Tree ring width predicted by machine learning

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Each year, a tree lays down a layer of dark and light wood. Credit: Monika Grabkowska, Unsplash

Tree rings are record books of annual growth, and the width of each ring is correlated to that year's environmental conditions. In a new study, Cameron Lee and Matthew Dannenberg use machine learning to demonstrate that ring width is well correlated with the types of air masses a tree experienced over the past year.

Previously, scientists linked tree ring variability to discrete climatic elements like temperature, precipitation, and drought. However, weather is not experienced as individual elements, but as a collective of all the different components acting together. The integrated experience of weather can be characterized as an air mass: atmospheric bodies thousands of kilometers in size.

In their new study published in the *Journal of Geophysical Research: Biogeosciences*, the authors gathered tree ring records for 130 species across 904 observational sites in the Northern Hemisphere. They also pulled weather data on the air masses at each site and on each day dating to as far back as 1979 using a publicly available data set called the gridded weather typing classification. This system sorts weather into 11 types based mostly on temperature and humidity.

Then, using artificial neural networks, the researchers correlated a tree ring's width to the number of days the tree experienced each different class of air mass over the preceding 12 months. For comparison, they used the same machine learning approach using traditional temperature and precipitation data.

The air mass approach outperformed the traditional one for 66% of tree species. That percentage rose to 83% among the species with the most available records. The researchers' analysis revealed that humid-cool air masses were most correlated with significant tree growth, while dry-warm air masses were most predictive of poor growth.

The researchers used the model to glean how past climate conditions affect tree growth, but they note that the directionality could be reversed: The tree ring record extends to nearly 14,000 years, and it could be used to classify ancient air masses.

The findings could be used even to peer into the future. By

characterizing current air masses and forecasting future ones, the model could gauge plant stress, mortality risk, and wildfire vulnerability for the coming year.

More information: Cameron C. Lee et al, Frequencies of Multivariate Air Masses Drive Tree Growth, *Journal of Geophysical Research: Biogeosciences* (2023). DOI: 10.1029/2022JG007064

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