EMEP case studies on HMs: State of the art

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EMEP/MSC-E

Assessment of HM pollution levels on a country scale

Objective: Analysis of factors affecting quality of the assessment of HM pollution levels with fine resolution (down to 5x5 km)

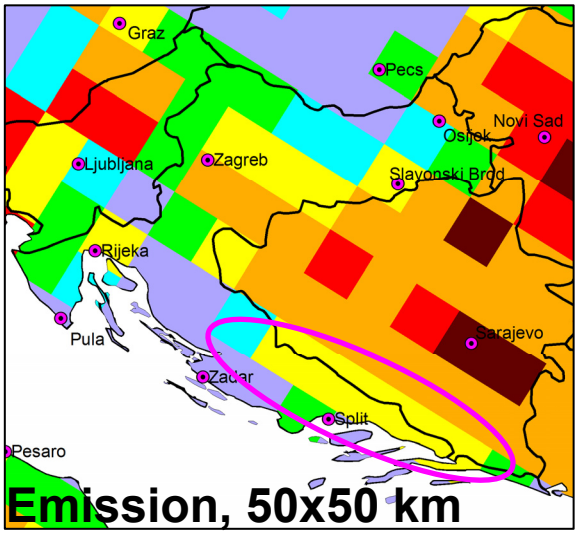
Participants: Croatia, the Czech Republic, the Netherlands (as of May 2013)

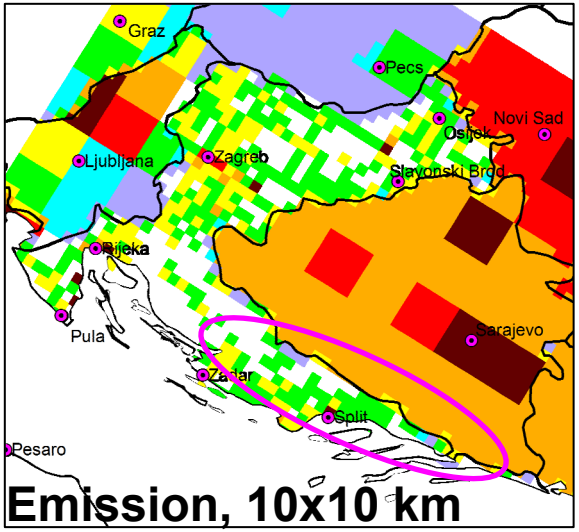
Progress:

Croatia:	**finished**
Czech Republic:	**finished**
Netherlands:	**ongoing**

Croatia

- Modelling with fine resolution improves model assessment due to better spatial representation of input data:
  a) emission fields



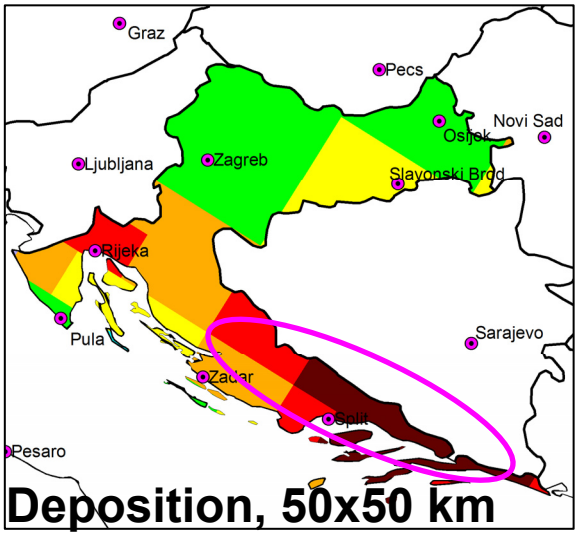


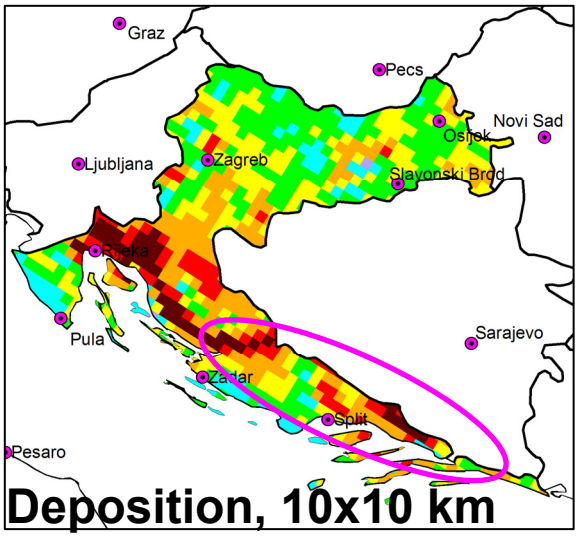
Overview of results for other countries

Croatia

- Modelling with fine resolution improves model assessment due to better spatial representation of input data:

  a) emission fields

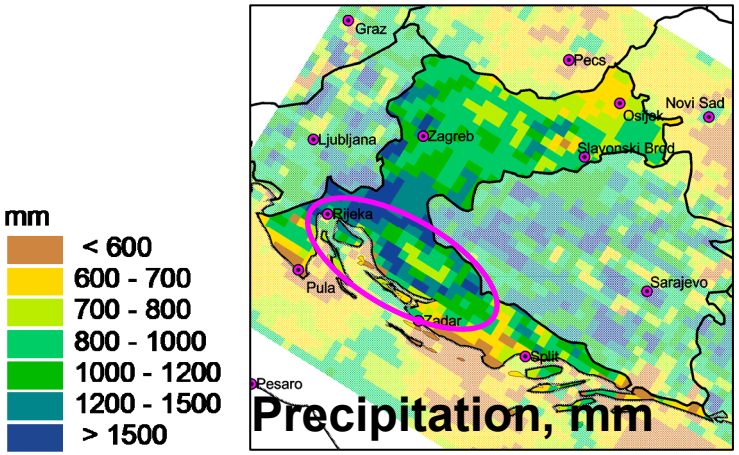


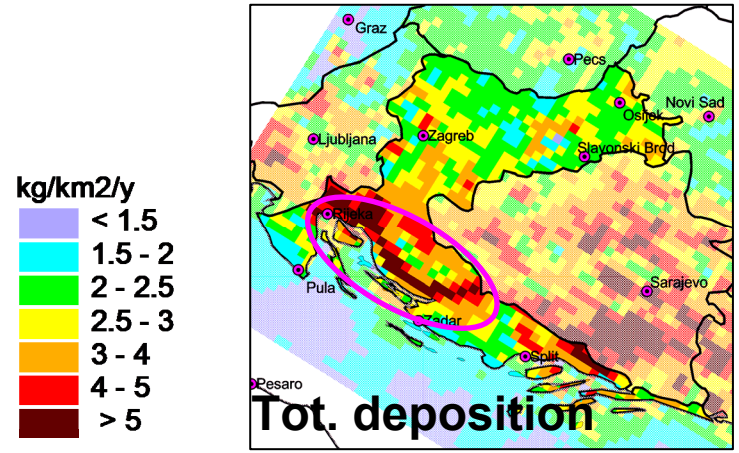


Overview of results for other countries

Croatia

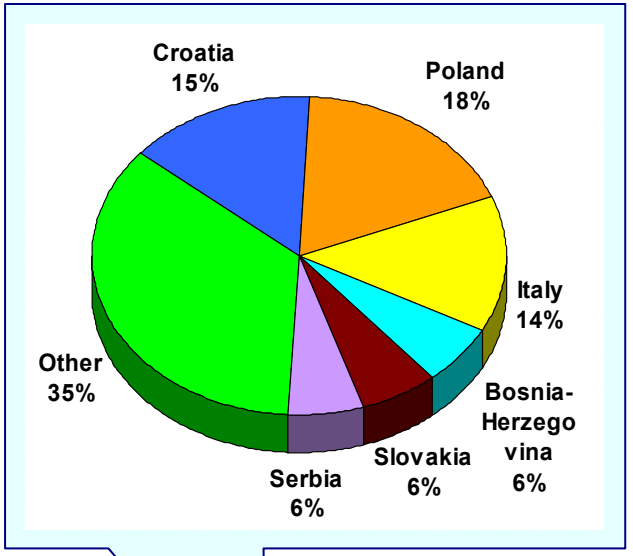
- Modelling with fine resolution improves model assessment due to better spatial representation of input data:
  - a) emission fields
  - b) Meteorological data

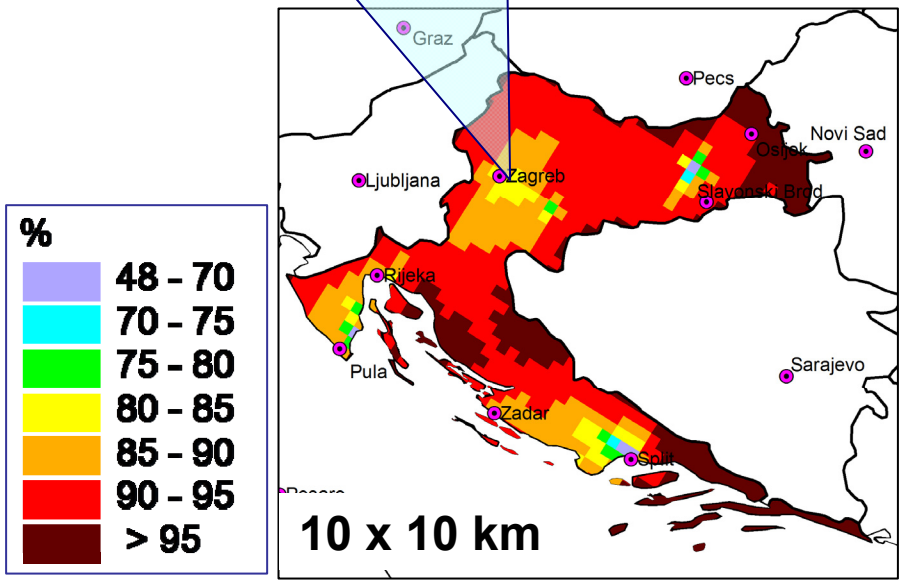




Croatia

- Modelling with fine resolution improves model assessment due to better spatial representation of input data:
  - a) emission fields
  - b) Meteorological data
  - c) Detailed country-specific information





Contribution of foreign sources to deposition in Croatia

Concluding remarks (Croatia):

Finer resolution modelling is highly important for counties with relatively small territory and complex terrain because:

• Spatial distribution of pollution levels is more detailed

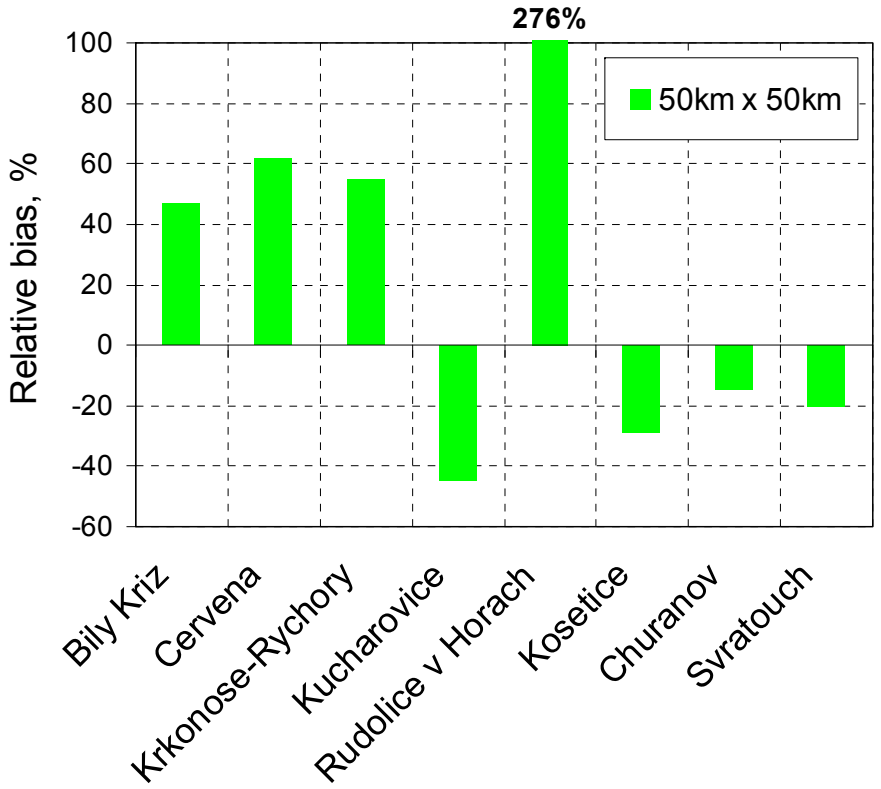
• Small-scale effects are reproduced better (e.g., orographic precipitation, deposition along state borders)

• It is possible to assess transboundary pollution for both the entire country and its administrative regions

Czech Republic

- Transition to fine resolution leads to improvement of modelling results

Mean relative bias, %



Czech Republic

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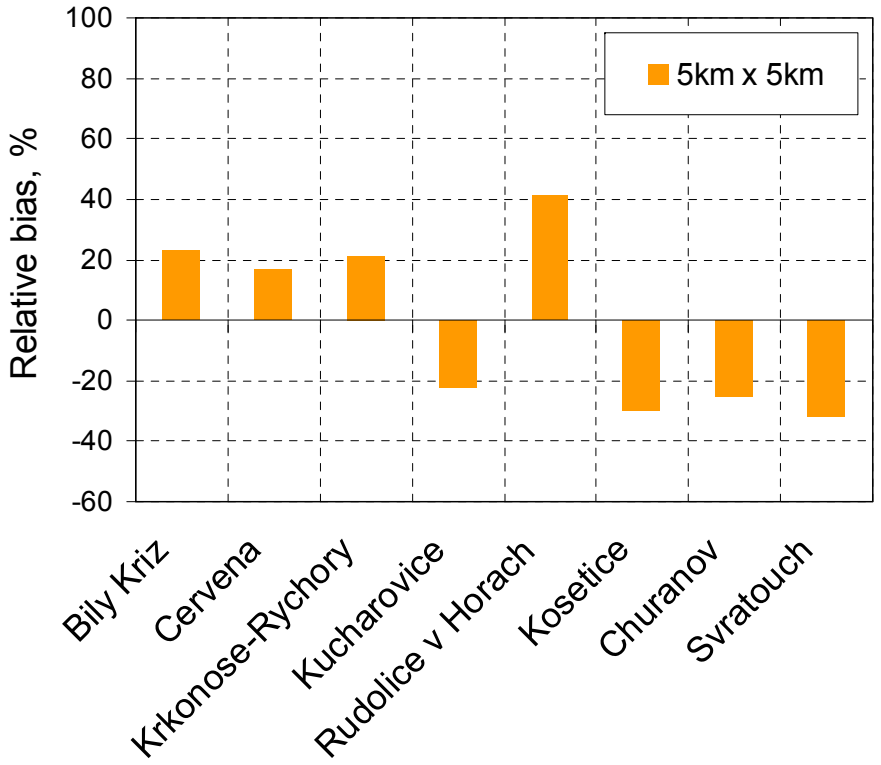

Czech Republic

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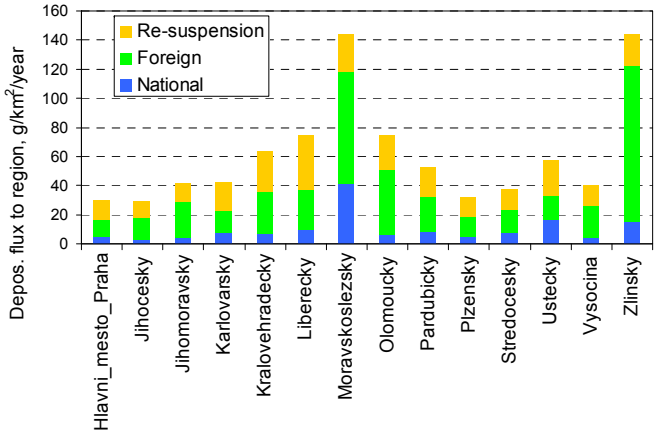
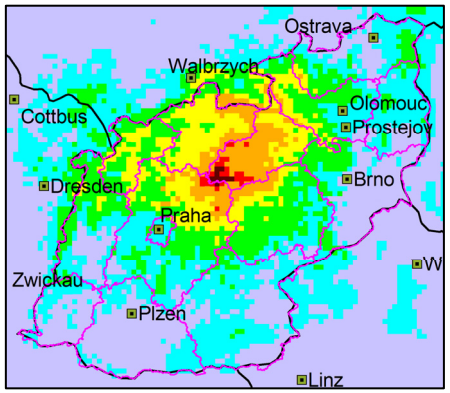
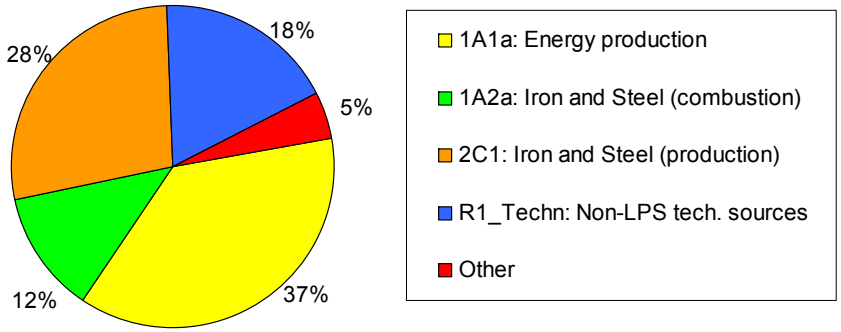


Pollution of country's provinces



Pollution from LPS

- Modelling with fine resolution allows us to produce more detailed data, if necessary input information is available.



Contribution of main source categories to country's pollution

Concluding remarks (Czech Republic):

- Transition to finer resolution of emission and meteorological data leads to better evaluation of pollution levels
- Rough spatial emission distribution in the neighbouring countries leads to additional uncertainties of pollution levels in the country
- Wind re-suspension is important contributor to HM levels and needs more detailed investigation
- Involvement of national measurement data increases a base for the analysis and validation of transboundary transport

Netherlands

Main stages of the research (Pb, 2007)

- Preparation of input data (emissions, monitoring, meteorology, land-cover) with fine spatial resolution (5x5 km2) — ✓ **complete**

- Modelling with coarse and fine resolution and analysis of factors affecting country-specific pollution levels — ✓ **ongoing**

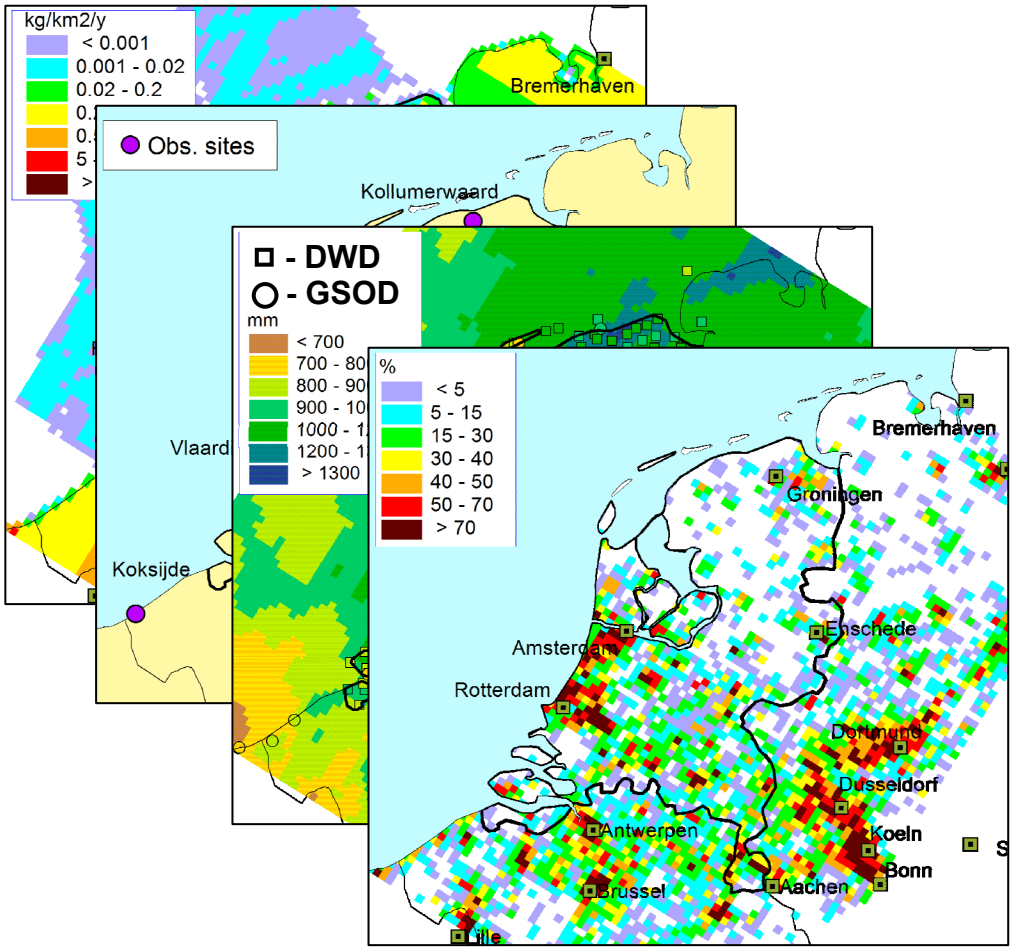
- Improvements of model parameterizations and input data — ✓ **ongoing**

- Preparation of country-specific information with fine resolution

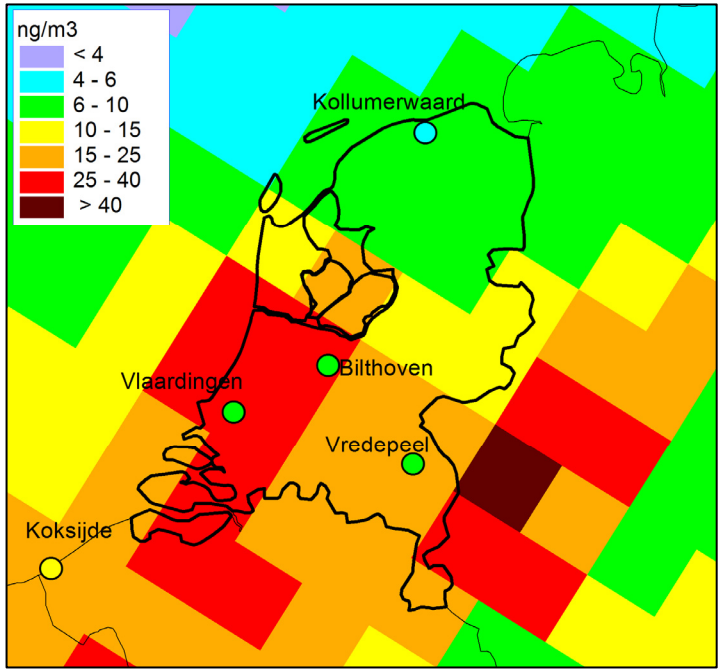
- Inclusion of other pollutants (Cd, Hg) and extension of period to 2007-2009

Input data involved in the study

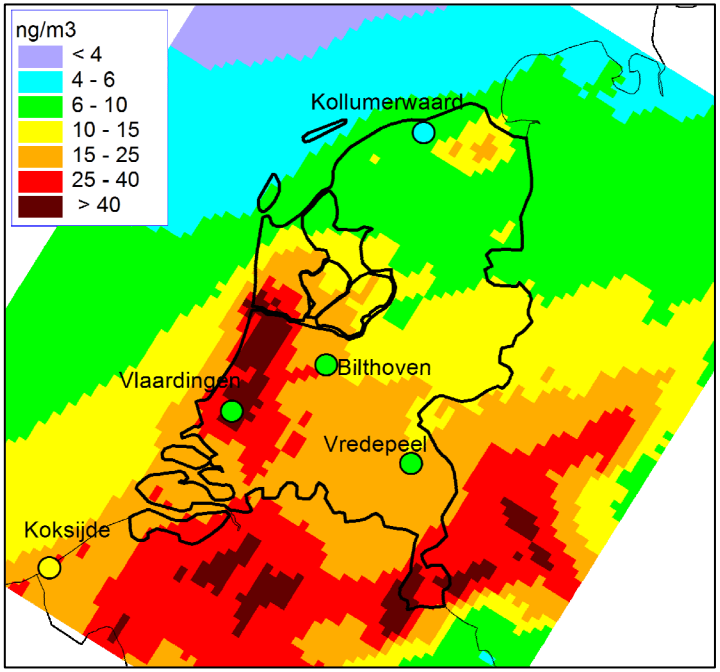
- **Emissions**
  - *Netherlands: 5x5 km (national data)*
  - *Other regions: 50x50 (EMEP data)*
- **Measurements**
  - *Concentrations in air (5 sites)*
  - *Concentrations in precip. (1 site)*
- **Meteorological data**
  - *For modelling: pre-processed by MM5*
  - *For verification: GSOD, DWD*
- **Geophysical data**
  - *Land-cover (MODIS)*
  - *Concentrations in soils (based on* http://weppi.gtk.fi/publ/foregsatlas/*)*
  - *Dust suspension flux (modelling)*
  - *…..*



Annual mean air concentrations of Pb with coarse and fine resolution, 2007

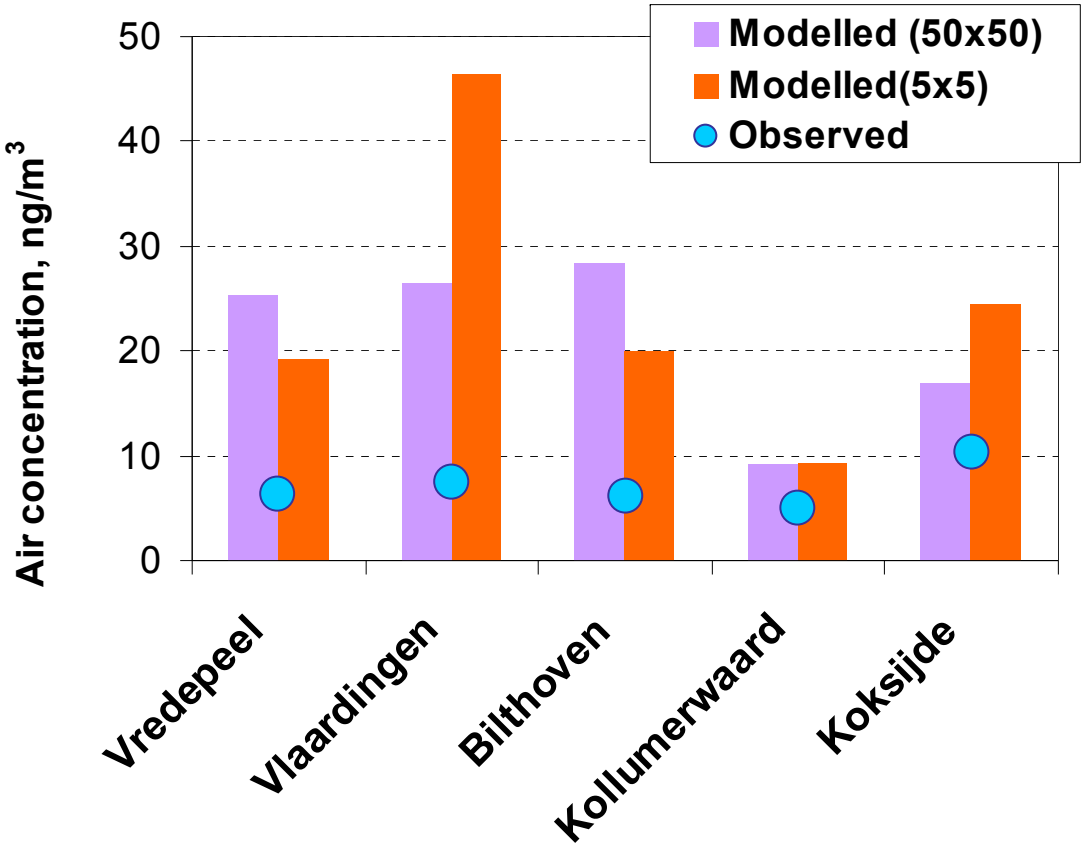


50 x 50 km

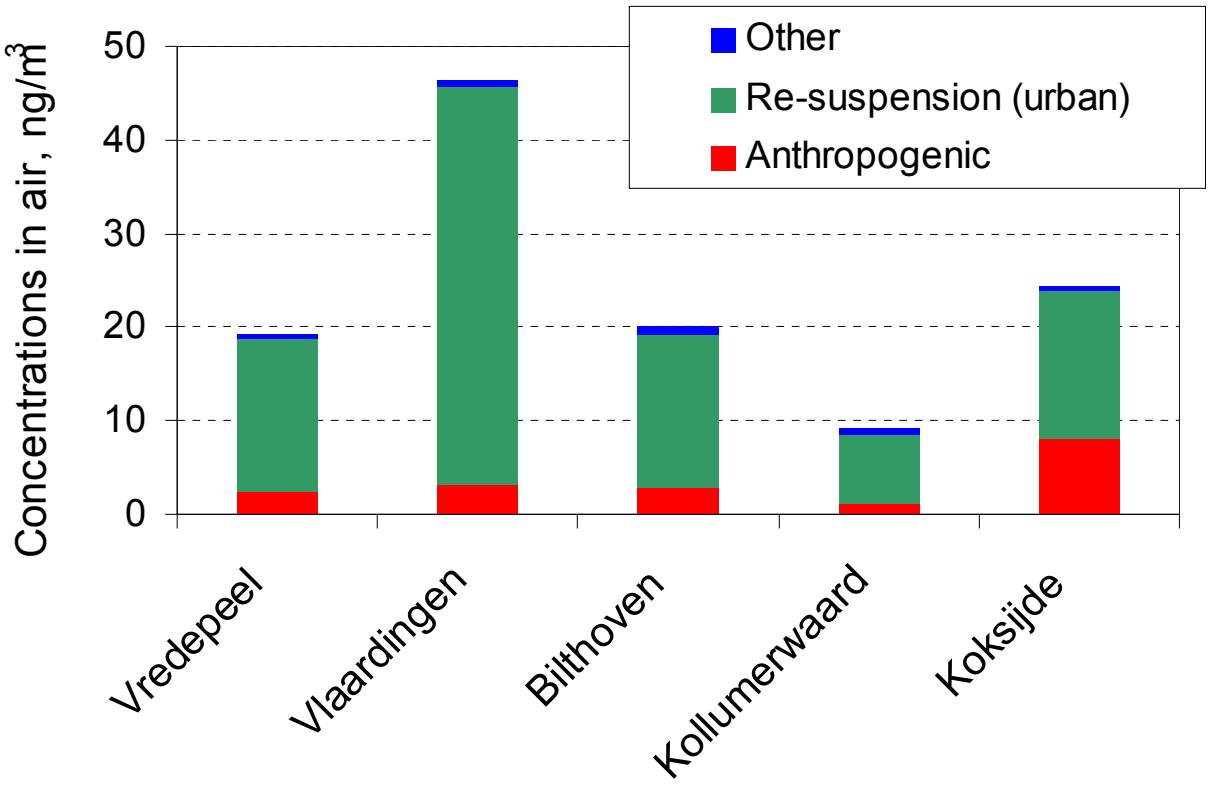


5 x 5 km

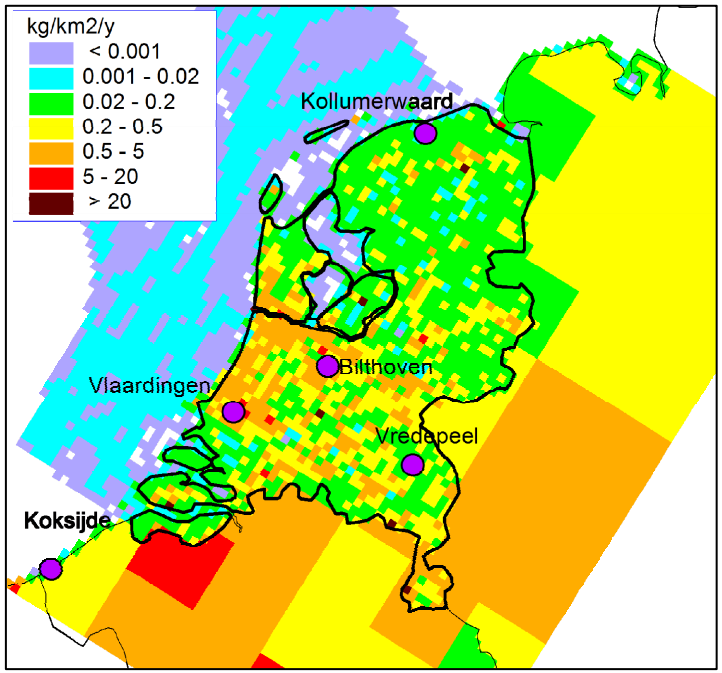
Modelled and observed annual mean concentrations in air at monitoring sites



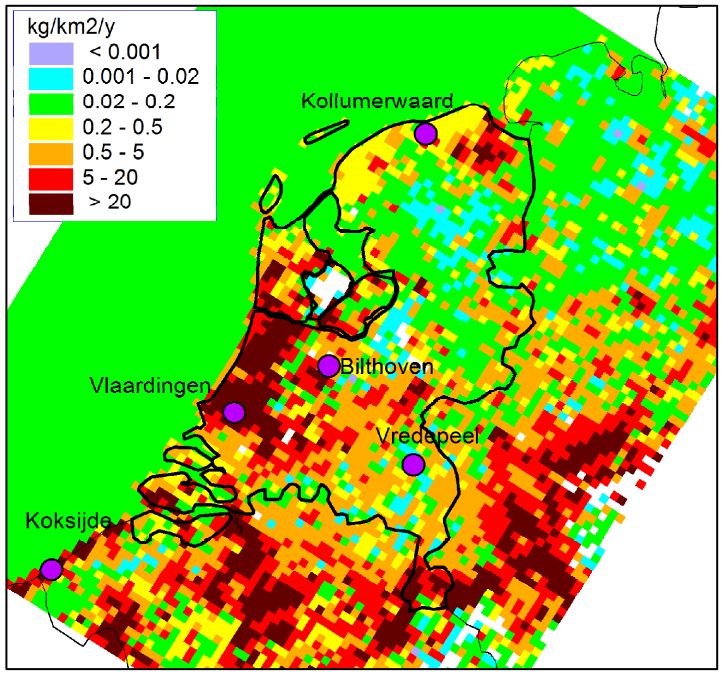
Contributions of anthropogenic and re-suspension sources to air concentrations at the stations



Annual anthropogenic emission and wind re-suspension of lead in 2007



Anthropogenic



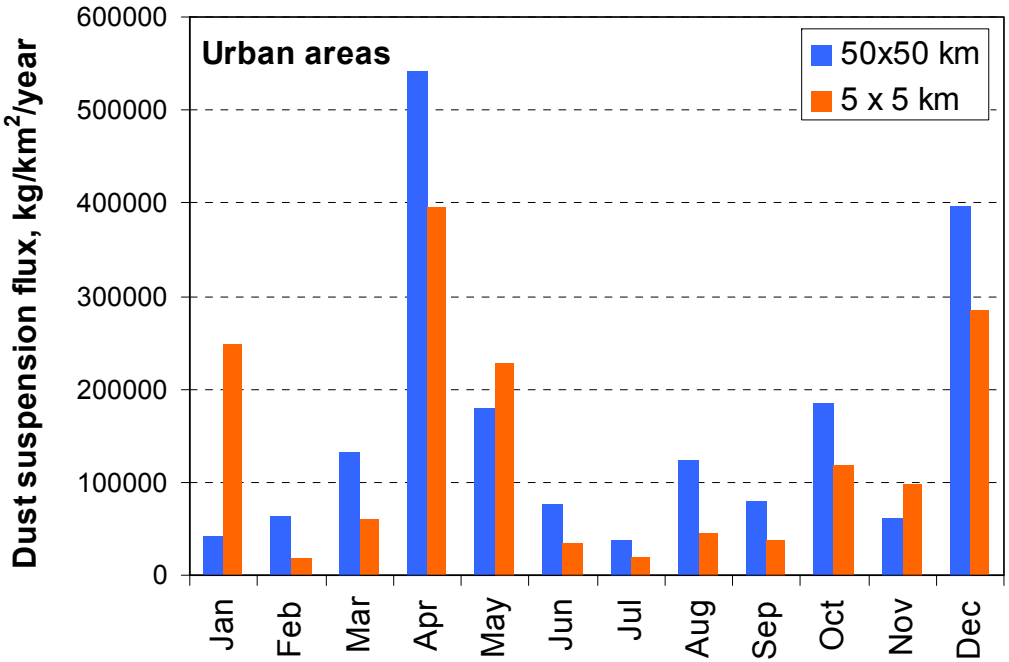
Wind re-suspension

Total suspension of dust from the local domain

HM re-suspension flux = ***Dust flux*** ● *HM soil concentration*

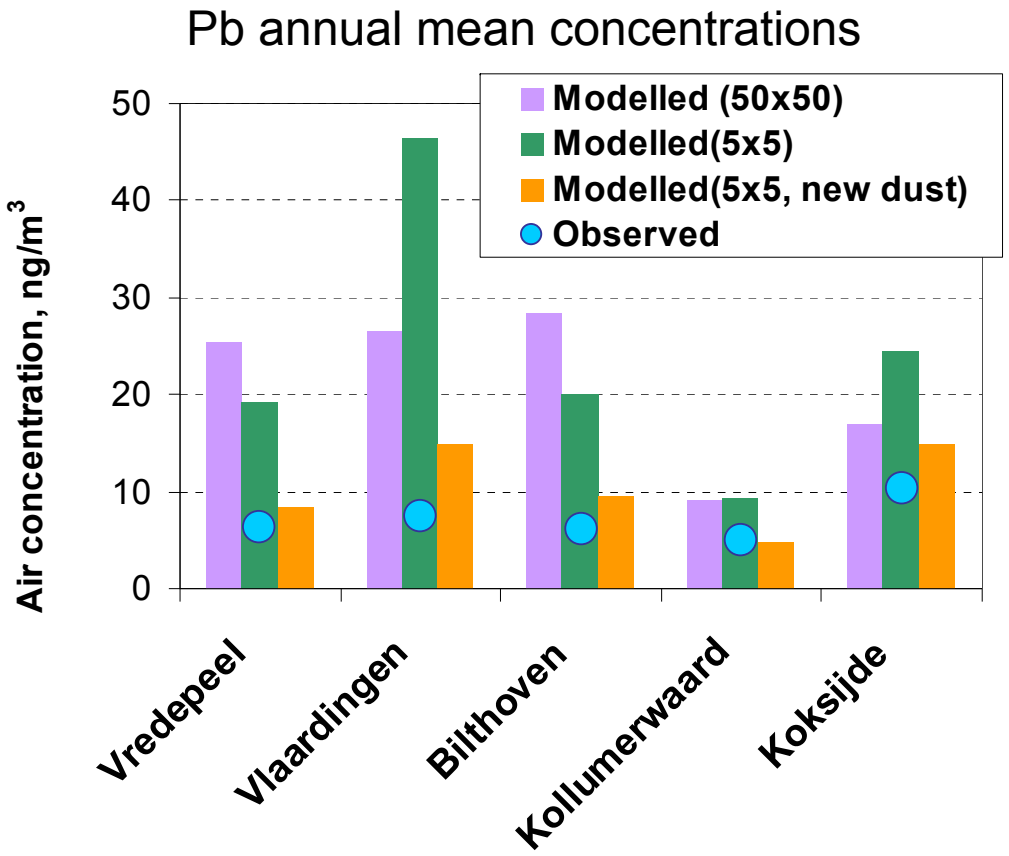
Soil concentration: The same (http://weppi.gtk.fi/publ/foregsatlas/)

Dust flux: depends on a) soil texture (the same for 5x5 and 50 x 50)
b) meteorological data (ABL parameters, **soil moisture**)



Seasonal variability of dust suspension from land cover type 'urban'

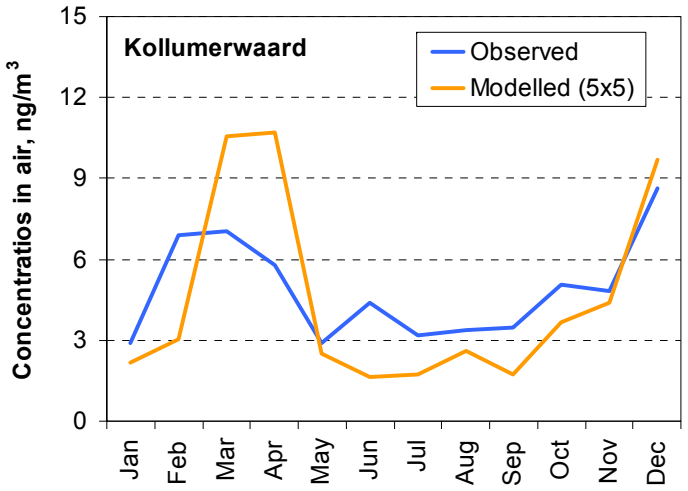
Correction of dust suspension in the local domain (Effect of soil moisture**)**

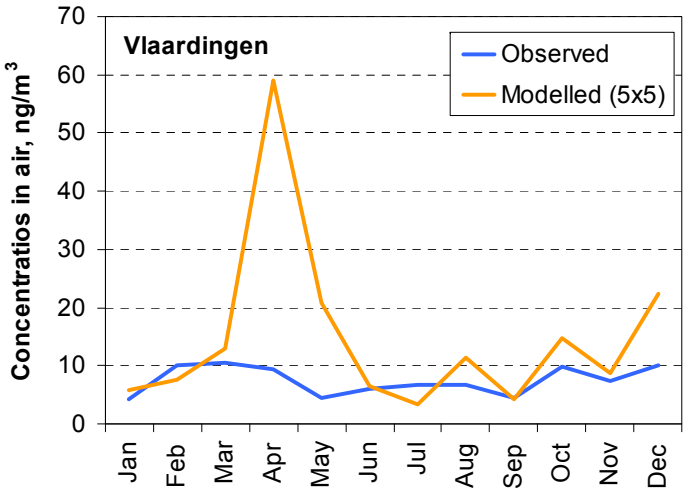


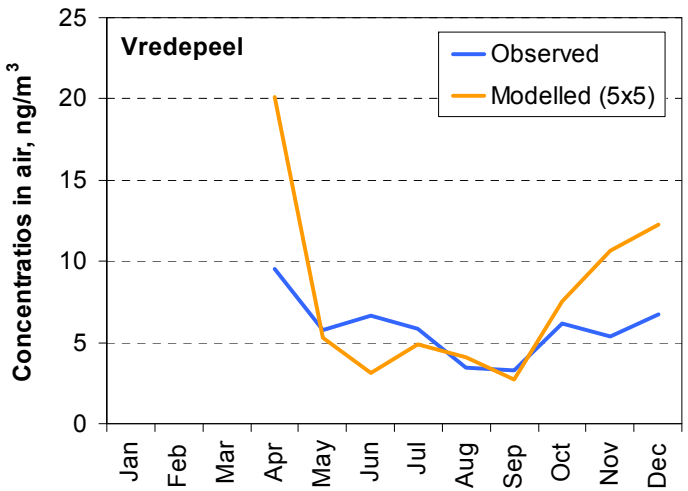
➢ Re-suspension flux of HMs is sensitive to soil moisture. Modified moisture was used (*Grini et al.,* 2005)

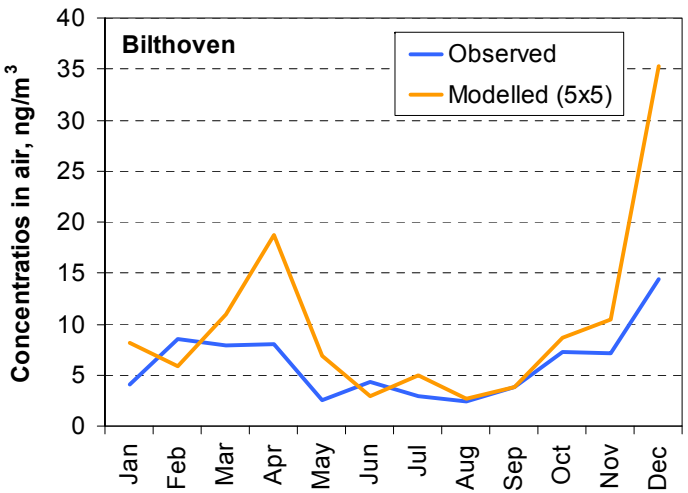
➢ Further investigation/improvement of soil moisture parameterization is needed

Monthly mean modelled and observed concentrations of Pb (corrected dust flux)

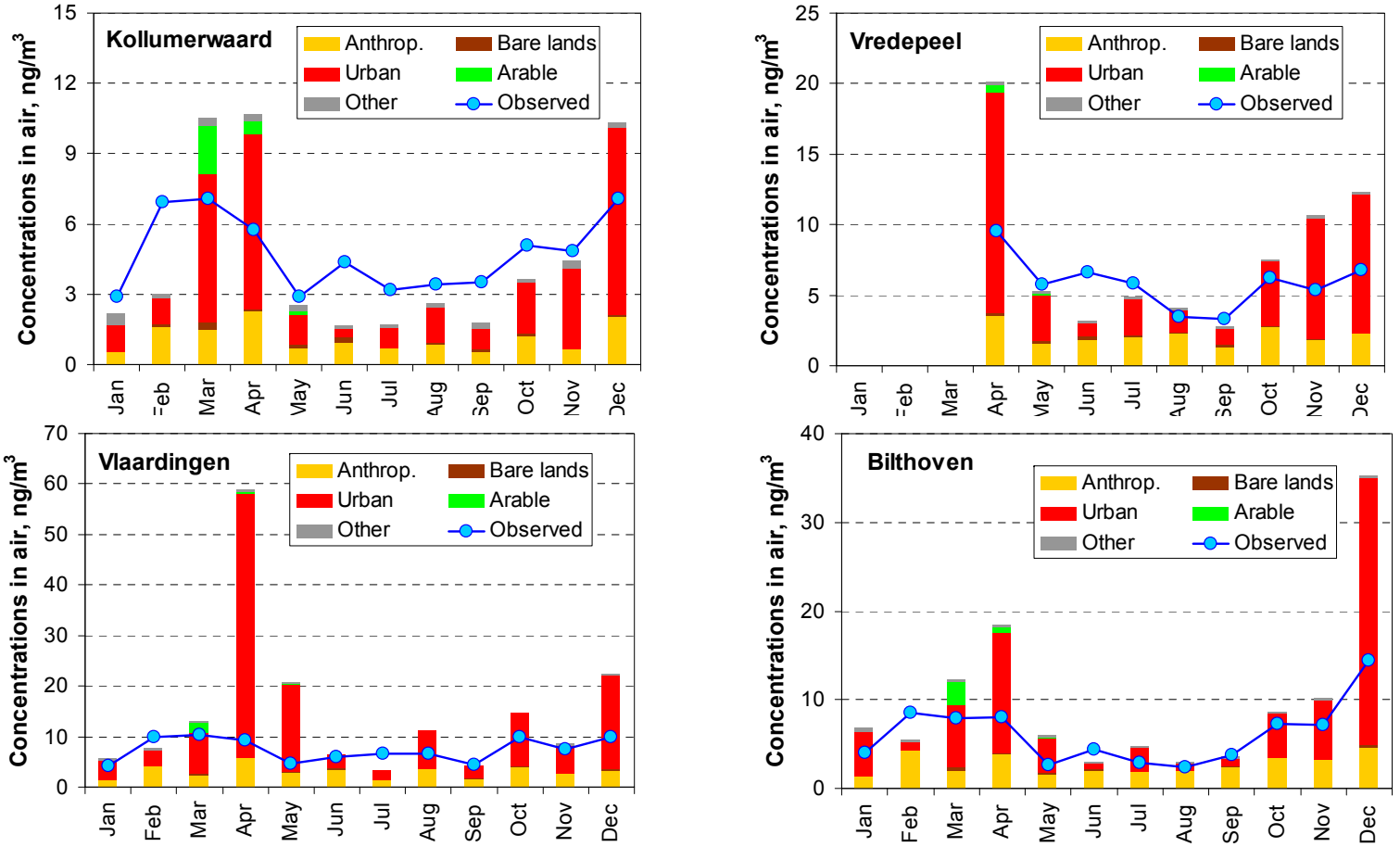








Contributions of main emission sources to air concentrations at the Dutch stations

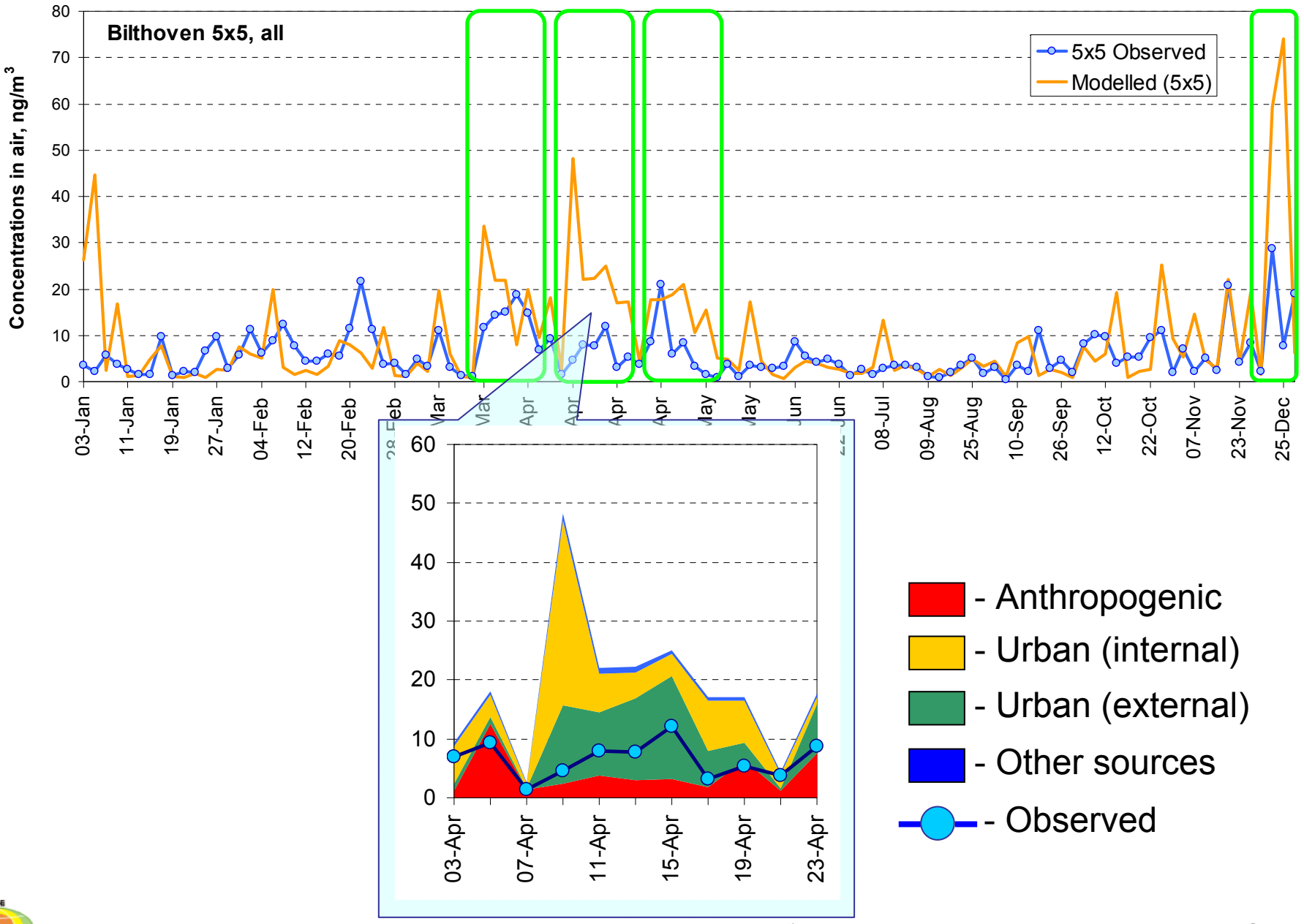


HM re-suspension flux = *Dust flux* ● ***HM soil concentration***

HMsoil(surface) = HMsoil(20 cm) x (1 + Enrichment Factor)

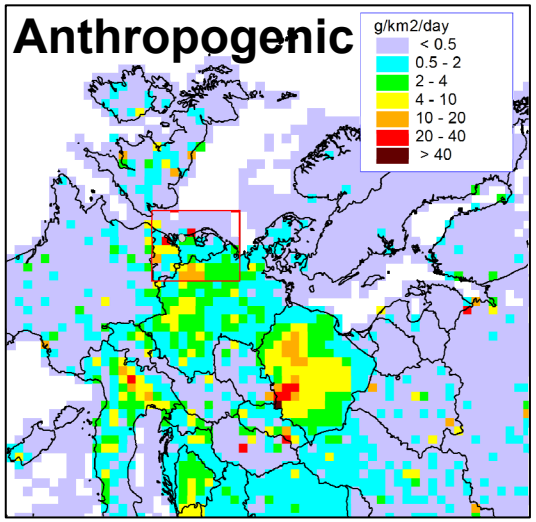
➢ Enrichment factor of soil concentration needs correction

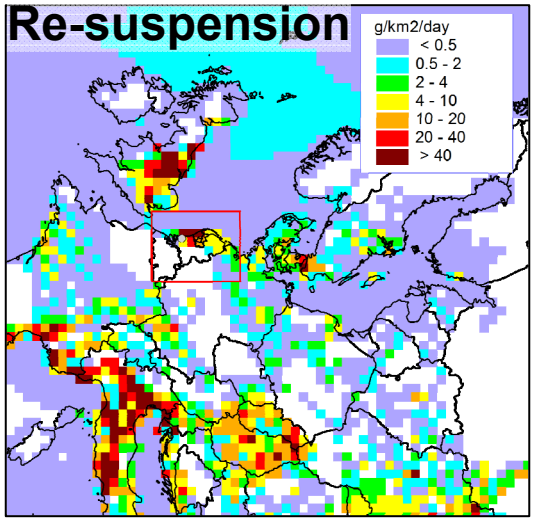
Analysis of short-term episodes (station Bilthoven)



Application of adjoint model approach

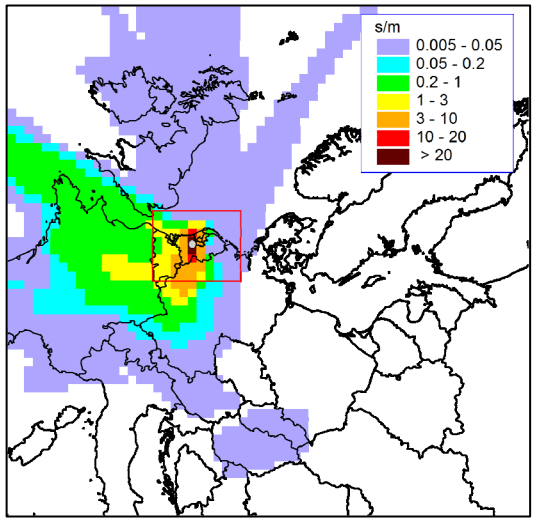
15th of April, station Bilthoven



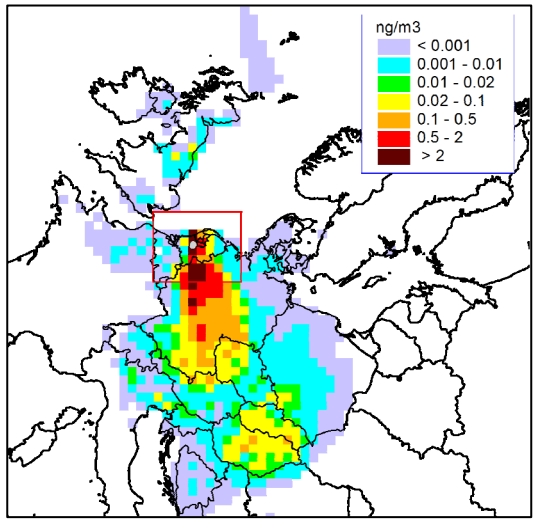


Daily emissions

X



Influence function

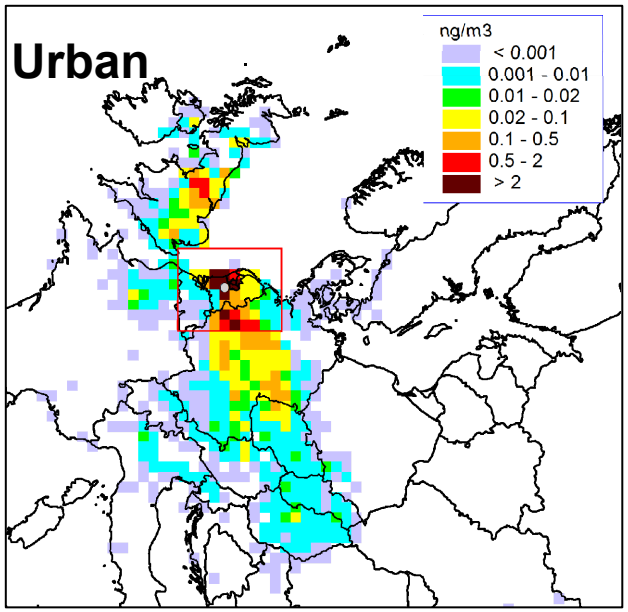


Contributions (ng/m^3) of emissions to daily mean air concentrations

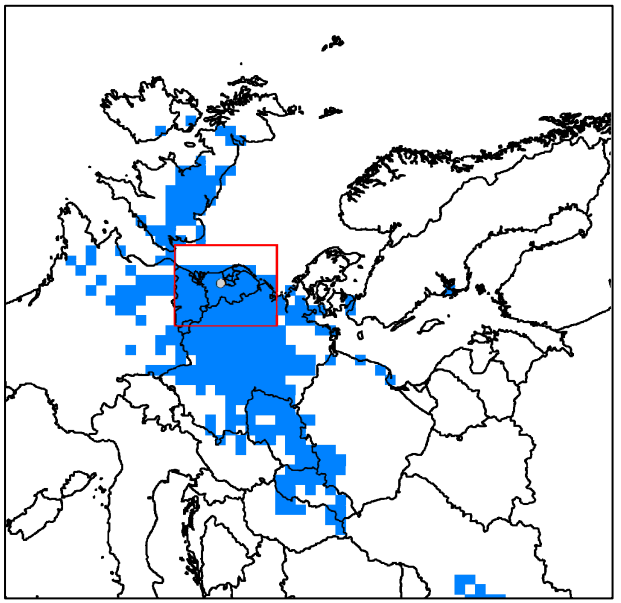
- The same approach was applied to other episodes and stations

Contribution of various sources to Pb air concentrations (station Bilthoven)

Averaged for 7-19 April



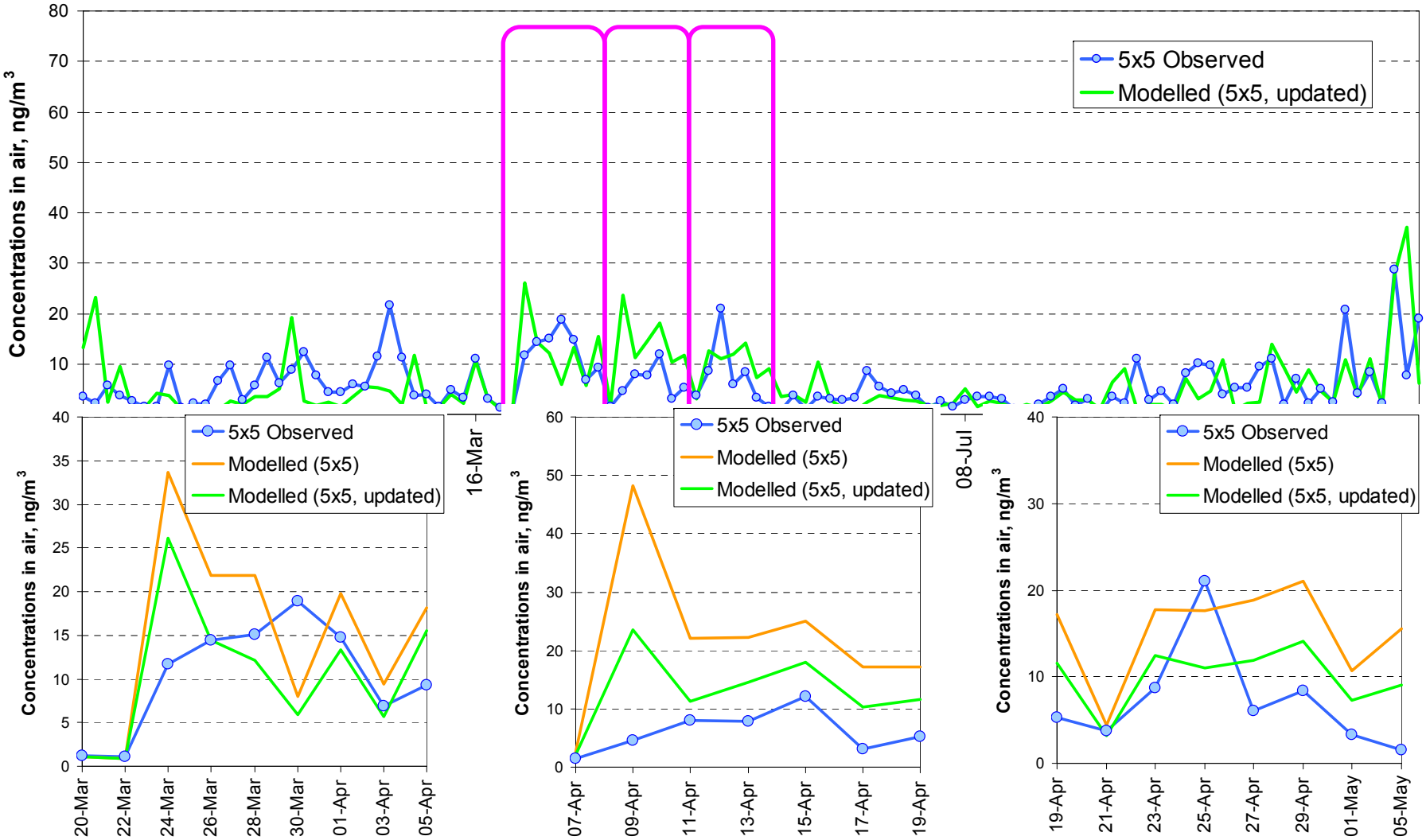
Contributions (ng/m^3) of re-suspension from urban areas to air concentrations (average for the period)



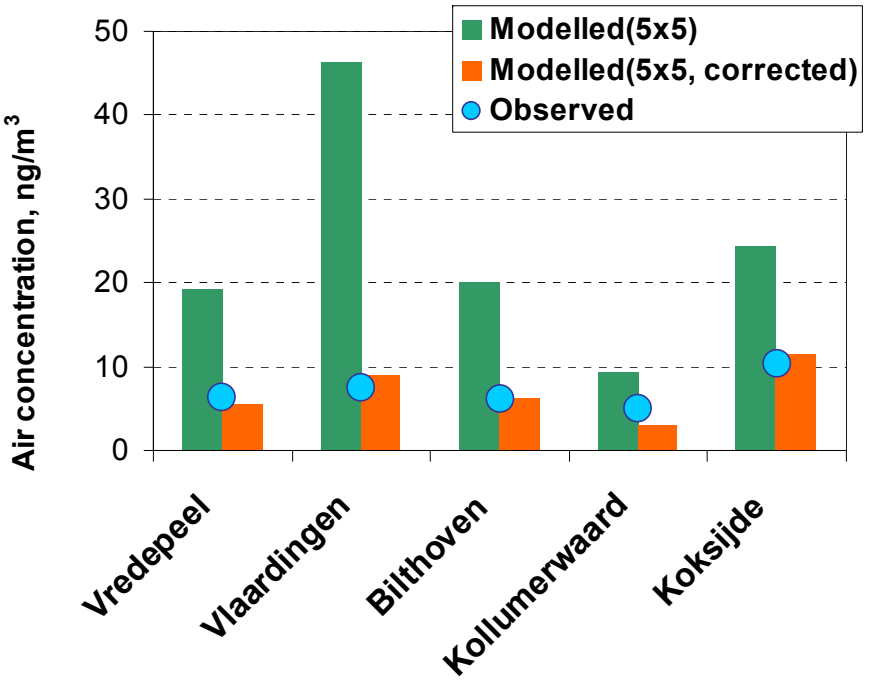
Area, where enrichment factor was reduced

- Soil enrichment factor was reduced by a factor of 0.5 in the selected area
- Modelling with 50x50 km^2 and 5x5 km^2 resolution was performed

Time series of modelled and observed Pb air concentrations at station Bilthoven



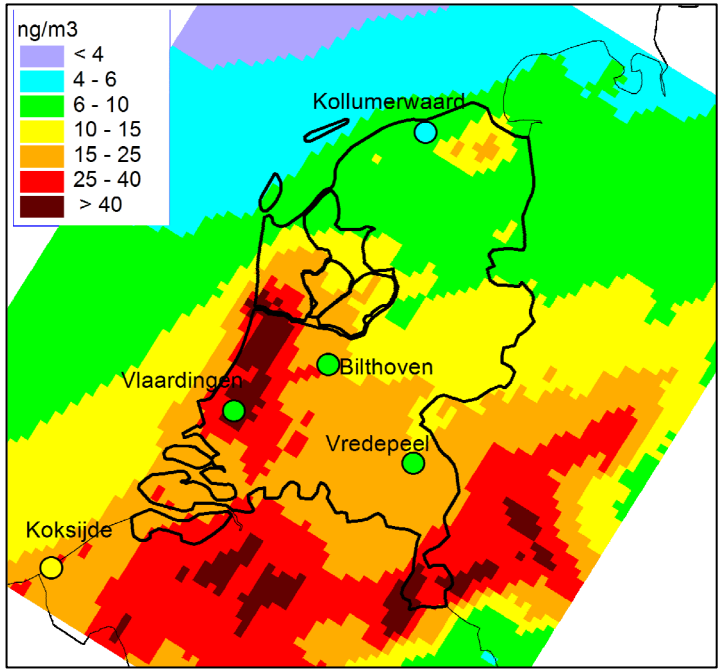
Modelled (50x50 and 5x5) and observed annual concentrations of Pb in 2007 at monitoring stations



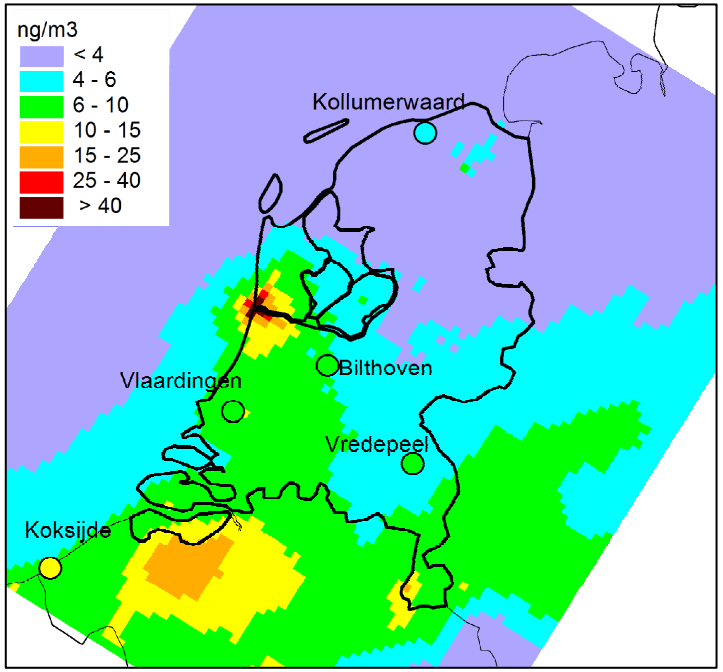
Factors affected:

- Correction of dust suspension flux (soil moisture)
- Correction of soil re-suspension of Pb (enrichment factor)

Annual mean air concentrations of Pb with coarse and fine resolution, 2007



5 x 5 km (original)



5 x 5 km (corrected re-suspension from urban areas)

Main conclusions (for the three countries-participants)

- Transition to finer resolution makes possible to better reproduce small-scale effects (e.g., orographic precipitation, deposition along state borders)

- Modelling with fine resolution allows us to produce more detailed country-specific information, if necessary input information is available

- Rough spatial distribution of emissions in the neighbouring countries leads to additional uncertainties of pollution levels in the country

- Formal transition to finer resolution does not always favours the improvement of modelling results. Detailed analysis of factors affecting the modelling results is needed.

- Wind re-suspension is important contributor to HM levels. More detailed investigation of factors affecting re-suspension is needed (soil moisture, concentrations in soil and their enrichment)

Further country-specific activity:

- Finalization of the country-specific research for the Netherlands

- Preparation of country-specific information with fine resolution:
  - Maps of pollution levels
  - Contributions of foreign and secondary sources
  - Pollution levels in individual provinces
  - Exceedances of critical loads

- Inclusion of other pollutants (Cd, Hg) and extension of time period (2007-2009)

- Initiation of country-specific activity, including modelling with fine resolution, for one EECCA country