Tree Ring Analysis: NY Times Article

By Jim Robbins

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TUCSON — From the early 1700s until the 1960s, the fast moving river of wind known as the North Atlantic Jet Stream, which drives weather extremes over Europe, was pretty steady on its course.

Then it became less predictable. But instrument data alone can't tell the jet stream's movements for comparison over the centuries, given that scientists began keeping records of weather events via instruments only in the late 19th century.

The rings of trees, however, offer a far more complete historical picture of climate variations. As they age, trees form new distinctive rings, outward from the center, and each year a new, distinct circle of dead wood is created around the trunk of most trees. In that ring, one can find information about precipitation, temperature and other data about that year.

A team led by Valerie Trouet, a dendrochronologist, sampled 400 trees from the Balkans and 200 in Scotland — including what might be the oldest known tree in Europe, a Bosnian pine in Greece named Adonis, which is 1,075 years old. The jet stream flows between these two regions, and trees revealed the range of temperatures in their rings and the frequency of fires over time, an expansive chronicling of jet stream behavior.

"More extreme positions create more extreme climate events, especially heat waves and storms," in Europe, Dr. Trouet said. And the tree rings show "big fires happen in the Balkans when the jet is in its southerly position."


2031
LARCH
BURYATIA
SIBERIA
1948
1913
1874
1804
1766
1727
1637

A sample from Siberia, with the core dating from 1637 and the outer ring from 2011, hangs on a wall at the research lab on the University of Arizona campus in Tucson.CreditAdriana Zehbrauskas for The New York Times

The fact that the stream has become more variable only in recent decades suggests that the shift is the result of humans' effects on climate, Dr. Trouet said. "The recent rise in variance is unprecedented in 300 years," she said. More analysis is underway to look back to even earlier centuries.

Reading the climate stories these trees tell will help with forecasting. "One of the big questions in the field is what's going to happen to the jet stream," said Dr. Trouet. "This data helps the modeling of climate change become more reliable."

Trees, it seems, are giant organic recording devices that contain information about past climate, civilizations, ecosystems and even galactic events, much of it many thousands of years old.

In recent years, the techniques for extracting information from tree rings has been honed and expanded. New technologies and techniques are able to pry a much deeper and wider range of information out of trees.

The field "has exploded," Edward Cook, director of the tree ring lab at Lamont-Doherty Earth Observatory, said.

The Laboratory of Tree-Ring Research here at the University of Arizona was founded in the 1930s by A.E. Douglass, an astronomer who turned to trees to better understand the connection between sunspots and climate.

The lab has helped establish other labs around the world, which in turn has rapidly increased the number of studied trees. There are now roughly a dozen large labs globally and data from 4,000 sites on all continents except Antarctica. The information is stored in the International Tree Ring Data Bank, a library open to all researchers. As more tree data becomes available, a much richer picture forms of the nexus of past climate, ecosystems and human civilization.

For its first 80 years, the lab was located in much smaller — and noisier — quarters under the University of Arizona football stadium. "If you worked on Saturdays you could hear people in the bleachers stamping their feet," said Russell K. Monson, who studies plant physiology here.

In 2012, the lab moved into a larger building to accommodate its growing mission and number of researchers — now some 70 or so — and to unpack its vast collection of tree rings and core samples. There are now more than a half-million samples, from slivers to an enormous slice of giant sequoia in the lobby, a large enough table top, perhaps, to seat all of King Arthur's knights. The building houses the world's largest collection of tree ring samples.

The basement storage area resembles a coffee table wood shop, infused with the fragrant perfume of cut wood. Hundreds of two-inch-thick slices of large trees, their rich grains sanded and polished, are stacked on their sides.

The lab also houses a slice of the bristlecone pine that was cut down in the 1960s by a graduate student named Donald Rusk Currey from the University of North Carolina at Chapel Hill. It wasn't until after he felled the tree and counted the rings that he realized, to his horror, that he had, with permission from the United States Forest Service, unceremoniously sawed down the oldest known tree in the world — a stately gnarled pine called Prometheus.

Research involving tree rings is divided into three main categories — dendroclimatology, the analysis of tree rings for past climate data; dendroarchaeology, the study of tree rings to understand how past climate affected human societies; and dendroecology, which reconstructs past forest ecosystems. The most common tree rings studied come from bristlecone pine, fir and spruce.

At this particular time, the most essential role for tree rings is probably their use in reconstructing past climate and providing much greater context. "The instrumental period provides a snapshot," of past climate, said David Meko, a researcher here, "but the tree rings are a panorama."

This window into the deep climate past has become vital in a rapidly warming world, to show how the climate of the last half-century is far outside the historical norms going back thousands of years.

Living bristlecone pine trees, for example, are several thousand years old and their information is added to by those that died thousands of years ago, but remained intact in their cold, dry high-altitude environment.

It's hard to argue with tree rings that huge environmental changes are not occurring. Climate change seen in the past six or seven decades has few, if any, comparisons in the far past, researchers say.

The current two-decade-long drought on the Colorado River, for instance, is the longest since medieval times when a drought lasted for 62 years — with no very wet years in between dry years. An occasional very wet year can make a long drought more bearable.

Moreover, conditions in some recent years are the hottest and driest in many centuries. "We keep breaking records year after year," Dr. Meko said. "It's a little worrisome to see the most extreme years right near the present."

Unprecedented hot droughts, like the current one, make a decline in precipitation even worse, by causing more evaporation. Officials along the Colorado River are deeply worried about the trend toward warmer temperatures and less precipitation and are preparing for a grim future without or with less river water — unthinkable just 20 years

ago. (This year though, was an El Niño year, and the snowpack in the Colorado Rockies was well above average.)

To make matters worse, tree rings show that water in the Colorado River was apportioned to states based on flow from 1905 to 1922, some of the wettest years in the last 12 centuries, an era known as a pluvial period.

Researchers can also look at snowpack in tree ring records. In 2015, in the Sierras the snowpack was the lowest in 500 years. This year may be one of the highest snowpacks in decades, a testament perhaps to climate whiplash. Researchers here are reconstructing snowpack data by examining tree ring records across the entire western United States for the last 2,000 years.

Trees hold other valuable information as well. Oxygen isotope analysis, for example, has unlocked the source of the water that a tree took up centuries ago and can determine whether it was from a hurricane or a severe thunderstorm.

Tree rings also provide a glimpse into the possible global impacts of geoengineering — a proposal to scatter aluminum sulfate into the atmosphere to block the sun and cool the planet, which some scientists have proposed as a solution to climate change.

“Volcanic eruptions are the best proxy of geoengineering,” Dr. Trouet said. Rings analyzed from trees in five locations around the world show that after a volcano erupted in 1568, the global climate cooled considerably for two years — evidenced in narrow tree rings — and the northern edge of the tropics receded as the planet cooled.

Those tree rings also showed that during six decades, from 1568 until 1634, there was, because of natural climate variation, six decades of expansion of the subtropics, which pushed desert climates north. Because of expanding zones of hot and dry weather, the Ottoman Empire began to decline, the Ming dynasty collapsed and the Jamestown colony in Virginia was abandoned, suggesting, Dr. Trouet said, they were in part at least, climate-related. “The way society handles a drought politically is also part of the picture,” she said.

Other sources — lake sediments; ice core samples; coral; the otolith, or ear bone, of fish; and even the shells from living and long dead geoducks, a large bivalve with a snakelike appendage — add to the broader picture.

“We have divers sucking up ancient geoducks off the ocean floor,” said Bryan Black, a professor of dendrochronology who also specializes in marine organisms. Combined with long dead geoduck shells, data could go back many thousands of years. Shells from the coast of Iceland already go back 1,000 years. “They show that the last century is unprecedentedly warm,” Dr. Black said.

Experts are using the shell ring information, combined with tree ring data, to understand how climate drives ocean productivity and the species mix of fish, to assist

fisheries managers. “The bottom line is to be aware of climate whiplash and what that means for fisheries,” Dr. Black said.

Even the stars give up some of their secrets to trees. The sun and other stars emit radiation called Galactic Cosmic Rays, or G.C.R.s, that react in the atmosphere with nitrogen and change the levels of carbon 14, which is taken up by every living thing and becomes a tracer for cosmic ray levels.

Past spikes in G.C.R.s from solar flares or other sources are largely a mystery, but have attracted keen interest from researchers, because if they occur now they could wipe out communication satellites and other technology. An event in 774-775, first found in Japanese cedar trees and since found globally, is the strongest cosmic ray event in the tree ring record, a magnitude larger than the Carrington event, a solar storm in 1859, and apparently noted by people alive at the time.

“This year also appeared in the heavens a red crucifix, after sunset,” was how the Anglo-Saxon Chronicles reported the event in the mid-eighth century.

It was most likely a huge solar flare. “It is unprecedented, there’s nothing else like it,” said Charlotte Pearson, a professor at the tree ring lab. “We’re trying to work out what it is and what caused it but we’re still not sure.”