

**Minutes of the
CCSM Scientific Steering Committee Meeting
6 April 2005
NCAR Vislab and Webcast**

Attendees: Bill Collins (Chair), Jim Hack, Jim Hurrell, Bill Large, Cecilia Bitz, Gordon Bonan, Scott Doney, Danny McKenna, Mariana Vertenstein, Anjuli Bamzai, Dave Bader, Jay Fein, Kiran Alapaty

Guests: Phil Rasch, Steve Jayne, Esther Brady, Marika Holland, Peter Hess, Jean-François Lamarque, Natalie Mahowald, Frank Bryan, John Drake, Lydia Shiver

1. **Welcome.** Bill Collins welcomed everyone and reviewed the meeting's agenda. Collins stated that several of the working group co-chairs would give brief reports about their CCSM near-term plans and priorities to help the SSC decide priorities for the CCSM project.

2. **Working Group Reports on Science and Software Priorities.**

Atmosphere Model Working Group. Phil Rasch reported that the new science taking place using CAM is in the areas of aerosols, tropospheric chemistry, WACCM, shallow and deep convection schemes, clouds, microphysics, isotopes, radiation issues, new dynamical cores, data assimilation, CAPT, and offline transport (MATCH and MOZART). These plans show increased opportunity for interaction with other working groups, such as Ocean, Polar Climate, Land, and Biogeochemistry, and resolved and mesoscale cloud modelers.

The AMWG's immediate priorities are that all development will be done in the context of the finite-volume (FV) dynamical core, that CAM will switch to the University of Washington's Planetary Boundary Layer shallow convection scheme, and will help in the transition to a "single executable, ESMF, development of a dynamics interface." Priorities over the next 1 to 2 years are reduction of systematic biases that contribute to problems in the coupled model context, such as tropical variability and sea ice growth.

Rasch also reported that the AMWG and Ocean Model Working Group (OMWG) have formed a coupled model task team of local collaborators to discuss configurations, diagnostics, and metrics; agree on an approach to ENSO, seasonal cycle, and diurnal variability and MJO; and entrain a larger community into the coupled model arena.

The AMWG's challenges are that there are enormous opportunities for interesting application-driven science, but few resources for development of the basic model (physical components and software issues), and not knowing how to solve the remaining biases issues in the coupled models.

Ocean Model Working Group. Steve Jayne reported that the OMWG's top two priorities over the next two years are tropical variability (realistic ENSO variability) and mesoscale ocean eddies resolved to 1/10-degree ocean model and parameterized.

A task team is working to deliver the “best” possible ocean component model, by delivering the “best” possible diurnal cycle of SST, “fully” resolved TIWs, “realistic” ocean only equatorial circulation, less diffusive thermocline, and decoupling from eastern boundary SST biases.

Jayne also reported that the NCAR Eddy-Mixed Layer CPT is formally documenting the sensitivity of the model solutions to various parameter choices in the GM isopycnal mixing parameterization, N^2 -dependent mixing coefficients (Marshall collaborating), and mixed layer bolus velocity with transition layer to adiabatic interior (Ferrari collaborating).

The OMWG’s challenges are the need for more computing power and more external scientists for collaboration. The OMWG co-chairs are trying to entrain more non-NCAR scientists by having OMWG meetings Webcast.

Land Model Working Group. Gordon Bonan summarized the LMWG meeting. Their priorities are the terrestrial carbon cycle (Thornton), development of a fire module that works with CLM (Randerson), and merging two models and resolving any issues. Peter Thornton is working on a carbon-nitrogen model, and he has many simulations that need to be run but he needs computational resources. Bonan stated that there would be a lot more science coming from the terrestrial carbon cycle in the next 10 years. The wildfire module is important to the carbon cycle because it has many feedbacks.

The LMWG’s focus will be to improve the water cycle in the Amazon. This focus has strong endorsement and many university collaborators. Some other collaborative projects are working with the University of Wisconsin on land use as a climate forcing (what is the land use forcing relative to other natural and anthropogenic forcings), working with University of Kansas on urban land cover and soil degradation, and working with University of Colorado, University of Kansas, and University of Wisconsin on transient land cover change. The transient land cover change experiments will complement IPCC runs done using CCSM, a 50-year spin up at T85 has been done, and computer resources are needed.

LMWG needs additional software engineering support to add the prognostic canopy air space to CLM to improve the diurnal cycle of surface fluxes and facilitate new science needed for isotope research. Colorado State University and Oak Ridge National Lab are collaborating with the LMWG on this major rewrite of surface physics and hydrology. LMWG also needs additional software engineering support to look at river routing in the CLM. A higher spatial resolution CLM is needed to study the impact of climate variability and climate change on national land management issues (water resources, wildfires, agriculture, urbanization, and carbon sequestration) and human health (heat stress, infectious diseases). The LMWG wants to bring the Variable Infiltration Capacity (VIC) model into the CLM to see if it improves the simulation of the hydrologic cycle.

LMWG’s longer-term priorities are a high-resolution version of CLM on a different grid than the atmosphere component model, putting CLM into the WRF model, and development by hydrologists of a new hydrologic model. The new hydrology model will need scientific and software engineering support.

Polar Climate Working Group. Marika Holland reported that the PCWG is involved in four major science topics: Abrupt Climate Change, sea ice and climate sensitivity, polar/tropical climate connections, and Arctic Ocean hydrological cycle. The Abrupt Climate Change project will examine the role of sea ice in driving or amplifying abrupt climate change in paleoclimate scenarios and examine abrupt transitions in Arctic sea ice in future climate projections, and involves collaborations with University of Washington, University of California, Berkeley, and University of Colorado.

PCWG is also involved in sea ice and climate sensitivity studies to examine the influence of ice model parameterizations on simulated polar amplification and examine the processes/feedbacks that influence polar amplifications, and involves collaborations with University of Washington and Los Alamos National Lab.

Polar/tropical climate connections is a priority in examining the influence of sea ice/land ice changes on tropical climate and tropical climate influences on polar regions, and PCWG members are collaborating with University of California, Berkeley and University of Washington.

PCWG is performing studies on the Arctic Ocean hydrological cycle to examine variability/change in the Arctic water cycle and the influence it has on global climate/ocean circulation, and involves collaborations with University of Colorado, NSF ARCSS FWI.

New sea ice model developments are a shortwave parameterization by University of Washington and NCAR; explicit melt pond parameterization by NCAR and University of Colorado; improved surface turbulent flux parameterization by Army's CRREL, Los Alamos, and NCAR; improved snow model by Los Alamos and University of California, Santa Cruz; improved mechanical redistribution/ridging scheme by Los Alamos; polar cloud parameterizations by University of Wisconsin; and software engineering enhancements by Los Alamos and NCAR.

Holland stated that the PCWG's challenges are that the human resources are limited and the group relies heavily on university and laboratory collaborators. She also stated that the computing resources are limited and work needs to be done to coordinate model runs across working groups, trying to change the SCD use-it or lose-it resources, and general need for resources for a higher-resolution model.

Biogeochemistry Working Group. Scott Doney summarized the BGCWG's near-term priorities as completing simulations of CSM1 coupled carbon climate, incorporating biogeochemistry into CCSM3, and combining Peter Thornton's carbon model with the ocean model component. Doney stated that a new level of complexity means both scientific and software engineering support would be needed to bring the land and biogeochemistry models together. The BGCWG focus will be in using the T31x3 ocean CCSM3 now and then going to a higher-resolution model.

Other new areas are the active dust cycle, inorganic nitrogen cycle that has strong interactions with the new Chemistry-Climate Working Group, regional ocean modeling to entrain more university scientists, wildfire to help incorporate isotopes, land use, and offline transport modeling with strong interactions with AMWG.

Areas of challenge in software engineering for the BGCWG are how to bring together the coupled component models and the biogeochemistry model and how to tune the models for interactive carbon and climate. There is also the science issue to investigate of carbon nitrogen causing feedbacks. Other challenges are the POP2 migration of tracers and ecology, not having an offline transport model, and using a sophisticated ocean convection scheme, which has not been done before.

Paleoclimate Working Group. Esther Brady reported that the PaleoWG science priorities are transient simulations of past climatic transitions, abrupt climate change simulations, warm greenhouse gases (GHG), and climates (LPTM, Cretaceous-Tertiary (KT) boundary); and new capabilities including dynamic vegetation model (DVM), dust, an ice sheet model, and biogeochemistry models.

The PaleoWG challenges are transient orbital forcing of past climates, ocean spin-up techniques for past GHG climates, and need for long control runs with new capabilities, such as DVM and dust plus aerosols. There are also challenges in the need for personnel and computing time, large uncertainties to data sets through sensibility studies, ocean spin-up techniques, and longer control runs with new capabilities to understand biases.

The PaleoWG software engineering priorities are to support paleoclimate initial data set creation tools, to support paleoclimate output data management, to code modifications for transient forcing simulations, and to implement an ice sheet model into CCSM3.

The PaleoWG is involved in the PMIP2 experiments in the mid-Holocene and LGM with many university collaborators. The group also plans to study the warm events in the deep Paleo Permian. This simulation is complete, and the data will be released to the community.

Software Engineering Working Group. Mariana Vertenstein reported on the priorities of the SEWG. A large effort is being placed on enhancing interoperability in both inter-model component communication and intra-model communication between different functional units (e.g., physics<-> dynamics coupling in CAM). Another priority is to increase software and scientific extensibility by providing enhanced data model functionality and the capability to easily exchange new fluxes/tracers between components. Focus is being placed on performance optimization on a select set of computer architectures with the associated goal of running at higher resolutions and saving information more frequently. Finally, improvement of the software engineering infrastructure will be achieved by the migration to a new revision control system and incorporating a new bug tracking system.

The SEWG has had to sharply reduce its community support due to fewer software engineers working on the project. Some positive steps forward are implementing a

lightweight design review process, improving tests suites in CCSM and CAM, moving toward improved software design (new code now includes layering and use of interfaces), moving toward incorporating well-defined, standard interfaces where appropriate, moving toward some script/build standardization, improving communications, and putting time lines in place to facilitate planning and priority setting.

3. **Discussion of Science and Software Priorities.** Collins summarized the working group issues as (1) coordination of intermediate releases (tropical variability task team, CPTs, working groups, etc.); (2) AMWG needs human resources, will transition to finite-volume dynamical core, and may propose a new radiation scheme; (3) OMWG needs more computing power, (4) LMWG is doing carbon cycle experimentation, needs computing resources for transient land cover change, and needs additional scientific and software engineering support for high-resolution CLM, VIC model; (5) PCWG needs additional human and computing resources and would like to see changes in coordinating runs across the project; (6) BGCWG is exploring feedbacks in a coupled carbon climate system, possibly adding regional climate modeling, coordinating a long control coupled run, looking at better advection schemes, and will need software engineering support to move beyond T31x3 to a higher-resolution model; and (7) PaleoWG needs 5 person-months of software engineering support. Collins said he would continue to discuss the challenges of the working groups with the CAB and NCAR management. It was suggested that the SSC look into additional computing time at Oak Ridge on the Climate Endstation, Japan's Earth Simulator, NASA/Ames Altex, and PACI centers (Linux cluster in Illinois). Collins also stated that CCSM needs to limit the number of computing platforms that it runs on so that the software engineering support team is not spread too thin.

Collins thanked the working group co-chairs and others for their reports, and he stated that the information would be used to help respond to the CAB about questions of university participation. Collins also thanked the Access Grid operators for helping to make the meeting possible via Access Grid.

4. **Update on Santa Fe Project and Formation of Chemistry-Climate Working Group.** Jean-Francois Lamarque reported on the Santa Fe (Scientific Analysis of Nitrogen Cycle Towards Atmospheric Forcing Estimation) Project, stating that the goals to identify the importance of nitrogen deposition on the carbon cycle during the 21st century under the A2 IPCC scenarios and to use a variety of climate and atmospheric chemistry models (coupled and uncoupled chemistry) to define a range of estimates have been completed. A manuscript that compiles and analyzes the results from 28 simulations from 6 different groups (GISS, Hadley Centre, IPSL, MPI-Mainz, LLNL, and NCAR) is under revision for JGR. The group is now using the CLM-CN to estimate the increased carbon uptake. In particular, Peter Thornton has done experiments on transient responses to changing CO₂ and nitrogen deposition. Ultimately they plan to force the climate model with the updated CO₂ concentration and repeat the experiment in a coupled (land-atmosphere) model (transient simulation). The third Chemistry-Climate Interactions Workshop was held in February 2005, and it helped to define a project to identify the stability of Earth's albedo.

Peter Hess discussed the future plans for a CCSM Chemistry-Climate Working Group, stating that the motivation for this working group is that climate chemistry does not fit well into any of the other CCSM working groups. The initial focus will be climate-chemistry problems involving the middle atmosphere, tropospheric aerosols, air quality in a future climate, feedbacks between chemistry and the land surface, and paleochemical studies. The first planning meeting for a CCSM Chemistry-Climate Working Group will be held on Monday, June 20, 2005, before the CCSM Workshop. McKenna agreed to identify a Chemistry-Climate Working Group liaison and software engineer working in ACD.

Bill Large asked if there were too many working groups already and if the SSC should be expanded to include someone from this new working group. One suggestion was that CCSM could eliminate existing working groups or merge them together.

It was asked what new resources would be brought to CCSM for the new working group. Hess stated that more outside community scientists would be entrained into the project. Danny McKenna stated that ACD would bring funds to help expand CCSM into chemistry-climate because it needs working group status to argue its future with NCAR management, ACD is using the CCSM already to address scientific problems, offline transport CAM will be the next MOZART, and the MOZART software engineering efforts will now go to CAM.

Large said that the chemistry-climate research would need much coordination across working groups, and the SSC must address how this will be coordinated. Collins stated that CCSM is committed to adding chemistry-climate to the CCSM because of the switch to the finite-volume dynamical core, and he stated that chemistry is a large part of the future growth for CCSM.

The SSC agreed to form a CCSM Chemistry-Climate Working Group, and appoint the co-chairs to be Peter Hess, NCAR, and Michael Prather, University of California, Irvine.

5. **Update on International Postdoctoral Network Workshop.** Natalie Mahowald discussed this workshop that will be held following the CCSM Workshop in Breckenridge. The goals of the workshop are integration of postdocs; inclusion of chemistry, biogeochemistry, and humans; and a need to find experts with some time to devote to scientific projects. There are 30 to 50 postdoctoral invitees with 5 to 10 from developing countries. The funding for the workshop came from NSF, AIMES core office, and ASP. Germany, France, and United Kingdom are adding funds by sending their postdocs to the workshop. The agenda topics are Human Earth System Interactions, Using Models of Different Complexities, and Future Planning that will identify leaders of the group and include more postdocs on the project committee. Some of the postdocs will be attending the CCSM Workshop also in the hope to entrain new and more postdocs. Collins requested that Mahowald keep the SSC up to date on how the postdoc network will interact with CCSM.

6. **Working Group Leadership.** Several new working group co-chairs were appointed, and a few will rotate off as a co-chair of their working group. Rick Smith, OMWG, was reappointed; Elizabeth Hunke and Marika Holland were reappointed as PCWG co-chairs;

Phil Rasch was reappointed as one of the AMWG co-chairs; David Lawrence, NCAR, was added as a new co-chair for the LMWG; Bette Otto-Bliesner will rotate off as PaleoWG co-chair and Zhengyu Liu, University of Wisconsin, Madison, was appointed as a new co-chair; Michael Alexander will rotate off as CVWG co-chair and Sumant Nigam, University of Maryland, will become the new co-chair; Natalie Mahowald was reappointed as a BGCWG co-chair; Warren Washington and Ben Santer were reappointed as CCWG co-chairs, and Peter Hess and Michael Prather were appointed as CCSM Chemistry-Climate Working Group co-chairs.

Large suggested staggering terms of co-chairs, and Collins said he would discuss this with Anthes, Killeen, and Fein.

7. **10th Annual CCSM Workshop.** Collins reported that registration is open, this year's theme is Crosscutting Science Using CCSM, and it will be at The Village at Breckenridge. Jay Fein and Dave Bader will receive the 2005 CCSM Distinguished Achievement Award, and Tim Killeen will present the awards to them at the workshop. Collins will prepare his overview (including major accomplishments, impacts of special journal issues, where we stand today, and near-term future plans) of the CCSM project early and send it to the SSC for comments. A few plenary speakers are still undetermined, and Collins asked SSC members to volunteer to serve as plenary session chairs. Collins also requested two SSC members volunteer to be on the travel committee.

The topics of the CAB meeting at the workshop will be university participation in developing CCSM, impact of level funding, institutional plans for ESM, and broader opportunities within NCAR for enhancement of the project.

The topics of the SSC meeting will be periodicity of workshop, tropical biases workshop report by Ed Schneider, COLA, resource and computing issues, coordination of the CCSM project, prioritization of working group work discussing what is the highest priority and where we are going as a group.

8. **General Discussion of Computing.**

Near-Term (1 year) Plans of SCD. Using a presentation provided by Tom Bettge, SCD, Collins reported that blackforest was decommissioned, and a linux cluster that is 40% faster than bluesky and 60% capacity of blackforest has been added. The target for sustainable computing will be 1 to 1-1/2 teraflops in 2006. The challenges in achieving this 2006 goal are capability vs capacity, SCD is on a fixed income and has asked NSF for additional funds, and capability costs more. A computer resource figure from the CCSM Business Plan was used for SCD's short-term planning. The SCD Strategic Plan can be accessed at www.scd.ucar.edu.

Update on CRIEPI Collaborations, Earth Simulator Use in FY05, and Petascale Computing Initiative. Frank Bryan reported that the CRIEPI/NCAR/LANL/Kyushu consortium proposal was combined with the CCSR/NIES proposal to the Earth Simulator for additional computing time (with combined award of 7% of ES, 2.5% of which has been

allocated to the CRIEPI led team). He reported that CRIEPI wants to do a few additional overshoot and stabilization scenario simulations with the IPCC version of CCSM3 on the ES. A 50-year WACCM run is in progress and is running somewhat efficiently, and a 50-year run of the 1/10-degree ocean model is planned. Bryan also advised the SSC that CRIEPI will upgrade its own supercomputing resources in Fall 2005 (24 SX8 nodes), which will give CRIEPI the equivalent of 1.5 times the allocation they have this year on the ES. CRIEPI's internal computing resources do not use a formal allocation process. CRIEPI wants to do more biogeochemistry research, and it is possible that CCSM will have direct access to NEC computers since CRIEPI now has its own.

Bryan reported on the Petascale Computing Initiative. He stated that a report articulating the needs for capability-class computing resources across the geosciences, and a technical prospectus describing a possible scenario for closing the gap between these needs and what is currently available to the geosciences research community has been completed by an Ad Hoc committee. A briefing was given to Dr. Margaret Leinen on April 19, 2005, with a recommendation to pursue a NSF MRE of \$390 million over 6 years in 2 phases. In 2007-2010 two or three 50 to 100 Tflop systems will be added including a data center, and from 2010-2012 a 1 Pflop peak system will be added.

Bryan also reported that UCAR and the ES center are in the process of writing a MOU for potential collaborative projects with ES center scientists.

Update on Climate Endstation. John Drake discussed Oak Ridge National Lab's plans for additional computing resources. They upgraded the Cray X1 to 6.4 Tflops in April 2005, and they will upgrade the Cray X1 again to 18.5 Tflops in September. In August 2005 they plan to install a Cray XT3 with 25 Tflops, and they hope to upgrade the Cray XT3 to 50-100 Tflops in 2006 subject to funding.

He briefed the SSC on the DOE computational climate endstation that will improve the scientific basis of models, address national concerns and contribute to DOE's science mission (e.g., regional climate change, carbon and biogeochemical cycles), proposals will be peer reviewed, and milestones will be accomplished through the endstation development and proposed experiments. It will be based on CCSM and supporting frameworks with overlap between the SciDAC CCSM Consortium and NCAR's software engineering group. Remote access and analysis will be through the Earth System Grid (ESG). Proposal announcement will be issued 1 June 2005 with proposals due 15 July 2005. An integrated proposal with a theme, such as primary influence on climate change (e.g., physics that affects feedbacks and some physics and some climate change) and increasing resolution to T170 should be sent with CCSM/DOE/university participation. The CCSM/DOE proposal will be competing against other disciplines, but climate is at the top of the list for use of the endstation.

Bonan suggested a team prepare a proposal to craft a set of experiments that look at climate change in coupled chemistry and carbon. Large stated that we must be ready to run immediately, and a plan to manage and use all of the time allocated should be done.

9. **Response to CAB Letter.** Collins reported that the CAB has asked for information on how level funding will impact CCSM's future plans and how much university participation is included in CCSM's development.

The CCSM Business Plan (2004-2008) has 22 positions identified and in April 2005, 18 are unfilled. We cannot continue with the sustainable level identified in the plan or even catch up due to reduced budgets. This budget reduction also impacts the hiring of new early career scientists to take over climate modeling research and development when others retire. Collins reported that in 2005 AMWG support was temporarily reduced; software engineering support for terrestrial sciences was reduced on isotopes, land cover change, river routing, hydrology, and high-resolution land modeling; and software engineering positions were reduced on code development, numerical methods, and atmospheric dynamics. Also, the loss of a program manager eliminates the support of CSL proposal writing, reporting, and oversight. CCSM will decelerate its forward progress due to these impacts.

Large stated that there are several risks due to the funding impacts, which are that each working group will deal with their loss of staff differently and this will defocus the project as a whole, more burnout, more loss of key personnel, and other modeling centers will go ahead of CCSM. Large stated that the SSC must prioritize and advise the working groups how to proceed.

Bitz asked how the ASP program was helping to entrain postdocs into CCSM. Collins stated that many ASP postdocs had contributed to CCSM.

Collins stated that the next CCSM Business Plan written should include DOE/NASA/NOAA funding projections.

Regarding university participation in CCSM development, Collins reported that CCSM has many healthy university collaborations. Bonan asked how we would be able to maintain these collaborations because they have new ideas and initial testing needs, and a person at NCAR will need to coordinate and integrate the new work into the model. Collins will draft a slide for presentation to the CAB early and circulate it to the SSC on university participation, probably using the land and ice information from the co-chair reports above.

10. **Open Discussion.** Fein requested an update on the work of the CPTs because the last 2 years of funding for them is being discussed among agency managers. Fein also requested information on clouds and water cycle projects.

There was a discussion of how CCSM could better manage its CSL allocation across working groups so that no allocation is lost. Because of the way it is allocated per working group per month, it is difficult to achieve 100% utilization because some groups have only a few people submitting jobs and they have teaching and other responsibilities also.

There was a discussion about adding regional climate modeling to CCSM. Fein and others stated that CCSM scientists are already overloaded and that the addition of regional modeling capability cannot be added without additional human and computational resources.

It was suggested that WRF scientists update the SSC on future plans, and it was also suggested that Greg Holland, new MMM division director, be invited to the SSC.

Fein reported that the agency managers that make up the Interagency Climate Modeling committee have decided not to meet with Jim Mahoney regarding the need for a national modeling plan until they can propose such a plan for the CCSP's reaction.

Fein requested a statement of what is needed for CCSM to participate in IPCC AR5. Doing less than we did in AR4 was suggested to offset reduced funding impacts.