Trace Gas Deposition: The Land/Atmosphere Interface

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Quantifying and Understanding the Earth System

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Trace Gas Deposition/Emission

ATMOSPHERE

stomatal uptake/emission

non-stomatal uptake/emission

CANOPY

SOIL
aerodynamic $R_a$

‘laminar’ sub-layer $R_b$

Atmospheric Resistances

Canopy Resistances

in-canopy aerodynamic $R_{a_{inc}}$

Cuticular interactions – surface water, chemistry, temperature

In-canopy dynamics and chemistry

Stomatal flux

Soil $R_s$

Stomatal $Rs$
List for compounds

1. Ozone
2. Nitrogen compounds
   - NOx
   - NH₃
   - aerosol NO₃⁻/NH₄⁺
   - PAN
3. Others (SO₂, organics, ...)

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Easter Bush $R_{ns}$

![Graph of Easter Bush $R_{ns}$](image)

- **0.5 h $R_{ns}$**
- Median
- %SE<90%, N > 5

$R_{ns} = 437 - 9.8T_{z0'}$

$R^2 = 0.73$

$R_{ns} = 146 + 359\exp(-0.08T_{z0'})$

$R^2 = 0.77$

**Equation:**

$$R_{ns} = \left[ \frac{1}{R_c} - \frac{1}{R_s} \right]^{-1}$$
$R_{ns}$ vs $T_{z0}$: Dry Surfaces – short canopies

- **Easter Bush** (managed grassland)
- **Auchencorth Moss** (upland peat bog)
- **Oensingen** (managed grassland)
- **Linden** (grassland)
- **Voghera** (onions)
- **Braunschweig 2000** (managed grassland)
**O$_3$ Deposition**

- Scheme for wet and dry surfaces with RH dependant transition
- Landcover specific parameters for
  - Grasslands
  - Coniferous
  - Deciduous (?)
  - Moorland (?)
  - Crops (?)
  - .......

**Easter Bush**

<table>
<thead>
<tr>
<th></th>
<th>DRY</th>
<th>WET</th>
<th>Δ%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easter Bush</td>
<td>242</td>
<td>177</td>
<td>-27%</td>
</tr>
<tr>
<td>Braunschweig</td>
<td>1282</td>
<td>1125</td>
<td>-12%</td>
</tr>
<tr>
<td>Oensingen</td>
<td>371</td>
<td>277</td>
<td>-25%</td>
</tr>
</tbody>
</table>
**NH₃ Canopy compensation point model**

\[
\chi_s = f(T, \Gamma)
\]

\[
\Gamma = \frac{[\text{NH}_4^+]_{\text{apo}}}{[\text{H}^+]_{\text{apo}}}
\]

Nemitz, Milford & Sutton (Quart. J. Royal Meteor. Soc. 2000)
Daily fluxes of NH$_3$ at Easter Bush (only presenting daily fluxes where data capture > 65%). Arrows indicate key periods of NH$_3$ exchange: 1) Pre-cut, 2) Post-cut, 3) Post-fertilisation, 4) Winter, 5) Grazing and 6) Urea application, a and b indicate periods in 1998 and 1999, respectively.

Milford, 2003
Parameters needed from a vegetation model

- surface roughness, $z_0$
- canopy height
- LAI and SAI
- sensible heat flux
- latent heat flux
- friction velocity
- rainfall/snow cover
- surface wetness
- canopy temperature
- stomatal conductance
- relative humidity, solar radiation ....
• Surface deposition to vegetation is a significant sink/source for some trace gases

• Making good predictions of atmospheric concentrations needs a good land/atmosphere transfer scheme

• For some species relatively detailed information on canopy structure maybe required (ie for in-canopy processes)

• Agricultural practice can have a major influence (tilling, sowing, fertiliser applications, harvest)