Evaluating the influence of regional gridded emissions distribution on air quality simulation

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Abstract

The aim of this work is the assessment of changes in modelled regional air quality, by the comparison of the EMEP inventory vs. the application of a regional inventory based in a mixed top-down and bottom-up methodology over the NW of the Iberian Peninsula. Air quality simulations were carried out with the CHIMERE model for an ozone episode in 2008. Comparison against measurements using the DeltaTool show better scores for the regional inventory daily maxima 8-hr and 1-hr ozone simulation results.
Keywords: emission inventories, bottom-up and top-down, ozone simulations, performance evaluation

Introduction

The compilation of emission information is a critical stage in air quality modeling. The uncertainties related to emissions inventories are unavoidable, as all the emissions sources cannot be monitored individually. These uncertainties are partly responsible for the lack of accuracy in results obtained by air quality modeling. Thus, a continuous development is needed to improve those results.

Typically bottom-up approaches are a very time-consuming task, due to the large amount of information handled. On the other side, the accurate distribution of emissions required in regional applications is not always well represented by using a top-down approach. The EMEP grid emission inventory with a spatial resolution of 50 km x 50 km is taken as reference in many European research applications. However, the inner variability within each cell of this grid is not considered, affecting the final result of air quality simulations (Denby et al 2011; Pulles & Heslinga 2010).

Methodology

The CHIMERE model (INERIS 2008) was applied to a domain covering the NW of Iberian Peninsula (from 10.0°W to 6.0°W, and 41.0°N to 44.8°N), comprising Galicia and part of northern Portugal, with an horizontal resolution of 3 x 3 km^2. Meteorological fields were provided by WRF simulations (Saavedra et al 2012). 1-15 August 2007 period including ozone peaks was considered.

A mixed top-down and bottom-up methodology was designed and applied to estimate year 2008 emissions. For point sources, a bottom-up validated inventory provided by the Galician regional government was used (Dios et al 2012); major road traffic sources (>50000 inhabitants cities and highways) were also obtained by bottom-up approach; other emissions were estimated following a top-down approach based in the EMEP inventory (CEIP 2008) with disaggregation criteria dependent on the source type (Butler et al 2008; Karvosenoja 2008). For the Portuguese region, the available inventory by municipality (Monteiro et al 2007) was segregated to the same high grid resolution using a GIS to process data.

Ozone results were compared to measurements using the DeltaTool developed in the scope of FAIRMODE (Thunis et al. 2011).

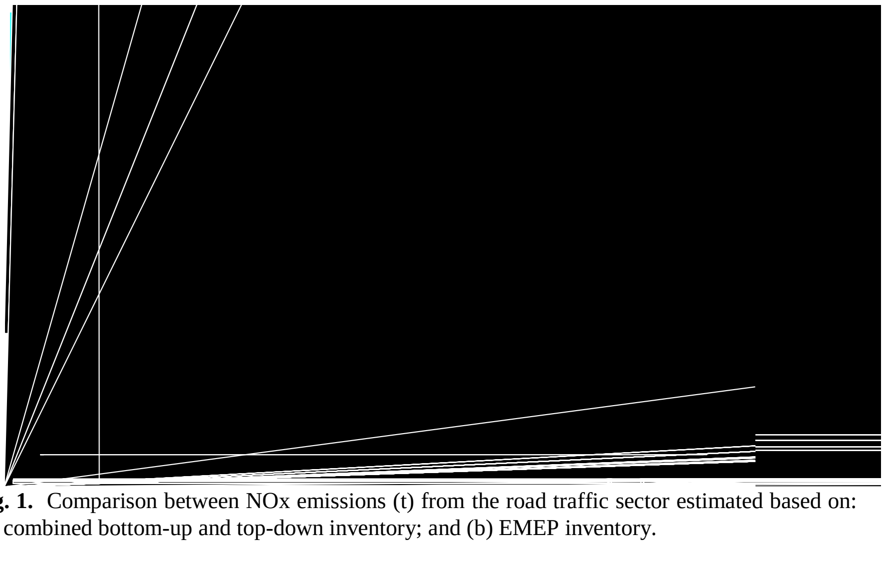


Fig. 1. Comparison between NOx emissions (t) from the road traffic sector estimated based on: (a) combined bottom-up and top-down inventory; and (b) EMEP inventory.

Results and concluding remarks

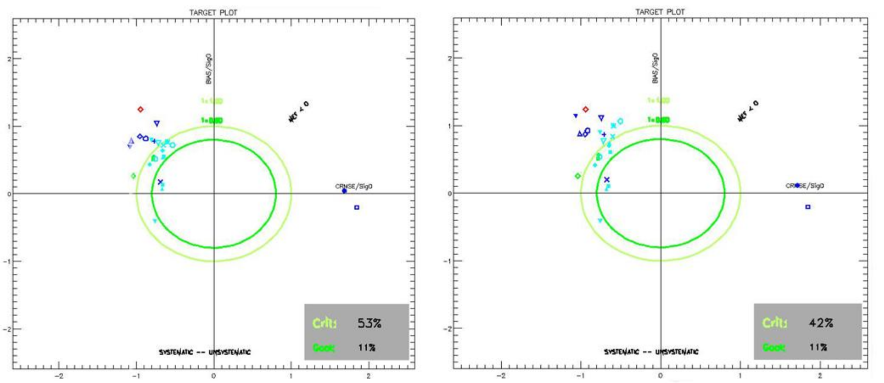
Figure 1 shows as an example the spatial distribution of annual nitrogen oxides (NOx) emissions from road traffic as estimated by the mixed approach and as directly coming from the EMEP inventory.

From the comparison of simulation results vs. measurements using the DeltaTool ozone daily maximum 8h mean values are always within the criteria for all DeltaTool scores (Table 1), with the exception of the target for ozone estimated with the EMEP inventory.

Table 1. Scores diagrams (DeltaTool) for the simulations of the daily max 8h mean ozone for (a) combined bottom-up and top-down inventory, and (b) EMEP inventory.

No of stations: 26 valid / 56 selected			
INDIC	**(Crit - Goal)**	**(a)** **90% percentile**	**(b)** **90% percentile**
MFB	(0.30 - 0.15)	0.22	0.27
FAC2	(0.50 - 0.60)	1.00	1.00
MFE	(0.45 - 0.30)	0.22	0.27
IOA	(0.65 - 0.78)	0.74	0.72
R	(0.65 - 0.78)	0.73	0.74
TARGET	(1.0 - 0.80)	0.97	1.08
RDE	(0.50 - 0.42)	0.22	0.22
RPE	(0.50 - 0.42)	0.23	0.28

The scale ranges from bad to good performances levels, with colored circles: red for worse than criteria, light green for between criteria and goal, dark green for better than goal.



(a) (b)

Fig. 2. Target plots for the CHIMERE simulation of the hourly maximum O_3 from DeltaTool for (a) combined bottom-up and top-down inventory and (b) EMEP inventory.

Regarding the EMEP emissions simulations, only TARGET score is not accomplished, which is mainly due to a higher overestimation of the O_3 concentrations, according to the BIAS/σ plotted in Fig. 2.

In general ozone simulations were better using the mixed top-down / bottom-up methodology to estimate emissions. This methodology is based on EMEP and other public information sources, which are easily updated and spatially distributed and analysed using geographical parameters.

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