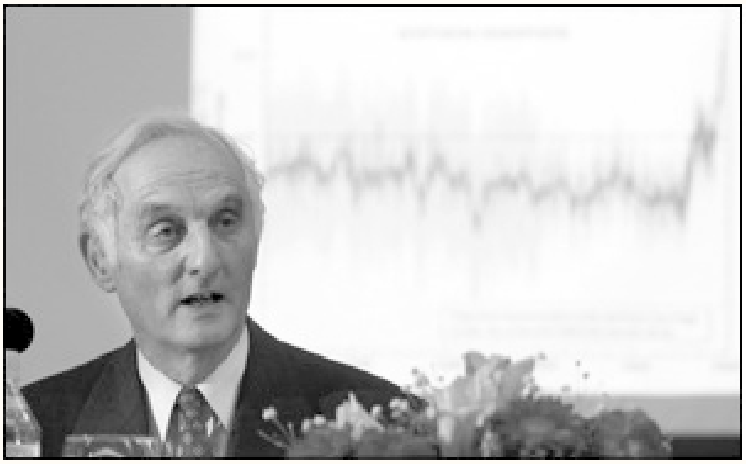
Tree-Ring Times

Newsletter of the University of Arizona Laboratory of Tree-Ring Research *Spring 2001*



Sir John Houghton of the Intergovernmental Panel on Climate Change uses evidence compiled by LTRR professor Malcolm Hughes and colleagues to illustrate his point about ongoing global warming.

AP

LTRR work helps convince panel world is warming up

By Melanie Lenart

Research by LTRR professor Malcolm K. Hughes, climatological colleagues and the tree-ring community figured prominently in the Intergovernmental Panel on Climate Change (IPCC) projections of future global warming.

During an international meeting in Shanghai held earlier this year, IPCC Working Group I co-chairman Sir John Houghton used a graph from a 1999 paper by Hughes and two colleagues to help illustrate why the panel of scientists now believe the Earth has already warmed unusually, and that the predicted warming could be nearly double its earlier projections.

"We always say we want to influence people, but when we do it's worrying because of the responsibility that goes with doing research that turns out to be socially relevant."

Malcolm K. Hughes

The latest IPCC report, approved at the Shanghai meeting this January, projects the Earth's average temperature will increase by 2.5 to 10.4 degrees Fahrenheit by 2100.

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Climatologist joins faculty

Michael Evans looks for signals in multi-proxy annual records

Q: What do corals and trees have in common?

a. They both have annual growth rings.

b. They both permit study of natural climate variability for periods when direct observations are unavailable.

c. They both have attracted the interest of Michael N. Evans, a newly hired assistant professor of dendrochronology who will join the University of Arizona's Laboratory of Tree-Ring Research this year.

d. All of the above.

The correct answer is all of the above. Evans, a paleoclimatologist by training, will join the LTRR faculty in August 2001 after completing two concurrent postdoctoral positions on the East Coast.

At Harvard, where he received his bachelor's degree in 1992, he holds a Climate and Global Change postdoctoral fellowship awarded by the National Oceanic and Atmospheric Administration (NOAA). At Columbia University, where he received his Ph.D. from the Department of Earth and Environmental Sciences in 1999, he is a postdoctoral research scientist at the Lamont-Doherty Earth Observatory.

During a recent visit to Tucson, Evans described the questions that fuel his work.

"Is recently observed El Niño activity, such as the strong 1997-98 event, part of the natural variability of the system? Or is it

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Photo By Steven Leavitt

LTRR Director Thomas Swetnam

A note from the Director

Welcome to the first issue of the LTRR's Tree-Ring Times! With so much going on, we thought a newsletter would be a good way to share with you some highlights of our recent activities. Another reason for this newsletter is to get the word out that we are seeking support for the LTRR. In order for the LTRR to grow and to fulfill its fantastic potential, we need help.

This help can come in a variety of forms. Gifts or endowments are only one of the tangible forms of help that we seek. Another form of help is your sharing with other people our common vision of a unique and vital LTRR, with goals that are both historic and central to the broad mission of the University of Arizona.

We strive to enhance our role as the world's premier and leading laboratory in tree-ring research, teaching and outreach. As you will note in this newsletter, and the ones to come, we are accomplishing our goals by expanding the scope of our research throughout the world, and by embracing our long tradition in the training of future dendrochronologists.

Thomas W. Swetnam

Tree-Ring Times Production Team *Spring 2001*

Editor	**Thomas W. Swetnam**
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connected to global warming? We might not have sufficient historical observations to tell," he said.

Instrumental records of El Niño activity stretch back about a century at best. But Evans and some colleagues, including Alexey Kaplan and Mark A. Cane at Lamont-Doherty, patched together coral records from 12 different tropical locations to create a 200-year record of sea surface temperature in the tropical Pacific Ocean.

"The corals, being from tropical places, were a great recorder of El Niño activity, of course," Evans said. El Niño is a natural phenomenon that tends to bring warmer waters and more rain to the eastern Pacific and coastal Peru. Its counterpart, dubbed La Niña, is associated with cooler waters in the eastern Pacific. The two patterns influence seasonal precipitation and temperatures all over the globe, including winter rainfall in southern Arizona.

The analysis of the coral records tentatively suggests that the early 1800s may have been a period of El Niño activity not unlike today's, despite the relatively cooler global temperatures that characterized the early 19th Century, Evans said.

This type of climate reconstruction is known as a proxy record of climate because it serves as a stand-in for instrumental data where none exist. Just as the relative width of tree rings tends to reflect variability in temperature and precipitation, annual growth rings in reef corals carry information on sea surface temperature and ocean salinity. Scientists retrieve the information by analyzing the chemistry and stable isotopic composition of the

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carbon and oxygen in the coral skeletons.

"If we're interested in big picture phenomena like El Niño, what's the best way to put all the proxy data to work? It turns out that when geographically diverse proxy records of climate agree with one another, they are most likely responding to some common climatic forcing. The problem then becomes one of reliably extracting that climate signal and estimating the uncertainty," Evans said.

Evans plans to apply the same statistical technologies he adapted for corals to interpreting climate patterns from tree rings and other paleoclimatic proxy archives, such as ice cores and ocean sediments. He and his colleagues are using these data to resolve additional patterns of variability in the climate system. His approach includes considering the uncertainty inherent in each data source to estimate, in turn, the statistical uncertainty in the resulting paleoclimate estimates.

"We began our work in the coral world, and came up with some surprising results. It turns out that a similar approach works with other proxy archives such as tree-ring data. That's why I'm thrilled to be here at the LTRR and the U of A," Evans said.

Analyzing multi-proxy data sets involves collaborations with many researchers. He is looking forward to future work with scientists from the LTRR, Geosciences, Atmospheric Sciences and the Institute for the study of Planet Earth at the University of Arizona, as well as with scientists from other universities.

This type of work also tends to involve travel to exotic locations. In fact, even as this publication goes to press in late March, Evans is busy collecting samples in Costa Rica.

"We need more observations from the tropics to better define past El Niño behavior," he said.

With Professor Daniel P. Schrag of Harvard University he is analyzing tropical trees. Tropical trees are notoriously difficult to interpret, mainly because there is no winter frost to create reliable annual rings. But Evans believes that he can coax out seasonal and interannual climate patterns using the stable isotopic composition of the wood.

Evans is also excited about the teaching that will be involved in his faculty position. At Columbia, he helped develop and teach undergraduate courses in environmental sciences and climate dynamics. At the University of Arizona, he plans to teach graduate courses in dynamical and statistical climatology, and undergraduate courses in environmental sciences.

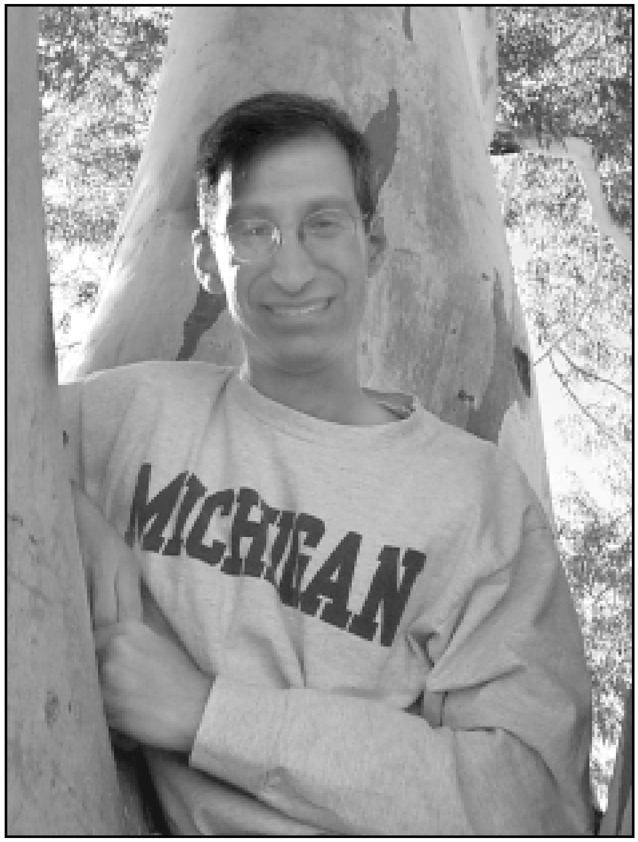

Photo By Melanie Lenart

Michael Evans plans to use stable isotopic analysis to seek climate signals in tropical trees.

"We began our work in the coral world, and came up with some surprising results. It turns out that a similar approach works with other proxy archives such as tree-ring data. That's why I'm thrilled to be here at the LTRR and the UA."

Michael Evans

Accomplishments and activities

Paul R. Sheppard, Adjunct Assistant Professor, received the 2000 CoS Staff Recognition Award and a UA New Learning Environments and Instructional Technologies Grant Program Award.

Dennis O. Bowden, III, Research Specialist, Senior, received an LTRR Lifetime Service Award, 1973-2000.

Richard Warren, Research Associate, received an LTRR Lifetime Service Award, 1965-2000.

Malcolm K. Hughes, Professor, was awarded a Bullard Fellowship, Harvard University.

Katherine K. Hirschboeck, Associate Professor, was appointed to the National Academy of Sciences Committee on Geography. It is a standing committee of the Board of Earth Sciences and Resources, Commission on Geosciences, Environment and Resources.

Thomas W. Swetnam, Director and Professor, was elected to the Editorship of the *Tree-Ring Bulletin* by the Tree-Ring Society. He was also appointed to the Valles Caldera National Preserve Board of Trustees by President Clinton, on December 13, 2000.

Donald, Falk, Graduate Associate, received the Achievement Rewards for College Scientists Scholar, 2000-01, and gave a keynote address at the Southwest Rare Plant Conference, Northern Arizona University, Flagstaff, 2000. He was also appointed Director of Science and Policy, Society for Ecological Restoration.

Melanie Lenart, Graduate Associate, received the Wassaja Foundation Scholarship from Fort Lowell Tribal Council, 2000.

Karen Porter, Student Assistant, was awarded an undergraduate research grant from the UA honors Center and she was awarded the *Alsie/Edmund Schulman Scholarship* through the LTRR, 2000.

Kiyomi Morino and **Linah Ababneh**, Graduate Associates, were jointly awarded the *Andrew E. Douglass Scholarship* for Spring 2001.

Christine Hallman, Graduate Assistant, was awarded the *Alsie/Edmund Schulman Scholarship* for Spring 2001.

Photo By Steven Leavitt

Measuring a life's work

Jeffrey S. Dean, above, recently received the Society for American Archaeology Lifetime Achievement Award. Professor Dean has been using his skills to date wood from ancient structures, among other activities, for the past 38 years as an LTRR dendroarcheologist.

At right is the graph of annual temperatures, with error bars, for the past millennium estimated from proxy records by Hughes and colleagues. More details can be found on the interactive web site listed at the bottom of the page.

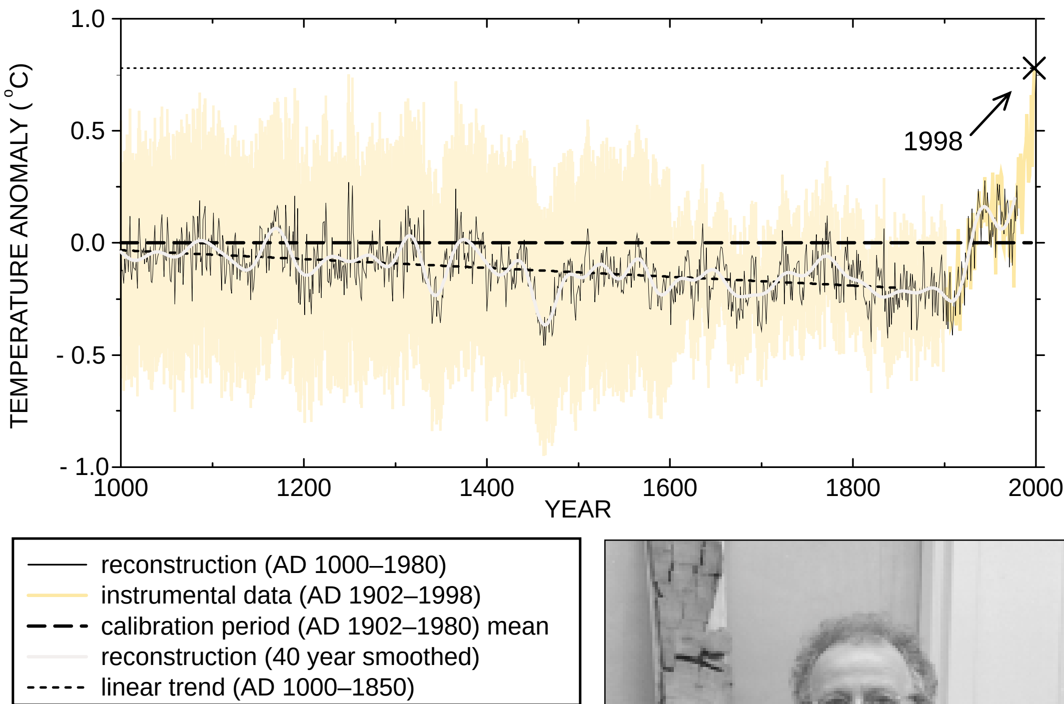

Photo By Steven Leavitt

LTRR Professor Malcolm Hughes

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The IPCC report and the press conference both featured the temperature reconstruction curve produced by Michael E. Mann and Raymond S. Bradley of the Universities of Virginia and Massachusetts along with the University of Arizona's Hughes.

Their statistical analysis of annual records of climate – drawn from existing records of tree rings, lake and ocean sediments, ancient ice and coral reefs – indicate the average global temperature during this past century was warmer than any century of the previous 900 years. Among other things, the temperature reconstruction indicates 1998 was the warmest year in the past millennium, with 1997, 1995 and 1990 hot on its heels.

The international attention given to his work has evoked a mixed reaction in Professor Hughes, who was director of the Laboratory of Tree-Ring Research for 14 years until he stepped down last year to devote more time to teaching and research.

"It's both exciting and worrying. We always say we want to influence people, but when we do it's worrying because of the responsibility that goes with doing research that turns out to be socially relevant. Even so, I am confident that our major findings will stand the test of time – that the past century, and particularly the 1990s, was unusually warm in the Northern Hemisphere compared to the previous five hundred years, and probably the previous nine hundred."

The estimates of temperature become less certain as one ventures back in time, and the researchers used error bars to help capture this uncertainty on the graph. Tree-ring records from Russia, Scandinavia, Tasmania, Argentina, Morocco and France, along with three sets of 1,000-year-long records from North America, helped them extend the temperature reconstruction back 400 years further than they had in an April 23, 1998, paper they published in Nature. Their 1999 paper was published in the March 15 issue of Geophysical Research Letters. Even more recently, they posted an interactive version of some of their findings on the following Earth Interactions website:

http://www.ngdc.noaa.gov/paleo/ei/ei_reconsa.html.

Isotopes answer questions of moisture, growth

By William (Ed) Wright

When I tell people I work with stable isotopes in wood, they usually change the subject. For most people, isotopes are something made by nuclear bombs, if they've heard of them at all. But isotopes are really very simple to understand. So, before describing my research questions, I'll tell you about isotopes.

All atoms of an element, such as oxygen or carbon, are made of protons, neutrons and electrons. A very specific number of protons are required to make an atom of an element. All carbon atoms have 6 protons, for instance, while oxygen atoms have 8. Neutrons, however, are another story.

If you were to compare atoms of a certain element, you would find most have the same number of neutrons in their nucleus. However, on occasion atoms can have more or fewer neutrons and still be the same element. Atoms of an element with different numbers of neutrons are the element's isotopes.

Having more or fewer neutrons changes the weight of the atom, changes the way the atom behaves as it moves through space and interacts with other atoms, and can change the atom's

Photo by Steven Leavitt

William (Ed) Wright works the LTRR's isotope line to answer a variety of questions on climate and tree growth.

stability. An atom with "too many" neutrons is unstable and cannot stay that way. It will eventually change to a more stable form. These unstable isotopes are also known as radioactive isotopes. For instance, carbon atoms with 8 neutrons are unstable while carbon atoms with 6 and 7 neutrons are stable.

I work with the most common stable isotope of oxygen, ^{16}O, and the next most common stable isotope of oxygen, ^{18}O, with 8 and 10 neutrons, respectively. (The 8 protons they both have, plus the number of neutrons, gives us the mass number to the upper left of the O.)

Isotopes with more neutrons are also called "heavy isotopes." The difference in isotope weights can affect what happens to the isotopes in certain interactions. A water molecule (H_2O, having one atom of oxygen and two atoms of hydrogen) with ^{16}O is lighter and evaporates more easily than a water molecule with the heavier ^{18}O. It also condenses into water droplets less readily than its heavier counterpart.

These differences mean that a quantity of water vapor in the air above the ocean will be "lighter" than the same amount of molecules in the ocean. It also means that the water vapor, making clouds and moving across the land, gradually loses the heavier water molecules when water vapor is lost as rain.

Rain collected from each storm and analyzed to find out the amount of heavy oxygen compared to light oxygen can sometimes tell us how humid the air was where the water evaporated or how much rain was lost from the moving water vapor.

Some of the water taken up by a tree is used to make food, or photosynthate. But it turns out that it takes the tree more energy to make food from the heavier water than from the lighter water, so the tree tries to avoid the heavier isotope. Luckily, the difference between the proportion of heavy and light oxygen in the leaf water and the amount in the photosynthate is always the same. So we can figure out what the ratio of different oxygen isotopes was in the leaf water from the photosynthate.

Much of the photosynthate ends up in the cellulose of the wood, where it can be extracted and analyzed. The patterns of changes in the stable isotope ratios from precipitation, across time and space, may provide information about the environment where the precipitation fell, or about the source of the precipitation. If so, the cellulose from the tree rings may provide long-term information about changes in moisture sources, or about changes in the local environment.

In my research, I am using stable isotopes in tree rings to address these questions, among others:

1. Where does the monsoon rain that falls in Tucson and in the Santa Catalina Mountains come from?

2. How does the proportion of heavy and light oxygen isotopes in water molecules change between the time the rain falls and the time the water is used for photosynthesis by trees in the Santa Catalina Mountains?

3. Does the proportion of heavy and light oxygen isotopes in cellulose in tree wood contain a signal from the environment around the tree, or from the precipitation source, that can be recovered by analyzing parts of each tree ring?

4. Can a subannual signal be recovered by subdividing the leaves?

5. Do these trees store food during warmer winter periods that is later used to begin the needle growth in spring?

6. How does the proportion of heavy and light oxygen isotopes in cellulose differ among distant mountain ranges over the same period of time?

Don Falk extracts a tree-ring core from a Ponderosa pine.

Trees yield information on fire regime

By Don Falk

Fire exerts a profound shaping influence on many forested ecosystems. In forests dominated by Ponderosa pine in southwestern North America, the historic fire regime consisted of relatively frequent, low-intensity fires that affected large areas in roughly the same way.

Beginning in the late 19th century and continuing into the present, the combined effects of grazing, fire-fighting efforts, and forest fragmentation have dramatically reduced fire frequencies in most forests. The result has been a profound shift in the ecology of these major forest types.

My dissertation work explores how variations in the size and timing of fires regulate forest processes. This work requires a detailed fire record and accurate estimates of tree establishment dates, both of which can be gleaned from tree-ring records and cores.

First, I am looking at the relationship between temporal variability in the fire regime (that is, how many years passed between fire events) and tree recruitment in the Jemez Mountains of northern New Mexico. I am examining how temporal variability in fire return intervals affects tree species distribution. For example, do fire-sensitive tree species use unusually long periods between fires as recruitment opportunities? I am also looking at how climate affects the interaction between fire regime and species recruitment.

Second, the study examines the spatial dimensions of the fire record, considering the effect of a fire's size on fire return intervals. Here I am interested in examining how the fire regime (for example, mean fire intervals) is affected by the scale at which one looks at the forest. For instance, fires might appear to occur less frequently in the vicinity of a single tree than it does somewhere on a 30,000-acre watershed. The results of this work should help other dendroecologists to adjust their results to reflect more accurately these issues of scale.

End Notes

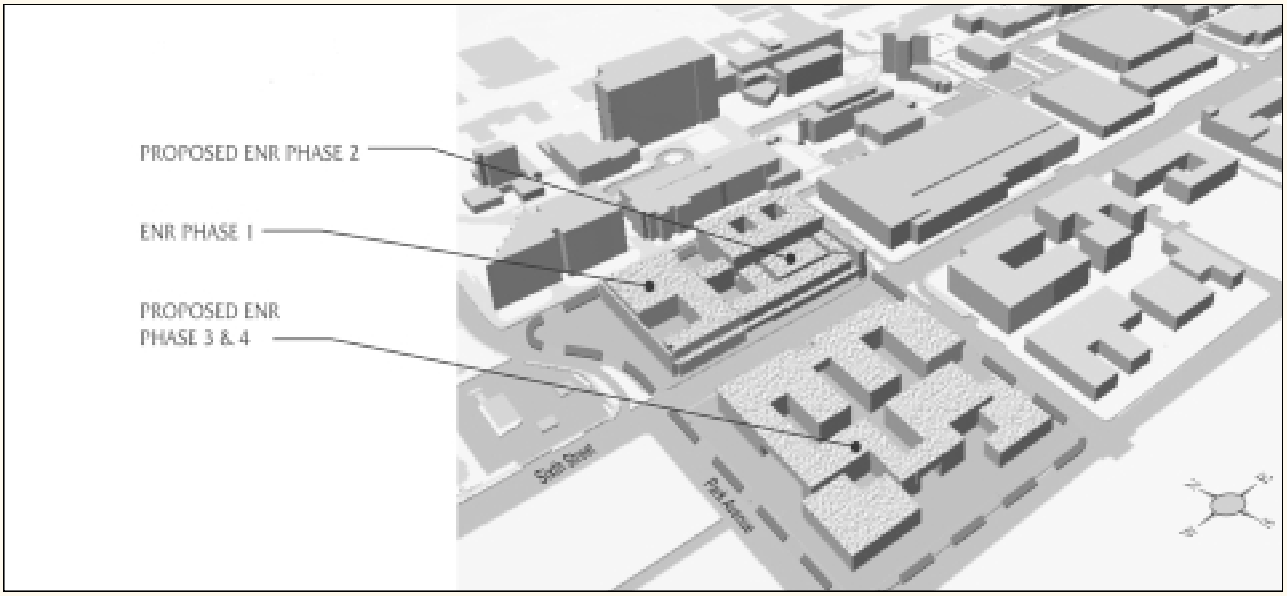

Image courtesy of Campus and Facilities Planning

64 years later, LTRR still waiting for new home

This 3-D view shows the location of the planned Environment and Natural Resources building (ENR Phase 2) on the UA campus. If all goes according to plan, LTRR should, at long last, have a new and "permanent" home in this building. Many of our readers will recall the legendary story of how our founder, A. E. Douglass was told – in 1937 – that his accommodations in the West Football Stadium would be "temporary" quarters!

The construction of ENR Phase 2 is dependent, in part, on fundraising efforts currently underway. LTRR has a "Capital Building Fund" with a goal of $6 million. This effort received a generous boost with a challenge-match gift from Agnese Haury. In honor of her late husband Emil Haury (a student and colleague of Douglass), Agnese Haury pledged $1 million to help fund the establishment of new facilities for LTRR. We still have a long way to go to make the new facility a reality.

If you would like to support the growth of the Laboratory of Tree-Ring Research (for the new building, or any other program), please contact Thomas Swetnam (520-621-2112, tswetnam@ltrr.arizona.edu) or Phyllis Norton (520-621-2191, pgress@ltrr.arizona.edu).

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