A Long-term Tree-ring Reconstruction of Atmospheric Mercury in Northern Yukon Territory

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Introduction

- Mercury exists naturally in a variety of forms.
- Anthropogenic activities (coal combustion and artisanal mining) release mainly elemental gaseous mercury (Hg0) to the atmosphere.
- Mercury may become methylated once deposited on landscapes1.
- MeHg is known to be a threat to aquatic and human life2.
- Future MeHg exposure in northern biological systems will be influenced by changes in Hg0.
- Anthropogenic emissions and natural mercury cycling are both not well understood due to a lack of long-term observations of Hg0.
- Natural archives (tree-rings) can be used to reconstruct and better understand long-term changes in Hg02.

Methods

- A three site network of white spruce ring-width chronologies near boreal treeline in Old Crow Flats, Yukon Territory.
- Chronologies span ~300 years.
- The Old Crow region is a low-lying basin with a climate that is highly seasonal1.
- This site network represents the northernmost extent of boreal treeline in Yukon, and the northernmost tree-ring mercury study to date. See Figure 1.
- Tree-ring widths were measured using the Velemax Measuring System.
- Tree-rings were cross-dated using the COFECHA software4.
- Mercury concentrations were measured by using the Tri-Cell Direct Mercury Analyzer (DMA-80).
- See Figure 2 for time-series.

Results

![Figure 2: A time-series plotting the mercury concentrations for the three sites studied. The mean is plotted in red, DP08-30 site is plotted in blue, OCTM2 site is plotted in green, and OC08-51 site is plotted in grey.]

Discussion

- Little is known about multi-centennial Hg0 changes in the Western Arctic, with the exception of several lake core archives in northern Alaska5.
- The Old Crow tree-ring data project a positive trend over most of the last ~3 centuries, which is consistent with the available Alaskan sediment core data.
- This overall trend coherence suggests that both proxies are sampling the same, well-mixed regional atmosphere, which is reasonable given that atmospheric circulation in this area is largely dictated by land-ocean pressure centers in the North Pacific sector.
- The increasing trend of mercury seen in the mid-1800's could be attributed to the onset of the industrial revolution.
- Probing the relationship between atmospheric mercury and climate will require a much longer term perspective going back many centuries before anthropogenic emissions started to influence the global atmosphere.

Conclusion and Future Prospects

- This research demonstrates the viability of long, well-dated tree-ring chronologies to study the mercury cycle.
- Could be applied over vast spatial scales given the distribution of boreal trees in northern North America and Eurasia.
- Further research should focus on greater replication, and longer chronologies which were limited by mass for our study.

References


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