Which are the priority sectors?Lessons learned and new emission sources to be considered

FAIRMODE
Forum for air quality modelling in Europe

Marc Guevara

Leonor Tarrason

27/02/2018

FAIRMODE plenary meeting, Baveno, Italy

Emissions in the Era of Big Data

Big and heterogeneous data is constantly being generated by a diversity of sources, but we are still asking the same questions:

- How many diesel EURO IV passenger cars pass through this street?
- What is the stack height of this industry?
- How many wood is being consumed in this district?
- When is the farmer applying fertilizers to this type of crop?

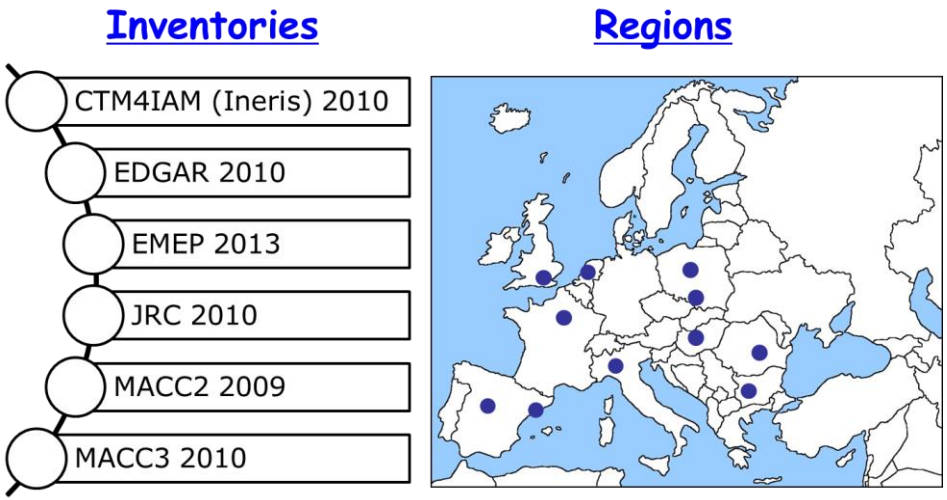
Are there new methods/tools (e.g. data analytics, data mining) that we can apply to improve the access to this (basic) information?

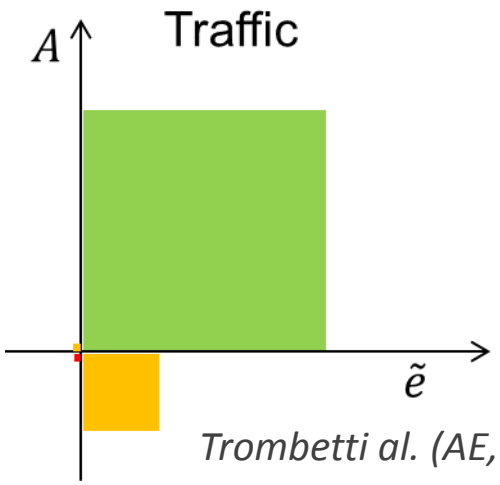
A specific challenge for each source

Activity/Emission Factors → Spatial Allocation → Temporal Allocation → Speciation

Road Transport

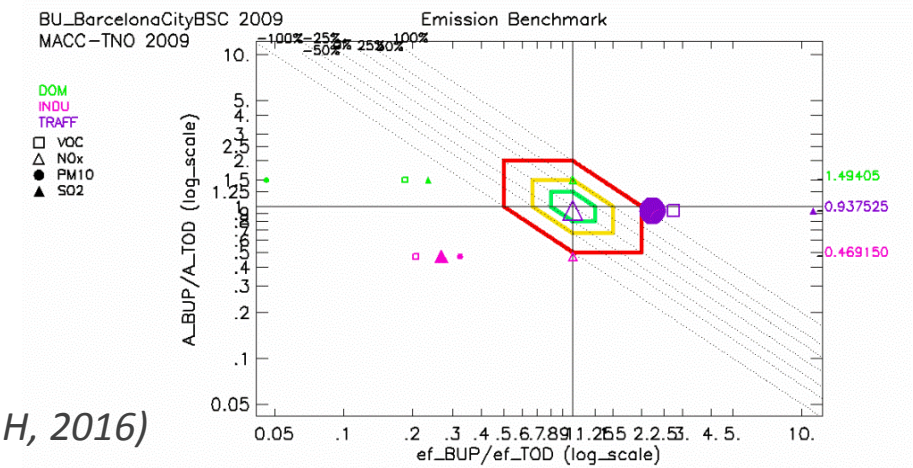
- NO_x: In general, good agreement between top-down and bottom-up and top-down emission inventories. But…





Trombetti al. (AE, 2018)

BARCELONA

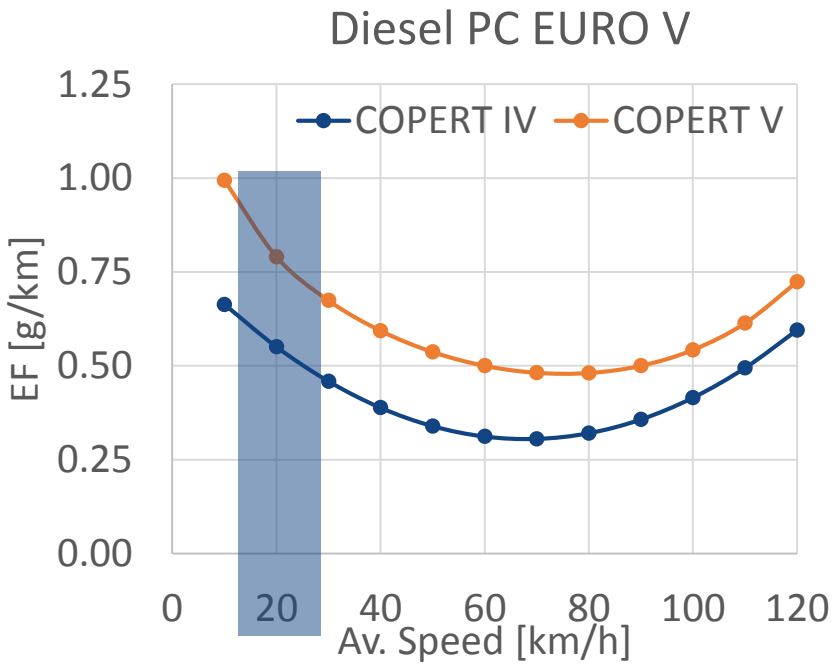


Guevara al. (AQAH, 2016)

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Road Transport

- NO_x: In general, good agreement between top-down and bottom-up and top-down emission inventories. But…
- Does it mean that both emission inventories are correct? (none of them can be taken as “the reference”)

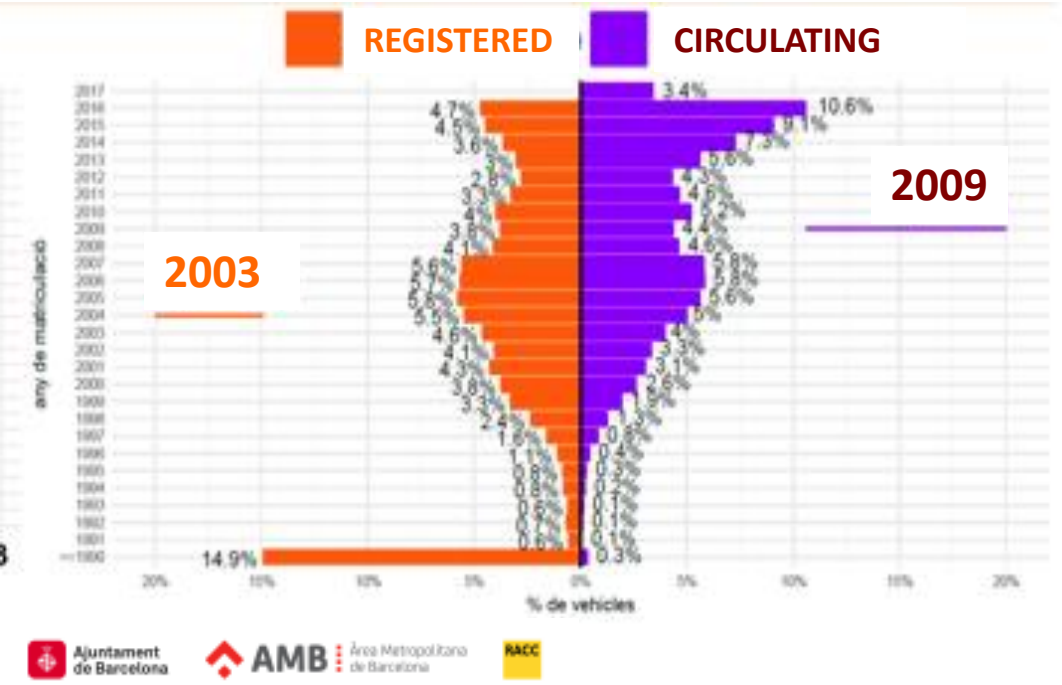


Emission inventories need to take into account real world observations

Road Transport

- Vehicle fleet composition profile

Average passenger car registration year in Barcelona



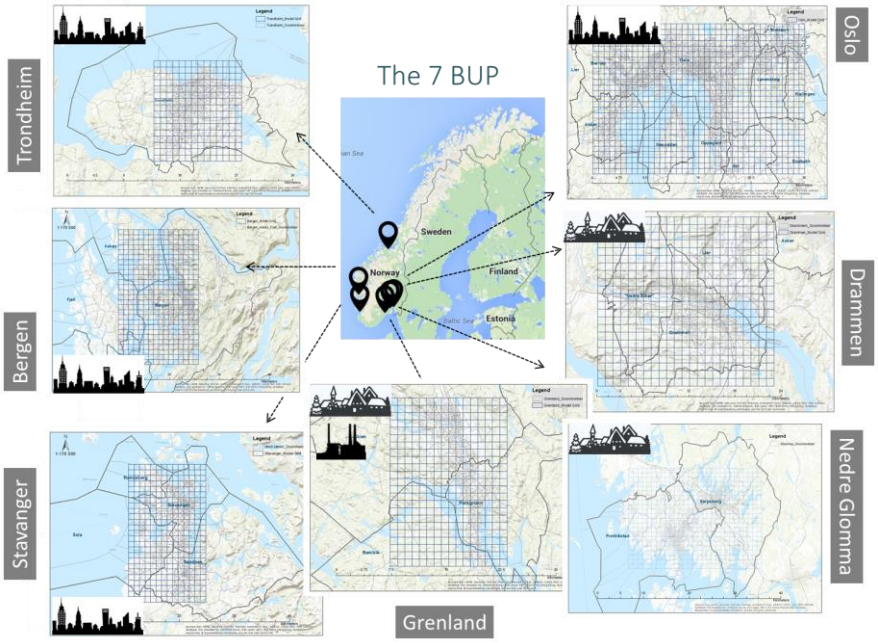
Low Emission Zone (December 2017)

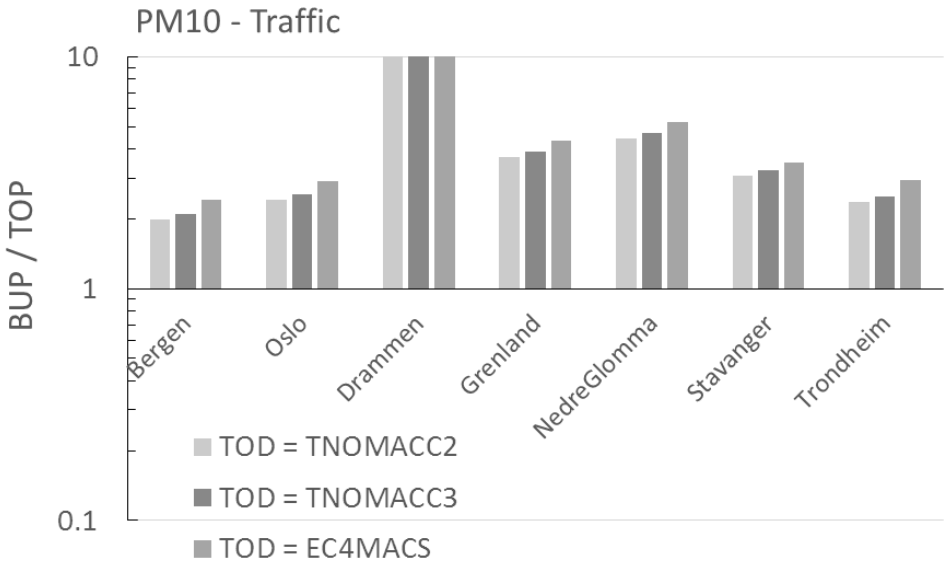
Petrol cars registered before 2000
Diesel cars registered before 2006
Vans registered before 1 October 1994

Number plate recognition systems: A necessary input for AQ planning (WG4)

Road Transport

- PM10: Member States are not requested to include resuspension traffic related sources in their official emission inventories. But…



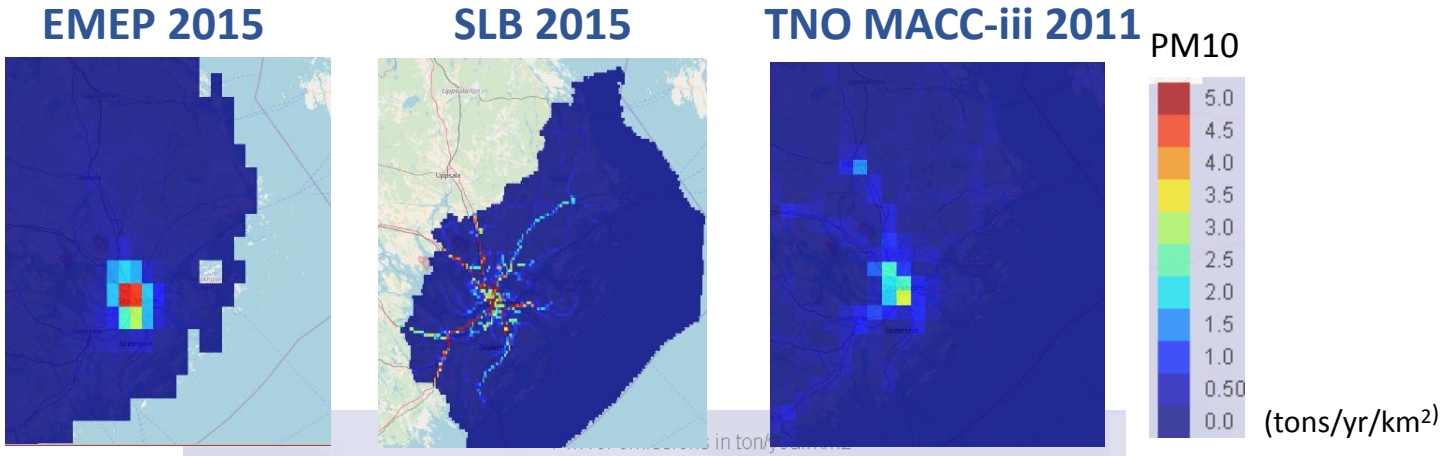


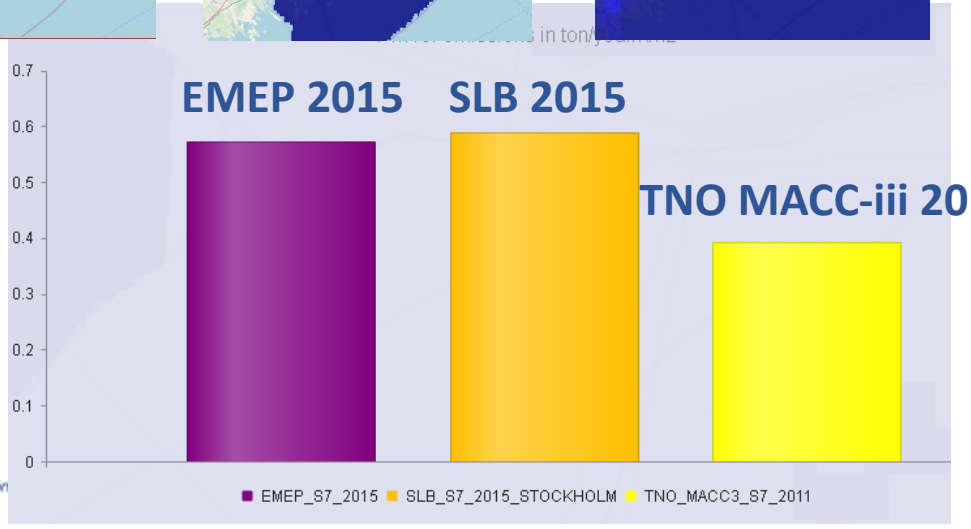
Lopez-Aparicio al. (AE, 2016)

Road Transport

- PM10: Member States are not requested to include resuspension traffic related sources in their official emission inventories. But…**There is hope!**

  Sweden's submission 2015: Resuspension included (increase almost a factor 2)





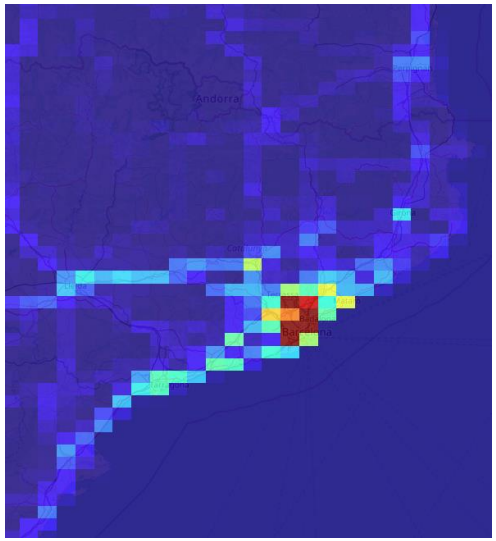
Road Transport

- Spatial distribution: urban / interurban / rural roads

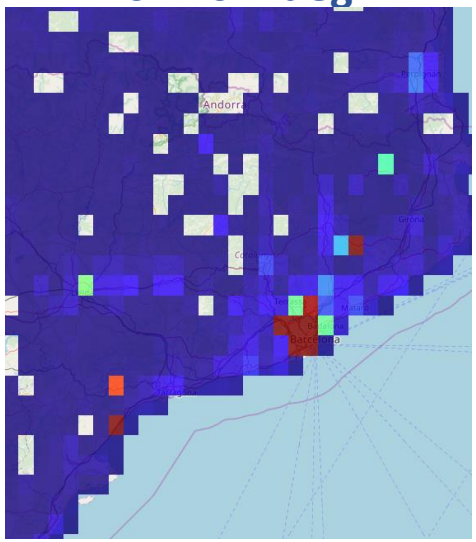
How to get the correct balance in top-down emission inventories?

HERMESv2.0 (2013)
1kmx1km

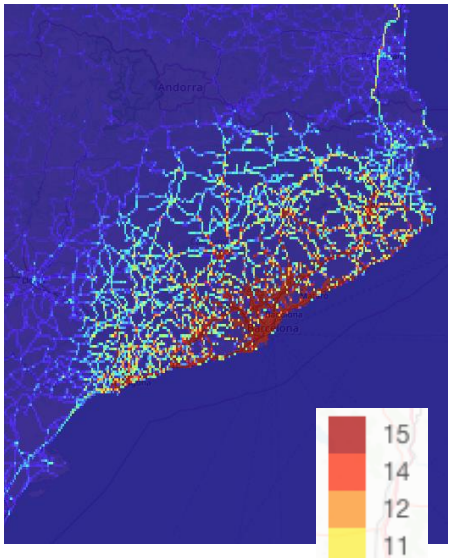
TNO MACC-III (2011)
7kmx7km



EMEP (2015)
0.1x0.1 deg



JRC (2010)
1kmx1km



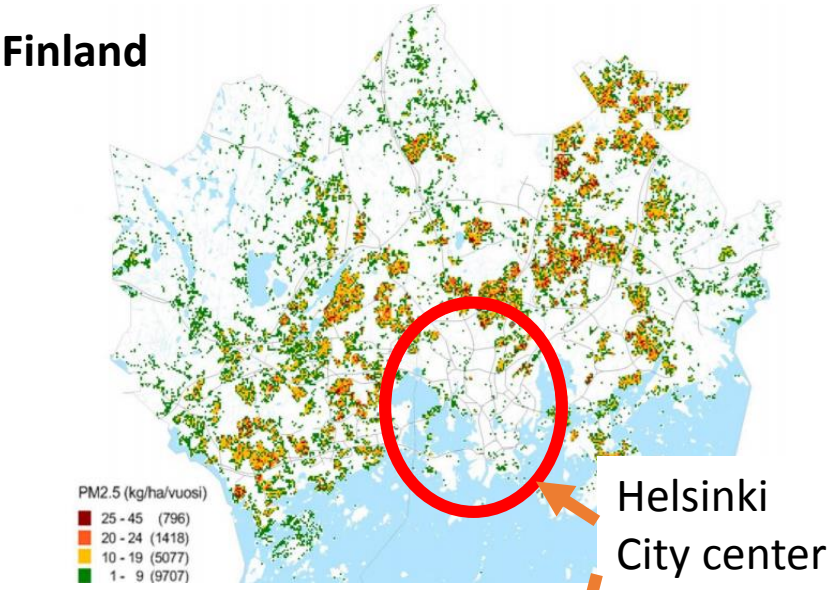
Is it possible to report in the IIRs the spatial proxies and methods used?

NOx (tons/yr/km$^{2)}$

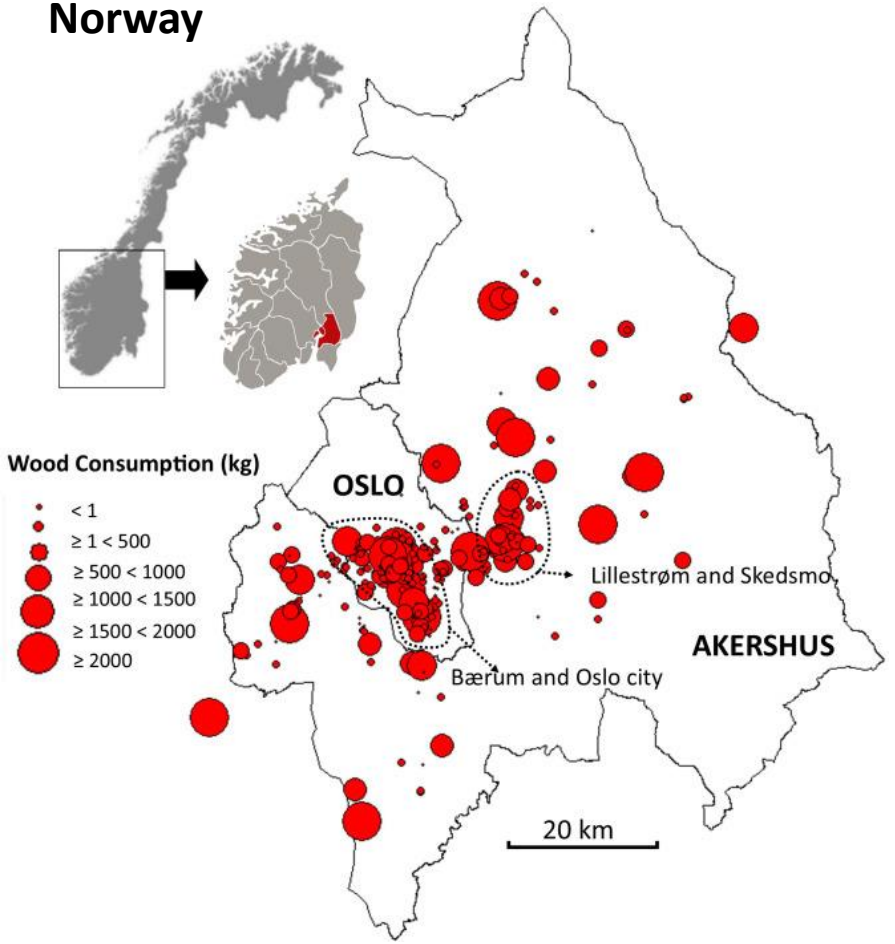
Residential Combustion

- Spatial allocation: Where is the wood being burned?

Finland



Norway



Lopez-Aparicio al. (JEM, 2017)

Residential Combustion

- PM Emission Factors:
  - National emission factors used on official reporting show a considerable range

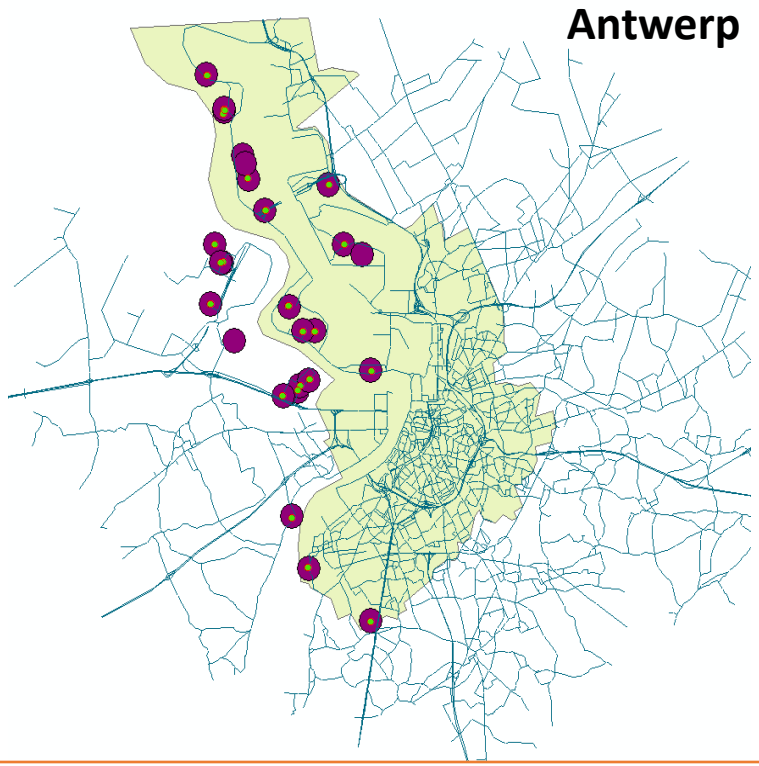
Tier 2 emission factors					
	Code	Name			
NFR source category	1.A.4.b.i	Residential plants			
Fuel	Wood and similar wood waste				
SNAP (if applicable)	020205	Residential - Other equipments (stoves, fireplaces, cooking,...)			
Technologies/Practices	Conventional stoves				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated					
Pollutant	**Value**	**Unit**	**95 % confidence interval**		**Reference**
			Lower	**Upper**	
NO_X	50	g/GJ	30	150	Pettersson et al. (2011)
CO	4000	g/GJ	1000	10000	Pettersson et al. (2011) and Goncalves et al. (2012)
NMVOC	600	g/GJ	20	3000	Pettersson et al. (2011)
SO_X	11	g/GJ	8	40	US EPA (1996/2)
NH_3	70	g/GJ	35	140	Roe et al. (2004)
TSP (total particles)	800	g/GJ	400	1600	Alves et al. (2011) and Glasius et al. (2005) [1)]
PM_{10} (total particles)	760	g/GJ	380	1520	Alves et al. (2011) and Glasius et al. (2005) [1)]
$PM_{2.5}$ (total particles)	740	g/GJ	370	1480	Alves et al. (2011) and Glasius et al. (2005) [1)]

Should the emission factor be also country-oriented?

Industries

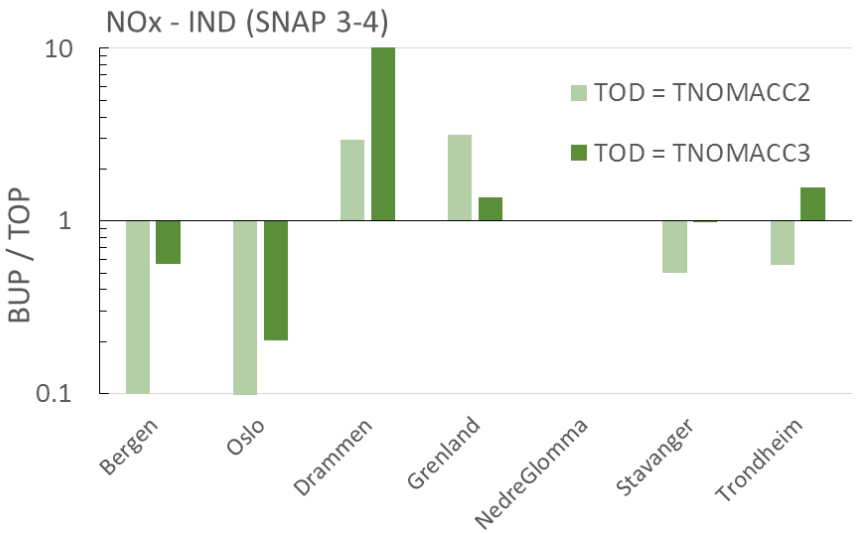
- Spatial allocation:

LPS: Is E-PRTR reliable enough?



Ton/year	NO_x	PM_{10}	$PM_{2.5}$
Local dataset (2012)	12488	425	219
CLRTAP (2010)	12589	0	0
E-PRTR (2012)	11422	106	0

MCP: Which is the best spatial proxy?



TNO_MACC-II: total population

TNO_MACC-III: **Industrial land cover**

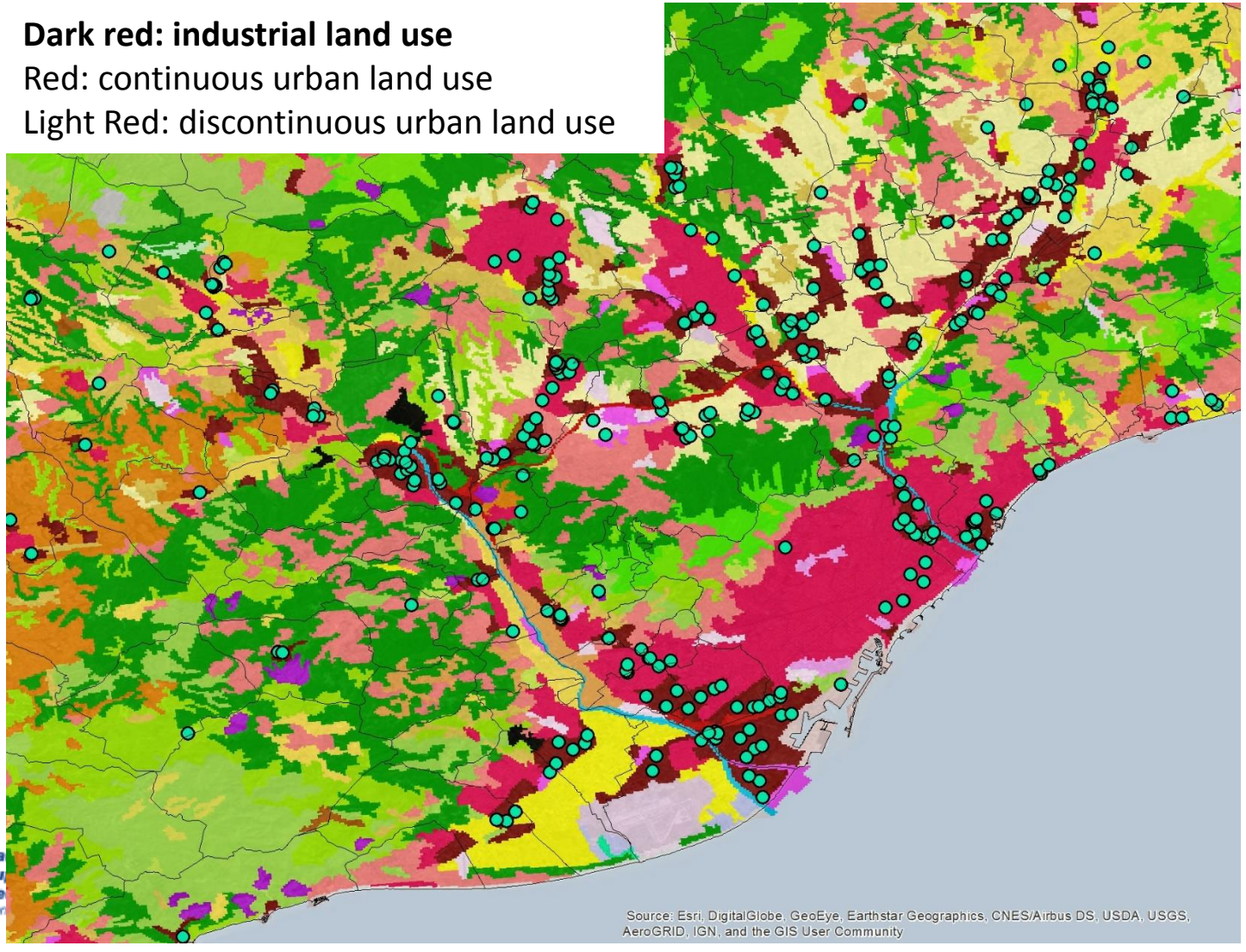
CORINE Land Cover: sanatoriums, spa facilities, hospitals, military bases, educational establishments, university sites, commercial centres bordering on or outside urban districts **are also associated with this category**.

Industries

- Spatial allocation:

Land Cover examples – CORINE 2006 (Barcelona)

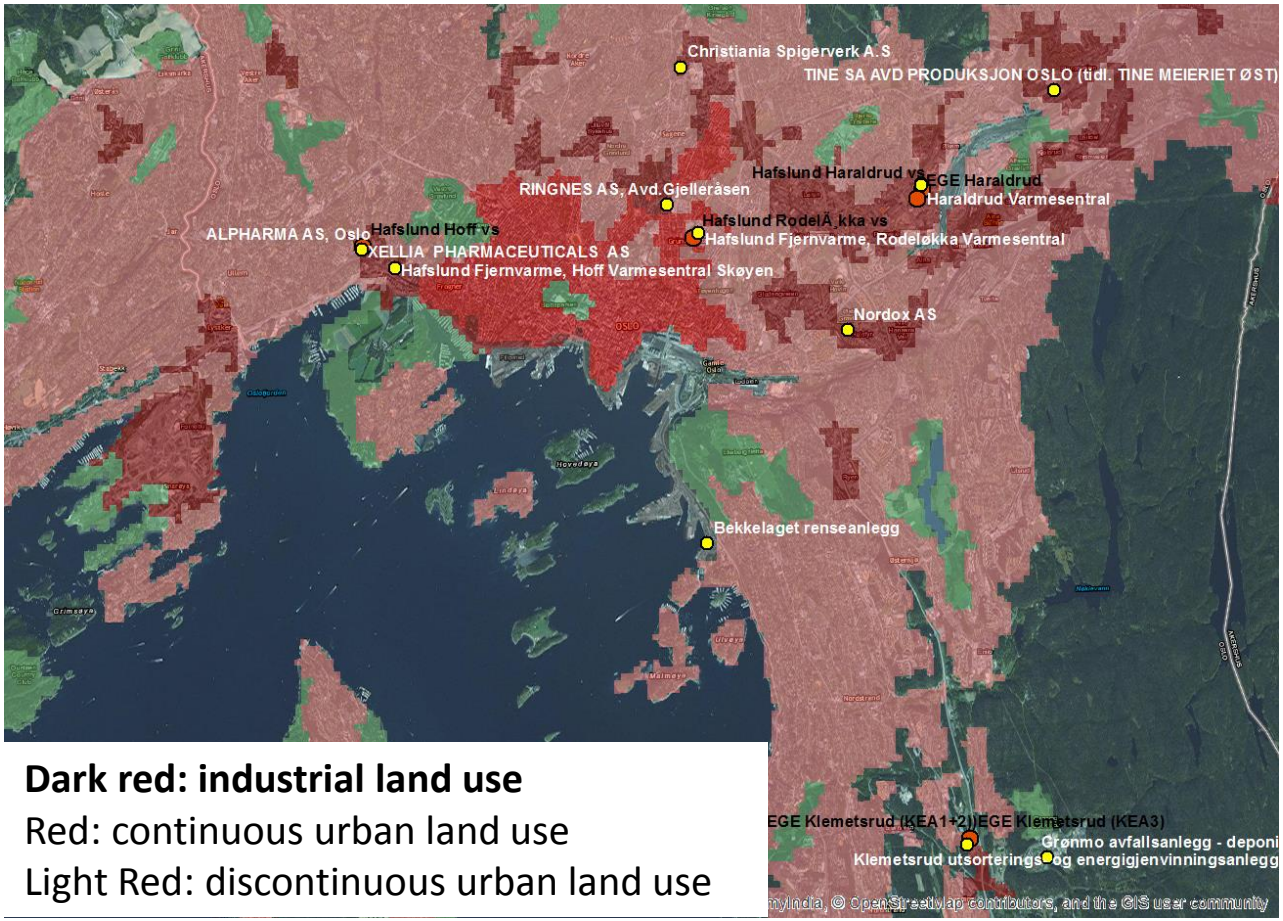
Dark red: industrial land use
Red: continuous urban land use
Light Red: discontinuous urban land use



Industries

- Spatial allocation:

Land Cover examples – CORINE 2006 (Oslo)



Dark red: industrial land use
Red: continuous urban land use
Light Red: discontinuous urban land use

Is it time to define a better industrial land use category?

Agriculture

Livestock (NH_3)

Fertilizer/Manure Application (NH_3)

Crop Operations (PM)

Vegetation (NH_3)

Waste Burning (PM)

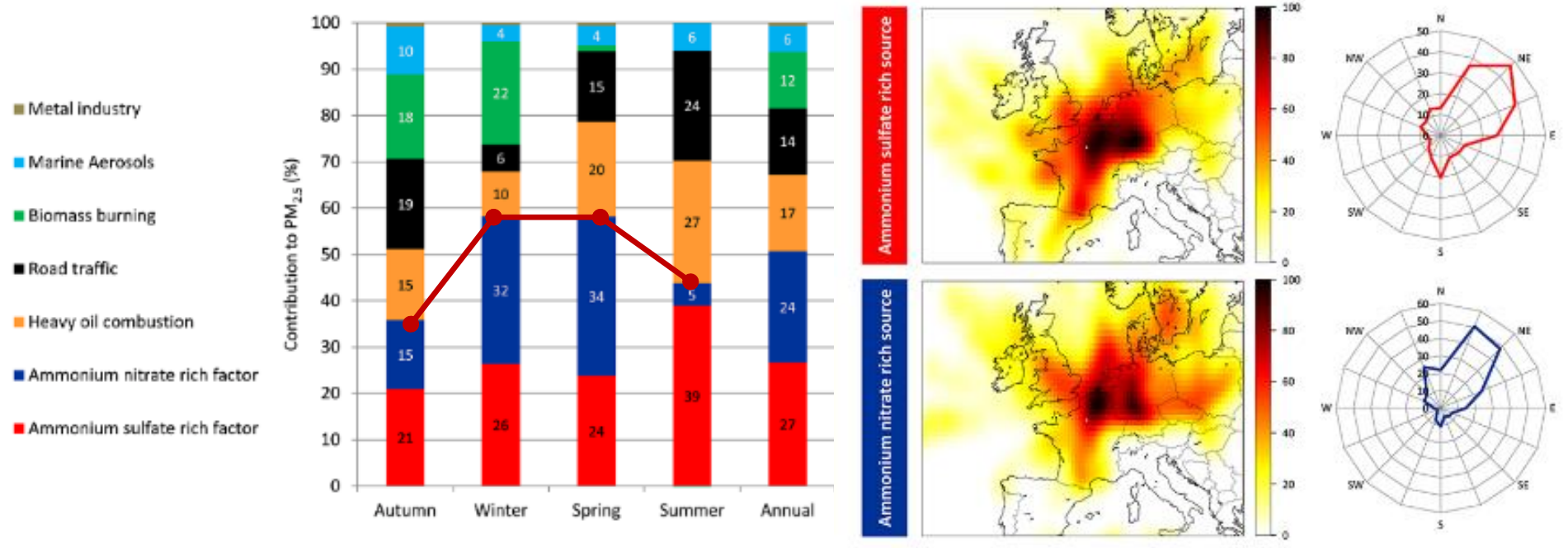
Covered by regional (top-down) annual emission inventories (usually not included in bottom-up urban emission inventories)

Covered by online models (MEGANv2.1, GFASv1.2)

Agriculture

Sources and geographical origins of fine aerosols in Paris (Bressi et al., ACP, 2013):

More than 50% of $PM_{2.5}$ levels are associated with (mid to) long-range transported pollution

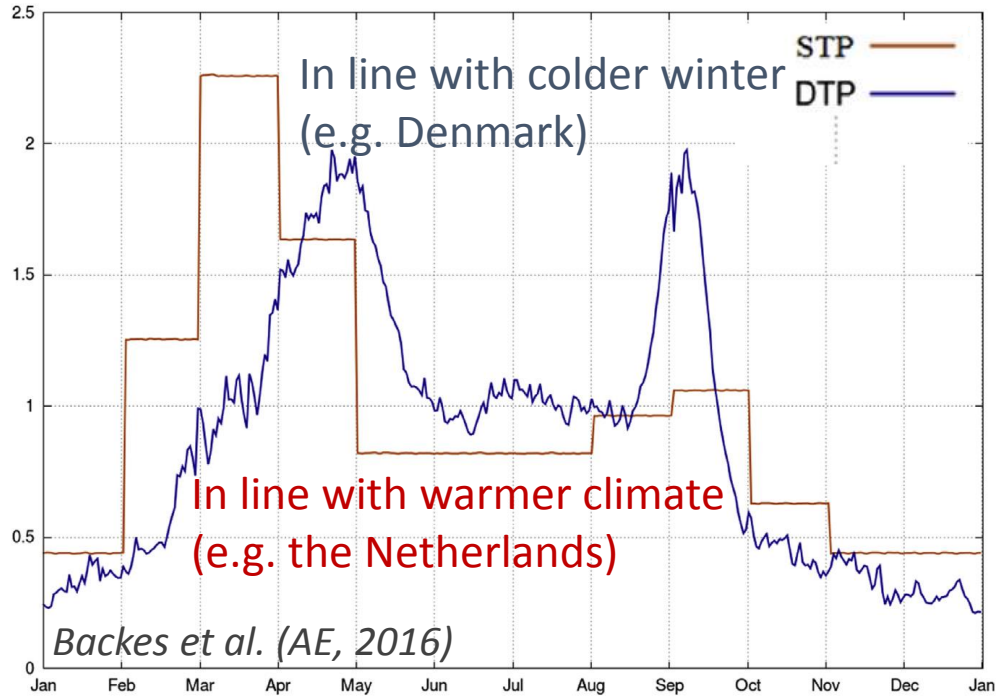


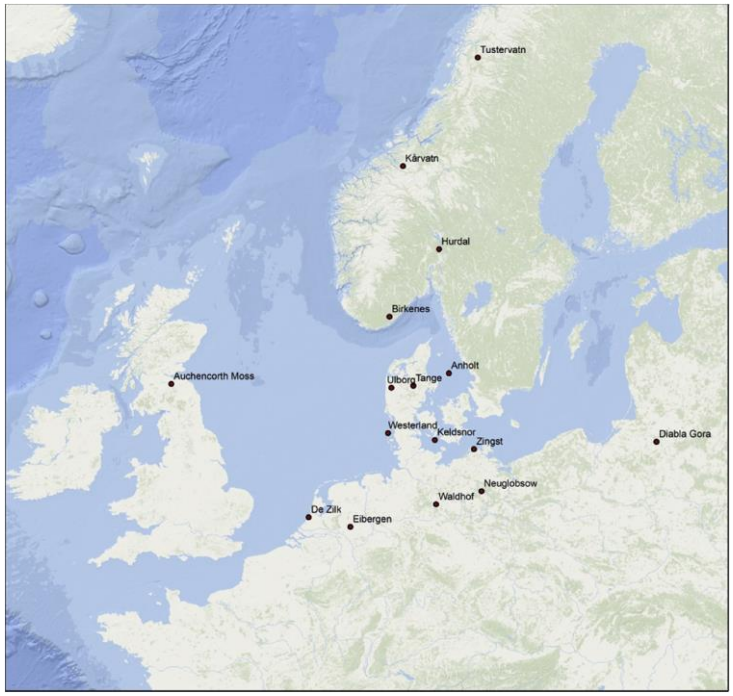
A seasonal pattern strongly influenced by agricultural emissions (meteorology, fertilizer application practices and legal restrictions)

Agriculture

- Temporal allocation:

Is a static (spatially constant) temporal profile representative enough?





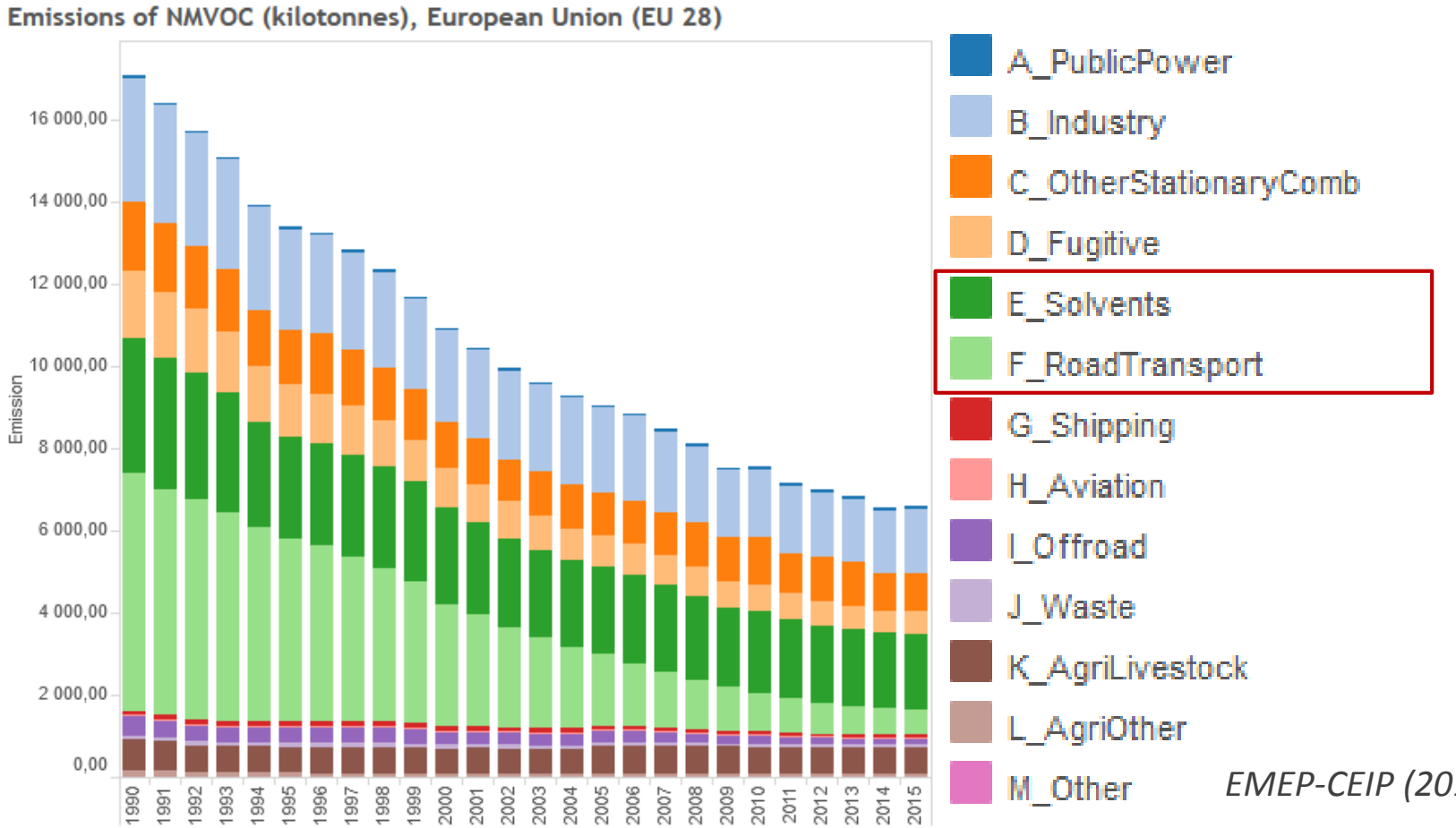
STP is the commonly used temporal disaggregation scheme for NH_3 in current CTMs for Europe

Is there a need for a gridded temporal profile for NH_3 agricultural emissions?

Use of Solvents

Change in inventories of urban NMVOC sources:

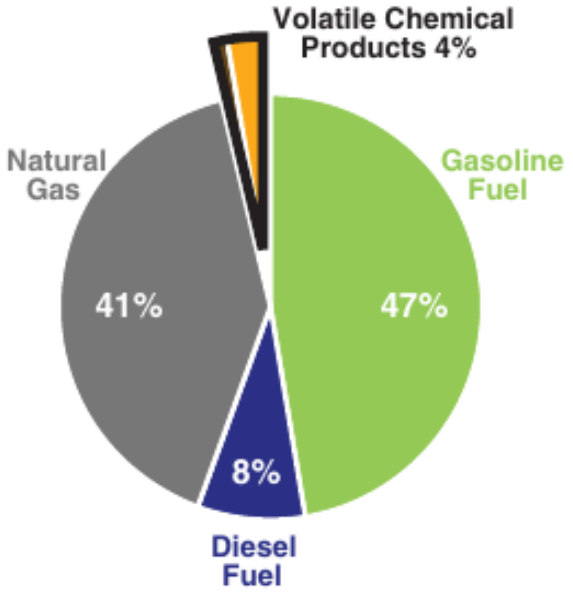
- Transportation emissions have declined rapidly.
- The use of volatile chemical products (VCPs) (e.g. personal care products) now constitutes half of fossil fuel NMVOC emissions



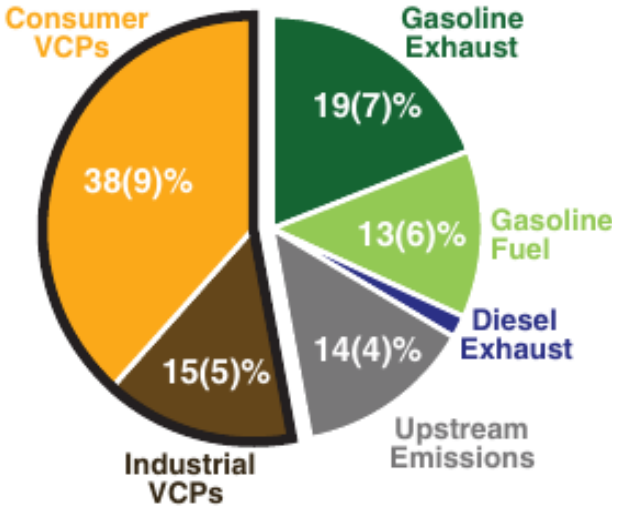
EMEP-CEIP (2018)

Use of Solvents

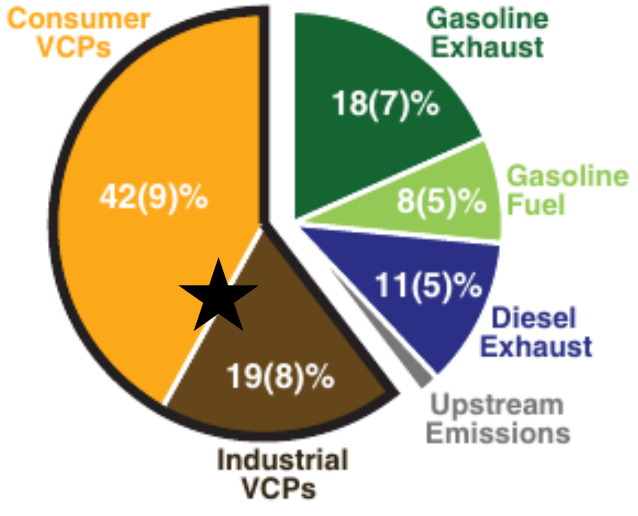
Human exposure to carbonaceous aerosols of fossil origin is transitioning away from transportation-related sources and toward use of VCPs.



Product Use = 37 Tg



VOC Emissions = 350 ± 50 Gg



SOA Potential = 11.5 ± 2.7 Gg

Straight, branched, and cyclic alkanes (42 ± 4%)
Alkenes and terpenes (17 ± 5%)
Aromatics (12 ± 3%)

McDonald et al. (Science, 2018)

Should we focus more on the speciation profiles that we are using?

Urban CO_2 emissions

Global Covenant of Mayors for Climate and Energy (2016): Signed by more than 600 cities
→ To reduce their greenhouse gas emissions and **create robust inventories**

Disagrements between local (bottom-up) and current global emission inventories exceed 100% for large urban areas.

Should we include this pollutant in our to do list?

Points for discussion

Road transport: How do we communicate our findings?

Residential Combustion: Do we need spatial proxies that are more (i) "emission inventory" oriented? (ii) heterogeneous (i.e. take into account local cultural factors)?

Next priorities:

- Industry
- Agriculture
- Use of solvents
- Temporal distribution
- Speciation
- CO_2 in urban areas

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EXCELENCIA SEVERO OCHOA

NILU

Thank you

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