EXPRESSO: Sampling a tropical atmospheric brew

by Robert Henson
UCAR Communications

Scientists from NCAR are working with an international group of collaborators on a major field study of the chemical and meteorological interactions between Africa’s rain forests and savannas and the atmosphere above them. The Experiment for Regional Sources and Sinks of Oxidants (EXPRESSION) will include two intensive study periods in 1996–97 that will last up to four weeks each.

Why Africa? The continent exerts a powerful influence on global air chemistry, says Patrick Zimmerman of NCAR’s Atmospheric Chemistry Division (ACD). Vast sections of grassland and forest are burned each year, pumping hydrocarbons and oxides of nitrogen (NO₃) into the air. These react in the presence of sunlight to produce ozone and other smoglike products. Satellite images sometimes show a bridge of tropospheric ozone that extends from Africa to South America. Ozone levels beneath these plumes can reach 100 parts per billion, roughly the same as on a high-pollution day in a major city.

Humans have been burning the African savanna for centuries to clear land for crops or a variety of other reasons. Though the burning isn’t new, the atmospheric effects—when combined with those of industrial processes—could be changing. The burning of the savanna has been shown to exert a dominant influence on the ecology and the atmospheric chemistry of most of the tropics through much of the year, say project planners. Because of the vast extent of the tropics, any understanding of global air chemistry has to come to grips with the chemical fluxes in and above the region. But that understanding has come slowly, if only because mounting a research project in a place like equatorial Africa is not easy.

EXPRESSION will perform an intensive survey of the atmosphere along Africa’s savanna-to-forest transition zone between 8° and 2°N. One of the first goals of the experiment was to choose a cross-sectional study area that would be politically and logistically feasible as well as representative of the larger surroundings. The Central African Republic (CAR) was a natural choice, in part because it is a former French colony, where the French have already done a lot of atmospheric chemistry research and where there’s a long history of collaboration between them and NCAR. Zimmerman and Lee Klinger, also of ACD, are serving as EXPRESSION’s U.S. coordinator and manager, respectively, in tandem with two French scientists, Robert Delmas and Jean-Pierre Lacaux of the Laboratory of Meteorology at Paul Sabatier University in Toulouse. Cooperative work between French and ACD scientists began in the 1980s with the Dynamics and Chemistry of the Atmosphere in Equatorial Forests experiment (whose French acronym is DECAFE).

EXPRESSION will build on the findings of DECAFE and other work in the area. “There have been a few

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Atmospheric chemist Lee Vierling samples gases emitted by plants in the Congo in preliminary studies to help plan the intensive field phases of EXPRESSION. (Photo by Lee Klinger.)
n 3 April 1995, a Pegasus rocket launched a small research satellite into a circular orbit of about 750 kilometers altitude. The disk-shaped satellite, which circles the earth every 100 minutes, carries a laptop-sized GPS (Global Positioning System) radio receiver to demonstrate sensing of the terrestrial atmosphere by a limb sounding technique. Each time this receiver rises and sets relative to the 24 operational GPS satellites, the GPS radio waves transit and are bent (refracted) by successive layers of the atmosphere before they reach the receiver. Thus, during each occultation, a vertical profile of refractivity is obtained. The refractivity is a function of pressure, temperature, and water vapor; GPS/MET (GPS/Meteorology) thus provides information on these variables that has the potential to be useful in weather prediction and weather and climate research.

The GPS/MET story is being told elsewhere; in this essay I describe one aspect of this program that touched me personally. GPS/MET was responsible for a renewal of my friendship and collaboration with the pioneer of satellite meteorology, Verner Suomi, who died at the age of 79 on 30 July 1995.

My first significant interaction with Vern was in 1965 at the University of Wisconsin–Madison in a graduate seminar in satellite meteorology. In those days satellite photographs from the TIROS series of satellites were mailed to Madison from Washington; they usually arrived a day or two after they were taken. But even with this delay and the relatively poor quality of the photographs, Vern’s enthusiasm and vision about the future of satellites and their unique role in studying the atmosphere were contagious and compelling.

Over the next 30 years our paths crossed from time to time, especially during Vern’s tenure as a UCAR trustee from 1983 to 1988. My last interactions with Vern began in January 1995, when I visited him in Madison to discuss the GPS/MET experiment. Even before the successful launch, Vern was a strong and effective advocate of the experiment, and was planning far ahead for his participation in the development of improved retrieval algorithms and the analysis of the data.

We continued our discussions over the next few months, and in May Vern participated in the production of a video describing GPS/MET and its potential. His excitement and enthusiasm came across strongly in this video, in spite of his deteriorating health.

My last contact with Vern was by telephone on 25 July, when he was in the hospital and was not expected to live for more than a few more days. He had asked that there be no further treatment or extraordinary measures taken to prolong his life. In our conversation, which lasted almost an hour, Vern was way ahead of me, as usual.

After expressing warm greetings and thanks for calling him, he jumped into a discussion of GPS/MET, saying the first results were extremely exciting and encouraging to him. He was, however, concerned about the loss of signal in the lower troposphere due to water vapor creating multiple radio wave paths. He thought we could make a guess at the water vapor and temperature structure, compute the ray path that would occur given this structure, and then select, based on this guess, the nearest path from the several that might be the actual one.

He then launched into a minilecture on how his experimental floating instrument to measure heat-flux over the ocean was working—very well, he said, measuring the fluxes with an accuracy of 2–3 Watts per square meter. The only problem was that birds used the instrument to rest on and this adversely affected the measurements.

Finally, he returned to a topic of lifetime interest to him: the hydrologic cycle. He reminded me of how important water vapor and evaporation are in the earth’s surface energy budget by telling me of his experience in Nebraska many years ago. On 21 June, with the sun as high in the sky as it gets, the daily temperature range over a dark green, wet cornfield was 15°C. Later that season, in September, when the sun was much lower in the sky but after the field and atmosphere had dried out, the daily temperature range was 30°C—twice the June value.

Enthusiastic and positive to the end, Vern’s voice was strong and his confidence and intellect as great as ever. He closed by saying that he had enjoyed his life immensely, had no regrets, was leaving many other competent scientists behind to carry on, and was ready to say good-bye.

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Rick Anthes
studies done in the continental tropics to measure ambient chemical concentrations and extrapolate those to other areas," Zimmerman notes, "but we still need to nail down the sources and sinks of important chemical species which may affect the regional and global oxidant balance."

To pave the way for EXPRESSO field work, Zimmerman and ACD scientist Alex Guenther went to Africa to scout potential study regions in January 1994. Klinger met with two French colleagues in the CAR and Congo later that year and has made two more trips to the republic this year, accompanied by other principals such as ACD deputy director Paul Sperry and logistics expert Karyn Sawyer (UCAR’s Joint International Climate Project/Planning Office). In January, the visitors covered over 2,000 kilometers in surveying the region.

The trips also have served as "pre-EXPRESSION" experiments, helping the researchers to focus the science for the intensive observing periods. On his most recent visit, Klinger and his colleagues collected volatile organic carbon emissions from a wide range of plant species and sampled ambient air concentrations.

The study region finally chosen extends from the northeast part of the CAR southward into the rain forests of the Congo. Across this band, about 800 kilometers long, average annual rainfall jumps from 80 to 180 centimeters per year. The north-south wobbling of the equatorial convergence zone produces wet conditions at the north end of the study area while the south is dry, with rains to the south when the north is dry. EXPRESSO plans to hold two intensives separated by about six months to capture the dynamics and chemistry of both climatic modes.

Fixed towers and tethered balloons at each of the four major field sites for EXPRESSO (listed below with the collaborators at each site) will allow for intensive sampling over areas ranging from the size of several football fields to several square kilometers. Collaboration with local CAR and Congolese scientists will take place at each location. The sites are

- **Awakaba**, CAR, a presidential hunting retreat with dry woodland savanna (Germany’s Max-Planck-Institut für Chemie)
- **Bogbale**, CAR, a moist woodland savanna near Bangui (Université de Toulouse, Université de Bangui, Centre National de la Recherche Scientifique [CNRS])
- **Maboké**, CAR, a secondary (recently disturbed) forest about 100 kilometers southwest of Bangui (CNRS; Washington State University; University of Lancaster, England)
- **Bomassa**, Congo, a national park operated by the Congolese government and the nonprofit Wildlife Conservation Society (University of Brazzaville)

Several students hope to glean material from the experiment for their doctoral dissertations. Lee Vierling, a NASA fellow and doctoral student at the University of Colorado, is working on characterization of remote sensing over tropical regions. Susan Canney (Oxford University, England) plans to do her dissertation on the effects of land-use change in central Africa.

Meteorological groundwork for EXPRESSO is being overseen by Greg Jenkins, a former postdoctoral fellow in the NCAR Advanced Study Program who is now at Pennsylvania State University. Jenkins plans to run the Penn State/NCAR mesoscale model, version 5 (MM5), for the study area before the intensives begin. The picture of local climate thus gained will help guide the deployment of radiosondes and ground-based stations.

"There’s never been a program in this region that has combined all the elements of photochemistry, biochemistry, and meteorology," says Zimmerman. "This could really be a landmark study for the atmospheric chemistry community.”

EXPRESSION details are available on the World Wide Web from the ACD home page:

http://acd.ucar.edu/

To view a CAR-produced video spotlighting the nation, contact Zimmerman (303-497-1406 or zimmer@ucar.edu). The July 1995 issue of National Geographic featured the Congolese national park that includes the Bomassa field site.
Education

Summer Employment Program:
Class of 1995

This year’s 12 participants in the UCAR Summer Employment Program (SEP) included four from last year, returning to pursue projects that built on their 1994 work. The purpose of SEP is to provide promising minority undergraduates with an opportunity to work on real-world problems under the guidance of an NCAR or UOP supervisor. During their ten-week stay in Boulder, the students conducted laboratory work, wrote software, composed papers on their projects, and prepared oral summaries. This immersion approach gives the students a realistic feel for the life of a working scientist, says Anna Reyna-Arcos, who manages the program. This year’s students are listed below, with their academic affiliations, majors, summer projects, and UCAR supervisors. Returnees from last year are marked with an asterisk.

**Roger Bautista**, Pacific Union College, applied mathematics. Used simple statistical techniques to analyze the success of monthly weather forecasts produced at NCAR. Ramalingam Saravananan, NCAR Climate and Global Dynamics Division (CGD).


*Edgar Estupiñan*, North Carolina State University, chemistry. Used several spectroscopic techniques to analyze the oxidation mechanisms of atmospheric hydrocarbons. John Orlando and Geoff Tyndall, NCAR Atmospheric Chemistry Division.


*Preston Heard*, Jackson State University, mathematics/meteorology. Researched and helped develop algorithms and translators to transfer data to and from the Cooperative Distributed Interactive Atmospheric Catalog System (CODIAC). Steven Williams, UOP Office of Field Project Support.

Linsey Marr, Harvard University, environmental engineering. Investigated observations and models of the carbon budget of northern forests and the potential effects of changing land use on atmospheric carbon dioxide. Kenneth Davis, NCAR Mesoscale and Microscale Meteorology Division (MMM).

**Joan Sanchez Nash**, Metropolitan State College of Denver, chemistry. Assessed the parameterization in numerical models of ice-crystal size distributions in tropical cirrus anvils. Gregory McFarquhar, MMM.

**Jennifer Price**, Bethune-Cookman College, aerospace engineering. Explored the relationship between atmospheric circulation above the North Atlantic and temperature/precipitation anomalies over adjacent land areas. James Hurrell, CGD.

* Sandra Pulido*, San Diego State University, mechanical engineering. Analyzed the performance of
the Solar/Stellar Irradiance Comparison Experiment Instrument. Dan Gablehouse, HAO.


Niranjan Sharma, University of Northern Colorado, engineering.

Analyzed cyclone formation over the continental United States and the western Atlantic Ocean using gridded analyses and numerical model output. Tomislava Vukicevic, CGD.

Lei Yu, Millersville University, computer science. Helped implement monitoring and analysis programs for the Internet Data Distribution system. Mitchell Baltuch, UOP Unidata.

For more information on SEP, contact Anna Reyna-Arcos (303-497-8706 or reyarc@ucar.edu).

SEPs success will help other students SOAR

Next year, a new five-year program funded by NSF and UCAR takes to the air from the SEP (Summer Employment Program) runway. UCAR’s Significant Opportunities in Atmospheric Research and Science (SOARS) will create a direct pipeline to bring ethnically diverse students into careers in the atmospheric and related sciences. Also participating in the program are a number of UCAR member and affiliate universities and historically black colleges.

The program was designed to help address a situation that its two principal investigators, UCAR’s Richard Anthes and Edna Comedy, describe as “bleak”: the low representation of minorities in the atmospheric sciences, especially at the Ph.D. level. A recent survey of the atmospheric sciences community by the American Meteorological Society found that out of 5,400 respondents only 0.7% were black, 1.4% were Hispanic, and 0.3% were Native American.

SOARS builds on what has been learned from the 15-year SEP (see accompanying article). SEP has been very successful; follow-up surveys and interviews of the 142 women and minorities who have completed it show most are proceeding with, or have completed, their atmospheric sciences education, and many credit the program with their decision to do so. But though SEP clearly gives these students a solid boost, Anthes and Comedy believe that more is needed in the way of seeing them through to careers in the atmospheric sciences. Hence SOARS.

SOARS has two primary goals: to bring a significant number of ethnically diverse students into the atmospheric and related sciences at the highest professional levels and to strengthen undergraduate and graduate research programs of all colleges and universities connected with it. It endeavors to provide not only academic education and training, but personal enrichment and mentoring as well.

SOARS will continue the SEP philosophy of providing real-world working experience under the guidance of scientific or technical mentors. It is structured to allow students maximum flexibility to explore different aspects of the atmospheric sciences and possibilities for graduate school. The program will support up to a dozen students in each of its five years. Each student’s first summer (usually after the sophomore year) will be much like SEP. Students will spend ten weeks at UCAR, working on selected research projects at NCAR or UOP under the guidance of scientific or technical mentors. Also like SEP, they will take a course in scientific and technical writing to prepare them for writing a paper and making an oral presentation on their research project, and will attend seminars to learn about education and career options in the atmospheric and related sciences.

After their first summer, students may apply to continue through the rest of the program by submitting a proposal on the research they wish to conduct and naming a choice of scientific or technical mentor. Continuing students will spend subsequent summers at participating universities or other research laboratories collaborating with mentors on publishable papers and/or conference presentations. During the school year SOARS students will maintain close ties with their UCAR mentors and may receive academic credit for SOARS activities or expand their initial projects into an honors project. Before completing their senior year they are encouraged to apply to a graduate program at one of the participating universities. Those accepted will receive full scholarships.

With current funding, the goal is for at least 32 SOARS participants to graduate with masters or doctoral degrees—more than doubling the
Six universities have already committed to participating in SOARS, says Comedy, and a larger number have expressed serious interest. The first students are already being recruited; they begin their work in Boulder in June 1996. For more information, contact Comedy (303-497-8705 or comedy@ucar.edu) or Anthes (303-497-1652 or anthes@ucar.edu). From federal (NSF) or state (Department of Education) sources. Generally, credit for such programs is offered either as graduate college credit (by 84% of respondents) or continuing education units.

University faculty continue to be significantly involved in judging science fairs (85%), giving guest lectures at schools (92%), and providing student field trips to their institutions' weather stations (82%). These activities are very commendable, says Smith. However, he adds that far greater return for the time invested can be achieved by providing instruction for teachers, who can then pass on their knowledge to students: "If you really want to improve things, work with the teachers and let the teachers work with the students." On the other hand, some faculty at responding institutions are actively involved in curriculum development, and many programs offer access to weather data (by computer or hard copy)—"excellent ways to enhance instruction."

Few institutions (only 21%) offer enrichment courses for promising elementary or high school students. Smith believes this represents a missed opportunity to reach students who might have an interest in science or might aspire to careers in meteorology or oceanography.

Both meteorology and oceanography courses are offered as electives or to satisfy science electives for nonscience majors at a high percentage of respondent institutions—81% for meteorology, 40% for oceanography. Meteorology courses are more likely to have a laboratory component than are oceanography courses (two-thirds vs. one-third). Meteorology courses also tend to have higher enrollments. In fact, says Smith, "I was surprised at the number of institutions reaching over 100 students a year. That's the good news. The bad news is, few of these...

Survey says...

Precollege education activities in the community: Good signs, and room for improvement

The results are in from a comprehensive survey on educational outreach in the atmospheric and oceanic science communities. The survey was conducted by a subcommittee of the UCAR Academic Affiliates chaired by David Smith of the U.S. Naval Academy. At the annual meeting of UCAR members' representatives last month in Boulder, Colorado, Smith reviewed the results, noting some encouraging news as well as possible areas for improvement in meteorological and oceanographic education.

The survey was designed to assess the involvement of the atmospheric and oceanic science communities in precollege educational and outreach activities and to determine the extent of university offerings of introductory courses for future science teachers. Surveys were sent to 102 institutions; responses were received from 71, including 38 UCAR members, 16 UCAR affiliates, and 17 other institutions. These respondents represent, Smith says, an excellent cross-section of the atmospheric and oceanic programs in the country, including those that offer both undergraduate and graduate courses. The survey did uncover a variety of activities, and also pointed out some potentially fruitful opportunities for the community to exploit more fully.

Although there are national networks of precollege teachers who serve as resource agents for the atmospheric and oceanic sciences and most respondents are familiar with the programs, less than a third of the universities interact with these teachers. This is unfortunate, Smith says, because these teachers could serve as a conduit to reach other precollege teachers.

Currently, most institutions are not actively involved in in-service training sessions or summer workshops for teachers, where they could reach large numbers of teachers with minimal commitment of resources. Only about a third of the responding institutions conduct in-service training sessions at local schools; about an equal number conduct summer workshops for teachers, with funding often coming...
students taking meteorology and oceanography courses are majoring in education." Fewer than 21% of the students in the meteorology service courses and 10% of the students in oceanography courses are preparing for precollege teaching careers. Looked at another way, the percentage of education majors enrolled in these courses is relatively low, largely because few education programs require courses in meteorology or oceanography, even for majors in science education (15% for meteorology, and only 5% for oceanography). "This is most unfortunate, considering that weather and ocean topics are included in science curricula at all levels, yet may be taught by teachers without a background in meteorology or oceanography," says Smith. "Encouraging education majors, especially science education majors, to take such courses would not only increase student enrollments, but would provide much-needed environmental education for prospective teachers."

Often education majors take courses in science methods rather than science content, which means, says Smith, "they're learning great ways to teach science, but may not know any science to teach." One encouraging statistic, Smith adds, is that most institutions are relying on science departments to provide science courses for science education majors (30% taught exclusively by science departments and nearly 40% in concert with education departments). "This suggests that courses taught to science education majors are of high scientific integrity." Smith urges greater interaction between science and education faculty to encourage greater inclusion of atmospheric and oceanic science in science education programs.

"The results of this survey suggest that our community is certainly involved in promoting educational outreach at the precollege level and general education at the university level," Smith concludes. "Further, considering the evolution of programs such as the American Meteorological Society's Project ATMOSPHERE and Maury Project and NCAR's Project LEARN (Laboratory Experience in Atmospheric Research at NCAR), to name a few, the future is quite bright. However, there is still need... to improve our efficiency and effectiveness. Perhaps the best ways to enhance our involvement within the confines of limited resources is to interact with teachers in our respective states who have participated in the above programs and to become more actively involved in the science education programs in our respective institutions, insuring that meteorology and oceanography are an integral part of the curriculum. By doing so, we can reach greater numbers of students and provide them with a basic knowledge of their physical environment."

For more information, contact Smith (410-293-6553 or drsmith@madn.navy.edu).

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Science Bit

University of Colorado, Rutgers, NOAA

Snow cover, glaciers, and global warming

Two separate studies at the University of Colorado at Boulder (CU) deal with possible symptoms of global warming. One team of researchers has found that the levels of Northern Hemisphere sea ice and snow cover in 1990 were the lowest since satellite records began in 1973, apparently as a result of record high surface temperatures that year. The scientists, Mark Serreze, James Maslanik, Jeffrey Key, and Raymond Kokaly of the CU/NOAA Cooperative Institute for Research in Environmental Sciences (CIRES) and David Robinson of Rutgers University, studied observations from satellites, weather stations, ships, and the Arctic Ocean Buoy Program, which provides weather information from buoys dropped by plane onto drifting pieces of sea ice. The data were analyzed by computer at CIRES. The researchers also found that 1993 was the second-lowest year on record for sea ice, and snow cover has been below normal since the late 1980s. The results of the NSF-supported study were published in the 15 August Geophysical Research Letters. For more information, contact Serreze (303-492-2963 or serreze@Kryos.colorado.edu) or Peter Caughey (303-492-4007 or caughey@spot.colorado.edu).

Mark Meier, a glaciologist at CU's Institute of Arctic and Alpine Research, reports that the volume of the world's glaciers outside of Greenland and the Antarctic has diminished markedly in the past century, and the rate of loss appears to be accelerating. Meier says that the total mass of small glaciers worldwide has apparently diminished by about 11% since the late 19th Century. In some places the change has been more dramatic; the European Alps appear to have lost more than 50% of their ice. Annual changes in the volume of the world's glaciers appear to be related primarily to changes in air temperature, Meier explains; the observed shrinkage does not appear to be related to any global change in precipitation. An estimate of long-term temperature trends from glacier volume change indicates global warming of a little over half a degree Celsius. Meier can be reached at 303-492-6556 or Mark.Meier@colorado.edu, or contact James Scott (303-492-3114 or scottjr@spot.colorado.edu).
Member Profile: University of Washington

From time to time, we will profile a UCAR Member or Affiliate in the UCAR Quarterly. If you would like your institution to be profiled, please let us know.

If two words can characterize the atmospheric sciences program at the University of Washington, they are “breadth” and “interactions.” These are the two facets that chairman Norbert Untersteiner points to as distinctive of his department. Active research and instructional programs cover nearly every sub-discipline of the atmospheric sciences, and there are multiple overlaps and collaborations with other departments and institutions.

Evidence of the department’s breadth is a lengthy list of current research areas (see box).

The bachelor’s program provides a comprehensive curriculum in weather forecasting, air pollution and air chemistry, climate change, radiative transfer, and boundary-layer processes. And as of last year, the department has offered an undergraduate minor in atmospheric science.

One measure of the department’s interactions is its strong and enduring ties with UCAR. Phil E. Church represented the university at a 1958 planning conference to discuss the establishment of a National Institute for Atmospheric Research, and UW has been a UCAR member since UCAR’s inception in 1959.

UW faculty have served on the board of trustees (including current board member Conway Leovy) and numerous UCAR and UOP advisory committees. Faculty members have joined UCAR staff and vice versa.

UW professor Kristina Katsaros is also director, Département d’Océanographie Spatiale, IFREMER, Centre de Brest, France.

Another UW professor, Michael Wallace, doubles as director of the Joint Institute for the Study of the Atmosphere and Ocean (JISAO), a cooperative effort with NOAA’s Pacific Marine Environmental Laboratory. The institute was established to foster collaborations between PMEL and UW’s atmospheric sciences department and School of Oceanography. The major atmospheric science focus in JISAO is the problem of physical and biogeochemical mechanisms of climate variability.

There are affiliate faculty at PMEL, the UW Applied Physics Laboratory (APL), Battelle’s Pacific Northwest Laboratories, and UCAR. Nine faculty members hold joint appointments in the UW departments of Geophysics, Applied Mathematics, and Oceanography; or in APL. Atmospheric sciences faculty hold a total of 13 adjunct appointments with the departments of Chemistry, Civil Engineering, Geophysics, Astronomy, Applied Mathematics, Oceanography, and Environmental Health; APL; and the Quaternary Research Center.

The research facilities reflect the interdepartmental interdisciplinary emphasis. Those on campus include clean rooms, cold rooms, a chemistry lab, a temperature/humidity controlled lab, a machine shop, electronic labs, and a wind tunnel. A joint project with the chemistry department is a state-of-the-art clean room and lab for research on trace gases in the atmosphere.

There’s a mobile Doppler radar and, stationed at Paine Field, an instrumented Convair C-131 aircraft that has flown research missions in many parts of the world. This aircraft is currently due for replacement by a Convair 580 twin-engine turboprop.

Other facilities are in more remote sites. The Cheeka Peak Atmospheric Research Station, on land leased from the Makah Indian Nation in the Olympic Mountains, is a unique site for monitoring the background chemistry and aerosol content of pristine marine air at midlatitudes. When the wind is blowing from the west, the station is predicted to have the cleanest air in the Northern Hemisphere. Plans for research there include continuous monitoring of atmospheric chemistry, precipitation chemistry,

Fields for research and graduate study at the University of Washington

Department of Atmospheric Sciences

- airflow over mountains
- air-pollution meteorology
- air-sea interaction
- atmospheric chemistry or dynamics
- atmospheric radiation
- atmospheric science and public policy
- boundary-layer meteorology
- climate dynamics and theory
- cloud microphysics
- glaciology and sea ice research
- global change
- large-scale and mesoscale atmospheric dynamics
- numerical modeling
- ocean dynamics
- planetary atmospheres
- precipitation processes
- remote sensing
- tropical meteorology
- weather analysis and forecasting
aerosols, and radiation, and cooperative atmospheric and cloud chemistry projects with PNL, PMEL, and Oregon State University.

Blue Glacier field station, established in 1957 on Mount Olympus, is the only permanent research facility alongside a glacier in the United States. There, UW researchers have kept an almost continuous record of the mass balance of the glacier. For the past eight years, the measurements have included a seismic record.

The Friday Harbor Laboratories provide facilities for oceanographic research and instruction. A complex of 61 buildings on 1,856 acres on San Juan Island north of the town of Friday Harbor, the labs have direct access to salt waters relatively free of pollution and to diverse intertidal areas of rock, sand, and mud, for research programs in zoology, health sciences, fisheries, botany, and oceanography.

The department's roots go back to World War II, when Church arrived at the university to teach climatology in the geography department. In 1946 atmospheric sciences was established as a degree-granting program and the faculty grew by three: Franklin Badgley, Robert Fleagle, and Richard Reed. After that, says Untersteiner, "the growth curve would look very typical of our kind of department: rapid in the postwar period, a pause, rapid growth in the 'fat science' years, leveling in the mid-80s."

Today, the number of state-funded academic faculty is 14.6 FTE (distributed over 19 individuals); research faculty supported by grants and contracts numbers 12. Two faculty members belong to the National Academy of Sciences and two have received the prestigious Rossby medal from the American Meteorological Society. Student enrollment is at 25 to 30 undergraduate majors and about 70 graduate students, and Untersteiner does not expect those numbers to grow. In fact, like many in the atmospheric sciences community, he is concerned about the job market for future graduates, particularly Ph.D.s. So far, he says, UW atmospheric sciences graduates have been much in demand. "It appears we are providing the market with the people they want." But a change is becoming noticeable. "For the first time we have some who are staying on as postdocs a little longer. And these are very good people who would have been snapped up in earlier years. They're improving their competitiveness for the next job that comes up. We shouldn't just keep producing Ph.D.s as if this weren't happening. We may have to somehow consciously scale down graduate programs."

The shrinking job market is related to the general change in funding priorities, and that shapes how Untersteiner sees the future of the department. "We are braced for tough times like everyone else. The writing is on the wall, and it's not just here; this is a worldwide trend. If you read statements by academicians and ministers of science in Norway, Germany, France... through it all goes this red thread. We have to think more about the immediate utility and social justification of what we do. We can't take for granted that because it's science it's desirable and useful. On the other hand, if research funding goes down there's nothing that says we have to do project X, which happens to be very expensive; if we're clever we'll find something equally useful but less costly. I'm not really pessimistic," he concludes. "In the long run, there is simply a need for what we do."

International Affiliates meeting: Update on issues, programs, plans

A meeting of the UCAR International Affiliates was held in July in conjunction with the XXI Assembly of the International Union of Geodesy and Geophysics in Boulder, Colorado. Representatives considered topics of current interest and heard reports on progress and plans for several UCAR, UOP, and NCAR programs. Present at the meeting were: Johnny Chan, City University of Hong Kong; Andrey Grachev, Institute of Atmospheric Physics, Russian Academy of Sciences; Ann Henderson-Sellers and Kendall McGuffie, Macquarie University; Zev Levin, Tel Aviv University; Jack Ming-sen Lin, Central Weather Bureau, Taiwan; Philip Merilees, Atmospheric Environment Service, Canada; Wei Huang, Peking University. Guests were National Weather Service director Elbert (Joe) Friday; Melanie Wetzel, University of Nevada Desert Research Institute and UOP's Cooperative Program for Operational Meteorology, Education and Training (COMET); and Jacques Derome, McGill University, Montreal, Canada.

UCAR president Richard Anthes opened the meeting and outlined three topics for discussion: the use of the World Wide Web in helping to develop policy positions, for (continued on pg. 10)
example, with respect to international distribution of data; systematic expansion of the International Affiliates Program (IAP) to include new affiliates with broader and more complete geographic coverage; and the importance of forging new alliances to accomplish research goals, which is of growing importance in a time of decreasing resources in support of science.

Friday reported on the recent World Meteorological Organization Congress, in particular the action taken regarding international exchange and availability of data. WMO's roots go back to the International Meteorological Organization, established in 1873 to provide for data flow across national boundaries. Over the past few decades there has been a growing trend that threatens free exchange of data: various meteorological services have begun to sell the data they collect to help offset their operating costs. For example, said Friday, the British Meteorological Office recovers 20-25% of its operating costs from the sale of service products.

The WMO Congress, Friday reported, confirmed formally that the policy of the WMO is for the "free and unrestricted exchange of data describing the state of the environment." This is defined to include upper atmosphere, in situ ocean, and synoptic surface (6-hour) observations. Satellite data are included "to the extent agreed to by WMO and satellite operators." Countries receiving data will be asked to honor whatever conditions the provider country imposes on use of the data. All global model information will be exchanged without restriction, and all data, including those with conditions attached, will be available to the research and education community for noncommercial use for only the cost of reproduction.

Next, NCAR director Robert Serafin described NCAR's work in developing a Climate System Model and Climate Simulation Laboratory, which will be widely available for scientists around the world. He commented on other current NCAR activities of potential international interest, including the Electra Doppler radar (ELDORA; see the Summer 1995 UCAR Quarterly), the C-130 and WB-57 aircraft, solar observations made on the corona at Mauna Loa, and the involvement of NCAR and UCAR programs in research leading to the design of the new Hong Kong airport.

Serafin also described a major new modeling initiative and efforts to entice international interest in funding it. A Consortium for Application of Climate Impact Assessments (ACACIA) is an outgrowth of the now-concluded Model Evaluation Consortium for Climate Assessment, which supported 20 climate modeling projects around the world on dedicated computing systems at NCAR. IAP meeting participants felt that ACACIA should tackle research problems aimed at solving questions of interest to the sponsors, especially those focused on region-specific impacts of global climate change.

University NAVSTAR Consortium director Randolph Ware traced the development of the GPS/Meteorology project, which uses global positioning satellites to derive temperature and humidity profiles in the atmosphere. Michael Exner, project director, demonstrated that results from GPS/MET soundings agree well with observations from other sounders and with models. He believes a relatively low-cost space-based system, in conjunction with ground-based techniques, could produce worldwide data around the clock.

COMET director Timothy Spaniger described COMET's expanding role in providing training, via distance learning, for the international community. And director David Fulk's review of Unidata emphasized the program's community-based aspect and referred to the extensive use of the World Wide Web. At the end of the meeting it was decided that UCAR should establish an active International Affiliates Web site to promote ongoing "virtual" meetings and conversations among the affiliates. An "alert" system should let affiliates know when a new item is posted. UCAR, through the IAP, also would pursue connections with the International Association of Meteorological and Atmospheric Sciences. The two groups together represent the international atmospheric sciences community and could assist each other in reaching common goals. Finally, representatives agreed that IAP membership should be expanded to more thoughtfully and deliberately achieve geographic balance and coverage.

The IAP home page is at http://home.ucar.edu/ucargen/org.info/intl.html

It includes a list of affiliates and representatives. The UCAR home page http://home.ucar.edu/ offers links to other programs mentioned in this story. For a complete list of UCAR web sites, see the next issue of the UCAR Quarterly.
Washington Update

Food for thought

by Laura Curtis
Office of Government Affairs

In these times when the purposes, directions, and funding of science seem beleaguered on all sides, scientists need to be informed on policy trends and issues, form a consensus, and make it known to the public and policymakers. A series of informal discussions at UCAR makes a strong beginning in this direction and might serve as a model for others in the UCAR community.

Since January, scientists, students, postdocs, and nonscientists have been convening on the last Friday of the month for informal lunchtime discussions of science policy issues. Called "Dialogues at Noon," the series is sponsored by the UCAR Office of Government Affairs and the NCAR Environmental and Societal Impacts Group. It is open to anyone in the UCAR community who is interested in voicing views and concerns on the topic of the day, or who just wants to listen and learn more about the current trends inside the Beltway. The discussions have been well attended and lively.

The debut topic, "Is Bigger Better?" was loosely based on an article in the Economist, "A Problem as Big as a Planet" (5 November 1994). The discussion evoked philosophical questions about the value of predictive models and whether the effort to build a comprehensive predictive model of the physical, chemical, and biological processes that regulate the earth can really fulfill the promise of averting catastrophe. The challenge, it was argued, is to get physical and social scientists working together.

"What role should 'curiosity-driven' play in research?" was a question that occupied the discussion for two consecutive months. The selected topic, "A Balancing Act at NSF: Fundamental vs. Strategic Research; Research vs. Education Activities," raised the problem of semantics. How does one distinguish strategic and fundamental research? Does basic research mean something different to scientists, policymakers in Washington, and the nonscientific world in general? Should basic research be raised to a pure ideal? And how is its success defined? If success is measured by health, prosperity, or national security, how should our research be measured? In the science community, the goal is understanding, and its achievement marks success. Does this meet the nation's goals? Should our research be driven by how it would contribute to society? Times have changed, many conceded, and holding up in the laboratory, doing one's science, is anachronism today. We must participate in outreach to the public.

"A Department of Science: the Pros and Cons" was the timely topic discussed at the June and July "Dialogues" lunches. A department of science is not a new idea; it dates back to the 1880s, when members of the House and Senate met in a joint commission to give the concept its first serious consideration. Between 1958 and 1977, some 50 proposals were introduced to (again) create such a department.

Now, Rep. Robert Walker (R-Pa.), chairman of the House Science Committee, is pressing hard for the creation of a cabinet-level department of science. The current plan would eliminate the departments of Energy, Commerce, Education, and Labor and toss the science programs left hanging into one departmental pot. NASA, NSF, NOAA, the Environmental Protection Agency, and the U.S. Geological Survey are just some of the agencies that would be housed in Walker's dream department. He promises that only 5,000 jobs would be eliminated and $2.1 billion would be saved over a seven-year period.

Subsequent discussion listed the following reasons against such a department:

1. Mission impossible. There's an inherent conflict in lumping the various agencies, with disparate missions, into one department. NSF is the only organization that has a mission to do science; for the rest, science is a means to an end.
2. Everyone's pet program cannot be top priority, so some programs will inevitably lose to other projects. What criteria will be used to rank the importance of the proposed projects?
3. It would put a lot of power in the hands of a few, compromising the very breadth that the science community aspires to maintain.
4. Diversity and creativity would be filtered out of the process.

In the "pro" column:

1. There would be greater visibility for science on the national scene.
2. Science funding would have its own niche in the budget process. Basic research would not have to compete with a new VA hospital or a public housing project in Chicago.
3. One-source shopping for funding would reduce duplication.

These summaries reflect the willingness of the science community to tackle very complex non-scientific issues. The policy series at UCAR will continue; topics seem infinite. If you can encourage
others throughout your institution to engage in such dialogues, the science community as a whole can build an even stronger and united voice, which will be heard at your university, in your state, and in Washington. To generate new ideas is not enough; we need to take them forward to a public venue to reach the decision makers in Washington. New, multidisciplinary, cross-boundary thinkers are needed to meet the challenges ahead. For ideas on science policy topics, check the American Association for the Advancement of Science (AAAS) home page at http://www.aaas.org. The UCAR Office of Government Affairs is constructing a home page that will be linked to AAAS and other relevant sources. In this environment of austerity, now more than ever, the “dialogue” must continue.

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Susan Avery, chairwoman of the UCAR Board of Trustees, chats with Timothy Wirth, Under Secretary of State for Global Affairs, at the annual meeting of UCAR members representatives in Boulder, Colorado. Speaking at the meeting, Wirth enjoined scientists to become more active in explaining their work and its results to the public and to political leaders. He offered pointers on contacting and communicating effectively with policymakers. The previous evening, Wirth had made a public presentation, “Global Change and Sustainability,” and participated in a panel discussion with NCAR’s John Firor; Patricia Limerick, a history scholar at the University of Colorado; and John Parr of the National Civic League. The event was sponsored by the Center for the American West, the CU/NOAA Cooperative Institute for Research in Environmental Sciences, and UCAR’s Walter Orr Roberts Institute. (Photo by Robert Bumpas.)

UCAR * Quarterly

University Corporation for Atmospheric Research
P.O. Box 3000, Boulder, Colorado 80307-3000

Editor: Louise Carroll
Design and Layout: Michael Shibao
Copy editing: Carol Rasmussen
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UCAR operates the National Center for Atmospheric Research and UCAR Office of Programs with support from the National Science Foundation and other sponsors.

The UCAR Quarterly will also be available on the World Wide Web at: http://home.ucar.edu/

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Boulder, Colorado
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