

Report of the First External Advisory Panel
for the
National Science Foundation Science and Technology Center
Center for Multi-Scale Modeling of Atmospheric Processes

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1. Introduction

The CMMAP External Advisory Panel (EAP) convened in Fort Collins September 24th-25th 2007 to review progress to date and, on the basis of assessing that progress, provide advice to CMMAP management. We gave an overview of our recommendations to management at the Fort Collins meeting; this report represents an expanded summary of our advice. We begin by discussing the center's research objectives and go on to cover education and outreach, diversity, knowledge transfer, resources, and management issues.

2. Research Objectives

We recognize that CMMAP is in its early years and that we saw only a snapshot of the research underway. We agree that the blending of modeling and phenomenological analyses is a good strategy for the coherence of the project, but it is a challenging one. That said, the links between the two were not made clear at this meeting. Given that next year the project will be approaching its critical 3-year review, we would like to see at the next meeting of this Advisory Panel a deeper and clearer discussion of this strategy and the specific progress that has been made. Two specific examples:

- 1) Diagnostic evaluation of model simulations using observations and phenomenological analyses, showing how well the MMF framework reproduces the diabatic forcing (radiative and latent) for different cloud regimes.
- 2) Progress towards the objective related to the development of improved parameterizations from the MMF framework: for instance: can the MMF provide guidance about how different physical processes influence the subgrid-scale variability of atmospheric variables such as total water, vertical velocity, etc. That would be very useful for the improvement of cloud statistical parameterizations (cf Proceedings of the ECMWF workshop on Cloud parameterizations in large-scale models). Ways to evaluate these relationships using atmospheric data (e.g. high-resolution satellite data or data from ground-based sensors) should be explored as much as possible.

We believe that CMMAP should provide open access to selected MMF datasets for further diagnostic analysis, in the spirit of the IPCC open access. This would serve both the needs for deeper independent analyses and insight, as well as further knowledge transfer.

We recommend more diagnostics to understand and document the role of microphysical, turbulent and other parameterizations within the MMF. Land-surface coupling issues are also important and should also be addressed, since the cloud-coupling issue is central to satisfactory solutions for the evolution of the convective BL over land.

We advise that coupling to an ocean model should perhaps be deferred until progress has been made in understanding the tropical cloud feedback issues, MJO dynamics etc., and certainly until researchers are satisfied with the surface energy balance and surface cloud forcing from the MMF. Climate modeling as such is not the

primary focus of CMMAP. On the other hand, the understanding of certain atmospheric processes may be enhanced through coupling with a simple, slab ocean model.

The aquaplanet idealized simulations are encouraging and should be carried further to simplify the analysis of the physical processes that dominate climate change cloud feedbacks (especially those related to boundary-layer clouds), and to better understand why climate sensitivity differs between MMF and traditional GCMs.

We strongly endorse the participation of CMMAP in CFMIP (the Cloud Feedback Model Intercomparison Project), since the analysis of the MMF results - as well as other CMMAP activities focused on low-cloud feedbacks - are likely to help the GCM community assess the credibility of cloud processes simulated by GCMs in the present day climate, and in general to better understand cloud feedback processes in climate change experiments. The participation of the MMF in CFMIP2 coordinated experiments and analyses is thus strongly encouraged.

3. Education and Outreach

CMMAP has an impressive K-12 education program that combines in-school activities (the Little Shops of Physics), teacher training, and web-based resources (in collaboration with UCAR Windows to the Universe). This successful program should be expanded by making it available to more schools over a wider area and by sharing CMMAP's experience with similar educational programs around the country. In this regard, the program benefits to the students need to be objectively demonstrated. This could be done through carefully designed experiments and statistical analysis, possibly in collaboration with other departments at CSU.

The material used in the K-12 program should be made widely available and easily transportable. It is also important to actively gather feedbacks from K-12 teachers and to improve the material accordingly.

Climate science could also be promoted at the high school level by lobbying for its inclusion in placement tests and in state science standards and testing.

CMMAP has the expertise in both education and research to provide strong educational material for undergraduate students. An advanced version of the Windows to the Universe comes to mind; this would support independent inquiry by discussing current issues in atmospheric and climate sciences.

The faculty forum ChangingClimates at CSU is a very interesting and innovative effort in starting a university-wide discussion on climate change, and could provide a new model for how universities can address complex societal issues such as global warming. It has many potential benefits for CMMAP itself and should be supported as much as possible.

Ethics

The climate change issue has broad ethical implications (far beyond the obligatory NSF professional ethics issue) and these are of fundamental importance to the training of graduate students, the recruiting of a diverse mix of students, to the

broader K-12 educational framework, and to the trust that society places in scientific guidance. We recommend that CMMAP embrace this issue fully, and perhaps use the CSU “Changing Climates” and summer programs for graduate student education as initial forums for developing ideas.

With incomplete understanding of the consequences of climate change, we are faced with a wide range of choices on the basic energy structures of our economies, which need broad, thoughtful public discussion as they will determine future climate change. Very few outside the sciences understand earth system science, yet traditionally scientists have not viewed it as their responsibility to discuss societal issues. This has to change if we are to have an informed debate. The next generation of graduate students in atmospheric science needs new skills and understanding to face this challenge; and awareness of these deep issues should permeate educational outreach. The challenge is to maintain the fundamental integrity of the scientific method, while expanding beyond the traditional walls of science to interact more broadly with other disciplines as well as with society at large.

4. Diversity

The panel was pleased with the range of CMMAP’s efforts to increase the diversity of participation in its activities. We have a few suggestions for improving and building on some of these efforts.

While the SOARS program is a good way to involve minority students in CMMAP activities, there is clearly some unhappiness on the part of both the students, who may feel disconnected from CMMAP’s main activities, and the faculty mentors, who understandably feel strained by the advising burden that their mentorship requires. Both these problems could be alleviated by appointing “assistant mentors” in the form of volunteer graduate students and/or postdoctoral fellows who would work with both the faculty mentors and the SOARS students. This could make mentoring considerably more attractive to faculty and would also involve more CMMAP personnel in SOARS.

CMMAP should also consider a more aggressive recruiting strategy, by advertising in physics and mathematics departments at institutions with high minority enrollment, such as historically black colleges. It could also help to identify specific issues that would attract minorities to the atmospheric sciences. An example might be ethics issues as discussed above, and the societal implications and policy considerations of anthropogenic climate change.

Attracting qualified minorities and women may be enhanced by providing an attractive working environment. For example, the easy availability of day care would make CMMAP more attractive environment for many female employee candidates.

Finally, we recommend that CMMAP take concrete steps to develop better and more quantitative metrics of progress in its efforts to increase diversity and of its influence on the greater community.

5. Knowledge Transfer

CMMAP is engaged in or has plans for a variety of activities that serve to enhance the propagation of scientific and technical knowledge to the broader community. Here we summarize some of these activities and provide some advice on how/whether to proceed; we also have a few suggestions for other possible ventures.

a. Journal of Advances in Modeling Earth Systems (JAMES)

CMMAP proposes to establish a new online journal, with the provisional title of *Journal of Advances in Modeling Earth Systems (JAMES)*. While there are a number of formal, print journals that deal with global climate modeling issues, the proposed journal differs from these in being open-access and by including a review or summary feature whose content would be digestible by the informed public, including policy makers, educators, etc. These two new features make JAMES an attractive proposition and a desirable product for an NSF science center. We have several comments and suggestions on the proposal:

We are concerned about the potential cost and manpower burden of operating a journal and encourage CMMAP to consider ways of minimizing both while at the same time minimizing production time. The CMMAP team presented some options and we favor those that are comparatively low cost. We discussed ways of curtailing costs and production time, including foregoing copy-editing and using guest editors rather than relying on a large in-house editorial staff. Low production time and publication cost would both be strong incentives in attracting authors. On the other hand, CMMAP might consider creating a parallel web site (or blog) for active, online discussion of articles. We regard it as essential to maintain an accessible archive of past articles. Finally, we enthusiastically endorse the idea of publishing review articles and also recommend that the team consider writing (or asking authors to write) laymen's abstracts or executive summaries for each article that would be published, BAMS-style, in a separate front section.

b. Book on the history of global modeling: "Complexity, Synthesis, and Computation: The Development of Atmospheric General Circulation Models".

We are happy to see CMAAP engage in this project. Some thought should be given to broadening the scope to include climate change issues and the global energy and water cycle; since one intent is to address the concerns of the policy community. If it is not too late, a chapter on the future of climate modeling might be considered.

c. Other knowledge transfer possibilities

CMMAP should consider inviting journalist interns who would be in residence for several weeks to as much as a year. This might greatly help with the communication of climate science to the general public. Such interns would participate in CMMAP group activities, attend seminars, and listen in on appropriate classes, as well as interact directly with CMMAP scientists. The Knight Journalist program is one successful example of such internships.

6. Resources

The original proposal contained a \$1M investment for a large cluster (1K processors). This is still an important component of the center for code development, exploratory runs and analysis. CMMAP should aggressively pursue opportunities like an NSF MRI grant to CSU to provide this component as a locally controlled resource. This would not be a new computer center, but rather a center level resource to support the projects objectives (including education support). The high end simulations will require allocations on high end petascale machines and the CMMAP should begin to form relationships with the NCSA (Illinois) and NSF Track 2 centers. Showing up early with a scalable, high-value science application will increase the chances for ample future allocations and remove computing as an obstacle to progress of the center's research agenda. The cluster should support model development of prototype and exploratory simulations as well as offering sufficient numbers of processors to deal with modest scalability of the algorithms and codes being developed.

Analysis of the large-scale simulation results will be the critical element in understanding how scale interactions work; thus the analysis framework is a critical component of the project. A dedicated computing infrastructure should support the analysis framework by developing and supporting tools and making available the standard datasets. A backup plan at SDSC with supporting archiving should also be continued as a project/center alliance. The primary purpose of a local system would be for data analysis. It could also be beneficial in providing a stable and dedicated environment for model development and prototyping. The human infrastructure, through addition of computer science and software engineering expertise, should also be developed locally. This will ease the burden on the scientists of the project of developing scalable application codes, as well as provide the expertise to quickly port codes and analysis frameworks to high-end platforms like the NSF Track 1 and 2 systems. The center does not want to waste time doing too much porting, so attention to general software structures early on and developing some human infrastructure/expertise locally, will facilitate the use of external NSF and DOE resources.

7. Management

For the next year, the primary management challenge will be to nurture scientific progress towards results that will feature prominently in the 2009 review. For a strong showing at the review, a few significant simulations with preliminary analysis of results yielding notable advances should be pursued. The CMMAP management should adopt an aggressive strategy for accomplishing scientific milestones before the 2009 review. The pace of ongoing work looks like it will yield substantial results, so maintaining and focusing the management vision and momentum is what is required. With the interesting developments of campus participation in the center's activities and the effort required to pursue proposals for infrastructure development there may be distracting forces that will require management prioritization and focus on the central goals and objectives.

One of the questions that was posed for the advisory panel was how to leverage new opportunities and, in particular, whether to pursue private sector funding. The advisory panel believes that the strengths and uniqueness of the CMMAP activities

make it attractive to private interests. This is particularly true as the broadening interest in the role of science, societal impacts and larger ethical questions are explored at CSU in conjunction with CMMAP. The Pew Trust was specifically mentioned as a potentially interested private party.

Other NSF and DOE SciDAC projects are currently being leveraged and the management is encouraged to continue its efforts to coordinate and collaborate with these projects. The Global Cloud Resolving Model (GCRM) collaboration could be utilized to provide a basis for evaluating super-parameterization approaches as well as the new Q3D models under development. The common analysis framework for examining and comparing cloud processes in the simulations can easily be leveraged to the benefit of all the investigators. Insights and even formal parameterization approaches based on high resolution models of limited area may also be available from other projects such as the WRF simulations and the Japanese cloud resolving studies. Other high-resolution simulations are in the works at GFDL that will inform tropical cyclogenesis as well as cloud and boundary layer processes. The opportunity to leverage findings from these projects should be explored through the partnering institutions.

The schedule of CMMAP activities over the last year indicates a staff that is fully engaged and working to make the center a success. The revisions of the strategic plan and the web reporting mechanism seem to have had nominal success as tools to keep the effort on track.

The NSF reporting obligation should be viewed as a framework for managing the project. The advisory panel found that the reporting structures were excessively hierarchical. While the specificity of required goals, objectives, actions and metrics is admirable (and required in a Strategic Plan), the cumulative efforts and results can better be understood through progress on the major themes of the center. In order to improve the process of hierarchical reporting required by NSF, a way must be found to gather more than a "pile of words". We suggest that reporting teams be responsible for writing the sections of the report and for accounting for how the metrics have been met through discussions with the responsible task leads. A more balanced and understandable process may emerge from aggregating the information at a higher level in the hierarchy while not burdening one or two with the job of making it all make sense. In addition, the management of CMMAP needs to think ahead, past the reporting requirements, and develop a better strategy to blend top-down and bottom-up management to creatively help teams overcome obstacles and keep them on task as well as to track metrics. The herding of cats can, in some instances, be replaced by teams pulling together to accomplish challenging goals.

8. Summary

The External Advisory Panel congratulates CMMAP on a very fine first year. We believe that the organization has made great progress in its first year and is well positioned to make substantial advances towards its objectives. The advice given in this report is meant to encourage steps to build on the success of an already strong program. The EAP looks forward to following the progress of CMMAP over the coming years.