Long-Term Measurements of Carbon Monoxide and Aerosols at the ZOTTO tall tower, Siberia

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ZOTTO – Current measurement program

• **MPI Biogeochemistry, Jena:**
  – BGC-Gases, continuous concentrations: CO₂, CH₄ (N₂O, CO, O₂/N₂)
  – Flask analyses (isotopes)
  – Meteorology, carbon, heat and water fluxes

• **MPI Chemistry, Mainz:**
  – Continuous CO, aerosol light scattering and absorption

• **IFT, Leipzig:**
  – Aerosol size spectra

• **SIF RAS Krasnojarsk:**
  – Forest inventories, satellite remote sensing

• **IAP RAS, Moscow:**
  – O₃, NOₓ, reactive gas chemistry

• **St. Petersburg State University**
  – Aerosol chemistry
CO Time Series 2006 - 2011
Seasonal Cycles: Combustion Tracers

![Graph showing seasonal cycles of absorption and CO concentration](image-url)
Seasonal Cycles: Total Aerosol

While the combustion tracers show a strong seasonal cycle, measures of total aerosol has relatively indistinct seasonality:

- Pollution aerosols in winter
- Biogenic aerosols in summer
An Example of Clean Air Episodes
Where does clean air come from?
## Characteristics of Clean Air at ZOTTO

<table>
<thead>
<tr>
<th></th>
<th>CO</th>
<th>Absorption Coefficient</th>
<th>Scattering Coefficient</th>
<th>N total</th>
<th>N &gt;80 nm “CCN”</th>
<th>Aerosol Volume</th>
<th>NO\textsubscript{x}</th>
<th>O\textsubscript{3}</th>
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<tbody>
<tr>
<td></td>
<td>ppb</td>
<td>Mm\textsuperscript{-1}</td>
<td>Mm\textsuperscript{-1}</td>
<td>cm\textsuperscript{3}</td>
<td>cm\textsuperscript{3}</td>
<td>(\mu\text{m}^3\text{m}^{-3})</td>
<td>ppb</td>
<td>ppb</td>
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<tr>
<td><strong>Winter</strong></td>
<td></td>
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<tr>
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</tbody>
</table>

- Pollution burdens, when present, are modest
- In summer, NCN and NCCN show no difference between “polluted” and clean
- Aerosol volume (mass) elevated during “pollution” periods
Aerosol size distributions, Winter

- Winter, polluted
- Winter, clean

Number concentration, dN/dlogD

Particle diameter, nm

10 13 16 20 25 32 40 51 64 81 103 130 164 207 261 329 415 524 662 835
Aerosol Size Distributions, Summer

Number concentration, dN/dlogD vs Particle diameter, nm

- 2007-2008 summer clean
- 2009 summer clean
- 2007-2009 summer polluted
ZOTTO in Global Aerosol Context

- Remote Marine
- Remote Continental
- Polluted Marine
- Polluted Continental

CCN$_{0.4}$ [cm$^{-3}$]

CN [cm$^{-3}$]

ZOTTO, winter

ZOTTO, summer
Conclusions

• ZOTTO receives episodically polluted and very clean airmasses
• In winter, pollution aerosols are dominant, while in summer natural aerosols provide comparable CN and CCN numbers
• Both, pollution and biogenic particles are large, and therefore good CCN
• During summer clean periods, the presence of a mode ~60 nm suggests new particle formation
• Short observation period does not yet allow detection of trends
Thank you!