From Europe to North-Rhine-Westphalia

Long-term Calculations of air pollutants with the EURAD model

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PM, Berlin, Nov 05, 2002, EURAD

Outline

- Introduction and Motivation
- Model description
- Model results
- Comparison with observations
- Summary, conclusions and outlook

MODEL OUTPUT

Focus on air pollutants relevant for EU-DD

Near surface layer:
PM_{10}, SO_2, NO_2, CO, NO_x, O_3

More available from 3D-CTM:
VOCs, NH_3, particle size and composition
Deposition

Motivation - CTM

- Filling the gaps between measurements
- emission scenarios
- Forecast of air pollution
- Investigation of processes
- Analysis of measurements

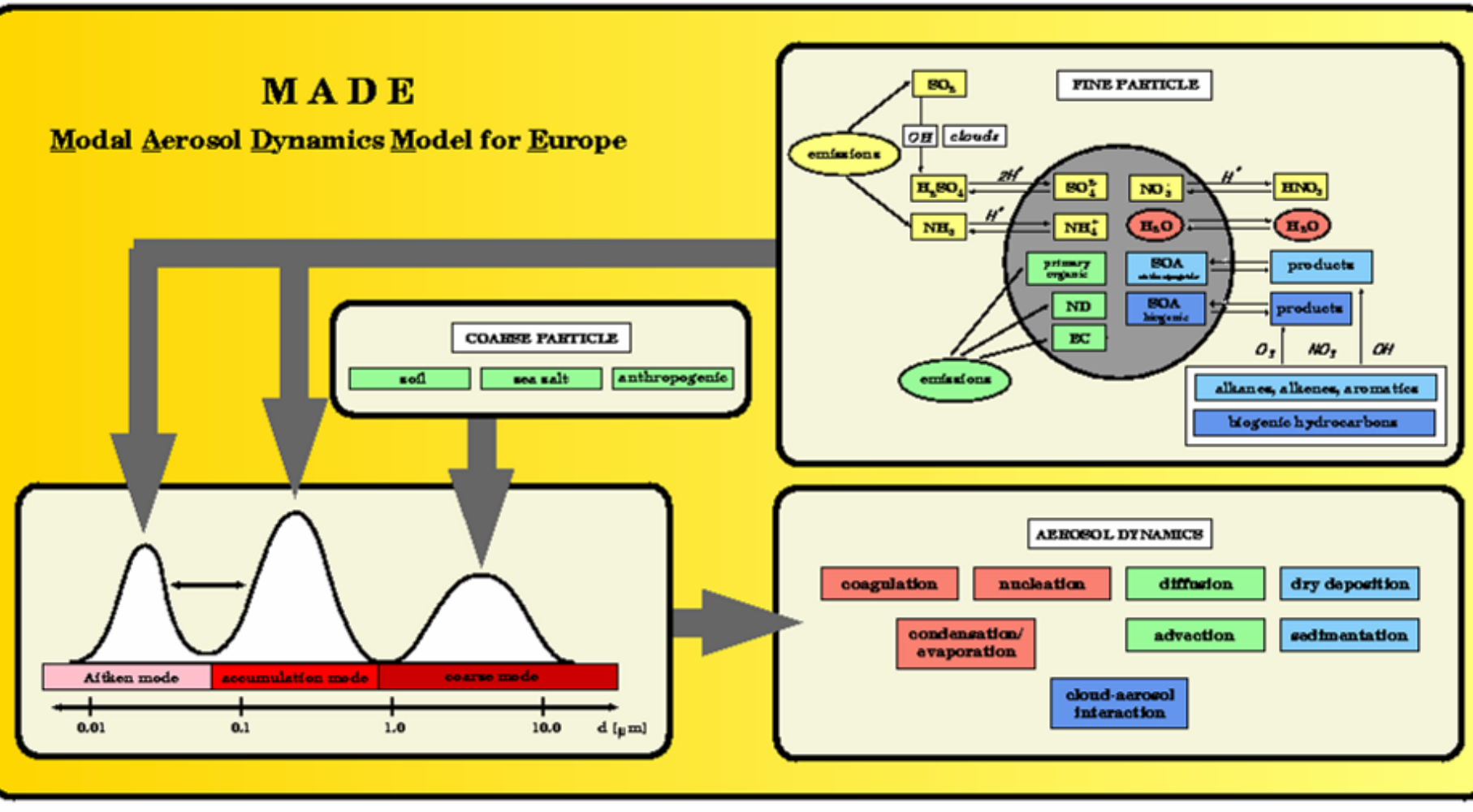
EURAD-SYSTEM

- Meteorology: MM5, input from ECMWF or NCEP
- Emissions: EEM, input from available emission data (e.g. TNO, EMEP, local)
- Chemistry: EURAD-CTM, MADE, Cloud chem. (aq.), RACM or RADM2
- Nesting option for local application

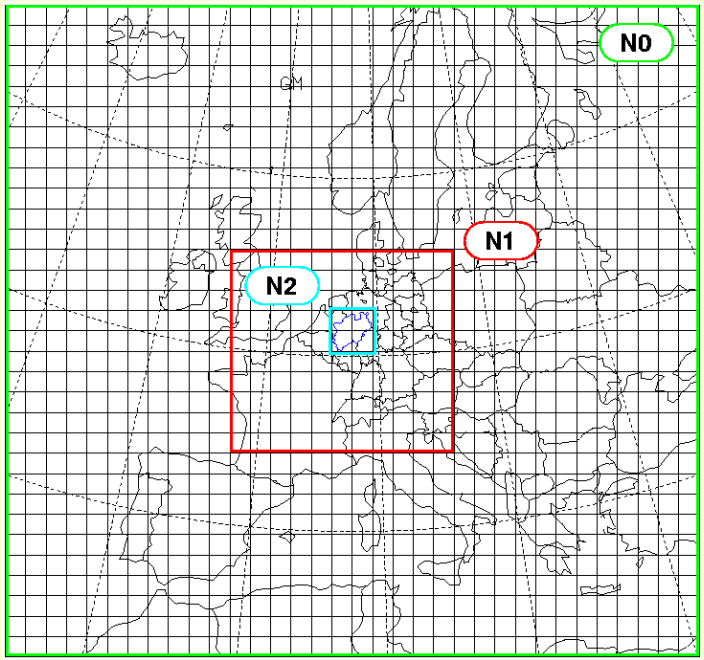
MODEL DESIGN

- Focus on NRW
- horizontal grid resolution (km): 125 - 25 – 5 – 1
- 23 layers, lowest layer about 40 m
- 15 layers
- Upper boundary about 16 km
- Annual run for 1997: 125 – 25 – 5 km

MADE

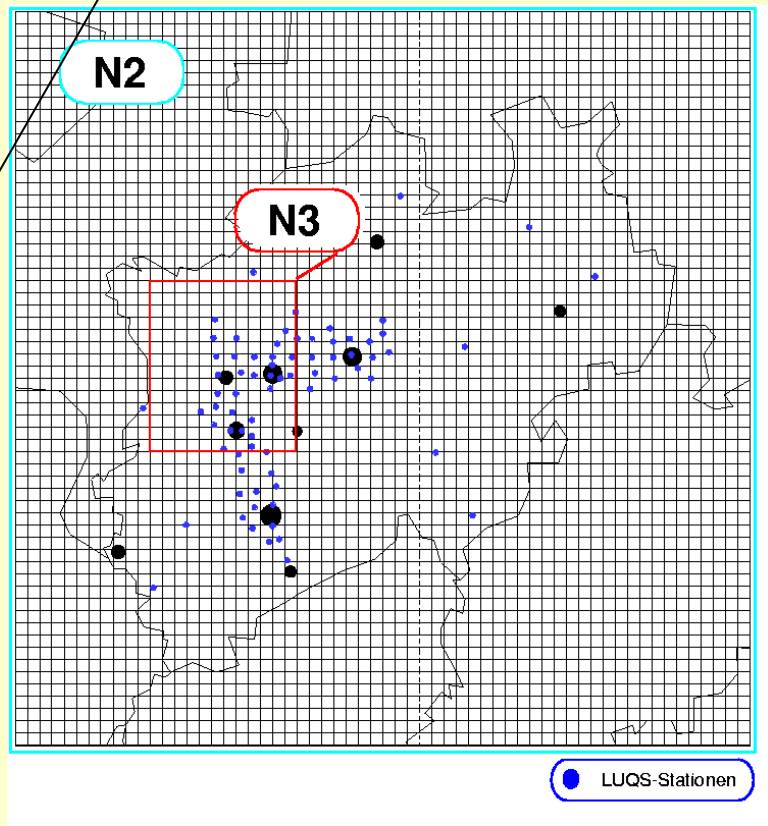

MADE
Modal Aerosol Dynamics Model for Europe
COARSE PARTICLE
soil
sea salt
anthropogenic
Aitken mode
accumulation mode
coarse mode
0.01
0.1
1.0
10.0
d [µm]
FINE PARTICLE
emissions
OH
clouds
primary organic
ND
EC
SOA
products
alkanes, alkenes, aromatics
biogenic hydrocarbons
AEROSOL DYNAMICS
coagulation
nucleation
diffusion
dry deposition
condensation/ evaporation
advection
sedimentation
cloud-aerosol interaction

MODEL DOMAINS

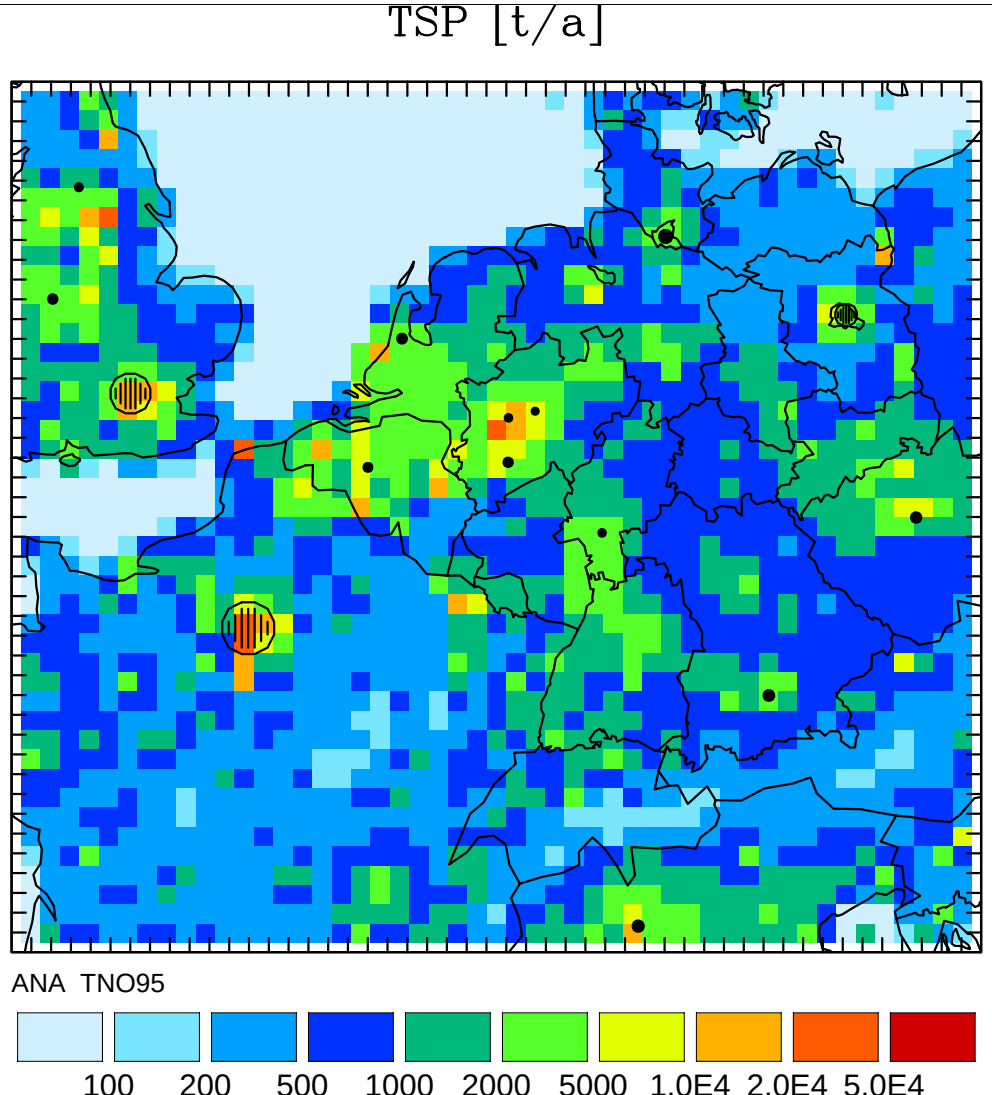


REGIONAL - EUROPE

LOCAL - URBAN



TSP-Emissions (TNO 1995)

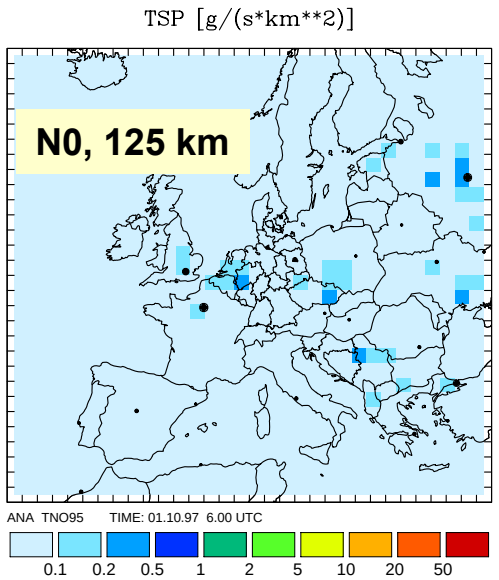


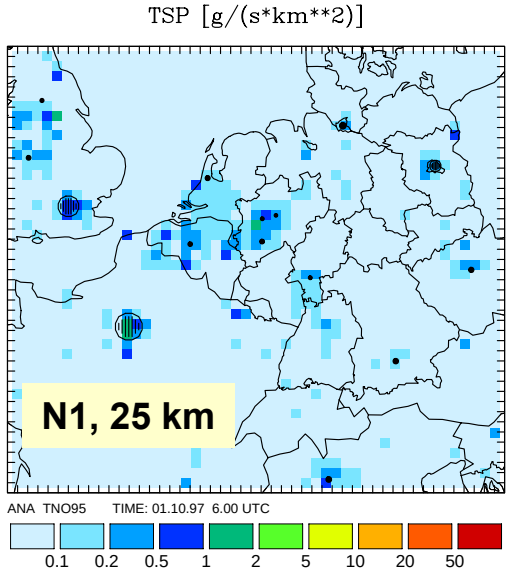
TSP-EMISSIONS - NESTING

EMISSIONS FROM

TNO, 1995

N0, N1 DOMAIN

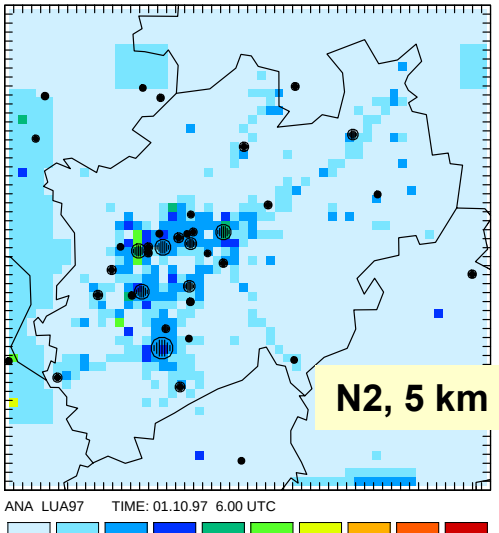


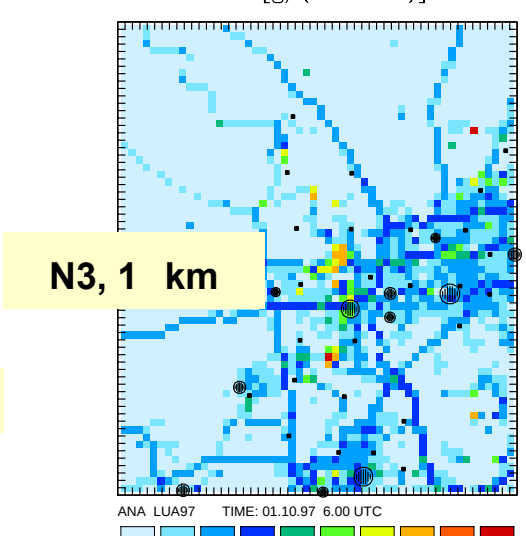


EMISSIONS FROM

LUA-NRW

N1, N2 DOMAIN





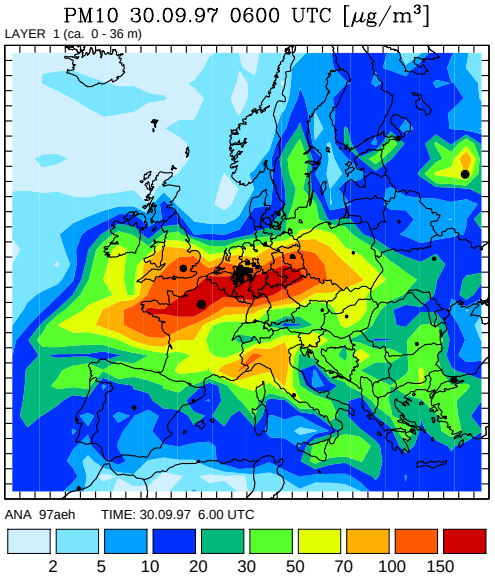
PM10 - NESTING

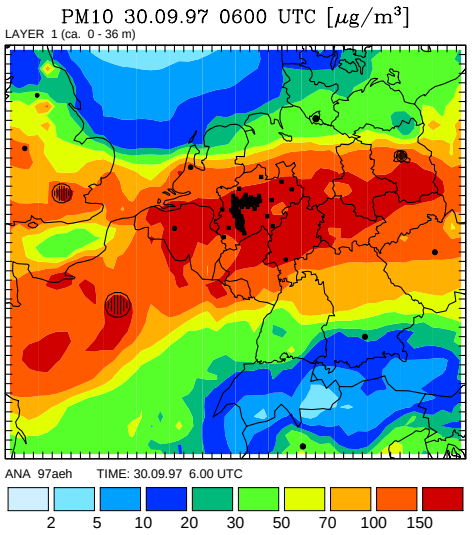
Sept. 30, 06 UTC, 1997

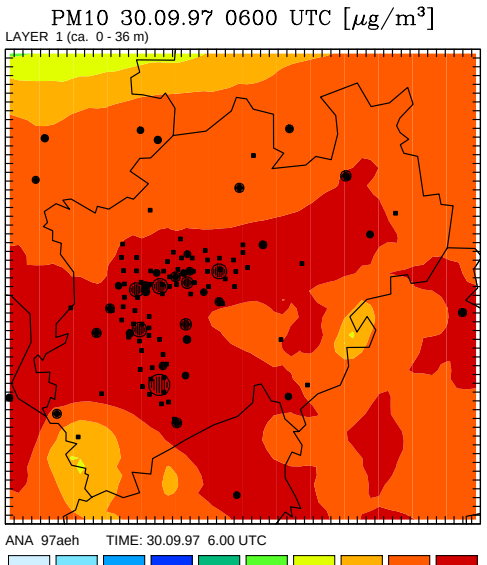
High pressure system over Central Europe

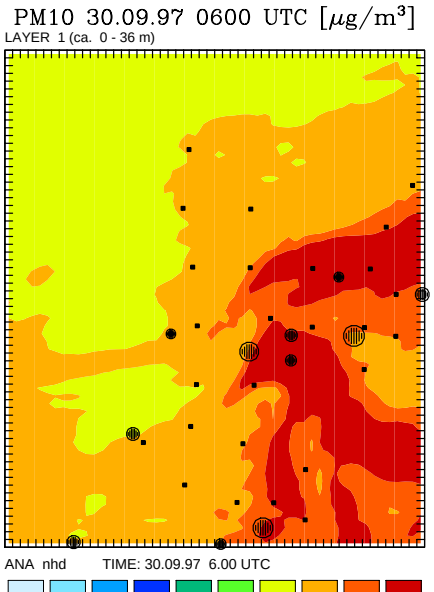
PM10 concentrations exceed 150 µg/m³

Concentrations for all domains



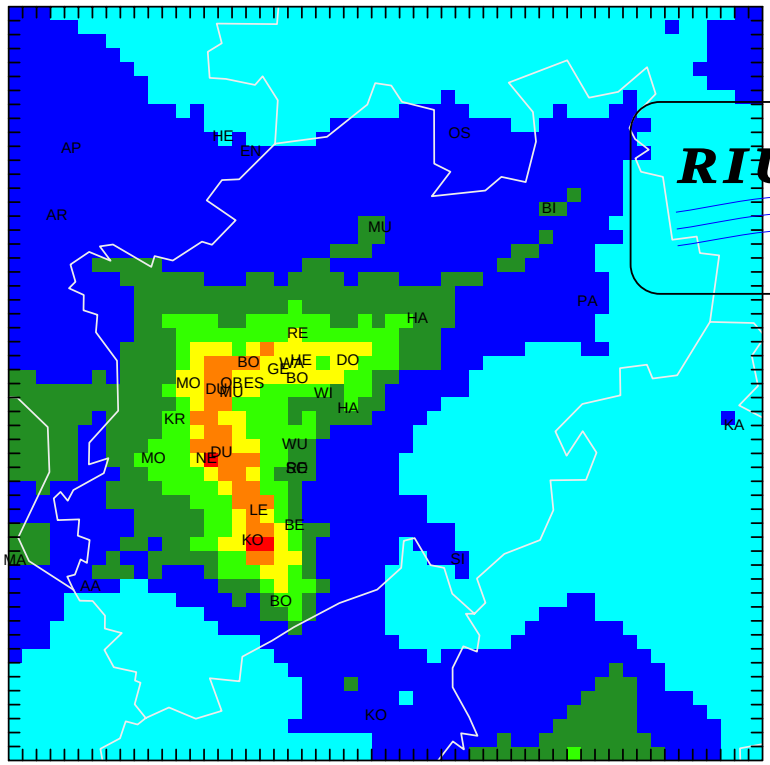


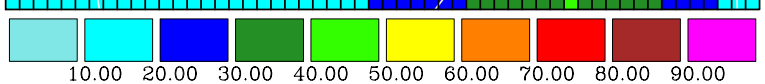




NOx – PM10 – ANNUAL

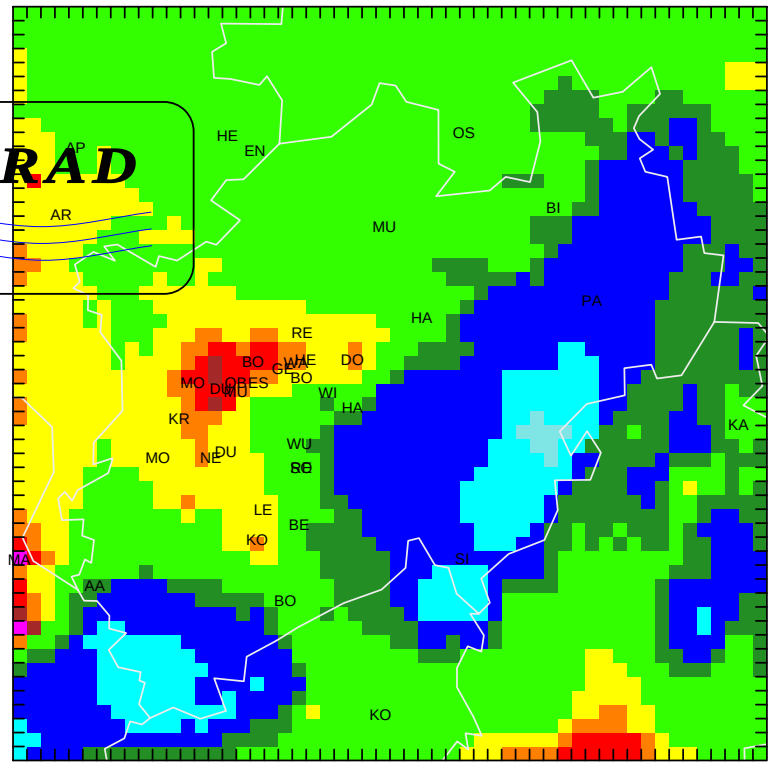
EURAD-CTM
NOx [ug/m**3] -- Jahresmittel 1997

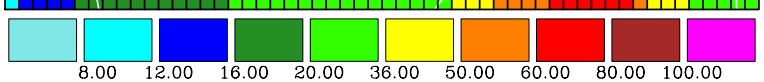




RIU EURAD

EURAD-CTM
PM10 -Anzahl der Tagesmittelwerte ueber 50 ug/m**3

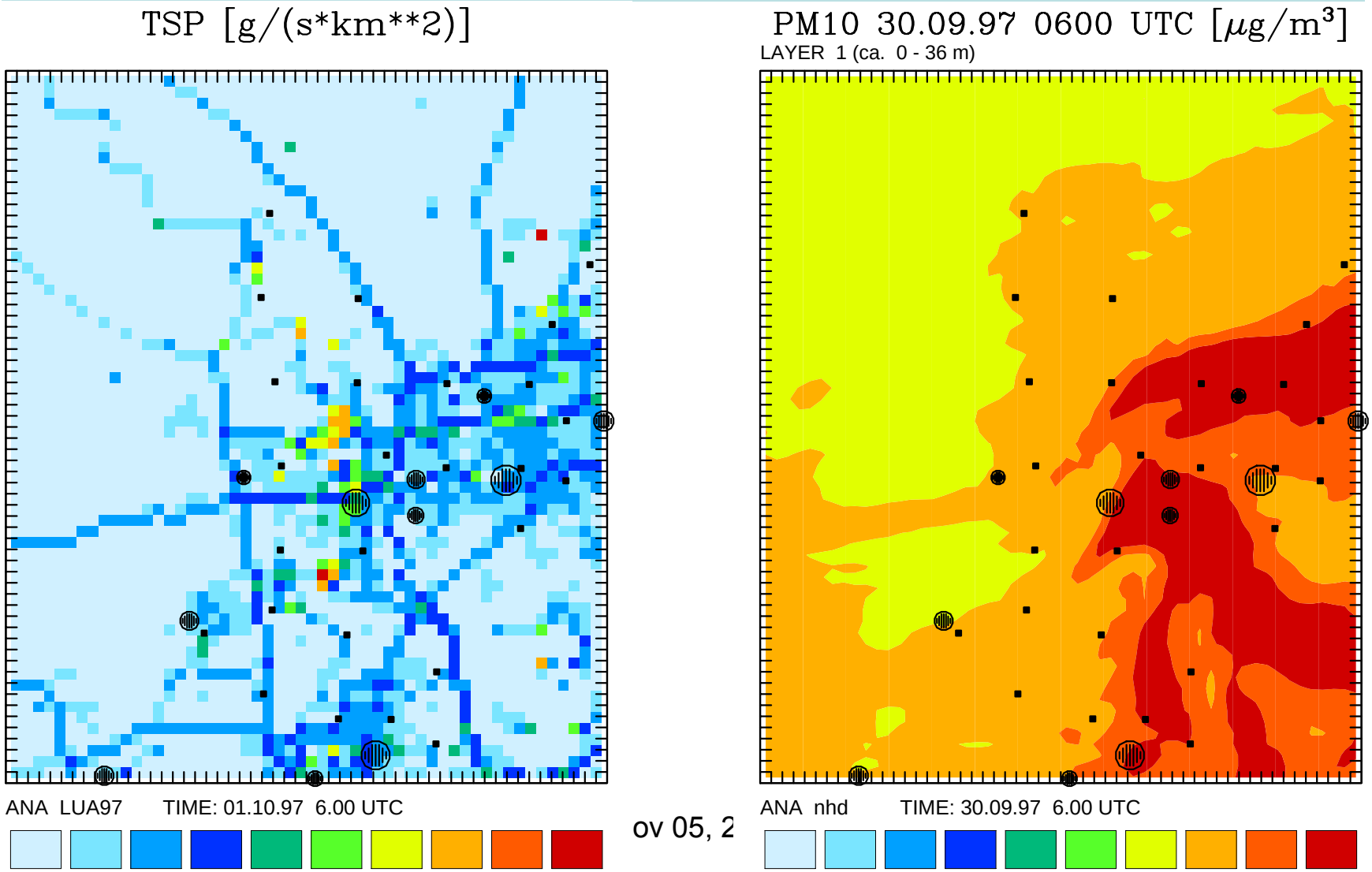




NO_X LIMIT VALUE: 30 µg/m³

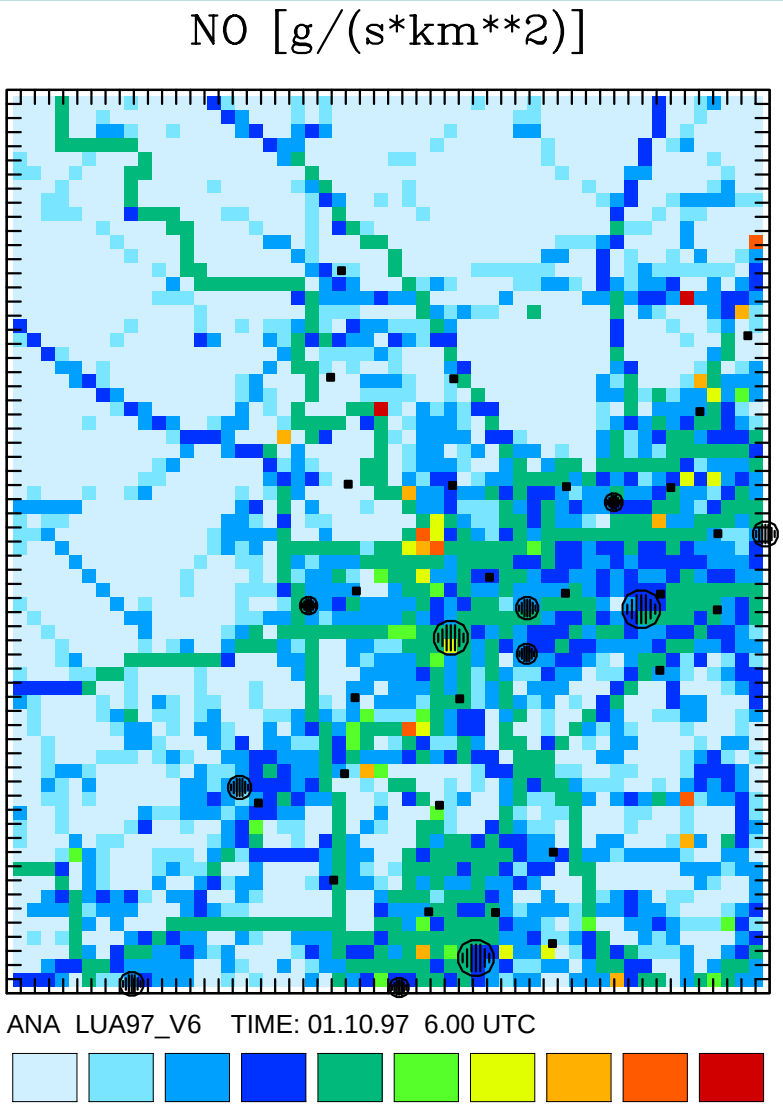
ov NOT MORE THAN 35 EXCEEDANCES

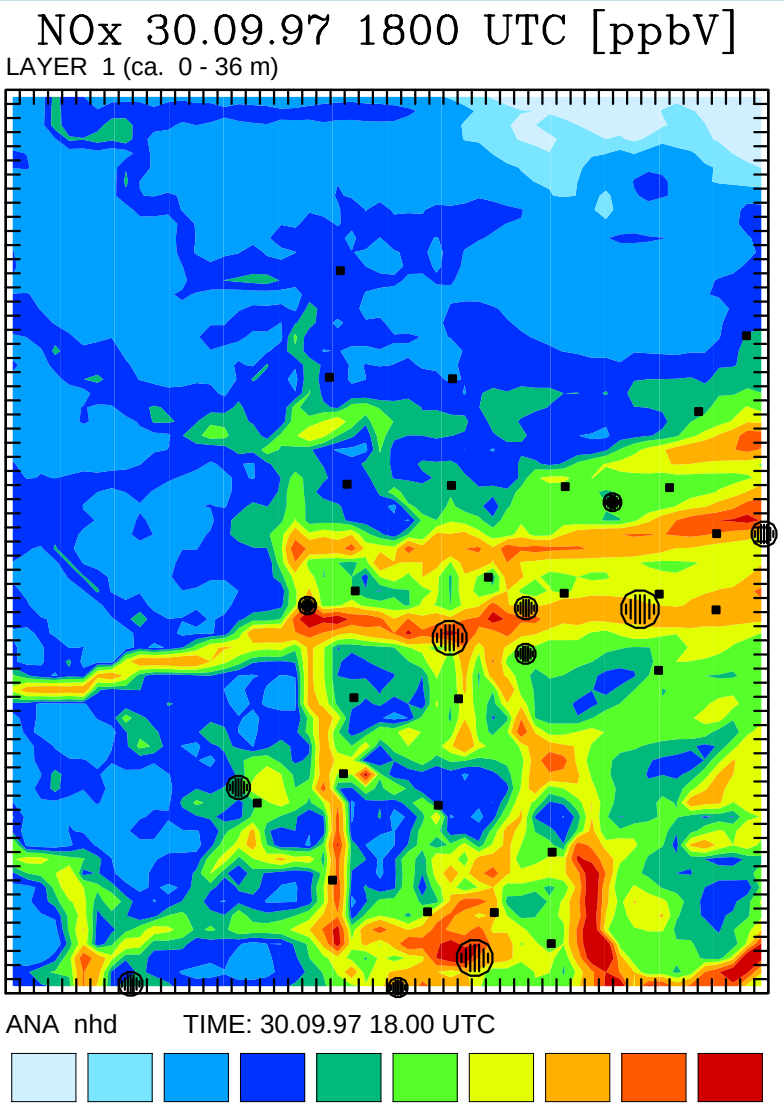
PM10 – N3 (1 km grid size)



ov 05, 2

Nitrogen Oxides – N3 (1 km)

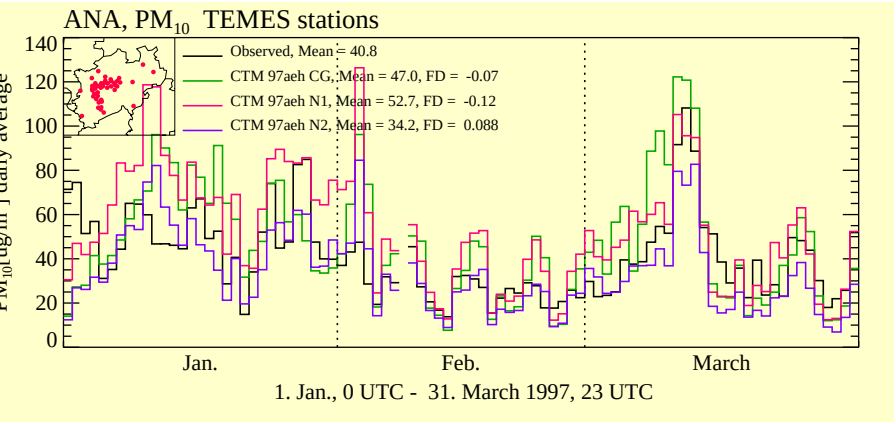


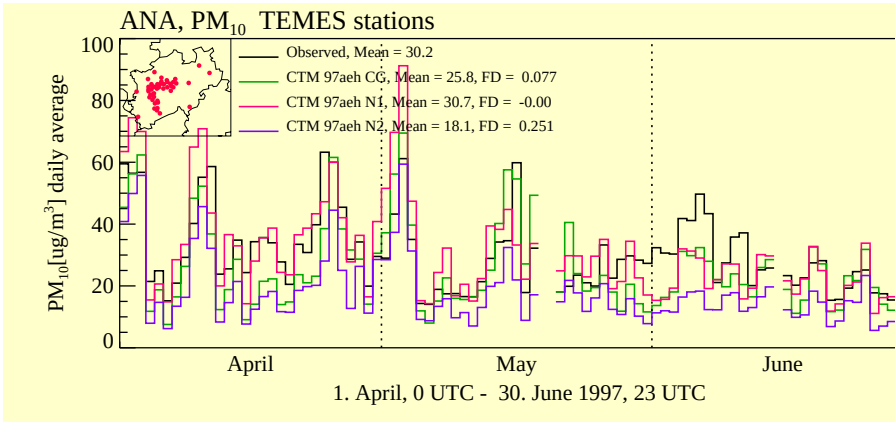


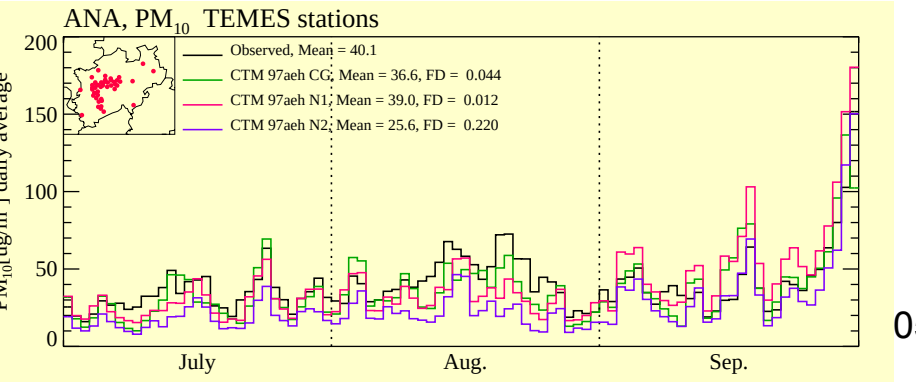
TIME SERIES PM10

DAILY AVERAGES BASED ON HOURLY VALUES FOR DIFFERENT MODEL DOMAINS (GRID RESOLUTION)

COMPARED WITH OBSERVATIONS







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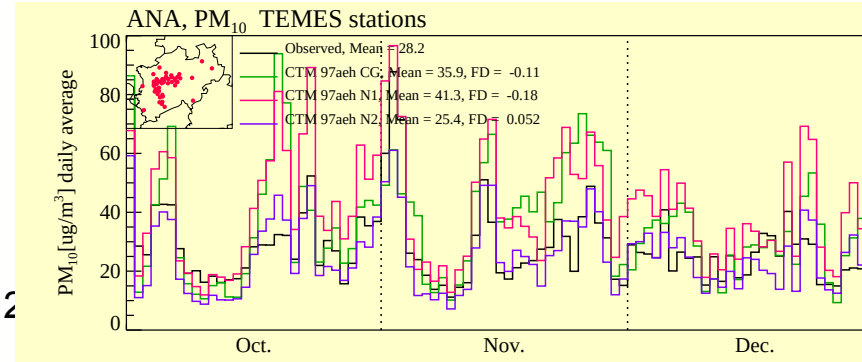


SCATTER DIAGRAMM PM10

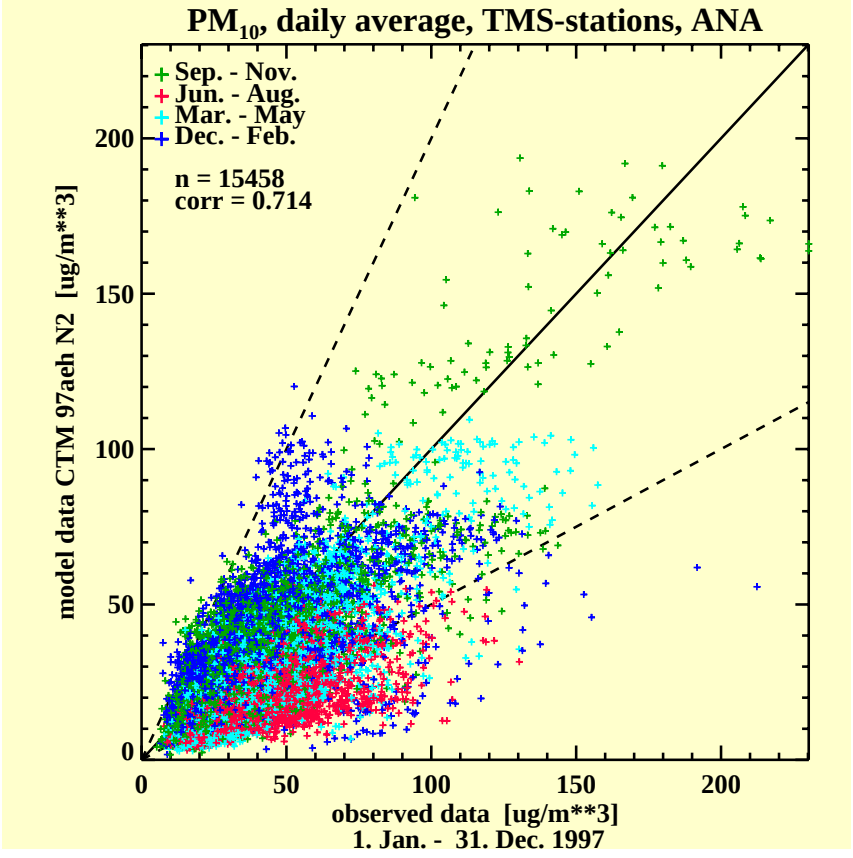
Daily average

Based on hourly values

PM10 from NRW stations only

PM10 = 0.83*TSP

Underestimation in summer



OBS – MODEL: COMPOSITION

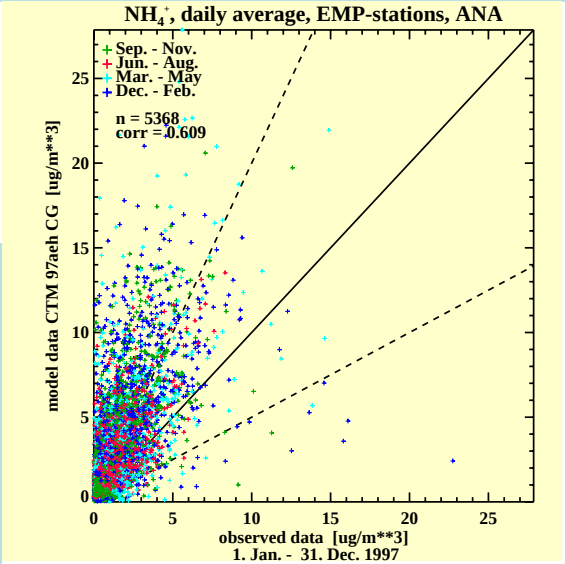
Observation vom EMEP

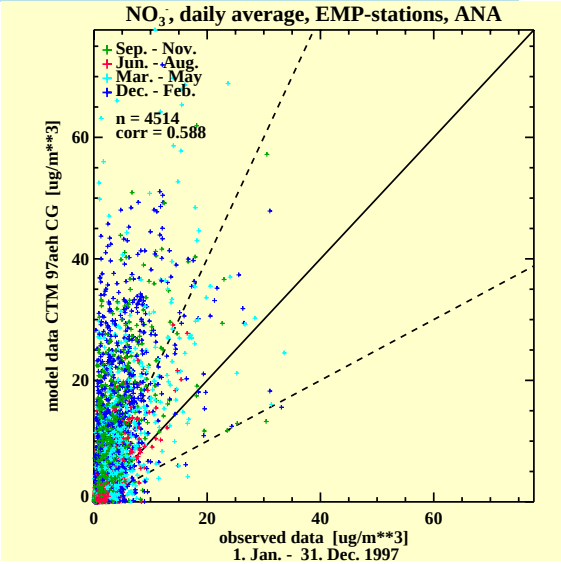
Ammonium

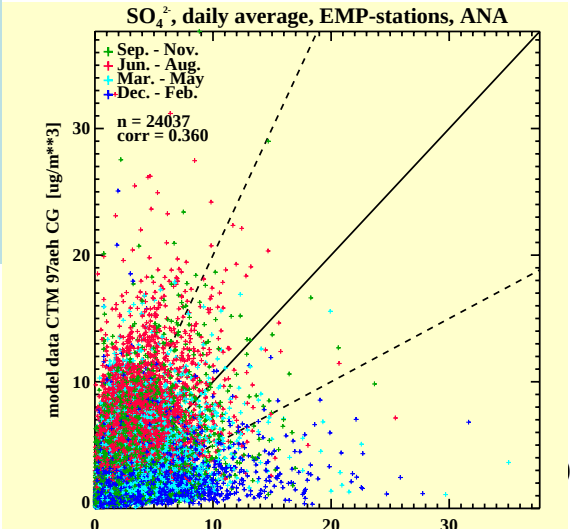
Nitrate

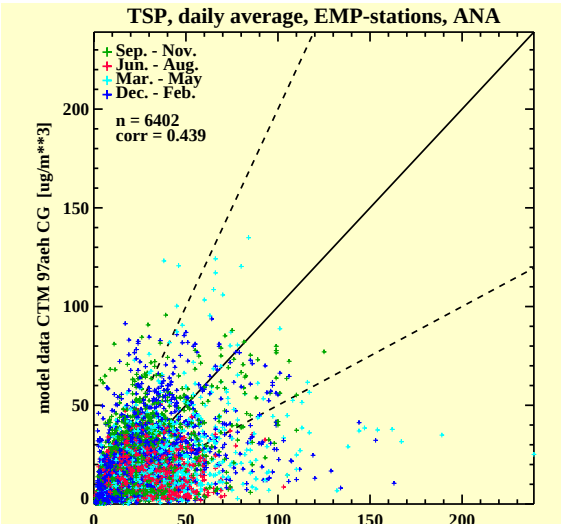
Sulfate

TSP









EMISSION SCENARIO

No anthropogenic emissions NRW

Episodic calculation for N2

Start of scenario: Sept. 27, 00 UTC

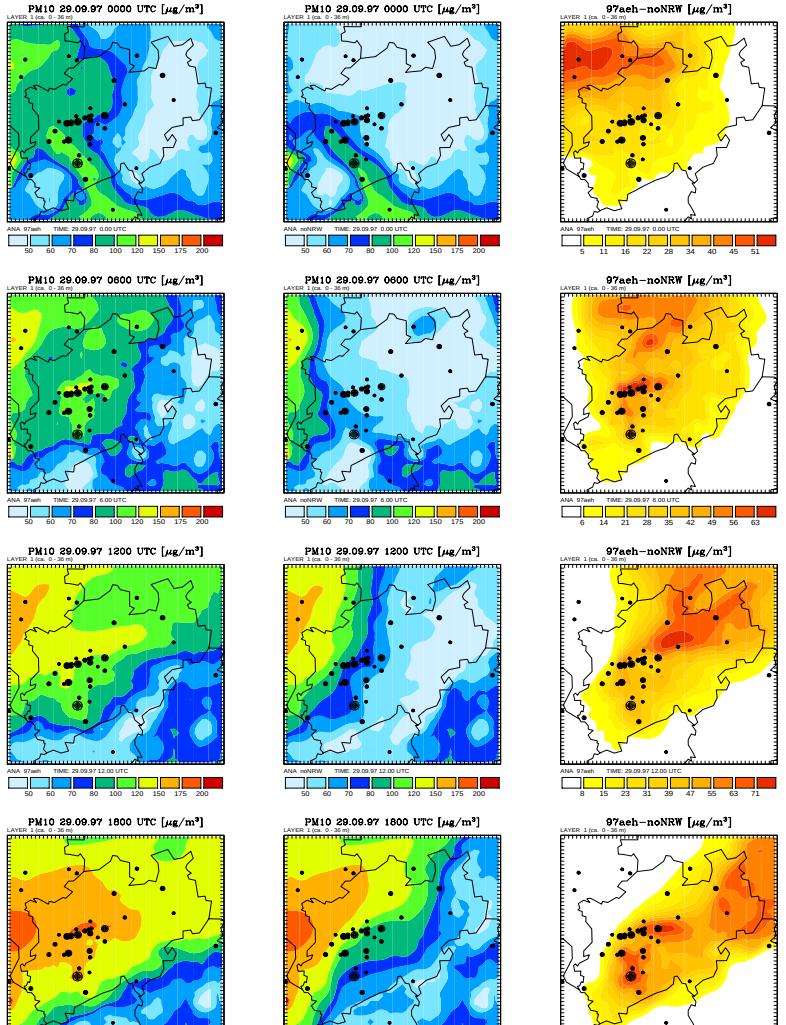
Example shown here for Sept. 29 00, 06, 12, 18 UTC

Left: base case
Middle: no emissions NRW
Right: difference

Wind turns from southeast (00 UTC) Towards southwest (18 UTC)

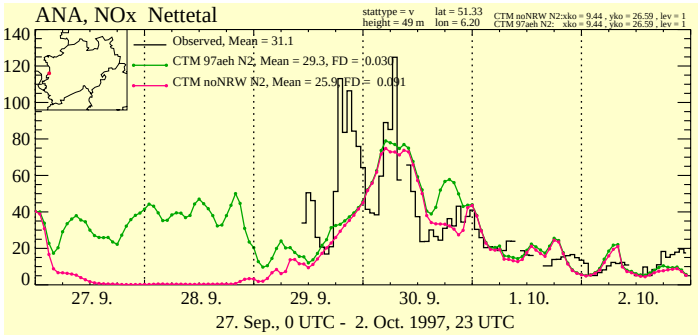
PM10 (N2) 29.09.97

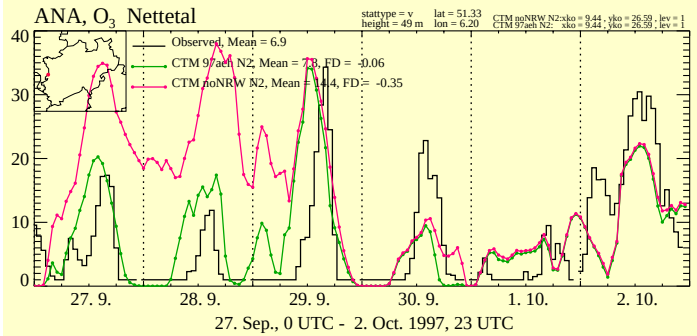
With/without NRW Emissions

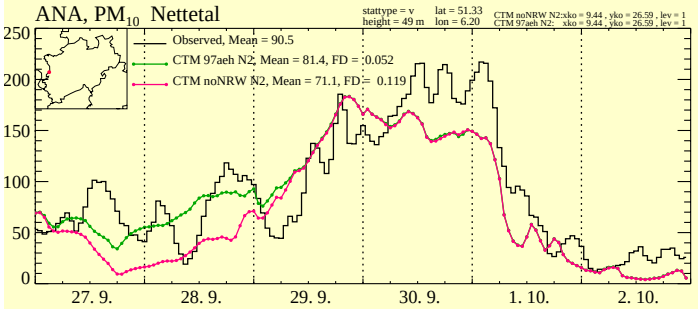


EMISSION SCENARIO

Nettetal





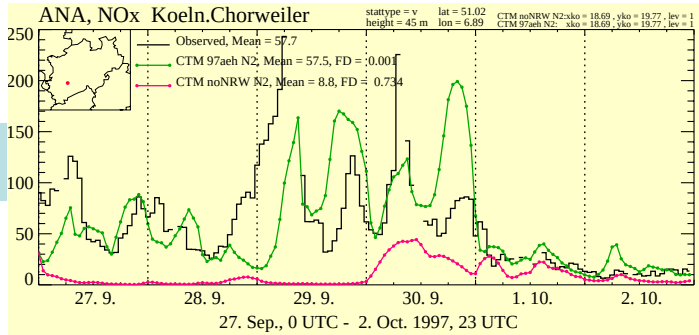


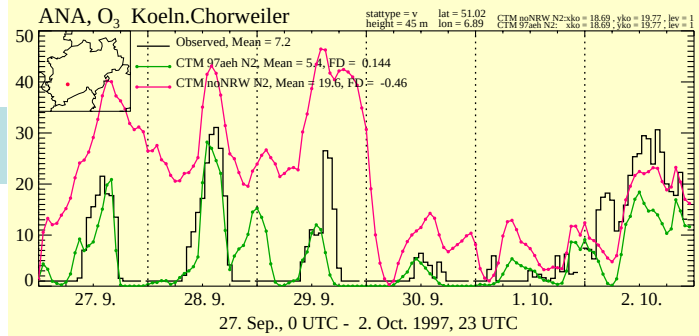
NO_x

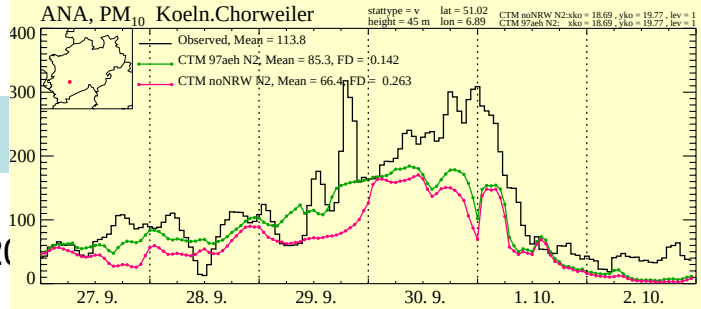
O_3

PM_{10}

Köln-Chorweiler







FORECAST

DAILY FORECAST

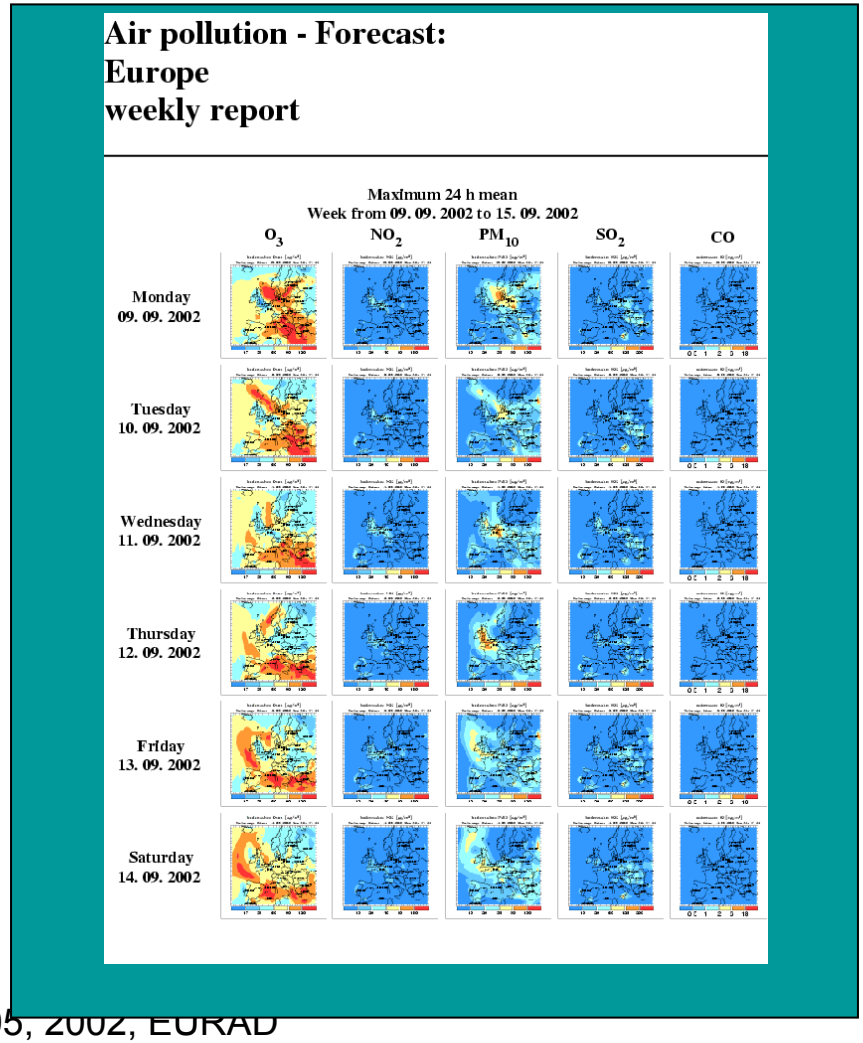
www.eurad.uni-koeln.de

From Europe to NRW

Air quality index

PM_{10}, NO_2, O_3, CO, SO_2

Data bank



SUMMARY AND CONCLUSIONS

- In general good agreement between observation and model simulation for PM10
- But: underestimation in summer
- Problems with incomplete and/or not harmonized emission data
- Single peaks can not be simulated, needs for street canyon modeling to account for „hot spots“
- Long range transport is important for background concentrations
- Composition of particles has not been investigated in detail yet

FUTURE PLANS

- Extension of the modelling system to hemispheric scale to treat the intercontinental transport of pollutants
- Coupling of models with satellite data (4DVar-data assimilation)
- Improvement and harmonization of emission data
- Process-oriented model evaluation, composition, size
- Multiphase chemistry
- Modal → sectional
- Couplimg of clouds and aerosols

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EMEP
TNO
Ford Forschungszentrum Aachen (FFA)
Regionales Rechenzentrum der Universität zu Köln (RRZK/ZAIK))
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European Center for Medium Range Forecast (ECMWF)
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EU