Minutes of the CCSM Advisory Board Meeting
13 and 14 January 2005
Wyndham San Diego at Emerald Plaza, San Diego, CA

CAB Attendees: Daniel Jacob (Chair), Ed Sarachik, Tony Hollingsworth, Isaac Held, David Schimel, Eric Sundquist, John Drake, Tom Crowley

CAB Ex-Officio Attendees: Richard Anthes, Tim Killeen, Jay Fein, Kiran Alapaty, David Bader, Annick Pouquet, James Hurrell, William Collins, Phil Merilees

SSC Attendees: James Carton, James Hack, Ben Santer, Danny McKenna

Guests: Don Johnson, Steve Meacham, Jerry Elwood, Chet Koblinsky, Susan Solomon, Huug van den Pool, J. Shukla, Lydia Shiver

1. **Welcome**. The new chair of the CAB, Daniel Jacob, welcomed everyone to the meeting, and Rick Anthes reviewed the charge of the CAB. Everyone introduced himself or herself. Anthes then presented Ed Sarachik with a plaque to thank him for his service to CCSM and also read a letter of thanks. Jay Fein added that many of the topics of discussion at the CAB meeting today would show Ed's influence on the CCSM project and issues outlined in the CAB annual letter. Bill Collins thanked Ed for his contributions, and then he introduced new ex-officio members, Annick Pouquet, Acting Director of ESSL; Jim Hurrell, Acting CGD Division Director; and Kiran Alapaty, NSF staff; and he thanked Susan Solomon for attending to hear discussions about IPCC.

Collins then reported on the issues from the CAB annual letter and the SSC's responses. Both letters are attached. He also stated that the SSC formally endorsed COLA hosting a second tropical biases workshop and has requested that a CCSM representative be invited to participate on the planning committee.

2. **CCSM3's IPCC Simulations and Lessons Learned**. Collins reported that CCSM staff is sending data to PCMDI for archival now, and all the Earth Simulator data are back at NCAR and part of the data set is being sent to PCMDI. The ocean (POP model) and ice data (CSIM) model are being looked at so that their data can be transferred in the format needed by PCMDI.

He discussed the history in that CCSM2 was released in June 2002, it was decided that it was not appropriate to use for IPCC scenarios, and development of CCSM3 was started.

CCSM ran four experiments at different locations: NCAR, Earth Simulator, and DOE's Oak Ridge National Laboratory and Lawrence Berkeley Laboratory. CCSM3 has the highest spatial resolution of all runs, except one run that was done by the University of Tokyo.

Collins stated that the CCSM *Journal of Climate* special issue was well under way, and a Web site was available to review those manuscripts. Several papers on CCSM IPCC scenario runs have been submitted or are in press at this time.

Collins showed CCSM3 results on global temperature and sea level, ocean temperature and overturning, increases in surface temperature and precipitation, Arctic sea ice concentrations, and changes in sea ice coverage. He stated there were no ice sheets included. Tom Crowley asked why the mean global temperature increase in the 2xCO2 run looked low. Collins responded that CCSM scientists were investigating this and had run the scenario through Tom Wigley's MAGIC model, which showed the correctness of the low number for 2xCO2.

Collins stated that the lessons learned from CCSM3's IPCC simulations were:

- Lesson #1: Experimental Design Plan needed that includes contents and goals of the experiments; descriptions of all forcing agents versus time; description of pre-industrial spin-up; experimental basis for pre-industrial spin-up; description and plan for CCSM resource requirements; and plan and timeline for dissemination of experiments.

- Lesson #2: Development of Forcings that include coordination with other groups to share data sets and develop common forcings and to develop components of state-of-art forcings, such as emissions as functions of space and time, chemical transport framework to simulate agents, parameterization development for indirect efforts, and exploration of indirect forcings, such as irrigation and land-use change.

- Lesson #3: Design of Model Spin-up.

- Lesson #4: Start Early that includes sequential and not concurrent milestones.

- Lesson #5: Check Throughput of Data Transfer. Because CCSM3 produces a very large data set with 8 to 10 times more data than other models, the speed of transferring data is very important. CCSM thanks Dave Bader and Anjuli Bamzai for increasing the speed of the data transfer for CCSM.

- Lesson #6: Plan for All End Users. CCSM's output is 100 TB of data, and this is several orders of magnitude more data than members of IPCC WG2 and WG3 are used to analyzing. We need to be sure that the data are accessible and usable.

Susan Solomon stated that CCSM is setting the standard for assessment for IPCC. She stated that she had tried to negotiate 1 standard forcing data set for everyone, but it wasn't possible. For the next IPCC, we need very early collaborations to get everyone to agree on 1 standard forcing data set. She also reported that the IPCC 5th assessment would be more of integrative systems, including carbon, so maybe standard forcings will not be so important for AR5.

Collins stated that NCAR spent the equivalent of $75-100 million in computer time on IPCC, and for that they got:

- greater understanding of sensitivity to forcings;
- nature of climate response;
- look at stabilization to tell society;
- precipitation information;
- more resolution and more ensembles than anyone but the University of Tokyo; and
- many groups running ensembles and comparing them and without IPCC that would probably not happen and the efforts would be undisciplined.

Fein stated that the CCSM team had done a spectacular job working on IPCC AR4, and he wanted to discuss what was the cause of CCSM staff's turnover and burnout at NCAR. Tim Killeen stated that NCAR had made an institutional commitment, bought more computing power, hired software engineers, noted the political implications of working on the Earth Simulator, and knew there was a human capital issue. Bader said that CCSM didn't think CCSM2 the proper IPCC model, so developing CCSM3 for IPCC and running IPCC simulations took a toll. Ed Sarachik stated that no new resources were provided to CCSM to do the IPCC AR4 simulations and that NSF must infuse CCSM with new funds to continue its program. Daniel Jacob stated that new resources should be invested to exploit data sets from CCSM3 for science. Annick Pouquet said she is worried because CCSM staff are overextended and cannot do their own science. Collins reported that an alarming number of staff left NCAR after the release of CCSM3. Collins pointed out that due to CCSM moving toward an increased number of components just makes the program more difficult. CCSM's challenge is to have an Earth System Model by 2007-2009 and use it for assessment and science, which will entail an enormous effort.

Hollingsworth stated that a strong institutional policy and planning for computing, science, and people for the next assessment needs to start immediately. Killeen stated that CCSM has a Business Plan, but because of decreasing budgets, it is very hard to make gains. Fein stated that he knows there is a need for new resources, but the budget outlook is dismal. He recommended that model centers (CCSM, GFDL) look at expectations, decide what expectations can be met, and send that message to Mahoney and others so they have realistic expectations and that limitations will have to put on CCSM staff's workload. Collins reported that CCSM has already cut back on community support due to budget limitations. Merilees suggested that the CAB should tell CCSM staff how well they have done and continue to tell them how well they have done and give them recognition for their hard work.

3. **NCEP's New Operational Climate Forecast System (CFS)**. Huug van den Pool gave a presentation about NCEP's new CFS components for seasonal to interannual climate. He reported that the model is T62 and 64 layers in the NCEP atmosphere component. The model top is at 0.2 mb, it includes a simplified Arakawa-Schubert convection scheme, non-local planetary boundary layer scheme, shortwave radiation scheme, prognostic cloud water scheme, and longwave radiation scheme. The ocean component is MOM3 with 40 levels, 1-degree resolution, and 1/3-degree on the equator. The fully coupled atmosphere-ocean model has no flux correction. He summarized the new model as one that displays realistic

behavior for monthly and seasonal forecasts, is used operationally to define forecast skill, and can be used in research mode for a wealth of climate studies of predictability. The monthly data from CFS will be available from NCEP at the end of January 2005.

4. **History and Future Possibilities of CCSM Program and Human Resources**. Collins stated the CCSM scientific objectives are to:

- develop a comprehensive climate model to study Earth's climate;
- investigate seasonal and interannual variability in the climate;
- explore the history of Earth's climate; and
- estimate the future of the environment for policy formulation.

Collins stated that CCSM's recent accomplishments are:

- release of a new version (CCSM3) to the climate community;
- studies linking SST fluctuations, droughts, and extratropical variability;
- simulations of last 1000 years, Holocene, and Last Glacial Maximum; and
- creation of largest ensemble of simulations for the IPCC AR4.

He also reported that since its release in June 2004, there have been over 1000 downloads of CCSM3; attendance at the annual CCSM workshop continues to rise; number of CCSM publications continue to rise with 229 publications total at this time, 87 from NCAR first authors, 94 from university first authors, and 48 from government laboratory and foreign institution first authors; and the science areas continue to grow, especially in the chemistry and biogeochemistry areas. A new Chemistry-Climate Working Group has been recommended, and the first meeting of this new group probably will be at this year's workshop. Jacob suggested the working group be called Atmospheric Composition Working Group.

Collins stated that CCSM staff is the largest group within CGD; collaborations with ACD, HAO, and SCD in the new Earth & Sun Systems Laboratory (ESSL) are continuing; 80% of CCSM's funding comes from NSF, which has been very generous in their support; and DOE's SciDAC and NASA's ESMF also contribute to CCSM funding. Three new scientists, 2 new project scientists, and 1 new software engineer have been added to work on CCSM issues and there have been 2 lateral transfers of software engineers and 2 project scientists converted to scientists. From the CCSM Business Plan, he showed that out of 21 staff identified, only 4 positions have been filled (chemical modeler, aerosol support scientist, atmosphere component software engineer, and Climate Change Working Group liaison). There have been several critical staff departures, and their departures have impacted support to the AMWG; software engineering support for core development, numerical methods, and atmospheric dynamics; software engineering support for isotopes, land cover change, river routing, hydrology, and high-resolution land model; and there is an urgent need for 4 to 5 additional software engineers to work on current tasks identified on the CCSM project list.

Collins showed a 5-year estimate of funding needed for a "sustainable" and "optimal" CCSM project that showed the CCSM funding is not adequate. Jacob recommended the

word “sustainable” be changed, and Anthes stated that NCAR could end one aspect of the project or slow down the whole project as an answer to the funding problem.

Jim Hurrell, CGD’s Acting Division Director, reported on the state of CGD’s funding and the effects of decreased funding on CCSM. He also discussed the effects of decreased funding on HAO, ACD, and MMM, which are all a part of the new ESSL. Jerry Elwood requested that all funding be shown for CCSM, not just funding at NCAR. It was suggested that the next business plan should show funding commitments from other agencies other than NSF. Jacob stated that CCSM needs to better engage the university community to get growth in CCSM. Fein stated that the university community is well engaged, however, when projects such as IPCC come into play, it is NCAR’s responsibility to complete such projects, so there is a need for a strong core group at NCAR. He stated university and laboratory collaborators are needed, but the final responsibility rests with NCAR. Killeen suggested that the CAB write a letter to national leaders (cabinet level, OMB, Leinen, NSF Director, president’s science advisor) that a presidential directive is needed to acknowledge and fund the climate modeling work in the U.S. Crowley agreed that letter writing would be useful for the long term, but he recommended that a highest priority list be generated for use in the short term.

Other issues that were discussed were limitations on CCSM user support as a way to relieve workload, aging of core scientists that do climate modeling and no new scientists to mentor to take over and replenish the core scientists, and how to develop the next generation of climate modelers. Fein stated that NSF will encourage scientist and graduate student sabbaticals and visits to NCAR, and he advised the group about the new ASP Faculty Fellowship program. Collins suggested that NCAR recruit very specific postdocs and grad students to bring them to NCAR, and Bader suggested that we also encourage visitor and postdoc programs. The CAB members met during lunch to continue to pursue ideas on how to bring attention to CCSM’s funding problems.

5. **History and Future Needs for Computing**. Collins stated that CCSM would like to acknowledge the IPCC initiative nodes bought by the NCAR Directorate, SCD’s and DOE’s computing support for CCSM’s IPCC work, and NCAR and NSF’s support for vectorization.

Collins reported that CCSM3 is executable on IBM Power clusters, Cray X1 vector systems, NEC SX vector systems, SGI Altix systems, SGI Origin systems, and specific linux systems. He also stated the computational requirements for the 3 different resolutions (T31, T42, T85) are:

- 62 CPU hours/simulated year for T31 land/atm x 3-degree ocean/ice;
- 292 CPU hours/simulated year for T42 land/atm x 1-degree ocean/ice, and
- 1146 CPU hours/simulated year for T85 land/atm x 1-degree ocean/ice.

CCSM3’s model and data users consist of downloads from 177 universities, 69 laboratories, 110 international institutions, 22 private sector institutions, 51 NCAR collaborators, and 87 that are unidentifiable.

Collins showed Tom Bettge's presentation on High Performance Computing at NCAR, showing SCD's future plans for high-end computing, which are to achieve a 25-fold increase over current sustained computing capacity in five years. Collins showed DOE's proposal for a Climate Science End Station, defined by three characteristics:

- addresses problems that are of national importance;
- scientific team willing to create and maintain end station; and
- suite of scientific codes in area tuned to National Leadership Computing Facility (end station) resources.

Collins also showed the strategy of establishing a Petascale Earth System Collaboratory project involving all U.S. high-end computing users, which will develop a strategy to address the gap between the scientific requirements for, and the availability of, high-end computational resources for geosciences research in the U.S. The mission is defined as providing "leadership class" computational resources that will make it possible to address, and minimize the time to solution of, the most challenging large-scale problems facing geosciences and substantially advancing our understanding and predictive capability of the components of the Earth system and their interaction with one another and with human society. The vision for the collaboratory is to enable simulations requiring 2-3 orders of magnitude more capability than currently delivered at NSF centers; give highest priority to a limited number of very high-end problems that can exploit large fractions of the resource for periods of time; serve both forward modeling and data assimilation problems; and support infrastructure for software engineering, balanced storage, and post-processing capability.

6. **Plans for 10th Annual Workshop and Celebration**. Collins stated that the workshop was scheduled from 21 to 23 June 2005 in Breckenridge, Colorado. The theme for this year's workshop is "Crosscutting Science Using CCSM." There will be 3 plenary sessions to discuss topics on IPCC, paleoclimate and abrupt climate change, and building an Earth system model. There will be short business working group meetings, return of the "wrap-up" session, and a formal poster session. Other highlights at the workshop will be a discussion of a proposed biases workshop, the first meeting of a chemistry working group, and an ASP conference on integrative Earth system modeling after the workshop.

7. **Progress of Interactions Among CCSM and Other Modeling Efforts**.

ESMF. Collins reported on CCSM's interactions with ESMF stating that the reasons for CCSM to adopt ESMF is to enable incorporation of assimilation capabilities; to simplify construction of complex, hierarchical models; and to facilitate development of a single-executable CCSM. CCSM has adopted a thorough set of acceptance tests, and phase 1 began 1 January 2005 and ends 30 September 2005. Proposals for future ESMF funding have been submitted and include funding for a software engineer in the CCSM SE Group. The first acceptance tests will include stand-alone CAM and CLM, and then we will advance to the full CCSM. The quantitative acceptance metrics for Phase 1 are computational performance, solution separation, and memory requirements; and AMWG, LMWG, and SEWG will evaluate the ESMF-enabled code. After the success of Phase 1, CSEG will begin phase 2 acceptance tests.

NCEP. Collins reported that he visited NCEP in May 2004 and during that visit agreed to use Don Johnson's tests of dynamics and explore model test-bed concepts with NCEP. Phil Rasch also attended a conference on isentropic coordinates organized by Don Johnson and Dave Randall, and Phil is working with Don on applying tests to the finite volume (FV) dynamics.

GSFC. Due to illness, Michele Rienecker was unable to attend the CAB meeting and report on interactions with NASA's GSFC.

GFDL. Isaac Held gave an overview presentation on GFDL's modeling and IPCC activities. GFDL ran 3 historical runs using CM2.0 and 1 each AR4 scenarios, GFDL ran 5 historical runs using CM2.1 with 1 each AR4 scenarios plus 10 A1B scenarios from 2000-2050 plus 0.5-degree time slices. The 3 Climate Process Teams (CPTs) collaborations are going very well and continue their atmospheric and oceanic collaborations. GFDL held a meeting of all U.S. FV core users in November 2004 to discuss common source code management and development. Other back burner projects at GFDL are *BAMS* paper describing "convergence" of climate sensitivities; water vapor and cloud feedback analysis; and explaining why polar lower stratospheric temperature biases are so different. Held suggested for a new, more attractive future project that we focus on regional climate changes for which predictions of two models are profoundly different, such as Sahel rainfall.

8. **Highlights from CCSM3's Special Issue of *Journal of Climate***. Collins reported that most of the 24 papers proposed had been submitted for this special issue, and the CAB will have access to the Web site where the papers are in draft form. The special issue topics are overview of CCSM, description of features and climate state for each component, climate sensitivity, response of CCSM to paleo and pre-industrial conditions, and major modes of coupled variability.

The CCSM and DOE laboratories software engineering groups are also submitting 12 papers for a special issue on software engineering for climate models and performance and portability of climate model codes to the *International Journal of High Performance Computing Applications (IJHPCA)*. Publication will be fall 2005.

Held reported that GFDL submitted 4 papers to the *Journal of Climate* and 2 other papers were submitted elsewhere.

9. **CAB Discussion and Recommendations**. Jacob reported that the CAB members will write a letter to Anthes, Killeen, and Fein stating that the CAB perceives CCSM as a high priority at NCAR and that NCAR should maintain CCSM as a very high priority, pointing out the serious problem of aging scientists with little or no revitalization planned, and discussing the monetary needs for climate modeling work.

10. Meeting Adjourned.