

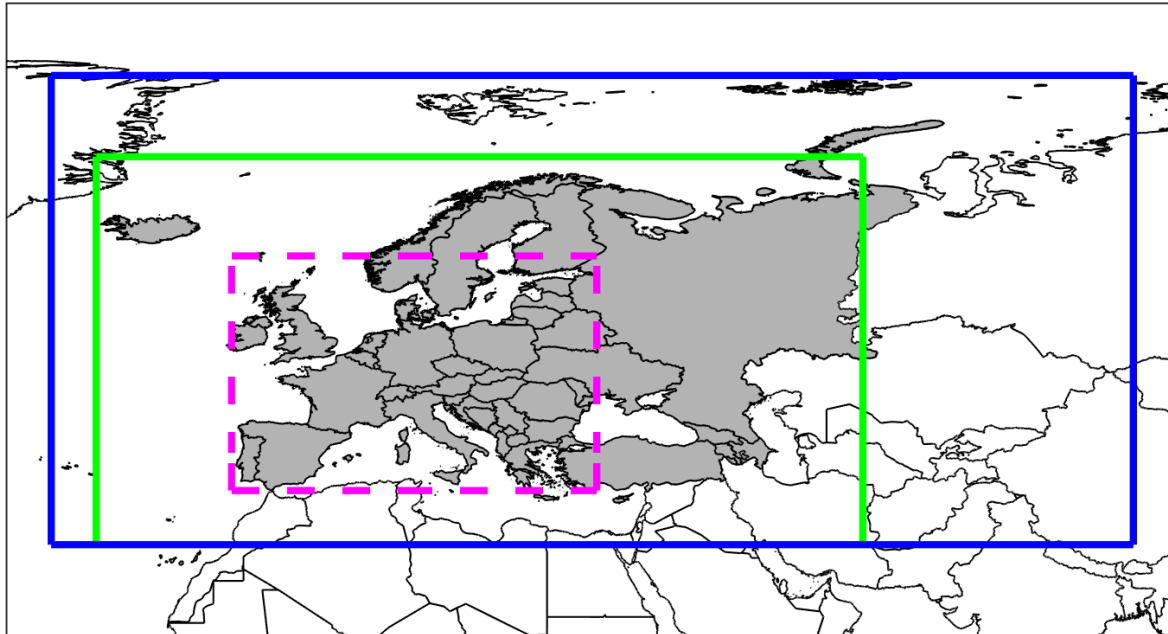
Progress in analyzing urban-rural air pollution in GAINS

Focus on West Balkan / EECCA

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Domains in GAINS



- 45 GAINS-Europe emission regions
- "28km" impact domain
- "7km" downscaling
- New EMEP domain covering all EECCA countries

- ⇒ New transfer coefficients needed (MSC-W end of 2021)
- ⇒ New downscaling needed (uEMEP)

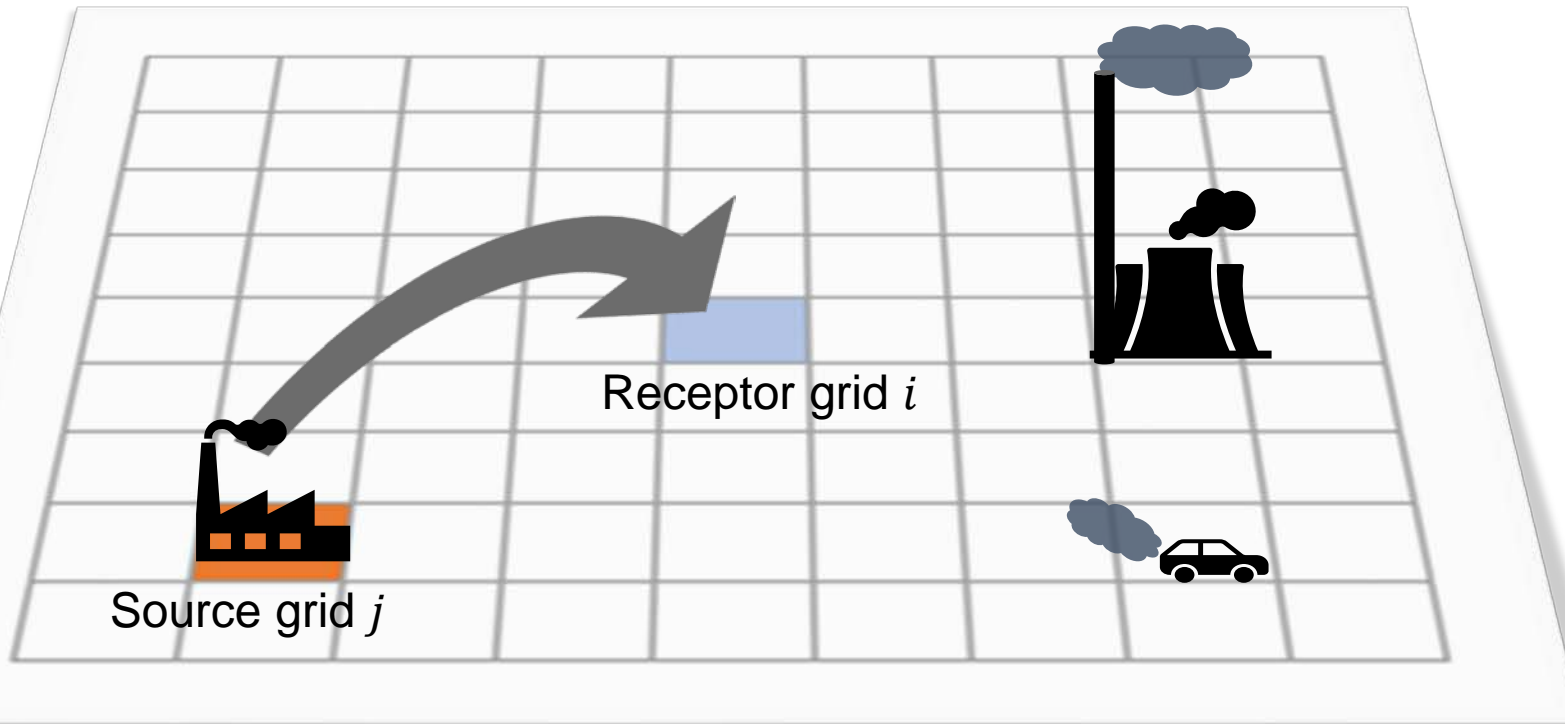
New transfer coefficients

- Extended EMEP domain
- Resolution: $0.3^{\circ} \times 0.2^{\circ}$
- Base case: 2030 Baseline scenario
- Reduction simulations for 50 land regions (incl split of Turkmenistan, Uzbekistan, Tajikistan) and 10 sea regions (5 seas, inside/outside 12nm)
- 5 met years (figures here use 2019 met!)
- 5 source pollutants (PPM, SO_2 , NO_x , NH_3 , VOC)
 - Separate reduction for soil NO_x – not yet implemented in GAINS
 - No separate treatment of dispersion of condensable PM (yet)
- Endpoints:
 - concentrations of $\text{PM}_{2.5}$, O_3 (SOMO35, AOT), NO_2
 - Health impacts from $\text{PM}_{2.5}$, O_3
 - Deposition -> ecosystem impacts (using updated CLs, yet to be implemented)

Extension with grid-to-grid tracking of PPM

- EMEP CTM can track PPM contributions grid-to-grid (0.1°)
- 4 different vertical emission “layers” (low-level 1&2, industry, power)
- monthly results allow for sector-specific time patterns

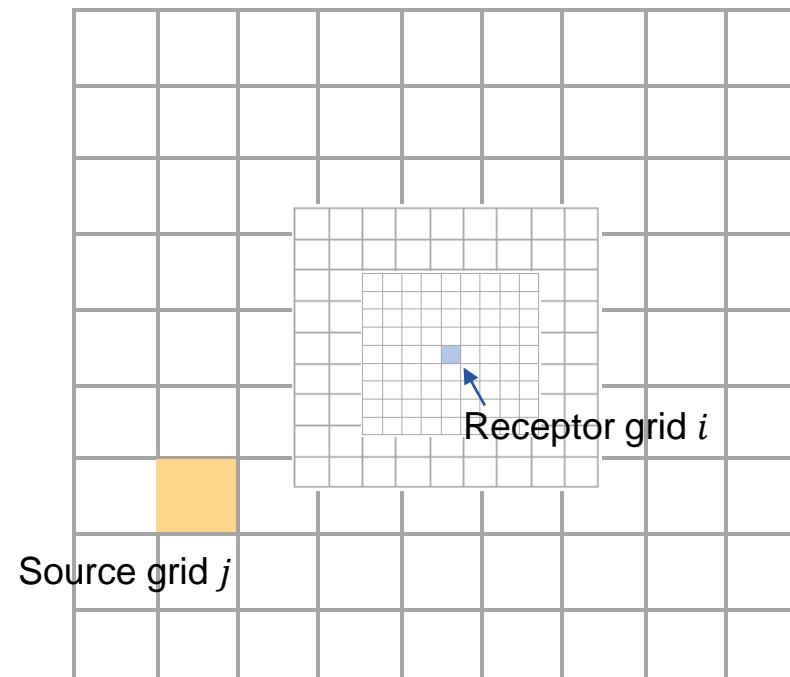
Sector specific transfer coefficients



Extension with grid-to-grid tracking of PPM

- EMEP CTM can track PPM contributions grid-to-grid (0.1°)
- 4 different vertical emission “layers” (low-level 1&2, industry, power)
- monthly results allow for sector-specific time patterns
- five nested resolutions for source grids: $0.1^\circ / 0.2^\circ / 0.5^\circ / 1^\circ (/ 2^\circ)$
20 grid cells in each direction => Complete domain coverage

Sector specific transfer coefficients



5 met year average has been calculated but so far only 2019 implemented

Combination: Sector specific transfer coefficients

- GAINS transfer coefficients for secondary aerosols: linear approximation of EMEP CTM

From source regions r , source pollutant p , to PM_{2.5} in receptor grid cell i :

$$T_{r,p,i} = \frac{[PM_{2.5}]_{i,base} - [PM_{2.5}]_{i,red}}{0.15 \cdot Emis_{r,p}}$$

- Grid to grid tracking (“local fraction”) of PPM with EMEP CTM at 0.1⁰, monthly results

=> sectoral transfer coefficients for PPM:

$$T_{r,s,i} = \frac{1}{12} \cdot \sum_{t=1}^{12} \sum_j D(r,s,l(s),j) \cdot \tau(s,j,t) \cdot G(j,i,l,t)$$

r ... source region, s ... source sector, i ... receptor grid cell (0.1⁰), j ... emission grid cell (0.1⁰), l ...vertical emission layer, t ...month

$D(r,s,l,j)$... spatial emission distribution pattern

$\tau(s,j,t)$... temporal (monthly) emission share

$G(j,i,l,t)$... grid-to-grid transfer coefficient from j to i in month t for emission layer l

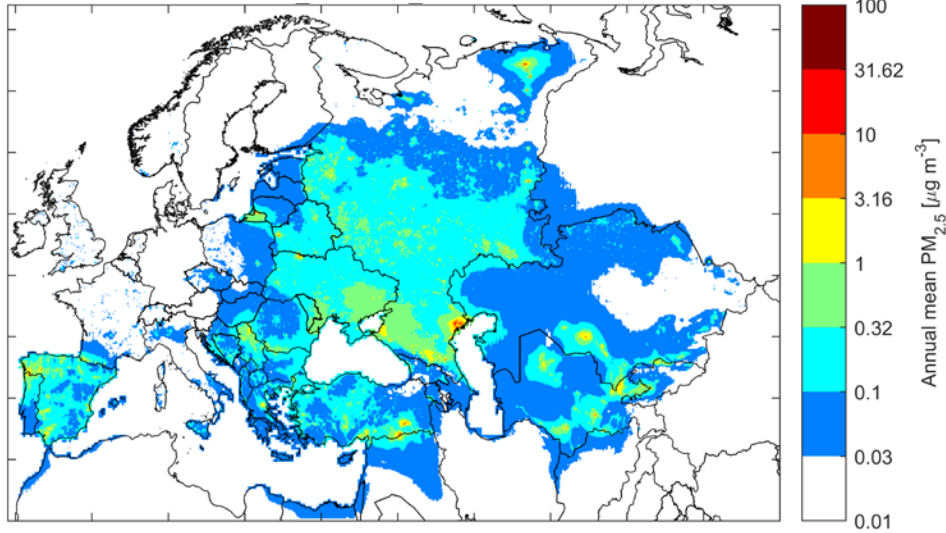
- So that

$$[PM_{2.5}]_{i,scen} = \delta_i + \sum_s \sum_r \sum_p Emis_{r,s,p,scen} \cdot T_{r,p,s,i}$$

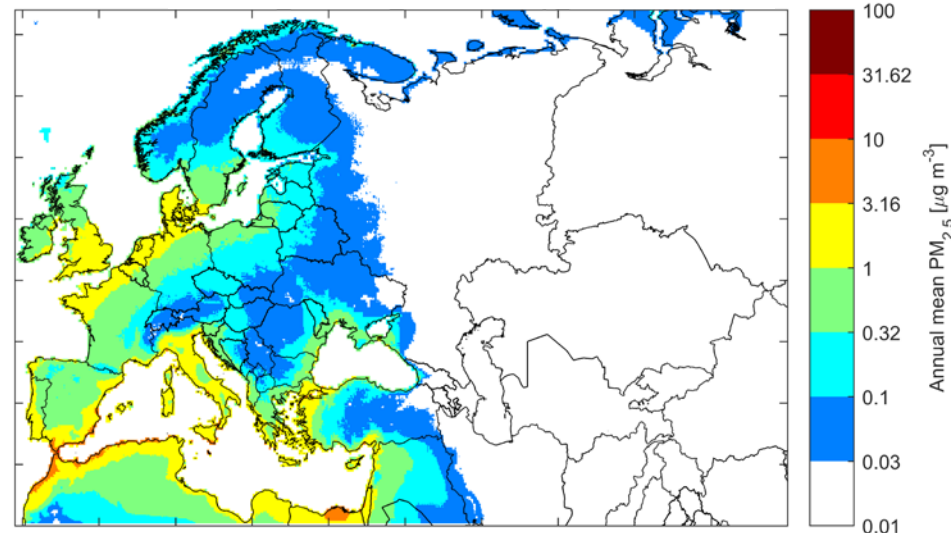
(applying relative sectoral contributions also to SO₂ and NO_x transfer coefficients)

Ambient PM_{2.5}: Contributions from sectors (2015)

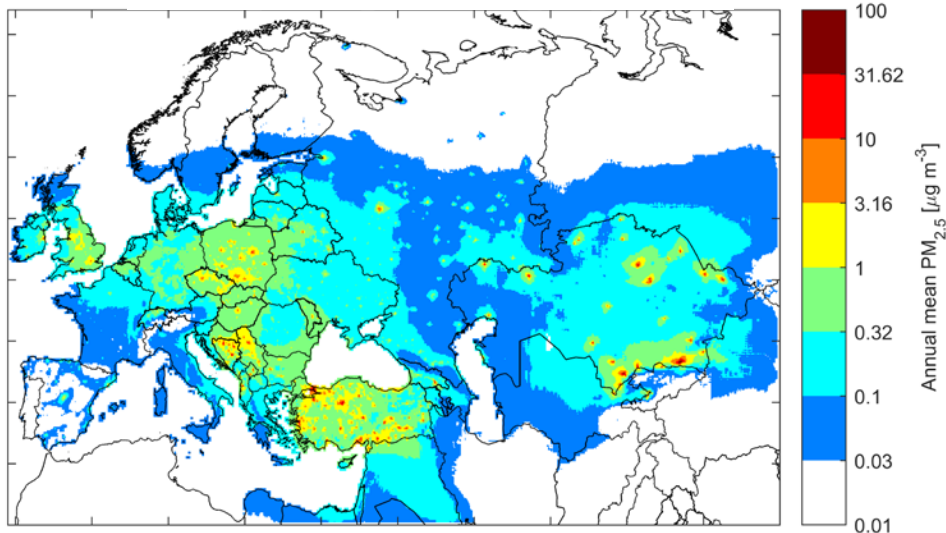
Agricultural waste burning



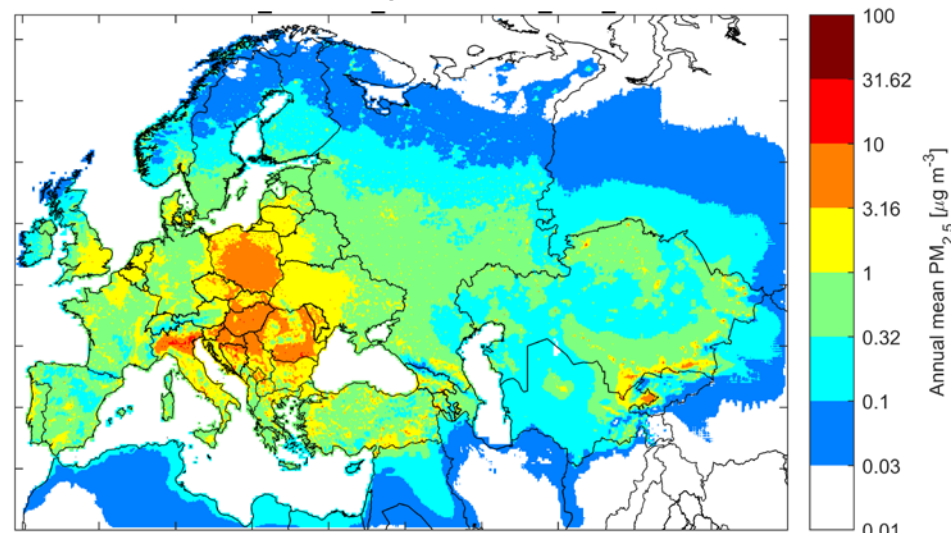
International shipping



Heating: urban



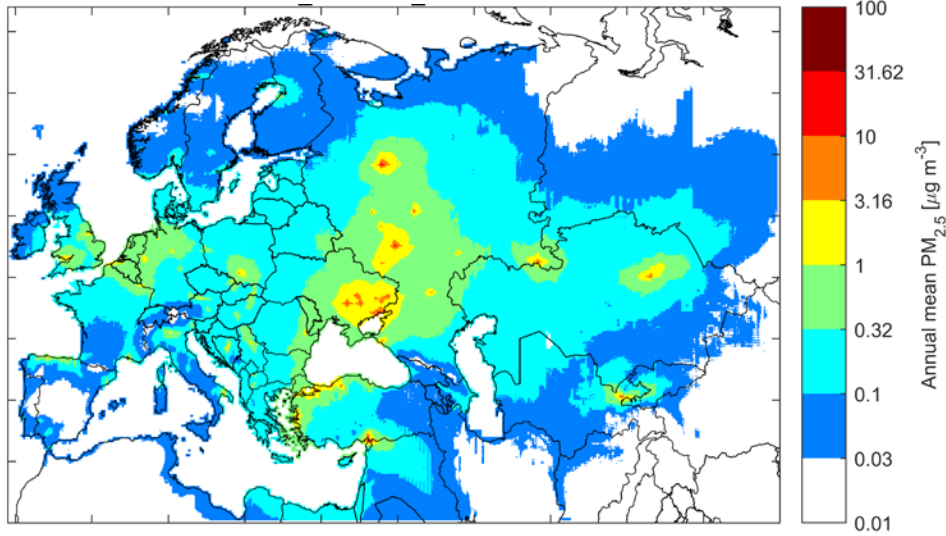
Heating: rural



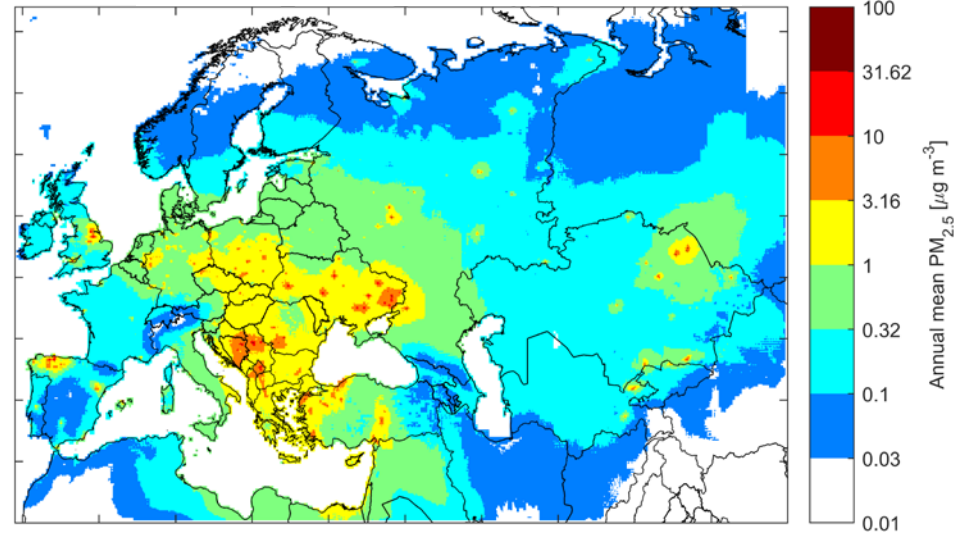
Preliminary results!

Ambient PM_{2.5}: Contributions from sectors - examples

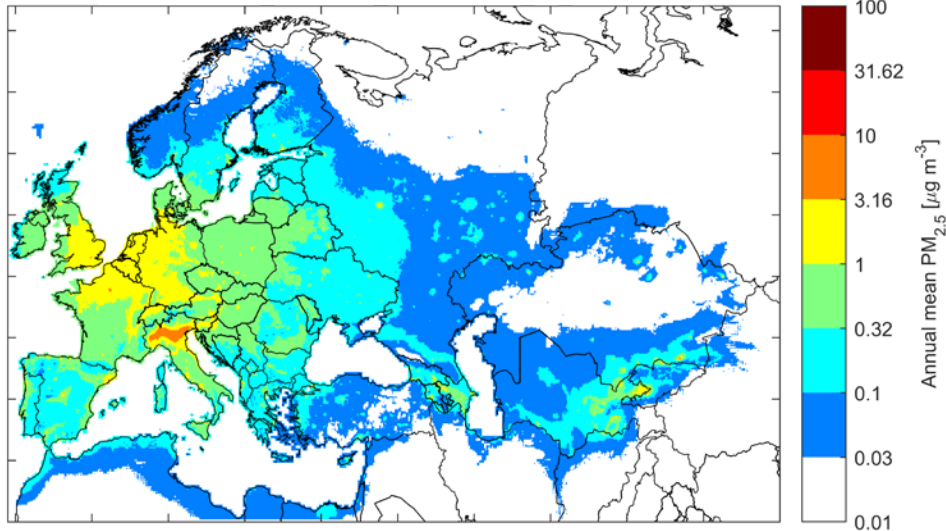
Iron & steel industry



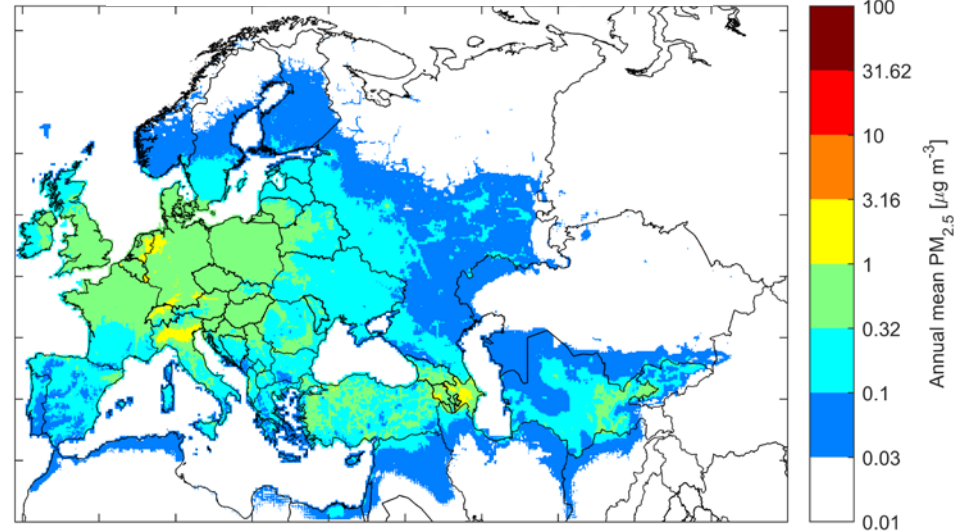
Coal power plants



Heavy duty trucks

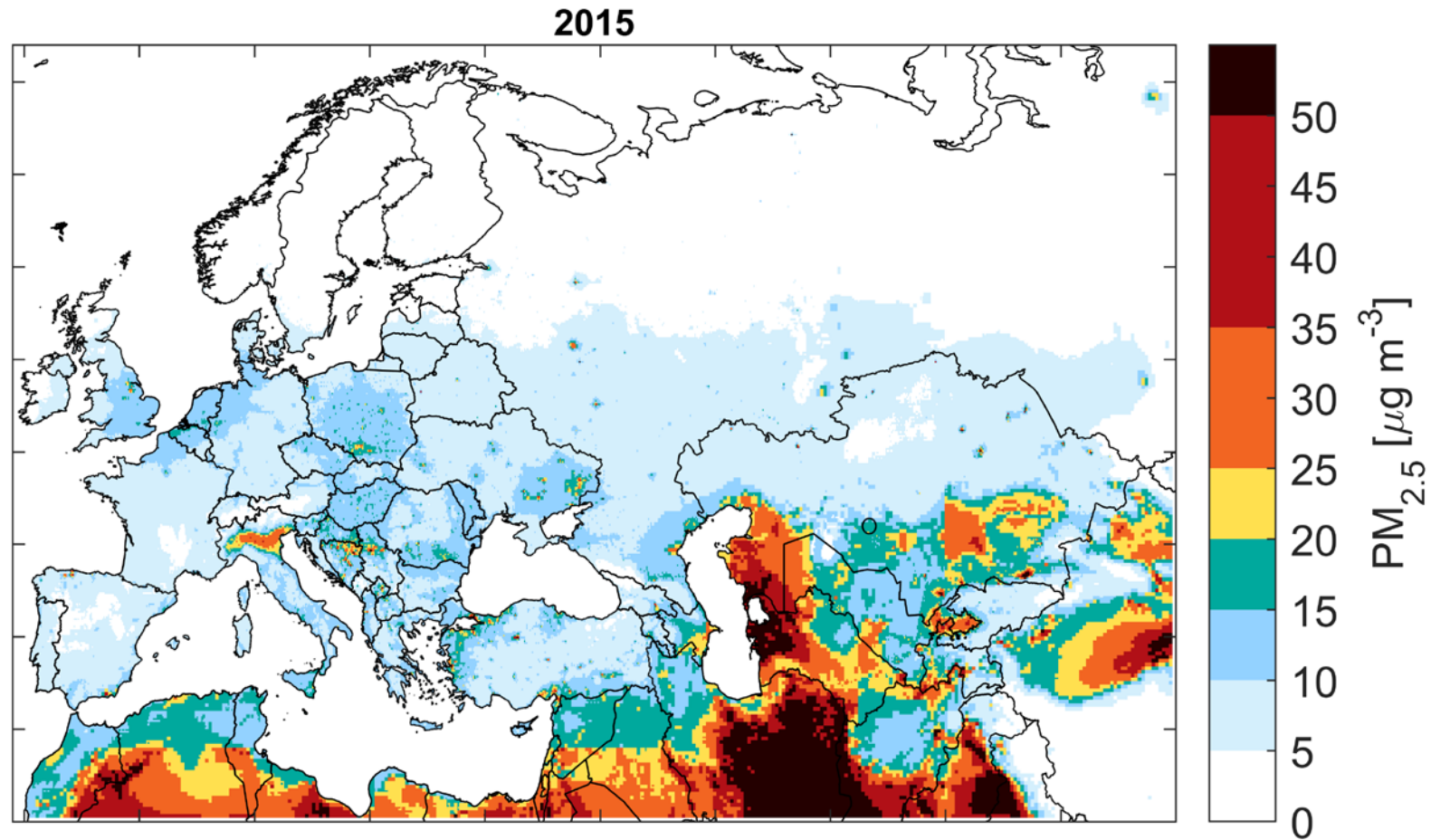


Cars & Light duty trucks

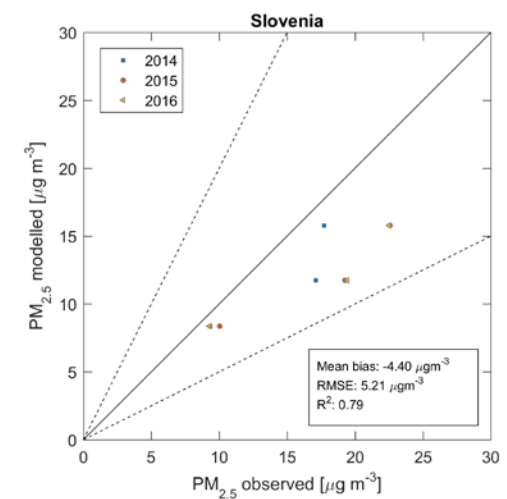
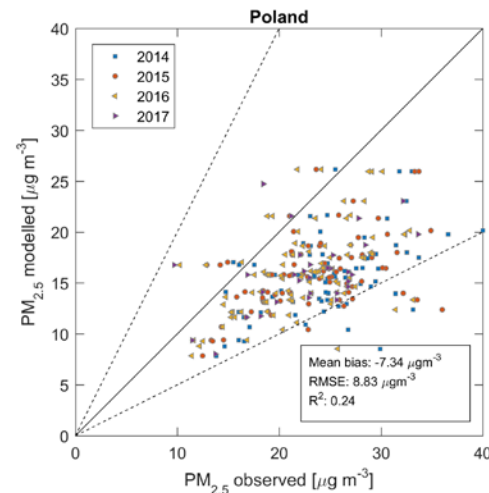
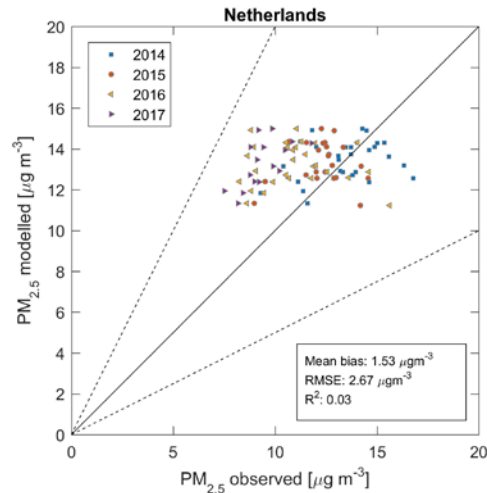
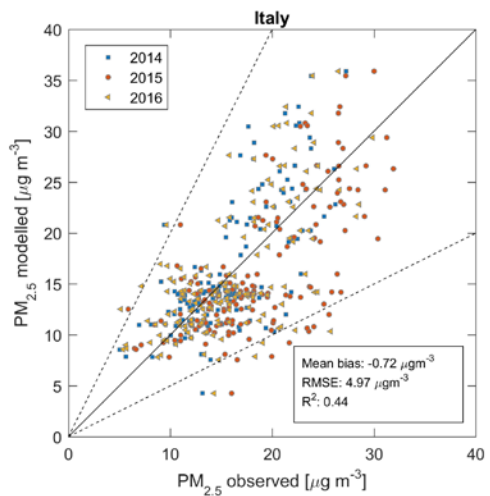
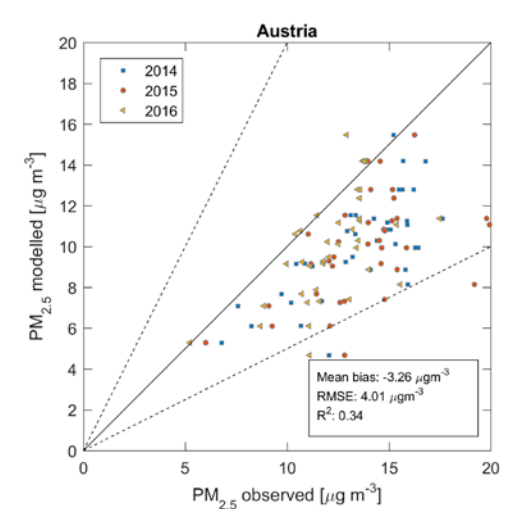
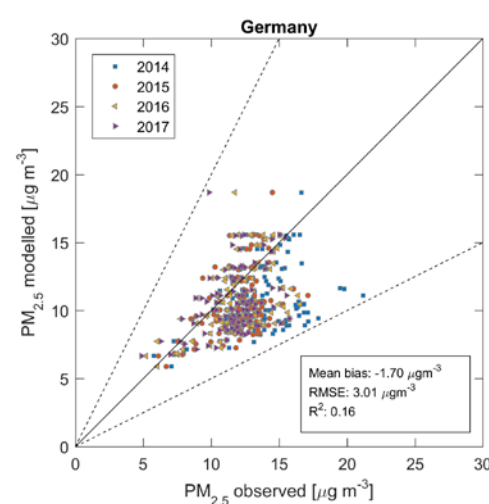
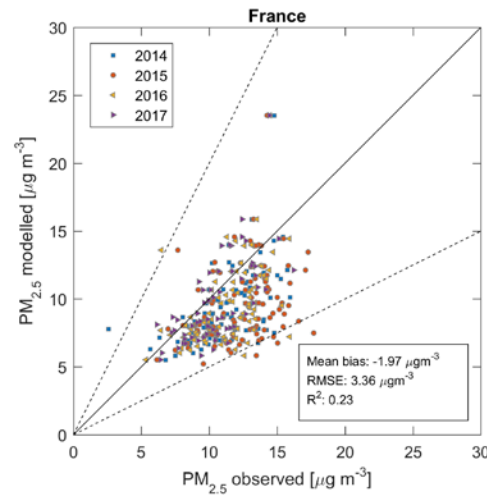
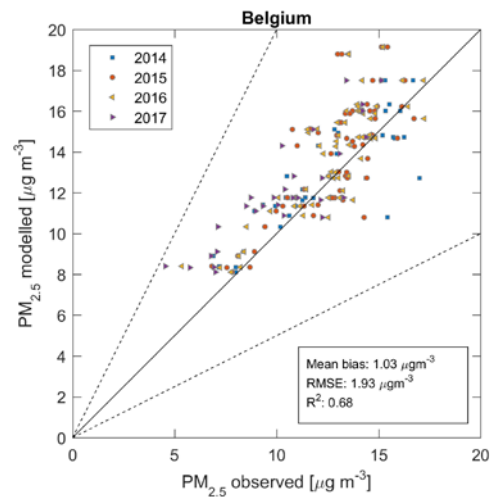


Preliminary results!

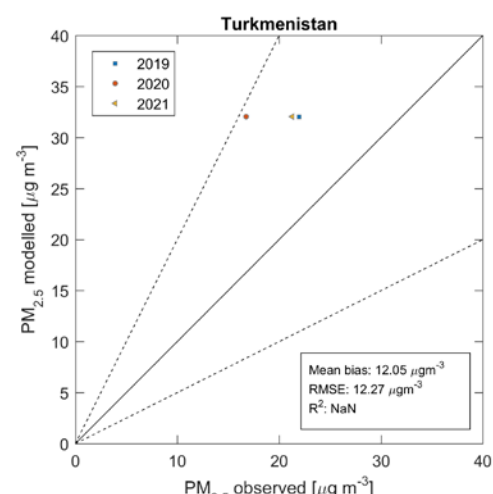
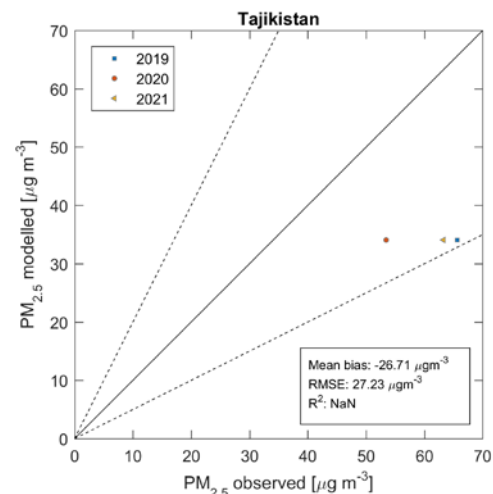
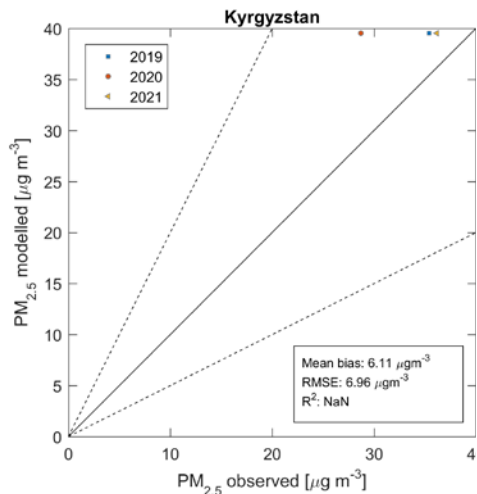
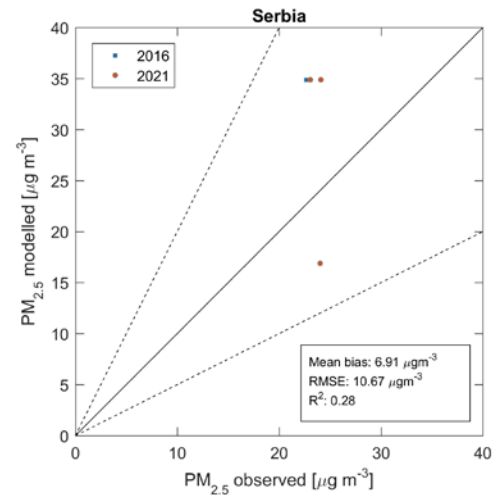
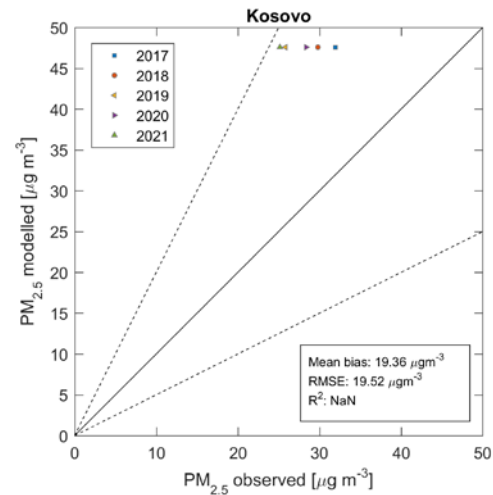
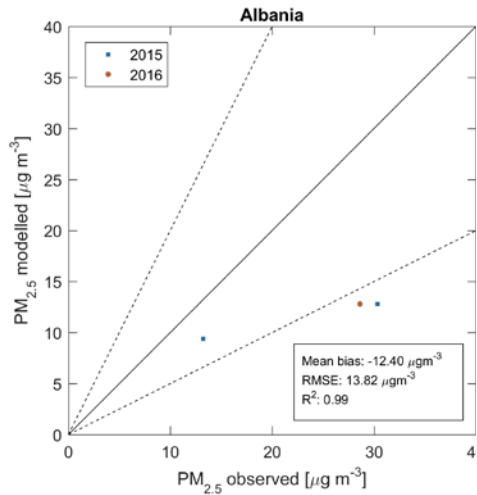
Ambient PM_{2.5} concentrations



Ambient PM_{2.5} concentrations – validation: EU



Ambient PM_{2.5} concentrations – validation: WB/EECCA

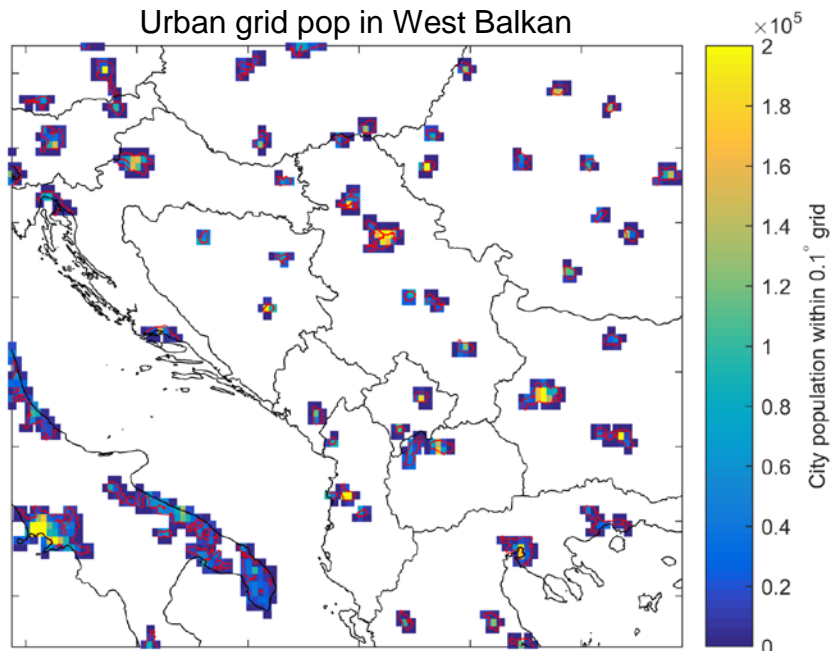


Not many stations available...

Preliminary results!

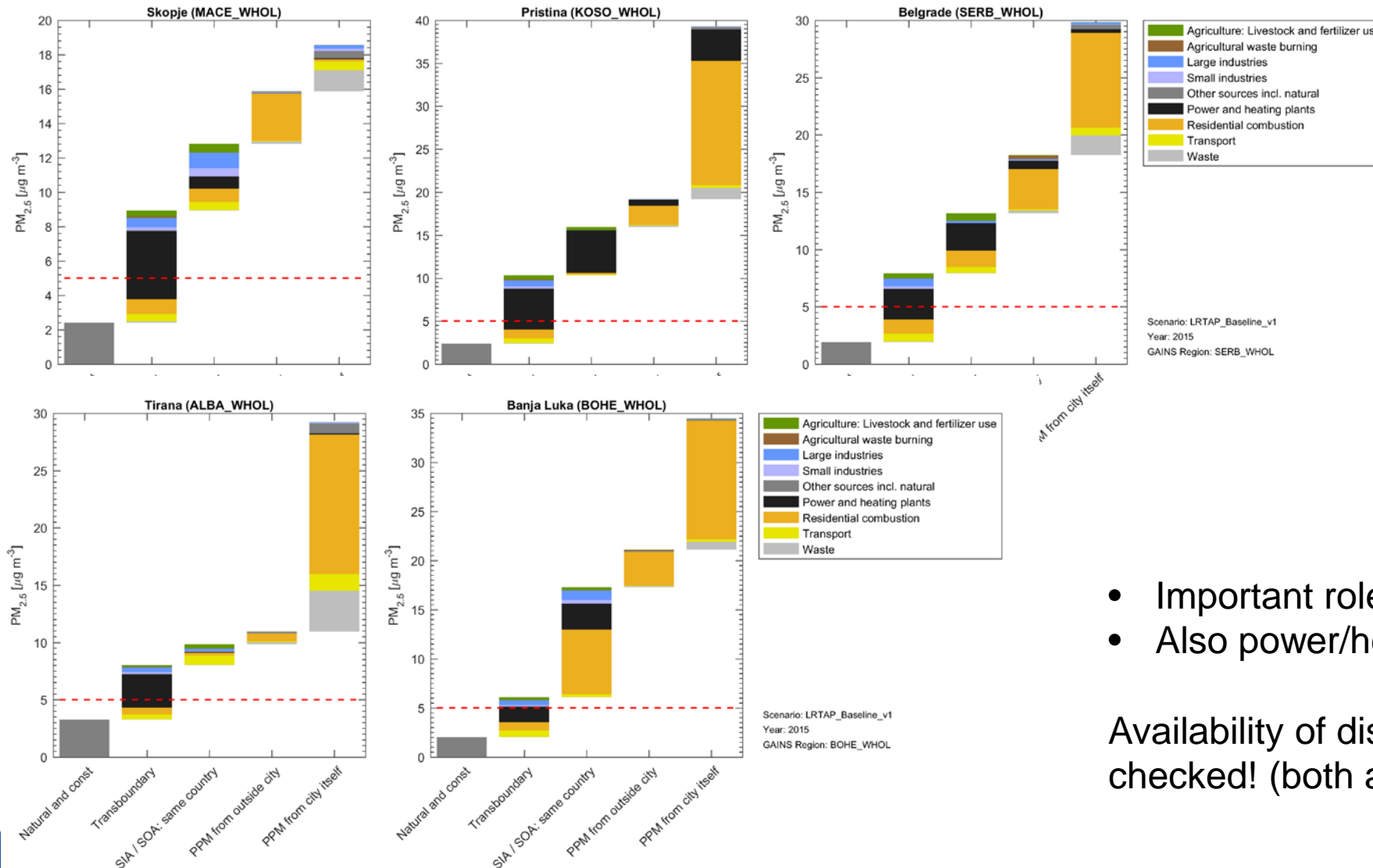
Contributions to PM_{2.5} in cities: Approach

- Application of the grid-to-grid PPM transfer coefficients:
 - For each city, split sectoral PPM transfer coefficients into contributions from the same city and outside
- City definition currently hybrid: GRUMP urban polygons + 250m grid population (GHSL R2015A) with population density threshold (10/ha), filtered for total pop in polygon



- 300 cities > 200,000 inhabitants in the extended GAINS-Europe domain (175 non-EU)
- Other definitions of city extents can (and should) be tested
- So far: “urban background” (0.1°) - downscaling planned based on uEMEP

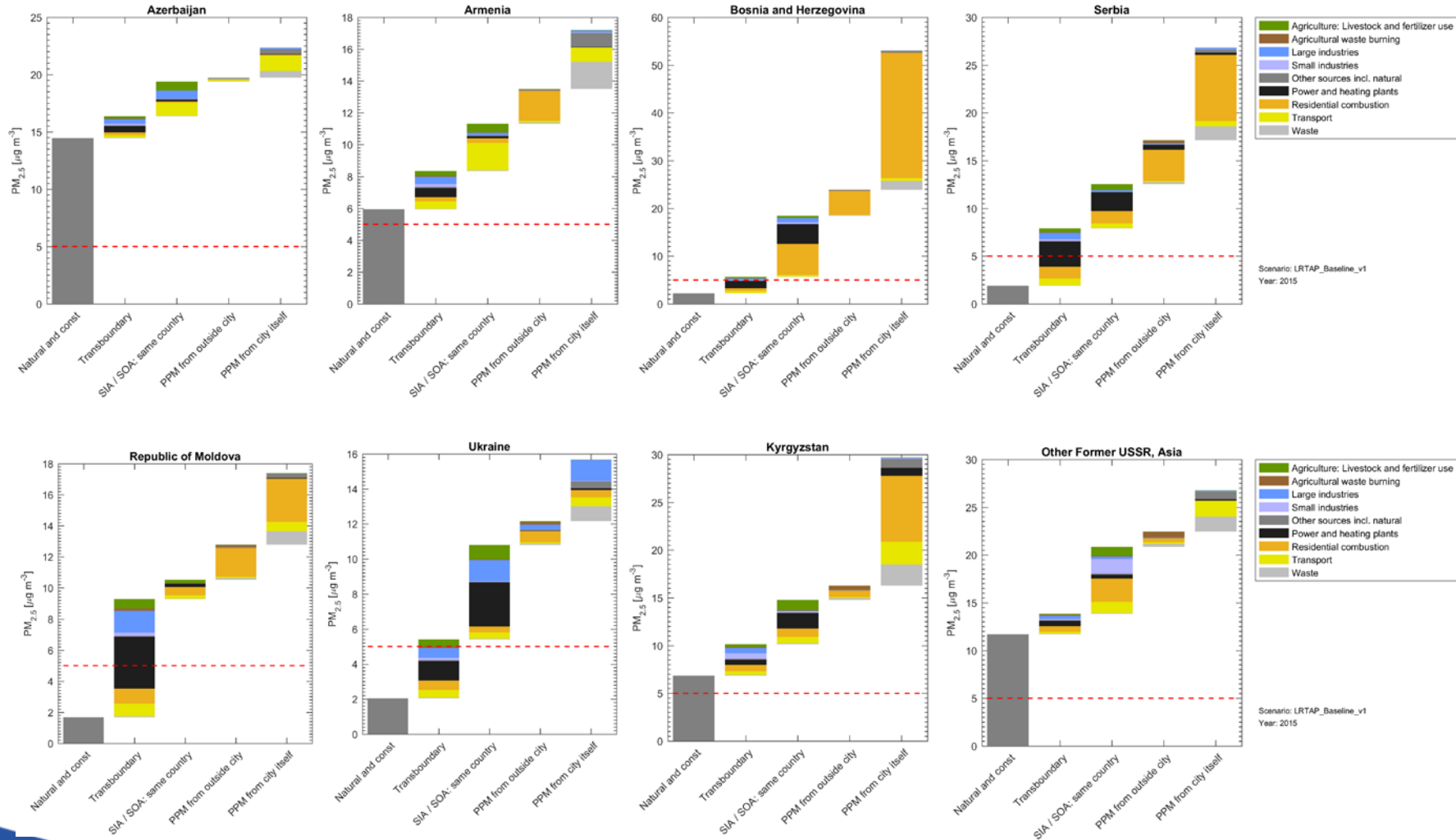
Source contributions to cities: West Balkan (2015)



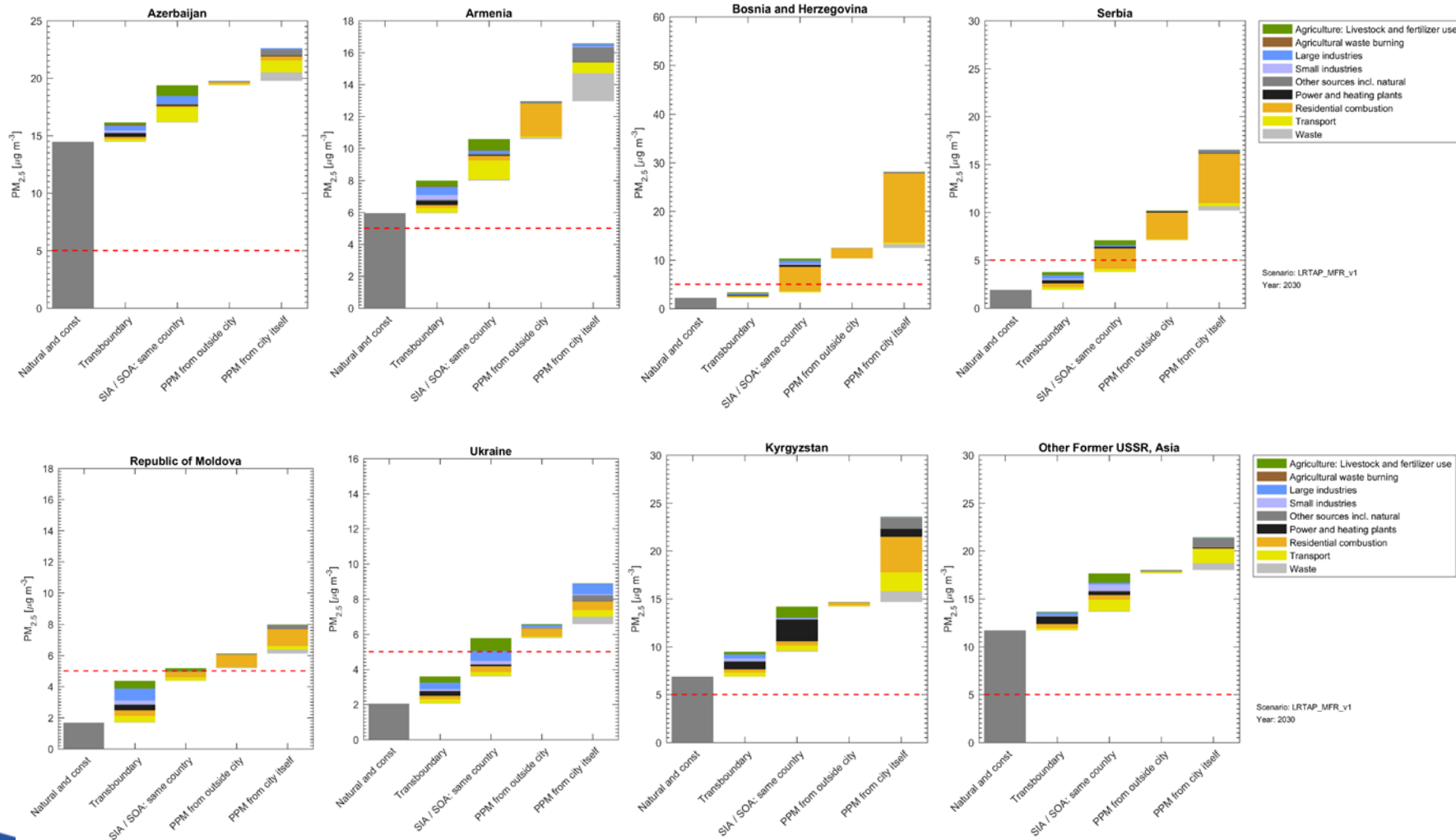
- Important role of residential sector
- Also power/heating plants

Availability of district heating needs to be checked! (both at national and city level)

Country means: 2015

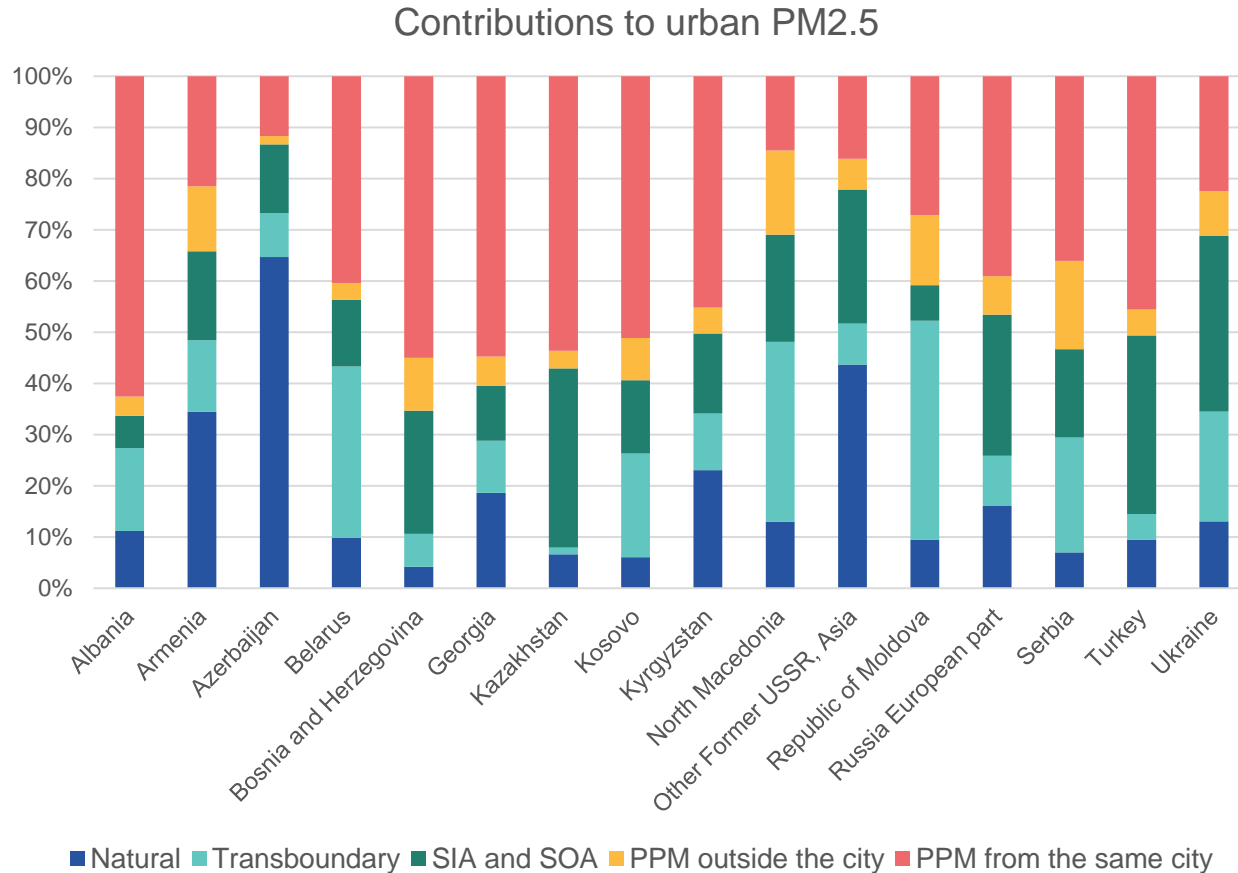


Country means: 2030 CLE



- Decreases in power and residential sectors
- Still high concentrations expected under CLE

Contributions to urban PM_{2.5}: West Balkan / EECCA 2015



- Contributions vary strongly between countries
- Often local contributions play a larger role than in Western Europe, owing to topography and local sources
- Balancing urban vs rural heating fuels, and checking availability of district heating is crucial

Conclusions & next steps

- Preliminary implementation of new transfer coefficients for the extended domain done
- Complemented by grid to grid tracking for PPM to derive sector specific transfer coefficients and splits for urban areas
- Preliminary city specific contributions have been derived for ~300 cities in Europe+
- Contributions depend strongly on the quality of the underlying emission patterns. Thanks to the methodology, there is room for improvement.
- In WB & EECCA, residential emissions and power/heating plants dominate; local contribution is often higher than in Western Europe. CLE brings decreases but does not solve the situation.
- Next steps:
 - 5-year average for sectoral transfer coefficients
 - Split of 'FSUA' region in GAINS = Turkmenistan, Tajikistan, Uzbekistan
 - Split of SIA contribution from cities
 - Downscaling based on uEMEP

Thank you!