Selected recommendations on the regional scale

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TNO | Knowledge for business

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I) Introduction

Main objectives of AQ assessment on the regional scale:

- Spatial assessment for the EU-Directives
- Assessment of source contributions

AQ-assessment on the regional scale as such

AQ-assessment especially for Regional Background to the urban scale

Focus on PM 10, (PM 2.5), NO_2, O_3, health related, so no focus on acidification/eutrophication

Focus on combining monitoring and modelling as innovative solutions

II) Monitoring on the regional scale

EMEP monitoring network, with regional (remote) stations, for air and precipitation chemistry, and ozone

New EMEP monitoring strategy, extension to $PM_{10, 2.5}$, NO_x, EC, OC

EEA-Airbase, with also rural and regional stations

Recommendations

- AQ monitoring should comply with EMEP practices

- Use of EMEP and Airbase stations, with assessment of the data quality and spatial representativeness
  (regional station > 1000 km^2)

Sampling and monitoring of PM has still problems

It is necessary to assess the performance of the monitor used, realising that even the reference method has artefact problems

Using regional stations to determine the regional background to cities requires careful selection and analysis of the siting of the station, and the up-wind / down-wind characterisation

Stations can not be used for scenarios, 2010/2020

III) Emissions on the regional scale

Top down emission inventories: CORINAIR/EMEP per administrative unit

Bottom up emission inventories: source oriented, activities and emission factors

Exclusive bottom-up: lack of available input data

Exclusive top-down: insufficient level of accuracy

Recommendations

Intelligent combination of top-down and bottom-up

Systematic documentation, including uncertainty assessment

Independent review by external experts

If possible: validation by inverse modelling

Attention for biogenic and natural emissions

IV) Modelling on the regional scale

Modelling “needed” to make AQ-maps, overall coverage and consistency

Modelling needed to assess source contributions and impact of scenarios, 2010/2020

Recommendations

The models to be used should be:

- As model type: 3-D Eulerain grid models
- Horizontal grid resolution of 50 x 50 km^2 or less
- Operational: able to perform hour-by-hour calculations over a year or more in relatively short time
- Model description + validation should be available

Current operational 3-D models have a good model performance for O_3, but (much) worse for NO_2 and PM_{10}

See the following overview:

Model performance for 1999 for Daymax O_3

Model	Bias, %	Cor
EMEP	-1.1	0.76
LOTOS/EUROS	-0.6	0.74
RCG	+4.9	0.74
DEHM	-13.8	0.78
CHIMERE	+5.6	0.83
MATCH	+6.2	0.80
TM5	-7.7	0.71
Ensemble		0.84

Model performance for 1999 for NO_2

Model	Bias, %	Cor
EMEP	-39	0.45
LOTOS/EUROS	-20	0.41
RCG	-20	0.42
DEHM	-36	0.46
CHIMERE	+2.4	0.44
MATCH	-46	0.44
TM5	-37	0.45
Ensemble		0.53

Model performance for 1999 for PM_{10}

Model	Bias, %	Cor
EMEP	-45	0.52
LOTOS/EUROS	-50	0.45
RCG	-30	0.57
DEHM	-50	0.55
CHIMERE	-37	0.55
MATCH	-40	0.44
TM5	-19	0.54
Ensemble		0.61

Recommendation concerning the use of modelled O_3-concentrations

- Any operational model would do, both on the Regional scale and as BC for the urban scale
- A better approach: Ensemble modelling

Conclusion:

Ensemble approach improves model-performance, takes care of uncertainty and non-linear effects, avoids the choice for the best model

See also EURODELTA

Useful for O_3, also improvements for NO_2 and PM_{10}

But: Still not great for NO_2 and PM_{10}

Possible reasons for the moderate performance for NO_2

- Too coarse horizontal grid, performance is better for urban scale models, see City-Delta
- Problematic description of vertical exchange in the models, especially during nighttime
- Monitoring problems at low concentrations

Possible reasons for the moderate performance for PM_{10}

- Missing emission sources: wind blown dust and resuspension (Recent Chimere analysis)
- Agricultural emissions from ploughing etc. (Recent Zalf analysis)
- Problematic description of Biogenic and Anthropogenic SOA (large variations between models)
- Episodic underestimation of Sulfate/Nitrate/Ammonia (Recent Melpitz analysis)

V) Combining monitoring and modelling on the regional scale

Combining goes from Statistical methods, Kriging, Optimal Interpolation to Ensemble Kalman Filter / Sequential Importance Re-sampling / Adjoint methods

a) Some Examples on the regional scale

O_3:

Kalman Filtering with LOTOS/EUROS

Adjoint methods with EURAD

NO_2:

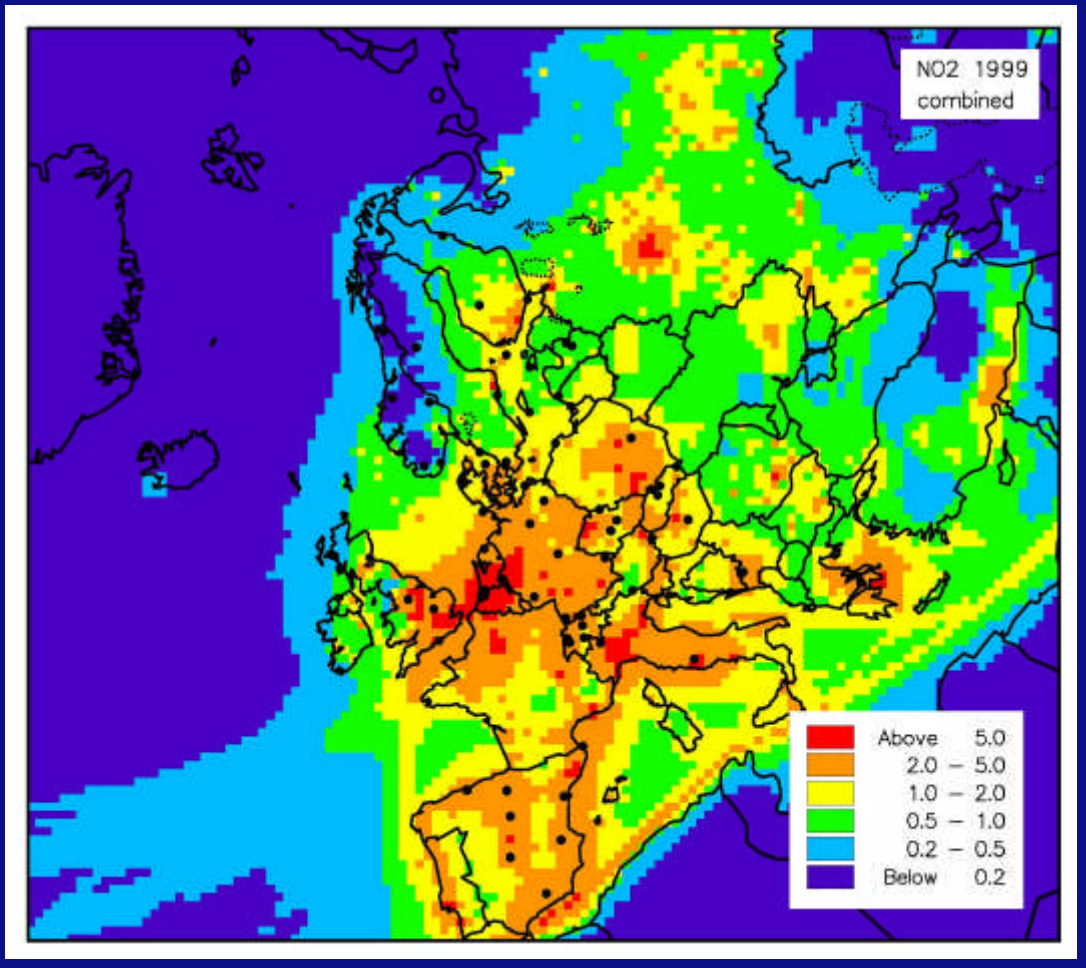
Spatial interpolation with EMEP

Aerosol Optical Depth-AOD from satellite data

Optimal interpolation with MATCH

Optimal interpolation with TM5

Kalman Filtering with LOTOS



Example of combined field for NO_2.
Yearly average concentration field from 1999

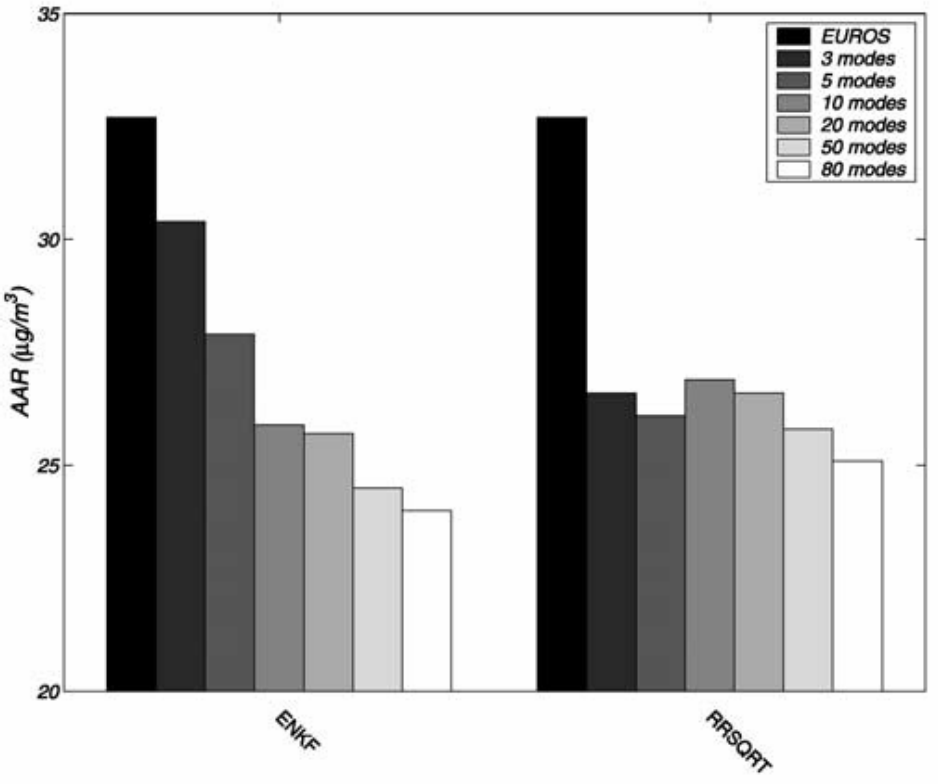


Figure 5. Comparison of the performance of the ENKF algorithm and the RRSQRT algorithms using different numbers of modes/ensembles. The AARs ($\mu g\ m^{-3}$) are averaged over all the validation stations in Europe. Noise was applied to all five parameters.

b) Some examples as regional background for city models, especially for NO_2 and PM

CHIMERE for Paris: “Kriging”, see this afternoon

RCG for Berlin: Correction method especially for the Delta’s, see this afternoon

VI) Recommendations / Remarks for combining monitoring and modelling for regional background

Avoid using only observations, or only modelling

For O_3 models can be used for regional background:

Ensemble has better performance than any single model

Data-assimilation would further improve the fields, but is not operational yet

For NO_2 and PM_{10} models cannot directly be used for regional background

Ensemble gives improvement, but not enough

(Possibility:better performance using $O_x = NO_2 + O_3$)

For O_3, and NO_2, PM_{10} full data-assimilation is not operational yet, something for the near (< 5 years) future

Kriging and similar methods should / can be used already now

Some additional remarks

Regional background should come from the same model structure as the urban model to avoid inconsistencies

Modelled Regional background should be taken from a large area around the city, like 300 x 300 km^2, see City-Delta

Practical problem: Availability of consistent modelled regional background concentrations