

# Users manual

## Emis\_Benchmark Tool

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## 1. Introduction

The Emis\_Benchmark analysis/visualization tool is an IDL-based tool developed in the framework of FAIRMODE – Working Group 2 on Emissions. It is designed to screen and benchmark emission inventories, especially to compare bottom-up and top-down estimates at the regional and/or city scale.

For general information we refer to the JRC DELTA website:

<http://aqm.jrc.ec.europa.eu/DELTA/>

and the FAIRMODE website:

<http://fairmode.jrc.ec.europa.eu/>

## 2. Download and installation - The Emis\_Benchmark (EB) Folder structure

Goto the Delta website:

<http://aqm.jrc.ec.europa.eu/DELTA/>

Register or log in, follow the instructions for the download of the Emission\_Benchmark Tool

The folder structure is as follows, where 'Emis\_Benchmark' stands for the 'Home' directory:

..\Emis\_Benchmark\emis\_benchmark.sav

..\Emis\_Benchmark\EBInput\

..\Emis\_Benchmark\Help\

..\Emis\_Benchmark\Output\

..\Emis\_Benchmark\UserInput\

Here 'emis\_benchmark.sav' is the IDL executable file to be run using the icon on the desktop.

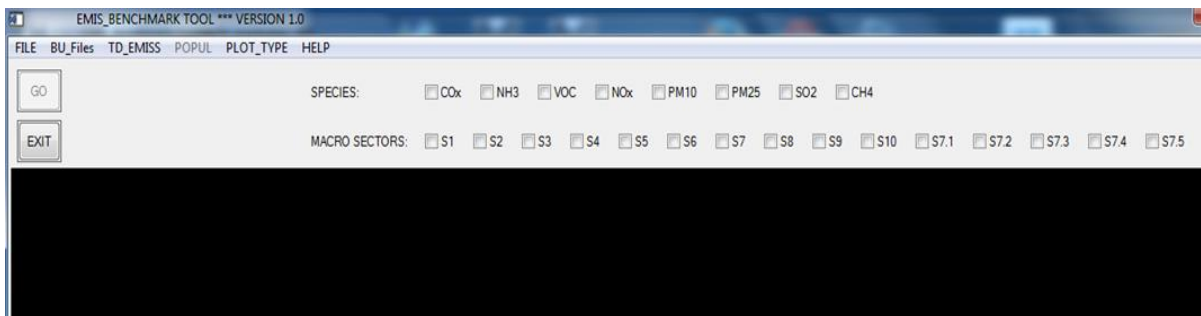
The directory 'EBInput' contains all the Emis\_Benchmark fixed input data (see Section 4).

The directory 'Help' contains specific files - both input and output (see Section 11).

The directory 'Output' contains all the output files.

The directory 'UserInput' contains all user defined input regarding emissions and shapefiles (see Section 5).

A double click on the icon and a Continue will start the Tool's opening window. Click on 'ENTER' and the Tool is ready for use. A snapshot of part of the opening window is shown here, where we see the 8 admissible pollutants (see Section 4.a), and the 15 admissible SNAP emission sectors (see Section 4.a):



### 3. EB input data:

#### a. Emission inventories

Two European TopDown emission inventories are available in the Tool for comparison with the user defined BottomUp information for Countries, Regions and Cities. Both inventories consider the following pollutants:

CO<sub>x</sub>, NH<sub>3</sub>, VOC, NO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, CH<sub>4</sub>

SNAP sectors S1, S2,..., S10 are considered. For the MACC-TNO inventory the SNAP sector S7 is disaggregated into S7.1,...,S7.5.

#### EC4MACS inventory (<http://www.ec4macs.eu/>)

This inventory is defined on a regular 842 x 779 cell longitude-latitude grid with resolution of 0.125 x 0.0625 and origin (-44.375, 29.875) (Centre of lower left cell). Emissions are available for the SNAP sectors S1,S2,...,S10. Emissions of CH<sub>4</sub> are not available and emissions in the sectors S7.1,...,S7.5 are set equal to zero.

The reference year for EC4MACS is 2009.

#### MACC-TNO inventories (ref: Kuenen et al. (2014))

This inventory is defined on a regular 720 x 672 cell longitude-latitude grid with resolution of 0.125 x 0.0625 and origin (-29.7395, 30.0313) (Centre of lower left cell). Emissions for CH<sub>4</sub> are available as well as emissions for the sectors S7.1,...,S7.5. These are sub sectors of S7 and defined as follows:

- S7.1 – Exhaust emission of Gasoline road transport
- S7.2 – Exhaust emissions of Diesel road transport
- S7.3 – Exhaust emissions of LPG transport
- S7.4 – non-Exhaust volatilization (Only VOC emissions)
- S7.5 – non-Exhaust Brake wear, Tyre wear, Road wear

MACC-TNO is implemented for the years 2003,...,2009. After selection of the user input file, the MACC-TNO is selected which is as close as possible in years to the user reference year.

MACC-TNO has a combined SNAP sector 3 and 4: MACC-TNO S3 is equal to SNAP S3+S4, and MACC-TNO S4 is empty.

## **b. Shapefiles**

For 39 Countries, 428 Regions, and 477 Cities, default shape files have been defined, each consisting of a set of polygonal vertices (longitude, latitude) defining the sub areas. The shape files have the following generic names:

shape\_CntrC.dat (example: shape\_FRA.dat)

shape\_CntrC-Region-RegC.dat (example: shape\_FRA-Region-IDF.dat)

shape\_CntrC-City-CityC.dat (example: shape\_FRA-City-Paris.dat)

For the Country, Region, and City codes we refer to section 4.c.

Country/Region/City shape files have the following structure:

Example: shape\_FRA.dat

Line 1: Country Code

Line 2: The shape consists of Nparts (6) subshapes

Line 3 and on: For each subshape the polygonal vertices are given by

lon number of vertices (898 for 1<sup>st</sup> subshape)

lat number of vertices

Example: shape\_FRA-Region-IDF.dat

Line 1: Region Code [FRA-IDF] (Nparts=1, 74 vertices)

etc

Example: shape\_FRA-City-Paris.dat

Line 1: City Code [FRA-Paris] (Nparts=53; Nvertices=7 for 1<sup>st</sup> subshape)

etc

## **c. Country, Region, City codes and names**

CRC Codes.dat:

This file contains all the Country/Region/City codes of type:

FRANCE FRA

FRA-Region-IDF

FRA-City-Paris

CRC Names.dat

This file contains information on available Countries, for each Country the available regions, and for each Country the available cities

Example (see above): IDF -> Ile de France

## **d. Population Files**

One of the diagrams (TD\_BU\_emisCap) shows emission quantities per capita. Two population files are used – one on the EC4MACS inventory grid, the other on the MACC-

TNO grid. Both population files are based on the INERIS 1x1 km<sup>2</sup> European Population density file (ref XXX).

The INERIS file can be replaced by the 1x1 km<sup>2</sup> EEA population densities (ref XXX), but Balkan states and some others are missing

[Should be complemented with a 5x5 km<sup>2</sup> population grid. [to be done]

### **e. Ranking Files**

One of the diagrams (TD\_BU\_emisCap) shows for each (user) pollutant and for each (user) macro sector the position of its emissions per capita (on the user shape) with respect to all type (Country, Region, City) related geographical default shapes available in the EBInput directory (see Section 4.b). In a preprocessing phase emissions for all pollutants, for all 15 SNAP sectors, were calculated on all the default shapes (Country, Region, City). These files are available from the EBInput directory and are named 'emisAllxxx\_type.dat, where xxx stands for EC4macs, or MACC2006, etc, and type for Country, Region, or City. The corresponding pop files contain the population numbers on each of the Country, Region, and City default shapes.

## **4. EB User input: csv input files, shapefiles**

All user bottom-up emission information is contained in an excel (csv format) file of the following structure:

Name of the file must start with 'BU\_' and be of csv type  
(example: BU\_Fra-Paris\_info.csv)

### First section (first line):

- The number of sub-shape files ( $\geq 0$ ). Equal to n ( $n > 1$ ) if the emission domain under consideration is composed of n sub-shape files;  
Equal to 0 if the region is defined by a sequence of longitude-latitude coordinates.
- The type of domain. The domain can be of Country, Region, or City type
- Identifier whether the shape file(s) are of default type 'dat' (i.e. if taken from the Emis\_Benchmark data base, see section 4.b), or of type 'shp' (i.e. defined by the user). A user defined shape file (of type 'shp') should be an ESRI standard shape file in a longitude-latitude coordinate system (e.g. wgs84).

### Second section (n lines):

- The first line is followed by n lines with the n sub-shape file names (e.g. 'FRA-City-Paris') which form together the emission domain.  
In the case of a 'dat' type shape file, the sub-shape name is completed to shape\_NAME.dat (e.g. 'shape\_FRA-City-Paris.dat'). Shape files of this type must exist in the EB Input data – Shapefiles directory (see section 4.b).

In the case of a 'shp' type shape file the name of the sub-shape is completed to 'shape\_NAME.shp' and should be provided by the user and put into the User Input directory together with the provided csv (excel) file. The shape\_NAME.shp file goes together with the corresponding shx, dbf, prj files (ESRI conventions).

- If the domain is defined by longitude and latitude values (number of shape files equal to 0 in first line), the second line contains the Country Code (see example 4 below).

Third section (one line):

- This line contains the reference year of the user bottom-up emissions.

Forth section:

- Lines with: Species, User defined short name of the emission macro sector; User defined long name of the emission macro sector; Correspondance of the macro sector to the SNAP sectors (S1, S2,..., S10, S7.1, S7.2,..., S7.5 ); The emissions in kTon/year.

Keep the abbreviation of the macro sector short, because this identification will appear on the diagrams.

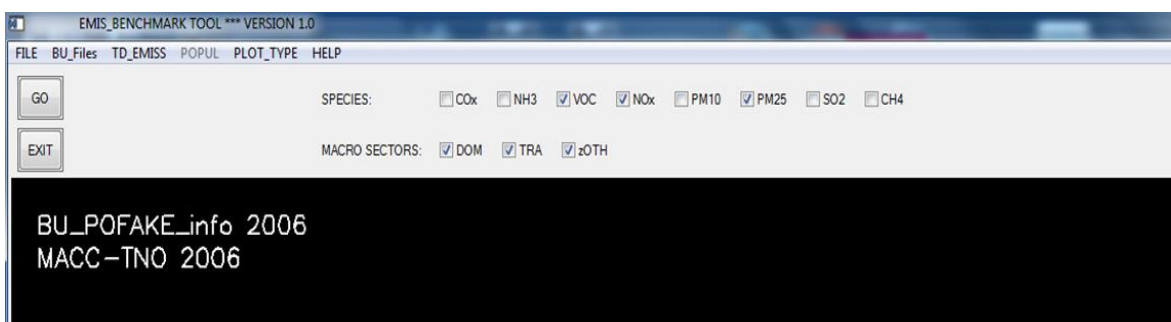
The correspondance to the SNAP sectors can be of arithmetic type, like  $S1+0.5*S2+0.75*S10+0.5*S7.1$  The minus sign is not allowed, nor other multiplication factors than decimal numbers, nor other arithmetic operations.

Last line:

- END

After selection of the (user) BU input file, the list of species and the list of (user) macro sectors on the screen will adapt themselves. The user can make his own choice by unchecking or checking the desired species and the desired macro sectors.

Example of BU\_POFAKE\_info.csv



Some (fictive) examples of user input files (see also the UserInput directory of the Tool)

Example 1: BU\_Fra-Paris\_info.csv

Shape	1	City	Dat	Shape Nr of shapes
-------	---	------	-----	-----------------------

				Country/Region/City: Type of shape shp or dat: ESRI type or dat type shape
FRA-City-Paris		# Name of the shape files. See list of Country/Region/City identifiers		
2006		# Reference year		
#Species	BU sectors abbreviation	BU sectors nomenclature	Correspondance with SNAP	Domain Total kTon/year
NOx	DOM	Domestic	S2	30
NOx	TRA	Traffic	S7	300
NOx	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	116
PM25	DOM	S2	S2	10
PM25	TRA	S3	S7	11
PM25	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	12
VOC	DOM	S2	S2	25
VOC	TRA	S3	S7	140
VOC	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	350
END				

Example 2: BU\_PoValley\_info.csv

Shape	7	Region	dat	
ITA-Region-VDA				
ITA-Region-PMN				
ITA-Region-LMB				
ITA-Region-TAA				
ITA-Region-VEN				
ITA-Region-FVG				
ITA-Region-ERM				
2006				
#Species	BU sectors abbreviation	BU sectors nomenclature	Correspondance with SNAP	Domain Total kTon/year
NOx	DOM	Domestic	S2	30
NOx	TRA	Traffic	S7	300
NOx	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	116
PM25	DOM	S2	S2	10
PM25	TRA	S3	S7	11
PM25	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	12
VOC	DOM	S2	S2	25
VOC	TRA	S3	S7	140
VOC	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	350
END				

Example 3: BU\_France\_info.csv

Shape	1	Country	dat
FRA			
2006			

#Species	BU sectors abbreviation	BU sectors nomenclature	Correspondance with SNAP	Domain Total kTon/year
NOx	S2	Domest	S2	5
NOx	S7	Traffic	S7	60
NOx	S1	Others	S1	12
PM25	S2	Domest	S2	2
PM25	S7	S7	S7	2
PM25	S1	Others	S1	1
VOC	S2	Domest	S2	5
VOC	S7	S7	S7	45
VOC	S1	Others	S1	0.5
END				

Example 4: BU\_FakeSpanishDomain\_info.csv

Shape	0	Region	dat	
ESP		If nr shapes = 0 then give Country Code		
lon	-5.,-3.,-3.,-5.	If nr shapes = 0 then # longitudes of polygonal vertices		
lat	39.,39.,41.,41.	If nr shapes = 0 then # latitudes of polygonal vertices		
1999				
#Species	BU sectors abbreviation	BU sectors nomenclature	Correspondance with SNAP	Domain Total kTon/year
NOx	TRAc	TrafficCars	S7.1+S7.2	10
NOx	DOM	Domestic	S2	1
NOx	PTS	PointSources	0.5*S3+S1	40
NOx	OTH	Others	0.5*S3+S4+S5	9
VOC	TRAc	TrafficCars	S7.1+S7.2	14
VOC	DOM	Domestic	S2	8
VOC	PTS	PointSources	0.5*S3+S1	0.5
VOC	OTH	Others	0.5*S3+S4+S5	2
END				

Example 5: BU\_Flanders\_info.csv

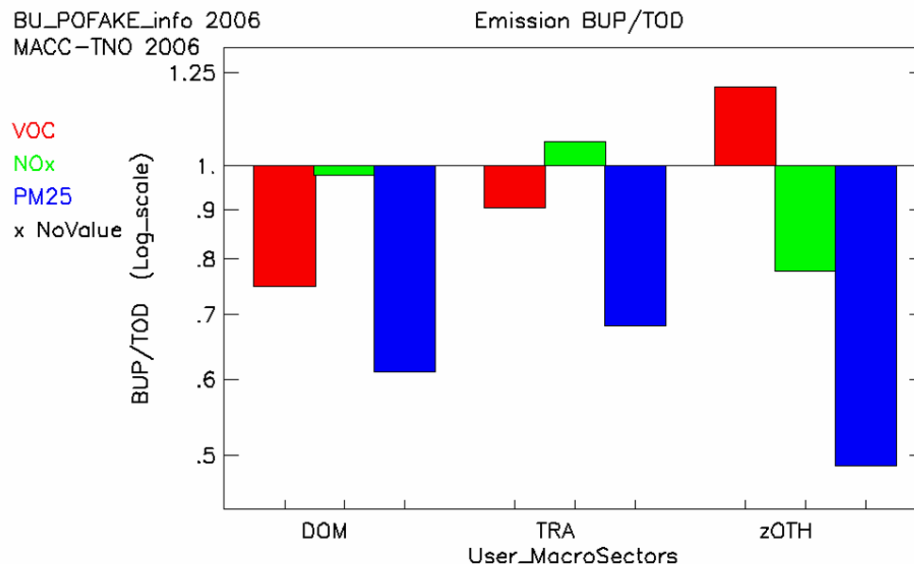
Shape	2	Region	shp	
FlandersWest_LL		# refers to ESRI shapefile: FlandersWest_LL.shp		
FlandersEast_LL		# refers to ESRI shapefile: FlandersEast_LL.shp		
2006				
#Species	BU sectors abbreviation	BU sectors nomenclature	Correspondance with SNAP	Domain Total kTon/year
NOx	DOM	Domestic	S2	30
NOx	TRA	Traffic	S7	300
NOx	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	116
PM25	DOM	S2	S2	10
PM25	TRA	S3	S7	11
PM25	zOTH	Others	S1+S4+S5+S6+S3+S8+S9+S10	12



## 5. EB diagrams

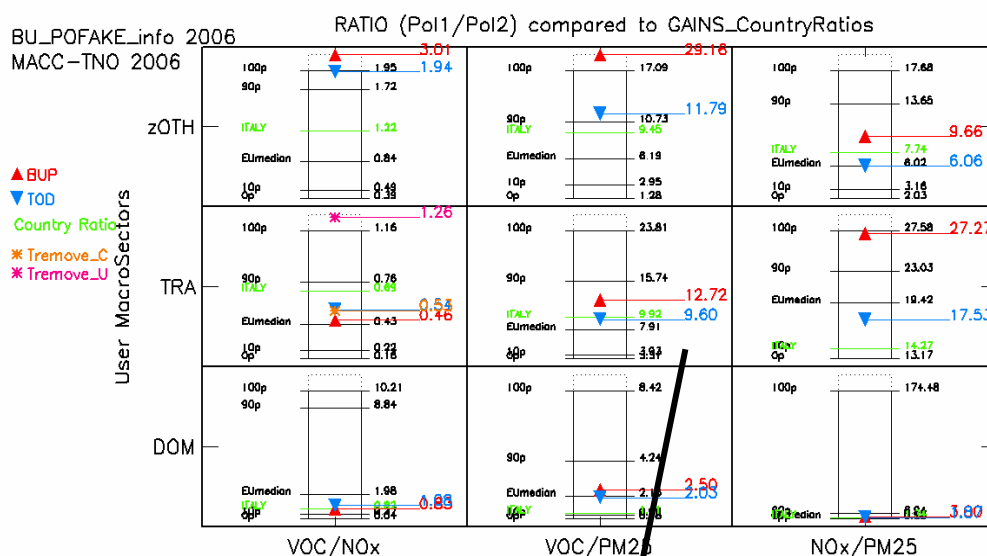
Diagrams for BU\_POFAKE\_info are now shown with short explanation

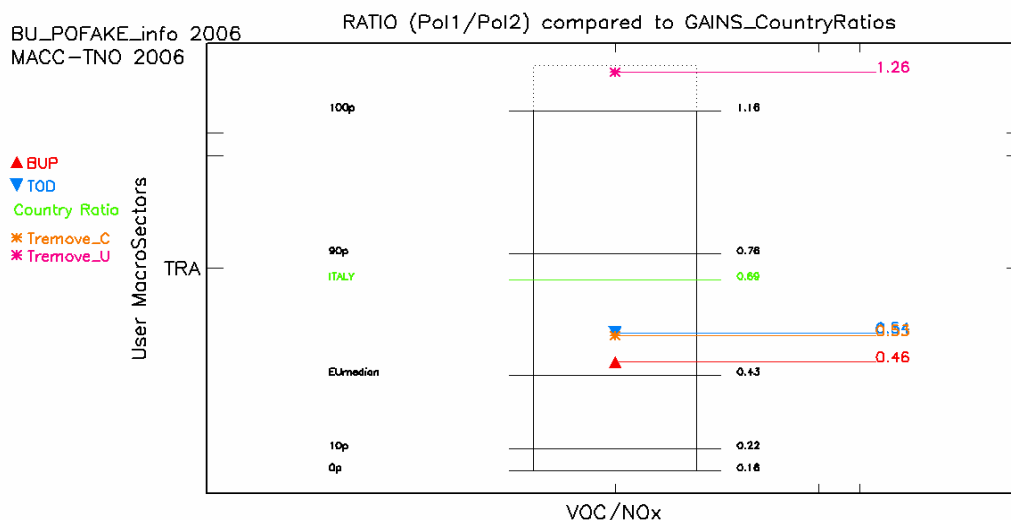
### a. TD\_BU\_bar



For the selected species and for the selected (user) macro sectors, this plot shows the ratios of BottomUp emissions to TopDown emissions. Note that the vertical scale is logarithmic.

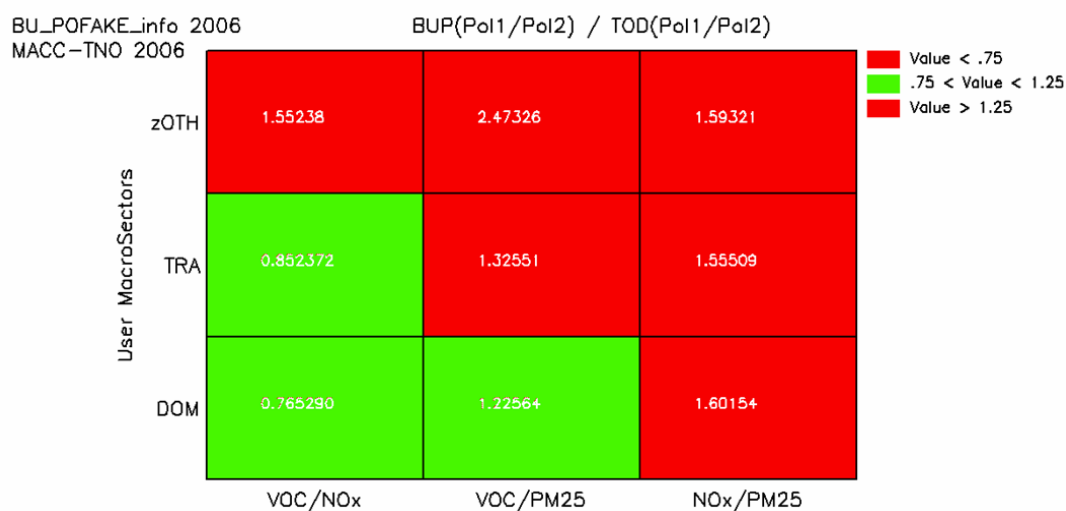
### b. TD\_BU\_ratio





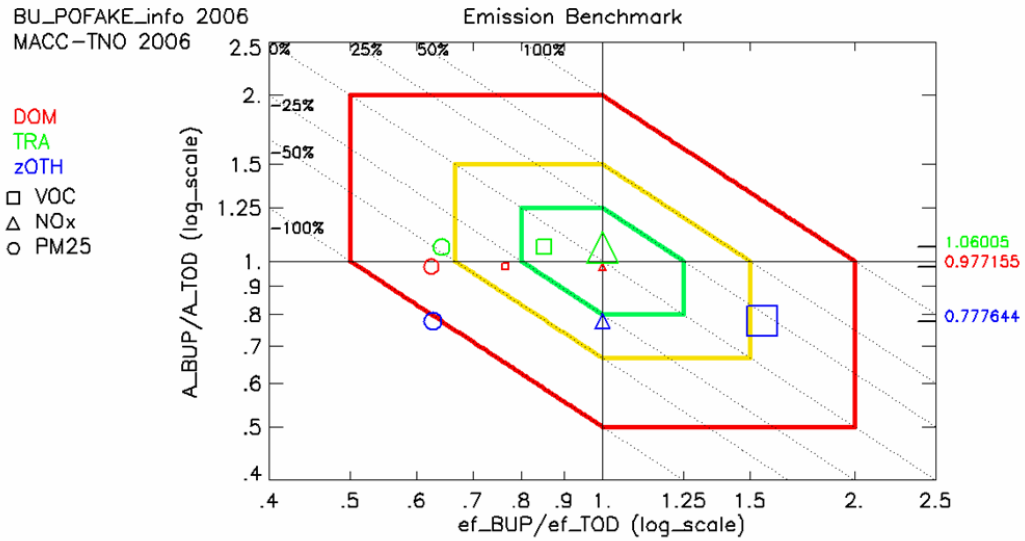
For the selected species and for the selected (user) macro sectors, this plot shows the ratios of Pollutant1 to pollutant2 (Pol1/Pol2). The red triangle represents the (user) BottomUp value, while the red triangle shows the TopDown value of the ratio. Besides these triangles, the diagram also shows the range of GAINS Country values for the ratio ranging from the Country with the lowest value (0 percentile) to the Country with the largest value (100 percentile), as well as the EU median value and the value for the Country for the shape under consideration.

### c. TD\_BU\_ratio2



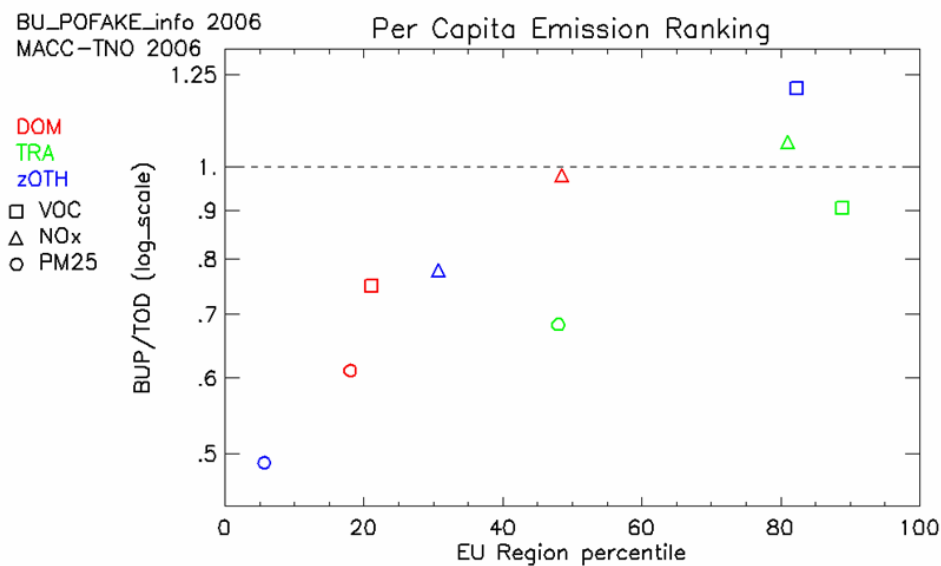
For the selected species and for the selected (user) macro sectors, this plot shows the ratio of ratios for Pollutant1 to pollutant2 (i.e. BottomUp(Pol1/Pol2)/TopDown(Pol1/Pol2)). Values between 0.75 and 1.25 are coloured in green; outside this range in red. [value 0.75, 1.25 to be discussed]

### d. TD\_BU-diamond



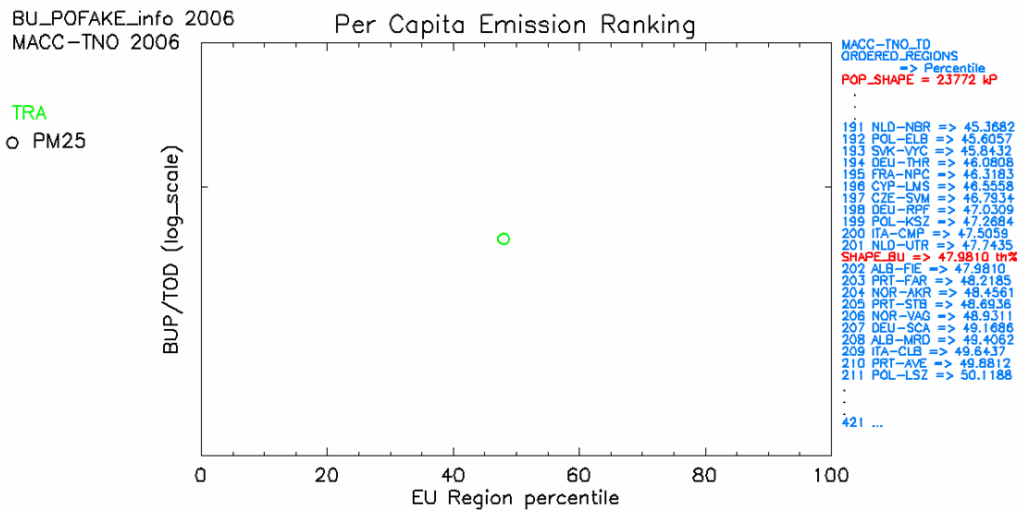
Activity- vs Emission Factor diagram. The X and Y axis indicate the discrepancies between the BottomUp and TopDown inventories in terms of emission factor and activity rate, respectively. The diagonal isolines are indicative of discrepancies in terms of total emissions. The coloured isolines delimitate the areas where the three factors: emission totals, activity rate and emission factors are all fulfilling a given threshold (e.g. red one for a factor 2 threshold). The size, shape and color of the symbols refer to the magnitude of the discrepancies, to the pollutant and to the (user) macro sector, respectively. Ref XXX.

### e. TD\_BU\_emisCap



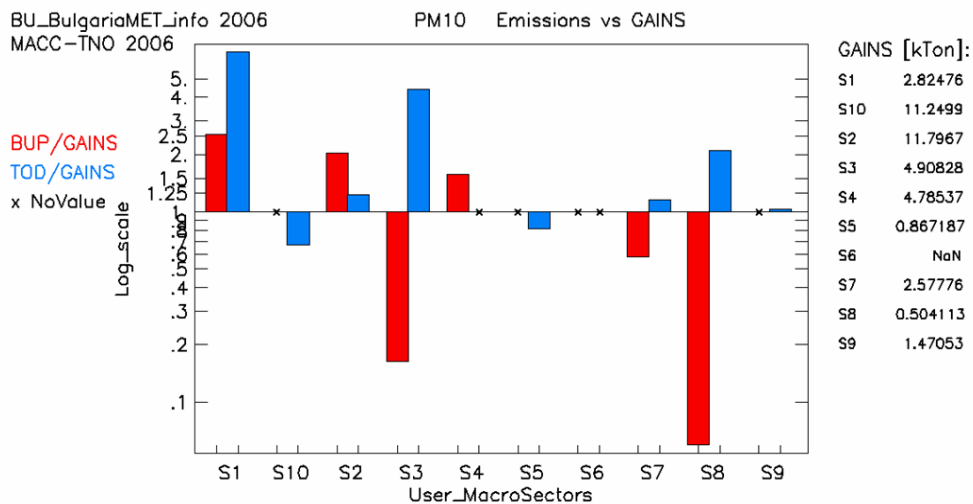
For each of the selected species and for each of the selected (user) macro sectors there is a corresponding symbol in the diagram, representing the ratio of the

BottomUp emissions to the TopDown emissions on the shape per capita (vertical axis). Depending on the geographical type (Country, Region, City), the horizontal axis represents the sequence of emissions per capita for the (user) macro sector, for the selected species, for all the default shapes of the same type – running from 0 percentile to 100 percentile. The horizontal axis always runs from 0 to 100, but the underlying ranking of geographical shapes is species and macro sector dependent.



This diagram is the same as the previous one, but for one species (PM<sub>25</sub>) and for one sector (TRA). The corresponding ranking of shapes ordered by emissions per capita on the default shapes is partly shown on the right-hand side of the picture, with the (user) shape percentile in red. The total population (in kPers) on the (user) shape is indicated above in red. The full ranking of default shapes can be edited from the 'PercOrderShapes' option in the 'HELP' droplist (see Section 11.d).

### f. TD\_BU\_GAINS



In the particular case of a Country type, and for one selected species, this diagram shows the ratios of BottomUp and TopDown to GAINS country values. BUP/GAINS and TOD/GAINS are shown in red and blue bars on a logarithmic scale, while the absolute GAINS country values for the (user) macro sectors are tabled on the right.

## 6. 'FILE' droplist

- a. SaveImage\_Wbgr: Saves the diagram (with White background) into a tiff file in the 'Output' directory. File name is 'PICT\_ED\_n.tif', with n equal to 1,2,3,...
- b. SaveImage\_Bbgr: Same as before with Black background
- c. DumpData: Dumps all information and the numeric data of the diagram into the dumpfile, named 'DumpData.dat' in the 'Output' directory. Subsequent calls to 'DumpData' will add new info/data to the dumpfile (i.e. no overwrite). The contents of the dumpfile can be edited from the 'EditDump' option in the 'HELP' droplist (see Section 11.e).

## 7. 'BU\_Files' droplist

User BU\* files can be selected from the BU\_Files droplist. These files are grouped by type: Country, Region, City. At any time the selected BU file can be edited from the 'BU\_UserInput' option in the 'HELP' droplist (see Section 11.a)

## 8. 'TD\_Emiss' droplist

Two European TopDown emission inventories are available in the Tool: EC4MACS (reference year 2009), and MACC-TNO (for reference years 2003,...,2009). Switching between these inventories is done in the TD\_Emiss droplist.

Remember that EC4MACS does not have CH<sub>4</sub> and no sectors S71,...,S7.5; MACC-TNO does have CH<sub>4</sub> as well as the subsectors of S7, but has a combined sector 3 and 4, where MACC-TNO S3 is equal to SNAP S3+S4, and MACC-TNO S4 is empty.

## 9. 'PLOT\_TYPE' droplist

In this droplist a choice is made for the various diagrams (see Section 6):

- a. TD\_BU\_bar
- b. TD\_BU\_ratio
- c. TD\_BU\_ratio2
- d. TD\_BU\_diamond

- e. TD\_BU\_emisCap
- f. TD\_BU\_GAINS (only for Country type)

## 11. 'HELP' droplist

- a. BU\_UserInput: Edit the user BU file (see Section 5)
- b. Macro=> SNAP: Correspondance between the User defined macrosectors and the SNAP sectors.
- c. CRC Codes: Edit Country/Region/City codes for which default shapefile are available (see Sections 4.b, 4.c).
- d. CRC Names: Edit full names of Country/Region/City codes (see Section 4.c)
- e. PercOrderShapes: Edit the full ranking of default shapes with the corresponding percentiles produces by the TD\_BU\_emisCap diagram in the case of one species and one sector (see the second diagram in Section 6.e). For the situation of diagram 6.e (TRA sector, PM<sub>25</sub>) the file contains the following quantities for the 421 Region shapes:

Ranking number – Percentile -- TopDown Emissions [Tons] -- Population [kPers]

```

Ranking EMIS_Benchmark
Fri Nov 28 16:42:06 2014
EB Input File = BU_POFAKE_info 2006 (type=Region)
Emission Inventory = MACC-TNO 2006
Spec=PM25 Sector=TRA
*****

```

Nr	SHAPE =>	%	Emiss [Ton}	Pop [kP]
	Region =>	47.9810	11000.0	23809
1	MDA-Region-MDA =>	0.237530	413.336	4219.95
2	CHE-Region-BST =>	0.475059	20.9256	193.132
3	CHE-Region-GLR =>	0.712589	7.48687	60.2000
4	GRC-Region-IIS =>	0.950119	30.5256	212.657
5	ROM-Region-BTS =>	1.18765	66.1176	446.670
6	ROM-Region-IAS =>	1.42518	120.652	798.398
7	DEU-Region-BER =>	1.66271	494.504	3266.93
8	ROM-Region-BAC =>	1.90024	118.907	775.928
9	GRC-Region-AIS =>	2.13777	67.0570	436.144
10	ROM-Region-GOR =>	2.37530	59.1113	377.977
11	....			
12	....			
-				
-				
-				
421	.....			

The considered region has a percentile of 47.9810 .

- f. Edit Dump: Edit the dumpfile. For the bar plot, the ratio plot and the diamond plot, and for the example (BU\_POFAKE\_info) above, the contents of the dumpfile looks like:

```

DumpFile EMIS_BENCHMARK TOOL

Tue Nov 25 12:09:02 2014
*****

EB Input File = BU_POFAKE_info 2006 (type=Region)
Emission Inventory = MACC-TNO 2006
Diagram = BarPlot: BUP, TOD, BUP/TOD

Sector= DOM:
VOC:      BUP=25.0000    TOD=33.3779    BUP/TOD=0.748998
NOx:      BUP=30.0000    TOD=30.6526    BUP/TOD=0.978710
PM25:     BUP=10.0000    TOD=16.3638    BUP/TOD=0.611106
Sector= TRA:
VOC:      BUP=140.000   TOD=154.722    BUP/TOD=0.904849
NOx:      BUP=300.000   TOD=282.601    BUP/TOD=1.06157
PM25:     BUP=11.0000   TOD=16.1139    BUP/TOD=0.682640
Sector= zOTH:
VOC:      BUP=350.000   TOD=289.496    BUP/TOD=1.20900
NOx:      BUP=116.000   TOD=148.946    BUP/TOD=0.778803
PM25:     BUP=12.0000   TOD=24.5486    BUP/TOD=0.488826
*****

EB Input File = BU_POFAKE_info 2006 (type=Region)
Emission Inventory = MACC-TNO 2006
Diagram = Poll/Pol2: BUP TOD GAINS_Country_Ratio p0 p100

Sector= DOM:
VOC/NOx:  BUP=0.833333  TOD=1.08891    GAINS=0.827507    p0=0.048    p100=10.215
VOC/PM25: BUP=2.50000    TOD=2.03975    GAINS=1.11261     p0=0.786    p100=8.428
NOx/PM25: BUP=3.00000    TOD=1.87320    GAINS=1.34453     p0=0.189    p100=174.488
Sector= TRA:
VOC/NOx:  BUP=0.466667    TOD=0.547492    GAINS=0.694876    p0=0.165    p100=1.162
VOC/PM25: BUP=12.7273    TOD=9.60176     GAINS=9.92169     p0=3.311    p100=23.817
NOx/PM25: BUP=27.2727    TOD=17.5377     GAINS=14.2784     p0=13.176   p100=27.583
Sector= zOTH:
VOC/NOx:  BUP=3.01724    TOD=1.94363     GAINS=1.22064     p0=0.394    p100=1.956
VOC/PM25: BUP=29.1667    TOD=11.7928     GAINS=9.45307     p0=1.285    p100=17.091
NOx/PM25: BUP=9.66667    TOD=6.06741     GAINS=7.74434     p0=2.037    p100=17.689
*****

EB Input File = BU_POFAKE_info 2006 (type=Region)
Emission Inventory = MACC-TNO 2006
Diagram = Diamond: E_BUP/E_TOD A_BUP/A_TOD SymSize(1-5)

Sector= DOM:
VOC:      E_BUP/E_TOD=0.765290  A_BUP/A_TOD=0.978710  SymSize=1.00000
NOx:      E_BUP/E_TOD=1.00000  A_BUP/A_TOD=0.978710  SymSize=1.11866
PM25:     E_BUP/E_TOD=0.624400  A_BUP/A_TOD=0.978710  SymSize=2.61305
Sector= TRA:
VOC:      E_BUP/E_TOD=0.852372  A_BUP/A_TOD=1.06157   SymSize=2.41538
NOx:      E_BUP/E_TOD=1.00000  A_BUP/A_TOD=1.06157   SymSize=4.95585
PM25:     E_BUP/E_TOD=0.643050  A_BUP/A_TOD=1.06157   SymSize=2.80513
Sector= zOTH:
VOC:      E_BUP/E_TOD=1.55238    A_BUP/A_TOD=0.778803  SymSize=5.00000
NOx:      E_BUP/E_TOD=1.00000  A_BUP/A_TOD=0.778803  SymSize=2.34088
PM25:     E_BUP/E_TOD=0.627664  A_BUP/A_TOD=0.778803  SymSize=2.99720
*****

```

- g. Save TOD as BU: This option will save the TOD selected emission inventory as a 'user' BU input file in the UserInput folder. The structure of the newly created file is exactly the same as the user City/Region/Country BU file. File naming is the same with BU changed into BU\_'TODemissionInventory'. Example: The user input file

BU\_MadridBSC.csv will be called BU\_EC4MACS\_MadridBSC.csv or BU\_MACC-TNO\_Madrid.csv. This allows to intercompare two TOD emission inventories on the shape defined by the City/Region/Country with its corresponding macro sectors.

h. User Guide: Edit this User Guide

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