Antiquity and turnover of terrestrial ecosystems in eastern North America since the Last Glacial Maximum

University of Wyoming

Yao Liu
Simon Brewer
Stephen T. Jackson
Introduction – motivation and goals

Motivation
- Landcover as a feedback
- Ecosystem dynamics
- Environmental control of ecosystems

Goals
- Identify ecosystem types and their transition periods in pollen sequence.
- Assess the antiquity and turnover of ecosystem types.
Modern pollen set (Whitmore et al. 2005)

Fossil pollen set (NEOTOMA database). Filtered for the quality of sample density and age control. 479 sites obtained.

25 typical pollen taxa in eastern North America (Williams et al., 2001) is used for the analysis.
First, we conducted a cluster analysis to the modern pollen set using k-means method.

15 modern ecosystem types are identified.
Method – ROC and MAT analysis

Modern Analog Technique (MAT) with receiver-operating characteristic (ROC) analysis.

Squared-chord distance (SCD) scores are calculated.

Likelihood ratio (LR) of analog to an ecosystem are related to SCD score (i.e. \( LR = a^{*}SCD^{b} \)), as ecosystem-specific parameters are estimated.

A Bayesian approach was applied to incorporate uncertainty in our estimates.

Transition between ecosystem types are identified when the confidence intervals of probability of analog no longer overlap.
Tannversville Bog, PA (Watts, 1979)

LGM

Present

**Betula**

**Picea**

**Pinus**

**Quercus**

**Tsuga**
Result – antiquity of ecosystem types

- **Grassland**: 33 sites
- **Spruce dominated**: 35 sites
- **Oak/hemlock**: 69 sites
- **Birch/spruce/hemlock**: 67 sites
Result – mapping antiquity

Tannversville Bog, PA (Watts, 1979)

- Synchronous establishment (drier and warmer conditions) around 6k.
- Previous vegetation (Birch/Alder deciduous woodland).
Result – mapping antiquity cont.

• Regional heterogeneity
It appears that no modern ecosystems in the eastern North America predate the beginning of the Holocene (12k B.P.).

There is also sufficient environmental change within Holocene to turnover the ecosystems.

Antiquities of modern ecosystems vary widely in their temporal and spatial patterns. Factors at both regional and continental levels may attribute to this.
The authors thank John W. Williams for providing the code for MAT and ROC analysis.

OSM poster session on Thursday!
Future directions

- Diagnostics of the antiquity patterns – looking more closely at the underlying patterns and dynamics of the pollen assemblages driving the patterns, and assessing the controlling climate feature.

- Exploring the turnover patterns – looking at all the ecosystems that existed before the current ones.
Likelihood ratio (LR) of analog has a relationship with SCD scores as

$$LR = a \cdot SCD^b,$$

where $a$ and $b$ are ecosystem-specific. We estimated $a$’s and $b$’s with uncertainty with the information provided by the ROC analysis.
The k.means explore!