EXTERNAL REVIEW
OF THE
COOPERATIVE INSTITUTE FOR MESOSCALE METEOROLOGICAL STUDIES
UNIVERSITY OF OKLAHOMA
NORMAN, OKLAHOMA

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SUMMARY

An external review of the research, education, public affairs and outreach programs within the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) at the University of Oklahoma (OU) was held on 15-16 October 2003 in Norman, Oklahoma. Guidelines for conducting the review were provided by the Office of Oceanic and Atmospheric Research (OAR) within the National Oceanic and Atmospheric Administration (NOAA). The CIMMS review was conducted under the auspices of the NOAA Science Advisory Board and therefore also under the purview of the Federal Advisory Committee Act (FACA). A list of Review Team Members is provided in Appendix I.

During its twenty-five year history, CIMMS has extended the expertise of NOAA in areas of mesoscale meteorology and provided significant contributions to the evolution of the science. Excellent research is being conducted within several theme areas, and there are examples of successful transition of research gains into operational improvements, e.g., the transition of Doppler radar technology. Over two hundred seventy refereed publications have been generated over the past five years in its six research theme areas - Basic Convective and Mesoscale Research; Forecast Improvements; Climatic Effects of and Controls on Mesoscale Processes; Socioeconomic Impacts of Mesoscale Weather Systems and Regional-Scale Climate Variations; Doppler Weather Radar Research and Development; and Climate Change Monitoring and Detection. There are over one hundred forty CIMMS employees, up from thirty-eight in 1991, and its budget has grown from $1.4 million in 1991 to over $10 million in FY2003. This growth, productivity and longevity demonstrate the significance of the contributions of the science and research of CIMMS to NOAA and its stakeholders. In addition, the participation by CIMMS in the proposed National Weather Center is a clear example of its forward-thinking planning in areas of weather research and operation and its role in advancing the state-of-the-science.

In keeping with the Joint Institute Review Format specified by NOAA/OAR, provided are review highlights in the areas of (i) Science Plan; (ii) Science Review; (iii) Education/Outreach; and (iv) Science Management Plan. There are several notable examples of CIMMS research that have led to improvements in operational meteorology. However, as the external review proceeded, the Review Team became concerned that the CIMMS two-day agenda and the content of the presentations within the agenda were heavily focused on scientific presentations and deficient in the areas of science planning and its management. The Review Team is concerned that the absence of comprehensive and coherent science and management plans resulted in the limited ability of CIMMS to address the questions included in the OAR Joint Institute Review Format. The Review Team holds that the formulation of such plans is required to maximize the value-added contributions of CIMMS to NOAA and to meteorology. Nine recommendations are proposed to OU, to CIMMS and to NOAA in areas of strategic, operational and tactical planning to ensure enhanced contributions by CIMMS to NOAA and to meteorology, climate, education and outreach for the nation.

I. OVERVIEW OF CIMMS

The Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) was established in 1978 as a cooperative program between the National Oceanic and Atmospheric Administration (NOAA) and the University of Oklahoma (OU) located in Norman, OK. This cooperative program is governed by a Memorandum of Agreement (MOA), last dated 22 June 1995, between

the NOAA Office of Oceanic and Atmospheric Research (OAR), the National Weather Service (NWS) and OU. As stated in the MOA, CIMMS was established *to act as a research interface between the organizations* [OU, OAR, NWS, NOAA], *and to assist in the transition of the products of that research into operational procedures and techniques.*

CIMMS-supported scientists and students conduct research in mesoscale dynamics; radar research, development, and analysis; weather forecasting techniques; atmospheric electricity; severe storms; cloud microphysics; and boundary layer studies, with increasing emphasis in recent years on the climatic effects of and controls on mesoscale processes, the socioeconomic impact of such phenomena, and climate change monitoring and detection.

PURPOSE The external review of CIMMS was guided by the prescribed and approved purpose of CIMMS as defined in the MOA, and is stated as follows:

> CIMMS is a research institute of the University, and will provide to the cooperating institutions:
>
> 1. A means to promote collaborative research on mesoscale meteorological phenomena associated with a wide variety of severe environmental storms, short-range prediction problems, the relation of mesoscale weather systems to regional climate and to processes relevant to climate and possible climate change, and the societal impacts of mesoscale weather systems and regional climate variations;
> 2. A means to improve the effectiveness of research through close collaboration of the parent institutions; and
> 3. A center at which scientists working on problems of mutual interest may come together and work advantageously in an environment different from that already provided in the separate Federal and University structures.

SCOPE The agreed upon scope of work conducted by CIMMS is also defined within the MOA. Addenda to the MOA were prepared 11 December 2000 and 8 August 2002. Of particular interest to this review are additions that extend or change the research themes for CIMMS. Because of their importance to the scope of this review, these changes are labeled here, for ease of reference, with an asterisk (*).

In brief,

> CIMMS will establish clearly defined program objectives in identified areas of mutual interest, while avoiding uncoordinated duplication of the activities of the parent organizations. The total research program of the Institute will normally be focused around a limited number of agreed-upon research themes. The selection of program objectives will be developed by the CIMMS Director and Council with the advice and approval of the CIMMS Advisory Board. Specific projects within the scope of approved program objectives or proposals for new program objectives may be initiated internally or at the behest of any of the parent organizations.
>
> Research in CIMMS is presently concentrated in six research themes:
>
> 1. Basic convective and mesoscale research;
> 2. Forecast improvements;
> 3. Climatic effects of and controls on mesoscale processes; and
> 4. Socio-economic impacts* of mesoscale weather systems and of regional scale variations.

5. Doppler weather radar research and development* [July 1, 1996 through June 30, 2001]
6. Climate Change Monitoring and Detection* [July 1, 2001 through June 30, 2006]

In addition, public affairs and outreach activities are included within the CIMMS Five-Year Plan for the period 1 July 2001 through 30 June 2006.

Additionally, the following cooperating partners were added to CIMMS in Addenda dated 11 December 2000 and 8 August 2002:

- The Operational Support Facility for the WSR-88D Radar [July 1, 1996 through June 30, 2001]
- The National Environmental Satellite, Data, and Information Service (NESDIS), and in particular its National Climatic Data Center (NCDC); and
- The Southern Region Headquarters (SRH) of the NWS

The changes as provided in the MOA and its addenda alter the scope of work for CIMMS and therefore extend the scope of the CIMMS external review.

II. SCIENCE PLAN

The Joint Institute Review Format calls for an assessment of the major components of a science plan – vision, goals, objectives, and partnerships. For purpose of this review, the Review Team defined a Science Plan as a clearly articulated set of strategies for planning and managing the science portfolio within the framework of the articulated Memorandum of Agreement (MOA).

The major components of a science plan clearly are consistent with the commonly accepted components of a strategic plan. The preparation of such a plan enables all scientists in an organization to come together to discuss and document a commonly held future direction and strategy for the organization, including education and outreach. The strategic plan then provides a vehicle for communicating the organization's direction and strategies to senior officials and constituents, and is an important tool for seeking needed resources.

Findings: Although the Review Team was provided with much relevant material that included a briefing book, web site, supporting documents, and oral/poster presentations, the Team was not provided with a coherent science plan for CIMMS. Hence, the Review Team sought to extract, assemble and synthesize diverse pieces of information from myriad sources, including interviews during the review and requests for information subsequent to the review. This exercise by the Review Team demonstrates the need for the leadership of CIMMS to engage in the on-going practice of developing strategic science plans. CIMMS provided a compendium of research papers and activities and labeled it as a Five-Year Science Plan. The Review Team did not deem this "plan" to be acceptable or informative regarding the science direction of CIMMS and the alignment of CIMMS with the NOAA strategic direction.

Recommendation 1: To effectively and efficiently serve the needs of NOAA, as defined within the NOAA and line office strategic plans, CIMMS must define a well-articulated strategic science plan that aligns with its established Memorandum of Agreement with NOAA. The Review Team holds that the preparation of a CIMMS Science Plan is crucial to the future of the organization and will provide a basis for strengthening the linkages between NOAA and the University of Oklahoma.

WHAT IS THE SCIENTIFIC (NOT PROGRAMMATIC) VISION FOR THE INSTITUTE?

The vision for CIMMS is to serve as a center of leadership and excellence where government and academic scientists may collaborate to learn about and apply their knowledge of mesoscale weather and regional-scale climatic processes. CIMMS has been very successful at achieving this broad vision, allowing, for example, for the successful transition from research-to-operations of Doppler radar. However, this vision, as defined by CIMMS, is more akin to a mission statement. The mission/vision of CIMMS is also expressed in a sentence in its five-year plan: *to improve observation, analysis, understanding, and prediction of weather elements and systems ranging in size from cloud nuclei to multi-state regions.* This mission/vision includes the transition from gains in observation, analysis, and understanding into gains in prediction. Currently, various CIMMS documents seem to mix mission and vision and a clear and specific vision for CIMMS for the next 5-10 years is not apparent. A more specific and dynamic vision is needed to set a marker for CIMMS for the next decade, together with a consistent articulation of its mission - separate from its vision. Also, any broad scientific vision for the institute, as stated by its leadership, seems secondary to the individual objectives of the six thematic areas that have evolved over the history of CIMMS.

Findings: The Review Team did not see, nor was it given, a unifying vision for CIMMS beyond one of conducting research in the six thematic areas. As stated, the vision is simply, "we will do research and make improvements in these areas" and it is left to the reader to see the linkages among the six themes and further extrapolate and postulate the benefits to society. Establishing research themes does not equate to establishing a unifying vision. Because of the addition of research themes and collaborating NOAA organizations via the Addenda to the MOA between NOAA and OU, a need for a clarifying vision is critical. The MOA states that "*...CIMMS will establish clearly defined program objectives in identified areas of mutual interest, while avoiding uncoordinated duplication of the activities of the parent organizations....*" Without a vision or a science plan, it is not apparent that this statement can be reified.

HOW IS THE SCIENTIFIC VISION RELATED TO THE NOAA STRATEGIC PLAN?

Findings: The scientific direction of CIMMS seems to be developed largely through an interactive process between NOAA and CIMMS that is somewhat independent of the NOAA strategic planning process. The Review Team did not see, nor was it given, an explicit, <u>focused</u> linkage of the CIMMS scientific vision to the NOAA Strategic Plan. What was sought was a description of the specific niche that CIMMS fills which assists NOAA in meeting its overall strategic goals. In response to Review Team questions, CIMMS leadership indicated that mesoscale weather research and regional climate research fall under two of NOAA's four strategic goals: Mission Goal Two: Climate; and Mission Goal Three: Weather and Water. In general, the Review Team agrees that the research being conducted falls into these categories; however, it did not see the linkage regarding how the CIMMS research plays a unique and complementing role in advancing NOAA's strategic agenda.

WHAT ARE THE GOALS AND OBJECTIVES?

In the CIMMS Briefing Book, the general goals for the six research theme areas are very similar in wording to the vision statement:

(1) **Basic Convective and Mesoscale Research** – (a) to understand cloud and mesoscale dynamics, microphysics, and the precipitation process, and their relationships to large- and small-scale forcing; (b) to develop procedures for assimilation of meteorological data into simulation and prediction models of these processes.
(2) **Forecast Improvements** – to accelerate the transfer of research knowledge and skills between the academic and operational mesoscale meteorological communities to: (a) improve the design and utilization of mesoscale weather observing systems; and (b) improve mesoscale weather prediction and warning.
(3) **Climatic Effects of and Controls on Mesoscale Processes** – to extend and apply the understanding of mesoscale weather processes to the problem of climate maintenance and change.
(4) **Socioeconomic Impacts of Mesoscale Weather Systems and Regional-Scale Climate Variations** – to estimate the socioeconomic impacts and values of mesoscale weather systems and regional-scale climate variations to facilitate mitigation of adverse impacts and enhancement of beneficial impacts.
(5) **Doppler Weather Radar Research and Development** – (a) to accelerate the transfer of knowledge between the meteorological and engineering communities to improve the design, usability, and supportability of the WSR-88D Doppler weather radar system, including efforts relating to Phased Array Radar and SMART Radar Systems and (b) to develop and improve radar algorithms used for forecasting and warning.
(6) **Climatic Change Monitoring and Detection** – to build long-term data sets using appropriate stations and to use these data to address climate change questions.

Findings: The Review Team did not see a statement of specific goals and objectives for the research program, in general, and the six research theme areas, in particular. As stated in the Overview Book, "CIMMS research contributes to the NOAA mission through improvement of the observation, analysis, understanding, and prediction of weather and climate elements and systems ranging in size from cloud nuclei to multi-state regions." It further elaborates conceptually on the benefit to NOAA and society, before describing general goals for each of the six research themes. The goals and objectives, for the most part, are stated as "improve the understanding", "extend the knowledge", "improve the use". The team believes that these rather general statements of objectives do not encourage aggressive research.

Some of the goals and objectives appeared to be derived from a "bottoms-up" process without apparent linkage to specific "top-down" research challenges. The team believes that the relevance of CIMMS research to the NOAA mission could be improved with a statement of goals and objectives at a level above that of the individual proposal. At the same time, the Review Team acknowledges that the planning process within NOAA is now**,** and has been in recent years**,** evolving rapidly. Matrix management teams have been established to address the major themes within the NOAA Strategic Plan, to have major roles in the process and to provide coordination across the line offices of NOAA. At present, the inclusion of the Joint Institutes, e.g., CIMMS, is minimal in the process of planning being conducted by the thematic planning teams.

Recommendation 2: OU and CIMMS must establish a process to coordinate specific thematic research goals and objectives with OAR as part of the NOAA strategic planning and programming process and to use these higher level specific goals and objectives to challenge individual scientists.

WHAT CRITERIA ARE USED TO MEASURE PROGRESS IN ACCOMPLISHING THESE GOALS AND OBJECTIVES?

Findings: The Review Team had difficulty understanding the method(s) employed by CIMMS management to measure research performance and progress. Individual researchers presented results indicative of progress. However, the Team could not see how the rate of progress is assessed or how it is determined whether satisfactory progress in meeting goals and objectives is

evaluated. These management assessments are made more difficult by the general wording of goals and objectives indicated above—for example, if a goal is to "improve understanding", then how much improvement is satisfactory is an arbitrary determination.

In response to Team questions, CIMMS management indicated "Measures of progress used are diverse, vary with the type of work involved, and include the following — number/quality of publications and presentations; amount/quality of technology transferred to operations; number/diversity of participants educated through outreach programs; and continuation/ enhancement of external (non-NOAA) funding." CIMMS management stated that these metrics are quantified annually during the preparation of each CIMMS Annual Report. The Team views these measures as general indicators of the quality and quantity of research work being done.

- ***WHAT ARE THE MAJOR SCIENTIFIC THEMES?***
- ***HOW WERE THEY IDENTIFIED?***
- ***WHICH THEMES/SUB-THEMES ARE NEAR COMPLETION?***
- ***WHAT ARE THE EMERGING THEMATIC AREAS? WHY?***

CIMMS has explicitly identified six major scientific themes. These are:

1. Basic Convective and Mesoscale Research;
2. Forecast Improvements;
3. Climatic Effects of and Controls on Mesoscale Processes;
4. Socioeconomic Impacts of Mesoscale Weather Systems and Regional-Scale Climate Variations;
5. Doppler Weather Radar Research and Development; and
6. Climate Change Monitoring and Detection

The Basic Convective and Mesoscale Research theme was established in 1982 and the remaining five themes were added in the subsequent 19 years. The Briefing Book and CIMMS leadership both indicated the theme areas were identified in collaboration with NOAA.

Findings: The lack of OU/CIMMS involvement in the NOAA strategic planning process mentioned above, would seem to indicate that an *ad hoc*, as opposed to a strategically driven process was employed. The team questioned the expansion of research into climate areas because it significantly broadened the CIMMS charter. Three of the six research themes deal with short-time-scale atmospheric processes—and require scientific expertise and focus which differs considerably from that required for climate research. CIMMS leadership offered a logical scientific explanation for the expansion of their research to areas of climate—for example, regional mesoscale climate can have an impact on short-term mesoscale system evolution. Having stated this, the Team wonders whether it is possible to sustain "critical mass" in such a diverse program—especially in the current tight budget environment. It seemed as if the research in Theme 3 was mostly directed at the influences of mesoscale weather systems on climate rather than vice versa.

There was no information provided indicating that any of the six themes is near completion nor is there a plan to guide research programs so that the research can be transferred to operations. Questions were asked of scientists who gave oral presentations during the review regarding their strategy to integrate their research into the operations of NOAA. While there have been several notable successes, it did not appear, based on the responses, that this was a universal part of the research paradigm of the scientists. Further, the lack of specific goals or objectives in each of the six areas led the Review Team to believe that, once established, each theme area will continue indefinitely without milestones or targets.

III. SCIENTIFIC PARTNERSHIPS

WHAT IS THE RELATIONSHIP TO OAR LABORATORIES AND OTHER NOAA ENTITIES?

Materials provided by CIMMS identified thirteen ongoing partnerships. The participating partners are: NOAA OAR National Severe Storms Laboratory (NSSL); the NOAA NWS Warning Decision Training Branch; the NWS Storm Prediction Center; Radar Operations Center, Forecast Office in Norman; NOAA NWS Southern Region Headquarters in Ft. Worth, TX; the NOAA NESDIS National Climatic Data Center in Asheville, NC; NOAA NWS International Activities Office in Silver Spring, MD; NOAA OAR Office of Global Programs in Silver Springs, MD; the University of Oklahoma; and other NOAA and non-NOAA organizations within Norman. CIMMS is to be commended for the active scientific collaboration with the Norman scientific community. CIMMS believes this collection of research and operational expertise creates a fertile environment for research focused on important science challenges with payback to operations. This environment further provides a close linkage between researcher and operational user, reduces research-to-operations transition costs and it increases the potential for optimum applicability to NOAA operations.

WHAT, IF ANY, FORMAL PROCEDURES EXIST FOR JOINT PLANNING?

CIMMS leadership indicated that its research plans are developed and coordinated with OAR. However, the issue raised earlier (in Recommendation 1 and 2) regarding the partnership between the Joint Institutes and OAR, indicates to the Review Team that there is a need for improvement in the area of joint NOAA/OU/CIMMS planning.

A topic of significant discussion during the review was that of the proposed National Weather Center (NWC). The NWC, as proposed, will transform the current Oklahoma Weather Center into a larger, much more structured organization under the leadership, administration and management of the University of Oklahoma. Specific responsibilities of the NWC include: lead and implement the University Radar Meteorology Initiative; and establish and direct the Center for Radar Meteorology and Engineering, the Radar Phenomenology Laboratory, the Radar Data Portal, and the National Mobile Observing Facility. The NWC would direct and administer CIMMS. It is proposed by OU that the Associate Director of the NWC be the Director of CIMMS.

Findings: The Review Team raised many questions regarding the relationship between CIMMS and NOAA; and CIMMS and OU as each pertains to the existing Memorandum of Agreement and the proposed National Weather Center (NWC). In response to questions, the OU Vice President for Research and Dean of Geosciences provided the Review Team with strategic and tactical plans for the NWC; organizational charts for the NWC which position CIMMS within the NWC structure; and a copy of a briefing delivered to the President of OU, which includes revenue projections for a ten-year period of time. Beyond that, the Review Team was given little information regarding joint planning between NOAA, OU, and CIMMS to maximize the gains of co-location within the NWC. The proposed co-location of NOAA offices and CIMMS within the NWC should strengthen interactions among members of the meteorological research community in Norman.

IV. SCIENCE REVIEW

WHAT ARE THE INSTITUTE'S MOST RECENT SCIENCTIFIC HIGHLIGHTS AND ACCOMPLISHMENTS? (NOTE THAT THIS IS AN OPPORTUNITY FOR EARLY-MID CAREER SCIENTISTS TO BECOME ACQUAINTED TO/BY UPPER NOAA MANAGEMENT.)

Excellent research is being conducted within the majority of the scientific theme areas, and there are examples of successful transition of research gains into operational improvements, e.g., the transition of Doppler radar technology. Over two hundred seventy refereed publications have been generated over the past five years in CIMMS six research theme areas - Basic Convective and Mesoscale Research; Forecast Improvements; Climatic Effects of and Controls on Mesoscale Processes; Socioeconomic Impacts of Mesoscale Weather Systems and Regional-Scale Climate Variations; Doppler Weather Radar Research and Development; and Climate Change Monitoring and Detection. There are over one hundred forty CIMMS employees, up from thirty-eight in 1991, and its budget has grown from $1.4 million in 1991 to over $10 million in FY2003. The growth, productivity and longevity are evidence of the value of CIMMS science and research to the advancement of NOAA. In addition, the participation by CIMMS in the proposed National Weather Center is a clear example of CIMMS forward-thinking planning in areas of weather research and operation; and its role in advancing the state-of-the-science.

Most noteworthy of CIMMS long-term accomplishments is their role in the modernization of the National Weather Service, particularly through upgrading of radar hardware and software systems to move the United States from the WSR-57 and WSR-74 era to the WSR-88D NEXRAD era. This type of effort continues as CIMMS assists in the testing and planning for potential operational deployment of polarization diversity capabilities to the WSR-88D system, in exploring the use of phased-array radar systems, and in planning for the incorporation of data from other radar systems into a national radar database.

Recent advances in accuracy and lead time of tornado warnings issued to the public can be tied back to observing and modeling advances in which CIMMS has had an important role. CIMMS activities indicate that it will continue to play an important role in these areas. In particular, it is noteworthy that CIMMS has established ties with the Office of Naval Research to work with the SPY-1 phased array radar used in the AEGIS radar system deployed on U.S. Navy cruisers and destroyers. CIMMS is working with SPY-1 hardware to investigate its potential as the basis for the next generation of weather radar to be used by the National Weather Service. The ability of CIMMS to garner support from other agencies and to provide a conduit for technology and research from those agencies into NOAA illustrates one of the strengths of OU/CIMMS.

The significance of the contributions of CIMMS research and transition of research into NOAA operations resulted in the awarding of the Department of Commerce Silver Medal in 1999 to the Warning Decision Support System (WDSS), while the Weather Event Simulator (WES) was awarded the Department of Commerce Gold Medal in 2003.

Several oral research presentations were delivered to the Review Team, which demonstrated the very high quality of ongoing CIMMS research. In addition, posters displayed, although time did not allow a thorough review of each, were further indicators of a robust research program. Presented research topics included:

- "Improved Understanding of Mesoscale and Storm-scale Processes Associated with Hazardous Weather"
- "Improving Severe Weather Forecasts by Infusing Science and Technology into Operations in the Storm Prediction Center" - described a blend of operational forecasters working with the research community to identify important forecast problems requiring scientific research, and how relevant research can have immediate payback in operational severe storm prediction
- "Overview of Polarimetric Weather Radar Applications" provided a short synopsis of ongoing research of timely and significant scientific importance to NOAA's planned upgrade to its operational Doppler Weather Radar to dual polarized capability
- "Climate Research and Seasonal Forecasting for West Africans: Perceptions, Dissemination and Use" is a creative piece of social scientific research which will benefit NOAA's International Affairs objectives.

There was a discussion of the potential importance of mesoscale research performed at CIMMS to the goals of NOAA in the area of climate. Improvements to climate models will emanate from improvements in the parameterizations of mesoscale processes and from the further assimilation of earth systems science data into numerical weather prediction models. The Review Team acknowledges that CIMMS mesoscale meteorological research is important to the attainment of the climate goals of NOAA.

Findings: Noteworthy research is being conducted and its transition into operations is underway in many areas. Opportunities exist to expand existing research areas in ways that should prove to be of more direct impact on NOAA operations. Information was provided in support of the theme area: Socioeconomic Impacts of Mesoscale Weather Systems and Regional Scale Variations, although several areas were discussed and/or presented, which included: Climate Research and Seasonal Forecasting for West Africans; Multiscale Evolution and Predictability of Warm Season Climate Anomalies; and the development of a new database for tornado research, which maps tornado paths onto census tracts.

Recommendation 3: CIMMS should consider assigning a higher priority to certain aspects of its research program where results would more directly impact NOAA operations. Examples include studies of forecasting and warning applications of lightning data and the further assimilation of Doppler radar data into numerical weather prediction models.

Recommendation 4: CIMMS should consider expanding its research initiatives in the theme area: Socioeconomic Impacts of Mesoscale Weather Systems and Regional Scale Variations. Data should be collected on the social impacts of CIMMS research on the economy and well-being of the nation. CIMMS should consider including in these research initiatives a strategy to quantify the value-added benefits to the nation of weather forecasting and research.

V. EDUCATION AND OUTREACH

WHAT TYPES OF EDUCATIONAL ACTIVITIES/OPPORTUNITIES (K-12, UNDERGRADUATE AND GRADUATE STUDENTS) DOES THE INSTITUTE OFFER ON AN ON-GOING BASIS?

CIMMS provided information regarding its education, public affairs and outreach programs. With the exception of providing for graduate student assistantships, however, NOAA provides minimal funding to CIMMS for educational and outreach activities. For FY2003, CIMMS had a combined budget of $10,146,626. Of this amount, NOAA provided over 60% of the total budget; OU 16% and 24% was provided by other external sources. Of the total budget, less than 1% of the budget was devoted to education, public affairs and outreach programs and initiatives, and it appears that the majority of these funds was provided by sources external to CIMMS and OU.

CIMMS leadership states that "...CIMMS has leveraged other federal and state funds into an exceptional array of educational programs that are competitive with any other similar programs worldwide." The recipients of these program opportunities fall into five categories: (1) University of Oklahoma graduate students, (2) undergraduate students, (3) K-12 students, (4) NWS and other scientists within the United States, and (5) international scientists. A full-time public affairs person, who is a federal employee and not funded by CIMMS, serves the four Norman NOAA units (NSSL, SPC, ROC, WFO). Examples of coordinated activities include:

- Tornado season kickoff news conference and media workshop
- Tours and presentations to Leadership Norman and other local community groups
- Providing speakers to schools, community organizations, and the media.

TYPES OF EDUCATIONAL ACTIVITIES/OPPORTUNITIES Twenty-seven graduate students received CIMMS support in fall 2003. An average of ten additional students, OU and non-OU, are able to participate in CIMMS research through the NSF-sponsored Research Experiences for Undergraduates (REU) program. Additional OU undergraduate students have been involved in CIMMS research.

Findings: While the CIMMS leadership provided an overview of existing and planned educational programs, data were not presented that quantifies the impact or demographics of their efforts. CIMMS further states that "Outreach to the general public, civic groups, student organizations, and other community-based groups or individuals, principally, is undertaken by individual CIMMS employees according to their time and interest". This statement, along with the delineation of outreach activities provided by CIMMS within its Briefing Book, suggests that the community outreach within CIMMS is voluntary and *ad hoc*. A CIMMS leveraged commitment of less than one percent of the total CIMMS budget is a nominal contribution in the combined areas of education, public affairs and outreach.

Recommendation 5: It is strongly recommended that CIMMS develop strategic, tactical and operational plans to address education, public affairs, and outreach, and that NOAA funds are appropriated for these activities. These plans should be informed and disaggregated by gender, age, ethnicity and citizenship during the academic year and during the summer. CIMMS should strive to promote diversity in its workplace.

WHAT ARE THE CURRENT AND PLANNED OUTREACH EFFORTS?

CURRENT AND PLANNED OUTREACH ACTIVITIES Though much of the funded interaction within CIMMS involves members of the Norman, OK community, there is considerable evidence that CIMMS affiliates are interacting and collaborating with substantial numbers of "external" researchers, some well outside the Norman community.

According to the Briefing Book and oral information provided by CIMMS:

- Five of the 55 CIMMS Fellows are from universities and other organizations that are not affiliated with the University of Oklahoma, NOAA, or CIMMS partner organizations.
- Fifty-seven percent (158 of 278) of refereed publications from 1998-September 2003 had at least one non-CIMMS-affiliated author.
- The University of Oklahoma operates international exchange programs with universities in England, Australia, and Kenya.
- There exists an arrangement between the University of Oklahoma and Vietnam that states that if Vietnam provides support for two Ph.D. students, then OU will provide support for two additional students.

The number of partnerships between CIMMS and other agencies and universities allows for further opportunities for professional growth. One multi-institution activity involves development of the Warning Decision Support System (WDSS) II. This involves CIMMS, OU, NSSL, NOAA/NWS, the Australian Bureau of Meteorology, and the Georgia Tech Research Institute.

Forecasting-related and field-program-related interactions involve participants from numerous universities and agencies outside of Norman. For example, the NSSL/CIMMS/SPC Spring Program involves four universities, Cooperative Operational Meteorological Education and Training (COMET), Meteorological Services of Canada, the UK Met Office, and USWRP. The SMART-R Program includes Texas A&M and Texas Tech.

The NWS International Activities Office has teamed with CIMMS to conduct a series of workshops to disseminate results of current climate research to the meteorological and hydrological services of developing nations. Four have been conducted and a fifth is planned. That office has also funded scientific exchanges with the African Center of Meteorological Applications for Development.

Other CIMMS programs and activities include: dissemination of software and training on the Weather Event Simulator (WES); and the CRAFT program, in cooperation with UCAR's UNIDATA program.

These activities are ongoing, and are part of the CIMMS Five-Year Plan.

VI. SCIENCE MANAGEMENT PLAN

A science management plan is prepared by managers to articulate to staff, senior officials, and other stakeholders how the organization is managed for purpose of developing and implementing the science plan. Included in a science management plan is the framework for the management of human, physical and financial resources. OU/CIMMS has over one hundred forty employees, the majority of whom are research scientists, research associates or graduate/undergraduate students. CIMMS did not provide a science management plan; however, did provide an organizational structure, which includes the CIMMS Council and Advisory Board, and the broad responsibilities of each. Further, CIMMS provided a list delineating the source of funding for each of its employees.

Finding: Because the list did not define the research area, level of support from each research task, nor salaries, the Review Team could not "construct" a science management plan or determine the level of effort for each research topic. A pie chart defining the funding available for each research theme was provided by CIMMS.

Recommendation 6: OU/CIMMS should develop a science management plan to state to staff, senior officials and other stakeholders how the organization is managed for purpose of developing and implementing its science plan.

- ***HOW DOES THE INSTITUTE IDENTIFY NEW INTELLECTUAL OPPORTUNITIES?***
- ***WHAT ARE SOME RECENT EXAMPLES OF INTELLECTUAL OPPORTUNITIES?***

CIMMS has a large and very accomplished scientific research staff. New intellectual opportunities are defined in collaboration with NOAA and with the CIMMS partners. As with most basic and applied research, the scientist, in collaboration with peers, determines the strategy for new starts. The proposed establishment of the National Weather Center, defined on page 7, is one such example of the strategic direction of OU/CIMMS in areas of weather research. It is projected that the National Weather Center will generate revenue in excess of

$200 million during its initial decade of operation. The NWC is an excellent example of the acumen of OU to develop strategic ventures and associated strategic and tactical plans.

The OU Meteorological Radar research initiative is another example of the involvement of CIMMS in the development of a new intellectual opportunity. OU provided the Review Team with an overview of its projected ten-year budget and a summary of its cost-benefit analysis. CIMMS will involve over fifty of its employees in this research initiative, which will include collaborations with NOAA/OAR/NSSL; private sector companies; and envisioned coordination and collaborations between other university and federal organizations.

- ***WHAT IS THE STRATEGY FOR NEW STARTS (PROJECTS, TECHNIQUES, CAMPAIGNS, ETC.)***
- ***HOW MUCH OF THE INSTITUTE RESOURCES ARE RESERVED FOR NEW OPPORTUNITIES OR BRIGHT IDEAS?***

It was not evident to the Review Team that CIMMS reserves any of its monies for new research starts. Of the total CIMMS budget of over $10 million, approximately, three percent is not obligated for specific tasks. This figure was estimated based on the direct contribution to CIMMS from the Oklahoma state budget and the sponsored research initiative return to CIMMS from OU, which constitutes a fraction of the indirect costs generated by CIMMS. CIMMS did not provide a plan regarding its use of these non-obligated funds, and therefore, the Review Team could not determine the amount of CIMMS funds reserved for new opportunities or "bright ideas." In some cases, start-up funding for promising ventures appeared to be provided by OU.

- ***WHAT IS THE DEMOGRAPHIC STRUCTURE OF THE INSTITUTE EMPLOYEES?***
- ***WHAT IS PROVIDED FOR HUMAN RESOURCES DEVELOPMENT? (RECRUITMENT, REWARDS, TRAINING)***

CIMMS provided summer demographic information for its employees. This information was disaggregated in terms of age, ethnicity, gender and citizenship. In brief, the majority of the CIMMS research staff is male (75%); under the age of forty (40); Caucasian or Asian/Pacific Islanders (95%); and U.S. citizens (73%).

Finding: CIMMS provided demographic disaggregated employee information for summer only. The Review Team, therefore, could neither assess nor evaluate the yearly or long-term state of diversity and its ensuing trends within CIMMS.

Recommendation 7: CIMMS should develop a human resource management plan to ensure a diverse workforce. It is suggested that this plan be coupled with the education and outreach plan for CIMMS. For future reviews, CIMMS should prepare materials that characterize its history and projected trends regarding its workforce.

- ***WHAT IS THE STATE OF THE FINANCIAL HEALTH OF THE INSTITUTE? (PROVIDE A BUDGET SUMMARY AND IDENTIFY IMBALANCES OR NEEDED ADJUSTMENTS.)***
- ***HOW DOES THE INSTITUTE INTEND TO WORK TOWARDS ACCOMPLISHING ITS FINANCIAL GOALS?***

The financial health of an institution is a reflection of a balance between revenue and needed expenditures. Funding for CIMMS is provided by NOAA through three mechanisms: (i) base

funding; (ii) non-base funding; and (iii) competitive proposals. Other agency funding is allocated to CIMMS through competitive proposals. In addition, OU provides direct contributions to CIMMS in an amount equal to a percentage of the extramural resources garnered by the Center. For fiscal year 2003, this amount was equal to $215,104.

CIMMS is well-positioned for continued success by virtue of its physical and human resources capital. This capital includes:

- Construction of the National Weather Center building, allowing for the co-location of University and NOAA personnel;
- Personnel from and facilities of numerous research and operational groups within the Norman community;
- Enthusiastic support by the President, Vice President for Research; Dean of Geosciences; Dean of the Graduate College and Director of the School of Meteorology;
- The Oklahoma Mesonet and ARM SGP CART site provide the largest and most comprehensively instrumented climate monitoring facility in the world, as well as data for mesoscale analysis and prediction.

Data provided in the Briefing Book only provide figures for income and expenditures in a gross sense. There was no breakdown by major expenditure categories, such as salaries and benefits, travel equipment, contractual, facilities, maintenance, etc. Data, on some of these items, were provided in the follow-up materials, however, were in a fragmentary and incomplete state. No information was provided on facilities maintenance, and very limited data were presented on equipment, travel, and supplies for CIMMS as a whole. Also, the Review Team was not informed of any difficulties in staff hiring or retention because of funding constraints.

It was stated in the Briefing Book that NOAA and other agency funding for CIMMS more than doubled from FY 1997 to FY2003. However, nearly all of this increase occurred from FY1997 to FY1999. Funding and the number of proposals submitted appear to be quite flat from FY2000 to FY2003. Whether flat funding has impaired CIMMS operations cannot be assessed or evaluated from the data and information provided.

Finding: Insufficient data and information were provided by CIMMS to the Review Team to evaluate the financial status of CIMMS and whether it had financial goals that align with a CIMMS Science Plan.

Recommendation 8: NOAA should require the Joint/Cooperative Institutes to provide to Review Teams briefing materials and presentations that are in direct response to the questions that NOAA requires the Review Teams to assess and evaluate.

- ***ARE THERE ANY ISSUES IN INTERACTING WITH NOAA THAT REQUIRE ATTENTION?***
- ***ARE THERE ANY ISSUES IN INTERACTING WITH THE UNIVERSITY THAT REQURE ATTENTION?***

In response to team questions, CIMMS leadership raised four issues, which are important in promoting an effective partnership between NOAA and the Joint Institutes in general. These issues and their basis are provided below:

Issue: CIMMS reported that the lack of timely distribution of NOAA funds to OU results in significant cash-flow problems for OU.

Issue: CIMMS identified the small increase in NOAA base funds as a problem, although the impacts of a less-than-desired increase were not specified.

Recommendation 9: NOAA should more fully involve Joint Institutes and their collaborative partners in its strategic, operational and budget planning sessions to ensure that the value-added contributions of the JIs are included in the final budget preparations and submissions; and in the development of implementation plans.

Issue: Involvement in the NOAA strategic planning process by Joint Institutes has not been meaningful.

Finding: Specifically, "on several occasions, the Joint Institute (JI) Directors have requested OAR involve them in the NOAA planning process at an early stage, when the JIs can have a meaningful influence, for example, when the OAR Laboratory Directors contribute. To date, however, this highly desirable early involvement seldom has occurred." It is not apparent that the strategic planning process in NOAA effectively includes the Joint Institutes nor is it apparent that the NOAA strategic goals are used by OAR to guide the missions and work program plans of the JIs.

Issue: Joint Institutes have received mixed signals over the past two years regarding the degree to which their work should have a "direct benefit" to NOAA.

Finding: The Review Team believes that virtually any research conducted by a Joint Institute in geophysical/environmental sciences could be construed as having a "direct benefit" to NOAA. Further, the Review Team questions the notion that NOAA would fund scientific research programs, which do not have a benefit to NOAA—a benefit that NOAA could leverage to the advantage of the United States. In response to Review Team questions, CIMMS leadership provided a three-page summary, entitled "Compliance with Department of Commerce (DoC) Legal Concerns over Research Activities and its Apparent Contradiction with the Desires of NOAA." In it, DoC lawyers indicate "there are several activities included in the proposal [CIMMS five-year funding plan] that appear to be procurement of services to the direct benefit of NOAA or other federal agencies in violation of the Competition in Contracting Act and Federal Acquisition Regulations." CIMMS responded by "removing offending sections and transitioning that work to Federal employees" and by "moving purely IT [Information Technology] staff from the cooperative agreement to a contract." The three-page document further notes that "NOAA appears to view the research activities of the JIs differently" and includes language, which indicates a desire for "research that directly supports the operations of other NOAA line offices." The team agrees with the concerns of the JIs regarding mixed signals.

From the perspective of the Review Team, the efforts of CIMMS reflected a strong focus on activities at OU/CIMMS and with its nearby NOAA partners. It was judged that additional value could be rendered for NOAA from CIMMS research if efforts were also made at CIMMS to connect with more distant NOAA laboratories and fellow Joint Institutes. Further, the staff of OU/CIMMS should encourage and more actively participate in planning and implementation of research programs such as GEWEX and CLIVAR in which NOAA plays an important role. The increased attention being paid to mesoscale meteorological variability and its relationship to climate variability and prediction programs such as the North American Monsoon Experiment (NAME) is indicative of the potential value of CIMMS staff and research in this area to these programs.

Finding: In the briefings and materials provided by OU/CIMMS, there was little evidence that efforts were made to coordinate CIMMS research across the many NOAA OAR laboratories and Joint Institutes across the country and to foster participation of CIMMS in international research activities where CIMMS research would add great value.

VII. SUMMARY AND CONCLUSIONS

During its twenty-five year history, CIMMS has extended the expertise of NOAA in areas of mesoscale meteorology and provided significant contributions to the evolution of the science. Excellent research is being conducted within several theme areas, and there are examples of successful transition of research gains into operational improvements, e.g., the transition of Doppler radar technology. Over two hundred seventy refereed publications have been generated over the past five years in its six research theme areas - Basic Convective and Mesoscale Research; Forecast Improvements; Climatic Effects of and Controls on Mesoscale Processes; Socioeconomic Impacts of Mesoscale Weather Systems and Regional-Scale Climate Variations; Doppler Weather Radar Research and Development; and Climate Change Monitoring and Detection. There are over one hundred forty CIMMS employees, up from thirty-eight in 1991, and its budget has grown from $1.4 million in 1991 to over $10 million in FY2003. This growth, productivity and longevity, places upon CIMMS the further responsibility to serve as an example of excellence for similar entities within NOAA. The participation by CIMMS in the proposed National Weather Center is a clear example of CIMMS forward-thinking planning in areas of weather research and operation and its role in advancing the state-of-the-science. This participation and role further highlights the essential need for a more clearly defined, well-articulated partnership with NOAA. The absence of a strategic plan and a science management plan, the current level of focus in areas of social science research, and the *ad hoc* attention to education and outreach should be addressed by the leadership of CIMMS in partnership with OU and NOAA. In addition, CIMMS should strive to be a model for diversity in the workplace. These issues, once addressed, will serve to more strongly position OU/CIMMS as an example of excellence for NOAA and the nation.

APPENDIX I

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