FACING THE FUTURE

The FACTS II (Aspen FACE) Newsletter

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Andrew J. Burton and Janet M. Pikkarainen, Editors

Aspen FACE is a highly successful project for global change research. Over 100 scientists and students contributing to the project have written over 170 scientific papers and Aspen FACE remains at the cutting edge of forestry and ecological research. Principally supported by the U.S. Department of Energy's Office of Biological and Environmental Research, the Aspen FACE (Free Air CO_2 Enrichment) project is located on USFS property 10 miles west of Rhinelander, Wisconsin. Since 1998, the project has been examining the impacts of elevated atmospheric carbon dioxide (CO_2) and tropospheric ozone (O_3) on the structure and functioning of a northern forest ecosystem dominated by trembling aspen, North America's most widely distributed tree species. The Aspen FACE project became part of DOE's distributed facility in 2003. The Aspen FACE facility is run by Michigan Technological University (MTU) with Andrew J. Burton as MTU's Lead Investigator for the Aspen FACE Project. All major decisions at the Aspen FACE facility are made by the Steering Committee which includes Andy Burton (MTU), Kurt Pregitzer (Univ. Nevada-Reno) and Alistair Rogers (Brookhaven National Laboratory). Dr. Mark Kubiske (USFS) is an ex-officio member of the Steering Committee and coordinates science at the site. Former members of the Steering Committee are David F. Karnosky (Director-deceased), Neil Nelson (U.S. Forest Service-retired), and Kevin E. Percy (Canadian Forest Service-retired).

***Note**: Previous issues of the newsletter are available at the Aspen FACE web site http://aspenface.mtu.edu*

Aspen FACE Harvest Complete

The Aspen FACE harvest has been completed! On June 8, 2009, harvest of the experiment began. Crews from the Forest Service, Michigan Technological University, the University of Michigan, and the University of Nevada teamed together to harvest the above- and below-ground portions of the experiment. All together, well over 25 students and staff from these institutions worked daily on the harvest through mid-August. First, an access lane was cut into each ring. The entire top of each tree measured was taken back to the David F. Karnosky Lab and picked apart and the components weighed. A small tracked excavator and commercial soil sieves were used to recover the coarse roots from volumetric soil pits. Then soil cores were extracted from the walls of the pit face to recover fine roots and study soil carbon. The FACE harvest was a very complex and daunting logistical task, but progress remained on schedule throughout the successful conclusion in August.

A tracked excavator was used to excavate a volumetric pit in each community type to quantify coarse root biomass.

Commercial “mud buggies” were used to forward the soil from inside each ring to the large soil sieves used to separate coarse roots from soil.

Long-time FACE Principal Investigators Kurt Pregitzer (University of Nevada) and Don Zak (University of Michigan) test the operation of the commercial soil sieve on June 9, 2009. The sieves worked very well and were used to separate coarse roots from soil.

Alex Pierson, an undergraduate student from the University of Nevada, collects soil cores from the pit face. These cores are used to quantify fine root biomass and soil carbon.

Stephen Slater, Wendy Jones Joyal (Aspen FACE site operator) & Marty Joyal

Crews from the Forest Service, Michigan Technological University, the University of Michigan, and the University of Nevada participated in the harvest

US Forest Service Dedicates Laboratory to Honor Late David F. Karnosky

The US Forest Service Northern Institute for Applied Ecosystem Studies has dedicated a new research lab in Rhinelander, Wis., in honor of the late David F. Karnosky. It will be called the David F. Karnosky Laboratory, in recognition of his contributions to global climate change science and to Forest Service research.

Karnosky, a Michigan Tech forestry professor who died in 2008, founded the Aspen FACE research project at the Forest Service research farm near Harshaw, Wisconsin. He collaborated there with partners including the US Department of Energy, Brookhaven National Laboratory and the Canadian Forest Service, conducting experiments to study the effects of increasing carbon dioxide and ozone on forest ecosystems.

In 2008, the US Environmental Protection Agency cited data from the Aspen FACE study as it announced changes to air quality standards for ozone.

The new field laboratory will accommodate researchers from around the world who visit the site while conducting climate change research.

Aspen FACE Featured in *Scientific American*

Aspen FACE made the list of top ten Atmospheric Science Experiments in a list presented by Scientific American in April, 2009 (http://www.scientificamerican.com/article.cfm?id=10-climate-experiments). The top ten included studies ranging from the "A-train" satellites to methane monitoring in Siberia.

The article included an aerial view of the Aspen FACE site and the following brief description: "**THE FACE OF THE EARTH -** Can you imagine what the world would look like if you took Earth's carbon dioxide levels from before the Industrial Revolution and doubled them?

Actually, no one can. That's because no one knows exactly how carbon dioxide fits into all of Earth's processes. That's why scientists use Free-Air Carbon Enrichment (FACE) to essentially turn up the knob on ambient carbon dioxide and create an artificial atmosphere of the future. Aspen FACE in northern Wisconsin

surrounds nine forest plots, each about the size of a baseball infield, with hoses that spray CO_2 on the trees. By cranking up the CO_2 to 560 parts per million (an optimistic guess for 2050 levels), they see how a mini ecosystem adapts to the change.

But unlike other FACE sites, Aspen also turns up the amount of ozone (the major ingredient of smog) around the trees. Among other things, they are finding that CO_2 boosts growth, ozone retards it, and pests seem to enjoy the futuristic mix."

***Environmental Pollution* Special Issue Update**

During April 2-4, 2008 at the Holiday Inn Express in Rhinelander, Wisconsin, Aspen FACE hosted a joint meeting of three Free-Air ozone experiments representing twenty different organizations with 93 people from eight countries. The meeting was chaired by the late Dave Karnosky (Aspen FACE), Don Ort (SoyFACE) and Rainer Matyssek (SFB, Munich, Germany). As a result of this meeting a Special Issue of *Environmental Pollution* will be published.

We are pleased to announce that the review process is now complete. Seventeen manuscripts have been accepted and are with the Editor-in-Chief for publication in the *Environmental Pollution* Special Issue entitled "Facing the Future: Joint Aspen FACE, SoyFACE and SFB Meeting". Guest editors for the Issue are Kevin Percy, Rainer Matyssek, John King and Dave Karnosky.

We will provide an update on publication date once it is available from Elsevier. The editors wish to thank Janet Pikkarainen for her excellent work during processing of all manuscripts received.

MTU's Global Change Summer Teacher's Institute Tours Aspen FACE

Michigan Tech hosted an annual program in July to help primary and secondary school teachers improve the way they educate students in natural resources and environmental science. In the process, teachers earned credits to put toward recertification or a masters degree. The university hosted three week-long sessions covering forest ecology and resources, future fuels, and forests and global change.

During the week of July 13, 2009 Tech hosted the Global Change Teacher's Institute. The Institute is sponsored by MTU's School of Forest Resources & Environmental Science and the Ecosystem Science Center with funding from the National Science Foundation. Institute co-director Andrew Burton, a School of Forest Resources & Environmental Science associate professor, said the Institute was not just about global warming; it also focused on subjects such as acid rain, nitrogen deposition and land use changes, and, of course, a changing atmosphere. He said the teachers learned by visiting research sites and talking with professors. "They want to get updated as much as they can on the latest science", he said.

As part of the Institute, a group of 16 teachers from throughout the Lake States took a field trip to the Aspen FACE research site. They had many positive comments about the Institute and especially enjoyed the Aspen FACE field trip. Many described this chance to see real science in action as the highlight of their week.

Aspen FACE Helps Development of FACE in Brazil

Dr. André Torre-Neto from Embrapa in Brazil (a sort of USDA-ARS) visited Aspen FACE on July 13, 2009. Dr. Torre-Neto is part of a team designing a FACE experiment in Brazil and wished to learn about the technical aspects of the implementation and operation of FACE facilities. Prior to visiting the Aspen FACE site, he met with Keith Lewin and John Nagy in North Carolina and also visited the SoyFACE site in Illinois. He left feeling the information gained during the visit would greatly aid the development of their fumigation system and operating protocols.

People at Aspen FACE

Andy Burton, Associate Professor of Forest Ecology
Michigan Technological University
Houghton, Michigan

Editors: Tell us about your career background and your present position at MTU.
Andy: Currently I'm an Associate Professor of Forest Ecology at Michigan Tech. I first came to Michigan Tech from Michigan State in 1994 with Kurt Pregitzer, who was my doctoral advisor. I finished my Ph.D. in Forest Ecology in 1997, and over the years I've worked with Kurt and others on a variety of projects examining carbon and nutrient cycling, especially that occurring belowground. These have included research on the effects of simulated nitrogen deposition and climatic variation on northern hardwood forests along the Michigan Gradient and understanding the effects of temperature, moisture and nitrogen availability on root systems in wide variety of ecosystems, ranging from slash pine in Florida, to pinyon-juniper in New Mexico, to balsam poplar and white spruce in Alaska. I'm currently also involved in research studying the effects of soil warming on root systems and the impacts of non-native earthworms on northern hardwood forests. Since 2000, I've also taught a variety of courses at Michigan Tech, including Measuring Forest Resources, Geomorphology, Landscapes & Ecosystems, Soil Science, and now Forest Ecology.

Editors: What are your primary research interests?
Andy: My main research interests include forest responses to global change factors, carbon and nutrient cycling, and the physiological ecology of tree roots. I also really enjoy involving undergraduates in research whenever possible and integrating research results into my teaching. The projects I work on generally try to integrate soil science, plant physiology and ecology in order to determine how ecosystems are affected by or adjust to environmental stresses and human manipulations.

Editors: How and when did you become involved in Aspen FACE?
Andy: Beginning in 2003 I helped process minirhizotron root images from Aspen FACE for Kurt Pregitzer in order to understand the impacts of the treatments on carbon allocated to annual root production. This work and relating the observed root production and mortality to treatment responses for soil respiration continued for several years. I also measured root respiration rates and isotopic signatures at Aspen FACE in recent years and have brought several educational groups to Aspen FACE, including participants in an NSF Research Experiences for Undergraduates Site and Michigan Tech's annual Global Change Teacher's Institute.

Editors: What do you see as your biggest challenges in your new role as the MTU representative on the Aspen FACE steering committee?
Andy: The biggest challenge has been to not mess up a good thing. Really, the team put in place by Dave Karnosky helped make this easy to avoid. There was a great group of people already in place both at Michigan Tech and on the Steering Committee who helped me to keep site operations at FACE going smoothly this year. I can't thank Wendy Jones Joyal, Scott Jacobsen, Janet Pikkarainen, and the Steering Committee enough for their help. With the harvest this year, one big challenge has been to accommodate the many requests for samples and data. With the help of the rest of the Steering Committee, we've been able to review numerous research requests and provide a wide variety of samples for topics ranging from wood anatomy and decomposition, to insect herbivory, to gene expression. Again, the previous efforts by Dave Karnosky, Mark Kubiske, Don Zak and Kurt Pregitzer in developing a comprehensive harvest plan made this task much easier to accomplish. Being able to work well with a large, diverse group of people has been important, but they've been a great group to collaborate with.

Eric Gustafson, Director
Institute for Applied Ecosystem Studies
USDA Forest Service
Rhinelander, Wisconsin

Editors: Please describe your professional background and your present position at the Forest Service.
Eric: I am the Director of the Institute for Applied Ecosystem Studies in Rhinelander, WI, inheriting that responsibility when Neil Nelson retired. I am a landscape ecologist, primarily developing and applying forest landscape models to project the effects of natural and human disturbance on forest composition and spatial pattern at broad spatial and temporal scales. One of my emerging interests is the use of the LANDIS-II model to scale up the results of the Aspen FACE experiment to the landscape scale. The model will integrate the CO_2 and ozone effects with a number of other ecological processes including seed dispersal, establishment, competition, windthrow, timber harvest and insect outbreaks. We can then make projections about how elevated CO_2 and ozone might interact with various landscape processes to affect the composition and spatial pattern of northern forests.

Editors: What is the Institute for Applied Ecosystem Studies?
Eric: The Institute has a mission to develop the theory and application of scaling science to provide knowledge at relevant scales in forestry. Our research is focused on four principal areas of study. 1. The development of fast-growing tree crops for use as bioenergy and fiber. 2. Studying climate change impacts on forest productivity, species composition, and the biogeochemistry of terrestrial ecosystems at multiple scales. Aspen FACE is the major component of this focus. 3. Studying the reciprocal link between the spatial and temporal dynamics of landscape elements and ecological processes, using this link to make reliable predictions to guide management and policy decisions. 4. Developing innovative scaling concepts and tools to integrate disciplinary research and translate forestry knowledge to policy-relevant scales.

Editors: Where do you see your role in management of Aspen FACE should funds become available to continue operation?
Eric: The Institute will continue to serve as host for the Aspen FACE experiment. My goal will be to encourage the highly productive cooperative relationships that are already in place. The Aspen FACE model of cooperative, collaborative research, guided by a steering committee of fully-engaged scientists, has served the Aspen FACE experiment well. I look forward to participating in that environment as an *ex officio* member of the steering committee.

New Aspen FACE Publications

Ainsworth, E.A., C. Beier, C. Calfapietra, R. Ceulemans, M. Durand-Tardif, D.L. Godbold, G.R. Hendrey, T. Hickler, J. Kaduk, D.F. Karnosky, B.A. Kimball, C. Korner, M. Koornneef, T. Lafarge, A.D.B. Leakey, K.F. Lewin, S.P. Long, R. Manderscheid, D.L. McNeil, T.A. Mies, F. Miglietta, J.A. Morgan, J. Nagy, R.J. Norby, R.M. Norton, K.E. Percy, A. Rogers, J.-F, Soussana, M. Stitt, H.-J. Weigel, and J.W. White**.** 2008. Next generation of elevated [CO_2] experiments with crops: A critical investment for feeding the future world. Plant, Cell and Environment 3:1317-1324.

Andrew, C. and E.A. Lilleskov. 2009. Productivity and community structure of ectomycorrhizal fungal sporocarps under increased atmospheric CO_2 and O_3. Ecology Letters 12:813–822.

Chakraborty, S., J. Luck, G. Hollaway, A. Freeman, R. Norton, K.A. Garrett, K. Percy, A. Hopkins, C. Davis, and D.F. Karnosky. 2008. Impacts of global change on diseases of agricultural crops and forest trees. CABI Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 3, No. 054.

Cseke, L.J., C-J. Tsai, A. Rogers, M.P. Nelsen, H.L. White, D.F. Karnosky, and G.K. Podila. 2009. Transcriptomic comparison in the leaves of two aspen genotypes having similar carbon assimilation rates but different partitioning patterns under elevated [CO2]. New Phytologist 182:891–911.

Darbah, J.N.T., M.E Kubiske, N. Nelson, E. Oksanen, E. Vapaavuori, and D.F. Karnosky. 2008. Effects of decadal exposure to interacting elevated CO_2 and/or O_3 on paper birch (*Betula papyrifera*) reproduction. Environmental Pollution 155:446-452.

Liu L., J.S. King, F.L. Booker, C.P. Giardina, H. L. Allen, and S. Hu. 2009. Enhanced litter input rather than changes in litter chemistry drive soil carbon and nitrogen cycling under elevated CO_2: a microcosm study. Global Change Biology 15:441–453.

Liu, L., J.S. King, C.P. Giardina, and F.L. Booker. 2009. The Influence of Chemistry, Production and Community Composition on Leaf Litter Decomposition under Elevated Atmospheric CO_2 and Tropospheric O_3 in a Northern Hardwood Ecosystem. Ecosystems 12:401–416.

Uddling, J., A.J. Hogg, R.M. Teclaw, M.A. Carroll, and D.S. Ellsworth. 2009. Stomatal uptake of O_3 in aspen and aspen-birch forests under free-air CO_2 and O_3 enrichment. Environmental Pollution (in press)

Uddling, J., R.M. Teclaw, K.S. Pregitzer, and D.S. Ellsworth. 2009. Leaf and canopy conductance in aspen and aspen-birch forests under free air enrichment of carbon dioxide and ozone. Tree Physiology (in press)

Wittig, V.E., E.A. Ainsworth, S.L. Naidu, D.F. Karnosky, and S.P. Long. 2009. Quantifying the impact of current and future tropospheric ozone on tree biomass, growth, physiology and biochemistry: A quantitative meta-analysis of the ozone literature. Global Change Biology 15(2):396-424.