Measuring historical non-climatic and climatic effects on tree ring width in Tioga Pass, California

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Introduction

Tioga Pass is located east of Mono Lake in Mono County, California. This pass is home to many trees, including the Jeffrey Pine. We are interested in determining whether these trees accurately measure climate data, what factors might influence their growth, and whether recent atmospheric CO₂ increases have affected their growth.

Methods

We first collected approximately 170 cores from the area around Tioga Pass as shown in Figure 1. Upon arrival home, these cores were dried, mounted, sanded, and scanned for processing. We then used a MATLAB program to manually measure the widths of each tree ring.

These ring widths were then standardized using the method described by Fritts (1976) to remove changes in growth rate as a variable for width. Any outlier cores that were either misshapen, impossible to measure or badly fit to a standardization curve were rejected. This gave us 328 years of tree growth history.

These indices could then be compared to other climate-related data such as precipitation and temperature.

Analysis - Non-climate factors

There are several non-climatic factors that may skew our tree ring data, especially as we attempt to fit it only to specific elements of weather (such as precipitation levels). Experimental error and location variables are two of the most significant areas of deviation in our project.

These plots separate variables within the data to see if specific characteristics of tree location are significant variables of tree ring widths. “Significant” here is qualitative - looking at deviations from our original measurements taken at the Mauna Loa Observatory, Hawaii. The increasing concentration of atmospheric carbon dioxide based on monthly measurements taken at the Mauna Loa Observatory, Hawaii. The increased trend of the curve correlates with the ring width indices data (the circled measurements). This suggests a relationship between carbon dioxide levels and the growth of trees in the area.

Analysis - CO₂ influence

Since 1958, the concentration of atmospheric carbon dioxide has steadily increased (Keeling et al., 2005). By examining the increasing trend in ring width indices in the most recent ten years of our collected data, a direct relationship between ring width and carbon dioxide levels is observed. Our data supports the hypothesis made by LaMarche (1984), which is that increased ring width, a sign of improved tree growth, is caused by fertilization effects of increased atmospheric carbon dioxide concentrations (Keeling et al., 2005). Hughes (1991) states that this is a short-term process caused by significant gas injections into the atmosphere, the abrupt significant increase relative to the other data. Our data is also geographically consistent with the hypothesis made by Graumlich (1991), which extended LaMarche’s conclusion to eastern California near the Sierra Nevada mountain ranges. However, in order to further confirm these hypotheses, continued tree core analysis into ring width is recommended to determine whether or not the increasing trend continues.

Conclusions

We found that the tree ring widths correlated very closely to the precipitation data for nearby stations, and that the correlation dropped off the farther away you were from Tioga Pass. We did not find any significant correlation of the data between temperature or level of Mono Lake.

The amount of variation in the data did not allow us to come to a conclusion about whether different elevations had an effect on the growth of trees.

We also conclude that our data supports work done by others suggesting that an increase in CO₂ can be correlated to an increase in tree ring growth.

Acknowledgements - We would like to thank Professors Adam Maloof and Frederik Simons, along with the other professors and assistants on the trip: Kevin, Blair, Catherine, Ryan and Nicole. Thanks to WMRS for hosting us in California. Finally, thanks to the rest of FRS 145 for your research assistance and pleasant company.

References:


