Written Public Comments on the *Strategic Plan for the U.S. Climate Change Science Program*
Chapter 4: Decision Support Resources (pp 38-53)
Comments Submitted 11 November 2002 through 18 January 2003
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Page 38, Chapter 4: This chapter does well to include both the physical climate and impacts modeling right at the outset. However, the bulk of the chapter is then dedicated to ways of achieving the most refined climate models, while impact modeling (to which the climate models must connect for decision support) is given short shrift. And while we can spend much money on super computers for more accurate climate projections, I believe that the largest knowledge gaps exist in the downstream impacts modeling and require further attention in order to support decision making.

JONATHAN PATZ, MD, MPH, JOHNS HOPKINS BLOOMBERG SCHOOL OF PUBLIC HEALTH

Page 38, Chapter 4: I am providing comments largely based on almost 5 years of experience as a co-investigator on the Climate Assessment For the Southwest (CLIMAS) project, which is one of the Regional Integrated Assessments (RISAs) funded by NOAA-OGP, and two years of experience on an EPA-STAR funded project to build a GIS model to produce fire risk maps based on integration of climate, fuels, fire history, and human factors components.

Reaching and Serving the Public

Sustaining *integrated* public participation needs to be more fully addressed. RISAs and other similar programs provide valuable bridges over which the kinds of knowledge generated through this program can reach stakeholders. For example, the RISA goal of assessing the impacts of climate variability on human and natural systems, and doing the research needed to provide the kinds of information required to eliminate or mitigate those impacts provides a way to move stakeholders up the learning curve in a manner that facilitates their ability to understand and employ climate change information.

It is important to stress the value of developing and using good scenarios and narratives that fit into regionally based stakeholders' experience and understanding of their milieu. Such tools provide a means of identifying and evaluating perceptions of exposure to different kinds of risks, and furnish a window of opportunity for changing ways of thinking based on invalid heuristics and illusions.

Meeting the scientific challenges

The plan should explicitly recognize the societal challenges associated with the long time frame needed to develop good regional scale models, not the least of which are the need to sustain stakeholder interest in involvement during the interim, and making sure that unrealistic expectations do not arise with regard to what the models will and will not be able to do.

Definitions of "region" vary greatly and care must be taken to assure that the definition of the "region" fits the particular problem(s) being addressed. Further, the plan needs to explicitly recognize and detail the resources required to build a regionally based science program that also encourages analysis of impacts and implications across *multiple scales*. From a societal perspective, this means working toward not only understanding how climate affects society and the environment within the defined region, but also how these impacts affect human and natural systems elsewhere – as well as how climate impacts elsewhere affect the region being assessed. Climate impacts work already carried out clearly reveals the deep connectedness of society at scales ranging from the super-regional to the national, international, and global. Climate science cannot afford to ignore the linkages and interactions occurring at multiple spatial, and temporal, scales. At the very least, the plan should recognize the importance of carrying out research at the scale of North America; there are too many interconnections and interrelationships among the USA, Canada, and Mexico to ignore this scale of inquiry.

From a biophysical perspective, even within the US, conducting multiscalar research involves installation of the kinds of infrastructure that will facilitate regional-scale observations, analysis, and dissemination of the fruits of such research. Good examples from our region include the need for a much better understanding of the North American Monsoon and better data characterize and understand ecological persistence and change. The former of these is somewhat addressed within the North American Monsoon Experiment initiative, but much more remains to be done. The latter requires a strongly stated commitment to fund a national ecological observation network, such as NEON.

Decision Support Factors

While much attention is paid to the regional scale, climate and weather happen in *local places*. I am convinced that the plan would be much more compelling if the local scale was better reflected, especially in this chapter. The science plan should articulate the importance of place-based science, and of the importance of involvement of community members in development and implementation of climate research projects aiming to improve decision capacity at local scales.

The chapter rightly stresses the importance of relevance to real-world problems. I strongly recommend that the text explicitly recognize that relevance is determined by society and its perceptions, risks, and values. This is not a simple concept, and grasping what "relevance" means in particular contexts requires active engagement of those who bear the impacts, as well as the advantages, of what science produces.

Along these same lines, it is important to keep in mind that science, as operationalized, is not neutral; rather, careful assessment of who benefits and who pays is essential and reinforces – particularly in the public's mind, the practice of socially responsible science. Supporting decision making processes entails.

This is one of the areas where regional integrated assessment activities have a lot to offer in terms of providing sustained engagement of stakeholders, concern for relevance, and expertise in assessing benefits and impacts. Again, this chapter should explicit recognize productive assessment activities and articulate how proposed activities would build on this work.

In light of the above comments, I would like to comment on the importance of assuring the *usability* of products and knowledge produced within this plan. Usability cannot be shortchanged. It requires careful research and analysis, and normally requires one or more iterations to "get things right." The plan would be stronger in demonstrating its goal of supporting relevant science if text were added that explicitly commits to assuring not only relevance but real-world usability – including all facets from user testing through attention to questions such as how things will be delivered, maintained, and updated. Also important is recognizing the potential need to educate users regarding how to interpret the information, provision of warnings about how the information should *not* be used, confidence levels, error bars, and other methods of providing as much guidance as possible for integrating the information into decision processes.

BARBARA MOREHOUSE, UNIVERSITY OF ARIZONA

Page 38, Chapter 4: Overview Comments: Decision Support Services constitutes a critically important facet of this draft Strategic Plan. Effective communication between the science community and decisionmakers at all levels regarding the scientific understanding of global climate change is a necessary precursor to responsible decisionmaking. With this fact in mind, there exist three main areas where this draft chapter fails to include the necessary stipulations called for by Dr. Mahoney's stated goals for the CCSP. **First, where emphasis is placed on communicating uncertainties to decisionmakers, too little emphasis is placed on the equally important need to communicate what is already scientifically understood.** Only with such complete information will decisionmakers be able to take responsible action in the near and long terms. Specifically, the risks posed with delaying action based on lingering uncertainties must be clearly communicated to decisionmakers in the short-term, and can only be done so based on current scientific understanding. Second, recognition must be given to the work that has already been undertaken on global climate change. The CCSP research effort should move forward by building upon these previous efforts, particularly the National Assessment, as a repetition of these previous assessments and research efforts will not only be a waste of resources but will delay the CCRI's goal of effectively communicating scientific evaluations regarding global climate change. Third, the chapter fails to include municipal decisionmakers within the definition of decisionmakers used by the chapter. Decisionmakers at the municipal level are important stakeholders with regard to climate change and their place within the decision support services must be strengthened. In sum, the CCSP must aim to efficiently move scientific research forward while aiding decisionmakers with a timely supply of holistic information regarding both current knowledge and lingering uncertainties.

EESI, CAROL WERNER AND J.R. DRABICK

Page 38, Chapter 4: **First Overview Comment:** Our Second Overview Comment on Chapter 1 challenged the notion that the research agenda of the CCSP should be guided by what is "policy relevant." Even assuming, for the sake of argument, that the research questions should be "policy relevant," Chapter 4 totally fails to indicate in meaningful ways what the processes or mechanisms should be "to identify policy decisions that should influence the focus of climate change research programs." (p. 40). Apparently, none currently exist, for the draft Strategic Plan states (p. 41): "The CCRI will *attempt to establish mechanisms* to foster a new class of working relationships to ensure that relevant issues are identified, articulated, and communicated to the research community." (emphasis added)

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It is remarkable that the draft Plan would tie the science research program to what is "policy relevant" (i) without knowing whether an acceptable process *can* be developed for determining what the "policy relevant" issues should be or (ii) without taking the time to suggest in the draft Strategic Plan what that process might look like.

In fact, it is rather worrisome that the draft Plan (p. 41) contemplates that the "CCRI will devote attention to the type of *institutional changes* necessary to forge effective interaction between research processes and policy development." (emphasis added). What is intended? To what extent would the "institutional changes" result in replacing the existing processes by which the federal science research agenda is established? For example, to what extent could the new institutional arrangements result in changing the preeminent role played by the Energy Information Administration in the identification and subsequent analysis of economics issues? What are the guiding principles for the new institutional arrangements – principles that would be aimed at assuring, for example, accountability and that a relatively small clique of individuals is not given free reign to mold federally sponsored climate-change science research to achieve their political objectives?

The draft Plan (p. 42) apparently allows six months for "[s]election of a set of potential policy relevant questions that require information support from the climate change community through a stakeholder/scientist interactive dialogue." Not indicated in the draft Plan is how much time will be allowed to identify and then establish the mechanism (the "institutional changes") that would be required for such "dialogue."

Second Overview Comment: The draft Strategic Plan states (p. 46): "A specific set of scenarios that can be used to address relevant policy and resource management questions – at the national, regional, and sectoral levels – will be developed in collaboration with stakeholders (2 years)." That raises a number of serious concerns.

(1) The draft Plan says (p. 46): "Decisionmakers, resource managers, and other stakeholders will be engaged to help identify the types of scenarios that could be used to provide them with timely and useful information. The CCRI will develop logical and internally consistent scenarios with input from the full range of relevant stakeholders . . . ." The draft Plan lacks any information that describes what the processes would be that involve input from decisionmakers and stake-holders on the separate tasks of (i) identifying types of desirable scenarios and (ii) actual development of the types of scenarios that are desired.

In developing those processes, the Strategic Plan should take into account that emissions scenarios drive the output of the climate models and, therefore, are highly capable of being politicized in order to achieve climate projections that support predetermined policy objectives. This was apparent throughout much of the development of the IPCC's SRES scenarios. The Strategic Plan should focus on ways to reduce that problem with respect to its scenarios identification and development.

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(2) The draft Plan says (p. 46): "The CCRI will coordinate its scenario development plans with the new IPCC scenario efforts." To begin with, it is not clear whether that statement refers to new IPCC impact scenarios or potential "updates" of the IPCC's emissions scenarios. More importantly, the draft Plan fails to explain what it contemplates by way of "coordination" and what types of scenarios used by the U.S. research program should or should not differ from IPCC scenarios.

(3) The draft Plan does not indicate when, if ever, emissions and impact scenarios it will develop should reflect *climate-change policies*. Generally, we agree with the IPCC's refusing to build scenarios based on *government policies* (climate and non-climate) that have not yet been enacted into law. The Strategic Plan should discuss the circumstances when climate-change policy proposals (such as legislation being given serious consideration by a congressional committee) should be the basis for a "scenario."

(4) The Strategic Plan should take into account the desirability of developing scenarios that have time horizons shorter (in some cases, perhaps substantially shorter) than the 100-year scenarios typically relied on by the IPCC. This is because, as the IPCC recognized when it first assessed its scenarios:

> "Scenario outputs are not predictions of the future, and should not be used as such; they illustrate the effect of a wide range of economic, demo-graphic and policy assumptions. They are inherently controversial because they reflect different views of the future. The results of scenarios can vary considerably from actual outcomes even over short time horizons. *Confidence in scenario outputs decreases as the time horizon increases, because the basis for the underlying assumptions becomes increasingly speculative.* Considerable uncertainties surround the evolution of the types and levels of human activities (including economic growth and structure), technological advances, and human responses to possible environmental, economic and institutional constraints. Consequently, emission scenarios must be constructed carefully and used with great caution." IPCC Working Group I, *Climate Change 1992: The Supplemental Report to the IPCC Scientific Assessment*, pp. 9-10 (1992)(emphasis added).

Nothing in the Global Change Research Act of 1990 *limits* scenarios to 100-year time horizons. See 15 U.S.C. §2936(3), which requires periodic assessment that "analyzes current trends in global change, both human-[induced] and natural, and projects major trends for the subsequent 25 to 100 years."

Given the IPCC's strong cautions about long-time-horizon scenarios, which it grudgingly reiterated in abbreviated form in IPCC Working Group III, *Special Report on Emissions Scenarios*, Summary for Policymakers, p. 11, n. 10 (2000), it would be unacceptable to limit scenarios to 100-year time frames. Further-more, the next version of the Strategic Plan should provide assurance that all reports of scenario-dependent research under the CCSP should contain the previously quoted cautionary conclusion of IPCC Working Group I, which was painstakingly negotiated in 1992 by a broadly diverse group of IPCC officials and researchers, government representatives, and NGO representatives.

(5) The draft Plan fails to discuss how many scenarios will be used for analysis of different types of issues. We agree with the IPCC's approach, which insists on use of multiple scenarios, which reflect a wide range of plausible assumptions, with each scenario being regarded as equally likely. Otherwise, there is, among other problems, unacceptably enhanced risk that one (or a limited number) of scenarios will be emphasized that could distort models' outputs so as to support predetermined policy outcomes.

(6) The draft Plan (p. 46) allows two years for scenario development. Given the experience of the IPCC in developing the SRES scenarios, that probably is unrealistically short. This is particularly true in view of lack of a defined *process* for scenario identification and development, as discussed above.

(7) The draft Plan fails to indicate which of the questions it poses in Chapters 2 and 5 through 11 will experience deferred research in order to enable the scenarios to be developed (theoretically over a mere two years). The next version of the Plan should explain why particular research, *which is substantially scenario dependent*, should proceed before new scenarios are finally developed.

(8) The draft Plan states (p. 44): "Climate model projections are another tool for understanding what future climate might be like, *to the extent of* their scientific credibility and *our ability to develop quantitative statements about levels of confidence.* ...[T]hese projections will not be viewed as specific predictions or forecasts of future outcomes, but rather as *probabilistic* alternative futures that 'paint a picture' of what might happen under particular assumptions." (emphasis added). As a participant stated in the workshop breakout group on "Scenario Development and Risk-based Decision Support," statements in the draft Plan (such as those just quoted) imply that probability analysis is a goal, although the extent to which it will be incorporated in the research program is not clear.

The next version of the Strategic Plan should clarify intentions in this regard and, if inclusion of probability analysis is proposed, there should be explanation in language understandable to policymakers and stakeholders, who are not experts in statistics, why such incorporation is both justified *and* necessary.

We appreciate the point made by Webster *et al*., in *Uncertainty Analysis of Global Climate Change Projections* (MIT Joint Program on the Science and Policy of Global Change, March 2001): "[T]he IPCC does not indicate whether there is a 1 in 5 or 1 in 10,000 chance of exceeding its upper estimate of 5.8ºC." Nevertheless, we are deeply skeptical of what necessarily would be essentially *subjective* estimates of the probability of the occurrence of different emissions scenarios, particularly over long time horizons (as much as 100 years), and of climate-change projections based on such emissions scenarios. Climate model outputs will be significantly driven by emissions scenarios, which, in turn reflect assumptions concerning the aggregate global effect of economic development and changes in economic structure on a regional basis, as well as the extent to which new technologies will be developed and penetrate global society. In these circumstances, the burden of persuasion is on those who would depart from the historic approach of the IPCC – refusal to assess probability in quantitative terms of either emissions scenarios or climate model outputs dependent on such emissions scenarios.

Probability analysis of emissions scenarios necessarily would lead to narrowing the focus on a wide range of plausible scenarios, either by excluding consideration of scenarios that have probability subjectively determined to be lower than that of other scenarios or by subjectively (explicitly or implicitly) assigning greater weight to allegedly "more probable" scenarios. That enhances the risk of politic-ally driven decisions about choice of scenarios, which was a major problem in the debates over the IPCC's SRES. Narrowing the focus of a wide range of scenarios would be contrary to the IPCC's admonition:

> "*The full range of scenarios should be used for climate analysis.* Considering the degree of uncertainty, the wide range of views about future emissions, and the absence of a most likely scenario, it is unwise to use only one scenario for climate analysis. Rather, it is recommended to use the full range of IS92 Scenarios for this purpose." IPCC Working Group III, *An Evaluation of the IPCC IS92 Emission Scenarios,* in *Climate Change 1994: Radiative Forcing of Climate Change and An Evaluation of the IPCC IS92 Emission Scenarios,* pp. 245-246 (1995)(emphasis in original).

The IPCC has been consistent in this regard. For example, the SRES "*recommended that a range of SRES scenarios with a variety of assumptions regarding driving forces be used in any analysis*." IPCC Working Group III, *Special Report on Emissions Scenarios*, Summary for Policymakers, p, 11 (2000). The SRES went on to explain:

> "*There is no single most likely, 'central,' or 'best-guess' scenario, either with respect to SRES scenarios or to the underlying scenario literature.* Probabilities or likelihood are not assigned to individual SRES scenarios. None of the SRES scenarios represents an estimate of a central tendency for all driving forces or emissions, such as the mean or median, and none should be interpreted as such. The distribution of the scenarios provides a useful context for understanding the relative position of a scenario, but does not represent the likelihood of its occurrence." (*Id.*- italicized emphasis in original; underscored emphasis added).

DONALD H. PEARLMAN, THE CLIMATE COUNCIL

Page 38, Chapter 4: Decision Support Resources Page 43-44: Sensitivity Analyses Sensitivity analyses need to be carried out through interdisciplinary consultations, involving both social and physical scientists' understanding of the range of variability in drivers and the resilience and dynamics of systems. Some analyses should be carried out at the extreme ends of the spectrum for each of the systems that interact with each other. These types of "breakdown scenarios" are very important to ensure that catastrophic consequences are at least included among the range of scenarios studied and presented to decision makers. For instance, emissions scenarios that assume no or only moderate improvements in emission factors over long time periods together with rising consumption levels well beyond the SRES assumptions should be combined with simple coupled climate models that involve THC variability (cf. Chen and Ghil, 1996: J.Phys. Ocean 26:1561-1578) and regional hydrologic impact models for vulnerable parts of the world. These could even be combined with social and economic strife models to show how decision makers could be faced with exceedingly complex and multiple social and environmental impacts. Such analyses cannot be derived from the middle-of-the-road, steady-state modeling techniques that have been deployed hitherto within much of the CC modeling community.

SUDHIR RAJAN, TELLUS INSTITUTE

Page 38, Chapter 4: Decision support refers to the provision of timely and useful information that addresses specific questions of decision makers. The long term nature of climate change signals will not be able to address the prediction requirements of decision makers – generally in the 1 to 5 years range. A key contribution to addressing this gap – between the expectation of decision makers and the ability of climate change science to provide information – is through the seasonal and inter-annual time scale of climate variability. IRI research on climate variability and its management would be of immense value in this regard.

Much of the writing about anticipated future climate information use by decision makers has not taken into consideration the perspective or context of the decision opportunities. The shift in focus within the US, from energy policy to socio-economic development, in the development of climate change science information, requires addressing the spatial and time scale needs of decision makers. Seasonal to interannual time scales and state level spatial scales dominate the decision making matrix in these latter sectors. Addressing the climate information needs at such scales would require tapping into the experience of institutions such as the IRI .

Real world demonstrations of the value of climate forecasts can be a primary mode of instilling confidence amongst policy makers and decision makers – indeed this was alluded to in the keynote speech of Prof. Obasi, WMO Secretary-General, noting that for decision makers to better use seasonal-to-interannual information was a route to building confidence for making difficult decisions on global change. It is an opportunity for decision makers to recognize the inherent probabilistic nature of climate information, and become comfortable with utilizing such information. Research and real-world project implementation on climate variability and its management would be of immense learning value in this regard. The IRI is an institute committed to such demonstrations.

In order to effectively address climate change impacts we need to harness the successful experience in managing climate variability. At the IRI this aspect of research includes the following perspectives: 1. Scenarios for identifying key policy arenas. In addition to the climate variability other drivers include demographic change, land use, water use etc. The scoping and development of the scenarios would need to include key stakeholders. They also need to introduce appropriately scaled forecasts to identify key policy areas, and subsequent decision support activities; 2. Identification of the most vulnerable sectors and populations; 3. Identification and spatial mapping of society's vulnerabilities to climate and the opportunities for better use of climate forecast information, based on key indicators. 4. Identification of existing practices and policy arrangements and their potential to enhance the management of climate variability.

Incremental improvements in scientific capability, or reductions of uncertainty, are not likely to lead automatically to improvements in decision capacity. That presently available information is generally not utilized speaks to the misfit of anticipated information needs from variable (and variably uninformed) perspectives of scientists and decision makers. Learning from the present is critically important for development of future what-if scenarios – especially regarding the networks that must be developed for use of information, in addition to the development of the information itself.

STEPHEN E. ZEBIAK, AND STAFF, INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE PREDICTION

Page 38, Chapter 4: First Overview Comment: Insufficient Sharing with the Public and Policymakers

Finally, the draft claims the U.S. government has spent almost $20 billion on climate change activities - or more than the entire gross domestic product of a quarter of the world's countries.

However, to date, far less than 1% of that amount has been spent providing the extraordinary results of that research with the people that need it - and paid for it - the public and the policymakers.

This draft plan should first commit to sharing the existing information obtained from THAT research. This draft plan should then have a specific funding plan to share all future research results the public and the policymakers.

Proposal #5: Priority and Budget of Outreach I propose each federal agency supporting this process commit funding for outreach, be commensurate with the magnitude, and the potential impact, on the communities that agency serves.

In no event, should any less than 20% of the total project budget be dedicated to public education and direct outreach to policymakers. All materials should include a factual analysis of response options, with estimated costs, as well as a listing of those federal, state and local entities, government and otherwise, offering to provide further assistance to them.

Finally, the cost-effectiveness of the federal education and outreach programs should be measured against the comparable results that could be expected from a private vendor specializing in public education and policymaker outreach.

BLAIR HENRY, JD, UNIVERSITY OF NORTH DAKOTA

Page 38, Chapter 4: **First Overview Comment (pp. 38-39):** In his June 2001 remarks, the President said that the "United States has spent $18 billion on climate research since

1990" which is "more than Japan and all 15 nations of the EU combined," but "we made" it clear that "we need to know a lot more." The President added:

> Today, I make our investment in science even greater. My administration will establish the U.S. Climate Change Research Initiative to study areas of uncertainty and identify priority areas where investments can make a difference.
>
> I'm directing my Secretary of Commerce, working with other agencies, to set priorities for additional investments in climate change research, review such investments, and to improve coordination amongst Federal agencies. We will fully fund high-priority areas for climate change science over the next five years. We'll also provide resources to build climate observation systems in developing countries and encourage other developed nations to match our American commitment.

However, in several ways Chapter 4 of the draft seems to shift the above purpose of CCRI's criteria away from research enhancement aimed at resolving the uncertainties and related study areas identified by the NAS toward an emphasis of support for decision-making.

Second Overview Comment (pp. 38-39): The draft asserts (p. 38) that the CCRI "will synthesize the results of the research conducted" by the CCSP "to present critical information to decisionmakers and resource managers both within and outside of the U.S. Government." The draft then provides a definition of "decisionmakers" as those that "engage in the development of national policy such as setting national goals for greenhouse gas emissions and negotiating with other countries over international agreements" (p. 38, lines 8-10). We presume that this definition is intended to apply to the entire draft. However, there is a different definition of this term in Chapter 13 (p. 150).

The definition with its references to national policy and negotiations for "international agreements" clearly covers only federal and other governmental persons, to the exclusion of others in and outside government. Clearly, this definition is too narrow. It does not, for example, include resource managers or stakeholders in the private sector, even though the President himself urged last February 14 that the business and industrial community undertake voluntary programs as part of the Administration's "Business Challenge." Undoubtedly, they also strive for greater research that provides "critical information," as shown by the following (pp. 38-39):

> One major key element of the CCRI is the ongoing engagement of scientists, decisionmakers, resource managers, and other stakeholders in identifying issues and questions, and providing data and products that include characterizations of uncertainties and the level of confidence associated with this information.

> Research will provide continually stronger foundation to help decisionmakers evaluate the suite of alternative policy options and operational strategies.

Further, the definition is too limiting when it focuses on emissions and international agreements, and does not even allude to adaptation, sustainable development, jobs, the environment or the economy. Only a few weeks ago, the U.S. delegation to COP-8 in New Delhi joined the G-77 and China in firmly resisting proposals by the European Union and others to start international negotiations for 2013 and thereafter, saying that "we must also recognize that it would be unfair—indeed, counterproductive—to condemn developing nations to slow growth or no growth by insisting that they take on impractical and unrealistic greenhouse gas targets."

We believe that if there is a need for a definition of "decisionmakers," it must be more inclusive of the private sector and not be narrowly focused on government officials.

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 38, Chapter 4: **First Overview Comment:** A stark omission from this chapter and a critical need for decision makers, is an analysis of a decision that has essentially been made by the current administration – namely, the decision to delay aggressive, mandatory reductions in greenhouse gas emissions for up to 10 years. The first and most important analysis to support decision making from this Climate Change Science Plan therefore must be to define as accurately as we can the consequences to our natural resources and our economy of delay in reduction of greenhouse gas emissions. The analysis should result in a breakdown of what the cost, both in dollars and in environmental damage could be due to delayed aggressive action to reduce greenhouse gas emissions. Costs could occur from direct damage from climate change, the expense of adaptation measures, costs to the insurance industry and increased costs that could occur when action is finally taken due to sunk capital costs in inappropriate technologies or infrastructure. If a decision to reduce greenhouse gas emissions is delayed to the year 2020, for example, many integrated assessment models show that it would be much more expensive to reduce greenhouse gas emissions than if steeper reductions were to occur today.

In addition, due to the fact that carbon dioxide and other greenhouse gases take decades to centuries to dissipate from the atmosphere, there are certain climate thresholds that may be unavoidably passed if greenhouse gas emission reduction is delayed. In the President's speech to NOAA announcing the Clean Skies and Global Climate Change Initiative on February 14, 2002, the Bush administration affirmed its support of the United Nations Framework Convention on Climate Change and it's central goal, to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate. Passing climate thresholds, such as carbon dioxide concentrations high enough to lead to the melting of the West Antarctic Ice Sheet or the shut down of thermohaline circulation in the Atlantic Ocean, constitutes many scientists definition of 'dangerous human interference with the climate system'. Yet, the decision support resources to adequately define such climate thresholds, what constitutes dangerous human interference with the climate, and how delayed action on reduction of greenhouse gas emissions might affect our ability to avoid dangerous human interference is conspicuously missing from this science plan.

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A description of dangerous thresholds and consequences of delay in reducing greenhouse gas emissions is given in O'Neill, B and Oppenheimer, M, (2002). Dangerous Climate Impacts and the Kyoto Protocol, Science: 296: 1971-1972.

I strongly suggest including an analysis of the consequences of delaying aggressive reductions of greenhouse gas emissions by 10 years on our economy and natural resources as a top priority of the US Climate Change Science Plan.

Second Overview Comment: The plan as a whole and this chapter in particular discusses resolving 'uncertainties' before appropriate decision making can take place. However, there is no discussion of what level of uncertainty is acceptable before a decision can be made. In any decision-making process based on science, some uncertainty exists. Science by its very nature is incapable of giving an absolute answer or of knowing something with 100% accuracy. Given this, and given the fact that avoiding a decision has serious and perhaps irreversible consequences (see First Overview Comment above) a discussion of what level of certainty and in what areas it is needed is appropriate for this chapter. Decision makers should be given an analysis of what is currently known about key climate change uncertainties discussed in Chapter 2 and how reduced uncertainties on these issues could affect their decisions. A series of what-if scenarios could be put together. For example, would decisions to reduce the use of fossil fuels be altered by a better understanding of the role of black carbon aerosols – which currently are believed to only increase radiative forcing of the climate (e.g., increase heat trapping)? What is the probability that better understanding could change the 'sign' of the decision?

Third Overview Comment. There is no doubt that better regional climate models and integrated assessment tools will be essential for helping regional decision makers and resource managers build resiliency and plan for adaptation to climate changes. This decision support goal however, should be clearly separated from the need by decision makers at local, state and federal levels to understand the trade-offs involved in delaying mitigation activities. Separate scenarios should be developed as discussed in the comment above, that directly address this issue and these scenarios should be analyzed on a fast schedule. This is because a different level of certainty is needed for mitigation decisions vs. adaptation decisions. If we are fairly certain that climate change impacts will be severely damaging to natural resources and ecosystems of concern, we don't need to know the exact details of how the damage will occur to make a decision that mitigation is warranted. But if we are trying to build specific resiliency into a system or develop a specific adaptation response, we need much more certainty and detail for specific estimates of damage. The chapter should clearly distinguish between scenario building to support resiliency and adaptation decisions from scenario development to support mitigation decisions and address each appropriately.

Fourth Overview Comment. I was somewhat at a loss where to place this next comment as the comment discusses the omission of an entire chapter from the Climate Change Science Plan. Since the chapter would fundamentally support Decision making, I felt the comment was best placed here. One of the most important decisions that will have to be made in the next decade is how to implement technologies that will reduce greenhouse gas emissions from energy use. While there is a separate Climate Change Technology Initiative (CCTI), supported by a number of government agencies, there is still a significant need for basic science research to support these technologies. Large research areas exist here - for example the unintended consequences of carbon storage in terms of safety, health, and the environment; improvements and funding for geologic and oceanic testing, measurement, and monitoring of disposed carbon dioxide; and consequences to the surface ocean ecosystem of fertilization with iron to increase carbon storage in phytoplankton. The CCSP must include a chapter that focuses on these issues. There was a breakout session at the workshop focusing on this but no corresponding section of the science plan. In addition, a formal relationship between the CCTI and the CCSP should be made with explicit funding of scientific research to support it. This will be crucial information for decision makers when deciding between different options to mitigate greenhouse gas emissions.

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 38, Chapter 4: First Overview Comment: Although this is present throughout the report, we wish in this chapter especially to raise the issue of the use of "long-term global climate change". It seems that the underlying assumption of this chapter and others is that climate change is only a long-term problem and that the CCRI will only focus on assessing long-term impacts. If this element is not changed to state "climate change" and not differentiate between long-term and short-term, it will at a minimum miss and at a maximum distort some of the key climate change findings. Recent editions of NATURE have documented the fact that climate change is already happening. This was also included in the Summary for Policymakers of the Third Assessment Report of the IPCC. Climate change is a complex issue that includes challenges for the short-, medium-, and long-term. All three should be included in this work program.

Second Overview Comment: The term uncertainty is utilized without any clear definition of the term. As this is the main theme of much of the report, it portrays an incorrect image of climate science that everything is uncertain and that no one can or should act until the uncertainty levels are diminished. It then goes on to lay out a high risk strategy of waiting until an unknown day for uncertainties to be reduced before any action can be taken. The risks are high as the lifetime of greenhouse gases in the atmosphere is long and mitigation efforts will not take immediate effect, unlike some other pollutants. This also ignores decades of research by US institutions and others that have reduced uncertainty levels on a wide range of climate issues. A guide to the uncertainty levels is clearly included in the IPCC's Third Assessment Report. We would therefore strongly recommend that the report and the research efforts around it not revolve around reducing uncertainties per se, but rather provide new and useful information for policymakers. Finally, to infer that policymakers must have 100% certainty before taking any decisions is not consistent with the current situation. As the report notes, there are many uncertainties surrounding terrorism, but the government is not waiting for 100% certainty before taking preventative measures such as increasing security in airports.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 38, Chapter 4: The Chapter focuses on decisions by natural resource managers and does not give enough consideration to other decision makers. For example, transportation planners and engineers need good decision support resources for the short and long-range plans that determine how federal, state, and local resources will be spent on transportation investments. Transportation decision-makers then need decision-support systems to apply in designing and building transportation infrastructure, and in developing other transportation strategies. Building new transportation infrastructure takes time – major projects take an average of over 10 years from proposal to completion. Once completed, infrastructure may stay in place for 25–50 years, or more. Adapting our nation's transportation infrastructure to the possible impacts of climate change will therefore take time, and good decision support resources are necessary to inform transportation infrastructure decisions in the near term. Decision-support resources can include improved data collection, performance measures, and forecast models that encourage linkages between climate change, and economic, environmental, and other related policies and decisions.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 38, Chapter 4: The nation clearly has an urgent need for a substantially enhanced understanding of climate variability and change that is tied directly to meeting the needs of both decision- and policy-makers. Given this context, improved decision-support resources are a critical component. However, as a stand-alone chapter, Chapter 4 lacks the focus and strong vision that is needed to meet the national need. The purpose of this contribution is to tap the wisdom and lessons learned in by the pilot-scale Regional Integrated Science Assessment (RISA) activities that have been active in bridging climate variability and society over the past five years. The goal is to elucidate a strategy that guarantee rapid success in meeting pressing stakeholder (decision-maker) and policy needs, while at the same time building the integrated science-society foundation required to ensure that our substantial investment in climate science provides an ever-increasing return for the nation in terms of economic, quality of life, and strategic payoffs.

The following is a suggestion to create a truly interdisciplinary, integrated and place-based program that serves to generate short-term pay-offs to decision-makers, as well as the knowledge for implementing a long-term national integrated science and decision-support capability. The goal is to create a "no-regrets" approach to climate science and society, one that empowers regional decision-makers to immediately start reducing costs and risks in the face of climate variability, while at the same time increasing options for economic growth and enhanced quality of life. Because regional climate variability is also the mechanism by which climate change impacts society, the same proposed integrated climate-society research approach also, by definition, creates adaptation capability and empowers policy-makers to develop cost-effective strategies for dealing with climate change. For these reasons, the proposed approach meets national need regardless of how large anthropogenic climate change turns out to be.

II. Specific Comments on Chapter 4: Decision Support Resources

Comments on Chapter 4

1. Suggestion: Provide strong focus and rapid (i.e., 2-4 year) results by advocating a new program designed to integrate short-term research and information needs of decision- and policy makers with the rest of the CCSP. Expand on proven regional efforts where the climate science-society partnerships are already working.

2. Suggestion: add the following new section in Chapter 4 or as a new cross-CCSP integration effort (Grand Challenge?):

Development of a major place-based program for user-driven integrated science and decision-support

The focus on improved decision-support provides the ideal integration point for the entire CCSP. Without consistent and sustained relationships between decision-support research and societal need as expressed through actual practice, the overall science program will fall short, just as CCSP would fail in the absence of the very best natural (e.g., climate and biological) science observations, process studies and modeling. The key to success is thus to create an integrated science-society research element that:

- recognizes that the critical climate science-society link is that of climate variability and stakeholders (decision-makers, plus all affected by climate variability); this is the linkage on which the success of the entire CCSP is dependent

- brings natural and social scientists together with decision- and policy-makers in explicit partnerships designed to build trust, understanding and success

- uses science-society partnerships to ensure that the decision- and policy-makers play a major role in driving the science, rather than simply being the recipients of products and information that the scientific community feels is most relevant

- works and is managed at the same local to regional ("place-based") scales of decision-making (e.g., by farmers, ranchers, water managers, forest managers, air-quality managers, public health officials, etc.)

- places greater emphasis on solving often difficult regional-scale climate science, which builds on continental- to global-scale knowledge

- communicates broader-scale science needs back to researchers involved in continental- to global-scale observations, process-studies and modeling

- facilitates greater interdisciplinary science integration to ensure that stakeholders can use climate knowledge in full context of information (e.g., hydrological, ecological, institutional, legal, cultural) needed for effective decision- or policy-making; integration across jurisdictions and agencies is also critical to facilitating more effective decision-support

- includes expanded commitments to the education and training of scientists, stakeholders, and the public who will together advance the climate science-society nexus of the CCRP

- further enhances societal understanding and trust via institutional (funding) mechanisms that ensure sustained and responsive partnerships with the science community; to do otherwise could erode the understanding, use and support of climate science

The important impacts of both natural and anthropogenic climate variability and change are, and will be, manifest as the regional impacts of climate variability. In addition to mastering our ability to observe, understand and simulate global- to continental-scale processes, the ultimate utility of this work hinges on making the connection between regional variability and humans or ecosystems. Rapid progress is already being made in this area via close regional interaction between climate scientists and decision-makers. Accelerated efforts to build on lessons learned has the opportunity to provide the methodological framework for improved decision-making in the face of climate variability and change. This "no-regrets" strategy will aid decision-makers whether the variability and change is due to humans or not, and it will also be the most effective way possible to develop an adaptive capability in case future climate and variability change turns out to be significant.

First and foremost, the climate science community needs to evolve from a strictly disciplinary "hand-off" or "product-driven" paradigm to one that involves true two-way partnerships with decision-makers. Only by listening and being responsive to these stakeholders can climate science be of maximum utility and elicit maximum benefit for the continuing development of research agendas. Furthermore, few stakeholders use climate information in a vacuum – although climate knowledge is perhaps the most widely needed, it is usually only one concern among many others (e.g., institutional, economic, legal, cultural, ecological, and hydrological) that are integrated by a stakeholder in making decisions. For this reason, climate scientists must work with others to ensure that climate knowledge is conveyed in an interdisciplinary or "multi-stress" context that facilitates more effective use. Moreover, this multi-stress approach is most effective when pursued in a multi-agency context where stakeholders have the simplest path possible to the knowledge that they require, and in the integrated form that is most helpful.

Another problem with "product-driven" climate service is that it limits the responsiveness of the climate science community to user needs. By contrast, research structures that encourage close partnership with social scientists and decision-makers have already proven to be the most effective in making climate knowledge usable. Not only can these interdisciplinary partnerships drive more effective science, they also ensure the most effective assessment of progress and thus the fastest evolution of user-driven climate science.

RESEARCH NEEDS

Comments on Chapter 4

Given that decisions are mostly carried out at local to regional "place-based" scales, and that policy decisions must be responsive to regional implications, a key to effective user-driven climate science is that it aggressively work on solving regional-scale climate issues in the absence of national boundaries. For example, the summer monsoon is of critical importance to many decision-makers in the SW US. This means that the Southwest Monsoon of both the U.S. and Mexico must be more of a priority to the climate science community, but also the nature of climate variability and predictability in topographically complex terrain. This type of science-society focus also makes will require investment of new resources on regional-scale climate process, observing systems and modeling.

It is unrealistic to develop user-driven climate science and services at a national-scale given current resource limitations. Focused efforts are needed to ensure critical mass and rapid demonstration of feasibility. There must be substantial investment in regional efforts where decision-maker need and partnerships (demand) are already well established (e.g., the western and southwestern U.S.). This approach will also ensure rapid progress in terms of stakeholder benefit and the development of methodologies that can be extended into additional regions as stakeholder demand and funding allows. Because climate-society partnerships must be regional, interdisciplinary and multi-agency, as well as research- and training-intensive, it appears inescapable that the partnerships must be university based with strong federal, state and private involvement.

Effective climate science "service" to society is in its infancy, and although making this a CCSP priority can surely net rapid progress and payoffs to society and scientific capacity, it must be explicit from the beginning that the commitment to this new paradigm is long term. Stakeholder partnerships can only work if they are sustained and highly responsive to user needs. This means that the scientific community will be pressed, as never before, to generate increasingly useful climate knowledge, particularly at local regional scales that are not well understood. Although this is a difficult objective, on-going integrated regional climate science and assessment pilot efforts are demonstrating that it is indeed possible to give regional stakeholder what they really need, particularly given the ability of the science-stakeholder partnerships to jointly learn how to make useful decisions in the face of uncertainty. This ability must be at the very heart of a successful CCSP, and thus represent a funding priority to be embraced as soon as is possible.

Any climate "service" investment will depend on research for years to come. During this time, society will also depend on an increasingly sophisticated climate infrastructure (e.g., observing systems, models, and customer service) in both the federal and private sectors. It must be stressed, however, that success in climate science-society partnerships will mean ever-increasing user (decision-maker) demand for improved climate knowledge. A successful CCSP must anticipate this growing demand by making strong investments in interdisciplinary basic climate science research at scales ranging from regional to global.

Lastly, because the whole range of CCSP science will ultimately serve the needs of decision- and policy-makers, there is a need for national science management and funding infrastructure designed to ensure coordination. A single management entity (e.g., NOAA OGP) with strong ties to regional science-society partnerships, climate research, observing systems and modeling is critical. Moreover, the fact that the majority of regional integration, as well as regional- to global-scale research, must be occur at universities requires an interdisciplinary management entity (e.g., NOAA OGP) with proven ability to work with both university researchers and federal research, observational, and modeling infrastructure. However, it must not be forgotten that the entire enterprise must ultimately be driven by the needs of the regional stakeholders (constituents).

SHORT-TERM PRODUCTS AND PAYOFFS

The foundation needed for the following products and payoffs has already been established by the NOAA-funded Regional Integrated Science and Assessment (RISA) pilot programs, in partnerships with other agencies and stakeholders. This ensures that there is the momentum needed to have significant products and payoffs in as few as 2-4 years. Products and payoffs include:

- an established set of integrated, interdisciplinary, multi-agency partnerships with regional stakeholder communities, each complete with new demand and demonstrated use of climate knowledge in decision-support (2-4 years).

- improved understanding of the linkages between broad-scale climate (e.g., ENSO, PDO) and regional climate, with particular emphasis on climate variables critical to decision making (e.g. temperatures, precipitation, snowpack, streamflow, atmospheric humidity, etc.) (2-4 years).

- new experimental long-lead (12 month) streamflow forecasts for major watersheds of the US, coupled with improved decision-support for water-managers and users (2-4 years).

- enhanced understanding and ability to forecast extreme weather events (e.g., extreme high/low temperatures, snow, rain, wind, etc.) designed to meet growing stakeholder demand (2-4 years).

- experimental to operational decision-support systems for SW and SE US agriculture and ranching (2-4 years).

- prototype regional (Western and SE US) to national integrated “multi-stress” and multi-jurisdiction decision-support systems for forest and wildfire management (2-4 years).

- improved and integrated national drought monitoring and regional drought decision-support systems (2-4 years).

- development of a blue-print for the improved regional climate, hydrologic and ecological observing systems needed for enhanced decision-support, particularly in mountainous regions (2-4 years).

- testing of existing regional modeling capabilities, and articulation of improved regional modeling capabilities needed for enhanced decision-support (2-4 years).

- development of international science-society partnerships with Mexico and Canada designed to enhance management of shared resources in face of climate variability and change (2-4 years).

- improved public-health decision-support for major climate modulated infectious disease threats in US, including mosquito-born viral disease (Dengue and West Nile Fever, Encephalitis), Hantavirus and Valley Fever (2-4 years).

- improved climate-air quality monitoring, forecasting and decision-support, including both natural (e.g., desert dust) and man-made air quality issues (2-4 years).

- expanded integration of climate-variability-society interactions into regional climate change assessments (2-4 years).

- provide a careful balanced assessment of the benefits and pitfalls of different management strategies that can be used to adapt to climate change impacts in different regions (2-4 years).

- well articulated, tested and peer-reviewed theory and methodologies of climate science, assessment, decision-support, and conflict-resolution for use in cost-effective expansion of regional science-society partnerships into a national program (2-4 years).

- well tested new methods and theory for education and training programs needed to sustain regional climate science-society partnerships (2-4 years).

- expansion to a stakeholder-driven integrated science and decision-support program (5-15 years).

Regional Integrated Science and Assessments (RISA)

Page 38, Chapter 4: **First Overview Comment:**
Section 2 of this Chapter (Analytic techniques for serving decision need) and especially the section on "Scenario Development" is remarkably imprecise regarding the decision support mechanisms for aiding policymakers and the difficulties inherent in the proposed "If…, then…" framework. <u>As drafted, this section requires serious thought and revision if it is to provide useful guidance to those seeking to implement the Strategic Plan and provide policymakers with useable information.</u>

Second Overview Comment:
Although the "If…, then…" is a common analytic framework, the problem in applying that framework in climate is that a single "if" rarely yields a single "then." Unless this problem is addressed in the *Strategic Plan* before the effort to support policymakers begins, the resulting analysis will exclude critical information or be seriously misleading or hopelessly complex.

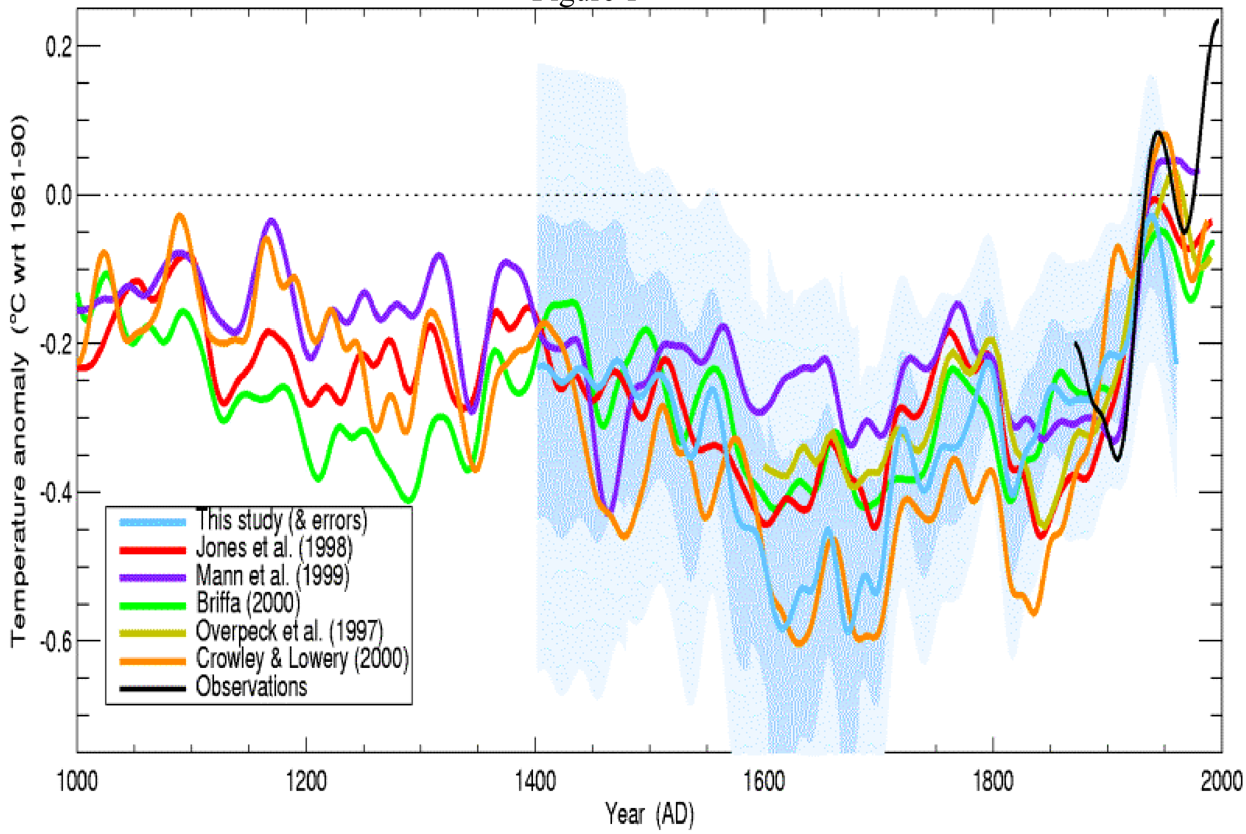
There are numerous reasons why multiple outcomes from a single "if" should be anticipated.

Climate History: As illustrated in Figure 1, from the Briffa & Osborn article in the March 22, 2002 issue of *Science,* there has been a blossoming of climate histories in recent years. No single climate model with a single set of parameter settings can simultaneously duplicate all the histories shown. As in economic model building, reproducing history is one of the key elements in model validation. With multiple histories, each model simulation duplicating a given "history" will give a different climate projection and this leads to different "If…, then" responses. Focusing on only one or two "thens" is arbitrarily selective.

Human Activity and Observationally Equivalent but Functionally Different Scenarios: The IPCC *Special Report on Emissions Scenarios* (SRES) highlights another aspect of the "single If…, multiple then" difficulty. The SRES effort developed multiple "families" of future emissions paths, depending on how societies develop over the next 100 years. Briefly, the difficult made clear by the SRES effort is that many scenarios gave similar to identical future emissions paths, but each of these paths occurred for different reasons. Because they occurred for different reasons, the response to a policy "if…," scenario would be different. Hence the problem of observationally equivalent but functionally different scenarios yields the "single if…, multiple then…" problem.

Unless the "single if…, multiple then…" problem is addressed, the staff working to develop useful information for policymakers likely will find themselves in the same or worse position as the IPCC and SRES authors, who effectively characterized the various scenarios as being "equally valid, but don't treat them as if they had equal probability."

Figure 1



Based on Briffa & Osborn, *Science*, March 22, 2002

Third Overview Comment:

The draft *Strategic Plan* makes several references to developing "probabilistic alternative futures." See for example Chapter 4, Section 2, subsection "Climate projections", page 44. This implies some assignment of probabilities to climate projections. The question for this effort is: How do you do that?

Very few elements in climate science have exact parameters. Many elements have great uncertainty over even the fundamental mechanisms. Take the possible impact of the solar activity on climate. According to one of the few new key findings of the *Third Assessment Report* (see pages 11-12 of the "Summary for Policymakers" of the Working Group I) the impact of "natural variation" has been included in climate models and natural variation plays an important role in explaining temperature change over the last 150 years, particularly the first 100 years of this period. Natural variation, in the IPCC analysis, included solar and volcanic activity.

However, the statements on pages 382 and 385 of the full Working Group I report state that "the level of scientific understanding [of total solar irradiance] is very low" and that "the mechanisms for amplification of solar forcing are not well established." Ignoring the valid question of why the IPCC based a key finding on something with a very low level of scientific understanding, one has to wonder, how would you assign probabilities to a scenario that included solar activity if you had to?

Actually, the situation is worse than this. The scientific community is considering other mechanisms by which solar activity could influence the earth's climate. One example is the 29 November 2002 issue of *Science* that investigates the "intriguing possibility that a cosmic ray-cloud interaction may help explain how a relatively small change in solar output can produce much larger changes in Earth's climate." Even within the "cosmic ray-cloud interaction" approach, different mechanisms are possible.

How do you, or do you, assign probabilities to scenarios generated by different theories or mechanisms on solar (or other climate mechanisms) impacts? Even a simple approach like assigning each mechanism an equal probability is not valid because the mechanisms might not be mutually exclusive.

The ill-fated *National Assessment* effort tried a similar approach. The results were analytically offensive. The problem with climate assessment is not that certain things "could happen," the problem is that many other things also "could happen." The challenge to the *Strategic Plan* is to do a better job than others to-date in making sense out of the multitude of possibilities. The current draft of the *Strategic Plan* barely acknowledges much less addresses these difficulties.

Fourth Overview Comment:
The draft *Strategic Plan* clearly focuses on climate science issues while the Climate Change Research Initiative (CCRI) contains the effort to develop decision support resources for policymakers. However, there is a very real concern that the CCRI resources are not adequate for a robust policymaker support effort. Simply put, Chapter 4 of the draft *Plan* does not reflect the complexity of the issues that have to be addressed in policymaker support.

Robust policymaker support will involve:

- Emissions scenarios, because these drive climate models;
- Science and climate models;
- Impacts assessments (include costs of climate change) for both natural and anthropogenic systems;
- Mitigation and adaptation options and costs, because these policy options feed back to emission scenarios, impacts and cost of mitigation/adaptation.

The *Strategic Plan* has an extremely heavy focus on science and climate models. In contrast, the IPCC Third Assessment program involved major efforts on all four components above through their *Special Report on Emission Scenarios* plus their three Working Groups.

An additional indication of the importance of factors other than science is contained in research by Dr. Nordhaus (Yale). Using an integrated assessment model, Nordhaus concluded that the combined value of improved information on non-climate science sensitivities was almost seven times that of the climate science sensitivities in the model.

See Nordhaus, "What is the Value of Scientific Knowledge," *Energy Journal,* 1997, Table 4.

The issues and range of possible outcomes for the emissions scenarios, impact assessments and mitigation/adaptation options are intellectually as complex and as varied as climate science. Without adequate resources and a balanced approach, the CCRI effort at policymaker support will be simplistic and potentially misleading.

Fifth Overview Comment:
Chapter 4 makes repeated reference to the desire to improve the information available for regional climate assessments within the United States. As realistically noted on page 44, lines 20-22, however, "different model projections are at times contradictory, a symptom of the unreliability of regional-scale projections at this time."

While developing regional information would be useful, great care should be taken to avoid distributing information that is unreliable and would lead to wasteful and ultimately unproductive expenditures of scarce local and state resources. Climate change is a long-term issue. Issuing premature pronouncements that are subsequently changed, discredited or withdrawn will damage the credibility of long-term effort on climate.

Sixth Overview Comment:
The Applied Modeling section of Chapter 4 makes reference to testing climate model results "…with a particular focus on the last 25 years…." This, by itself, will be useful.

However, there is a risk here not unlike that of building an economic model based on one-half of the business cycle. That model will not help you much during the other half of the business cycle. If there are important elements in climate, including natural variation or oscillation, that persist for significantly longer than 25 years, then the proposed analysis could well be misleading because the climate models would have been evaluated only for a portion of a climate "cycle."

Seventh Overview Comment:
The Applied Modeling section of Chapter 4 makes reference to testing climate model results "against the paleoclimatic record." The question here is, which paleoclimatic record? As indicated in Briffa & Osborn, *Science*, March 22, 2002, there are currently multiple climate temperature anomaly records for the past 1000 years.

Eighth Overview Comment:
The Applied Modeling section of Chapter 4 makes reference to testing climate models ability to simulate major modes of climate variability (page 50). The draft *Plan* also states (lines 40-42) that "While these modes of variability by their nature may not be predictable, it is nonetheless necessary that models simulate their amplitudes and frequency structure."

The *Strategic Plan* should acknowledge and confront the issue that our ability to identify and understand past natural variability goes to the core of our ability to separate anthropogenic impacts from natural variability over the last 150 years. In this regard, climate models are no different than economic models. A model that does a "good" job of explaining history, but which in fact excludes or mischaracterizes natural variation, will end up placing misleading importance (too much or too little) on anthropogenic factors. As a result, projections of future anthropogenic impacts and evaluation of policy options will be misleading.

As stated in the Preface of the National Academy of Sciences Study *Decade-to-Century-Scale Climate Variability and Change: A Science Strategy*, "Without a clear understanding of how climate has changed naturally in the past, and the mechanisms involved, our ability to interpret any future change will be significantly confounded and our ability to predict future change severely curtailed."

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE

Page 38 Chapter 4 Decision Support Resources deals with an absolutely essential aspect of the CCSP. Getting climate information into existing and emerging decision support systems is absolutely essential. There is a very significant identified need for this, which will continue to grow. The number of decisions and decision makers that would benefit from better climate information is indeed large.

ROGER C. BALES, UNIVERSITY OF ARIZONA

Page 38, Chapter 4: First Overview Comment: Section 3 of this chapter discusses the use of applied climate modeling to support policy decisions. Three themes pervade this section: 1) the value of models in exploring "if...then" scenarios, 2) the value of a probabilistic approach in presenting climate change information, and 3) the importance of regional information to inform climate-related decisions. In my view, the climate modeling community lacks the resources to satisfy all three of these desires. The pursuit of many "if...then" scenarios means many climate change experiments must be performed, the expression of outcomes in terms of probabilities requires large ensembles for each climate change experiment, and the desire for regional information requires climate models to substantially increase their horizontal (and perhaps vertical) resolution. To pursue all three of these goals would produce an explosion in the demand for both computing power and human resources, which is not realistic given current budgetary constraints. Reviewer's name, affiliation: Anthony J. Broccoli, NOAA/Geophysical Fluid Dynamics Laboratory

Remedies: These three goals should be prioritized based on their scientific viability and likelihood of improving our knowledge of future changes in climate. Quantitatively estimating uncertainties should be the highest priority, since a methodology (i.e., the use of ensembles) already exists and has been demonstrated to be successful. The next priority is the development of models capable of yield robust regional information. Current models can only provide sketchy regional information. However, there are major obstacles to developing reliable climate change projections at the regional scale, including technical difficulties in using a nested modeling approach, and the confounding influence of internal climate variability on smaller spatial scales. The exploration of a plethora of "if...then" scenarios seems least valuable, as there is little evidence that subtle changes in emission characteristics affect the climate system in a nonlinear way. Simpler climate models--not full-blown 3-d coupled atmosphere-ocean models--are the appropriate tools for gauging the dependence of climate on modest changes in emission scenarios.

ANTHONY J. BROCCOLI, NOAA/GFDL

Page 38, Chapter 4: This chapter begins to address the need to link scientists and planners/decisionmakers that I discussed in my comments on chapter 3. However, there is a strong sense of a "disconnect" between these two communities. If our focus is on delivering climate services (specifically characterizing and quantifying uncertainties) these must address "vulnerabilities." This entire process requires a close interaction between researchers and decisionmakers from the beginning and throughout the process. The mechanisms proposed in this chapter do not provide the necessary level of integration. For example, scientists generally work on time scales of 3-5 years, politicians on scales of 1-2 years, and business people on scales of 3-6 months. How will we match these impedances?

The discussion of climate modeling concentrates on the technical issues (computer power, spatial resolution, software frameworks, etc.) Although these are important, I would argue that these are not the important issues. Agreement on metrics to assess model performance is notably absent. We must move to quantitative estimates of higher level fields (variance, fluxes, etc.) and not simply compare mean fields or simple metrics. We must also begin to identify fundamental assumptions and simplifications that are made in circulation models but may defeat attempts at coupled models. For example, restoring models back to climatological nutrient fields introduces artificial fluxes. Errors in vertical velocity fields may not be important if we are only interested in sea surface temperature but they cause carbon cycle models to break. We must also improve forcing fields and initialization fields. For example, we cannot run high-resolution ocean models as the data fields that are needed to initialize these models simply do not exist and therefore the models cannot get to the "correct" state. Many processes are not known and have dramatic effects on our projections of the climate system. For example, we do not understand how organic carbon is remineralized, and existing models make simple assumptions regarding this process. However, some minor adjustments in this process (for example, incorporating modern process and time series studies) can change the sign of the ocean carbon flux.

This must be an important element of the CCSP. We make the leap from observing systems to model-based climate projections with a serious analysis of what models can provide, what data could improve the models, and what specific information is needed by decisionmakers and planners. We have developed a plan that is much like a specialized assembly line where each step is done well without much consideration of the overall process. We need to look at climate from an end-to-end point of view where improvements must be made in the context of the overall system.

This may seem overwhelming and unrealistic, but I propose that now is the time to start on this approach.

MARK R. ABBOTT, OREGON STATE UNIVERSITY

Page 38, Chapter 4: Applications of the Paleoclimate Record
One should keep an eye on developments in paleoclimate research, but it's unclear whether the findings of such research are of sufficiently credible, i.e., have sufficiently low uncertainty, as to be used to test climate models. The data record seems hopelessly sparse and invariably it's subject to innumerable caveats and interpretations.

JIM COAKLEY, OREGON STATE UNIVERSITY

Page 38, Chapter 4: Decision Support Resources
Climate model testing. A more rigorous testing approach using paleo proxy records of climate is needed. To my knowledge, current GCMs still cannot produce a northern hemisphere ice sheet using glacial boundary conditions of incoming solar radiation and CO2. This may indicate that the sensitivity of the current models is lower than the actual climate system. It is also clear that the climate system has experienced very large, abrupt changes; I am unsure if GCMs can recreate them. To reduce uncertainty in future predictions, climate models must be able to reproduce similar changes. Abrupt changes in climate have been common in recent earth history, but not in the human-observed record of climate change.

WILLIAM B. CURRY, WOODS HOLE OCEANOGRAPHIC INSTITUTION

Page 38, Chapter 4: First Overview Comment: While the explicit call for a formal program of climate model testing is excellent, much of this chapter is highly problematic. In essentially endorsing the scenario driven impact prediction techniques of the IPCC, the CCSP is paving the way for more worst-case, speculatively derived scenarios of gross climate impacts at regional levels. The chapter fails to make the distinction between legitimate, and illegitimate "if-then" modeling. It's reasonable to ask questions such as "IF gas concentration reaches Y ppm, THEN temperature could reach Z degrees," or "IF the temperature of region X increased/decreased by X, THEN impacts of Z could occur." It's not reasonable to ask unbounded questions such as "If we postulate a world with no technological development, and increased population, and so on and so on, THEN we can predict an increase in GH gases of X, THEN we can predict regional impacts of Y."

KENNETH GREEN, FRASER INSTITUTE

Page 38, Chapter 4: One of the cross cutting activities of the plan is the development of decision support systems. To address the CCSP objectives, decision support systems will need to be linked to large databases of satellite and *in situ* observations. This is one of the grand challenges to which the participating agencies will have to rise to if the decision support objectives of the CCSP are to be achieved. We recommend formation of a working group to explore and implement advances in operational decision support systems with functional linkages to satellite data archives and *in situ* data.

CHRIS ELVIDGE, NOAA-NESDIS

Comments on Chapter 4

Page 38, Chapter 4:This chapter is in many ways the most interesting and innovative in the draft Strategic Plan. Its commitment to producing a dramatically upgraded array of resources for decision-making and to link those resources with decisions is welcome, appropriate, and very promising.

1) The frequent mentions of consultative processes and stakeholder interactions are laudable, since these sorts of communications in both directions are a key to assuring the relevance and usefulness of climate change science. Recent experience indicates that user communities not only offer essential perspectives about what variables to examine as well as valuable reviews of draft materials, but they also possess knowledge bases important to integrated assessments of climate change and its effects that are otherwise unavailable to (or at least unknown by) the scientific community.
2) The prominent attention to uncertainties and decision support resource needs at regional scales is especially welcome. The capacity to carry out scientifically valid integrated assessment research at a regional scale has advanced significantly in recent years; one example is the Middle Atlantic regional assessment effort, supported by EPA, that is continuing. This scale connects climate change science with climate change <u>impact</u> science in ways that are more relevant to resource managers, national and regional, than much of the research conducted at a national scale.
3) A weakness of the chapter is that it appears to assume that adequate decision support tools are generally available now, when in many cases integrated climate change modeling and assessment tools need further development. If the decision support is to be grounded in good science, it is important to identify a limited number of tools for improvement over the next several years, to serve the needs of CCRI, along with further tool development for the longer term as a part of GCRP (not clearly outlined in the GCRP chapters).
4) The main issue posed by the chapter is not what it proposes but with what it does <u>not</u> say: (1) how these initiatives are going to be carried out, and (2) who is going to support them and at what level. If, as a key element of CCRI, substantial progress in these regards is to be made within four years, a major effort will need to be mobilized relatively quickly, not only within the world of science (e.g., scenario development and sensitivity analysis) but also in linkages between science and regional resource managers and other stakeholders. A lot is known about how to do these things, but the implementation approach and structure are unclear from the draft.
5) In terms of decision support needs, more attention should be paid to the <u>impacts</u> of different climate change scenarios (e.g., greenhouse gas stabilization levels) on people and ecosystems. This kind of decision support assistance can be strengthened while applied climate modeling is improved, and it is critically important for decisions about investments in climate change adaptation or mitigation.
6) In particular, improved data bases and tools are needed to support estimations of the costs and benefits of alternative responses to sets of conditions sketched by different climate change scenarios. For instance, costs and benefits of adaptation

have received less attention than costs and benefits of mitigation, and integrated analysis of the two sets of pathways has received almost no research attention.

7) In general, links between sections 1 and 2 on the one hand and section 3 on the other are unclear. In what ways does progress with applied climate modeling relate to the broader commitments to decision support? In a number of ways, progress in these two efforts can be made in parallel, but the chapter would be more coherent if it addresses these relationships.

DOE NATIONAL LABORATORIES

Page 38, Chapter 4: Suggestion: Decision Support Systems or Services (DSS) should comprise a spectrum of "end-to-end" activities that encompass research and applications, and including decision makers themselves. The DSS should be considered more than just a means for information delivery or an interface with decision makers at the end of the research process as it is now expressed in the Plan, but rather DSS should be viewed as an entire research to decision-making process. In essence, DSS is as much about creating processes that generate continuous interaction among scientists and decision makers to solve climate problems as it is about creating and transferring information products in support of decision-making. This more holistic view of DSS design will likely increase the probability that useful information will be created that can indeed be transferred.

Disagreement: Given problems related to data, model quality, and verification of longer-term analyses of climate impacts, one could assert that regional and local scale analyses are more actually more reliable than longer-term analyses of continental-scale and century long trends, as currently asserted in the plan. Advances in regional downscaling of models over seasonal time-scales also supports this assertion (reference Page 44, Line 16-22).

JOSH FOSTER, NOAA/OGP

Page 38, Chapter 4: If climate model projections are to be used by stakeholders and government policy makers it is important that models have been openly evaluated by the broadest possible set of the Earth Science community. In the past the greatest amount of global model evaluation has been carried out by the global modeling community. The evaluation has concentrated on integral measures from the model such as global temperature trends from the models compared to global estimates of the observed temperature. While these model integral measures appear to match global observations and thus support their use in policy assessments, the attempted use of these models in regional assessments has in general not been successful (see Chapter 4 page 10).

The general scenario for model use has gone something like this in at least two generations of assessments. Based on the integral successes of the climate models, policy makers have pushed these models to be used in regional assessments. However, once regional scientists began to look at the details of the model performance on regional scales they find glaring discrepancies in the model. In the first generation of assessments in the early 1990,s, model representation of hydrology on the regional scale couldn,t support even major river systems such as the Mississippi in the current climate scenarios. Thus, all the plans for making agricultural and water resource assessments were either shelved or made useless by the regional failures. Eventually, the discovery of these problems lead to model improvements.

In the most recent round of regional assessments (USGCRP "Preparing for a Changing Climate") model performance for past and current regional climates appeared to be substantially improved. However, there were still substantive disagreements between observed climate trends and model projections in areas such as the Southeast. The more alarming problem in this assessment was the large discrepancy between future climate scenarios in the two global models used in the assessment process especially in the Midwest and Southeast. This large divergence for the future climate made any conclusions about impacts extremely tenuous (this is discussed in Chapter 4. page 10).

This method of evaluating models in the assessment mode has been an inefficient process that has lead to an increasing skepticism of global models by regional scientists and regional stakeholders. It has contributed to the sense of gridlock on climate policy and brings to question the viability of the assessment process.

The problems in climate models pointed out by the regional assessment process have also been paralleled by problems found in global climate models by process modelers and process observers in the scientific community. For example, after global modelers released their results for the assessment process (whether IPCC or Regional) process scientists or special observationalists have found critical problems or inconsistencies. As an example while trends in sea ice in models were found to apparently fit observations in the Northern Hemisphere the same models missed the trends in the Southern Hemisphere sea ice. Or special analyses found the vertical distribution of temperature changes in the tropics in models to be quite different than that in observations.

The difficulty with this assessment period evaluation schedule is that we are well into the assessment stage before independent process modelers or observationalists have an opportunity to evaluate processes or compare model data to specialized data sets that have not been looked at by the model developers. At least part of this problem of slow feedback in the model evaluation has to do with the fact that global modelers may not have the resources, time, and organizational focus to effectively use the data sets and analysis techniques that observational or regional scientists have at their disposal. This is probably especially true for satellite remote sensing data sets that require special skills and software to handle. Additionally, modelers have their plates full in just doing integral evaluation and in improving processes.

Suggestion: In order to improve the fidelity of the performance of climate models and the rate of improvement in the performance of climate models, we strongly endorse the concept that CCRI and USGCRP foster programs to bring regional modelers, observationalists, and process scientists together with the global scale modeling community earlier in the process. Together these combined teams working in a cooperative mode can continually evaluate the model. Identification of systematic model errors and how they change with model version would aid model developers. Conducting this procedure so as to focus on those model variables and products of critical interest to the applications community would better characterize error properties and build confidence in how best to use model output. This would accelerate the model evaluation and improvement process. Even intermediate results and sensitivity runs could be evaluated without having to wait for some final assessment grade model results to be released.

This parallel or continuous model evaluation will require the global scale modeling community and observationalists/process scientists to develop close partnerships and trust. Global scale modelers will have to be open with both their codes and intermediate outputs. Observationalists and process scientist will have to involve themselves in the details of the model runs and work in a non-adversarial way with the modelers.

It is suggested that as part of the next year's CCRI that initial teams of process and observationalists be formed, funded and paired with GCM development and scenario centers as a prototype to begin this parallel and continuous model evaluation program.

RICHARD T. MCNIDER, NATIONAL SPACE SCIENCE AND TECHNOLOGY CENTER

Page 38, Chapter 4: Restatement of main points made in Panel Presentation regarding Chapter 4, and presentation of a few additional points regarding other parts of the document.

1. There are a number of comments made in the plan on the importance of information on the regional scale, but there is not clear plan presented as to how to improve the quality of information on that scale, at higher resolutions.

2. While uncertainty is mentioned in the document, there is no clear plan for characterizing and quantifying uncertainty in the different parts of the climate change problem. Moreover, the emphasis in the document is mainly on reducing uncertainty, which may not be appropriate for parts of the problem that are not well understood.

3. There is insufficient detail in the discussion of decision making in relation to climate change - particularly in consideration of the different time lines of decision making related to different planning horizons of different resource systems.

LINDA MEARNS, NCAR

Page 38, Chapter 4: The stated objectives of the Climate Change Research Initiative are to: (1) reduce significant uncertainties in climate science; (2) improve global climate observing systems; and (3) develop resources to support policy- and decision-making. These objectives do not cover the breadth and depth of the CCSP and do not provide motivation for the program.

I suggest the following goal and objectives for the CCRI.

Comments on Chapter 4

The ultimate goals of the CCRI and the USGCRP are to protect and enhance human wellbeing and the environment in the face of the threats and opportunities of climate variability and change.

Specific objectives include:

Develop information necessary for setting national goals for greenhouse gas emissions and for negotiating with other countries over international agreements.

Assess current strengths and vulnerabilities to climate variability and change.

Facilitate the development of strategies and policies to increase adaptive capacity to climate variability and change.

Facilitate the implementation of adaptation measures to reduce the potential negative impacts and exploit the opportunities of climate variability and change

1. For Chapter 4, I suggest the following specific objectives:

    Assess the level of current vulnerability and describe the adaptation strategies, policies and measures that are in place. Research should determine how widely the adaptation measures are adopted and what were the obstacles to implementation.

    Project future vulnerability. Research should identify what information is required, and what new adaptation measures could be possible and helpful.

    Prioritize policies and measures in the context of stakeholder concerns. Research should identify what steps are needed to create and implement these measures, and where and when they should be implemented.

    Determine and implement the actions needed to evaluate the adaptation measures adopted and to make needed adjustments.

2. There appears to be little integration between Chapter 4 and the other chapters of the CCRI, or between Chapter 4 and the USGCRP. Harmonization across the documents will help facilitate an efficient and effective research program.

3. It is important that this document define terms, particularly vulnerability and adaptive capacity, because these terms are defined and used differently in different sectors.

4. The focus on climate science surveillance and response limits the development of information critical to decision-making for adaptation. Given the inertia in the climate system, the United States can expect at least 70 years of climate change before mitigation efforts take effect. Therefore, adaptation strategies, policies and measures need to be implemented to reduce vulnerabilities to climate variability and change, and to take advantage of opportunities.

5. This chapter misses several opportunities to enhance decision support tools, including the generation of information on the potential non-market impacts of climate variability and change. It should be recognized that impacts will be site specific and path dependent.

   Understanding the risks of potential non-market impacts requires the development of long-term prospective and retrospective records for the exposure (climate) and the response, on similar temporal and spatial scales. Developing long-term databases requires a sustained commitment to research funding at particular locations. Without this commitment, it will take considerably longer to determine the answers to questions of concern to policymakers, such as whether a particular pathogen is changing its range.

6. Another missed opportunity is the extension of integrated assessment models (IAM) to include models for social systems. Models need to be developed and refined to quantify potential non-market impacts of climate variability and change, taking into account appropriate contextual factors, in such a way that they can be included in IAMs. The addition of models for non-market impacts will provide better information to decision makers as to the possible consequences of various policy choices.

7. This chapter does not recognize that models can be used proactively to set research agendas to provide timely information for future decisions. For example, if it is assumed that a particular policy choice will likely need to be made in 2030, then models can determine what information will be needed at various points in time to make an informed decision. This information should be used in the development of appropriate and timely research programs.

8. This chapter does not discuss the importance of determining the contextual factors associated with either potential impacts or adaptations. Impacts from and adaptation to climate variability and change are influenced by other factors, whether from population growth or from land use change. Poor information and poor choices can result from not these including factors.

9. One possible research question not mentioned is the determination of the least amount of information required to make a particular decision. For example, clinical trials have established criteria for deciding the minimal amount of information necessary to determine when a drug or treatment is beneficial or harmful. It might be valuable to investigate whether something similar could be done for adaptation. It is critical to recognize that decisions can and are being made in the face of uncertainty. The question is whether those decisions can be better informed.

10. This chapter does not clearly acknowledge that most decisions related to potential impacts and adaptation measures will be made locally, within a particular sector. For example, although the National Centers for Disease Control and Prevention provides information on steps to help prevent morbidity and mortality related to heat waves,

actual heatwave early warning systems are designed and implemented by individual cities. Research could aid the identification of lessons learned from sectoral responses to other stresses that could apply to decisions related to climate variability and change.

11. One way to organize the research agenda is along the lines of the key questions that decision-makers will need to answer:
    What to do more/less/better in the face of climate variability and change? What not to do?
    What needs to be done differently?

12. The CCSP makes frequent reference to resilience, with the implication that resilience should always be encouraged. However, resilience is not necessarily a good thing. For example, there was significant riverine flooding in Northern California during the 1997/8 El Nino event. In the local news coverage one evening, a newscaster was interviewing a homeowner who had lost everything in a flood. After the usual questions and responses about how that felt, the newscaster asked the homeowner what he intended to do. The homeowner said that he would rebuild – just like he had done the last five times. Where and when to support and increase resilience, and where and when to facilitate change, is an important research question.

Much of this chapter discusses uncertainty in the sense of uncertainty around the question of attribution of climate change to anthropogenic activities. This ignores the considerable uncertainties that need to be addressed in research on the potential impacts of and adaptation to climate variability and change. The question of attribution has little relevance to impacts; if a heat wave causes hundreds of deaths, it does not matter that x% were due to anthropogenic emissions and the remainder due to natural climate change.

KRISTIE L. EBI, EPRI

Page 38, Chapter 4: First Overview Comment: The Plan has an obvious focus on the development and implementation of strategies to adapt to increasing concentrations of greenhouse gases, increasing climate variability, and climate change. It rarely places the same emphasis on strategies to mitigate climate change through policies that aim to reduce the primary threat to our climate, namely, anthropogenic sources of greenhouse gases. I believe that these two chapters, as well as the Plan overall, should reflect a more balanced approach to climate change, that offers not only the potential costs and benefits of adaptation strategies but, also outlines the costs of and potential costs and impacts avoided by mitigation strategies.

Educational institutions, corporations, and local governments across the country have already developed and implemented programs to reduce their greenhouse gas emissions. Most are realizing substantial cost savings from new energy efficiency measures. Few, if any, report any negative impacts of new measures to reduce greenhouse gas production. The substantial actions that have already been taken by institutions and local governments, with little or no federal vision or financial support, demonstrate the level of concern in many communities around the country and their will to develop these inititatives on their own. Their efforts and their successes deserve recognition in the introductory paragraphs of these 2 chapters to foster hope and encourage further local action. Furthermore, the evaluation of their efforts should be a research priority in both chapters, enabling communities, institutions, and corporations to learn from past experience and more effectively determine actions that they can take now to reduce GHG emissions, increase their energy efficiency, improve air quality, and save money.

KRISTIN MARCELL, NYSDEC HUDSON RIVER ESTUARY PROGRAM

Page 38, Chapter 4: First Overview Comment: This chapter is characterized, in part, by a de-emphasis on decision-support issues related to mitigation. As the chapter notes, this reflects, inter alia, the legitimate goal of broadening the research agenda to include priority issues beyond the energy sector. However, by the standards of success defined by this chapter, developing and applying effective decision support related to mitigation and the energy sector is, in effect, an unsolved problem. Moreover, on the time-scales for research and policy application considered in this document, large-scale energy-related mitigation, while not the focus of current federal policy, may very well come back into play at the national level. At the same time, at the local and regional levels (which are one focus of this chapter), energy-related mitigation is, in many areas of the country, an active and indeed growing policy priority, and is closely intertwined with adaptation and resource management concerns related to climate change. The authors are, no doubt, aware of this.

For these among other reasons, a final version of this Chapter should include a more thorough treatment of outstanding decision support research needs related to the energy sector and energy-related mitigation. First and foremost among these needs are improved estimates of the costs of carbon abatement, and improved methods for applying such estimates to policy design and implementation, whether at the local, regional or national levels. Such estimates are the sine qua non of decision support related to mitigation. There is a broad (although not universal) consensus that the magnitude and timing of reductions required by the Kyoto Protocol would have entailed unacceptably high economic costs on the United States. Short of this benchmark however, there is both considerable uncertainty and a conspicuous lack of consensus among stakeholder groups regarding not just the costs of mitigation but also the appropriate social and economic criteria to apply to potential mitigation policies.

It is not apparent why the research agenda proposed here, which is focused "beyond energy," is likely to succeed when a very large amount of research related to energy has failed to generate the degree of certainty and consensus that the chapter views as desirable. Stated perhaps more optimistically, the same research priorities and activities that are recommended in this chapter should also be applied to energy-related mitigation. (A specific comment related to these overview comments, re page 41, lines 17-18: it should be explained exactly what is meant by the statement that "For policy development related to mitigation, it will be difficult to generate a true representation of salient decisions.") Two examples are immediate: First, the history of model-based projections related to energy and the economy (in the sense of forecast accuracy), which are the basis for much, if not most policy analysis related to mitigation, does not inspire confidence that current projections of this type are a sound basis for policy. Thus, new research on scenario design related to energy/economic policy modeling and along the lines described in pages 45-47should be a research priority. Second, and closely related, the discussion in Section 3, pages 47-51, regarding improving the quality and performance of climate models, applies fully and equally to economic, policy and integrated assessment models. Whether applied to energy-related mitigation specifically or more broadly to resource management and adaptation issues, a high research priority should be applying (with appropriate modifications) the sort of testing, calibration, and validation procedures recommended here for climate modeling to policy and economic models.

CALIFORNIA ENERGY COMMISSION

Second Overview Comment: This section goes to the heart of the purpose for the CCRI yet seems to obfuscate the central policy questions facing both state and federal governments, treating them as an output of research several years hence rather than an essential input today. As noted above, the policy debate really focuses on the costs of both type I and II errors related to both mitigation and adaptation. The CCRI should explicitly address this issue. Beyond that, the institutional arrangements needed to ensure a productive dialogue between research and policy development are similarly treated as research outputs for the future rather than policy commitments by the management of the CCSP today. Should we not expect the existing management structure of the CCSP to deal seriously with these questions now rather than wait for research to propose some other structure as the appropriate institution to address these issues years in the future?

Third Overview Comment: The State of California is extremely interested in resources that the CCRI might make available for the "development of a structure and process for integrating science with decision processes" at the regional level. California has already embarked on that course through research and development activities of the Public Interest Energy Research (PIER) Program of the California Energy Commission. The state and federal government might find common purpose in the development of more powerful computing platforms for applied climate models and integrated assessment models.

Fourth Overview Comment: The nation would benefit greatly from increased computing capacity focused not only on climate modeling but also on linked earth and economic models more generally. While the CCRI recognizes this limitation, the Plan neither emphasizes the "keystone" nature of this problem, nor explicitly outlines plans to augment our capacity. The plan must address this key constraint in more detail and with increased resources.

CALIFORNIA RESOURCES AGENCY

Page 38, Chapter 4: Any exercises to enhance policy-makers' capacity to make decisions under uncertainty should account for the rate of progress of climate change science. It is clear from the *Draft Strategic Plan* that a number of important developments in the science necessary to make significant reductions in uncertainty are 5-15 years off. These time scales of knowledge gain should be weighed in decision options. For example, what are the relative costs and benefits associated with delaying various policy alternatives for addressing climate change 1-2 decades for a particular scientific aspect to become more certain? Given that the Administration frequently refers to the difficulties in making climate change decisions given scientific uncertainty, the CCSP must give consideration to the time-scales over which uncertainty will be reduced and what the implications of those time-scales are for decision-making.

Comment 2

An interesting policy consideration that is absent from the *Draft Strategic Plan*, but that was addressed in the NRC (2001) report *Climate Change Science* (upon which much of the agenda for the Climate Change Research Initiative (CCRI) is based) is whether or not there is a ”safe” atmospheric concentration of greenhouse gases. As the NRC and numerous other authors have pointed out, this is a difficult question to address, due to a wide range of subjective considerations that science alone cannot address. Nevertheless, a number of institutions, both in the United States and abroad, are giving some thought to this issue, particularly with respect to its implications for greenhouse gas stabilization. The exploration of potential stabilization levels could serve as a basis for evaluating various policy responses to climate change (e.g., mitigation) with respect to costs and benefits. If the Administration is truly interested in placing the United States on a path to absolute reductions in greenhouse gas emissions, the CCSP must give consideration to both near- and long-term targets for emissions reductions and stabilization.

VICKI ARROYO AND BENJAMIN PRESTON, PEW CENTER ON GLOBAL CLIMATE CHANGE

Page 38, Chapter 4: We strongly support the idea that CCRI will "acclerate the development of a structure and process for integrating science with decision processes" (p 39 lines 4-5). This is very important.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 38, Chapter 4: This document should not ignore the previous U.S. National Assessment on the potential consequences of climate variability and change as if it never existed. Many of the stated goals and methods are similar to those used in the U.S. National Assessment. At a minimum, lessons, both positive and negative, can be learned from this previous effort, rather than ignoring it entirely. References should be made at least to the Overview document (National Assessment Synthesis Team (2000), *Climate change impacts on the United States: the potential consequences of climate variability and change*, US Global Change Research Program, 400 Virginia Ave., SW, Suite 750, Washington DC, 20024, or as USNA, 2000 to be more general) in several locations, particularly throughout Chapter 4.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 38, Chapter 4: Development and delivery of products from climate variability/change research that serve policy, planning and operational decision making are key elements of the CCRI. Potential users of these products are comprehensively listed, and interaction between users and scientists is identified as an important step to target and prioritize research that will lead to useable information for policy analysis, decision makers and resource managers. However, given the importance of this step, surprisingly vague and unspecific language is used to describe how this is to be accomplished, and what the strategy is to get from "here" to "there". This chapter could be strengthened by including more specific examples on how to engage users, the level of interactions, and who should be included in the interactions (program manager - agency head - department head level interactions; mid-management level interactions; scientist-to-scientist interactions; scientist-to-user interactions; etc.). How will these interactions be promoted and established (departmental directive, new resource allocation, etc.)? How and by whom will "useful research information" be defined (users, scientists, managers, and useful to whom)? What kind of effort would benefit from collaboration and at what level? Who should lead the integration of the research information into decision support systems? Answers to these type of questions will produce the outline of a strategy to achieve the goals of the CCSP.

The interaction and working relation between decision makers and scientists is emphasized throughout the chapter. However, the general impression is that the decision makers will only inform the scientist of what is important/useful information, and as a result the sponsored research will be informed on what is important (see page 38 lines 10-12). This is a rather weak working relationship that leaves the door wide open for misunderstanding, unmet expectations, unintended consequences, etc. This reviewer suggests that the working relationship must be much stronger, such as collaboration and partnerships between the sponsored research, the decision support developers and the decision makers. Sponsored research encompasses the "climate change scientists", whereas decision support developers include specialists in the area of application (scientists/engineers) that can integrate the climate research products with the multiple facets of application specific information, and decision makers are those persons that make the decision based on the resulting integrated and within context decision support tool, product or information. For example in agriculture, a climate scientists would develop agriculturally relevant climate variability/change data at regional and local scales which is combined by an agronomist with agricultural practices information to produce an integrated decision support tool that can be used by farmers and agricultural producers to adjust production operations. Such a partnership overcomes the unrealistic expectation that the "climate scientist" is also knowledgeable of agronomic practices before a useable product can be developed for the end user/decision maker, here the farmer. Such partnerships between climate scientists and application specialists are essential to produce high quality, integrated, useful and complete decision support information, though research resources may have to be shared, which can be expected to be a significant obstacle in under funded programs.

The language used in the "Two Center Strategy" (page 52) is exclusive. It gives the appearance that these centers provide the only two viable approaches that should be recognized and funded. Such a strategy would limit opportunities for new and innovative alternatives, as well as limit the adoption of other methods/models developed by countries such as Japan, and the European community. The language in this section should explicitly recognize the model development/application efforts by other centers and universities. And it should better define the relations between the "two centers" and other applied climate modeling efforts (for example IRI).

This Chapter 4 could be shortened and focused by limiting the sometimes lengthy explanatory paragraphs.
Section 4 in this Chapter 4 is less than 1 page long whereas the first 3 sections have coverage over 4 pages each. It looks like a hasty, undeveloped addition. Section 4 should either be developed to similar length to reflect the importance of risk analysis and decision making under uncertainty (a major goal of CCRI), or it should be removed and incorporated into the first three sections.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 38, Chapter 4: The concept of stakeholder involvement in the decision-making process is a good one. My concern is this consideration may not be broad enough to represent the range of stakeholders that are and will be impacted by climate change.

STEVEN R. SHAFER, USDA-ARS

Page 38, Chapter 4: Section 1 on evaluations and synthesis mentions a couple of times that a broader agenda is needed to include greenhouse gasses other than CO_2 and that it is important to examine the tradeoffs among greenhouse gasses. This is a critical point, especially for the agricultural sector, that needs to be emphasized and strengthened. The past decade has seen a significant increase in carbon sequestration in agricultural soils but this increase has been almost completely offset by an increase in N_2O emissions. I,m not sure if this is the best place to make this point, but, the interaction between the nitrogen and carbon cycles, and the impact that efforts to increase carbon sequestration has on nitrogen emissions needs to strengthened throughout the document. We cannot afford to focus solely on carbon or we may find that we have won the battle but lost the war.

R. HOWARD SKINNER AND STEVEN R. SHAFER, USDA-ARS

Page 38, Chapter 4: Chapter 4 is in many ways the most interesting and innovative in the draft Strategic Plan. Its commitment to producing a dramatically upgraded array of resources for decision-making and to link those resources with decisions is welcome, appropriate, and very promising. The frequent mentions of consultative processes and stakeholder interactions are laudable, since these sorts of communications in both directions are a key to assuring the relevance and usefulness of climate change science. Recent experience shows that user communities not only offer essential perspectives about what variables to examine, as well as valuable reviews of draft materials, but they also possess knowledge bases important to integrated assessments of climate change and its effects that are otherwise unavailable to (or at least unknown by) the scientific community.

The main issues posed by the chapter are not <u>what</u> it proposes but <u>how</u> it proposes to carry out these initiatives. The central issues include who will be responsible for specific activities, especially when some of them need to get started very soon; how these activities will be funded; assuring that CCRI decision support activities are based on the scientific knowledge bases on decision-making processes, stakeholder participation, and scenario construction and use. In addition, more attention in decision support activities should be paid to the <u>impacts</u> of different climate change scenarios (e.g., different greenhouse gas stabilization levels) on people and ecosystems. This kind of decision support assistance can be strengthened while applied climate modeling is improved, and it is critically important for decisions about investments in climate change adaptation or mitigation. In particular, improved data bases and tools are needed to support estimations of the costs and benefits of alternative responses to sets of conditions sketched by different climate change scenarios. For instance, costs and benefits of adaptation have received less attention than costs and benefits of mitigation, and integrated analysis of the two sets of pathways has received almost no research attention.

The current draft of Chapter 4 suggests some imbalances in envisioning the kinds of issues that should be addressed by CCRI decision support systems. For example, the current draft -- while noting (and perhaps exaggerating) the limits of current climate modeling as applied to a regional scale -- does not appear to recognize the potential for extensive analyses of regional scale impact and response issues via alternative methodologies such as those noted above. Effective explorations of "if this, then that" questions do not necessarily depend on high-confidence forecasts of regional impacts. As another example, the draft seems to reflect a view that targeted scientific research on climate science issues that have proven intractable for a decade or more can relatively quickly reduce uncertainties -- and that, as a result, within 2 to 4 years, many uncertainties that now inhibit decision-making will be removed and confident policy actions can be taken. This does not reflect current scientific understanding of most of the issues, which shows that such certainty is often not necessary for effective decision-making. Indeed, decision-making under conditions of uncertainty is the normal condition in life at every scale; a lack of certainty is not a valid reason for inaction, especially if there might be adverse consequences of inaction, and information to inform decision-making under uncertainty should be specifically emphasized by CCRI . As a third example, the chapter seems to ignore the experience provided by the National Assessment, when this significant recent national investment is one of the most important sources of lessons learned for the kinds of decision support called for by CCRI. The successes and failures of the National Assessment can provide crucial guidance on how to do better at linking science to decision-making via stakeholder involvement.

If -- as a key element of CCRI -- substantial progress in decision support to policymakers and regional and sectoral resource managers is to be made within four years, a major effort will need to be mobilized relatively quickly, not only within the world of science (e.g., scenario development and sensitivity analysis) but also in linkages between science and regional resource managers and other stakeholders. This discussion raises urgent questions about the availability for financial support; the general approach and framework imply a massive effort, especially if it is to deliver results within a four-year period. As a minimum, Chapter 4 seems to require a commitment -- within a period of perhaps six months -- to design the infrastructure for stakeholder consultations that will be utilized by CCRI, along with agency responsibilities for implementing this infrastructure, which will then provide a framework for consultations and information transfers within GCRP as well (see the mentions of such interactions in most of the GCRP chapters). This process, in turn, needs to be informed by the existing knowledge base on such processes (see above). In addition, implementing agencies will need to be able to commit appropriate resources to support this infrastructure over the CCRI period (and subsequent activities of GCRP) in ways that assure quality, continuity, and scientific validity.

THOMAS J. WILBANKS, ORNL

Page 38, Chapter 4: This section has a lot of good material, but is subject, I think to the criticism that it doesn't clearly identify how we move forward. A suggestion for how it might be re-organized is as follows.

Key problems:
1. Current climate models give similar mean climates and responses to past changes but different predictions of the future. Where does this problem come from and how might we deal with it?

Where does the problem come from:

Differences in bias. A model with more sea ice will have more sensitivity to climate warming than a model with less sea ice.

Differences in feedbacks: A model with bright sea ice will have more sensitivity to climate warming than a model sea ice is dark (albedo is lower).

Models are often tuned so that feedbacks which would cause runaways in regions of bias are weak. The great problem is that a bias may come from one part of the model (the sea ice edge may be in the wrong place because of the winds) and the feedback may come from another part (sea ice physics). Fixing one of these won't necessarily improve the models.

How do we deal with it?:
Reducing biases: A comprehensive program of model testing where models are evaluated against observational datasets will have the effect of reducing biases, and of identifying cases where biases in one field are traded off against biases in other fields. These latter cases represent should represent targets for climate process teams to focus on.

Improving representations of feedbacks: There needs to be an identification of key coupled feedback processes which the climate process teams can then focus on.

The two-center strategy:
Both GFDL and NCAR will work to identify and reduce sources of bias in their models and to identify compensating processes that lead to differences in sensitivity. NCAR will take the lead in working to improve representations of individual processes that play a key role in climate feedbacks. GFDL will take the lead in working to produce realistic simulations which can be used by the wider research, impacts and policymaking communities.

ANAND GNANADESIKAN, NOAA/GFDL

Page 38, Chapter 4: The concept of stakeholder involvement in the decision-making process is a good one. My concern is this consideration may not be broad enough to represent the range of stakeholders that are and will be impacted by climate change. In the present form the chapter almost infers the stakeholders are those involved in climate change research.

JERRY L. HATFIELD, USDA-ARS NATIONAL SOIL TILTH LABORATORY

Page 38, Chapter 4:
First Overview Comment: Chapter 4 needs to better define the decisions to be addressed and the decision-makers involved in making those decisions.

Second Overview Comment: Chapter 4 needs to better define the articulation between the efforts in the short-term program (2- to 4-year time frame) and the long-term program.

Third Overview Comment: Chapter 4 needs to better define the criteria for evaluating the products and payoffs.

Fourth Overview Comment: Chapter 4 needs to better define the linkage with the Climate Change Technology Program.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 38, Chapter 4: I would first like to thank the organizers for inviting me to participate in this panel as well as commend the authors and contributors to this chapter of the Strategic Plan for a very thorough and well-written draft. I will also note that my perspective in these comments reflects not only my five years of grad-school brainwashing in neo-classical economics, but also the recent year I spent advising senior policymakers on this and similar issues at the President's Council of Economic Advisers. There, I gained a particular appreciation for how science, scientists, and policymakers interact.

Frequently, especially during my first few months at the Council of Economic Advisers, I received emails of the form "*If we reduce emissions 10% in 2010, the cost will be ____. Please fill in the blank.*" Initially, I responded as best I could but eventually I became frustrated at my inability to convey the complexity of the answer in a simple response. Eventually, I pushed back: Why are you asking this question? What do you really care about? *I think you are asking the wrong questions*.

This is my over-arching point in these comments: Scientists need to not only respond to policymaker questions, they need to push back and tell them when they are asking the wrong questions.

The interaction between scientists and decisionmakers so far has led to a number of invaluable improvements in our thinking about the climate change problem. One is a view of the problem that focuses on risk management. This is not about affecting relatively well-known outcomes associated with current activity—this is about influencing the risk of adverse and poorly understood consequences. A second is a recognition of the role of irreversibilities—both in the environment and in our investments in human and physical capital—and how that affects the timing of decisions, especially as new information becomes available. A third is an understanding that significant uncertainty exists about mitigation costs as well as climate change consequences, and this has important relevance for the design of policies.

Despite these advancements, I would emphasize that these points have not been well disseminated to all the people who need to understand them. An important continuing role for the interactions between scientists and policymakers, as this chapters describes, should be improved communication of these points. While there is a tendency to want to move on to new and interesting things, nailing down the basics should remain a priority.

Looking forward, my main concern is that decision support efforts highlight for policymakers not only what is known and not known well, but what is *likely* to be known in a timely matter. I think Professor Jacoby's analogy in yesterday's New York Times article nails the point home: when you find out you have high cholesterol, your immediate response should not be to try and get better information about the timing and intensity of the upcoming heart attack—it should be to reduce the risk. This is especially true if the information is likely to arrive after the heart attack occurs. Nonetheless, a frequent line of questioning on climate change has been to focus on ascertaining a safe concentration level for 2100 rather than contemplating real policy options to reduce risk in 2002.

Turning to some specific points in the chapter itself, the discussion initially moves back and forth between issues of decision support for "decisionmakers"—i.e. those people setting national policy and negotiating international agreements—and "resource managers"—i.e., those people engaged in regional and sectoral policy, planning and operating decisionmaking. This distinction between decisionmakers and resource managers might loosely be recast as a distinction between mitigation—efforts to reduce the likelihood or magnitude of climate change—and adaptation—efforts to minimize the impact of, or maximize the resilience to, climate change when it occurs.

My first comment would be that despite the inevitably of adaptation (it is the default policy after all), I think the emphasis on adaptation/regional *decision-making* is less important than the document presents at this time [e.g., page 39, line 5]. While we need to understand the *scope and cost* of adaptation in order to make an appropriate aggregate trade-off between mitigation and adaptation, adaptation *decisions* remain relatively far in the future while the mitigation decisions are much more pressing.

I would make a related comment about the importance of other greenhouse gases and emissions from land-use [e.g., page 40, line 7]. We need to understand the *scope and cost* of emission reductions in these areas in order to make an appropriate trade-off with energy-related carbon dioxide reductions. And we should certainly pursue those reductions in a timely matter. However, the magnitude of the potential reductions as well as the time profile of consequences suggest that an emphasis on energy-related mitigation decisions—versus non-energy-related mitigation decisions—remains paramount.[1]

So let's talk about the main decision: energy-related carbon dioxide mitigation. The draft document states that it will be difficult to generate a true representation of the salient decisions concerning mitigation given the diversity of issues identified over the

[1] The profile of concentration reductions over time from mitigation investments in methane capture or carbon sequestration is relatively flat compared to capital investment in energy-related carbon dioxide reductions.

past several years [page 41, line 17]. The document highlights issues such as the costs and impacts of concentration paths over time, and costs and benefits of various stabilized atmospheric concentrations [line 19]. It then goes on to describe an increased role for stakeholder interaction and management of this interaction [line 27].

My belief is that taking the immediate concerns of policymakers as a given—or even as a primary research driver—ignores the crucial feedback that scientists have on policymaker thinking. I have one particular concern in mind: the focus both at home and abroad on "safe" atmospheric concentrations of carbon dioxide. In my opinion, the climate-related decision research has focused too much on pathways to various concentration targets, leading policymakers to focus on questions of long-run stabilization—emission pathways, technologies, international burden-sharing, etc.—that *we may never be able to agree upon.*

This is the main point I made a second ago. The 1992 Rio Convention commits its signatories to stabilize atmospheric greenhouse gases at a safe level. We imagine first that such a threshold exists, and second that science can reveal it in a timely way.[2] We are trying to manage the exact time and severity of our heart attack rather than starting to reduce the risk.

To this end, I believe that one of the most valuable contributions of a decision support program could be to elaborate on the kinds of uncertainties that are likely to remain for some time and the consequences for decision makers. Interaction with policymakers remains critical, but scientists and research agenda managers should actively challenge whether the policymakers are asking the right questions based on what may or may not be answerable. If a policymaker is asking for a cost-benefit analysis of different long-run concentration levels, someone needs to explain that the range of uncertainty on such an analysis is so large, and unlikely to diminish, that it is of questionable value. Instead, the policymaker might be encouraged to ask whether, absent a concentration target, science can inform an alternative kind of goal to get things started. I will note that this is one of the key problems we faced when I was at CEA: absent a roadmap of the ultimate goal, how do we calibrate the first step?

Along these same lines, I would ask whether the scenario development [page 45, line 14] might be supplemented by an analysis of how gradual, incremental, policy could be reformed over time as the true scenario unfolds. Not only based on increased knowledge about climate change, but based on increased knowledge about the policy's own efficacy in reducing emissions as time passes. Does a first round of technology incentives work? How will we know if they have worked? If they do not work, how should the policy be reformed and when?

Basic scenario development is useful for conveying a story. How many nuclear power plants do I need if no conservation occurs and no other non-fossil alternatives are viable? But there are so many combinations of possible assumptions, one can quickly become overwhelmed by the different "If…, then…" possibilities. I would encourage a scenario effort that attempts to highlight the importance of a flexible, diversified, and adjustable policy response, but not one that purports to fine-tune a particular decision.

I am very supportive of research to improve simulation of climate change consequences in response to alternative emission scenarios and natural forcings through

[2] The National Ambient Air Quality Standards under the 1970 Clean Air Act similarly seek a safe level of pollution that does not harm the public health.

applied climate modeling [pages 47-52]. Despite the difficulty in using such models to establish “safe” concentration levels in a timely matter, over time, they should provide feedback to the policy process.

A final area that I might add to the discussion is some attention to the evolutionary nature of policymaking. One need only look as far as the Clean Air Act over the past thirty years to see that an initial policy approach will almost certainly be modified. Are there certain policy designs that lend themselves to modification and others that do not? In particular, will a policy that initially addresses a subset of emission sources in a differential manner—say power plants and passenger vehicles through cap-and-trade and CAFÉ—create institutional obstacles to future improvements? Are there some institutions, such as a project-based crediting system for the capture of fugitive greenhouse gas emissions, that will be useful regardless of the future policy design?

Summarizing, my main concern is that decision support not be viewed as a way to simply make science more responsive to policymaker *questions*. I believe this ignores the fact that the scientific discourse over climate change is what has led to policymaker questions in the first place, and that a failure to grasp the limitations of scientific analysis can lead to a dead-end in policy development. The science program should continue to work on communicating the basics of risk management and decisions in the face of uncertainty and learning, but should also keep policymakers focused by showing them (1) why some decisions are less important than others, *now*, (2) which decisions must be made before uncertainty is resolved, and (3) what lines of questioning are unlikely to help resolve policy debate.

BILLY PIZER, RESOURCES FOR THE FUTURE

Page 38, Chapter 4: Uneven with respect to climate variability and change.

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 38, Chapter 4: This chapter is of critical importance: "synthesizing scientific results and producing decision support resources responsive to national and regional needs" (p.38). One panel member emphasized the need for "timely information to decisionmakers." Since books become quickly out of date, official WEB sites which are continually updated with new research findings, may be one potential solution. And this panelist also said "decisions will be made within particular sectors," while another panelist stressed information "usability." Natural resources management has many sub-audiences (e.g., protected area managers). WEB sites might be designed to reach some of these sub-audiences. These comments blend into comments on yet another chapter.

CRAIG SHAFER, NATIONAL PARK SERVICE

Page 38, Item 2: Historical data records can characterize climate variations, but cannot provide attributions of causes for change **without analysis**. This text should be revised to make this clear: simply examining the data record does not answer the questions about causes.

WILLIAM B. ROSSOW, NASA GODDARD INSTITUTE FOR SPACE STUDIES

Page 38, line 3: It is unfortunate that this section does not seem to have anything about economic modeling—is this not essential?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 38, lines 5-8: The draft report states that the CCRI will synthesize results of research conducted by the Climate Change Science Program (CCSP) and present critical information to decision makers, who are defined as persons "engaged in the development of national policy such as setting national goals for greenhouse gas emissions and negotiating with other countries over international agreements." This definition appears to exclude state officials completely, notwithstanding the facts that (a) state officials have jurisdiction over numerous activities that impact national GHG emissions, such as power plant emissions within their borders, or that are key to mitigating the effects of climate change, from open space preservation to flood control; (b) many states have set their own goals for GHG emissions, in the absence of significant federal commitments to do so, and have developed detailed action plans to achieve those targets; and (c) the New England states have agreed with the provinces of Eastern Canada to set GHG reduction targets over a total area whose combined GHG emissions are greater than those of all but 10 countries worldwide. The report should be amended to recognize that many states have developed realistic climate change policies and to include state officials in the definition of key decision makers who are consumers of information from the CCSP.

KENNETH A. COLBURN, NESCAUM

Page 38, lines 5-7 (also see page 38, lines 20-22): This type of language is VERY SCARY. Hopefully, what is meant is that the CCRI will support the integration and synthesis (one might say evaluation and assessment) of the results of research in an open and peer-reviewed manner, but the words literally seem to mean that this process will be done internal to the program, for example by the agencies (collectively?) or their representatives. This would be a very serious step, as it would clearly introduce political considerations into the summarization of the science, raising serious issues of credibility. In the National Assessment process we worked very hard to make sure there was a clear separation so that the scientific-expert-stakeholder community summarized the information and this effort was external to the agencies and was peer-reviewed, etc. (and Republican Congress insisted on this), and then these evaluations could be input for the agencies to consider, and place in the context of all their various interests. Implying, as is done here, that the CCRI would synthesize the information would seem to paper over the varied interests of the agencies and intermix political and policy considerations with the scientific results. I also found it interesting that the wording seems to leave out the input of other key stakeholders, such as governors, industry, public interest groups, etc. In addition, this notion of the synthesis being done under CCRI auspices would seem to be closing out the approach of an international assessment and consideration of issues and replacing it with a US-only perspective, again a real step backwards. The plan should be openly indicating support for regional, national, international, and other assessments that are done independently and openly—not be calling for a build-up of internal synthesis activities.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 38, Line 6: Mention linkage with the Climate Change Technology Program.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 38, Line 8: Change sentence to "Decisionmakers, as defined here, engage in the development of national, **state, or local policies that address climate change causes, impacts, or mitigation strategies. These policies may include the setting of greenhouse gas emission goals and the negotiating of international agreements**.

EESI, CAROL WERNER AND J.R. DRABICK

Page 38, lines 8-10: "Decisionmakers, as defined here, are persons from both the public and private sectors engaged in climate change policy development and implementation and in identifying relevant issues and questions for researchers and include resource managers and stakeholders."

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 38, lines 8-10: There are many other types of decisionmakers interested in results of this research. This phrasing makes it seem like the only issue that matters is the national decision on mitigation under the UNFCCC whereas the USGCRP covers global change and there are a vast array of potential decisionmakers.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 38, line 10: This notion of "resource managers" is too narrow (using conventional usages of words). There are many more groups interested in the results—from industry to the public, from local to international, etc. As just one example of an international coupling that surely works in reverse, ranchers in the Great Plains were most interested in projected climate change in Australia, Russia, China and Argentina for that is where their competitors are. There also needs to be explicit recognition given to the need for adaptation, among other types of response.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 38, line 11 and 12: Integrating science with decision process (lines 3 and 4) will require the development of a new class of working relationships (line 11), however, this working relationship should not be limited to ensure that sponsored research is only informed by an understanding of what information is timely and useful (line 12). The working relationship should go well beyond "being informed", and should include collaborations and partnerships where scientists and decision support engineers are working together, each in their area of expertise. For example the USGS, USDA, EPA and other federal agencies with expertise in their specialized application fields should be specifically mentioned for such partnerships. In addition to the energy sector, the agricultural sector is particularly affected by short term climate variability, where a single seasonal drought and flood can cause billions a dollars in lost productivity. Hence, the agricultural science, research and application community (USDA) should be engaged in such partnerships.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 38, Lines 14-15: The phrase "a number of the decisions and natural resource issues affected by climate variability and change" is too vague. This needs to be more explicit.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 38, line 14: The phrase "natural resources" is much too narrow. There are issue having to do with infrastructure and operations, and lost more (e.g., see DOT workshop results). The terminology here is simply much too narrow and needs to be greatly broadened.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 38, Lines 17-18: Add the topic of strategies to reduce and manage uncertainty to the topic of "characterizations of uncertainties and the level of confidence associated with this information".

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 38, Lines 21-22: The phrase "national and regional needs" should clarify that the U.S. ability to deal with international issues is a national need. For example, the Office of U.S. Foreign Disaster Assistance needs information about climate-related impacts in other countries.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 38, line 22-23: "Decision support resources include a wide variety of mechanism for creating and supporting a dialogue between scientists and decision makers to identify issues and questions of concerns …". At this point a few examples of the "wide variety of mechanism" should be listed.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 38, Line 24: The phrase "framing the research agenda needed to answer the questions" needs more specific identification of the questions as well as an articulation between short-term and long-term needs by decision-makers. The CCRI focuses on products with payoffs in the short term, but research will also serve the needs of decision-making over longer time periods.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 39: decision processes to assist the development of regional and sectoral adaptation responses 5 Why focus on adaptation here rather than using predictions to help build the case for mitigation?

The main constraint on any such reductions has been the desire to maintain modern living standards 35.

This is a preposterous and biased way to put the issue. France has only one fourth the per capita CO2 emissions as the US, and if the US attained French standards the global change problem would be greatly reduced. It is preposterous to claim that France does not have "modern living standards" as a result of its lower CO2 emissions per person.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 39: **Third Overview Comment (p. 39):** The draft states (p. 39) that "[o]ne component of the CCRI will focus on national-level challenges associated closely with the mitigation issue . . . associated with long-term global climate change" and "[i]n a parallel effort, the CCRI will accelerate development of a structure and process for integrating science with the decision processes to assist the development of regional and sectorial adaptation responses . . . to variability and long-term changes in climate." We are concerned that the draft at this point appears to treat mitigation separately, although on a parallel path, from adaptation. Yet we note that last year, the U.S., in response to an invitation by the FCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA), submitted views "on priority areas of research for the scientific community" relevant to the FCCC *(FCCC/SBSTA/2002/MISC.15)*, which called for an integrated assessment of alternatives and an integrated analysis of mitigation and adaptation options. The U.S. said:

> The United States believes that adaptive responses and consideration of adverse effects of climate change are important areas for further investigation of potential responses, evaluation of their effectiveness and estimation of their costs. Further, the application of integrated assessment and decision analytical frameworks, which take into account economic, social, and biophysical data could allow for the prioritization of adaptive responses, as well as the relative emphasis on adaptation and mitigation.
>
> The question of an economically efficient transition to a future that minimizes the economic and environmental consequences of climate change cannot be answered without simultaneous consideration of adaptation and mitigation. This should be a priority of the scientific and technical community. In this regard a major concern is the inadequacy of decision models to capture both the benefits and costs associated with climate change and relevant mitigation strategies. The importance of a better assessment of accounting to reflect the full range of benefits and costs across sectors and on the nation's GDP, investment patterns, consumption levels, and jobs throughout the economy merit investigation.

We believe that the integrated approach to mitigation and adaptation suggested by the U.S. to SBSTA should be the focus of the CCRI. They should not be treated separately.

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 39-41: The President's February 14, 2002, "New Approach" document states (section 5, p. 24) that the CCRI was "created" to "study areas of scientific uncertainty" and to "identify priority areas where investments will make a difference." The document adds:

Comments on Chapter 4

> The CCRI promotes a vision focused on the effective use of scientific knowledge in policy and management decisions and continued evaluation of management strategies and choices. The "focus" of the investment is "on answering key questions" identified by the NAS.

However, Chapter 4, section 1 of the draft seems to have a different "focus," namely providing that the "CCRI will initiate a process" of identifying "policy decisions that should influence the focus of climate change research programs" and stating that "[o]ne goal of the decision-support efforts of the CCRI is to identify national-level decisions and to use the list to develop decision support activities as well as to prioritize climate change research" (p. 40). The draft states (pp. 39-41):

> For the last decade, the primary focus of the development of climate change science information at the national level has been in response to the debate on energy policy.

> It will be important to consider likely future policy decisions, because there can be lag time in the delivery of research results. The resulting articulation of potential policy questions will serve as a foundation for the subsequent decision support activities. One goal is to expand the range of decisions from an emphasis on energy policy to a broader agenda that includes greenhouse gases and pollution other than carbon dioxide (CO_2)….

> Research projects that contribute to decision support will be supported under CCSP.

> CCRI will attempt to establish mechanisms to foster a new class of working relationships to ensure that relevant issues are identified, articulated, and communicated to the research community.

> Accomplishing a productive and effective relationship among researchers, federal research managers, and policy specialists will require new working arrangements. The CCRI will devote attention to the type of institutional changes necessary to forge effective interaction between research processes and policy development.

> For policy development related to mitigation, it will be difficult to generate a true representation of salient decisions.

> Based on the regional and sector-specific research that has been conducted over the last decade, preliminary target areas for accelerated research that will be considered include air quality; water availability and quality; forest and wildlife management; drought; and public health.

These draft statements seem to shift the express focus for which the CCRI was "created" by the President away from the "key questions" identified by the NAS and the "study areas of scientific uncertainty" toward a focus on decisions and contributing to "decision support," and away from an emphasis on energy policy toward non-energy issues. That shift is inappropriate. Climate change research should be aimed at resolving uncertainties and other issues raised by the NAS. It should help to formulate policy and related decisions. It should not convey the impression, implied or otherwise, that policy decisions "influence the focus of climate change research programs" of the CCRI. The NAS did not suggest a shift from energy policy "to a broader agenda." We believe that the draft should focus on the reasons for the creation of the CCRI as expressed by the President.

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 39, Lines 1-3: A focused national–level effort to identify emissions reduction options is important. This issue deserves a more prominent role within the CCSP. However, there may be a need for state or regional level analyses because of the unique characteristics of different states, which may result in different regional opportunities.

CALIFORNIA ENERGY COMMISSION

Page 39, line 2: The "costs and benefits" for an analysis relevant to U.S. policy need to include global data.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 39, third sentence. This sentence indicates a painful insensitivity to the global nature of climate change issues. This strategy should show more awareness of policy issues that go beyond our own borders.

DOE NATIONAL LABORATORIES

Page 39, Lines 3-7: Mitigation measures must be included, even in regional models. States and consortia of states are already engaged in GHG reduction measures. The CCSP could greatly improve the cost-effectiveness of these decisions by developing better information on the costs and benefits of both adaptation and mitigation.

CALIFORNIA RESOURCES AGENCY

Page 39, lines 3-7: I would think that this activity of CCRI should be in a separate paragraph. This parallel effort sounds very much like an extension of the parts of the regional and sectoral parts of the National Assessment process (note that the process is broader than the national level efforts). It would seem absolutely incumbent for the plan to recognize the preceding efforts and to indicate that it will learn from and build upon them. I would also note that in the list of various actions, some effort will have to be devoted to adaptation, and this should be mentioned—reducing vulnerability and enhancing resilience sound like things done in advance to prepare, but there will also be a need to adapt in many cases.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 39, Line 17: re Decision Support Resources: I strongly endorse the goal stated of ensuring that research is well informed by understanding of what information is timely and useful. The missing issues not noted, which are central to the debate, are the identification and implementation of "no regrets" measures which increase resilience to climate variation by increasing social capacity and well-being in other ways. These are also sometimes called "piggy-back" ideas, but the resilience notion is much more useful. Local and regional governments especially need full information on the measures and goals which would benefit their citizens in almost any conceivable situation, such as rational transit and transportation management and infrastructure, and energy and water conservation. Overlooking needed steps simply because they are needed for more than one reason is not desirable. The full scope and scale of social investment is under appreciated, under studied, and under considered. The regional and local freedom in regard to investments is also *[text missing?]*

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 39, lines 20-23: This sentence discusses a key point, but provides no indication of how this will be done, or even approached. The way that the National Assessment process did it was to make sure the first question posed in the workshops and as part of the assessments had to deal with all the other issues than climate, and so it worked to build context and richness. This is an example of how this can be done. There really needs to be elaboration on this point here.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 39, line 29: The apparent aversion to using the word "Assessment" is really striking, especially given that the USGCRP law calls explicitly for "assessments". Were there some discussion that clarified the various meanings of the word "assessment," ranging from evaluations about how various monitoring instruments work to the process of stakeholder-scientists interaction and communication, the absence of the word assessment would seem plausible. But, without this, it appears to be (and I understand was) a political decision, and this should not be intruding on the science—and that it is, is very troubling.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 39, Lines 31-32: This statement is incorrect. Much of climate change science has been driven by other agendas, especially by an interest in knowing whether the earth is in danger from climate modification.

DOE NATIONAL LABORATORIES

Page 39, Line 31- Page 43, Line 3: The premise of this entire section incorrectly describes the status of the mitigation literature on climate change as well as the reasoning as to what the main constraints to mitigation have been. For example, in line 33 it states that the main constraint was the issue as to whether immediate and steep reductions would be required. While it is true that the IPCC calls for 60-80% reductions in CO_2 emissions, one decade ago the UNFCCC merely called for a voluntary aim to return emissions back to 1990 by 2000. Five years later the Kyoto Protocol only called for a 7% below 1990 reduction by 2010 for the United States. During the last decade there have been numerous government and private sector studies demonstrating that these targets would indeed be achievable and affordable (see studies done by the five national laboratories, 1998). It is incorrect to state that there was a concern about massive change of lifestyle. Rather, decisions were made to maintain the current fuel base for a number of reasons, not the least of which was political.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 39, Lines 32-34: The Pew Center takes issue with the characterization of climate change policy discussions over the last decade as focusing on "immediate and steep decreases in fossil fuels". The discussion has been both more broad and more nuanced than that – including a realization by many that climate change is a long-term issue that will require phased-in policies and the development of new technologies and alternative fuels. The debate has also long-recognized the need to address non-CO_2 greenhouse gases. Furthermore, although it would be incorrect to assume that adaptation is a sufficient approach to addressing climate change, a broad range of policy-makers and stakeholders recognize that the United States needs to give consideration to adapting to the impacts of climate change that cannot be avoided via mitigation. Thus, the assumption that climate change policy is simply an issue of large short-term emissions reductions is a fallacy. We expect the CCSP to have a more advanced understanding of climate change policy issues, particularly if it is to be responsible for conducting "policy-relevant" research. If Chapter 4 is going to summarize the current issues for climate change policy discussions, then a more rigorous description is in order.

VICKI ARROYO AND BENJAMIN PRESTON, PEW CENTER ON GLOBAL CLIMATE CHANGE

Page 39, lines 33-34: The suggestion that what was at issue was a potential requirement of "immediate and steep reductions in fossil fuel emissions" is really not at all correct at all. All of the plausible scenarios considered, for example, by IPCC talked about slow implementation and a gradual turnover. In no way is even the Kyoto Protocol talking about steep or immediate reductions. This is all creating a strawman for political and not scientific purposes.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 39, line 34: (18-P) "The main constraint has been the desire..." Not only is this value-laden (and probably inflammatory in some circles), it's not clear that it's even true. Perhaps a better statement would be "The main constraint on any such reductions has been the perceived cost of changing the status quo of a fossil-fuel driven economy."

HOWARD P. HANSON, LANL

Page 39, Line 37-40: Change final sentence to "Issues central to the debate have included distinguishing between natural climate variability and human-induced climate change; the adequacy of observations to determine climate variability and change; the reliability of climate modeling; the prediction of expected costs of climate change impacts and adaptation strategies; and the prediction of the costs and benefits of mitigation options."

EESI, CAROL WERNER AND J.R. DRABICK

Page 39, lines 37-38. Not really dealt with in the plan.

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. OF MARYLAND

Page 39, Lines 39-40: The invocation of the "immediate costs and possible benefits of mitigation" should be complemented with an additional focus on the "immediate and long-term costs and possible benefits of adaptation options if no mitigation is forthcoming", along with a description of the production possibilities frontier defined by varying levels of investment in mitigation and adaptation. This broadening of the question gets much closer to the true nature of the policy debate.

CALIFORNIA RESOURCES AGENCY

Page 39, line 40. Add to this list, 'the costs of adaptation options'. Also, in the phrase 'the prediction of the immediate costs and possible benefits of mitigation options' change *possible* to *potential*.

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 40: The relevance to regional and local decision support is critical; it is not correct, however, that relevance and usefulness demands certainty or precision. Usually, the range of choice working in real-world complexities is constrained and effectively insensitive to much more than the sign of the change, let alone additional decimal places on the estimate of the range of error in the ensemble of simulations.

It is far more important to show how the climate variation situation can interact with other trends and variables to either increase the value of useful responses, or work at cross-purposes with choices that are contra-indicated by these considerations. (Rayner and Malone's 1998 Human Choice and Climate Change series, Battelle, covers the usefulness issues very well.)

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 40: One goal is to expand the range of decisions from an emphasis primarily on energy policy to a broader agenda that includes greenhouse gases and pollution other than carbon dioxide (CO2).

While some more attention to methane and black carbon might be salutary, it is undeniable that in the next 50 years CO2 emissions will be the most critical part of the problem, and the most threatening, given the persistence of CO2 in the atmosphere. Insofar as this statement is meant to imply that energy policy can be appreciably de-emphasized, it is dead wrong.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 40: Regional- and local-scale analyses of potential climate impacts are limited by the fact that currently available model projections are not reliable at the smaller scales that are required for these analyses.

This is a situation that is not likely to change in the next 2-4 years, and so it is hard to see how a big investment in regional modelling for decision making can fit in with the short-term emphasis of CCRI.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 40, first sentence. The following discussion makes it clear that this process is to be broadly consultative. How will this be organized and carried out?

DOE NATIONAL LABORATORIES

Page 40, Line 2, 10 The "evaluations and synthesis" section of chapter 4 calls for CCRI to " initiate a process to identify policy decisions that should influence the focus of climate change research programs." This is highly appropriate, and consistent with the statements in chapter 1 that the CCSP should be policy relevant but not policy driven. The recognition that both national and regional decision making are part of the CCRI is also right on target. Climate data and information, including the systems to serve information, are essential resources for decision support at the regional level.

The report notes that " regional scale climate analyses can and have been used effectively in regional decision making contexts, creating an important demand for useful .. data." There are very large gaps in data and information systems to effectively serve these data, and in many cases neither the type of information needed nor the form in which it is needed have been sufficiently defined. There are a few prototype systems, but research is needed on: i) how to visualize data for different stakeholder communities, ii) what information is needed (and when) to meet their decision calendars, and iii) what information is actually most important in reducing their vulnerability to climate change/variability.

The comments in the preceding paragraph apply equally to historical climate data or model output reflecting a changed climate. In the near term, serving useful historical climate information to decision makers will be more important than providing information on scenarios developed from climate models. The record of the past 100 to 1,000 years is a good starting point for stakeholders who need to develop a better understanding of the spatial and temporal variability of climate. Appropriate, effective, sustainable data and information systems are essential, and are generally not yet in place. These systems should not only serve data in a usable form, but should also have some analysis capability.

ROGER C. BALES, UNIVERSITY OF ARIZONA

Page 40, line 2: Is it not better to try to forecast future policy "challenges" versus "decisions"? The latter are driven by much more uncertainty – hence it is better to anticipate the challenges facing decision makers, and provide tools to assist them – rather than trying to guess the decisions future policy makers will make.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 40, Line 4: This chapter and others state that if the US only knew how to mitigate climate change, it would be doing so. This statement ignores the decades of research of premier US institutions, as well as the actual practices of top US businesses to reduce their emissions with cost savings. This should be reflected in this line, where a delay in decision-making is stated. No delay is needed. Adequate information and experience exists today to reduce CO2 and other greenhouse gases now.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 40, lines 6-12: While it is good to consider other policy arenas – the focus should remain on climate change. The strategy should avoid becoming entwined in the complexities of arenas such as health care where factors other than climate change dominate.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 40, Lines 6-12: While it is reasonable to broaden the inquiry to support decisions in other sectors, that effort should not slow the development of decision-support systems that elucidate the costs and benefits of mitigation and adaptation on the basis of current knowledge. The better is frequently the enemy of the good; we suggest that the CCRI develop a "good" initial decision-support platform as a 2-4 year goal. This platform could be subsequently revised as new information becomes available, or supplanted by an entirely new and better platform developed as part of the USGCRP longer-term effort.

CALIFORNIA RESOURCES AGENCY

Page 40, top paragraph mixes the two very different policy goals of reducing greenhouse gas emissions ("mitigation") and natural resource management ("adaptation"). The science needs for each set of policy goals are quite different. Separating this discussion into two paragraphs might make more sense.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 40, line 8-9. It would be appropriate to note the role of land use on albedo, which in turn has major impacts on climate, at this point.

SUSAN SOLOMON, NOAA

Page 40, line 8, delete "and pollution other than carbon dioxide (CO_2)."

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 40, line 11: Recommend adding transportation planning and infrastructure to the list of broad policy areas needing research as a good example of a non-natural resource.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 40, lines 11-12: It appears that "resource management" is meant to include "agriculture, water resources, air quality, forestry, wildfire management, public health, and foreign aid" and possibly more. Some of these policy domains, such as public health, are not conventionally included under the terminology of resource management. Therefore this definition should be made more clearly and earlier.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 40, Line 12: Add sentence “However, the primary focus of the decision support strategies will still surround energy policy and its relation to climate change.”

EESI, CAROL WERNER AND J.R. DRABICK

Page 40, line 14: Providing an adequate food supply to the people is an important consideration and line 14 should include "agricultural food production" in the list of impacted areas.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 40, Lines 15-18: Subject of regional and sectoral vulnerabilities and resiliences should be referenced to USNA, 2000, as the U.S. National Assessment on the potential consequences of climate variability and change did this exact type of analysis for regions and sectors of the U.S.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 40, line 16: (19-P) To be fair, it would be a good idea to add another clause here:

“...some more resilient to climate variability and change (indeed, some may actually benefit), and taking steps...”

HOWARD P. HANSON, LANL

Page 40, Line 25-33: Again, here is a statement that the current models are course and inadequate and that there is a serious lack of available information. Again, we would refer to the IPCC’s Third Assessment Report, which includes a broad array of findings linked to certainty levels. This is an excellent decision-making tool for policymakers as it clearly outlines what is already highly certain and what could benefit from further research.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 40, lines 28-33: As noted above, regional- and local-scale analyses of potential climate impacts are essential tools for decision makers at the state level. Improving the resolution of current projections and making these tools available to decision makers at all relevant levels should receive high priority under the CCRI.

KENNETH A. COLBURN, NORTHEAST STATES FOR COORDINATED AIR USE MANAGEMENT (NESCAUM).

Page 40, Line 29. The research program could do more to encourage improvements in regional-scale knowledge. For example, climate modelers have been able to make significant strides recently in improving the horizontal resolution of their models. For Europe, the Hadley Centre has produced climate scenarios at a 50km scale and for the UK, we expect to have 25km resolution information available this year, and 12km data within the next four years or so. The user community in the UK sees the production of high resolution information as a priority when it comes to informing its adaptation decisions, and at the USGCRP meeting, stakeholders showed a strong interest in regional information, including on regional climate impacts. Our experience in the UK, has shown that such regional impact analysis is very important in motivating stakeholders to study and consider how to respond to potential climate change.

DAVID A. WARRILOW AND DIANA WILKINS – UK DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS

Page 40, lines 29-30: The statement "are not reliable at the smaller scales that are required for these analyses" is really an unjustified oversimplification. The confidence that can be put in the model results at all scales depends very much on the issue being considered and the detail with which an evaluation needs to be made. Indications that global warming will lead to a rise in the snowline in the west, or will lead to an intensification of convective storms, etc. are very robust and can be applied at local scales—understanding whether a change might be larger in Chicago or St. Louis is of course, quite uncertain, but does this really matter. The type of generalized statement here is simply not justified.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 40, lines 30-33, this is a very important point, and one further point should be made: Even if the guidance from climate models for regional- to local-scale future climate change is poor, the exercise of incorporating some kind of climate change scenario into a planning process can be so valuable from a management standpoint that the details (e.g., 2 or 4 degrees by 2020) don't matter that much. In other words, in most cases the greatest need is **not** for better climate scenarios, but to use any reasonable scenario to bring new thinking.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 40, line 31: It is not at all clear how "prove to be accurate" will be determined and used, especially in that most interest focuses on projections of future conditions, and waiting for confirmation is not a useful approach. It is also not at all clear what "accurate" might mean in terms of some specified level of uncertainty. The point to be made is that various types of decisions can be informed by information to which varying levels of confidence can be accorded, and there is no magic threshold between accuracy and inaccuracy that applies across all types of decision, and all types of value systems being used to consider decisions. Much more nuanced phrasing is needed here.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 40, Line 33: Add: "Concerns have also arisen regarding the degree of certainty necessary for decisionmakers to take action. With respect to this concern it is necessary that the degree of uncertainty within current models be communicated in ways that contribute to risk management analysis. While our current climate models may have many areas that need improvement, the value they can offer decisionmakers in the near-term must be communicated effectively."

EESI, CAROL WERNER AND J.R. DRABICK

Page 40, Line 35: Change sentence to "…CCRI is to identify national, **state, and local-level** decisions and to…"

EESI, CAROL WERNER AND J.R. DRABICK

Page 40, line 35: Is CCRI really going to identify "national-level decisions"? This is a bit like policymakers identifying scientific uncertainties. CCRI can orient its research in ways that can help provide useful information and help to explain the basis for having confidence in indications of likelihood, etc. But I would not think that the CCRI (and is this the people running the CCRI, those supported by it, or what) would be identifying particular decisions—perhaps areas in which decisions are being considered.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 40, lines 35-39: Lofty goal!

ANN FISHER, PENN STATE UNIVERSITY

Page 40, line 35. It should be recognized that national-level decisions interact with decisions in other countries as well. Our focus cannot only be inward.

DOE NATIONAL LABORATORIES

Page 40, lines 35-39: it is unclear why it is necessary to have a separate CCRI goal for policy making and another to address the role of climate in human affairs? Does policy not address the state of human affairs? Are national level decisions not driven by impacts at the regional level? There is no such thing as a "national impact". The national impact is the integration of regional impacts. Hence, it is suggested that these not be presented as separate CCRI goals. A single CCRI goal would do. For presentation purposes a separate structure can still be maintained, but on the basis of the user of the information: one application being the use by regional and local resource managers, and the other for policy analysis at the national level. However, the underlying climate variability/change research is the same, and the regional impact is the same.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 40, line 41: Does the sentence “Research projects that contribute to decision support will be supported under CCSP.” refer only to decisions in the 2- to 4-year time frame? Is this meant to be CCSP, which includes CCRI and USGCRP, or only CCRI?

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 40, lines 41-43: It would be appropriate to also indicate that what is done on decision support will be benefiting from what was done in the National Assessment process—at least it should be.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Pages 41-42, section on Decision Support Resources for Regional Resource Management. This discussion raises urgent questions about the availability for financial support; the general approach and framework imply a massive effort, especially if it is to deliver results within a four-year period.

DOE NATIONAL LABORATORIES

Pages 41-42: THANK YOU! I think the treatment of decision support for regional resource management here is excellent. The sustained interactions between science and stakeholders are proving critical in my own research and cases I know of, having the benefit especially of the NOAA Office of Global Programs research conferences.

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 41, Line 8: relationships between what
JAMES BONTA, USDA

Page 41, lines 10-11: Are these "decisions for which science-based information will be useful" meant to decisions only in the 2- to 4-year time frame? If multiple time frames are involved, that should be made explicit.
JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 41, line 13: the need for "new working arrangements" is identified. More detail of what these arrangements are and how they would work may help provide a clearer strategy to how to move forward.
JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 41, Lines13-15: There is already a long research history about the nature of effective institutional relationships between science and decision-making, yet the Plan neither references it nor provides any clear direction about what the institutional changes will be.
CALIFORNIA RESOURCES AGENCY

Page 41, lines 13-15: Agree that overcoming institutional barriers is key to forge effective interactions between science and policy decisions. However, how the CCSP will accomplish this needs further definition.
DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 41, line 14: What does it mean to "devote attention" to necessary "institutional changes"? This component needs to cross-reference Chapter 12 (Grand Challenges in Modeling, Observations, and Information Systems), Chapter 13 (Reporting and Outreach), and Chapter 15 (Program Management and Review).
JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 41, lines 17-25. The list of issues should include costs and benefits of alternative policies and actions to reduce possible damages from climate change impacts and to explore opportunities associated with such impacts.
DOE NATIONAL LABORATORIES

Page 41, line 17. Why will it be difficult to generate a true representation of salient decisions for policy related to mitigation? There are certainly a large number of diverse issues but representing the possible decisions need not be difficult. Suggest change this line to " Developing scenarios and other decisions support resources related to mitigation will be a core focus of the climate change science plan."
JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 41, Line 17-25: Once again it is stated that there is a lack of salient information on mitigation options. This clearly is not the case. Numerous studies from many sources are available for review. In fact, other countries that are moving ahead with serious mitigation plans may provide a good information source for the United States in these research efforts. In fact we would recommend that one element of the CCRI is to explore the co-benefits of mitigation including reduce air and water pollution and related reductions in health impacts.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 41, Lines 17–25: "*For policy development related to mitigation, it will be difficult to generate a true representation of salient decisions. Over the last several years there has been an interest in issues as diverse as estimating the costs and impacts of concentration paths over time; costs and benefits of various stabilized atmospheric concentrations; priorities for technology R&D; evaluating regulatory instruments; analyzing uncertainties; analyzing the role of the United States with respect to the rest of the world; analyzing which gases to control and how to trade off certain greenhouse gases versus others; the connection of greenhouse gas emissions to other pollutants, such as aerosols; assessing impacts from possible climate change at a local level; high-consequence but low-probability events; and others.*"

Given the slant of this document, it is not surprising that under "mitigation", improving energy efficiency—increasing output per unit of energy consumed—was not even mentioned. In fact, "efficiency" is mentioned only twice in the document: "water use efficiency" (page 8, line 11) and "to increase economic efficiency" (page 68, lines 13–14). Improving energy efficiency—or more generally, increasing the Second Law (of Thermodynamics) efficiency of industrial and commercial processes and equipment—is a necessary but insufficient response to mitigating climate change.

DAVID L. WAGGER, SELF

Page 41, line 17: Add "adaptation" so the text reads, "For policy development related to mitigation and adaptation…" Reason: policymakers will consider adaptation (taking steps to avoid damages due to climate change) as well as mitigation (taking steps to limit climate change).

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 41, Lines 17-25: We dispute that the decision space facing national decision makers is so difficult to characterize, though we do not underestimate the difficulty of arriving at sound decisions. The central issue we believe can be cast as an economic one, involving the returns to a portfolio of mitigation and adaptation options under conditions of uncertainty. All of the decisions noted in the referenced lines are sub-issues related to this overarching economic framework. The CCRI will benefit if the Plan ceases to treat the policy issue as unframeable – the issue has indeed been framed – and instead creates the decision framework needed to assess potential answers, one of which certainly ought to be the administration's current policy of adaptation rather than mitigation. But the framework must be large enough to evaluate mixes of adaptation and mitigation.

CALIFORNIA RESOURCES AGENCY

Page 41, line 17, what does this sentence mean? The purpose of the paragraph whole is unclear.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 41, lines 17-18: It is a bit bizarre to on the previous page indicate that CCRI will be developing a list, and then to here to say it is difficult for the mitigation area. I would suggest that it will be much, much more difficult for the vulnerability and adaptation areas, and in fact in the adaptation area private industry will not even let you into the process as they don't want to expose their business plans or vulnerabilities. Industry may well provide some indication of general areas (like changes in frequency of extreme events), but not specific ones. In addition, the array of types of decisions in the vulnerability and adaptation areas is so vast that it will be hard to narrow things down. I would also add that the National Assessment process has generated a quite extensive list and a quite insightful framework indicating the types of things that need to be done, and a paper by Ted Parson et al. will soon be out in Climatic Change. Really, much has been done on this and recognition has to be given.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 41, line 19: Add text so the line reads: "estimating the costs and impacts of concentration paths over time and undertaking adaptation to reduce those costs and impacts;…" Reason: society is adapting to climate change and will continue to do so.

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 41, line 23, delete "to other pollutants," and insert "to pollutants."

EDISON ELECTRIC INSTITUTE, WILLIAM FANG/ERIC HOLDSWORTH

Page 41, line 27: Replace "Stakeholder involvement …" to "Stakeholder, user and implementation specialist involvement …".

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 41, Lines 27-30: Stakeholder interaction was a hallmark of the U.S. National Assessment on the potential consequences of climate variability and change, and is a primary reason why "researchers have spent the last several years learning how to interact with resource managers and local planners". To not reference the USNA, 2000 is a serious omission here.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 41, line 30: Add agriculture to the list of candidates for user relationships.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 41, line 35: What are the products and payoffs of "Identification of Decision Issues at the National Level"?

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 41, Line 36 and following. It would be a waste of time, resources and money to start from scratch in developing regional stakeholder groups and prioritizing issues on the issue of climate change. Stakeholder groups were formed as part of the National Assessment across the country, regionally and by sector. These groups still exist or could be easily brought together again. The Climate Change Science Plan should explicitly mention the National Assessment and its stakeholder groups and urge continued or renewed funding of these groups, including their academic partner institutions.

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 41, Line 36- Page 42, Line 5: In the list of elements for the framework we would recommend including: "Assessment of the various levels of mitigation on the need or possibility of adaptation on the regional level." It is clear that if no serious mitigation efforts occur, the ability for ecosystems and other systems to adapt to climate change is extremely unlikely. It is therefore necessary to know the emission scenarios and likely temperature changes in order to assess adaptation needs and possibilities.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 41, line 36 through Page 42, line 28: This support resources contemplated in this section on "decision support resources for regional resource management" fails to reflect the caution contained on page 44: "In fact, different model projections are at times contradictory, a symptom of the unreliability of regional-scale projections at this time." The decision support resources need to reflect the realities of unreliable regional modeling that occurs for many complex reasons. Without the proper context, unreal expectations will be established and unreliable policymaker support will be developed.

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 41, Line 40: global change information will be provided at what time-scales?

JOSH FOSTER, NOAA/OGP

Page 41, Line 40: Add "…decisionmakers that would most benefit from increased communication of current global change information, such as the National Assessment, as well as improvements upon this information."

EESI, CAROL WERNER AND J.R. DRABICK

Pages 41, lines 40-41, and 42, lines 25-28: Here the CCRI identifies a number of target areas for integrating science more effectively into policy development, including "air quality; water availability and quality; forest and wildfire management; drought; and public health." These are all areas in which states play central regulatory and/or policy roles. As such, the stated goal on page 41 of identifying "regions, sectors, and decision makers that would most benefit from improved global climate change information" should make states an explicit focus.

KENNETH A. COLBURN, NORTHEAST STATES FOR COORDINATED AIR USE MANAGEMENT (NESCAUM).

Page 41, line 40 - Page 42, line 5: How will the CCRI evaluate the six components of the framework to enhance decision support for regional resource management?

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 41, Lines 40-41: California is ripe for a regional project.

CALIFORNIA RESOURCES AGENCY

Page 41, line 42: Replace with "Establish working relationships with decision makers and develop indicators for assessing vulnerability and/or opportunities".

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Pages 42-45: Again, THANK YOU! This represents a lot of hard-won experience, and I appreciate the clear expression. The one concept that is missing on 41-44 here, unfortunately, is the necessary idea of thresholds and discontinuities in system responses, both human and ecological. Disregarding this is risky because it creates the impression that the uncomfortable is being hidden or waved away. I was relieved that it appeared on page 45, but I wish it were up front in this topic and research guidance.

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 42, the US National Assessment should be explicitly mentioned in the paragraphs beginning lines 7 and 19. In particular, to the list ending on line 28 should be added marine and aquatic ecosystems and the coastal zone.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 42, lines 1- 2: The statement “facilitate risk assessment given remaining uncertainties” implies that we have a specific list of “remaining uncertainties.” Isn’t this language a bit presumptuous given that the medical profession seems to be continually revising our perception of risks to and treatments for the human body, and that the earth’s eco-system is somewhat more complex than that of the human body contained within the earth’s eco-system?

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 42, lines 8-9: Setting as a goal “absolute predictions for future outcomes” is really ridiculous—of course science can’t provide this and even if they could such predictions would likely not be the governing factor in many decisions (where scientists cannot predict, like lobbying influences, etc.). Managers generally work adaptively, and what they need are indications of possibilities, and if-then types of studies so they can adapt and modify their decisions along the way. Rephrasing is needed here to more realistically portray the situation and how decision-making works.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 42, Lines 9-13: The “sustained relationship between investigators and decisonmakers” is a result of the U.S. National Assessment on the potential consequences of climate variability and change, and so must be referenced (USNA, 2000) here.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 42, Lines 13–17: “*Through regional and sector-specific research, investigators will continue to work closely with decisionmakers and resource managers to identify the level of certainty required for different decision contexts, and mechanisms for best communicating the uncertainties, which may include acknowledging that it may not be possible to provide meaningful information at the required level of certainty.*”

The last part of the sentence leaves the following unasked and unanswered questions: (1) What is “the required level of uncertainty”? This is certainly a political decision because there is no scientific basis for such a value judgment. (2) Does confirming that “the required level of uncertainty” cannot be obtained mean defaulting to a “no action” policy?

DAVID L. WAGGER, PH.D., SELF

Page 42, lines 14-15: Language about “the level of certainty required for different decision contexts” is confusing because decisions are made every day. The point is to better understand and manage uncertainty, and to reduce it as much as possible.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 42, line 14: replace "… to identify …" with " to develop decision support information and to identify …"

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 42, Line 15: Add “…required for different decision contexts, identify if and when this level of certainty has been achieved with regard to risk management analysis, and mechanisms for best…”

EESI, CAROL WERNER AND J.R. DRABICK

Page 42, lines 19-28. Good.

DOE NATIONAL LABORATORIES

Page 42, Line 24: Change sentence to “It also includes analysis of both mitigation and adaptation options to improve societies ability to respond effectively to the risks and opportunities currently emerging.”

EESI, CAROL WERNER AND J.R. DRABICK

Page 42, Lines 25-28: Several of the research areas listed here, water availability and quality, forest management, and public health, constituted specific sectoral studies of the U.S. National Assessment on the potential consequences of climate variability and change, and so should be referenced either once (USNA, 2000), or by each of their individual reports.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 42, lines 25-28: What does it mean to “expand research”? The cited areas are very broad – need specificity.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 42, Line 26: Add “…that has been conducted over the last decade, **with particular deference given to the National Assessment,** preliminary target areas…”

EESI, CAROL WERNER AND J.R. DRABICK

Page 42, line 26: Recommend adding transportation planning and infrastructure as a preliminary target area for accelerated research.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 42, Lines 27-28: Another target area that might be considered is the impact of climate change and associated sea-level rise on coastal-structures in the United States. Such an undertaking will be important in order to identify and mitigate the impacts of climate-induced sea-level rise on residential, commercial, and industrial buildings along the national coastline. This line of inquiry is even more important in light of the fact that so many of the nation's largest cities are located along the coast.

CALIFORNIA ENERGY COMMISSION

Page 42, line 27: A target that is mature and ready to benefit from climate research is agriculture. As such "agricultural productivity" should be added to the list of target areas.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 42, line 27: Does it mean anything here that other sections of CCRI say things will be done, and here they will only be considered? Does this mean that these types of activities really won't get funded any time soon, etc.?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 42, lines 30 to 43: The development of formal working relationships, the selection of policy questions and the establishment of a consultative process are not products and payoffs. They are initial steps that need to be done to facilitate the integration research and application products. Products could be regional climate variability/change predictions for use in decision making; decision support tools that incorporate climate variability/change information; risk tables that define observational/model uncertainties and natural variabilities; etc. Payoffs may include a more secure water supply and food production; flexible and adaptable resource management procedures; etc.

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 42, line 30 - Page 43, line 3: How will the CCRI evaluate these products and payoffs? This should be linked to Chapter 12 (Grand Challenges in Modeling, Observations, and Information Systems), Chapter 13 (Reporting and Outreach), and Chapter 15 (Program Management and Review).

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 42, lines 36-39. Within six months!??! Better get started right away.

DOE NATIONAL LABORATORIES

Page 42, lines 36-39:
This section discusses a process of "stakeholder/scientist" interaction that leads to "potential policy questions" that will guide the development of scenarios. This is imprecise and unclear. If "stakeholder" does not include "policymakers", and it is not clear that does, then the policy questions developed may not encompass the questions policymakers think they need answered.

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 42, Line 37: insert word "…climate VARIABILITY AND change community…"
JOSH FOSTER, NOAA/OGP

Page 43: important insights into how vulnerable or resilient these systems may be in the future.

It is not stated explicitly here, but I hope it is intended that studies of vulnerability and adaptability worldwide, and not just in N. America or the US, are to be embraced. If US agriculture were to benefit but Indian agriculture were to tank, that raises important international security and distributional issues that we obviously need to know about.
RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 43, line 2: in order to provide services to whom. All to often past research results provides services to other researchers. Add "… provide service to regional resource managers, decision makers and policy analysts …".
JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 43, lines 7-17: Applies to climate variability as well, if not more, in terms of immediate relevance
ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. OF MARYLAND

Page 43, line 7 and following. The National Assessment regional stakeholder groups have already spent years developing questions, prioritizing issues and creating initial answers to issues of most importance to resource management and decision making. Yet these paragraphs are written as if this never happened. The paragraphs must be rewritten to reflect accurately existing scientific and decision support resources.
JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 43, lines 8-11. Make clear that this refers to decision-makers in the private sector as well as the public sector.
DOE NATIONAL LABORATORIES

Page 43, lines 11-17: While these are interesting questions, there really has not been any framework laid to explain that different types of tools would be used for different types of questions. For example, some might well be done with economics models (which, of course, have no uncertainties, it would seem) and others with global climate models (for which everything is apparently viewed as uncertain). This section, in particular, really needs to have a box that lays out how various types of issues are approached, the types of physical to societal uncertainties that exist, etc., and that does this in a balanced way so that it is clear that, for example, the physical based models have a much stronger basis than the economic ones in terms of large-scale, long-term responses, and perhaps vice-versa for short-term types of issues.
MICHAEL MACCRACKEN, LLNL (RETIRED)

Comments on Chapter 4

Page 43, lines 19-21: These techniques apply to questions over many time frames. The full spectrum of decisions should be articulated, although priority will be placed on only a subset.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 43, line 19: Replace "Techniques that serve to articulate ..." with " Communications and working relations should be developed to better articulate …".

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 43, Line 22: insert word "…of climate VARIABILITY AND change,…"

JOSH FOSTER, NOAA/OGP

Pages 43-44, Lines 29 (on Page 43)-22 (on Page 44): The first three methods for analyzing climate impacts, historical records, sensitivity analysis, and climate projections, were first used by the U.S. National Assessment on the potential consequences of climate variability and change to conduct it's vulnerability and impact analysis. Page 14 of the NAST, 2000 overview document, titled "Tools for assessing climate change impacts", contains has three sections subtitled "Historical Records, Climate Model Simulations, and Sensitivity Analysis" to illustrate it's approach. To not reference the USNA, 2000 here is another serious omission.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 43, line 29. This section does a very nice job of describing methods for analyzing climate impacts – but what is different (what else needs to be done) under the CCSP?

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 43, line 32: (20-E) "Historical" is the right word here. ["Historic" connotes significance rather than just age.]

HOWARD P. HANSON, LANL

Page 43, lines 32ff: another advantage of studying historic records is that it provides insight to human responses, not merely the impacts of climate change or weather events.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 43 L32-38 - Note that many future climate changes lie outside the limits found in the historical record.

RONALD STOUFFER, GFDL/NOAA

Page 44, re Climate Projections. It is hard to assess potential impacts of climate change at a regional or local scale in part because projections of economic/demographic change, technological change, land-use change, etc. are unavailable to match up with projections of climate change. Without adequate contextual information, climate projections alone do not tell much of the impact story.

DOE NATIONAL LABORATORIES

Page 44, lines 6-22: this paragraph goes too far in maligning climate models. For all their faults they are currently the only credible means of producing projections of future climate. There is no well-constrained analog of past climate in a future with, say, 500 ppmv of CO2 in the atmosphere. Replace "another tool" with "the primary tool" and replace "what might happen" with "what would happen". For lines 16ff, see comments above on Page 40 lines 30-33. Responsible policy makers are recognizing that uncertainty in climate models (or, more likely, biological models) is no excuse for ignoring the possible impacts of climate change.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 44, line 6: (21-S) Here is another case where "projections" as differentiated from predictions is critical, and it's used quite effectively. This underscores comment (7) above.

HOWARD P. HANSON, LANL

Page 44, Line 16-22: Given problems related to data, model quality, and verification of longer-term analyses of climate impacts, in conjunction with advances in downscaling over seasonal time-scales, one could assert the opposite, that regional and local scale analyses are more reliable than longer term analyses.

JOSH FOSTER, NOAA/OGP

Page 44, lines 20-22: Variation among model outcomes is not necessarily a reason to discard models. Why? Variation among model outcomes may be used to investigate vulnerability and resilience. Variation may also indicate how different assumptions about human activities influence outcomes. An analysis of the reasons for variation among model outcomes may also be insightful.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 44, lines 20-22: This statement really is poorly phrased. First, model results can differ because there are different scenarios, so inputs, and this type of difference is not contradictory, but intentional. Second, there is no indication here about whether the differences might be simply different (e.g., due to the natural chaotic nature of the system—something that occurs frequently when only single model runs are made), or whether the results might really be different and whether there might be causes for this, etc. It is not at all clear that for vulnerability studies differences in model results should be indicating "unreliability"—a word that implies there is some expectation that a single prediction would be the most useful result, etc. Indeed, there are times when simulations where similar answers would be expected do not arise, but whether these differences are first real and second important involves a much more careful explanation than is given here. Please rework, correcting the misconceptions.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 44, lines 23-42, excellent points. we strongly affirm these goals.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 44, lines 40-42: Probabilistic distributions are often difficult to understand and have their own intrinsic uncertainties and limitations. Low-probability, high-impact events are especially problematic.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 44, lines 40-42. This section refers to the development of "probabilistic distributions of expected events." While this is sometimes a useful approach to providing information, the *Strategic Plan* fails to address the difficult questions in how these probabilistic distributions would be developed.

DR. RUSSELL O. JONES, AMERICAN PETROLEUM INSTITUTE.

Page 45-46: The CCRI scenario development represents an important step forward for U.S. climate modeling, as it enables scientists and stakeholders to account for uncertainty in future trends in emissions as well as the potential effects of mitigation policies. For example, the U.S. Global Change Research Program's (GCRP) *National Assessment* used two different models, but relied upon only one scenario for future emissions, and thus was unable to produce the full-range of uncertainty associated with human contributions to future climate change. The *Draft Strategic Plan* indicates the CCRI scenarios will potentially be developed in cooperation with the Intergovernmental Panel on Climate Change (IPCC). Synchrony between emissions scenarios used for U.S. applied climate modeling and the IPCC assessment process would offer a number of benefits. First, it would enable direct comparison between U.S. and international modeling efforts, thus maximizing information exchange. Second, U.S. involvement in scenario development may improve the quality of IPCC scenarios, and thus the IPCC assessment process as a whole, which would be beneficial to the United States and the international community. Lastly, conflicts could result in the communication of applied climate modeling results if there are substantive differences between the U.S. and IPCC scenarios. We therefore encourage active U.S. coordination with the IPCC in scenario development.

A well-known criticism of the development and application of the IPCC scenarios was the assumption that all scenarios were equally likely, despite the fact that some scenarios were clearly more plausible than others. Thus, in the development of CCRI scenarios, serious consideration should be given to the assignment of probabilities to various selected scenarios. Without this, the scenario development process is of lessened utility due to the inability of policy-makers to weigh the relative likelihood of various scenarios.

VICKI ARROYO AND BENJAMIN PRESTON, PEW CENTER ON GLOBAL CLIMATE CHANGE

Page 45, line 5: Customizing "model-based and statistical climate information" is essential to make information useful but it has a potential downside of filtering out important information. The co-production of knowledge by scientists and decision-makers may be too narrowly driven by pressure to find answers quickly in response to a specific problem arising in a political or legal context. To guard against this problem, there should be a structured process permitting review by people other than the co-producers. In the CCSP workshop's breakout session 17 on resource management decision support, William O'Keefe (Marshall Institute) suggested a process to incorporate skeptical analysis that is analogous to the U.S. military's "red teaming" investigations.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 45, Lines 14-25 (first paragraph on Scenario Development): The use of "scenario" here is similar to that used in the U.S. National Assessment on the potential consequences of climate variability and change (USNA, 2000), and so should be referenced. As stated in the NAST, 2000 Overview document, " Scenarios are plausible alternative futures – each an example of what might happen under particular assumptions. Scenarios are not specific predictions or forecasts. Rather, scenarios provide a starting point for examining questions about an uncertain future and can help us visualize alternative futures in concrete and human terms. The military and industry frequently use these powerful tools for future planning in high-stakes situations. Using scenarios helps to identify vulnerabilities and plan for contingencies".

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 45, Line 14- Page 46, Line 9: With the thought of assessing if…then scenarios we would recommend that the CCRI assess a number of scenarios linked to temperature change. This can also be nicely linked with the objective of the UNFCCC and the Presidents' statements about finding ways to avoid dangerous climate change. For example, if a 2degree C threshold was to be avoided (due to the likely impacts that would occur at 2 degrees C or above), what would the necessary emissions pathways be for the United States, linked with the rest of the world? This can then be linked with certain impacts that are shown to be associated with various temperature changes.

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 45, line 15: (22-E) Here's a rearranged version of this paragraph that makes the point somewhat more clearly:
'The term "scenario," as used here, refers to any description of the world as it might evolve or be made to evolve in response to decisions. For many decision alternatives, an "If…, then…" analysis enabled by such scenarios can be performed that provides information to a decisionmaker. Assuming a particular action is taken, the analysis predicts the consequences of that action. Scenarios play a key role in the decisionmaking process by providing the opportunity to explore options against a variety of alternative possible backgrounds. The goal of the CCRI scenarios activity is to develop, maintain, and enhance the capability to answer "If…, then…" questions relevant to the full range of climate change decisionmaking, from the management of resources to the formation of national and international policy. The activity will seek to ensure that a balanced approach is taken that maintains objectivity and avoids focusing on "worst-case analysis" alone.'

HOWARD P. HANSON, LANL

Page 45 Lines 15-25: While I agree that "worst-case-analyses" shouldn't dominate scenario development and plans for future research, I believe it is important to understand threshold levels of environmental change required to force ecosystems into modes of rapid and perhaps catastrophic change. Without experimental data on, and modeling evaluation of critical thresholds we may not realize how close a particular scenario might take us to an undesirable result. Experiments and models of ecosystem response should emphasize ‘reasonable’ scenarios of climate change, but they should also be able to show where results for a reasonable scenario lie in relationship to thresholds for catastrophic response.

PAUL HANSON, ORNL

Page 45, lines 24-25, another excellent point: worst-case analysis has an important place, but cannot be taken as the likeliest case.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 45, Lines 24–25: “*The activity will seek to ensure that a balanced approach is taken that maintains objectivity and avoids focusing on “worst-case analysis” alone.*”

This rhetorical statement implies that there are “unbalanced” and “unobjective” approaches that this activity is meant to counterbalance. Any such approaches should be identified.

DAVID L. WAGGER, PH.D., SELF

Page 45, line 28: **(23-E)** “above” suggests to readers to look a paragraph or more back. Here’s a new second (and third) sentence:

As framed, however, this question is insufficiently specified—it lacks detail.

HOWARD P. HANSON, LANL

Page 45, line 34: replace "… through interactions …" with "… through interactions and working arrangements …".

JURGEN GARBRECHT AND STEVEN R. SHAFER, USDA-ARS

Page 46: I want to specifically acknowledge the central importance of more user involvement in the scenario specification process. Without that, it may often be the case that the scenario will fail to serve its purpose no matter how accurate or illustrative (these are not the same) it may be. Involvement is much more than courtesy; it is investment and engagement.

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 46: use of scenarios to drive climate models, although the model outputs have seen limited use in studying the impacts of climate change. 5

This statement is not justified. In fact the IPCC model outputs have been used quite extensively in the literature for impacts assessment. This includes the US National impacts assessment, and the IPCC impacts volume, among many others.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Pages 46-47: Start scenario development with less precise inputs and less certainty, right now. The decision-relevant features are already available, and the critical need of discovering and anticipating thresholds should not be delayed for unneeded refinements.

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 46, lines 3-5: The statement that the "model outputs have seen limited use in studying the impacts of climate change" is simply mistaken—considerable use has been made of the results by groups around the world. And considerable care is taken in doing this. This statement misrepresents the state of scientific activities.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 46, lines 3-5. In fact quite a bit of impact research has been done using IPCC scenarios, e.g., the work of Martin Parry et al. on food system impacts. This sentence understates how much has been accomplished.

DOE NATIONAL LABORATORIES

Page 46, Lines 5-7: This reference to the U.S. National Assessment on the potential consequences of climate variability and change (USNA, 2000) as "controversial assessments" ought to be deleted, since the USNA, 2000 underlies most of the assumptions inherent in this chapter (as illustrated in my above comments). It would be more constructive to include a few sentences or paragraph on lessons learned from the previous assessment, such as what went wrong (and right) and therefore, what can be done differently in the future.

BENJAMIN FELZER, MARINE BIOLOGICAL LABORATORY

Page 46. Line 6. Delete the word 'controversial'. This sentence seems to refer to the National Assessment. There has been no scientifically supportable, peer-reviewed argument for why the qualitative and quantitative scenarios developed in the National Assessment should be considered controversial or anything less than completely acceptable. On the contrary, these scenarios should be the basis of continued Scenario Development – building and improving on what worked, modifying what was less successful. Replace this sentence with "Qualitative and quantitative scenarios that have been developed as part of the National Assessment of climate variability and change will be used as a basis for continued scenario development."

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Page 46, Line 6: Change "controversial" to "federally sanctioned."

EESI, CAROL WERNER AND J.R. DRABICK

Page 46, line 6: the reference to "controversial assessments" is really inappropriate and unjustified. If a few people objecting to the National Assessment makes it controversial, then everything in society is controversial, even consensus elections. The issues raised by Pat Michaels are mostly wrong (and a paper has been submitted to make these points); the lawsuit was about process and not findings, and the lawsuit was dismissed. There have been virtually no criticisms of the findings of the assessment regarding consequences, and even if there were problems with the scenarios these would not affect the findings on impacts. This statement is thus really totally unjustified and unnecessary. As indicated in the many comments at the workshop, the National Assessment deserves a much more careful and appreciative treatment in the plan.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 46, Line 11: re Research Approaches. This section seems to understate the importance of having valid models of complex interrelationships -- and how far we still have to go in developing them or developing valid reduced-form strategic models for use in the meantime.

DOE NATIONAL LABORATORIES

Page 46, line 11: Recommend the scenario development research consider the importance of relative contributions to climate change of transportation modes, as well as the relative cost of implementing mitigating options across modes (for example, mitigating strategies for land based systems are generally simpler and less costly than for airborne systems).

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 46, lines 12-20: The development of multiple scenarios with multiple components is subject to the risk of "assumption drag", which is a term introduced by William Ascher to describe the retention of outmoded assumptions in forecasting models (that is, errors may arise when outmoded assumptions are not updated). This phenomenon is definitely relevant to longer-term studies but is also an issue for the shorter time frame focus of CCRI. There may also be tradeoffs among being up-to-date, complete, accurate and internally consistent. Some sources of data are more rapidly updated than are others. There should be a management structure that can track and report on the component pieces of models. This should be linked to Chapter 12 (Grand Challenges in Modeling, Observations, and Information Systems), Chapter 13 (Reporting and Outreach), and Chapter 15 (Program Management and Review).

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 46, Line 17: "Weeks" should be "years".

RONALD STOUFFER, GFDL/NOAA

Page 46, Line 18: change "level of scientific" to "level of detail and scientific"

JAMES BONTA, USDA

Page 46. Line 22: Change "go beyond" to "**build upon**"

EESI, CAROL WERNER AND J.R. DRABICK

Page 46, lines 22-24 and 36-38. Bravo regarding stakeholder participation, but how is this going to be organized, informed, and carried out?

DOE NATIONAL LABORATORIES

Page 46, Line 24: Add "…with timely and useful information, including scenarios that have already been developed."

EESI, CAROL WERNER AND J.R. DRABICK

Page 46, lines 25-26: How will these stakeholders be identified and persuaded to stick with the process long enough to get scenarios that are logical and internally consistent?

ANN FISHER, PENN STATE UNIVERSITY

Page 46, line 28: **(25-E)** Sorry to be such a fuddy-duddy, but, strictly speaking, this should read "There is a number..." so that the verb works. That, of course, sounds awkward, so it can be rewritten as:
"A number of obstacles challenge the application..."

HOWARD P. HANSON, LANL

Page 46, Line 32: Delete sentence "The IPCC may be interested…" and replace with "Collaboration and cross-adoption of scenarios between the CCRI and the IPCC will be encouraged so as to discourage unnecessary overlap and analysis."

EESI, CAROL WERNER AND J.R. DRABICK

Page 46, lines 32-33: The phrasing of this sentence would seem to be insulting to the IPCC and not recognize how the IPCC works. To a very great degree, the IPCC summarizes work that is done; it may also encourage work to be done. It would be totally improper for the IPCC to somehow adopt just what the US does without considering what others do. It would be more appropriate to be phrasing this to indicate that the US will be expanding its efforts to help to meet the objectives of and criticisms of scenarios by the IPCC. The world is looking to the IPCC as the arbiter and integrator—having the US support more in this area is fine and the IPCC may benefit from this, but the IPCC adopting what the US does is not how the IPCC works. (Maybe the UK should suggest that the IPCC should adopt its modeling of the climate and ecosystems and ignore inputs of others?)

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 46, line 35: **(24-E)** In this "Products and Payoffs" section, there are parenthetical time frames for several of the bullets, which is inconsistent with the previous such sections. These continue throughout the rest of the document. For consistency, the previous such bullets in other Products & Payoffs sections should also have time frames.

HOWARD P. HANSON, LANL

Page 46, Line 36-40: We would recommend that the CCRI build upon the stakeholder engagement in the National Assessment. There are strong networks of scientists around the country that participated in that process. It would be wise and cost-effective to start with that network instead of building a "new stakeholder-oriented process."

JENNIFER MORGAN, WORLD WILDLIFE FUND

Page 46, Lines 36-43 and Page 47, Lines 1-12: The emphasis on stakeholder involvement, scenario development, and integrated assessment models corresponds perfectly with California's approach to climate change. We would suggest that lines 10-12 emphasize an integrated assessment modeling framework (instead of a single model) run within a scenarioing context (i.e. one that recognizes the irreducible uncertainties). Such an emphasis would lead to robust strategies. Also given the importance we attach to these efforts, we would like to see much greater detail about the research approaches (lines 12-33) needed to advance this effort. Much of what appears on pp. 43-44 should be subsumed under this heading. Once again, California would welcome a partnership with the CCSP to develop a regional project with these characteristics.

CALIFORNIA RESOURCES AGENCY

Page 46, lines 37-38: What assurance is there that this "will be in place" and what might it look like, how open might it be?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 46, lines 37, 40, 42, 43 and Page 47, lines 2, 4, 9, 10: All these indications that things "will" happen seems a bit of a promise that it is likely to be hard to keep. That such efforts will be pursued would be more realistic, as such efforts can be notoriously hard to accomplish, especially in that stakeholder involvement can take time.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 46, Line 41. The UK has also had some experience of developing socio-economic scenarios with stakeholders and has found them valuable way of gaining a fuller understanding how development could potentially exacerbate/ameliorate exposure to climate risks. The IPCC's SRES scenarios could be useful in informing work in this area.

DAVID A. WARRILOW AND DIANA WILKINS, UK DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS

Page 46, line 42. Scenarios need to address global trends and developments as well.

DOE NATIONAL LABORATORIES

Page 46, line 43. It is unconscionable to plan to take 2 years to develop scenarios for relevant policy and resource management questions when these scenarios exist already as part of the National Assessment. This is in essence re-running the National Assessment process. Replace this bullet point with "A specific set of scenarios that can be used to address relevant policy and resource management questions – at the national, regional, and sectoral levels – will be developed based on existing scenarios from the National Assessment and in consultation with existing stakeholder groups (6 months)".

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE

Pages 47–52: In regard to "3. Applied Climate Modeling", there is an apparent great misunderstanding about the nature of sensitivity and uncertainty. The often-cited "If…, then…" scenario analysis is really about how model results change with changes in model parameter values (and perhaps even initial conditions). This, of course, presupposes that the model parameter values (and initial conditions) themselves are "locally stable"—that is, that small, even infinitesimal, variations in parameter values (and initial conditions) cause only proportionately small variations in model results. It can be that varying even slightly the value of a model parameter with a highly certain value (e.g., using 0.808 or 0.792 instead of 0.800) produces a disproportionately different result; thus, a small degree of uncertainty can still entail a large degree of sensitivity (the converse can also be true).

Deterministic equations do not always generate neatly ordered results. Some can be extremely sensitive to initial conditions; others, to parameter values that lead to bifurcations. For example, the simple equation, $x_{n+1} = \alpha x_n(1 - x_n)$, where $0 \leq x_n \leq 1$, exhibits extremely complex behavior depending upon the value of α and x_0 (e.g., perturbations at $\alpha = 4$, $x_0 = 0, 0.25, 0.5, 0.75$, and 1).

The point here is that the use of traditional "If…, then…" scenarios, while necessary, is not sufficient to adequately map out the **possible** range of model-system behaviors. High degrees of sensitivity and uncertainty in model results can actually accurately reflect model-system behavior rather than indicate a poorly constructed model system.

It is striking that the CCSP contains no mathematical-research component for climate-model structure (the document mentions mathematics only under "Outreach for K-12 Education" on page 153), and the CCSP needs one.

DAVID L. WAGGER, SELF

Page 47, lines 1-9: really important to retain this!

ANN FISHER, PENN STATE UNIVERSITY

Page 47, line 4: There should be not only an analysis of the uncertainty, but also strategies to manage uncertainty.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 47, lines 8-9: To imply that there will be some final report on a topic this difficult really shows a misunderstanding of the issue. One might have a final report on this project, but not on this topic.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 47, Line 14 The capability for "applied climate modeling" is developing, to meet a small but growing demand for scenarios that infrastructure, business and natural resource managers can use for long-term planning. Again, effective user interfaces that provide the right information, in a useful form, need to be specified, tested and built.

ROGER C. BALES, UNIVERSITY OF ARIZONA

Page 47, line 35-36: The main theme of applied climate modeling is "Identify, Quantify, and Systematically Reduce Uncertainty in Climate Model Predictions". This theme is so central to the entire CCRI that it should be introduced, in boldface capital letters, much earlier in the document, say on p.14.

NOAA/CMDL

Page 47, line 38: (26-S) See comment 6 above. No change needed here, but one is needed there.

HOWARD P. HANSON, LANL

Page 48: The Climate Process Team idea could be dangerous to progress if it gives the impression of taking control of the interpretive function, making "sense" of the data. This must be transparent and must be conducted with the utmost respect for credibility. The tobacco industry has already convinced a lot of people that science is just advocacy, and we are all injured by that. Teams are going to have to work in a fishbowl, as the planners put it, and that will be annoying. But its better than being written off as this week's fad claim with no substance. This applies also to the evaluative functions in the two modeling centers (pp. 51 et seq.)

JOHN WIENER, INDIVIDUAL COMMENTATOR

Page 48: It will be important to identify the one or two largest sources of uncertainty in feedback processes currently represented in climate models, determine the causes of the uncertainty, and 23

It's all well and good to say that climate models need improvement, and it is extremely well established that cloud radiative feedbacks are a major, probably the major, source of uncertainty in models. Certainly, any amount of additional research on cloud effects would be justified. However, if the report goes no further, this is just a motherhood and apple pie statement. It's not as if we climate scientists didn't already know that clouds are a problem. There has been a decade or more of ongoing effort to solve the cloud problem, and there is no magic bullet here. Can the report identify particular areas of the cloud problem where injection of more funds can remove stumbling blocks and produce short term results? I am hard pressed to see aspects of the cloud problem that clearly fit into this category. The one case where I can see some possibility of a big payoff in the short term is to fund the study of cloud effects in paleoclimate problems, notably the last glacial maximum. It is only through the application of cloud models to different climates that we will be able to build confidence or adequately evaluate the performance of the models.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 48: Enhance Model Credibility through a Formal Program of Model Testing
There are possibilities of improvement in the datasets used for testing of models, but this section seems to be ignorant of the extensive and detailed tests already routinely carried on to validate climate models. The existing testing goes well beyond just looking at global mean temperature, of course. This section is symptomatic of a general problem of the report, in that it reads as if the authors of the report were hardly aware of IPCC or the vast array of other model evaluation and intercomparison efforts. All too often, the report takes potshots at the modelling community, implying that this community has been ignoring important issues like validation, whereas in fact the community has been responding quite well to these needs.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 48, line 1: even though models have a wide range of sensitivity, the true sensitivity is well enough constrained by observations to reject or underweight certain models in forming statistics of future global or regional change; see Giorgi and Mearns (J Climate 2002) and Stott and Kettleborough (Nature 2002). These approaches are more suitable for the CCRI-timescale than the ambitious process-improvement focus in the paragraph beginning line 8.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 48, line 1: What is an "unacceptable" range in climate sensitivity? How do you know when you are done with model development (when are the models "good enough")?

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 48, Line 1: "unacceptably large range" - How is this assessed? What is the measure? Reference?

RONALD STOUFFER, GFDL/NOAA

Page 48, Line 3: after (CCSM), and the related DOE supported Parallel Climate Model (PCM)

WARREN WASHINGTON, NCAR

Page 48, lines 5-6: I strongly disagree with the **opinion** expressed here (and at least one other place in a later chapter) that the particular climate models at the extremes of the climate change sensitivity range are ideal for studying sensitivity. This is meaningless nonsense! They may be at the extremes because they are the worst models and hence, provide the most misleading results. Nor can one assume that the models in the middle of the range are "ideal" since they may also be wrong. There is no way to pick a sub-set of currently available models as "best" for such studies. This text should be eliminated.

The Climate Process Teams are a good idea. You might compare this with an actual, functioning example provide by the activities in the GEWEX Cloud System Study, where the working groups focused on particular problems are composed of such a mix of modelers and data analysts.

A major obstacle to progress is that methods for comparing models and observations that **reveal and explain** model deficiencies have not been formulated or agreed upon. This is because the real climate and our models of it are very complex, multi-variate, non-linear dynamical systems. We do not have analysis methods that are adequate to the task (most analysis tools being used for publications even today assume linear systems and/or Gaussian statistics, neither of which is true of the real climate or a full climate model). Hence, there is an urgent need for funding specifically targeted on research to develop advanced model-observation comparison methodologies. This is a focused task that CCRI could take on in the short term and make a significant difference.

WILLIAM B. ROSSOW, NASA GODDARD INSTITUTE FOR SPACE STUDIES

Page 48, lines 12-13: Might change "to be related to" to "to contribute to"

MICHAEL MACCRACKEN, LLNL (RETIRED)

Comments on Chapter 4

Page 48, line 16: The goal is really to facilitate understanding, not just to do intercomparisons. One learns from modeling—it is not the end all.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 48, lines 21-29: The concept of a Climate Process Team (CPT) to narrow the uncertainties associated with particular processes or feedbacks is attractive, although implementation issues will need to be addressed. Extension to several of the United States varying climatic regimes (tropical, arctic), for which the key processes can vary widely, seem to merit consideration.
Add sentence at end of line 29: A regional focus by particular Climate Process Teams may be a useful means to enhance the model simulations and scenario development for widely differing climatic regions of the United States (e.g., tropical regimes such as Hawaii, Florida; Arctic regimes such as Alaska).

GUNTER WELLER, ET AL., UNIVERSITY OF ALASKA FAIRBANKS

Page 48, Line 21: section on Characterize and Reduce Key Uncertainties. Need to link this back with consultative processes to assure awareness of user needs.

DOE NATIONAL LABORATORIES

Page 48, lines 26: CPT should be attributed to CLIVAR

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 48, Line 27-29: The teams listed are two narrow, and by excluding other disciplines, you will not have the diversity in disciplines that is needed for this project (e.g., add life science, agricultural, and watershed scientists). If you limit this to a narrow group of researchers, you will stifle creativity.

JAMES BONTA, USDA

Page 48, lines 27, 28: Again, more use of the word "will." Does this not really imply an Administration promise that the funds needed to accomplish this are going to be appropriated, with no qualification?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 48 L31-40 - It is stated that new and better testing of models is needed. What are the specific tests proposed? How to improve the testing of the models is very unclear.

RONALD STOUFFER, GFDL/NOAA

Page 48, line 35: It is not impossible to envisage a rigorous program of testing akin to NWP. Operational seasonal forecasting potentially provides an excellent test-bed for coupled models and should be exploited. The forecast starts from an initialized state for the ocean and atmosphere (and potentially land also, particularly when SMOS etc come on-line) and so error growth in the forecast can be studied. Of course this means that there must be an integrated modeling program that covers both the operational seasonal to decadal prediction and the climate change scenarios. One potential advantage of such integration is the utility of initialized states for the climate change scenarios that reflect the current state of the ocean. Coupled ocean-atmosphere data assimilation should be a goal, which then exploits the huge investment in ocean observing systems such as the Argo program.

JULIA SLINGO, NCAS/CGAM, UK

Page 48, lines 37-38: What is the policy question that requires that there be results that can detect such "small differences." There are inherent uncertainties due to many factors, from the societal and emission scenarios, to volcanoes and solar influences, and lots more. This is setting up a goal that is really a strawman—what is the basis for this.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 48, line 38: This is based on a secular trend in a global mean metric. Need to move beyond this with more rigorous metrics and those that can be tested with relevance to regional scales and modes of variability.

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 48, line 38: When suggesting that something "must" be done, much more explanation is needed of what is meant—how tight? How accurate? Which variables? For what purpose? This is again setting up an unreasonable request for certain (many) types of decisions.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 49: It is also critical that models be tested against the paleoclimatic record. 23

This is one of the few mentions of paleoclimate in the whole report. Paleoclimate provides a crucial test of the models, and I would like to see paleoclimate emphasized much more strongly as a research theme. It could have short term as well as long term payoffs, since paleoclimate modelling is a rather underfunded field currently.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 49: clouds and water vapor are the primary contributors 43

Again, this statement is wrong with regard to water vapor. As far as the range of model predictions go, clouds are a source of uncertainty, but emphatically not water vapor. This was very clearly discussed in the IPCC Third Assessment Report.
Work on water vapor is of course still justified, but it is not correct to point to it as a source of divergence amongst model forecasts.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 49, lines1-2: Where is "feedback" to observing system design? Should not be one way from observations to models.

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 49, line 1: Will this assessment be of only US models, or of the international set of models? And is there some basis for expecting that if this is done it will make some sort of difference?

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 49, line 4ff: "Testing against the climate record." I strongly agree that climate models need to be more rigorously tested against the global temperature record both in the recent past (the period for which we have satellite data) and the paleoclimatic record. Contrary to vague assertions to the contrary elsewhere in the Strategic Plan, the models have done a poor job fitting historic data, particularly satellite data. To the extent the models and data agree, it seems to be due to urban heat islands, jet contrails, and other processes unrelated to greenhouse gas emissions. I suggest the models be thoroughly and objectively tested by organizations and individuals who are independent of the institutions and agencies that create (and personally benefit from acceptance of) the tests. I further suggest the USCCSP fund critical analysis of claims that the models "prove" that anthropogenically induced global warming is either occurring or will occur to balance the natural biases of the sponsors of these models. –

JOSEPH L. BAST, THE HEARTLAND INSTITUTE

Page 49, lines 5-11: This is more setting up impossible types of test that are likely to be unrelated to the types of decision and ways in which they will be made. For a number of the necessary quantities, there is no way to go back and get the necessary measurements 9and we still have to get proofs that the ones we have are right). In addition, in that the real climate is only one manifestation of a manifold of possible climates given the existing forcing and boundary conditions, there are practical limits to how close one might expect agreement. While testing against the historic record is important, this is way too narrowly drawn, and it is done in a biased way.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 49, Line 6: high-end is a vague term

JAMES BONTA, USDA

Page 49, Line 10: Page 49L10 - One has to note the relatively short record increases the noise in the observations, making this testing more difficult.

RONALD STOUFFER, GFDL/NOAA

Page 49, Line 19: Need to mention that one also needs to reduce the uncertainty in the observations.

RONALD STOUFFER, GFDL/NOAA

Page 49, lines 23-24: This is one statement I want to wholeheartedly agree with—and it is really the whole point of the program. That is, “it is not clear that the 20th century will be representative of the future state of the Earth’s climate.” Please move this up to the opening statement of the whole plan.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 49, line 23-24, this statement is amusing. A more accurate phrasing would read "It is clear that the 20th century climate will probably not be representative of the future state of Earth's climate."

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 49, line 23: The paleoclimatic record used for testing climate models should include times prior to the past several centuries in order to exercise climate models using changes in controls that are similar in magnitude to those expectable in the future. The activities of the Paleaeoclimate Modelling Intercomparison Project (Harrison et al., 2002, EOS 83(40):447 have shown that the basic assumption that it is reasonable to use climate models to simulate climates other than the present is indeed valid, but they have also shown that the present generation of models probably underestimates the sensitivity of climate to changes in controls due to the omission of key feedbacks.

PATRICK J. BARTLEIN, DEPT. GEOGRAPHY, UNIV. OREGON

Page 49, lines 23-27: Although it is important to compare climate predictions over a long period of time, comparing predictions to both paleoclimatic records and very recent, more accurate measurements must be done with care to ensure we do not introduce an "apples and oranges" scenario.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 49, Line 25-27: Statement too strong. Forcings are not well-known. Testing models against paleo-record is important. The issue is the limitations.

RONALD STOUFFER, GFDL/NOAA

Page 49, Lines 29-35: This needs restated to reflect the now ongoing work to identify the causes of the differences in these records.

RONALD STOUFFER, GFDL/NOAA

Page 50, Line 1-8: There are no clear paths to do this work. This is a hard problem.

RONALD STOUFFER, GFDL/NOAA

Page 50, line 17 change:
A focus on accuracy, assessed through an unbroken calibration measurement chain with uncertainties tied to national and international standards, preferably based on SI standards, is critical.

NIST, HRATCH SEMERJIAN

Page 50, line 22: Sensitivity to unresolved atmospheric processes should also be addressed here. For example, we know that there are major difficulties in representing cumulus convection in atmospheric models (an unresolved process) which leads to major systematic errors in the clouds, the diabatic heating fields, global teleconnections, and forcing of the ocean. Exploring the sensitivity to atmospheric resolution is should be a key activity.

JULIA SLINGO, NCAS/CGAM, UK

Page 50, Line 23-34: This section is very weak. Given the recent work of Levitus, it is very important that climate models be tested against this new data. With the increase in computer power, it is likely that ocean eddies will begin to become resolved in the next generation climate models. This seems to be an area that needs brought out more in the document.

RONALD STOUFFER, GFDL/NOAA

Page 50, More verb issues: lines 25-26: (27-E) "None...resolves..."; lines 29-30 "A series...is..."

HOWARD P. HANSON, LANL

Page 50, lines 36-43. Should go way beyond this and extend to the application of decision support on regional scales.

ANTONIO J. BUSALACCHI, EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER (ESSIC), U. MARYLAND

Page 50, Line 36-40: Indeed, a plan to better understand and improve the simulation of known modes of climate variability such as the El Niño-Southern Oscillation (ENSO), and the Pacific Decadal Oscillation (PDO) is warranted. These two modes of natural variability impact California. We are concerned with the fact that the two most intense El Niño events in the last 100 years occurred in 1982 and 1997. Some global models suggest that these two events occurring so recently and so closely together may represent a climatic trend. Evidence of such a trend would be in agreement with the suggestion that climate change may manifest itself in changes in the frequency and magnitude of natural climatic oscillations. The California Energy Commission is funding some preliminary work along these lines and we will be very interested in coordinating our work with your program.

CALIFORNIA ENERGY COMMISSION

Page 50, line 39 … (NAO/NAM) North Atlantic Oscillation / Northern Annular Mode …

MARTIN VISBECK, COLUMBIA UNIVERSITY

Page 50, bottom and page 51, top. Statements about ENSO are overly strong - given the lack of a complete physical mechanism for ENSO, it is not clear how much of a problem the simulation (or non-simulation) of ENSO really is. This should be changed to note that while ENSO is an important mode of the climate system, predictive (as opposed to diagnostic) studies of its mechanisms are still incomplete and deserve study. But it should not be presented as some kind of essential test.

SUSAN SOLOMON, NOAA

Page 51: As a near-term product, a critical comparison of the model sensitivity of major US models will 6 be undertaken by the major modeling centers (1-1.5 years), followed by publication of a 7 reviewed interim report (3 years). 8

What, exactly, does this mean? We already know how the NCAR CSM and GFDL models, stack up on sensitivity to doubling CO2, not just with regard to global mean

temperature but with regard to other climate variables and their geographic distribution. Most of this study has been published already in the peer-reviewed literature. So what, exactly is meant here by the above statement?
Spending 3 years on this report looks like a stalling tactic more than anything else. I think what is really called for here is a more specifically targeted study of the sensitivity of each model forecast to variations in uncertain parameters, such as those governing cloud physics and ocean mixing.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 51, line 3: The diurnal and seasonal cycles, as the major forced modes of natural climate variability, should also be the focus of study and appear to provide stringent tests for models.

JULIA SLINGO, NCAS/CGAM, UK

Page 51, line 5: (28-E) Again, Products & Payoffs has time frames, which is inconsistent. (Maybe the previous such sections that don’t have them should?) This comment also applies to the second such section on this page, beginning on line 24.

HOWARD P. HANSON, LANL

Page 51 L6-10 - This needs to include a statement that the uncertainties will only slowly be reduced. This is a hard problem that has a long history.

RONALD STOUFFER, GFDL/NOAA

Page 51, lines 6-10: This paragraph does not really describe a payoff; rather it is an outline for an approach. Need to provide both an approach and a clear product and payoff (with a timeline) to justify investment.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 51, Line 7: There should be no major modeling centers. This should be a multidisciplinary effort. It appears that the modeling centers described require more disciplines. It is unclear what is intended, but you could stifle creativity if you exclude others not working with the major modeling centers and you will not cover all the disciplines needed to make progress as outlined in this document.

JAMES BONTA, USDA

Page 51, line 10: To be correct and international, please change “between” to “among” in both places.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 51, lines 15ff, but note (Stott and Kettleborough, Nature 2002, and others) that over the next 40 years - and few people care what happens beyond that - uncertainty in emissions scenarios play a secondary role to uncertainty in climate sensitivity.

PHILIP MOTE ON BEHALF OF THE CLIMATE IMPACTS GROUP, UNIVERSITY OF WASHINGTON

Page 51, Line 17: The five lines following line 17 explicitly endorse the very scenario-driven modeling exercises that led to the ridiculous worst-case predictions of the IPCC Third Assessment Report. Again, there are "if-then" questions that are direct, as in "If GHGs increase by X, then temperatures would increase by ?" And then, there are indirect "if-then" questions that are so speculative as to have little value. The CCPS should not be building the bigger stick with which future wielders of the process might mug the policymaking process more effectively than they already have.

KENNETH GREEN, FRASER INSTITUTE

Page 51, Lines 25-31: Given the state of computing power and meaningful climate modeling scales, regional modeling should not be given priority in the CCPS in any way. Synchronizing US regional models with IPCC scenario development is a recipe for generating scary disaster scenarios and predictions.

KENNETH GREEN, FRASER INSTITUTE

Page 51, Lines 25 – 32. Co-ordination with the IPCC is to be welcomed and the aim to work in the international context. We suggest the additional scenarios should include those that lead to stabilisation, something which the IPCC is already considering under it Task Group on Climate Impact Assessment (TGCIA).

DAVID A. WARRILOW AND DIANA WILKINS, UK DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS

Page 51, Line 25-32: Developing sets of ensemble global simulations that project climate change at continental, national, and regional (e.g. western United States) scales will certainly be important. Our only suggestion is to use not only the ensemble means but also the excursion from the mean to elucidate potential extreme events. In addition, recent research (Allen and Ingram 2002) suggests that the range of potential warming reported by the IPCC in the Third Assessment Report (TAR) does not provide a measure of uncertainty in climate forecast. Formal uncertainty analyses, such as the one done by Allen and Ingram suggest that temperatures may increase well beyond the range reported by TAR. We recommend reproducing the study reported by Allen and Ingram with different AOGCMs models.

The appropriate reference for Allen and Ingram (2002) is:

Allen M. R., W. J. Ingram, 2002. Constraints on future changes in climate and the hydrologic cycle. Nature 419, 224-232.

CALIFORNIA ENERGY COMMISSION

Page 51, line 28: Is the indication that there will be policy applications in 3 years an indication that the Bush Administration will be reviewing its policy earlier than 1012 as it has previously stated? This is supposed to be a science plan—it should indicate what the scientific community will do, not what the policy community will be doing.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 51, lines 30-32: It is nice that the CCRI will coordinate with the IPCC, but this plan really needs to say this much more generally and forcefully than this, and do so up front as an underlying principle of the US efforts. Ignoring the IPCC as is nearly done seems inappropriate. In addition, in that the NRC (the one true base of knowledge, it does seem) in a 1998 report called for US model simulations for the purposes of National Assessment, it should be mentioned that this type of simulation will also be done.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 51, lines 34-40: This is all a bit confusing, as emissions from North America mix with emissions from elsewhere to contribute to forcing, and this cannot all be done simply by superposition—there are interactions.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 52: Two Center Strategy.
It is appropriate for the two centers mentioned to have the responsibility for running the IPCC scenarios. However, I am afraid that this section gives short shrift to the important role that universities and other national laboratories (e.g. Livermore and Argonne) have had in advancing the state of the art in climate modeling. Among other things, lack of facilities for running big high resolution models is only part of the problem in the US. An equally big part of the problem is lack of flexibility in models -- the difficulty of modifying them to test new physical ideas, of trying novel scenarios, and of exploring a wide range of hypotheses. Much work of this type will be necessary to address important sea ice, cloud and ocean mixing problems, and the best way to advance progress is to make it possible for more university earth and atmospheric science departments to get involved in modeling. NCAR does not by any means substitute for the need for local modeling capabilities at universities, and the NCAR CSM has rather sever problems with regard to portability and flexibility.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 52: Common Modeling Infrastructure.
A serious problem with regard to developing a common modeling infrastructure is that climate modelers are still using 1960's vintage software development technology (compiled FORTRAN). The only common innovation is the use of FORTRAN-90, but this is very limited compared to much more powerful techniques used for software development in other areas of computer science. For models to become more flexible it is necessary to break the information technology logjam. I have a small project of my own funded by the NSF ITR program, which seeks to do this (http://geosci.uchicago.edu/~rtp1/itr), and I think that the modeling field could benefit greatly from expanded funding of projects of this type throughout the university system.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 52: Access to Computational Capability. 27
In addition to very large scale national supercomputer facilities, there should be a very extensive program to fund beowulf (moderate scale clusters of Linux processors) in the $200,000 range at University departments. This is a very cost-effective way to promote innovative climate modelling research in university departments, and will also help to train the next generation of climate modellers.

Resources for risk analysis and decisionmaking under uncertainty

I really doubt that it is worth putting much money into this area. It would only give an illusion of precision to the decision making process. In the face of uncertainties in climate projections, the difficulty of assigning probabilities to various outcomes, and the possibility of the "worst case" being catastrophically bad, decision theory of the sort that might be applied to beer marketing is just a waste of time, money and researchers' energy.

RAYMOND PIERREHUMBERT, THE UNIVERSITY OF CHICAGO

Page 52: "The US contributions to the IPCC's century-long runs and assessments will be primarily accomplished by the high-end models developed at two complementary high-end modeling centers...CCSM....GFDL...". It seems that this approach is based on older model simulations. However, both CCSM and GFDL are developing new models, which may produce much different outcomes. Thus, the new model results may not represent the range of uncertainty and the focus on just two groups may not be a wise strategic move. Also, why is the GISS model not included?

X.-Z. LIANG, ILLINOIS STATE WATER SURVEY

page 52-53: although we at the pew center agree that complex policy decisions are frequently made under significant, or even great, uncertainty, this segment of the *draft strategic plan* is unclear, and of questionable utility. what are the resources that will be developed and/or utilized for addressing scientific uncertainty in decision-making? how will these tools be made available to policy-makers? are policy-makers interested in using such tools? to what extent is scientific uncertainty inhibiting decision-making? the activities outlined in this section of chapter 4 appear to be rather academic exercises that don't necessarily reflect the needs of decision-makers or the manner in which decision are made. it would seem more appropriate to provide decision-makers with the best possible understanding of the implications of climate change and more realistic projections than have previously been used of the costs and benefits of a broad-range of policy options. if a significant investment is going to be made in decision support tools, then the *draft strategic plan* should include a more thorough description of the tools that will be developed and how they will be made accessible and utilized by policy-makers.

VICKI ARROYO AND BENJAMIN PRESTON, PEW CENTER ON GLOBAL CLIMATE CHANGE

Page 52, Line 5-16: "Strengthening US Applied Climate Modeling Capability-Two Center Strategy" should also include a center for regional and shorter-term climate modeling in addition to longer-term and global models.

JOSH FOSTER, NOAA/OGP

Page 52, Lines 5-16: The section that describes the two center indicates that NCAR, as the host of the Community Climate System Model (CCSM), and GFDL, as the host of the GFDL model that will be used for model product generation, will be the principal sources of applied climate modeling capability in order to contribute to scenarios and assessments. We suggest that it is imperative that the section clearly describe the important role played by universities and smaller modeling centers in advancing the science of climate modeling. While the CCSM does include some input from these groups, substantial achievements and progress in climate modeling are being made in universities and smaller modeling centers that are not necessarily reflected in the evolution of the CCSM.

2. It is imperative that the two centers, NCAR and GFDL, make their models, input data sets, output data sets and documentation of codes and data sets available to the research community outside these centers. This flow of information needs to be continuous, i.e., whatever is the latest version of the model at each of the two centers and whatever model integration output data sets that have been generated must be available to researchers and modelers as soon as they are ready.

JAMES KINTER, CENTER FOR OCEAN-LAND-ATMOSPHERE STUDIES

Page 52, line 5: The Two Center Strategy sounds fine but neither is an operational forecasting facility – note earlier comments on the benefits of model initialization and rigorous testing against seasonal forecasts.

JULIA SLINGO, NCAS/CGAM, UK

Page 52, lines 5-16: This relates to the general comment voiced many times at the meeting that there doesn't appear to be any funding attached to this plan. This paragraph refers to a portion of the plan over which there was some controversy. The specific problem that I would like to focus on is that it charges GFDL with carrying out "research, assessment, and policy applications." Historically, GFDL has done only research. Their GCM is very famous despite the minimal staff that is assigned to it, and this is in part reflective of their sharp focus on strictly scientific questions on what is the global effect of greenhouse gas increases on basic meteorological and oceanic quantities. Adding assessment and policy applications to the mix at that location would require additional personnel, i.e. money. Additionally, an oft-repeated comment at the meeting was that there is a need for more regional modeling activity, which I very much agree with. A corollary to that which parallels the previous comment is that regional modeling efforts would need to be supplemented by provision for supporting the transfer of their output to assessment and policy activities.

BRENT LOFGREN, NOAA/GLERL

Page 52, Lines 6-16: The *Draft Strategic Plan* indicates that the CCSP will focus on the development of two U.S. high-end climate models (the NCAR Community Climate System Model (CCSM) and the Geophysical Fluid Dynamics Laboratory Model (GFDL)), which will serve as the principle models for identifying and reducing uncertainties in climate model projections and for applied climate modeling. As mentioned in the *Draft Strategic Plan*, the climate sensitivities associated with these general circulation models (GCMs) lie at opposite extremes of the expected range of uncertainty in climate sensitivity. Although this does make these models useful for investigating factors that affect uncertainty in climate sensitivity and for capturing the full range of uncertainty in model projections based upon various emission scenarios, the representation of extreme climate sensitivities could be seen to create some problems in the communication of model results. For example, the principal models used in the

National Assessment (Canadian Climate Model and the Hadley Center Model version 2), also represented extremes, the Canadian Model for temperature, the Hadley Model for precipitation. Although it is helpful to be able to bracket the range of uncertainty, it is also helpful to have models that yield outcomes that are most consistent with expectations. Thus, if the CCSP plans on supporting only two high-end modeling centers, it would seem prudent to continue to partner with foreign modeling centers in order to conduct applied climate modeling with other GCMs, to at least enable applied modeling with models of high, medium, and low sensitivities, rather than just the extremes.

VICKI ARROYO AND BENJAMIN PRESTON, PEW CENTER ON GLOBAL CLIMATE CHANGE

Page 52, Line 6-16: The justification for the two model strategy is weak. This strategy seems justified given the wide range of climate sensitivity (1.5-4.5C). This argues that one needs a high and low sensitivity model to try to cover the range in the uncertainty of the model response.

RONALD STOUFFER, GFDL/NOAA

Page 52, line 6: that the US will be continuing to participate in IPCC should be a more general point made up front in the overall plan.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 52, line 15: Change "or" to "and"

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 52, Line 18-25: There needs to be a common structure for data too. Include mention of the data distribution issues and refer to ESG, PRISM and NOMADS.

RONALD STOUFFER, GFDL/NOAA

Page 52, Lines 27-35: The issue of computing power is so basic to advances in climate change research that it ought to be featured more prominently than as a sub-bullet.

CALIFORNIA RESOURCES AGENCY

Page 52, lines 28-52: What is the basis for justifying allocating computing power to climate change? What are the relative national priorities? And how does the CCSP propose to interface with the National research agenda to allocate computing resources?

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 52, lines 33-35. How will access to this increase in computational capability be handled?

DOE NATIONAL LABORATORIES

Page 52, line 36ff: It is really unfortunate that this subsection, and this section generally, do not include any resources for regional modeling, which is said to be one of the key uncertainties. This needs to be addressed.

MICHAEL MACCRACKEN, LLNL (RETIRED)

Page 52, Line 36: Future needs for climate information for regional and local impacts assessments are best met by a distributed but coordinated collection of regional climate modeling centers. Such an arrangement takes advantage of capacity and climate-awareness at points of impact. It also engages a mix of national centers and universities, thereby allowing access to computing resources as well as capacity building through educational and outreach programs. The broad range of disciplinary expertise needed for impacts analysis exists primarily on university campuses and is most effectively engaged by partnerships with local or regional modeling centers. Finally, such an arrangement will encourage engagement by local, state, and regional decision-makers and stakeholders through existing public, private, and academic sector links common to many universities.

EUGENE S. TAKLE, IOWA STATE UNIVERSITY, RICK ANTHES-UCAR, RAYMOND ARRITT-IOWA STATE UNIVERSITY, DANIEL CAYAN-SCRIPPS, PHILIP DUFFY-LAWRENCE LIVERMORE NATIONAL LAB, GUTOWSKI-IOWA STATE UNIVERSITY, CHUCK HAKKARINEN-PRIVATE CONSULTANT, LAI-YUNG LEUNG-PACIFIC NORTHWEST NATIONAL LABORATORY, XIN-ZHONG LIANG-UNIVERSITY OF ILLINOIS, MIDWEST REGIONAL CLIMATE CENTER, AMANDA LYNCH-CIRES/UNIVERSITY OF COLORADO, PHIL MERILEES-NCAR, FEDOR MESINGER-NAT'L CENTERS FOR ENIVERONMENTAL PREDICTION, NORMAN MILLER-LAWRENCE BERKELEY LABORATORY, KENNETH MITCHELL-NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION, JAMES O'BIREN-FLORIDA STATE UNIVESITY, ZAITAO PAN-IOWA STATE UNIVERSITY, JOHN ROADS-SCRIPPS, LISA SLOAN-UNIVERSITY OF CALIFORNIA AT SANTA CRUZ, JOHN TAYLOR-ARGONNE NATIONAL LABORATORY

Page 52, Line 38: We believe that the proposed work on handling risk and developing socio-economic scenarios is an important and innovative part of the program. Dealing with risks, whether in relation to the current or future climate, is of great relevance to stakeholders, but although there is work on this topic, including in the UK, it is at an early stage. While the general principles of risk management are widely known, they need to be more widely promulgated to the impacts community and adapted to a climate change setting. Our experience in the UK is that flood management is the area where the need for knowledge and advice on how to take adaptation measures is perhaps most acute because of defenses designed and implemented now will have to be able to cope with change many decades. They are also have long planning horizons and are resource intensive.

DAVID A. WARRILOW AND DIANA WILKINS, UK DEPARTMENT FOR ENVIRONMENT, FOOD AND RURAL AFFAIRS

Page 52-53, Lines 38-41 and 1-24: This treatment of uncertainty as a topic for fundamental research separate from scenarioing and the development of integrated assessment seems misplaced. The topic of uncertainty should not be treated separately but incorporated into the other aspects of the chapter, since it is the cause of the policy debates and an inescapable aspect of all policy analysis and modeling.

CALIFORNIA RESOURCES AGENCY

Page 53, lines 3-4. Also consider such modeling tools as genetic algorithms and intelligent agents, systems dynamics, and dynamic simulation modeling.

DOE NATIONAL LABORATORIES

Page 53, Line 6-17: Some illustrative examples of "resources for risk analysis and decision making under uncertainty" would be helpful. Include some examples of what "new paradigms", "new approaches", and "new resources" will be created and how they will emerge.

JOSH FOSTER, NOAA/OGP

Page 53, Line 17: Add sentences "…users. The advancement of these new techniques and strategies will improve decisionmakers ability to address global change not at the cost of current strategies, but in addition to them. The CCRI aims to build upon current strategies that elicit decisionmaker response rather than replace these strategies."

EESI, CAROL WERNER AND J.R. DRABICK

Page 53, lines 20-24: This paragraph also does not really describe a payoff; rather it is an outline for an approach. Need to provide both an approach and a clear product and payoff (with a timeline) to justify investment.

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 53, references: Recommend reference be correlated to text (via numbers). Also – was there really only one reference used to prepare this Chapter?

DEPARTMENT OF TRANSPORTATION, LINDA LAWSON

Page 53, line 20: The timeline for the accelerated fundamental research program is unclear. The connections between fundamental research on decision-making and the translation into use for decision-making applications are complex. It is unrealistic to assume that fundamental research on decision-making can affect operational decisions in 2 to 4 years.

JOAN L. ARON, SCIENCE COMMUNICATION STUDIES

Page 53, line 38 and following. A critical omission from this section is the need for tools to support decision making about mitigation under uncertainty (see first overview comment above). This is at the heart of the debate between the administration's 'wait for more research (i.e., less uncertainty)' decision and those who feel that there is enough certainty to support more aggressive control of greenhouse gas emissions. Decision makers at the federal level could greatly benefit from an analysis of how previous decisions under uncertainty were made and how to bound uncertainty that exists. For example, given specific issues, how will uncertainty change in a quantitative sense given an additional 5 years of research. Will we be 5%, 10% 50% more confident? Will the finding change in sign? This should be a very high priority activity.

JANINE BLOOMFIELD, ENVIRONMENTAL DEFENSE