Characterization of terr. organic matter transported through the Lena River Delta (NE Siberia) to its adjacent nearshore zone using lignin phenols, $\delta^{13}C$, and $\Delta^{14}C$

Maria Winterfeld$^{1,2}$, Miguel Goñi$^3$, Janna Just$^4$, Jens Hefter$^2$, Pai Han$^1$ & Gesine Mollenhauer$^{1,2}$

$^1$Alfred Wegener Institute, Germany; $^2$University of Bremen, Germany; $^3$Oregon State University, USA; $^4$Marum, Germany
Permafrost distribution & Arctic watersheds

Permafrost distribution: Brown et al., 1997
Lena River catchment

- strong seasonality of discharge → **flood** end of May/early June with ~50% of annual sediment, DOC, and POC export

![Satellite image of Lena River catchment on 22. Mai 2014 and 26. Aug 2002](image)

22. Mai 2014 (NASA, LANCE-MODIS)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lena River catchment size</td>
<td>~2.5 x 10^6 km^2</td>
</tr>
<tr>
<td>Water discharge</td>
<td>588 km^3 (1999-2008)</td>
</tr>
<tr>
<td>Sediment export</td>
<td>20.7 Tg/year</td>
</tr>
<tr>
<td>DOC export</td>
<td>5.7 Tg/year</td>
</tr>
<tr>
<td>POC export</td>
<td>1.2 Tg/year</td>
</tr>
</tbody>
</table>

*Sources: Holmes et al. 2002, 2012; Rachold & Hubberten 1999; ArcticRIMS (www.rims.unh.edu)*
Motivation

Sources in the Lena River catchment

1. Tundra
2. Taiga

Holocene (recent to $10 \times 10^3$ yrs)

Late Pleistocene (10 to $40 \times 10^3$ yrs)
Research questions

1. **plant-derived lignin phenols**
   - Does the POM exported to Laptev Sea shelf reflect a watershed integrated signal?
   - How big is the contribution from taiga (gymnosperms) versus tundra (angiosperms) in exported POM? Affected by degradation?

2. **POM $\delta^{13}C$ & $\Delta^{14}C$**
   - Can we use bulk POM $^{14}C$ analysis to characterize soil-derived POM from the watershed?
   - What is the soil-derived $^{14}C$ signature from the Lena catchment?
Sampling locations

- Holocene soil profiles
- Pleistocene soil profile
- Suspended matter 2009-2011
- Surface sediments
Lignin-phenols – degradation of POM

- Holocene soils
- Pleistocene soils
- suspended matter 2009-2010
- surface sediments
- DOM (from Amon et al. 2011)

Winterfeld et al. in review
Lignin phenols – sources of POM

Winterfeld et al. in review
Lignin phenols – sources of POM

~50% contribution from taiga and tundra

Winterfeld et al. in review
POM $\Delta^{14}$C

**surface water**
particulate organic matter

**surface sediment**
particulate organic matter

<table>
<thead>
<tr>
<th>$\Delta^{14}$C [‰]</th>
<th>$^{14}$C age [years BP]</th>
</tr>
</thead>
<tbody>
<tr>
<td>-150</td>
<td>1,250 yrs BP</td>
</tr>
<tr>
<td>-100</td>
<td>780 yrs BP</td>
</tr>
<tr>
<td>-200</td>
<td>1,730 yrs BP</td>
</tr>
<tr>
<td>-300</td>
<td>2,800 yrs BP</td>
</tr>
<tr>
<td>-400</td>
<td>4,050 yrs BP</td>
</tr>
<tr>
<td>-500</td>
<td>5,500 yrs BP</td>
</tr>
</tbody>
</table>

Winterfeld & Mollenhauer in review
Winterfeld & Mollenhauer in review
Conclusion

1. **Plant-derived lignin phenols**
   - degradation in suspended matter & surface sediments > soils → degradation of during thawing and/or transport or finer fraction of POM
   - ~50% contribution from gymnosperm & angiosperm → despite tundra area only ~12% of catchment area

2. **POM δ¹³C & Δ¹⁴C**
   - estimated Δ¹⁴C of soil derived POM between –190 to –700‰ (1640 to 9720 ¹⁴C years BP)
   → reflects heterogeneity and age range of catchment soils
   more accurate than bulk POM ¹⁴C