Development of a web guidance application

ETC/ACC CONTRIBUTION TO FAIRMODE WG1

Proposal by

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Aim of the application

- Ready available user friendly guidance for those that use models for regulatory puposes

- Indexed access to relevant guidance documents (HTML versions) – can be extended with links to IC documents

- First step towards support to harmonised reporting – development of reporting templates

Categorisation of the application

A1: Directive related applications

a. □ Assessment of air quality for estimation of exceedances
b. □ Assessment of source contributions □
c. □ Planning and scenario calculations
d. □ Air quality forecasting
e. □ Assessment of population exposure

A2: Spatial scale

a. □ Local/hotspot scale (Resolution: 1 - 100 m; extent: 1 km)
b. □ Urban/agglomerate scale (Resolution: 1 - 10 km; extent: 300 km)
c. □ Regional scale (Resolution: 10 - 50 km; extent: continental)

A3: Time resolution

a. □ Annual or seasonal mean
b. □ Daily mean (Daily percentiles)
c. □ Hourly mean (Hourly percentiles)

A4: Pollutant

a) □PM10, b) □PM2.5, c) □NO2, d) □NOX, e) □O3, f) □SO2, g) □Benzene, h) □PAH, i) □Heavy metals, j) □CO

A5: Estimated level of pollution (?)

a. □ In exceedance or above the upper assessment threshold
b. □ Above the lower assessment threshold
c. □ Below the lower assessment threshold
d. □ Unknown or uncertain

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Resulting in a list of example applications

IF (A1.b 'Source contributions' & A2.b 'Urban scale' & A4.a 'PM10')

a. □ Source contributions of natural sources
b. □ Source contributions of non-exhaust and exhaust emissions
c. □ Source contributions of industry
d. □ Source contributions from long range transport

IF (A1.a 'Assessment' & A2.b 'Urban scale' & A4.a 'NO2')

a. □ ✖ Assessment of annual mean NO2 in urban environments
b. □ Assessment of hourly mean NO2 in urban environments

IF (A1.a 'Assessment' & A2.a 'Local scale' & A4.a 'NO2')

a. □ Assessment of annual mean NO2 on open roads and street canyons
b. □ Assessment of hourly mean NO2 on open roads and street canyons

CHOOSE ONE OF THESE

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ETC/ACC work plan for 2010

FAIRMODE WG1 includes the development of this prototype web guidance for one example:

Assessment of annual mean NO_2 in urban environments

Assessment of annual mean NO_2 in urban environments

Quality assurance and documentation

- ❑ Has the model been documented including a complete description of parameterisations and numerical methods?
- ❑ Has the model been documented in the MDS? [Chapter 1.4]
- ❑ Has the model been validated locally? [Chapter 2.1]
- ❑ Has the model been validated in a similar environment?
- ❑ Has the uncertainty of the model been determined?
- ❑ Has the model been applied by an experienced modeller? [link]

Dispersion

- ❑ Has the dispersion model been validated against local NO_X measurements?
- ❑ Is the model type 'fit for purpose' for the spatial and temporal scales assessed?
- ❑ Does the dispersion model resolve the local/hotspot spatial scales?

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Assessment of annual mean NO_2 in urban environments

Meteorology

- Are the meteorological fields representative for the year and area assessed?
- Is the meteorological data fit for the dispersion model?
- Are topographic effects important for the application region? [Chapter 5.4]
- Are there episodic stagnation and recirculation events? [Chapter 5.4]
- Do the wind fields vary significantly over the application region?

Emissions

- Have emission data for all known sources been included?
- Is traffic congestion a problem and is it reflected in the modelling?
- Do the emission inventories for traffic include traffic counts and traffic speed per vehicle class?
- Have the emission inventories been updated in regard to fleet composition, and emission factors (both for NO and NO_2)?

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Assessment of annual mean NO_2 in urban environments

Other input data

- Is representative background or boundary condition data on ozone available and applied in the model?
- Are background NO_2 concentrations available for the assessment?
- Have monitoring data been used in combination with the model?

Chemical and physical processes

- If an empirical scheme is used to convert NO_X to NO_2 concentrations, is this based on local measurements? [Chapter 3.3]
- If an empirical scheme is used to convert NO_X to NO_2 concentrations, has the uncertainty in conversion been assessed?
- Does the model include photochemical reactions?
- Does the model include peroxy radical reactions? [Chapter 3.4]

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Discussion

- Is the proposal for this web guidance useful?
- How should it develop in the future?
- Should WG1 aim at developing this guidance and, based on its feedback, propose harmonised templates for reporting?

Thank you for your attention

NO_2 model guidance document: Chapter 1.4

Within Europe there are currently two repositories where an overview of meteorological and air quality models may be found. These are the COST 728/732 model inventory hosted by the University of Hamburg (http://www.mi.uni-hamburg.de/Model-Inventory.6295.0.html?&no_cache=1) and the Model Documentation System (MDS) established by the European Environment Agency (http://air-climate.eionet.europa.eu/databases/MDS/index_html). The first of these is more technically oriented towards model developers whilst the second is oriented towards model users, providing more general information.

NO_2 model guidance document: Chapter 2.1

Recommendations

All of the available Gaussian ORLS models listed above will provide reasonable estimates of the dispersion of line source emissions for the application areas in which they were developed. Inter-comparisons of some of these models have shown significant differences but these differences are also related to different input requirements as well as to model formulation.

If such a model is applied in a new application area then it should be validated with local observations when ever possible.

NO_2 model guidance document: Chapter 2.2

Recommendations

The models listed above can provide reasonable estimates of pollutant dispersion in street canyons for a wide range of street configurations and traffic loads. However, the ability to resolve details of the local geometry (e.g. lateral openings), either parametrically or explicitly, varies to a great extent between model formulations. For obtaining yearly averages and inter-annual trends, any one of the more simple models should suffice given accurate enough input conditions.

Despite their superior physical accuracy, CFD models can only provide estimates of typical "steady state" patterns of dispersion over short periods of time as well as sensitivities of the calculated fields to traffic emissions in the same temporal and spatial scales. Due to their high computational burden, such models are usually limited to simulations of steady state flows over periods of a few hours and for spatial scales covering a few hundreds of meters.

It is worth noting the following concluding statement in the street canyon review carried out by Vardoulakis et al. (2003) which provides a recommendation for authorities using the results of street canyon modelling: *"It should be stressed that all mathematical models need thorough validation against experimental data. The accuracy of their predictions is bounded by the accuracy of input data such as emission factors, traffic and meteorological data, street geometry, etc. Therefore, decision-makers should use modelling results cautiously, especially when relevant field measurements are not available."* [Return]

NO_2 model guidance document: Chapter 5.4

Recommendations

For almost all regional and urban scale applications the use of prognostic meteorological models is recommended as they provide the most physically consistent method of assessing meteorological fields. This is particularly important when episodic poor air quality occur due to recirculation of air masses. Though diagnostic wind fields may capture stagnation events they do not usually capture recirculation events, as prognostic models are capable of doing.

A description of the impact of the urban canopy on meteorological fields is preferred in a meteorological model as this can significantly influence the wind profiles in the lower levels of any prognostic model.

Models, or schemes within models, that include turbulence parameterisations that are suitable for low wind conditions are preferable for urban scale air quality applications over models, or schemes, that are developed only for weather prediction.

Prognostic meteorological models require application by expert users. It is highly recommended that only trained experts run and interpret these types of models.

Meteorological models should be validated against observations when applied to air quality assessment.

NO_2 model guidance document: Chapter 3.3

Recommendations

Statistical or empirically based conversion algorithms will generally provide a good approximation to the available measured annual mean concentrations of NO_2 in the domains and for the sites from which they were derived. However, it is never certain to what extent the available monitoring data is representative of the entire domain being modelled. Even so empirical algorithms can provide a good estimate of the annual mean NO_2, based on NO_x, in urban regions where sufficient measurements are available for their establishment.

It is not recommended to apply an empirical algorithm in an area for which it was not developed since the coefficients are very site specific.

Such algorithms are generally not appropriate for planning purposes since they will not provide the correct dynamic sensitivity to changes in emissions or changes in boundary conditions, unless these aspects are implicitly included in their formulation.

NO_2 model guidance document: Chapter 3.4

Recommendations

It is recommended in large and polluted urban areas that a chemical scheme that includes the reactions of nitrogen oxides, ozone and hydrocarbon radicals be used for modelling the concentration of NO_2 at the urban scale. This is particularly important when carrying out planning activities, where the effect of emission changes on NO_2 concentrations are to be determined, since changes in VOC emissions may have an impact on these.

Many of the atmospheric chemistry schemes developed for regional and global models include reactions on time scales much longer than the resident time scales of the pollutants in urban areas and as such introduce an additional complexity and computational time that is unnecessary. However, when nesting urban scale models with regional or global models it is always useful to apply the same chemical schemes to ensure continuity with the regional scale models. As such it is recommended to use the same chemical schemes in both the urban and the regional scale models.

[Return]

Chemistry: recommendations

'Fitness for purpose' assessment for NO_2 chemistry

State of the art
Conditionally applicable
Not fit for purpose

Chemistry	Empirical schemes	Photostationary and ozone limitting 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	

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