Emissions

The FAIRMODE Δ-Emis tool - Simplified guide

FAIRMODE
Forum for air quality modelling in Europe

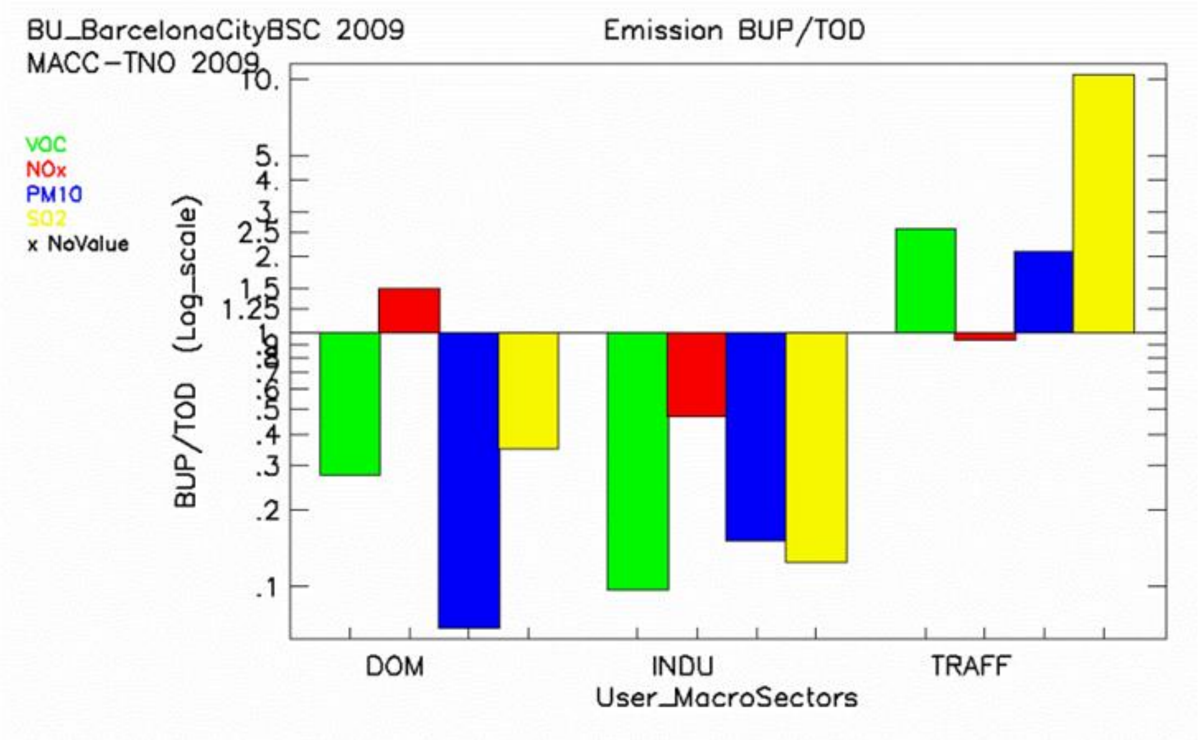
THE BAR-PLOT

1) Evaluate the overall total emissions per sector and pollutant

This first screening gives an overview of the different inter-inventories emission ratios, and allows to identify the largest/lowest over or underestimation (discrepancies) of the total emissions per sector and pollutant. E.g. the largest discrepancies are observed for PPM10 - DOM sector and SO2 – TRAFF sector. The best agreement seems to be for NOx.

2) Consistency for a given activity sector

For a given sector, the activity is the same for all pollutants therefore the BUP/TOD ratio also provides information about the emission factors ratios. It is expected that for a given sector, the sign (under/overestimations) is the same.



THE DIAMOND DIAGRAM

1) Evaluate the overall distribution

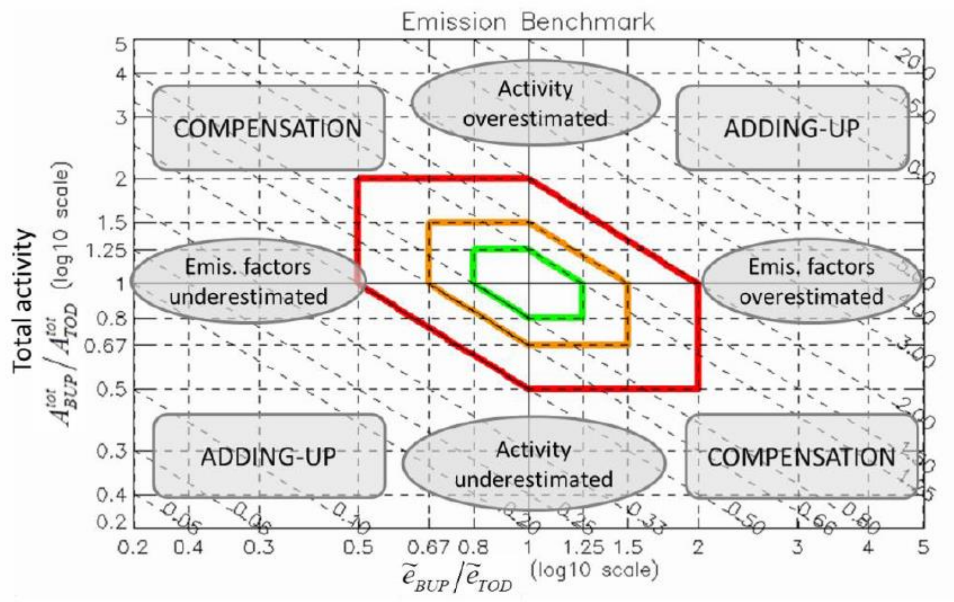
Identify which points (sector-pollutant) are further away from the origin. E.g. most of the points are outside the red diamond (factor 2), indicating issues to be solved.

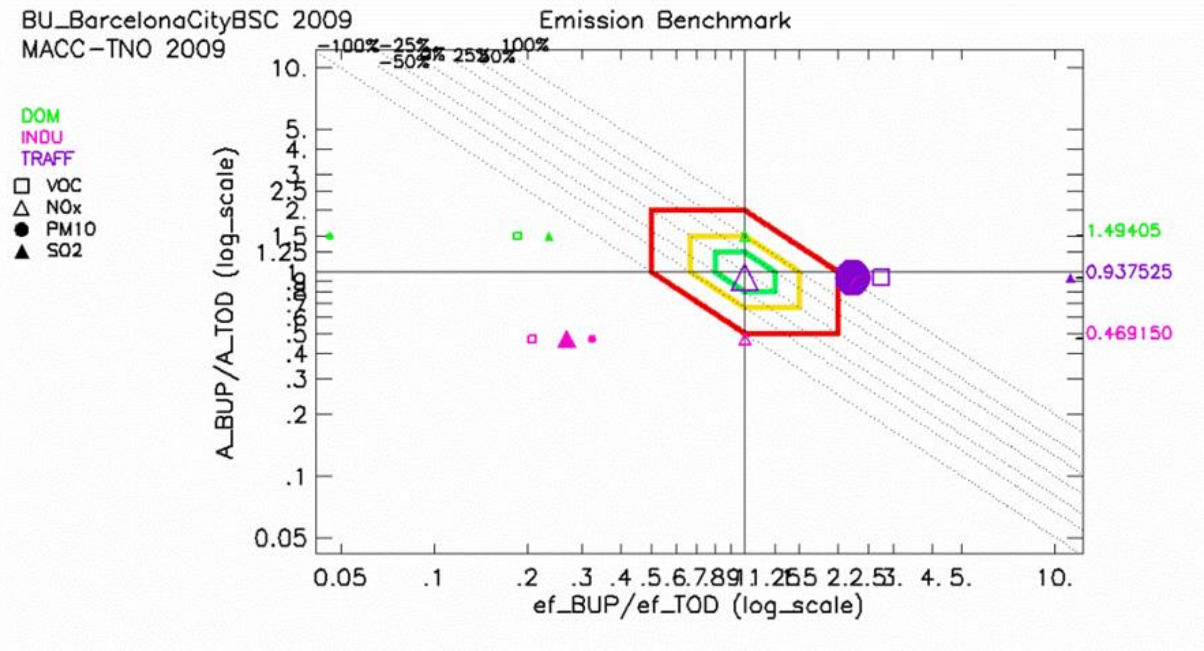
2) Analyze total emissions per sector

Over/underestimation of total emissions are identified by the distance of the points from the diagonal -1. It is expected that points representing pollutants are very close to each other within a given sector. If not, this may indicate a problem in terms of weighted emission factors (i.e. emission factors or activity shares).

3) Emission factors vs. activities

Identify if inconsistencies are mainly related to emission factor, activity and/or total emissions. The distance along the X axis indicates inconsistencies dominated by weighted emission factors (under/overestimations), whereas along Y axis provides information in terms of activity.





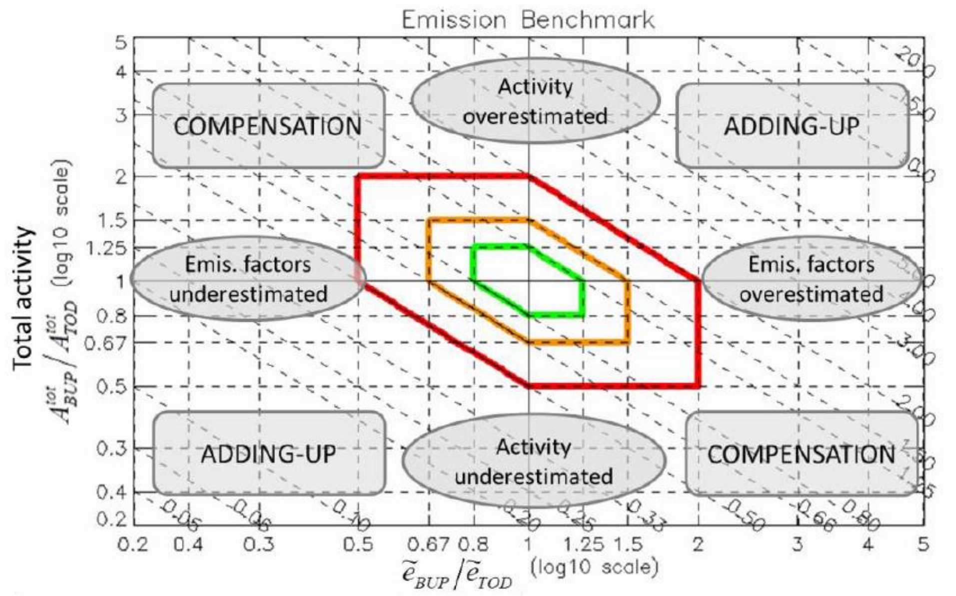
THE DIAMOND DIAGRAM

4) Identify compensation vs. adding-up

Points in the compensation zone are characterized by 1) over-estimation of the activity and under- estimation of the emission factor (left-top corner) or by 2) under-estimation of the activity and over-estimation of the emission (right-bottom corner). Similarly, adding-up zones are identified.

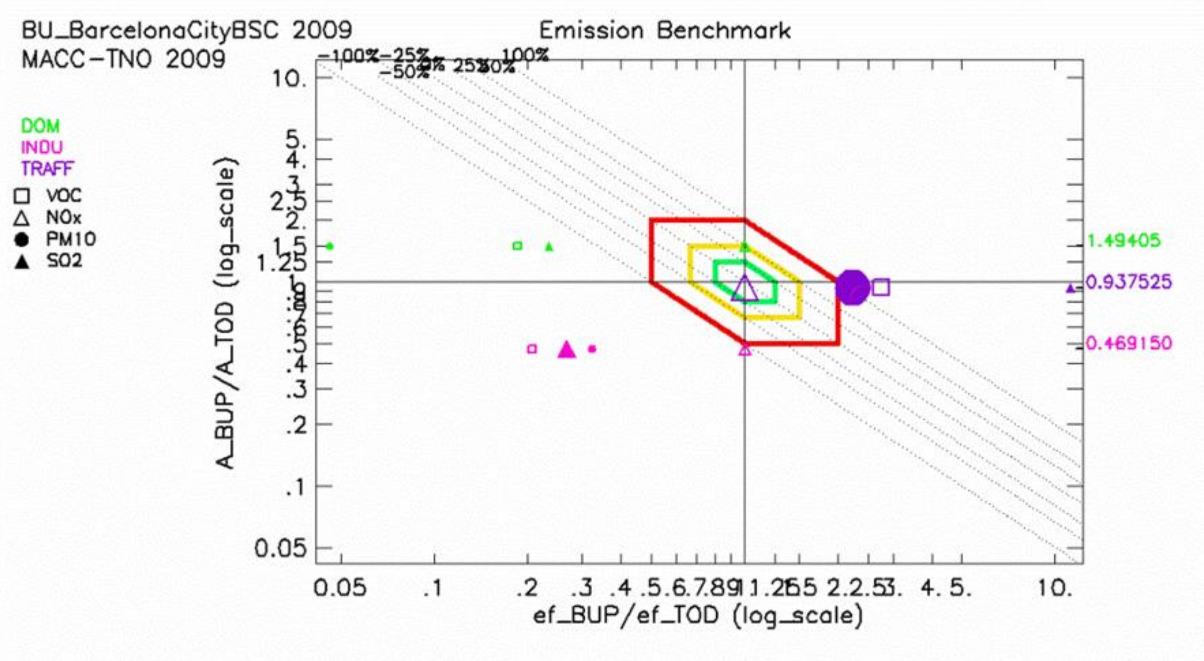
5) Assess distances between points

Distances along the X axis provide information on pollutant ratios, and along the Y axis, the distance between the different sector lines indicates discrepancies in terms of relative sectorial emission ratios between the two inventories.



Emission factors

Activity shares



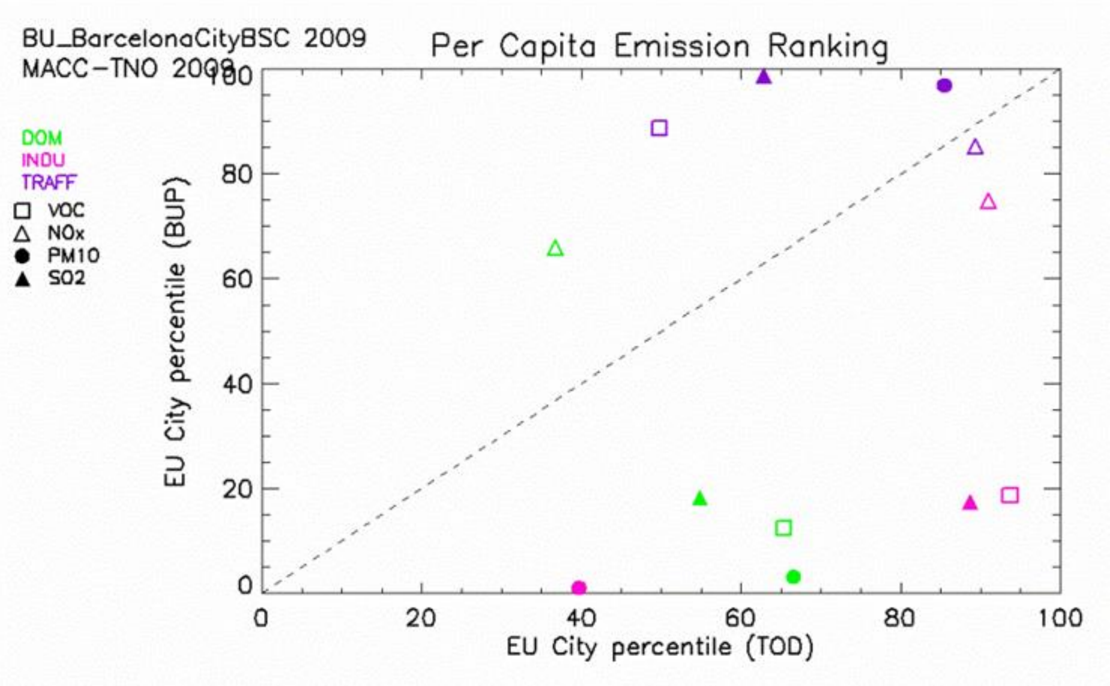
PER-CAPITA DIAGRAM

1) Evaluate if the top-down ranking is reasonable

For each sector/pollutant point the position along the X axis provides information on how the city/region is considered within the top-down inventories. E.g. the position of the points along the X axis shows large distances between pollutants belonging to the same macro-sector. This may indicate inconsistencies in the TOD emission inventory.

2) Check if the BUP and TOD ranking are consistent

The consistency can be seen by the distance from the diagonal. In addition to the overall under- or over-estimation it is important to assess whether the ranking difference is important with regards to the overall EU variability (e.g. do we remain within the range of the top-down ranking?)



RATIO DIAGRAM

1) Evaluate if all pollutant ratios are consistent among each other for a given macro-sector

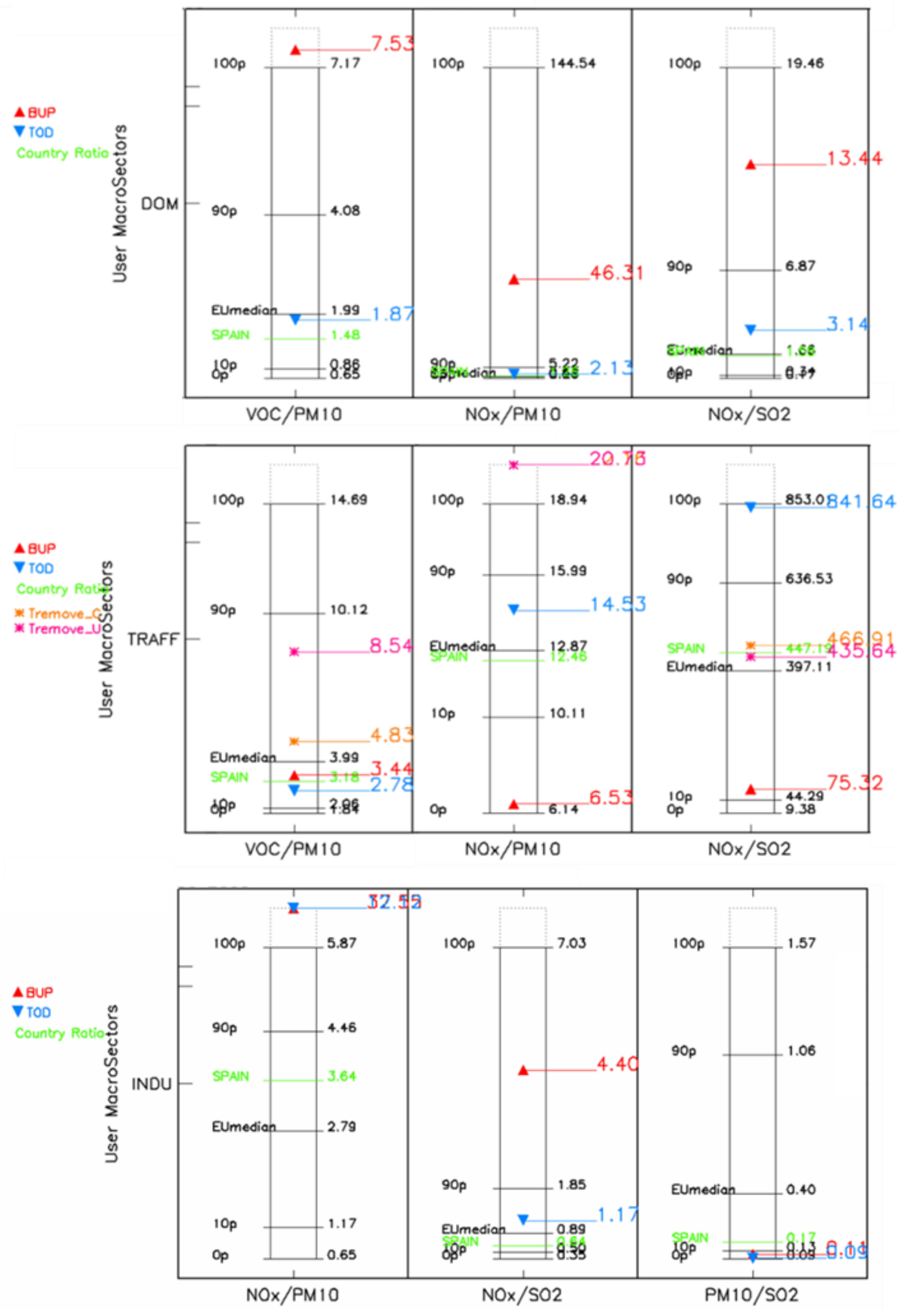
A reasonable ratio between two pollutants might be obtained although the two pollutant emission estimates are wrong (e.g. compensation of overestimations). Cross-checking the consistency of all ratios is therefore important.

2) Check if the BUP/TOD differences are reasonable with regards to the EU reference scale

The EU country scale provides minimum and maximum bounds against which it is interesting to put the BUP-TOD difference in perspective.

3) Is there any information about underlying processes that can be extracted

See examples in the table



RATIO DIAGRAM

MS	Ratio	2015			Variability	Comment
		min	med	95p	2025/2015	
SNAP01	NO_x/SO_2	0.3	1.4	4.6	1.1	Close to 0 for liquid or coal based fuel. Much higher for natural gas
	NO_x/PPM_{10}	1.5	13	28	1.2	
	NOx/NH_3	17	119	473	0.4	Low if SCR or SNCR systems are in place. Higher values indicate incomplete reaction of NH_3 additive
	VOC/PPM_{10}	0.2	1.4	3.4	1.5	Close to 1 for liquid or coal based fuel and much higher for natural gas
	SO_2/PPM_{10}	1.5	8.6	27	0.6	Very high for liquid based fuel, high for coal based fuel and close to one for natural gas
SNAP02	SO_2/NO_x	0.1	0.5	4.0	0.9	Close to 0 for natural gas. Much higher for liquid or coal based fuel
	PPM_{10}/NO_x	0.2	1.3	4.7	0.9	
	PPM_{10}/VOC	0.2	0.5	1.1	0.9	Close to 1 for liquid, coal or biomass based fuel and much higher for natural gas
	PPM_{10}/SO_2	0.4	2.9	13	0.9	Very low for liquid based fuel, low for coal based fuel, close to one for natural gas and higher for biomass
SNAP03	SO_2/NO_x	0.2	0.6	1.3	0.9	Close to 0 for natural gas and higher for liquid or coal based fuel
	NO_x/PPM_{10}	1.7	8.7	34	1.0	Low for liquid or coal based fuel and high for natural gas
	PPM_{10}/VOC	0.3	1.7	9	0.7	Very high for process furnaces and processes with contact (e.g. iron and steel industries)
	SO_2/PPM_{10}	1.6	6.4	16	0.9	Very low for biomass, low for coal based fuel, close to 1 for natural gas and much higher for liquid based fuel
SNAP04	SO_2/NO_x	0.3	3.2	23	0.4	Very high values identify processes in petroleum industries (i.e. sulphur recovery plants) aluminium and sulphuric acid production plants
	PPM_{10}/NO_x	0.4	1.9	15	1.1	High values identify coke ovens and aluminium and fertilizer production plants
	NH_3/NO_x	0.1	0.4	2.6	1.0	High values identify ammonia and fertilizer production
	SO_2/NH_3	1.5	9.6	44	1.2	Low values identify ammonia and fertilizer production
	PPM_{10}/SO_2	0.1	0.6	10	1.1	Low values identify refinery, aluminium and sulphuric acid plants and high values identify fertilizer production plants
SNAP07	NO_x/SO_2	273	548	848	0.6	High values indicate move to ultra-low sulphur content
	PPM_{10}/SO_2	19	44	73	1.3	
	NO_x/PPM_{10}	5.6	12	17	0.7	High values identify gasoline-powered vehicles or modern Euro diesel-powered vehicles equipped with particle filters
	NOx/NH_3	22	49	90	0.9	Values between 10 and 50 indicate SCR systems. Higher values for emerging economies
	NO_x/VOC	1.2	4.2	8	0.8	High values for gasoline-powered vehicles and much lower for diesel-powered vehicles
SNAP08	SO_2/NO_x	0.0	0.0	0.2	0.6	High values for fuels with high sulphur content values, usually related to maritime activities (e.g. residual oil)
	NO_x/PPM_{10}	9.9	14	22	1.2	Values are usually stable (several dozen). Very high values (several hundreds) identify air traffic activities
	VOC/SO_2	0.8	13	116	0.8	Very high values identify industrial or agricultural machinery and low values identify port facilities
	PPM_{10}/SO_2	0.2	3.5	34	0.3	
SNAP09	PPM_{10}/NO_x	5.5	17	173	1.6	Above means unabated PM low values indicate reverse
SNAP10	PPM_{10}/NO_x	8.5	58	744	1.0	High values identify manure management
	PPM_{10}/VOC	1.4	6.3	117	1.0	
	NH_3/VOC	4.6	64	1106	1.0	Low values for cultures without fertilizers
	NH_3/PPM_{10}	3.0	8.2	35	0.9	Low values (<15) indicate manure management rather than crop production (>40)

REFERENCE MATERIAL

- Cuvelier, C., Thunis, P., 2015. User manual Emis_Benchmark Tool. Available from: http://fairmode.jrc.ec.europa.eu/
- A benchmarking tool to screen and compare bottom-up and top-down emission inventories, M. Guevara, S. Lopez-Aparicio, C. Cuvelier, L. Tarrason, A. Clappier and P. Thunis, Submitted to Environmental Modelling and Software, 2015.
- A novel approach to screen and compare bottom-up vs. top-down emission inventories, P. Thunis, B. Degraeuwe, K. Cuvelier, M. Guevara, L. Tarrason and A. Clappier, Submitted to Atmospheric Environment, 2015.

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