Atmospheric Sciences Section of AGU Newsletter

Volume 3, Issue 5 November 2009

NASA Global Hawk.

Autonomously operated aircraft for environmental science missions that require long-endurance, high-altitude capability (NASA's Dryden Flight Research Center) (see page 8).

AS Newsletter - Editorial -

Dear Readers,

This new issue of the newsletter brings you interesting articles and reports. But first of all I would like to thank you for the emails that we have received congratulating us on the quality of our previous issues. The newsletter is made by you and for you and we really appreciate your feedback.

From a global perspective the most important issue is the Climate Change Conference to be held in Copenhaguen this December. The previous meeting in Barcelona finished a few days ago without reaching a clear agreement. But there is also good news. This month Spain has set two new records in wind power generation, since for more than five hours more than the 50% of the energy generated in the country was provided by wind turbines. Moreover on Sunday 8th November a total production of 11546 MW, equivalent to 11 nuclear reactors, was reached.

In this number we include information about a new project to use cosmic rays to measure soil misture, the projected NCAR-Wyoming Supercomputing Center, an interview with Dr. Raino Heino who is a remarkable Finnish meteorologist and climatologist, reports from several workshops, conferences and schools and an article about meteorology in Poland. We also include our section with opportunities, schools and conferences.

Happy Reading,

Juan A. Añel, Editor-in-Chief

EPhysLab, Univ. of Vigo at Ourense, Spain, and CESAM, Univ. of Aveiro, Portugal.

Section News

Alan Robock

Contribute to AGU's Voluntary Contribution Campaign

Last year, members of the Atmospheric Sciences Section contributed $43,410 to AGU's Voluntary Contribution Campaign. In 2008, due largely to member donations like these, AGU facilitated career development events attended by 600 students, hosted 75 K-12 teachers at Fall Meeting workshops, and sponsored 31 members' visits with U.S. policy makers.

Additionally, voluntary contributions allowed AGU to provide travel grants to 135 deserving students to present their research for the first time at an AGU meeting. These programs are essential for AGU's relevance and vitality. I know Atmospheric Science members want AGU to do more. Please join me in supporting AGU's efforts to strengthen our scientific society by making a gift to the 2010 Voluntary Contribution Campaign. Unrestricted contributions are used to support AGU's greatest needs, but you can directly support students pursuing Atmospheric Sciences by making a gift to the Holton-Kaufman Grant, or Namias Travel Grant. You can also choose the David Hofmann Travel Grant. David Hofmann, AGU Fellow and 47-year member, died recently. Dave was a great guy, a pioneer in scientific ballooning and lidar, a leader of in ozone and stratospheric aerosol research, and most recently, Director of the Global Monitoring Division of the NOAA Earth System Research Laboratory. He traveled to Antarctica 19 times to conduct his studies. To honor his memory, NOAA has endowed a fund in his name to support travel of students to AGU meetings. Your contribution will allow the income to grow and allow the fund to support more students.

You can make your gift when you renew your AGU membership, or you can give today at: http://www.agu.org/givingtoagu

David J. Hofmann

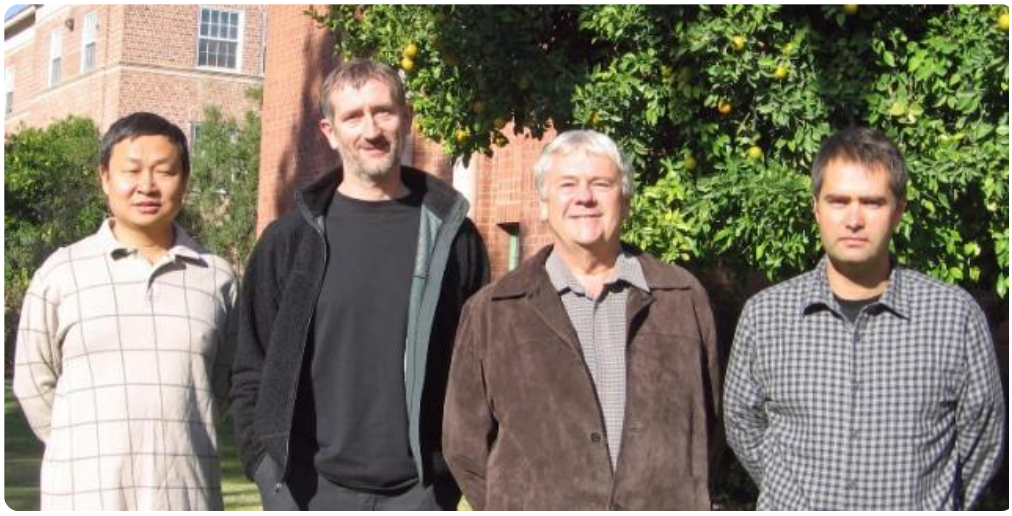
Voluntary Contribution Campaign

http://www.agu.org/givingtoagu/annual_campaign.shtml

AS Horizons

Yolande Serra

Cosmic Rays Used To Measure Soil Moisture



COSMOS scientists. From left to right: Xubin Zeng, Marek Zreda, Jim Shuttleworth and Chris Zweck. Photo by Erma Santander, Department of Hydrology and Water Resources, University of Arizona.

An interdisciplinary team of University of Arizona researchers is building a network of soil moisture probes to improve short-term and seasonal weather forecasting. The National Science Foundation has awarded the University of Arizona (UA) $5.45 million over four years to fund the project, known as the COsmicray Soil Moisture Observing System, or COSMOS.

Water in the soil, said COSMOS team members, exerts an important influence on the climate system, particularly regional precipitation. The project will measure low-energy neutrons produced when cosmic rays hit the soil. Some neutrons are absorbed by the soil, while others are reflected back to space. The number of neutrons in air above the soil surface is inversely related to soil moisture, which affects absorption. "The project will generate data that may improve weather forecasts, particularly over a longer term-maybe up to two weeks in advance, instead of two to three days," said Marek Zreda, a UA associate professor of hydrology and water resources and principal investigator of the project.

A recent National Research Council report called for a national network of soil moisture measuring devices, said co-principal investigator Xubin Zeng, a UA professor of atmospheric sciences. The COSMOS project will help fulfill that need, the investigators said.

Peter Schifflett, from Zetetic Institute of Tucson, Ariz., programs a cosmic-ray probe to detect soil moisture on the grounds of Biosphere 2. The probe was installed in April 2008. Photo copyright 2008 Marek Zreda.

Up until now, measuring soil moisture at the relevant spatial scale was difficult. Researchers could take point soil measurements by digging up soil and drying it. "Such measurements cannot be repeated over and over for the same location," Zeng said. "If you dig out a hole, you can take some measurements today," he said. "If you want to take measurements again, you have to dig a hole again."

Another method of detection requires burying wires in the soil and measuring electrical impulses. Zreda said, "If you want to get soil moisture over a large area that is meaningful for atmospheric or hydrologic scientists, you would have to measure maybe hundreds of those points. That's very labor-intensive, time consuming and expensive."

Scientists can also use satellite images to get average soil moisture for county-sized areas, but only to a soil depth of about 2.5 cm. The COSMOS project will fill the gap between point measurements and large-scale measures by deploying probes approximately 1 m above the ground that can detect soil moisture within an area of approximately 34 hectares (a circle with a radius of 330 m). The sensors can assess soil moisture as deep as 70 cm, less if soil is very moist.

COSMOS will provide more of a measure of the integrated moisture rather than a point measure, which is better for data assimilation into models, investigators said. In addition, the COSMOS project sensors provide soil moisture information quickly, said W. James Shuttleworth, co-principal investigator and Regents' Professor of hydrology and water resources. "With these sensors you can get the information within an hour or so, via the Web, so it can go into weather forecasting," Shuttleworth said. The probes will form a data-gathering network and will generate continuous, near real-time measurements.

The researchers will also investigate whether the cosmic-ray probes can distinguish between water in the soil and snow-and-ice moisture that sits above it. Satellites cannot accurately report the water content of frozen soil or snow-and-ice-covered soil, Zreda said. Although the technology is not new, it has not been applied in this manner before, the researchers said.

Three probes are already installed and running in southern Arizona. They are located on Mount Lemmon near Tucson, at Biosphere 2 near Oracle, and along the San Pedro River near Sierra Vista. Data from the probes are available online at http://ace.hwr.arizona.edu/NeutronProbes.

The probes, which were designed by a former University of Arizona student, cost about $20,000. Zetetic Institute and Quaesta Instruments, LLC, both located in Tucson, and Hydroinnova of Albuquerque, N.M., were involved in designing and manufacturing them. The team of scientists anticipates spending the first two years of the project installing and testing the probes on different types of terrain and vegetation. They will use the elbowgrease method of digging holes for their calibration. It is planned to test 50 probes across the continental United States. To determine where they should be deployed, the team will hold a workshop in December at the American Geophysical Union meeting in San Francisco to solicit input from the larger scientific community. If you want to participate, please contact Marek Zreda (marek@hwr.arizona.edu) as space is limited.

(continued in the next page)

The continued success of the COSMOS program depends largely upon working with other parts of the scientific community who could also use the data produced by the COSMOS project, Shuttleworth said. For example, ecosystem processes such as the activity of soil organisms, the growth of plants and the carbon cycle are all linked to soil moisture. Scientist are encouraged to visit the COSMOS website to learn more about the project and data availability (http://cosmos.hwr.arizona.edu/).

Once the testing phase is complete, the researchers hope to be able to expand the network substantially, Zreda said.

Zeng cited support from the UA's Water Sustainability Program, or WSP, as crucial to getting the project off the ground. WSP provided seed money through the Technology and Research Initiative Fund, or TRIF. Chris Zweck, a UA hydrology and water resources research assistant professor, is also a co-principal investigator on the grant. Stephanie Doster of UA's Institute of the Environment and Mari N. Jensen of UA's College of Science contributed to this article.

The NCAR-Wyoming Supercomputing Center

Anna Harper

Picture yourself in Wyoming. You might watch buffalo wandering among spouting geysers, gaze upon the magnificent Tetons, or watch a storm rolling across grassland spotted with pronghorn antelope. Or, you might be in one of the nation's leading supercomputing centers. The latter could be the case if plans for the NCAR-Wyoming Supercomputing Center (NWSC) Project go through (http://www.cisl.ucar.edu/nwsc/).

Wyoming has historically relied upon extraction of natural resources to boost its economy, but the construction of the NWSC will herald a shift in focus toward high technology and earth science research. Situated near the intersection of interstates 25 and 80 in Cheyenne, it will be within 100 miles of three major universities – the University of Wyoming (UW) in Laramie, the University of Colorado (CU) in Boulder, and Colorado State University in Fort Collins.

"This project could help expand the technology corridor from Colorado up into Wyoming," said Krista Laursen, the Project Director at NCAR. NCAR is partnering with UW, the state of Wyoming, the Cheyenne-Laramie County Corporation for Economic Development (Cheyenne LEADS), the Wyoming Business Council, Cheyenne Light, Fuel and Power Co. (CLF&P), UCAR, and NSF. The site was selected in January of 2007, and the NSF approval process is still pending one final design review, scheduled for spring of 2010.

Providing for the Atmospheric Science Community

1967 was an important year for our field. Against a background of societal change and discontent with the Vietnam War, three interesting events set the tone for the next 42 years of supercomputer utilization by atmospheric scientists. First, Gene Amdahl gave a talk partly about "data management housekeeping" in multiple processor computations. This talk later led to the formulation of Amdahl's Law, which defines limitations on the speedup of a multiple-processor program based on the program's sequential fraction. Meanwhile, Syukuro Manabe and Richard Wetherald published a paper estimating a 2 ºC global temperature increase resulting from doubling atmospheric CO_2. Their simple radiative-convective model with fixed relative humidity laid a foundation for coupling radiative transfer and the hydrologic cycle in general circulation models.

And finally, in Boulder, the NCAR Mesa Lab opened. Although nonscientists might only recognize the Mesa Lab as the headquarters of a sinister government plan in Woody Allen's comedy Sleeper, its role in atmospheric science over the past 40 years has been huge. One of the first computers housed at the lab was the Control Data Corporation's 6600, the first computer designed as a supercomputer. It was the fastest of its time, with a clock speed of 100 nanoseconds. NCAR still houses some of the world's fastest computers, such as the current IBM system, Bluefire. In the four decades since Amdahl's Law and the pioneering work of GCMs, a lot has changed. The energy and space requirements for today's supercomputer users are outgrowing the space available at the Mesa Lab.

The NWSC site is a 24-acre plot that already includes close proximity to fiber optic lines and a guaranteed power supply from CLF&P. The center will have access to a 24-megawatt feed, compared to a 19-megawatt feed available for the entire CU campus in Boulder. The supercomputer center will be multigenerational, allowing for future expansion and adaptations as the capabilities of computers continue to evolve. "Our design plans are for a facility that is highly modular and flexible," said Laursen. The exact computers to be housed at the center are yet to be determined, but a competitive search led by a committee of scientists, administrators, computer technicians, and contract personnel will procure a system that maximizes scientific productivity.

"Everything that we're working on is related and pertinent to our mission to provide for the atmospheric science community and other geosciences," said Marijke Unger, External Relations Specialist at CISL. The computer system is expected to be on the order of 1.0 to 1.5 petaflops, meaning it can compute more than 1015 floating-point operations per second.

Another primary objective for the center is energy efficiency. "The irony of running climate models is that the computing systems required use large amounts of power," Laursen said. The project has recruited H+L Architecture and California Data Center Design Group to design the building. They plan to use recirculated air for cooling and also sustainable materials within the offices. CLF&P will provide the electricity, with an

(continued in the next page)

Artistic rendering of the NCAR Wyoming Supercomputing Center, by H+L Architecture.

initial goal of using a minimum of 10% renewable energy. Some of the power will come from a CLF&P coal-fired plant that chemically scrubs the coal to reduce emissions of certain pollutants. The project leaders hope to be certified by the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. "We want the most energy efficient design possible so we can minimize the carbon footprint," said Laursen.

Construction is planned to begin after the design review next spring. According to the proposed timeline, the NWSC will be completed by summer 2011 and will be online early in 2012. According to Craig Douglas, a University of Wyoming professor with a background in computer science and parallel algorithm development, the supercomputing center will be a peer with top-notch facilities like the National Center for Supercomputing Allocations (NCSA) at the University of Illinois. "This is a great resource for people in Colorado and Wyoming, and the world," he said.

Winds of Change in Wyoming

Wyoming is one of the least economically diversified states in the nation. However, this is changing, and the NWSC has a large role to play. The state of Wyoming and the University of Wyoming are investing heavily in the supercomputing center project. UW is providing $20 million to the center's construction, and the university plans to contribute $1 million annually toward computing and data storage costs. Over the next 20 years, the expected budget for the center is $535 million.

Being part of the NWSC fits in well with the state's push for more advanced energy research in Wyoming. "Even before we have shovels in the ground, the university has already benefited from the proposed center," said Laursen. UW has a new School of Energy Resources, and 20% of the center's computing resources will be shared by university and NCAR researchers. This has already attracted faculty to Wyoming. The center itself will employ a staff of roughly 20 people, about half of whom will move from NCAR in Boulder. And having a high-tech supercomputing center in Cheyenne could attract more technology-based business to the area.

Douglas was brought to the UW School of Energy Resources in 2008 because of his expertise in supercomputing. He is the Director for the Institute of Scientific Computation and a distinguished professor in mathematics. Douglas is anticipating using the NWSC for research on carbon sequestration techniques. "I'm really excited that the University of Wyoming is involved in this," he said. For Douglas, determining what research questions to pursue with the computing allocations is all "part of the fun and excitement." If the business, education and technology leaders who have pushed to bring the NWSC to Cheyenne are correct, watching Wyoming's economy grow and diversify will be exciting as well.

From Cheyenne to the World

The increased electrical and storage capacity of the new supercomputing center will benefit atmospheric scientists. From climate change to severe weather or carbon sequestration, the research that will be done at the center will have important implications, much like the work that has been done through the NCAR Mesa Lab over the past 42 years. Unger points out that much of the public is still unsure about if or how climate change will affect them. "[The NWSC] will take us a step closer to delving into local impacts and will give decision makers the tools to take action," she said. Laursen agrees, adding, "It will be a key piece to help researchers work on these problems."

Reference

Manabe, S., and R.T. Wetherald (1967), Thermal equilibrium of the atmosphere with a given distribution of relative humidity, *J. Atmos. Sci., 24*(3), 241-259.

* Incidentally, 1967 was a big year for the University of Wyoming as well. The Cowboys football team went 10-1, with their only loss coming against Louisiana State University in the Sugar Bowl**.**

Interview with Raino Heino

Hans von Storch

Raino Heino, Finnish Meteorologist and Climatologist, was born in 1943, with a M.Sc. in 1968 and a Ph.D. in 1994 from the University of Helsinki. Since 1996 responsible Research Manager for Climate at the Finnish Meteorological Institute (FMI), and an adjunct professor at the University of Helsinki since 1999. For more than 25 years representative of FMI at the World Meteorological Organization (WMO) (in particular in the Commission for Climatology); a national delegate for the Intergovernmental Panel on Climate Change (IPCC) since 1994; vice-president of the European Meteorological Society 2002-2008, and Chair of the Meteorological Division of the Geophysical Society of Finland since 1999. Among his more private achievements is his stamp collection of meteorology, which has received several gold medals in international stamp exhibitions. The collection was also published by the WMO (Nr. 1023).

Raino Heino in the military weather service (1964).

In which areas of meteorology have you worked?

Mostly in climatology at the Finnish Meteorological Institute (FMI). In the beginning of my professional life I also worked in the information-communication technology-area, for instance by using the first computer of my country in the mid-1960s. In addition, I was a teacher of meteorology at Helsinki University (Dept. of Meteorology) for 30 years.

What about your international activities?

Since the 1970s I worked with various climate-related tasks of the WMO; at present time I am leading the climate data management activities of the Commission for Climatology. In addition, I am serving on the Commission for Basic Systems (CBS) Expert Team on Evolution of Global Observing System and GCOS Atmospheric Observations Panel for Climate.

I have also taken part in different European activities during these years, for example in the European Meteorological Society from its foundation. In Europe, the climate-related cooperation is promoted by the European Climate Support Network (ECSN), which coordinates the work of the National Meteorological Services and (continued in the next page)

Meteorology also as a hobby. Several gold medals for the thematic exhibit "From Weather Gods to Modern Meteorology" of meteorology-related stamps and postal history items, to trace the development of weather-related activities, as illustrated in the philatelic pictorial material published by the postal administration of numerous countries.

organizes conferences and workshops among European climatologists. I have been involved in that work from the beginning of the ECSN in the early 1990s, and worked since then as a member of its advisory committee. European Union-funded projects have also had a key role in European climatology.

What's your role in the IPCC as well as the BACC (BALTEX Assessment of the Baltic Sea Region)?

I was the Finnish national IPCC delegate and focal point for 15 years during the 2nd, 3rd and 4th Assessment Reports and thus I was part of the IPCC when it was awarded with the Nobel Prize in 2007.

BACC, also known as the "Baltic IPCC", was created to assemble, integrate and assess available knowledge of past, current, and expected future climate change and its impacts on ecosystems in the Baltic Sea basin. The BACC book was published in 2008. I was the coordinating lead author of the chapter on Past and Current Climate Change. Thanks to you Hans for working as the overall coordinator of the project. Also thanks for leading the new BACC II assessment that hopefully will result in a new book to be published in 2012, thus supporting the 5th IPCC report.

Is it an advantage to live and work in a relatively small meteorological community?

Well, it's nice to know practically all the Finnish meteorologists by first teaching them at the only university dedicated to meteorology in Finland, and afterwards by working with them at the FMI. But this is not limiting, since the involvement in various international projects results in having many contacts outside your own country, too.

What would you consider the two most significant achievements in your career?

The fact of initiating the computer-based work in the 1960s, not only in climatology, but also in many other fields of meteorology of the FMI, may be a major achievement. The FMI will soon celebrate the 50-year anniversary of the use of computers, and the 40-year anniversary of its own computers. I seem to be the only "pioneer" still working at the FMI.

Various climate-related activities ranging from data processing to all kind of climate applications and research represent maybe not major achievements, but the sum of this large number of smaller steps certainly had an impact.

The IPCC-related work is of course the "crown" of my career as a climatologist.

When you look back in time, what had been the most significant, exciting or surprising developments in atmospheric science?

The development of computers and new observing techniques have been the most significant, especially to our science. Both of them have improved weather forecasting as well as the research process as a whole. Quite surprising, on the other hand, was the sudden change of scientists' attitudes from the threat of the next ice age in the 1970s to the present over-warming by the greenhouse effect.

Is there a politicization of atmospheric science?

Yes, but only concerning the climate change issues. It is understandable, because the economic values involved are tremendous. The work of the IPCC, however, is the major cornerstone in assessing regularly what's going on in climate science. It makes it also easier for individual scientists to respond to increasing inquiries from all sides.

What constitutes "good" science?

Good education, hard work and honest output of the results.

What is the subjective element in scientific practice? Does culture matter? What is the role of instinct?

The subjective element is also present in science, but probably it is not very dominant, especially concerning the normal scientific communication. The internet has, however, opened an influential door for subjectivity. Culture may not matter very much in international science. Concerning the role of instinct I would like to refer to H.Wanner's interview [in Atmospheric Sciences Section of AGU Newsletter 3 (3), 4-5]: "Instinct is an important ingredient of a good scientist, but has to be combined with enthusiasm, creativity and stamina."

Reference

Heino, R. (Ed.) (2008), *WMO-No.1023. From Weather Gods to Modern Meteorology: A Philatelic Journey*, 112pp, World Meteorological Organization, ISBN: 978-92-63-11023-7.

"From Weather Gods to Modern Meteorology: A Philatelic Journey." (WMO) (cover).

Iowa Symposium on Energy and Climate Change for the Midwest

Morgan Yarker

Scientists and policy makers discuss issues relating to energy and climate change in the Midwest United States. Photo provided by Soheil Rezayazdi.

Scientists and policy makers gathered this last October in Iowa City, Iowa, to discuss issues in Energy and Climate Change. Many participants discussed the importance of holding this symposium in the Midwest United States. Tom Wright, from the The Chicago Council on Global Affairs, gave a compelling argument that "per capita, the Midwest has more carbon emissions than the Nation as a whole." Therefore, it is important the Midwest lead the nation to use more renewable energy for the sake of mitigating climate change and reducing our carbon footprint.

The unique aspect of the two-day symposium was that it specifically provided an environment for dialogue between scientists and policy makers. This event had many speakers from both perspectives, providing the other with very useful information. Iowa State Senator and one of the symposium organizers, Joe Bolkcom, says, "Bringing together the people who understand the science with policy makers is important...policy makers are looking for good information to make difficult choices. This symposium is an opportunity to do that."

Greg Carmichael, co-director of the Center for Global and Regional Environmental Research, explained that scientists at this symposium realized that "policy makers are generally well informed on the climate science." More importantly, it became clear that developing policy to mitigate climate change is very difficult to do. This is in part due to the public not being well informed about the issues of climate change and energy.

Carmichael stressed that an important outcome of this conference turned out to be education. Carmichael said, "We need to work on ways to educate the public. A follow up activity to this symposium could be to have a workshop focused on that."

An example of such situations is that many households may "have an energy efficient car, but 6 high definition televisions plugged in at home," Carmichael explained. Having an energy efficient car is one step, but leaving appliances plugged in is an enormous waste of energy.

Iowa Congressman Dave Loebsack stressed that the issue is "not just about climate change, it's about reducing our dependence on fossil fuels". Generally, the public is aware of this concept, but they do not understand the role that economy plays in mitigation and adaptation. As many speakers mentioned, there are opportunities to save money by switching to alternative energy, but it requires an initial investment that the public does not often desire.

The underlying concept that came out of this symposium is that policy makers generally understand the science and the need to switch to alternative energy sources. However, the public needs to be included in the dialogue. Without having everyone in our society involved in this issue, it is difficult to move forward in mitigating climate change and reducing our dependence on fossil fuels.

Unlocking the carbon cycle: the Eighth International Carbon Dioxide Conference

Anna Harper

The most recent carbon cycle research was presented at the eighth edition of the International Carbon Dioxide Conference in Jena, Germany, in September. Most of the talks were held in a plenary session, allowing the attendees to pick up as much information as possible. The communal atmosphere fostered discussion, feedback, and plans for future collaborations. What was learned from more than 500 posters and 100 talks could easily fill a comprehensive textbook on the carbon cycle. Here we summarize some of the content of the meeting, which covered all aspects of the carbon cycle, including land and ocean sinks, atmospheric concentrations and transport, and fossil fuel emissions.

Oceans

Roughly half of the CO_2 emitted by human activity each year remains in the atmosphere. The other half is split between the terrestrial biosphere and the oceans. Several talks were focused on the oceanic sink for anthropogenic CO_2. Andrew Watson, from the University of East Anglia, spoke about evidence for decadal changes in the oceanic carbon cycle, such as decreases in the anthropogenic CO_2 at depth due to changes in deep water formation in the Labrador Sea from 1997 to 2003. These changes appear to be partially forced by anthropogenic climate change and partially by natural oscillations in oceanic circulation and the climate system. Such observations challenge the conventional assumption that the oceanic carbon cycle is in a steady state.

Land

Carbon scientists have been working to quantify the land carbon sink for more than a decade. Two of the talks were focused on the roles of land use change and natural disturbances in the land sink. Richard Houghton, of the Woods Hole Research Center, estimated an annual flux of CO_2 from land use change of 1.5 +/-0.7 petagrams of carbon (PgC). Conversion of forest to crops and pasture are the largest components of this flux. Depending on the dataset, tropical emissions from land use change in the 1990s were anywhere between 0.9 and 2.4 PgC per year. Disturbances such as the pine beetle in the Canadian Rockies, fire and extreme drought result in disequilibrium in the strength of the land sink according to Yiqi Luo, from the University of Oklahoma. Quantifying these disturbances and understanding how climate change will affect them are essential tasks for quantifying the future land sink. Enhanced observational networks and experimental studies will be necessary to achieve these goals.

(continued in the next page)

Participants in the International Carbon Dioxide Conference during a break.

Datasets

Many observational datasets were presented at the conference. Masakatsu Nakajima from the Japan Aerospace Exploration Agency gave an overview of the GOSAT satellite, which monitors CO2 and other trace gases. Spectral data will be available by November 2009. Next, Osamu Uchino from Japan's National Institute for Environmental Studies presented results from the initial validation of column-averaged CO_2 and CH_4 dry air mole fractions. The GOSAT retrievals were low compared to data collected from commercial airliners, and the sensors are still being calibrated.

Steven Wofsy, from Harvard University, presented results from five flights from the HIAPER Pole-to-Pole Experiment (HIPPO), which is primarily funded by the National Science Foundation. The plane collected cross-sectional measurements of CO_2, CH_4, CO, N_2O, and O_3 on five flights in 2009. During a January flight, some major transport processes that are not well captured by models (such as the warm conveyer belt south of the Aleutian Low) were clearly delineated.

Paleo Perspective

Several talks put the current carbon cycle into a historical perspective. Phillipe Ciais, from the Laboratory for Climate Sciences and the Environment in France, spoke about the ice age carbon cycle. Although he estimated a decrease in land productivity (carbon uptake) during the last glacial maximum, the carbon stored on land was comparable to that during the pre-industrial era. Therefore, since atmospheric CO_2 was roughly 80 ppm less than pre-industrial during the LGM, excess carbon had to be stored somewhere other than terrestrial vegetation. Ciais suggested frozen peat deposits, tropical wetlands along exposed oceanic shelves, or organic sediments in the oceans as possible stores of this carbon.

Anthropogenic CO_2

Today we are at a point where science has proven that recent greenhouse gas increases in the atmosphere are due to humans. According to Pieter Tans, from at NOAA's Climate Monitoring and Diagnostics Laboratory, we cannot afford to wait to take action. He cited a one-in-six chance that continental temperatures will rise by 20 °C due to doubling CO_2 [*Roe and Baker*, 2007]. "I think this is a chance we should not take," he said. He claimed that the developing world carries the burden to reduce emissions, and "we need to demonstrate to developing countries that development is possible with very low emissions." But what role will scientists play? Tans said that observations and atmospheric transport models can give assurance that emissions reductions are working. In doing this work scientists must fully disclose their data and methods. He also recommended scientific assessment of proposed geoengineering solutions.

David Archer, from the University of Chicago, presented the long-term implications of not reducing fossil fuel emissions. Once emissions are cut, the amount of CO_2 in the atmosphere will decrease over a period of several hundred years due to its dissolution into the ocean. However, the ocean's ability to take up CO2 will be depleted eventually, and CO_2 will be removed from the atmosphere via reactions with calcium carbonate and silicate rocks. Once atmospheric CO_2 and calcium carbonate reach equilibrium, approximately 10% of the carbon dioxide will remain in the atmosphere, Archer said. According to a study by *Berner and Kothavala* [2001], it could take 400,000 years before the last of the human-released CO_2 is removed from the atmosphere. In other words, our actions today will impact climate on a geologic time scale. For example, Archer stated that emitting 5,000 gigatons of carbon would increase global mean temperature by 3 °C for tens of thousands of years. Archer drove in his point of the long-term implications of fossil fuel emissions by saying, "It's like somebody's walking off a cliff. It will take them 10 seconds to hit the ground and you're telling them the next 10 milliseconds won't be all that painful."

A Continuing Legacy

The International Carbon Dioxide Conference has been held every four years since 1982, when it began from a small group of dedicated scientists such as Wallace Broecker and David Keeling. The carbon cycle itself is not more or less important today, but awareness of its role in climate change and mitigation has boosted the number of attendees to more than 600 people – nearly twice as many as in 2005.

This year, the conference was held from Sept. 13-19 and was hosted by the Max Planck Institute for Biogeochemistry. Despite the growth of the conference, the conference chair, Martin Heimann, said there was still a community feeling to the week. "Some of the old timers are missed," he said. "But we have a new generation."

References

Berner, R. A., and Z. Kothavala (2001), Geocarb III: A revised model of atmospheric CO_2 over Phanerozoic time. *Am. J. Sci., 301*, 182-204.

Roe, G. H., and M. B. Baker (2007), Why is climate sensitivity so unpredictable? *Science, 318*, 629-632, doi: 10.1126/science.1144735.

In honor of this new generation of carbon cycle scientists, the conference organizers gave recognition to five young scientists for their excellent posters. Congratulations to Yukio Terao (National Institute for Environmental Studies, Japan), Lisa Welp (Scripps Institution of Oceanography), Tobias Steinhoff (Leibniz Institute of Marine Sciences, Denmark), Erica McGrath-Spangler (Colorado State University) and Robert Getzieh (Max Planck Institute for Earth System Modeling, Hamburg).

Terrestrial Environment (Climatic) Criteria Guidelines For Use In Aerospace Vehicle Development, 2008 Revision

William W. Vaughan

NASA has published the latest revision to the unique "Terrestrial Environment (Climatic) Criteria Guidelines For Use In Aerospace Vehicle Development" (NASA/TM-2008-215633). It was initially published in 1964 and has been periodically updated by NASA since that time and it is based on the products of research by researches of atmospheric science. This unique 856 page document provides guidelines for the terrestrial environment (earth surface to 90 km altitude) applicable in the development of design requirements/specifications, plus associated operational criteria, for aerospace vehicles, payloads, and associated ground support equipment. Moreover, it contains considerable information of general and scientific interest and value concerning the terrestrial environment. A detailed table of contents is provided. The document is currently available to download on-line without charge at the NASA Technical Reports Server:

http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20090022159_2009021428.pdf.

Information on ground and in-flight winds, atmospheric thermodynamic models, radiation, humidity, precipitation, severe weather, sea state, lightning, atmospheric

(continued in the next page)

chemistry, seismic criteria is included, as well as a model to predict atmospheric dispersion of aerospace engine exhaust cloud rise and growth. In addition, a section has been included to provide information on the general distribution of natural environmental extremes in the conterminous United States and world wide. A section on atmospheric attenuation has been added since measurements by sensors on certain Earth orbital experiment missions are influenced by the Earth's atmosphere. There is also a section on mission analysis, prelaunch monitoring and flight evaluation as related to the terrestrial environment inputs. The introduction contains a summary of lessons learned in the development and applications of these terrestrial environment criteria guidelines.

WAVACS International Summer School

Didac Fortuny

From 14-26 September 2009 the International Summer School on Water Vapour in the Climate System (WAVACS) took place in Cargèse (Corsica, France). The aim of the summer school was to provide the students with an overview of the state-of-the-art and the recent progresses in the observation and understanding of the distribution of the water vapour in the atmosphere and its role in the climate system.

The school was held in the Institut d'Etudes Scientifiques de Cargèse and it brought together around 80 students and 16 lecturers from leading worldwide universities and research centres. The students background were very diverse in experience (Msc students, PhD students, postdocs...) and in scientific discipline (physics, mathematics, engineering...). Some of us were partially or totally supported by the COST Action WAVACS (ES0604) (http://www.isac.cnr.it/wavacs), the Centre National de la Recherche Scientifique (CNRS), the Institut Pierre Simon Laplace (IPSL), and the UCAR Visiting Scientist Program.

The summer school mainly consisted of lectures scheduled in two sessions with two or three lectures in the morning and three or four in the afternoon. The lectures were classified in seven different subjects (water vapour, climate change, climate models, microphysics, clouds, observations and convection) and each of them lasted one hour, with the last minutes dedicated to questions and discussion. There were also some practical sessions in which we could see practical demonstrations of some measurement instruments. Apart from the lessons, around 50 students' posters were presented in several sessions and also during the free time since they were hanged outside within reach of everybody during the whole summer school. Finally, in the last days, in two different discussion panels the lecturers talked about issues proposed by the students.

To not lose the opportunity of enjoying the wonderful place where we were, the organizers prepared a social programme which consisted of a one-day boat trip to the gulf of Girolata and Scandola Peninsula, a UNESCO World Heritage place. We also had some free time every day after lunch to rest, work with our computers, play the piano in the music room or go to the beach, where every day students and lecturers unwound from science swimming and playing volleyball.

William Lahoz, one of the organizers, keeps very positive impressions of the summer school. Regarding the students, he said "their level was very high; they participated after the lectures and panel discussions, asking many good questions". He also has good memories about the time we were out of the lecture room. He said that "the social aspect was also very good, and the students took advantage of the opportunity of mixing with the lecturers and their peers and, thereby, building connections for future collaboration."

Extra information about the summer school, as well as the lecturers' presentations and the students' posters, are available online: http://www.lmd.ens.fr/wavacs/.

Participants in the WAVACS International Summer School.

Workshop Report: The Extratropical UTLS, Observations, Concepts and Future Directions

Juan A. Añel and Andrew Gettelman

From 19-22 October 2009 more than 90 researchers met in the National Center for Atmospheric Research (NCAR) in Boulder, CO, U.S.A., for a workshop on the extratropical upper troposphere/lower stratosphere (UTLS). They represented 41 different research centers from 12 countries. The workshop was sponsored by the Stratospheric Processes and their Role in Climate (SPARC), and the National Science Foundation (NSF). 56 talks and 24 posters were presented.

The session topics were (1) UTLS Dynamical Structure, (2) UTLS Chemical Structure and Extratropcial Tropopause Transition Layer (ExTL), (3) Transport and Stratosphere-Troposphere Exchange (STE), (4) Chemical and Microphysical Distributions, (5) Long-Term Variability and

(continued in the next page)

Participants in the workshop on the Extratropical UTLS.

Trends, and (6) Future Observations. The topics spanned observations, theory and modeling, with plenty of discussion and attempts to synthesize the sessions.

Results of the meeting are available at : http://www.acd.ucar.edu/utls/, and will be summarized in the SPARC newsletter: http://www.atmosp.physics.utoronto.ca/SPARC

There was a wide variety of research presented, but several common themes emerged from the meeting. The dynamical structure of the tropopause was discussed using several methods and tracers. Radiatively, ozone and water vapor are important in maintaining the tropopause structure. Models need to be able to reproduce the detailed structure.

The influence of the large scale wave driven stratospheric circulation (the Brewer-Dobson circulation) was also discussed, as were transport pathways in the UTLS. Downward transport into the UTLS from the stratosphere was discussed, as was quasi-isentropic horizontal motion from the tropics to the extratropical UTLS. This occurs in summer when the transport barrier of the subtropical jet is weak, and it occurs on top of the subtropical jet. This last pathway was found to be important in several recent field experiments.

There were several talks linking the stability structure of the extratropical UTLS, which features a peak in static stability (called the tropopause inversion layer, or TIL) just above the extratropical tropopause, to the tracer structure and dynamical structure. A consistent picture is emerging that links the chemical structure, dynamical structure and stability with definitions of the tropopause.

Different definitions of the Tropopause were used and examined, including chemical, thermal and dynamical definitions. The use of different perspectives and different definitions was felt by the participants to be appropriate for different scientific questions, and different types of observations. The picture from different definitions of the extratropical tropopause was felt to be complementary. Specific topics covered included: multiple thermal tropopause cases, stratosphere-troposphere exchange estimated using a dynamical (potential vorticity based) tropopause, the chemical definition of the tropopause using O_3 and/or H_2O concentrations .

The Asian summer monsoon circulation was shown to dominate the boreal summer season in the UTLS with global implications for transport of species through the UTLS and into the stratosphere.

Several papers discussed trends in the UTLS, both in the past and projected into the future using chemistry climate models. The tropics appear to be broadening over the last 40 years or so, with increasing height of the tropopause. The trends are consistent with theories relating changes in the UTLS and a broadening of the tropopause to increasing anthropogenic greenhouse gases. The changes are asymmetric between hemispheres. The asymmetry appears to be due to ozone depletion. Trends are expected to continue into the future with asymmetry due to ozone recovery.

Finally, upcoming measurement campaigns by both US and European aircraft were discussed, as well as proposed satellite missions. The meeting ended with a strong call to continue current measurement systems and augment them for the future due to the importance of understanding UTLS processes and trends for air quality and surface climate.

Meteorology in Poland: Research and Service

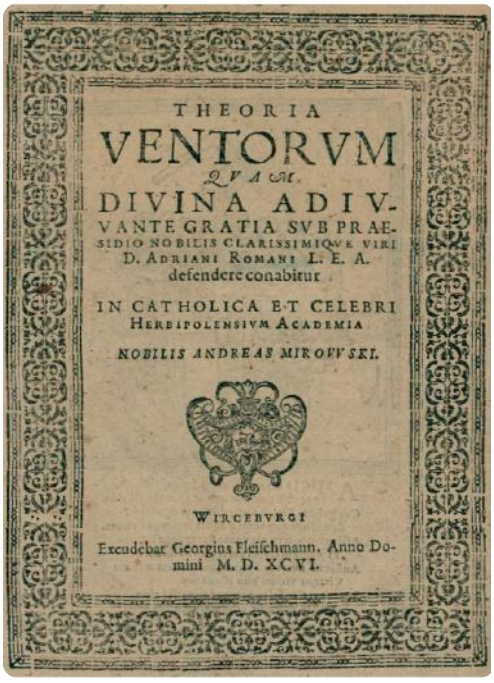
Joanna Wibig

History

Polish "meteorology" began with the publication of both Andrzej Mirowski's "Theoria ventorum" (Theory of wind) at the end of the sixteenth century and Wojciech Tylkowski's "Meteorologia curiosa" (Curious meteorology) in 1669. Antoni Magier prepared the first "scientific" weather forecast based on thermal conditions of forthcoming winter (1821/22) for Warsaw.

Shortly after the invention of the barometer in July 1647, Walerian Magini began measuring the air pressure at the Royal Castle at Warsaw at the request of king Władysław IV. In 1655, the observations made in Warsaw became part of the first international meteorological network of weather stations established by Grand Duke Ferdinand II of Tuscany. Unfortunately, only a short fragment of these measurements (10-16 May 1655) have been preserved. Regular meteorological observations began in Poland at the Warsaw observatory at Royal Palace on 1st January 1779, at Wrocław in 1791 and at Cracow in 1792. At that time Poland was governed by three European powers, namely Prussia, Austria and Russia. The Prussian Meteorological Institute was founded in 1847, the Main Geophysical Observatory in Petersburg was founded in 1849 and the Central Institute of Meteorology and Geomagnetism was established in Vienna in

(continued in the next page)


THEORIA
VENTORVM
QVAM
DIVINA ADIV-
VANTE GRATIA SVB PRAE-
SIDIO NOBILIS CLARISSIMIQVE VIRI
D. ADRIANI ROMANI L. E. A.
defendere conabitur
IN CATHOLICA ET CELEBRI
HERBIPOLENSIVM ACADEMIA
NOBILIS ANDREAS MIROVVSKI.
WIRCEBVRGI
Excudebat Georgius Fleischmann. Anno Domini M. D. XCVI.

Cover of "Theoria ventorum".

Map of Poland with the location of the several universities and research centers.

1851. After regaining self-rule, the Polish State Meteorological Institute was established in 1919, which took responsibility of all the meteorological stations in the area of Poland.

Science

Scientific studies are conducted at a large number of institutions. Among them are the Universities in (U1) Cracow, (U2) Poznań, (U3) Warszawa, (U4) Łódź, (U5) Toruń, (U6) Lublin, (U7) Gdańsk, (U8) Sosnowiec, (U9) Szczecin, (U10) Wrocław, (U11) Słupsk; the Life Science Universities (former High Agriculture Schools) in (L1) Wrocław, (L2) Cracow, (L3) Poznań, (L4) Warszawa, (L5) Lublin; the technical universities in (T1) Szczecin, (T2) Wrocław, (T3) Cracow and in (T4) Warszawa, and (G) Gdynia Maritime University. The Institutes of Geography and Spatial Organization (P1) and of Geophysics of the Polish Academy of Sciences (P2) deal with meteorological issues. Of particular relevance are the Institute of Meteorology and Water Management (IM) (in Warszawa, Cracow, Poznań, Gdynia, Wrocław and Katowice) and the Institute of Soil Science and Plant Cultivation (IS) in Puławy.

Main areas of scientific interests in meteorology include:

Urban meteorology and climatology: Urban Heat Island effects, anthropogenic heat emission and storage and heat fluxes, albedo in relation to different types of surface and/or building structure geometry. (U3, U4, U10, IM).

Agrometeorology: Energy and water exchange between earth surface and atmosphere, and evapotranspiration from different cultivated fields, albedo from - different surfaces (different crops, different phenological phases). Local microclimate of different cultivated fields, phenology and variability of phases, growing season, snow cover and their variability. Agrometeorological forecasts, assessment of risks related to extreme weather events. Impact of climate change on agriculture. (T1, IS)

Weather and circulation: Classification of circulation patterns and their relation to different weather elements. (U1-11, G, IM).

Extreme weather events: A big national scientific project on extreme weather events and their impacts on societies has just been finished. (U1-11)

Polar meteorology has a long history in Poland. Antoni Dobrowolski (the author of "Natural history of ice") and Henryk Arctowski took part in historical Antarctic expedition on "Belgica" in the end of the nineteenth century. A Polish Polar Station is operated at southern Spitsbergen (Hornsund) during the whole year. They are interested in analyzing typical features of polar weather and climate and long-term changes of sea ice and glaciers. (U2, U5, U10, U6, P2)

Numerical weather forecasts for Poland are made with different models, among the Coupled Ocean/Atmosphere Mesoscale Prediction System of the US Naval Research Laboratory and the Met Office Unified Model, the Aladin model of Meteo France. The regional WRF model is also used. Statistical downscaling schemes are also available. (U3, U4, IM, P2)

Microphysics: Studies of clouds and atmospheric composition change, dispersion of air pollution, ozone related phenomena. Total ozone measurements in Belsk since 1973. (U3, T4, IM, P2, T2, T3)

Biometeorology: The influence of weather conditions on human feelings in rural, urban and polar conditions. (P1, U5, U4)

Service

The main tasks of the meteorological service run by the Institute of Meteorology and Water Management include: (1) Regular observations within the meteorological network and other specialist measurement systems; (2) Collecting, storing, archiving and making available measurements and observations; (3) Preparing forecasts and warnings protecting society and economy; (4) Forecasting of air and water qualities. (5) Preparing warnings about extreme weather events.

Additionally, air quality measurements (content of CO, SO_2, nitrogen oxides, dust, tropospheric ozone and some others) are made by 16 provincial divisions of Inspection of Environmental Protection.

Opportunities

Note: You may be asked for your AGU member # to open the following links. Visit the AS Section website for links to other job opportunities not listed here.

Some of these job postings and others can be found at:

http://www.agu.org/cgi-bin/membership_services/joblistings.cgi

Atmospheric Sciences

* Tenure-track Assistant Professor position on Paleoclimate Modeling, Department of Geography at the University of Nevada, Reno, Nevada. Contact: Dr. Scott Bassett (sbassett@unr.edu).

* Tenure-track Assistant Professor position on Ecoclimatology, Department of Geography at the University of Nevada, Reno, Nevada. Contact: Dr. Franco Biondi (fbiondi@unr.edu).

* Assistant Professor on Mesoscale Meteorology & Severe Weather, Department of Geosciences, University of Nebraska-Lincoln. Contact: Dr. Adam Houston (ahouston2@unl.edu).

* Faculty Position in Climate Sciences, Department of Earth and Planetary Sciences, Johns Hopkins University.

* Postdoctoral Research Position in Chemistry - Climate Modeling, Department of Earth and Planetary Sciences, Johns Hopkins University. Further information about research activities can be found at http://www.jhu.edu/~dwaugh1/ .

* Research Scientist II, Special/UV-B Monitoring and Research Program, Natural Resource Ecology Laboratory, Colorado State University. More information: http://uvb.nrel.colostate.edu .

* Postdoctoral Position at Meteo-France (DCLIM) Extraflo Project, Climatology Department, Toulouse, France. Contact: Jean-Michel Veysseire (jean-michel.veysseire@meteo.fr).

* Lecturer in Climate Change, Institute for the Environment, Brunel University, United Kingdom (Vacancy Ref: DEB0023-1). Contact: Professor John Sumpter (john.sumpter@brunel.ac.uk).

* Senior Climate Modeler, Centre for Australian Weather & Climate Research, Bureau of Meteorology, Australia. Contact: jobs@bom.gov.au quoting position 11174.

* Urban Climate Modeler, Birmingham City Council and the University of Birmingham, UK. Contact: Professor John E Thornes (j.e.thornes@bham.ac.uk).

* Postdoctoral Position in Climate Science, Climate Physics Group, Atmospheric Science and Global Change Division, Pacific Northwest National Laboratory, Richland, Washington (Job ID: 117483).

* Climate Change Adaptation Scientist, College of Sciences and Engineering, University of Leicester. Contacts: Professor Martin Barstow (mab@le.ac.uk) or Professor Mike Petterson (mp329@le.ac.uk).

* Three Lecturer Positions, Tyndall Centre for Climatic Change Research, Norwich, UK. (Ref: ATR842).

* Postdoctoral Research Associate in Air Pollution Modelling, Lancaster Environment Centre, Lancaster University, Lancaster, UK. (REF: AA40R). Contact: Rob MacKenzie (r.mackenzie@lancaster.ac.uk).

* Postdoctoral Research Assistant in Satellite Remote Sensing/Time Series Analysis, Bristol Glaciology Centre, Bristol, UK. Contact: Professor J.L: Bamber (j.bamber@bristol.ac.uk).

* Assistant Professor in Geography, Faculty of Social Sciences, Department of Geography, University of Victoria, Canada. Contact: Dr Philip Dearden (chair@mail.geog.uvic.ca).

* Research Assistant on a NERC funded research project "End-to-end Quantification of Uncertainty for Impacts Prediction", Centre for the Analysis of Time Series/Department of Statistics and Grantham Research Institute on Climate Change and the Environment, London School of Economics, London, UK (Ref: RES/09/10).

* Computational Scientist in atmospheric and climate modelling, Cyprus Institute, Cyprus. Contact: (castorc.info@cyi.ac.cy).

Interdisciplinary

* Assistant Professor in Ecology, Department of Renewable Resources, University of Wyoming. Contact: Dr. Ann Hild (SystEcol@uwyo.edu).

* Department Chair, Department of Geological & Environmental Sciences, Youngstown State University. Application details: http://cfweb.cc.ysu.edu/hr/Position_Announcements.htm

* Earth Scientist, Nanyang Technological University, Singapore. More information: http://www.earthobservatory.sg/careers/.

* Faculty Position in Climate Dynamics/Climate System Variability, University of Rochester.

* Faculty Position in Climate and Global Change, Department of Geological Sciences, University of Florida. More information: http://web.geology.ufl.edu/search/facultyposition.html

* Faculty Position in Environmental Science, New York University Abu Dhabi. Contact: nyuad.environment@nyu.edu

* Faculty Positions in Climate Science, Arizona State University.

* Faculty Positions in Global Change and Earth System Science, Beijing Normal University, China.

* Faculty Positions in Planetary Atmospheres, Arizona State University.

* Flint Postdoctoral Fellowship in Geosciences, Department of Geology and Geophysics, Yale University.

* Green Scholar Positions in Geophysics, Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography.

* Interdepartmental Postdoctoral Fellowship in Geosciences, Department of Geology and Geophysics, Yale University.

* Postdoctoral positions in the PACE Fellowship Program, UCAR, Boulder, CO. For detailed information: http://www.vsp.ucar.edu

* Postdoctoral Research Positions, Department of Geosciences, Princeton University (Requisition #0900505).

* Postdoctoral Fellowships, Yale Climate & Energy Institute, Yale University.

* Research Scientist II-Special, Colorado State University, UV-B Monitoring and Research Program, Natural Resource Ecology Laboratory. More information: http://uvb.nrel.colostate.edu

Student Opportunities

* PhD Position on 'Satellite measurements of metal species in the mesosphere and lower thermosphere', Institute of Environmental Physics, University of Bremen, Bremen, Germany. Contact: Dr. Miriam Sinnhuber (miriam@iup.physik.uni-bremen.de).

* PhD Position within the project PRIME "Precipitation in the past millennium in Europe", Institute for Coastal Research, Geesthacht, Germany (Code-No.: 2009/KS 9).

* PhD Position in Atmospheric Science of Wildfires, Laboratory for Atmospheric Research, Washington State University, Washington. Contact: Dr. Fok-Yan Leung (fokyan.leung@gmail.com).

* Postgraduate Studentship: Relating Climate Models and Reality, Centre for the Analysis of Time Series and the Grantham Research Institute on Climate Change and the Environment, London, UK. Contact: Lyn Grove (l.grove@lse.ac.uk).

* Graduate Assistantship (M.S. and Ph.D.) Opportunities, Department of Geosciences, Western Michigan University. Contact: Daniel Cassidy (daniel.cassidy@wmich.edu).

* Graduate Fellowships in Sustainability Science, Maine's Sustainability Solutions Initiative. More information: http://www.umaine.edu/sustainabilitysolutions

* 10-week undergraduate summer program at the Arecibo Observatory in Puerto Rico. More information: http://www.naic.edu/science/summer_set.htm

* Ph.D. Positions in Isotope Chemistry, Laboratoire de Glaciologie et Geophysique de l'Environnement (LGGE), University of Grenoble, France. Contact: Joel Savarino (jsavarino@lgge.obs.ujf--grenoble.fr).

Schools

9th International NCCR Climate Summer School - "Adaptation an Mitigation: Responses to Climate Change" -

Grindelwald, Switzerland. 29 August - 3 September 2010.

http://www.nccr-climate.unibe.ch/summer_school/2010/

Conferences

// AGU 2009 Fall Meeting //

San Francisco, CA, U.S.A., 14 - 18 December 2009.

http://www.agu.org/meetings/fm09/

// International Conference on Energy, water & climate change in the Mediterranean & the Middle East //

Nicosia, Cyprus, 11 – 15 January 2010.

http://www.cyi.ac.cy/node/242

// 90th AMS Annual Meeting //

Atlanta, GA, U.S.A., 17 – 21 January 2010.

http://www.ametsoc.org/meet/annual/index.html

// Local Air Quality and its Interactions with Vegetation //

Antwerp, Belgium, 21 - 22 January 2010.

http://www.vito.be/aq-vegetation-workshop

// Arctic Frontiers 2010 //

Tromsø, Norway, 27 - 29 January 2010.

http://www.articfrontiers.com

// International Conference on Polar Climate and Environmental Change in the Last Millennium //

Torun, Poland, from 1 - 3 February 2010.

http://www.zklim.umk.pl/nowa/polarna

// AGU Chapman Conference on Complexity and Extreme Events in Geosciences //

Hyderabad, India, 15–19 February 2010.

http://www.agu.org/meetings/chapman/2010/bcall/

// 29th Conference on Hurricanes and Tropical Meteorology //

Tucson, Arizona, 10 – 14 May 2010.

// CWE2010 - Fifth International Symposium on Computational Wind Engineering //

Chapel Hill, North Carolina, USA. 23-27 May 2010.

http://www.cwe2010.org

// 13th Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes //

Paris, France, 1 - 4 June 2010.

http://www.aria.fr/harmo/

// Water 2010 //

Quebec City, Canada, 5 - 7 July 2010.

http://www.water2010.org

// 11th International Meeting on Statistical Climatology //

Edinburgh, Scotland, 12 - 16 July 2010.

http://cccma.seos.uvic.ca/imsc/11imsc.shtml

==========

Newsletter of the AGU Atmospheric Science Section

Volume 3 Issue 5 - November 2009