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Parallel session FAIRMODE

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EMISSION NEEDS AT LOCAL SCALE FOR AIR QUALITY MODELLING

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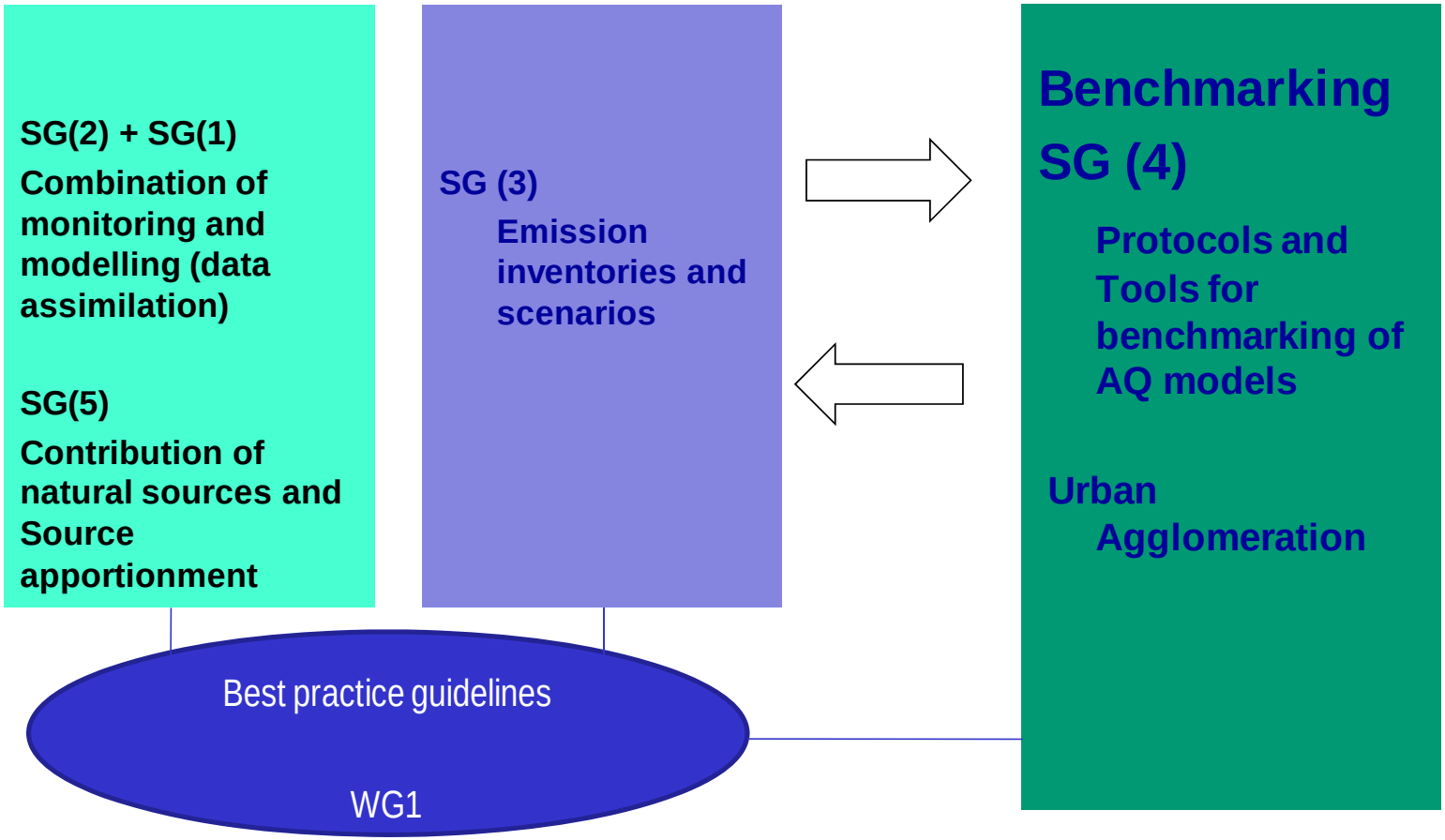
OUTLINE

1. Introduction
2. Available methodologies
3. Key issues for urban inventories
4. Key issues for urban projections
5. Conclusions

1. Introduction

FAIRMODE
Forum for air quality modelling in Europe

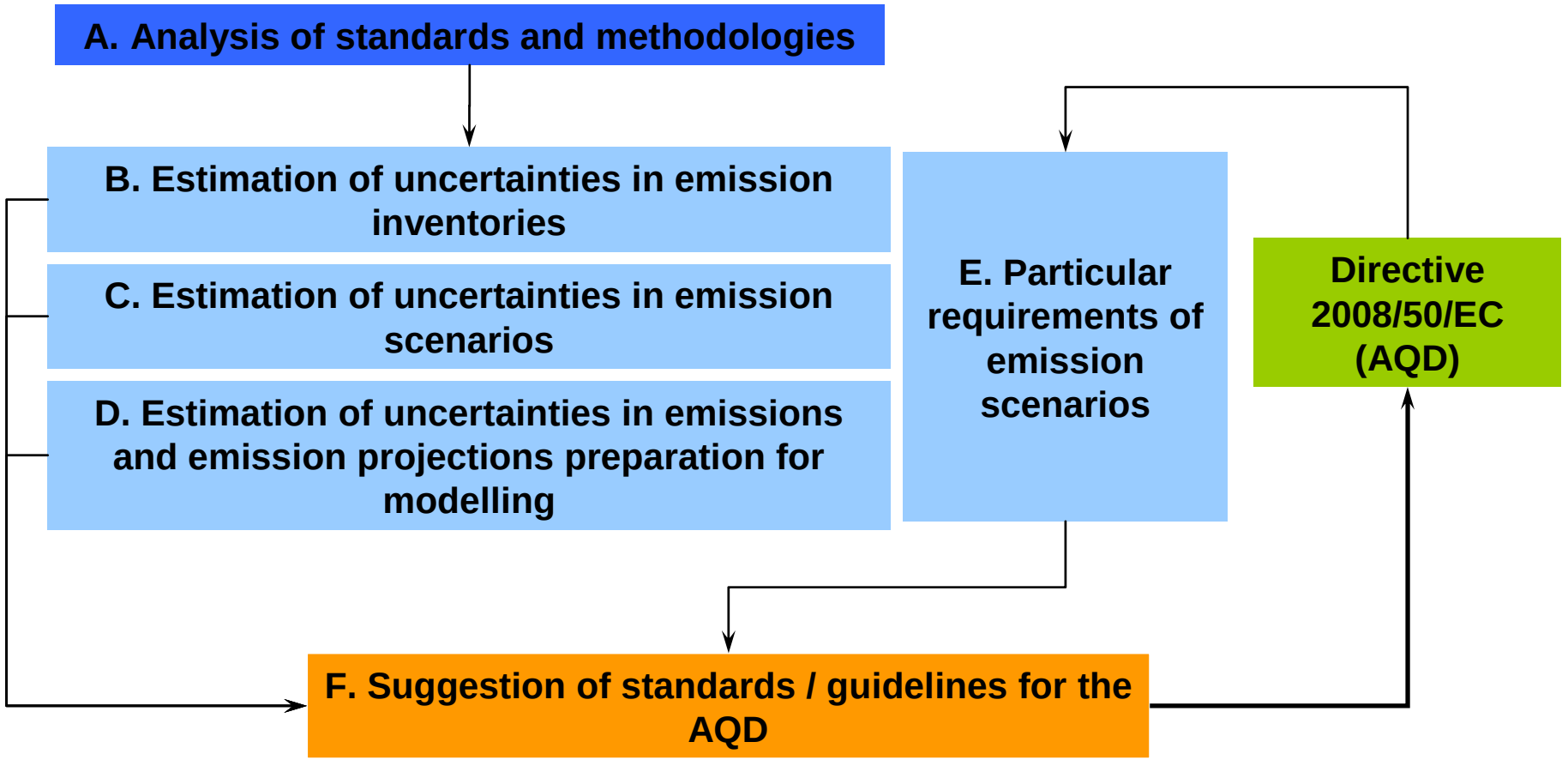
Flowchart as agreed on 2nd plenary meeting (Nov. 2009)



SG(3) objectives (urban emissions and projections)

- To identify and minimize errors and uncertainties involved in emissions and scenarios used in air quality models
- To provide guidelines or suggestions that may help to reach the model quality objectives (MQO)
- To discuss specific issues related to scenario development
- Make use of relevant information from existing procedures, projects and working groups, i.e. TFEIP-EMEP/EEA air pollutant emission inventory book

General approach



Tasks done

- Development of a “Background document on the emissions neeeds at local scale”
  - last revision December 2010
- Development of EI questionnaire

1. Individual questionnaire for each sector:
   i. Transport (SNAP 7 & 8)
   ii. Residential, commercial and institutional (SNAP 2 & 6)
   iii. Industry, energy and waste management (SNAP 1, 3, 4, 5 & 9)
   iv. Agriculture/Nature (SNAP 10 & 11)
2. Specific multi-choice questions depending on methodological approach:
   i. Top-down
   ii. Bottom-up
   iii. Hybrid

Example of the questionnaire for top-down methods

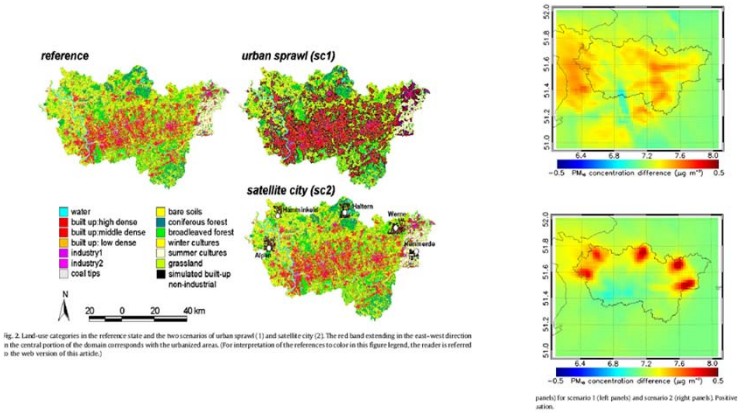
From which inventory do you downscale?	National EMEP/IIASA	regional/local non-regulatory	scientific literature	
What horizontal spatial resolution do you downscale to?	< 1 km^2	1 > km^2 < 5	>5 km^2	
How do you allocate the geographical distribution of emissions	by use of geographical data (e.g. land use)	by use of ancillary data (e.g. surrogates)	other	
What type of sources do you distinguish	Point Sources	Lineal Sources	Area Sources	Only gridded area sources
Are you providing vertical resolution for this sector?	YES	NO		
What is the temporal resolution for this sector?	Annual	Weekly	Daily	Hourly
What is the source for your emission factors?	EEA / CORINAIR	USEPA	National specific	HBEFA
What is the source for your chemical speciation?	EEA / CORINAIR	USEPA	National specific	Scientific literature

2. Available methodologies

- Air Pollution: specific information on urban inventories (e.g. Berlin, London, Paris)
- GreenHouse Gases:
  - Focused on carbon footprint → final energy consumption, and including sources outside the modelling domain
  - Examples: GHG protocol (http://www.ghgprotocol.org); guidebook to develop Sustainable Energy Action Plans (SEAP manual, http://www.eumayors.eu)
- Three main particular inventory features critical for AQ modelling:
  - Spatial allocation (surrogate definition, landuse and population density covers)
  - Temporal allocation (inventory categories and temporal patterns)
  - Chemical speciation (inventory categories, chemical mechanisms, cross-references)

There are no unified criteria or specific procedures for Air Quality emission inventory compilation at urban scale

1) Spatial resolution and emission allocation (Mensink et al., 2008, Cheng et al., 2008, Pisoni et al., 2010)



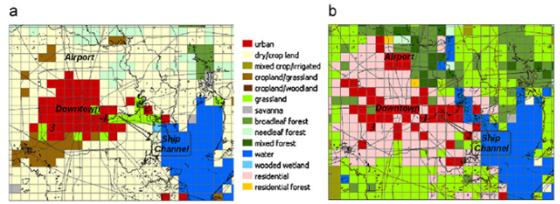


Fig. 1. Dominant land use types at 4-km grid resolution from (a) original USGS 25-category and (b) TFS-LULC data set. The location of the Houston downtown, ship channel and airport are identified. Number 1, 2 and 3 on the figures indicate the location of Clinton, La Porte and Bayland Park sites, respectively.

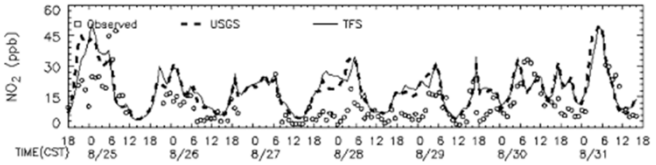


Fig. 5. Time series comparison of observation and simulation for O_3, CO, NO, NO_2, PAN, ethylene (ETH) and formaldehyde (HCHO) concentrations at La Porte (608) site (dashed line is from M1E1 and solid line is from M2E2 simulations.)

2) Temporal allocation (Wang et al., 2010, Kühlwein et al., 2002)

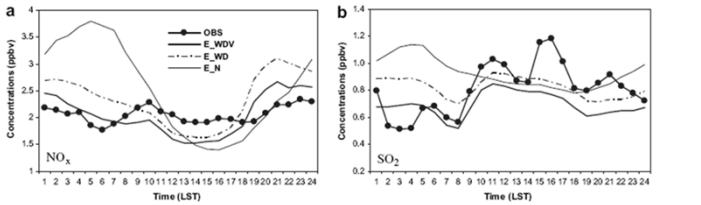


Fig. 4. The diurnal cycles of surface NO_x (a) and SO_2 (b) concentrations observed (OBS) and simulated by E_WDV, E_WD, and E_N at the EANET sites in Japan for July of 2001.

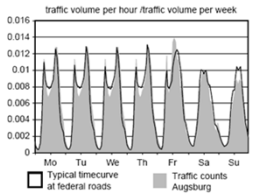
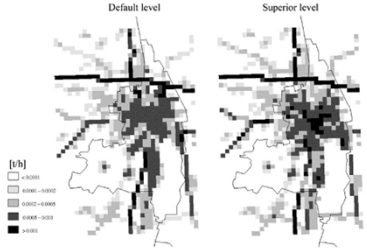
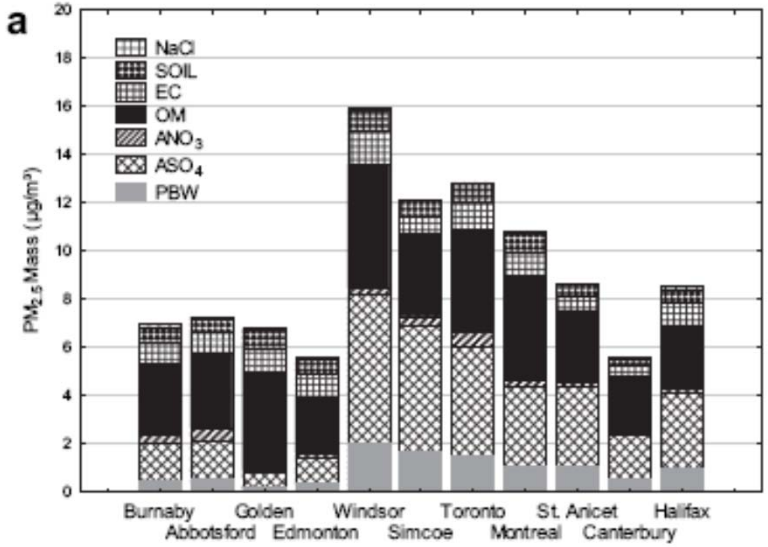


Fig. 3. Weekly variation of mean traffic volume data—comparison between a typical time curve (default precision level) and a time curve derived from traffic counts in Augsburg (superior precision level).



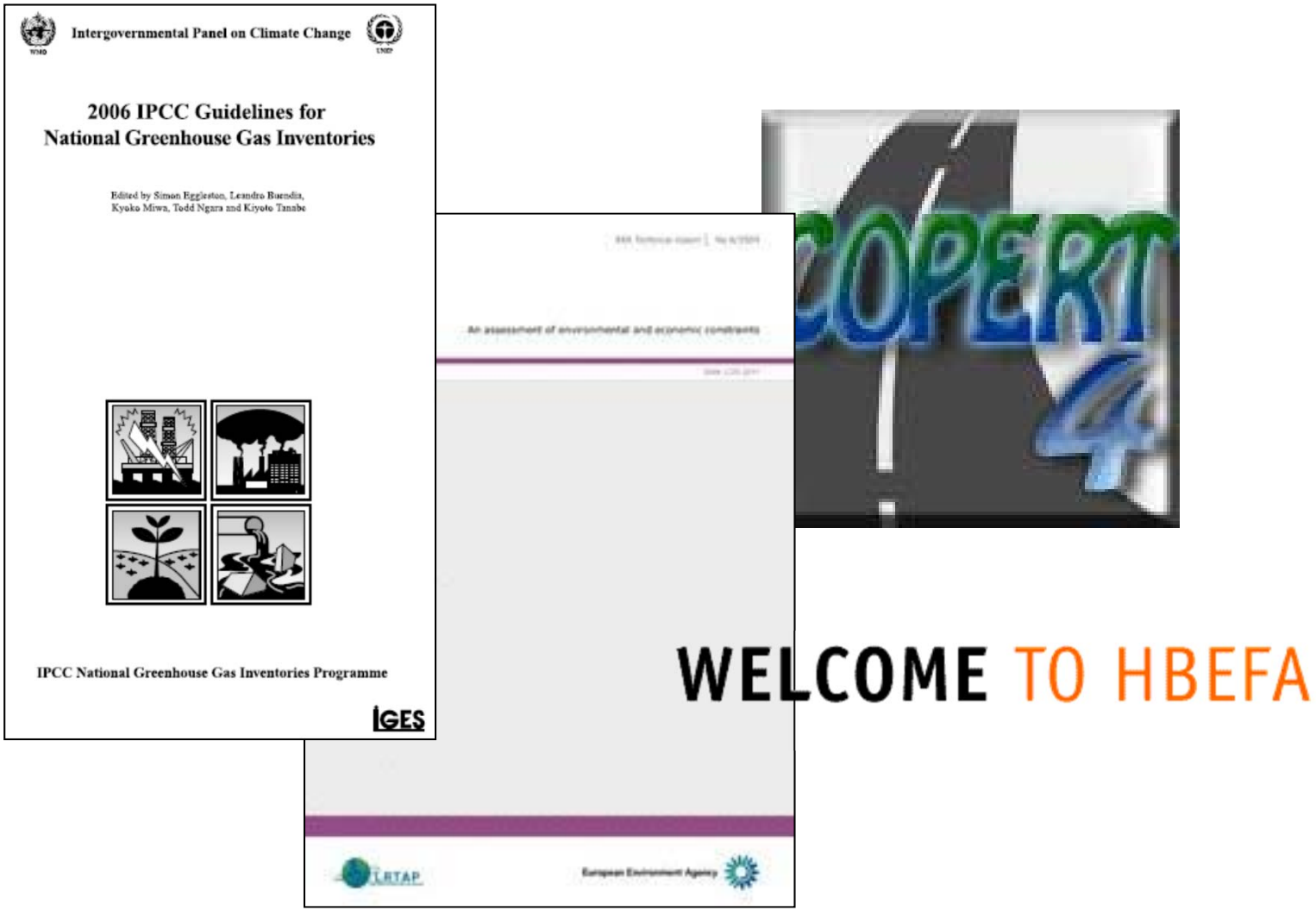
3) Chemical speciation (Dabek-Zlotorzynska et al., 2011)



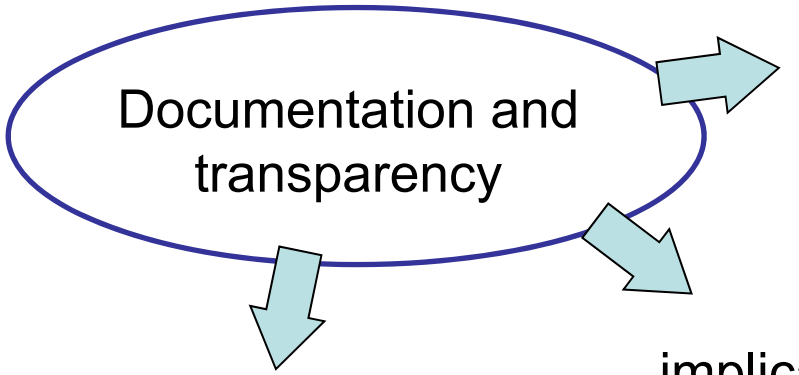
3. Key issues to develop urban emission inventories

- General considerations (representativeness):
  - appropriate for the modelling system and simulation purpose (spatial and temporal resolution)
  - consistency across domains and models (multiscale problems)
  - adequate cover of emission sources and pollutants paying special attention to main sources (e.g. road traffic)
  - flexible and detailed enough to reflect the outcome of relevant measures

1. Emission estimates must be based on a general methodology → transparent and sensible method



2. Checks and documentation:
   - sources included in the inventory
   - comparison of emission factors used for the main sectors and pollutants
   - aggregation of the bottom-up inventory to a common geographic reference and comparison with the top-down approach
   - references and comparison of statistics used, differences in the statistical information used as activity rates (sources, criteria, updates)



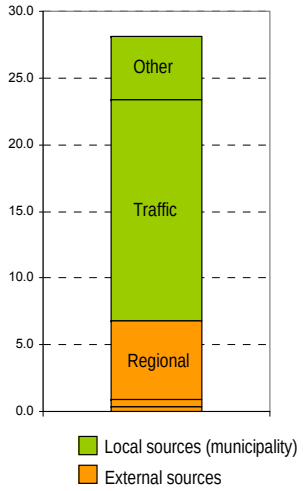
reasons for potential differences

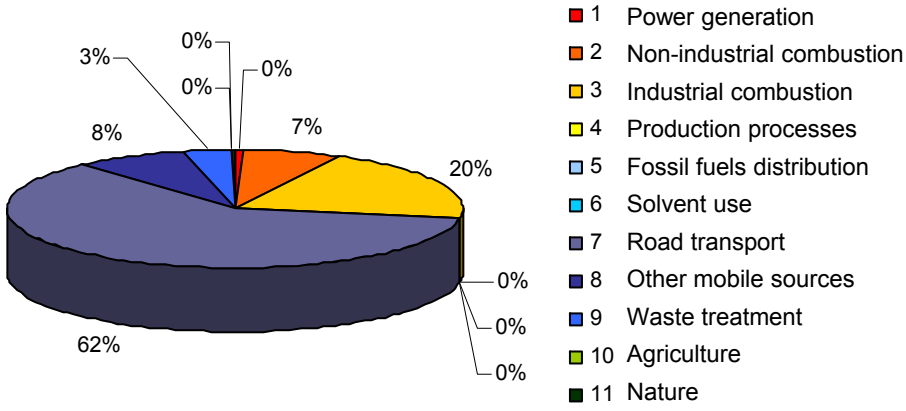
limitations and implications/recommendations for the interpretation of the modelling results

comparativeness

3. Adequate cover of pollutants and sources:

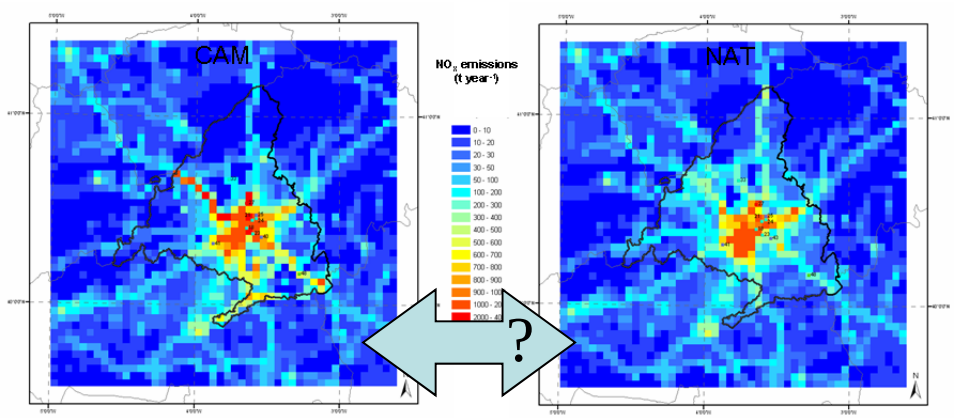
- Complete set of sectors with relevant emissions depending on the simulation purpose (including very specific activities)



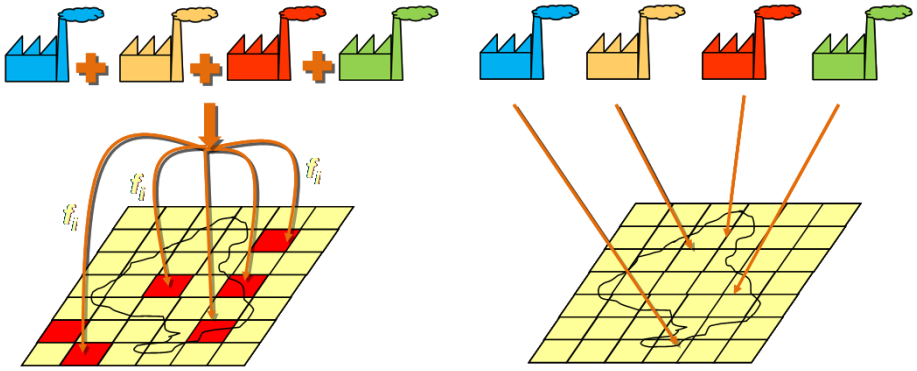


- Include a rough estimation for those with a priori lower emissions (e.g. from larger-scale inventories)
- In agreement with the specific requirements of the modelling system (e.g. NOx speciation)
- Discuss the convenience of expert judgments or non specific references (a simpler model, using specific and controlled information, may result better fitted for purpose)

4. Limit uncertainty:
   - Emission estimates based on sound E.F. databases, accepted and well-documented software, etc.
   - Activity data from observations and official, well-documented statistics
   - Emission measurements, or facility-specific statistics (bottom-up approach) are preferred
   - If more than one inventory exist for a particular urban area, a comparison may be useful to understand uncertainty sources:
     - scope (sources, boundaries,etc.)
     - basic statistics (energy balances, traffic data, etc.)
     - methodological approach (bottom up, top down)



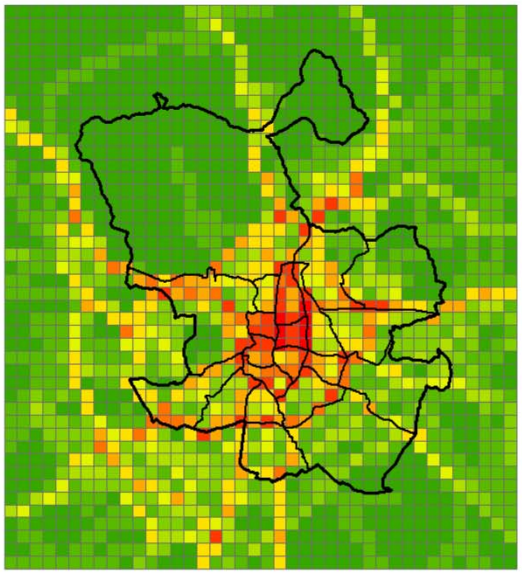
5. Accurate spatial and temporal distribution:

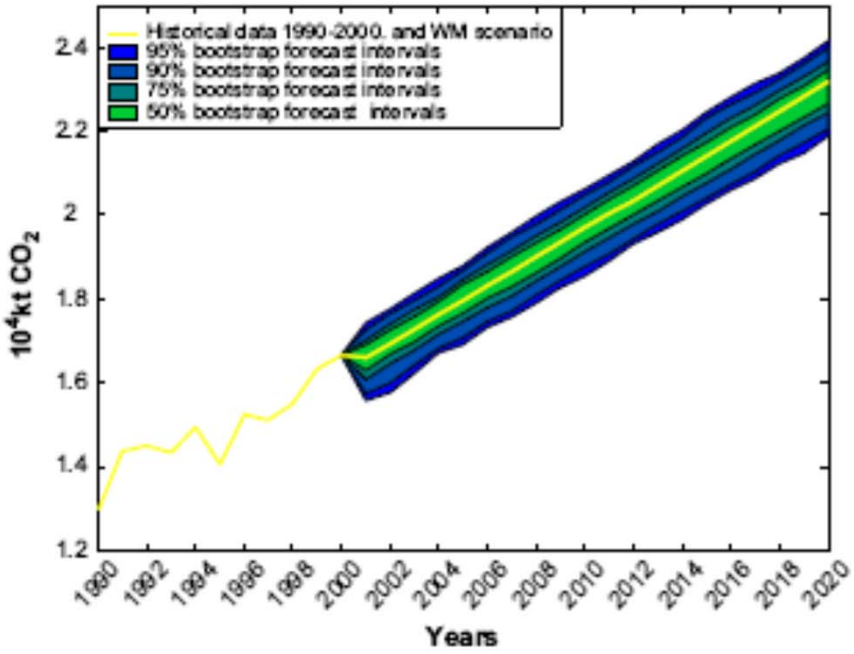


- The bottom-up approach (geo-referenced emissions) is preferred when there is information enough to support a very detailed emission estimation
- A top-down approach in combination with an updated high-resolution landuse/population cover may provide a valid picture of general emission distribution pattern
- Vertical allocation of emissions for 3D models should be suitable for the vertical model structure. Release conditions for buoyant emissions should be dealt with properly for point sources
- Hourly measured emissions are to be used if possible. If measurements are unavailable, source-specific temporal patterns must be used

4. Key issues to develop urban emission projections

- Useful for:
  - short term forecasting
  - scenario analysis
- General concerns:
  - To meet the same requirements as for the emission inventory
  - Representativeness also depends on the accuracy of the simulation of the impact (in terms of emissions) that a particular measure would have if implemented

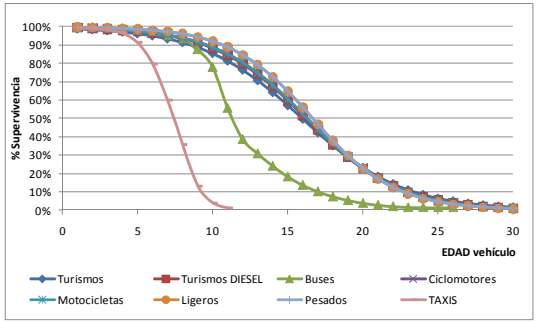


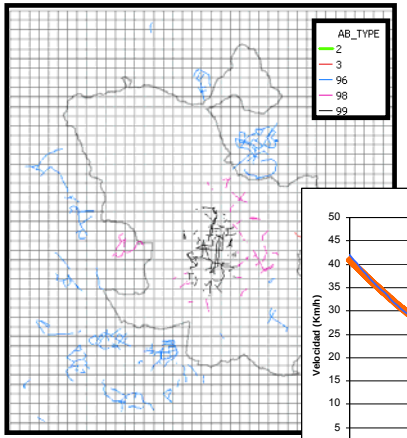


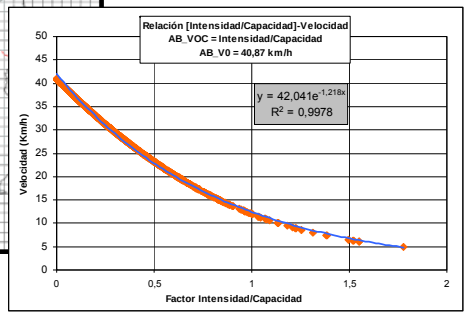
1. The level of detail should be consistent with the corresponding detail in the base year emission inventory and in accordance with the measures to be simulated:

- Low emission zones (access restrictions by vehicle type, age or technology)
- Speed limits
- Penetration of new technologies (combustion engines standards, hybrid and electric vehicles, etc.)
- Specific fleet turnover and limitations by segments (buses, taxis, light duty vehicles, passenger cars, etc.)
- Measures to alleviate urban congestion

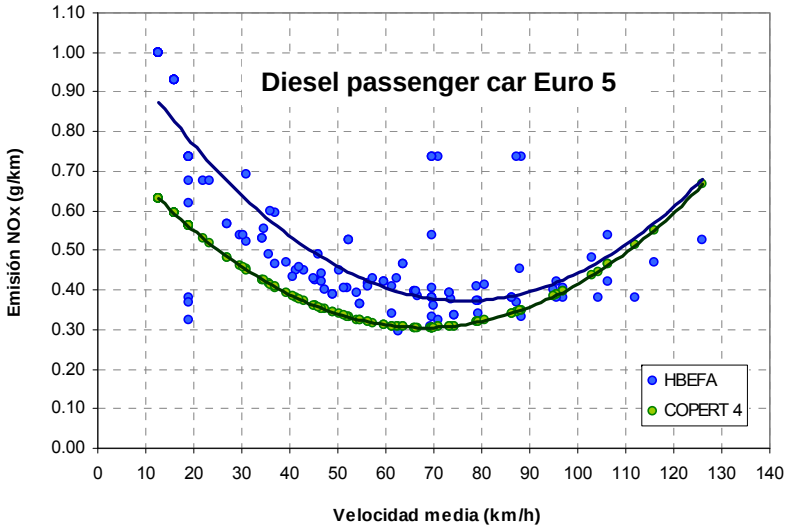
Impact on the variables/parameters involved in emission computation

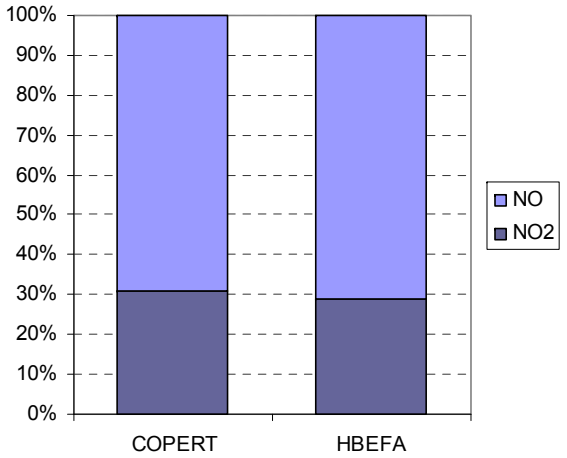






2. Future-year emission estimates should be ideally based on the same computation algorithms





3. Variation in the emission factors and/or activity levels should be well documented and supported by consistent emission databases, activity level projections and plan targets

4. Information regarding the methods considered to assess the measures effectiveness is necessary for transparency (particularly for non-technical measures)

5. Urban emission scenarios should reflect the impact of Policies & Measures (P&M) at different administrative level (i.e., European, national, regional, and local). Special attention should be paid to avoid double-counting of P&M effects

6. Measures likelihood should be assessed to avoid distortion in the results (include, at least, references on the instruments envisaged to implement the P&M)

7. Check if there is projected any change on either temporal or spatial emission patterns

8. A detailed description and documentation of the underlying hypotheses considered, both for the measurements included and the emission estimation methodology should be included, paying special attention to critical parameters: i.e. NO_2/NO_X ratio

4. Summary and conclusions

- Estimation of urban emissions and projections is essential for AQ assessment, development of AQ action plans, and short-term forecast
- They are a key input to determine the origin of exceedances to limit values and to identify means to reduce them in the future
- General top down approaches for downscaling emissions from regional to urban scale may not be sustable because they do not enable the necessary link between measures, plans and emission reductions at urban scale
- Some recommendations were prepared to help emission inventory and projections compilers to improve their work:

Basic recommendations for Emission Inventories

1. Appropriate for the modelling system and simulation purpose:
   - temporal resolution
   - chemical speciation
   - spatial allocation (horizontal and vertical)
2. Consistent across domains and models
   - computation methods
   - data and statistics
   - administrative divisions, official inventories
3. All sources included in the inventory (emphasis on the most relevant sectors)
4. Flexible and detailed enough to reflect the outcome of relevant measures
5. Well documented

Basic recommendations for Emission Projections

1. Abatement measures focused on the sectors responsible for emissions and exceedances (source apportionment)
2. Consistent with emission model/methods used for the reference year
3. Plans and measures simulated as accurately as possible, highlighting critical hypotheses and parameters
4. Transparent and well documented

THANK YOU FOR YOUR ATTENTION!

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