ISSUE 1, FALL 2011

CMMAP NEWS

Reach for the sky.

To keep the CMMAP Team Connected and Informed

MEET THE INTERNS - SUMMER 2011

Student	University	Major/Minor	Mentor
Brittany Fields	Colorado State University	Environmental Engineering	Tom Vonder Haar
Jennifer Gahtan	University of Miami	Meteorology/Math	Dave Randall
Julie Huang	University of Chicago	Geophysics and Public Policy	Michele Betsill
Jason Keefer	State University of NY - Albany	Atmospheric Science/Math	Thomas Birner
Molly Morman	Colorado College	Environmental Science/French	Sonia Kreidenweis
Moises Garcia Rosa	University of Puerto Rico-Mayaguez	Ind. Biotechnology/Meteorology	Sonia Kreidenweis
Ian Shiach	Colorado College	Environmental Science/Spanish	Ian Baker
Dustin Snare	California Univ. of Pennsylvania	Meteorology/GIS/Math	Chris Kummerow
Jessica Taheri	Millersville University	Meteorology/Math	Wayne Schubert
Chun-Chih (David) Wang	Pennsylvania State University	Meteorology/Geoscience	Dick Johnson
Keri Younger	Embry Riddle Aeronautical Univ.	Applied Meteorology/Math	Eric Maloney

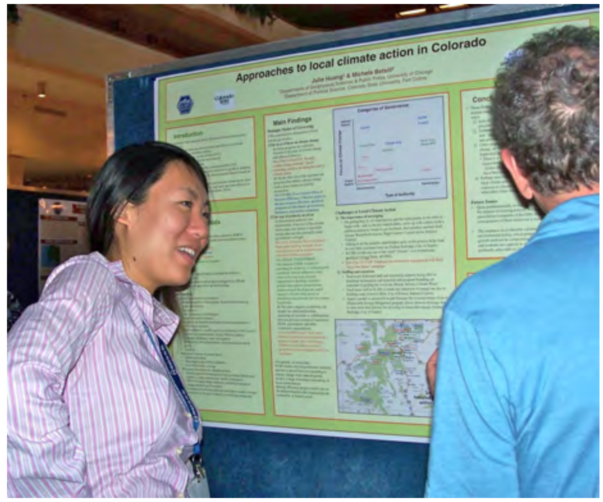
Pictured from top left to right, Jennifer, Ian, Moises, David, Jessica, Brittany, Molly, Jason, Keri and Dustin visiting NCAR

For more information on our Interns, please visit the CMMAP website at: http://www.cmmap.org/scienceEd/internships.html

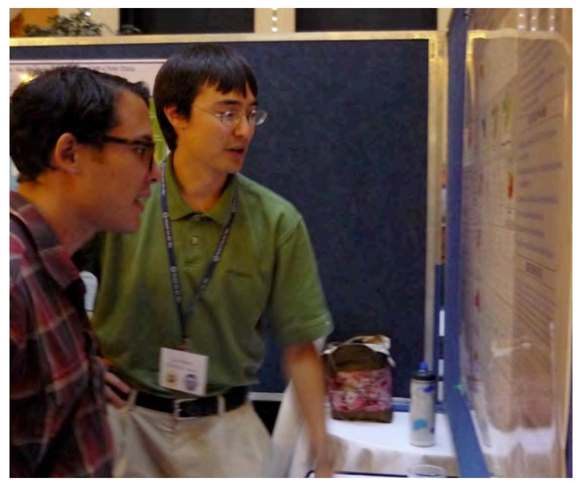
CMMAP INTERNS (CONT'D.)

Summer is a busy time at CMMAP. Our summer undergraduate internship program has been bringing fresh faces and ideas to the Colorado State University campus for the last five years. Our numbers have grown with a total of 42 interns who have participated in our 10 week research experience. The summer internship gives undergraduate students the opportunity to conduct innovative and cutting-edge research in Atmospheric Science and Climate Policy. Each summer, students with majors ranging from Meteorology, Physics and Chemistry to Math, Environmental Science and Engineering, join world class Atmospheric Scientists to investigate the science of clouds, climate, weather, and policy. CMMAP offers interns a broad range of research areas: climate modeling, cloud processes, atmospheric chemistry, tropical meteorology, hurricanes, climate policy, and much more.

Each intern has a mentoring team, which consists of a CMMAP faculty mentor, research mentor, and community mentor. The internship program introduces interns to the intensive research environment of CMMAP and the graduate student experience. Through partnership's with the Graduate School, CMMAP undergraduate interns interact with other residential internship programs at CSU, including being co-housed, participating in seminars and engaging in social activities. Our interns participate in a variety of seminars throughout the summer including: learning effective oral and written communication, getting into graduate school, and our CMMAP Student Colloquium. The CMMAP Student Colloquium is an opportunity for CMMAP graduate students and summer undergraduate interns across four institutions to develop contacts and learn together in a small group setting that is specifically designed to meet the needs of our students. Past colloquium topics have been: writing research proposals, reviewing manuscripts, supercomputing, climate policy and politics, 100 views of climate change, and climate, careers and teaching.



Julie Huang discusses her poster with Professor Scott Denning



Parker Kraus - CMMAP Intern 2007 and current CMMAP grad student, scopes out Ian Shiach's poster

To see more on what our interns have been doing please visit the CMMAP website at: http://www.cmmap.org/scienceEd/internships.html

To see more posters, please follow this link: http://www.cmmap.org/research/docs/aug11/posters.html

TEACHER TRAINING COURSE

— Melissa Burt, CSU

Science teachers in public schools face a difficult challenge to educate tomorrow's leaders about climate and global change while meeting state standards in physics, environmental, and Earth sciences. Scott Denning, Director of Education and Diversity for CMMAP, and Brian Jones, Director of the Little Shop of Physics, have developed a 2-credit course on Weather and Climate for Teachers that combines advanced undergraduate content with pedagogical innovation and a library of classroom inquiry modules to give teachers the tools they need to succeed. The course is taught during the summer to avoid conflicting with teachers' busy academic-year schedules, and presents a semester's worth of material in five action-packed days.

Dr. Thomas Birner and Adam Pearlstein portray Issac Newton and Edmond Halley combining history and science to help introduce Dr. Birner's lesson on the trade winds.

Standards-based course content is organized by "following the energy" from the Sun through the atmosphere to the Earth's surface and back to space, driving wind, weather, and ocean currents along the way. It is divided into 10 half-day units, each of which is taught according to the "Five E's: Engage, Explore, Explain, Extend, and Evaluate." We begin with a "bang" by surprising teachers with a 5-minute classroom experience (Engage) that challenges their assumptions and piques their curiosity. This is followed by a longer inquiry activity (Explore) in which participants learn basic physical principles of climate by hands-on experimentation. Formal academic content is then presented through in lecture format with notes and visual aids (Explain), after which teachers spend an hour or so working in groups to solve problems in depth (Extend). Each unit culminates in a discussion of how the activities and content could fit into existing curricula and classrooms, and how the unit itself could be improved (Evaluate). This past year we have incorporated a sixth "E", Exploration, which introduces how some of these Atmospheric Science concepts were explored and discovered. Thomas Birner, CSU Atmospheric Science Professor, joined the course this year, playing the role of historical scientists Teisserenc de Bort and Edmond Halley.

The course has so far been offered to 170 K-12 teachers over five summers, and is available as a "kit" including all science content, media, and inquiry activities at http://www.cmmap.org. Course participation has been expanded to emphasize underrepresented groups and underserved school districts in the region, and from large urban districts nationwide. Over the last 3 years we have reached out to teachers who are affiliated with CSU's Alliance Partnership and most recently with teachers from the Pine Ridge Reservation in South Dakota.

Teachers receive a stipend for their participation, as well as breakfast and lunch each day and about three large boxes of classroom supplies to allow them to easily use or adapt the inquiry activities to their own lessons. They submit a written lesson plan to receive University credit, which is important for their own professional development. We also want the next generation of leading climate modelers to be excellent teachers, so graduate students at the Center participate in every aspect of the course, and lead the Extend sections of each unit. They gain valuable classroom experience in a fun but very intense week of work.

Dr. Scott Denning on Finding Common Ground with Climate-Change Contrarians.

"At least this year they didn't bring hockey sticks! In late June I attended the Heartland Institute's 6th International Conference on Climate Change (ICCC) in Washington DC." - Dr. Scott Denning

Trust is almost completely missing in a dialog about climate change with a dismissive group. Appeals to "overwhelming scientific consensus" are more likely to confirm the audience's suspicions of some kind of nefarious conspiracy than to change minds. Even the concept of peer review can sound sinister.

How then, to meaningfully engage climate-change contrarians in a way that is informative, persuasive, and productive? Here are some lessons from my experiences:

Begin from common ground. At ICCC I proposed that we could all agree that "we need public policy based on facts, rather than facts based on a political agenda," and received thunderous applause. Rather than start with time-series graphs that all turn up sharply at the end, I started with a question: "Did you ever wonder why it's warmer during the day than at night? Warmer in summer than winter? Warmer in Miami than Minneapolis?" The answer is that when more heat is added to the Earth's surface than subtracted, temperatures rise. If you don't like the weather, wait five minutes. But if you don't like the climate, you'll have to move. Climate changes very slowly and is very predictable. We can predict that the world will warm in the 21st century for precisely the same reason that we can predict that Miami is warmer than Minneapolis, and with the same kind of confidence.

Engage the audience on a human level. I tell jokes. I wiggle and dance and make funny noises on stage to imitate the absorption of thermal radiation by greenhouse gas molecules. I explain that climate and global change is not rocket science, that each and every one in the audience is plenty smart enough to understand the basic physics of climate change from their own everyday experience. I invoke ordinary examples from daily life in almost every slide. I build credibility and a personal connection with the audience, and when it is time, I seek to challenge their preconceptions from this base of trust.

Emphasize the basics. Here are some relevant facts that are not in dispute:

Burning coal, oil, and natural gas releases both energy to run modern economies and carbon dioxide gas.

CO2 molecules emit more heat than other molecules of air at the same temperature. This was first measured in 1863 by John Tyndall, and the emission spectrum has been repeatedly measured thousands of times since, with precisely the same result.

Heat warms things up. Though credited to 19th-century Europeans as the first law of thermodynamics, this idea is much older and could instead be called the Law of Ugh! Hot!

CO2 is chemically nonreactive in the air and close to being balanced biologically, so much of the CO2 our descendents emit in the next hundred years will stay in the air for many centuries.

Taken together, these indisputable facts lead to the conclusion that continued burning of fossil fuels will warm the climate. You don't have to believe experts, and there doesn't have to be an overwhelming consensus behind them. It just makes sense for the same reason that a teapot placed on a hot stove will get hot.

There remains a huge gap between the pieces of common ground I found with the ICCC and the reluctance of climate-change doubters to recognize the gravity of the climate problem. Indeed, the backdrop used in one of the sessions included the question "Global Warming: Was It Ever Really a Crisis?"

If there is to be any hope of bridging this gap, it will take the committed and respectful participation of mainstream climate scientists in settings that may lie outside their comfort zones. James Taylor says he has invited dozens to attend ICCC and has been almost completely unsuccessful. It seems to me that strong, persuasive engagement of the dismissive segment of the public is important and can be effective. I would certainly do this again, and I would encourage like-minded colleagues who can afford the time to join me.

To Learn More About Our August Team Meeting......

Thanks to everyone who was able to attend the team meeting this August. To see all the presentations, photos, and to get details about Monday's Education and Diversity Retreat, please go to this link: http://www.cmmap.org/research/meetings.html on the CMMAP website.

Jay Fein says Adieu. Jay has been the Project Manager for CMMAP since it's inception. Jay has decided it is time to take life a little easier. We all wish him the very best as he scales down his work at The National Science Foundation.

Upcoming Events:

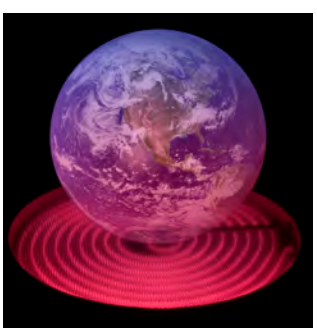
The Colorado Global Climate Conference - October 17, 2011 at Lory Student Center, CSU - http://www.cmmap.org/scienceEd/cgcc11/

James Balog - November 7-9, coming to Atmos November 9th. http://www.jamesbalog.com/pages/publications.php

CMMAP Team Meeting - January 10-12, 2012 in Fort Lauderdale, Flordia

LSOP Open House - February 25, 2012 at the Lory Student Center, CSU

Education and Diversity Retreat - February 28, 2012 at UCAR



Climate Sense

ClimateSense is a new, online, open access publication for university students, scientists and scholars, and the broader general public.

Our aim is to foster cross-disciplinary conversations about current topics related to the Earth's climate, and to promote climate literacy. What sets us apart is that we foster connections and encourage exchange among many fields, including physical, natural, and social sciences, humanities, and the arts.

ClimateSense plans to go live at the end of 2011. In the meantime, we are looking for people to:

➡Give us feedback on our focus and website design;

➡Submit your original article, or links to interesting content related to the Earth's climate;

➡Recommend a colleague (or yourself) as an editor.

Please visit the ClimateSense website for more details at www.climatesense.org.

New Objective Team Leads and Working Groups for Research in CMMAP Years 6-10

Objectives		Working Groups
1. Further development of global models with diverse representations of cloud processes	Randall & Konor	Dynamical frameworks
2. Further development and testing of improved parameterizations of microphysics, turbulence and radiation	Moeng & Morrison	Physical processes
3. Application of CMMAP models to study multiscale interactions of the atmosphere and land surface	Denning & Bonan	Land surface
4. Application of CMMAP models to study the coupled climate system	Stan & DeMott	Coupled Modeling
5. Community-based evaluation of results produced by CMMAP models, through the use of diverse observations	Bretherton & Blossey	Cloud-Climate Interactions, including CFMIP and the YOTC MJO Intercomparison
6. Management, analysis and visualization of very large model ouput datasets -- creation of infrastructure	Helly & Schuchardt	Cyberinfrastructure

As part of our new strategic plan we have made modifications to our objectives and corresponding working groups.

This has been done in large part to stay current with our research activities.

We are very much looking forward to the research that will take place during our renewal period and are very proud of the work that has been done!

Brian Jones Receives Robert A. Millikan Award for 2011

A sea of tie dyed tee shirt wearers give a standing ovation as Brian Jones accepts the Millikan Medal.

The Robert A. Millikan Medal for 2011 was presented to Brian Jones for his work as the developer and director of the Little Shop of Physics at the American Association of Physics Teachers (AAPT) annual Team Meeting held in August in Omaha, Nebraska. In describing Mr. Jones to the AAPT Awards Committee, former AAPT President Chris Chiaverina said, “His lifelong passion for communicating both the content and beauty of physics to diverse audiences is exemplary; his impact on his students, his colleagues, the local, national and international physics teaching community, and the public is extraordinary. Simply stated, Brian Jones is an evangelist for physics.”

Student's Corner

Congratulations to all CMMAP supported graduate students who have received their PhD's.

We wanted to provide updates on where our PhD students have gone and what they are doing since attaining their PhD's.

CSU, Sociology - *Candace May* is currently a post doc working for Mike Lacy.

CSU, Political Science -
Nicole Detraz is a Professor at the University of Memphis, Department of Political Science specializing in international relations and environmental politics.

CSU, Psychology -
Stefanie Aki Hosoi is a Psychologist in San Francisco, CA working for the Dept. of Veteran Affairs Medical Center

Samantha Farro is a licensed psychologist working in Denver, CO and is actively involved in the Colorado Psychological Association.
Erin Winterrowd is an Assistant Professor in Psychology at the University of Wisconsin Oshkosh.

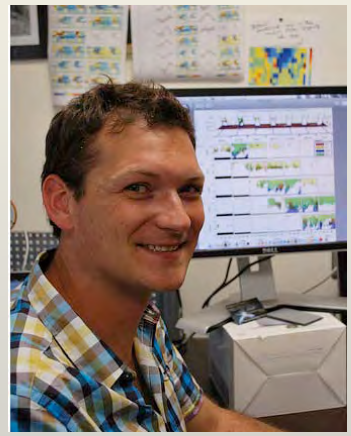
CSU Atmospheric Science -
Maike Ahlgrimm is at the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, UK.
Jim Benedict is working as a postdoctoral fellow with Dr. Eric Maloney of the Atmospheric Science department at CSU.
Ian Baker is a Research Scientist II in Scott Denning's lab at the Atmospheric Science Department, College of Engineering, CSU.
Levi Silvers is a post doc working for Wayne Schubert.
Greg Elsaesser is starting a Research Scientist I position here at CSU in Chris Kummerow's group.

From the University of Utah:
Ruiyu Sun is an Associate in the Environmental Modeling Center at NOAA in Camp Springs, Maryland.
Peter Bogenschutz is a Project Scientist 1 in the Atmospheric Modeling and Predictability section of Climate and Global Dynamics Division at NCAR.

From UCLA:
Brian Medeiros is at NCAR in the Climate and Global Dynamics Division: Atmospheric Modeling & Predictability.
Chien-Ming Wu is a Professor of Atmospheric Sciences at the National Taiwan University.

From Scripps:
Mike Pritchard is a postdoc at the University of Washington with Chris Bretherton and Tom Ackerman, supported by a NOAA fellowship.

Revkin on Pritchard



A recent paper by Mike Pritchard, written when he as still a CMMAP supported student is mentioned in a New York Times Article by Andrew Revkin about the April 2011 tornado outbreaks.

The article can be accessed at the CMMAP website as follows:

http://dotearth.blogs.nytimes.com/2011/06/01/closeup-aprils-tornado-outbreaks/

Nancy Baron, Outreach Director of the Communication Partnership for Science and the Sea (COMPASS), Aldo Leopold Leadership Program, speaks to young scientists from Colorado State University during the Environmental Science Communication Workshop.

Communication Workshop for CSU Graduate Students

In Spring 2011, The School of Global Environmental Sustainability (SOGES), the Graduate Degree Program in Ecology, and the Center for Multiscale Modeling of Atmospheric Processes (CMMAP) sponsored the 2011 Environmental Science Communication Workshop for 23 doctoral and post-doc Fellows. Jim Benedict, a CMMAP post-doc, attended the workshop and has provided a brief overview of the two-day event. Other CMMAP graduate students attending were Parker Kraus, and Rachel McCrary.

It is the age of information. It is bombarding us from all directions. As part of the mass media explosion, global climate change is receiving more attention. The jobs of journalists—and the scientists they interview—has become critically important. Journalists report on cutting-edge science for the curious public. They artfully filter an abundance of information and package it for literary scholars, astrophysicists, local and national government officials, and the voters who elect them. Members of the media can strongly influence public opinion and thereby impact public policy. When scientists speak directly to the public, the journalist filter is bypassed. Both young and veteran scientists must learn to accurately communicate their research findings to non-specialists...and soon.

On May 9-10, thirty doctoral and postdoctoral students from Colorado State University (CSU) participated in the 2011 Environmental Science Communications Workshop, which was sponsored by the School of Global Environmental Sustainability, the Graduate Degree Program in Ecology, and the Center for Multiscale Modeling of Atmospheric Processes. I had the privilege of participating in this workshop, and it made clear the rewards, risks, and responsibilities that come with stepping into the public eye.

"Step out of your comfort zone," were the words on a slide during the workshop's opening presentation–complete with an image of a gauge and its needle pivoting reluctantly from green to red.

Speaking to the media and the public, as it turns out, is not at all like speaking to other scientists at a conference. I sensed then that "thunderstorms" would be replacing "deep moist convection" in my vocabulary until further notice. During the workshop, we learned that skill is essential to becoming an effective communicator, to know who the audience is and how to adapt the message to fit them. Are they knowledgeable about the subject? Will they be receptive to the message? How can I make the topic more interesting? We learned that answering these questions before speaking to the media or developing a public speech makes it much easier to engage the audience and communicate our findings and ideas successfully.

Another important topic that emerged from the workshop was the challenge for many of us young scientists to see and understand how our concentrated area of research relates to "The Big Picture," which includes the connections among the branches of science and between science and society. Too often we become so focused on the details of our research—investigating why something behaves as it does—that we forget its broader context and why we study it in the first place. The links among society, animals, plants, soils, water, and weather, and how these connections might be altered by climate change, were brought to the forefront during our workshop discussions.

As global climate change and its impacts on our society and the environment continue to make headlines, we as scientists will be called upon to explain to the public what our lab results, computer models, and field experiments mean to them and to the world. Programs like the 2011 Environmental Science Communications Workshop at CSU provide young scientists with the tools required to effectively communicate with any audience, and to face the challenges of stepping out of our comfort zone.

Thanks to everyone who submitted abstracts. They are listed below alphabetically by first author.

Toward unification of the multiscale modeling of the atmosphere.

Arakawa, A., Joon-Hee Jung, and Chien-Ming Wu, 2011: Atmos. Chem. Phys., 11, 3731-3742. doi: 10.5194/acp-11-3731-2011.

As far as the representation of deep moist convection is concerned, only two kinds of model physics are used at present: highly parameterized as in the conventional general circulation models (GCMs) and explicitly simulated as in the cloud-resolving models (CRMs). Ideally, these two kinds of model physics should be unified so that a continuous transition of model physics from one kind to the other takes place as the resolution changes. With such unification, the GCM can converge to a global CRM (GCRM) as the grid size is refined. This paper suggests two possible routes to achieve the unification. ROUTE I continues to follow the parameterization approach, but uses a unified parameterization that is applicable to any horizontal resolutions between those typically used by GCMs and CRMs. It is shown that a key to construct such a unified parameterization is to eliminate the assumption of small fractional area covered by convective clouds, which is commonly used in the conventional cumulus parameterizations either explicitly or implicitly. A preliminary design of the unified parameterization is presented, which demonstrates that such an assumption can be eliminated through a relatively minor modification of the existing mass-flux based parameterizations. Partial evaluations of the unified parameterization are also presented. ROUTE II follows the "multi-scale modeling framework (MMF)" approach, which takes advantage of explicit representation of deep moist convection and associated cloud-scale processes by CRMs. The Quasi-3D (Q3D) MMF is an attempt to broaden the applicability of MMF without necessarily using a fully three-dimensional CRM. This is accomplished using a network of cloud-resolving grids with large gaps. An outline of the Q3D algorithm and highlights of preliminary results are reviewed.

Multiscale modeling of the moist-convective atmosphere – A review.

Arakawa, A, and Joon-Hee Jung, 2011: Atmospheric Research (Accepted for publication). doi: 10.1016/j.atmosres.2011.08.009.

Multiscale modeling of the moist-convective atmosphere is reviewed with an emphasis on the recently proposed approaches of unified parameterization and Quasi-3D (Q3D) Multiscale Modeling Framework (MMF). The cumulus parameterization problem, which was introduced to represent the multiscale effects of moist convection, has been one of the central issues in atmospheric modeling. After a review of the history of cumulus parameterization, it is pointed out that currently there are two families of atmospheric models with quite different formulations of model physics, one represented by the general circulation models (GCMs) and the other by the cloud-resolving models (CRMs). Ideally, these two families of models should be unified so that a continuous transition of model physics from one kind to the other takes place as the resolution changes. This paper discusses two possible routes to achieve the unification. ROUTE I unifies the cumulus parameterization in conventional GCMs and the cloud microphysics parameterization in CRMs. A key to construct such a unified parameterization is to reformulate the vertical eddy transport due to subgrid-scale moist convection in such a way that it vanishes when the resolution is sufficiently high. A preliminary design of the unified parameterization is presented with supporting evidence for its validity. ROUTE II for the unification follows the MMF approach based on a coupled GCM/CRM, originally known as the "super-parameterization". The Q3D MMF is an attempt to broaden the applicability of the super-parameterization without necessarily using a fully three-dimensional CRM. This is accomplished using a network of cloud-resolving grids with gaps. The basic Q3D algorithm and highlights of preliminary results are reviewed. It is suggested that the hierarchy of future global models should form a "Multiscale Modeling Network (MMN)", which combines these two routes. With this network, the horizontal resolution of the dynamics core and that of the physical processes can be individually and freely chosen without changing the formulation of model physics. Development of such a network will represent a new phase of the history of numerical modeling of the atmosphere that can be characterized by the keyword "unification".

Surface ecophysiological behavior across vegetation and moisture gradients in Amazonia.

Baker, I.T., H.R. da Rocha, A.B. Harper, A.S. Denning, A.C. Araujo, L.S. Borma, H.C. Frietas, M.L. Goulden, A.O. Manzi, S.D. Miller, A.D. Nobre, N. Restrepo-Coupe, S.R. Saleska, R. Stockli, C. von Randow, S.C. Wofsy, 2011: Agricultural and Forest Meteorology, in review.

Surface ecophysiology at 6 sites across vegetation and moisture gradients is investigated. From the moist northwest (Manaus) to the relatively dry southeast (Pe de Gigante) simulated seasonal cycles of latent, sensible, and carbon flux produced with the Simple Biosphere Model (SiB3) are confronted with observational data. In the northwest, abundant moisture is available suggesting that these ecosystems are light-limited. In the wettest regions, Bowen ratio is consistently low, with little or no annual cycle. Carbon flux shows little or no annual cycle as well; efflux and uptake are determined by high-frequency variability in light and moisture availability. Moving downgradient in annual precipitation amount, dry season length is more clearly defined. In these regions, a dry season sink of carbon is observed and simulated. This sink is the result of the combination of increased photosynthetic production due to higher light levels, and decreased respiratory efflux due to soil drying. The differential response time of photosynthetic and respiratory processes produce observed annual cycles of net carbon flux. At dryer regions, moisture and carbon fluxes are in-phase; there is carbon uptake during seasonal rains and efflux during the dry season. At the driest regions (cerrado, or savanna), there is also a large annual cycle in latent and sensible heat flux. The transition forest, or cerradao, is a highly heterogeneous region incorporating elements of forest and savanna. Our simulations closely resemble a previously described cerradao site, but have substantive differences from the transition forest site explored in this study.

Impacts of Idealized Air–Sea Coupling on Madden–Julian Oscillation Structure in the Superparameterized CAM.

Benedict, J. J., and D. A. Randall, 2011: J. Atmos. Sci., 68, 1990-2008.

Air–sea interactions and their impact on intraseasonal convective organization are investigated by com- paring two 5-yr simulations from the superparameterized Community Atmosphere Model version 3.0 (SP-CAM). The first is forced using prescribed sea surface temperatures (SSTs). The second is identical except that a simplified oceanic mixed-layer model is used to predict tropical SST anomalies that are coupled to the atmosphere. This partially coupled simulation allows SSTs to respond to anomalous surface fluxes. Implementation of the idealized slab ocean model in the SP-CAM results in significant changes to intra- seasonal convective variability and organization. The more realistic treatment of air–sea interactions in the coupled simulation improves many aspects of tropical convection on intraseasonal scales, from the re- lationships between precipitation and SSTs to the space–time structure and propagation of the Madden–Julian oscillation (MJO). This improvement is associated with a more realistic convergence structure and longitudinal gradient of SST relative to MJO deep convection. In the uncoupled SP-CAM, SST is roughly in phase with the MJO convective center and the development of the Kelvin wave response and boundary layer convergence east of the convective center is relatively weak. In the coupled SP-CAM, maxima in SST lead maxima in MJO convection by 1/4 cycle. Coupling produces warmer SSTs, a stronger Kelvin wave re- sponse, enhanced low-level convergence, and increased convective heating ahead (east) of the MJO con- vective center. Convective development east of the MJO precipitation center is more favorable in the coupled versus the uncoupled version, resulting in more realistic organization and clearer eastward propagation of the MJO in the coupled SP-CAM.

Monsoon Intraseasonal Oscillations as simulated by Superparameterized Community Atmosphere Model.

Bidyut B. Goswami, Neena Joseph Mani, P. Mukhopadhyay, D. E. Waliser, J. J. Benedict, E. D. Maloney, M. Khairoutdinov and B. N. Goswami, 2011: under revision Journal of Geophysical Research-Atmosphere

The relative success of the Community Atmosphere Model with superparameterized convection (SP-CAM) in simulating the space-time characteristics of the Madden Julian Oscillation (MJO) encourages us to examine its simulation of the Indian summer monsoon and monsoon intra-seasonal oscillations (MISOs). While the model simulates the onset and withdrawal of the Indian monsoon realistically, it has a significant wet bias in boreal summer precipitation over the Asian monsoon region. The space-time characteristics of the MISOs simulated by the SP-CAM are examined in detail and compared with those of the observed MISO to gain insight into the model's bias in
simulating the seasonal mean. During northern summer, the model simulates a 20-day mode and a 60-day mode in place of the observed 15-day and 45-day modes, respectively. The simulated 20-day mode

- *Bidyut B. Goswami, Neena Joseph Mani, P. Mukhopadhyay, D. E. Waliser, J. J. Benedict, E. D. Maloney, M. Khairoutdinov and B. N. Goswami, 2011 (Continued)*

appears to have no observed analogue with a baroclinic vertical structure and strong northward propagation over Indian longitudes. The simulated 60-day mode seems to be a lower frequency version of the observed 45-day mode with relatively slower northward propagation.

The model's underestimation of light rain events and overestimation of heavy rain events are shown to be responsible for the wet bias of the model. More frequent occurrence of heavy rain events in the model is, in turn, related to the vertical structure of the higher frequency modes. Northward propagation of the simulated 20-day mode is associated with a strong cyclonic vorticity at low levels north of the heating maximum associated with a smaller meridional scale of the simulated mode. The simulated vertical structure of heating indicates a strong maximum in the upper troposphere between 200 and 300 hPa. Such a heating profile seems to generate a higher order baroclinic mode response with smaller meridional structure, stronger low level cyclonic vorticity, enhanced low level moisture convergence and higher precipitation. Therefore, the vertical structure of heating simulated by cloud resolving model within SP-CAM may hold the key for improving the precipitation bias in the model.

Accomplishments and challenges for a diversity of women in science, technology, engineering, and mathematics education and occupations.

Byars-Winston, A., & Canetto, S. S. (2011). .Journal of Women and Minorities in Science and Engineering, 17, 1-3.

Two critical forces are shaping the future of science, technology, engineering, and mathematics (STEM) in the United States. One is the accelerating need for a scientifically and technologically competent workforce (National Science Board, 2003). Reflecting this labor market demand, the STEM occupations growth expected between the years 2004 and 2014 is 22o/o-almost double that of all other occupations (Commission on Professionals in Science and Technology, 2006; Terrell, 2007). Computer specialists and engineers will account for the largest share of this growth (Bureau of Labor Statistics, 2009a; Carnevale, Smith, & Strohl, 2010). The national demand for STEM workers already exceeds the national supply of STEM-trained individuals.

The second critical force is the increasing diversity of individuals in higher education and in the workforce. For instance, college enrollment and labor market participation of women and ethnic minorities have dramatically increased over the last three decades (National Center for Education Statistics, 2009). More than 59% of women were in the labor force in 2008 (Bureau of Labor Statistics, 2009b). At the same time, women and some ethnic minorities (i.e., African-Americans, Latinas/os, and Native Americans) are not evenly distributed across fields of studies and occupations. STEM education and careers stand out for their limited diversity, specifically for the underrepresentation of women and some ethic minorities.

Women's withdrawal from STEM fields appears to start in college. Although as many girls as boys leave high school prepared for STEM studies, in the first year of college women are less likely than men to indicate an intention to major in STEM disciplines [National Science Foundation (NSF), 2009]. By graduation, women are a minority in almost every STEM field. In some STEM disciplines, including engineering, women represent less than 20% of college graduates. Women's participation in STEM declines further at the graduate level, and again at the transition to the workplace [American Association of University Women (AAUW), 2010J. At the same time, patterns of female STEM interest and persistence vary depending on ethnicity. For example, African American women demonstrate persistent interest and involvement in science and are more likely to be employed in science eight years after high school than European American women (Hanson, 2004; Hanson & Palmer-Johnson, 2000). However, the number women occupations is very low, comprising about 3% of the more than 18 million and engineers employed in 2006 (NSF, 2009).

Sensitivity of a simulated squall line to horizontal resolution and parameterization of microphysics.

Bryan, G., and H. Morrison, 2011: Mon Wea. Rev. (in press)

Idealized simulations of the 15 May 2009 squall line from VORTEX2 are evaluated in this study. Four different microphysical setups are used, with either single-moment (1M) or double-moment (2M) microphysics, and either hail or graupel as the dense (rimed) ice species. Three different horizontal grid spacings are used: Dx = 4, 1, or 0.25 km (with identical vertical grids). Overall, results show that simulated squall lines are sensitive to both microphysical setup and horizontal resolution, although some quantities (i.e., surface rainfall) are more sensitive to Dx in this study. Simulations with larger Dx are slower to develop,

- *Bryan, G., and H. Morrison, 2011 - Continued*

produce more precipitation, and have higher cloud tops, all of which are attributable to larger convective cells that do not entrain mid-level air. The highest-resolution simulations have substantially more cloudwater evaporation which is partly

attributable to the development of resolved turbulence. For a given Dx, the 1M simulations produce less rain, more intense cold pools, and do not have trailing stratiform precipitation at the surface, owing to excessive rainwater evaporation. The simulations with graupel as the dense ice species have unrealistically wide convective regions. Comparison against analyses from VORTEX2 data show that the 2M setup with hail and Dx = 0.25 km produces the most realistic simulation because: this simulation produces realistic distributions of reflectivity associated with convective, transition, and trailing-stratiform regions; the cold pool properties are reasonably close to analyses from VORTEX2; and relative humidity in the cold pool is closest to observations.

Improved low-cloud simulation from a multiscale modeling framework with a third-order turbulence closure in its cloud-resolving model component.

Cheng, A and K.- M Xu, 2011: J. Geophys. Res., 116, D14101, doi:10.1029/2010JD015362, published 16 July 2011.

In the original multiscale modeling framework (MMF), the Community Atmosphere Model (CAM3.5) is used as the host general circulation model (GCM), and the System for Atmospheric Modeling model with a first-order turbulence closure is used as the cloud resolving model (CRM) for representing cloud physical processes in each grid column of the GCM. This study introduces an upgrade of the MMF in which the first-order turbulence closure scheme is replaced by an advanced third-order turbulence closure in its CRM component. The results are compared between the upgraded and original MMFs, CAM3.5, and observations. The global distributions of low-level cloud amounts in the subtropics in the upgraded MMF show substantial improvement relative to the original MMF when both are compared with observations. The improved simulation of low-level clouds is attributed not only to the representation of subgrid-scale condensation in the embedded CRM but also is closely related to the increased surface sensible and latent heat fluxes, the increased lower tropospheric stability (LTS), and stronger longwave radiative cooling. Both MMF simulations show close agreement in the vertical structures of cloud amount and liquid water content of midlatitude storm-track clouds and subtropical low-level clouds, compared with observations, with the upgraded MMF being better at simulating the low-level cumulus regime. Since the upgraded MMF produces more subtropical low-level clouds and does not produce an excessive amount of optically thick high-level clouds in either the tropics or midlatitudes as the original MMF does, the global mean albedo decreases. The positive bias in albedo and longwave cloud radiative forcing (CRF) and negative bias in shortwave CRF are reduced in the tropical convective regions.

Publication productivity and career advancement by female and male psychology faculty: The case of Italy.

D'Amico, Rita; Vermigli, Patrizia; Canetto, Silvia Sara, Journal of Diversity in Higher Education, Vol 4(3), Sep 2011, 175-184. doi: 10.1037/a0022570

In the United States, women tend to publish less than men do and to be overrepresented at the lower ranks of academia. This study examined the scientific productivity and career status of female and male psychology faculty in Italian universities. Psychology was selected as a discipline because for decades, it has had a female majority among its doctorates. Italy was the case study country because it has one of the highest representations of women among university faculty. This study's questions were: What is the representation of female psychology academics across faculty and high administration ranks? Is the publication productivity of female psychology academics different from that of their male peers? Finally, what institutional factors are associated with publication productivity among psychology academics? Our study focused on the 511 university psychology professors (250 women and 261 men) listed in 2004 in the Italian Ministry of Education University and Research website. We examined scientific productivity over 7 years, from 1998 to 2004, using PsycINFO. We found that women represented two thirds of assistant professors but only one third of full professors and department chairs. Overall, women published somewhat less (approximately one third less) than men, especially in international journals and as senior authors. However, consistent with prior evidence, when multiple predictors were considered together, both academic rank and institutional setting, but not sex-of-faculty, were associated with publication output. This study confirms prior observations that a strong female doctoral pipeline and scientific productivity are very slow at influencing the underrepresentation of women at the top ranks of academia.

The Asian Monsoon in the Super-Parameterized CCSM and its Relationship to Tropical Wave Activity.

DeMott C.A., C. Stan, D.A. Randall, J. L. Kinter III, and M. Khairoutdinov, 2011: submitted: Journal of Climate

Three general circulation models (GCMs) are used to analyze the impacts of air–sea coupling and super-parameterized (SP) convection on the Asian summer monsoon: CCSM (coupled, conventional convection), SP-CAM (uncoupled, SP convection) and SP-CCSM (coupled, SP). In SP-CCSM, coupling improves the basic-state climate relative to SP-CAM, and reduces excessive tropical variability in SP-CAM. Adding SP improves tropical variability, the simulation of easterly zonal shear over the Indian and western Pacific Oceans, and increases negative sea surface temperature (SST) biases in that region.

SP-CCSM is the only model to reasonably simulate the eastward-, westward-, and northward-propagating components of the Asian monsoon. CCSM and SP-CCSM mimic the observed phasing of northward-propagating intraseasonal oscillation (NPISO) SST, precipitation, and surface stress anomalies, while SP-CAM is limited in this regard. SP14 CCSM produces a variety of tropical waves with spectral characteristics similar to those in observations. Simulated equatorial Rossby (ER) and mixed Rossby-gravity (MRG) waves may lead to different simulations of the NPISO in each model. Each model exhibits some northward propagation for ER waves, but only SP-CCSM produces northward-propagating MRG waves, as in observations. The combination of ER and MRG waves over the Indian Ocean influences the spatio-temporal structure of the NPISO, and contributes to the differences seen in each model.

The role of ocean coupling must be considered in terms of the timescale of the SST response compared to the timescale of tropical variability. High-frequency disturbances experience coupling via its changes to the basic state, while lower-frequency disturbances may respond directly to SST fluctuations.

Indirect impact of atmospheric aerosols in idealized simulations of convective-radiative quasi-equilibrium. Part 2: Double-moment microphysics.

Grabowski, W. W., and H. Morrison, 2011: J. Climate, 24, 1897-1912.

This paper extends the previous cloud-resolving modeling study concerning the impact of cloud microphysics on convective–radiative quasi equilibrium (CRQE) over a surface with fixed characteristics and prescribed solar input, both mimicking the mean conditions on earth. The current study applies sophisticated double-moment warm-rain and ice microphysics schemes, which allow for a significantly more realistic representation of the impact of aerosols on precipitation processes and on the coupling between clouds and radiative transfer. Two contrasting cloud condensation nuclei (CCN) characteristics are assumed, representing pristine and polluted conditions, as well as contrasting representations of the effects of entrainment and mixing on the mean cloud droplet size. In addition, four sets of sensitivity simulations are also performed with changes that provide a reference for the main simulation set.

As in the previous study, the CRQE mimics the estimates of globally and annually averaged water and energy fluxes across the earth's atmosphere. There are some differences from the previous study, however, consistent with the slightly lower water vapor content in the troposphere and significantly reduced lower-tropospheric cloud fraction in current simulations. There is also a significant reduction of the difference between the pristine and polluted cases, from 20 to 4 W m−2 at the surface from 20 to 9 W m−2 at the top of the atmosphere (TOA). The difference between the homogeneous and extremely inhomogeneous mixing scenarios, 20 W m−2 in the previous study, is reduced to a mere 2 (1) W m−2 at the surface (TOA). An unexpected difference between the previous and current simulations is the lower Bowen ratio of the surface heat flux, the partitioning of the total flux into sensible and latent components. It is shown that most of the change comes from the difference in the representation of rain evaporation in the subcloud layer in the single- and double-moment microphysics schemes. The difference affects the mean air temperature and humidity near the surface, and thus the Bowen ratio. The differences between the various simulations are discussed, contrasting the process-level approach with the impact of cloud microphysics on the quasi-equilibrium state with a more appropriate system dynamics approach. The key distinction is that the latter includes the interactions among all the processes in the modeled system.

The Role of Moisture–Convection Feedbacks in Simulating the Madden–Julian Oscillation.

Hannah, W. M., and E.D. Maloney, 2011: J. Climate, 24, 2754–2770.

The sensitivity of a simulated Madden–Julian oscillation (MJO) was investigated in the NCAR Community Atmosphere Model 3.1 with the relaxed Arakawa–Schubert convection scheme by analyzing the model's response to varying the strength of two moisture sensitivity parameters. A higher value of either the minimum entrainment rate or rain evaporation fraction results in increased intraseasonal variability, a more coherent MJO, and enhanced moisture–convection feedbacks in the model. Changes to the mean state are inconsistent between the two methods. Increasing the minimum entrainment leads to a cooler and drier troposphere, whereas increasing the rain evaporation fraction causes warming and moistening. These results suggest that no straightforward correspondence exists between the MJO and the mean humidity, contrary to previous studies.

Analysis of the mean column-integrated and normalized moist static energy (MSE) budget reveals a substantial reduction of gross moist stability (GMS) for increased minimum entrainment, while no significant changes are found for an increased evaporation fraction. However, when considering fluctuations of the normalized MSE budget terms during MJO events, both methods result in negative GMS prior to the deep convective phase of the MJO. Intraseasonal fluctuations of GMS, rather than the mean, appear to be a better diagnostic quantity for testing a model's ability to produce an MJO.

Optimized Icosahedral Grids: Performance of Finite-Difference Operators and Multigrid Solvers

Heikes R. P. , David A. Randall and Celal S. Konor, 2011: JAMES, submitted July, 2011

The use of the icosahedral hexagon/pentagon grids is becoming increasingly prevalent in global atmosphere models because the grids have excellent uniformity and isotropy. This paper discusses the grid generation and optimization, performance of finite-difference Laplacian, Jacobian and divergence operators, and construction of the two- and three-dimensional multigrid-based elliptic solvers. Two different grid optimization procedures, the tweaking and spring dynamics are introduced. Error convergence analyses of the three operators show that the grid optimization is essential for the accuracy. The tweaked grid overall performs better in these analyses than the sprung grid.

This paper also examines the performance of the two- and three-dimensional multigrid solvers with the optimized icosahedral hexagon/pentagon grids. The three-dimensional elliptic solver is constructed by combining a horizontal multigrid procedure with a vertically implicit (tridiagonal) solver. The solutions converge super linearly in both two- and three-dimensional applications. The computational performance of the multigrid solvers is also presented, which indicates excellent parallel scaleability up to 80000 processors.

Women in graduate engineering: Is differential dropout a factor in their underrepresentation among the engineering doctorates?

Hosoi, S. A., & Canetto, S. S. (2011). Journal of Women and Minorities in Science and Engineering, 17, 11-27.

In the United States, women represent at most 20% of doctoral-level engineers. Differential dropout has been proposed as an explanation, but few studies have tested this theory for women in graduate engineering programs. Additionally, past research has not taken into consideration how the influx of foreign students into graduate engineering programs may affect women's proportionate enrollment and degree completion. To address these gaps, this study examined factors associated with enrollment and degree completion of female and male students (n = 470) in graduate engineering programs at a state university between 1990 and 2004. Women comprised 14% of graduate engineering students, but were as likely as men to complete doctoral degrees when factors associated with graduation (e.g., final GPA, engineering field) were considered. Among U.S. citizens, women had higher rates of degree completion than men, while the opposite was observed for foreign nationals. If replicated across institutions, these findings suggest that differential enrollment, not differential dropout, is the dominant factor in women's underrepresentation among engineering doctorates. This study's findings also point to the importance of examining the intersection of gender and culture to understand and support engineering educational choices, persistence, and success.

On constraining estimates of climate sensitivity with present-day observations through model.

Klock, D., R. Pincus, J. Quaas, 2011: Climate In Journal of Climate (25 May 2011) doi:10.1175/2011JCLI4193.1

The distribution of model-based estimates of equilibrium climate sensitivity has not changed substantially in more than 30 years. Efforts to narrow this distribution by weighting projections according to measures of model fidelity have so far failed, largely because climate sensitivity is independent of current measures of skill in current ensembles of models. This work presents a cautionary example showing that measures of model fidelity that are effective at narrowing the distribution of future projections (because they are systematically related to climate sensitivity in an ensemble of models) may be poor measures of the likelihood that a model will provide an accurate estimate of climate sensitivity (and so degrade distributions of projections if they are used as weights). Furthermore, it appears unlikely that statistical tests alone can identify robust measures of likelihood.

The conclusions are drawn from two ensembles: one obtained by perturbing parameters in a single climate model, and a second containing the majority of the world's climate models. The simple ensemble reproduces many aspects of the multi-model ensemble, including the distributions of skill in reproducing the present-day climatology of clouds and radiation, the distribution of climate sensitivity, and the dependence of climate sensitivity on certain cloud regimes. Weighting by error measures targeted on those regimes permits the development of tighter relationships between climate sensitivity and model error and hence narrower distributions of climate sensitivity in the simple ensemble. These relationships, however, do not carry into the multi-model ensemble. This suggests that model weighting based on statistical relationships alone is unfounded and perhaps that climate model errors are still large enough that model weighting is not sensible.

Design of a Dynamical Core Based on the Nonhydrostatic Unified System of Equations.

Konor, C.S., 2011: JAMES, submitted 7/2011.

This paper presents the design of a dry dynamical core based on the nonhydrostatic "unified system" of equations. The unified system filters vertically propagating acoustic waves. The dynamical core predicts the potential temperature and horizontal momentum. It uses the predicted potential temperature to determine the quasi-hydrostatic components of the Exner pressure and density. The continuity equation is diagnostic (and used to determine vertical mass flux) because the time derivative of the quasi-hydrostatic density is obtained from the predicted potential temperature. The nonhydrostatic component of the Exner pressure is obtained from an elliptic equation. The main focus of this paper is on the integration procedure of this unique dynamical core. Height is used as the vertical coordinate, and the equations are vertically discretized on a Lorenz-type grid. Cartesian horizontal coordinates are used along with an Arakawa C-grid. A detailed description of the discrete equations is presented with the rationale behind the decisions made during the discretization process.

The performance of the model in simulating a wide range of dynamical scales is demonstrated through idealized extratropical cyclogenesis simulations, and warm and cold bubble test cases. The results show that the dynamical core performs successfully in all these experiments.

Comparison of two-moment bulk microphysics schemes in idealized supercell thunderstorm simulations.

Morrison, H., and J. A. Milbrandt, 2011: Mon. Wea. Rev., 139, 1103-1130.

Idealized three-dimensional supercell simulations were performed using the two-moment bulk microphysics schemes of Morrison and Milbrandt-Yau in the WRF (Weather Research and Forecasting) model. Despite general similarities in these schemes, the simulations were found to produce distinct differences in storm structure, precipitation, and cold pool strength. In particular, the Morrison scheme produced much higher surface precipitation rates and a stronger cold pool, especially in the early stages of storm development. A series of sensitivity experiments was conducted to identify the primary differences between the two schemes that resulted in the large discrepancies in the simulations.

Different approaches in treating graupel and hail were found to be responsible for many of the key differences between the baseline simulations. The inclusion of hail in the baseline simulation using the Milbrant-Yau scheme with two rimed-ice categories (graupel and hail) had little impact, and therefore resulted in a much different storm than the baseline run with the single-category (hail) Morrison scheme. With graupel as the choice of the single rimed-ice category, the simulated storms had considerably more frozen condensate in the anvil region, a weaker cold pool, and reduced surface precipitation compared to the runs with only hail, - -

- *Morrison, H., and J. A. Milbrandt, 2011: Mon. Wea. Rev., 139, 1103-1130. (Contined)*

whose higher terminal fall velocity inhibited lofting. The cold pool strength was also found to be sensitive to the parameterization of raindrop breakup, particularly for the Morrison scheme, due to the effects on the drop size distributions and the corresponding evaporative cooling rates. The use of a more aggressive implicit treatment of drop breakup in the baseline Morrison scheme, by limiting the mean-mass raindrop diameter to a maximum of 0.9 mm, opposed the tendency of this scheme to otherwise produce large mean drop sizes and a weaker cold pool compared to the hail-only run using the Milbrandt-Yau scheme.

Intercomparison of cloud model simulations of Arctic mixed-phase boundary layer clouds observed during SHEBA.

Morrison, H., P. Zuidema, A. S. Ackerman, A. Avramov, G. de Boer, J. Fan, A. M. Fridlind, T. Hashino, J. Y. Harrington, Y. Luo, M. Ovchinnikov, and B. Shipway, 2011: J. Adv. Mod. Earth Systems, Vol. 3, M06003, 23 pp., doi: 10.1029/2011MS000066.

An intercomparison of six cloud-resolving and large-eddy simulation models is presented. This case study is based on observations of a persistent mixed-phase boundary layer cloud gathered on 7 May, 1998 from the Surface Heat Budget of Arctic Ocean (SHEBA) and First ISCCP Regional Experiment - Arctic Cloud Experiment (FIRE-ACE). Ice nucleation is constrained in the simulations in a way that holds the ice crystal concentration approximately fixed, with two sets of sensitivity runs in addition to the baseline simulations utilizing different specified ice nucleus (IN) concentrations. All of the baseline and sensitivity simulations group into two distinct quasi-steady states associated with either persistent mixed-phase clouds or all-ice clouds after the first few hours of integration, implying the existence of multiple states for this case. These two states are associated with distinctly different microphysical, thermodynamic, and radiative characteristics. Most but not all of the models produce a persistent mixed-phase cloud qualitatively similar to observations using the baseline IN/crystal concentration, while small increases in the IN/crystal concentration generally lead to rapid glaciation and conversion to the all-ice state. Budget analysis indicates that larger ice deposition rates associated with increased IN/crystal concentrations have a limited direct impact on dissipation of liquid in these simulations. However, the impact of increased ice deposition is greatly enhanced by several interaction pathways that lead to an increased surface precipitation flux, weaker cloud top radiative cooling and cloud dynamics, and reduced vertical mixing, promoting rapid glaciation of the mixed-phase cloud for deposition rates in the cloud layer greater than about 122610–5 g kg–1 s–1 for this case. These results indicate the critical importance of precipitation-radiative-dynamical interactions in simulating cloud phase, which have been neglected in previous fixed-dynamical parcel studies of the cloud phase parameter space. Large sensitivity to the IN/crystal concentration also suggests the need for improved understanding of ice nucleation and its parameterization in models.

Orogenic Propagating Precipitation Systems over the United States in a Global Climate Model with Embedded Explicit Convection.

Pritchard, Michael S., M. W. Moncrieff, R. C. J. Somerville, 2011: *J. Atmos. Sci.*, 68, 1821–1840. doi: 10.1175/2011JAS3699.1

In the lee of major mountain chains worldwide, diurnal physics of organized propagating convection project onto seasonal and climate time scales of the hydrologic cycle, but this phenomenon is not represented in conventional global climate models (GCMs). Analysis of an experimental version of the superparameterized (SP) Community Atmosphere Model (CAM) demonstrates that propagating orogenic nocturnal convection in the central U.S. warm season is, however, representable in GCMs that use the embedded explicit convection model approach [i.e., multiscale modeling frameworks (MMFs)]. SP-CAM admits propagating organized convective systems in the lee of the Rockies during synoptic conditions similar to those that generate mesoscale convective systems in nature. The simulated convective systems exhibit spatial scales, phase speeds, and propagation speeds comparable to radar observations, and the genesis mechanism in the model agrees qualitatively with established conceptual models. Convective heating and condensate structures are examined on both resolved scales in SP-CAM, and coherently propagating cloud "metastructures" are shown to transcend individual cloud-resolving model arrays. In reconciling how this new mode of diurnal convective variability is admitted in SP-CAM despite the severe idealizations in the cloud-resolving model configuration, an updated discussion is presented of what physics may transcend the re-engineered scale interface in MMFs. The authors suggest that the improved diurnal propagation physics in SP-CAM are mediated by large-scale first-baroclinic gravity wave interactions with a prognostic organization life cycle, emphasizing the physical importance of preserving "memory" at the inner resolved scale.

The multi-scale aerosol-climate model PNNL-MMF: model description and evaluation.

Wang, M; S. J. Ghan, R. C. Easter, M. Ovchinnikov, X. Liu, E. Kassianov, Y. Qian, W. Gustafson, V. E. Larson, D. Schanen, M. Khairoutdinov, and H. Morrison, 2011: Geoscientific Model Development., 4, 137–168.

Anthropogenic aerosol effects on climate produce one of the largest uncertainties in estimates of radiative forcing of past and future climate change. Much of this uncertainty arises from the multi-scale nature of the interactions between aerosols, clouds and large-scale dynamics, which are difficult to represent in conventional general circulation models (GCMs). In this study, we develop a multi-scale aerosol-climate model that treats aerosols and clouds across different scales, and evaluate the model performance, with a focus on aerosol treatment. This new model is an extension of a multi-scale modeling framework (MMF) model that embeds a cloud-resolving model (CRM) within each grid column of a GCM. In this extension, the effects of clouds on aerosols are treated by using an explicit-cloud parameterized-pollutant (ECPP) approach that links aerosol and chemical processes on the large-scale grid with statistics of cloud properties and processes resolved by the CRM. A two-moment cloud microphysics scheme replaces the simple bulk microphysics scheme in the CRM, and a modal aerosol treatment is included in the GCM.With these extensions, this multi-scale aerosol-climate model allows the explicit simulation of aerosol and chemical processes in both stratiform and convective clouds on a global scale.

Simulated aerosol budgets in this new model are in the ranges of other model studies. Simulated gas and aerosol concentrations are in reasonable agreement with observations (within a factor of 2 in most cases), although the model underestimates black carbon concentrations at the surface by a factor of 2–4. Simulated aerosol size distributions are in reasonable agreement with observations in the marine boundary layer and in the free troposphere, while the model underestimates the accumulation mode number concentrations near the surface, and overestimates the accumulation mode number concentrations in the middle and upper free troposphere by a factor of about 2. The overestimation of accumulation model number concentrations in the middle and upper free troposphere is consistent with large aerosol mass fraction above 5 km in the MMF model compared with other models. Simulated cloud condensation nuclei (CCN) concentrations are within the observational variations. Simulated aerosol optical depths (AOD) are in reasonable agreement with observations (within a factor of 2), and the spatial distribution of AOD is consistent with observations, while the model underestimates AOD over regions with strong fossil fuel and biomass burning emissions. Overall, this multiscale aerosol-climate model simulates aerosol fields as well as conventional aerosol models.

Aerosol indirect effects in a multi-scale aerosol-climate model PNNL-MMF

Wang, M., S. Ghan, M. Ovchinnikov, X. Liu, R. Easter, E. Kassianov, Y. Qian, R. Marchand, and H. Morrison, 2011:, Atmos. Chem. & Phys., 11, 5431-5455, doi:10.5194/acp-11-5431-2011.

Much of the large uncertainty in estimates of anthropogenic aerosol effects on climate arises from the multiscale nature of the interactions between aerosols, clouds and dynamics, which are difficult to represent in conventional general circulation models (GCMs). In this study, we use a multi-scale aerosol-climate model that treats aerosols and clouds across multiple scales to study aerosol indirect effects.

This multi-scale aerosol-climate model is an extension of a multi-scale modeling framework (MMF) model that embeds a cloud-resolving model (CRM) within each vertical column of a GCM grid. The extension allows a more physicallybased treatment of aerosol-cloud interactions in both stratiform and convective clouds on the global scale in a computationally feasible way. Simulated model fields, including liquid water path (LWP), ice water path, cloud fraction, shortwave and longwave cloud forcing, precipitation, water vapor, and cloud droplet number concentration are in reasonable agreement with observations. The new model performs quantitatively similar to the previous version of the MMF model in terms of simulated cloud fraction and precipitation.

The simulated change in shortwave cloud forcing from anthropogenic aerosols is -0.77Wm-2, which is less than half of that (-1.79Wm-2) calculated by the host GCM (NCAR CAM5) with traditional cloud parameterizations and is also at the low end of the estimates of other conventional global aerosol-climate models. The smaller forcing in the MMF model is attributed to a smaller (3.9 %) increase in LWP from preindustrial conditions (PI) to present day (PD) compared with 15.6% increase in LWP in stratiform clouds in CAM5. The difference is caused by a much smaller response in LWP to a given perturbation in cloud condensation nuclei (CCN) concentrations from

Wang, M., S. Ghan, M. Ovchinnikov, X. Liu, R. Easter, E. Kassianov, Y. Qian, R. Marchand, and H. Morrison, 2011:, Atmos. Chem. & Phys., 11, 5431-5455, doi:10.5194/acp-11-5431-2011.(Continued)

PI to PD in the MMF (about one-third of that in CAM5), and, to a lesser extent, by a smaller relative increase in CCN concentrations from PI to PD in the MMF (about 26% smaller than that in CAM5). The smaller relative increase in CCN concentrations in the MMF is caused in part by a smaller increase in aerosol lifetime from PI to PD in the MMF, a positive feedback in aerosol indirect effects induced by cloud lifetime effects from aerosols. The smaller response in LWP to anthropogenic aerosols in the MMF model is consistent with observations and with high resolution model studies, which may indicate that aerosol indirect effects simulated in conventional global climate models are overestimated and point to the need to use global high resolution models, such as MMF models or global CRMs, to study aerosol indirect effects. The simulated total anthropogenic aerosol effect in the MMF is -1.05Wm-2, which is close to the Murphy et al. (2009) inverse estimate of -1.1±0.4Wm-2 (1) based on the examination of the Earth's energy balance. Further improvements in the representation of ice nucleation and low clouds in MMF are needed to refine the aerosol indirect effect estimate.

Fast cloud adjustment to increasing CO2 in a superparameterized climate model.

Wyant, M. C., C.S. Bretherton, P. N. Blossey, and M. Khairoutdinov, M., 2011: JAMES, submitted 7/2011.

Two-year simulation experiments with a superparameterized climate model, SP-CAM, are performed to understand the fast tropical (30S-30N) cloud response to an instantaneous quadrupling of CO2 concentration with SST held fixed at present-day values.

The greenhouse effect of the CO2 perturbation quickly warms the tropical land surfaces by an average of 0.5 K. This shifts rising motion, surface precipitation, and cloud cover at all levels from the ocean to the land, with only small net tropical-mean cloud changes. There is a widespread average reduction of about 80 m in the depth of the trade inversion capping the marine boundary layer over the cooler subtropical oceans. One apparent contributing factor is CO2-enhanced downwelling longwave radiation, which reduces boundary-layer radiative cooling, a primary driver of turbulent entrainment through the trade inversion.
A second contributor is a slight CO2-induced heating of the free troposphere above the MBL, which strengthens the trade inversion and also inhibits entrainment. There is a corresponding downward displacement of marine boundary layer clouds with a very slight decrease in mean cloud cover and albedo.

Two-dimensional cloud-resolving model (CRM) simulations of this cloud-topped boundary-layer response are run to steady state using composite SP-CAM simulated thermodynamic and wind profiles from a representative cool subtropical ocean regime, for the control and 4xCO2 cases. Simulations with a CRM grid resolution equal to that of SP-CAM are compared with much finer resolution simulations. The coarse-resolution simulations maintain a cloud fraction and albedo comparable to SP-CAM, but the fine-resolution simulations have a much smaller cloud fraction. Nevertheless, both CRM configurations simulate a reduction in inversion height comparable to SP-CAM. The changes in low cloud cover and albedo in the CRM simulations are small, but both simulations predict a slight reduction in low cloud albedo as in SP-CAM.

NEWS

This is the first issue of the CMMAP NEWS. We would very much like to hear from CMMAP Team Members with news and/or articles for future issues.

Please provide any information you would like to have considered for the newsletter to Marcia Donnelson, Editor.

EMAIL ADDRESS: marcia@atmos.colostate.edu