AQ Assessment at hotspot/local scale
First Recommendations

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Why AQA?

- Pollutants from industrial sources and road traffic, e.g. Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_x), Carbon monoxide (CO), Volatile Organic Compounds (VOC) and Particulate Matter (PM10), fall under the control of the EC Integrated Pollution Prevention and Control (IPCC) Directives, European Union framework directive on air quality (EC/96/62) and their daughter directives and national legislations.

The new European regulations (EC/99/30) also require prediction of local peak values (very high percentiles) at specific points (hot spots).

Purposes of hotspot monitoring

- Compliance checking with limit values,
- Surveillance of levels to ensure that exposure is acceptable,
- Addressing concerns by local population,
- Checking if unacceptable short-term or continuous emissions occur (eg point sources)

Current practice for monitoring and limitations

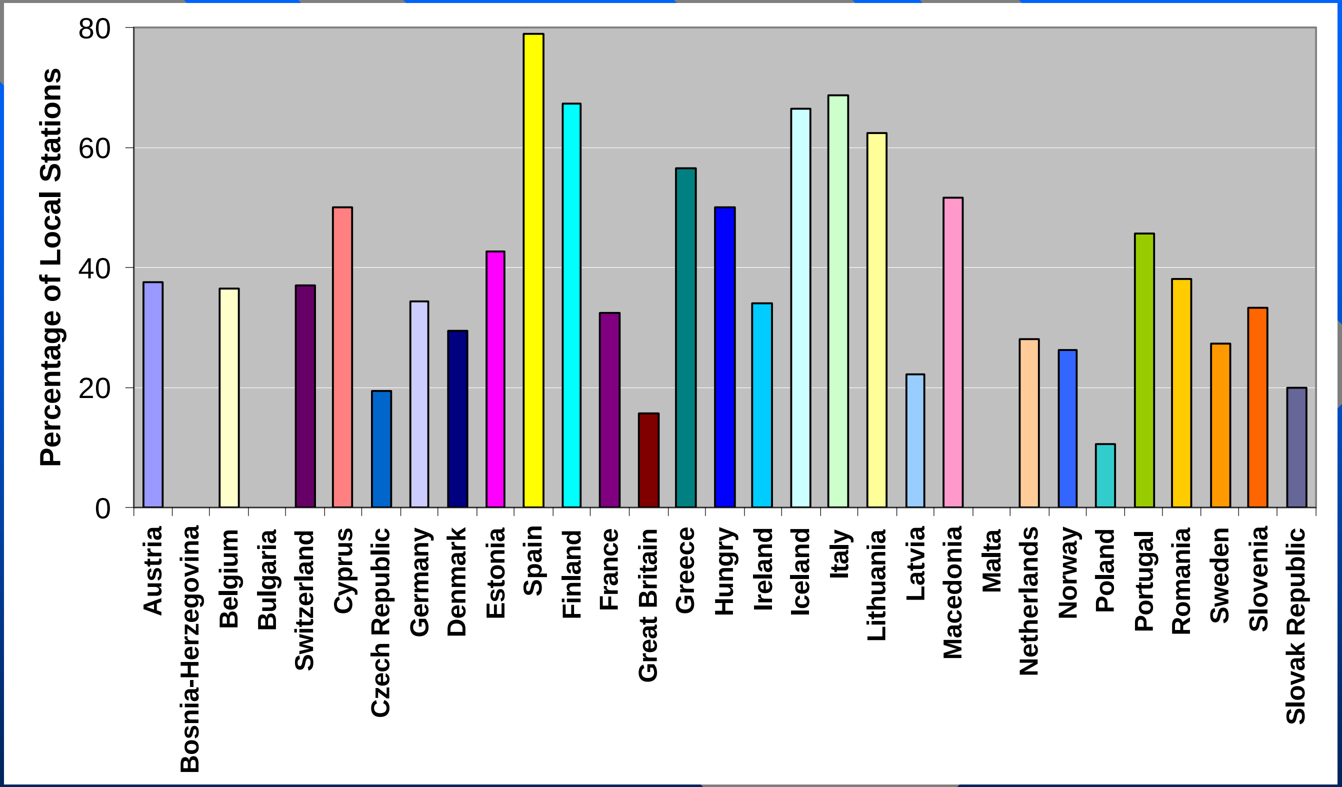
- **Active Monitoring station at local scale (Traffic and Industrial stations):** (from AirBase datebase, 2003)

country	NL	NO	Greece	Germany	GB	PT	FR	IT	CZ
Number of Stns	13 (*)	5 (*)	17	168	52	21	233	220	13
% of total Stns	28	26	57	34	16	46	32	67	19

- Most frequently monitored pollutants are NO2, PM10, O3 and SO2
- PM10 measurements from TEOM and is converted to gravimetric equivalent

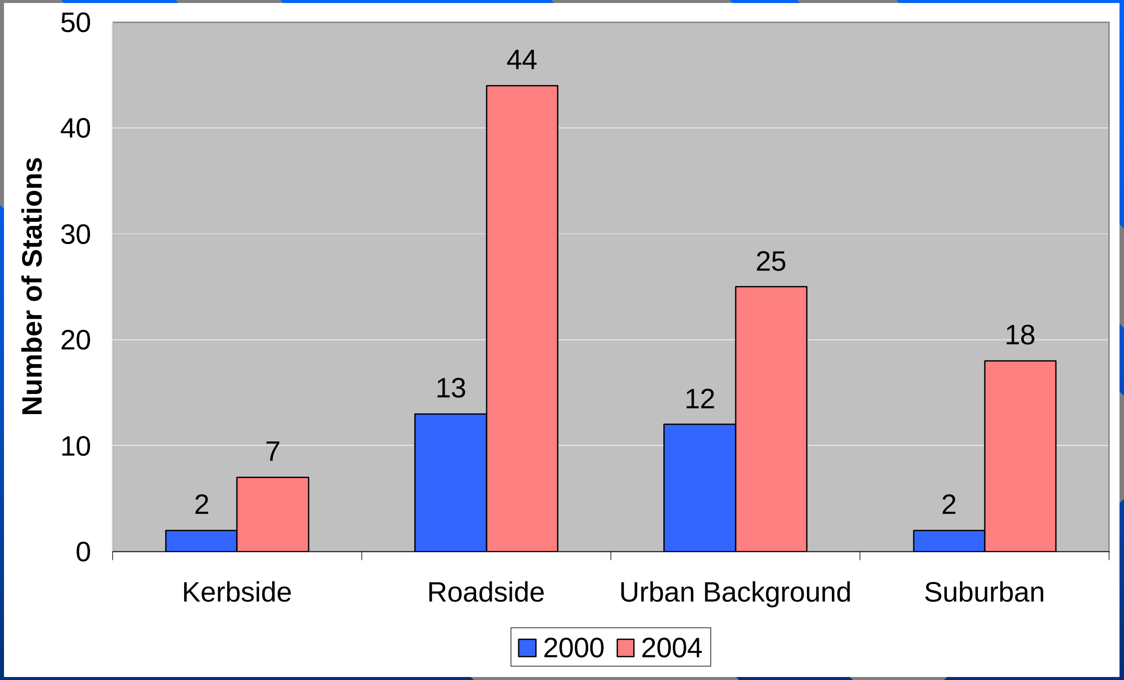
* No industrial monitoring stations available

Local air quality stations (traffic and industrial) that submitted data to AirBase in 2003



Variations exist between cities and countries in both number of stations and type of stations

Current practice for monitoring air quality in London



Various air quality monitoring stations in LAQN in year 2000 and 2004

The network has expanded more than threefold in the four years and the share of local scale air quality (kerbside and roadside) is more than 50%

Current practices across Europe for modelling air quality

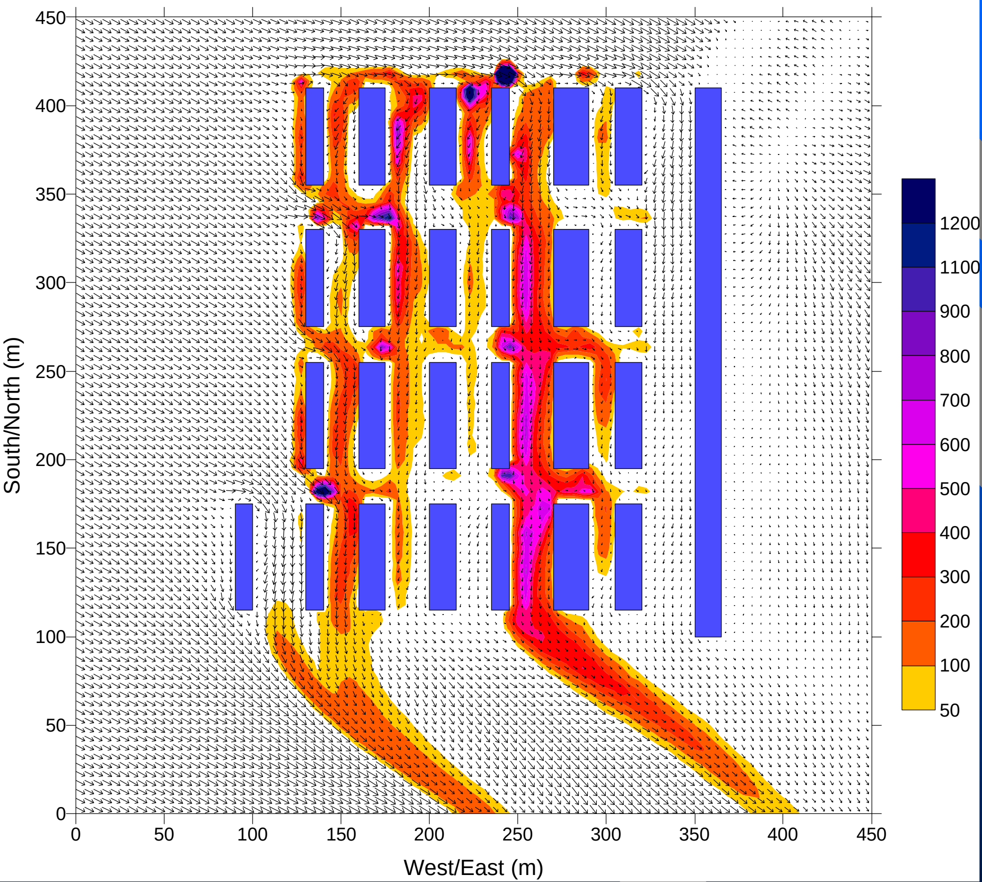
- **Models:**
  - Empirical /Semi-empirical models : OSCAR , DMRB , CAR, PEARL, OSPM
  - Gaussian models: CAR-FMI , GAMMA, TNO-Traffic, CALINE4 , ADMS-Road, DMRB etc.
  - Eulerian grid model : MIMO, AIRQUIS-EPISODE
  - CFD Models : ADREA-HF , VADIS, FLUENT

Model Properties

- Empirical /Semi-empirical models: deficiencies in resolving the fine structure in the concentration dependence on wind direction. But can be run for longer period
- CFD models: extensive computing time; difficult to handle low wind conditions; Complexity of setting up model runs. Usually too difficult to be used in users

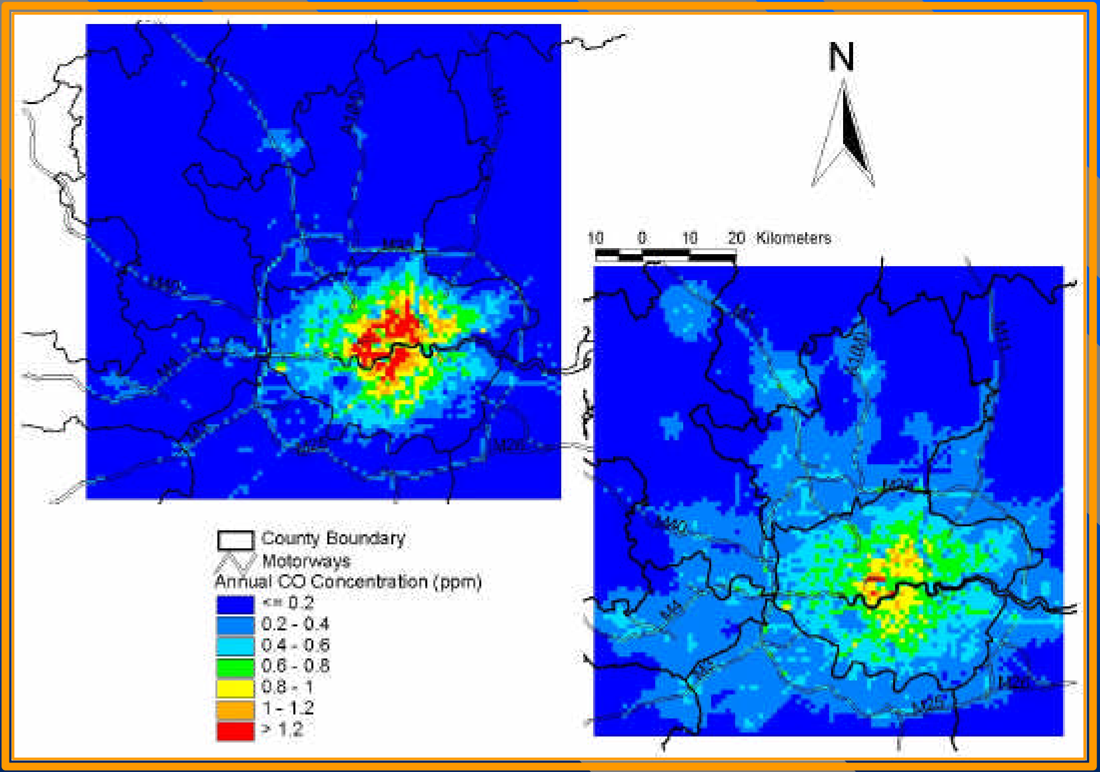
No model is capable of handling all different street configurations and simulate all real-life conditions. Current trend is to use combinations of various models.

VADIS application to the Lisbon case



CO dispersion simulation for 3 p.m. of 8th July (? -Location of the Prata air quality station).

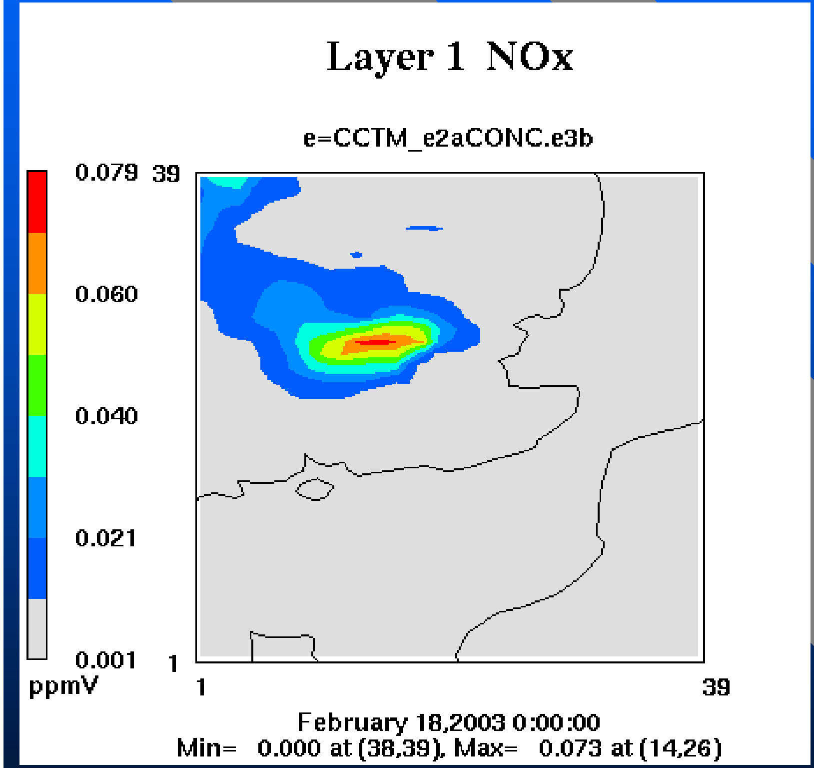
Integrated method

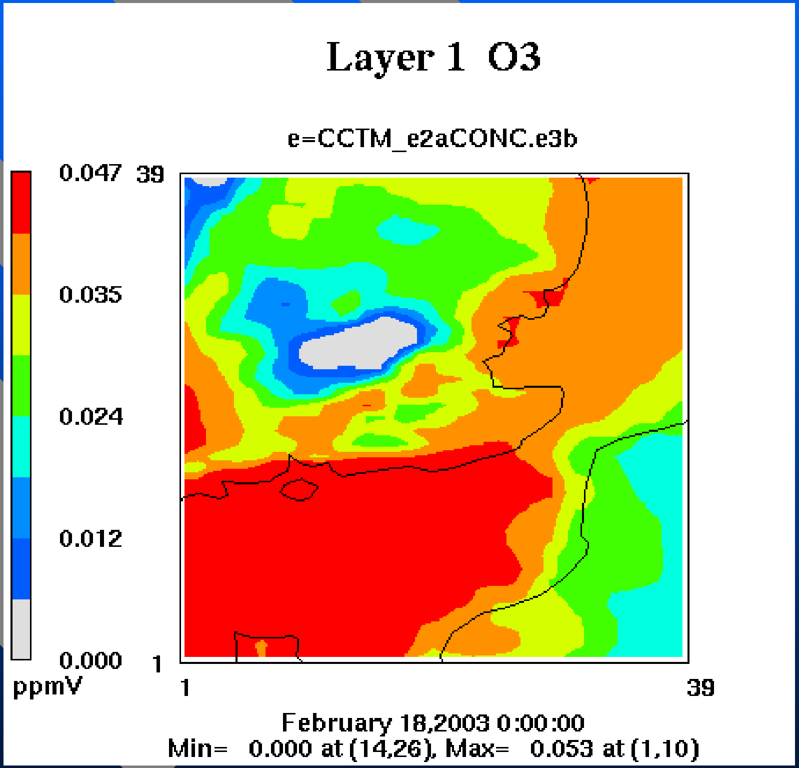


Annual (1997) CO concentration (ppm) predictions from (a) unmodified model assuming uniform surface and (b) modified model using LANDSAT Thematic Mapper Imagery derived land cover data

London NOx and O3 – Domain 3

18 FEB 2003



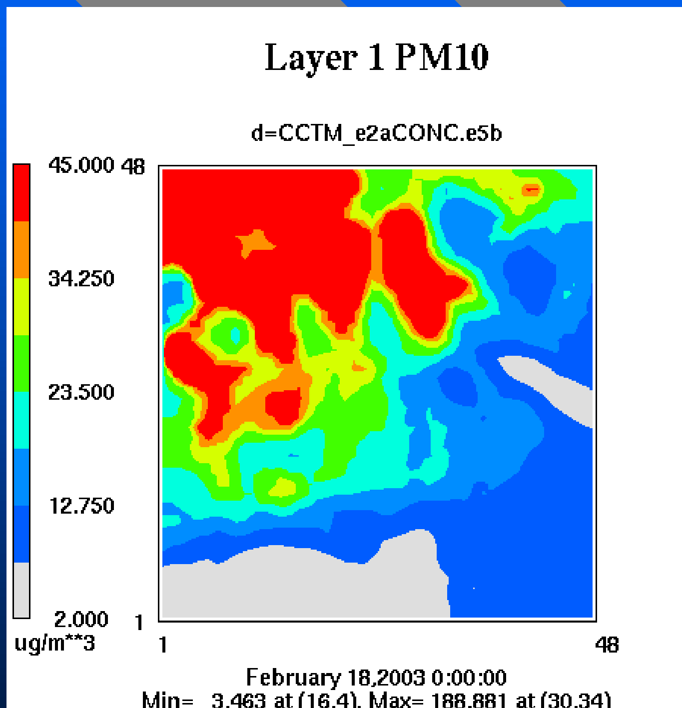


Atmospheric Science Research Group (ASRG)

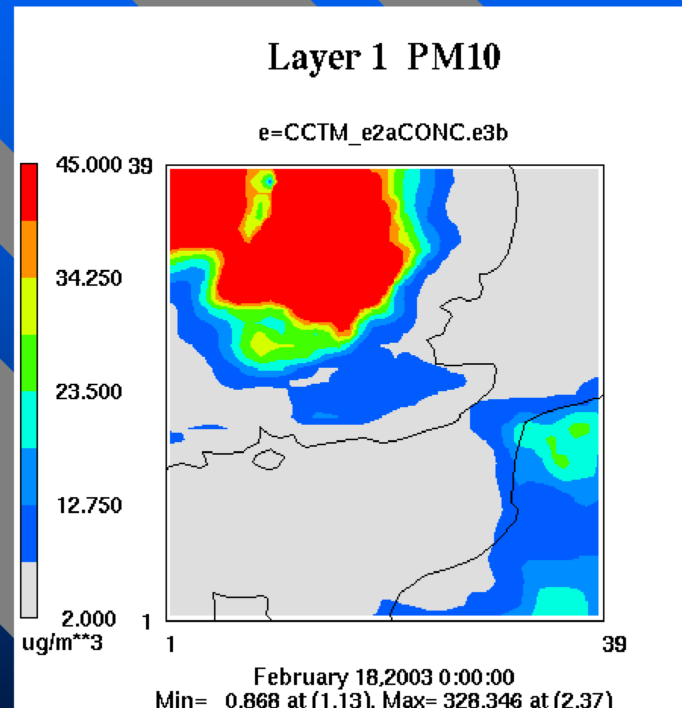
University of Hertfordshire

London PM10
18 Feb 2003

Innermost Domain



Domain 3



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University of Hertfordshire

Recommendations (monitoring)

- The numbers of monitors and the appropriateness of their locations depends on the objective, pollutants and the complexity of surroundings, e.g. in an area of heterogeneous emissions density, more PM than O_3 monitors might be needed.
- Concurrent measurements – Street (AQ, Traffic, Met), Roof top Met, Synoptic met, urban BG, regional BG
- Database of physical parameters for industrial sources, e.g. stack height, stack diameter, emission rates, exit velocity, exit temperature etc
- Monitoring strategy to be designed to meet requirements for AQA modelling methodologies

Recommendations (modelling) (1)

- Use models to help formulate monitoring strategy
- With regard to regulatory purposes, simple models (eg empirical relationships) are useful for day to day environmental impact assessment of planning policies.
- Models of intermediate complexity offer an efficient option for air quality management purposes especially for calculating long term concentrations.
- Proper background concentrations are important - avoid ‘double counting’
- For flow and dispersion in complex geometrical situations CFD models is a good alternative as semi-empirical or Gaussian models may not be able to simulate the conditions.
- Model should be able to provide output in the form comparable to EU directives
- Improvement of empirical relations based on observations
- Select model that include physicochemical processes that are most important for the study purpose – based on latest science

Recommendations (modelling) (2)

- Traffic data:
  - Traffic volume and composition
  - Traffic speed, acceleration, deceleration
  - Street geometry
- Meteorological data:
  - use observations at a nearby/close site
  - Check quality of measured data
  - Obtain measurement protocols – eg height of station, instrument, surrounding…

Recommendations (modelling) (3)

- Emission data:
  - bottom-up approaches is preferred
  - Emissions factors for urban/congested conditions
  - vehicle emissions from road traffic should be calculated based on detailed data on technology level, driving conditions and supplemented by manual traffic counting for selected days
  - Non-exhaust emissions of particulate matter due to tyre wear, brake wear and road dust suspension should be included as they contribute significantly to the PM10 concentration – no consistent approach
  - Emissions from large point sources should be included as well as individual plant or emission outlets
  - Trend scenario calculations should include regional/local conditions.

- Model evaluation/uncertainties
  - Yearly datasets if possible
  - Use appropriate data from concurrent monitoring stations
  - Quantify uncertainties, limitations, validity conditions

Recommendations (Integrated method)

- **Data assimilation**
  - ✓Recommended/suggested methods;
    3D-Var, SIR
  - ✓Recommended/suggested classes of methods
    Var-F, PF

  SIR: Sequential Importance Resampling

  PF: Particle Filter

  Var-F: Variational filter
- **Derive empirical relationships from observations**
- **Coupling with urban scale models, especially when modelled location is affected by complex topography/land cover or variable background including LRT – linkages between scales**
- **Inverse modelling for estimating emissions**

Conclusions

- To improve our methodologies/responses to air quality policy
- Monitoring
  - Effective use of information from existing stations
  - Improved strategies for new monitoring networks
  - Organised with AQA modelling in mind
- Modelling
  - Use combination of approaches eg OSCAR System
  - Treatment of input data – met, traffic, BG
- Combined use of monitoring and modelling
  - More effective response strategies to meet EU directive requirements
  - Data assimilation
  - Use of models for defining monitoring strategies
  - Empirical relationships
  - Source attribution – receptor and dispersion modelling

Summary of current practice
continued

- **Input Requirement:**
  - *Meteorological input data* : time series of observations (above roof level) or urban scale model
  - *Emission input*: emission models
  - *Background concentrations*: time series of rural observations or urban scale model output

Purposes of AQA

- Evaluate methods for assessing air quality at the local and hotspot scales
- Recommend techniques that maximize synergy between monitoring and modelling
  - Development of criteria for optimised siting of monitoring stations (representative)
  - How traffic and industrial sources/emissions are incorporated into a range of models (use of emission data)
  - how to optimize the representation of subscale fluxes at the local and hotspot scales and how to best prescribe boundary conditions from urban/regional scale model results (scale interaction)

First Recommendations

- **Monitoring:**
  - – Best available/suitable technique – depends on pollutants (eg CO, NO2, PM, VOCs, O3)
  - – Where to set up stations (representative); Station types and duration of monitoring (based on purpose)
  - – Statement of typical\ uncertainties and QA/QC of data

Possible recommendations (continued)

- **Modelling:**
  - Different models should be used for different stages of assessment and purposes (screen stage: simple models, e.g. CARII etc; compare with directives: advanced models, e.g. ADMS, AIRQUIS, CAR-FMI etc.; complex flow: e.g CFD near buildings; longer term averages: simpler models; high temporal resolution: advanced models)
  - Model evaluation methods: instead of comparing one hourly value, it is more meaningful to compare longer periods of data (to reveal overall trends)
  - Statement on uncertainties (expressed as statistical parameters for different pollutants, location and purposes)

Possible recommendations
(continued)

- **Treatment of input data**
  - Meteorological data: rely on individual models, surroundings of interested location and purposes.
  - Emissions: use the available database as much as possible (inventory, traffic characteristics) with modifications for local conditions, e.g. temporal profiles, emission factors etc.
  - Background field: from observations or urban scale model output (it is important to use data that is representative of the ‘background’ being transported into the local region)
  - Boundary conditions: should reflect the influence of larger scale contributions (allow scale interactions)

Possible recommendations
(continued)

- **Integrated method** (monitoring and modelling)
  - – inverse modelling for emission
  - – derive empirical relationships (pollutants) from observations
  - – Adjust model parameterisations (chemical, dispersion)
  - – Data assimilation techniques

Monitoring Quality objectives established by European Directives

Pollutant	Quality Indicator	Quality Objective	Directive
SO_2, NO_2, NO_x	Hourly mean	50-60%	1999/30/EC
	Daily mean	50%	
	Annual mean	30%	
PM, Pb	Annual mean	50%	
CO	8-hour mean	50%	2000/69/EC
Benzene	Annual mean	50%	
Ozone	8-hour daily maximum	50%	2002/3/EC
	1-hour average	50%	

QA/QC programmes only exist in a few monitoring networks in the EU Member States and with varying degrees of efficiency.

Modelling Quality objectives established by European Directives

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One objective is set for all scales of models restricting the uncertainty estimation process to models with variable temporal applications of several days, such as CFD models.