Correlations of Climate Indices and *Pinus taeda* Growth Rates

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Introduction

Annual growth rings are a look into how a tree has grown over its life. Widths of these rings can be compared to established climatic data to understand what data have greater or lesser of a correlation.

Using tree cores from Tier II (active experimental plots) sites within PINEMAP (Pine Integrated Network: Education, Mitigation and Adaptation Project) and the corresponding climate data from the sites location, we wanted to determine which of the five common climatic indices would give the highest correlations. There is an interest in knowing if there is a geographical pattern in highly correlated sites. This research is being done in order to be able to predict future productivity and carbon sequestration.

Methods

Tree cores were sourced from control plots from PINEMAP Tier II sites, eight trees per site were sampled with three cores taken per tree (Figure 1). Cores from 40 sites are used. Cores were sampled at DBH and include the bark and extend through the pith. Cores were stored and dried in paper straws to prevent mold growth. The best of the three sampled cores was then mounted. These cores have the bark intact allowing for accurate start dates, hit the pith, and are free from staining or abnormal growth. While cores that hit the pith were not common, the cores with the least amount of offset from the pith were used. The cores were then mounted with the fiber vertical, allowing for better visualization of the rings. To clarify the rings they were sanded on a large belt sander, further sanding with finer grit paper was done on an as need basis.

The mounted and sanded cores were measured using a Velmex unislide along with MeasureJ2X software. The MeasureJ2X records each year's growth in decadal format with a precision of 0.01 mm, starting from the sample date and going back in time. The cores were read from the bark end starting at the end of last year's late wood to the previous year's late wood. Cores with stained or indistinct rings were flagged for further consideration.

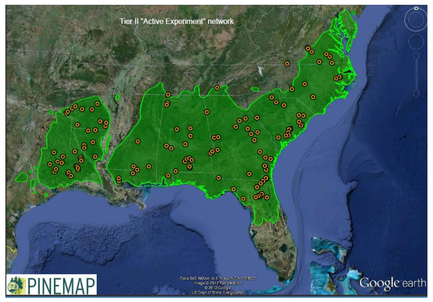

Figure 1: Natural range of Loblolly pine and Pinemap Tier II sites.

To convert ring widths from decadal format to chronological order a custom function in R: A Language and Environment for Statistical Computing was employed. Growth rates within each site were graphed and combined to highlight outliers. Mean of the annual growth rates was then calculated. The mean growth rates once graphed, were separated subjectively into juvenile and mature stages using stable growth as the threshold.

With the means found, the mature stage was then used to find correlation using historical climate indices from the North Carolina State Climate Office. The indices used were, precipitation, temperature, palmer draught severity index (PDSI), palmer hydrological draught index (PHDI), Z-index, and the palmer modified draught index (PMDI). These indices are classified into NOAA climate divisions. The correlation were found from each sites corresponding divisional climate data. The sites correlation was then grouped into 6 categories from -1 to 1. The sites are mapped with their corresponding correlation group.

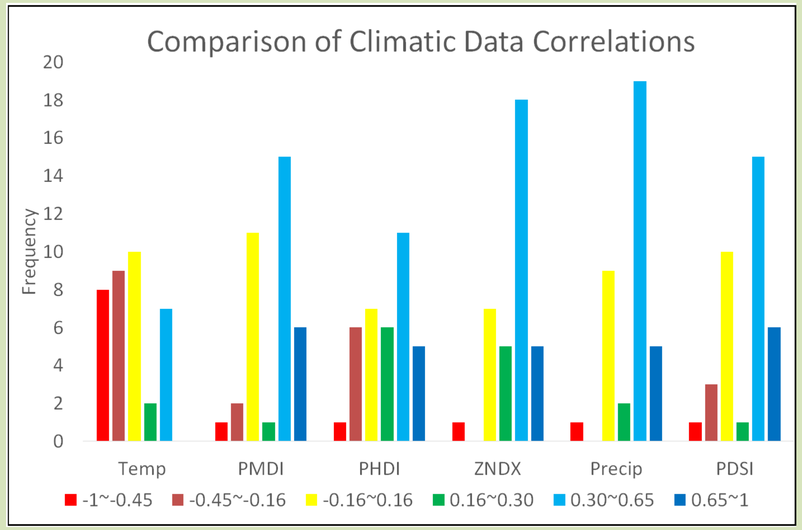

Figure 2: Frequency of correlations of PINEMAP Tier II sites growth rates and climate indices.

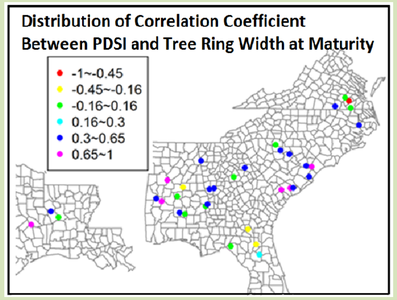

Figure 3: Spatial distribution of measured Tier II sites and the Palmer Draught Severity Index correlation coefficient.

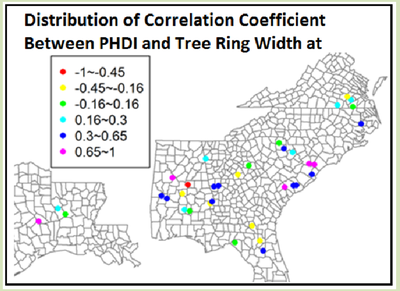

Figure 4: Spatial distribution of measured Tier II sites and the Palmer Hydrological Draught Index correlation coefficient.

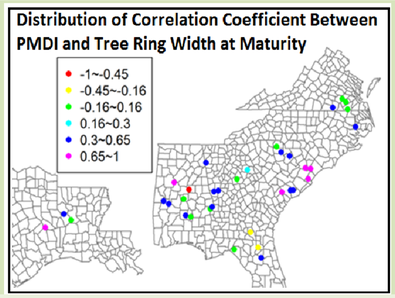

Figure 5: Spatial distribution of measured Tier II sites and the Palmer Modified Draught Index correlation coefficient.

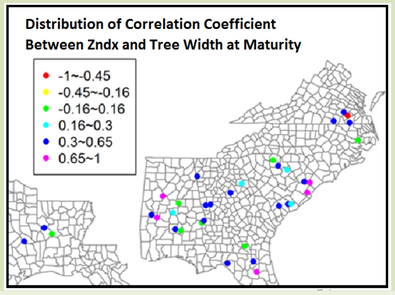

Figure 6: Spatial distribution of measured Tier II sites and the Z-Index correlation coefficient.

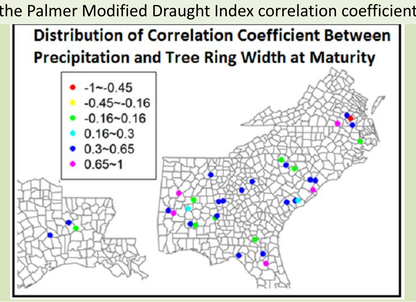

Figure 7: Spatial distribution of measured Tier II sites and Precipitation correlation coefficient.

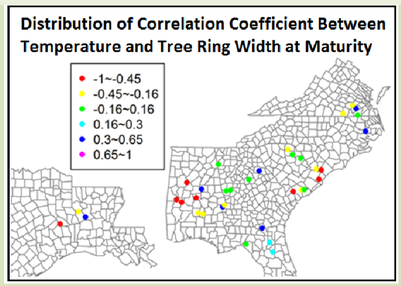

Figure 7: Spatial distribution of measured Tier II sites and Precipitation correlation coefficient.

Results

Using the mature stage of 36 sites in the Southeast United States the correlations between historical climate data and mean annual growth rate were categorized into six classes: -1 to -0.45, -0.45 to -0.16,-0.16 to 0.16, 0.16 to 0.3, 0.3 to 0.65, and 0.65 to 1 (Figure 2).

- PDSI: 21 sites above r=0.30, 4 sites below r=-0.45, and 11 sites between r=-0.16 and r=0.30 (Figure 3).
- PHDI: 16 sites above r=0.30, 7 sites below r=-0.45, and 13 sites between r=-0.16 and r=0.30 (Figure 4).
- PMDI: 21 sites above r=0.30, 3 sites below r=-0.45, and 12 sites between r=-0.16 and r=0.30 (Figure 6).
- Z-Index: 23 sites above r=0.30, 1 site below r=-0.45, and 13 sites between r=-0.16 and r=0.30 (Figure 7).
- Precipitation: 24 sites above r=0.30, 1 site below r=-0.45, and 11 sites between r=-0.16 and r=0.30 (Figure 8).
- Temperature: 7 sites above r=0.30, 17 sites below r=-0.45, and 12 sites between r=-0.16 and r=0.30 (Figure 9).

Conclusions

The greatest correlations between growth rates and climate data were precipitation and Z-Index

Precipitation and Z-Index show the greatest predictive capabilities for future growth responses. However, there is little spatial relationship between highly correlated sites age geographically area.

Attributions

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