SMHI

UK Air Quality Frorecasting Seminar
Birmingham July 16, 2009

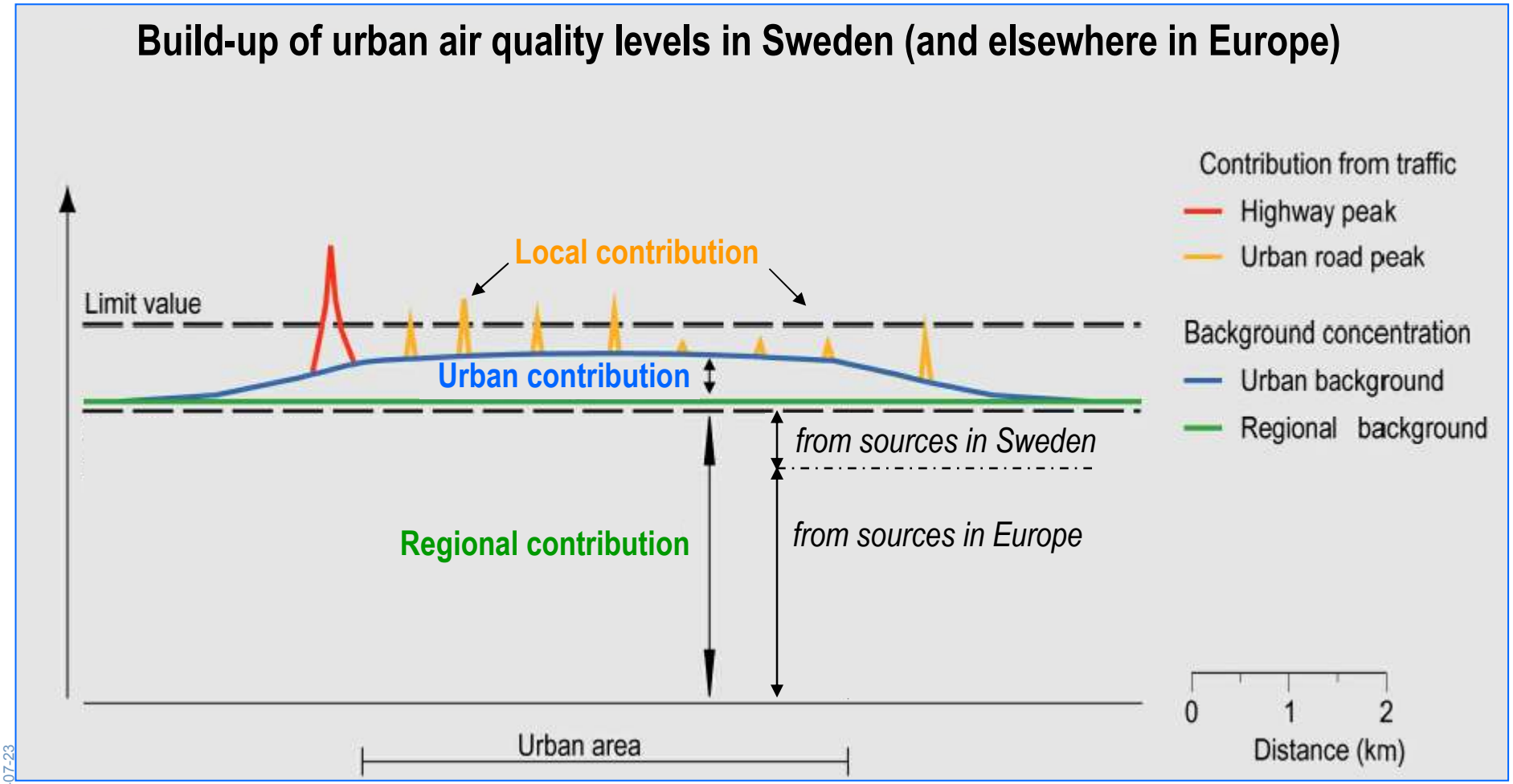
A Swedish concept of coupling air quality forecasts from the European scale down to local scale

OBJECTIVE:
Providing air quality forecasts to susceptible individuals may reduce unnecessary suffering, illness, exacerbations of respiratory diseases and hospital admissions due to air pollution

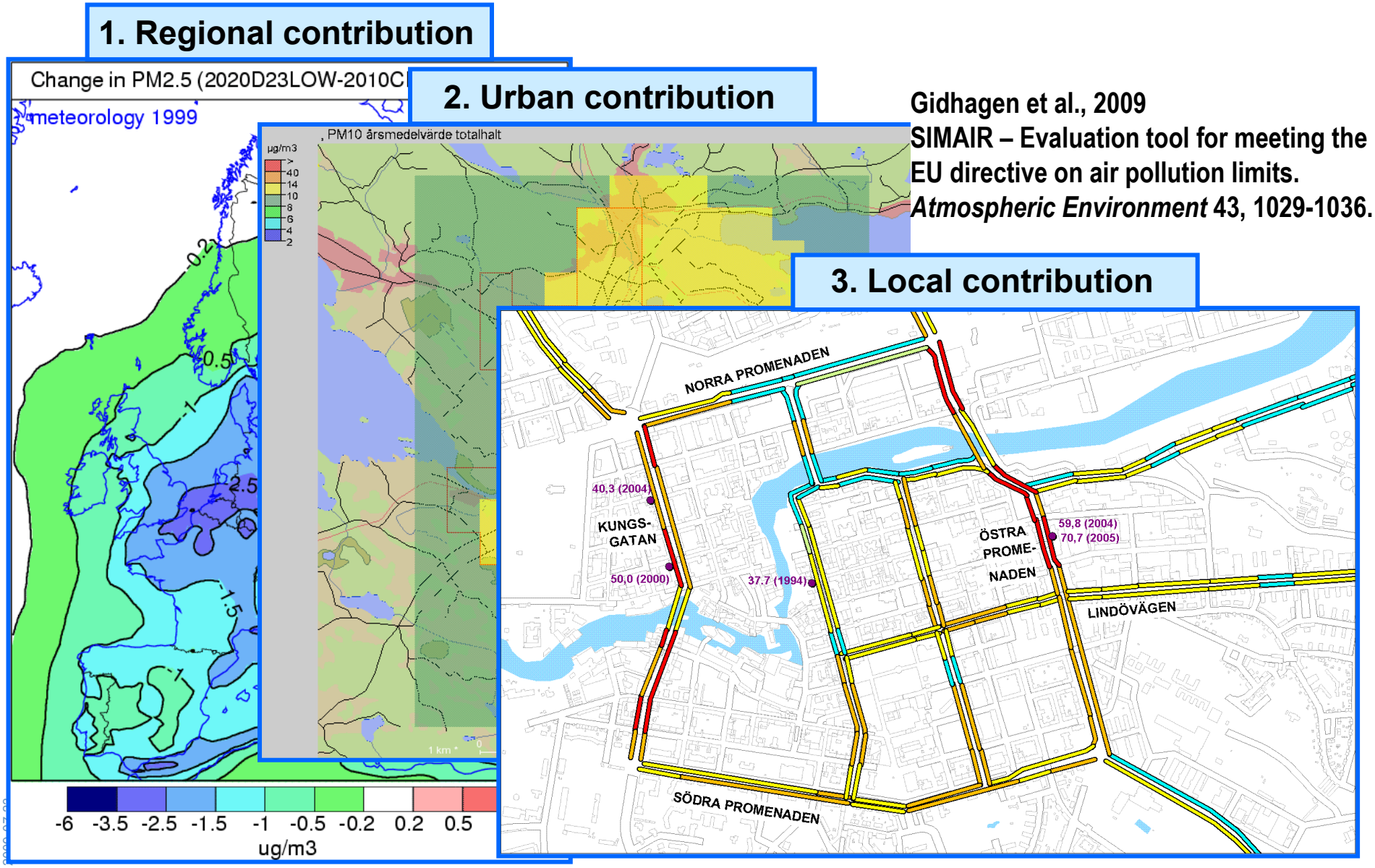
by Lars Gidhagen

Swedish Meteorological and Hydrological Institute

Modelling AQ levels in Europe: coupling of models on different scales



SMHI coupling of the three scales:



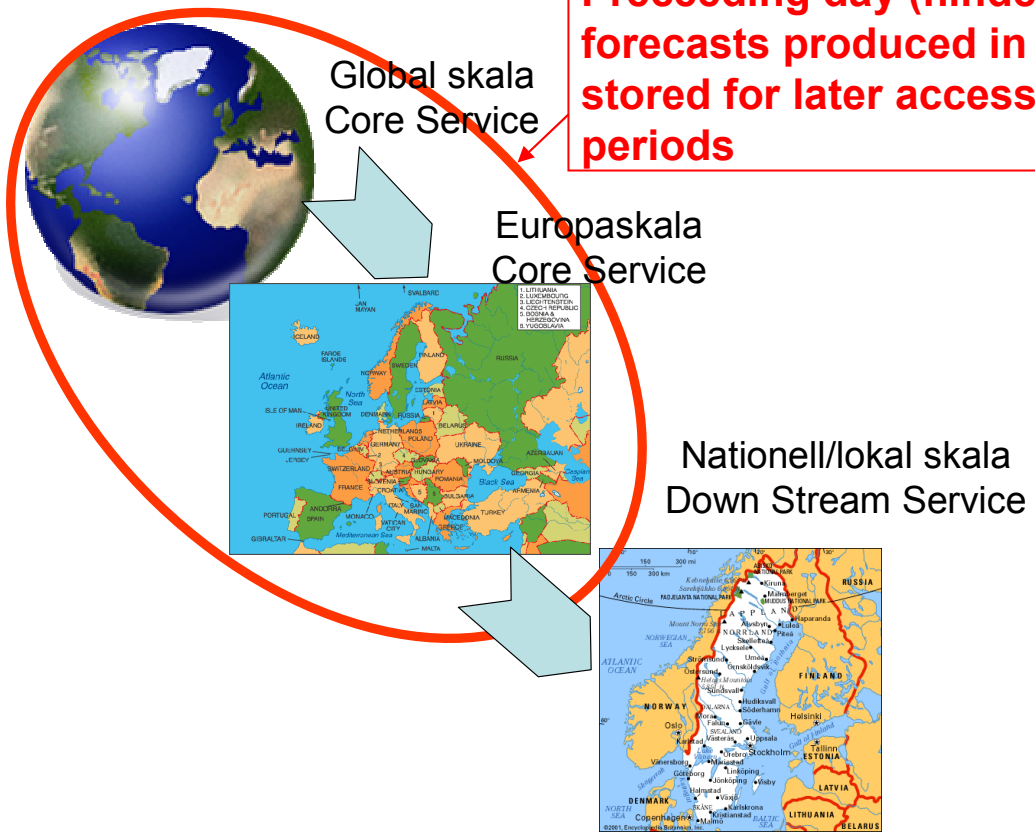
Gidhagen et al., 2009
SIMAIR – Evaluation tool for meeting the EU directive on air pollution limits.
Atmospheric Environment 43, 1029-1036.

The European regional scale background concentrations part of EU core services

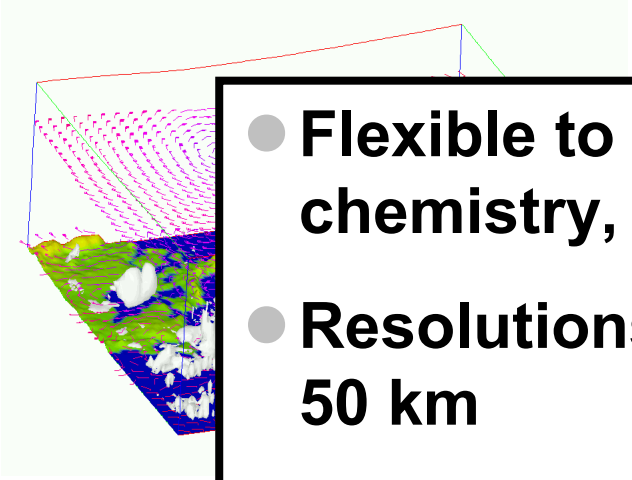
Product: Gridded air pollution data over Europe (all available in Airviro)

”Forecasts” in a wide sense: historical ⇔ scenarios for 2020
(2030-2050 with climate change predictions feasible within the coming years)

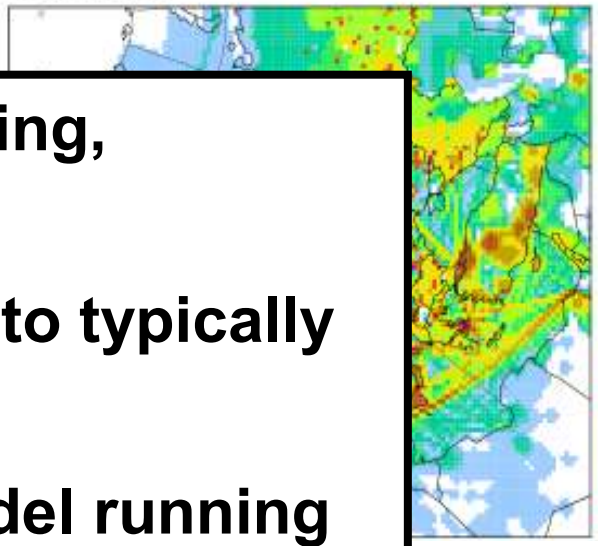
Preceeding day (hindcast) and 2 day forecasts produced in a routine way, stored for later access of historical periods



MATCH offline regional CTM

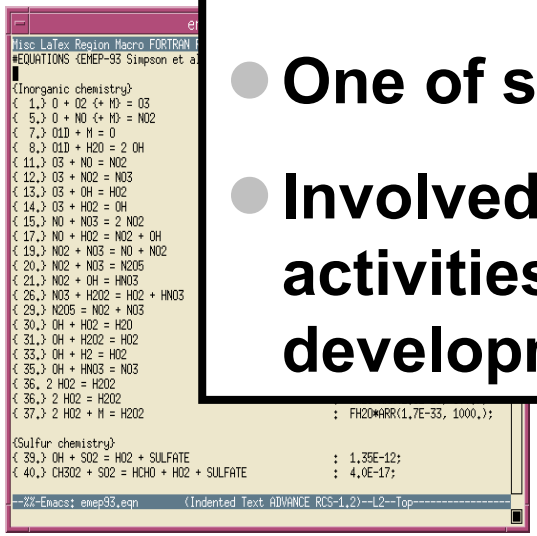


3D meteor
ECMWF, M



MEP-2003

- Flexible to use different met forcing, chemistry, and domains
- Resolutions ranging from 500 m to typically 50 km
- Used in GEMS regional part (model running on ECMWF systems since 2004)
- One of six regional models in MACC
- Involved in EURODELTA and several other activities supporting the evaluation and development of EMEP models



```
Misc LaTex Region Macro FORTRAN
#EQUATIONS {EMEP-93 Simpson et a
{Inorganic chemistry}
{  1.} O + O2 {+ M} = O3
{  5.} O + NO {+ M} = NO2
{  7.} O1D + M = O
{  8.} O1D + H2O = 2 OH
{ 11.} O3 + NO = NO2
{ 12.} O3 + NO2 = NO3
{ 13.} O3 + OH = HO2
{ 14.} O3 + HO2 = OH
{ 15.} NO + NO3 = 2 NO2
{ 17.} NO + HO2 = NO2 + OH
{ 19.} NO2 + NO3 = NO + NO2
{ 20.} NO2 + NO3 = N2O5
{ 21.} NO2 + OH = HNO3
{ 26.} NO3 + H2O2 = HO2 + HNO3
{ 29.} N2O5 = NO2 + NO3
{ 30.} OH + HO2 = H2O
{ 31.} OH + H2O2 = HO2
{ 33.} OH + H2 = HO2
{ 35.} OH + HNO3 = NO3
{ 36. 2 HO2 = H2O2
{ 36.} 2 HO2 = H2O2
{ 37.} 2 HO2 + M = H2O2                    : FH2O*ARR(1.7E-33, 1000.);

{Sulfur chemistry}
{ 39.} OH + SO2 = HO2 + SULFATE            : 1.3E-12;
{ 40.} CH3O2 + SO2 = HCHO + HO2 + SULFATE  : 4.0E-17;

--%%-Emacs: emep93.eqn      (Indented Text ADVANCE RCS-1.2)--L2--Top----------
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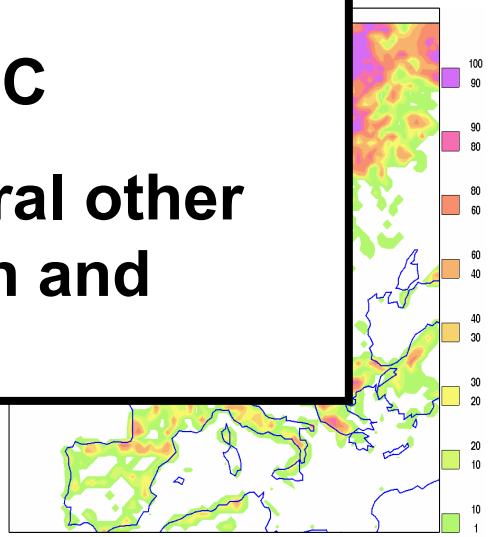
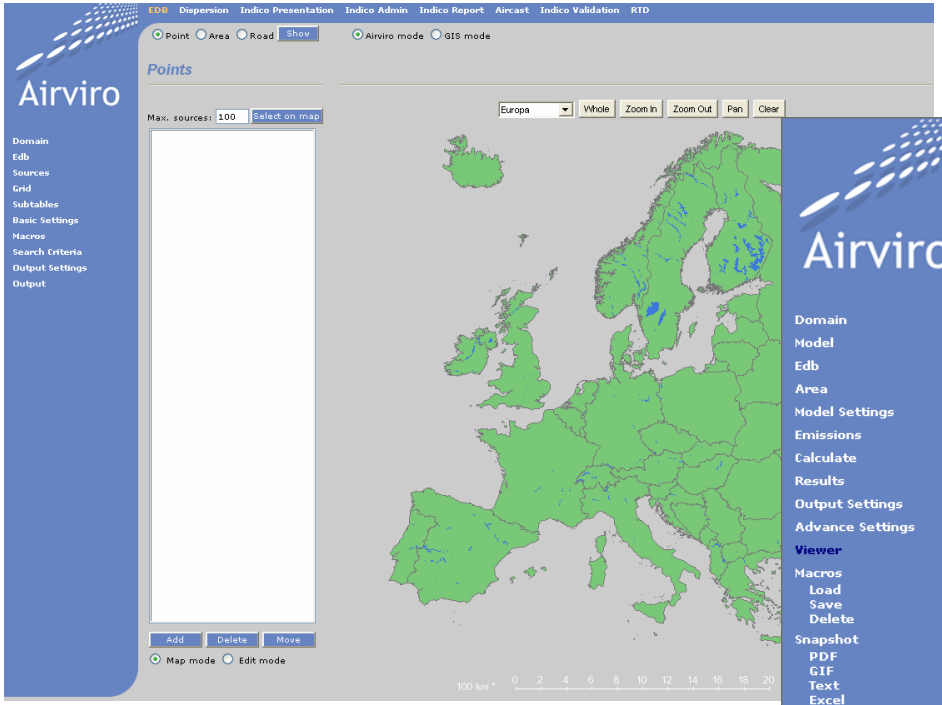
Chemical mechanism, KPP syntax



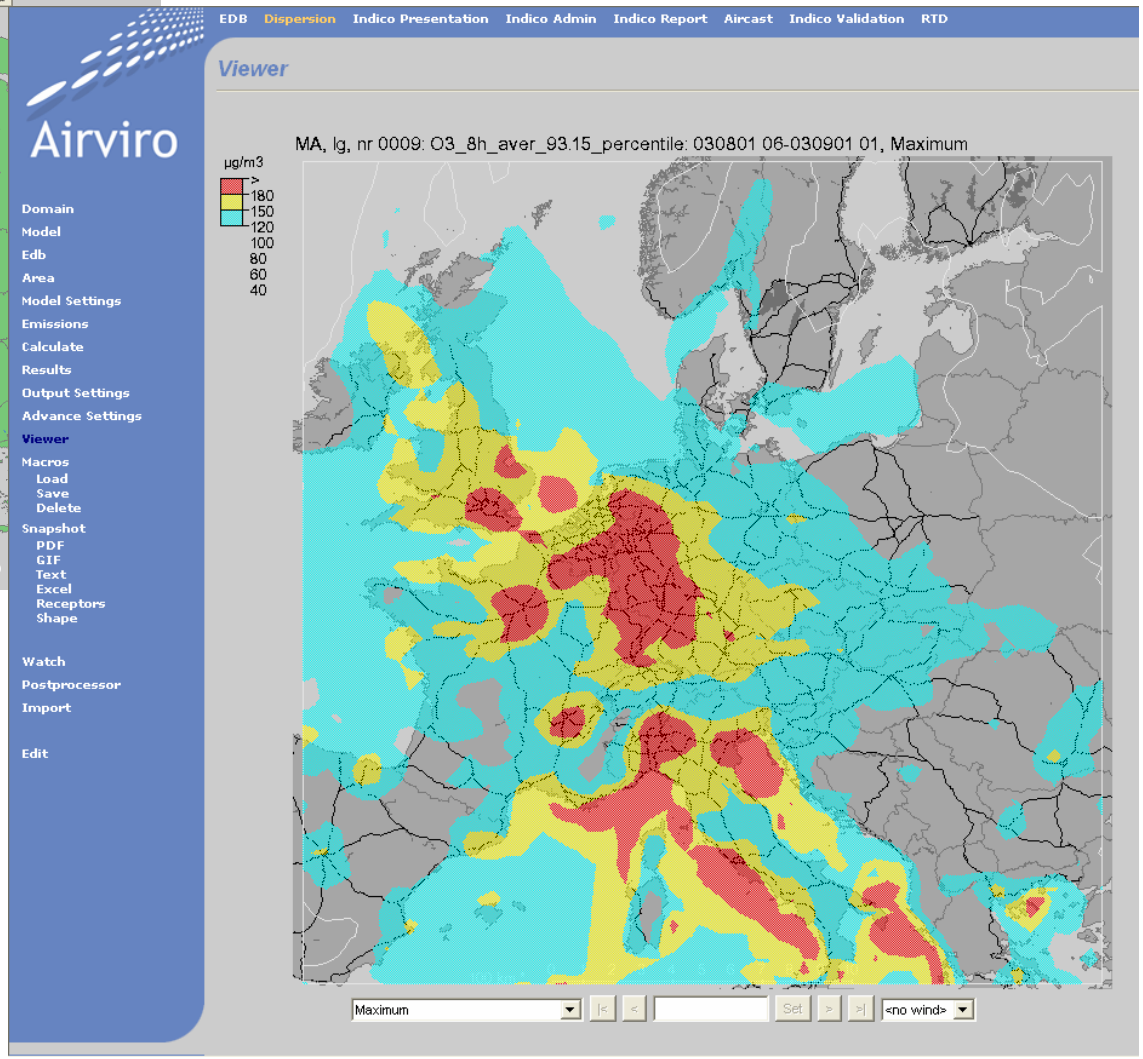
Land use - forest

Airviro MATCH Europe with photochemistry

- tool and archive for historical simulations, short term forecasts and climate change scenarios



Maximum 8h average O3 (August 2003)



Introducing MATCH Europe in Airviro:

- A serie of databases and tools for storage, data dissemination and presentation on the web
- Local Airviro users will have access to LRT impact, possible to couple to local model simulations incl. AQ forecasts

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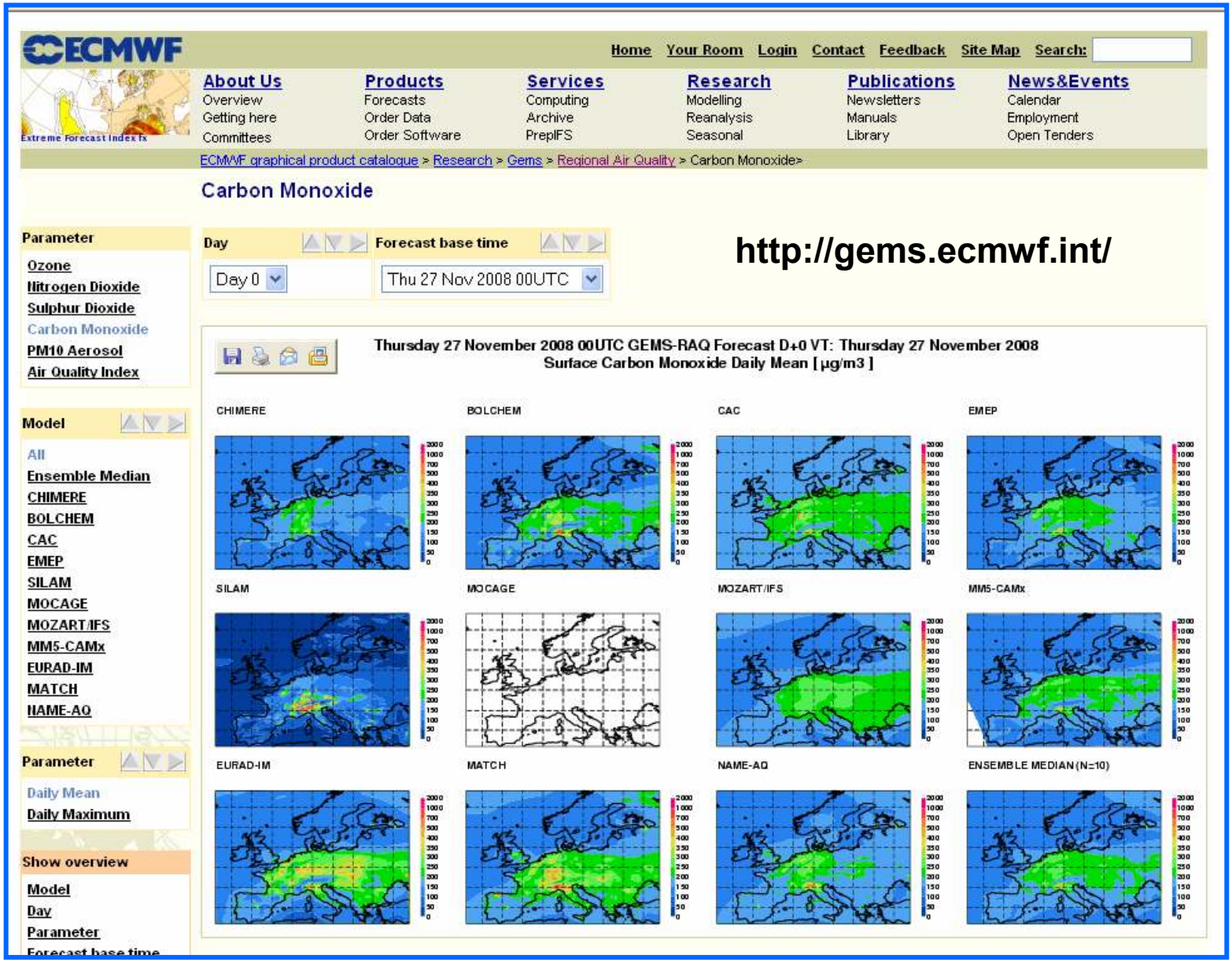
MATCH one of the GEMS/MACC models



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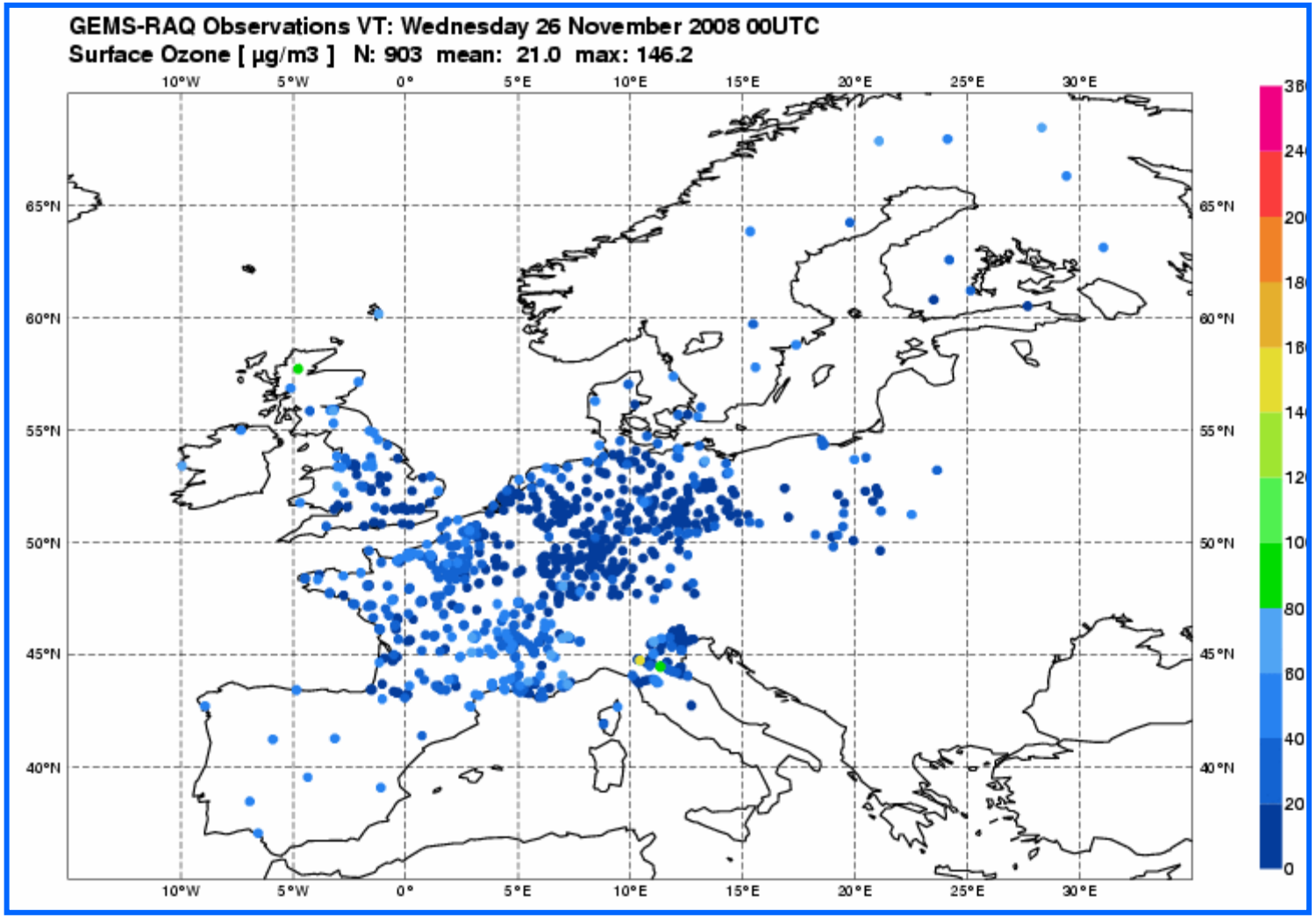
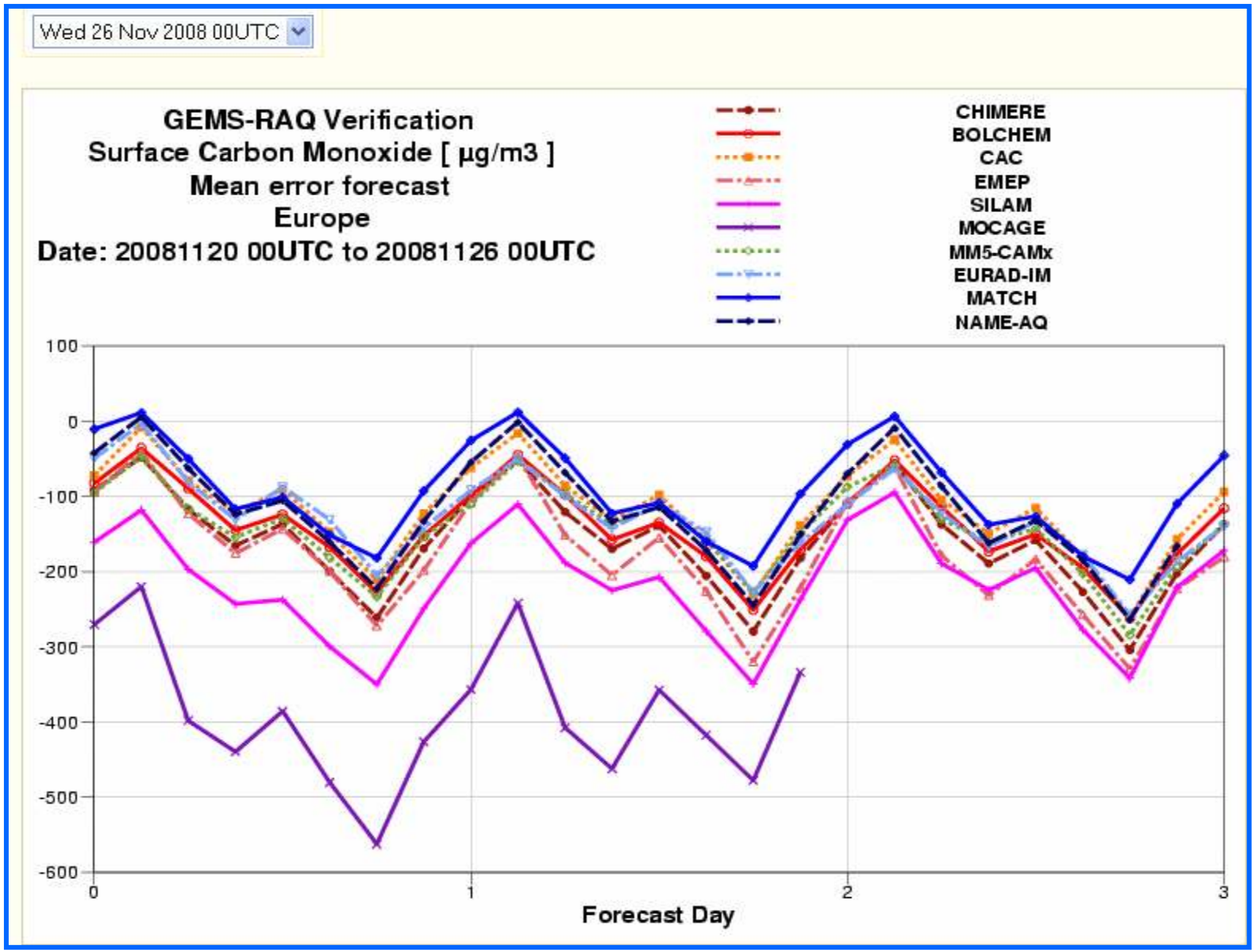
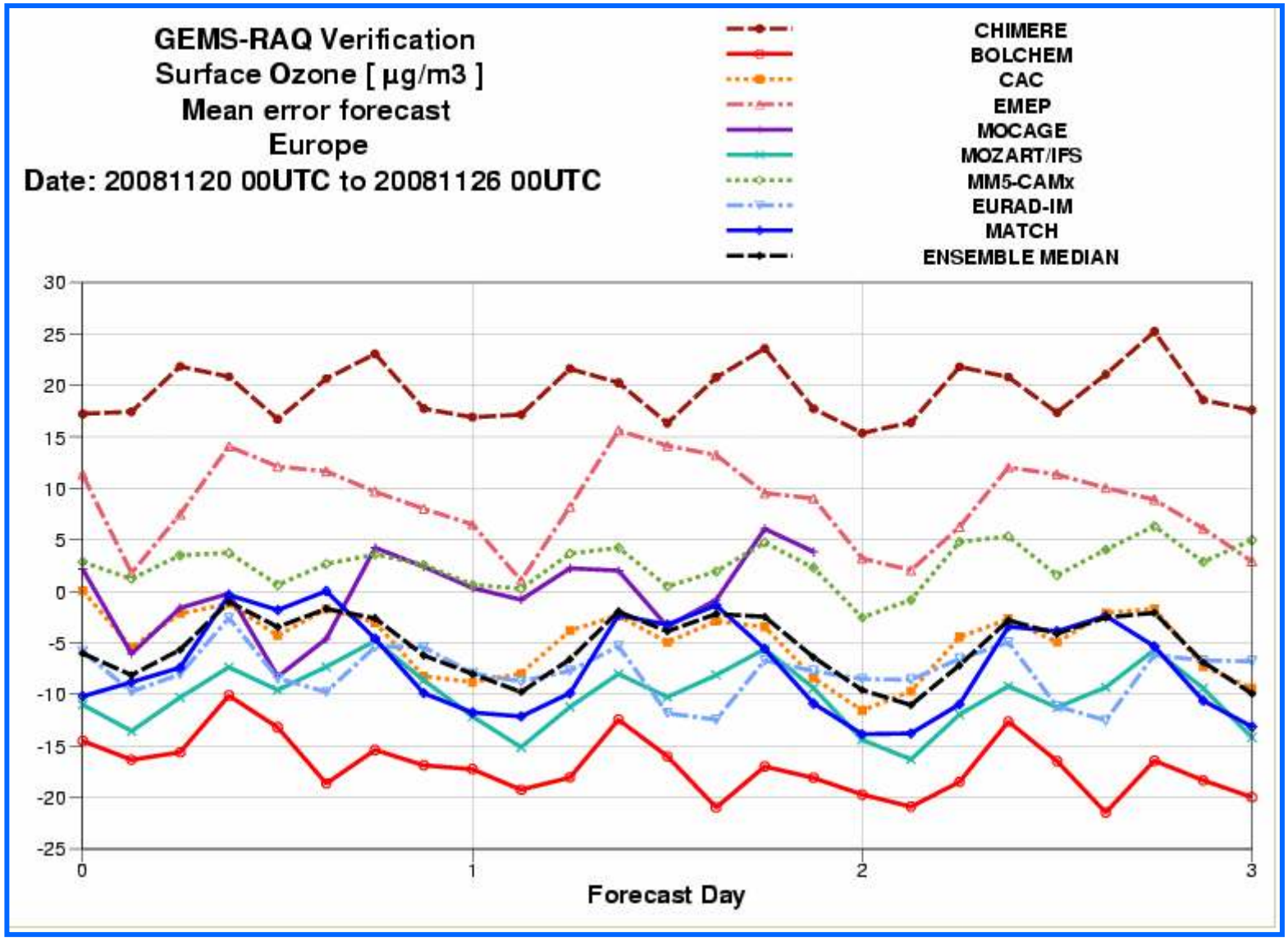
GEMS/MACC: All models are continuously evaluated against monitored data



GEMS/MACC: Verification of CO forecasts



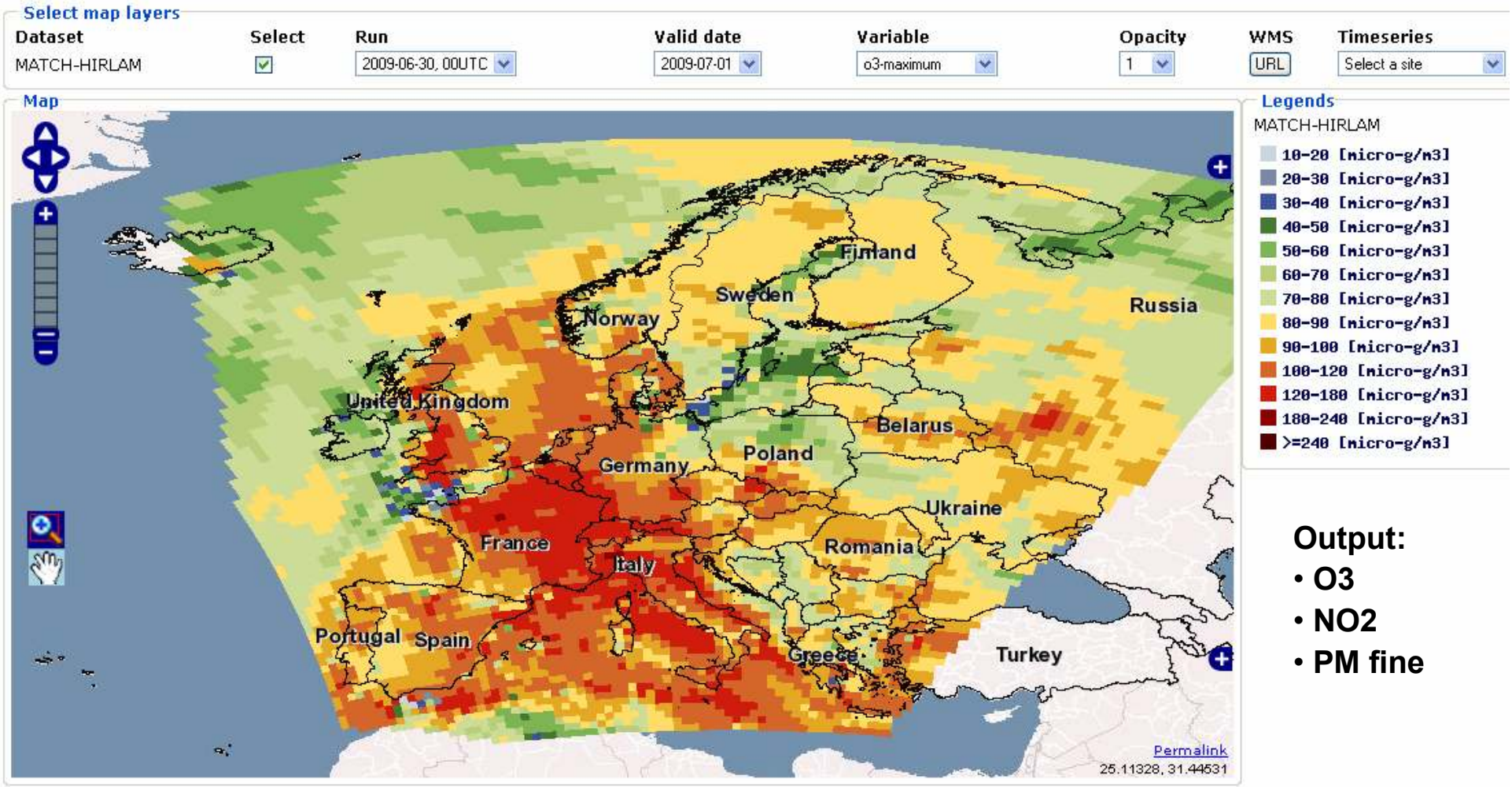
GEMS/MACC: Verification of O3 forecasts



Preliminar core service:

MATCH regional forecasts with HIRLAM forcing (runs at NSC, Sweden)
1-day historical and 2-days forecasts run once a day based on
HIRLAM 00UTC 44x44 km

http://www.airviro.smhi.se/MAQS/maqs/aq/aq_1.1/mapview/index.html



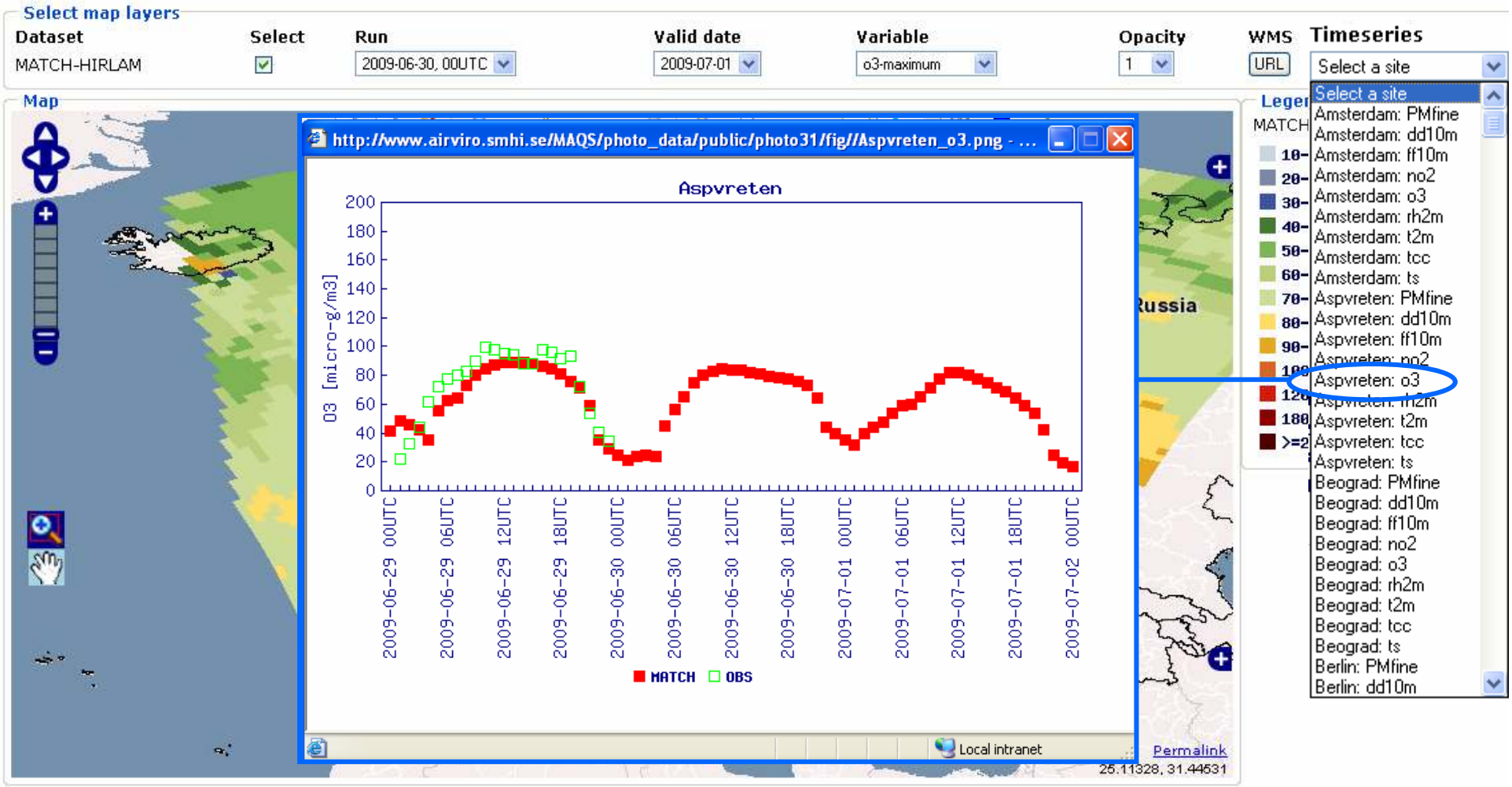
Output:

- **O3**
- **NO2**
- **PM fine**

Preliminar core service:

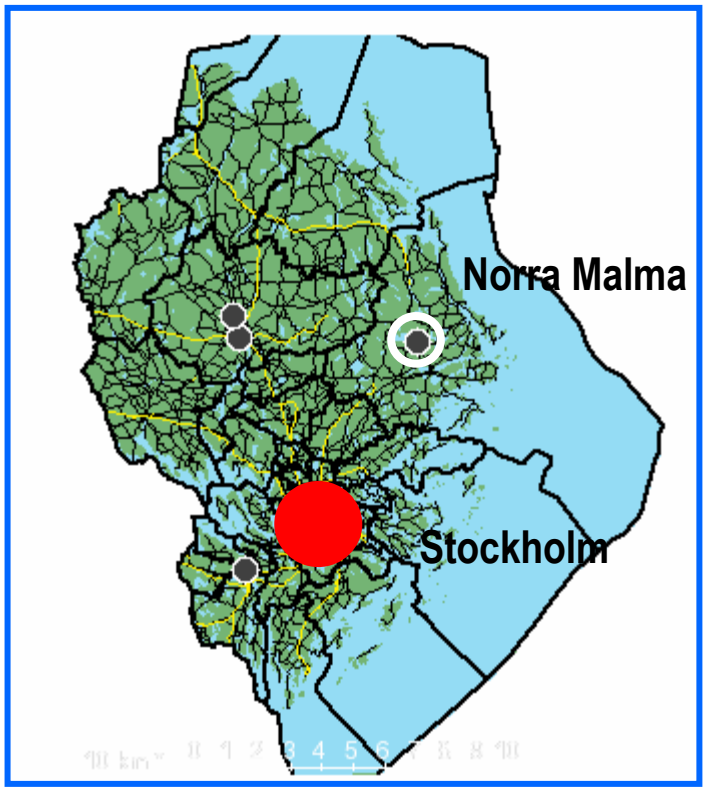
Output in major cities plus comparison with monitored data in Sweden

http://www.airviro.smhi.se/MAQS/maqs/aq/aq_1.1/mapview/index.html

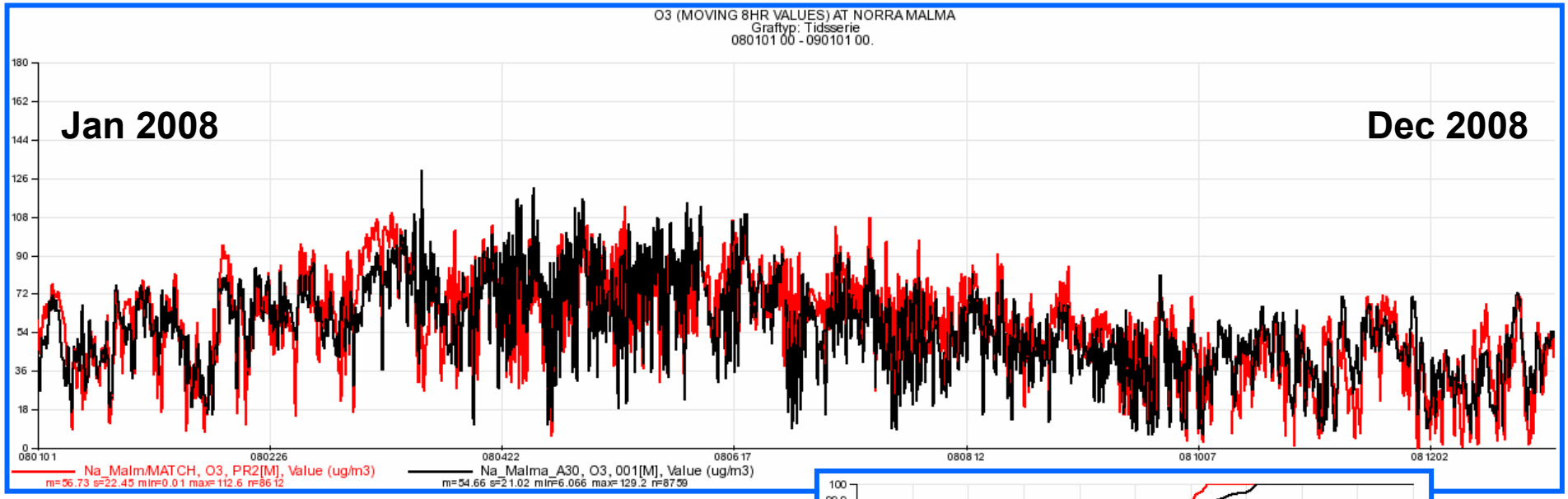


Evaluation of MATCH regional forecasts

– Norra Malma rural station (operated by Stockholm municipality)

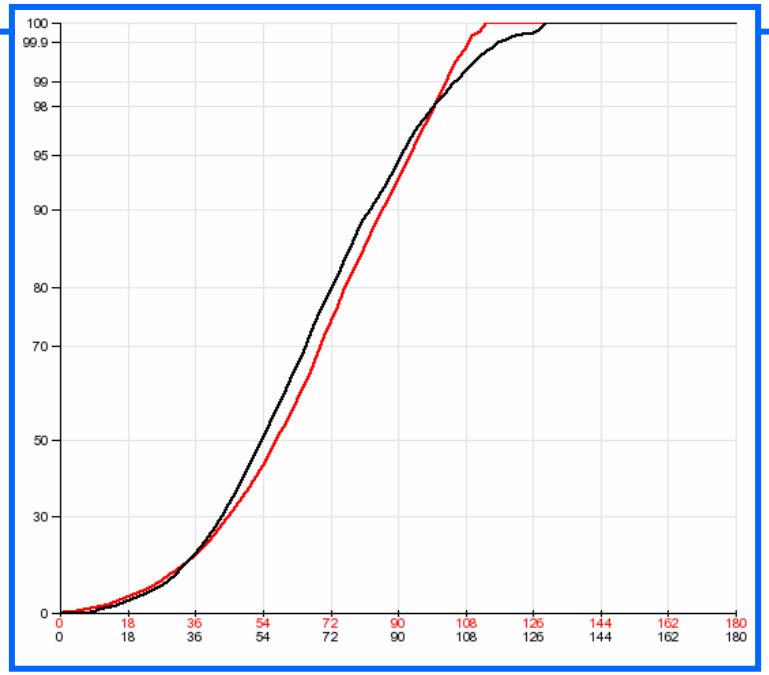


Forecasted (+2days in red) versus monitored O3 (black)

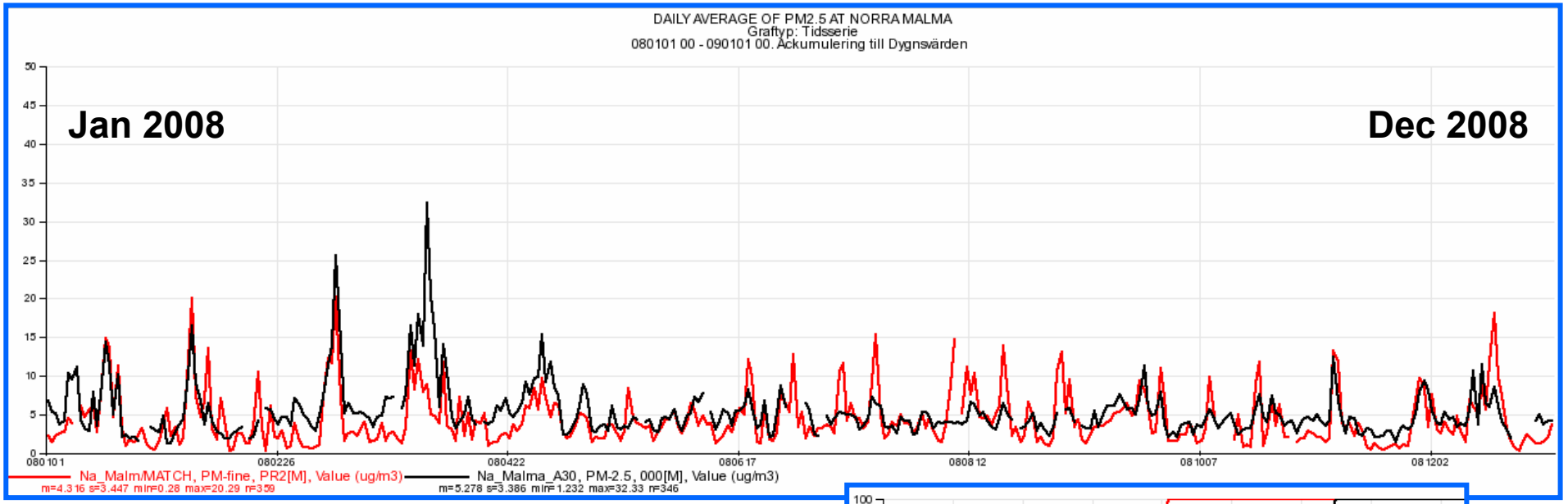


Norra Malma, Stockholm

(ozone 8hr regional background)

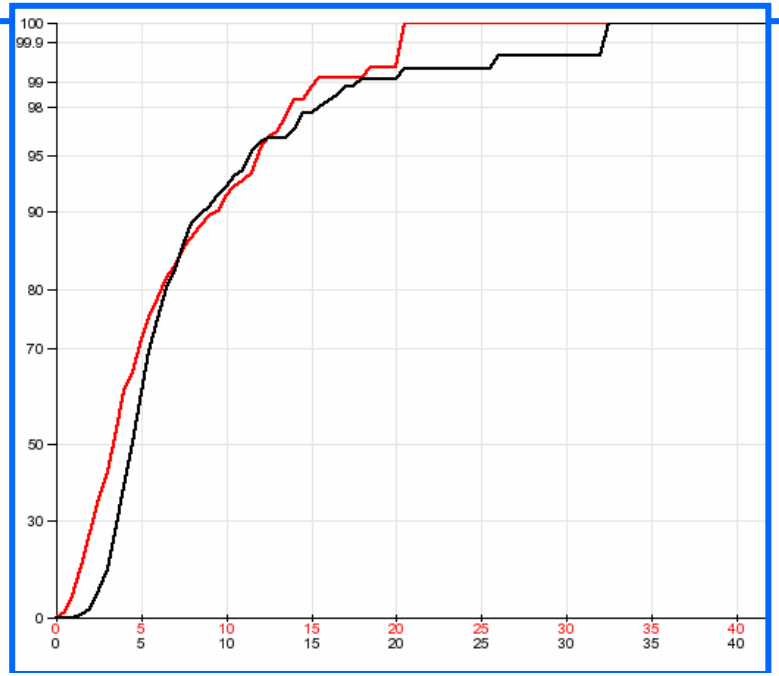


Forecasted (+2days in red) versus monitored PM2.5 (black)



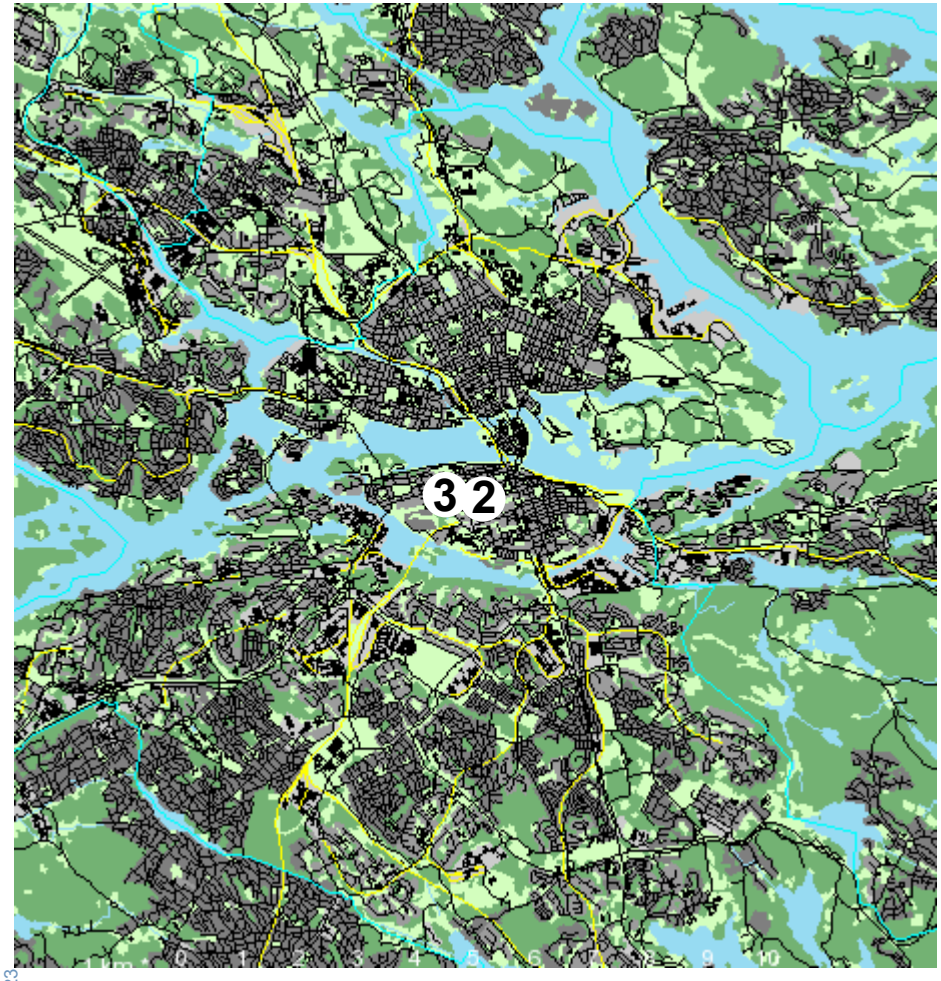
Norra Malma, Stockholm

(daily PM2.5 regional background where model PM presently is determined as only sum of all secondary inorganic aerosol - SIA)



Evaluation of MATCH urban and local forecasts

- Torkel (roof, 2)
- Hornsgatan (street, 3)



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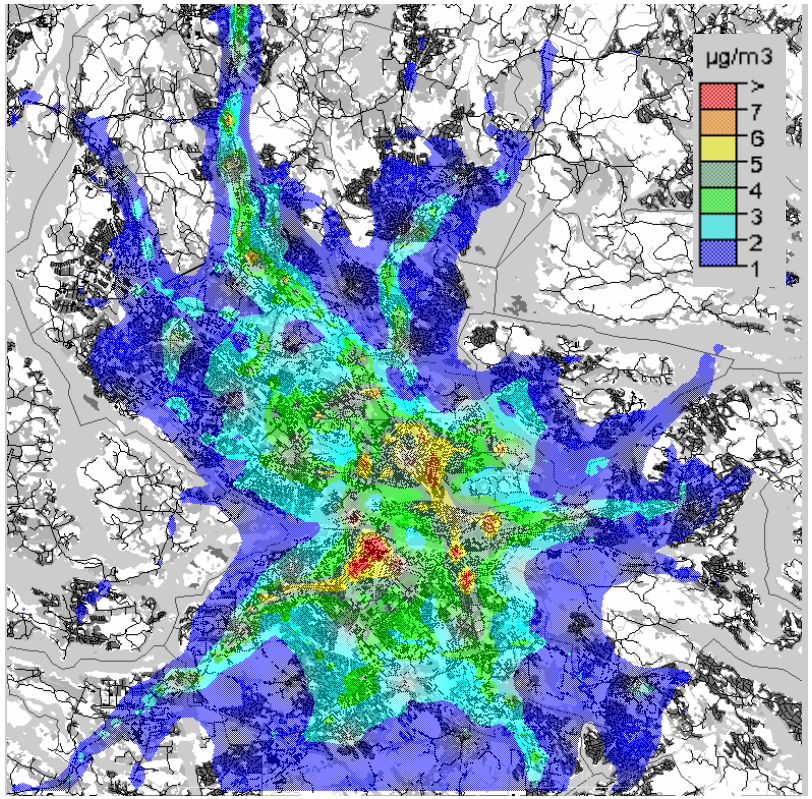
Models used for forecasts of urban and local street contributions:

Urban contribution:

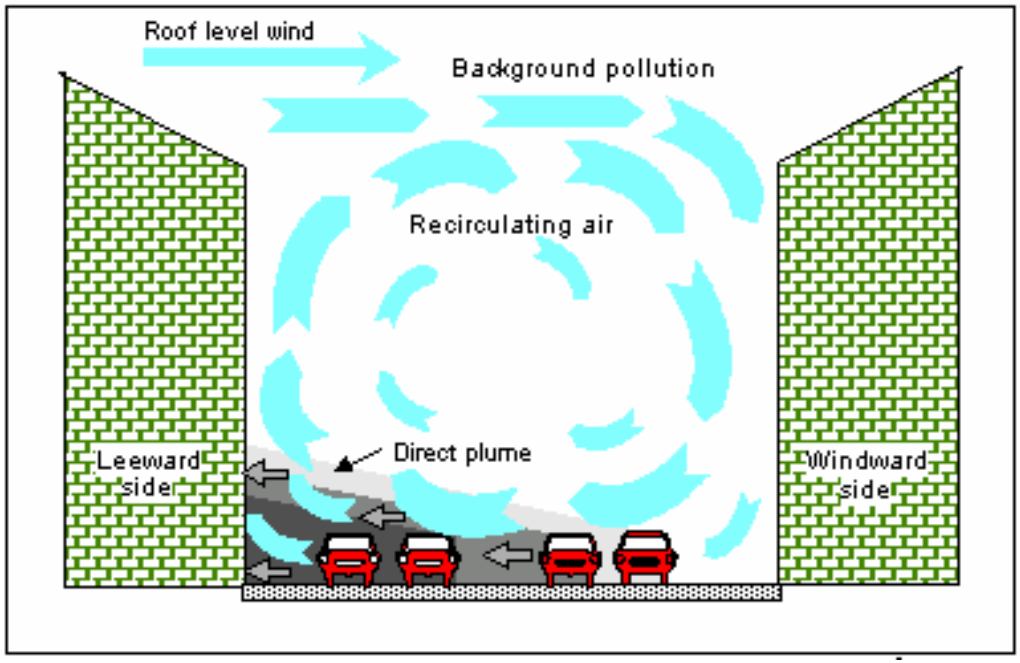
- Airviro Gaussian or Grid model (example with 500x500 m resolution)



Local street contribution:

- OSPM

Berkowicz, R., 2000:
OSPM - A parameterised street pollution model.
Environmental Monitoring and Assessment Vol. 65:323-331.

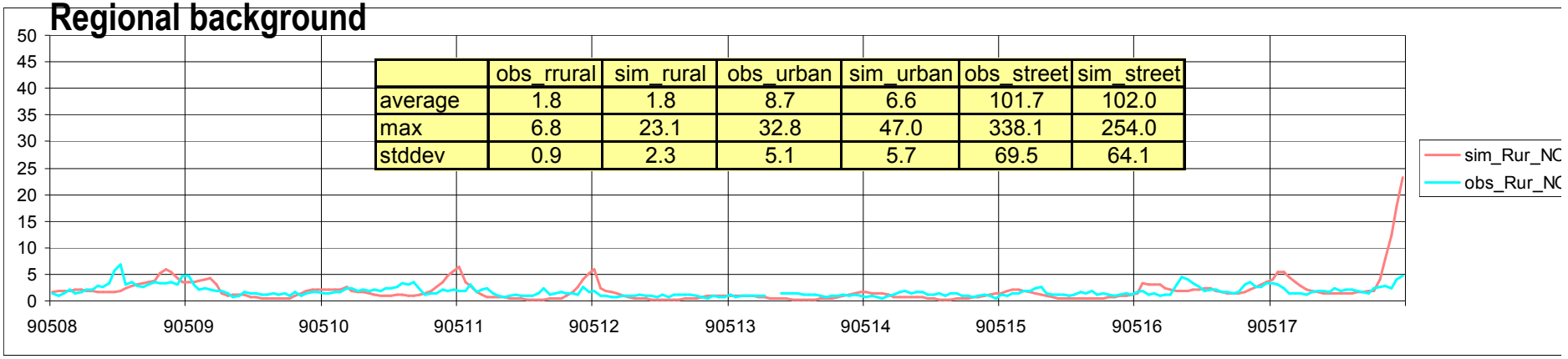


Meteorological forcing from HIRLAM forecasts

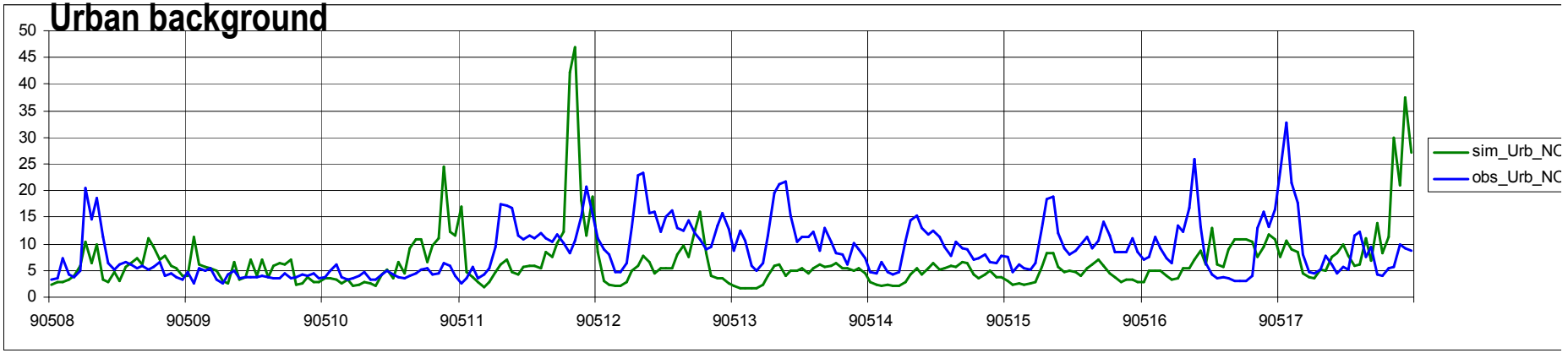
Stockholm NOx forecasts coupling 3 scales:

Regional background

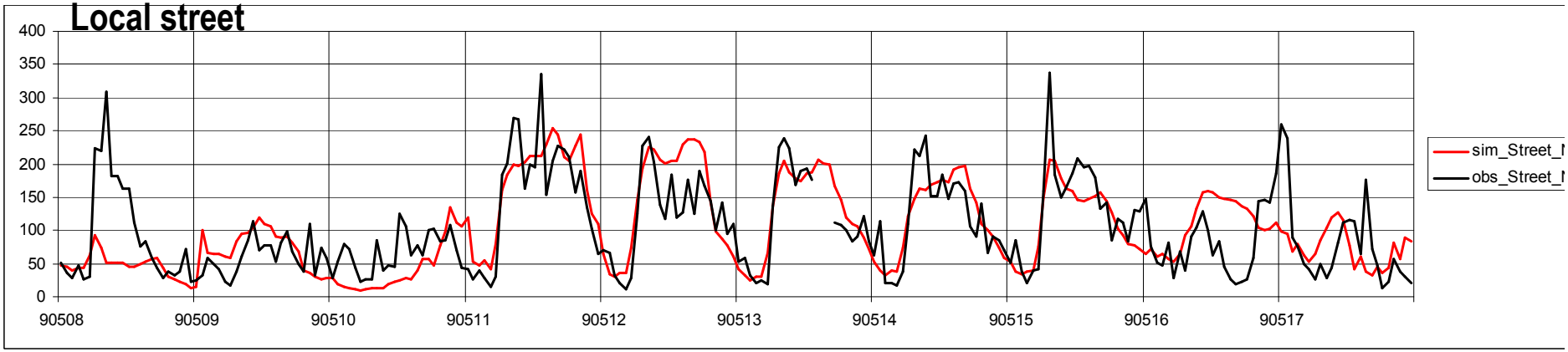
	obs_rrural	sim_rural	obs_urban	sim_urban	obs_street	sim_street
average	1.8	1.8	8.7	6.6	101.7	102.0
max	6.8	23.1	32.8	47.0	338.1	254.0
stddev	0.9	2.3	5.1	5.7	69.5	64.1



Urban background



Local street

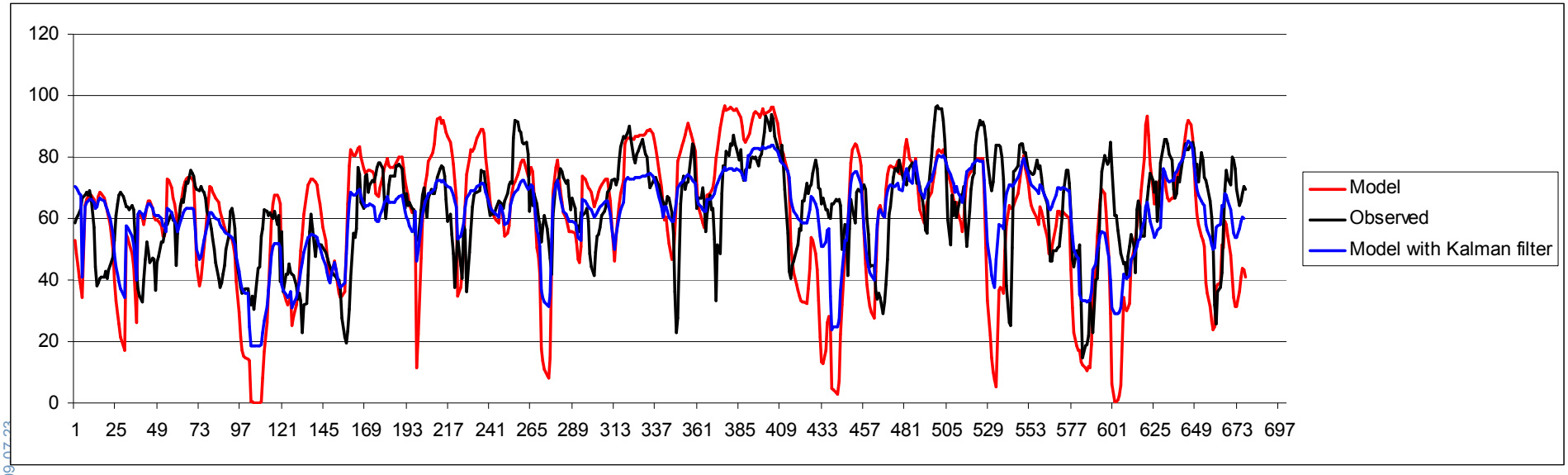


Further improvements under implementation:

1. Statistical postprocessing of the deterministic model forecast (Airviro Aircast)

Kalman filtering of model forecast:

- **uses 48 hourly data pairs of historical observations and model forecasts**
- **outputs adjusted 48h forecast**
- **one or various on-line monitor stations used to update forecasted concentration fields**



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Further improvements under implementation:

2. Improved PM description in MATCH Europe

- **including primary PM emissions and sea salt**
- **including secondary organic aerosol (cooperation SMHI-EMEP in Swedish SCARP project)**

3. Use of Airviro MATCH photochemistry model also on the national/regional/urban scale

- **increases the spatial resolution (down to 500x500 m)**
- **possibility to use local emission inventories**
- **improved NO2 forecasts**

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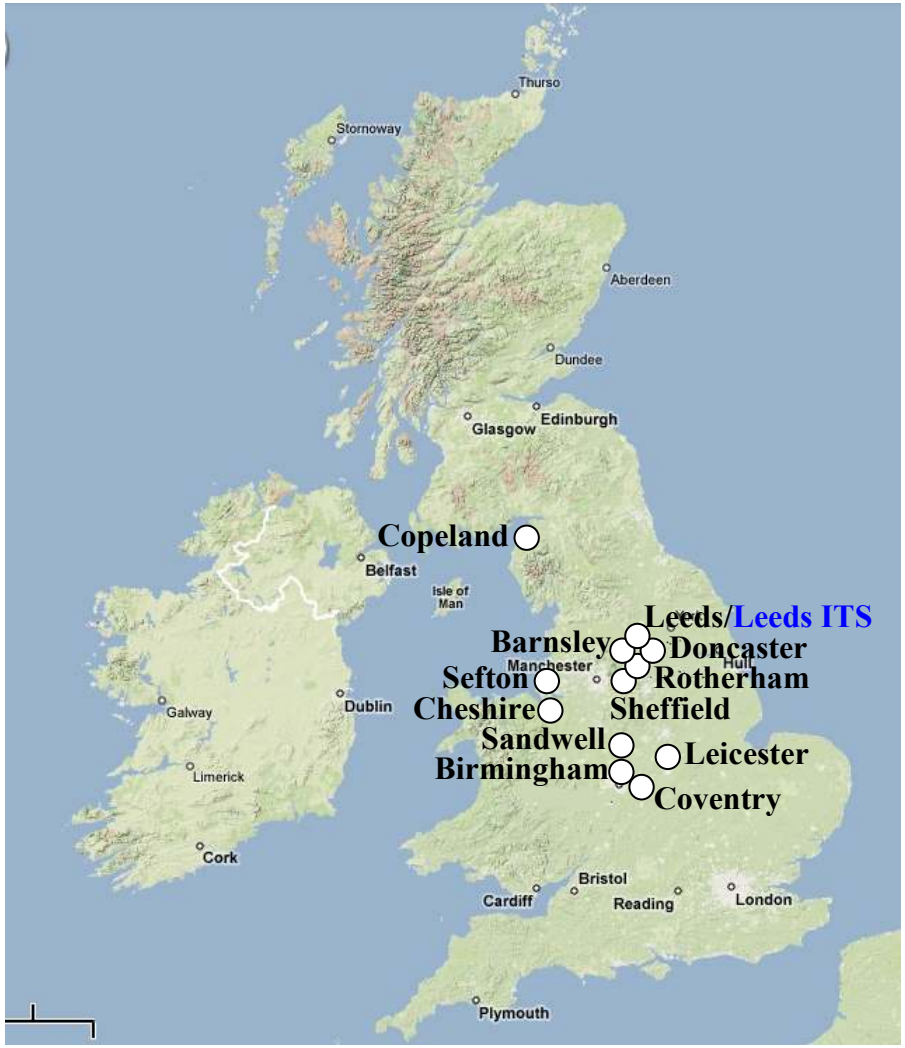
Further improvements under implementation:

4. Use of the SMHI PM10/PM2.5 non-exhaust emission model

- **improves local PM emissions (weather forecast affects vehicle induced non-exhaust emissions)**
- **tested principally in Scandinavia**

Omstedt G., Bringfelt B. and C. Johansson, 2005:
***A model for vehicle induced non-tailpipe emissions of particles along Swedish roads*. Atm. Env. 39, 6088-6097.**

SMHI in UK, working with Westlakes Scientific Consulting Ltd.



Airviro Installations for Local Authorities and Universities:

- Leeds
- Leeds ITS
- Sheffield
- Doncaster
- Barnsley
- Rotherham
- Coventry
- Birmingham
- Sandwell
- Sefton
- Cheshire
- Leicester
- Bureau Veritas (nationwide)

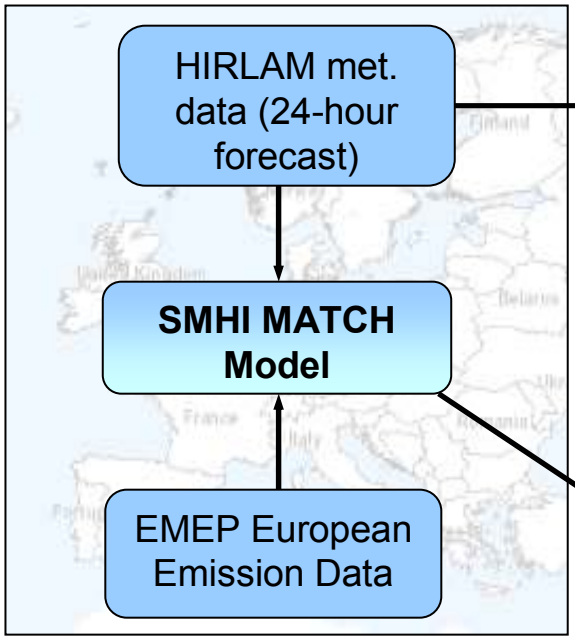
SMHI

WESTLAKES
SCIENTIFIC CONSULTING

Air Pollution Forecasting in Leeds, UK

- Leeds City Council require daily air pollution (NO2, PM10 and O3) alerts to disseminate to the general public
- An Air Pollution Index will identify pollution levels as Low, Moderate, High and Very High
- 24-hour met. forecast provided by HIRLAM model
- O3 forecast to performed by SMHI European Scale MATCH model
- NO2 and PM10 forecasts performed using Leeds City Council Airviro system (Aircast)
- Forecast disseminated to the public by email and SMS text

Air Pollution Forecasting in Leeds, UK



HIRLAM met. data (24-hour forecast)

SMHI MATCH Model

EMEP European Emission Data

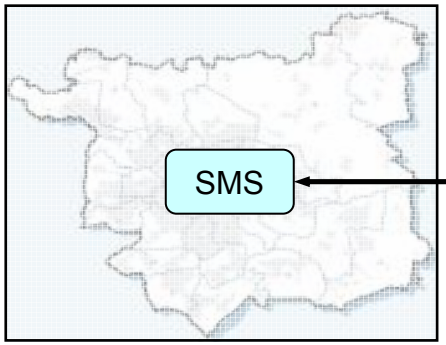
Leeds Airviro Time series database

Leeds City Emissions Database (PM_{10} and NO_2)

Leeds Airviro Dispersion Module

Daily pollution forecast for NO_2 and PM_{10}

2-day pollution forecast for O_3



SMS

Leeds City Council

E-mail

Leeds Airviro System - Aircast


Thank you for your attention!