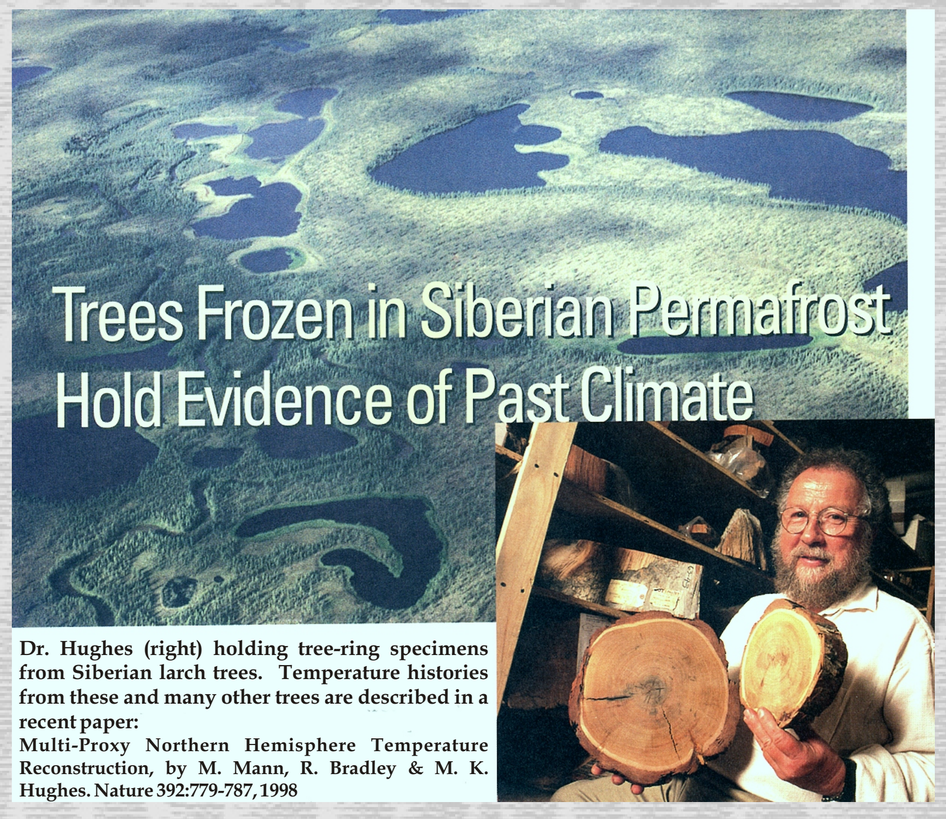
Laboratory of Tree-Ring Research

Environmental and Cultural Change: Putting the Past and Present into Perspective

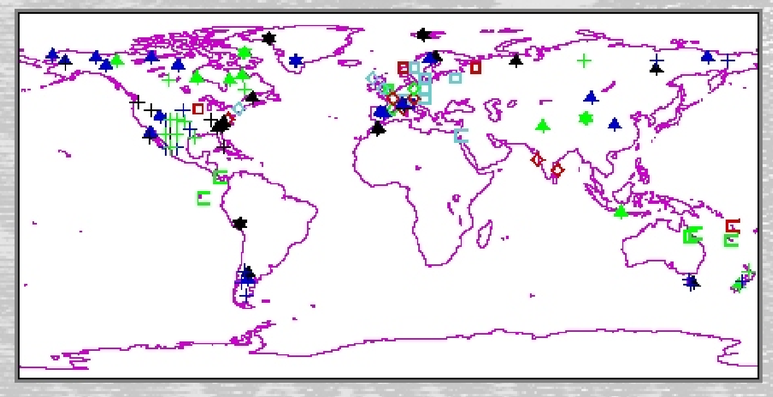
Scientists at the Tree-Ring Lab engage in cutting-edge research with regional to global-scale implications. Tree-rings, for example, provide a long-term perspective of climate change that is essential to place the present climate into the context of the past. Research on enormously complicated issues, such as the influence of greenhouse gases, volcanic eruptions and solar variability on climate, can be addressed by our scientists because it is possible to obtain exactly dated measurements of environmental conditions from tree rings in many places around the world. Our interdisciplinary approaches are particularly powerful at unraveling the multiple interactions between climate, ecosystems, and people.

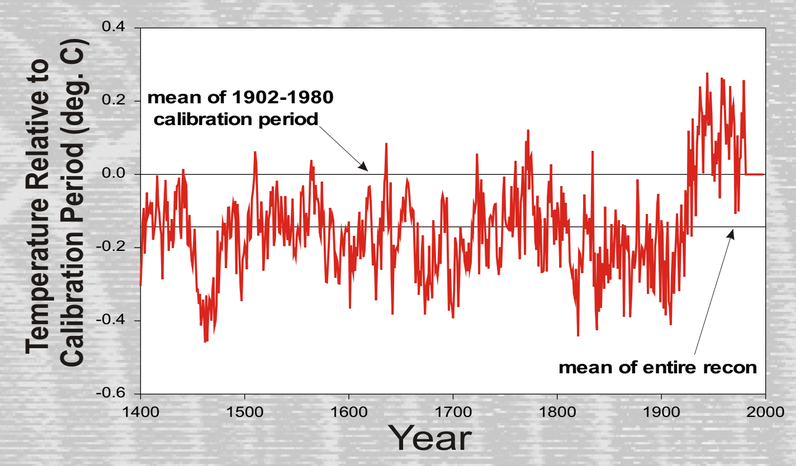


Dr. Hughes (right) holding tree-ring specimens from Siberian larch trees. Temperature histories from these and many other trees are described in a recent paper:
Multi-Proxy Northern Hemisphere Temperature Reconstruction, by M. Mann, R. Bradley & M. K. Hughes. Nature 392:779-787, 1998

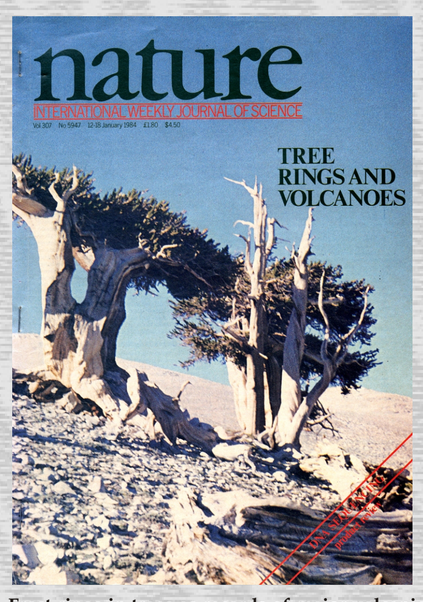
Dr. Malcolm Hughes and his colleagues in Russia and the Universities of Massachusetts and Virginia have pioneered techniques of reconstructing the history of temperature changes in the northern hemisphere. Tree-ring specimens from ancient living and dead trees provide a massively replicated record of growing season conditions spanning hundreds to thousands of years.

The map (upper right) shows the locations of dozens of tree-ring, coral, ice core, and thermometer measurements from around the world that Dr. Hughes and his colleagues have used to reconstruct an estimate of temperature variations over the past 600 years (right).

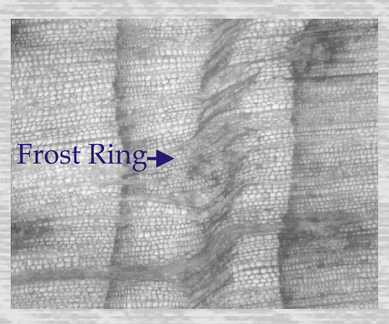




Dr. Katherine Hirschboeck studies the climatology of extreme events, such as floods, droughts, and freezes. The economic and ecologic impacts of these events are enormous. Hence, it is essential that we learn more about their history so that we may identify the broad-scale mechanisms that are involved. Dr. Hirschboeck and her students have applied new statistical and spatial analysis methods to this endeavor, providing new understanding of the climate system.



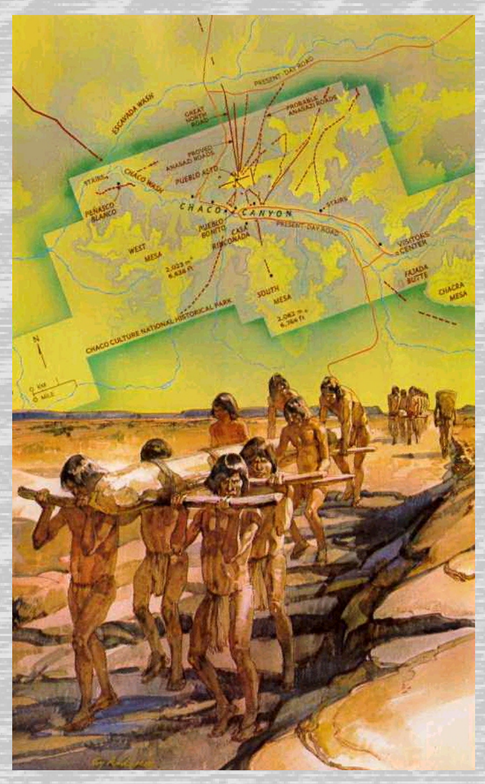
Frost rings in trees as records of major volcanic eruptions, by V. C. LaMarche, Jr. And K. K. Hirschboeck, K.K. Nature 307: 121-128. 1984

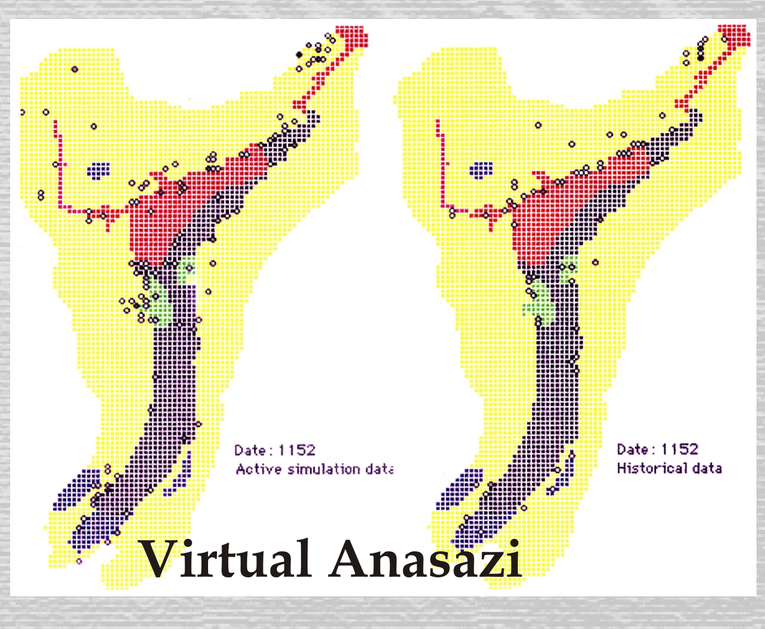


A remarkable kind of extreme climatic event is a deep freeze - or frost - during the spring or summer. In recent years climatologists have learned that massive volcanic eruptions, which inject huge quantities of dust and ash into the atmosphere (upper left), can result in cooler global temperatures, leading to freeze events at high elevations during the growing season. These freeze events are faithfully recorded by high elevation conifers, such as the bristlecone pine, as clearly defined zones of damage within the tree ring that was being formed at the time of the event (left). Dr. Hirschboeck (near right) began this work with the late Dr. Valmore LaMarche Jr., of the Tree-Ring Lab, and she continues her research on this topic with Geosciences graduate student Christine Hallman (far right).

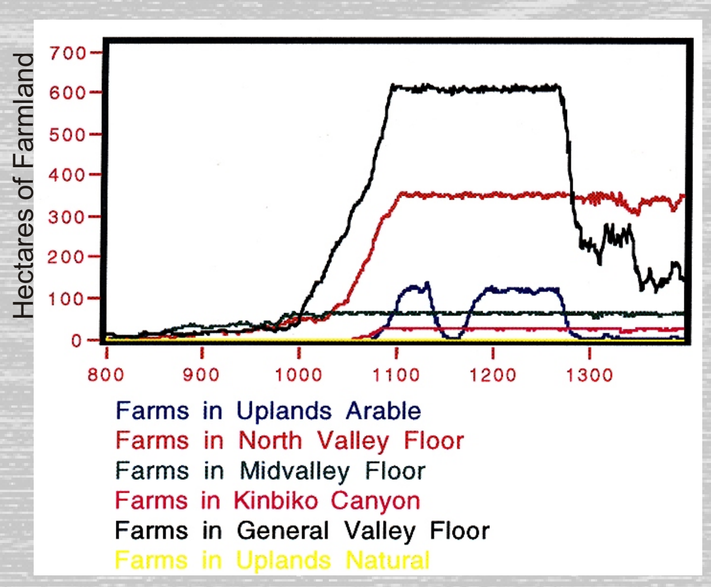
Interdisciplinary and innovative techniques are called for if we are to learn how past environmental changes affected people, and how people affected their environments. Dr. Jeffrey Dean of the Tree-Ring Lab and his colleagues at the Arizona State Museum and the Santa Fe Institute are combining the unparalleled tree-ring data sets of archaeological and climatological history of the Southwest with state-of-the-art computer modeling of human behavior and agriculture systems. Their work is providing new insights on how people respond to climate change (see diagrams below).

Dr. Dean is also working with other colleagues on an innovative project involving soil chemistry and elemental analyses of tree rings designed to discover the source of thousands of wooden timbers that were laboriously carried long distances by the Anasazi to the great houses at Chaco Canyon during the 10th to 13th centuries AD (right).





Simulated digitized map of Long House Valley compared with historical digitized map at A.D. 1152 (left). The different colors represent different environmental zones. Settlements are indicated by circles; the darker the circle the greater the number of households in the settlement. The pixels colored partially red in the simulated map indicates simulated agricultural fields.



Simulated distribution of Anasazi farmland among different environmental zones from 800 to 1400 A.D. (left). Note that the abandonment of the area in late 14th century is captured by the model for some of the zones..