Operational validation of SILAM model in differently inhabited areas

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Estonian pre-operational SILAM model application in „Eastern Baltic“ domain: how reliable it is?

- NOx, SO₂, PM10, M2.5
- 3.3 km resolution
- driven by HIRLAM (Estonia)
- boundary fields of pollutants – SILAM (Finland)
- meteo boundaries – ECMWF

Emission data:
- in Estonia – national, 0.5 – 1 km resolution
- outside – TNO MACC, 7 km
Validated so far


- Urban peak concentrations represented rather well.
- Urban averages underestimated.
- Background NOx rather well.
- Summertime PM underestimated (no wind-blown dust).
Validated
so far

6 urban stations and 3 rural background stations non-uniformly distributed – not enough for good validation!
Two-week series in 2012:
(26 sites)
• 13.02 – 26.02
• 14.05 – 27.05
• 27.08 – 09.09
• 19.11 – 03.12

Average concentrations
How the classification performs?

Population density in 3x3 km cells vs. subjective urban – rural classes.

$R^2 = 0.8505$

Population density per km² vs. Urban – rural (subjective) index.
Results: measured vs. modelled
Results: measured vs. modelled

\[ y = -0.0026x^2 + 0.3202x + 1.2788 \]

\[ R^2 = 0.3813 \]

**NO\textsubscript{2}**

<table>
<thead>
<tr>
<th>Measured concentration, ( \mu g m^{-3} )</th>
<th>Modelled concentration, ( \mu g m^{-3} )</th>
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</thead>
<tbody>
<tr>
<td>13.02 – 26.02</td>
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</table>
Results: measured vs. modelled

SO$_2$

Measured concentration, $\mu$gm$^{-3}$

Modelled concentration, $\mu$gm$^{-3}$

- 13.02 – 26.02
- 14.05 – 27.05
- 27.08 – 09.09
- 19.11 – 03.12
Results: concentrations vs. population density

**NO$_2$ measured**

- **13.02 - 26.02**
  - $y = 0.0024x + 5.6104$
  - $R^2 = 0.5572$

- **14.05 - 27.05**
  - $y = 0.0023x + 1.9818$
  - $R^2 = 0.6202$

- **27.08 - 09.09**
  - $y = 0.0019x + 1.9139$
  - $R^2 = 0.6673$

- **19.11 - 03.12**
  - $y = 0.0018x + 5.8834$
  - $R^2 = 0.2540$
Results: concentrations vs. population density

**NO₂ modelled**

- **13.02 - 26.02**
  - $y = 0.0003x + 3.8373$
  - $R^2 = 0.2127$

- **14.05 - 27.05**
  - $y = 0.0008x + 0.7968$
  - $R^2 = 0.5441$

- **27.08 - 09.09**
  - $y = 0.0002x + 1.0843$
  - $R^2 = 0.5287$

- **19.11 - 03.12**
  - $y = 0.0002x + 3.8228$
  - $R^2 = 0.0299$
Other results

- No substantial dependence of SO₂ concentrations on urbanisation/population density – expected.
- Black carbon constitutes only a small fraction of PM2.5 or PM10, but is considerably correlated with modelled PM2.5: correlations 0.2 – 0.6 (nearly as modelled – measured PM in monitoring stations).
- Site-wise modelled – measured correlations of NO₂ and SO₂ are substantial in summer, but don’t exist in winter:

<table>
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<tr>
<th>Campaign, 2012</th>
<th>NO₂</th>
<th>SO₂</th>
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<tbody>
<tr>
<td>13.02 – 26.02</td>
<td>0.09</td>
<td>-0.07</td>
</tr>
<tr>
<td>14.05 – 27.05</td>
<td>0.78</td>
<td>0.39</td>
</tr>
<tr>
<td>27.08 – 09.09</td>
<td>0.68</td>
<td>0.53</td>
</tr>
<tr>
<td>19.11 – 03.12</td>
<td>0.46</td>
<td>-0.10</td>
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Conclusions

• Estonian application of SILAM tends to “smooth out” the urban-rural differences – urban emissions underestimated?
• Urban peak levels have been reproduced fairly – is the diurnal cycle of emissions (and perhaps dispersion conditions) overestimated?
• Grid cell resolution (3.3 km) may be still critical for small towns.
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