Life Sciences

Tree Rings Provide Evidence for Climate Regime Shifts

Tree rings, with their special characteristics of precise dating, annual resolution, long time series and climate sensitivity, have been widely considered a useful proxy for past climate variations.

Researchers at the Institute of Botany of the Chinese Academy of Sciences (IBCAS) have given an overview on using tree rings to identify climate regime shifts in a perspective paper entitled "Tree rings circle an abrupt shift in climate," which was published in *Science* on November 27, 2020.

In the paper, Prof. ZHANG Qi-Bin and Dr. FANG Ouya provided background in the field and discussed its advances. They also referenced a paper reporting a recent climate regime shift to a hotter and drier climate over inner East Asia, which was written by lead author ZHANG Peng from South Korea and published in the same issue of *Science*.

"Careful attention is required when using tree rings to reconstruct a specific climate variable over a large geographical region," said Prof. ZHANG Qi-Bin. "Signals from the macroclimate must be extracted efficiently while removing the nonclimate noise embedded in the tree rings."

Changes in climate have dramatic effects on natural

A cross section cut reveals climate-sensitive tree rings in a Scots pine (*Pinus sylvestris L.*), one of the species used for soil-moisture reconstruction in inner East Asia. (Image by IBCAS)

ecosystems and human society. Less well understood is whether these changes are irreversible beyond a certain tipping point, that is, whether they represent a climate regime shift.

Scientists worldwide are alarmed about the potential risks of abrupt climate changes and their impacts on ecosystems and society, yet it is still difficult to identify the exact occurrence of climate regime shifts.

To judge whether climate systems undergo regime shifts from one steady state to another, scientists must understand the natural range of climate variability over a time scale that is much longer than the new regime.

ZHANG Peng *et al*. compiled tree-ring width data from 76 sites throughout inner East Asia and successfully screened 20 sites with strong signals of summer heatwave frequency and soil moisture content.

They found that the magnitude of the warm and dry anomalies compounding in the past two decades is unprecedented over the past 260 years. They further illustrated that the heatwaves and droughts became tightly coupled, which is likely caused by a pronounced enhancement of land-atmosphere coupling along with anthropogenic climate change.

However, it is still challenging for scientists to disentangle the interaction of climate variables and clarify whether these interactions generate negative or positive feedbacks, according to Prof. ZHANG Qi-Bin and Dr. FANG.

Furthermore, spatial differences related to climate regime shifts are worthy of study.

Using tree-ring data as a proxy for past climate variability and forest dynamics, Prof. ZHANG Qi-Bin's lab has long been engaged in investigating the responses of tree growth to multiple dimensions of climate change and ecological disturbances, and in exploring spatial and temporal patterns of forest health.

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Reference

Qi-Bin Zhang, Ouya Fang, (2020) Tree rings circle an abrupt shift in climate. *Science* 370, 1037. doi: 10.1126/*science*.abf1700.