Modelling in PMinter

a holistic approach – from base data to emissions to exposure, considering local, regional & long range transport & chemistry

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Background – Results EU-Project KAPAGS
Starting Point PMinter

Traffic exhaust
Traffic non-ex
Dom. heating
Trade/Industry

51.4% at busy road?

Transport?
Secondary PM?
Aim: Better Quantified Understanding of PM concentration levels → effective AQMP

• Secondary particles?
• Impact of transport (regional & long range)?
• Domestic heating – „piece“ realistic?
• Which measures are effective on:
  – Local level?
  – Regional level?
• Specific assessment health/environment
... to Achieve our Aims

Outline

• Develop Holistic Model Approach
  – Regional transport + Local effects (GRAL-Sys)
  – Secondary formed PM
  – Adapt input data for approach → Emission Processing

• Validate this new Approach
  – Results base cases vs. observations

• Analysis Base Cases
  – Identify main sources & local/regional origin?

• Develop & Evaluate scenarios/measures

• Conclusions & Effects on AQMP
Model Approach
(regional & chem)

Model WRFchem
RADM
MADE/SORGAM

Domains:
D1 ~25 km
D2 ~5 km
D3A & D3B ~1 km

Meteo. Forcing ERA-Interim (ECMWF)

Emissions:
MACC (TNO) with corrections (low resol)
Aggregation Local inventories & data
Own processing
Transport vs. Local Effects

GRAL Lagrangian Particle Model count. grid 10 m x 10 m
Develop Holistic Model Approach
Consider Inorganic Secondary Aerosols

Links different gaseous precursors species from different sources e.g. NOx traffic – NH3, agriculture – SO2 industry.
Emission Processing

• Aim: resolve basins and valleys for key emissions (traffic, precursors secondary PM, domestic heating)

• Different local inventories & data from ARSO SLO (Komar) Styria, Carinthia, KlGF, MB, TUG

• challenging processing/aggregating & harmonization
  • coord systems & resolutions
  • emission classifications SNAP vs customized/model specific
  • missing values (MACC ~7 km used)

• all road transport with NEMO (IVT)

• domestic heating MB/K own processing by TUG
Processed Emission Data from different Data Sources – NH3 (SNAP10) agriculture

Coarse resolution

Processed data on 1 km x 1km
Processed Emission Data NOx (SNAP7) Traffic

course resol (5 km x 5 km)  fine resol (1 km x 1 km)
Processed Emission Data NOx SNAP7 (Traffic)
Processed based on traffic data with NEMO
Processed Emission Data SNAP2 (Domestic Heating) various data sources
Base Case: Approach to Distinguish Local & Regional Effects in Domains LB, MB & K

- Set all emissions = 0 in micro scale domains
- Emissions (primary) are processed for GRAL-Sys simulations (10m x 10m)
- Run 2\textsuperscript{nd} WRFchem base run simulation
- Combine results GRAL-Sys with “background” levels by WRFchem
- Processing regional (transport) local contributions on PM
Results Base Cases
PM10 Jan 2010 - Domains D02, D03 a&b
Results Base Cases
PM10 Domains D03a&b

D03b January 2010
PM10 Mean:

- PM10 [µg/m³]
  - < 10
  - 10 - 15
  - 15 - 20
  - 20 - 30
  - 30 - 40
  - 40 - 50
  - > 50

GRAL Domain

0 20 Km

PMinter

Naložba v vašo prihodnost
Operacijo delno financira Evropska unija
Evropski sklad za regionalni razvoj

Investition in Ihre Zukunft
Operation teilfinanziert von der Europäischen Union
Europäischer Fonds für regionale Entwicklung

Slovenia
Evropska
Evropische
EU
AT

EVROPSKE
TERITORIJNE
SODELOVANJE
ZUSAMENARBA
Results Base Case WRFchem & GRAL-Sys
MB PM10 Jan 2010
Results Base Case WRFchem & GRAL-Sys
LB PM10 Jan 2010
Results Base Case WRFchem & GRAL-Sys Klgf PM10 Jan 2010
Simulation PM10 Jan 2010 versus Observations Jan/Dez 2010 & Jan 2011

R² = 0.94
Assessment Main simulated PM10 Components vs. Measurements (TUW/Aerosol) V-M Klglf

Simulated Jan Mean 2010

K VM (WRF+GRAL, base case)

- not spec
- traffic exh
- dom heat
- NaCl
- sec inorg

Mean 31 days Jan/Feb 2011

K VM (TUW, base case)

- traffic exh
- non ident PM
- rest OM
- mineral dust
- de-ice salt
- wood smoke

PMinter
Comparison main simulated PM10 Components vs. measurements (TUW/Aerosol)
Regional/Transport or Local in Origin? Important for Measures/AQMP
Conclusions Base Cases & Implications on Scenarios

• Good representation of PM mass & comp. by combined modelling approach possible

• Reduction secondary PM (conc.) \(\rightarrow\) Acting on Regional level

• Reduction carbonaceous PM (domestic heating/traffic exhaust) \(\rightarrow\) Acting on Local level

• 3 regional scenarios & impact on secondary PM

• 2 local scenarios & impact on primary PM
Scenario Speed-Limit A2/A9 Styria – 2nd reduction effect by Secondary Formed PM?

80 km/h – to achieve high NOx reduction

- 700 t/a NOx
- 125000 t/a CO2
- 21 t/a PM10 exh
Scenario 35% Reduction NH3 Agricultural Emissions (area wide Styria, Carinthia, SLO)
Scenario 35% Reduction NOx traffic Emissions (area wide Styria, Carinthia, SLO)
Scenarios MB Environmental Zone

- Scenario development & traffic modelling for entire MB municipality carried out by Marko Celan & Branka Trcek Uni MB
Results Scenarios extended environmental zone PM10 AMV MB

Scenario 1, 2014:
restrictions for vehicles Euro 0, 1, 2 engine
+15% public transport MB munic.

Scenario 2, 2016:
restrictions Euro 0, 1, 2; parking restrictions, more pedestrian zones
30% increased public transport MB munic. & outside; P+R @ periphery
Scenario Replacement Individual Heating Facilities by Biomass District Heating Klagenfurt

- Additional 95 MW biomass district heating plant
- Additional 175 GWh district heating available
- Replacement of individual burners/stoves for light fuel oil and solid fuels
Scenario Replacement individual heating facilities by biomass district heating Klagenfurt
Summary & Conclusions

Model Approach

- Detailed PMinter emission data base established
- New holistic modelling approach developed
  - generally good agreement in PM10
  - realistic representation of chemical composition
- Combination regional & micro scale modelling allows:
  - replacement of the “unspecified PM background”
  - better specification of PM components $\rightarrow$ specified health & environmental assessment
  - evaluation of measures/AQMP on regional & local level
PM dominated in most areas by locally produced “wood smoke” PM (mainly carbonaceous & UFP)
• PM dominated regionally by secondary inorganic aerosols
• Domestic heating „piece“ previously too small (K)
• Traffic exhaust & Non-exhaust (road & tire wear, resuspension) PM only at main arterial roads a significant source
• Even at Klglf V-M (Völkermarkter Straße) traffic exhaust (carbonaceous & UFP) significantly smaller than domestic heating contributions
Summary Scenarios

• Speed Limit Styria: minor impact on PM10 exhaust, no impact secondary PM, impact on NO2 (- 0.9 – -2 µg/m³)
• -35% agric. E-NH3 regional: area wide significant reductions -2 - -3 µg/m³ up to -4 µg/m³
• -35% traffic E-NOx regional: area wide minor reductions ~-0.1 µg/m³, significant area wide NO2 reductions -8 µg/m³
• Env. Zone MB Scenario 1, 2014 close to roads significant PM reductions (< -1.2 µg/m³ AMV), NO2 significantly reduced; Env. Zone MB Scenario 2, 2016 significant reductions within the env. zone and main arterial roads, major NO2 reductions
• biomass district heating Klgf: reductions -2.5 µg/m³ inner City
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