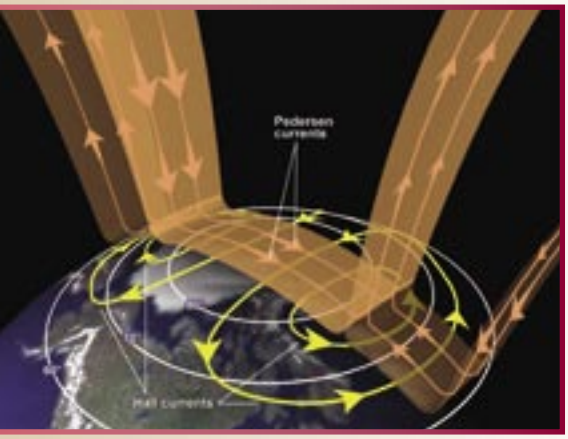
PROGNOSTICATORS AT

HOW UCAR HELPS TRAIN FORECASTERS

Peering into the future of the atmosphere is hard work, whether you're doing so as a professional forecaster or a student. Through on-site classes and workshops, distance learning tools, and a school-based observing program—all drawing on NCAR, UOP, and university expertise—UCAR helps educators, learners, and working forecasters better understand the weather and today's tools for predicting it.

Not only does "everybody talk about the weather," as Charles Dudley Warner observed more than a century ago: almost everyone talks about weather forecasts, too. Producing forecasts is another matter, though. Few people do it for a living, and those who've sampled the task know how tough it is to do well. Computer guidance now handles routine weather with skill, but it can be unreliable during extreme events—exactly when an accurate outlook is most needed.



Vivid diagrams show the forces that help shape auroras in an online module created by UOP's COMET program.

The knowledge and technique that undergirds modern weather prediction makes its way to a wide range of audiences through several UOP programs. Working forecasters brush up on their skills on site in Boulder or through online modules. NCAR helps middle-school teachers learn about computer modeling and its usefulness in the classroom. And by sampling the atmosphere themselves, schoolchildren discover the importance of weather observing. In each case, UCAR also helps create community. Peers meet in person or through the Internet, share perspectives, and join forces to comprehend the workings of the atmosphere.

A FOUNDRY FOR BETTER FORECASTING

History gives Teresa Murphy a sober recognition of the job she faces. Murphy is the hydrologist at the National Weather Service (NWS) office in Rapid City, South Dakota. Rapid Creek, which tumbles into town from the nearby Black Hills, lived up to its name in June 1972, when a devastating flash flood killed more than 200 people.

Murphy came to Boulder in August 2004 for a flash-flooding course at UOP's Cooperative Program for Operational Meteorology, Education and Training (COMET). "At the time," says Murphy, "I knew the course was good. But it wasn't until I got back to the office and started applying some of the information that I realized how good it was." Inspired by presentations in the class, she's been using geographic information system software to identify critical slopes and exposures across her region's rugged landscape. The new data may help predict not only flash flooding but wildfire behavior as well.

Hundreds of forecasters each year trek to Boulder for classes at COMET's on-site training facility. Laced with high-end communications tools, the classroom hosts up to 30 operational forecasters for each of its intensive courses, which run from several days to as long as six weeks. Lecturers from universities, NOAA, NCAR, and UOP deliver the latest research findings, while lab work enables the students to apply the knowledge to realistic forecast scenarios. Special courses keep university faculty and international students abreast of new science developments.

In many cases, the students are learning on behalf of colleagues. Each of the nation's 123 NWS forecast offices has specialists, called focal points, who are charged with keeping the office up to date on various topics: one for climate science, one for radar issues, and so forth. "There's really a pretty small staff at each office," says COMET classroom manager Wendy Abshire. "Focal points don't get many opportunities like these courses to meet people from other offices in similar roles."

Those who can't attend COMET's Boulder classes—including the public at large—have a smorgasbord of other learning options at hand through the program's award-winning MetEd Web site. Over 350 hours of distance-learning instruction covers topics that include coastal weather, satellite meteorology, hurricanes, and severe thunderstorms. With advanced undergraduates in mind, COMET teamed with NCAR's High Altitude Observatory to

WORK

AT FIRST

Boot camp for meteorologists

The front lines of armies during World War I inspired a group of scientists in Bergen, Norway, to name the weather features they'd analyzed "fronts." In the United States, the Great War had its own impact on meteorology. With only a handful of academic programs at the time, there were far too few meteorologists to meet wartime needs. A training school established at Texas A&M University in 1918 taught some 300 men, most with college-level science or engineering backgrounds, the basics of meteorology in a three-month program. Heading the school was the U.S. Weather Bureau's **Oliver Fassig,** *the first person to obtain a Ph.D. in meteorology and climatology (from Johns Hopkins University in 1899). After the war, Fassig returned to complete his 49-year career with the bureau, while others from the training course went on to help establish the American Meteorological Society in 1919.*

AT THE UNIVERSITIES

Bringing research into real-world prediction

James Moore (Saint Louis University) *applies his teaching and research skills to serve meteorologists around the country. A specialist in analyzing heavy rain and winter weather, Moore got involved with UOP's COMET program shortly after its inception in 1990. He's been both teacher and student, helping to lead several multiweek courses for National Weather Service staff and taking courses designed for university faculty. During his Boulder visits, Moore finds it easy to connect with NCAR scientists as well as NWS forecasters. "You meet a lot of interesting people and get a lot of ideas to spark research," says Moore. Through COMET's outreach program, which supports collaboration between the NWS and academia, Moore is involved in several studies aimed at predicting heavy precipitation across the Midwest. His group is working to better understand how thunderstorms propagate, as well as their precipitation efficiency—the percentage of in-cloud moisture that reaches the ground as rain or snow. "These are difficult parameters to get a handle on in the operational environment," says Moore, "yet they are critical for estimating the potential for heavy rain or snow." He adds, "There's no doubt in my mind that my association with COMET has dramatically improved both my teaching and research. I owe a lot to COMET."*

create its first nonmeteorological module in 2004, a guide to the physics behind the aurora.

Over the past 15 years, COMET's classroom courses have kept pace with changing priorities in the NWS and the military weather services. In the 2005 lineup, "there's a strong emphasis on flash flooding. It's still a huge safety issue," says Abshire. A new three-day course in the wake of September 11 tackles forecasting the dispersion of airborne materials.

COMET's on-site classes often serve as springboards for online modules, which are created when a broad enough audience exists to justify the added expense. "We capture key lectures in the classroom and convert them into something people can take at a distance whenever it's convenient for them," says Abshire. One of the growing crop of online modules related to climate features NCAR's Kevin Trenberth addressing the science of global climate change and human influences. The Trenberth lecture is one of a number of COMET products that reach an even wider audience via the Digital Library for Earth System Education, a community effort whose project office is based in UOP.

The opportunity to rub shoulders with world-renowned experts like Trenberth makes the COMET classroom unique among training options for forecasters, says Abshire. "It's exciting for them to be able to say, 'I met Rol Madden of the Madden-Julian Oscillation, and he taught me about the MJO.' They like the aspect of getting to interact with someone they've heard about their entire career."

Kids as observationalists

One of UOP's newest arrivals is one of its most ambitious. The GLOBE program stormed onto the education scene in 1994, championed by then–Vice President Al Gore. Its goal was to engage children around the world in Earth science by having them make weather and environmental observations on their home turf and report them via the Internet. The vast database would also serve as a resource for scientists examining the state of the planet and attempting to project its future.

GLOBE came under UCAR management in 2003, when the program had achieved much of the worldwide reach its founders had sought. Now supported by NASA, NSF, and the U.S. Department of State, GLOBE has trained some 25,000 teachers and engaged more than a million children in over 100 countries.

In 2004, a new director for GLOBE began contemplating a new approach for its second decade. Craig Blurton, an award-winning science educator from the University of Hong Kong, arrived to lead GLOBE through a lengthy process to evaluate which parts of the program were succeeding and which could be strengthened. As Blurton discovered, GLOBE's stellar potential was being underutilized: Many teachers left the program soon after training, fearful that their students' data wouldn't measure up or unsure how GLOBE might fit into their demanding teaching loads. And fewer scientists than expected were using GLOBE data.

While they pondered how to increase GLOBE's value to researchers and teachers, Blurton and his colleagues continued to involve many thousands of schoolchildren in creative ways of seeing the planet. On Earth Day 2004 and again that fall, GLOBE sponsored a contrail-counting event, inviting students worldwide to track and report the aircraft-produced clouds, which recent studies have found to have significant climate implications.

"We thought spotting contrails would be a fun and educational activity that could include more schools and the general public, since no instruments are required," says Margaret LeMone, who splits her time as an NCAR senior scientist and GLOBE's chief scientist. "The distribution of sightings tells us both where jets are flying and where weather conditions favor contrails forming."

GLOBE's strengths have been recognized—in 2004, the program earned a $25,000 Goldman Sachs Foundation Prize for Excellence in International Education—yet one of its more intangible benefits is its role in diplomacy. Each new country joins the program only after a formal, high-level agreement between that nation and the U.S. Department of State. "We're a program that carries very little political baggage. We're educational and scientific, and it excites people," says Blurton. He is encouraging new regional GLOBE consortia to identify topics of scientific and educational interest to their locales. In the Middle East, for example, a

Middle school educators share techniques while at NCAR for a summer workshop on geoscience modeling.

proposed set of teacher-training workshops is designed specifically for women.

"GLOBE has been seen as a terrific program, but U.S.-centric," adds Blurton. "If we're going to continue to thrive and succeed, we need to truly become international. We're moving in that direction."

Taking models out for a spin

The foundation of a computer forecast model—seemingly inscrutable to nonspecialists—can be simplified for use by middle and high school students, says UCAR's Sandra Henderson. "We use models to teach students all the time, but we don't always explicitly call them out as models. If you're building a cloud in a jar, or a tornado in a bottle, that's a model."

Henderson coordinated a two-week class in the summer of 2004 that brought 17 middle and high school science educators to Boulder to learn about modeling. Sponsored by NASA, the Modeling in the Geosciences Workshop explained how computer-based models are built, how Earth system scientists use them for research, and how teachers can use them in the classroom.

Although the models that spit out guidance on tomorrow's or next week's weather run on supercomputers, simplified models of the atmosphere can run on an everyday desktop machine. The teachers visiting NCAR learned about some streamlined computer models suitable for their students, and they returned with software ready to install in their schools.

"These models give students a chance to play 'what if?' games and to explore interactions within a complex system," says Roberta Johnson, UCAR's director of education and outreach. A student might decrease rainfall in a model, for example, and see how that affects vegetation and temperature—which, in turn, could affect future rainfall. "Done right," adds Henderson, "a model can be a very engaging tool."

The workshop content is in line with national standards for science education, and the participants each develop their own teaching units to complement the standards-based curriculum. The teachers share knowledge with peers in their districts while keeping in touch with other workshop graduates online and through follow-up meetings in Boulder.

NCAR sponsors a similar teacher-training workshop each summer on climate and global change. In both cases, competition is keen for the limited space, says Henderson. "We look for teachers who are leaders, who aren't afraid to go beyond established curricula, and who are always looking to challenge their students."

The workshop meshed well with the goals of Benjamin Sensen, a high-school teacher in Madison, Wisconsin. "I'm always looking for a way to make science real—to take real-world situations and techniques and bring them into the classroom. Modeling is ever-increasingly important to how science is really carried out in the world, so this was perfect."

Web links and updates to this article: www.ucar.edu/communications/highlights/2005

AT UOP & NCAR

Chief scientist for thousands of young observers

When the ten-year-old GLOBE program moved to UOP management in 2003, it sought a chief scientist with top research credentials and a passion for educating youngsters. It found both in **Margaret LeMone.** *Inspired to study weather at the age of eight after lightning struck her Missouri home, LeMone joined NCAR in 1972. She became a leader in studying clouds (including the vortices that produce cloud "streets") and momentum transfer in the atmosphere's ground-hugging, kilometer-thick boundary layer. Amid her frequent field work, LeMone found time to address countless groups of schoolchildren and to write a kid-friendly booklet, "The Stories Clouds Tell," published by the American Meteorological Society. The senior scientist now splits her time between NCAR research and GLOBE, where she works to boost the program's credibility among scientists and the usefulness to them of its data. GLOBE's focus on collecting close-at-hand environmental readings appealed to her. "One of the things that's really critical is to know what the land cover is," says LeMone, whose own work has increasingly dealt with heat and moisture exchange between Earth's surface and the boundary layer. For LeMone, the ultimate measure of success for GLOBE and related efforts would be "a generation of children who are sufficiently aware of the environment to be aware of its fragility, to be aware of our impact, and to act accordingly."*