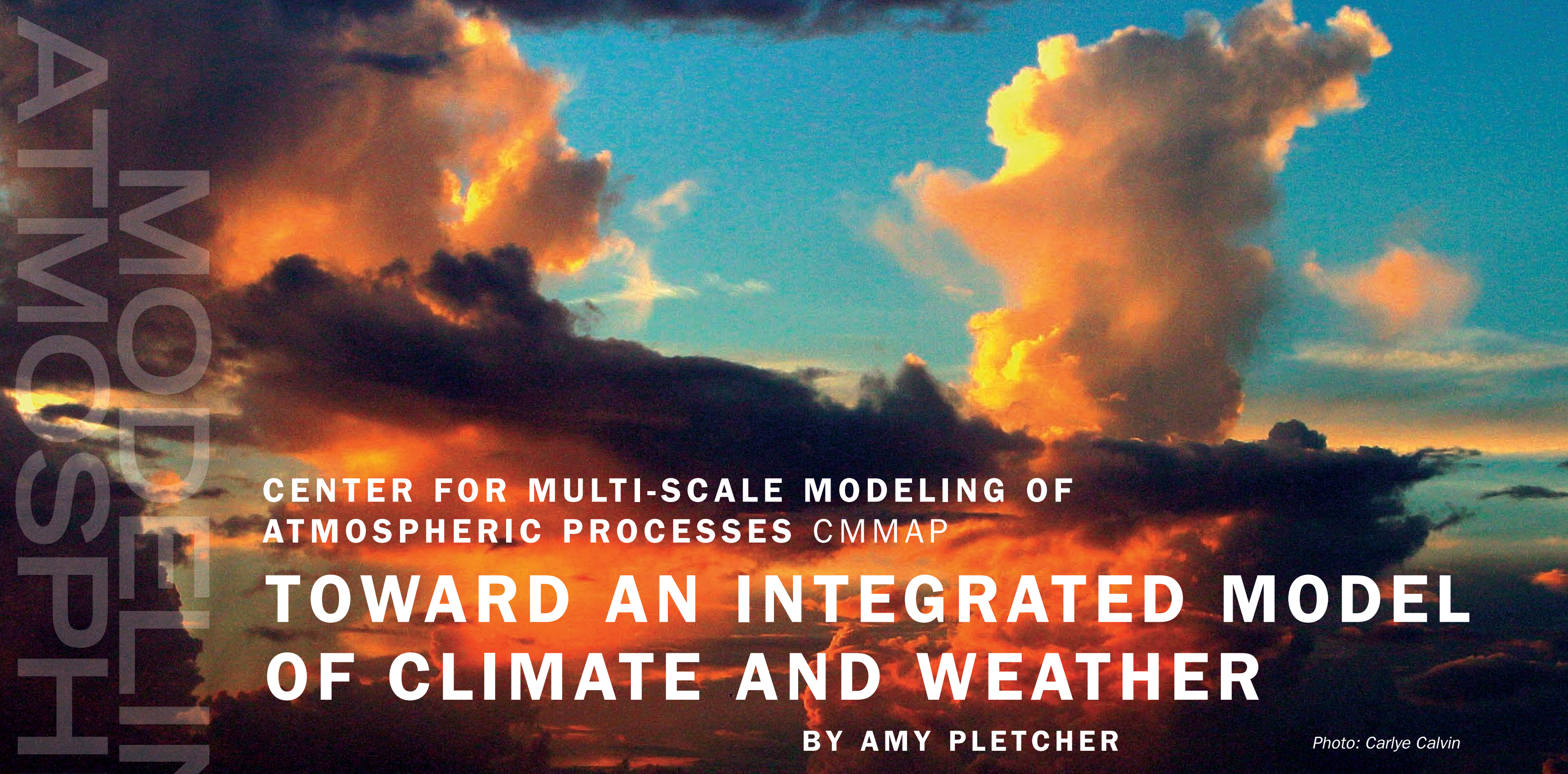


MODELING OF ATMOSPHERIC PROCESSES

CENTER FOR MULTI-SCALE MODELING OF ATMOSPHERIC PROCESSES CMMAP

TOWARD AN INTEGRATED MODEL OF CLIMATE AND WEATHER

BY AMY PLETCHER

Photo: Carlye Calvin

Critical mass can be defined as an amount necessary to have a significant effect or to achieve a result. For scientists in the field of atmospheric science and climate change, the creation of the Center for Multi-Scale Modeling of Atmospheric Processes (CMMAP) provides the critical mass needed to tackle fundamental problems that have remained mysteries for far too long.

Established in July 2006, and based at Colorado State University in Fort Collins, CMMAP is a partnership of nine degree-granting institutions and 20 additional collaborators whose mission is to improve climate and weather forecasting for scientists around the globe by building atmospheric models that will more accurately describe cloud processes than anything developed thus far. The center is undertaking work on many of the same atmospheric science topics that scientists have been targeting for years. What sets the center apart, however, is the scale at which they are able to tackle these issues.

"We're using new mathematical methods to simulate in the computer the way the clouds interact with the global circulation of the atmosphere, relying on extremely powerful computers in a way that wasn't possible until five years ago," says center director David Randall.

Eventually, with enough computing power, center researchers hope to gain the ability to actually simulate individual clouds and atmospheric circulation. This critical mass in computing power and resources is allowing the center to tackle several phenomena that scientists have long sought to understand, including the Madden-Julian Oscillation (MJO) and the boundary layer of thunderstorms.

"The embarrassing thing for atmospheric scientists is that no one knows how [the MJO] works even though we've known about it, [and] we even have a model that simulates it pretty well," says Randall. The combination of computing power and the number of institutions involved are allowing the scientists to finally confront these modeling problems head on.

Scientists will go through multiple phases in their research, first developing a new model that will more accurately represent the atmospheric effects of interest and evaluating the model based on comparisons with actual observations, and then eventually applying the model to understand how clouds interact with global systems like oceans and land surfaces. Projects range from the macro to the micro scales: everything from observations of entire weather systems to the properties of individual ice crystals. Until now, groups of research studying these phenomena have had trouble communicating because there weren't global models that took into account data sets from these different scales.

Because the center was recently founded, much of the science is still getting started, but there are several projects already underway that focus on cloud models. Historically, modeling has been done in roughly three levels of granularity, or resolution: global climate models, which operate on the scale of thousands of kilometers; cloud system resolving models, which represent processes between 1 and 500 km in scale; and large-eddy simulation models representing individual clouds on a scale between 10 m to 1 km. These distinctions in resolution are done for practical purposes and have little do to with the existence of actual differences in nature, explains project scientist Akio Arakawa of the Department of Atmospheric and Oceanic Sciences at UCLA. Center researchers are trying to incorporate information from these different scales into one unifying model. □

AN INTERVIEW WITH CENTER DIRECTOR David Randall

Q: What should the public know about interdisciplinary centers?
Randall: NSF has struck a good balance between single principal investigator projects and the centers. Most NSF money goes to single-PI projects, but we need larger centers to attack the bigger problems.

Q: What has surprised you most about your center as a whole, or about being a center director?
Randall: You spend a lot more time fighting for things that you need that you couldn't even have asked for previously. I've also been really happy with the willingness of scientists and educators to come together and work on a problem defined at the center level—to bend their research goals to match and work with the center.

Q: If you could have one or more wishes granted today for your center, what would they be?
Randall: Right now we're still in the process of getting going, so we're in the middle of the hiring process. I'd want that to go faster.

Q: What is your greatest challenge right now?
Randall: I'm awfully busy. What it feels like is skeet shooting: a problem comes up and you have to shoot it immediately.

Q: How did you get to this point in your career?
Randall: It's not what I expected. When I took my faculty position in 1988, I came from a job in NASA. I thought that I'd get my feet under me and I'd have three or four grad students and a postdoc and that would be my lifestyle. It turns out that's not my natural mode of operation, and I found that out as it happened. I apparently tend to naturally build these collaborations, these structures like the STC—it was a bit of self-discovery.

Q: What advice would you give to students in high school and college now about how to prepare themselves for careers in science or research in the future?
Randall: I think that people that want careers in the sciences need to understand how important it is to be able to communicate well, both in presentation and writing. It's very common for people to have good ideas but to be unable to communicate them.

CMMAP leadership, from left to right: A. Scott Denning, associate director for education and outreach; David Randall, center director; and Wayne Schubert, associate director for knowledge transfer.

Background photo: Carlye Calvin

Above: Little Shop of Physics director Brian Jones, a CMMAP education partner, and a group of students use a fish tank full of gelatin to demonstrate light scattering in the atmosphere and why the sky is blue.

Photo: University Corporation for Atmospheric Research

CMMAP EDUCATIONAL PROGRAMS REACH DIVERSE AUDIENCES

While the research and modeling projects at CMMAP are just getting started, the educational activities of the center are well underway. Education ranges from employing and supporting graduate and undergraduate students across the nine degree-granting institutions to outreach to state policy makers, farmers, teachers, and K-12 students.

CMMAP supports graduate research assistants not only in atmospheric and ocean sciences but also in fields as divergent as sociology, psychology, and education. Each student is involved in or studying the research at the center. In addition to their own research, graduate students are involved in teaching and public policy.

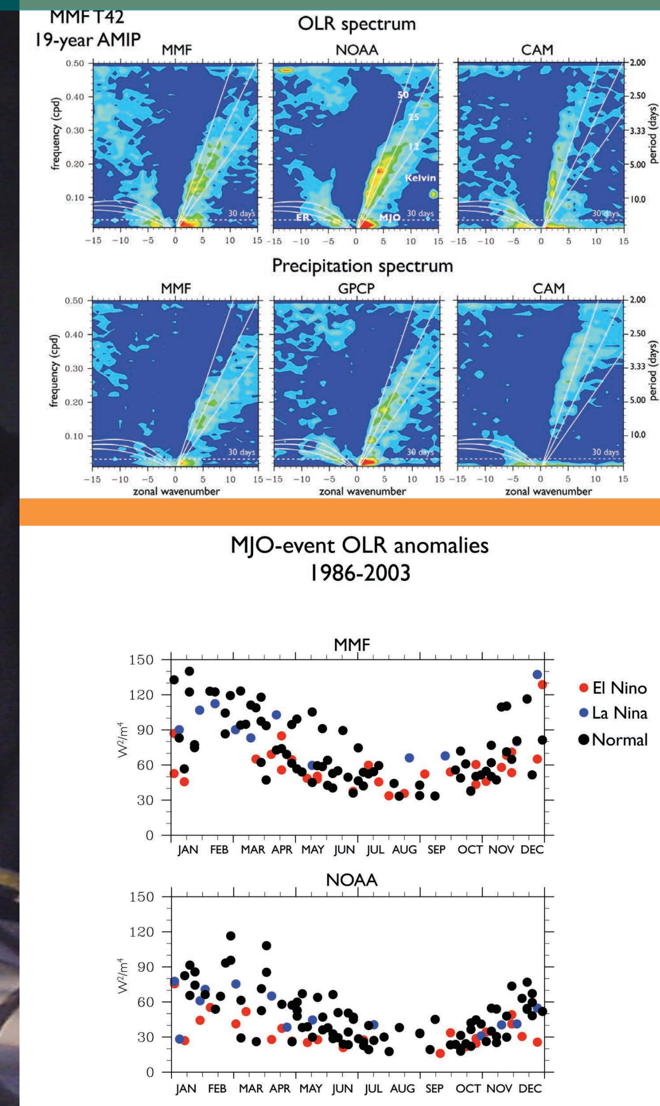
Broader education is part of CMMAP's strategy as well, with outreach to local stakeholders at the forefront. CMMAP is creating a series of pamphlets on climate change that are developed in conjunction with workshops for regional stakeholders, including farmers and water managers.

CMMAP has the advantage of being situated at Colorado State University, where there is already an active educational outreach program called the Little Shop of Physics, which reaches over 15,000 K-12 students with hands-on experiments every year. The "Little Shop" also produces a television series called Everyday Science that airs on Rocky Mountain Public Television. A DVD of the series is expected to be available soon.

CMMAP works with both of these initiatives, providing materials, information, and hands-on experiments. And because Little Shop of Physics is primarily run by undergraduate students at CSU, the effort delivers a double impact.

"The undergraduates have lots of face time with the kids, learning about teaching and learning about working with schools," says CMMAP education director Scott Denning. "We're delivering the material, but we're also developing science educators."

CMMAP also is one of the collaborators on a set of Web-based outreach tools called "Windows to the Universe," providing science materials to the public.



ABOUT THE MADDEN-JULIAN OSCILLATION

The El Niño and La Niña meteorological phenomena have been much in the news in recent years. An El Niño event occurs when unusually warm surface waters in the western Pacific Ocean, near Asia, flow eastward toward the west coast of South America. This flow of warm water toward the Americas prevents upwelling of nutrient-rich, cold, deep water and disrupts regional and global weather patterns. It tends to occur at intervals of two to seven years and usually lasts from several months to a year or more.

However, there are also phenomena lasting less than a season that still have large effects on weather on a global scale. One of the most infamous of these is the Madden-Julian Oscillation, or the MJO.

Residents in the Pacific Northwest know the MJO by another name, the Pineapple Express, with its propensity to drown the West Coast of the United States with as much as 20 inches of rain in a month during the winter.

The MJO is about a 40- to 50-day oscillation that affects weather variations in the tropics, most notably in the Indian and western Pacific Oceans. The MJO involves variations in wind, sea surface temperature, cloudiness, and rainfall. These events begin over the Indian Ocean and move slowly eastward over the Pacific.

Tracking and predicting the movements of the MJO may help researchers assess whether conditions are conducive to tropical storm development during the Atlantic hurricane season and may help West Coast residents deal with future drenchings.

KNOWLEDGE TRANSFER

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— SCOTT DENNING
CMMAP EDUCATION DIRECTOR

Photo: University Corporation for Atmospheric Research

THE CMMAP LEGACY

Beyond the formal education programs in place, CMMAP has two primary projects in the works for disseminating information on a broader scale.

The first is a book called *A History of Atmospheric General Climate Modeling.* The field of atmospheric science is getting old enough that some of its roots are being forgotten. The book documents methods of modeling, including numerical weather prediction and circulation models through their creation and development, as understood by the founders and giants of the field.

The second initiative is the launch of a new technical journal, likely entitled Journal of Advances in Modeling the Earth System. The journal is expected to have a nonspecialist section for broader audiences interested in climate science.