TOTAL NITROGEN CONTENT AND $\delta^{15}N$ SIGNATURES IN MOSS TISSUE: DEPOSITION PATTERNS AND SOURCE ALLOCATION ON A NATION-WIDE SCALE

Data collection: moss

- 220 sampling sites (2.5/1000 km²) according to overall method
- Analysis of 5 sub-samples at 68 sites
- Analysis of Al, As, Cd, Co, Cr, Cu, Fe, Hg, Ni, Mo, Pb, Sb, S, V, Zn, S, N-total and δ15N in moss
- Analysis of δ¹⁵N by continuous flow isotope ratio mass spectrometry (IRMS)
δ 15N signatures

- $^{15}$N:$^{14}$N = δ 15N value
- Source allocation:
  - signatures more negative for NH$_4^-$
  - signatures more positive for NO$_3^-$
  - signatures for NH$_3$ depending on the amount of N-deposition and distance to N source
- Amount of deposition
  - Different uptake capacities for various forms of N
    - For example: NH$_3$ (dry deposition) is three times as high as for NH$_4^-$ (e.g. Skinner et al. 2006)
Data collection: deposition

- UN-ECE ICP Forest - 20 sites
- National network (including 3 EMEP stations) – 15 sites
- Deposition data on: N, NO$_3^-$, NH$_4^+$, SO$_4^{2-}$, H$^+$, S and precipitation for each station
Results: N total and δ15N in moss

Extremely low within site variability (p < 0.001)

Average: $1.21\% \pm 0.25$

Average: $-6.04 \pm 1.27$
Moss species
PCA with selected data
Correlation coefficients of all parameters from measurement sites

<table>
<thead>
<tr>
<th></th>
<th>all stations (n=35)</th>
<th>stations &gt; 1000 mm precipitation (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N content</td>
<td>$\delta^{15}$N signature</td>
</tr>
<tr>
<td>H+</td>
<td>-0.05</td>
<td>0.08</td>
</tr>
<tr>
<td>NH$_4^+$-N</td>
<td>0.25</td>
<td>-0.12</td>
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<tr>
<td>NO$_3^-$-N</td>
<td>0.22</td>
<td>0.04</td>
</tr>
<tr>
<td>S</td>
<td>-0.11</td>
<td>0.14</td>
</tr>
<tr>
<td>N</td>
<td>0.41*</td>
<td>0.14</td>
</tr>
<tr>
<td>NH$_4^+$/NO$_3^-$</td>
<td>0.09</td>
<td>-0.09</td>
</tr>
<tr>
<td>site</td>
<td>0.23</td>
<td>-0.22</td>
</tr>
<tr>
<td>altitude</td>
<td>-0.14</td>
<td>0.64**</td>
</tr>
<tr>
<td>precipitation</td>
<td>0.02</td>
<td>0.16</td>
</tr>
</tbody>
</table>
Correlation altitude / δ15N
Consequences

Hypothesis:
• There is a change in N source with altitude
• Occult and dry deposition (similar δ15N signatures) increases compared to wet deposition

We remember:
• Uptake capacity for NH₃ (dry deposition) is three times as high as for NH₄⁺

Conclusion:
• Limited quality of information of %N on N-deposition at higher altitudes
Take Home Message

Can we estimate N deposition from N concentration in moss tissue?

Yes, we can!

**Drawback:** N depo estimation from N tissue concentration has to be taken with caution in areas differing strongly in precipitation regime and altitude.
More details in:


Thanks for Attention
Take Home Message

• Low within site variability of N tissue concentrations and δ15N signatures proofs the method as basis for large scale monitoring

• Significant correlations between N depo (bulk deposition) and N content in moss

• δ15N signatures provided evidence for a change in N source with altitude, e.g. due to long-distance transport of reactive N and as a result of changes in the wet:dry deposition ratio

• N depo estimation from N tissue concentration have to be taken with caution in areas differing strongly in precipitation regime and altitude