



FACING THE FUTURE

The FACTS II (Aspen FACE) Newsletter

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David F. Karnosky 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 70 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 CO₂ Emission) 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 (CO₂) and tropospheric ozone (O₃) on the structure and functioning of a northern forest ecosystem dominated by trembling aspen, North America's most widely distributed trees species. The Aspen FACE project became part of DOE's distributed facility in 2003. The Aspen FACE facility is run by Michigan Technological University with MTU's Dave Karnosky as Director. All major decisions at the Aspen FACE facility are made by the Steering Committee which includes Dave Karnosky, Kurt Pregitzer (MTU), Neil Nelson (U.S. Forest Service), Kevin Percy (Canadian Forest Service), and George Hendrey (Queens College). Dr. Mark Kubiske is an ex-officio member of the Steering Committee and he coordinates science at the site.



Adam Weise Continues Climbing Training

Adam Weise, a USFS technician in Don Riemenschneider's project, continued his capable safety training with a large class (see photo) for climbing on June 14, 2005 at Aspen FACE. Over the past 3 years, Adam has trained over 100 people to use the climbing belts and climbing buddy system to access our elevated canopy access walkways. **Reminder: Anyone wishing to use the elevated walkways must complete this climbing training. Please**

contact Wendy Jones (wsjones@mtu.edu) or Mark Kubiske (mkubiske@fs.fed.us) before coming to the FACE site. Thanks for the good work, Adam!

Nesting Pair of Eastern Kingbirds Makes Aspen FACE Home

A nesting pair of eastern kingbirds (photo below) has made an Aspen FACE ring home again this year. The pair laid four eggs (see photo) in a nest near the top of an elevated canopy-access walkway, as they had done last year. The nest has come as quite a surprise to local birders. The birds get quite agitated when anyone comes near their young, so please do not try to get too close to them.



Aspen FACE Open House and Environmental Assessment

The Aspen FACE facility held an open house on June 15 that included three tours of the experiment (Ring 1.4 which is both elevated CO₂ and O₃). The tours were started with welcomes by Dr. Neil Nelson (U.S. Forest Service Project Leader) (photo on left) and Dr. David Karnosky, Aspen FACE Director (photo on right).



Neil explained the plans to expand the height of the gas delivery system at each ring (see photo below on left). Dr. Mark Kubiske (USFS) and Aspen FACE Science Coordinator (see photo below on right) led discussions in front of posters during a break in the evening session.

Open discussion times in the afternoon and evening, led by the Environmental Assessment team from Argonne National Laboratory, gave the local people an opportunity to voice their concerns about the Aspen FACE project. The Environmental Assessment web site is site http://www.ncrs.fs.fed.us/projects/face_ea/. Comments can be sent via the web site or mailed to Mr. Rick Sindt, U.S. Forest Service, 1992 Folwell Avenue, St. Paul, Minnesota 55108.

Stories about the Aspen FACE open house were written up in both the Rhinelander Daily News (June 16, 2005) and the Vilas County News-Review (June 15, 2005). In addition, the story was featured on the Rhinelander Channel 12 television news on June 15.



EPA Hummingbird Prototype Study at Aspen FACE

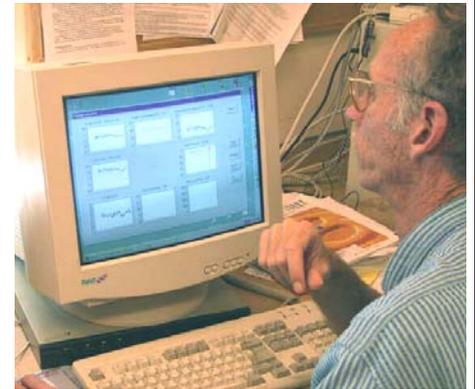
A team of U.S. Environmental Protection Agency scientists studying ozone effects on hummingbird behavior, ecologists spent the week of June 16 setting up their feeders and calibrating the motion detectors in control and O₃ rings. Team members included engineer Allen Ledbetter (left), summer intern Jeff Swain (center), and ecologist Tim Lewis (right). The team is headquartered in Raleigh, North Carolina. Dr. Lewis is one of the EPA team leaders for the Ozone Criteria Document from which the adequacy O₃ standard in protecting human health and welfare is determined.





CFS Scientist Examines Pathogens

Chuck Davis, a forest pathologist with the Canadian Forest Service's Great Lakes Centre in Sault Ste. Marie, Canada, recently spent a week at Aspen FACE to evaluate this year's *Venturia* symptoms on aspen. Luckily, this appears to be a light year for *Venturia*, which kills the new shoots of aspen causing multiple shoot leaders to occur. *Venturia* has been a problem on certain clones (especially clone 216) since the early days of our experiment. Chuck is also working with USFS scientist William Mattson and CFS scientist Anthony Hopkin to evaluate the occurrence and spread of *Hypoxyylon* canker (see photo below of Chuck examining a young *Hypoxyylon* canker). Chuck also took part in our Aspen FACE open house, discussing his pathogen research at Aspen FACE.



Naturally High Ambient O₃ Occasionally Occurs in Harshaw (Nagy's Corner)

During the early summer of 2005, the Wisconsin Department of Air Quality reported incidents of 70-90 ppb background ozone (O₃) in both Harshaw and Eagle River, Wisconsin. These events are about 30-50 ppb above the region's normal mean value. Sensitive bioindicator plants in the region, including milkweed and eastern white pine, have since shown visible foliar symptoms in Oneida and Vilas Counties. Ozone is created here in the Rhinelander area hundreds of miles from where its precursors, nitrogen oxides (NO_x) and volatile organic compounds (VOCs), are first released in dense industrial and urban areas. This is classic long-distance transport of O₃ precursors. What is often misunderstood is that O₃ itself does not last long in the atmosphere but that the precursors to its formation (NO_x and VOCs) do. The Aspen FACE project does not produce NO_x or VOCs. The relatively minute amount of O₃ generated by electrical discharge has not in any way contributed to these regional O₃ events. **Note: Dr. John Nagy is a physicist at Brookhaven National Laboratory.**



Ozone Symptoms on Forest Floor Vegetation Seen in Rings Only

Ozone causes distinct visible symptoms consisting of red, black, tan, or grey flecks (also referred to as stipple) on the upper leaf surface of O₃-sensitive plants. During mid to late June, we began detecting such symptoms (see area near arrow in photo) on O₃-sensitive understory plants such as red clover and dandelion inside the FACE O₃ rings. The distinctive symptoms generally occur a little later (late July or early August) on paper birch and aspen in our O₃ rings. In addition, black bifacial stipple or larger necrotic areas sometimes occur with trembling aspen in the O₃ rings. Later in the growing season in the O₃ rings, an additional symptom is premature senescence (also called accelerated leaf aging) of leaves.

Over the 8-year life of the experiment, the lack of these distinctive symptoms on O₃-sensitive plants (referred to as bioindicator plants), such as hybrid poplar clone NM6 (which borders all FACE rings), black cherry, milkweed, and clover outside of the treatment rings are invaluable in demonstrating there is no problem of O₃ drift downwind of our O₃ rings.



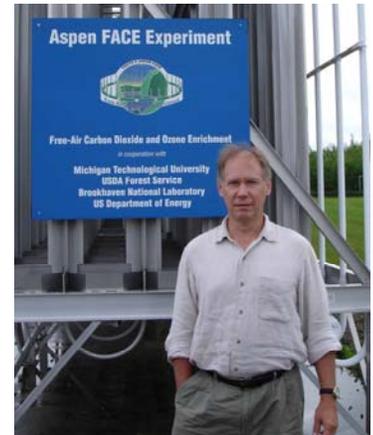
Kull Visits Aspen FACE

Dr. Olevi Kull (photo), Professor at the University of Tartu, Estonia's Institute of Botany and Ecology, visited Aspen FACE from June 13-20, 2005. Funded by the U.S. Consulate, Dr. Kull was visiting Dr. David Karnosky, Aspen FACE Director and Michigan Tech Professor, to discuss future collaborations on canopy structure and scaling. Drs. Kull and Karnosky have collaborated on various projects over the past 10 years starting in 1994 when Dr. Kull conducted gas exchange measurements in Dr. Karnosky's open-top chamber experiment in Alberta, Michigan. Dr. Kull was instrumental in the development of our optical LAI measurement system at Aspen FACE.



Dr. Cseke Visits Aspen FACE

Dr. Leeland Cseke (right), a molecular biologist with Dr. Gopi Podila at the University of Alabama-Huntsville, visited the Aspen FACE project on June 14, 2005 to assist in the collection of aspen samples for microarray analysis of gene expression. Dr. Cseke is an expert on functional genomics and has recently run our first 2004 Aspen FACE samples using a *Populus* chip containing some 25,000 expressed sequence tags. This project is a cooperative one with Dr. David Karnosky, Michigan Tech, and Dr. Gail Taylor, University of Southampton, UK, and is sponsored by the U.S. Department of Energy.



New USFS FIA Ozone Biomonitoring Study at Aspen FACE

Ed Jepsen (photo – right), Air Quality Division, Wisconsin Department of Natural Resources, and Gretchen Smith, University of Massachusetts head of the USFS FIA Ozone Biomonitoring Program, are evaluating Aspen FACE rings monthly this season to calibrate their crown evaluation procedures for foliar injury symptoms from O_3 against known O_3 doses. Ed has been a scientist with Aspen FACE for many years having worked with Drs. David Karnosky (MTU), Mark Kubiske (USFS) and Eric Kruger (University of Wisconsin) on previous modelling efforts. The USFS FIA Ozone Biomonitoring program is evaluating O_3 effects on forest vegetation across the U.S.

Canadian Forest Service Provides Passive O_3 Monitors

Dr. Roger Cox (photo below) and his team of John Malcolm and Gary Henderson, Natural Resources Canada, Canadian Forest Service-Atlantic Forestry Centre has again provided passive O_3 samplers to monitor spatial variation throughout all O_3 rings at Aspen FACE. This is the third year we have deployed the samplers, called CanOxy Plates (see photo of sampler on fence) (web site: http://www.nrcan-rncan.gc.ca/cfs-scf/science/technologies/pas_e.html) to characterize vertical and horizontal distribution of O_3 in the Aspen FACE rings. The samplers are changed monthly and are processed in Dr. Cox's laboratory in Fredericton. This year Dr. Cox sent along another 12 passive monitors that are being used as additional fence line monitors. Thanks much to the CFS team for providing us this invaluable service! Thanks also to site operator Jaak Sober and our student operators for placing and maintaining the samplers!





Percy Keynotes Plant Canada 2005

Dr. Kevin Percy (Canadian Forest Service and Aspen FACE Steering Committee) presented an invited plenary lecture in the session "Plants, Canada and Climate Change" on June 17 entitled "Rising Levels of Greenhouse Gases and Forests in a Changing Climate: Key Messages from the Aspen FACE Project", at the Plant Canada 2005 meeting on July 15-18, 2005 at the University of Alberta, Edmonton, Canada. Plant Canada 2005 was the first joint meeting of six major Canadian scientific societies dedicated to plant research, bringing together 450 basic and applied researchers from across Canada.

Canadian Forest Service Administrators Visit Aspen FACE

Dr. Kevin Percy (CFS-Atlantic Forestry Centre and member Aspen FACE Steering Committee) and Dr. Anthony Hopkin (CFS-Great Lakes Forestry Centre) brought a contingent of CFS to tour Aspen FACE on July 12, 2005. Joining Drs. Percy and Hopkin were J. Edward Hurley (A/Research Director, Atlantic Forestry Centre), Wendy Beilhartz (Research Director, Great Lakes Forestry Centre), Nancy Kingsbury and Peter Hall (both Science Advisors at CFS HQ, Ottawa). Following a welcome by USFS Rhinelander Forestry Sciences Lab Project Leader Dr. Neil Nelson and a brief overview of the project by Aspen FACE Director Dr. David Karnosky (Michigan Tech), the group spent the afternoon touring the site and discussing collaborative research possibilities. Thanks to Drs. Bill Mattson (USFS-Rhineland), John Hom (USFS, Northeastern Experiment Station, Newton Park) and Dave Karnosky (MTU) for participating and speaking to the group within the rings on above-ground effects.



National Science Foundation High School Teaching Training Session

Dr. Kurt Pregitzer (Aspen FACE Steering Committee member from Michigan Technological University), Dr. William (Bill) Holmes (University of Michigan), and Dr. Kate Bradley (post-doc, Michigan Technological University) brought 14 high school teachers to visit the aspen FACE on July 13, 2005. The high school and middle school chemistry, math and biology teachers from Michigan and Wisconsin were a part of an NSF-sponsored "Global Change Teachers Institute" run by Michigan Tech the week of July 12th. The teachers were very interested in the FACE experiment and will use its web site in their classrooms this coming year.



Aspen FACE Scientists Have Key Roles at the International Botanical Congress

Drs. Kurt Pregitzer (Michigan Tech and Aspen FACE Steering Committee Member) and Dave Karnosky (Michigan Tech and Aspen FACE Director) presented invited addresses at the XVII International Botanical Congress in Vienna, Austria on July 13-20, 2005. Dr. Pregitzer (left) spoke on “Plant-microbe Interactions in Soil Regulate Ecosystem Response to Atmospheric CO₂” in Dr Kristian Korner’s session entitled “Forests in a CO₂ Rich World”. Dr. Karnosky (right) presented the keynote address entitled “Responses of Northern Forest Trees to Rising Atmospheric CO₂ and Tropospheric O₃: Mechanisms of Altered Forest Productivity” in Dr. Stephen Long’s session entitled “Mechanisms of Plant Response to Global Atmospheric Change”. The congress was attended by over 2,500 scientists.

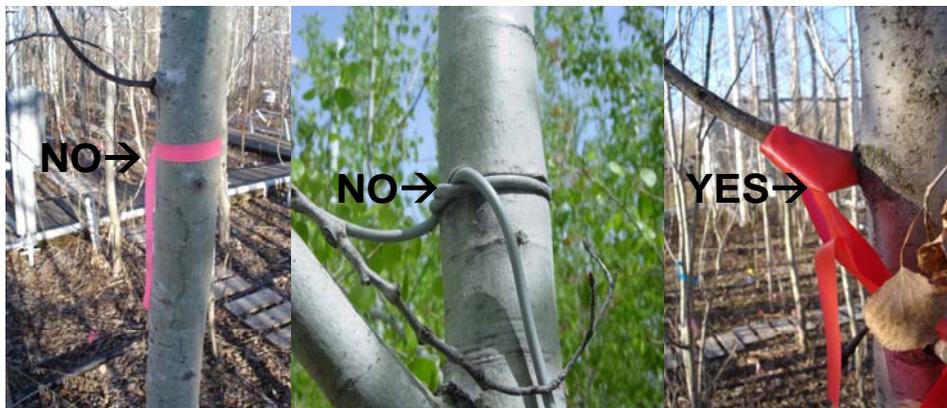


Aspen FACE Experiment Contributes \$50,000 to Cassian Township Road Improvement

Drs. Dave Karnosky (Michigan Tech - left) and Neil Nelson (U.S. Forest Service, Rhinelander Forestry Sciences Lab Project Leader - right) presented the Town of Cassian a check for \$50,000 to help the town with the planned improvement of the Horsehead Lake Road during the Cassian Town Board Meeting on July 5, 2005. Accepting the contribution was Mr. Larry Hendrickson, Cassian Town Chairman (center). Cassian is planning to repave approximately one mile of Horsehead Lake Road later this summer and this donation will help them to make the road better suited for large vehicles such as our CO₂ delivery trucks.

Flagging and Wires Endanger Aspen FACE Trees

We ask all Aspen FACE scientists and students to refrain from placing flagging or any other materials around the main stems (photo on left) as these flags can eventually girdle the stems. Rather, please attach flagging to lateral branches (photo on right).



Hazard Analysis Signs at Aspen FACE

Bill Danfield, Safety Officer (photo), and Rodney Eternicka, USFS Rhinelander Forestry Sciences Laboratory, have recently



put up a series of hazard analysis signs – at the main control building and at each FACE ring. These clearly point out key areas to be aware of at Aspen FACE to keep our excellent safety record intact. Thanks, Bill and Rodney!



Walkway Reminders

The editors remind all scientists to use the wooden walkways in the rings whenever possible to avoid trampling ground cover and compacting the soil. There are many belowground studies that suffer when careless walking in the rings occurs.

Please remember that everyone must be trained for canopy access walkway use and must use the climbing buddy system for accessing the walkways! Please contact Wendy Jones (wsjones@mtu.edu; 715-282-7240) or Mark Kubiske (mkubiske@fs.fed.us; 715-362-1108) in advance to request climbing training and equipment.

Soil Profile Pit Dug

A soil profile characterization pit was recently dug at Aspen FACE. Besides providing excellent soil profile information, the pit was very useful in documenting this season's drought as very little soil moisture was seen even down to a depth of over one meter. Drs. John King and Mark Kubiske are using soil from the pit to backfill soil cores taken from the Aspen FACE rings for their water balance study supported by the USDA NRI Competitive Grant Program. The profile pit will be refilled later this summer.



People at Aspen FACE

Anu Sober, Research Scientist--Estonia

Editors: What is your position in Estonia?

Anu: I am senior research scientist at the Institute of Botany and Ecology (University of Tartu). This position includes lectures (Plants under stress), supervision (one doctoral and two master students) and research in ecophysiology.



Editors: How did you get involved in Aspen FACE?

Anu: Olevi Kull and I collaborated with Dave Karnosky in "open-top" experiments (1992-1995) and this collaboration continued under the "Aspen FACE" project. Additionally, I am bound to Aspen FACE via my husband Jaak (Senior Site Operator).

Editors: What are you working on now at Aspen FACE?

Anu: I have measured photosynthetic parameters, distribution of nitrogen and chlorophyll and water relations of aspen and maple leaves. Also, I have trained students (Asko Noormets, Pooja Sharma, Joseph Darbah, Katre Kets).

In this season I hope to find out how photosynthetic activity affects bud formation.



Editors: Have any of your research experiences or

findings at Aspen FACE surprised you?

Anu: I was surprised that my main objects -stomata - were not very important in determining photosynthesis in aspen as we have shown very low stomatal limitations in aspen. I was also surprised that water potential in upper leaves was lower than in lower leaves in aspen.

Editors: How does this Aspen FACE experiment compare to others you have been involved in?

Anu: Aspen FACE is the biggest project that I have worked on. It is great to see so many new and interesting people and to take part in the large number of authors on papers, as so many disciplines are covered.

Joseph Darbah, PhD Student—Ghana

Editors: Where are you from?

Joseph: I am from Ghana in West Africa

Editors: What is your background?

Joseph: I graduated from Kwame Nkrumah University of Science and Technology (KNUST) Ghana, W/Africa in 2001 with a B.Sc. degree in Natural Resource Management. I researched "the influence of canopy gaps on the development of forest undergrowth" for my B.Sc. Thesis. I majored in forestry. The University asked me to serve as a Teaching assistant for my national service which I did for a year. I started my M.Phil program in Silviculture and Forest Management with focus on Forest Genetics (with encouragement from the then Director of the institute (Dr. Frimpong-Mensah) and Head of Dept (Dr. Kyereh) and Mrs. Agbanyega, all lecturers who taught me at the undergraduate level) and served as a demonstrator at the same time for the department for a year just before coming here.



Editors: How did you end up at Aspen FACE?

Joseph: To make a long story short, one of Prof. Karnosky's students, Mr. Opuni-Frimpong, recommended me to Prof. Karnosky when he got to know that Prof. Karnosky was looking for a hard working student to train. Within a month I was enrolled in a Ph.D Program here in Michigan Technological University. Since I am researching into some aspects of the impact of increased greenhouse gases on the forest ecosystem, there is no better place for me to collect data than at the Aspen FACE site here in Rhineland. So I was here last summer 2004 and this summer I am back again. Hopefully, I will be back again next summer.

Editors: What are you working on at Aspen FACE?

Joseph: I am studying the effects of increased carbon dioxide and ozone gases and their combinations on (1) gas exchange (photosynthesis, stomatal conductance, water deficit, etc.), (2) canopy dynamics, and (3) ozone flux at the Aspen FACE site.



Editors: What are your long-term career goals?

Joseph: My long term career goals are very flexible and dynamic as I love to do research and also love to teach. I know that the training that I am receiving now under Prof. Karnosky (my advisor) and Drs. Kubiske, Giardina, Keen, Sober, and Nelson will equip me well to be able to serve as a very resourceful scientist with any relevant research institution anywhere and/or a well-rounded lecturer at any university I will work with, either as a lecturer or a post doc. It's my goal to be a consultant in the field of plant physiology and air pollution.

Editors: Can you see any relevance of this research to Ghana?

Joseph: Even though ozone pollution is not a serious issue in Ghana as in most developed countries, air pollution and increases in greenhouse gases is a global issue. Ghana, as any other country, is interested in finding answers to some of today's most pressing questions on the minds of many environmental scientists on the role of forest ecosystem in global environmental change.

Findings from this research and on a broader note, results from the Aspen FACE site will provide useful information for policy formulation (with respect to forestry, natural resource management, environmental protection, energy use, pollution levels etc.).

It will also be used to update course outlines on courses (e.g. forest ecology, eco-physiology, plant physiology, meteorology for natural resource scientists, etc.) offered in some of the universities in Ghana. So, this research is very relevant to Ghana.

As a member of the Ghana Institute of Professional Foresters, the knowledge that I acquire through this research will help me make meaningful contributions to the professional body as a whole and in effect the management of Ghana's tropical rain forests.

Aspen FACE New Publications

Chapman, J.A., J.S. King, K.S. Pregitzer, and D.R. Zak. 2005. Effects of elevated atmospheric CO₂ and tropospheric O₃ on the decomposition of fine roots. *Tree Physiology* (In Press)

Cseke, L.J., S.B. Cseke, N. Ravinder, L.C. Taylor, A. Shankar, B. Sen, R. Thakur, D.F. Karnosky and G.K. Podila. 2005. SEP-class genes in *Populus tremuloides* and their likely role in reproductive survival of poplar trees. *Gene* (In Press).

Gupta, P., S. Duplessis, H. White, D.F. Karnosky, F. Martin, and G.K. Podila. 2005. Gene expression patterns of trembling aspen trees following long-term exposure to interacting elevated CO₂ and tropospheric O₃. *New Phytologist*. 167:129-142.

Karnosky, D.F., K.S. Pregitzer, D.R. Zak, M.E. Kubiske, G.R. Hendrey, D. Weinstein, M. Nosal, and K.E. Percy. 2005. Scaling ozone responses of forest trees to the ecosystem level in a changing climate. *Plant, Cell and Environment* 28:965-981.

King, J.S., M.E. Kubiske, K.S. Pregitzer, G.R. Hendrey, C.P. Giardina, E.P. McDonald, V.S. Quinn, and D.F. Karnosky. 2005. Tropospheric O₃ comprises net primary production in young stands of trembling aspen, paper birch, and sugar maple in response to elevated atmospheric CO₂. *New Phytologist* (In Press).

King, J.S., K.S. Pregitzer, D.R. Zak, W.E. Holmes, and K. Schmidt. 2005. Fine root chemistry and decomposition in model communities of north-temperate tree species show little response to elevated atmospheric CO₂ and varying soil resource availability. *Oecologia* (In Press)

Liu, L., J.S. King, and C.P. Giardina. 2005. Effects of elevated atmospheric CO₂ and tropospheric O₃ on leaf litter production and chemistry in trembling aspen and paper birch ecosystems. *Tree Physiology* (In Press)

Mankovska, B., K.E. Percy, and D.F. Karnosky. 2005. Impacts of greenhouse gases on epicuticular waxes of *Populus tremuloides* Michx.: Results from an open-air exposure and a natural O₃ gradient. *Environmental Pollution* 137:580-586.

Mattson, W.J., R. Julkunen-Tiitto, and D.A. Herms. 2005. CO₂ enrichment and carbon partitioning to phenolics: do plant responses accord better with the protein competition or the growth-differentiation balance models? *Oikos* (In press)