An Ensemble Precipitation Prediction Model for Sub-Saharan Africa Using a Dendrochronological Reconstruction and Satellite Data

Speer, Leif (School: Terre Haute South Vigo High School)

Sub-Saharan Africa is vulnerable to variations in precipitation levels, as a large percentage of the population practices subsistence farming and most of their electricity is from hydropower. I created a precipitation prediction model from northern Zambia to southern Botswana. The features for this model include a dendrochronological precipitation reconstruction and satellite data from the region. To create the dendrochronological reconstruction, I sampled 22 trees with two cores per tree in Zambia in July 2025 from the species Julbernardia paniculata. I mounted the cores on wooden core mounts and prepared their surfaces by sanding them with progressively finer sandpaper. I compiled the chronology and checked the dating quality. Then I standardized the series with an age-dependent spline. My chronology is now one of the best-dated chronologies in the region (series intercorrelation = 0.36). I downloaded 19 other chronologies from the International Tree-Ring Databank and analyzed them for dating quality. I narrowed this down to the five strongest chronologies based on their series intercorrelation and EPS cut-off date to combine with my own chronology to build a regional precipitation reconstruction for January using R ($r^2 = 0.171$, RE = 0.198, CE = 0.195, $p < 0.001$). I downloaded the satellite data from NASA's EOSDIS Earthdata website. After preprocessing all of these features, I put them into a series of gradient boosting models. I then stacked the results of these models to create an ensemble prediction model for precipitation in the Sub-Saharan region. I was able to use the long-term tree-ring reconstruction to model future low frequency variability and combine that with the high-frequency satellite data to create a precipitation forecast for the next 100 months.

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