

Guidance on the use of models for the European Air Quality Directive

Activity of WG1 **FAIRMODE**

Forum for air quality modelling in Europe

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Presentation

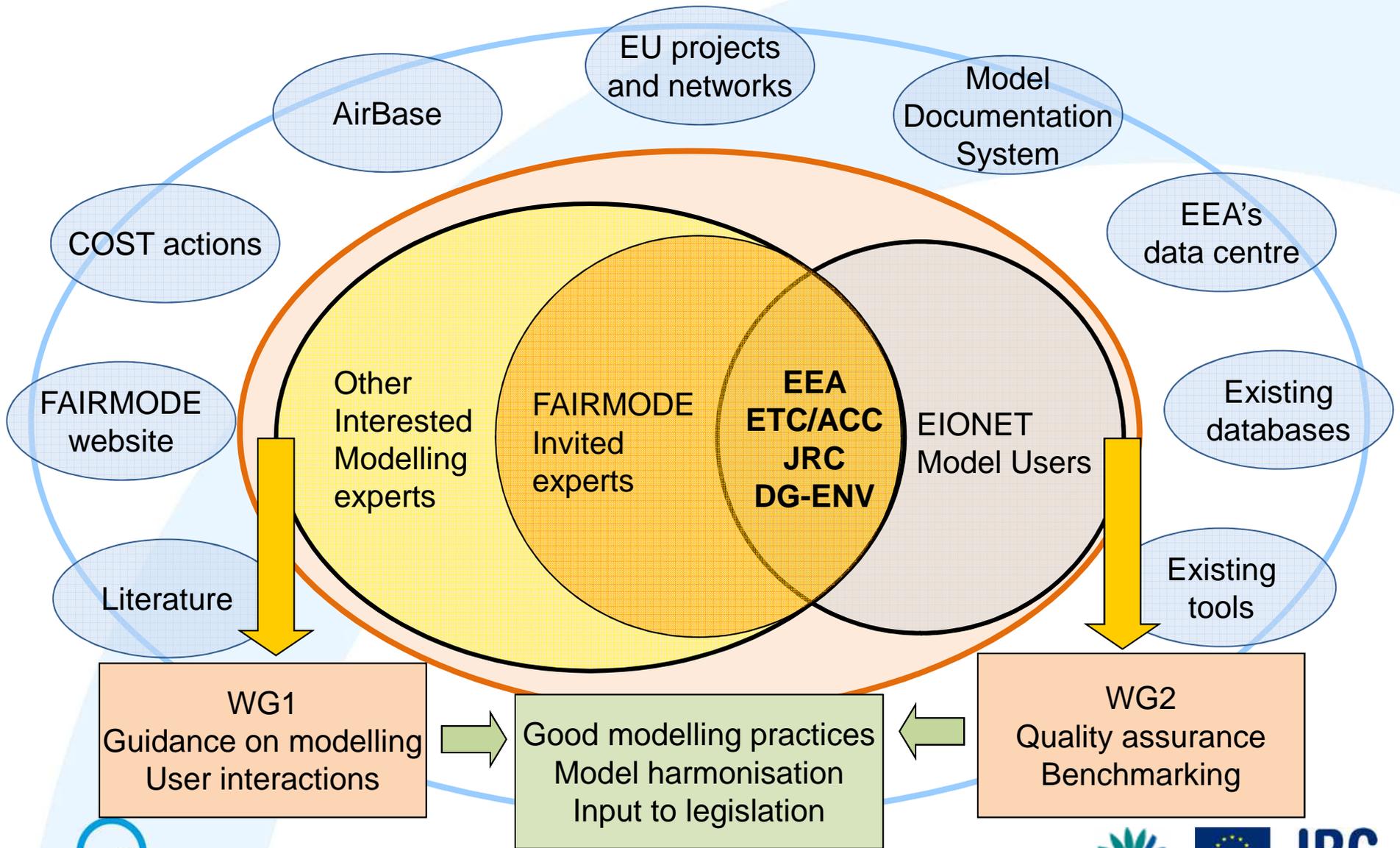
- Brief background to FAIRMODE
- Status of the guidance documents
- Examples from the guidance documents:
 - General guidance document
 - NO₂ guidance document
- Work plan

Terms of reference of FAIRMODE

- To provide a **permanent European forum** for AQ modellers and model users
- To produce **guidance** on the use of air quality models for the purposes of implementation of the AQ Directive and in preparation for its revision
- To study and set-up a system (protocols and tools) for **quality assurance** and continuous improvements of AQ models
- To make **recommendations** and promote further research in the field of AQ modelling

FAIRMODE

<http://fairmode.ew.eea.europa.eu/>



Why guidance?

- Modelling is carried out by diverse modelling groups using a range of models within Europe
- FAIRMODE seeks to harmonise model results so that these are comparable
- Provide transparent information for model developers, users and authorities alike
- Promote 'good practise' in modelling and reporting for Directive related applications

STATUS: Guidance documents

- **General modelling guidance document (Version 5.1a)**
 - Aimed at modellers and authorities, providing guidance for application of models for AQD
 - Input from FAIRMODE plenary last November (Ispra)
 - Update and review of examples with comments from the implementation group to be included
 - New version to be available before the 3rd plenary in September
- **NO₂ modelling guidance document (in preparation)**
 - Aimed at authorities, providing background information and recommendations on modelling methods and applications for NO₂
 - Focus on local and urban scale
 - Presentation at the NO₂ 'postponement' workshop in Brussels
 - First version to be available before the 3rd plenary

CONTENT: General guidance (pp. 113)

1. Introduction
 2. Summary of the 2008 AQ Directive
 - 3. Interpretation of the AQ Directive in regard to modelling**
 4. Reporting and public information when using models
 5. Model quality assurance and evaluation
 6. Applications of models for assessment
 7. Application of models for air quality planning
 8. Special topics
- Annexes 1 – 4 with examples

EXAMPLES: General modelling guidance

Spatial representativeness and modelling (p. 17)

- The AQ Directive specifies the placement of measurement sites ([Annex III.B.1](#)) and points out that for modelling the same type of criteria should apply ([Annex III.A.1](#))
- NB: The AQ Directive applies *everywhere* but is *not* to be *assessed* at:
 - a) any locations situated within areas where members of the public do not have access and there is no fixed habitation
 - b) on factory premises or at industrial installations
 - c) on the carriageway of roads and on the central reservations of roads except where there is normally pedestrian access

EXAMPLES: General modelling guidance

Spatial representativeness and modelling (p. 17)

- For **industrial** sites concentrations should be representative of a 250 x 250 m area
- For **traffic** emissions the assessment should be representative for a 100 m street segment and monitoring should be carried out less than 10 m from the kerbside
- **Urban** background concentrations should be representative of the exposure of the general urban population ('several square kilometres')

EXAMPLES: General modelling guidance

Consequences of spatial representativeness when modelling traffic

- Models used for assessing near road concentrations are Gaussian based models (street canyon or open road)
- Positioning of receptors has impact on the modelled concentrations
- Model receptors should be positioned at kerbside (*AQD 'valid everywhere'*) and within the breathing zone (1.5 – 4m)
- Model receptors on both sides of a road every 100 m is sufficient for roads longer than 100 m.

EXAMPLES: General modelling guidance

Interpretation of the Directive quality objective (p. 20)

- Quality objectives for modelling provided in [Annex I](#)
- Most modellers present results in terms of some interpretation of these objectives
- No standard interpretation exists

- Relative Percentile Error

Uses observed concentrations at the percentile

$$RPE = \frac{|O_p - M_p|}{O_p}$$

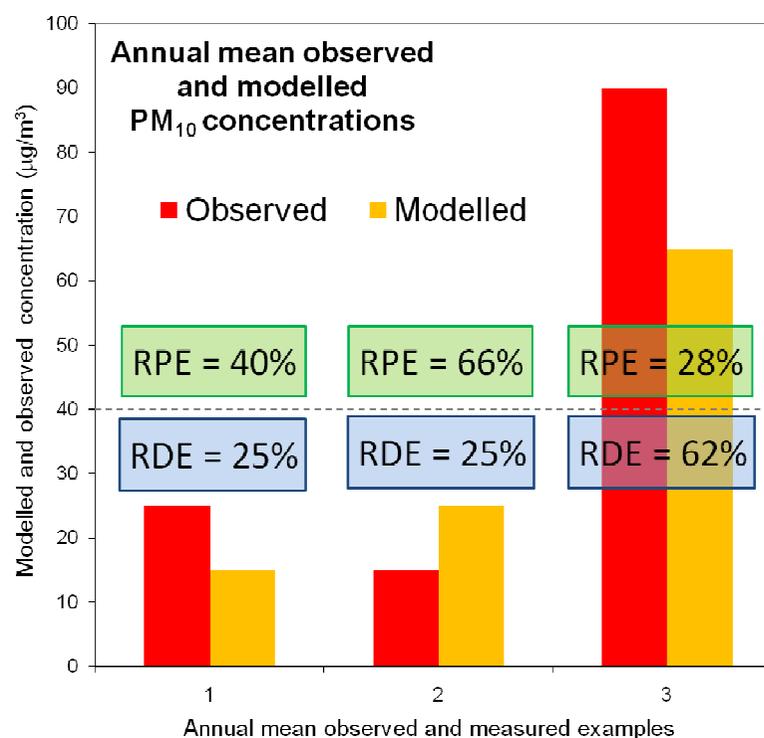
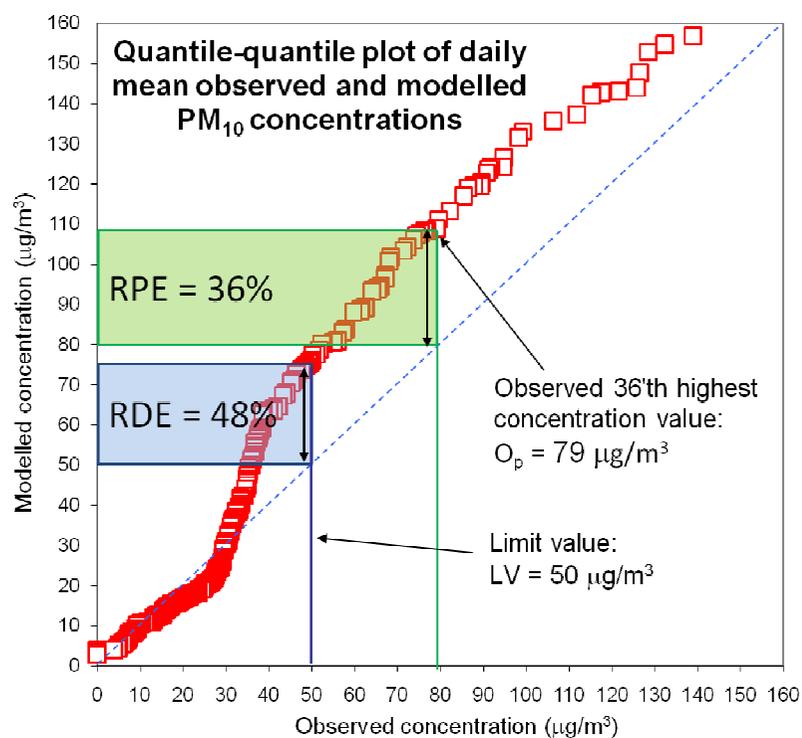
- Relative Directive Error

Uses concentrations closest to the limit value

$$RDE = \frac{|O_{LV} - M_{LV}|}{LV}$$

EXAMPLES: General modelling guidance

Interpretation of the Directive quality objective (p. 20)



$$RPE = \frac{|O_p - M_p|}{O_p}$$

$$RDE = \frac{|O_{LV} - M_{LV}|}{LV}$$

EXAMPLES: General modelling guidance

Interpretation of the Directive quality objective

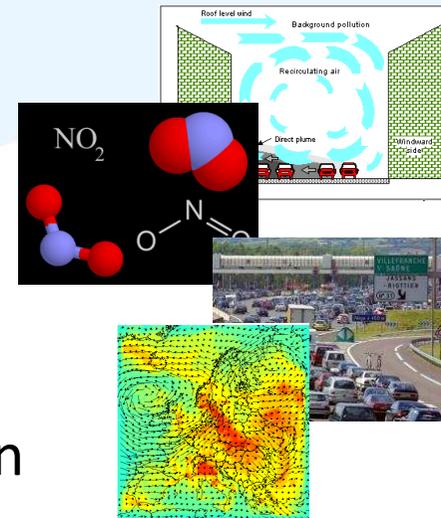
- RDE "reasonable" for percentiles or when $O < LV$
but unnecessarily stringent when $O > LV$
$$RDE = \frac{|O_{LV} - M_{LV}|}{LV}$$
- RPE "reasonable" for annual means when $O > LV$
but unnecessarily stringent when $O < LV$
$$RPE = \frac{|O_p - M_p|}{O_p}$$

Recommendations:

- The Commission has no specific preference
- Choose the lowest indicator
- Review these criteria for the following Directive

CONTENT: NO₂ modelling guidance

1. Introduction
2. Dispersion modelling
3. **Chemistry modelling**
4. Emission data and implementation
5. Meteorological data and implementation
6. Application of air quality models for assessment and planning
7. Modelling requirements for notification of postponement



Chemistry: NO₂ dependence

- The total NO_x emission
- The primary NO₂ emission
- The VOC emission
- The existing chemical balance in the atmosphere
- The available ozone (and other oxidants)
- The distance from the source (time)
- The degree of turbulent mixing

Chemistry: local scale modelling

How do local scale models represent the chemistry?

- Majority use empirical functions relating NO_2 to NO_x (dependent on year, city, site)
- Some use photostationary approximation (only valid far from sources)
- Some use parameterised 'distance from source' dependent solutions (more realistic)
- Some use parameterised 'limited mixing' dependent solutions (reflects the turbulent mixing)

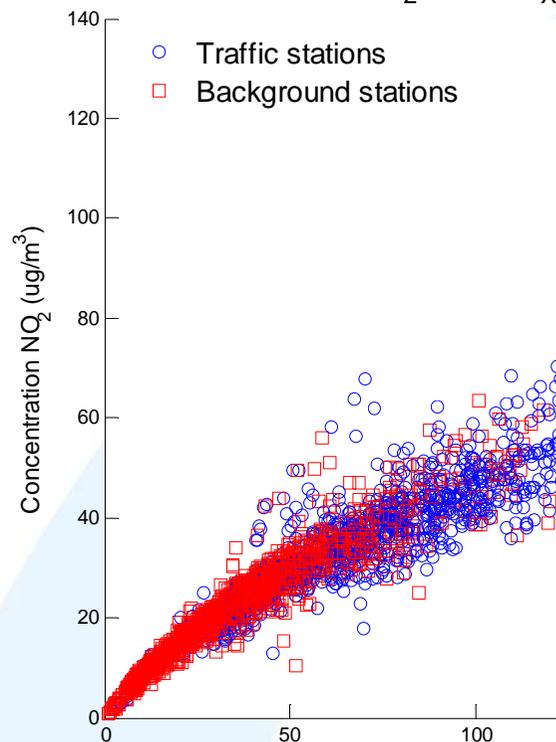
Chemistry: urban scale modelling

How do urban scale models represent the chemistry?

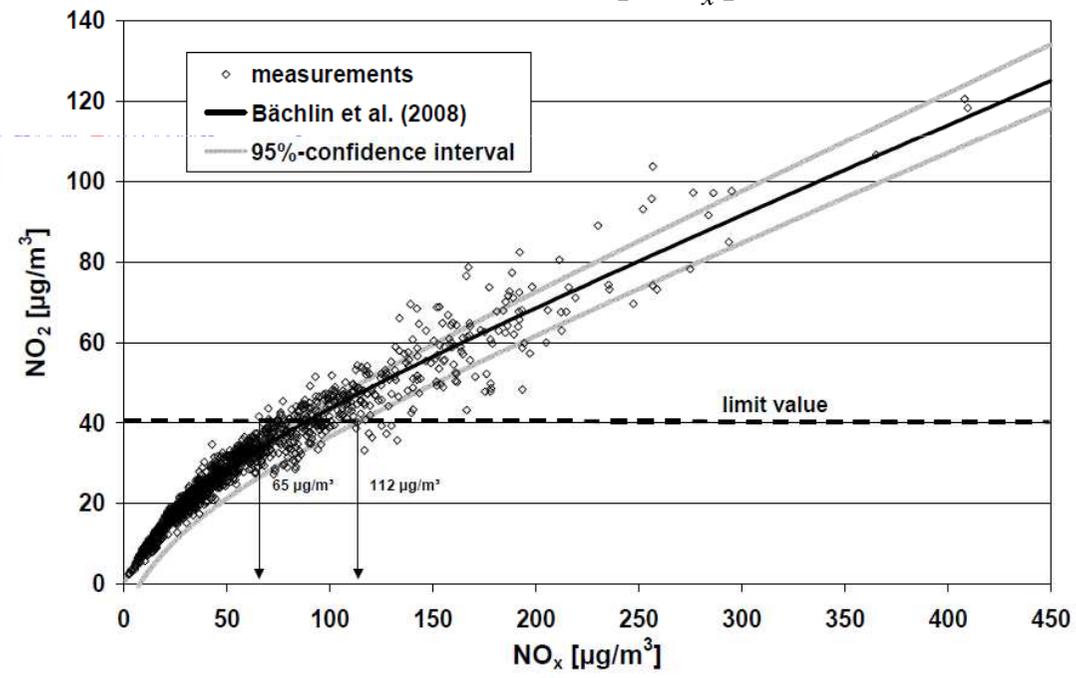
- Empirical functions relating NO_2 to NO_x
- Some use photostationary approximation (**only really valid when hydrocarbons are not involved**)
- Some use 'reduced' photochemical schemes (**e.g. Generic Reaction Scheme**)
- Some use 'complete' photochemical schemes (**based on regional scale CTMs**)

Chemistry: empirical functions

Comparison of NO₂ and NO_x annual mean concentrations from Airbase (2006 - 2008)



$$[NO_2] = \frac{A \cdot [NO_x]}{[NO_x] + B} + C \cdot [NO_x]$$



Bächlin W., R. Bösinger, 2008: Untersuchungen zu Stickstoffdioxid-Konzentrationen, Los 1 Überprüfung der Rombergformel. Ingenieurbüro Lohmeyer GmbH & Co. KG, Karlsruhe. Projekt 60976-04-01, Stand: Dezember 2008. Gutachten im Auftrag von: Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein--Westfalen, Recklinghausen.

Chemistry: overview

'Fitness for purpose' assessment for NO₂ chemistry

State of the art
 Conditionally applicable
 Not fit for purpose
 Not applicable

Chemistry	Empirical schemes	Photostationary and ozone limiting schemes	Distance from source and mixing schemes	Reduced photochemical schemes	Full photochemical schemes
Assessment					
Street level	Given sufficient observations	Overestimates NO ₂		Difficult to apply at this scale	
Urban scale	Given sufficient observations	Suitable for winter or low hydrocarbons	Suitable for winter or low hydrocarbons		
Regional scale				Missing significant chemistry	
Planning					
Street level	Not sensitive to changes in ozone or NO ₂ emissions	Sensitivity to ozone and NO ₂ emissions represented		Difficult to apply at this scale	
Urban scale	Not sensitive to changes in ozone or NO ₂ emissions	Suitable with low light or hydrocarbons	Suitable with low light or hydrocarbons		
Regional scale				Missing significant chemistry	

FAIRMODE guidance workplan

- General guidance document updated regularly, available from FAIRMODE website
- A guidance document on NO₂ modelling is under development, 60% complete. Version will be available on the website by September
- NO₂ guidance will also lead to a web based test guidance scheme by the end of 2010.
- Next FAIRMODE plenary is on 15-17 September 2010 in Kjeller, Norway.

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