Centralised and national submissions of transport emissions

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Summary

This report has been prepared by LAT/AUTh on behalf of the European Topic Centre on Air Emissions and Climate Change of the European Environment Agency. The objective of the report is to compare national submissions of transport emissions, as submitted to CLRTAP and UNFCCC by the parties, and centralised emissions calculated with COPERT 4 for all EEA countries (excluding Iceland and Lichtenstein for which no data were available). Results and main conclusions of this comparison have been presented to the parties for their consideration and review of both input data and emissions results for years 2000 and 2005. Some interesting findings are derived based on the feedback received from the parties.

Keywords

National submissions, COPERT 4, UNFCCC, LRTAP, emissions

Internet reference

http://adonis.meng.auth.gr/centralized/

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1 Background and objectives

The main objective of the current exercise is to compare centralised and national submissions of transport emissions, with emphasis on road transport. This means to check whether centralised calculations are consistent with national data and thus to enable quality control by identifying, and possibly also explaining cases where national data exhibit unusual departures from centrally calculated emissions.

The main reasons to attempt this comparison are the following:

1. European policy is mostly based on centralised tools to calculate and project emissions. For road-transport, the TREMOVE[1] model is being used by the European Commission, and includes centralised vehicle stock information for EU27 member states, collected in the framework of research and policy support projects. However, centralised estimates and projections may differ from national ones and this produces conflicts related to state of environment, emissions trading, etc. The dataset used in this report will be the main input to the new TREMOVE version being prepared.

2. Several of the TERM indicators[2] are produced on the basis of models, such as the TREMOVE model. For example, TERM 27 on the overall energy efficiency, and TERM 28 on specific emissions of air pollutants are based on such modelling approaches. Therefore, it is important to recognise how much these models capture the actual trends reported in each country.

3. Some of the reporting parties use own methods and tools to estimate emissions. Comparison of these data with centralised calculations, using an established method (COPERT 4) may provide an additional tool in the quality control of the submissions.

For at least these three reasons, it was considered useful to attempt a comparison between national and centralised estimates of road transport emission inventories. This would assist in quantifying differences, understand their origins, and propose methods to correct erroneous results, if such were identified. In the past, the EEA has supported a similar exercise, aiming at understanding differences in projections and emission calculations (EEA Technical Report 74)[3].

This report provides only a summary of the results. Detailed results, available per country and per vehicle category are available in the accompanying Excel spreadsheet. Also, input data for the calculations are available at http://adonis.meng.auth.gr/centralized/. Results and main conclusions have been presented to the parties for their consideration and review and an

[1] http://www.tremove.org
[2] http://www.eea.europa.eu/themes/transport/indicators
[3] http://www.eea.europa.eu/publications/technical_report_2002_74

action list was compiled to provide some guidance on the response requested by them. This report includes parties' responses and discusses the main findings.

2 Data collected from national submissions

With regard to the main pollutants (CO, VOC, NOx, PM), emission data from road transport were collected from the official 2008 submissions of the Parties to the Convention on Long Range Transboundary Air Pollution (CLRTAP) via the UNECE secretariat[4]. For most countries, emission data were available also at the vehicle/process sub-category level specified in the NFR, i.e. passenger cars, light duty vehicles, heavy duty vehicles, mopeds & motorcycles, gasoline evaporation, automobile tyre & brake wear, and road abrasion.

Greenhouse Gas (GHG) emission data were collected from the 2009 national inventory submissions to the United Nations Framework Convention on Climate Change (UNFCCC)[5]. CO_2 and fuel consumption data per type of fuel (gasoline, diesel, LPG) from road transport were extracted from the 2009 submissions. A distinction into vehicle categories is not required by UNFCCC and therefore no such data have been made available.

This emission / consumption information has been collected for the EEA32 countries, excluding Iceland and Liechtenstein, for the years 2000 and 2005. The reason for excluding these two countries is that no centralised stock and activity datasets were available for these two parties. Although data completeness is in general satisfactory, some data gaps exist, particularly referring to the year 2000 (see Table 1 for countries where data are missing).

3 Calculation of centralised emissions estimates

In 2008, the European Commission (DG Environment) collected and produced streamlined road stock and activity data for all EU27 member-states and, in addition, for Croatia, Norway, Switzerland and Turkey. These data were collected to feed COPERT and TREMOVE models (FLEETS project[6]). Detailed (down to vehicle technology level) data have been collected for the year 2005 (and in some countries for the year 2006). Historic data at a vehicle category level are available at least back to 1995 for all countries. The data that have been made available were streamlined and gap-filled by means of mathematical models.

[4] Downloaded from http://www.ceip.at/emission-data-webdab/emission-as-reported-by-parties/
[5] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4771.php
[6] http://lat.eng.auth.gr/copert, link under the "Data" menu-item.

Transport activity data from the FLEETS database were collected for EEA30 countries (except Iceland and Liechtenstein) for the years 2000 and 2005. These included all data that are required as input to COPERT, such as vehicle stock, mileage, speeds, driving shares, etc.

These data were first fed to COPERT 4 (v6.1) and the fuel consumption per fuel type was estimated for each country. These values were then compared to national fuel use statistics, as submitted to UNFCCC. In cases of differences between calculated and statistical values the annual mileage of the vehicle types operating on the particular fuel was proportionally adjusted to fit the nationally reported fuel consumption. After this mileage 'calibration', calculations were repeated, and GHG and pollutant emissions were calculated for the years 2000 and 2005.

Table 3-1: Road transport emissions (kt) from national submissions ("national") and calculated with COPERT 4 ("centralised")

	National 2000	Centralised 2000	Excluded countries	National 2005	Centralised 2005	Excluded countries
EU15						
CO	14928	14781	GR, LU	9506	9393	LU
VOC	2472	2298	GR, LU	1492	1351	LU
NOx	4820	4863	GR, LU	3918	4039	LU
$PM_{2.5}$	250	273	GR, LU	209	227	GR, LU
CO_2	763451	772414	LU	793188	802966	LU
EU27						
CO	15343	15159	BG,CZ,GR,HU LT,LU,MT,PL,RO	11735	11300	LU, MT
VOC	2538	2356	BG,CZ,GR,HU LT,LU,PL,RO	1861	1643	LU
NOx	4918	4970	BG,CZ,GR,HU,LT LU,PL,RO	4694	4710	LU
$PM_{2.5}$	256	278	BG,CZ,GR,HU,LT LU,PL,RO	246	256	BG, GR, LU, RO
CO_2	842852	854144	CY,LU,MT	896018	908538	CY, LU, MT
EEA30						
CO	15969	15892	BG,CZ,GR,HU,LT LU,MT,PL,RO,TR	12154	11706	LU, MT, TR
VOC	2640	2455	BG,CZ,GR,HU,LT LU,PL,RO,TR	1929	1696	LU, TR
NOx	5076	5127	BG,CZ,GR,HU,LT LU,PL,RO,TR	4813	4815	LU, TR
$PM_{2.5}$	265	285	BG,CZ,GR,HU,LT LU,PL,RO,TR	255	262	BG,GR,LU,RO,TR
CO_2	897363	911280	CY,LU,MT	955508	967941	CY, LU, MT

4 Comparison of emissions

Emission data collected from national submissions were compared to respective emissions calculated with COPERT 4 and the results for the individual Parties are presented in the accompanying Excel spreadsheet. In this report, EU15, EU27 and EEA30 totals have been calculated and are summarised in Table 3-1 at an aggregated level (not differentiated per vehicle category).

In order for the results of the two approaches to be directly comparable, only those countries having submitted national data were included in the calculations performed with COPERT 4 for the above country groupings. The number of countries excluded from the calculations for each pollutant is considerably lower for 2005 compared to 2000. These countries are clearly indicated in Table 3-1. EEA30 results for 2000 and 2005 are graphically represented in Figure 4-1 and Figure 4-2 respectively, where the contribution of each sub-category (according to NFR as explained previously) is also shown.

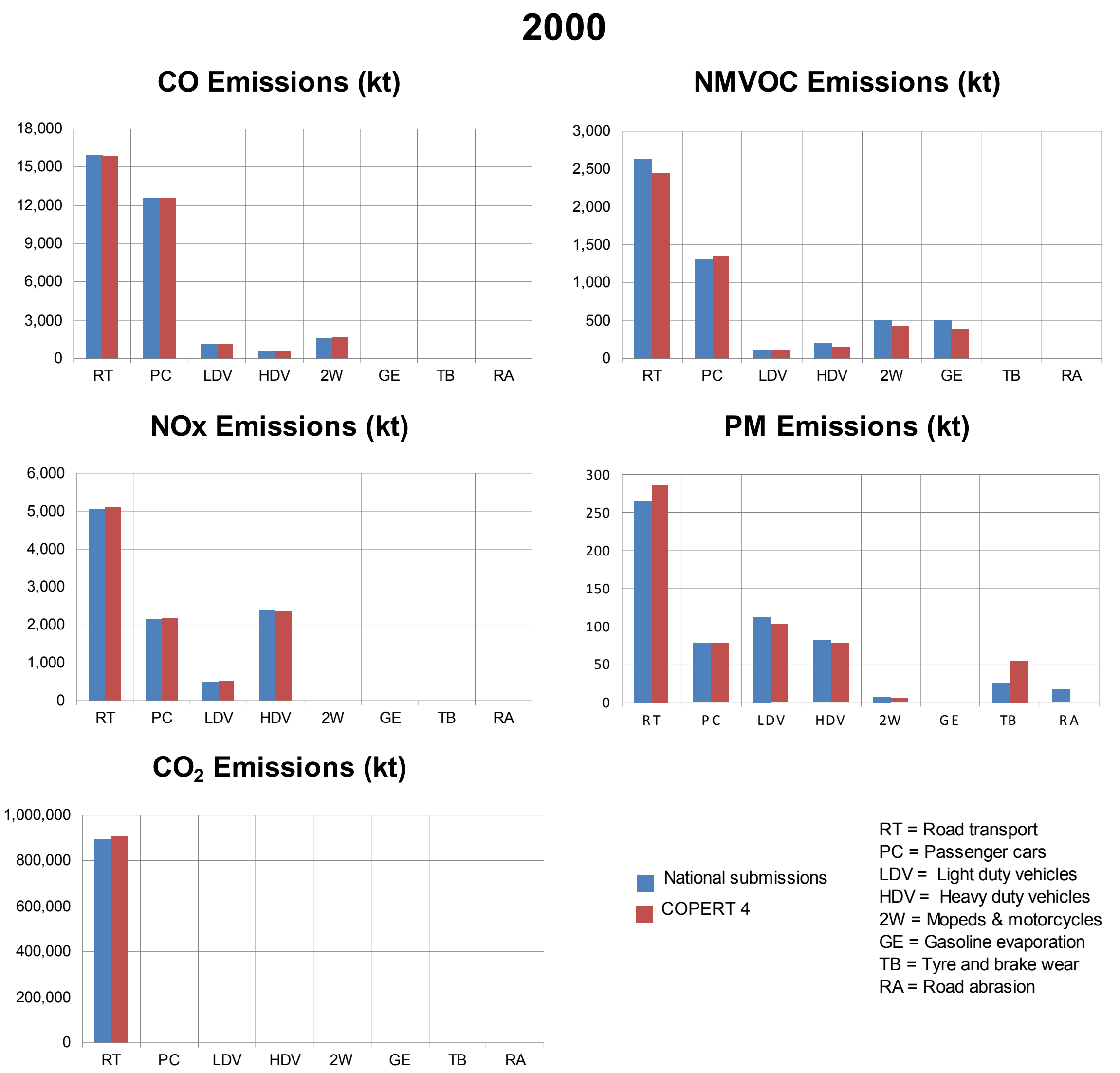

Figure 4-1: Comparison of national and central emission estimates per road transport category for the year 2000 in the EEA30 countries (those not included summarized in Table 3-1)

The comparison shows that the difference of the individual vehicle categories is generally larger than the percentage difference of the centralised and national submissions for the whole road transport. This means that individual differences generally counterbalance each other, or that there is no significant bias of the centralised over the national calculations.

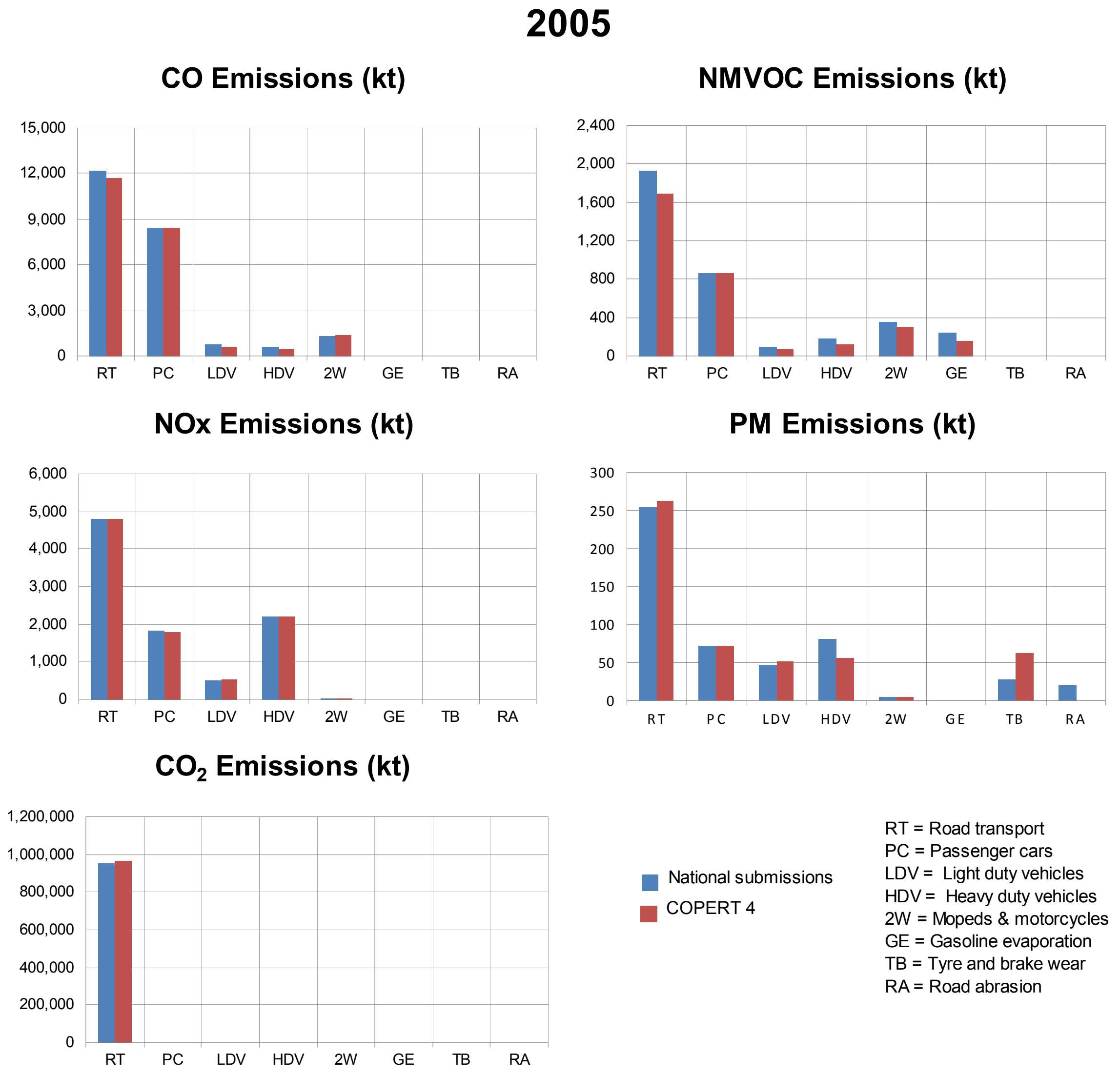

Figure 4-2: Comparison of national and central emission estimates per road transport category for the year 2000 in the EEA30 countries (those not included summarized in Table 3-1)

In addition to the absolute emission estimates, indicators expressed as g of pollutant per kg of fuel consumed have been produced and are summarised in Table 4-1. The same countries excluded from the calculations in the previous cases, have also been excluded here.

Table 4-1: Indicators (in g/kg fuel) produced based on emissions and fuel consumption data from national submissions and calculated with COPERT 4

	National 2000	Centralised 2000	Excluded countries	National 2005	Centralised 2005	Excluded countries
EU15						
CO	61.1	60.5	GR, LU	37.4	37.0	LU
VOC	10.1	9.4	GR, LU	5.9	5.3	LU
NOx	19.7	19.9	GR, LU	15.4	15.9	LU
$PM_{2.5}$	1.0	1.1	GR, LU	0.8	0.9	GR, LU
CO_2	3125.8	3162.5	LU	3124.3	3162.8	LU
EU27						
CO	56.8	56.1	BG,CZ,GR,HU LT,LU,MT,PL,RO	40.8	39.3	LU, MT
VOC	9.4	8.7	BG,CZ,GR,HU LT,LU,PL,RO	6.5	5.7	LU
NOx	18.2	18.4	BG,CZ,GR,HU,LT LU,PL,RO	16.3	16.4	LU
$PM_{2.5}$	0.9	1.0	BG,CZ,GR,HU,LT LU,PL,RO	0.9	0.9	BG, GR, LU, RO
CO_2	3120.4	3162.2	CY,LU,MT	3118.3	3161.9	CY, LU, MT
EEA30						
CO	55.4	55.1	BG,CZ,GR,HU,LT LU,MT,PL,RO,TR	39.7	38.2	LU, MT, TR
VOC	9.2	8.5	BG,CZ,GR,HU,LT LU,PL,RO,TR	6.3	5.5	LU, TR
NOx	17.6	17.8	BG,CZ,GR,HU,LT LU,PL,RO,TR	15.7	15.7	LU, TR
$PM_{2.5}$	0.9	1.0	BG,CZ,GR,HU,LT LU,PL,RO,TR	0.8	0.9	BG,GR,LU,RO,TR
CO_2	3113.4	3161.6	CY,LU,MT	3120.8	3161.4	CY, LU, MT

Figure 4-3 shows the indicators (g/kg of fuel) per pollutant and country. The indicators have been classified in an increasing order, i.e. starting from the country with the lowest indicator per pollutant. The classification order has been based on the national submissions. Figure 4-4 shows the ratio of centralised over national emissions, classified again in an increasing order. Two lines indicating ±20 % deviation from unity are also shown for each ratio.

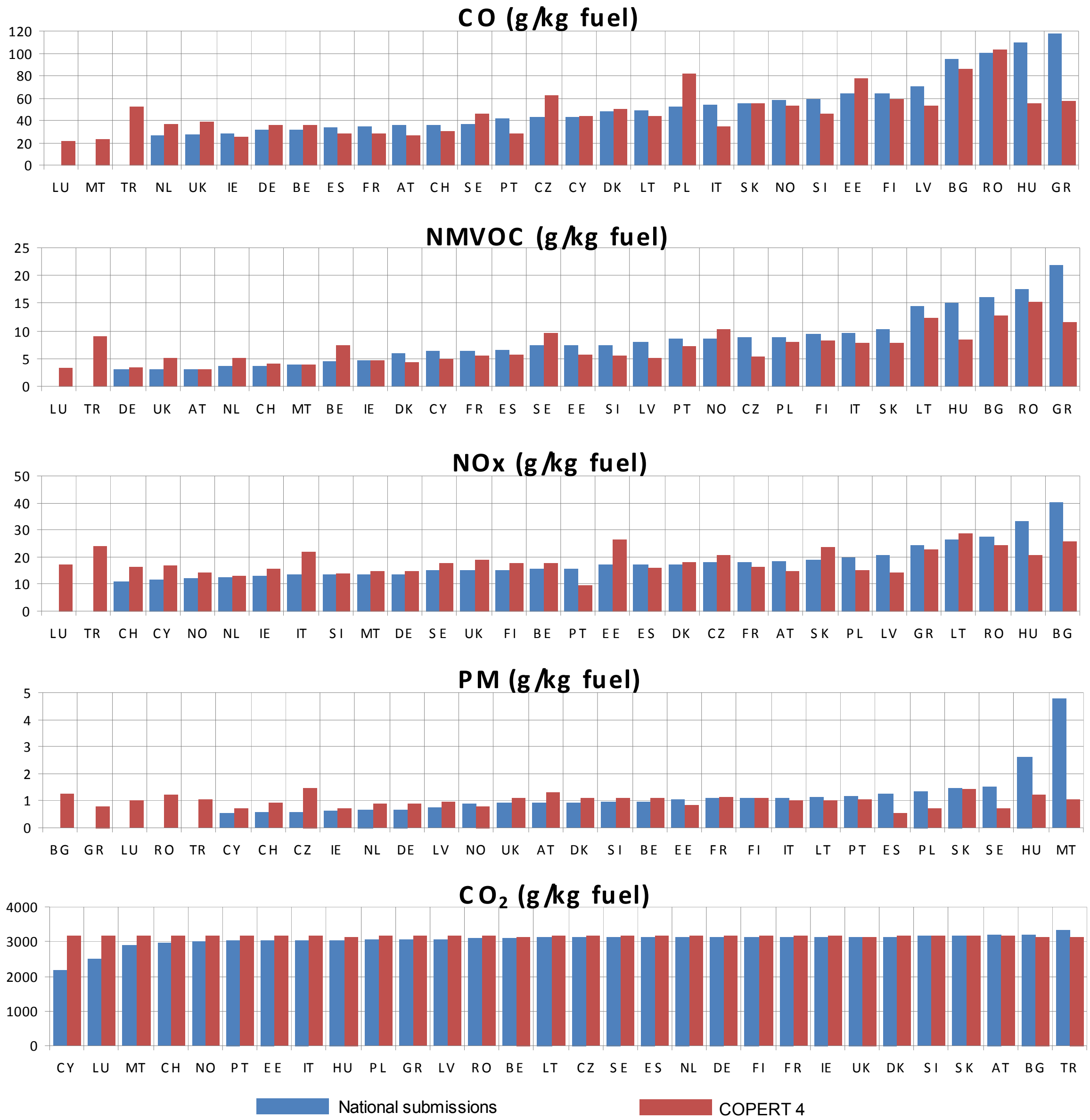

Figure 4-3: Country-specific indicators (in g/kg fuel) in increasing national emissions order compared with COPERT 4 calculations for the year 2005

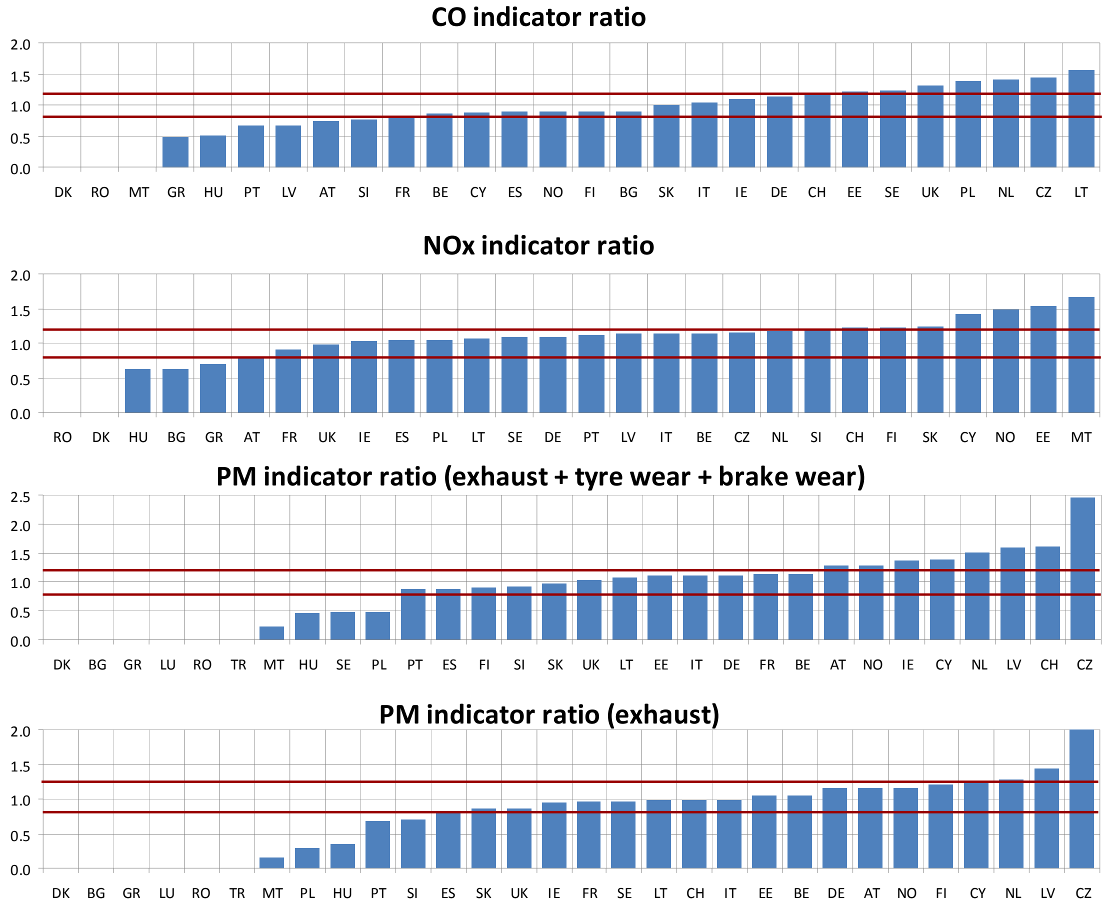

Figure 4-4: Country-specific ratio of centralised vs national emissions for the year 2005

5 Action List

In order to better understand differences between centralised and national calculations, countries were requested to review the data and make recommendations and suggestions according to this review. The list of questions following was used as a guide to the countries on how to review the data and provide recommendations. Alternative ways of review were also welcomed.

Input Data: Check centralised input data for years 2000 and 2005. These data (also for other years) are available for all EEA32 countries, except Iceland and Liechtenstein, at http://adonis.meng.auth.gr/centralized/. Items to be looked at (prioritized):

- Do LRTAP submissions correspond to the UNFCCC fuel consumption? If not, what is the fuel consumption that should be used for the years 2000 and 2005?
  - This question aimed to clarify the extent of tank tourism, i.e. transport which is conducted in the country but is not fuelled in the country or vice versa. UNFCCC submissions correspond to the fuel sold in the country. On the other hand CLRTAP submissions correspond to the transport activity

conducted in the country (fuel used). If the fuel sold does not correspond to fuel used, the a disparity will be on the basis of calculation of UNFCCC and CLRTAP submissions.

- How does the total activity (veh-km) per vehicle category (PCs, LDVs, trucks, busses, PTWs) correspond to your national data?
    - This question tries to identify whether the total activity, in terms of both vehicle stock size and annual mileage is correctly represented for aggregated vehicle categories.
- How does the allocation of vehicles to different technologies correspond to your national data?
    - Vehicle allocation to different technologies is very important to estimate correct emission factors. This allocation is known for some countries but for some others it is only estimated on the basis of the vehicle age distribution.
- Does the annual driven mileage decrease with vehicle age in your calculations?
    - It is well established from campaigns and statistics that the annual driven mileage on average falls when the vehicle age increases. This is important because it significantly decreases the emission contribution from older vehicle technologies. The centralised calculations have taken this into account. The question therefore is whether this has been taken into account in national statistics as well.
- What about mean travelling speeds and mileage distribution to urban, rural, highway driving?
    - Travelling speeds and allocation of emissions to urban, rural and highway driving do affect the total emission calculation.

Emissions: Review results and identify major differences. These may occur either from differences in the input data or differences in the emission factors used:

- What is the method used for the calculations (Tier 1, COPERT (version?), other?)
- Have you included non-exhaust PM in your calculations? If yes, what is the method used for tyre, brake, road wear?
- Have you included fuel evaporation in your calculations?
- Have you used baseline emission factors or are they corrected for emission degradation as a function of age, vehicle load, road gradient, and fuel effects?

6 Summary of comments received

National experts from six countries, namely Belgium, Switzerland, Cyprus, Finland, Poland and Slovenia, have responded to the results of this study based on the above action list.

From these, Cyprus and Finland have found the emission results to be consistent with their own estimations and thus had no further comments. Poland and Slovenia have identified some differences in the input data used for the calculations and have requested further explanations on the data sources used.

For Belgium, no reliable conclusions may be drawn, since only data from the Flemish region were included in the response. These are in general in good agreement with those used for the 'centralised' calculations.

In the case of Slovenia there are some differences in the total activity (vehicle-kilometres) per vehicle category, as well as in the allocation of vehicles to different technologies. This is due to the fact that the 'centralised' dataset used in the present study, although based on the FLEETS dataset, it has been 'corrected' to be consistent with the fleet description of the updated TREMOVE model (version 3.3), currently under preparation. Since TREMOVE requires a detailed age distribution for all vehicle categories, appropriate lifetime functions were introduced, which resulted in changes in the vehicle stock allocation to the various technologies.

Despite these differences in the Slovenian vehicle fleet, the officially reported data compare reasonably well with the emissions estimated with the 'centralised' approach (they are within a +/-20% range). The use of an older COPERT version (COPERT III v2.1) in the Slovenian calculations might also explain some of these differences.

For Switzerland some large deviations from national emission data were identified. More specifically, 'centralised' emissions of all pollutants were considerably overestimated by 20% (for CO and NOx) to 50% (for VOC and PM). This was due to the fact that one of the largest 'corrections' for diesel mileage was introduced (~50% for 2005) for Switzerland, in order to match the official fuel consumption figures. Gasoline mileage was also 'corrected', to a lower extent though (~25%). As a matter of fact, 'centralised' emissions compared reasonably well with national emissions before the correction. However, a large deviation incurred when introducing the mileage 'correction' to match the reported fuel consumption, as shown in Table 6-1 below.

Average fuel consumption factors used for the individual vehicle categories of both calculations were examined in an attempt to explain the differences. Since no major differences were found there, the most realistic explanation is that there is some transit mileage included in the fuel consumption but not the emission calculations. This is also evident from the specific CO_2 indicator calculated from national data, which is relatively low (2.9 kg/kg fuel) compared to other countries (3.15 kg/kg fuel on average). This is a known problem for some countries and one that can lead to significant deviations before the UNFCCC and CLRTAP submissions.

Table 6-1: Swiss emissions and fuel consumption (kt) from national submissions and calculated with COPERT 4 with and without mileage correction

	Without correction		Corrected		National data	
Year	2000	2005	2000	2005	2000	2005
Total CO emissions	311.9	187.4	455.1	235.5	261.6	195.6
Total VOC emissions	44.5	24.8	61.3	29.1	29.9	18.8
Total NOx emissions	52.3	37.3	91.0	52.3	55.2	42.7
Total $PM_{2.5}$ emissions	1.7	1.7	4.0	2.9	2.1	1.8
Total CO_2 emissions	11 916	12 567	19 092	16 733	15 332	15 390
Gasoline consumption	2 667.8	2 850.3	3 854.0	3 594.0	3 854.0	3 594.0
Diesel consumption	569.7	1 121.5	1 287.0	1 694.0	1 287.0	1 694.0

7 Discussion

Some interesting conclusions may be drawn from the above analysis and the various comments received from national experts:

- As expected, CO_2 emissions calculated with COPERT 4 are in good agreement with submissions to UNFCCC for all countries due to mileage tuning as explained above;

- There is a fair agreement for other pollutants at an aggregated level, however differences increase when looking in more detail at the country and/or sector level;

- Centralised NOx emissions are somewhat higher than national estimates due to the higher HDV emission factors in COPERT 4 than COPERT 3 that is still being used by many MS for calculating their national emissions;

- Generally, deviations of centralised from national estimates are within a range of ±20 % for most countries. There are very few cases of larger differences on the order of ±50 % or more. These need to be examined by the reporting parties;

- For countries using COPERT to compile their national inventories, the observed differences may be attributed mainly to the different technology mix of the vehicle fleet used in the calculations (further to the COPERT 4 vs 3 version);

- In those MS where tank tourism is significant, mileage correction may result in overestimating emissions compared to national data.

Overall, this exercise appears useful to and may be used to better understand vehicle fleet activity and emissions data and thus to be able to improve both models and inventories. To this aim, country comments are valuable.

Annex

This report is accompanied by the Excel spreadsheet "centralised vs national emissions data FINAL.xls". This is required to make detailed comparison for each party.