RESULTS and INTERPRETATION

Background and Rationale

Reconstructions of Holocene climate in the Arctic have been accumulating, allowing for better understanding of how the region may respond to future climate
changes. However, long-term records from the Alaskan Arctic are scarce. We conducted sedimentological and isotopic analyses at Wahoo Lake to infer
Holocene climate variability in northern Alaska. Lithology variations in δ18O from Wahoo Lake generally correspond to fluctuations in total
solar irradiance, suggesting that solar variability may play an important role in the long-term climate of the Alaskan Arctic.

Methods and Chronology

- Sediment core chronology
  - 11.186 ages from bulk sediment
  - Ages derived from terrestrial macrofossils
  - Ages reported in calendar years before CE 1950 (ka BP)
- Sedimentary and Isotopic Analysis
  - Loss-on-ignition (LOI) at 550°C and 600°C
- Plotted carbonate shells at δ13C and δ18O

- Water samples analyzed for δ18O and δ2H
- Inter/inlet/outlet streams
- Every 1 m from subbasin water column
- Wahoo monthly precipitation modeled using the Online Isotopes in Precipitation Calculator

- Regional Meteoric Water Line (RMWL) defined by Global Network of Isotopes in Precipitation (GNIP) data from Barrow, Weather Station

Water Isotopes

- Modern δ18O values provide interpretive framework for what environmental variations influenced variations in 
  Plidium record
- Samples indicate winter precipitation dominates lake water isotopic composition
- Evaporative enrichment between inlet and outlet water
- However, water column isotopic data is not indicative of evaporation, despite clear stratification

Controls on δ18O in Plidium

<table>
<thead>
<tr>
<th>Post-Input Modification</th>
<th>Calcareous Precipitation Temperature (summer)</th>
<th>Meteoric Precipitation Temperature</th>
<th>Meteoric Precipitation Seasonality</th>
</tr>
</thead>
<tbody>
<tr>
<td>High δ18O</td>
<td>High Evaporation</td>
<td>Low Temperature</td>
<td>More Summer Precip</td>
</tr>
<tr>
<td>Low δ18O</td>
<td>Low Evaporation</td>
<td>High Temperature</td>
<td>More Winter Precip</td>
</tr>
<tr>
<td>Potential Impact</td>
<td>Several %</td>
<td>~0.2‰ per °C</td>
<td>0.6-0.7 ‰ per °C</td>
</tr>
</tbody>
</table>

- We interpret variations in the Plidium δ18O record as indicative of changes in evaporative
  enrichment and changes in temperature and/or seasonality of precipitation

Core Lithology and Carbonate Isotopes

- Lithology suggests changes in lake level during the Holocene
  - 11.5-8.5 kcal BP high CaCO3 content indicates closed-basin conditions and evaporative enrichment associated with a warm, dry Holocene Thermal Maximum
  - Mid-Holocene = increasing lake-level supported by Plidium disappearance and reduction in calcite at ~6.5 kcal BP as well as shelf-core basal date of 5.3 kcal BP
  - 3.5-2.0 kcal BP increase deposition of calcite during high lake level (i.e., open basin conditions) and increasing δ18O indicates increasing temperature and/or increasing contribution of summer precipitation
  - 2.0-1.0 kcal BP = δ18O generally declines, indicating temperature decrease and/or increased contribution of winter precipitation
- High degree of δ18O variability in late Holocene suggests dramatic temperature changes (as much as 0.9 °C)

Summary

- Isotopic and sedimentological analyses provide the first climate record from Alaska’s North Slope.
- During the Holocene, Wahoo Lake changed from a relatively low-productivity, closed-basin lake to a more productive, open-basin lake as a result of regional climatic changes.
- Total solar irradiance seems to play an important role in the long-term climate of the Alaskan Arctic.
- Long-term trends in solar irradiance may also influence lacustrine productivity.

Acknowledgments

We thank Shari Wassenaar and Mike Eastoe for carbonate isotope and Holocene age determinations. Dr. Scott Fröhlich and Dr. Charles Michel for radiocarbon analysis. Meteorological data were provided by the National Oceanic and Atmospheric Administration (NOAA). Thank you to Dr. Ella Shiu and the grant’s reviewers for their support comments and criticisms.

Funding for this research was provided by NSF and WCC (Department of Education Undergraduate Research Award).