COPERT 4 VS Version : COPERT Street Level MANAGING STREET EMISSIONS

Calculating emissions from road transport on a street level with COPERT4 and COPERT Street Level, a case study

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COPERT 4

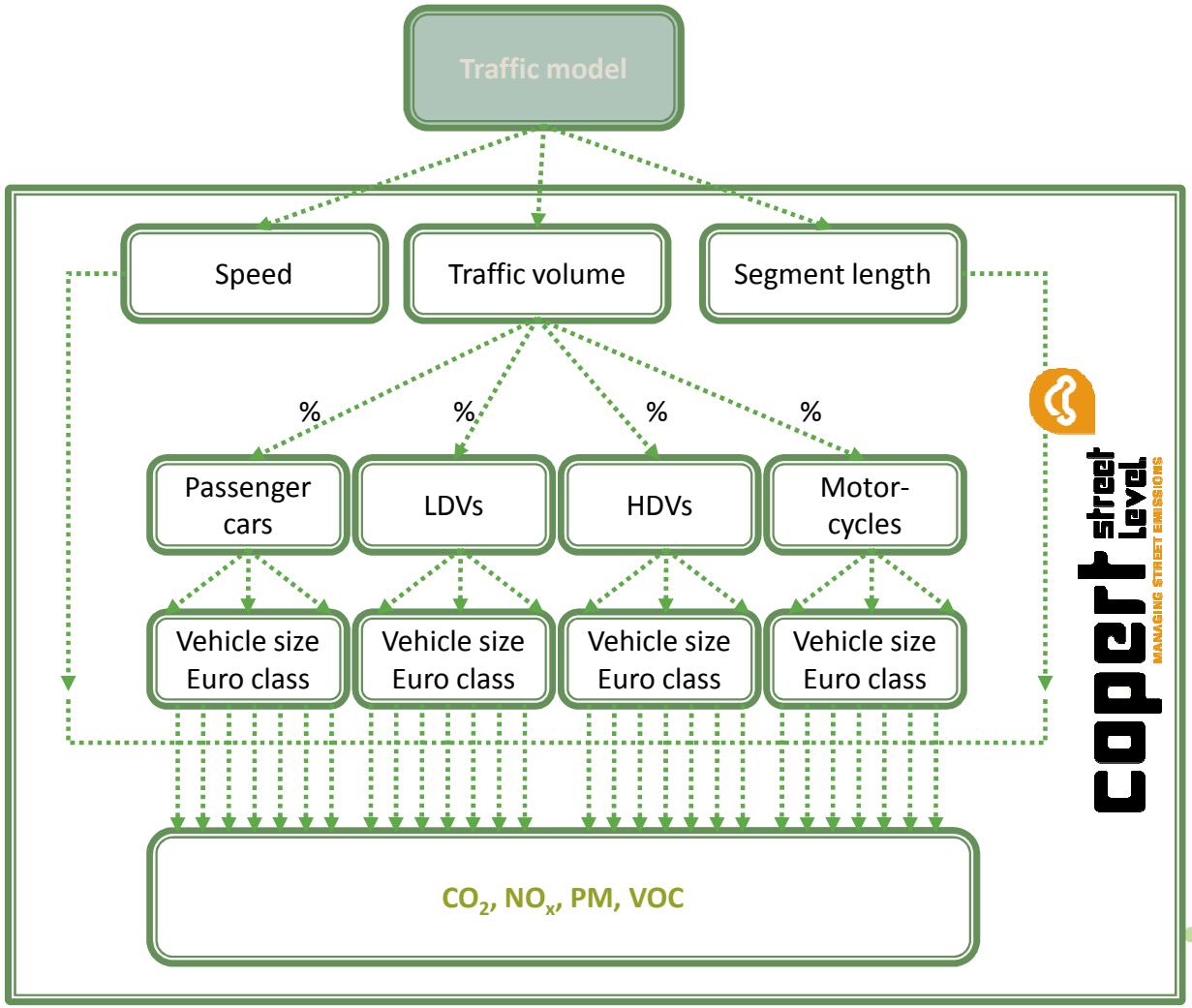
- It is a model used to calculate air pollutant and greenhouse gas emissions from road transport
- The development and continuous update is coordinated by the European Environment Agency (EEA)
- The methodology is part of the EMEP/EEA air pollutant emission inventory guidebook and is consistent with the 2006 IPCC Guidelines for the calculation of greenhouse gas emissions.
- It has been initially developed to help national experts compile their emission inventories.
- COPERT4 is an average speed emission model.

$$Emission[g] = VehiclePopulation[veh] \times AnnualMileage[km] \times EmissionFactor[\frac{g}{veh\ km}]$$

COPERT Street Level

- It is a model used to calculate emissions from road transport
- The development and continuous update is performed by EMISIA SA
- The methodology is based on the hot emission factor calculation of the EMEP/EEA air pollutant emission inventory guidebook.
- It has been initially developed to work alongside traffic analysis models in order to calculate emissions on a road network.

COPERT Street Level calculation flowchart



COPERT vs COPERT Street Level

	COPERT	COPERT street level
Minimum temporal level	Year	Hour
Minimum spatial level	City	Small road
GIS visualization	No	Yes
Emissions covered	Regulated and Non Regulated pollutants, GHG	CO, CO_2, NO_x, PM, VOC
Energy consumption calculation	Yes	Not
Automated scenario execution	No	Yes
Input data	Important requirement	Flexible

Scenario description (1/3)

- 3 scenarios for a business day for the city of Thessaloniki (2015, 2020, 2025 and 2030)
- Pollutants covered CO_2, NO_x, PM and VOC
- WISERIDE database
  - direct input to COPERT Street Level
  - post processing required for COPERT4

	COPERT Street Level		COPERT4	
	Aggregation level	Source of information	Aggregation level	Source of information
Activity	Road segment, hour, major vehicle category	WISERIDE	Vehicle type	WISERIDE, SIBYL
Speed	Road segment, hour, major vehicle category	WISERIDE	Vehicle Type	WISERIDE
Vehicle categorization	Vehicle type (included in the model)	SIBYL	Vehicle type	SIBYL

Scenario description (2/3)

- Business as usual
  - WISERIDE database for a business day
- Dieselisation
  - 2011 Diesel passenger car ban lifted in Thessaloniki

%	2015	2020	2025	2030
Gasoline	36	32	28	23
Diesel	64	68	72	77

%	2015	2020	2025	2030
Diesel – BAU	3.8	7.2	10.9	12.4
Diesel - Dieselisation	4.5	8.0	11.9	13.6

Scenario description (3/3)

- Metro
  - 31 km lines
  - about 2.7 million passengers per day
  - half would replace passenger car activity
  - the city was divided in 2 zones, around stations and other city

Results – COPERT4

- 3 scenarios, 4 years each

Scenario	Model	Pollutant	2015	2020	2025	2030
BAU	COPERT4	CO_2	6,265,966	5,996,888	5,720,345	5,538,284
		NO_x	13,802	10,504	8,121	6,943
		PM	615	452	315	249
		VOC	31,431	23,157	16,943	15,457
Dieselisation		CO_2	6,263,614	5,994,773	5,718,047	5,535,765
		NO_x	13,847	10,548	8,164	6,986
		PM	615	452	315	249
		VOC	31,430	23,156	16,942	15,456
Metro		CO_2	6,046,740	5,787,296	5,520,204	5,344,217
		NO_x	13,361	10,180	7,881	6,744
		PM	593	436	304	240
		VOC	30,319	22,335	16,341	14,908

results in tones

Results – COPERT Street Level

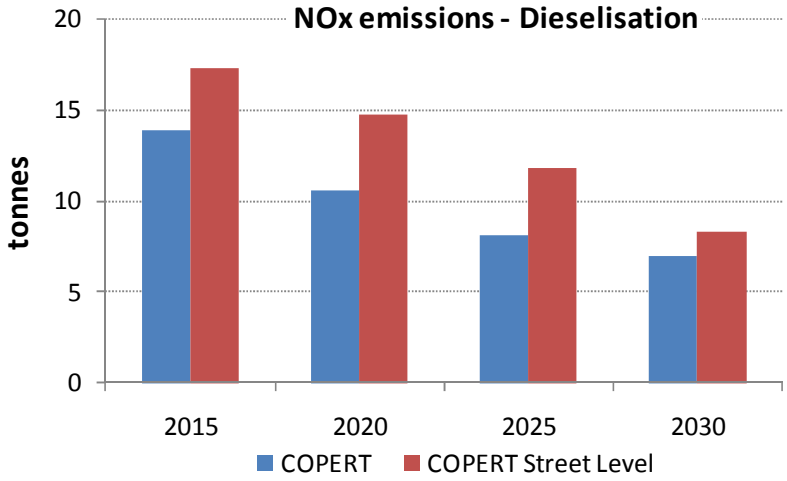
- 3 scenarios, 4 years each

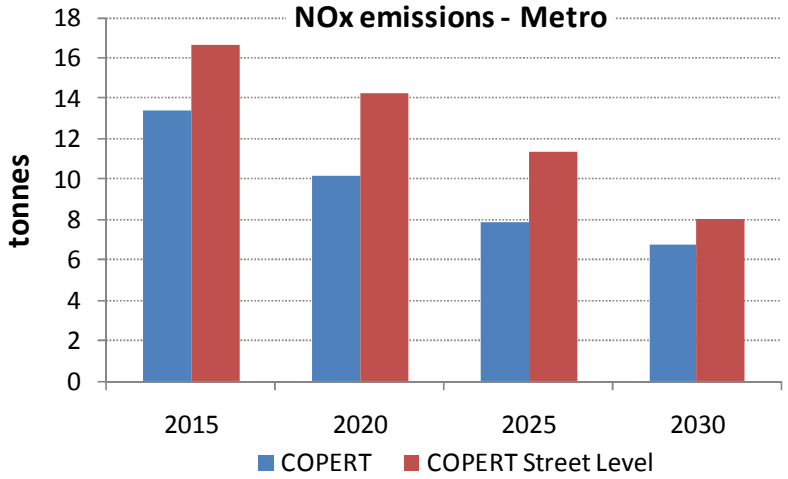
Scenario	Model	Pollutant	2015	2020	2025	2030
BAU	COPERT SL	CO_2	7,752,144	7,679,065	7,554,748	7,338,186
		NO_x	18,327	15,212	11,634	8,230
		PM	665	533	391	216
		VOC	19,491	13,997	9,335	7,018
Dieselisation		CO_2	7,741,458	7,674,841	7,552,600	7,335,325
		NO_x	17,247	14,780	11,772	8,300
		PM	668	536	394	216
		VOC	17,356	13,049	9,440	7,049
Metro		CO_2	7,471,683	7,407,274	7,289,041	7,079,190
		NO_x	16,639	14,260	11,359	8,009
		PM	645	517	380	209
		VOC	16,751	12,593	9,109	6,802

results in tones

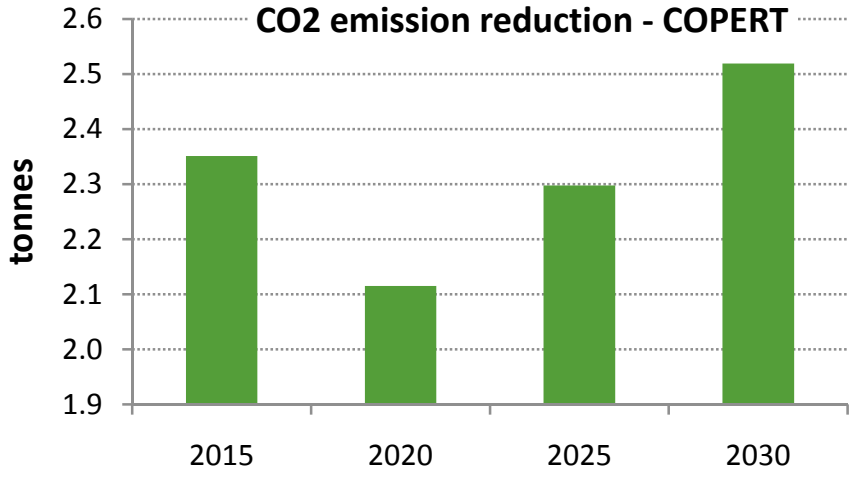
Results – time series

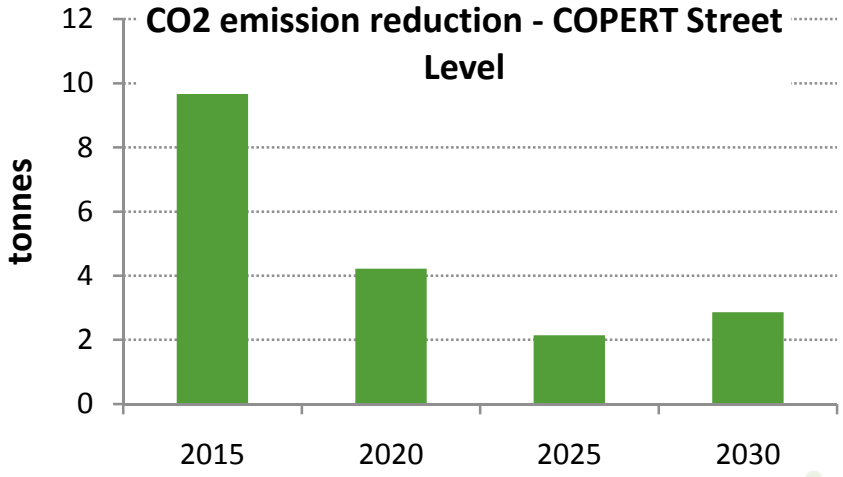
- NOx emissions

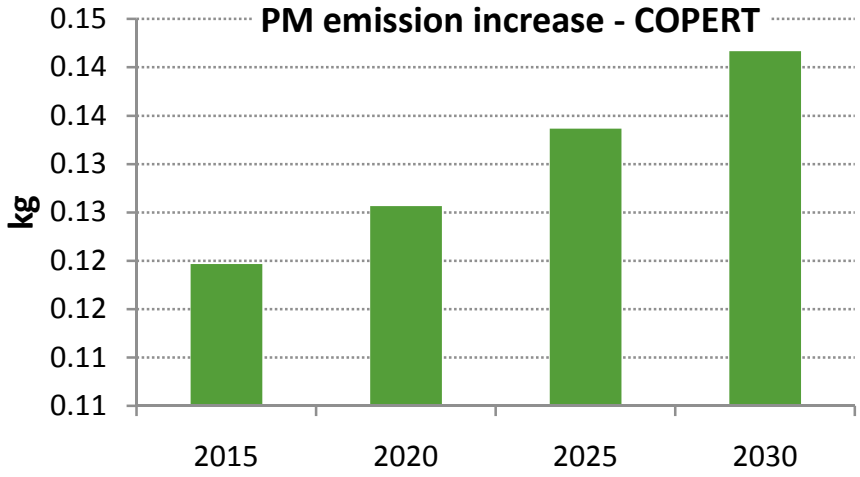


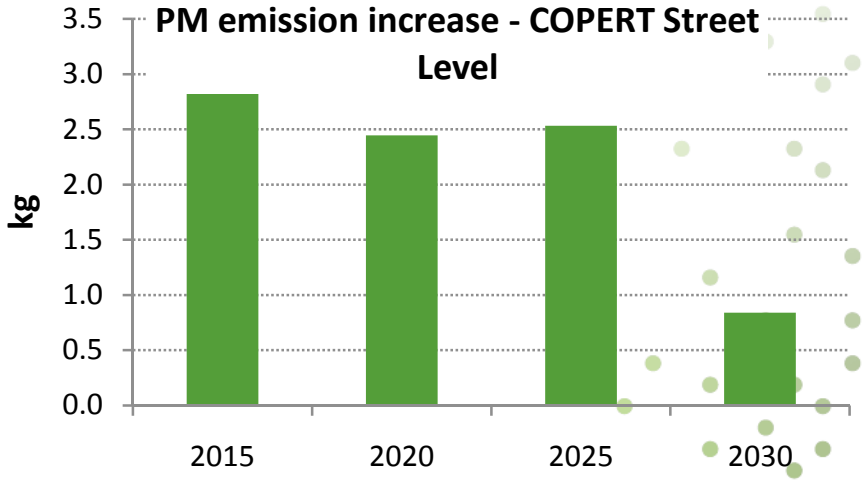


Results – BAU vs Dieselisation

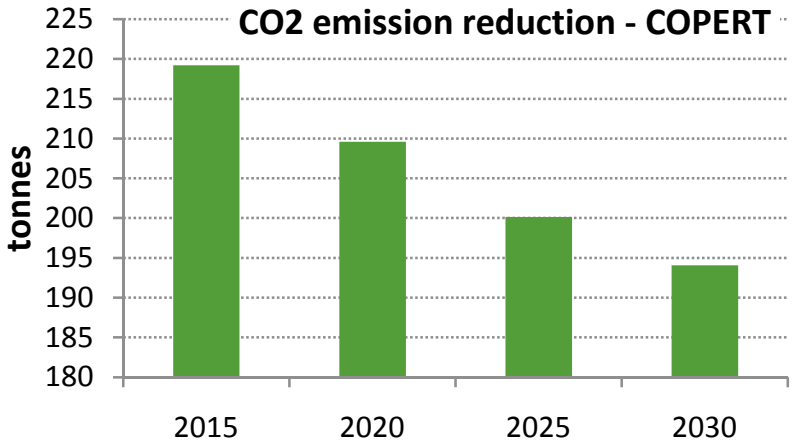


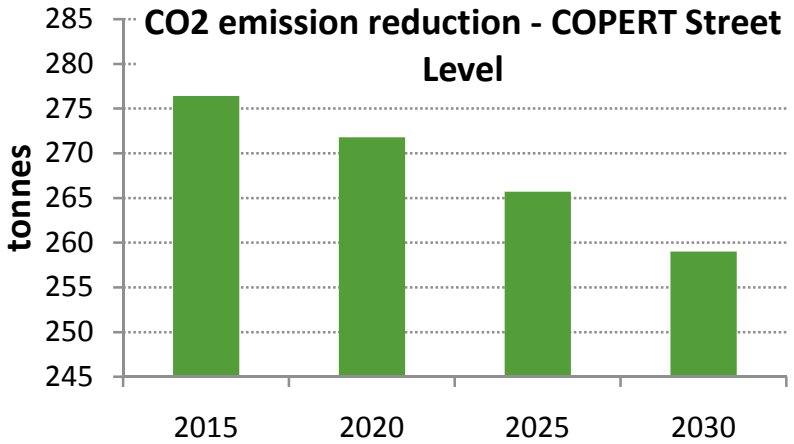


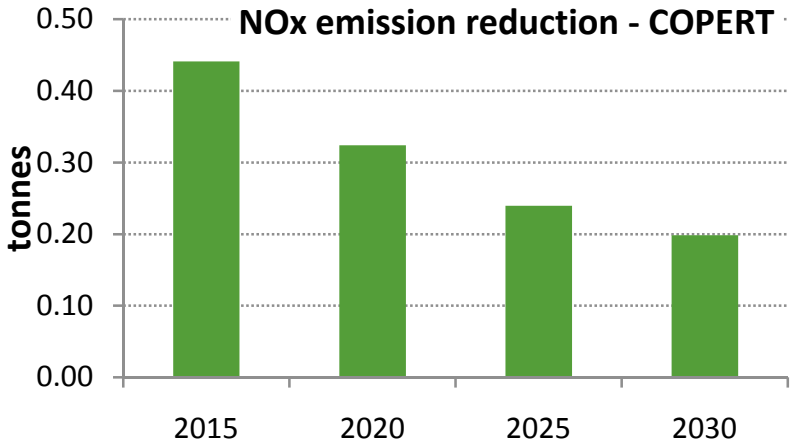


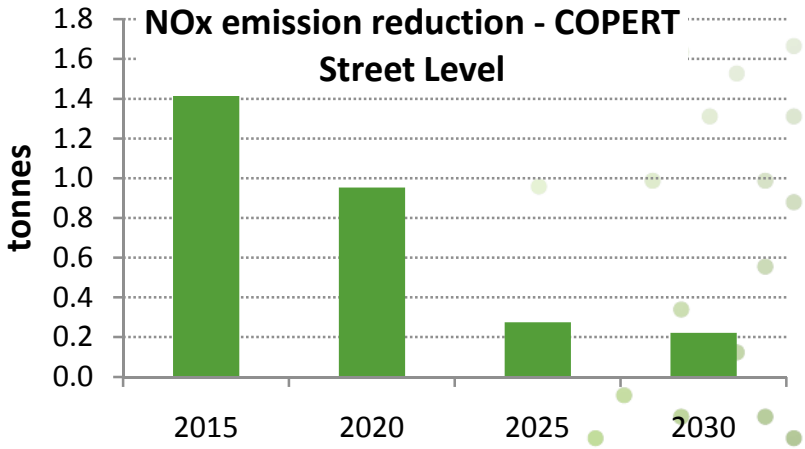


Results – BAU vs Metro







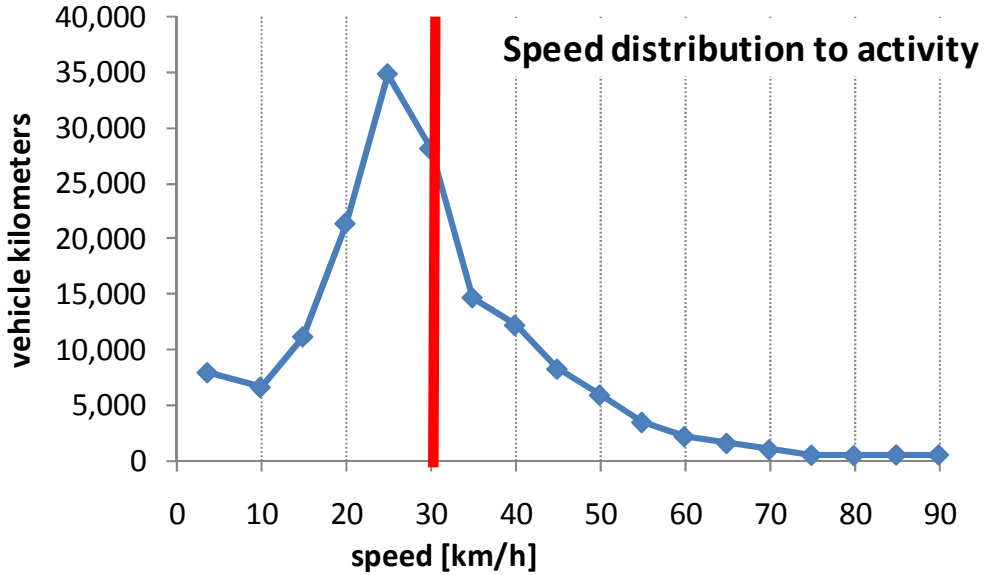


Software comparison

- COPERT4 requires post processing and average values for input data (speed, vehicle mileage, fleet composition)
- COPERT Street Level calculates using different input data for each road segment (speed, segment length, fleet composition)

Effect of average speed on results

- Example:
  - Heavy Duty Vehicle <7.5t Euro I, NO_x emissions



  - COPERT4: 500 kg
  - COPERT Street Level: 586 kg

Effect of average fleet composition on results

- Two different fleet distributions, VOC emissions on COPERT4

Vehicle category	Fleet distribution (COPERT4 default)	Activity [vehkm]	VOC emission factor [g/vehkm]	VOC emissions [t]
Passenger Cars	54%	12,665,371,729	0.013	163.9
Light Commercial Vehicles	11%	3,030,954,215	0.016	48.3
Heavy Duty Trucks	2%	797,844,662	0.161	128.6
Buses	0%	42,757,019	1.056	45.1
Mopeds	19%	7,203,148,971	1.578	11,367.8
Motorcycles	15%	5,558,812,048	0.666	3,703.2
Sum	100%	29,298,888,646		15,456.9

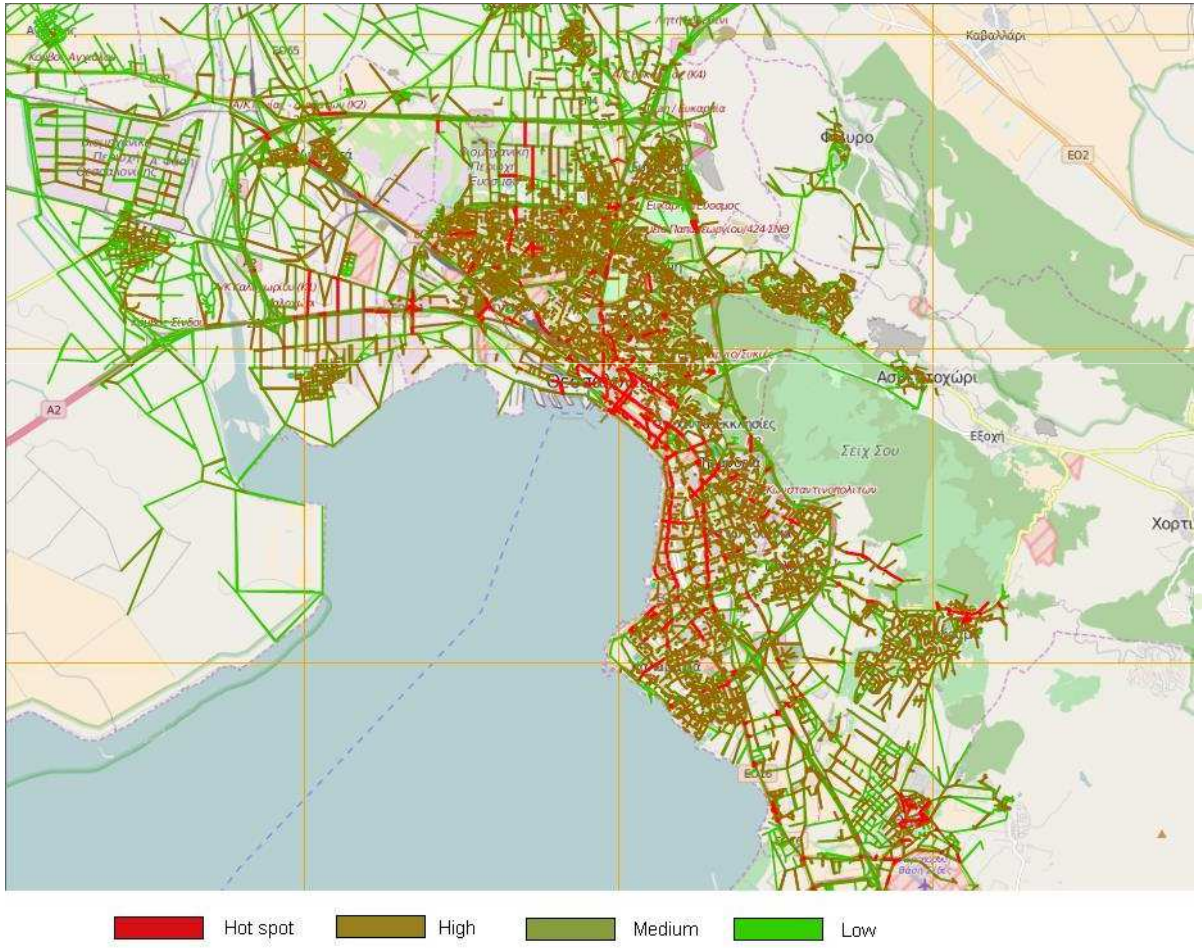
Vehicle category	Fleet distribution (4 lane road, hour 09:00-10:00)	Activity [vehkm]	VOC emission factor [g/vehkm]	VOC emissions [t]
Passenger Cars	88%	12,665,371,729	0.013	332.1
Light Commercial Vehicles	1%	3,030,954,215	0.016	5.7
Heavy Duty Trucks	1%	797,844,662	0.161	28.8
Buses	0%	42,757,019	1.056	75.3
Mopeds	5%	7,203,148,971	1.578	2,136.1
Motorcycles	6%	5,558,812,048	0.666	1,119.1
Sum	100%	29,298,888,646		3,697.1

Conclusions - quantitative

- Both models show expected emission trends
- Average approach (COPERT4):
  - eliminates hotspots
  - excludes important information such as different fleet composition in each road type and hour (traffic model)
  - can lead to increased or decreased total emissions

Example

- CO_2 emissions for BAU scenario in year 2015



Conclusions - qualitative

- Post processing requirement (COPERT4) increases calculation and working time, especially when dealing with large amount of data
  - 55.000 road segments
  - 30.000.000 vehicle kilometers
  - 9 road types
  - 24 hours

Thank you for your attention