TNO innovation for life

URBAN EMISSION MONITORING ICOS CITIES TALKS

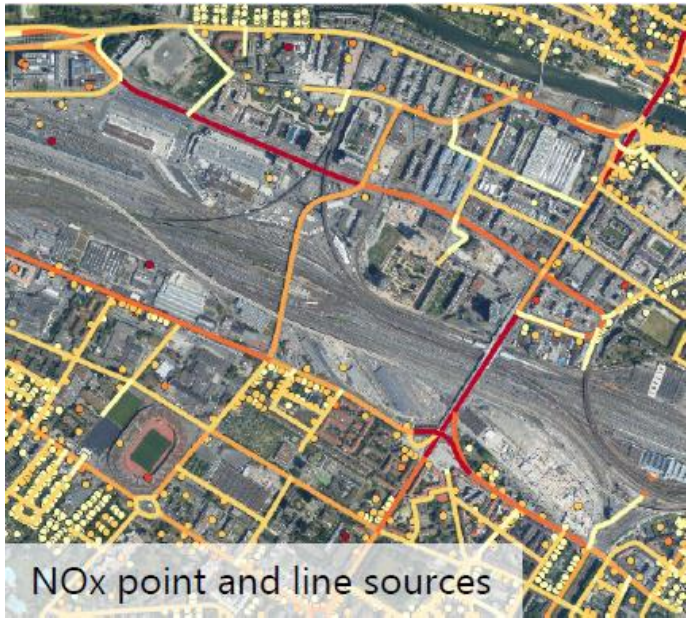
URBAN EMISSION INVENTORIES | I. SUPER, J. KUENEN

25 January 2023

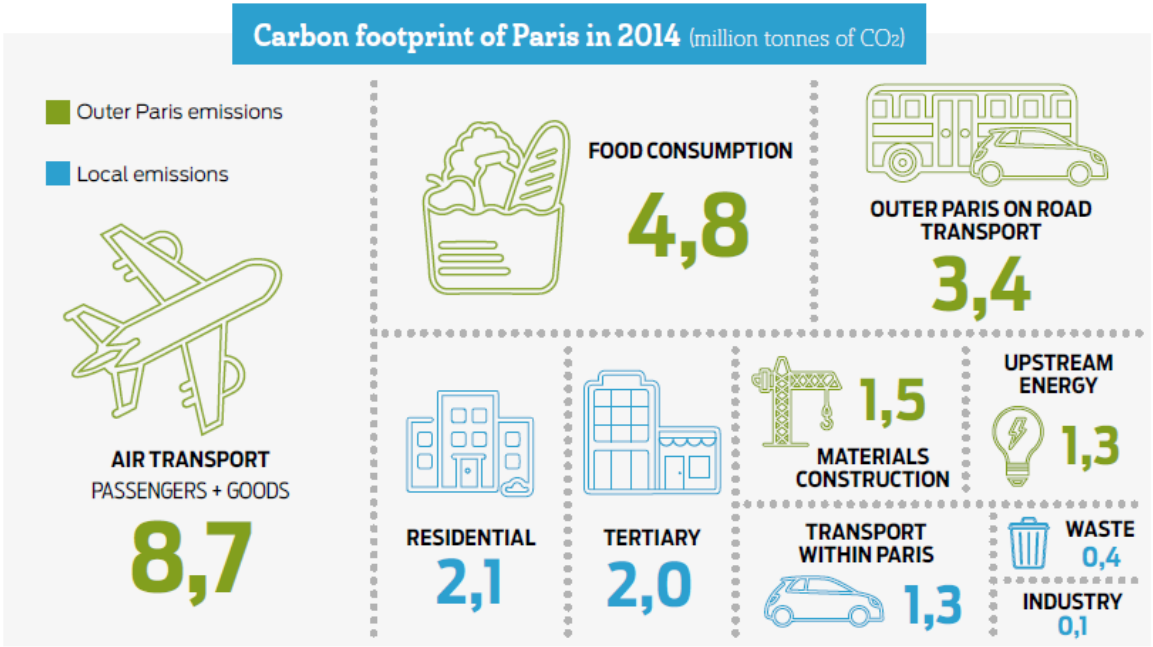
URBAN EMISSION INVENTORY: WHAT IS IT AND WHY DO WE NEED IT?

An urban emission inventory is a database containing information on emissions occurring in a specific region and time frame, often for specific sources. It can take different forms, depending on the goal (users) and data availability.

- Policy support, such as identifying major sources of pollution or carbon footprinting for climate mitigation
- Air quality modelling and exposure assessment
- Scenario development, e.g. climate goals
- Scientific research



NOx point and line sources



THE STARTING POINT

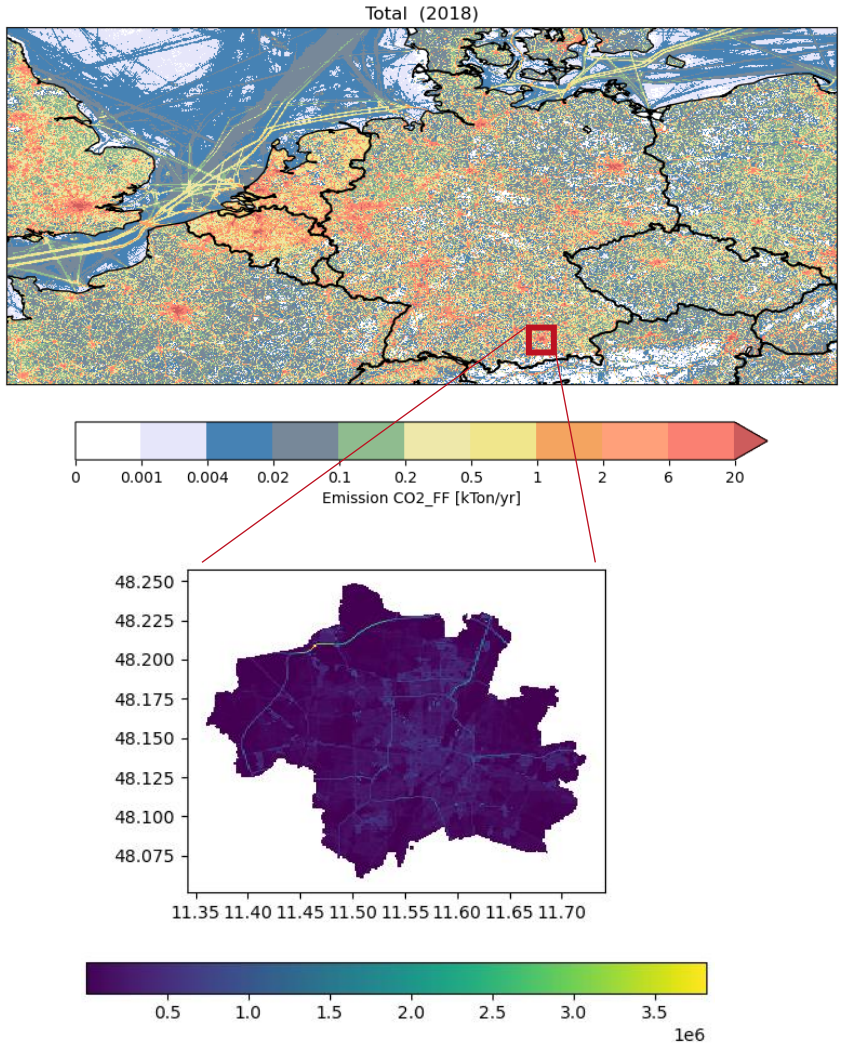
There is not one way to build an urban emission inventory. The starting point:

- Country-level reported emissions: consistency with national inventory, annual totals
- Local data: city-scale fuel consumption statistics or other proxy data, takes into account local situation, more dynamic

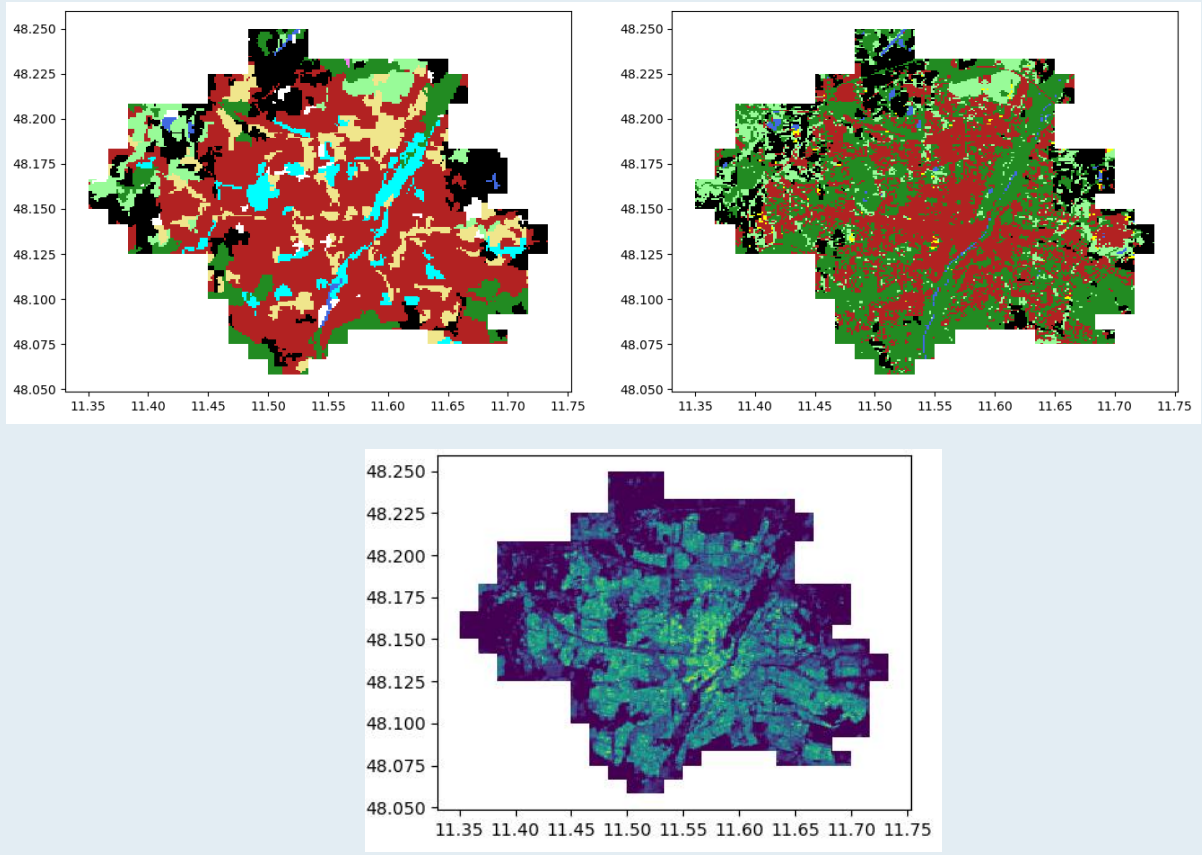
Courtesy of Patrick Aigner (TUM)

ADDING SPATIAL INFORMATION: DOWNSCALING

Starting point: European 1km resolution inventory



Proxy data for downscaling: land use cover, population

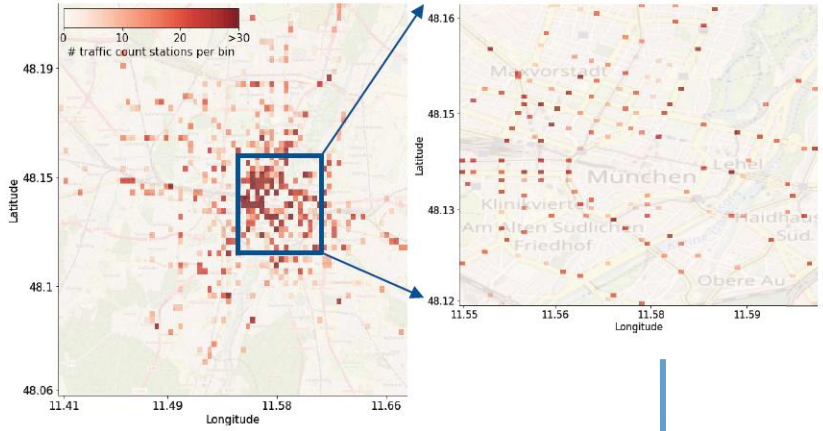


CORINE land cover, ESA WorldCover, Global Human Settlement Layer

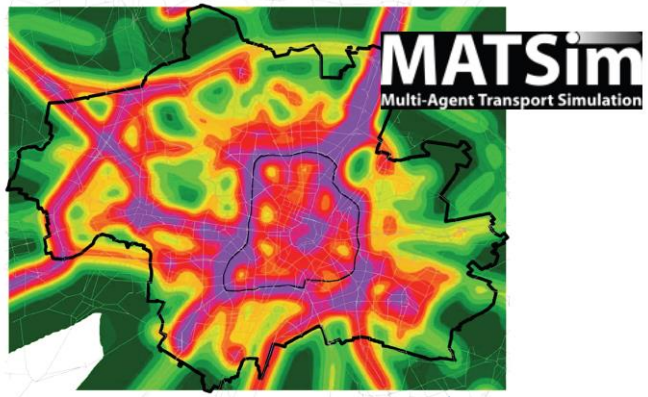
ADDING SPATIAL INFORMATION: LOCAL DATA

Local traffic count data and calibrated traffic model

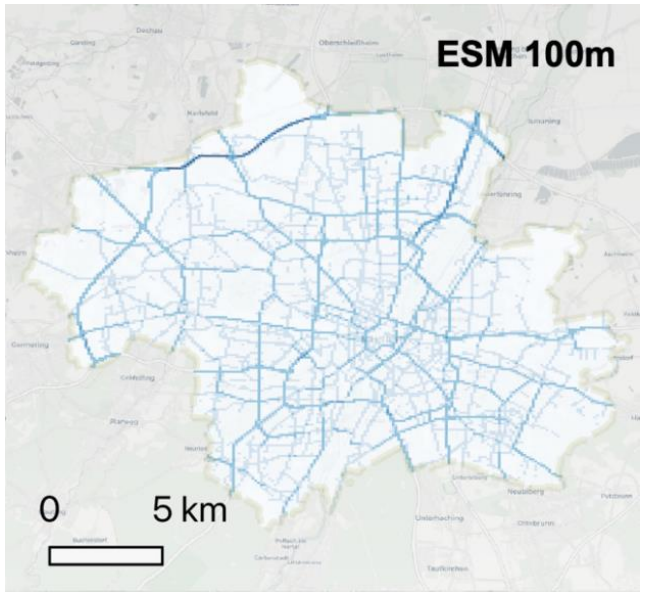
Traffic count (9000 stations, 15 min)



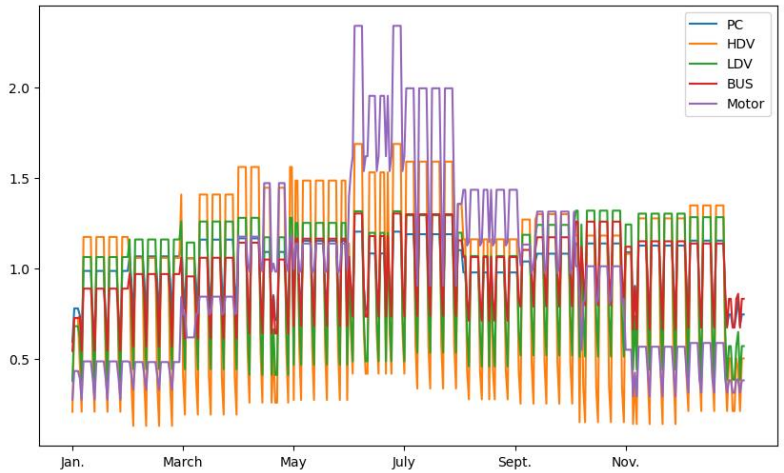
Traffic modeling (30 min, street level)



Spatial information

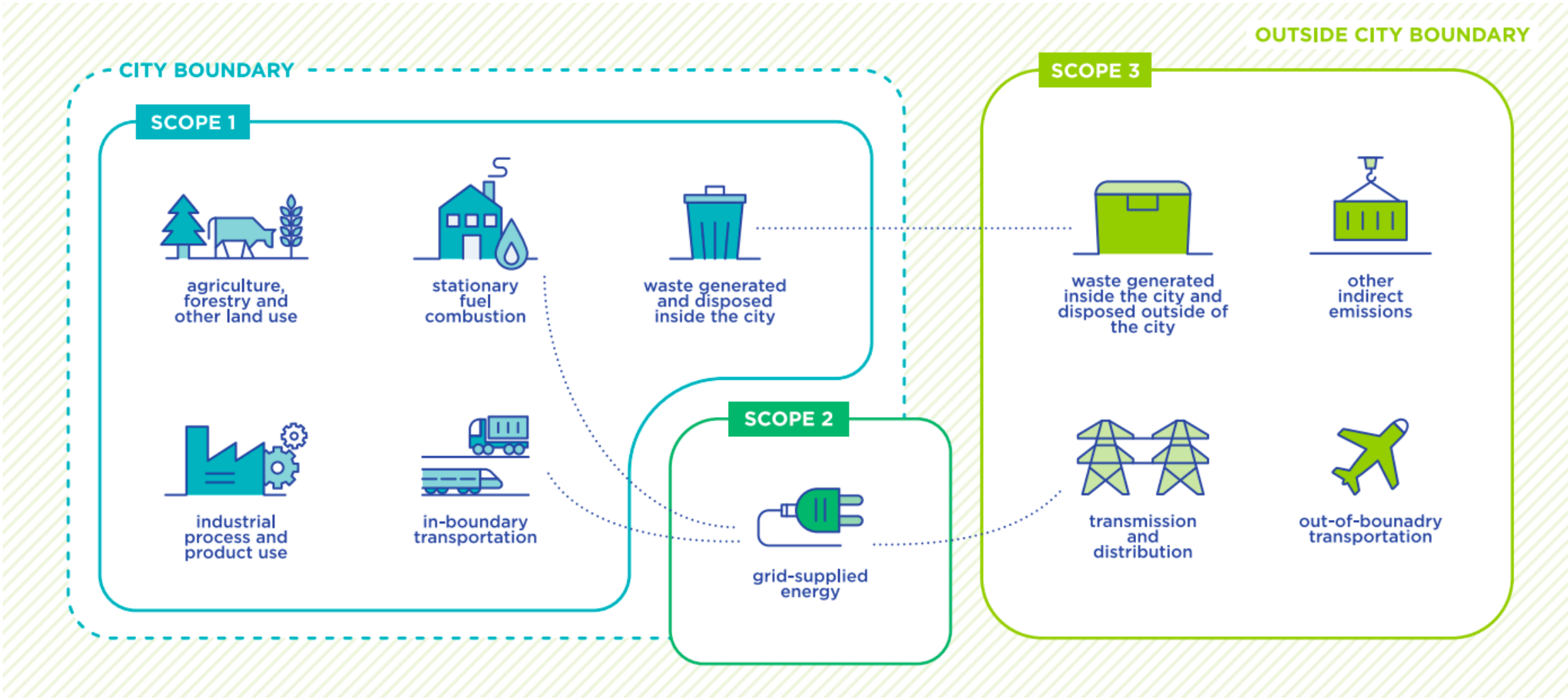


Temporal information



Jia Chen, Daniel Kühbacher, Patrick Aigner (TUM)

SCOPING


OUTSIDE CITY BOUNDARY
CITY BOUNDARY
SCOPE 1
agriculture, forestry and other land use
stationary fuel combustion
waste generated and disposed inside the city
industrial process and product use
in-boundary transportation
SCOPE 2
grid-supplied energy
SCOPE 3
waste generated inside the city and disposed outside of the city
other indirect emissions
transmission and distribution
out-of-bounadry transportation

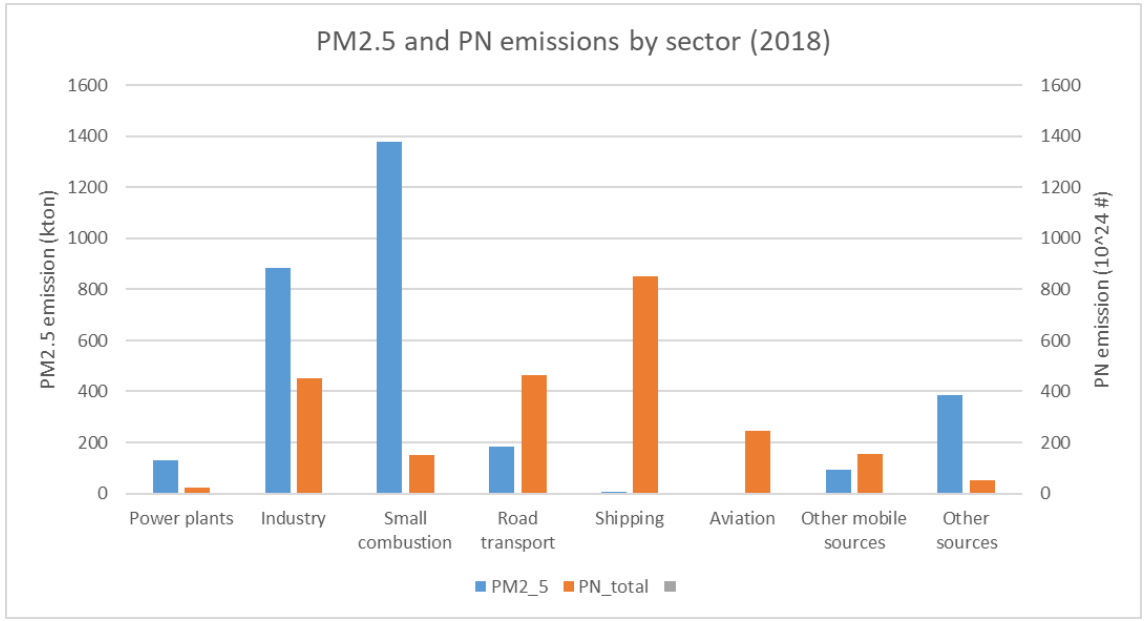
MAIN CHALLENGES FOR WORKING WITH INVENTORIES

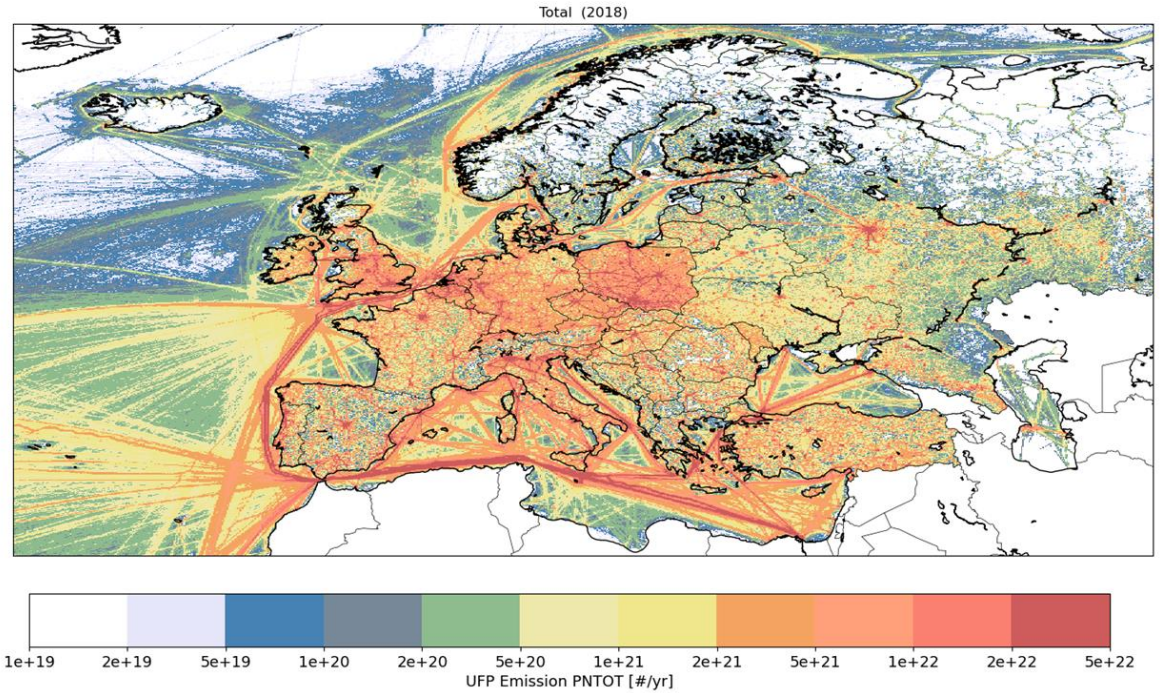
- There are guidelines for GHG inventories:
  - GHG Protocol for Cities: developed by World Resources Institute, C40 Cities Climate Leadership Group and ICLEI – Local Governments for Sustainability (ICLEI)
  - Non for air pollutants at city level

- Inconsistency between city inventories due to lack of guidelines
  - Sectors: only most important ones or total emissions, only scope 1 or also scope 2/3
  - Sector definitions: GNFR, SNAP, other
  - GHG emissions in CO_2 eq.
  - Data availability: recent years, privacy

AIR POLLUTION IN URBAN AREAS

- Cities are hotspots for air pollution
- Emerging concerns about main air pollutants (NOx, $PM_{2.5}$) but also ultrafine particles (UFP) and their impact on health
  - How to monitor urban air emissions? (Scope 1)
  - Downscaling from European-wide bottom-up inventories building on a) official national inventories and b) science!
  - European size distributed particle number (PN) inventory





0.05°x0.1° (lat-lon) ~ 6x6km
in line with CAMS-REG inventory
Kuenen et al., ESSD, 2022

Atmosphere Monitoring Service

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DOWNSCALING TOOL (~6KM => ~1KM)

Open Access Article

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

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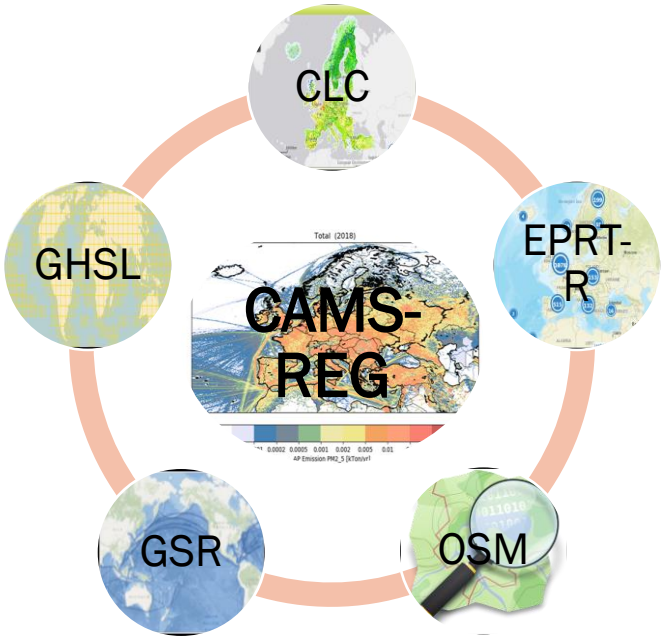
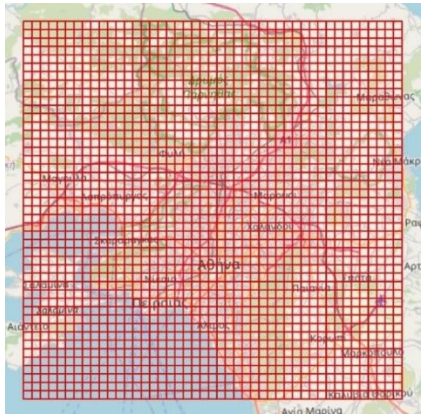


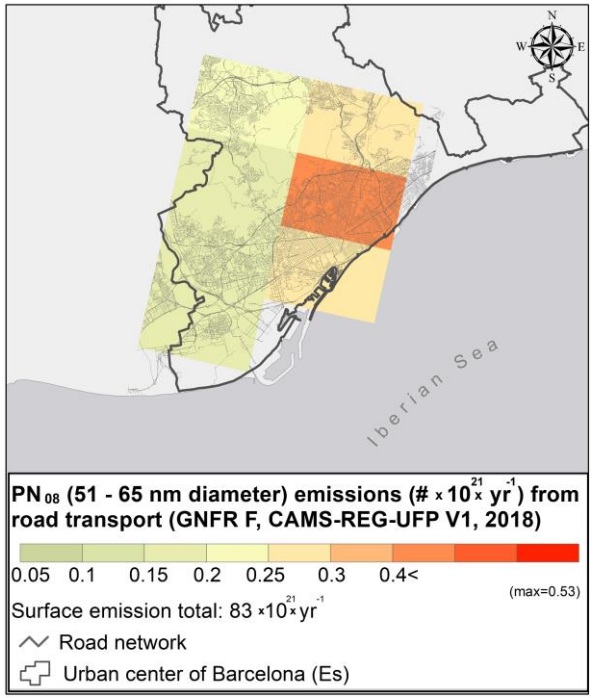


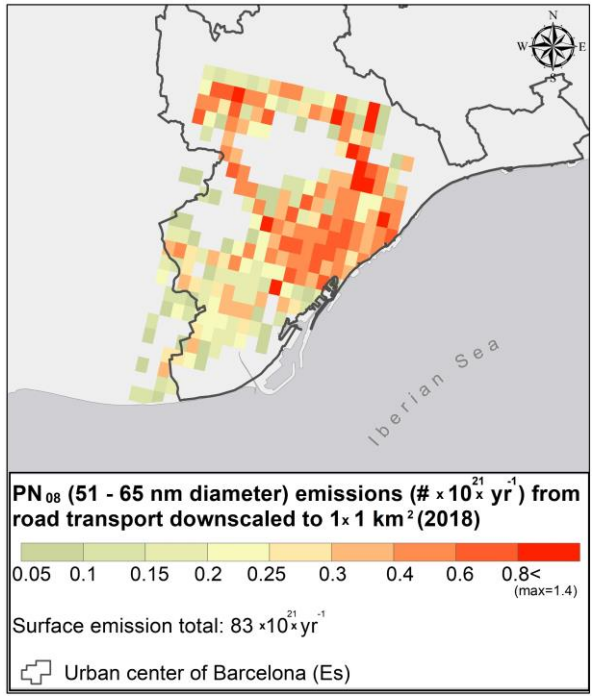
Optimization in the frame of RI-URBANS

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

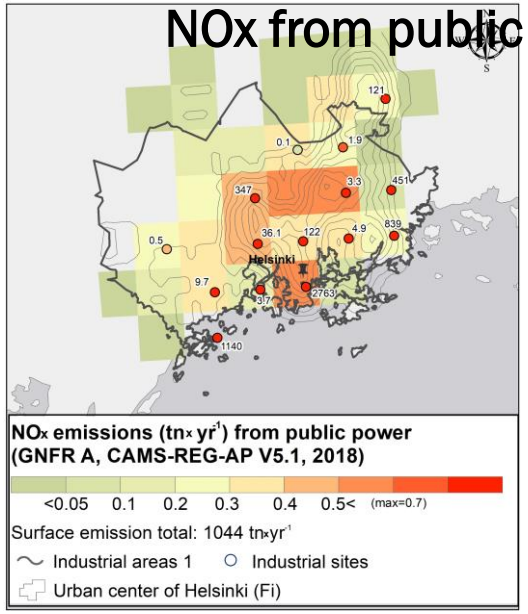
PRELIMINARY RESULTS

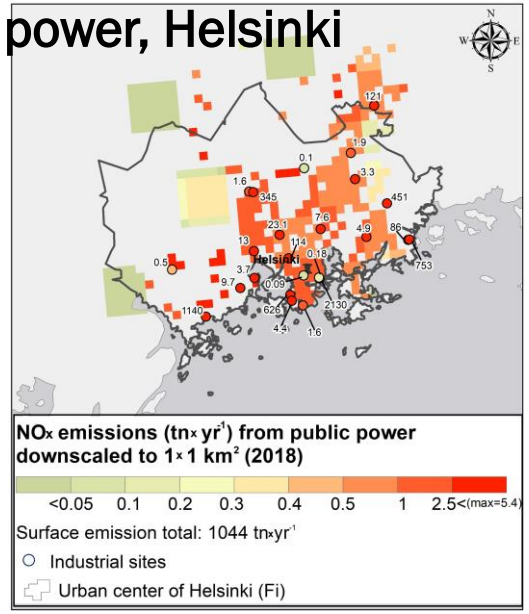
UFP from road transport, Barcelona



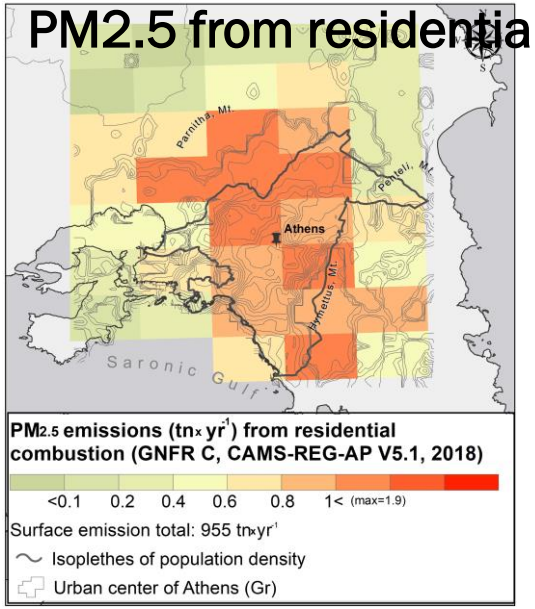


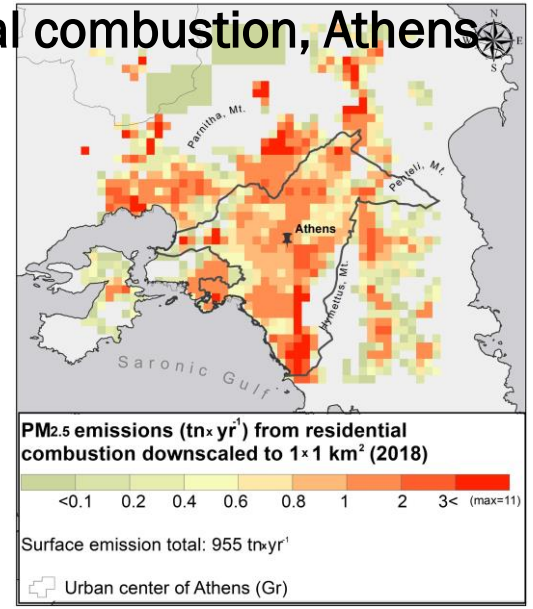
NOx from public power, Helsinki





PM2.5 from residential combustion, Athens



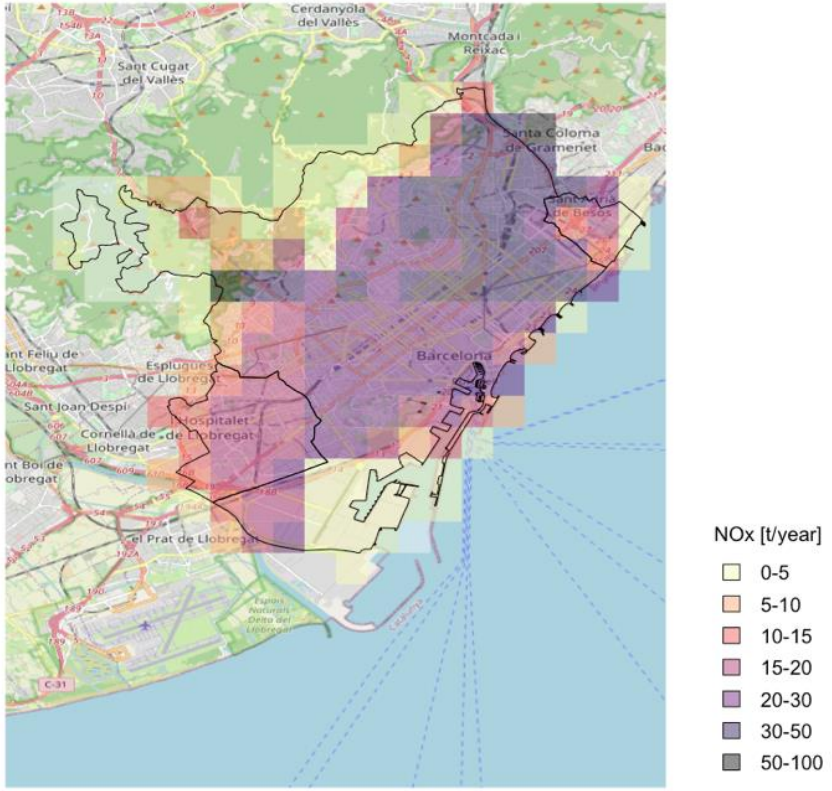


Eleni Athanasopoulou, Nasia Kakouri, Evangelos Gerasopoulos (NOA)

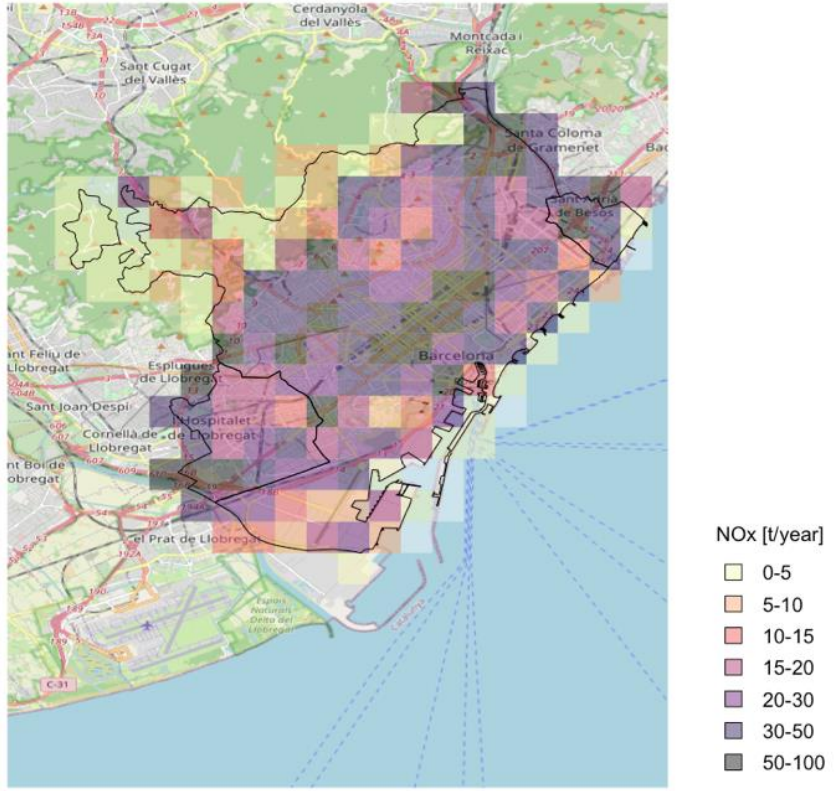
COMPARISON BETWEEN DIFFERENT APPROACHES

ROAD TRANSPORT NOX EMISSIONS

Downscaling of CAMS-REG using UrbEm approach



HERMES v3 bottom-up inventory for Barcelona (BSC)



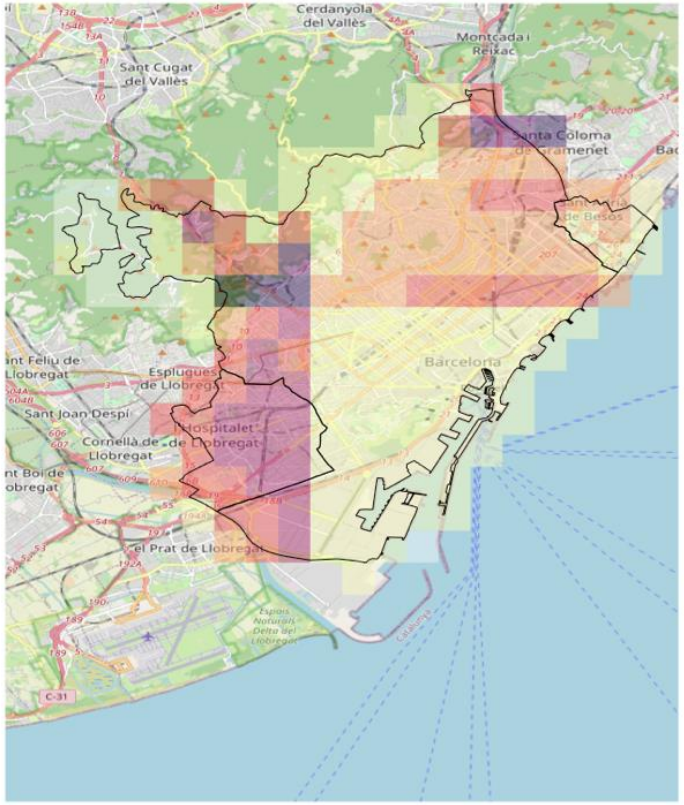
- Relatively good agreement in most locations, but larger discrepancies in certain areas (e.g. Port area, with large HDV activity)

Marc Guevara, Santiago Enciso (BSC)

COMPARISON BETWEEN DIFFERENT APPROACHES

RESIDENTIAL/COMMERCIAL COMBUSTION PM2.5 EMISSIONS

Downscaling of CAMS-REG using urbEm approach



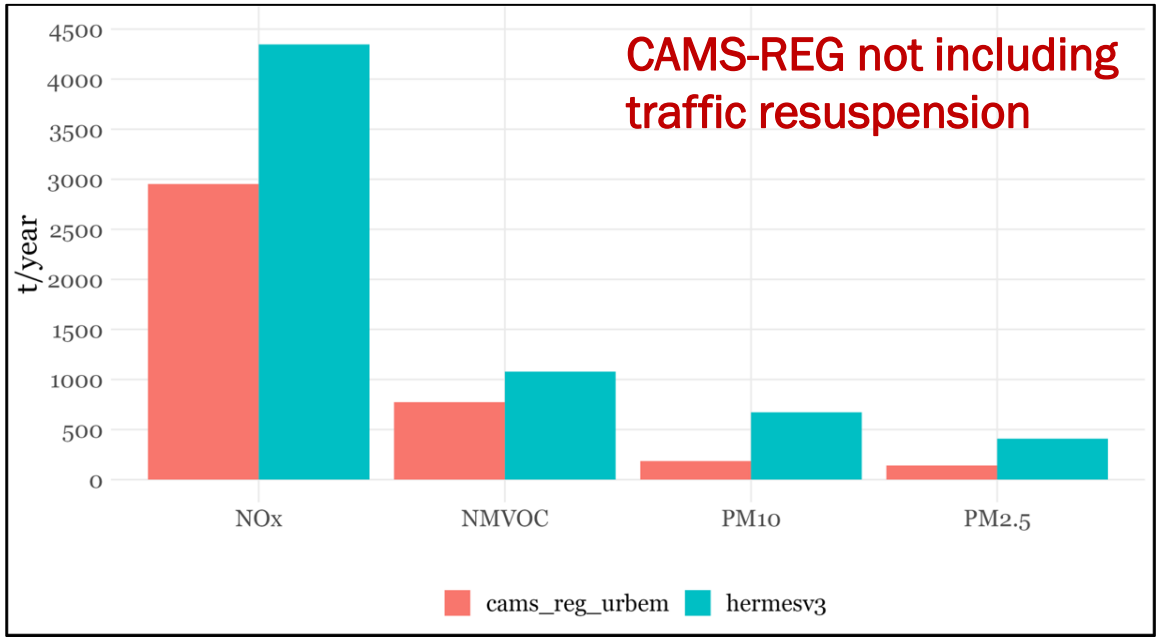
HERMES v3 bottom-up inventory for Barcelona (BSC)

- Poor agreement, bottom-up inventory PM emissions significantly lower
- Mostly related to distribution of PM emissions related to <u>wood burning for heating</u>

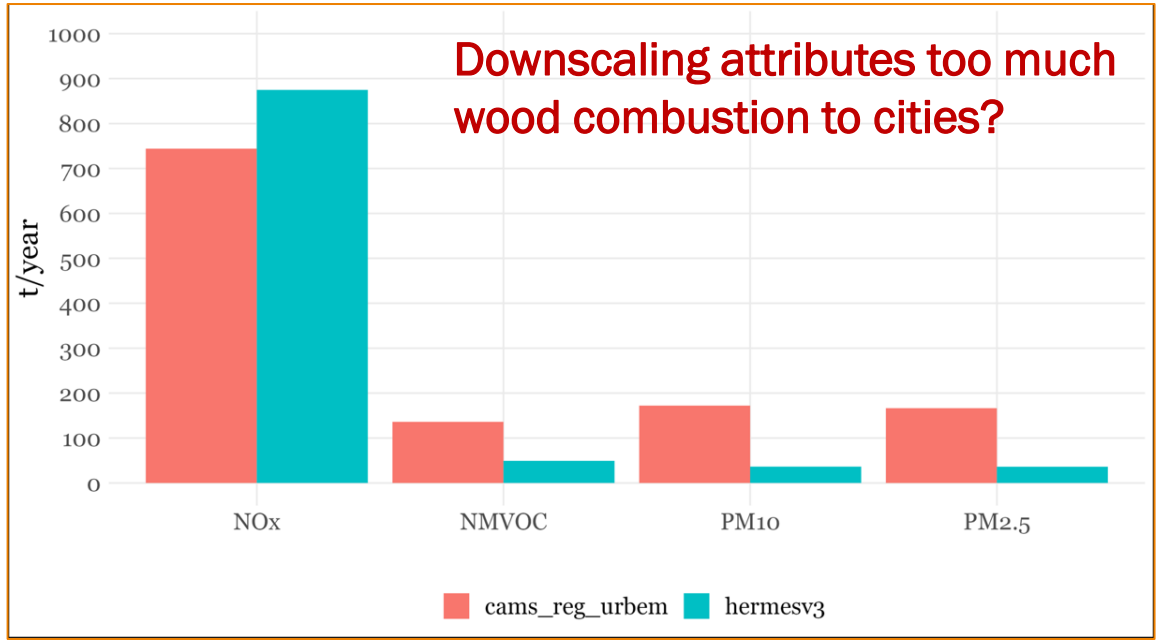
Marc Guevara, Santiago Enciso (BSC)

SUMMARY COMPARISON - BARCELONA

Road transport



Residential/comercial combustion



Similar values for total PM emissions but completely different source contribution

CONCLUSIONS

- Urban emission inventories can serve a range of purposes, which determines the requirements w.r.t. resolution, scope, etc.

- Downscaling is a useful methodology to compile high resolution urban emission inventories at various spatial scales, especially when no local inventory is available
  - But downscaling comes with uncertainties - generic national or European inventories are mostly consistent, but may lack specific local circumstances
  - Local inventories are not always based on the same principles

- Comparing different approaches for emission inventories is the way forward
  - Learn which sources are different (both in total emissions and spatial patterns) or which specific areas
  - Understanding what drives these differences gives guidance for improvement
  - But also measurements & modelling (***top-down***) are key in supporting our understanding
  - Different pollutants or gases may behave differently for different sectors, beware of compensating differences

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  - RI-URBANS (Research Infrastructures Services Reinforcing Air Quality Monitoring Capacities in European Urban & Industrial AreaS)

RI URBANS

European Commission


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