High resolution emission inventories

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RI-URBANS (101036245)

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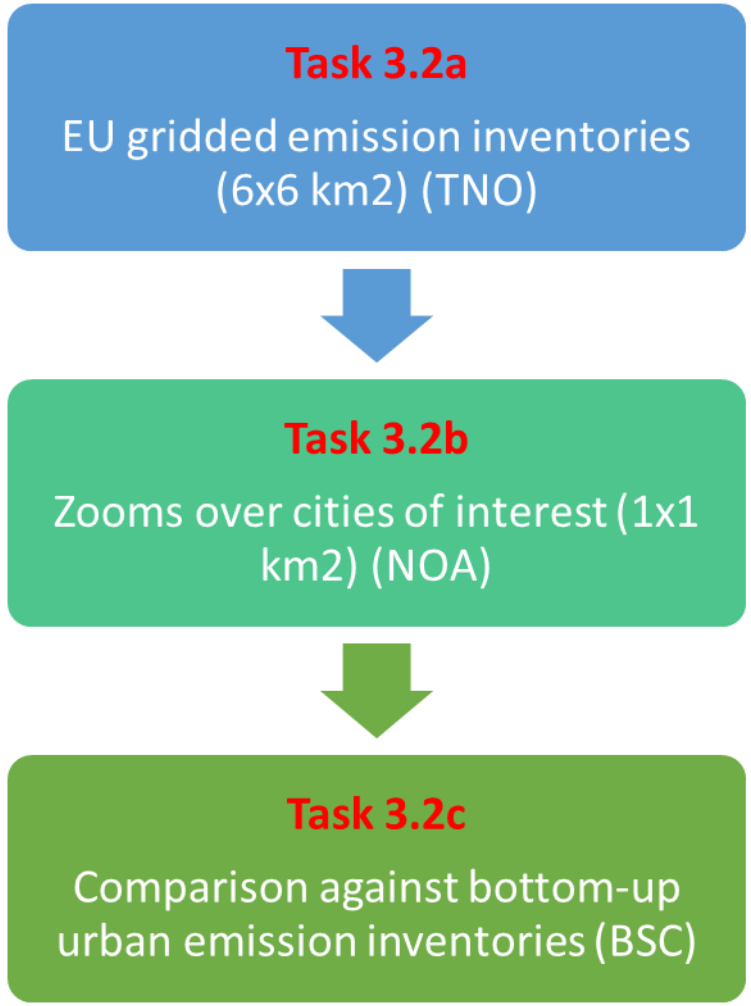
Content of this presentation

- European emissions for UFP and road transport (non-)exhaust
- Methodology to downscale emissions to 1x1km over urban areas
- Comparison of downscaled emissions with local bottom-up emission inventories



European scale emissions

- CAMS-REG-v5.1 emission dataset for main air pollutants
  - Extension of earlier CAMS-REG-v4.2 (Kuenen et al., 2022)
  - Road transport: consistent bottom-up inventory developed covering both exhaust and PM from non-exhaust (wear)
  - Small combustion emissions estimated consistently for PM including condensable organics (Simpson et al. 2022)
  - Year 2018

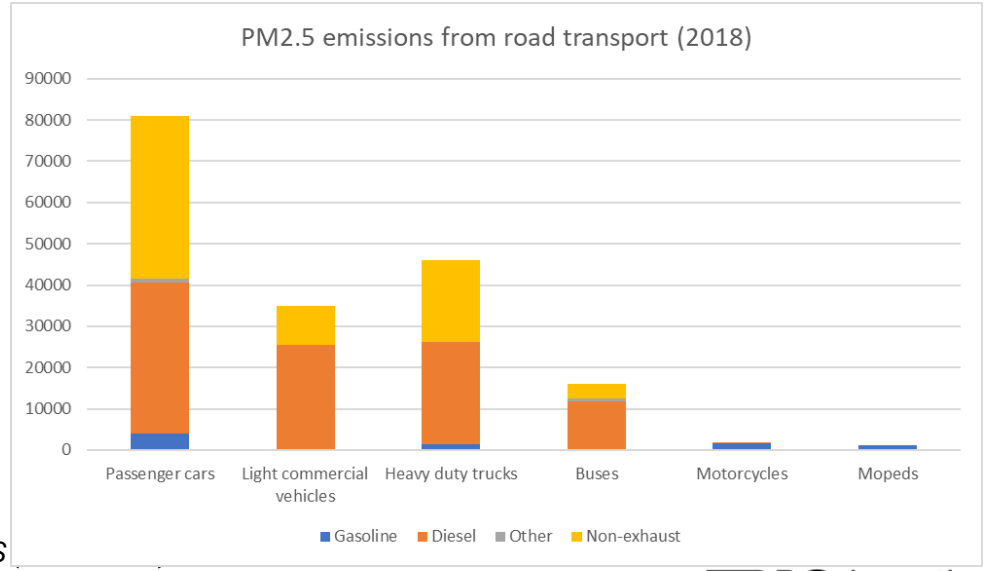
Road transport emissions

Annual data per country
Total vehicle stock & mileage
>500 different types of vehicles

Exhaust emission factors (g/km) taken from various sources:
- EMEP/EEA Guidebook (2019)
- Dutch emission inventory

Non-exhaust emissions calculated using detailed approach described in EMEP/EEA Guidebook (2019)

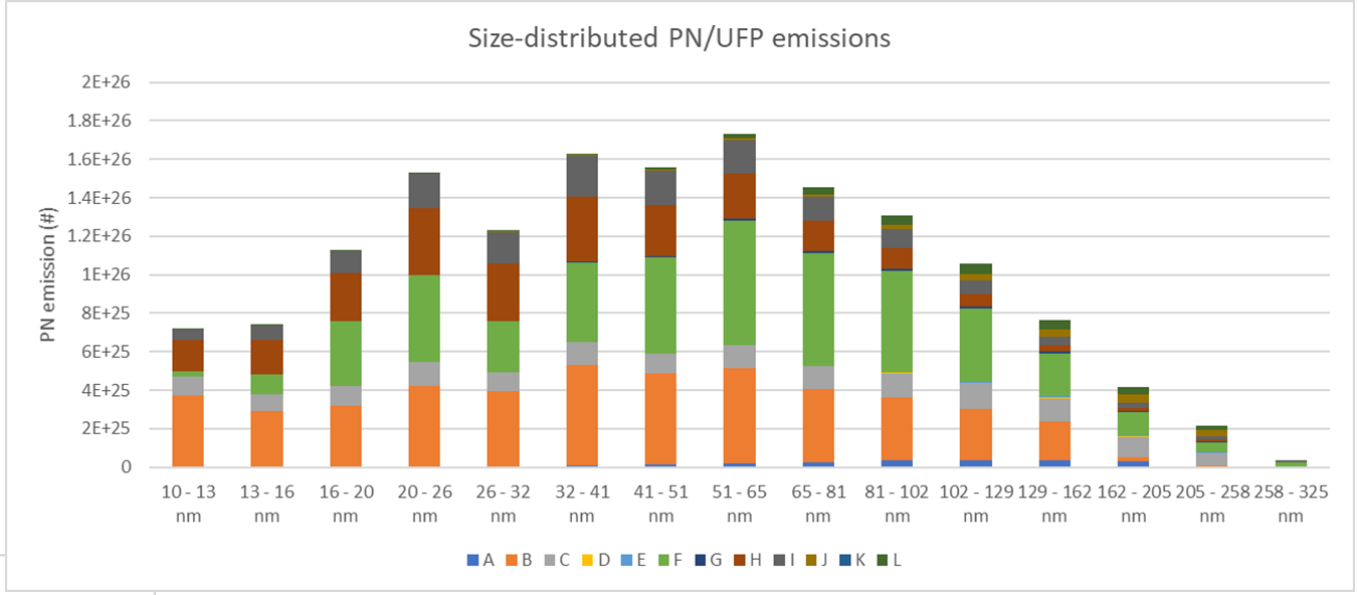
- Distinguishing all relevant categories for emissions (Euro classes)
- Focus on PM10, PM2.5, secondary PM precursors and UFP (PN)
- Consistent spatial distribution of emissions (CAMS-REG approach)

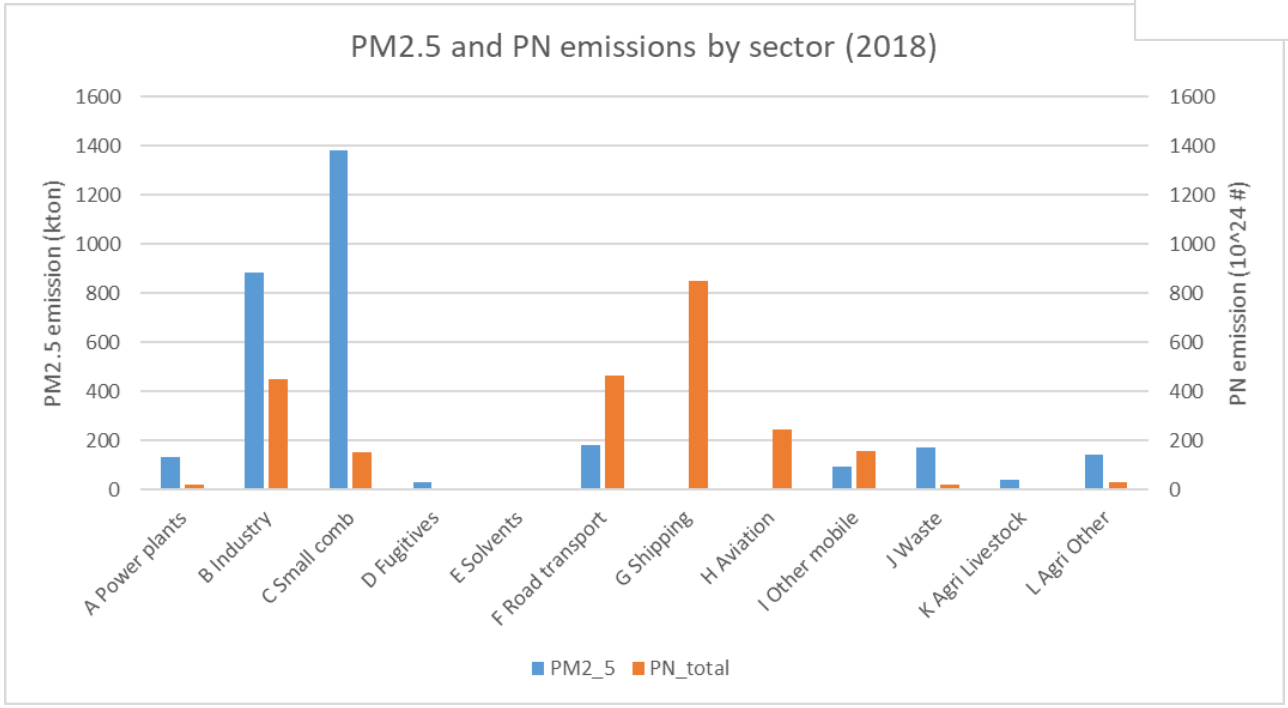


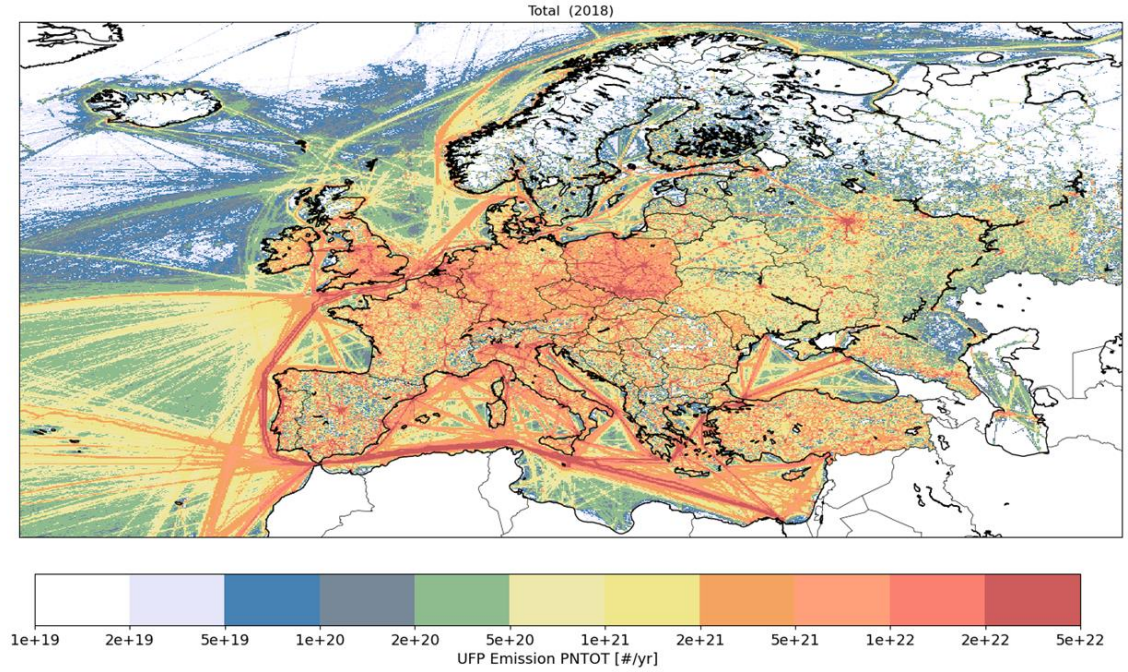
Ultrafine particles

- UFP expressed as particle number (PN) emissions
- Two calculation methods, depending on source
  - Direct estimation: activity with total PN emission factor (# particles / activity unit)
  - Estimation through particle size: PM2.5 => PM1 => PM0.3 => # particles/PM0.3
- For each source a particle size distribution is derived and emissions are distributed over 15 different size bins
- Each of these size bins are individually spatially distributed

Ultrafine particles







Methodology to improve European urban emission inventories

Objectives:

- Exploit credible, open access, generic, contemporary, high-resolution (≤1 km^2) spatial datasets of the European area (namely Copernicus data)
- Optimize coupling between CAMS-REG & UrbEm (independent of version and city): Multiple versions of CAMS-REG (e.g. ri-urbans version) are directly disaggregated at the city level (any European urban area).
- **Provide emissions of gaseous and particulate pollutants at spatio-temporal scales relevant to urban areas**
- Support city-scale CTM simulations, especially when bottom-up emission data for European cities do not exist, or are not open, or are not complete (by source, pollutant and spatio-temporal coverage) or a combination of some of the above.
- Develop a horizontal methodology, allowing for consistent, comparative studies among cities

Outcomes:

- **Optimized Methodology to exploit regional emissions towards urban emission inventories**
- **Spatial disaggregation of CAMS regional inventory: Zooms over cities of interest (1x1 km^2)**

Method and tool in service of air pollution mapping *(available online at: https://riurbans.eu)*

Open Access Article

The UrbEm Hybrid Method to Derive High-Resolution Emissions for City-Scale Air Quality Modeling

by **Martin Otto Paul Ramacher** [1], Anastasia Kakouri [2,3], Orestis Speyer [2], Josefine Feldner [1], Matthias Karl [1], Renske Timmermans [4], Hugo Denier van der Gon [4], Jeroen Kuenen [4], Evangelos Gerasopoulos [2] and Eleni Athanasopoulou [2,*]

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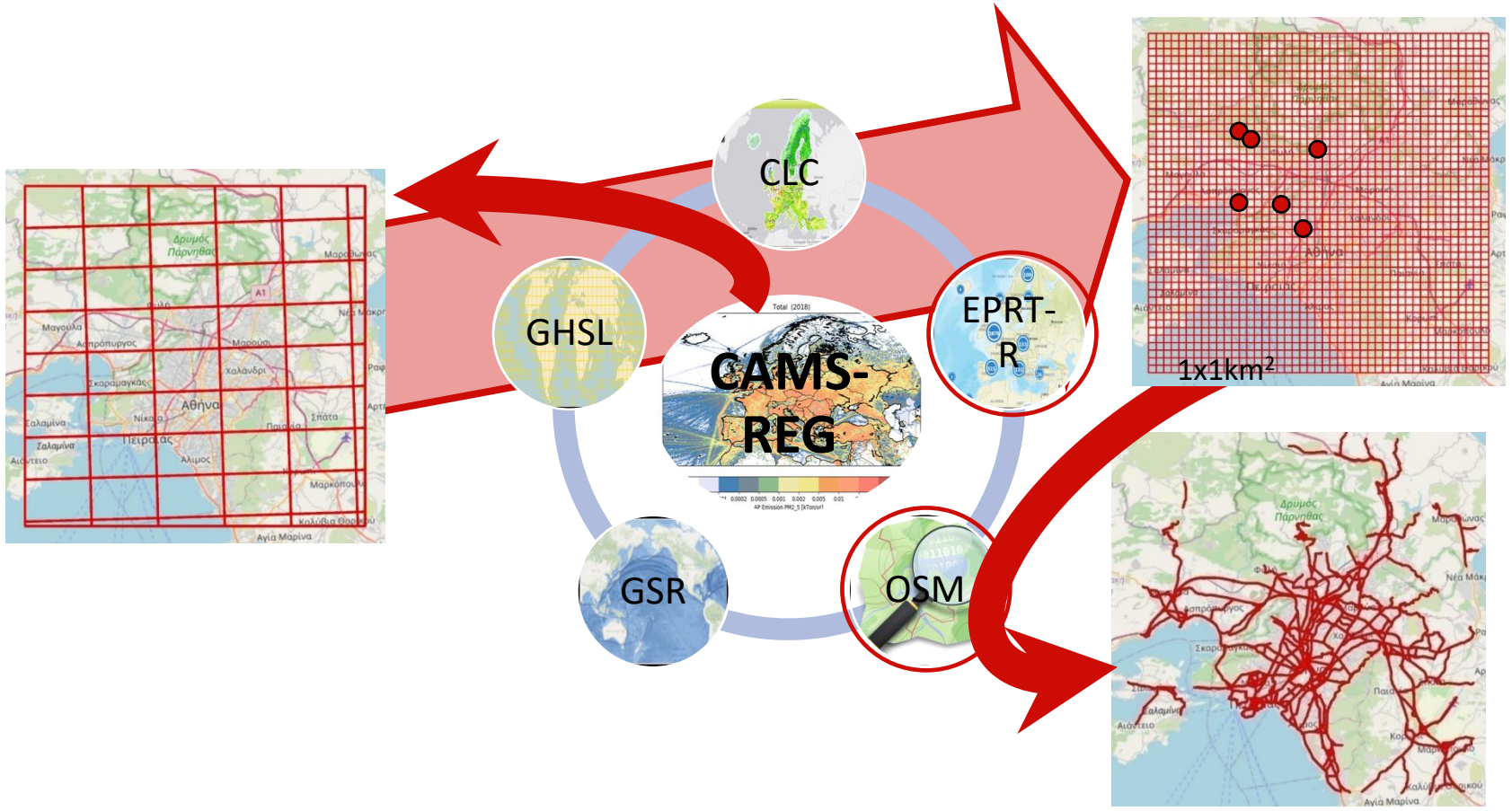
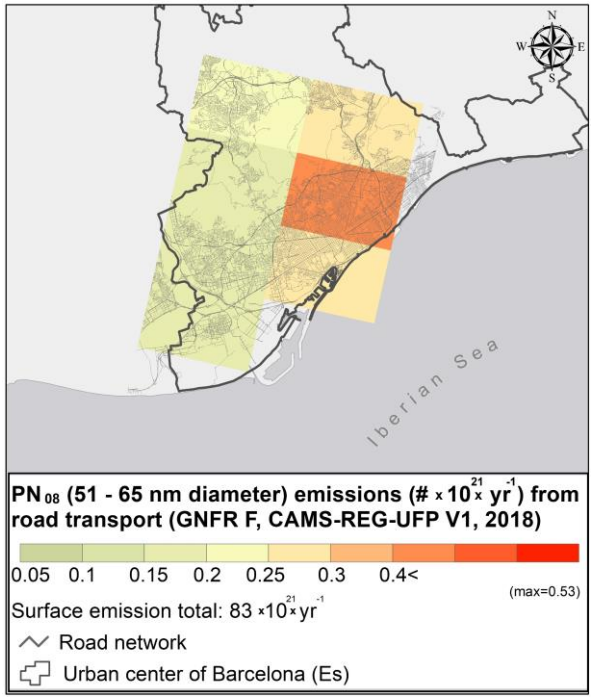
Optimization in the frame of RI-URBANS

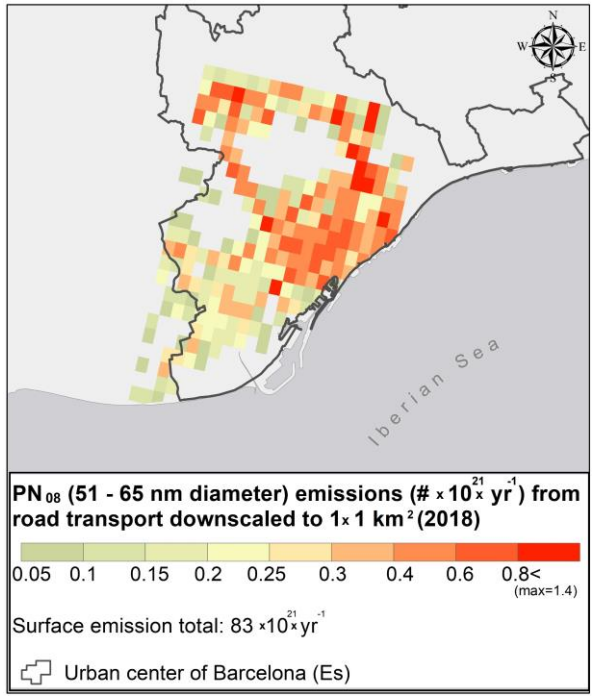
- Railway and Ship lanes from OSM
- OSM spatial proxy for road transport
- Different spatial proxies per subcategory of mobile machinery
- Other modifications



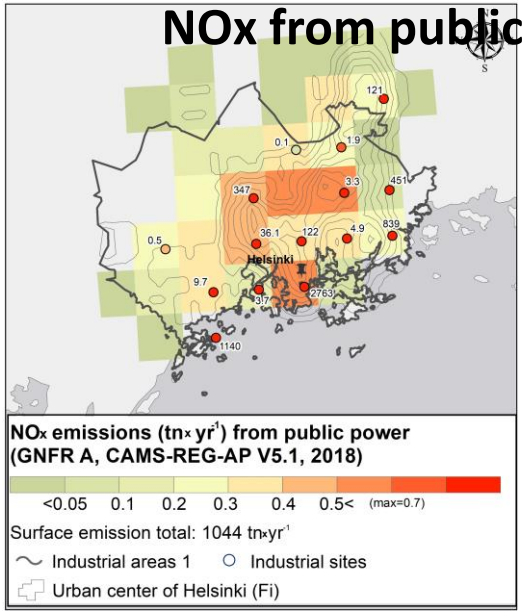
Preliminary results

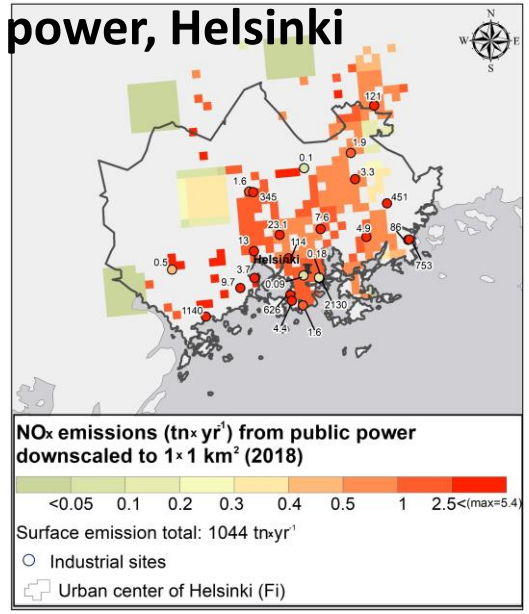
NEW: UFP from road transport, Barcelona



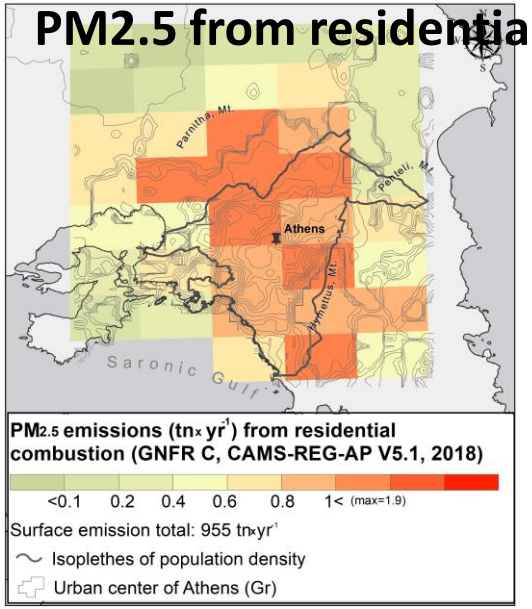


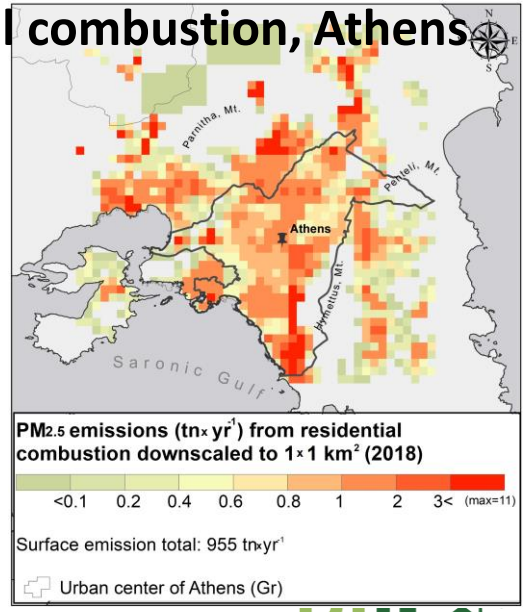
NOx from public power, Helsinki





PM2.5 from residential combustion, Athens

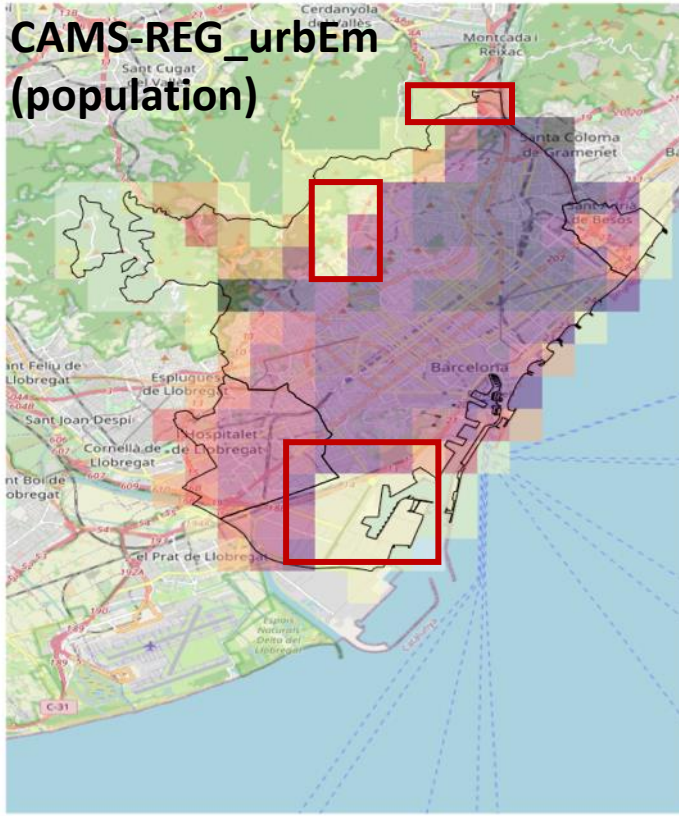


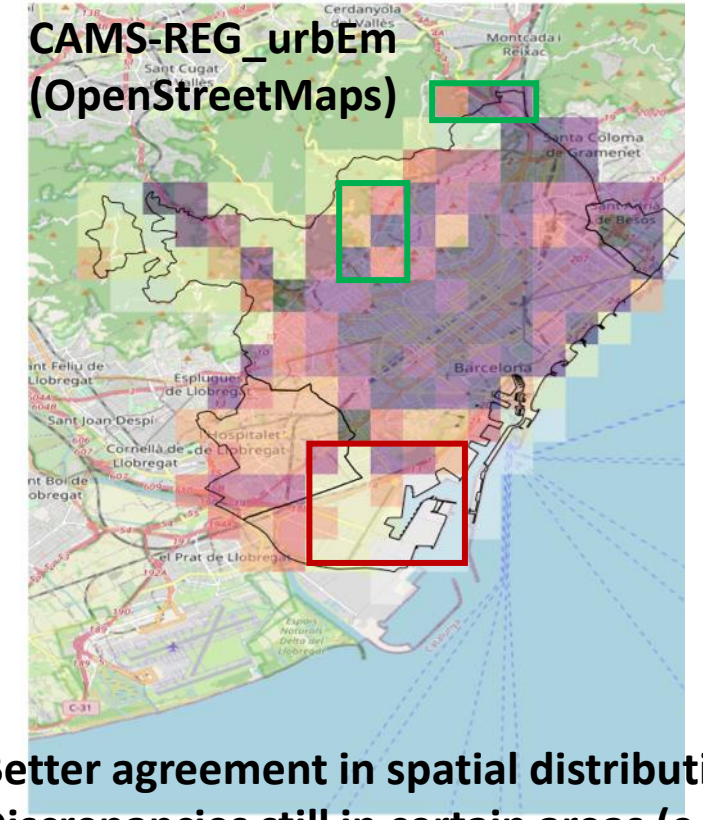


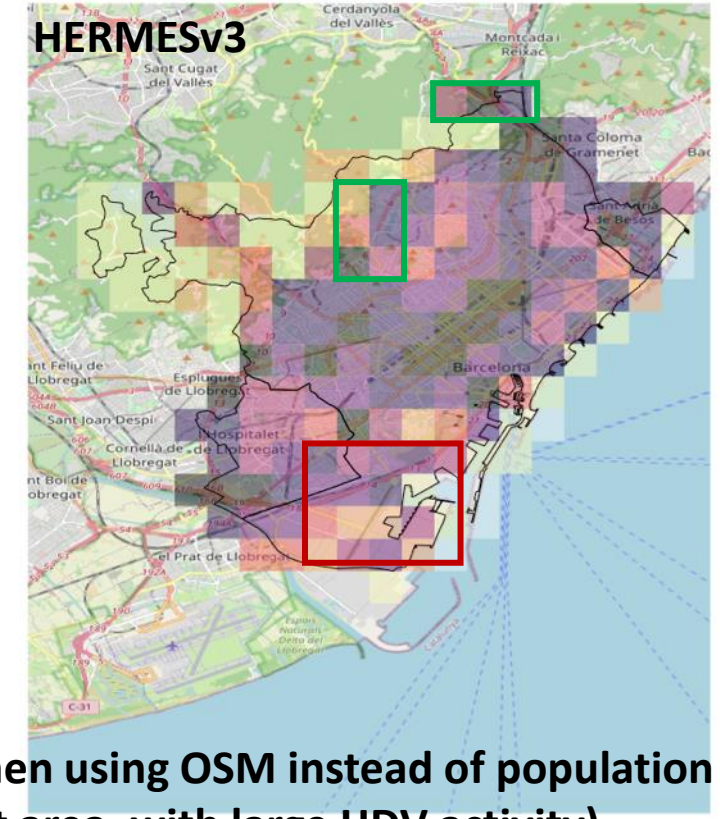
Comparison regional/bottom-up inventories
Bottom-up inventories available

Pilot city	Year	Pollutants	Spatial resolution	Provider
Barcelona	2019	NOx, CO, NH3, SO2, NMVOC, PM10, PM2.5, UFP, BC	1kmx1km	BSC
Rotterdam-Amsterdam	2018	NOx, CO, NH3, SO2, NMVOC, PM10, PM2.5	1kmx1km	RIVM
Athens	2018	NOx, CO, NH3, SO2, NMVOC, PM10, PM2.5	Under discussion	NOA
Birmingham	2018	NOx, CO, NH3, SO2, NMVOC, PM10, PM2.5, PM1, PM0.1	1kmx1km	Defra & BEIS
Bucharest				
Helsinki	2019	PM2.5, BC, BaP, NOx, EC	Under discussion	FMI
Milan-Bologna				
Paris	2018	CO, SO2, NOx, PM10, PM2.5, NH3, NMVOC	regions (i.e., Paris city, metropolis, Ile-de-France)	Airparif
Zurich	2015	NOx, SO2, CO, PM10, VOC, Benzene, CO2, NH3	Under discussion	UGZ

Comparison regional/bottom-up inventories
Barcelona – road transport emissions



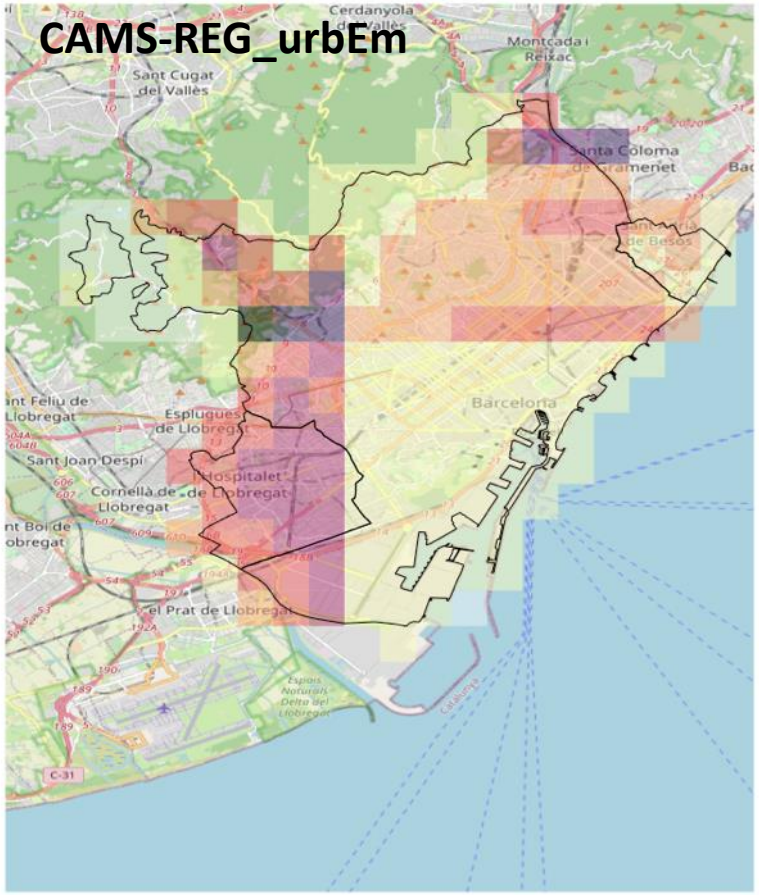




NOx [t/year]
- 0-5
- 5-10
- 10-15
- 15-20
- 20-30
- 30-50
- 50-100

- **Better agreement in spatial distribution when using OSM instead of population**
- **Discrepancies still in certain areas (e.g. Port area, with large HDV activity)**

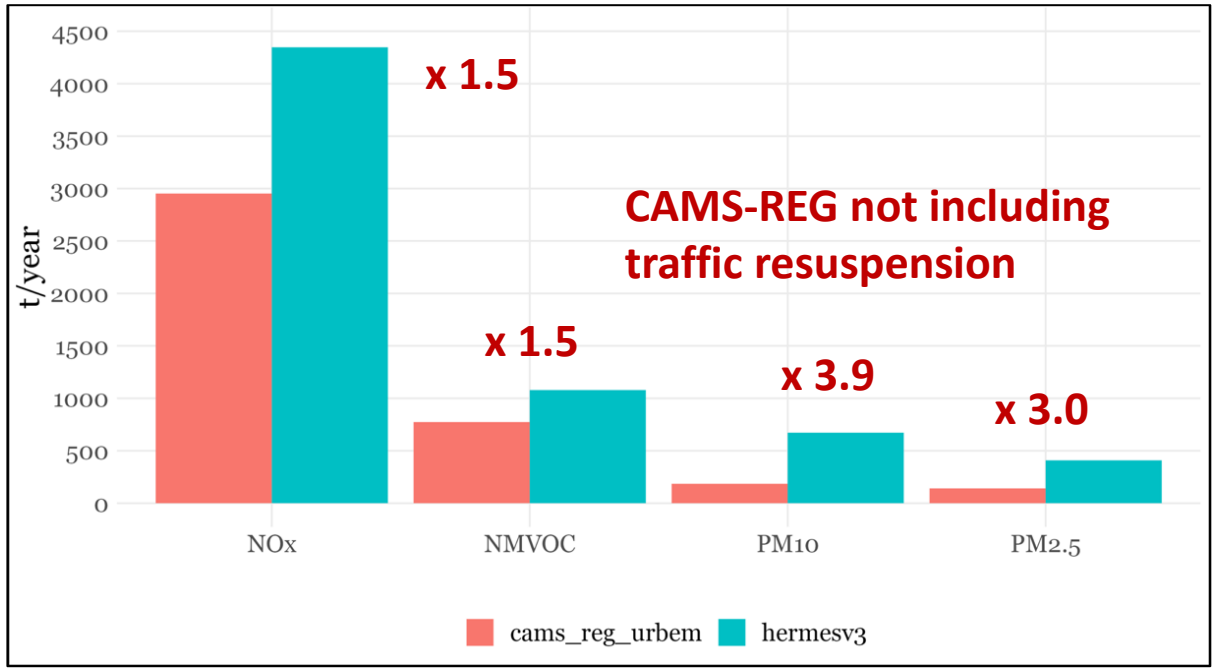
Comparison regional/bottom-up inventories
Barcelona – residential PM2.5 emissions



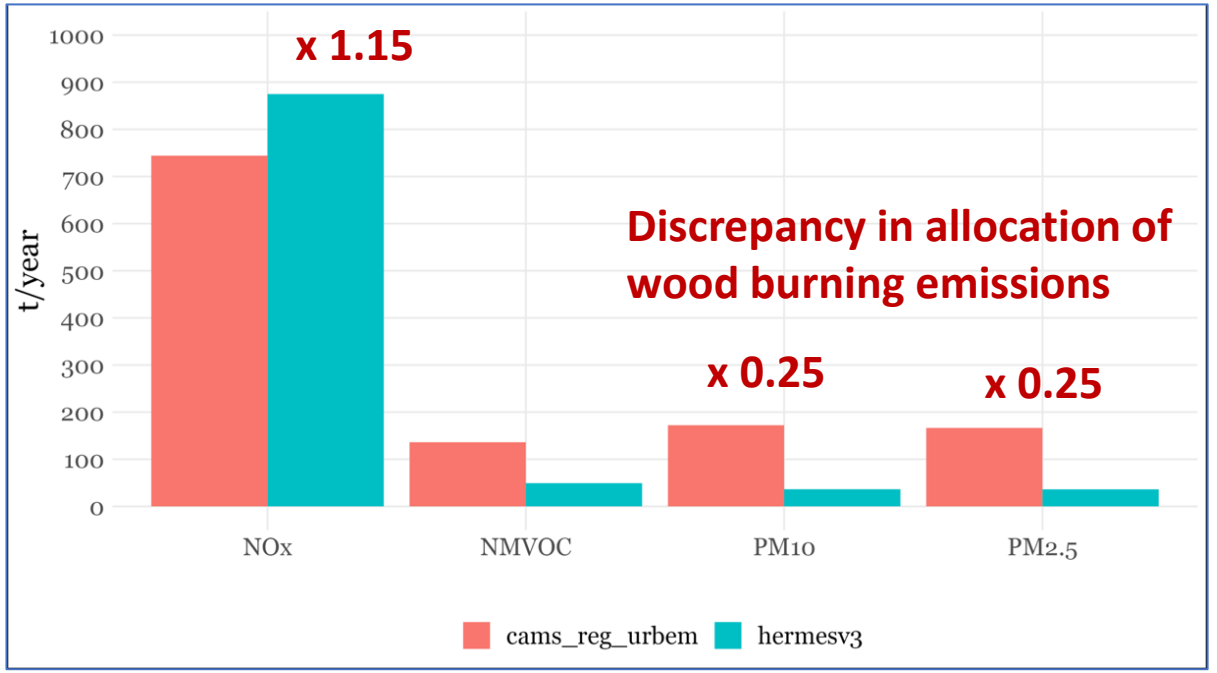
PM2.5 [t/year]
- 0-0.5
- 0.5-1
- 1-2
- 2-3
- 3-5
- 5-10
- 10-15

Comparison regional/bottom-up inventories
Barcelona – summary

Road transport



Residential/comercial combustion



Similar values for total PM emissions but completely different source contribution

Conclusions and next steps

- Make available downscaled 1x1km emissions for pilot cities
  - Modellers/users: please approach us to ensure smooth exchange of data
- Compare emissions for more pilot cities and interpret results
- Dialogue with the users of our initial products
- Refine European main pollutant and UFP inventories