The missing elements included unambiguous goals and a clear timetable for accomplishing those goals, as well as a management plan ensuring the goals are met. *See id.*

the Draft Strategic Plan was that it needed to better inform decision-makers about uncertainty yet it failed to determine which uncertainties were most important to decision-makers.[76]

The establishment of the Climate Change Research Initiative (CCRI), in June 2001, appeared to be the beginning of an effort to identify and reduce uncertainties in climate science.[77] The CCRI program had a stated goal of identifying research initiatives which would help reduce "the present uncertainties in climate science and develop the enabling modeling capabilities, and . . . develop research and data products that will facilitate the use of scientific knowledge to support policy and management decisions."[78]

It is generally agreed that uncertainty in the validity and reliability of climate modeling remains, and improving those models remains necessary and desirable.[79] The level of uncertainty in the climate models must be reduced before national policy should be formulated (or re-formulated in the United States' case) based in part on model predictions. The exact level of uncertainty, however, remains an issue. One noted critic disagrees with the IPCC's findings regarding the ability of current climate models to replicate observations of atmospheric conditions, notably cloud cover and water vapor.[80] Other climate and atmospheric observers reported a similar discrepancy between general circulation models (GCMs) and observed atmospheric temperature trend lines.[81] They have found "that while the models generally agree with each other, they disa-

76. *See id.* at 6 (noting importance of CCSP having clear process for setting priorities).

77. *See* United States Global Climate Change Research Program, THE UNITED STATES CLIMATE CHANGE RESEARCH INITIATIVE (CCRI): SURVEY OF RESEARCH STRATEGIES TO REDUCE SCIENTIFIC UNCERTAINTIES 4 (Aug. 2001), http://www.usgcrp.gov/usgcrp/Library/CCRIreport-aug2001/CCRIreport-aug2001.pdf (last visited Oct. 24, 2007) (discussing development and goals of CCRI).

78. *See id.* (stating CCRI's proposed research initiatives).

79. *See* CICERONE ET AL., *supra* note 66, at 15 (discussing necessity of updating current climate models).

80. *See* Daniel Grossman, *Dissent in the Maelstrom*, SCI. AM. (Nov. 2001) at 37, *available at* http://www.wbur.org/special/antartica/images/RichardLizden/pdf (last visited Feb. 27, 2007) (noting failure of models to predict outcome). Professor Richard S. Lindzen contends that in certain configurations, water vapor and cloud cover may produce "negative feedback," that is, may bring about a cooling or at least a stabilization in the planet's surface temperature. *See id.* This hypothesis is in contrast to IPCC conclusions asserting clouds and water vapor will likely bring about "positive feedback;" that is, an increase in global surface temperature. *See id.*

81. *See generally* David Douglass et al., *Altitude Dependence of Atmospheric Temperature Trends: Climate Models Versus Observations,* GEOPHYS. RES. LETT., Vol. 31, L13208 (2004) (presenting study performed by Douglass).

gree with the observations."[82] The observations conflicting with the models are atmospheric (above surface) as "the three state-of-the art greenhouse models . . . show positive temperatures that increase with altitude . . . . [H]owever, the existing observational data sets show decreasing as well as mostly decreasing trends since 1979."[83]

In attempting to explain this discrepancy, Professors David Douglass, Benjamin Pearson and Dr. S. Fred Singer[84] pose two possibilities. The first possibility is that "the models are correct and account for all relevant forcings. If so, then we must conclude that the observational data sets . . . are all incorrect."[85] The other possibility is that "[t]he models do not fully capture the multitudinous climate effects (including various feedbacks) of an increase in greenhouse gases. Since the observed surface temperature trends . . . agree with the models, then they too must be questioned."[86] Douglass and his researchers, believing it unlikely that the unnecessary observational data sets would all be inaccurate, concluded that "it seems more likely that both the models and observed *surface trends* are problematic."[87]

The central point of Douglass's argument was that the GCM temperature predictions disagreed with the observational data sets relative to *atmospheric* measurements of temperatures, but the GCM temperature predictions agreed with observational surface temperature measurements.[88] Since the observational data sets all agree with each other, Douglass stated the GCMs must be questioned, particularly their predictions regarding atmospheric temperatures.[89] If the models' validity regarding atmospheric temperatures are questionable, then the accuracy of the model predictions pertaining to surface temperatures are also questionable.[90]

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82. *See id.* at 5 (discussing disagreement between modes and observation).

83. *See id.* (discussing temperature difference between models and observations).

84. *See id.* (stating authors). Profs. Douglass and Pearson are on the faculty at the University of Virginia, Department of Physics and Astronomy. Dr. Singer is with the Science & Environmental Policy Project, Arlington, VA. *See id.*

85. *See id.* at 6 (describing first possibility).

86. *See* Douglass et al., *supra* note 81, at 6 (describing second possibility).

87. *See id.* (emphasis added) (concluding probability of problematic observations).

88. *See id.* (finding that models all disagree with near surface data in Global, tropics and SH averages).

89. *See id.* (stating that models show positive temperature trends increasing with altitude, while observational data sets show decreasing trends since 1979).

90. *See id.* (questioning accuracy of surface temperature based on other inaccuracies).

Researchers followed with a critical inference: If the validity of the GCMs is questionable, and the observed surface temperature trend lines agree with GCMs, then the surface temperature trend lines themselves are questionable.[91] This inference allowed the investigators to conclude both the GCMs and the observed surface temperature trends are problematic and their *agreement* was irrelevant.[92] In the end, this group of investigators posited this "apparent agreement may be a coincidence."[93] But the more somber suggestion, that the latter agreement may have been a result of "a 'tuning' of the models to the surface temperature trends,"[94] was also proposed and is addressed below.[95]

The Douglass research counters the mainstream position of climate scientists.[96] Douglass's work is an example of a distinct minority position in the scientific community regarding anthropogenic causes of climate change. It is presented here to note the existence of a minority position, not to imply that it is a compelling one.

Douglass's work is not compelling for two reasons. First, the inference that surface temperature trends are suspect because they must agree with questionable models is dependent on both the confidence one has in a particular observational data set and the model designed to replicate the observed trend. The United States Climate Change Science Program (USCCSP) generated new findings, published in April 2006, which appear to support the ability of GCMs to make valid predictions of temperature trends (tropospheric and lower stratospheric) by more correctly simulating observations.[97]

In one section of the USCCSP Report, a team of scientists used nineteen different models and observational data from the two de-

91. *See* Douglass et al., *supra* note 81, at 6 (positing that since observed surface temperature trends agree with models, surface temperature trends must also be questioned).

92. *See id.* (stating that it is likely that both models and observed surface trends are problematic).

93. *See id.* (discussing second of two conclusions).

94. *See id.* (discussing second of two conclusions).

95. For a discussion of incentives for research scientists, *see infra* notes 113-17 and accompanying text.

96. *See* Jerry D. Mahlman, Global Warming: Misuse of Data and Ignorance of Science, Union of Concerned Scientists (2001), *available at* http://www.ucsusa.org/assets/documents/global_warming/ACFCGy9yc.pdf (asserting much of minority position contrarian science is methodologically weak).

97. *See Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences* (2005), http://www.climatescience.gov/Library/sap/sap1-1/finalreport/sap1-1-final-all.pdf (last visited Oct. 24, 2007) (*Temperature Trends*) (examining differences in atmospheric temperature at varying levels of atmosphere and causes of such differences).

cades between 1979 and 1999 to examine global mean tropospheric temperature trends.[98] This team found "[a]ll of the satellite- and radiosonde-based [balloon and aircraft temperature sensors] trends. . . are contained within the spread of model results. This illustrates that there is no fundamental discrepancy between modeled and observed trends in global-mean tropospheric temperature."[99] The finding that there is no discrepancy between the modeled trends and observable trends directly contradicts the inferences the Douglass team made.

Additionally, a research effort lead by Thomas Karl, Director of the National Oceanic and Atmospheric Administration's National Climatic Data Center, offered a plausible explanation for the lack of consonance between atmospheric observational temperature trends and GCM atmospheric temperature predictions, noted both by Richard Lindzen[100] and David Douglass.[101] The Karl team said, "In reality, all data sets are not equally plausible realizations of the true climate system evolution. The climate system has evolved in a single way, and some data sets will be closer to this truth than others."[102] This statement suggests atmospheric observational data sets need to become more accurate and more complete. The USCCSP tried to produce this result in the April 2006 publication.[103] In doing so, it has diminished the importance of the Lindzen and Douglass critiques.

The second reason Douglass's work is not compelling is it suggests other climate scientists have not accurately utilized the data the models generated. This would likely prompt a strong rebuttal from the targets of such an assertion. The group of climate scientists and policy advocates who put forth this assertion and question the motives of some researchers working in the climate change

98. *See id.* at 89-90 (explaining data compiled by using fingerprint studies, which utilize meticulous statistical methods to compare spatial and temporal patterns of climate change by using both computer models and observation).

99. *See id.* at 110 (explaining in detail results from observations of tropospheric temperature trends).

100. For a discussion of Linzden's argument regarding the inaccuracy of GCM's in depicting climate sensitivity, *see infra* notes 105-08 and accompanying text.

101. *See* Douglass et al., *supra* note 81, at 6 (describing inconsistency between GCMs and observed climate trends).

102. *See Temperature Trends*, *supra* note 97, at 87 (arguing tools must be developed to objectively differentiate data sets).

103. *See id.* at 117 (stressing importance of complementary data sets in better understanding differential warming).

mainstream is a very small one (relative to the mainstream). This Article will return to this discussion below.[104]

Professor Richard Linzen[105], a prominent climatologist at the Massachusetts Institute of Technology, has also expressed strong distrust of the ability of GCMs to correctly depict climate sensitivity to increasing volumes of GHGs. He expressed his doubts by saying:

> [O]ur own research suggests the presence of a major negative feedback involving clouds and water vapor, where models have completely failed to simulate observations . . . . If we are right, then models are greatly exaggerating sensitivity to increasing CO_2. Even if we are not right . . . the failure of models to simulate observations makes it even less likely that models are a reliable tool for predicting climate.[106]

It must be stressed that Professor Lindzen and his colleagues are part of a small, but vocal, minority within the climate scientist community. They published a paper which appears to offer support for the preceding expressed doubts.[107] The Lindzen team notes: "[T]he model feedbacks are, at present, simply artifacts of the models. Our work strongly suggests that the relevant feedbacks are negative rather than positive, and very large in magnitude. If this is indeed correct, then concerns for global warming are greatly exaggerated."[108]

In a vein similar to Douglass, Professor Lindzen asserts that current GCMs remain unconvincing in predicting climate sensitiv-

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104. For a discussion of the skepticism toward many mainstream scientists, *see infra* note 134 and accompanying text.

105. *See* Lindzen, Richard S., http://www-eaps.mit.edu/faculty/lindzen.htm (listing accomplishments). Lindzen is the Alfred P. Sloan Professor of Atmospheric Science in the Department of Earth, Atmospheric, and Planetary Sciences at the Massachusetts Institute of Technology. *See id.* Professor Lindzen was a major contributor to a portion of the 2001 IPCC Third Assessment Report concerned with physical processes (Chap. 7). *See id.*

106. *See Testimony of Richard S. Lindzen before the Senate Environment and Public Works Committee on 2 May 2001*, 107th Cong. (2001), *available at* http://www-eaps.mit.edu/faculty/lindzen/Testimony/Senate2001.pdf (last visited Oct. 24, 2007) (*Lindzen Testimony*) (expressing doubts about reliability of models system).

107. *See* Richard S. Lindzen et al., *Does the Earth Have an Adaptive Infared Iris?*, 82 BULL. AMER. METEOR. SOC. 417 (2001) (articulating hypothesis of cloud modulated "iris" effect, which operates to minimize global warning).

108. *See* Richard S. Lindzen, *Richard S. Lindzen Answers a Few Questions About this Month's Fast Breaking Paper in Field of Geosciences*, ESI Special Topics, Feb. 2003 (*Lindzen Answers*), *available at* http://www.esi-topics.com/fbp/2003/february03-RichardLindzen.html (last visited Oct. 24, 2007) (addressing questions about his article on iris effect). This article is entitled *Does the Earth Have an Adaptive Infrared Iris?*. *See Lindzen Testimony, supra* note 106 (stating effect of hypothesis).

ity to increasing concentrations of GHGs. In a separate paper, however, a team of atmospheric scientists mounted a direct challenge to Lindzen's theories. This paper, authored by a team led by Dr. Bing Lin of the NASA Langley Research Center, relies on direct observations of broadband radiation fields to examine the impact of water vapor and clouds on climate sensitivity.[109] Lindzen's "iris hypothesis" states that the "cloudy-moist [tropical upper tropospheric] regions contract when the surface warms and expands when the surface cools. In each case the change in the troposphere acts to oppose the surface change, and thus presents a strong negative feedback to climate change."[110] Lin's paper notes "[t]he observations show that the clouds have much higher albedos and moderately larger longwave fluxes than those assumed by Lindzen. As a result, decreases in these clouds would cause a significant but weak positive feedback to the climate system, instead of providing a strong negative feedback."[111] The Lin paper counters the Lindzen and Douglass teams' earlier work.

Strong skepticism from a small minority, based on arguments about data and methods, exists within the scientific community; these arguments are recognized and are within the bounds of acceptable scientific debate.[112] But, in public testimony, Lindzen raised the issue, similar to the Douglass paper, about the motives of many of those doing "mainstream" science.[113] The Douglass paper suggested some of the GCMs had been "tuned" to fit the data, while Lindzen asserted the scientific endeavor in the United States has developed, in his view, an unfortunate "incentive structure."[114] He contends that, "[s]cientists associate public recognition of the relevance of their subject with financial support, and relevance has come to be identified with alarming the public. It is only human for

109. *See* Bing Lin et al., *The Iris Hypothesis: A Negative or Positive Cloud Feedback?*, 15 J. CLIMATE 3 (2001) (using Tropical Rainfall Measuring Mission satellite measurements over tropical oceans in order to evaluate iris hypothesis proposed by Lindzen group and subsequently demonstrate its contrasting results).

110. *See* Lindzen testimony, *supra* note 106 for a summary of the significance of Lindzen's research.

111. *See id.* at 3 (quoting abstract and noting several limitations of iris study as possible reasons for their conflicting conclusions).

112. *See* Bjorn Lomborg, THE SKEPTICAL ENVIRONMENTALIST: MEASURING THE REAL STATE OF THE WORLD (Hugh Matthews trans., Cambridge University Press 2001) (1998) (discussing doubt as to validity of models).

113. *See* Douglass et al., *supra* note 81, at L13208 (suggesting that agreement between models and observed surface trends reflects tuning of models to fit surface trends).

114. *See Lindzen Testimony*, *supra* note 106 (asserting scientists respond to incentives like all humans).

scientists to wish for support and recognition . . . ."[115] Professor Lindzen, in response to the question of what he would do if he controlled federal funds for climate change research, said he would reduce the level of such funding, because by doing so, the collection of "vested interests" involved researching the problem would dwindle.[116]

Those doubting the validity of the models predicting climate sensitivity[117] have cited Lindzen's belief that climate sensitivity to increasing levels of GHGs in the atmosphere is significantly lower than the estimates provided by the IPCC.[118] In several GCMs, Professor Bjorn Lomborg supported Lindzen's beliefs by noting that none of the selected models seemed able to incorporate the negative cloud and water vapor feedback Lindzen pointed to, "indicating that present models seriously overestimate CO_2-induced warming."[119] Lomberg actually relied considerably on Lindzen's work in criticizing the IPCC and the "mainstream of environmental science."[120] Lomberg stated, "[t]he cloud simulations are fraught with uncertainty and new research seems to indicate a strong, negative cloud feedback which would lower the climate sensitivity dramatically."[121]

A second paper by Dennis L. Harmann and Marc L. Michelson was recently published and offered evidence to contest Lindzen's "iris effect."[122] Lindzen and his team attempted "to use both obser-

115. *See id.* (adding that broad consensus among scientists that climate change is significant must be viewed in context of human inclination).

116. *See* Grossman, *supra* note 80, at 36 (highlighting Lindzen's belief that science is in premature stage, creating much reason for skepticism and virtually no foundation for consensus). For further discussion of Lindzen's thesis on "financial incentives embedded in current science," *see supra* notes 134-136 and accompanying text.

117. *See* Lomborg, *supra* note 112, at 271 (discussing those who express doubts about validity of models). Bjorn Lomborg is a political scientist based at the University of Aarhus, Denmark. *See id.*

118. *See id.* (explaining Lindzen's view that there is little reason to be concerned for our future). Lindzen estimates climate sensitivity to be roughly 0.4°C, while the IPCC estimate is in the range of 1.5° - 4.5°C). *Id.*

119. *See id.* at 271 (asserting lack of replication of negative feedback indicates CO_2-induced warming overestimations).

120. *See* John Rennie, *A Response to Lomborg's Rebuttal*, SCIENTIFIC AMERICAN, Apr. 15, 2001, *available at* http://www.sciam.com/article.cfm?articleID=00040A72-A95C-1CDA-B4A880 9E C5 88 EE DF & page Number= 1& cat ID=9 (describing term mainstream used by Lomborg critic).

121. *See* Lomborg, *supra* note 111, at 273 (stating new research shows negative cloud feedback may lower climate sensitivity).

122. *See* Dennis L. Hartmann & Marc L. Michelsen, *No Evidence for Iris*, 82 BULL. AMER. METEOROLOGICAL SOC. 249 (2002) [Hartman & Michelson] (concluding observational analysis presented by Lindzen group provides no support for

vations and theory to determine the climate feedbacks from clouds and water vapor that [can] determine the sensitivity of climate to such factors as increasing greenhouse gases."[123] The Hartmann and Michelsen paper does not support the conclusions of Lindzen's paper.[124]

The Lindzen paper concluded that increased sea surface temperatures (SST) lead to a reduced area of anvil clouds, which are those cumulonimbus clouds whose higher elevations have reached the upper troposphere and have spread out horizontally, potentially trapping significant amounts of heat.[125] The anvil clouds are tied with lower level deep convective cloud systems, which transport solar heating of the ocean into the troposphere.[126] "[P]recipitation forms more efficiently in warmer cumulus towers, and hence leaves less unprecipitated moisture and ice to form clouds outside the towers."[127] The consequent reduction in anvil clouds likely will produce a negative feedback to climate change because of lower levels of moisture (water vapor) in the troposphere.[128] Smaller quantities of clouds and water vapor in the troposphere will allow heat to escape, lessening the greenhouse effect. The Hartmann and Michelson team found:

> The deep convection cores are separated by more than 1000 km from the clouds that are associated with most of the variation in cloud-weighted SST. The explanation for the correspondence between cloud-weighted SST and cloud area is thus a shift in the latitude or longitude of the cloudiness and not a change in the relation between deep convective and associated tropical anvil cloud amounts.[129]

Hartmann and Michelson's work weakens Lindzen and Lomborg's conclusions regarding climate sensitivity mechanisms.

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hypothesis that increased sea surface temperature reduces area covered by tropical anvil cloud).

123. *See Lindzen Answers*, *supra* note 108 (providing reasoning used by Lindzen of observation and theory examining greenhouse effect).

124. *See* Hartmann & Michelsen, *supra* note 122, at 254 (stating lack of evidence of change in ratio of anvil area to convective area).

125. *See* Lindzen et al., *supra* note 107, at 419 (finding very strong inverse relationship between mean sea surface temperature and cloud area).

126. *See* Hartman & Michaelsen, *supra* note 122, at 251 (noting that higher colder clouds and warmer convective clouds in tropics are part of same cloud system).

127. *See id.* (discussing effects of precipitation and temperature).

128. *See* Lindzen et al., *supra* note 107, at 427-32 (listing computations).

129. *See* Hartmann and Michelsen, *supra* note 122, at 249 (explaining relationship between cloud weight and cloud area).

An atmospheric scientist based at the National Center for Atmospheric Research in Colorado, Jerry Mahlman, also expressed doubts about Lomborg's arguments regarding climate change.[130] Mahlman remarked that Lomborg appropriately noticed "the measured tropospheric temperatures are not warming as much as the measured surface temperatures."[131] He remarked that Lomborg affirms the Lindzen team's conclusion that if sustained, this difference "could reduce the magnitude of the positive water vapor feedback and thus reduce the magnitude of climate warming."[132] Mahlman is wary of such a conclusion. He points out others have analyzed these conclusions, and these analyses should give us pause before drawing conclusions based on this data. "Clearly . . . sweeping conclusions from these data sets concerning the magnitude of expected climate warming are not warranted."[133]

This Article now turns to a very different critique from the critique based on the uncertainty of science. While the focal point of this Article is scientific uncertainty, the question of what might motivate certain scientists to engage in the study of climate change (aside from the "pure science" and "policy science" stimuli just mentioned) is serious and merits at least a brief reference.

Professor Lindzen noted that scientists are human beings who respond to particular incentives.[134] During an interview, Lindzen stated that current government policy regarding the funding of science creates incentives to publicize a subject in a manner that will keep the subject or issue relevant.[135] On certain issues, Professor Lindzen noted science funding depends on "alarming" the policy-making community.[136]

Others have taken up this criticism of the mainstream scientific community, particularly the IPCC. Two university-based social scientists, Boehmer-Christiansen and Kellow, devote a good deal of

130. *See generally,* Mahlman, *supra* note 96 (reviewing BJORN LOMBORG, THE SKEPTICAL ENVIRONMENTALIST 2001) (asserting doubts about Lomborg's arguments regarding climate change).

131. *See id.* at 4 (explaining reasoning behind doubts concerning Lomborg's arguments).

132. *See id.* (discussing potential effects of Lomborg and Lindzen team's conclusions).

133. *See id.* (reasoning sweeping statements made unwarranted).

134. *See* Paul Georgia, *IPCC Report Criticized by One of Its Lead Authors,* ENVIRONMENT & CLIMATE NEWS, June 1, 2001, *available at* http://www.cei.org/gencon/019,02098.cfm (referring to Lindzen's comments at briefing sponsored by Cooler Heads Coalition in U.S. Senate Environment Committee Room).

135. *See id.* (noting incentives leads to questionable behavior by scientists).

136. *See id.* (stating financial support for science depends on alarming public).

attention to the composition of the Working Groups of the IPCC, particularly Working Groups I and II.[137] They describe Working Group I as composed "largely of energy policy and technology advocates who are generally supportive of policies for energy conservation and renewable energy technologies that they think governments will be 'forced' to adopt as responses to the prospect of dangerous anthropogenic climate change."[138] In Boehmer-Christiansen and Kellow's view, the investigators who wrote the chapters on impacts in the IPCC's three general assessment reports were predisposed toward recommending a turn toward conservation and renewable energy *before* evidence on climate change had been assembled and analyzed.

Working Group I predominately consisted of atmospheric physicists, meteorologists and computer programmers specializing in climate modeling.[139] Boehmer-Christiansen and Kellow point to what they perceived became:

> [A]n institutionalization within the IPCC process of scientists, who were either government employees or working in government funded, often rather financially insecure, centres frequently associated with meteorological offices and institutes that had an interest in there being a climate problem which would justify further research. Few university scientists contributed to the IPCC process because they lacked the travel funds, access to the largest computers and the ability to attend meetings regularly, since they had to teach. The IPCC process has therefore been dominated by scientists whose livelihoods depend upon *direct government allocations* for climate research, and thus on a belief now deeply entrenched even at the official level that dangerous climate change was both likely and subject to mitigation by policy.[140]

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137. *See generally,* SONJA BOEHMER-CHRISTIANSEN & AYNSLEY KELLOW, INTERNATIONAL ENVIRONMENTAL POLICY: INTERESTS AND THE FAILURE OF THE KYOTO PROCESS (Edward Elgar 2003) (noting two scientists reviewed purposes of Working Groups). The missions of the IPCC's Working Group I, Working Group II and Working Group III were "assessment," "impacts" and "response strategies," respectively. *See id.*

138. *See id.* at 139 (describing composition of Working Group I).

139. *See* Appendix IV, Reviewers, *in* THE SCIENTIFIC BASIS at 845 (listing reviewers and their academic departments).

140. *See* Boehmer-Christiansen & Kellow, *supra* note 137, at 140 (emphasis added) (explaining composition of membership of Working Group I).

This order of criticism fails for at least two reasons. First, it asserts that many university scientists were not able to participate in the IPCC process due to other time commitments elsewhere. This assertion, however, does not necessarily show that if more university-based scientists had been able to participate, IPCC recommendations would have been significantly different than they in fact were.[141] Secondly, that atmospheric physicists and climatologists receive government funding for their work does not show that scientists submitted proposals because of a need to maintain their salaries or their laboratories.

Upon observing the flow of government funds to scientists with properly structured evidentiary-based proposals, one could just as easily conclude that those scientists applying for funds recognized an interesting question which they placed in a selective funding process. If a funding panel found the question interesting and the investigative process sufficiently rigorous, then the funding panel would have had reason to support the proposed research. An inference that funding is being allocated to scientists with sincere intentions is at least as plausible as that proposed by Boehmer-Christiansen and Kellow, and Lindzen.[142]

B. Prominent Questions

Early in 2001, the administration asked the NRC to assist the administration in its review of United States climate change policy. The NRC responded by analyzing a set of "key questions."[143] One question asked if there is a safe concentration of greenhouse gases. In response, the NAS analysis carefully stated:

> The question of whether there exists a "safe" level of concentration of greenhouse gases cannot be answered directly because it would require a value judgment of what constitutes an acceptable risk to human welfare and ecosystems in various parts of the world, as well as a more quantitative assessment of the risks and costs associated

141. *See* Naomi Oreskes, *The Scientific Consensus on Climate Change* 306 SCI. 1686 (2004) (explaining peer-review process, not scientist's base, determines quality of research).

142. *See* Georgia, *supra* note 134 and accompanying text (comparing inference from mainstream climate science to inference put forth by Lindzen). *See also* BOEHMER-CHRISTIANSEN & KELLOW, *supra* note 137, at 135 (comparing inference from mainstream science to inference put forth by Boehmer-Christiansen and Kellow).

143. *See* Cicerone et al., *supra* note 66, at 1 (stating how NRC assisted in review of United States climate change policy).

> with the various impacts of global warming. In general, however, risk increases with increases in both the rate and the magnitude of climate change.[144]

Early in 2001, the President organized a Cabinet-level review of United States policy and programs on climate change.[145] The Cabinet group asked NAS to analyze a set of prominent climate change questions, including the question stated above about safe GHG levels. The questions the current administration posed to NAS indicated that the administration has doubts regarding the wisdom of the approach to climate change taken by the Kyoto Protocol.

In a letter responding to a March 6, 2001 inquiry from Senators Hagel, Helms, Craig and Roberts, President Bush discussed the administration's views on global climate change.[146] The current administration voiced its strong opposition to the Protocol because "it exempts 80 percent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the U.S. economy."[147] Most observers cite this letter as evidence of the United States rejection of the Kyoto Protocol.[148]

In practical terms, rejecting the Protocol merely meant the Executive Branch decided not to submit the Protocol to the Senate for ratification and publicly disavowed any support for the international instrument. The Clinton Administration first submitted this protocol to the senate in 1997, after the passage of the Byrd-Hagel resolution.[149] "The [Bird-Hagel] resolution was to provide gui-

144. *See id.* at 4 (stating response to whether science has determined if safe level of concentration of greenhouse gases exists).

145. *See* Press Release, Office of the Press Secretary, President Bush, President Bush Discusses Global Climate Change (June 11, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html (citing report on climate change policy). *See also* CICERONE ET AL., *supra* note 66, at 51. (referencing this report).

146. *See* Press Release, Office of the Press Secretary, Text of Letter from the President to Senators Hagel, Helms, Craig and Roberts (March 13, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/03/20010314.html (on file with author) (discussing current administration's stance on global climate change issues).

147. *See id.* (explaining current administration's opposition to Kyoto Protocol).

148. *See* Press Release, President Bush Discusses Global Climate Change, *supra* note 145 (explaining current administration's opposition to Kyoto Protocol). In his remarks, the president noted, "we do not know how much effect natural fluctuations in climate may have had on warming." *See id.*

149. *See* S. Res. 98, 105th Cong. (1997) (stating how Kyoto Protocol was first addressed). "In July, 1997, the Senate adopted by a vote of 95-0, Senate Resolution 98, commonly known as the 'Byrd-Hagel' Resolution." *See* Frank H. Murkowski,

dance to the Administration and its global climate negotiating team as they entered negotiations in Kyoto."[150]

Before the United States could become a signatory to an international agreement on climate change, the following conditions had to be met: (1) emission limitation commitments from developing countries[151] and (2) an absence of harm to the United States economy.[152] These two conditions continue to be major issues today. The economic argument is powerful and not easily refuted. It serves as the basis for what the current administration labeled in February 2002 as "a reasonable, gradual" approach to the problem of climate change.[153]

> A reasonable, gradual goal . . . offers advantages over the reductions set out in the Kyoto Protocol. The Kyoto Protocol focused on rather dramatic short-term reductions with unclear consequences and, in turn, jeopardized the ability to invest in long-run scientific and technological solutions. A reasonable goal offers insurance consistent with existing climate science without putting the economy at risk.[154]

A healthy economy should be safeguarded and should not be subjected to undue risk. But a measure of risk to the economy may need be tolerated in order to protect the value of a stable "anthropogenic friendly" climate.

The United States objection, stemming from the Kyoto Protocol and the international community's perception of unprecedented warming of the global climate, appears to be threefold: (1) economic cost and issues of fairness in bearing these costs; (2) scientific uncertainty regarding whether the observed climate change is something other than an iteration of a natural variation which

The Kyoto Protocol is Not the Answer to Climate Change, 37 HARV. J. ON LEGIS. 345, 353-54 (2000).

150. *See* Frank H. Murkowski, *The Kyoto Protocol is Not the Answer to Climate Change*, 37 HARV. J. ON LEGIS. 345, 353-54 (2000) (explaining that Senate recognized developed nations must participate).

151. *See* HEIKE SCHROEDER, NEGOTIATING THE KYOTO PROTOCOL: AN ANALYSIS ON NEGOTIATION DYNAMICS IN INTERNATIONAL NEGOTIATIONS 37 (Lit Verlag 2001) (discussing further United States position toward developing country emission limitation commitments).

152. *See* Murkowski, *supra* note 150, at 353-54 (explaining conditions for signing climate change agreement).

153. *See* Council of Economic Advisors, Economic Report of the President, H.R. DOC. NO. 107-788, at 247 (2002), *available at* http://origin.www.gpoaccess.gov/usbudget/fy03/browse.html (last visited Oct. 24, 2007) (stressing need to policy flexibility in order to keep economic growth at high level).

154. *See id.* (quoting current administration's statement comparing Kyoto Protocol with reasonable, gradual approach).

has occurred in the past; and (3) uncertainty pertaining to whether human activity has made a significant contribution to the observed change in climate. In response to a request for analysis from the administration, the NRC reported "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."[155]

Although it appears to be true that a causal link cannot be established, it may be imprudent for the administration to avoid taking action. To some extent it is a statistical matter. There are early statistical indications that anthropogenic activity is contributing to climate change.[156] Despite these studies, the United States has not become a signatory to the Kyoto Protocol because it would risk harm to the United States economy and allow developing countries to avoid emission limitations.

The administration argues it would be unjust to impose the cost of GHG emission reductions on the United States economy if developing countries were providing an exemption from GHG emission reductions, thus shielding their economies from the costs associated with emission reductions. The administration has clearly articulated its stance regarding the fairness issue, stating, "[t]he Kyoto Protocol is unfair to the United States and to other industrialized nations because it exempts eighty percent of the world from compliance."[157] Members of Congress also expressed this concern, as evidenced by the 95-0 vote in favor of the Byrd-Hagel amendment in the Senate. In the House of Representatives, there is a similar concern "that implementing the Kyoto Protocol would create incentives for moving jobs offshore to developing countries that have no emission reductions."[158] To further strengthen its enmity

155. *See* CICERONE ET AL., *supra* note 66, at 17 (explaining effects of human activities on climate change).

156. *See* Andrew C. Revkin, *Can Global Warming Be Studied Too Much?*, N.Y. TIMES, Dec. 3, 2002, at F1 (stating casual link exists between anthropogenic activity and climate change).

157. *See* Christie Todd Whitman, Statement by EPA Administrator Christie Whitman on Meeting with Members of the European Community (April 3, 2001), *available at* http://yosemite.epa.gov/opa/admpress.nsf/b1ab9f485b098972852562e7004dc686/acf69d4a9b345ffe85256a23006aa7fc?OpenDocument (explaining why Kyoto Protocol is unfair to United States and other nations).

158. *See* Zoya E. Bailey, *The Sink that Sank the Hague: A Comment on the Kyoto Protocol*, 16 TEMP. INT'L & COMP. L.J. 103, 115 (2002) (discussing concern of potential job loss from Kyoto Protocol). For a full presentation of the "job loss" argument, applied particularly to the United States steel industry, *see* Heather A. Steinmiller, Comment, *Steel Industry Watch Out! The Kyoto Protocol is Lurking*, 11 VILL. ENVTL. L.J. 161, 191-94 (2000).

for the Protocol, in 1998, Congress began the now regular practice of circumscribing Environmental Protection Agency (EPA) appropriations so that no funds could be expended for "the purpose of implementation or in preparation for implementation of the Kyoto Protocol."[159]

If the United States signed the Kyoto Protocol, many industries would potentially be vulnerable to increased costs of production. The formation of umbrella lobbying is a mechanism through which industries can attempt to prevent mandated emission limits. These lobbying organizations are delegated to voice objections of the member industries before Congress and executive branch agencies. The Climate Control Coalition (CCC) is an example of such an organization. It presented the criticism that the Kyoto Protocol's specific emission reductions timetable injected into the Protocol a basic defect. The CCC believed timetables would impose undue costs on industries producing a significant GHG volume.[160] The Cooler Heads Coalition, another United States industry umbrella lobbying organization, voiced a particular concern with the debate over carbon sinks.[161] In general, the administration prefers defining sinks less stringently. In contrast, the European Union (EU) would prefer a climate change regime with greater focus on actual emission reductions and less emphasis on carbon sequestration.[162]

159. *See* Veterans Affairs and HUD Appropriations Act, Pub. L. No. 105-276, 112 Stat. 2461, 2496 (1998) (proscribing EPA from making any effort to "proscribe or issue rules, regulations, decrees or order" designed to implement the Protocol); *see also* H. R. REP. NO. 105-769, at 37 (1998) (preventing funds from being used to implement Kyoto Protocol).

160. *See* Bailey, *supra* note 158, at 113 (citing Eric J. Lyman, *Climate Change: Industry Says Failure of Hague Talks Proves Kyoto Protocol Cannot Work*, INT'L. ENV'T. DAILY, Nov. 29, 2000, at D2) (explaining Global Climate Coalition's criticism of Kyoto Protocol).

161. *See* Kyoto Protocol, *supra* note 19, at art. 3.1, 37 I.L.M. 33. (carbon sink can be understood as any land form (forest, agricultural land or rangeland) able to store, or sequestrate, carbon dioxide). The Protocol, however, only allows carbon stored by forests to count toward reduction obligations. *See id.* The United States delegation at the Conference of the Parties 6 (COP-6) to the UNFCC at the Hague in Fall 2000, which initially took the position that farm land should also be counted toward emission reductions, modified that position during the course of the negotiations, and agreed (for the purposes of the COP-6 negotiations) not to insist on the inclusion of farmland as a category of carbon sink. *See* Bailey, *supra* note 158, at 109-10 (citing Eric J. Lyman, *Climate Change: US Compromises on Kyoto Protocol Fails to Gain Support of EU/Insustry Groups*, INT'L ENV'T. DAILY, Nov. 22, 2000, at D4) (describing position of UNFCC at Hague). In the end, the EU countries in particular, and the United States, could not reach an agreement on several aspects of the carbon sinks issue. *See id.*

162. *See* Bailey, supra note 158, at 110 (characterizing inability to reach agreement as a failure when compared with purpose of COP-6). The Protocol has been adopted, but only in February, 2005, not in the two year time frame originally

C. Uncertainty

Far and away the greater proportion of the scientific community finds the anthropogenic signal unmistakable, and that its "effects can reasonably be predicted and that prudence calls for more action now."[163] It is prudent to take steps to minimize risk of harm even in the face of uncertainty.[164] The United States takes the position that uncertainties surrounding the risk to global climate are such that the Kyoto Protocol's restrictions, like the emission reduction timetables, are unwarranted. The issue might be cast as an argument about risk: (1) how much risk is tolerable; (2) what steps can and should be taken to achieve a "tolerable" risk; and (3) what principles, or rules of thumb, should be adopted to answer what is effectively a public policy question.[165]

Disagreement exists within the scientific community as to the risk created by the government's refusal to strictly adhere to the Kyoto Protocol's climate change regime.[166] This disagreement over climate change has been acknowledged publicly by the United States government. The President noted this small measure of scientific disagreement prior to a June 11, 2001 statement, in which

envisioned. *Id.* But the issue of carbon sequestration's ability to "offset" GHG emissions is a cost issue for the United States; that is, not being able to offset emissions in this way, and thus in order to meet Kyoto emission limitations within the 2008-2012 time frame, having to reduce GHG emissions to meet those limits has been viewed as untenable by two United States administrations. *Id.* A statement by Roger Ballentine, a member of the United States COP-6 delegation during the Clinton administration, is instructive. He stated,"[a]t the end of the day, we will sign a treaty that will be right for the environment, but one that accomplishes that without hurting the economy." *Quoted in* Bailey, *supra* note 158, at 110 (citing Eric J. Lyman, *Climate Change: U.S. Compromises on Kyoto Protocol Fails to Gain Support of EU/Industry Groups*, INT'L ENV'T. DAILY, Nov. 22, 2000, at D4).

163. *See* Revkin, *supra* note 156, at F4 (explaining that effects can be reasonably predicted), *available at* http://query.nytimes.com/gst/fullpage.html?sec=health&res=9A03E7DD1F38F930A35751C1A9649C8B63&n=Top%2FNews%2FScience%2FTopics%2FGlobal%20Warming. One participant in the climate change debate has commented that certain parties "do not want to take action based on early indications, and with climate, early indications is what we have." *Id.*

164. *See* Heidi Feldman, *Prudence, Benevolence, Negligence: Virtue, Ethics and Tort Law* 74 CHI.-KENT L. REV. 1431, 1443 (2000) (citing PHILIPPA FOOT, VIRTUES AND VICES AND OTHER ESSAYS IN MORAL PHILOSOPHY 3 (1978)) (noting how ideas of prudence are incorporated into American principles of negligence law).

165. *See* CICERONE ET AL., *supra* note 66, at 20 (discussing risk in relation to safe levels of greenhouse gases).

166. *See* Grossman, *supra* note 80, at http://www.sciam.com/article.cfm?articleID=00095B0D-C331-1C6E-84A9809EC588EF21 (arguing that humans have little discernible effect on climate change). An interested layperson studying public statements of reputable scientists may become perplexed by this less than unanimous scientific opinion regarding the risks that climate change presents to society. Disagreement in scientific opinion regarding the major issues of the day is not uncommon.

he referenced a National Academy of the Sciences report discussing "uncertainty" in regards to the "effect natural fluctuations in climate may have had on warming."[167] In testimony before Congress, Senator Hagel asserted that "most of this century's global warming occurred in the first half of the century before there was a significant concentration of anthropogenic GHG emissions."[168] Senator Hagel made a second statement in the Senate, included in the Congressional Record, advancing the belief that "research has failed to establish that global warming is a significant problem."[169] These statements illustrate the strong skepticism regarding human contribution to climate change and whether the observed change in climate is more than that which is expected to occur through natural variation.

While there is a measure of dissent, the dissent is quite modest compared to the mainstream belief regarding the significance of climate change and the magnitude of the human contribution to the change. This dissent is at least partly attributable to uncertainty in the results of extremely complex computer models developed to study climate changes. The Environmental Protection Agency (EPA) alluded to this uncertainty. "[V]irtually all published estimates of how climate could change in the United States are the result of computer models. . . . These complicated models. . . are still not accurate enough to provide reliable forecasts on how climate may change."[170]

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167. *See* Press Release, Office of the Press Secretary, President Bush, President Bush Discusses Global Climate Change (June 11, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html (noting President Bush's acknowledgment of scientific disagreement on climate change). *See also* THE DYNAMICS OF EVOLUTION: THE PUNCTUATED EQUILIBRIUM DEBATE IN THE NATURAL SCIENCES AND SOCIAL SCIENCES (Albert Somit and Steven A. Peterson, Eds., 1992) (providing an example of scientific debate regarding an *aspect* of evolution). For an example, see Chapter Five, authored by Antoni Hoffman. The volume illustrates how the theory of evolution, although widely accepted in biology and paleontology, still generates vigorous argument as to its particulars. *See id.*

168. *See* Denee A. Diluigi, *Kyoto's Fatal Flaws: A Springboard for Domestic Greenhouse Gas Regulation*, 32 GOLDEN GATE U.L. REV. 693, 703 (2002) (citing 143 CONG. REC. S10308-01 (daily ed. Oct. 3, 1997)) (quoting Sen. Chuck Hagel of Nebraska). The quoted sentence is from Dr. Patrick Michaels, a University of Virginia Professor of Environmental Science. Senator Hagel has modified his position on climate change in recent years. *See* Next Steps on Climate Change, *available at* http://www.swnebr.net/newspaper/cgi-bin/articles/printversion.pl?157008 (last visited Oct. 24, 2007) (setting forth Senate floor speech introducing three proposed pieces of legislation).

169. *See* Diluigi, *supra* note 168 at 703 (citing 143 CONG. REC. S10308-01) (daily ed. Oct. 3, 1997)) (referring to statement by Professor Lizden at Massachusetts Institute of Technology and stating political support of current policy).

170. *See* U.S. Environmental Protection Agency: Office of the Administrator, *U.S. Climate*, http://www.yosemite.epa.gov/oar/globalwarming.nsf/content/cli-

But at the same time, most of the persons executing the mathematical computer modeling of climate change recognize the shortcomings in their own models. Several scientists, in a recent paper reviewing the extent of scientific understanding of climate change, first point to a certain degree of confidence in the models' predictive capabilities. Despite their simplified form and consequent limitations, the models reproduce seasonal distributions of pressure and temperature well.[171] The authors are, however, forthright in pointing to the imperfections of present climate change modeling by noting that despite progress, imperfections in the models remain:

> Despite these gains there are a number of features of the climate system that are still rather crudely represented in climate models. The coarse [spatial] resolution of these models (typically 3° or roughly 300 km) restricts their ability to accurately represent terrain effects and to simulate processes that occur on smaller scales. Other shortcomings occur in the representation of aerosols, precipitation, and clouds and changes in solar irradiance. For these and other reasons there remain *substantial scientific uncertainties in model predictions,* including uncertainties in the predictions of local effects of climate change, occurrence of extreme weather events, effects of aerosols, changes in clouds, shifts in the intensity and distribution of precipitation, and changes in oceanic circulation.[172]

In the evaluative lexicon the scientific community utilizes, it seems safe to say the role of greenhouse gases in climate change, including anthropogenic GHG emissions, particularly carbon dioxide, is not well understood. If predictive abilities of the models simulating a phenomenon are not fully developed, then we cannot say we adequately understand the phenomenon under investigation. Once our predictive abilities pertaining to the phenomenon at hand are adequate, the extant uncertainties will diminish. The current administration, taking special note of the uncertainties, stated that the science remained too uncertain to pursue "a prema-

matefutureclimateusclimate.html (last visited Nov. 12, 2004) (on file with author) (discussing accuracy of computer models).

171. *See* Tamara S. Ledley et al., *Climate Change and Greenhouse Gases,* 80 EOS, Transactions, American Geophysical Union 39, Sept. 28, 1999, at 463 (discussing accuracy of climate models).

172. *See id.* at 463 (citing Hansen et al., 1998; Houghton et al., 1996; *Nohlman,* 1997) (emphasis added) (explaining shortcomings of model predictions).

ture Kyoto-style agreement."[173] Renowned science writer Andrew C. Revkin states that because of the uncertainties, the current administration has:

> [C]alled for a decade of research before anything beyond voluntary measures is used to stem tailpipe and smokestack emissions of heat-trapping gases that scientists say are contributing to global warming . . . . Administration officials say further research is still necessary because scientists cannot say *exactly* what effects human activity will have on global climate and how dangerous they will be. It is worth taking the time to conduct more analysis at least to clarify the balance of environmental and economic risks, they say.[174]

Most of the scientific community would not disagree with the call for further research to reduce the uncertainty still contained in the climate models. Disagreement does arise, however, with regard to the decision to delay adoption of Kyoto Protocol. The debate surrounded how much further to clarify the uncertainty before further action is taken. It appears that the current administration prefers to have further research establish, with *certainty*, that global warming is a genuine threat to the health of the global community. The administration stated that "[n]o one can say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."[175] The current administration also appears to be seeking a causal link between anthropogenic activity and a *consequent* increase in climate change before making a commitment to proceed with the steps for GHG emission reduction called for by the Protocol. "The current uncertainty surrounding climate change implies that a realistic policy should be a gradual, measured response, not a risky precipitous one."[176] If a causal linkage could

173. *See* Andrew C. Revkin, *U.S. Planning Gradual Curb on Emissions, Taking Years*, N.Y. TIMES, Feb. 6, 2002, at A5 (quoting R. Glenn Hubbard, Chairman of the President's Council of Economic Advisors) (discussing current administration's view of uncertain science).

174. *See* Revkin, note 156, at F1 (emphasis added) (discussing current administration's interest in further research).

175. *See* Press Release, Office of the White House, Remarks by the President on Global Climate Change (June 11, 2001) (stating that exact levels of danger are unknown).

176. *See* White House Council of Economic Advisors, 2002 Economic Report of the President, *available at* http://www.gpoaccess.gov/usbudget/fy03/pdf/2002_erp.pdf (explaining policy should be gradual due to current uncertainty); *see also* Revkin, *supra* note 156, at F5 (discussing policy response to climate change). Interestingly, in May 2002, the Department of State authored the Third National

be established, the uncertainty surrounding climate change could be reduced dramatically.

D. Prudence

A prudent national policy would be one that did not delay taking action to prevent or lessen the likelihood of potential environmental harm, even if a causal link is not established yet. A prudent or precautionary policy would perhaps advise against adopting the administration's posture. Such a prudent approach would advise that steps be undertaken to lessen the activity believed to have some likelihood of actually causing the environmental harm. In the instance of climate change, the activity most associated with the harmful emission of greenhouse gases and enhanced greenhouse effects is the burning of fossil fuels.

Further, analysts have commented that "research on the impacts of different atmospheric GHG concentrations is important, but should not become an excuse to defer short-term action to reduce emissions."[177] This statement does not deny the importance of refining climate models in order to reduce uncertainty in climate science. It suggests that to delay taking steps to reduce emissions, even in the face of the present uncertainty, would risk substantial harm to the global climate system. The UNFCCC explicitly counsels against citing scientific uncertainty as reason to deny or delay an implementation of precautionary or mitigating measures.[178] The UNFCCC and the Kyoto Protocol embody the global community's response to this recognized, but imprecisely gauged, peril. The three basic objectives of an emission limiting treaty in the short to medium term are to, "(i) create strong incentives to start to reduce GHG emissions, (ii) provide a cost-effective framework for international cooperation, and (iii) maintain options and flexibility

Communication describing steps taken by the United States to meet the goals outlined in the treaty. The report states that "[g]reenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and sub-surface ocean temperatures to rise . . . . Human-induced warming and associated sea level rises are expected to continue through the Twenty-first century." CICERONE ET AL., *supra* note 66, at 1. There are indications that the current administration was not entirely satisfied with all of the Report's content. This dissatisfaction produces some irony in that the Report appears to provide the kind of statement the administration has been seeking, yet part of the science which the Report relies upon is disputed by the administration. *See* Andrew C. Revkin, *U.S. Sees Problems in Climate Change*, N.Y. TIMES, June 3, 2002, at A11.

177. *See* David B. Sandalow & Ian A. Bowles, *Fundamentals of Treaty-Making on Climate Change*, 292 SCI. 1839 (2001) (discussing GHG concentrations).

178. *See* UNFCCC, *supra* note 1, art. III(3), at 854 (1992) (noting desire for precautionary/mitigating measures).

as an international regime is built over the coming years and decades."[179]

A "gradual, measured response"[180] and a "short-term action to reduce emissions"[181] represent opposing viewpoints on the role of human activity in climate change. These varying perspectives produce different levels of certainty sufficient to provoke a commitment by the United States to accept the Kyoto Protocol prescription. The Kyoto Protocol calls for reduced GHG levels seven percent below that of 1990 levels, achieved within the 2008-2012 time frame.[182] Broad-based scientific organizations have made efforts to provide the background against which the divergent views within the scientific community may be viewed. The issue of feedbacks described above[183] concerns climate system sensitivity to a particular forcing, i.e., "global mean temperature change that would be expected after a time sufficiently long for both the atmosphere and ocean to come to equilibrium with the change in climate forcing."[184] The Committee on the Science of Climate Change of the United States NRC believed the feedback issue should be given a high priority for future research because the feedback mechanism contains such a large measure of uncertainty.[185] The American Geophysical Union (AGU) has described the problem in the following manner:

> [u]nderstanding climate response to a specified forcing is one of the major challenges facing the climate research community. The equilibrium response of the nonlinear climate system depends in complex ways on various feedbacks, such as changes in water vapor concentrations and cloudiness that can augment or diminish climate response from that which would occur in the absence of such feedbacks. In principle, empirical inferences of climate sensitivity would be of great value, but development of such inferences is confounded by the natural variability of the

179. *See* Sandalow & Bowles, *supra* note 177, at 1839 (stating treaty response objectives).

180. *See id.* (noting challenges to treaty-making on climate change).

181. *See id.* (noting United States government's reaction to climate change).

182. *See* Kyoto Protocol, *supra* note 19, Annex B, 37 I.L.M. 22 (discussing some goals of Kyoto Protocol).

183. *See* Houghton et al., *The Climate Stystem: An Overview, in* WORKING GROUP I, *supra* note 2, at 93 (noting impact of climate feedbacks).

184. *See* CICERONE ET AL., *supra* note 66, at 1 n.2 (explaining global temperature change would be long enough for atmosphere and ocean to come to equilibrium).

185. *See id.* at 31 (stating research priority).

> climate system, by local or regional effects that can be different from the global effects, and by the simultaneous workings of multiple transient forcings and responses. For these reasons a principal means for understanding climate system response to forcing is by use of computer models of the Earth's climate system.[186]

But what the AGU sees as a valid method of reducing climate change uncertainty, the administration views as a weakness in the science of climate change. In the administration's view, the computer models developed thus far "are still not accurate enough to provide reliable forecasts on how climate may change."[187] The United States administration's critique of current climate change science is exacting indeed. Not only are there vexing uncertainties attached to climate change science, but the principal mechanism which climate scientists developed to reduce these uncertainties with computer modeling is severely inadequate.

The AGU's position statement on climate change acknowledged the present uncertainties in climate change science but suggested the global community will likely have to learn to live with these uncertainties. Specifically, the AGU states:

> In view of the complexity of the earth climate system, uncertainty in its description and in the prediction of changes will never be completely eliminated . . . . It is important that public debate take into account the extent of scientific knowledge and the uncertainties. Science cannot be the sole source of guidance on how society should respond to climate issues. Nonetheless, scientific understanding based on peer-reviewed research must be central to informed decision-making.[188]

In a summary to the article forming the background from which the AGU position statement was drawn, the authors presented their understanding of the climate change question from a geologic viewpoint.[189] An excerpt from that summary states:

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186. *See* Ledley et al., *supra* note 171, at 4 (stating AGU's description of problem).

187. *See* EPA, *supra* note 170 (explaining government's view on computer models).

188. *See* Ledley et al., *supra* note 171, at 453 (stating AGU's position on climate change).

189. *See id.* at 12 (presenting information on response of climate system, over extended period, to increases in greenhouse gases).

> Global mean temperatures have increased between 0.3° and 0.6° during the last 150 years. This change has not been monotonic, but it is unusual in the context of the last few centuries. On the timescale of the last few thousand years there [has] been larger climatic variation during times when variations in CO_2 have been relatively low. It is clear that atmospheric CO_2 is not the only influence on global climate. However, there have been large natural variations of CO_2 in the geologic past, and these changes are correlated with general features of climate change. *There is no known geologic precedent for large increases of atmospheric CO_2 without simultaneous changes in other components of the carbon cycle and climate system.*[190]

This is not scientific hyperbole or alarmist reaction to inconclusive data. It is, instead, a notice to members of the policy-making community alerting them to potential changes in climate brought about by increasing concentrations of GHGs. The AGU notes "[t]hese changes are predicted to include increases in global mean surface temperatures, increases in global mean rates of precipitation and evaporation, rising sea levels, and changes in the biosphere."[191] GHG concentrations will increase in this century because of a presumption that without policy prescriptions at the national and global levels, "the rapidity and uneven geographic distribution of these changes could be very disruptive."[192] The AGU "believes that the present level of scientific uncertainty does not justify inaction in the mitigation of human induced climate change and/or the adaptation to it."[193]

E. Key Findings

Recently uncovered evidence from the Arctic region seems to support AGU's predictions that increases in the global mean surface temperatures, increases in precipitation, and rising sea levels may result as a consequence of increasing concentrations of

190. *See id.* (emphasis added) (summarizing background of AGU position).

191. *See* FYI, Text of AGU Position Statement on Climate Change, American Institute of Physics, (Jan. 29, 1999) http://www.aip.org/fyi/1999/fyi99.012.htm (explaining specific inclusions of predicted changes).

192. *See id.* (discussing problems associated with GHG concentration increases).

193. *See id.* (discussing AGU's recommendations). The term "mitigation" may imply the restraint on the imposition of limits and the reduction of GHG emissions. There may be differing interpretations.

GHGs.[194] The Arctic Council[195] and the International Arctic Science Committee[196] conducted a study evaluating the impact of climate change on the Arctic region over a four-year period, releasing the results in Fall 2004.[197] The Overview Report portion of the assessment integrated the results of the Scientific Report into a set of ten "Key Findings."[198] The heading introducing the key findings offers what is, as Dr. Corell comments,[199] in effect a succinct summary of the ACIA findings:

194. *See* Ledley, *supra* note 171, at 463 (discussing climate changes from increased greenhouse gases).

195. *See ACIA, Arctic Climate Impact Assessment – Scientific Report*, iii (2005), http://www.acia.uaf.edu/PDFs/ACIA_Science_Chapters_Final/ACIA_Preface_Final.pdf (last visited Oct. 24, 2007) (discussing effects in increase of GHGs). The Arctic Council is an intergovernmental organization "that provides a mechanism to address the common concerns and challenges faced by arctic people and governments." *See id.* The Council "is comprised of the eight Arctic nations (Canada, Denmark/Greenland/Faroe Islands, Finland, Iceland, Norway, Russia, Sweden and the United States of America), six Indigenous Peoples organizations (Permanent Participants: Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Conference, Russian Association of Indigenous Peoples of the North, and Saami Council) . . . ." *See id.*

196. *See id.* at iii. (describing commissioning of ACIA). The International Arctic Science Committee (IASC) is an NGO (composed of the national science organization of eighteen countries, including the United States) which works toward gaining cooperation between scientific organizations conducting Arctic research. The IASC works closely with the Arctic Council. *See id.* (describing International Arctic Science Committee).

197. *See* Dr. Robert W. Corell, Statement before the U.S. Senate, Committee on Commerce, Science and Transportation (Nov. 16, 2004), http://www.acia.uaf.edu/PDFs/Testimony.pdf (last visited Oct. 24, 2007) (stating purpose of study). Dr. Corell is Chair of the Arctic Climate Impact Assessment (ACIA). The assessment is divided into two parts: one part is a Scientific Report of more than 1,200 pages that is "fully referenced, and is composed of detailed scientific and technical information describing current understanding of climate change, climate variability, and increased UV radiation and their consequences over the entire Arctic region." *Id.* The second part of the study is an Overview Report written in plain language summarizing the science underpinning the assessment, and it attempts to "synthesize the key findings of the assessment and place those insights in a policy-makers framework. It states our collective consensus of understanding and knowledge concerning the consequences of climate change over the entire Arctic region." *Id.*

198. *See id.* at 4 (describing key findings). These ten key findings are: (1) Arctic climate is now warming rapidly and much larger changes are projected; (2) Arctic warming and its consequences have worldwide implications; (3) Arctic vegetation zones are very likely to shift, causing wide-ranging impacts; (4) animal species' diversity, ranges, and distribution will change; (5) many coastal communities and facilities face increasing exposure to storms; (6) reduced sea ice is very likely to increase marine transport and access to resources; (7) thawing ground will disrupt transportation, buildings, and other infrastructure; (8) indigenous communities are facing major economic and cultural impacts; (9) elevated ultraviolet radiation levels will affect people, plants and animals; and (10) multiple influences interact to cause impacts to people and ecosystems. *See id.*

199. *See id.* (stating purpose of key findings).

> The Arctic is now experiencing some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social, and economic changes, many of which have already begun. Changes in [A]rctic climate will also affect the rest of the world through increased warming and rising sea levels.[200]

The following discussion will only draw from the ACIA's findings pertaining to this question, found in the discussion of the first key finding. One relationship in the discussion is a similarity between observation and prediction in the temperature trend lines for the Arctic region. This similarity may not exhibit a one-to-one correlation, but it is discernible. The ACIA "drew upon results of five climate models from leading climate research centers and one moderate emissions scenario. . . to be the primary basis for its assessment of the impacts of future climate conditions."[201]

The ACIA projected five GCMs opposing what they contended were moderate emissions scenarios in terms of the level of future GHG emissions. The different GCMs make different assumptions regarding the range of possible responses to increasing GHG concentrations (e.g., the loss rate of polar ice sheets, which can change ocean salinity and surface density, and can consequently change ocean depth or direction by particular ocean currents).[202] The results were described in the following manner:

> Regardless of the emissions scenario or computer model selected, every model simulation projects significant

200. *See id.* at 3 (quoting report introduction).

201. *See id.* (describing basis for future conditions). An emissions scenario includes an estimate of how societies are likely to evolve, including factors such as population growth, technological change and economic growth. Integrating these and other factors into the calculation, an estimate is made of the level of emissions global society will likely emit. The ACIA notes that climate models represent "aspects of the climate system (such as how clouds and ice cover might be expected to change, and ultimately how climate and sea level might be influenced) somewhat differently [different assumptions], resulting in differences in the degree of warming projected." *Id.* The models (GCMs) attempt to show how the climate system will likely respond to the increasing emission of GHGs predicted by the emission scenarios, i.e., what will be the "climate sensitivity" to those emissions. *See id.*

202. *See* WORKING GROUP I, *supra* note 2, at 50 (noting range of possibilities).

> Reduction of sea ice gives a positive feedback on climate warming at high latitudes. Furthermore, because sea ice contains less salt than seawater, when sea ice is formed the salt content (salinity) and density of the surface layer of the ocean is increased. This promotes an exchange of water with deeper layers of the ocean, affecting ocean circulation.

Id.

> global warming over the next 100 years. Even using the lowest emissions scenario, and the model that generates the least warming in response to changes in atmospheric composition, leads to a projection that the earth will warm more than twice as much in this century as it warmed over the past century. Model simulations further indicate that the warming in the Arctic will be substantially greater than the global average (in some regions, more than double).[203]

The five GCMs utilized by the ACIA under a middle range emissions scenario project temperature change over roughly the next century. After averaging the change calculated by the five models, the ACIA reported that:

> By the latter part of this century, annual average temperatures are projected to rise across the entire Arctic, with increases of roughly 3-5 degrees Centigrade over the land areas and up to 7 degrees Centigrade over the oceans. Winter temperatures are projected to rise significantly more, with increases of 4-7 degrees Centigrade over the oceans.[204]

These projections are commensurate with recently gathered observational data from the Arctic region. This data observes the following:

> Records of increasing temperatures, melting glaciers, reductions in extent and thickness of sea ice, thawing permafrost, and rising sea level all provide strong evidence of recent warming in the Arctic. There are regional variations due to atmospheric winds and ocean currents, with some areas showing [more] warming than others and a few areas even showing a slight cooling; but for the Arctic as a whole, there is a clear warming trend. There are also patterns within this overall trend; for example, in most places, temperatures in winter are rising more rapidly than in summer.[205]

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203. *See* ACIA, *supra* note 195, at 27 (describing results).

204. *See id.* at 28 (quoting ACIA report).

205. *See id.* at 22 (describing patterns and trends). Recent work on the Arctic, particularly on what is known as the "ice-albedo feedback" effect, seems to support the notion that a discernible receding of the Arctic ice cap is occurring due to climate change (it seems unlikely that the rate of loss in sea ice in the Arctic is due to natural variation), at least a portion of which may be due to anthropogenic activity. *See* Gabrielle Walker, *Climate Change: The Tipping Point of the IceBerg*, 441

The findings by the ACIA for the Arctic region provide support for some of the IPCC's results at the global level in 2001:

> *There is a wide range of evidence of qualitative consistencies between observed climate changes and model responses to anthropogenic forcing.* Models and observations show increasing global temperatures, increasing land-ocean contrast, diminishing sea-ice extent, glacial retreat, and increases in precipitation at high latitudes in the Northern Hemisphere. Some qualitative inconsistencies remain, including the fact that models predict a faster rate of warming in the mid-to upper troposphere than is observed in either satellite or radiosonde tropospheric records.[206]

The ACIA's reported work and, at least partial substantiation of findings by the IPCC's Third Assessment prompted Dr. Robert Corell, the ACIA's Chair, to remark:

> The major message is that climate change is here and now in the Arctic. The scientific evidence of the last 25 to 30 years is very dramatic and substantial. The projections of future change indicate that this trend will continue and be substantially greater than the trends we're seeing on a global scale.[207]

Thus, there are rapidly approaching consequences of Arctic region climate change.

NATURE 802 (2006) (discussing effect of melting of Arctic sea ice). Apparently the annual reduction in Arctic sea ice caused by solar radiation in the summer has been excessive in recent decades. This change from past patterns results in more open water in the Arctic region.

> Open water reflects much less sunlight than ice – in what it is known as lower albedo – so the greater the area of dark open water, the more summer warmth the ocean stores. More stored heat means thinner light ice in the next winter, which is more vulnerable to melting the next summer – meaning yet more warmth being stored in the open water in the following year . . . .

Id. at 802. There could be multiple impacts due to a substantial loss of sea ice, including a change in high-altitude wind patterns (including jet streams), deterioration of the Greenland ice sheet and most importantly, a shift in the thermohaline circulation. Thermohaline circulation is an ocean current which transports heat between different regions of the oceans, due to a "freshening" (diluted salinity) of the circulation. *See id.* For a discussion of thermohaline circulation, *see infra* notes 374-75 and accompanying text.

206. *See* WORKING GROUP I, *supra* note 2, at 57 (emphasis added) (quoting IPCC report supporting findings of ACIA report).

207. *See* Andrew C. Revkin, *Study Finds Warming Trend in Arctic Linked to Emissions*, N.Y. TIMES, Oct. 29, 2004, at A3 (quoting ACIA chair).

F. Mitigation

The AGU contends a cautionary posture by the global community toward future possible climate change is advisable.[208] The UNFCCC appears to have incorporated a precautionary "approach":[209]

> 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, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.[210]

In this quote from the UNFCCC, the term "mitigation" refers not to the causes of climate change, in the sense the AGU appears to utilize the term, but to the consequences of climate change. Although it is conceded that scientific uncertainty is not an appropriate reason for postponing steps to prevent or minimize the causes of climate change, this directive is qualified by the statement that such steps should be "cost-effective."[211] The present administration included, as a major component of its climate change strategy, a plan for the adaptation to and mitigation of the potential adverse *effects* of a change in the global climate, with greater emphasis on adaptation.[212]

This administration is fully justified in seizing upon the language in Article 3 of the Kyoto Protocol when shaping a national response to climate change. Article 3 calls for signatories to "prevent or minimize the causes of climate change and mitigate its ad-

208. *See* AGU, HUMAN IMPACTS ON CLIMATE (2003), http://www.agu.org/sci_soc/policy/climate_change_position.html (outlining extent of changes which climate change may cause and recommending adoption of strategies including emissions reduction).

209. *See id.* (calling for mitigation of adverse effects of climate change).

210. *See* UNFCCC, *supra* note 1, art. III(3) (emphasis added) (incorporating precautionary approach).

211. *See id.* (emphasizing that measures responding to climate should have lowest possible cost).

212. *See* Janet Gamble & Caitlin Simpson, *Chapter 9: Human Contributions and Response to Environmental Change, Climate Change Science Program, in* CH. 9 STRATEGIC PLAN FOR THE U.S. CLIMATE CHANGE SCIENCE PROGRAM AT 94-100 (2003), http://www.climatescience.gov/Library/stratplan2003/final/ccspstratplan2003-chap9.pdf (last visited Oct. 1, 2007) [FINAL STRATEGIC PLAN] (noting disposition of present administration towards adaptation over mitigation).

verse affects."[213] Additional language in the UNFCCC, specifically Article 4 language, calls for developed countries and all Annex 1 countries generally to "adopt national policies and take corresponding measures on the mitigation of climate change, by *limiting its anthropogenic emissions of greenhouse gases* and protecting and enhancing its greenhouse gas sinks and reservoirs."[214] In its exploitation of the UNFCCC's Article 3 language, the administration mistakenly emphasized mitigation. The administration emphasized minimizing adverse consequences, but it should have emphasized emission reduction or limitation.

Both the AGU and the IPCC would support an effort to adapt to the effects of climate change, but only as part of an overall strategy placing the highest priority on prescribed emission limits and reduction. Many of those who have deliberated on the climate change issue understand the term mitigation to mean something other than just limiting impact. Because it will take many years to alter the warming process, any action to reduce emissions will:

> [R]equire two sets of actions: one, *called mitigation, to slow the speed and amount of future climate change by reducing greenhouse gas emissions*; and the other, called adaptation, to attempt to limit adverse impacts by becoming more resilient to the climate changes that will occur while society pursues the first set of actions.[215]

The AGU and ACIA contend that to arrange policy priorities otherwise would place the global environment at risk.[216] To some observers, this is precisely what the current administration did by opting out of the Kyoto Protocol's prescribed emission limits and placing a high priority on societies' adaptation and the mitigation of climate change *effects*.

The current administration argues that the hierarchy it has structured, with varied emphasis placed on different aspects of the climate change question, is the best policy for the United States. It is important to consider how national governments can come to grips with public policy decisions as difficult as climate change.

213. *See* UNFCCC, *supra* note 1, art. III(3) at 854 (emphasis added) (advocating precautionary measures).

214. *See id.* art. IV(2)(a) (emphasis added) (stating Article 4 restrictions).

215. *See* Susan Joy Hassol, *Arctic Climate Impact Assessment in* IMPACTS OF A WARMING ARCTIC 8-9 (Cambridge University Press 2004) (emphasis added) (discussing global climate changes).

216. *See* AGU, HUMAN IMPACTS ON CLIMATE, *supra* note 208 (emphasizing importance of adaptation); ACIA, *supra* note 195 (stressing need to reduce emissions).

These decisions are particularly difficult because they are immersed in uncertainty. The policy choices of the current administration seem to be rooted in the language of the UNFCCC that calls for mitigation of the adverse effects of climate change. The United States Climate Change Science Program (CCSP) identified the mitigation of, and adaptation to, climate change as a critical research need: "[The] assessment of the full costs and benefits (including productivity impacts) of environmental policy and technology choices (mitigation and adaptation). . . effect human well-being at different scales, including the individual or household level."[217] The current administration's policy statements indicate that the administration intends the "environmental policy and technology choices" to apply to the adverse *effects* of climate change.

On a global scale, considerable gaps exist in understanding, modeling and quantifying the sensitivity and vulnerability of human systems to global change and measuring the capacity of human systems to adapt. For instance, little is known about the effectiveness of applying adaptation experience with past and current climate variability and extreme events to the realm of climate change adaptation; nor is much known about how this information could be used to improve estimates of the feasibility, effectiveness, costs, and benefits of adaptation to long term change.[218] Most climate scientists believe work on adaptation to climate change is necessary, but they also believe it should not be performed at the expense of work on reducing projected future emissions. Because GHGs have long residence times in the atmosphere, there will be varying, but significant, impacts on different societies in future decades affecting the well-being of future generations. Thus, gaining an understanding of climate fluctuations is an important milestone along the path towards sustainability.[219]

G. Negotiations

It is difficult to fault the current administration for heavily emphasizing adaptation, and for what the administration terms a "mitigation of impacts" strategy. But commentators note how critical it

217. *See* UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, *supra* note 65, at 95 (stating importance CCSP places on climate change as critical research need).

218. *See id.* at 90 (discussing some problems regarding current climate variability).

219. *See* Shardul Agrawala & Mark A. Cane, *Sustainability: Lessons from Climate Variability and Climate Change*, 27 COLUM. J. ENVTL. L. 309, 310 (2002) (discussing impacts of climate fluctuations on people's sustainability).

is for the administration to make use of an entire range of options in responding to climate change:

> [A]ttention needs to be paid to the associated costs and benefits of adaptation strategies, strategies for mitigating the impacts of global change on different economic sectors and people in different locations and economic brackets, market and non-market valuations of positive and negative impacts, the possibility of new economic instruments for responding to global change, and the role of public and private institutions and public policies in influencing adaptive capacity.[220]

The current administration's climate change research agenda includes the intent to study the effects of mitigation steps regarding emissions limitations or reductions in the more common usage of the term. The administration's preferred term, instead, appears to be "emission targets." In its CCSP[221] the administration recently identified a key research need to pursue the:

> Development of the capability to study the economic and trade effects of various mitigation options that differ in complex ways, both within and among countries, including broad policy approaches (e.g., *emission targets*, technology subsidies, voluntary national goals) and means of implementation (e.g., voluntary programs, incentives, taxes, cap and trade systems and quantity constraints).[222]

A clear research objective of CCSP is to study the economic impacts of efforts to reach certain emission targets. The efforts would be voluntary, with added reliance on incentives. Depending on the size of incentives and how vigorously the voluntary efforts are promoted, positive results could be realized. The research leading to the implementation of such a mitigation program, however, is not necessarily focused on reduction or limitation. The chapter

220. *See* Gamble & Simpson, *supra* note 212, at 96 (discussing costs and benefits of adaptation strategies). Interestingly, in this passage the authors cite to the IPCC, perhaps in an effort to show there is a measure of compatibility between the IPCC's recommendations for responses to climate change, and the future policy choices of the United States administration. *See id.*

221. For a discussion of the history of the CCSP, *see supra* note 65 and accompanying text; *see also* NRC, REVIEW OF DRAFT STRATEGIC PLAN 1, *supra* note 75 and accompanying text (describing research goals).

222. *See* Gamble & Simpson, *supra* note 212, at 95 (emphasis added) (discussing key research plans).

covering "human contributions and responses to environmental change" poses two key questions:

> What can be projected about the effectiveness, cost, and environmental and health effects of alternative energy and mitigation technologies, including sequestration options? How can this research contribute to efforts to develop mitigation technology options by, for example, placing values on such items as temporary carbon storage and the availability of limited resources such as land and water?[223]

Carbon sequestration occurs when oceans or various activities[224] store, remove, or absorb carbon dioxide existing in reservoirs[225] or sinks.[226] The UNFCCC integrates sequestration in its precautionary measures. When forming national policies, precautionary measures "should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors."[227] The Kyoto Protocol attempts to strike a balance between technically achievable and economically manageable ways to reduce anthropogenic emissions on one hand and possible increases in CO_2 absorption by terrestrial systems on the other. Regarding the increases in CO_2 absorption, the objective is to reduce GHG concentrations in the atmosphere.[228]

In attempting to achieve this aim, at COP1 in Berlin in 1995, the parties stipulated a policy that formed part of the Berlin Mandate.[229] The policy stated that the soon to be negotiated Protocol

223. *See id.* at 94 (stating questions for technological change).

224. *See* ROBERT T. WATSON ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC SPECIAL REPORT ON LAND USE, LAND USE CHANGE AND FORESTRY 6 (2000), http://www.ipcc.ch/pub/srlulucf-e.pdf (last visited Oct 1, 2007) [Watson et al., LAND USE] (describing land use, land use change, and forestry).

225. *See* UNFCCC, *supra* note 1, at art. I(7) (defining term reservoir). A reservoir is a "component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored." *Id.*

226. *See id.* (defining term sink). A sink is "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere." *Id.*

227. *See id.* at art. III (stating principles for Article III).

228. *See* Schulze et al., *supra* note 21, at 506 (discussing specific and broad goals of Kyoto Protocol to UNFCCC).

229. *See* Paul G. Harris, *Common But Differentiated Responsibility: The Kyoto Protocol and United States Policy*, 7 N.Y.U. ENVTL. L.J. 27, 32-33 (1999) [KYOTO AND U.S. POLICY] (citing Report of Conference of Parties on its First Session [Conference of the Parties I]). The main thrust of the Berlin Mandate was concerned with the "common but differentiated responsibilities" principle (CBDR). *Id.* "The CBDR principle was reaffirmed in 1995 at the first conference of the FCCC parties in Berlin. Countries agreed to the 'Berlin Mandate,' whereby developed countries

to the UNFCCC would cover "anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol."[230] The Kyoto Protocol mandated that:

> The net changes in greenhouse gas emissions by sources and removals from sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period shall be used to meet the commitments in this Article of each Party included in Annex I. The green-

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pledged to act first to reduce their GHG emissions before requiring developing countries to do so." *Id.* at 32-33 (citing Conference of the Parties I), *see* U.N. Framework Convention on Climate Change Conference of the Parties, 1st Sess., at 1, U.N. Doc. FCCC/CP/1995/7/Add.1 (1995), *available at* http://unfccc.int/resource/docs/cop1/07a01.pdf. "The Berlin Mandate declares that the process of implementing the Climate Convention shall be guided, inter alia, by the CDBR principle." *See* Harris, KYOTO AND U.S. POLICY at 33 (citing Conference of the Parties I, art. 1(1)(a), at 4).

> It reminds parties that they are required to consider the special needs of the developing countries and that the largest share of historical and current global emissions of greenhouse gases had originated in developed countries, that the per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs.

Id. (quoting Conference of the Parties I, art. I(1)(d), at 5) (internal citations and quotations omitted). "It goes on to state: 'The global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions.'" *Id.* (quoting Conference of the Parties I, art. I(1)(e), at 5).

230. *See* United Nations Framework Convention on Climate Change Conference of the Parties, MARCH 28 – APRIL 7, 1995, FIRST SESSION HELD AT BERLIN, 5, FCCC/CP/1995/7/Add.1 (June 6, 1995), *available at* http://unfccc.int/resource/docs/cop1/07a01.pdf. *See also* United Nations Framework Convention on Climate Change Ad Hoc Group On the Berlin Mandate, OCTOBER 30 – NOVEMBER 3, 1995, SECOND SESSION HELD AT GENEVA, ¶ 17-46, at 7-11, FCCC/AGBM/1995/7 (Nov. 21, 1995), *available at* http://unfccc.int/resource/docs/1995/agbm/07.pdf (noting discussions held at meeting on possible policies which could be implemented to advance goals of Berlin Mandate); *see also* Alexander Gillespie, *Sinks and the Climate Change Regime: The State of Play*, 13 DUKE ENVTL. L. & POL'Y F. 279 (2003) (discussing objectives set by Berlin Mandate); Jennifer L. Morgan, *Global Climate*, 6 Y.B. INT'L. ENVTL. L. 223, 229 (1995) (explaining Berlin Mandate). Afforestation can be defined as the laying down of tree plantations that occurs on land that has not been forested for at least 50 years. *See also* Watson, et al., *supra* note 224, at 6 (defining afforestation and deforestation). Reforestation is a conversion of non-forested land into forested land through human activity, but the land in question has not been through a 50-year span in which it was not forested. *See id.* But in practical terms reforestation means the planting of new tress immediately after a disturbance or harvesting, and where no land use change has occurred. *See id.* In general terms, deforestation is the clearance of forests from land with no intention of reforestation, i.e., to put the land in question to different use. *See id.*

> house gas emissions from sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner and reviewed in accordance with Articles 7 and 8.[231]

The Protocol's language, however, was sufficiently ambiguous to produce major disputes over its interpretation and application, particularly in the COP negotiations. Although the basic idea behind the Kyoto Protocol was to promote greater natural carbon sequestration then pre-1990 levels, the Protocol's ambiguous wording created major discrepancies in interpretation.[232]

Divergent views on the appropriate method of carbon accounting began with the negotiation of the Protocol itself. The United States urged the inclusion of GHG reduction through the use of sinks and "actual emission limitations in measuring attainment of its overall commitment."[233] Most other countries in the negotiations opposed using sinks and reservoirs and prevailed on this position.[234] Although the power to use sinks is limited to "afforestation, reforestation, and deforestation,"[235] due to the lack of research in that area, the Protocol allows a degree of creativity in defining sinks and their use. Countries may use carbon sinks to offset emissions by "planting new forests (afforestation and reforestation) instead of practicing deforestation . . . , or by applying *new* management approaches . . . ."[236] The IPCC notes that modifications in management are included in the Protocol. It states, "[f]or those activities where only narrowly defined management changes under Art. 3.4 are involved (e.g., conservation tillage) and the land use remains

231. *See* Kyoto Protocol, *supra* note 17, art. III(3) (discussing monitoring of net changes in GHG emissions caused by certain sources and removal).

232. *See* Schulze et al., *supra* note 21, at 509 (stating basic idea of Kyoto Protocol and discrepancies caused by wording of Protocol).

233. *See* Perry E. Wallace, *Global Climate Change and the Challenge to Modern American Corporate Governance*, 55 SMU L. REV. 493, 506 (2002) (describing United States commitment to reduction of GHGs through sinks and actual emission limitations).

234. *See* Schroder, *supra* note 151, at 82 (noting how most developing countries were opposed to unearned credits for naturally occurring absorption).

235. *See id.* (quoting Kyoto Protocol art. III(3)); *see* Kyoto Protocol, *supra* note 17, art. III(3) (discussing limits of sink use).

236. *See* Schulze et al., *supra* note 21, at 507 (discussing alternatives of using carbon sinks to offset emissions). *See also* Kyoto Protocol, *supra* note 17, art. 3(4), at 3 (encouraging establishment of rules and guidelines to outline role of sinks in Protocol).

the same, it may be feasible to partially factor out natural variability and indirect effects."[237]

After the Protocol was finalized in 1997 at COP3, debate over sinks continued among different groups of countries. By the time of COP6 in 2000, which was held in two parts, there were at least six identifiable discrete groups of states engaged in the debate.[238] The two most important groups were the Umbrella group and the European Union (EU) group. Both groups were important because their members were all Annex I states that held the largest responsibility under the Protocol to reduce GHG emissions in the first commitment period (2008-2012).[239] These two groups had opposing views on the appropriate method of carbon accounting. The Umbrella group's position was:

> [B]iological sinks should be credited to balance fossil fuel emissions . . . . [L]and management is an important tool to produce or enhance sinks. [Also,] a national full carbon balance (full carbon accounting) should be used as [a] basis for negotiations, because virtually all land in industrialized nations is in fact being managed; even national parks [which] are [being] set aside by human actions. The [United States] delegation made clear in the general assembly that they would use statistical sampling and models in order to integrate the biological sinks of North America and determine from this the C storage of the nation.[240]

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237. *See* Watson et al., *supra* note 224, at 11 (discussing possibility of factoring out natural variability and indirect effects).

238. *See* Schulze et al., *supra* note 21, at 509 (stating existence of six identifiable groups of states).

> In negotiating a complicated issue among more than 100 nations it is inevitable that the partners will form groups to more effectively articulate their demands and requests. The main groups in the Kyoto negotiations were: (1) the Umbrella group consisting of the USA, Canada, Japan, Australia, Norway, New Zealand, and the Russian Federation; (2) the EU group, comprising its 15 member states; (3) the G77 with China, which contains the developing countries, including Saudi Arabia; (4) AOSIS, the Association of Small Island States, which run the risk of being drowned by sea level rise; (5) G11, i.e., the European countries with transition economies, and (6) the Environmental Integrity Group, led by Switzerland.

Id.

239. *See id.* at 506 (explaining industrial prominence and higher emission standards for Annex 1 states under protocol).

240. *See id.* at 509 (describing position of Umbrella Group on bio-sinks and United States delegation's insistence on using statistical sampling models with bio-sinks).

The position of the EU group differed greatly from that of the Umbrella group: "The EU [group] wished to restrict the accountability of sinks, and to encourage technological changes that reduce fossil fuel emission (increased efficiency of energy use, and of alternative energies sources) [and] [t]he only area proposed to allow accounting of biological sinks was afforestation and reforestation. . . ."[241] The carbon accounting issue serves as a useful illustration of the admistration's decision to rely on policy when responding to climate change. The United States defines mitigation as an action taken to reduce adverse effects of GHG emissions instead of as a measure taken to reduce fossil fuel emissions.

At the COP6 2000 Hague meeting, the United States declared its strong support for full carbon accounting and its opposition to any restrictions on that method.

> However, due to scientific uncertainty in calculation of carbon sequestration by sinks, the EU rejected the United States position and demanded limits on how much forest sequestration could be claimed toward meeting Kyoto obligations. Although the two factions neared agreement in this area (with the United States offering to reduce its sink claim from 312 to 20 million tons), an accord proved too elusive and the talks collapsed.[242]

The talks were unsuccessful because of technical concerns. One concern surrounded the debate of the term *forest management.* "Normal forest management is excluded from the Kyoto Protocol, although [normal forest management] is by no means always carbon-neutral [and] can result in additional sinks or sources for CO_2."[243] Although the Protocol itself, in Article 3(3), speaks only to "human-induced land use change and forestry" as eligible for inclusion as sinks, the relevant terms became "land use, land use change, and forestry" (LULUCF).[244] This change occurred partly because of the recognition that forest management need not include a change in the purpose for which the forest is used. Simple land use, therefore, should be explicitly incorporated in deliberations

241. *See id.* (contrasting view of EU group with Umbrella Group).

242. *See* Gillespie, *supra* note 22, at 289 (citing Sarah Simpson, *Debit or Credit?*, SCI. AM., Feb. 2001, at 25; *Hotting Up in the Hague,* ECONOMIST, Nov. 18, 2000, at 97) (describing factors contributing to failure of talks at 2000 Hague meeting).

243. *See* Schulze et al., *supra* note 21, at 509 (discussing possibility of additional sinks and CO_2 sources due to forest management).

244. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, LAND USE, LAND USE CHANGE, AND FORESTRY at 61 (Robert Watson eds. 2000) (explaining current terminology stemming from Article 3(3) of the Kyoto Protocol).

leading to a decision on the proposed acreage's eligibility as a sink. Land use is the "total of arrangements, activities, and inputs that people undertake in a certain land cover type," with land cover being the "observed physical and biological cover of the earth's land, as vegetation or man-made features."[245]

The issue, at least in part, centered on whether certain types of land use could be legitimately placed in the category of *forest management.* A forest is typically defined as "[a]n area managed for the production of timber and other forest products or maintained as woody vegetation for such indirect benefits as protection of catchment areas or recreation."[246] During the COP6 Hague Meeting, the EU's initial position was that the inclusion of sinks in a carbon accounting system should be limited to forests because the aim was to "restrict the accountability of sinks, and to encourage technological changes that reduce fossil fuel emission (increased efficiency of energy use, and of alternative energies sources)."[247] The EU proposed to allow accounting of biological sinks only for "afforestation and reforestation."[248] This position was consistent with the Protocol's language discussing net changes in GHG emissions by sources and removals by sinks. The Protocol specified that commitments must be met by "direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990."[249] The Protocol provides that in the future COPs may consider "removals in the agricultural soils" and possible modification of LULUCF categories.[250]

During the course of the two sessions of COP6, the Parties considered certain "additional activities" under the Protocol's Article 3(4).[251] Activities in addition to afforestation, reforestation and de-

245. *See id.* at 61 (citing UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION (FAO), STATE OF WORLD'S FORESTS (1997); FOOD AND AGRICULTURE ORGANIZATION/UNITED NATIONS ENVIRONMENT PROGRAM (FAO/UNEP); TERMINOLOGY FOR INTEGRATED RESOURCES PLANNING AND MANAGEMENT (1999)) (defining land use and land cover).

246. *See id.* (defining forest).

247. *See* Schulze et al., *supra* note 21, at 511 (presenting positions of Umbrella group and EU).

248. *See id.* at 508 (stating net changes in GHGs must be directly human induced). *See also* Fred Pearce, *Kyoto Lives,* NEW SCI., July 28, 2001, at 13 (discussing net changes).

249. *See* Kyoto Protocol, *supra* note 19, at art. 3(3) (stating goals of EU and only proposed area for sink use).

250. *See id.* at art. 3(4) (stating possible consideration of sinks in future COP's).

251. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 244, at 195-98 (describing additional activities as reforestation and deforestation or ARD, in addition to afforestation).

forestation (ARD) would be accountable in the first commitment period. The Parties agreed at COP6 to include the emissions by sources and removals by sinks of greenhouse gasses created by re-vegetation, in addition to ARD.[252] The Bonn draft decision on land use explained:

> Based on the Agreement at COP6, caps and discounts are to be applied to the national reports[253] in order to account for effects of elevated CO_2 and N-deposition as well as to account for pre 1990 management activities. For crop- and grazing-land management and re-vegetation sinks will be accepted as full C-sinks on a so-called net-net basis (i.e., the flux rate from 2008 until 2012 minus the flux at 1990 times five.). In contrast, forest management

252. *See* United Nations Framework Convention on Climate Change Conference of the Parties, October 29 – November 10, 2001, SEVENTH SESSION HELD AT MARAKESH, 58, FCCC/CP/2001/13/Add.1 (Jan. 21, 2002), *available at* http://unfccc.int/resource/docs/cop7/13a01.pdf (last visited Oct. 2 2007) [COP7] (discussing agreement at COP7 of what activities would be counted). Under "definitions, modalities, rules and guidelines relating to land use, land-use change, and forestry activities under the Kyoto Protocol," the following definitions are given:

> (e) '[r]evegetation' is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here;
>
> (f) '[f]orest management' is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner;
>
> (g) '[c]ropland management' is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production;
>
> (h) '[g]razing land management' is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

Id.

253. *See* Schulze et al., *supra* note 21, at 513 (citing why discounts applied). *See also* UNFCCC, *supra* note 1, at art. XII(1)(a), 31 I.L.M. 849, 865 (requiring communication of information related to objectives of Convention). National Reports are national communications which each party to the UNFCCC is obligated to make to the Conference of the Parties. *See id.* at 865. In part, a national report is "[a] national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties." *See id. See also* UNFCCC National Reports, *available at* http://unfccc.int/national_reports/items/1408.php (last visited Oct. 24, 2007) (listing types of required reports). There are three different types of reports that are submitted: "periodic submissions by developed countries covering all aspects of implementation," that is, Annex I countries; "annual submissions by developed countries on greenhouse gas emissions and removals," often referred to as inventories; and "periodic submissions by Parties not included in Annex 1," covering all aspects of implementation. *See id.*

> sinks are defined based on the change in C-pools during the commitment period (2008 to 2012), discounted by 85% in order to account for the effects of elevated CO_2, N-deposition and forest age structure resulting from activities and practices before the reference year.[254]

This was the essence of the Bonn Agreement (Bonn) as pertaining to additional activities reached at COP6.

The United States rejected the agreement, and after the COP6 Hague meeting, the delegation did not participate in any Bonn sessions. COP6 President Jon Pronk summarized the additional activities and achievements of the Hague session. To a certain extent, the following Pronk summary is a restatement of the preceding quote:[255]

> *First interval (full crediting up to level of 3.3 debit)*
> Parties recognize the unintended outcome of article 3.3, namely that countries who have an overall increase in their total forest carbon stock, may nevertheless have their assigned amounts reduced because of accounting and definitional conventions under article 3.3. Therefore, Parties decide that Parties may fully account for carbon stock changes and net GHG emissions in areas under forest management up to a level that is equal to the net debit incurred under the provisions of article 3.3, under the condition that the total forest carbon stock changes since 1990 in that country compensates the net debit incurred under the provisions of article 3.3. This first interval shall not be more than 30 Mt CO_2.
> *Second interval (discounted crediting in remaining interval to factor out non-direct human induced effects and to address uncertainty)*
> Parties decide that carbon stock changes accounted for in accordance with the provisions of article 3.4 shall, for the broadly defined management activities, exclude the effects of indirect nitrogen deposition, elevated CO_2 concentrations, other indirect effects and, (for forest ecosystems) the dynamic effects of age structure resulting from man-

254. *See* Schulze et al., *supra* note 21, at 513 (citing paragraph 1(h) and n.5 of Bonn draft decision on land-use FCCC/CP/2001/L.11/Rev.1/CMP.1), *available at* http://www.blackwell-synergy.com/doi/full/10.1046/j.1365-2486.2002.00523.x (last visited Oct. 24, 2007).

255. For a discussion of climate change impact *see infra*, note 268 and accompanying text.

> agement activities before 1990. Therefore, Parties shall apply a reduction of [30 percent] of the net carbon stock changes and net GHG emissions that result from additional cropland and grazing land management activities and 85% to the net carbon stock changes and net GHG emissions that result from *additional forest management.*[256]

The conference thus recognized that countries where sinks had come under direct human management activities should be allotted credit for those sinks.

In summary, those Annex 1 countries acting to fulfill their obligations under Article 3.3 of the Protocol (afforestation, reforestation and deforestation) which incur a net gain of GHGs (a debit) may offset that debit with additional activity removals under Article 3.4 up to a certain limit. The parties decided that to fulfill their obligations under Protocol Article 3.4, the parties "shall apply a reduction of thirty percent to the net carbon stock changes and net GHG emissions that result from additional cropland and grazing land management activities and of eighty-five percent to the net carbon stock changes and net GHG emissions that result from additional forest management activities . . . ."[257] The parties' agreement on these proportions came at a cost; the United States stopped participating in the COP6 Hague negotiations. The main issue at debate was the appropriate discount rate to apply to additional activities, particularly additional forest management. At one point during the COP6 Hague negotiations, the United States proposed that under Article 3.4, "all countries would be able to count fully not more than [twenty] million tonnes of annual carbon uptake in managed forests," and "[c]redits beyond this level would be limited by two-thirds."[258] In this respect, some groups of countries stressed the need to differentiate credits for additional human induced CO_2 uptake from natural, non-human induced CO_2 uptake. They as-

256. *See* United Nations Framework Convention on Climate Change Conference of the Parties, November 13-25, 2000, FIRST PART OF ITS SIXTH SESSION HELD AT THE HAGUE, 13, FCCC/CP/2000/5/Add.2 (Apr. 4, 2001) (emphasis added), *available at* http://unfccc.int/resource/docs/cop6/05a02.pdf [COP 6] (applying discount rate to net GHG emissions resulting from direct human activities on cropland, land grazing, and forest management).

257. *See* Gillespie, *supra* note 22, at n.136 (discussing what parties agreed with regard to first commitment period).

258. *See* INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD), SUMMARY OF THE SIXTH CONFERENCE OF THE PARTIES TO THE FRAMEWORK CONVENTION ON CLIMATE CHANGE (2000) VOL. 12 EARTH NEGOTIATIONS BULL., NO. 163 NOV. 27, 2000, at 11 (summarizing outcome of COP6, and U.S. proposals for Art. 3.4), *available at* http://www.iisd.ca/vol12/enb12163e.html.

serted that countries should not be able to offset carbon emission debits with non-human induced carbon removals. The problem was basically one of scale. The EU and other groups in the Hague negotiations responded to the United States proposal to allow twenty million tons of annual carbon uptake from managed forests:

> [T]he UK, on behalf of the EU, responded to the [United States] proposal. [It] said the EU accepts the concept of carbon sinks, especially forests, but, with the Central Group Eleven. . . and Norway, stressed a number of problems, especially of scale. The G-77/China change stressed the need to exclude credits for natural uptake. The [United States], with Japan, said natural effects *cannot be factored* out in a satisfactory manner.[259]

The majority of parties at the Hague believed a discounting mechanism would make it difficult to satisfactorily factor out natural CO_2 uptake:

> With regard to the second interval[260] a discounted crediting was to apply due to non-human induced effects and remaining uncertainties in this area. In particular, in the second period parties were to exclude the effects of indirect nitrogen deposition, elevated carbon dioxide concentrations, other indirect effects and, (for forest ecosystems) the dynamic effects of age structure resulting from management activities before 1990.[261]

The United States delegation disagreed with the Hague majority on two points for two reasons. First, the United States disagreed with whether the amount of carbon uptake, human or non-human induced, should be held fully accountable.[262] Second, disagreement arose over what discount rate should be applied for carbon uptake above that level.[263]

The EU group ultimately rejected the United States proposal, which the United States considered more a concession than a pro-

259. *See id.* at 11 (emphasis added) (discussing EU and other country groups' response to United States proposal of Article 3.4).

260. *See* Schulze et al., *supra* note 21, and accompanying text (discussing second interval).

261. *See* Gillespie, *supra* note 22, n.136 (discussing application of discounting credit).

262. *See* Schulze et al., *supra* note 21, at 513 (stating EU belief that if Umbrella position were accepted, no incentive for particular industrial states to reduce emissions would remain).

263. *See id.* (discussing discount rate concept).

posal. Key EU environmental ministers (some of them leading members of national Green parties) could not tolerate the concessions, offered by British deputy Prime Minister John Prescott to the United States chief negotiator Frank Loy, regarding the counting of forests as carbon sinks.[264] The dynamics of this exchange are described as follows:

> On Wednesday, 22 November, [Mexican] Minister Carabias Lillo reported on two sessions of informal consultations on LULUCF, which had explored different conditions for including Article 3.4 activities possibly even in the first commitment period, under controlled conditions. She noted that the issue had not been resolved . . . . On Thursday, 23 November, she reported that the informal group on LULUCF had split into two subgroups the previous night, with one group focusing on the analysis of Article 3.4, and the other on the inclusion of LULUCF activities on the CDM [Clean Development Mechanism]. On the work of the former, she said ideas had been discussed for *discounting* some elements, such as pre-1990 uptake . . . . She then said the LULUCF group had now reached a limit, and there was little prospect for convergence.[265]

The convergence mentioned by the Mexican delegate did not occur during the COP6 Hague meeting.[266] The British and United States delegations did not reach a last gasp deal. John Prescott's "compromise package, which possibly sought to cater to Umbrella Group demands on sinks, was not acceptable to others within the EU. While Pronk's Note made a valiant attempt to find convergence on this issue, it seems the stakes were too high."[267] Convergence has still not occurred. At COP7 the Parties formally adopted the original draft agreement from COP6 (Bonn). The agreement states:

> A Party included in Annex I may choose to account for anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from any or all of the following

264. *See* Fred Pearce, *A Broken Pact*, 168 NEW SCIENTIST, 5, Dec. 2, 2000 (noting EU negotiators lack of counter proposals after rejecting U.S. proposal).

265. *See* IISD, *supra* note 258, at 11 (stating problems with talk as stressed by media).

266. *See id.* (stating convergence did not transpire during COP6).

267. *See id.* at 18 (discussing certain delegations' disapproval of compromise package).

> human-induced activities, other than afforestation, reforestation, or deforestation, under Article 3, paragraph 4 and in the first commitment period: revegetation, forest management, cropland management, and grazing land management . . . . For the first commitment period, accountable anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from cropland management, grazing land management and revegetation under Article 3, paragraph 4, shall be equal to anthropogenic greenhouse gas emissions by sources and removals by sinks in the commitment period, less five times the anthropogenic gas emissions by sources and removals by sinks resulting from these eligible activities in the base year of that Party, while avoiding double accounting.
>
> For the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3, paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3 paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.[268]

At COP6, the EU position stressed the importance of "prevent[ing] the accounting of the large sinks attributed to forest management and agriculture, because if the numbers cited by the Umbrella group were accepted, this would provide no incentive to reduce fossil fuel emissions by some industrialized nations."[269] With respect to forest land, in COP6 the United States concluded that virtually all forests in industrialized countries were "managed," e.g., national park forests, and as such, these lands ought to be in-

268. *See* United Nations Framework Convention on Climate Change Conference of the Parties, October 29 - November 10, 2001, SEVENTH SESSION HELD AT MARAKESH, 59, FCCC/CP/2001/13/Add.1 (Jan. 21, 2002), *available at* http://unfccc.int/resource/docs/cop7/13a01.pdf (stating agreement adopted at COP7).

269. *See* Schulze et al., *supra* note 21, at *1 (discussing EU's position at COP6).

cluded in a full carbon accounting scheme.[270] The United States suggested that a full accounting of sinks, particularly forests, could meet as much as half of its emission reduction obligations for the first commitment period.[271] Some quarters have strongly doubted the accuracy of the United States estimates due to measurement uncertainties.[272]

The United States negotiations leading up to and during COP6 illustrate the formulation of its response to the climate change issue. Acting as a UNFCCC party and a Kyoto COP participant indicates recognition that a degree of precaution regarding climate change is necessary. The United States, however, continues to pursue a pedestrian rather than an expeditious application of the precautionary principle. To evade significant GHG emission restrictions, the United States prefers to offset a large proportion of those emissions through absorption by sinks. The creation or management of sinks to absorb or store GHG emissions is not a reprehensible course of action, but for the country that leads the emission of GHGs, it seems a less than laudable alternative.

The possibility that the current administration may be exploiting the UNFCCC is disconcerting to some observers. The UNFCCC's mitigation terminology creates an opportunity to implement a climate change policy that is weaker than preferred, but still complying with UNFCCC language. The current administration adopted a form of the precautionary principle, or precautionary approach, in its policy toward climate change. This precautionary principle is intended to prevent harm to the environment from proposed or ongoing human activity.[273] The current administration, however, has adopted a weak and utilitarian form of the precautionary principle. Given the potential adverse consequences of future climate change, a stronger and more robust principle is needed.

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270. *See id.* at 511 (stating United States position on carbon accounting scheme in COP6).

271. *See* Gillespie, *supra* note 22, at 289 (discussing claim potential of COP6).

272. *See id.* at 293 (presenting wide-range of results from different studies).

273. *See generally* Daniel Bodansky, *Scientific Uncertainty and the Precautionary Principle*, 33 ENVTL. 4, 5 (1991); *see also* James E. Hickey, Jr. & Vern R. Walker, *Refining the Precautionary Principle in International Environmental Law*, 14 VA. ENVTL. L. J. 423, 432 (1995) (discussing vague and variable duties placed on states by principle). The precautionary idea has been ascribed the status of a legal principle because of the conceptual impression surrounding the concept. *See id.* at 448.

III. PRESCRIPTIONS & POLICY APPLICATIONS

A. Precautionary Forms

A substantial amount of debate has been generated over whether precaution as a legal concept is a principle of international law or remains only a policy guideline. A number of international legal instruments have incorporated the precautionary concept. These documents may impose binding legal obligations (i.e., assigning liability for violations of legal obligations) on signatories or it may only suggest the proper ethical (and voluntary) policy path signatories are urged to adopt. Where a legal instrument's language indicates binding obligations, a reference to the precautionary concept is a call for voluntary measures on the part of signatory states. At a minimum, the concept of precaution is an emerging international norm.[274]

The precautionary concept as a principle does have its defenders.[275] One commentator correctly stated that where the precautionary idea might fully be placed in an international law hierarchy, "[a]t a minimum . . . there is sufficient evidence of state practice to justify the conclusion that the [precautionary] principle . . . reflects *a broadly accepted basis for international action*, even if the consequence of its application in a given situation remains open to interpretation."[276] Because the term *precautionary principle* is widely applied, it will frequently be used along with selective use of the term "precautionary approach," a usage found in several international instruments to convey the nuanced adoption of the precautionary concept by particular instruments. A good example of this usage can be found in Agenda 21 from the United Nations Conference on Environment and Development, held in Rio de Janeiro in June, 1992:

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274. *See* Zygmunt J. B. Plater, *From the Beginning, A Fundamental Shift in Paradigms: A Theory and Short History of Environmental Law*, 27 LOY. L.A. L. REV. 981, 1000 n. 73 (1994) (discussing adoption of view that humans are part of environmental whole). For further argument in support of this view, *see* Owen McIntyre & Thomas Mosedale, *The Precautionary Principle as a Norm of Customary International Law*, 9 J. ENVT'L. L. 221 (1997).

275. *See* David Freestone & Ellen Hey, *Origins and Development of the Precautionary Principle*, THE PRECAUTIONARY PRINCIPLE AND INTERNATIONAL LAW: THE CHALLENGE OF IMPLEMENTATION 3 (1996) (defending precautionary principle); James Cameron & Julie Abouchar, *The Precautionary Principle: A Fundamental Principle of Law and Policy for the Protection of the Global Environment*, 14 B.C. INT'L. & COMP. L. REV. 1, 2 (1991) (stating benefits of precautionary principle).

276. *See* Philippe Sands, *The "Greening" of International Law: Emerging Principles and Rules*, 1 IND. J. GLOBAL LEGAL STUD. 293, 301 (1994) (emphasis added) (discussing status of precautionary principle as governing rule of international rule).

> In the face of threats of irreversible environmental damage, lack of full scientific understanding should not be an excuse for postponing actions which are justified in their right. The precautionary approach could provide a basis for policies relating to complex systems that are not yet fully understood and whose consequences of disturbance cannot yet be predicted.[277]

This statement suggests that an approach, rather than a principle, might be better suited to address those phenomena that are not well understood, but which appear to pose threats of some magnitude to the environment. An approach may imply a broader range of actions in response to perceived threats. An approach should not be construed to mean that measures in response to threats of environmental harm should be less than resolute.

Language in the Rio Declaration on Environment and Development, which parallels language in Agenda 21, suggests that states intend to avoid taking resolute steps if such action exceeds or excessively taxes their capacities. This provides a justification for hesitation in responding to climate change.[278] The phrase *cost-effective measures*, when linked to a precautionary approach, provides an economic conditionality not attached to many conceptions of the precautionary principle.

This kind of conditionality depicts a precautionary approach as weaker in its response to threats than a precautionary principle. It would seem to call for a policy cognizant of the need for precaution, rather than a policy advocating precautionary steps. "The precautionary approach is more of a conceptual framework than a legal instrument. In contrast, the "principle" carries stronger legal implications."[279]

One might very well associate a "precautionary approach" with the climate change policy framework put in place by the current

277. *See* United Nations Conference on Environment and Development, Agenda 21, U. N. Doc. A/CONF. 151/PC/100/Add. 1, Ch. 35, 3 (1992) (promoting scientific knowledge in decision-making process regarding development).

278. *See* Rio Declaration on Environment and Development, Principle 15, June 13, 1992, 31 I.L.M. 874, 879 (applying precautionary approach discretionarily on states). Specifically, it notes: "[i]n order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." *Id.*

279. *See* Sonia Boutillon, *The Precautionary Principle: Development of an International Standard*, 23 MICH. J. INT'L. L. 429, 434 n.11 (2002) (discussing wide terminology used to reference precautionary principle).

administration. The UNFCCC employs the term "precautionary measures" and declares that those measures should be employed "at the lowest possible costs."[280] The UNFCCC incorporates the idea of precaution with a degree of conditionality attached. The Second North Sea Conference is generally recognized as the first instance of state recognition of a precautionary approach, usually at the ministerial or cabinet level. The Ministerial Declaration (London Declaration) issued by the conference urged recognition of the precautionary idea to protect the North Sea from potential harm due to the release of toxic substances.[281] The London Declaration states, "a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence."[282]

Use of the current administration's climate change policy as an example of a precautionary approach appears justified.[283] The question, however, is how a government might move from only an approach, or general orientation, or perhaps even a weak version of the principle itself, to a more rigorous policy which rests on a stronger and reasonably well-defined principle.[284] A government might be persuaded to do this upon a clear showing that accession will bring greater benefits than reluctance, where the benefit is reduced risks of significant environmental harm. A number of sources examining different components of the principle might help determine if particular components would be valuable in the construction of a policy framework toward an issue like climate change.

Governments signatory to legal instruments have presumably found the articulations therein politically acceptable; but the United States rejection of the Kyoto Protocol illustrated how governments can lose their affection for international agreements over time. The Kyoto Protocol considerably strengthened the articulation of the precautionary principle employed by the UNFCCC into

280. *See* UNFCCC, *supra* note 1, at art. III(3) at 854 (giving list of principles in art. 3).

281. *See* Second International Conference on the Protection of the North Sea: Ministerial Declaration Calling for Reduction of Pollution: London, Nov. 25, 1987, 27 I.L.M. 835, (1988) (noting precautionary approach to protect North Sea).

282. *See id.* at 838. (justifying precautionary approach to protecting North Sea).

283. *See* Boutillon, *supra* note 279, at 431 (noting benefits of precautionary principle).

284. *See* Hickey & Walker, *supra* note 273, at 439 (explaining usefulness of consensus on criteria of adequacy).

an articulation which included "a specification of those human activities for which precautionary measures are required."[285] This shift to a more robust agreement caused the United States to distance itself from the UNFCCC and to reject the Kyoto Protocol. It is worth considering what aspects of the precautionary idea, if incorporated into a *principle*, would render that principle *strong*, as opposed to *weak*.

B. Standards

A strong precautionary principle might call for a "proof of harmlessness" standard to determine whether a proposed activity should go forward, be suspended, or be cancelled altogether.[286] This standard would correspond with the establishment of a standard at or approaching zero-risk. It may be that demanding a proof of harmlessness or zero-risk standard is asking too much of environmental or natural resource scientific studies. Occasionally, though, such a demand has been made. One instance where the zero-risk standard has purportedly been applied is the whaling moratorium debate within the International Whaling Commission (IWC).[287] Such a standard may not be fully applicable, however, since the IWC achieved a high degree of confidence through biological surveys of different whale species regarding the "causal link" between intensive commercial exploitation of Baleen whales and the decline in the Baleen whale species.[288]

The imposition of the moratorium was more a protective measure than a precautionary determination because the IWC was con-

285. *See id.* at 426 (stating articulation of principle if proposed criteria is uniformly applied).

286. *But see* Vern R. Walker, *The Siren Songs of Science: Toward a Taxonomy of Scientific Uncertainty for Decisionmakers* 23 CONN. L. REV. 567, 572 (1991) (discussing proof of harmlessness standard).

287. IWC, *Chairman's Report of the Thirty-Fourth Annual Meeting*, 33 REP. INT'L WHALING COMM'N 20-21 (1983) (discussing whaling moratorium). The International Whaling Commission established the whaling "moratorium" in 1982, and it took effect in 1986 to allow countries with national whaling industries to prepare for the economic consequences of the temporary ban on commercial whaling. The key language establishing the ban reads as follows:

> Notwithstanding the other provisions of paragraph 10 [of the ICRW Schedule containing national catch limits], catch limits for the killing for commercial purposes of whales from all stocks for the 1986 coastal and 1985-86 pelagic seasons and thereafter shall be zero. This provision will be kept under review, based upon the best scientific advice, and by 1990 at the latest the commission will undertake a comprehensive assessment of the effect of this decision on whale stocks and consider modification of this provision and the establishment of other catch limits.

Id.

288. *See id.* (discussing details of how species surveys are conducted).

fident of a close association between over-exploitation of Baleen whales and the decline in those whale species. The IWC's confidence had risen virtually to the level of a causal relationship between the former and the latter. Thus, the risk to Baleen whale abundance due to excessive hunting is almost certain. The IWC's position was that a high degree of certainty of a causal link between an identified human activity and a consequent harm existed, and the organization was obligated to take measures to prohibit the activity.[289] There is a measure of ambivalence in the precautionary principle pertaining to the role of a causal link between a proposed, or ongoing, activity and a consequent harm. A perceived association between a proposed activity and a potential consequent harm invokes the precautionary principle. It would be difficult to justify taking precautionary measures absent this perception. Yet, as the observed association becomes stronger and the probability increases that a potential harm will occur due to a human activity, the need for protective steps rather than precautionary ones becomes imperative.

The policy of the IWC to *maintain* the moratorium on biological grounds may be an application of the precautionary principle. In its application, estimates of species abundance are a critical component of determining catch limits. Calculation of abundance estimates are nonetheless contentious within the IWC. Certain IWC members continue to express doubts about the *level of certainty* attached to the species abundance estimates.[290] Observers of the whaling debate within the IWC have expressed strong skepticism regarding the estimates, and in some instances, they opined the population estimates are overestimated.[291] At the same time, additional biological data has stimulated strong opinion that the IWC has failed to sufficiently take into account the relative health of certain whale populations.[292] Certain populations may have recovered to a point where limited commercial exploitation of those populations could be re-instituted without threatening their continued health.[293] Despite such skepticism, the IWC acted cautiously and

289. *See id.* (outlining IWC's position).

290. *See id.* (illustrating debates within Commission concerning species abundance estimates).

291. *See* William C. Burns, *The International Whaling Commission and the Future of Cetaceans: Problems and Prospects*, 8 COLO. J. INT'L. ENVT'L. L. & POL'Y 31, 52 (1997) (discussing IWC's role in whaling debate).

292. *See* Jon Conrad & Trond Bjorndal, *On the Resumption of Commercial Whaling: The Case of the Minke Whale in the Northeast Atlantic*, 46 ARCTIC 164, 170 (1993) (noting recovery of certain whale species).

293. *See id.* (noting recovery of Baleen whale and sperm whale species).

kept the moratorium in place, overriding sentiment by several IWC members that the abundance estimates for certain species provide that commercial whaling for those species could safely be re-introduced.[294]

The IWC has applied a strong form of the precautionary principle by keeping the moratorium in place despite mounting evidence that lifting the moratorium would not endanger the health of certain species.[295] Continued uncertainty exists regarding the level of risk to certain whale populations if commercial exploitation re-commenced. Although the degree of uncertainty is reduced, it has not been reduced sufficiently for the majority of IWC member states. The IWC majority position is primarily concerned with the magnitude of harm that would ensue if the risk to whale populations materialized.

Species extinction presents a clear example of an irreversible harm.[296] In the face of such harm, the IWC majority decided that virtually any degree of *uncertainty* about whether a re-institution of commercial whaling *would* result in species extinction is too much.[297] The IWC majority used precautionary language, given the possibility of irreversible harm, and decided not to alter the status quo and rescind the moratorium for certain whale populations short of established proof that no harm would ensue to those populations.[298] In a sense, the IWC turned a component of the precautionary principle on its head by demanding that the causal link[299] (or high degree of association) between commercial ex-

294. *See* IWC, *Chairman's Report of the Forty-Second Meeting*, 41 REP. INT'L. WHALING COMM'N 11, 25-28 (1991) (explaining Norway's position in lifting whaling moratorium). Norway is a country that has taken this position regarding the minke whale (*Balaenoptera acutorostrata*).

295. *See* Alexander Gillespie, *The Ethical Question in the Whaling Debate*, 9 GEO. INT'L. ENVTL. L. REV. 355, 358-59 (1997) (positing reintroduction of commercial whaling can be "scientifically justified"); *see also Whale Population Estimates*, International Whaling Commission, *available at* http://www.iwcoffice.org/conservation/estimate.htm (last visited Oct. 24, 2007) (estimating population of various whale species).

296. *See* IWC, *Chairman's Report of the Forty-First Meeting*, 40 REP. INT'L. WHALING COMM'N. 18 (1990) (referring to acceptable risk that stock not be depleted, so that risk of extinction not seriously increased by exploitation).

297. *See id.* at 40 (presenting argument that zero catch limit should be retained to avoid risk of species extinction).

298. *See* Gillespie, *supra* note 295, at 374-76 (noting need for certainty before lifting species protections).

299. *See United Nation Convention on the Protection and Use of Transboundary Watercourses and International Lakes*, 31 I.L.M. 1312, 1316 (1992) [*Transboundary*] (giving text of Helenski Convention); 32 I.L.M. 1069, 1076 (1993) (emphasis added); *see also Unition Nation Convention for the Protection of the Marine Environment of the Northeast Atlantic*, 32 I.L.M. 1069, 1076 (1993) [*Marine*] (giving text of OSPAR Con-

ploitation and the risk of species extinction be conclusively *disjoined* before exploitation could be re-instituted.[300] This may be a case of asking for *proof of harmlessness* or *zero-risk.*[301]

The IWC has stated that those who wish to undertake an activity which may pose some risk of environmental harm or diminish a natural resource "must prove that the proposed action will not degrade or negatively impact the environment or resource."[302] This burden-shifting is a key element of any strong form of the precautionary principle.[303] This burden-shifting aspect has been noted in a number of articulations of the precautionary principle. One such articulation occurred in the Nuclear Tests Case, *New Zealand v. France.*[304] In *New Zealand v. France,* the dissenting opinion recommended that those who propose a potentially environmentally harmful activity must establish the activity will do *no harm,* rather than ask those who are opposed to an activity to prove that it will be

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vention). Most articulations of the precautionary principle which incorporate language referring to a degree of causality do so in a fairly straightforward manner. Two such instruments are the Helsinki and the OSPAR Conventions. The Helsinki Convention obligates the parties to recognize:

> [t]he precautionary principle, by virtue of which action to avoid the potential transboundary impact of the release of hazardous substances shall not be postponed on the ground that scientific research has not *fully proved a causal link* between those substances, on the one hand, and the potential transbounday impact, on the other hand. . . .

Transboundary, 31 I.L.M. at 1316 (emphasis added). The OSPAR Convention, in reference to the release of wastes from the normal operation of ships, states:

> [t]he contracting parties shall apply: (a) the precautionary principle, by virtue of which preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm to living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a *causal relationship* between the inputs and the effects . . . .

Marine, 32 I.L.M. 1316.

300. *See* Steinar Andresen, *The Effectiveness of the International Whaling Commission,* 46 ARCTIC 108, 111 (1993) (discussing key IWC goals and motivations).

301. *See* Jonathan Adler, *More Sorry than Safe: Assessing the Precautionary Principle and the Proposed International Biosafety Protocol,* 35 TEX. INT'L L.J. 173, 204-05 (2000) (noting inability of research to eradicate risk).

302. *See* John M. MacDonald, *Appreciating the Precautionary Principle as an Ethical Evolution in Ocean Management,* 26 OCEAN DEV. & INT'L L. 255, 263 (1995) (explaining precautionary principle).

303. *See* Sonia Boutillon, *The Precautionary Principle: Development of An International Standard,* 23 MICH. J. INT'L L. 429, 439 (2002) (noting best informed must prove harmlessness of their conduct).

304. *See Request for an Examination of the Situation in Accordance with Paragraph 63 of the Court's Judgment of 20 December 1974 in the Nuclear Tests (New Zealand v. France),* 1995 I.C.J. 288, 348 (Sept. 22) (arguing in dissent that reversing burden of proof was critical in environmental protection).

harmful.[305] Those who propose the activity bear the burden to establish that the activity will do no harm.[306]

The IWC majority holds that commercial whaling proponents have not yet met the burden of proof by establishing, *with an extreme degree of certainty*, that such an action would not deliver harm to particular whale populations.[307] This debate that continues within the IWC seems to have certain parallels to the debate surrounding the UNFCCC and the 1997 Kyoto Protocol.[308] The current administration concedes there is a measure of association between anthropogenic activity and climate change, but it denies that an unequivocal causal link exists.[309] Thus, the administration does not believe the application of a strong version of the precautionary principle is warranted.[310] Rather than initiate action to reduce GHG admissions in the absence of scientific certainty, the administration requires proof of harm.[311]

C. Initial Conditions

The United States, in effect, has rejected an application of a strong precautionary principle for two reasons. First, it determined that initiating action to diverge from the status quo in a precipitate fashion is not warranted *because* a causal link has not been established.[312] This posture did not begin with the current administra-

305. *See id.* at 348 (arguing that absent proof of safety of tests from France, New Zealand's claim of potential harm was established).

306. *See id.* (stating shift in burden of proof approach is sufficiently well established in international law for Court to act upon it).

307. *See* MacDonald, *supra* note 302, at 272 (quoting J.A. Gulland, *Fishery Management: How Can We Do Better?, in* MANAGEMENT OF WORLD FISHERIES: IMPLICATIONS OF EXTENDED COASTAL STATE JURISDICTION 255, 259 (Edward L. Miles, ed., 1989) (noting need to reestablish whale population completely before whaling recommences).

308. *See* IWC, *Chairman's Report of the Thirty-Fourth Annual Meeting*, 33 REP. INT'L WHALING COMMISSION 20, 20-21 (1983) (outlining doubts about level of certainty in whale abundance estimates).

309. *See* CICERONE ET AL., *supra* note 66, at 17 (denying definite causal link between anthropogenic activity and climate change).

310. *See* Paula Dobriansky, Sec'y of State for Global Affairs and Head for United States Delegation to Conference, "The Convention After Ten Years: Accomplishments and Future Challenges," Dec. 15, 2004, http://www.state.gov/g/rls/rm/2004/39805.htm (discussing complex nature of environmental science as requiring further study before committing to action).

311. *See* CICERONE ET AL., *supra* note 66, at 23-4 (stating United States should support actions that would improve IPCC process and promote clear appraisal of uncertainties pertaining to climate change).

312. *See id.* at 17 (contending uncertainty of natural variability in observed climate change during last century cannot be positively correlated to climate change and extant climate models do not provide conclusive results).

tion, but rather "negotiations over the 1992 Framework Convention on Climate Change were delayed by the [George H. W.] Bush administration, which espoused the notion that it was premature to set binding targets and timetables controlling greenhouse gases as long as uncertainty existed regarding the impact and scope of global warming."[313] Second, the United States has rejected burden-shifting by indicating that those opposed to the status quo bear the burden of establishing a high degree of certainty.[314]

The majority of states in the IWC have asserted that there is a causal link between commercial exploitation and whale population decline which must be rebutted for the target populations before the moratorium for those species can be lifted.[315] Oddly, the IWC stated that because a near causal link has been established, there should be a very high degree of association and no divergence from the status quo, or more simply that there shall not be a lifting of the moratorium.[316] Conversely, the administration has said because a causal link between anthropogenic activity and climate change has *not* been established, there should be no divergence from the status quo, and consequently no mandate requiring a reduction in emissions.[317] The IWC has said that whaling advocates must show that their *proposal* to engage in commercial whaling will not result in an irreversible harm such as species extinction.[318] The current administration maintains that those, including the IPCC, who want the United States and other countries to reduce GHG emissions more quickly must show the *ongoing* GHG emissions level is a major contributor to climate change.[319] In other words, the current adminis-

313. *See* Gregory D. Fullem, Comment, *The Precautionary Principle: Environmental Protection in the Face of Scientific Uncertainty*, 31 WILLAMETTE L. REV. 495, 513 (1995) (explaining no immediate negotiations were necessary because of uncertainty in timetable for global warming).

314. *See* Revkin, *supra* note 173, at F4 (discussing the burden of proving certainty); *see also* CICERONE ET AL., *supra* note 66, at 17 (noting current data has less than ninety percent certainty and contending greater certainty is required to demonstrate climate change).

315. *See Chairman's Report of the Forty-First Meeting*, 40 REP. INT'L WHALING COMMISSION 18 (1990) (discussing need to rebut presumed link before changing current procedures).

316. *See id.* (discussing existence of near causal link).

317. *See* White House Council of Economic Advisors, *supra* note 176, at 245 (presenting administration view that climate science requires additional research of climate change itself and mitigating technologies).

318. *See* Gillespie, *supra* note 295, at 374-76 (discussing threatened extinction by indigenous peoples for cultural reasons).

319. *See* Press Release, Office of the Press Sec'y, President Bush Discusses Global Climate Change, (June 11, 2001), http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html.

tration posits the IPCC must provide evidence of harm extruding from anthropogenic activity and that it is not incumbent on the United States to provide evidence that current emission levels are harmless.

The United States posture on climate change would seem to show that campaigns to have a government apply or adopt a strong form of the precautionary principle will have a greater likelihood of success if the activity thought capable of causing serious environmental harm is *in preparation* rather than *ongoing*. An ongoing activity suspected of potentially causing environmental harm may be more difficult to arrest than would an activity under consideration.

The relevant activity here is the private sector burning of fossil fuels. The United States government made no energy policy proposal to the private sector when the United States economy began the transition to fossil fuels in the second half of the nineteenth century. Still, the United States economy currently remains highly dependent on fossil fuels.[320] This dependence was not proposed by the United States government, but that same government now has the option of altering the dependence. In the late nineteenth century, atmospheric science was only in a nascent stage. Consequently, the potential for negative climate consequences resulting from a fossil fuel combustion dependent economy and inadequate regulatory emissions regime was not known. An argument suggesting an alteration in the regulatory machinery for emissions would likely have been better received by a late 19th century administration, when the fossil fuel dependence was being created, rather than in the early twenty-first century, when that dependence is quite mature.

It is difficult to overestimate the importance of the *condition* in which the United States finds itself in terms of the willingness to adopt a robust form of the precautionary principle. In March 2001, President Bush pointedly referred to the disruption and costs to the United States if it adopted the Protocol.[321] The implication was that the United States economy could not absorb the costs or withstand the disruption because of the ongoing momentum of the

320. *See* Raul A. Estrada-Oyuela, *Equity and Climate Change, in* ETHICS, EQUITY AND INT'L NEGOTIATIONS ON CLIMATE CHANGE, 36, 36-46 (Luis Pinguelli-Rosa & Mohan Munasinghe, eds., 2002) (describing most industrialized countries' continued dependence on fossil fuels).

321. *See* Press Release, Office of the Press Sec'y, Text of a Letter from the President to Senators Hagel, Helms, Craig and Roberts (Mar. 13, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/03/20010314.html (on file with author) (explaining President Bush's opposition to Kyoto Protocol based on exemption of other countries).

economy.[322] Political leaders are reluctant to take responsibility for engineering the steps perceived to bring economic costs and social disruption. This is true if it becomes clear later that the risks of harm were overstated, the steps initiated to avoid or minimize the environmental harm were not necessary, and the benefits lost because of mandated regulatory controls on industry should not have been borne. Because the U.S. is heavily dependent on carbon based energy sources, many of those benefits are economic in nature. Therefore, "reducing United States emissions to [seven] percent less than their 1990 level (the Kyoto target) over the next ten years [could] cost[ ] up to [four] percent of GDP in 2010—a staggering sum when there is no scientific basis for believing this target is preferable to one less costly."[323] This has been labeled the "harms of precaution" problem,[324] or in other commentaries, the "foregone benefits problem."[325]

Critics of the precautionary principle have often pointed out that the danger of "false negatives" may be greater than the danger of "false positives" in regulatory decision making.[326] A false negative could result when the regulator fails to find any danger to a proposed activity and approves the activity, when in fact there was a danger which later becomes evident and causes serious harm.[327] A false positive could result when the regulator erroneously finds there is danger from a proposed activity and denies approval of the proposed activity, when it is later established that the disapproved

322. *See* Miranda A. Schreurs, *Competing Agendas and the Climate Change Negotiations: The United States, the European Union, and Japan*, 31 ENVTL. L. REP. 11218, 11221 (Oct. 2001) (discussing Bush administration's rejection of Kyoto Protocol based on energy and economic concerns).

323. *See* White House Council of Economic Advisors, *supra* note 176, at 247 (discussing administration's position on economic effects of implementation of Kyoto Protocol).

324. *See* Jonathan H. Adler, *More Sorry Than Safe: Assessing the Precautionary Principle and the Proposed International Biosafety Protocol*, 35 TEX. INT'L L.J. 173, 196 (2000) (describing FDA application of precautionary principle).

325. *See* Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 890 (1996) (exemplifying where substantial benefits foregone).

326. *See id.* at 852 (comparing risks of scientific false positives with cost of scientific false negatives with respect to environment). For example, one observer has made just such a claim that false negatives do carry more danger than false positives. *See* Donald T. Hornstein, *Reclaiming Environmental Law: A Normative Critique of Comparative Risk Analysis*, 92 COLUM. L. REV. 562, 641 (1992) (concluding impacts of false positives are less serious than false negatives).

327. *See generally* Talbot Page, *A Generic View of Toxic Chemicals and Similar Risks*, 7 ECOLOGY L.Q. 207, 233-35 (1978) (detailing rationale for limiting false negatives with environmental risk).

activity would have caused no harm.[328] The potential harm of undue precaution in the health regulatory field has been described in the following manner:

> Perhaps the most prominent example of the harm caused by excessive 'precaution' in regulatory policy is FDA-induced 'drug lag.' The FDA must approve new pharmaceuticals and medical devices before they may be used or prescribed in the United States. The purpose of FDA approval is to ensure that only those drugs deemed 'safe and effective' are approved for use. In a precautionary fashion, the FDA seeks to prevent the release of an unsafe drug. Delaying the availability of potentially life-saving treatment, however, poses risks of its own. Consider the question posed by one prominent FDA critic: 'If a drug that has just been approved by FDA will start saving lives tomorrow, then how many people died yesterday waiting for the agency to act?'[329]

Delaying action to avoid certain costs may therefore bring about unintended and perhaps larger costs.[330]

The decision to reduce emission levels radically and more quickly does not have an immediate and direct impact on human mortality; however, the economic and presumably social costs as depicted by the Council of Economic Advisors are potentially severe.[331] The administration contends that sacrificing current economic gains to protect against potential future societal losses would be unwise and probably unnecessary.[332] This policy of adaptation seems to be firmly entrenched.

The United States had the world's largest economy and the economy most dependent on fossil fuel energy sources when the scientific community initially began to perceive an association between climate change and GHG gases emanating from burning fossil fuels. The current administration, however, has significant doubts about the association between burning fossil fuels and cli-

328. *See id.* at 230-33 (providing information pertaining to false positives problem faced by environmental or health regulatory authorities).

329. *See* Adler, *supra* note 301, at 195 (citations omitted) (providing well-known illustrations of problems created by overly precautious decision-makers).

330. *See id.* (discussing unanticipated harms stemming from precautionary principles).

331. For a full discussion and analysis of the uncertainties of concern to the current administration, *see supra* notes 172-75 and accompanying text.

332. *See* Press Release, *supra* note 146 (addressing financial considerations influencing administration's views on global climate change).

mate change. Combining these doubts and the United States economic dependence on GHG-producing energy sources makes it profoundly difficult to persuade the administration to agree to an application of a robust, rather than utilitarian, form of the precautionary principle.

In some cases, it would be important to ask a particular state to apply a strong version of the precautionary principle in the management or regulation of an activity, whether that activity was only in the proposal stage or was extant. The scientific community may only be able to perceive a linkage between an activity and a possible harm after the activity has been ongoing for a lengthy period. In the case of the Montreal Protocol, activity resulting from producing products whose use resulted in ozone depleting substances was ongoing in many countries when the Protocol was devised in 1987.[333] In that instance, however, there was widespread consensus about which activities produced ozone-depleting substances. Despite the fact that compliance with the Montreal Protocol brought some costs to particular sectors of signatories' economies, widespread compliance was forthcoming.

Applying robust forms of the precautionary principle to an activity may receive a warmer reception by governments if the activity is only proposed, rather than ongoing. In the United States, this association between activity and harm only occurred long after the industrial activity had commenced. The Cartegna Protocol incorporates a strong form of the precautionary principle, which appears to explicitly shift the burden of proof to the country exporting a living modified organism (LMO).[334] Provisions in the Cartegna Protocol call for an "advance informed agreement" between the exporting and importing countries of an LMO.[335] The LMO exporting country must perform risk assessments and then provide the

333. *See* United Nations, *Montreal Protocol on Substances that Deplete the Ozone Layer* (Sept. 16, 1987) 1522 U.N.T.S. 3, *as amended* June 29, 1990, *reprinted in* 26 I.L.M. 1541, 1550 (1987) (*entered into force* Jan. 1, 1989), *reprinted* in 32. I.L.M. 875 (1993) (*amended* Nov. 23-25, 1992) (noting results on ozone depletion). The Protocol is part of the Vienna Convention for the Protection of the Ozone Layer, Mar. 22, 1985, T.I.A.S. No. 11, 097, at 4, 1513 U.N.T.S. 324, *reprinted in* 26 I.L.M. 1516, 1529 (1987) (*entered into force* Sept. 22, 1988) (providing specific obligations established by Protocol).

334. *See* Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Jan. 29, 2000, 39 I.L.M. 1027 (2000) (providing text of Cartagena Protocol). The Protocol is part of the Convention on Biological Diversity, June 5, 1992, 31 I.L.M. 818 (1992) (establishing perogatives of LMO importing country).

335. *See* Jonathan H. Adler, *The Cartagena Protocol and Biological Diversity; Biosafe or Bio-Sorry?*, 12 GEO. INT'L. ENVTL. L. REV. 761, 771 (2000) (indicating provisions support precautionary principle).

information to the importing country.[336] The importing LMO country can make decisions, with the goal of minimizing potential adverse effects, even in the absence of scientific certainty, to reduce the risk to human health.[337]

Countries that substantially invest in LMOs may incur economic costs from the risk assessment carried out by the importing country, regardless of whether the risk assessment conforms to the exporter's assessment. In this instance of an existing activity, such as corporate research on LMOs, the precautionary principle places a potential economic cost burden, as well as a proof of negligible harm burden, on the exporting country. This insistence that economic costs are a burden that states must prepare to incur to avoid or minimize adverse effects of LMOs is a robust form of the precautionary principle. The United States is reluctant to accept this burden.

The United States has been unwilling to accept the Kyoto Protocol's notion that United States GHG emission levels must be reduced by a specified percentage by a specified date range to decrease the risk of inflicting environmental harm on the global climate system. The administration has not accepted the burden shift, which is the burden of proving harmlessness or a negligible harm. The United States has not accepted the economic burden that would be required to meet the Kyoto timetable.

D. Causal Proofs

The United States is resolute in its fidelity to the burden of proof remaining with the opponents of proposed or existing activity. In fact, the administration indicated it seeks proof of a causal link between an increase in GHGs and climate change before a shift in current policy would be instituted.[338] A major component of the administration's policy is an emphasis on mitigation and adaptation

336. *See* Deborah Katz, *The Mismatch Between the Biosafety Protocol and the Precautionary Principle*, 13 GEO. INT'L. ENVTL. L. REV. 949, 954 (2001) (explaining precautionary principle generally giving power to importing party).

337. *See* Cartagena Protocol, *supra* note 334 (noting Protocol supports granting of power to importing party).

338. *See* CICERONE ET AL., *supra* note 66, at 252 (noting causal link between GHGs and climate change is not clearly established). "The fact that the magnitude of the observed [global] warming is large in comparison to natural variability as simulated in climate models is suggestive of such a [causal] linkage, but it *does not constitute proof* of one because the model simulations could be deficient in natural variability on the decadal to century time scale." *Id.* at 17 (2001) (emphasis added) (explaining effect of human activities on climate change). For a description of human-induced changes in the climate, *see supra* notes 55-57 and accompanying text.

measures, with the mitigation directed toward the effects or consequences of climate change.[339] On one level, there seems little to criticize about an effort that seeks to minimize the potential adverse effects of climate change on individuals and communities. The issue is whether the current administration's policy pursues a strategy including the substitution of mitigating effects and adaptation endeavors in response to climate change effects, in lieu of measures to reduce activities that may be helping to bring about climate change itself.

The emphasis on understanding the vulnerability of human systems to global change, and to then evaluate the ability of those systems to adapt to climate change, may be a misplaced emphasis.[340] In a worst-case scenario, it is conceivable that the long term effects of climate change may swamp national and international efforts to reduce emissions. In that instance, measuring the capacity of human systems to adapt would likely be a very prominent need.

The current administration is skeptical about the validity of the IPCC thesis which states anthropogenic activity is making a strong contribution to climate change. There is, therefore, reason to doubt that the administration is emphasizing mitigating effects and adaptation because it fears the worst. The administration's policy may be predicated on the view that recent observed climate change is more a result of natural variability than anthropogenic causes, and that observed climate change has occurred in the past.[341]

339. *See generally,* UNITED STATES CLIMATE CHANGE SCIENCE PROGRAM, *supra* note 65 at Chapter 11 (researching effects of climate changes). The plan states: "On a global scale, considerable gaps exist in understanding, modeling, and quantifying the sensitivity and vulnerability of human systems to global change and measuring the capacity of human systems to adapt." Climate Change Science Program and the Subcommittee on Global Change Research, *Strategic Plan for the U.S. Climate Change Science Program,* 95 (2003), http://www/climatescience.gov/Library/stratplan2003/final/ccspstratplan2003-all.pdf (clarifying level of knowledge and information available on global environmental variability and change).

340. *See* Gamble & Simpson, *supra* note 212, at 95 (noting researching vulnerability of human systems may be misplaced).

341. *See* CICERONE ET AL., *supra* note 66, at 8 (discussing natural variability in climate).

> Over long time scales, outside the time period in which humans could have a substantive effect on global climate (e.g., prior to the industrial revolution), proxy data (information derived from the content of tree rings, cores from marine sediments, pollens, etc.) have been used to estimate the range of natural climate variability. An important recent addition to the collection of proxy evidence is ice cores obtained by international teams of scientists drilling through miles of ice in Antarctica and at the opposite end of the world in Greenland. The results can be used to make inferences about climate and atmospheric composition extending back as long as 400,000 years. These and other proxy data indicate that the range of natural climate variability is in excess of several

If climate change can be reliably attributed to natural variation, then the research agenda outlined immediately below gains even greater weight. The agenda explains:

> Research needs include empirical studies and model-based simulation studies of the influence of social and economic factors on vulnerability and adaptive capacity in households, organizations, and communities; assessments and economic analyses of the potential impacts of climate variability and change . . . retrospective analyses of the consequences of surprising shifts in climate and the ability of society to respond to negative impacts and potential opportunities . . . . Specifically, attention needs to be paid to the associated costs and benefits of adaptation strategies, strategies for *mitigating the impacts* of global change on different economic sectors and people in different locations and economic brackets, market and non-market valuation of positive and negative impacts, the possibility of new economic instruments for responding to global change, and

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> degrees C on local and regional space scales over periods as short as a decade . . . . It is more difficult to estimate the natural variability of global mean temperature because large areas of the world are not sampled and because of the large uncertainties inherent in temperatures inferred from proxy evidence. Nonetheless, evidence suggests that global warming rates as large as 2°C (3.6°F) per millennium may have occurred during the retreat of the glaciers following the most recent ice age.

Id.

Most recently, additional ice core data from Antarctica has been accumulated, providing information regarding atmospheric GHG concentrations from 650,000 years before the present. Two teams of scientists sampled deposits in the ice core record taken from depths of two miles. One team sampled atmospheric carbon dioxide (CO_2) and methane (N_2O), and found that pre-industrial concentrations had never reached present levels of these two gases during the previous 650,000 years. *See* Renato Sphani et al., *Atmospheric Methane and Nitrous Oxide of the Late Pleistocene from Antarctica Ice Cores,* 310 SCI. 1317, 1318 (2005) (describing European Project for Ice Coring in Antarctica Dome Concordia). Working in the same region of Antarctica (Dome Concordia area), a second team sampled CO_2 deposits in ice cores taken from the same depth as those extracted by the first team. The analysis of the second team showed that current concentrations of atmospheric carbon dioxide did not reach comparable levels for 650,000 years before the present. *See* Urs Siegenthaler et al., *Stable Carbon-Cycle-Climate Relationship During the Late Pleistocene,* 310 SCI. 1313, 1317 (2005) (indicating relationship between CO_2 and Antarctic remained constant during late pleistocene). The work of the two teams has shown that present day concentrations of three very important GHGs were not produced during the past 650,000 years. This evidence suggests that recent anthropogenic activity may have a causal relationship with current GHG (CO_2, CH_4, and N_20) levels. *See* Andrew C. Revkin, *Gases at Level Unmatched in Antiquity, Study Shows,* N.Y. TIMES, Nov. 25, 2005, at A6 (noting high levels of CO_2, methane, and nitrous oxide today are highest in 650,000 years).

> the role of public and private institutions and public policies in influencing adaptive capacity.[342]

President Bush has explicitly commented on the amount of the observed climate change that can be attributed to natural variation. In a Press Release, the President stated: "[t]he Academy's report tells us that we do not know *how much effect natural fluctuations* in climate may have had on warming. We do not know how much our climate could, or will change in the future. We do not know how fast change will occur, or even how some of our actions could impact it."[343] After linking public statements of the current administration with documents issued by agencies declaring the direction of a significant proportion of future research, it seems evident the administration is strongly disinclined to adopt a strong form of the precautionary principle as a major plank of its climate change policy.

The President's statement expresses strong doubt regarding the existence of a causal link between GHGs produced by anthropogenic activity and climate change. It suggests the United States need not embark upon an emission reduction program on the scale called for in the Kyoto Protocol. The administration disagrees with other countries regarding the immediacy of the climate change problem.[344] The administration's lack of action in reducing GHGs may not be harmful if natural variability is at fault. In the administration's view, a "proof of harmlessness" standard should not, therefore, be imposed on those countries choosing not to institute a headlong nationwide emissions reduction program.[345]

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342. *See* Gamble and Simpson, *supra* note 212, at 96 (emphasis added) (outlining research needs).

343. *See* Press Release, *supra* note 148 (emphasis added) (discussing policy objectives regarding climate change).

344. *But see* David M. Reiner, *Climate Impasse: How the Hague Negotiations Failed*, 43 ENV'T 36, 41-43 (2001) (detailing various splits among European states, among developing countries, and between two groupings of states). Although almost all the members of these two groups strongly desired the United States' participation in Kyoto, not all were prepared to make concessions of the magnitude the United States desired. The issue seemed to be whether a "gutted" Protocol, with United States' participation, was worth more than a stronger Protocol, absent United States' participation. *See id.* at 42 (noting United States differing position and its possible impact).

345. *See* Paula Dobriansky, Remarks: "The Convention After 10 Years: Accomplishments and Future Challenges," *supra* note 310 (stating parties to UNFCCC need to absorb lessons learned prior to taking new action).

To a certain extent, the administration's view can be characterized as partially requiring imminence of harm.[346] The administration repeatedly cites the lack of certainty in the climate science regarding a degree of association between anthropogenic activity and climate change.[347] The administration also appears to consider the view that the threat is not immediate. A harm that is imminent and dictates an urgent response exists where the probability of harm is far beyond a mere possibility, seemingly approaching certainty, and near temporally.[348] This posture indicates that the United States has adopted a form of the precautionary principle that is "pedestrian" rather than "expeditious."[349]

This imminence requirement implies that the harmful consequences of an event not near in time may be less likely. In this instance, the administration seems to believe that the harmful effects of climate change, because they are farther in time, are less probable if future mitigation of effects and adaptation efforts are successful. This Article contends that the probability of the harm is no less, and the gravity of the harm may be undiluted, regardless of the perceived temporal proximity of the harm. An over-reliance on mitigating effects and adaptation measures may be risky in itself.

A strong form of the precautionary principle would call for policies to lessen the risk of environmental harm induced by climate change. The *Bamako Convention on the ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa* (Bamanko Convention) is a treaty signed by African nations in January 1991, to prohibit the import of hazardous waste.[350] The Bamako Convention employed a form of the precautionary principle that seems to have language applicable to the climate change issue:

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346. *See* Daniel Dobos, *The Necessity of Precaution: The Future of Ecological Necessity and the Precautionary Principle*, 13 FORDHAM ENVTL. L. REV. 375, 381-82 (2002) (defining imminence requirement). The article states "[t]he imminence requirement dictates that there must be 'a threat to the interest at the actual time.'" *Id.* at 381.

347. *See* CICERONE ET AL., *supra* note 66, at 3 (noting major advances in understanding and modeling necessary to reduce uncertainty).

348. *See* Dobos, *supra* note 346, at 381 (discussing requirements of imminence). Specifically, Dobos noted one view where a peril is sufficiently imminent when it is "far beyond the concept of 'possibility' and is unavoidable." *Id.*

349. *See SA Perspectives: The Climate Leadership Vacuum*, SCI. AM. At 6 Mar. 2004 (warning that as time proceeds, United States' and other countries' leverage over climate change erodes).

350. *See* Basel Action Network, http://www.ban.org/Library/bamako_treaty.html (explaining the Bamako Convention).

> Each Party shall strive to adopt and implement the preventive, precautionary approach to pollution problems which entails, inter-alia, preventing the release into the environment of substances which may cause harm to humans or the environment without waiting for scientific proof regarding such harm. The Parties shall co-operate with each other in taking the appropriate measures to implement the precautionary principle to pollution prevention through the application of clean production methods, rather than the pursuit of a permissible emissions approach based on assimilative capacity assumptions.[351]

The last sentence in this quote is particularly relevant to the climate change issue. The Kyoto Protocol calls for clean production methods as the best answer in avoiding environmental harm from climate change. The current administration opted for a "permissible emissions approach," linked with further research and, in my estimation, an unwise amalgamation of efforts to "mitigate effects" with adaptation measures and too great an emphasis on these measures.[352] Implicit in this approach is the belief that the global climate is able to absorb or assimilate current levels of GHG emissions on a global basis, at least until the global community is able to more fully understand the dynamics of climate change.

Even before the Kyoto Protocol's introduction on February 16, 2005,[353] the global community began to take steps to move beyond the Protocol's provisions and time frame. In December 2004, at COP10 in Buenos Aries, some participants hoped to organize a series of seminars under the auspices of the UNFCCC to discuss ways to mitigate climate change after the Protocol's expiration in

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351. *See* Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes Within Africa, Jan. 29, 1991, 30 I.L.M. 773, 781 (citing Art. 4 paragraph 3(f) to show efforts devoted to adopting precautionary measure).

352. *See* Gamble & Simpson, *supra* note 212, at 96 (noting United States' passive approach to preventing harm from climate changes).

353. *See* Kyoto Protocol, *supra* note 17, 37 I.L.M. at 41 (stating Kyoto Protocol will be in effect when specific number of countries creating certain amount of carbon dioxide emissions have ratified instrument). *See also* Steven Lee Meyers, *Putin Ratifies Kyoto Protocol on Emissions*, N.Y. TIMES, Nov. 6, 2004, at A10 (describing start of international efforts to reduce emissions and help stop heat trapping). *See generally* Cory C. Miller, *Comment: Developments in Climate Change in 2004: Three Cheers for Russia*, 2004 COLO. J. INT'L. ENVTL. L. & POL'Y 143 (2004) (summarizing both significant and insignificant nature of Kyoto protocol).

2012.[354] The United States delegation believed such discussions would be premature. The head of the United States delegation stated that "[s]cience tells us that we cannot say with any certainty what constitutes a dangerous level of warming, and therefore what level must be avoided."[355] Because of this objection, the substantive mitigation discussions could not be scheduled. In their place, a number of workshops were planned to facilitate information exchange between the parties, primarily targeting adaptation rather than mitigation.[356]

The current administration thus continues to support a weak version of the precautionary principle to formulate the administration's policy regarding climate change. That is, the administration is unwilling to accept the burden of proving the global climate would not suffer undue harm despite continuous levels of GHG emissions. This burden-shifting from the opponent of an ongoing or proposed policy to the party engaging in an ongoing policy or proposing to institute a particular policy is a strong form of the precautionary principle. The administration insists that the burden of proof resides with those opposed to the current United States GHG emission policy. As Under Secretary of State for Global Affairs, Paula Dobriansky reiterated, the United States' position is that we "cannot say with any certainty what constitutes a dangerous level of warming."[357] Those opposed must show that ongoing United States emissions and anthropogenic emissions generally, are contributing to a change in climate which cannot be attributed to natural variation alone. Thus, the United States stance toward climate change embodies a weak, "pedestrian," form of the precautionary principle.

IV. PALEO CLIMATE

The United States at COP10 opposed progressing on mitigation measures as a response to climate change. This shows a contin-

354. *See* Larry Rohter, *U.S. Waters Down Global Commitment to Curb Greenhouse Gases*, N.Y. TIMES, Dec. 19, 2004, at 116 (discussing United States' unwillingness to become involved in international efforts against global warming).

355. *See id.* (quoting Paula Dobriansky, head of United States delegation).

356. *See* United Nations Framework Convention on Climate Change Conference of the Parties, December 6-18, 2004, TENTH SESSION HELD AT BUENOS AIRES, FCCC/CP/2004/10 (Apr. 18, 2005), *available at* http://unfccc.int/resource/docs/cop10/10.pdf (last visited Oct. 24, 2007) (providing purpose and details of international conference to create discussion on adaptation measures).

357. *See* Rohter, *supra* note 354 at 116 (quoting Secretary Paula Dobriansky, reaffirming United States' position of uncertainty as to level of danger signaling need for action).

uation of a policy position highlighted earlier in this Article.[358] Specifically, the Draft Strategic Plan of the USCCSP was criticized by the National Research Council (NRC) for "not adequately [articulating] the utility of better characterizing uncertainty."[359] The NRC, however, recognized uncertainty as being "inherent in science and decision making and therefore not in itself a basis for inaction."[360] The NRC suggested that the revised Strategic Plan should "identify what sources and magnitudes of reductions in key climate change uncertainties are especially needed, and where an improved characterization of uncertainty would benefit decision-making. . . ."[361] Secretary Dobriansky's statement at COP10 does not fairly convey the sense that uncertainty is inherent in science. United States Special Representative to COP10, Dr. Harlan Watson, commenting on whether the Kyoto Protocol was based on sound science, concluded "[i]t was not based on science."[362] Dr. Watson believed the Protocol would be better characterized as a "political agreement."[363]

An inspection of the NRC's evaluation of the USCCSP's Final Strategic Plan is instructive in furthering this Article's contention that the administration employs a weak version of the precautionary principle. The 2003 Final Strategic Plan received a higher evaluation by the NRC relative to the 2002 Draft Strategic Plan. In its review of the Final Strategic Plan,[364] the NRC placed special emphasis on goals four and five in the 2003 version. Goal four seeks to "understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate change and related global changes."[365] Goal five is to explore the uses and iden-

358. For a further discussion of the United States' opposition, *see* Gamble & Simpson, *supra* notes 212-218 and accompanying text.

359. *See id.* (noting United States' means of mitigation of climate change).

360. For a further discussion of the issue of uncertainty, *see supra* notes 75-79 and accompanying text.

361. *See id.* (calling for clarification of uncertainty).

362. *See* Harlan L. Watson, Remarks at the U.S. COP - 10 Press Conference, Dec. 7, 2004, *available at* http://www.state.gov/g/oes/rls/rm/2004/39557.htm (last visited Oct. 20, 2007) (commenting on climate policy from United States).

363. *See id.* (describing United States and international efforts on climate control).

364. *See* National Research Council, *Implementing Climate and Global Change Research: A Review of the Final U.S. Climate Change Science Program Strategic Plan*, 2004, http://books.nap.edu/openbook.php?record_id=10635&page=6, at 6 (discussing various USCCSP goals and emphasizing discussion of different influences involved in environmental effects in fourth goal and discussion of positive influences of scientific information in fifth goal).

365. *See id.* at 7 (listing and explaining fourth goal).

tify the limits of evolving knowledge to manage risks and opportunity related to climate variability and change.[366]

The NRC review of the Final Strategic Plan is mixed at best. The NRC commends particular components of the Plan, but its criticisms are correspondingly meted out. The following passage is an apt illustration of this pattern:

> The revised plan identifies 'the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes' as its fourth overarching goal, appropriately calling attention to these research areas. The plan's chapters on human contributions and responses to environmental change. . . and ecosystems. . . are improved over the draft. Integrated assessment analyses. . . include impacts modeling of the environment as well as socio-economic systems. Other research activities relevant to economics are only weakly addressed in the plan. Although at least one product addresses mitigation strategies. . . the plan's overarching goals *emphasize adaptation rather than mitigation.*[367]

The administration stated, during COP10, that the follow-up period to that conference was not the appropriate time to talk about post-2012 Kyoto negotiations.[368] Inasmuch as those negotiations were intended to consist of "substantive discussions"[369] about mitigation in the post-Kyoto period, this comment is evidence that the administration is unwilling to seriously respond to climate change in a way to mitigate causes.[370]

A. The Science of Abrupt Climate Change

The implications for this policy choice are profound. The tactical decision is to defer forming a policy imbued with greater urgency until more definitive knowledge regarding possible adverse consequences of climate change is known. A strong form of the precautionary principle would advise against this. The Bamako

366. *See id.* (listing and explaining fifth goal).

367. *See id.* at 12 (emphasis added) (providing brief illustration of revised plan).

368. *See* Watson, *supra* note 224, (emphasizing United States' position of opposition to discussion in COP10 conference).

369. *See* Rohter, *supra* note 354, at 16 (noting United States blocked discussion efforts).

370. For a discussion of the current administration's dealings on climate control, *see supra* notes 269-272 and accompanying text.

Convention represents a strong form of the principle.[371] In addition to allowing action to prevent the release of harmful substances into the environment, prior to scientific certainty, the Bamako Convention also disallows the consideration of a cost-benefit calculation to be incorporated into the policy making process.

A strong form of the precautionary principle advises that mitigating steps should not be deferred until scientific certainty is established. An application of a strong form of the principle would suggest that it is unwise to assume that current rates of GHG assimilation in the oceans and atmosphere will remain constant in the future. At a minimum, there are grounds for concern that the ocean's ability to absorb CO_2 and consequently retard the advance of climate change may not be linear. If oceanic CO_2 assimilative capacity slows, extra CO_2 would be retained in the atmosphere. The rates of increase in atmospheric temperatures could possibly rise, resulting in a positive forcing.

The NRC issued a 2002 study explicitly addressing the potential for non-linear climate change.[372] Much of its evaluation was based on an assessment of models currently available to project the likelihood of rapid climate change. The NRC placed limited confidence in these models. Climate models can only partially simulate the extent of the large climatic changes that have occurred. The models may be incomplete, or not as sensitive to abrupt climate change as the natural environment.[373]

For example, deep-ocean circulation such as the North Atlantic Thermohaline Circulation (THC) may be adequately represented in climate models. This ocean current brings warm water from the tropics and the South Atlantic to the North Atlantic Ocean surface region and causes colder water to sink to much deeper levels; this occurs at least in part because of ocean water density and salinity differences.[374] Evidence exists showing that

371. *See* Bamako Convention, *supra* note 351 (stating that each party shall strive for precautionary approach).

372. *See* NATIONAL RESEARCH COUNCIL, *National Academy of Sciences, Abrupt Climate Change: Inevitable Surprises* 1, 2002 [NRC *Abrupt Climate*] http:books.nap.edu/openbook.php?record_id=10136&page=R1 (discussing findings of 2002 study).

373. *See id.* at 4 (explaining problematic features of past models).

374. *See generally,* W. Broecker, *The Great Ocean Conveyor,* 4 OCEANOGRAPHY 79 (1991) (providing explanation of thermohaline circulation). One of the best accounts of the operation of the thermohaline circulation, and of a specific aspect of that circulation known as the north Atlantic deep water (NADW) circulation, has been provided by a professor of geochemistry based at Columbia University, who was one of the earliest investigators of possible past abrupt climate change. *See id.*

THC changes have driven interglacial climate changes in the past.[375]

In the Executive Summary of the NRC's report, the "current scientific emphasis on abrupt climate change was motivated by strong evidence in proxy records that showed extreme climatic changes in the past, sometimes occurring within periods of fewer than [ten] years."[376] Whether we are approaching such a precipice is unknown. In addition, whether the assimilating capacity of the global environment is linear is uncertain. If it is linear, we do not know whether it would remain so, and thus, whether the velocity of change in climate is linear remains unknown. Since discernible signals indicate that the global environment's assimilative capacity might be non-linear, a shift from the current weak precautionary formulation of the administration as a basis for policy might be proper.

Two additional areas of inquiry surrounding the likelihood of abrupt or precipitous climate change and current United States climate change policy warrant comment. First, there is the question of whether there has been a discernible paradigm shift among climatologists regarding the likelihood of abrupt climate change. Second, there is a question regarding the sufficiency of the evidence used to prove the concentration of GHGs, particularly carbon dioxide, has served as an abrupt change trigger. The underlying issue emerging from these questions is whether the United States policy, emphasizing adaptation to the consequences of climate changes, is the most prudent approach given some likelihood of abrupt change greater than zero.

Strong evidence exists that abrupt climate change has occurred with some frequency during the past quaternary period of 250,000 years, which includes alternating epochs of glacial-intergla-

375. Andrew J. Weaver & Tertia M. C. Hughes, *Rapid Interglacial Climate Fluctuations Driven by North Atlantic Ocean Circulation*, 367 NATURE 447, 449 (1994) (discussing results of scientific experiments leading to this conclusion). Other sources state:

> It is worth remembering that models such as those used in the Intergovernmental Panel on Climate Change report consistently underestimate the size and extent of anomalies associated with past changes of the THC; if the underestimate results from lack of model sensitivity possibly linked to overly coarse resolution or other shortcomings rather than from improper specification of forcing, future climate anomalies could be surprisingly large.

NRC *Abrupt Climate*, *supra* note 372, at 116 (discussing potential effect of underestimating anomalies associated with THC).

376. *See id.* at 6 (discussing origin of concern regarding climate change).

cial climate.[377] The view that climate change occurred in a gradual manner, with moderate temperature gradients, over millennia was pervasive in climatology through the first half of the twentieth century.[378] That former paradigm appears to have shifted in recent decades.[379] This paradigm shift in climatology has been accepted by the National Research Council (NRC),[380] although it took some years for the scientific community to adapt to the notion that the climate system could be highly variable.

Definitions of abrupt climate change vary mostly by whether the attempt is to define the idea in the temporal sense, or in a relatively stable climate state context.[381] In general, an abrupt climate change occurs when the climate system is pushed across some threshold, triggering a shift to a new state. The climate system itself modulates the rate of this shift; this rate is more rapid than the cause of the shift.[382]

The scientific community recognized that the global climate system should be characterized as having been subject, at times, to

377. *See* M. Anklin et al., *Climate Instability During the Last Interglacial Period Recorded in the GRIP Ice Core*, 364 NATURE 203, 207 (1993) (discussing evidence of past abrupt climate changes); *see also* W. Dansgaard et al., *Evidence for General Instability of Past Climate From a 250-kyr Ice-Core Record*, 364 NATURE 218, 219 (1993) (discussing evidence of past instability in climate as well as abrupt climate change).

378. *See* Spencer Weart, *The Discovery of Rapid Climate Change*, 56 PHYSICS TODAY 30, 31 (2003) (noting researchers have only recently accepted possibility of abrupt climate change).

379. *See* Claus U. Hammer et al., *Preface* 102 J. GEOPHYSICAL RES., 26, 315 (1997) (noting special issues speaks to question of paradigm shift). This entire issue of one scientific journal has a compilation of 47 articles detailing research drawn from the Greenland ice cores of the Greenland Ice Sheet Project2 (GISP2), and the European Greenland Ice Core Program (GRIP). *See id.*

380. *See* NRC, *Abrupt Climate*, *supra* note 372, at 16 (reporting new thinking was not well appreciated in wider community of natural and social scientists).

381. *See* National Climactic Data Center, National Oceanic and Atmospheric Agency, *Abrupt Climate Change*, http://www.ncdc.noaa.gov/paleo/abrupt/story1.html (last visited Oct. 24, 2007) [NCDC, *Abrupt Climate Change*] (discussing systematic measurements used by scientists studying abrupt climate change). This latter manner of defining climate change has been labeled "mechanistic." National Climate Data Center, National Oceanic and Atmospheric Agency, *Abrupt Climate Change*, http://www.ncdc.naa.gov/paleo/abrupt/story2.html (defining climate change terms). Also note that when referring to the temporal sense, it is important to consider the span of time in which the change, whatever the magnitude, must be confined. *See id.*

382. *See id.* (discussing rate of climate system shift).

certain precipitate fluctuations[383] in particular climate attributes.[384] The latter idea seems a better fit to current understanding where temperatures, ice, and snow cover, and GHG concentrations all remain within a relatively narrow flux, with significant change in those attributes occurring only over many millennia.[385]

An aspect of the paradigm shift in climatology, or paleoclimatology, is most striking. Not only has climate change happened in the past with some frequency, but also the past change is now known to have occurred in some instances on decadal time scales, making the magnitude of the change surprising.[386] It is now well-established that the current interglacial period, the Holocene, regarded in earlier decades as a period of relative warmth and stability, is now known to have been subject to abrupt changes in climate of some magnitude, although perhaps not on the same scale as changes (also frequently abrupt) recorded during glacial epochs.[387]

The key question is what drove climate change in the past, specifically what mechanisms or forcings brought about such

383. *See* Taylor et al., *The 'Flickering Switch' of Late Pleistocene Climate Change*, 361 NATURE 432, 432-34 (1993) (reporting electrical conductivity measurements from Greenland ice core revealing rapid climate change); *see also*, W. Dansgaard et al., *supra* note 377, at 219 (stating that scientific community recognizes climate changes).

384. For a discussion of historical climate changes, *see supra* note 376 and accompanying text. Climate attributes include atmospheric temperatures, water vapor, and cloud content, ocean surface temperatures, ice and snow cover and trace gas concentrations in the atmosphere (including GHGs). *See id.*

385. *See* NRC, *Abrupt Climate Change*, *supra* note 372 (characterizing climate element). Recent work by glaciologists has suggested that a loss of ice cover in Greenland and West Antarctica is occurring and is in fact accelerating, and the loss of ice cover is not just from meltwater. *See id.* "Now glaciologists have a second mechanism for the loss of ice: accelerated flow of the ice itself, not just its meltwater, to the sea." Richard Kerr, *A Worrying Trend of Less Ice, Higher Seas*, 311 SCI. 1698, 1701 (2006). The evidence is particularly striking. "Although the duration of the recent warming is too short to determine whether it is an anthropogenic effect or natural variability, in either case, the data suggest that modest (~1°C) changes in temperature can lead to large changes in discharge of glacial ice to the ocean." Ian Joughlin, *Greenland Rumbles Louder as Glaciers Accelerate*, 311 SCI. 1719, 1719 (2006) (finding that changes in temperature can lead to glacial ice).

386. *See* R.B. Alley et al., *Abrupt Increase in Greenland Snow Accumulation at the End of the Younger Dryas Event*, 362 NATURE 527, 529 (1993) (noting climate transformations); *see also* Jonathan T. Overpeck, *Warm Climate Surprises*, 271 SCIENCE 1820 (1996) (describing changes in climate system); W. Dansgaard et al., *The Abrupt Termination of the Younger Dryas Climate Event*, 339 NATURE 532, 533 (1989) (suggesting changes in climate system).

387. *See* O'Brien et al., *Complexity of Holocene Climate as Reconstructed from a Greenland Ice Core*, 270 SCIENCE 1962, 1964 (1995) (describing climate change during Holocene).

change.[388] The paleoclimatology community is seeking to determine which of several candidate forcings (although not necessarily internal to the climate system)[389] served as the primary trigger for past abrupt climate change.[390] Three candidate forcings which received significant attention are orbital,[391] volcanic, and solar.[392] Some investigators, however, have indicated that these forces may have less explanatory power for *abrupt* climate change than the forcing produced by changes in ocean current density, salinity, and temperature, coupled with atmospheric transport of GHGs, including water vapor.[393]

Although there is not universal acceptance that this is the most plausible hypothesis, changes in the THC explanation for abrupt climate change have generated voluminous study:

> [I]n the presently most likely hypothesis, warm, salty water flowing into the North Atlantic densifies as it cools and then sinks. However, precipitation and runoff from surrounding land masses supply more fresh water to the North Atlantic than is removed by evaporation. Failure of sinking would allow freshening to decrease surface den-

388. *See* NRC, *Abrupt Climate Change*, *supra* note 372 (considering climate change over period of time because of mechanism internal or external to system).

389. *See* Houghton et al., *supra* note 38, at 87 (describing forcings not derived from one of five components considered external). The IPCC defines the climate system as "an interactive system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere [ice cover], the land surface and the biosphere." *See id.*

390. *See* R. B. Alley et al., *Abrupt Climate Change*, 299 SCI. 2005, 2006 (2003) (determining which forcing was primary trigger for past climate change).

391. *See id.* There has been thorough investigation of the thesis that orbital forcing is an important factor in explaining variations in ice cover of great magnitude (sometimes producing ice ages or glacial periods). *See id.* This astronomical theory of ice ages suggests that the most important parameters of orbital forcing are the angle of inclination of the earth's axis, and the precession of the equinoxes due to the "wobble" of the earth's axis. *See id.* These attributes of orbital forcing "strongly affect the distribution of available energy between latitudes and seasons." *See* C. Lorius et al., *The Ice-Core Record: Climate Sensitivity and Future Greenhouse Warming*, 347 NATURE 139, 141 (1990) (suggesting orbital forcing affects latitudes and seasons).

392. *See* Thomas Crowley, *Causes of Climate Change Over the Past 1000 Years*, 289 SCI. 270, 271 (2000) (considering study of volcanic and solar forcings on millennial time sealers). *See generally* David J. Thomson, *Dependence of Global Temperatures on Atmospheric CO_2 and Solar Irradiance*, 94 PROC. OF THE NAT'L ACAD. OF SCI. OF THE U.S. 8370 (1997) (exploring solar irradiance hypothesis).

393. *See* Wallace S. Broecker, *Thermohaline Circulation, the Achilles Heel of Our Climate System: Will Man-Made CO_2 Upset the Current Balance?*, 278 SCI. 1582, 1584 (1997) (discussing power of changes in ocean and atmospheric elements).

> sity, preventing further sinking and the associated inflow of warm waters.[394]

Researchers believed this change in circulation of warm and cold water between different regions of the ocean would have consequences. One of those consequences would be a redistribution of CO_2 between the cold and warm water ocean reservoirs, resulting in a change in atmospheric CO_2 content.[395] Individual reservoirs would thus have an increased concentration of CO^2.

If the increased concentration of CO_2 (and other GHGs) derived from changes in the thermohaline circulation is large, past abrupt climate change may be more fully explained.[396] If GHGs may have been responsible for past abrupt climate change, through natural forcing, then GHGs generated from anthropogenic activity may produce a similarly rapid future change in climate.[397] Ocean current flux, as a climate system perturbation needed for abrupt climate change, is only one of several candidate triggers that have been investigated. Changes in ocean temperature, salinity and circulation have received as much or more study as the other possible perturbations.[398] Work on connecting past abrupt changes in North Atlantic surface-ocean and atmospheric temperature with variation in deep ocean circulation has made significant progress in recent years. This work has strengthened the belief that major reorganizations of the Atlantic THC have played an important role in abrupt climate change.[399]

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394. *See* Alley et al., *supra* note 390, at 2006 (suggesting change in circulation of warm and cold water could result in climate change).

395. *See* Wallace S. Broecker et al., *Does the Ocean-Atmosphere System Have More Than One Stable Mode of Operation?*, 315 NATURE 21, 23 (1985) (citing Broecker's previous works which have been refined over several years). *See also* Broecker, *supra* note 393, at 1585-86 (discussing sedimentary cycles).

396. *See* Lorius et al., *supra* note 391, at 141 (suggesting increased CO_2 could have caused past climate change); *see also* Peter U. Clark et al., *The Role of the Thermohaline Circulation in Abrupt Climate Change*, 415 NATURE 863, 869 (2002) (explaining how GHG may have caused reduction in Atlantic thermohaline circulation).

397. *See* Peter A. Stott et al., *External Control of 20th Century Temperature By Natural and Anthropogenic Forcings*, 290 SCI. 2133, 2136 (2000) (discussing GHGs effects on climate change).

398. *See* Britton B. Stephens & Ralph F. Keeling, *The Influence of Antarctic Sea Ice on Glacial-Interglacial CO_2 Variations*, 404 NATURE 171, 174 (2000) (suggesting reduced ventication was driven by increased sea ice); *see also* Minze Stuiver, *Solar Variability and Climatic Change During the Current Millennium*, 286 NATURE 868, 871 (1980) (setting causes of possible perturbations); *but see* Hartmut Grassl, *Status and Improvements of Coupled General Circulation Models*, 288 SCI. 1991, 1993 (2000) (discussing other factors of abrupt climate change).

399. *See* Clark et al., *supra* note 396, at 863 (discussing past changes in thermohaline circulation); *see also* Jean Lyncy-Stieglitz, *Hemispheric Asynchrony of Ab-*

It is far from certain whether a perturbation to the climate system generated by anthropogenic activity will produce abrupt climate change in the future similar to past changes.[400] It is clear that abrupt change has occurred in the recent past, during the current interglacial period, especially on a regional or hemispheric scale.[401] There has not been consensus as to what is the most likely triggering mechanism for past episodes of abrupt climate change, particularly during the Holocene, which is approximately the past 10,000-11,000 years.[402] Further, the changes in the ocean current circulation hypothesis have not always received the strongest support.[403]

One of the best connections between past abrupt climate change (non-anthropogenic) triggers and possible future abrupt climate change (anthropogenic) triggers is based on changes in ocean current circulation and the resultant ability of the ocean to act as a sink for atmospheric carbon dioxide. When the ocean acts as a sink, it is engaging in carbon uptake of anthropogenic CO_2.

> We investigated a *potentially* important positive feedback loop that involves atmospheric CO_2, global warming, the hydrological cycle, ocean circulation, and the marine carbon cycle in a world of continued carbon emissions. Rising atmospheric CO_2 leads to increased radiative forcing, resulting in higher sea-surface temperatures (SSTs) and a stronger hydrological cycle that may reduce sea surface salinity at high latitudes. These changes may induce a reorganization of the thermohaline circulation (THC) and a collapse of the North Atlantic Deep Water (NADW) formation, a reorganization of the marine carbon cycle, and a reduction in the surface-to-deep transport of anthropogenic carbon. The resulting reduction in oceanic carbon

rupt Climate Change, 304 SCI. 1919 (2004) (discussing past rapid and dramatic changes of climate).

400. *See* Stott et al., *supra* note 397, at 2136 (discussing uncertainty of future climate changes).

401. *See* J. C. Stager & P. A. Mayewski, *Abrupt Early to Mid-Holocene Climatic Transition Registered at the Equator and the Poles*, 276 SCI. 1834, 1836 (1997) (examining timing of halocene reorganization); *see also* F. S. Hu et al., *Abrupt Changes in North American Climate During Early Holocene Times*, 400 NATURE 437, 439 (1999) (discussing abrupt climate change based on sediments in Minnesota Deep Lake); Lyncy-Stieglitz, *supra* note 395, at 1919 (stating rapid climate change occurred in past).

402. *See* Overpeck, *supra* note 386, at 1820 (detailing returned attention to changes during Holcene).

403. *See* Crowley, *supra* note 392, at 275 (suggesting thermoalic arculation changes play secondary role to climate changes).

> uptake may in turn accelerate the atmospheric CO_2 growth.[404]

This investigation is a valuable extension of work carried out at an earlier time. The reorganization of the THC and consequent reduction of surface-to-deep-ocean transport of anthropogenic carbon is a human-induced modification of the process pointed to several decades ago by Broecker and Takahashi.[405]

Though an oversimplification of the relationship, there is at least one association between the ocean surface temperature and the concentration of atmospheric CO_2 exists. Historically, an increasingly warm ocean may have been less able to absorb carbon dioxide, thus increasing the greenhouse effect. The enhanced greenhouse effect occasionally brought rapid climate change.[406]

Different candidate triggers, possibly producing the perturbation in the climate system necessary to rapidly move the system past a certain threshold and into a different state, brought about the confirmed record of past abrupt climate change. Members of the scientific community voiced concern that the anthropogenic production of GHGs may provide a similar perturbation (an external forcing), producing a similar rapid switch of the climate system into a new state.[407] This concern has evoked the question of how likely a perturbation and subsequent switch of the system into a new state or equilibrium will occur in the future.

Climate change skeptics expressed criticism toward the reliance on General Circulation Models (GCMs) to gain greater predictive ability.[408] Other climate scientists have argued that the

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404. *See* Fortunat Joos et al., *Global Warming and Marine Carbon Feedbacks on Future Atmospheric CO_2*, 284 SCI. 464 (1999) (citations omitted) (emphasis added) (discussing global warming simulations that show weakening of North Atlantic THC circulation).

405. *See* Broecker et al., *supra* note 395, at 23 (citations omitted) (explaining that an earlier paper used several-fold higher rate of transfer between cold and warm water spheres to explain lower CO_2 during glacial time period).

406. *See* Alley et al., *supra* note 386, at 2009 (stating that data indicates dramatic climate changes occurred often in past). "Although the largest effects were centered on land-surface moisture and high latitude temperatures, the climatic effects were global." *Id.*

407. *See* Broecker, *supra* note 393, at 1587 (explaining concern of abrupt climate change); *see also* Clark et al., *supra* note 396, at 863 (theorizing increasing CO_2 levels could trigger abrupt change in earth's climate).

408. For a discussion of the criticism toward reliance on GCMs, *see supra* note 106 and accompanying text. "Even if we are not right . . . the failure of models to simulate observations makes it even less likely that models are a reliable tool for predicting climate." *Id.* This comment by Lindzen has been weakened by a recent paper which shows that current model refinements have allowed the models to capture an increasing concentration of water vapor in the upper troposphere.

models need not be abandoned, only improved.[409] The latter climate scientists called for the kind of work that appears to be occurring currently. Scientists have recently conducted investigations of abrupt (sub-decadal) climate change coupled with GCMs executing simulations, both with and without external forcing.[410]

At least some of these models appear to have achieved a measure of success. One participant in the paleoclimatology enterprise has expressed confidence that "improved models evaluated against expanded high-fidelity paleoclimate databases are on the horizon, and should be adequate to support policy decisions concerning the reduction of fossil-fuel CO_2 emissions."[411] If the findings of these improved models prove able to replicate the actual results from a large series of GCM simulations, certain national policy modifications may be necessary.

The policy modifications should be driven by a sense of urgency. There is a lack of certainty that abrupt climate change brought about by an anthropogenic activity is any more likely than abrupt climate change generated through multiple potential internal forcings. Because of the possible harms abrupt climate change may bring to particular regions and possibly to the globe, this Article suggests a more expeditious United States public policy stance regarding climate change.

Given the recent evidence from the paleoclimatic record, the likelihood of future abrupt climate change is high. It is not currently possible to predict how soon abrupt change will occur or how imminent such change might be.[412] Given some likelihood that climate change could be abrupt rather than gradual and could occur

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This increased concentration is termed a "moistening" effect. *See* Brian J. Soden et al., *The Radiative Signature of Upper Tropospheric Moistening*, 310 SCI. 841-44 (2005) (examining the connection of water vapor to climate changes).

409. *See* Overpeck, *supra* note 386, at 1821 (discussing expanding testing of predictive models). Overpeck notes: "If the climate system turns out to be highly sensitive to elevated atmosphere trace gas concentrations, then we may be confronted with modes of climate variability without precedent. This possibility further highlights the need to expand our testing of predictive models against the varied patterns of significant paleoenvironmental change." *Id.*

410. *See* Alex Hall & Ronald J. Stouffer, *An Abrupt Climate Event in a Coupled Ocean-Atmosphere Simulation Without External Forcing*, 409 NATURE 171, 174 (2001) (discussing use of coupled ocean-atmosphere model); *see also* Stott et. al., *supra* note 397, at 2136 (detailing simulated change in ocean surface temperatures).

411. *See* Lee R. Kump, *Reducing Uncertainty About Carbon Dioxide as a Climate Driver*, 419 NATURE 188, 190 (2002) *available at* http://www.nature.com/nature/journal/v419/n6903/full/nature01087.html (last visited Oct. 20 2007) (explaining improvement in indicator technology).

412. *See* Overpeck, *supra* note 386, at 1820 (noting that goal of research is to improve predictive capacity).

in the near term rather than in the distant term, it might seem wise to pose some alteration in the current United States climate change posture. As the current administration relies on adaptation to address the consequences of climate change, foregoing a greater emphasis on mitigation (reducing GHG emissions), the need for policy alteration is particularly evident.[413]

The Final Climate Change Science Program Strategic Plan recognizes the need to address mitigation. The Plan questions what future projections can be made about the effectiveness and cost of alternative energy and mitigation technologies, including possible sequestration options.[414] The response to the posed question should be an effort to develop assessment models better able to analyze the social and economic effects of efforts to reduce greenhouse gas emissions.[415]

The response is meant to help answer the larger question of how to evaluate the primary human drivers of global environmental (climatic) change.[416] An equally large question posed is "what factors influence the capacity of human societies to respond to change, and how resilience can be increased and vulnerability reduced?"[417] The response provided in the Strategic Plan is, in part, to give attention to "the associated costs and benefits of adaptation strategies, [and] strategies for mitigating the impacts of global change on different economic sectors and people in different loca-

413. *See generally* Gamble & Simpson, *supra* note 212 (discussing United States administration reliance on adaptation to consequences of climate change). This chapter is the preeminent statement in the current administration's Strategic Plan on how anthropogenic activity may be contributing to climate change, and in the administration's view, what the appropriate response to climate change ought to be (regardless of the origins of climate change). There is some attention given to mitigation (in reducing GHG emissions) in the chapter, but it is certainly not expansive; for example, "Evaluations will be developed of the economic opportunities to reduce greenhouse gas emissions or increase sequestration in the agriculture and forestry sectors." *Id.* at 95. A much more extensive discussion of adaptation is contained in the chapter, of which the following statement is illustrative:

> [L]ittle is known about the effectiveness of applying adaptation experiences with past and current climate variability and extreme events to the realm of climate change adaptation, nor about how this information could be used to improve estimates of the feasibility, effectiveness, and costs and benefits of adaptation to long-term change.

Id. at 95.

414. *See id.* at 94 (specifying questions still remaining in realm of technological change).

415. *See id.* at 95 (identifying key research needs).

416. *See id.* at 93 (summarizing major questions on global change).

417. *See id.* at 95 (summarizing another question regarding human change).

tions and economic brackets . . . ."[418] Here, mitigation means the amelioration of the consequences of climate change, rather than a reduction of the sources of climate change.

It is important that human vulnerabilities to climate change be reduced. The positioning of research priorities (GHG reduction against a reduced human vulnerability to climate change) in this section of the revised Strategic Plan gives one pause in grasping where the greater emphasis resides. This Article argues that an equivalent emphasis on both GHG reduction (mitigation) and adaptation is insufficient and ill-advised; a greater emphasis must be placed on mitigation.

Adaptation measures require some minimum time frame for implementation. The parameters of these time frames will vary with the pains taken and expenditures put forward by the current administration. The receptiveness of states asked to embrace adaptation measures and their implementation is central to the success of an adaptive policy.[419] The consequences of climate change, either gradual or abrupt, need not be catastrophic. Abrupt climate change, if it were to occur, would shorten the time frames necessary for the implementation of adaptive measures. The magnitude of certain consequences from gradual or abrupt climate change could ultimately be comparable, such as a two-foot rise in sea level. Because abrupt climate change compresses societal response time, however, the consequences of a two-foot rise in sea level would be more harmful.

Some commentators believe the precautionary principle has not reached the level of a peremptory norm, a norm "from which no derogation is permitted."[420] This may indeed be the

418. *See* Overpeck, *supra* note 386, at 1820 (articulating where analysis should be focused).

419. *See* Gamble & Simpson, *supra* note 212, at 96 (determining that embracing and implementing adaptation measures is essential). The (revised) FINAL STRATEGIC PLAN comments: "Much of this research will need to be place-based analysis at regional and local scales in order to capture the complexities of the human-environment interface and the adaptive strategies of individuals, industries, institutions, and communities . . . . " *Id.*

420. *See* Vienna Convention on the Law of Treaties, May 23, 1969, 8 I.L.M. 679, 1155 U.N.T.S. 331 (defining peremptory norm). The full article, "Treaties Conflicting With A Peremptory Norm Of General International Law," (*Jus Cogens*) states:

> A treaty is void if, at the time of its conclusion, it conflicts with a peremptory norm of general international law. For the purposes of the present Convention, a peremptory norm of general international law is a norm accepted and recognized by the international community of States as a whole as a norm from which no derogation is permitted and which can

case.[421] If this is true, the United States faces no international restraints against, or reprobation for, its decision to employ a weak, utilitarian, and pedestrian restatement of the principle. In the case of climate change, however, accepting the risks of such a restatement of the precautionary principle may be unwise.

Other observers have opined that the precautionary principle has achieved a status of a norm in international law, if not yet a peremptory norm.[422] This view on the precautionary concept "rejects a policy based on the assumptions that science can accurately determine the assimilative capacity of the environment and that, once determined, sufficient time for preventive action will remain."[423] By failing to employ a robust version of the precautionary principle, the United States may be accepting a large risk at the global community's peril.

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be modified only by a subsequent norm of general international law having the same character.

See id.

421. *See* Hickey & Walker, *supra* note 273, at 432 (determining peremptory norm may not have been reached). "No uniformity exists regarding the definition of the term 'precautionary principle' or regarding when and how the principle should be applied." *Id.*

422. *See* Phillipe Sands, PRINCIPLES OF INTERNATIONAL LAW: FRAMEWORKS, STANDARDS AND IMPLEMENTATION 212-13 (1995) (indicating precautionary principle is international norm). "This level of academic support, coupled with recent State practice and ICJ commentary, would appear to conclusively endorse the principle's status as a norm of customary international law." *Id.*

423. *See* Ellen Hey, *The Precautionary Concept in Environmental Policy and Law: Institutionalizing Caution*, 4 GEO. INT'L. ENVTL. L. REV. 303, 305 (1992) *cited in* Gregory D. Fullem, Comment, *The Precautionary Principle: Environmental Protection in the Face of Scientific Uncertainty*, 31 WILLAMETTE L. REV. 495, 498 n.13 (1995) (stating policy rejected by precautionary concept).