

Response to the 2007 Report of the External Advisory Panel

For the *Center for Multi-Scale Modeling of Atmospheric Processes*

Submitted to the EAP by the CMMAP Management Team

Response finalized in September 2008

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1. Introduction

The CMMAP External Advisory Panel (EAP) convened in Fort Collins on September 24th-25th 2007 to review progress to date and to provide advice to CMMAP management. This document is a Response by CMMAP to the advice of the EAP, summarizing our thoughts and also what we have done during the year since we received the advice. We briefly summarize the EAP's comments (**in Ariel Bold red**), and then give CMMAP's response. Additional details will be available in response to questions from the EAP during its 2008 meeting.

2. Research Objectives

Explain strategy for combination of model development and phenomenological analyses

As a reminder, CMMAP's main research focus is model development. The CMMAP models include two CRMs (SAM, the "legacy" model, and VVM, the "Vector Vorticity Model" of Jung and Arakawa (2008), which is our focus going forward); three MMFs (the "legacy" SP-CAM and the geodesic Super-BUGS at present, and the Quasi-3D MMF under development); the global cloud-resolving model (GCRM) under development; and two conventional GCMs (the CAM and CSU's geodesic GCM).

The eight Research Objectives listed in CMMAP's Strategic Plan are mostly about model development, including model evaluation. Here the main foci at present are the Quasi-3D MMF and the GCRM, including both their dynamical frameworks and their physical parameterizations.

Collaborative activities within the Center are organized around five Research Themes, however. Two of these (Dynamical Framework and Physical Processes) are explicitly about model development, two are about applications (MJO and Low-cloud feedback), and one is about the Cyber-Infrastructure needed to support our modeling activities.

The table below summarizes linkages between the four CMMAP models, listed along the top row, and the five CMMAP Research Themes, listed along the left column.

All four models can use the "Unified System" and the "Vector Vorticity" dynamical framework. Our model development activities are aimed at these outcomes, and we are part-way there already.

All four models benefit from the improved parameterizations of microphysics, turbulence, and radiation that are under development by the Physical Process Theme's Working Group.

The MMF, GCRM, and GCM are, in principle, all capable of producing MJO simulations, although in its present form the GCM does not actually do so. The CRM can be used as a relatively inexpensive testbed for ideas used in MJO simulations with the other models.

Low-cloud feedback is being studied using all four of the models.

Finally, the CMMAP Cyberinfrastructure is useful to all four modeling activities. We currently have output from both the CRM and the MMF in the Digital Library. We expect to archive output from the GCRM and the GCM later in 2008.

	CRMs	MMFs	GCRM	GCMs
Dynamical Framework	Unified system VVM	Unified system VVM	Unified system VVM	Unified system VVM
Physical processes	Improved parameterizations of turbulence, microphysics, and radiation			
MJO	Cloud process diagnostics	Forecasting Climate runs Numerical experiments	Forecasting	MJO simulation with improved parameterizations
Low-cloud feedback	SCM	Aquaplanet	New turbulence parameterizations	New parameterizations of PBL clouds
Cyber-Infrastructure	HPC Digital Library Visualization & analysis			

In May of 2008, the NSF Site Visit Panel suggested that CMMAP shorten and prioritize its list of Research Objectives. In response, we have combined into one our three separate objectives on development of parameterizations for cloud-resolving models (microphysics, turbulence, and radiation), thus reducing the number of research objectives from 8 to 6. In addition, we identified our top priority research objective as development of the Q3D MMF and the global cloud-resolving model, and our second priority as development of improved conventional parameterizations.

This reorganization of our research objectives does not affect the table above, except that it improves the correspondence between the “Physical Processes” Theme and the research objective on development of improved parameterizations for CRMs.

Open access to MMF datasets “in the spirit of IPCC open access”

We have created a CMMAP digital library system at the San Diego Supercomputer Center. This archive will contain not only MMF simulations, but also results from other large calculations, including GCRM runs and other large-domain CRM runs. At present, the archive contains results from our AMIP run with the Super-CAM (Khairoutdinov et al., 2008). We are currently transferring to the archive the results of a large-domain LES of deep convection. Additional runs will be archived in the future.

Access to the results in the archive will be limited to CMMAP researchers until the initial papers have been written.

Following publication of the initial papers, the results will be made available to the larger community, via a web site, in the same way as CCSM results (<http://www.cesm.ucar.edu/experiments/ccsm3.0/>).

CMMAP cannot provide much in the way of support for individuals wishing to use the data, however. We do not have, and cannot afford to create, an infrastructure comparable to that of the CCSM or of PCMDI.

Several model-output datasets are already available through the digital library. More will be added as they are created.

Add diagnostics to document the roles of parameterizations within the MMF, including land-surface coupling

We are preparing two more experiments with the 3D CRM, one with and one without momentum transport. In preparation for these, we have prepared extensive new diagnostics. These experiments will be run in late 2008 or early 2009. Computer time has been requested from NCAR for this purpose.

We are eager to study land-surface coupling with the MMF. Such work will be most fruitful after the land-surface model has been incorporated into the CRM. During this past year, we ported SiB 3 to SAM, the CRM which is used in the prototype MMF. We also plan to couple SiB3 to the VVM.

Defer coupling to an ocean model

For reasons described below, we are pursuing coupling with a dynamical ocean model.

In preparation for coupling, we are actively evaluating the simulated surface energy budget and surface wind stress pattern, and will submit a paper on this work for publication later in 2008. This diagnostic work is revealing previously unrecognized strengths and weaknesses of the MMF. We are also doing some sensitivity experiments in preparation for tuning the MMF; realistically, any coupled ocean-atmosphere model has to be tuned, and the evidence to date suggests that the tuning needed by the MMF is similar in nature to that needed by conventional GCMs, i.e., it relates mainly to the shortwave cloud forcing (Gleckler et al., 1995).

Once this work has been done, we want to use the MMF to explore the nature and strength of the interactions between the MJO and ENSO. This has been a controversial topic over the past decade (e.g., McPhaden, 1999). Our approach will be to run the MMF coupled to POP, the ocean component of the CCSM, using the CCSM coupler. Here it is important to point out that the ocean model actually adds very little to the total magnitude of the computation. The standard CCSM, which does not produce an MJO, does produce an ENSO cycle, but the simulated period and amplitude are different from those observed

(Deser et al., 2006). Comparison of the standard CCSM results with those of an experiment in which the MMF is substituted for the CAM can shed some light on the role of the MJO in regulating ENSO.

In the planned experiment, we are not simply coupling the MMF with the ocean model for the sake of doing so. We are using the MMF to explore important air-sea interactions that occur on time scales of years to decades -- time scales that are readily accessible with the MMF, as demonstrated by our 19-year AMIP run (Khairoutdinov et al., 2008).

Two lines of activity are ongoing. First, Charlotte DeMott of CSU is near completion of a study on the surface energy and momentum fluxes produced in the MMF's AMIP run. This study will provide guidance for tuning the MMF for coupling.

Second, Cristiana Stan of COLA has performed and is analyzing a three-year simulation with the MMF coupled to POP. This activity was undertaken by COLA without funding or computer time from CMMAP, but we are of course keenly interested in the results.

Continue Aquaplanet work

We have been doing Aquaplanet studies for several years, and will continue to do so. We will work to strike the appropriate balance between Aquaplanet simulations and Earth simulations that use realistic boundary conditions. More information will be presented at the 2008 EAP meeting.

Participate in CFMIP2

CMMAP plans to participate in CFMIP 2. D. Randall, M. Khairoutdinov, and C. Brertherton participated in the CFMIP 2 meeting in Toulouse, June 2008.

3. Education and Outreach

Availability and transportability of K-12 material, and teacher feedback

We are developing very thorough documentation of K-12 curriculum enhancement material, and disseminating it through a variety of widely-accessible media. To date, we have published over 30 inquiry-based activity kits on weather and climate science suitable for use in K-12 classrooms on our website. The downloadable pamphlets (which are PDF files) cover scientific background, learning objectives, itemized lists of inexpensive materials (and sources for their purchase), step-by-step instructions, questions&answers for leading classroom discussion, and expected outcomes. The kits are available freely on the web in both English and Spanish, and most are also demonstrated as part of our freely-distributed DVD series. The activities are also presented to over 50 schools each year, many of which are under-served schools in urban or remote districts with large minority populations.

Each summer, we offer a 2-credit senior-level course in Teaching Weather and Climate to about 40 teachers, which combines traditional content lectures with hands-on training using our curriculum enhancement kits. In addition to free tuition, two meals each day, and a stipend, every participating teacher receives all the materials for dozens of these kits as part of the course. Each teacher then develops written lesson plans for formal evaluation, and tests the material in their classroom during the following school year. Teachers provide written feedback to CMMAP education professionals as part of this evaluation process, as well as lots of oral feedback during the course.

CMMAP sought and obtained private-sector support that made it possible for 20 additional teachers to take the training course. The support came from the Hach Scientific Foundation (<http://www.hachscientificfoundation.org/>).

Windows to the Universe continues to develop additional weather/ climate fun and games for kids, resources for teachers, and connections to arts, literature and culture sites relating to climate and weather. Content developed in the last year includes: cloud types, the cloud image gallery, atmospheric processes that are responsible for the development of different types of clouds, climate models, weather content, and art and culture.

These materials (web-based kits, school visits, summer course, DVD series) are advertised and promoted on the *Windows to the Universe* website, which is viewed by over 2,000,000 people each month (20% in Spanish). For example, CMMAP developed and implemented a 35-hour course for middle school students on “Clouds, Climate and Weather,” and is packaging and porting the course for distribution in the fall of 2008. All lessons will be available on the web. In addition CMMAP accepts requests from universities to train staff so that they can offer the course to middle-school students on their own campuses.

The program (LSOP) benefits to the students need to be objectively demonstrated

We are providing \$58 K of additional funding in this area for Year 3, and possibly for later years. The PI is Michael Lacy, Associate Professor of Sociology at CSU. He will involve other researchers as necessary.

Lobby for inclusion of climate science in state standards

We are acutely aware of the prevailing tendency to “teach to the test,” and thank the EAP for this helpful suggestion. In particular, we thank John Drake for providing contact information for relevant Colorado officials. A review shows that Colorado’s state science standards are already surprisingly strong in the areas of weather, climate, and water resources. That being said, they could certainly be stronger. CMMAP has expressed a willingness to work with the Colorado Governor’s office on this and other climate-related issues, but no substantive interactions have occurred yet.

Undergraduate education and support for the ChangingClimates initiative

CMMAP scientists have now developed an interdisciplinary undergraduate course in global climate change, three sections of which has been offered at Colorado College at

the Freshman level. The course spans physical and biological science as well as ethics, policy, economics, and engineering approaches to this important issue. CMMAP graduate students have the opportunity to visit CC for 3.5 weeks and actually teach this course each year, thanks to the innovative “block schedule.” We are now developing another freshman-level course at CSU on “*The Science of Climate Change*,” which will be offered each year by the Department of Atmospheric Science beginning in 2010. The university approval process for this class is underway, and it has already been approved by the Department of Atmospheric Science.

We have been very active as leaders in the ChangingClimates initiative at CSU, both as lecturers in the faculty forum and in planning for future infusion of climate change as an issue across the entire undergraduate curriculum at the University. We helped planned and participated in the Focus The Nation activities in 2008, which reached over 2000 CSU students and faculty. We are now planning a public lecture series for fall and winter which will feature high-profile speakers on all aspects of this issue, with travel and logistical support from the Center. We are also supporting faculty salary time for two faculty members in the English Department who will coordinate and further develop the initiative. As part of the ChangingClimates initiative, thousands of undergraduates in freshman Composition will learn expository writing using climate change “prompts” beginning in Fall 2008. CMMAP staff will participate in a Freshman Seminar course in 2008-2009 on climate change at CSU; D. Randall has already given one such lecture, in September 2008. He also gave an on-campus public lecture on climate change to 370 people on September 11, 2008.

CMMAP has provided funding to buy Prof. John Calderazzo out of a course, so that he can devote more time to the further development of ChangingClimates. In addition, CMMAP is funding travel support for speakers, logistical expenses such as meeting rooms, printing costs, and travel expenses. CMMAP’s ED managers assist with the ChangingClimate series, and with Focus the Nation.

CMMAP is providing substitute teacher pay so that 20 teachers can attend Focus the Nation, and also is working to develop and promote K12 lesson plans to support Focus the Nation.

We are preparing an REU proposal to NSF. In addition, we are planning to submit a proposal to NSF for the “Diversity in Geosciences” solicitation. We are also participating in the NSF STARS program, and hope to get \$25 K to support additional undergraduate interns in summer 2009.

4. Ethics

Climate change ethics and graduate students

At the CMMAP Team Meeting in January 2008, we sponsored a well-attended evening public lecture at UCLA by Professor Richard Somerville on the Ethical Implications of Climate CHange, which engaged a large community in a spirited

discussion. We plan to hold similar events at CSU and at other partner institutions in the future.

Our annual Graduate Student Summer Institute is a great venue for exploring these issues with our graduate students. Last year we sponsored a half-day forum on scientists engagement in the policy process at this institute. In 2008, we are inaugurating support for Professor Michele Betsill in the CSU Department of Political Science and one of her PhD students. She has written a prominent book on policy instruments for climate change mitigation, and we look forward to enhancement of our graduate students' opportunities in this area.

We thank Alan Betts for his offer to provide material on climate change ethics, and will gladly take him up on it!

1. Diversity

Hiring action

CMMAP's Diversity-related work, and also its undergraduate outreach, have been given a big boost by the hiring of Melissa Burt, an African-American former SOARS Protege who has an Master's Degree in Atmospheric Science from CSU. Melissa's scientific training allows her to interact with interns and other prospective graduate students on a technical level.

"Assistant Mentors" for Undergraduate Interns

For 2008, we have substantially improved the overall organization of the undergraduate summer internship program, combining elements of the SOARS, Colorado College, and Hampton University programs. We had eight summer interns this year. CMMAP provided housing and transportation, and social events for the interns. Each intern was paired with three mentors: a faculty advisor, who helps to choose and oversee the research project; a graduate student or research associate who works with the intern day-to-day and provides practical help with the research; and a community mentor, who will help interns adapt to life in Fort Collins and share in social events.

More Aggressive Recruiting from Minority-Serving Institutions

We have initiated a special relationship with Morehouse College and Spelman College in Atlanta (two historically black colleges) and hosted five prospective graduate students in spring 2008. The students visited CMMAP as well as a number of other graduate programs in the College of Engineering. One of their former students will join CMMAP in 2008, working with Wayne Schubert, and another will come to CSU in Mechanical Engineering. We look forward to building this relationship each year, and plan a recruiting visit in the fall.

We have also begin working more closely with Ms. Jodie Hanzlik in the CSU Graduate School, who is CSU's Associate Vice President for Graduate Affairs at the Graduate School, in the Diversity Recruitment and Retention Section. She oversees

multiple programs to promote diversity in graduate programs across the university. She will coordinate visits of CMMAP scientists in 2008 to Metropolitan State College in Denver (which has a large African-American population) and to CSU Pueblo (which has a large Hispanic population). We hope that these contacts will yield further increases of diverse students at the Center.

In addition, Melissa Burt is scheduled to make recruiting trips, with members of Jodie Hanzlik's staff, to Metro State, Ft. Lewis, Mesa State, Adams State, and CSU Pueblo, in October. CMMAP and Jodie Hanzlik's office have agreed to help each other with recruiting where opportunities arise.

We are reviewing our existing partnership with Hampton University, and will discuss this with the EAP at its 2008 meeting. Melissa Burt will be visiting Hampton in the near future.

Quantitative Metrics of Progress

We now track all CMMAP diversity activities: visits, email contacts, number of students attending our programs, number who follow up with phone or email contact; number who apply for internships or graduate school, etc. We will expand this tracking in the next year to include diversity promotion at the K-12 level and in undergraduate institutions.

2. Knowledge Transfer

JAMES:

- We are enthusiastic about open-access journal**
- Prefer low cost model; would consider doing without copy-editing**
- Consider guest editors**
- Try to achieve low production time**
- Review function is important**
- Maintenance of accessible archive is important**
- Consider parallel web site for discussion**

JAMES is now up and running, and has received 6 submissions as of mid-September 2008. We are aware of several more that will come soon. We expect to have our first two accepted papers and our first rejected paper approximately during the week of the 2008 EAP meeting.

Following the 2007 EAP meeting, a business plan for the journal was written. It addresses the comments of the EAP and incorporates most of their suggestions.

A low cost, self publishing model has been adopted. This involves a partnership with the Institute for Global Environment and Society to create a management structure for JAMES, and contracting with a low cost publisher for copy-editing and layout services. The bid from the selected publisher was sufficiently low to allow the journal to operate within a low cost structure.

Editorial and Advisory Boards are in place. Guest editors will be used as appropriate.

The journal's online format, automated peer-review system, and the fast publisher-turn-around allow rapid publication times.

In line with the EAP's recommendation, JAMES hosts a parallel online discussion forum, which results in almost instantaneous dissemination of submitted manuscripts. Public comment is invited while the manuscripts undergo formal peer-review.

Naturally, JAMES will provide access to an archive of all published articles.

Book:

Consider chapter on future of climate modeling

A book proposal has been submitted to Cambridge University Press. Reviews of the proposal were generally quite positive. A contract is now in place. Due to the enthusiasm of the reviews, it was decided in early 2008 that changes to the book's content, such as adding a chapter, were not appropriate.

General:

Consider inviting Knight and other intern-based journalists to be in residence

CMMAP should strongly consider pursuing larger issue of ethics of climate, e.g. social justice

The Knowledge Transfer Director and Manager looked into the Knight Internship program at other universities and discussed the possibility of implementing a similar CMMAP based program. Their investigations showed that most university-based Knight Internship programs are fairly broad in scope, in that interns enroll in a diverse range of courses and activities hosted by the sponsor university. CMMAP would not be able to offer a similar range of exposure to various disciplines. Our thought is that a Journalism Department would be a better sponsor of this type of internship program, with CMMAP being one of many science based activities available for interactions with the interns. CMMAP will suggest the idea to CSU's Department of Journalism and Technical Communication, to gauge their interest in initiating a such a program.

The suggestion to pursue larger issue of ethics of climate, e.g., social justice is excellent. The Center has an ethicist on-staff, affiliated with CSU's Philosophy Department, and will work with her to expand the Center's role in communicating with the public about ethical issues related to climate. We have already sponsored a well-attended public lecture on Climate Change Ethics at UCLA, delivered in January 2008. We are planning additional such work in connection with the ChangingClimates initiative at CSU.

3. Resources

Pursue cluster and other resources

We successfully proposed a DOE INCITE project, which provided 1.3 million cpu hours at NERSC during 2008. We have requested a continuation with 2 million CPU hours in 2009.

We have pending proposals for a total of 250,000 GAUs at NCAR.

NSF's most recent MRI solicitation required cost-sharing, which CSU was not in a position to provide. We submitted a pre-proposal to the MSI solicitation that was issued by NSF Atmospheric Sciences. It was declined. We will continue to pursue resources for a large cluster at either CSU or SDSC, or possibly both.

We have joined with NCAR and COLA in submitting to NSF a proposal to prepare for using the Track 1 system to be installed at NCSA.

Computing infrastructure

We are looking for additional funding to support "human infrastructure." In the mean time, we are using existing resources to create an "MMF support center" that will make it easy for CMMAP scientists to run the MMF.

4. Management

Prioritization

CMMAP management is well aware of the need to show major accomplishments at the review in spring 2009. We agree with the Panel that we should assign the highest priority to meeting that goal.

In the mean time, our second NSF Site Visit, in May 2008, resulted in a very positive evaluation by NSF.

Leveraging other funding

We will pursue private-sector funding. This is an excellent suggestion, which we had considered only casually before receiving the Panel's input.

We were able to attract additional DOE funding to support a two-year visit by Dr. Hiroaki Miura of the Frontier Research Center for Global Change, in Yokohama. We also enjoy an active collaboration with scientists at the University of Tokyo, without any need for CMMAP funding (which would not be permitted by NSF anyway). Miura arrived in late January 2008, and will stay until the end of 2009.

Reporting

progress; in contrast, the first-year report involved a lot of rather frantic work, and as a result yielded somewhat less insight.

Top-down versus bottom-up

We agree that goals and strategies that originate from the grass-roots of the project should be encouraged and fostered. As an example, a move for an MMF support facility was a grass-roots idea that emerged in the winter of 2007-8, and was quickly embraced by the Center's management. A second example is the large-domain LES of deep convection, completed in late April 2008, which emerged through the Working Group on Physical Processes. The results of this simulation are of great interest to many CMMAP researchers; we expect to be analyzing it for several years.

At the same time, "top-down" management is needed to keep the Center's overall direction on track. We are striving for a balanced approach.

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