DRAFT
Minutes of the
Climate Change Program Product Development
Advisory Committee (CPDAC) Meeting,
November 15, 2006,
National Academy of Sciences, Washington, D.C

CPDAC members present:

David C. Bader (by telephone)
Leon E. Clarke
James A. Edmonds
Karen Fisher-Vanden (by telephone)
William J. Gutowski (by telephone)
David G. Hawkins
Henry D. Jacoby
Kenneth E. Kunkel (by telephone)
Richard S. Lindzen
Ronald L. Miller (by telephone)
Edward A. Parson (by telephone)
Hugh M. Pitcher (by telephone)
William A. Pizer
Soroosh Sorooshian, Vice Chair (by telephone)
John M. Reilly (by telephone)
Richard G. Richels (by telephone)
Robin T. Tokmakian (by telephone)
Mort D. Webster (by telephone)
Robert M. White, Chair
Julie A. Winkler (by telephone)

CPDAC members absent:

Antonio J. Busalacchi, Jr.
Curtis C. Covey
Brian P. Flannery
Isaac M. Held
David W. Keith
Linda O. Mearns
Cynthia E. Rosenzweig
Virginia R. Van Sickle-Burkett
Gary W. Yohe
Minghua H. Zhang

Also participating:

Anjuli Bamzai, Climate Change Research Division, Office of Biological and Environmental Research, Office of Science, USDOE
John Houghton, Life and Medical Sciences Division, Office of Biological and Environmental Research, Office of Science, USDOE
Julie Malicoat, Oak Ridge Institute for Science and Education
Frederick M. O'Hara, Jr., CPDAC Recording Secretary
Robert Vallario, Planning and Analysis Division, Office of Science, USDOE

About three others were also in attendance.

Wednesday, November 15, 2006

Chairman **Robert White** called the meeting to order at 12:58 p.m. and reviewed the purpose and agenda of the meeting. He asked each of the members to introduce himself or herself.

James Edmonds was asked to give an update on the synthesis and assessment product on Scenarios of Greenhouse-Gas Emissions and Atmospheric Concentrations, SAP-2.1a.

Three modeling groups were brought together: Massachusetts Institute of Technology (MIT) with its IGSM model, Pacific Northwest National Laboratory (PNNL) with its MiniCAM model, and the Electric Power Research Institute (EPRI) with its MERGE model. Each of these models could handle a global scale with multiple regions, six greenhouse gases and forcing, technical resolution of the energy sector, macro cost analysis, and simulations to 2100. Each group developed a scenario set for six specific gases and four levels of radiative-forcing targets; they gained insight into emissions, energy, and economics; and they prepared an analysis, joint report, and data set. Existing measures were to remain in place only until 2012, and then they went away. Equal marginal cost was used across regions and sectors. All other inputs (e.g., technologies used and specifications for atmospheric chemistry) were left to the modelers.

Nine issues arose during the August 17, 2006, CPDAC meeting: the Executive Summary, cost-benefit analysis, policy assumptions, technology assumptions, emissions of other radiatively important substances, aerosol forcing, differences across models, indirect effects of other radiatively important substances, and climate feedbacks in the models.

The Executive Summary has been substantially revised and now contains a number of explanatory figures from the report. It should serve much more effectively as a stand-alone summary of the effort.

Text in several prominent locations in the document was set in bold-face type to make it clear that these scenarios are *not* a cost-benefit analysis. The report looks only at the cost side of a basket of six gases at four levels.

The importance of the ideality of the underlying policy assumptions in the models has been stressed and highlighted more extensively in the body of the report as well as in the Executive Summary.

The authors worked very hard and responded to the issue of technology assumptions several ways:

- Detailed documentation on the models and their associated technology assumptions as they are presented in the models will be made available to the public.
- The text that describes technology has been enhanced and now discusses the difficulties in making apples-to-apples comparisons.
- Information that indicates technology costs and performance has been highlighted in the report.

Information about black carbon, organic carbon, and other radiatively important entities is being collected and will be represented upon publication of the report.

The figure showing aerosol forcing in 2000 (in Chapter 1) is consistent with the literature on the bundle of gases specified in the Prospectus (CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6). The report has been revised (1) to be clear that these scenarios are limited to the six gases, (2) to be explicit about the fact that this estimate of their radiative effects does not represent the total well-mixed greenhouse-gas forcing from preindustrial conditions, and (3) to make it clear that aerosol effects are not included. Some models have aerosol effects, and those effects are not included in the radiative forcing that is reported here. A data set on these other gases will be released with the report. Hawkins asked what the implications were of not including aerosols. Reilly replied that that

reduces cooling and tropospheric ozone precursors. This fact is mentioned in the report. There are small feedbacks. Jacoby pointed out that another SAP, 3.2 covers this topic.

The discussion of why the economic implications of stabilization vary among the models was sharpened throughout the report largely in response to the Stern report issued in the United Kingdom. A draft text has been supplied to the Committee. Two factors for these differences appear to play prominent roles: (1) the degree of emissions mitigation that had to be carried out for a given stabilization level and (2) the assumptions made about post-2050 technology by the different models. The differences in the degree of emissions mitigation are particularly important for stabilization levels 3 and 4. The percent reduction summed for the century varies from 7 to 28%. This variation can be traced to carbon-cycle representations, economic growth scenarios, energy use, and other assumed variables. The models had different reference-case emissions, different carbon cycles, and different non-CO_2 greenhouse gases. The complexity of the whole system affects the understanding of model results. The role of technology becomes more enhanced as one goes into the future, producing a huge difference among models in 2100. There, technology has improved in MiniCAM and MERGE, and the MIT model's costs separate from the other two. Reilly noted that, while biomass energy will occur in 2100, it will be quite limited. It is an abatement option early on but cannot keep increasing. Natural gas is available in 2100 but then disappears. Not everything grows proportionately.

Edmonds continued by pointing out that all three models assumed a form of “when flexibility” (cost over time), resulting in the price of carbon rising at an exponential rate for most of the analysis. In the MIT model, marginal cost and discounting stay the same and price rises with interest. At levels 1 and 2, the MIT model is pushed into high costs, and this increases with interest rates for all subsequent years. Hawkins asked how it affects costs. Edmonds replied that it says that one does not want to do as much at the beginning because "the cavalry is coming." It is a century-scale problem with century-scale implications.

Additional insights gained during the study: All technologies matter in all periods. All three modeling teams decarbonize electric power generation by 2100 and stabilization levels 1 and 2 even though they all have different visions of how stabilization will evolve. Especially for levels 1 and 2, the technology availability in end-use sectors (industry, transportation, and households) plays an important role in shaping the cost of stabilization. Stabilization options include electrification with non-emitting power sources, efficiency improvement, and non-fossil end-use fuels.

Hawkins noted that it would be good to have a table on the transportation sector and what options are available. Jacoby pointed out that not all models break out the different sectors. Clarke pointed out that there are a lot of electrical substitutes in some models, and MERGE and MiniCAM end up electrifying things more than IGSM does.

Edmonds returned to the list of improvements that had been made in the report. Text has been added to clarify the effects of other radiatively important substances. To the extent that temperature is affected by these substances, they have an indirect influence on the results because trace-gas cycles are climate-dependent. For example, climate affects vegetation and ocean temperature, and thus carbon uptake, natural emissions of methane and nitrous oxide, and the lifetime of methane also depend on climate. This point is now explicitly included in the text.

Text has been added to clarify the degree to which the models include these feedback effects, especially a temperature feedback to the oceans. Lindzen pointed out that this feedback also affects clouds etc. It would be good to extrapolate some of the effects that cancel some radiative forcing today. Edmonds pointed out that this is only half of the information set that would be needed.

What remains is to conduct a final cleanup of the report in November and December, issue an electronic publication by December 2006, and have a rollout in January 2007.

Jacoby noted that this was a useful exercise. A lot was learned about modeling and the value of fundamental research. A rich set of insights was obtained from using three models.

White asked for further questions that had not yet been addressed and if the received report was acceptable. All agreed that it was, with the exception of Hawkins. Lindzen added that the marine geochemistry could be simplified. Hawkins stated that the Executive Summary needs to explain the cost differences among models. The outputs were broken down into component parts, where they differed. He suggested identifying the drivers for the differences and providing definitions for allowable emissions for each of the three models. A metric on cumulative emission levels at four identified levels for the three models would be helpful. More work is needed on the key driver (the reference case). It takes a lot of work to tease out what is going on. The "technology toolbox" could also be made more understandable to the lay reader. He offered to suggest some edits.

Jacoby said that the new (November 15) document could be integrated into the Executive Summary, which would go a long way in dealing with these issues. The term "toolbox" is not meaningful to these modelers. The models are very different in internal structure.

Hawkins said that the description of substitutability in the November 15 document is helpful, but more is needed on what the resources are that are deployed in the three models. Edmonds responded that these comments can be accommodated with the help of Hawkins. There are limits on how far one can project. Richels asked if Hawkins wanted quantitative rather than qualitative answers. If so, it will take a lot of effort to tease the answers out of the models. Hawkins replied that he would like to see a table, but that he realized that the document has to meet a schedule.

A break was declared at 2:40 p.m. The meeting was called back into session at 2:50 p.m., and **Ted Parson** was introduced to review the response to comments on the draft of SAP-2.1b.

Many helpful specific suggestions came out of the August 18 CPDAC meeting, all of which were adopted as detailed in response document. A complete response to the public comments was made and posted on the Web. A comprehensive edit was conducted to improve the organization, reduce the length, and make the document more accessible. This editing included a major revision of the conclusions and the Executive Summary, producing a substantial improvement. Substantive issues that remain outstanding include consistency in terminology about “decision makers.” the graphics in Chapter 2, the need for a more explicit treatment of uncertainty, and the enhancement of the concept of a capacity for scenario production and use.

On the question of uncertainty, at least some scenarios of global emissions and climate change are most useful when (1) key variables are few and quantitative; (2) the

purpose is to provide quantitative input for other models or assessments; and (3) the potential users are numerous, diverse, and in close contact. They are least useful when (1) scenarios are rich, complex narratives; (2) the purpose is sensitivity analysis, heuristic exploration, or generation of insights (qualitative inputs to other models); and (3) the users are few, similar, and collaborative

A number of changes were made in the text:

- The fact that the recommendation was for increased effort in some scenario exercises, not a demand for probability density functions (PDFs) in all exercises, was clarified.
- It was made explicit that the recommendation for new scenarios capacity should pursue more explicit uncertainty in the context of developing scenario methods and should promote diverse approaches.
- Several qualifications were added: Explicit uncertainty is easiest and least controversial when distributions can be formally produced from models. While it is always possible to produce subjective PDFs, one should acknowledge that some subjective probability estimates have stronger bases than others, and an extremely broad or unstable distribution might not be of much practical use.
- A new point was added on expanding and sustaining capacity for scenario production and use. The Committee had said that the recommendations were too broad and vague and that there was an inadequate recognition of foreseeable pitfalls. This section has been completely rewritten.

Asked if he had seen the Granger Morgan piece on uncertainty, Parson replied that he had not, but that Granger Morgan was a reviewer of SAP-2.1b and that he had given detailed criticism. Bamzai noted that SAP 5.2, Best-Practice Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Decisionmaking, was in draft and being reviewed. Vallario commented that there is a lot of crossover between the reports and that the lexicon should be consistent. Parson added that there should be no overt contradictions.

Parson continued: The text now describes the capacity for scenario production and use as a program to support diverse scenario activities and the development of related tools and methods. The primary functions of the program would be to facilitate, commission, and disseminate scenarios, applications, and related methods; to convene reviews; and to provide support and archiving. It would *not* be an office to produce scenarios.

The conditions necessary for the program's success are twofold:

- It needs to maintain strong, sustained connections with a diverse outside expertise, analytic and modeling groups, and user groups and it needs to collaborate with other scenario activities (regional, national, and international). It would be a networking activity. It would not do the work itself; rather, it would play a coordinating and catalytic role.
- The program needs to integrate and balance scientific/technical standards and practical/utility standards; this should be obvious. A tension needs to be maintained between capability and needs.

The other stated attributes of this program remain unchanged, as described in the previous presentation. Again, it would need the requisite authority and resources to carry out its functions.

Comments and suggestions were requested from the Committee members. Gutowski suggested that extremely broad PDFs would serve to highlight uncertainty. Kunkel said that he liked the changes made on substitutability. Winkler said that this draft was an improvement. Pizer said that the people selected to determine the scenarios should be chosen carefully. Parson added that political influence over substance should be limited. All of the other members of the committee were happy with the changes or had no comments.

White asked if any changes should be made to the report as it now stands and is amended. Hearing none, he found the report acceptable to the committee and asked for any general comments. Houghton thanked the authors for their excellent work, the amount of which had been terribly underestimated. White commented that two good reports had been gotten out of the effort and also thanked the authors.

The meeting was adjourned at 3:21 p.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
Recording Secretary
Nov. 22, 2006

Corrected,