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

Activity of WG1 FAIRMODE
Forum for air quality modelling in Europe

Bruce Denby

Bruce Denby¹, Emilia Georgieva⁶, Steinar Larssen¹, Cristina Guerreiro¹, Liu Li¹, John Douros², Nicolas Moussiopoulos², Lia Fragkou², Michael Gauss³, Helge Olesen⁴, Ana Isabel Miranda⁵, Panagiota Dilara⁶, Philippe Thunis⁶, Sari Lappi⁷, Laurence Rouil⁸, Anke Lükewille⁹, Xavier Querol¹⁰, Fernando Martin¹¹, Martijn Schaap¹², Dick van den Hout¹², Andrej Kobe¹³, Camillo Silibello¹⁴, Keith Vincent¹⁵, John Stedman¹⁵, Maria Gonçalves¹⁶, Guido Pirovano¹⁷, Luisa Volta¹⁸, Addo van Pul¹⁹, Alberto González Ortiz²⁰, Peter Roberts²¹, Dietmar Oettl²²
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
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
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
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
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

\[ RPE = \frac{|O_p - M_p|}{O_p} \]

Uses observed concentrations at the percentile

• Relative Directive Error

\[ RDE = \frac{|O_{LV} - M_{LV}|}{LV} \]

Uses concentrations closest to the limit value
EXAMPLES: General modelling guidance

Interpretation of the Directive quality objective (p. 20)

Quantile-quantile plot of daily mean observed and modelled PM$_{10}$ concentrations

RPE = 36%
RDE = 48%

Observed 36th highest concentration value: $O_p = 79\ \mu g/m^3$

Limit value:
$LV = 50\ \mu g/m^3$

Annual mean observed and modelled PM$_{10}$ concentrations

RPE = 40%  RPE = 66%  RPE = 28%
RDE = 25%  RDE = 25%  RDE = 62%

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

$RDE = \frac{O_{LV} - M_{LV}}{LV}$
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: NO$_2$ dependence

- The total NO$_x$ emission
- The primary NO$_2$ 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\textsubscript{2} to NO\textsubscript{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 ’limentted mixing’ dependent solutions (reflects the turbulent mixing)
Chemistry: urban scale modelling

How do urban scale models represent the chemistry?

- Empirical functions relating $\text{NO}_2$ to $\text{NO}_x$
- 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)
Comparison of NO\textsubscript{2} and NO\textsubscript{X} annual mean concentrations from Airbase (2006 - 2008)

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

## Chemistry: overview

‘Fitness for purpose’ assessment for NO₂ chemistry

<table>
<thead>
<tr>
<th>Chemistry</th>
<th>Empirical schemes</th>
<th>Photostationary and ozone limiting schemes</th>
<th>Distance from source and mixing schemes</th>
<th>Reduced photochemical schemes</th>
<th>Full photochemical schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street level</td>
<td>Given sufficient observations</td>
<td>Overestimates NO₂</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Urban scale</td>
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<td>Suitable for winter or low hydrocarbons</td>
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<tr>
<td>Regional scale</td>
<td></td>
<td></td>
<td></td>
<td>Missing significant chemistry</td>
<td></td>
</tr>
</tbody>
</table>

## Assessment

### Street level
- Given sufficient observations
- Overestimates NO₂
- Difficult to apply at this scale

### Urban scale
- Given sufficient observations
- Suitable for winter or low hydrocarbons

### Regional scale
- Missing significant chemistry

## Planning

### Street level
- Not sensitive to changes in ozone or NO₂ emissions
- Sensitivity to ozone and NO₂ emissions represented
- Difficult to apply at this scale

### Urban scale
- Not sensitive to changes in ozone or NO₂ emissions
- 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 NO$_2$ modelling is under development, 60% complete. Version will be available on the website by September

• NO$_2$ 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.
For information and contributions contact

Bruce Denby
bde@nilu.no

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