Atmospheric transport and deposition of pesticides in Sweden

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Pesticide Monitoring Programme
as part of the Swedish EPA’s national monitoring programmes for agriculture and air  (Started in 2002)

- 4 catchments (8-16 km²)
- 2 rivers (90-500 km²)
- Atmospheric deposition at Vavihill

Halland  Vavihill  Vege å  Skåne

Västergötland  Östergötland  Skivarpsån
Vavihill: A rural monitoring site within the EMEP network in southern Sweden.

Located on a ridge in a forested area, >1 km to treated fields.

Methods

- Rain water collected
  - Event related sampling using a bulk sampler (a stainless steel funnel, area 0.5 m², above a fridge)
  - 12 samples per year during May/Jun & Sep/Oct
  - Analysis including ca 85 different pesticides and some metabolites
Results 2002-2005

- 40 pesticides & 5 degradation products were detected in rainwater
  - 26 herbicides, 8 fungicides & 6 insecticides
- Most detects at the ng/l-level, though some were occasionally detected above 0.1 µg/l (prosulfocarb, isoproturon, MCPA & pendimethalin)
- Max conc. 0.8 µg/l (prosulfocarb)

Results (ctd)

- 11 of the pesticides detected are no longer registered for use in Sweden (most of them since more than ca 10 y)
  - 2,4-D, atrazine, dichlobenil, diuron, endosulfan, lindane (incl. α-HCH), terbuthylazine (incl. DETA), vinclozolin
Frequency of detection in rainwater at Vavihill 2002-2005 (n=47)
red bars = pesticides not used in Sweden

Deposition
- Total deposition 0.3-0.9 g/ha (4 months)
- Deposition 0.01-0.0004% of appl. dose
**Question 1**

- Is there a correlation between composition of detected pesticides and origin of air-masses

- Major rainfall event occurring when air-masses came from the south-west
- Total deposition included 12 pesticides (6 of these were not registered in Sweden)
• Major rainfall event occurring when air-masses came from the north-west

• Total deposition included 6 pesticides (2 of these were not registered in Sweden)

• Major rainfall event occurring when air-masses came from the south-west

• Total deposition included 25 pesticides (10 of these were not registered in Sweden)
• Major rainfall event occurring when air-masses came from the north-west

• Total deposition included 15 pesticides (5 of these were not registered in Sweden)

• First year lindane only appeared when air-masses came from the south-west

Correlation between sold amounts of pesticides (Sweden and Denmark) and total deposition

\[ R^2 = 0.32 \quad R^2 = 0.54 \]
Vapour pressure

<table>
<thead>
<tr>
<th>Substance</th>
<th>log Vp (Pa)</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>dichlobenil</td>
<td>-0.8</td>
<td></td>
</tr>
<tr>
<td>trifluralin</td>
<td>-2.2</td>
<td></td>
</tr>
<tr>
<td>prosulfocarb</td>
<td>-2.2</td>
<td></td>
</tr>
<tr>
<td>lindane</td>
<td>-2.4</td>
<td></td>
</tr>
<tr>
<td>fenpropimorph</td>
<td>-2.5</td>
<td></td>
</tr>
<tr>
<td>chlorpyrifos</td>
<td>-2.6</td>
<td></td>
</tr>
<tr>
<td>alachlor</td>
<td>-2.7</td>
<td></td>
</tr>
<tr>
<td>pendimethalin</td>
<td>-2.7</td>
<td>Prosulfocarb, fenpropimorph and pendimethalin used in Sweden</td>
</tr>
</tbody>
</table>

Question 2

- Lindane has now been taken off the market within the EU - are there any changes in the deposition of lindane in Sweden?
Lindane (gamma-HCH) concentrations (ng/l) in Swedish rainwater during recent years compared to the early 90’s

- A 10-fold decrease in concentrations during last 10 y (in 2005 lowest conc. ever)
- Alpha/gamma ratio indicating a longer atmospheric residence time for southern Sweden today

**Conclusions**

- Currently used pesticides are regularly detected at ng/l-levels in rainwater
- Deposited amount corresponds to ca 0.01-0.0004% of applied dose
- A significant contribution to atmospheric deposition in southern Sweden from pesticides that are no longer used within Sweden
- There is a correlation between origin of air-masses and composition of detected pesticides
- Lindane, now banned within the EU, is detected at decreasing concentrations