Generating New Ultra-sensitive Temperature Reconstructions in Mongolia Using Blue Intensity Reflectance

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ABSTRACT

Density information derived from the intensity of blue light reflectance (BI) of the latewood in tree rings is a new method of tree-ring analysis that strongly correlates with instrumental summer temperatures. In many cases, tree-ring density derived from BI captures a stronger climatic signal compared to the measurement of ring width, which is typically used in dendroclimatic studies. Mongolia, a country in central Asia with a semi-arid climate, has been rapidly warming leading to an influx of drought conditions. Knowledge of past climatic conditions is limited due to sparse meteorological records. The purpose of this study is to improve existing dendroclimatic records in this region. To determine if there are differences between the response among tree species, existing ring-width chronologies from Mongolia were analyzed in comparison to the new BI methods. We focus on developing BI records from Siberian pine and Siberian larch from Solongotyin Davaa (Sol Dav), a timberline (2420 m) site in the Tarvagatay Mountains. Hundreds of tree core samples have been revisited for analysis using BI. We find that BI has a stronger climate signal then RW and will result in a millennial length temperature reconstruction that was not previously possible using RW alone. Thus, the scientific community will be able to better understand the long-term context of millennial scale variability and recent rapid warming in Mongolia. Understanding Mongolia's past and present climate is crucial for the region and for its people to understand the possible climatic conditions that may occur in the future.

INTRODUCTION

- Multiple tree- ring studies from the last few decades derived from high latitudes have shown that latewood density is superior to ring width when reconstructing summer temperatures (Wilson et al. 2014).
- This superiority lies with the fact that the density of latewood can provide a more extensive and accurate climatic signal due to its' temperature sensitivity. Blue intensity accurately measures latewood density through its' lignin content; it measures the reflected blue light that has been absorbed by lignin from a scanned core or cross- section (Wilson et al.2014). The reliance of blue light intensity is imperative in understanding past and future climate.
- The focus of our study is in Northwestern Mongolia and is an area of concern because it is warming at an alarming rate.
- Understanding Mongolia's climate has been extremely difficult due to multiple variables such as limited meteorological records and temperature reconstructions from the past 1,000 years.
- In order to combat this problem, we have analyzed and compared two species of trees (Siberian Larch and Pine) at a high latitude tree line in Solongotyin Davaa (Sol Dav), a site located in Northwestern Mongolia. The Siberian Larch and Pine trees are excellent to study because their growth is limited to temperature.

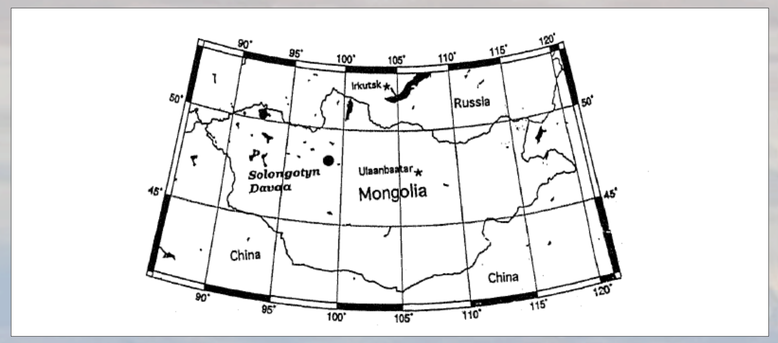
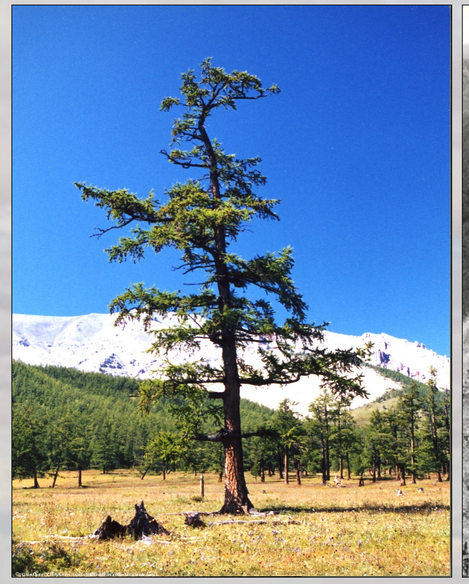


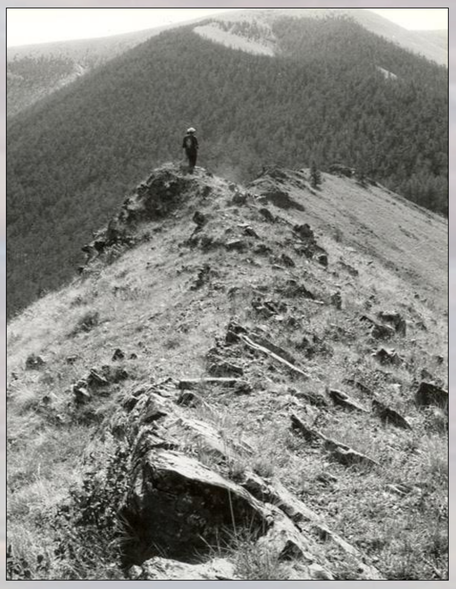
Figure 1. *Site Sol Dav is located in the Tarvagatay Mountains, a small range that extends from the North side of the Hangai Mountains in Mongolia.*

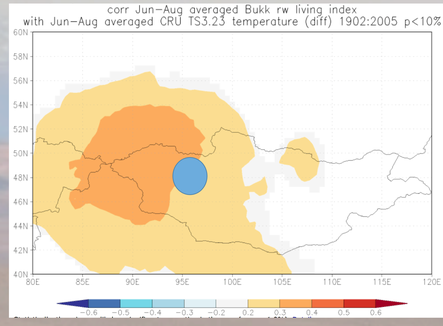
METHODS

- 30 Siberian pine (Pinus sibirica, TPR), and 23 Siberian larch (Larix sibirica, TPL) tree cores were sampled in 1999 from Sol Dav and recently revisited for blue intensity analysis.
- The cores were submerged in acetone for 72 hours in order to extract them from any impurities such as resin, mold, or discoloration. These impurities can alter blue intensity data significantly if left untreated.
- They were then scanned at a high resolution on Silverfast at a minimum of 3200 dpi. Ring width is first dated and measured on Coorecorder. Once done, blue intensity can be initiated

Figure 2A*. Tree cores in an acetate bath for extraction.* ***2B.*** *A screenshot of blue light reflectance performed on a high resolution core scan. The blue band represents latewood density values extracted from image analysis.*







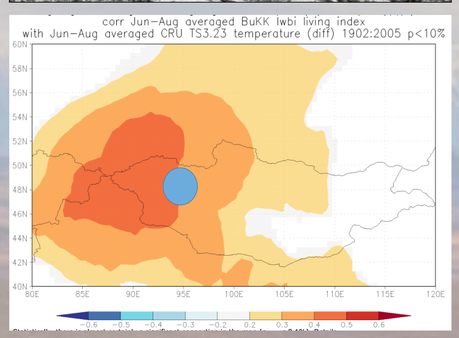


Figure 3*. A comparison between ring- width and blue light intensity in Bairam Uul and Khalzan Khamar, Mongolia.*

DISCUSSION

- Long term climatic reconstructions put recent warming in a long term context. The scientific community has been studying why Central Asia is warming faster than many other areas in the world.
- In central Mongolia there are only 2 millennial length, tree-ring sensitive temperature reconstructions. At Sol Dav there is only one climate sensitive chronology and by using BI we hope that we can create a temperature sensitive reconstruction of the past 1,000 years.
- Recent analysis done at a site near Sol Dav called BUKK shows that blue intensity is superior to ring width spatially. With this evidence it will be promising that we can create a millennial length reconstruction for Sol Dav in high latitude locations.

REFERENCES

Davi, Nicole K., et al. "A long-term context (931–2005 CE) for rapid warming over Central Asia." *Quaternary Science Reviews* 121 (2015): 89-97.

D'Arrigo, Rosanne, et al. "1738 years of Mongolian temperature variability inferred from a tree-ring width chronology of Siberian pine." *Geophysical Research Letters* 28.3 (2001): 543-546.

Wilson, Rob, et al. "Blue Intensity for dendroclimatology: The BC blues: A case study from British Columbia, Canada." *The Holocene* (2014): 0959683614544051.