

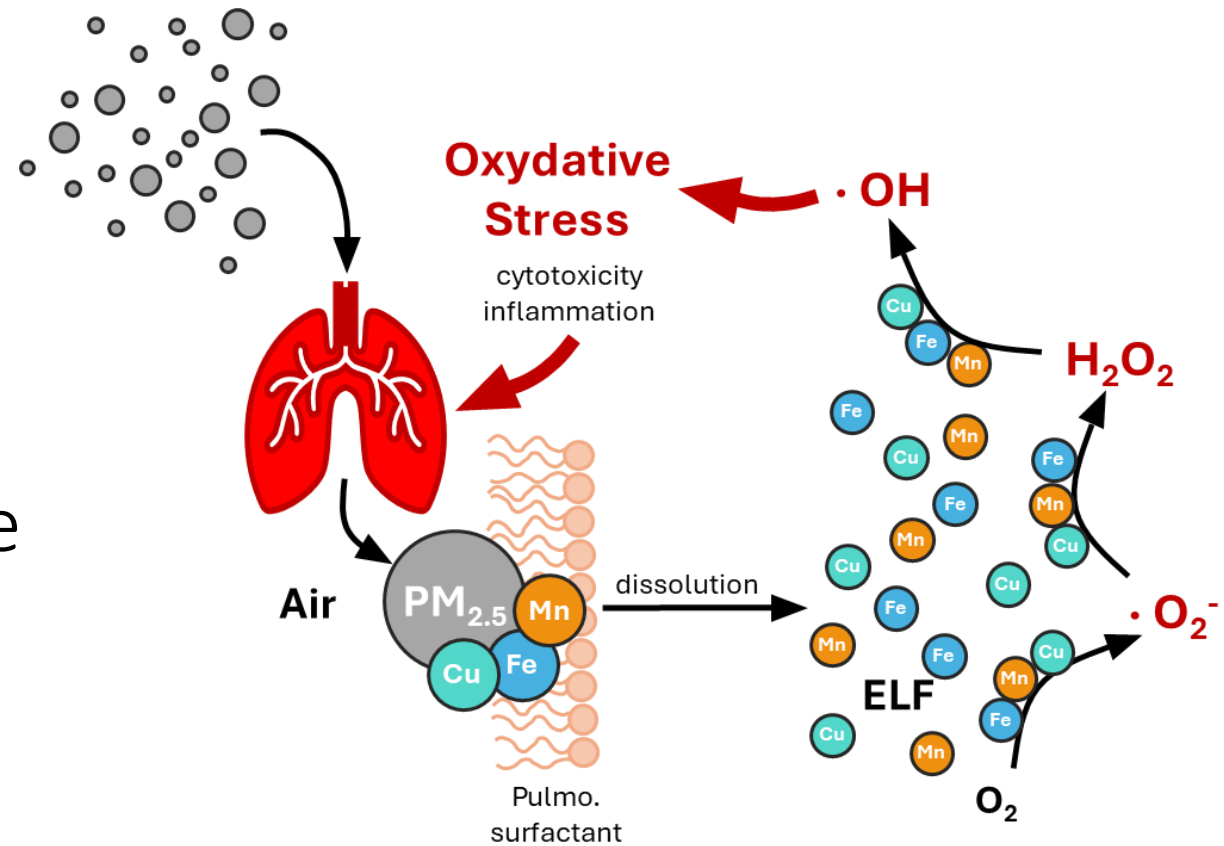
Metal modelling in Europe

- Cu, Fe, Mn -

*G. Foret , N. **Dubois**, G. Siour , T. **Truong**, G. Uzu, F. Amato, J-M. André, A. Alastuey, L. Y. Alleman, R. Aujay-Plouzeau, S. Conil, F. Couvidat, A. Ito, Y. Kim, S. Moukhtar, C. Pallares, X. Querol, N. Sirina-Leboine, G. Salque-Moreton, E. Stratigou, M. Vida, L. Lugon, J-L. Jaffrezo, O. Favez, K. Sartelet, M. Beekmann*

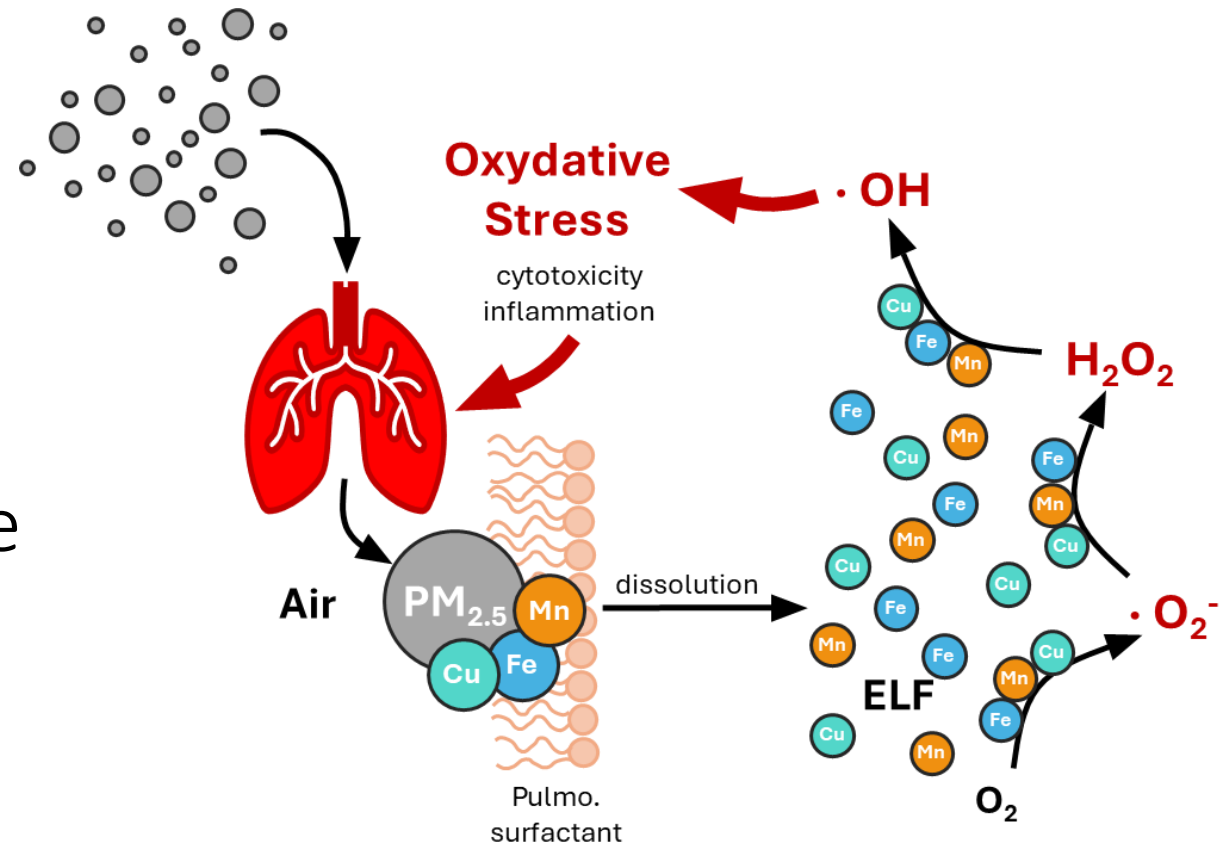
General context

- Particulate Matter (PM) do impact human health
- Some fractions of PM could be more toxic than others, e.g Cu, Fe, Mn



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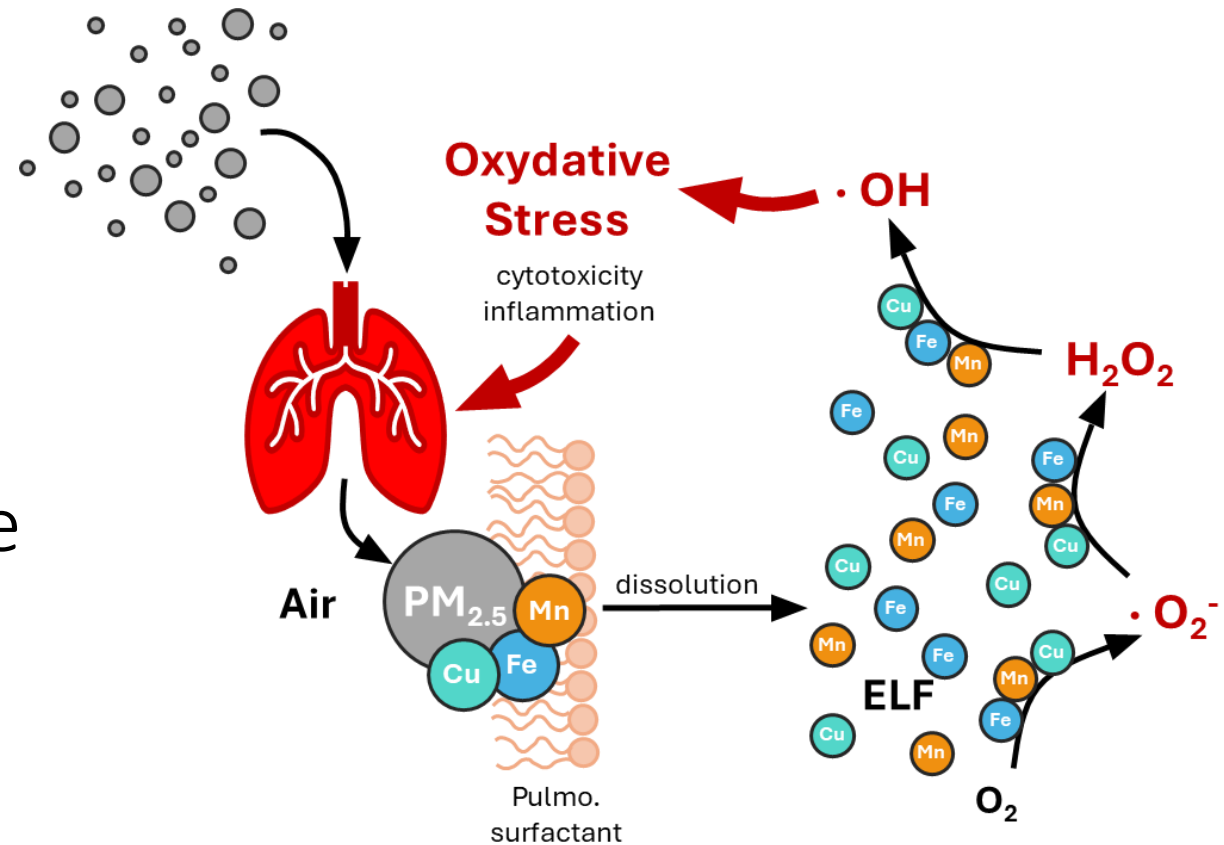
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- Cu, Fe and Mn modeling still not very present in AQ modeling

General context

- Particulate Matter (PM) do impact human health
- Some fractions of PM could be more toxic than others, e.g Cu, Fe, Mn
- Absence of Cu, Fe and Mn in air quality models



Objective : Modelling Cu, Fe & Mn at European scale

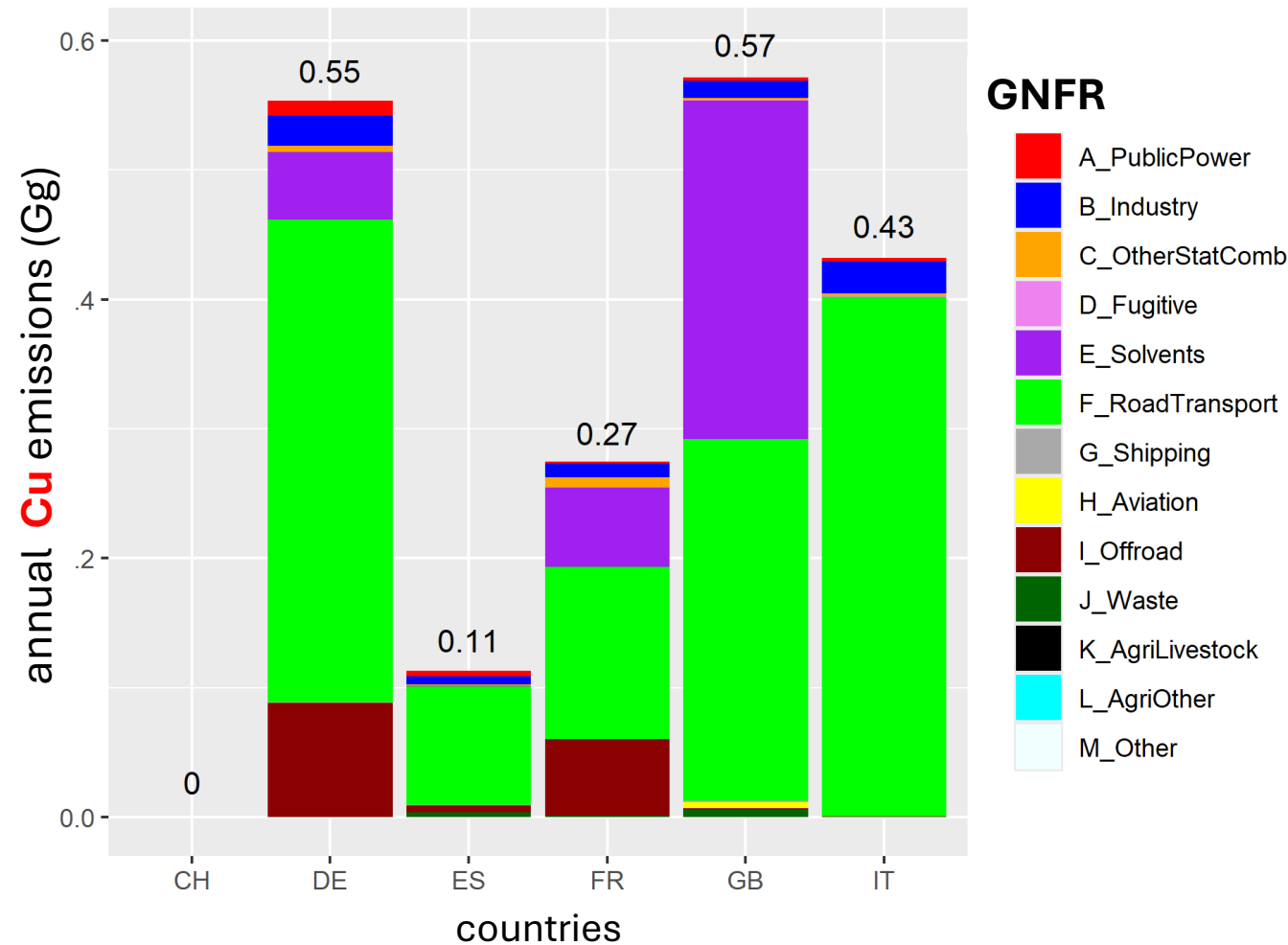
European Emissions for Cu

$$Emission = \sum_{source} Activity_{source} \times Emission\ factor_{source}$$

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EMEP - Cu - 2013



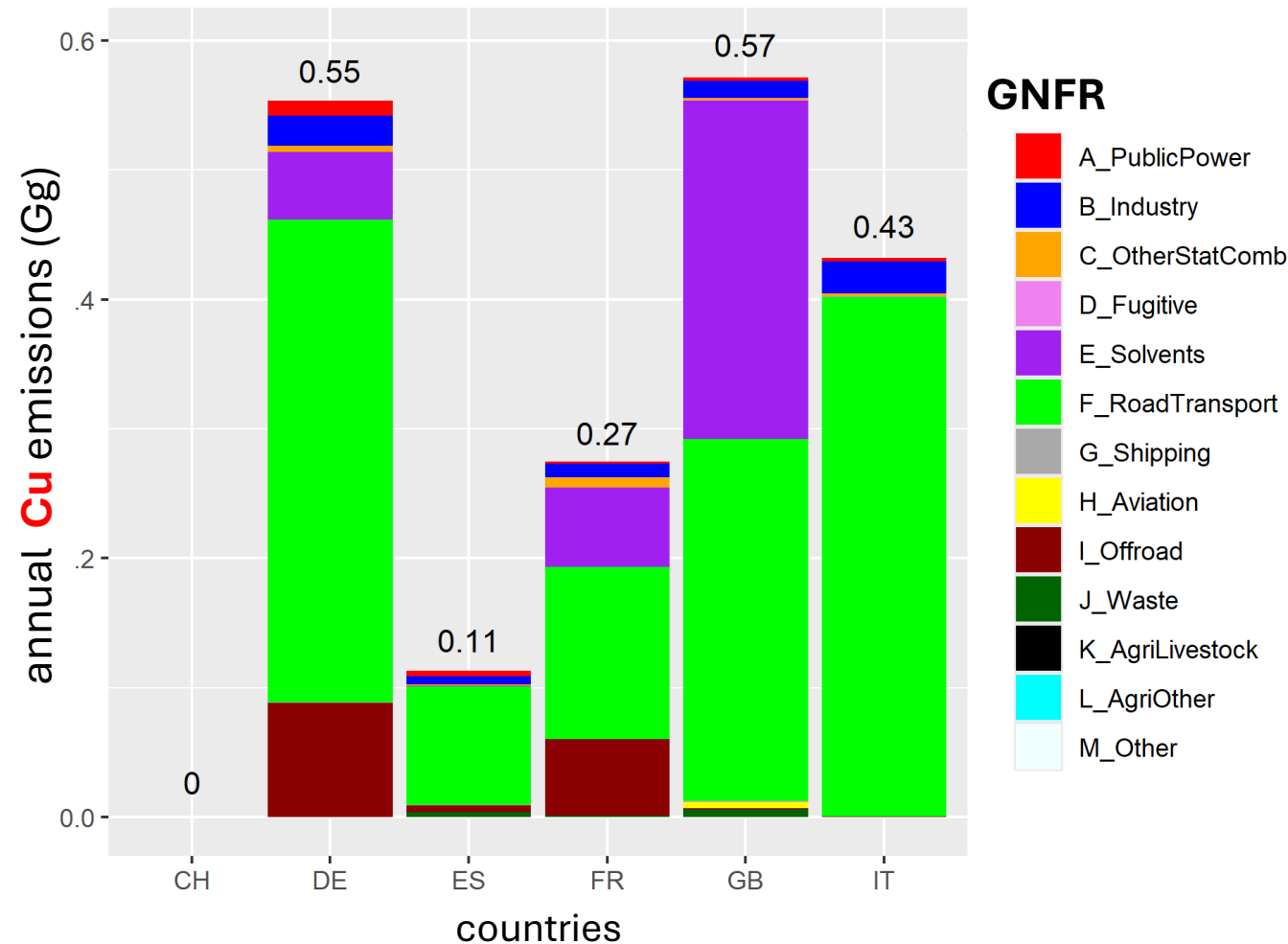
main Cu emission's sources

GNFR	NFR & sub-NFR
F_RoadTransport	Brake abrasion (1A3bvi)
E_Solvents	Engine Lubricants (2G)
I_Offroad	Railway - catenary abrasion (1A3c)

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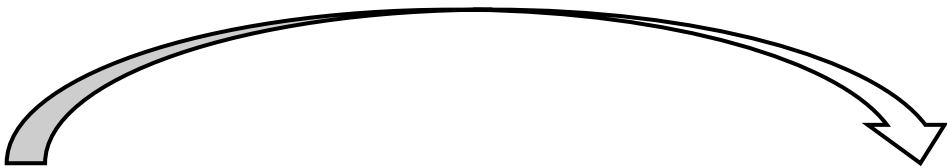


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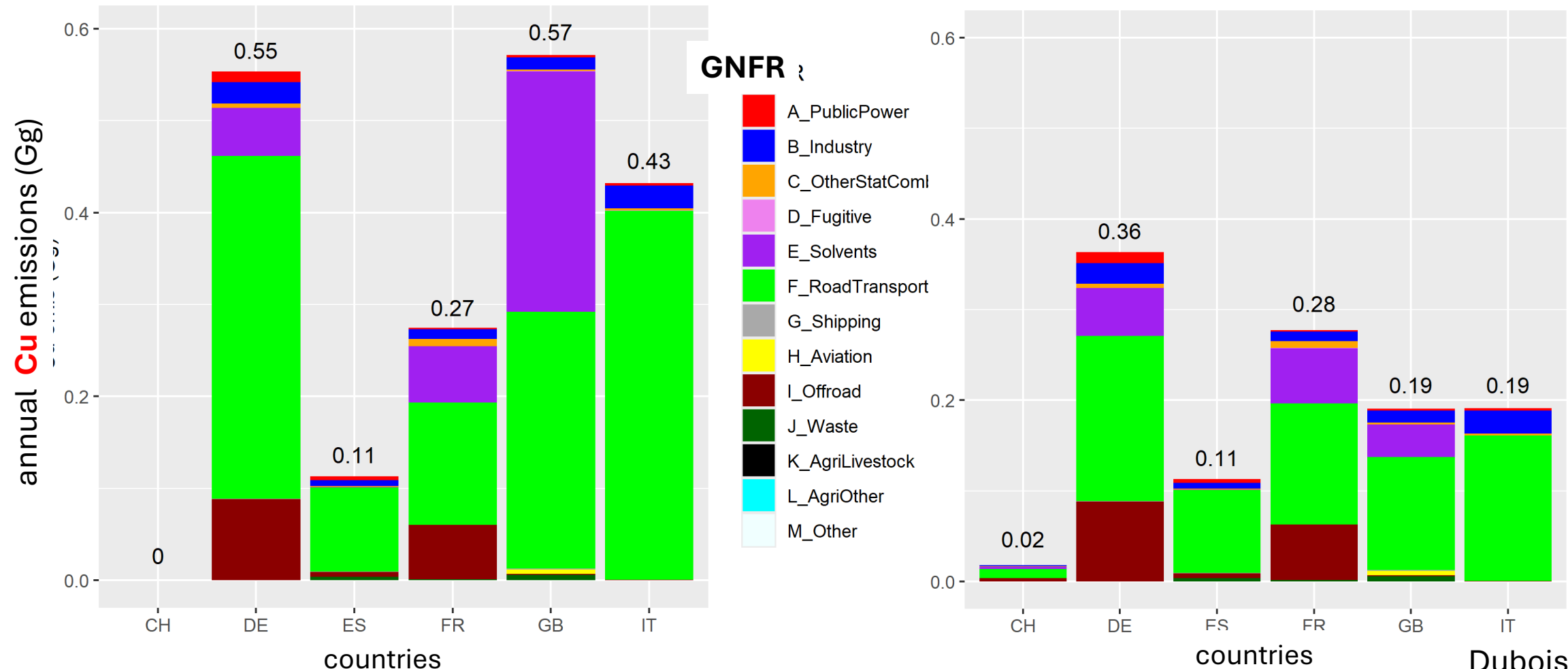
- Non harmonized methods and data
- Wrong/missing emission factors
- Wrong/missing activity data

European Emissions for Cu



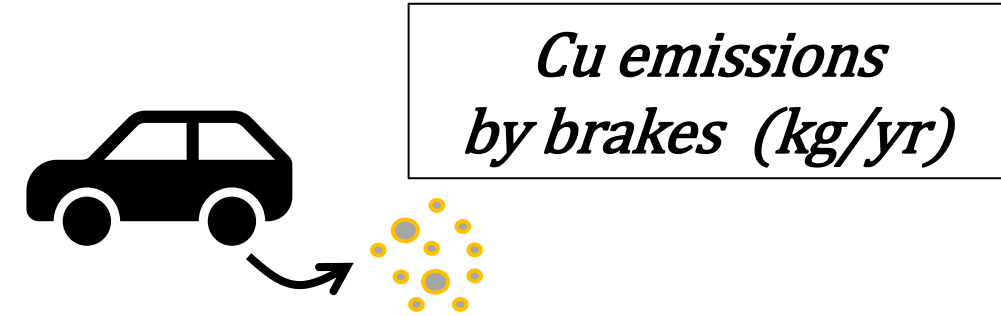
EMEP - Cu - 2013

Corrected EMEP - Cu - 2013



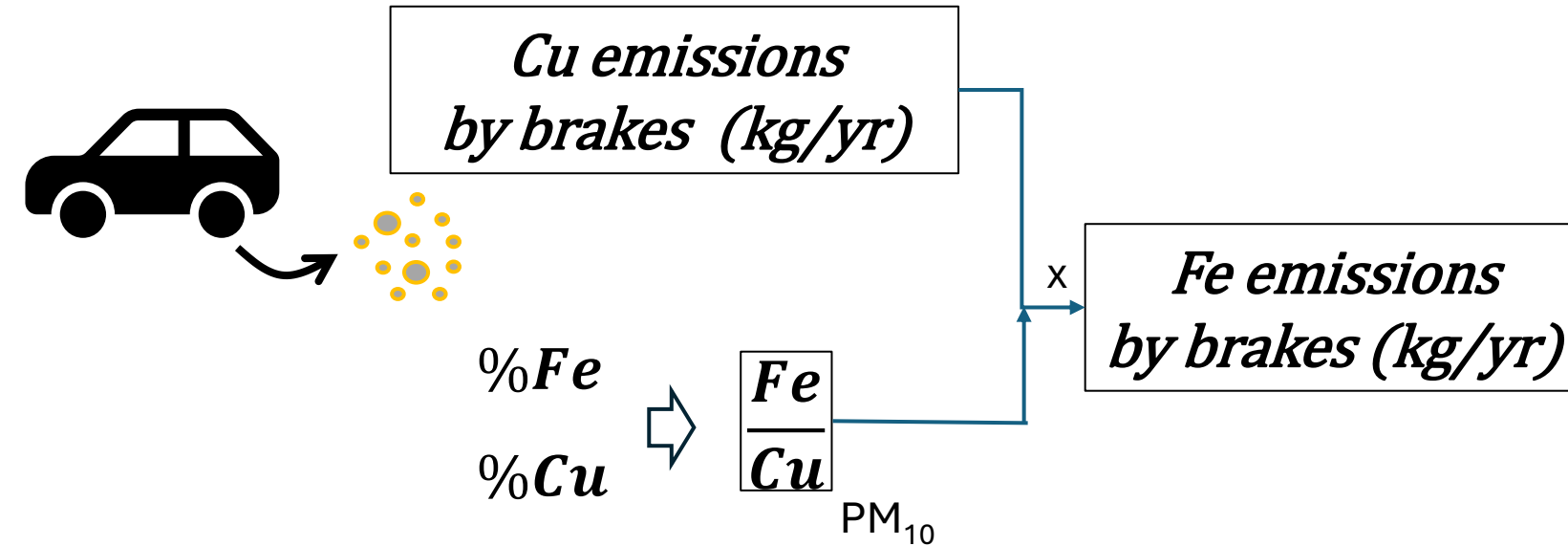
European Emissions for Fe and Mn

Example of the building of Fe emission inventory



European Emissions for Fe and Mn

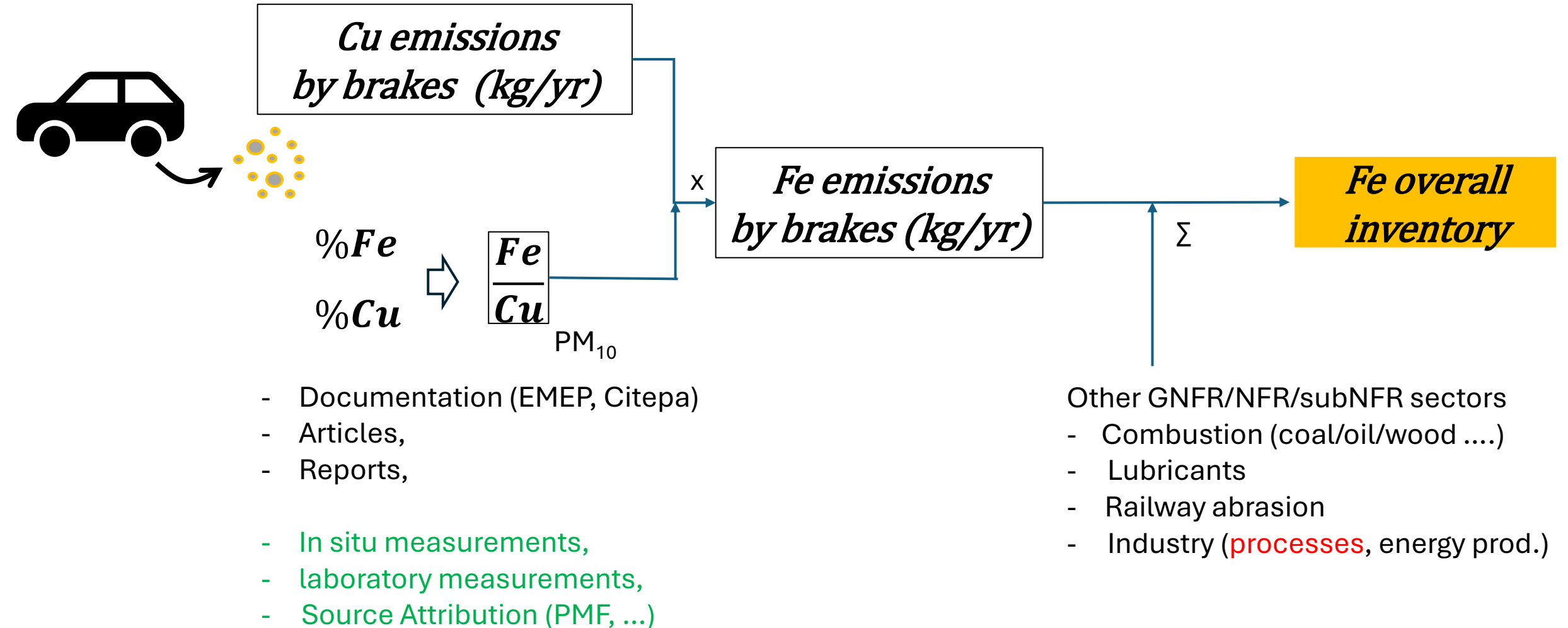
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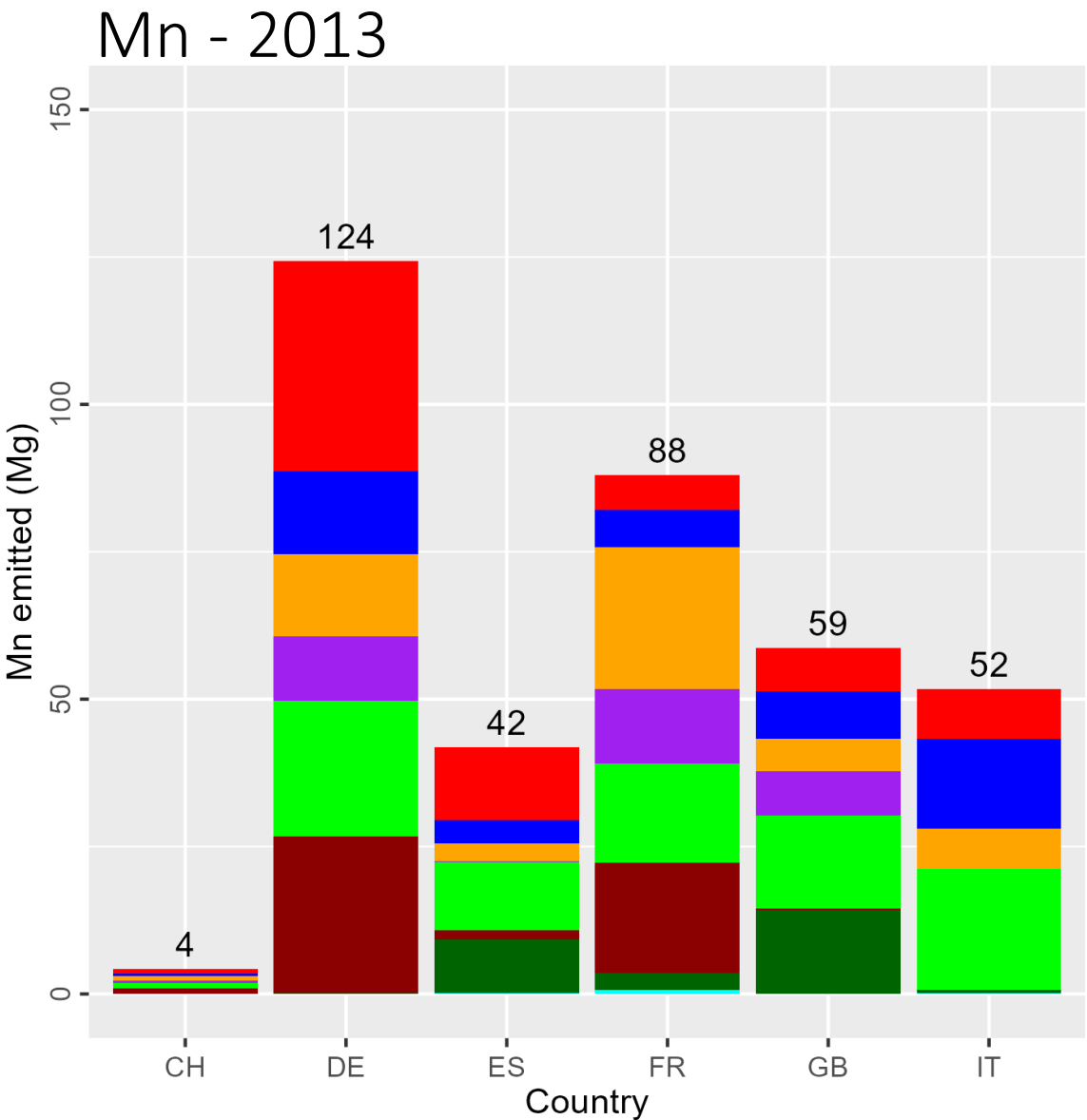
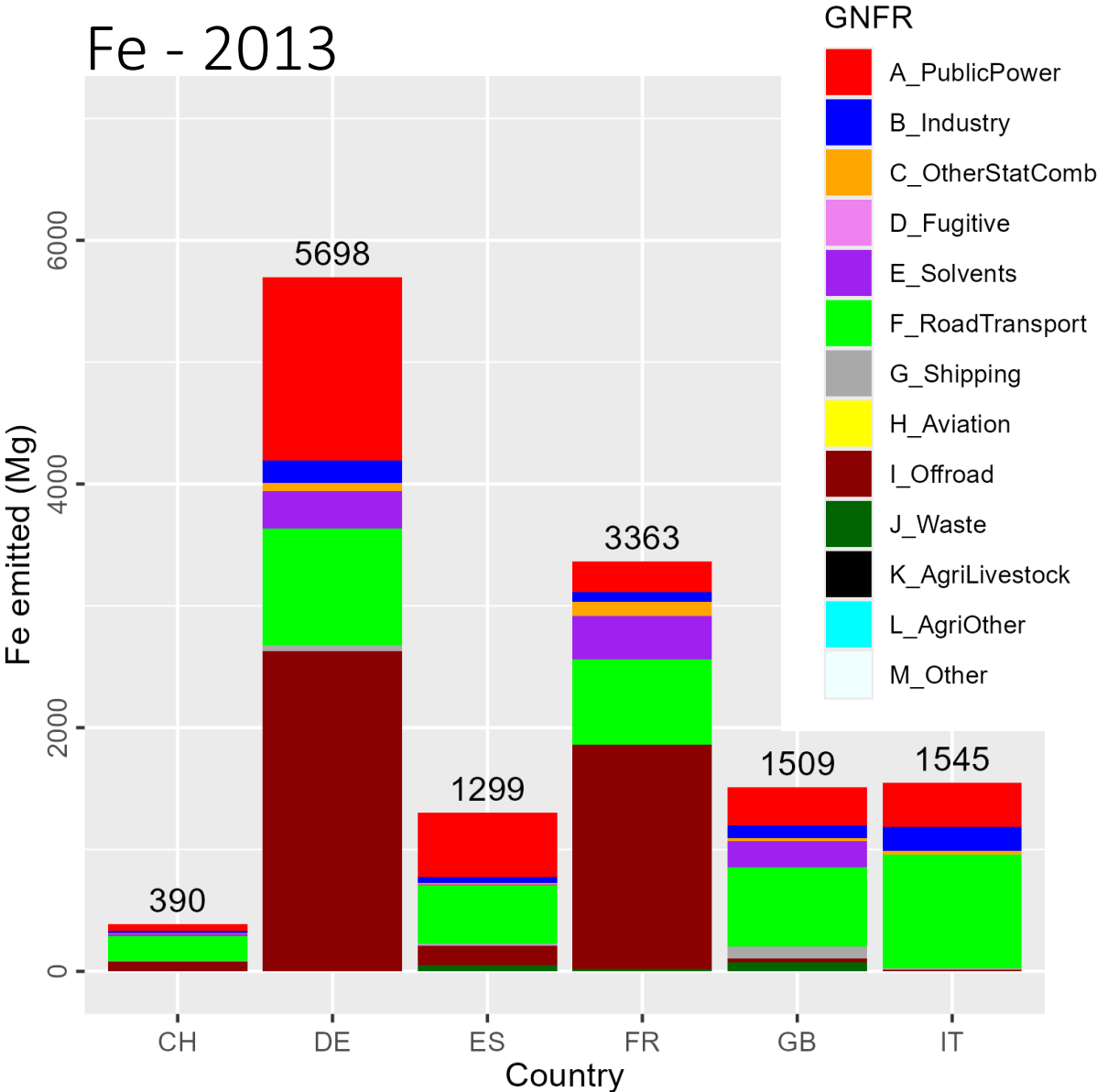
- Documentation (EMEP, Citepa)
- Articles,
- Reports,
- In situ measurements,
- laboratory measurements,
- Source Attribution (PMF, ...)

European Emissions for Fe and Mn

Example of the building of Fe emission inventory



European Emissions for Fe and Mn



Simulation at European scale

- Regional CTM CHIMERE
9km x 9km over Europe
- Metals are *chemically inert*
- Cu, Fe, Mn emissions in coarse
mode (median 4 μ m)

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- **Natural Soil Dust**
CAMS Boundary conditions
- **Resuspension of urban dust**
(Loosmore et al, 2003)

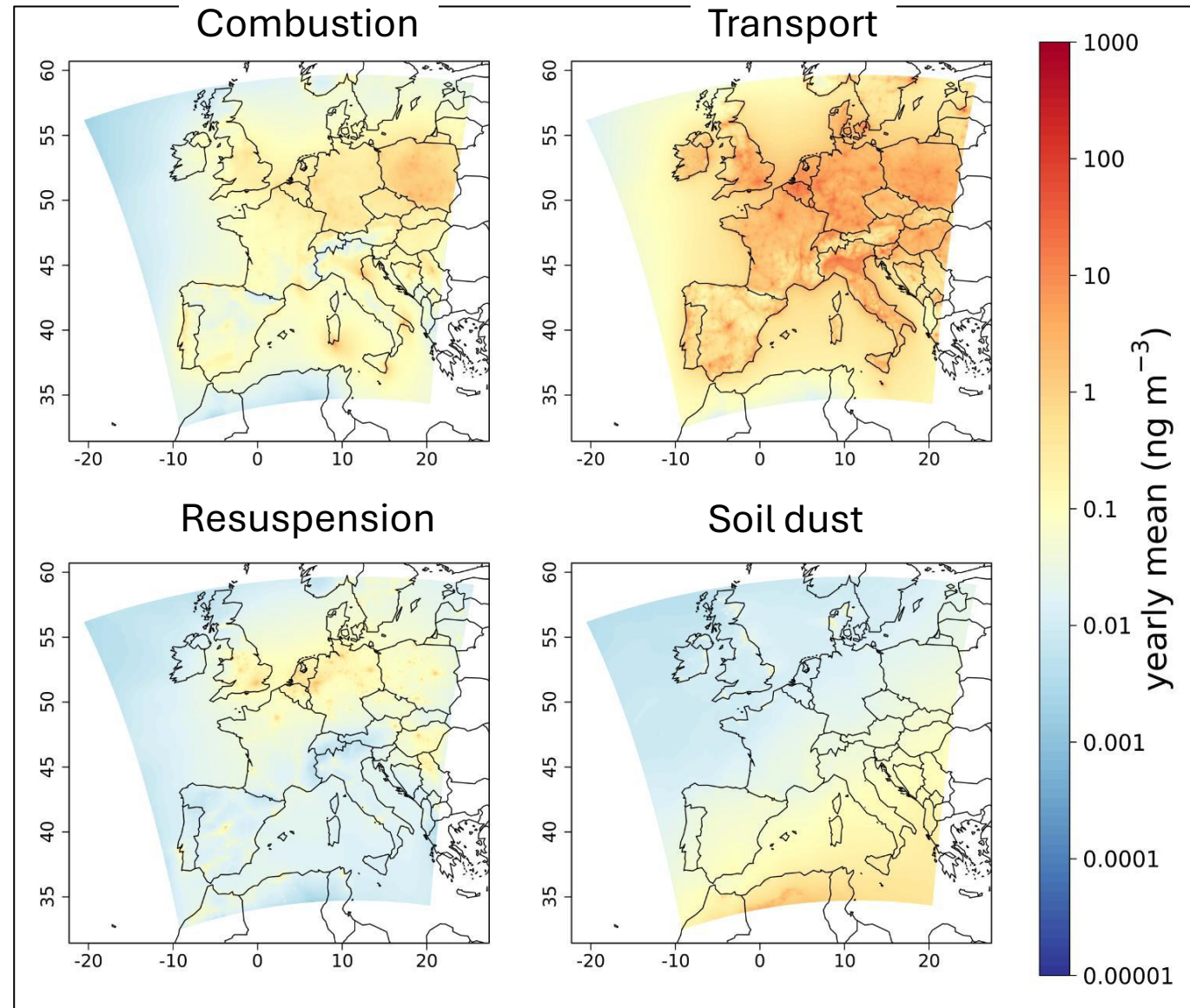
→ **Cu, Fe and Mn composition**
Soil Dust - Moreno et al (2009)
Urban dust – Amato et al (2016)

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Cu concentrations / source – 2013-2014 mean

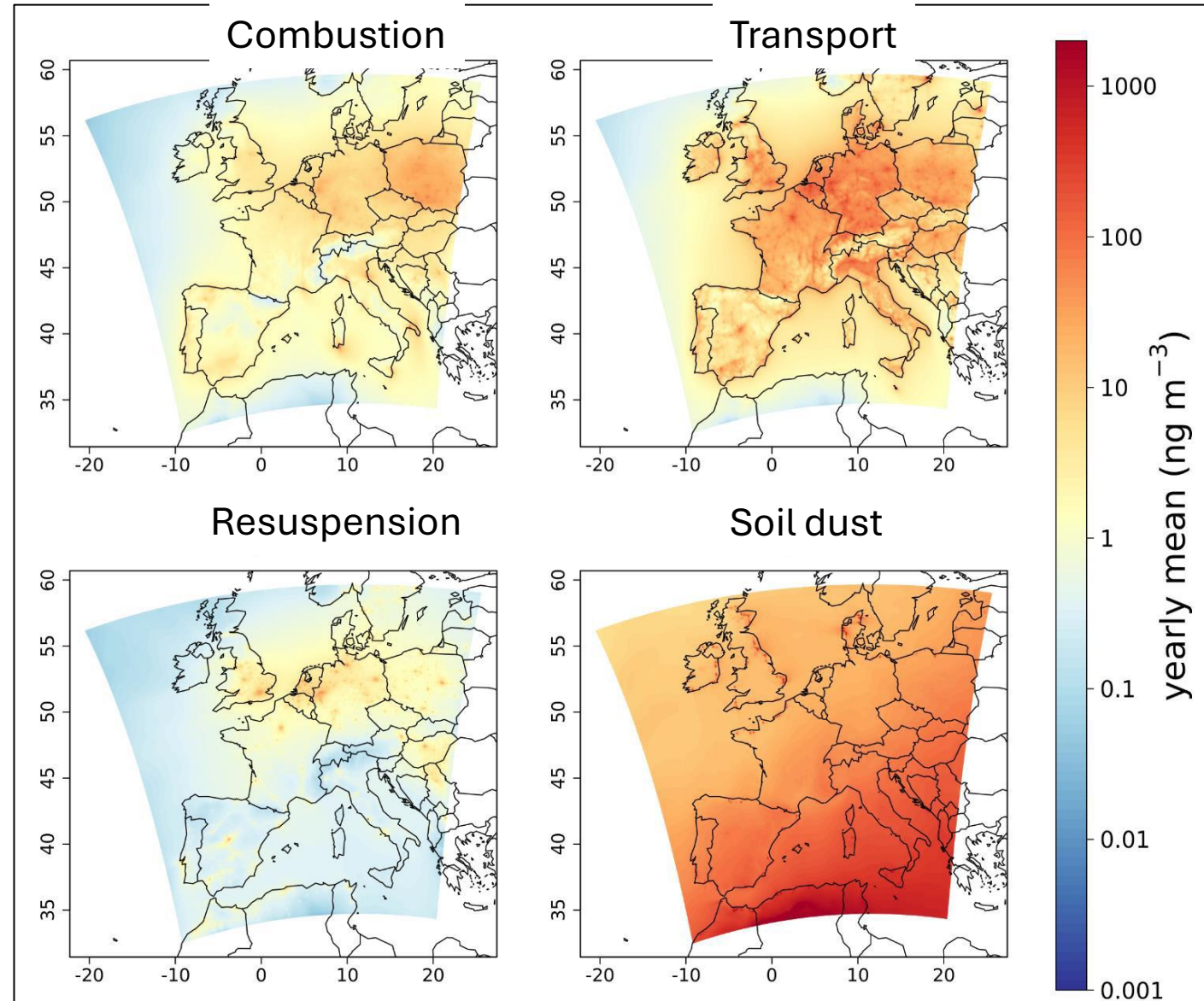


Simulation at European scale

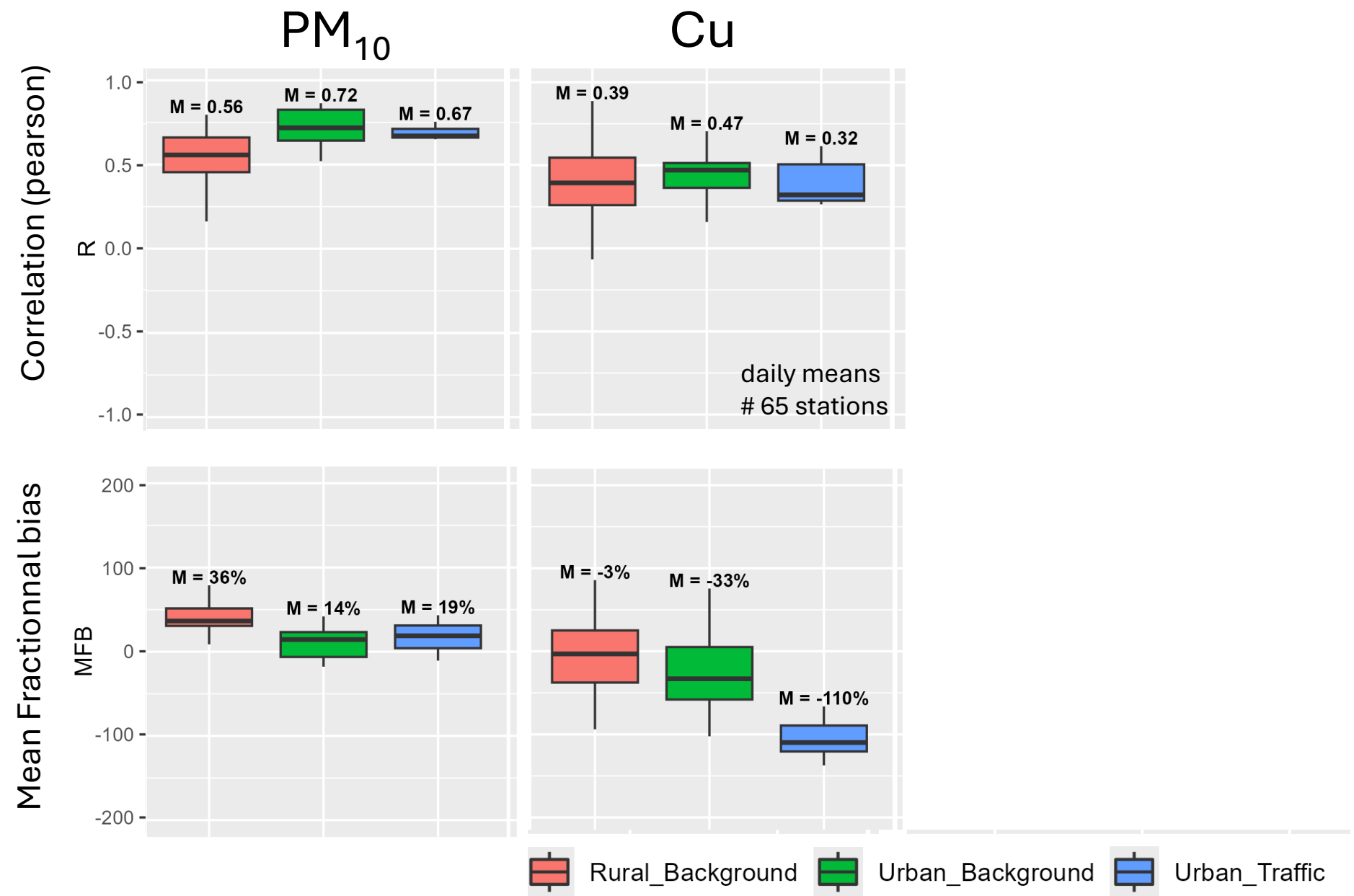
Fe concentrations / source – 2013-2014 mean

- Regional CTM CHIMERE
– 9km x 9km over Europe
- Metals are *chemically inert*
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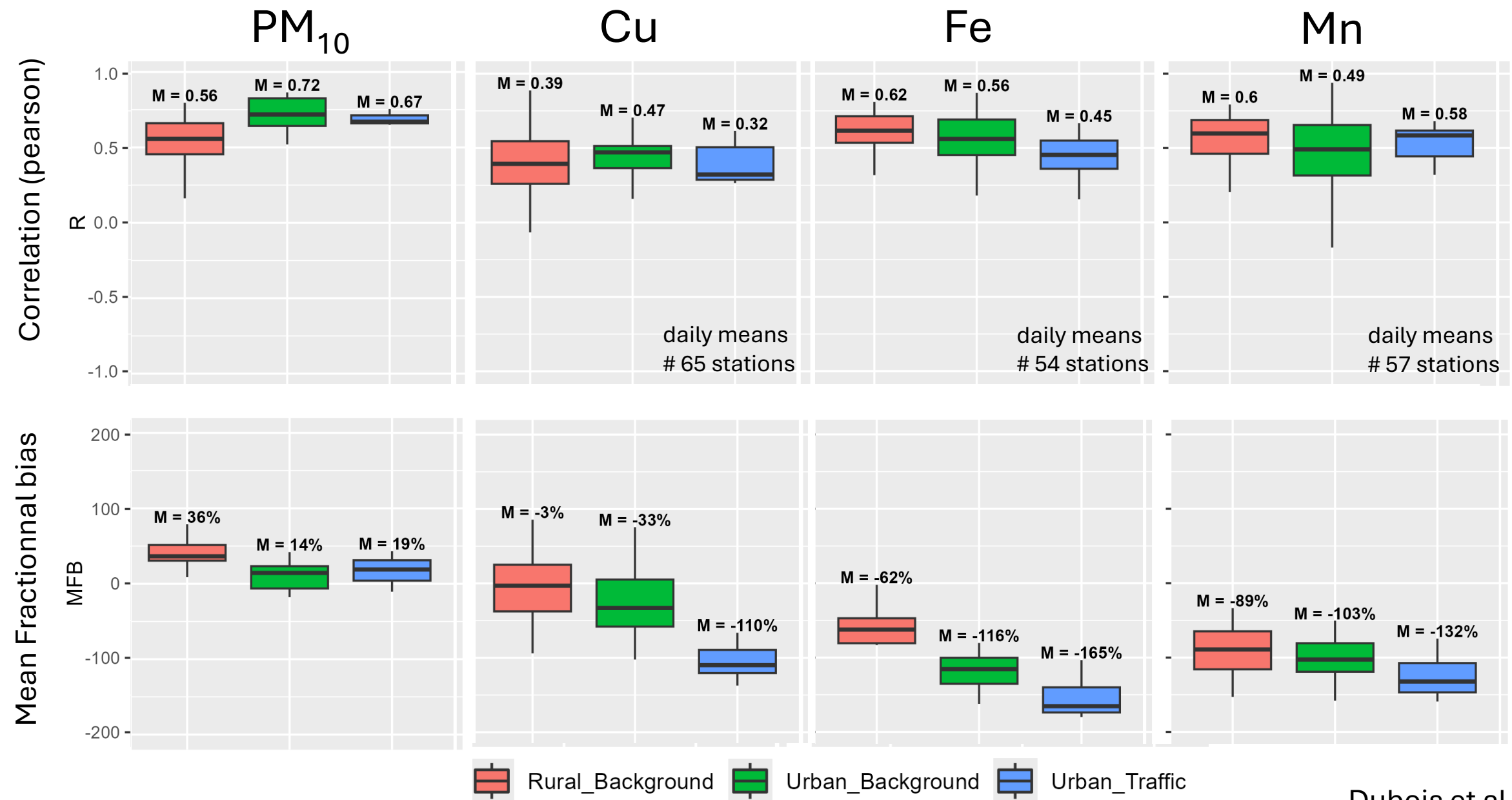
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Simulation at European scale - model evaluation – 2013-2014



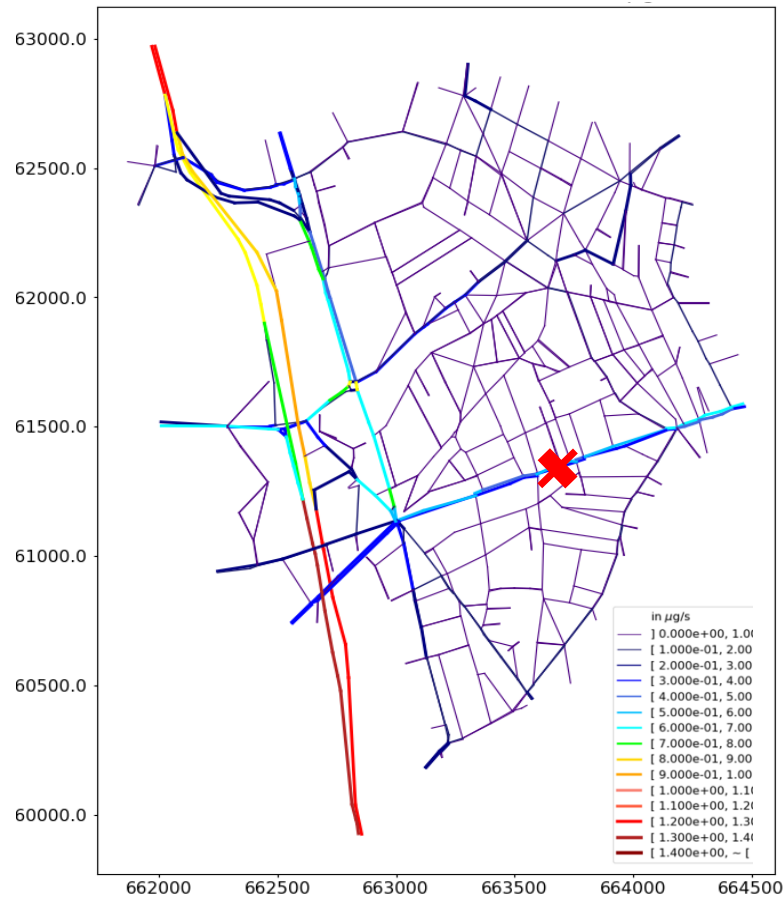
Simulation at European scale - model evaluation – 2013-14



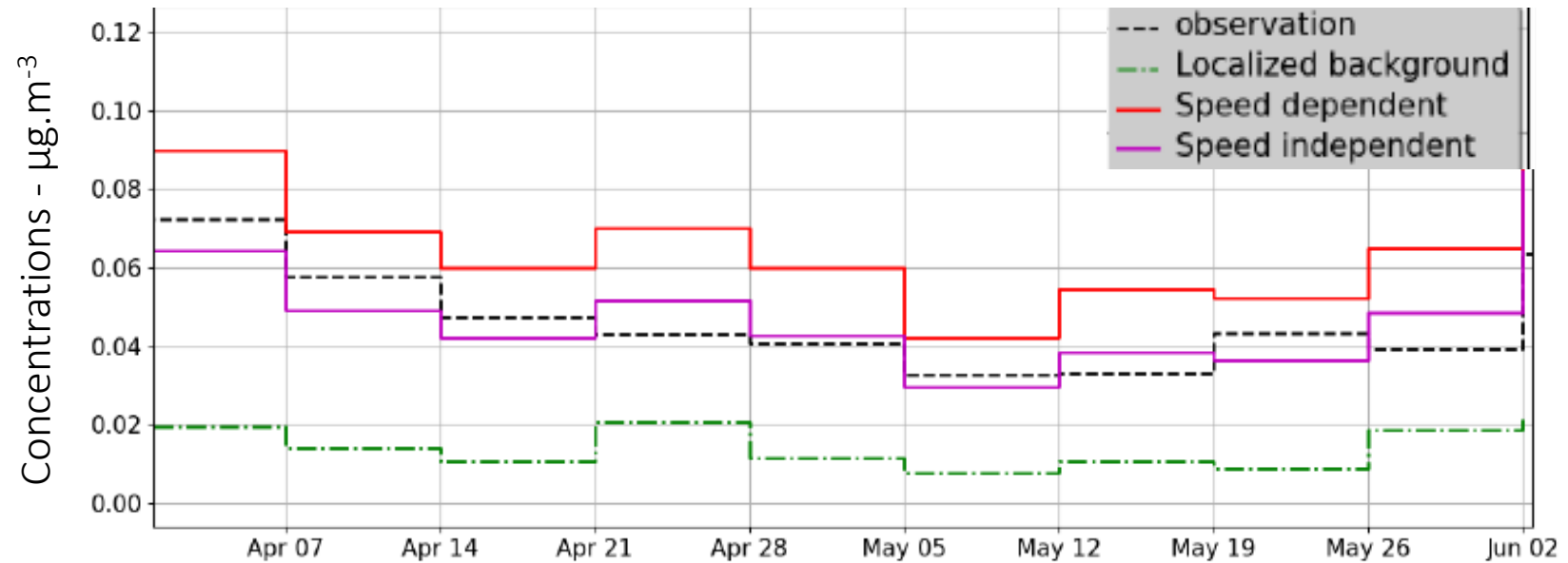
Simulation at street scale - Cu

- Street-scale Munich model – Kim et al, 2022
- Cu, Fe Emissions from traffic = COPPERT
- April-June 2013

Cu emissions



Cu concentrations at measurement station

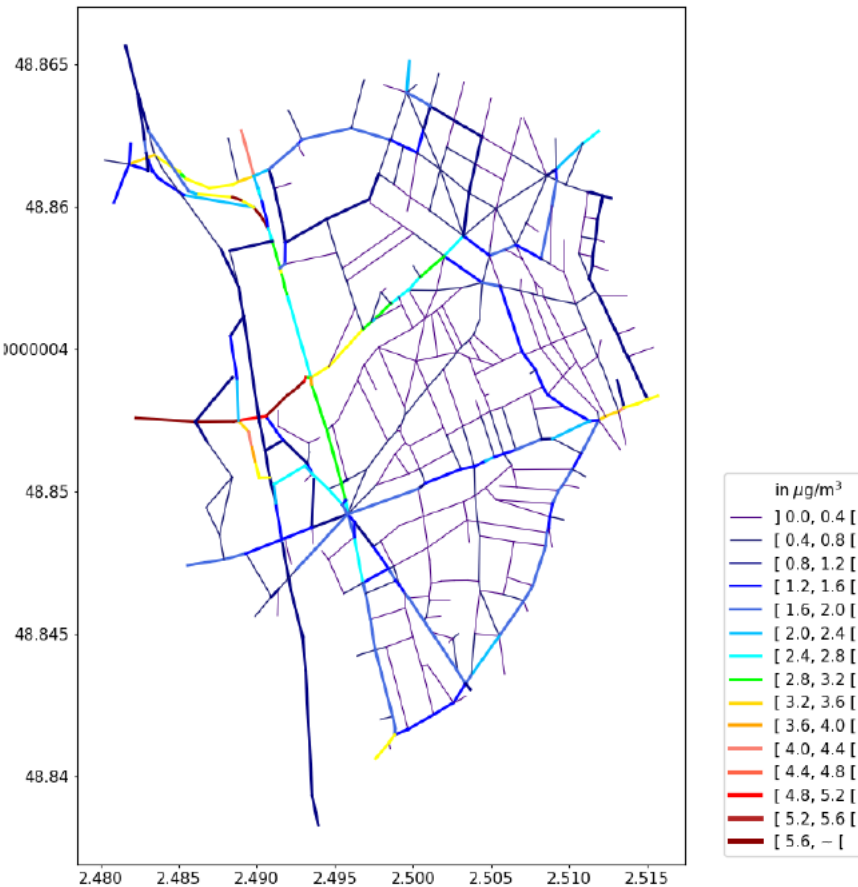


→ Simulation of Cu concentrations are satisfactory

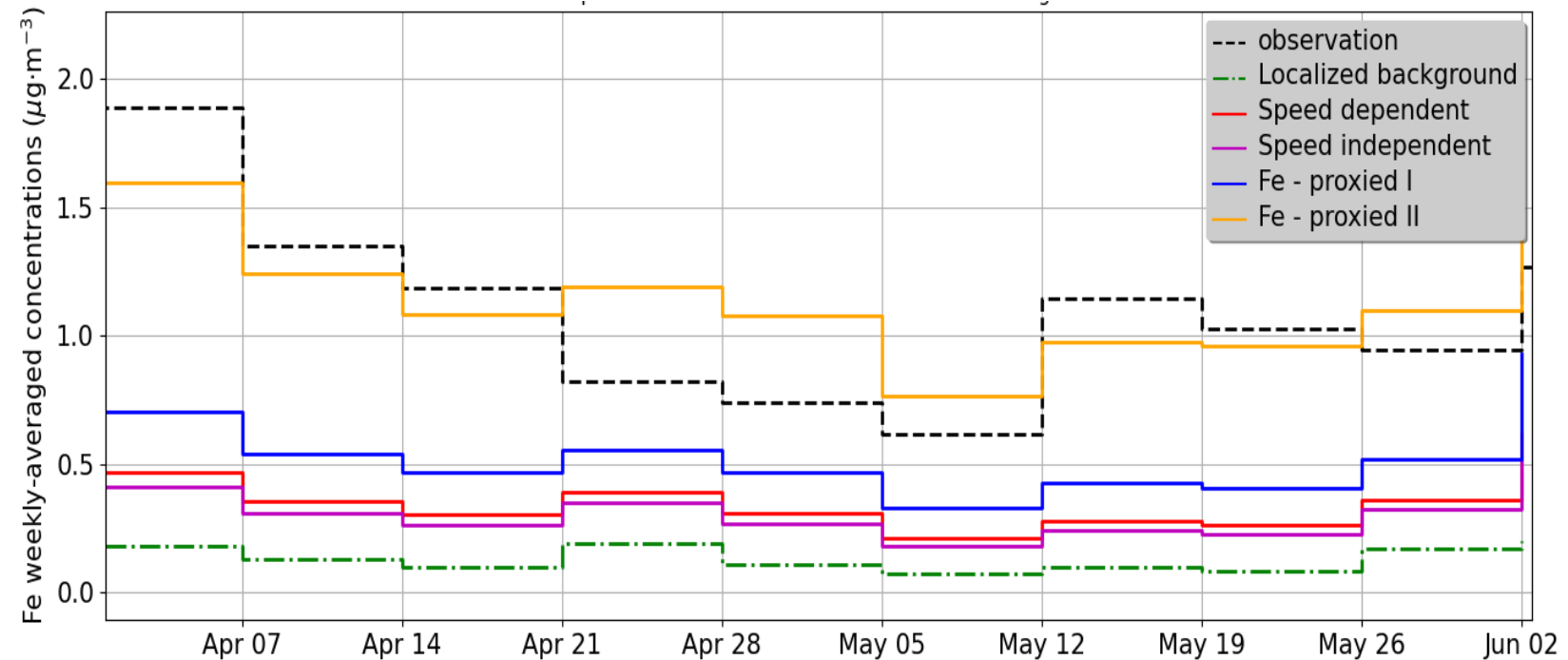
Simulation at street scale - Fe

- Street-scale Munich model – Kim et al, 2022
- Cu, Fe Emissions from traffic = COPPERT (consistent with EMEP/CITEPA)
- April-June 2013

Fe concentrations



Fe concentrations at measurement station

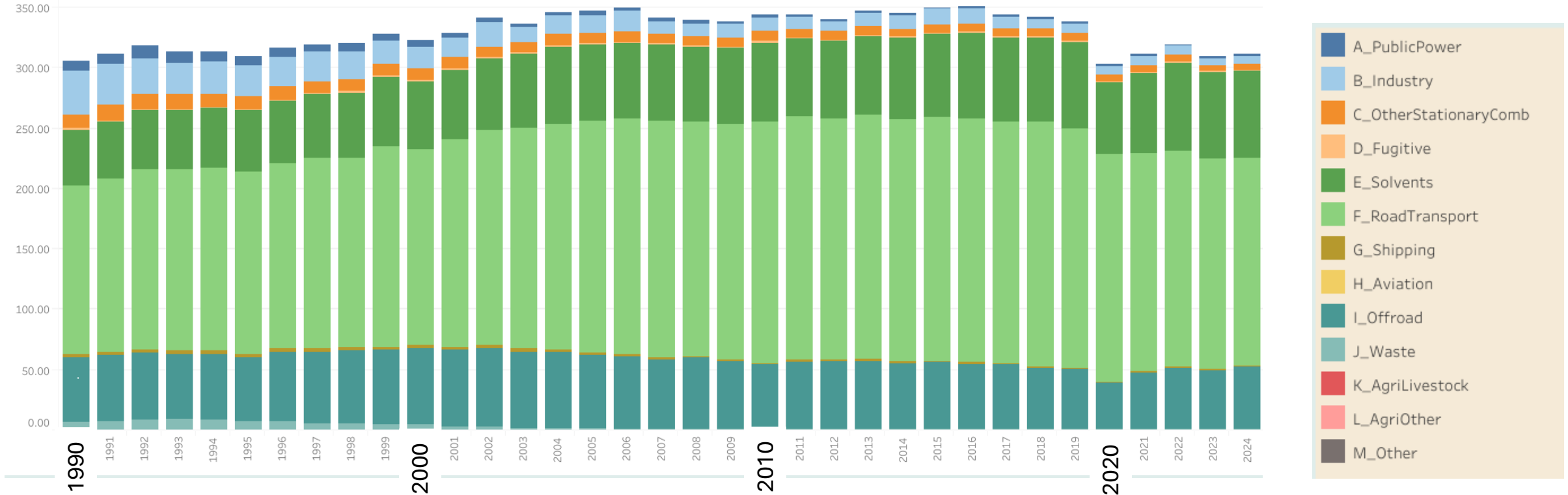


- Fe emission linked to traffic are underestimated
- New Fe/Cu ratios must be tested - 20-30 instead of 4-6

Conclusions & perspectives

- New inventories available for European Cu, Fe and Mn emissions
- Cu inventory is already satisfying
- Fe and Mn inventory much too low
- Brake abrasion source for Fe and Mn likely too low
- What do we think of railway emissions ?
- What about size distribution ?
- Coupling with lung chemistry model is planned
 - Adding solubility information is then needed (PhD Sara-Fanta Kouyaté)

Perspectives -> Cu emissions (t) trends for France



- Cu trends are stable contrarily to other pollutants (exhaust)
- Trends driven by vehicle fluxes (veh.km) – Private cars, trucks ...
- Electric or hybrid vehicles with regenerative braking have much lower emission factors
- Formulation of pads can be changed (Copper removed in the US)

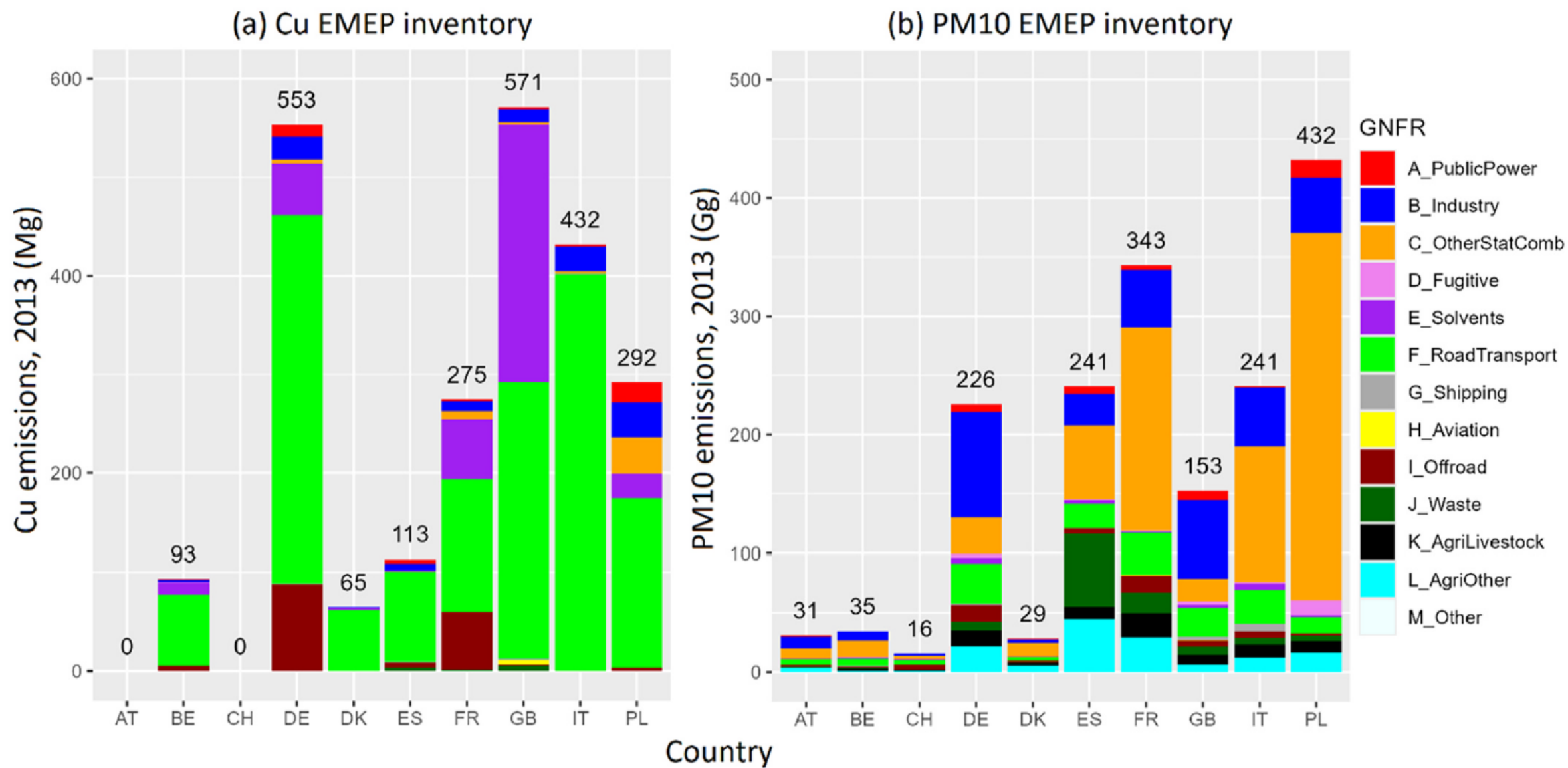
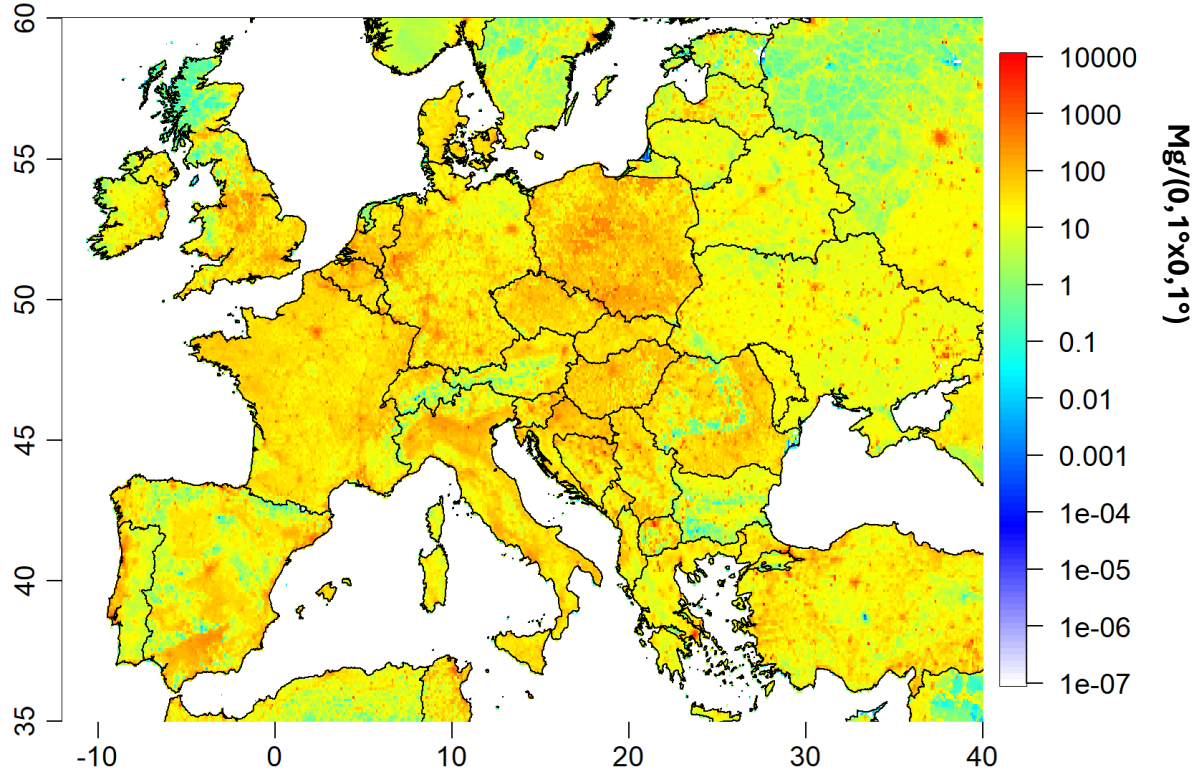


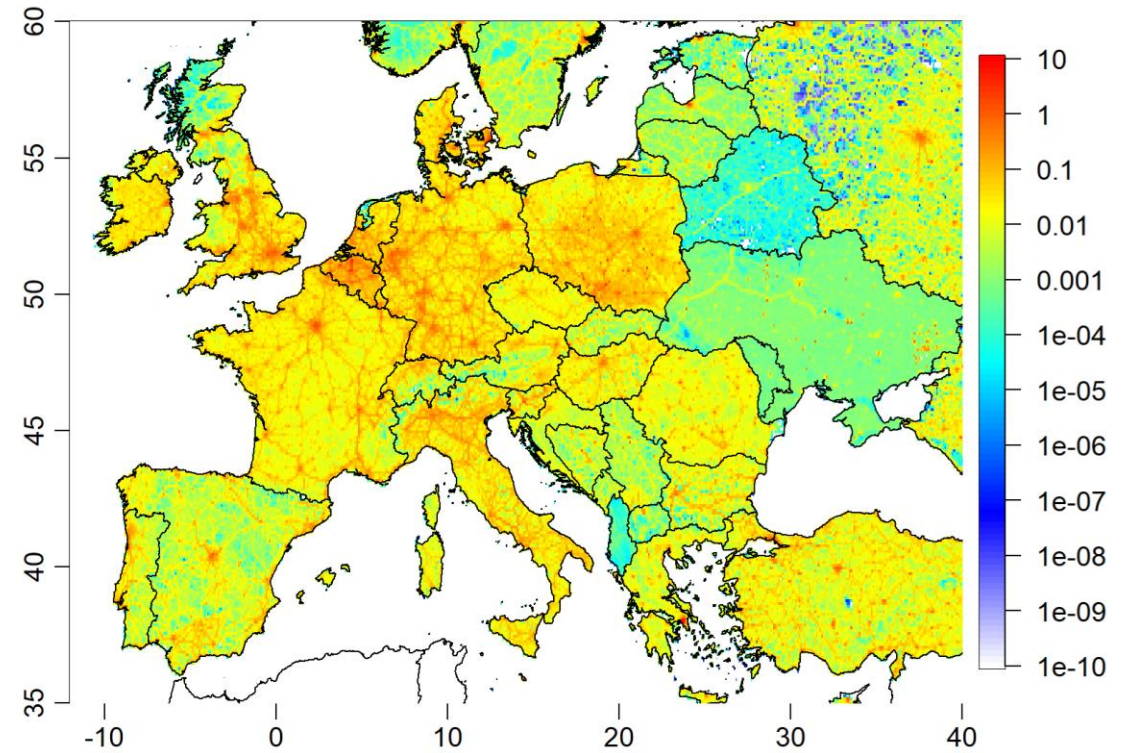
Fig. 2. (a) Cu emission (Mg) and (b) PM₁₀ emission (Gg) for the year 2013, from EMEP.

European Emissions for Cu → Spatialization

PM₁₀, 2013, EMEP



Cu, 2013



Cu/PM₁₀ by GNFR (activity sector)