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Methodological development in GAINS for the GP Review – Understanding the scales better

Gregor Kiesewetter
Center for Integrated Assessment Modelling (CIAM)

Task Force for Integrated Assessment Modelling (TFIAM), 50th session, 21-23 April, 2021

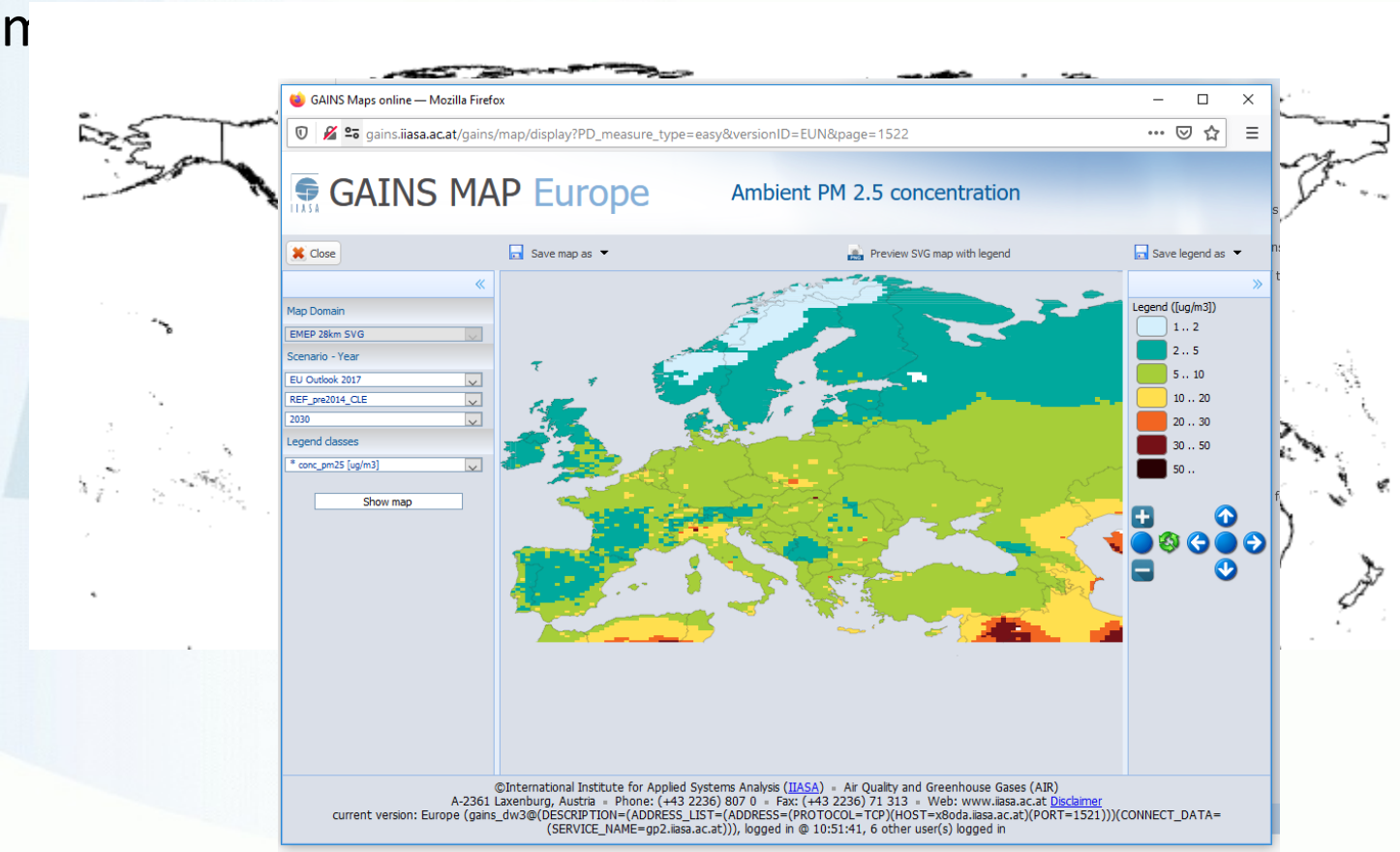
Content

- Current GAINS-Europe domains
- Planned updates of atmospheric calculations in the context of the GP Review
- Some examples from recent work on South Asia

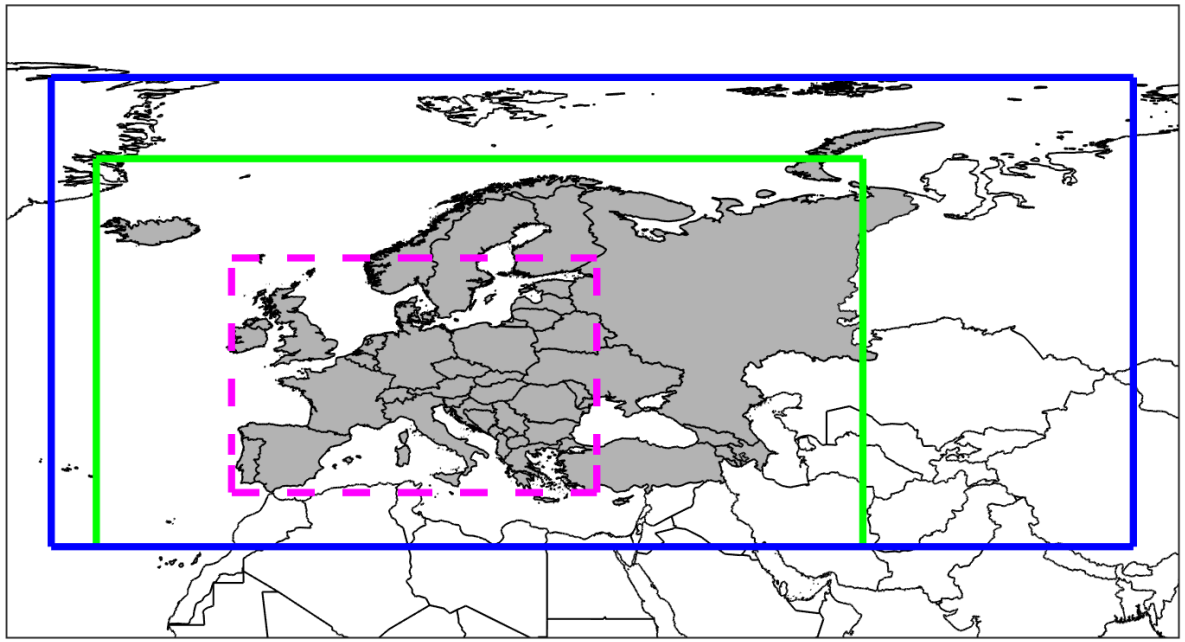
Domains in GAINS

Greenhouse Gas – Air pollution Interactions and Synergies
gains.iiasa.ac.at

- GAINS is global…
- But it con



Domains in GAINS



45 GAINS-Europe emission regions

Current “28km” impact domain

Current “7km” downscaling

New EMEP domain
will allow to cover all EECCA countries

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

⇒ New downscaling needed (uEMEP)

Plans for new transfer coefficients

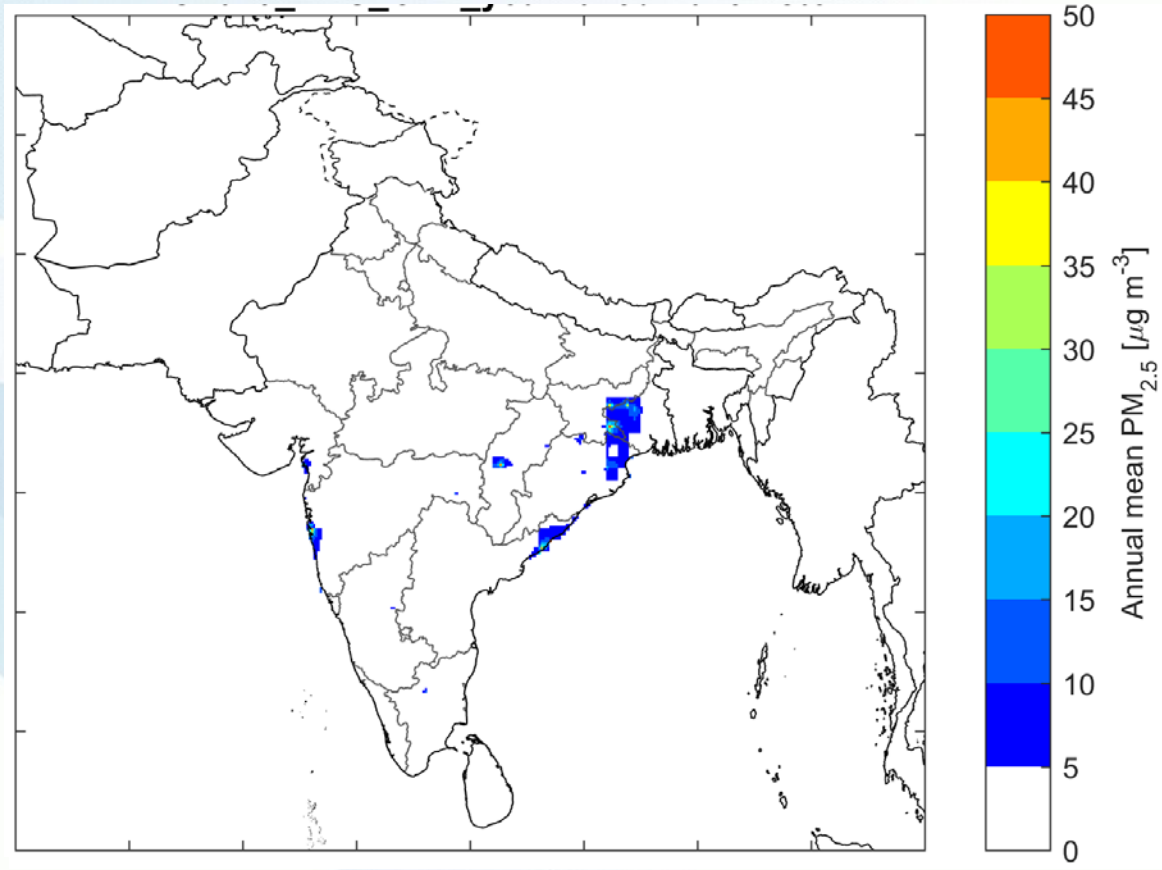
- country to grid (0.3°x0.2°?), based on reduction runs of the EMEP CTM
- 5 met years
- 5 source pollutants (PPM, SO_2, NOx, NH_3, VOC)
- All current impact endpoints: $PM_{2.5}$ concentrations & related mortality, O_3 (SOMO35) & mortality, AOT, acidification, eutrophication, radiative forcing
- Local fraction tracking of PPM within EMEP (0.1° resolution)
- Downscaling with uEMEP
- Particular focus: bridging the scales from regional to local

Some recent experience from elsewhere…

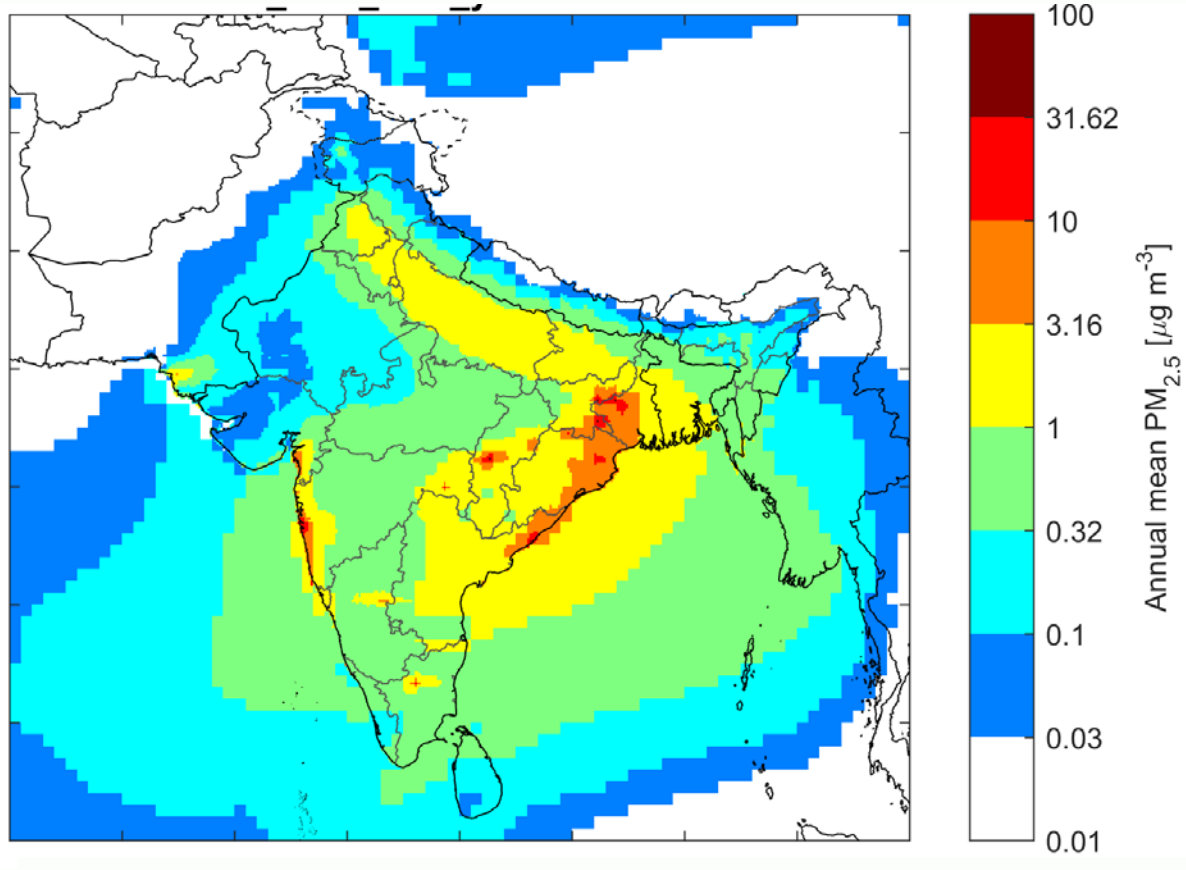
- Local fraction tracking of PPM was implemented for South Asia
- 0.1°, grid to grid, 4 pseudo sectors (vertical emission injection heights)
- Used for generating sectoral transfer coefficients, enhanced urban-rural split
- Endpoints:
  - Enhanced understanding of sectoral contributions to ambient $PM_{2.5}$
  - Local versus long-range contributions to states and cities
  - (Cost optimal) strategies for reducing ambient $PM_{2.5}$:
    - Uniform limit value (WHO interim targets)
    - Reducing average population exposure

Computed $PM_{2.5}$ concentrations: iron & steel, 2018

Linear scale



Logarithmic scale

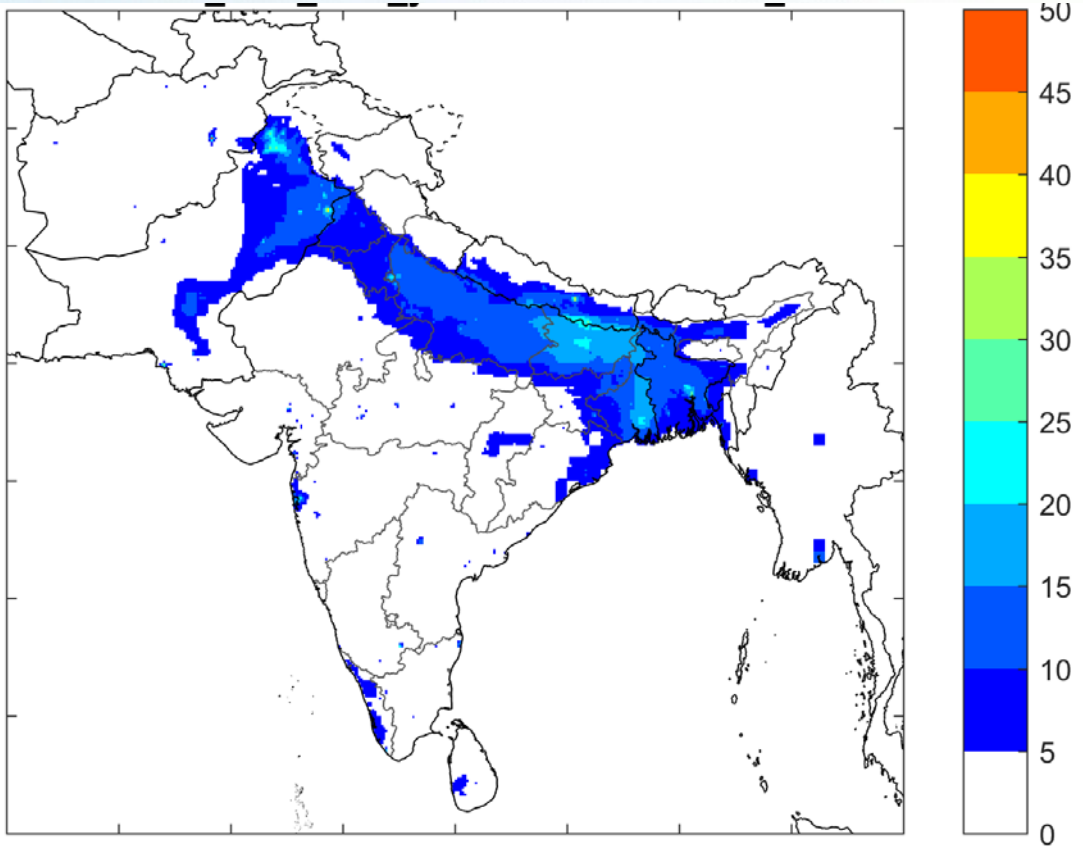


Few strong point sources

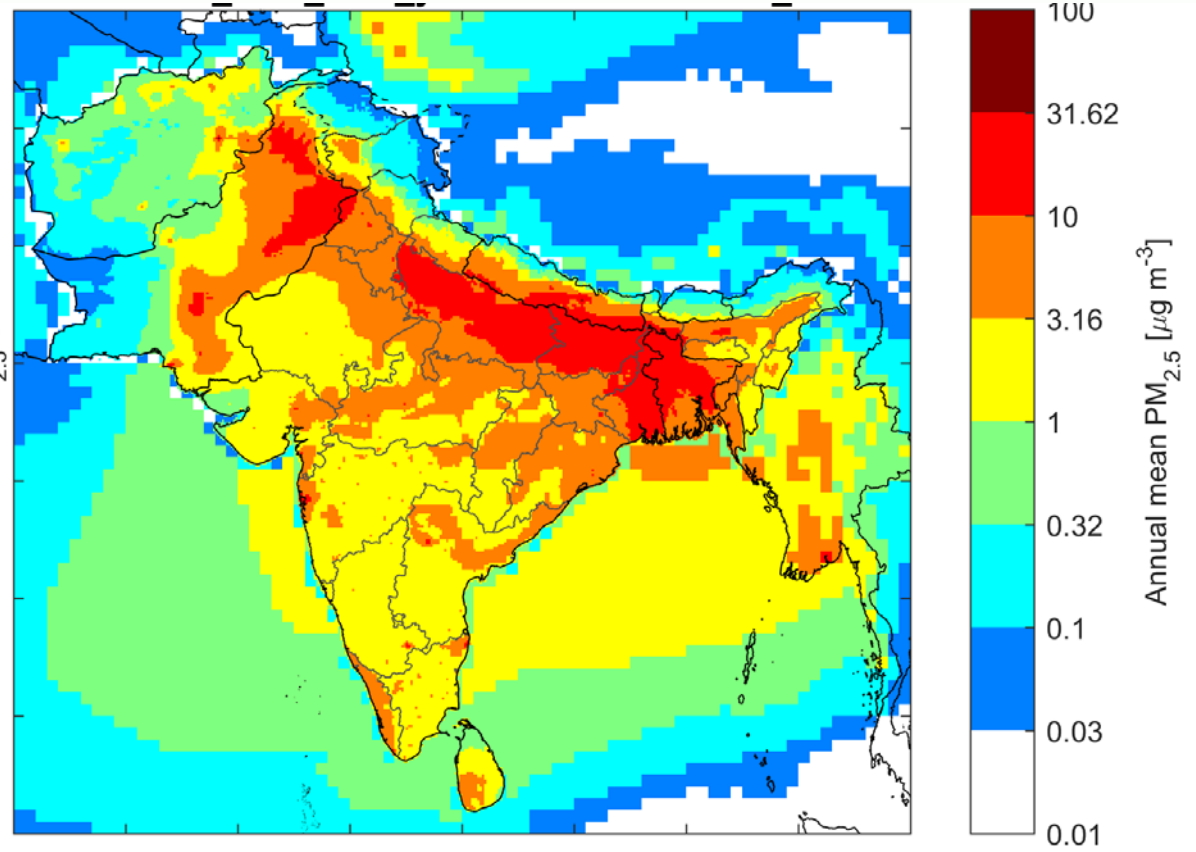
Preliminary results!

Computed $PM_{2.5}$ concentrations: Cooking, 2018

Linear scale



Logarithmic scale

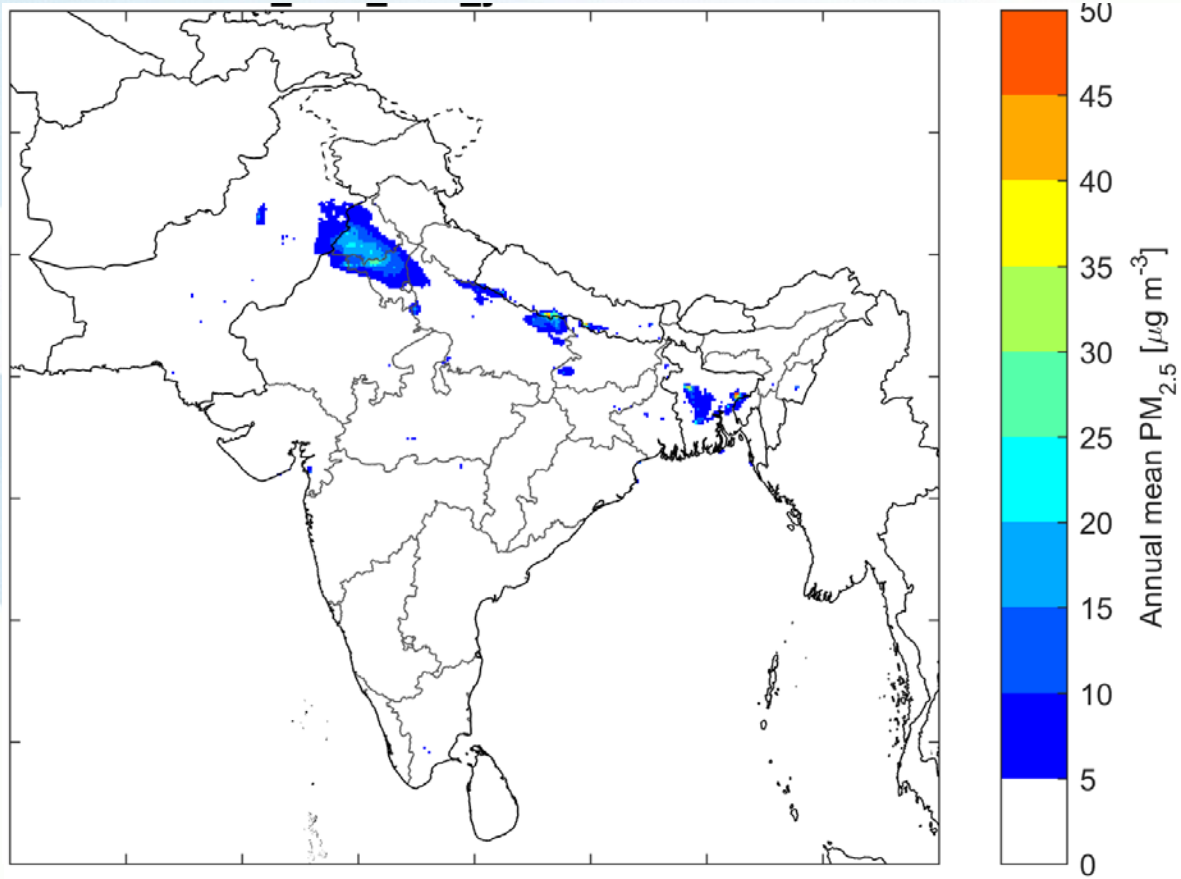


Mainly relevant in Gangetic Plain (Uttar Pradesh, Bihar…)

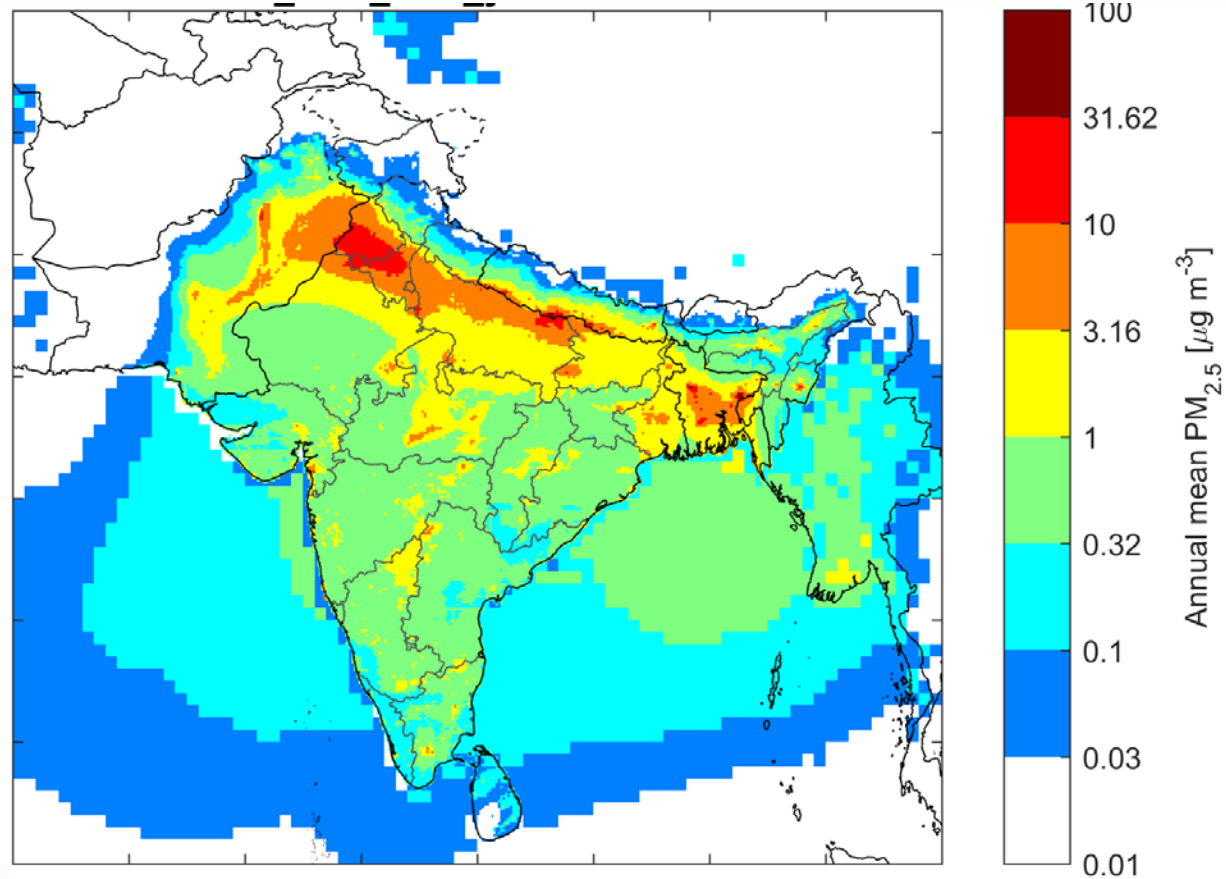
Preliminary results!

Computed $PM_{2.5}$ concentrations: Agricultural residue burning, 2018

Linear scale



Logarithmic scale

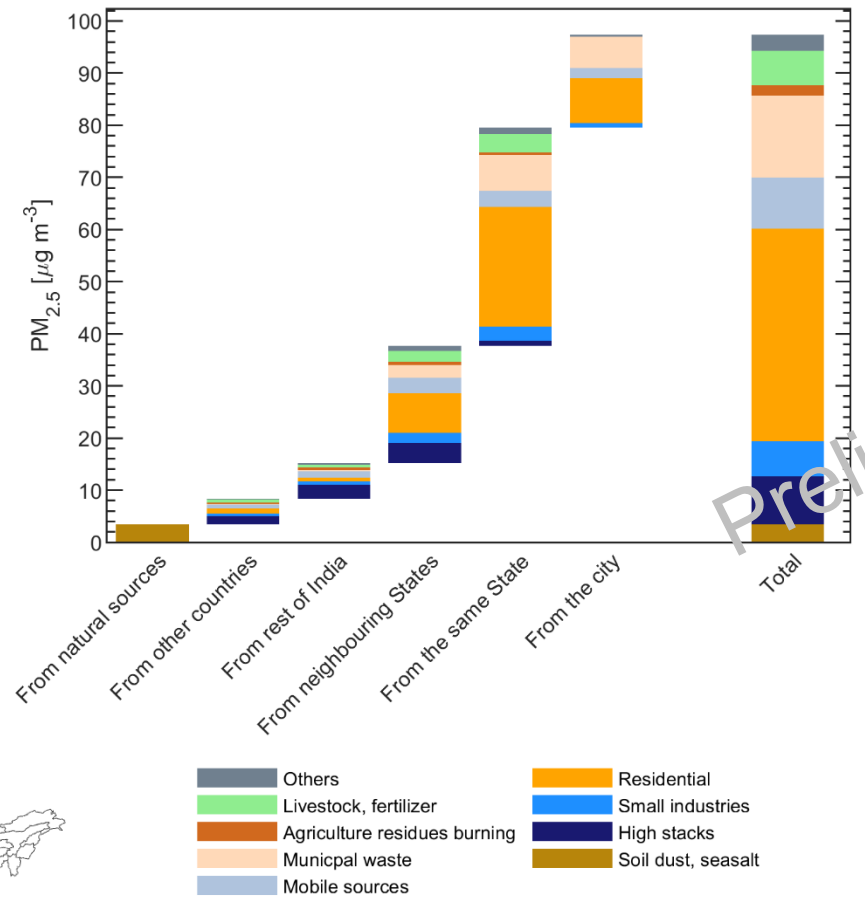


Mainly relevant in NW India, only during limited periods

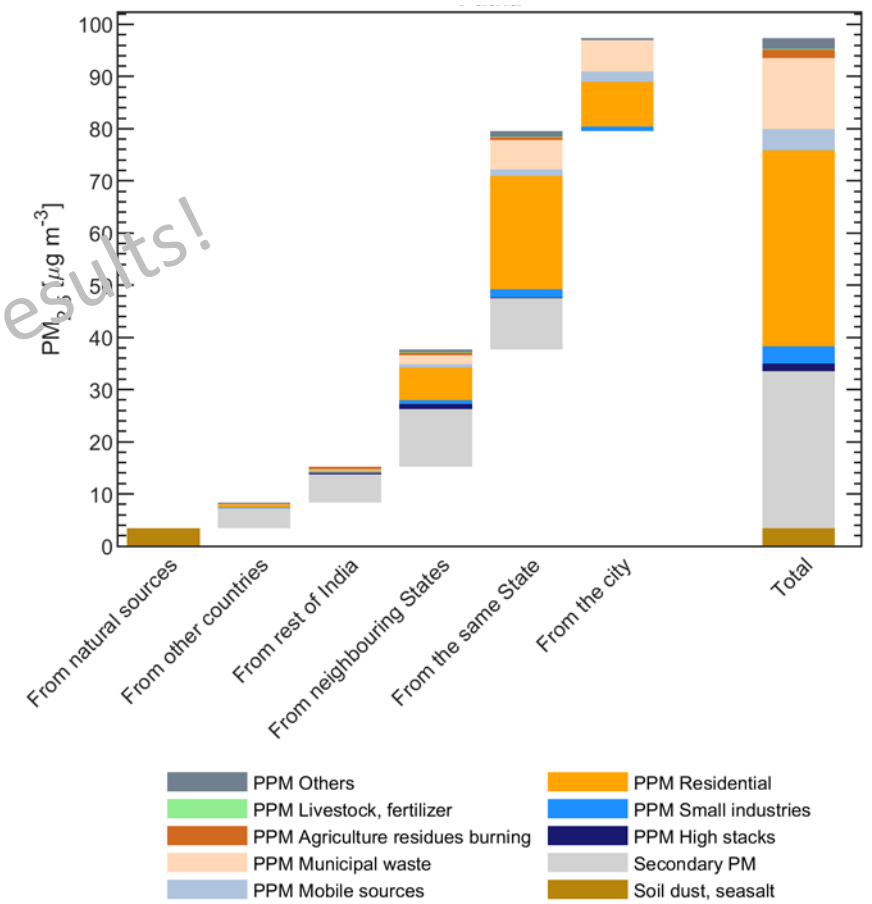
Preliminary results!

Contributions to city-mean $PM_{2.5}$ in Patna, 2018

All $PM_{2.5}$ precursor emissions

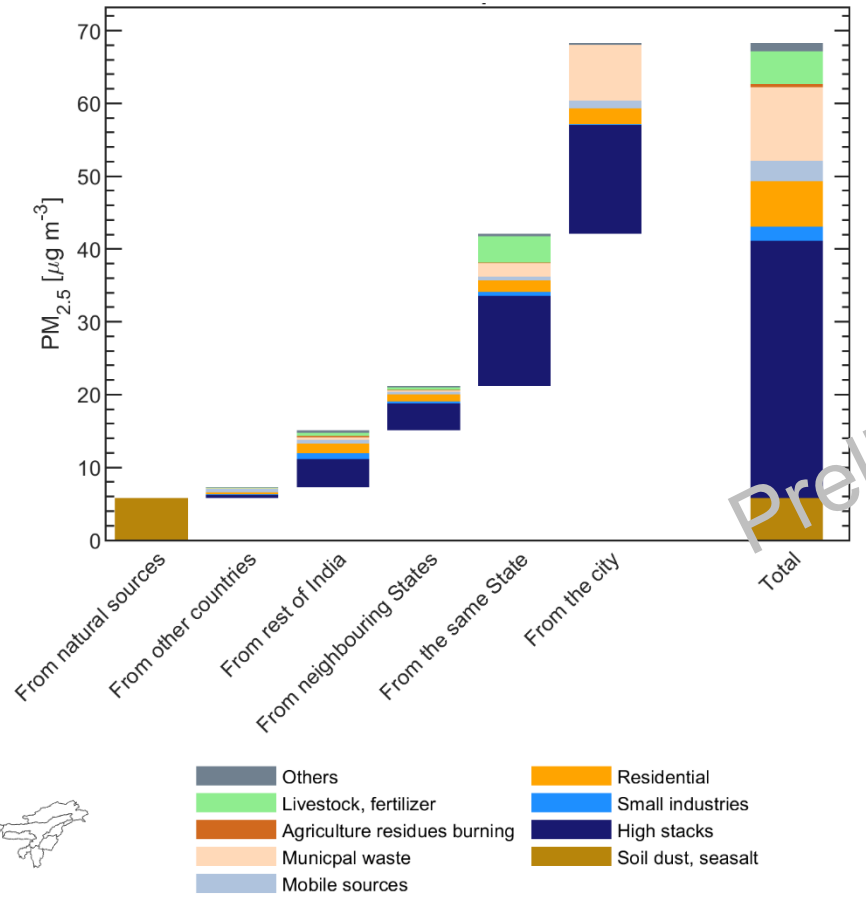


Primary $PM_{2.5}$ vs precursors of secondary $PM_{2.5}$

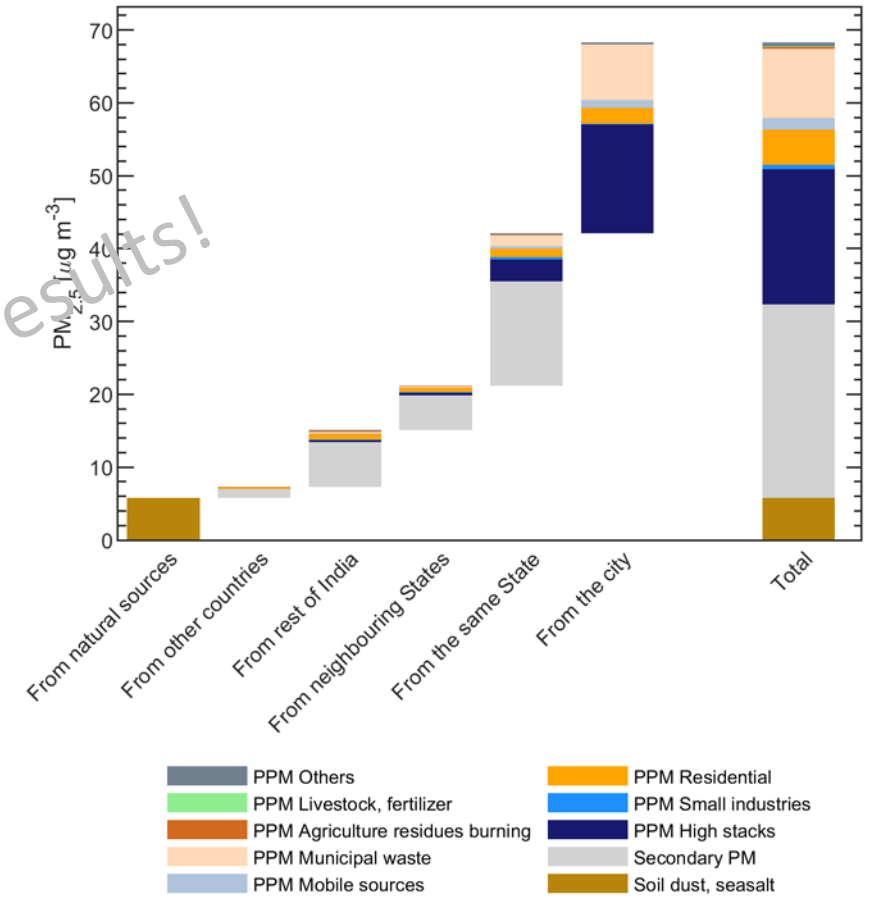


Contributions to city-mean $PM_{2.5}$ in Visakhapatnam, 2018

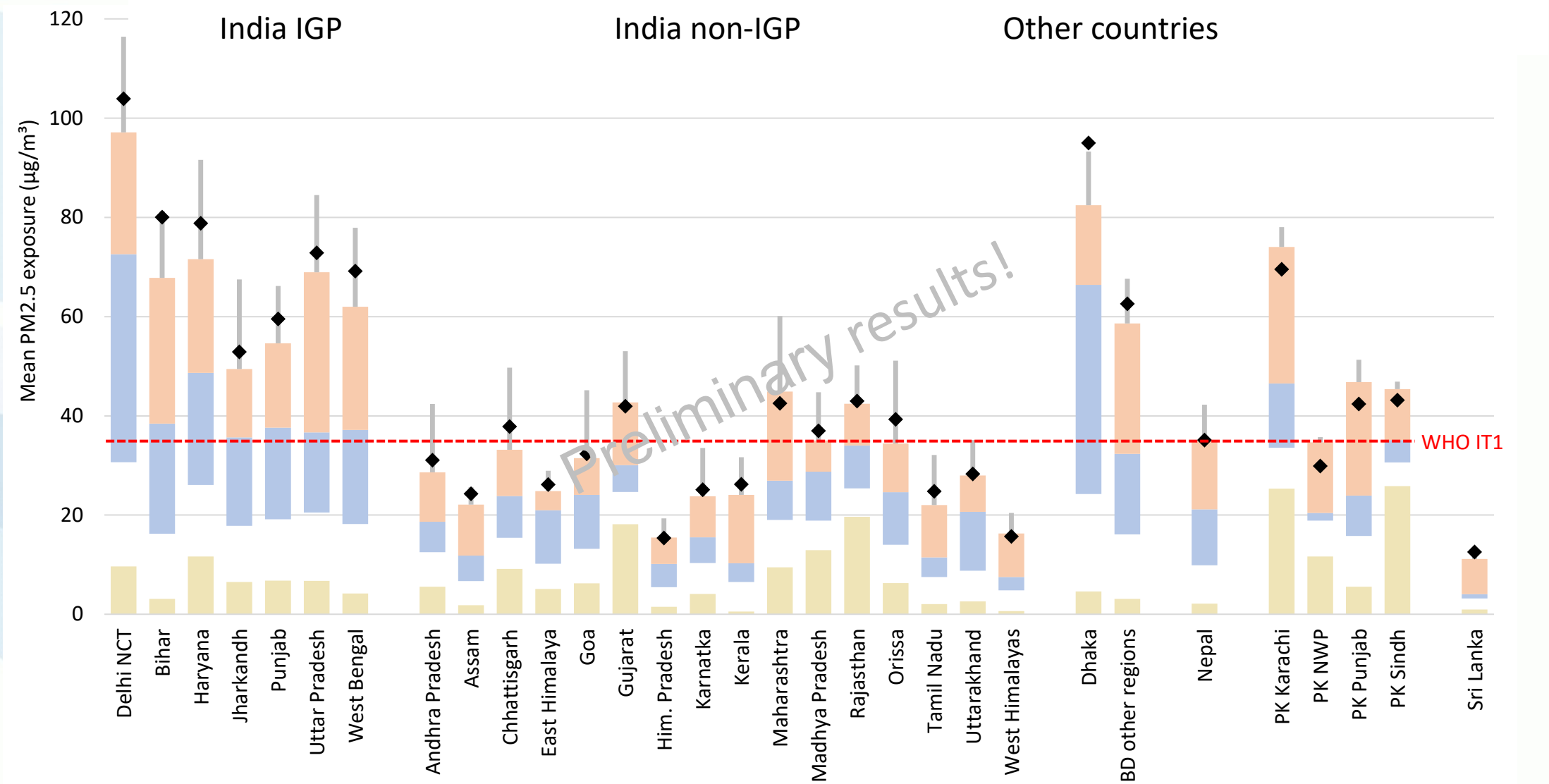
All $PM_{2.5}$ precursor emissions



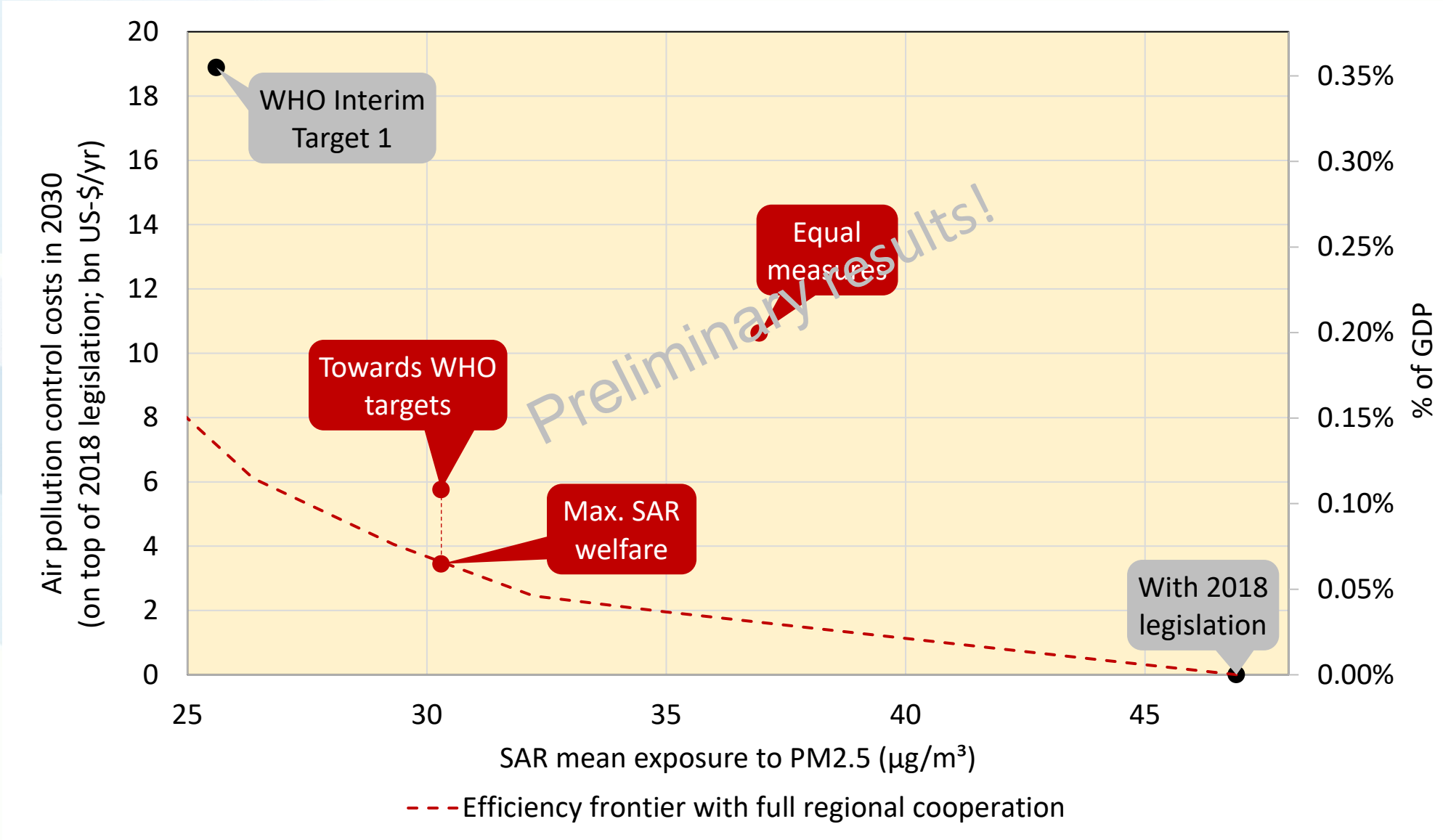
Primary $PM_{2.5}$ vs precursors of secondary $PM_{2.5}$



Scope for additional exposure reductions in 2030



Costs and exposure reductions of different AQM options



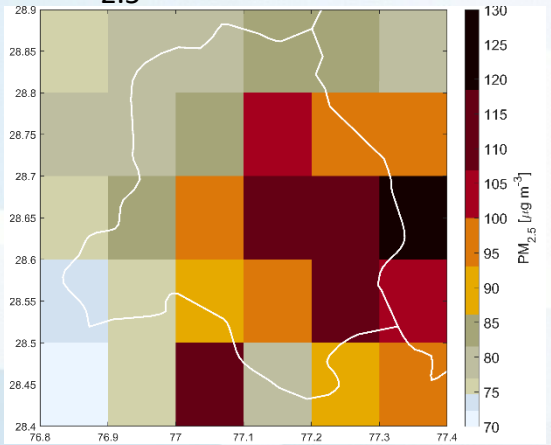
Conclusions

- Extension/update of GAINS-Europe impact calculations is ongoing
- New transfer coefficients, PPM tracking, and downscaling are planned
- Tentative timeline:
  - Emission gridding summer 2021,
  - EMEP model simulations & tracking runs fall 2021,
  - Transfer coefficient implementation early 2022
- All EECCA countries can be covered with the same methodology
- This methodology was successfully implemented in South Asia, used in an upcoming World Bank flagship study for source apportionment and cost effectiveness analysis

Backup slides

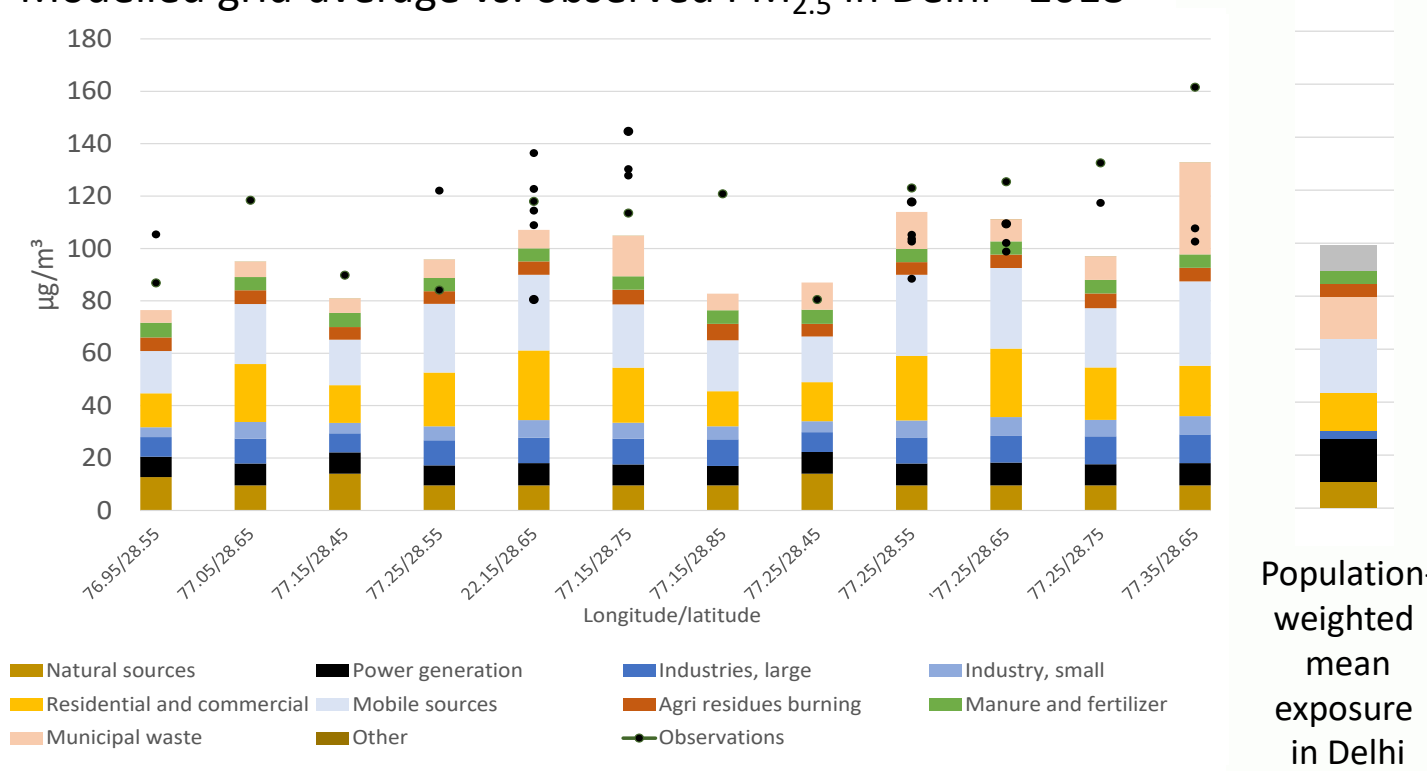
Comparison of monitoring data with model estimates

Modelled grid-average $PM_{2.5}$ in Delhi - 2018



GAINS calculates ~10 km*10 km grid average concentrations

Modelled grid-average vs. observed $PM_{2.5}$ in Delhi - 2018



Population-weighted mean exposure in Delhi

Alternative metrics for different purposes:

<u>Peak concentrations:</u>
for compliance with ambient air quality standards

<u>Grid-average concentrations:</u>
a spatially more representative measure

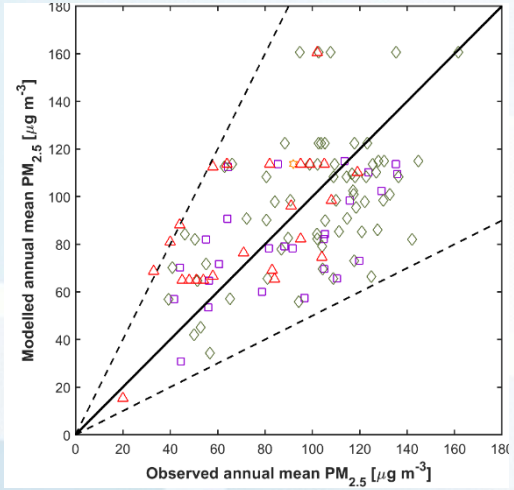
<u>Concentrations at specific monitoring sites:</u>
for validation of model results

<u>Population-weighted mean exposure:</u>
to maximize economic efficiency of AQM strategies

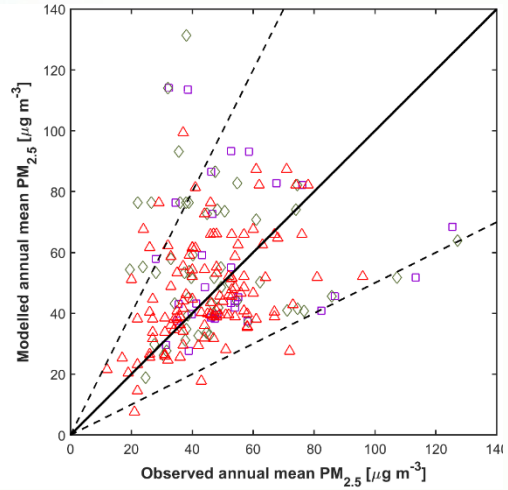
Validation of model results against observations – 2018

Only stations with more than 75% data coverage are considered

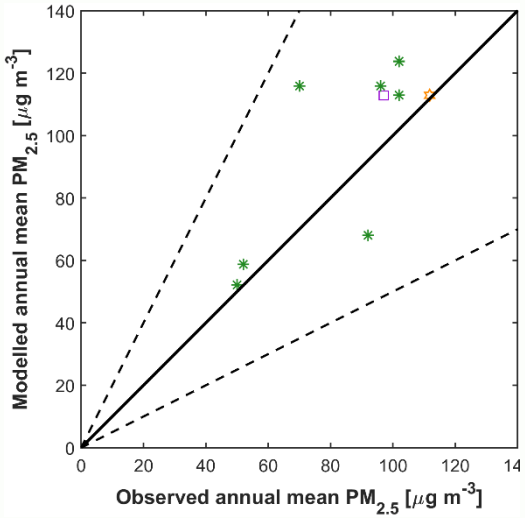
India IGP



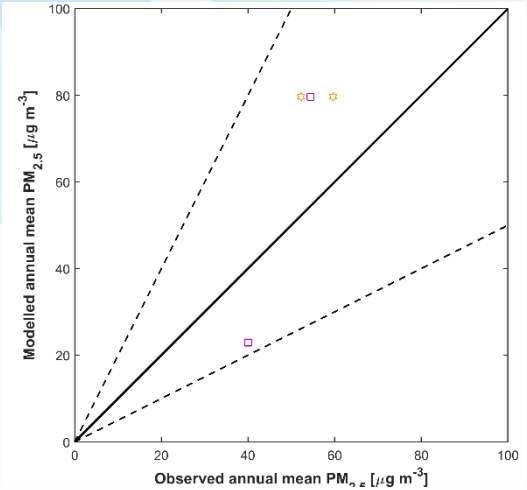
India – non-IGP States



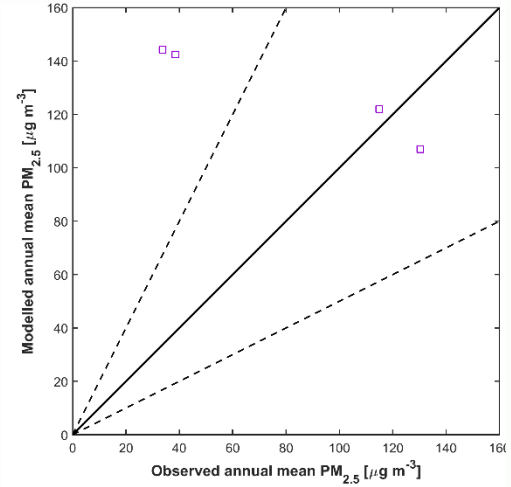
Bangladesh



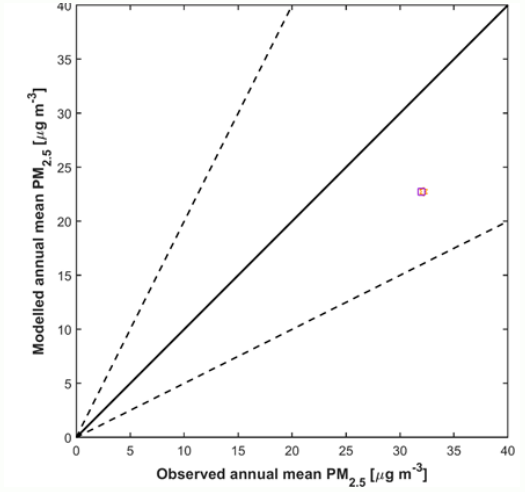
Nepal



Pakistan



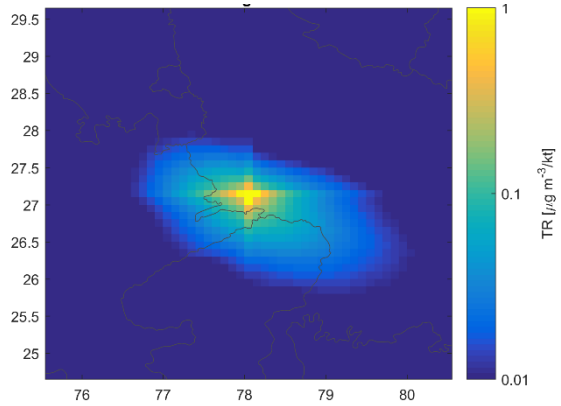
Sri Lanka



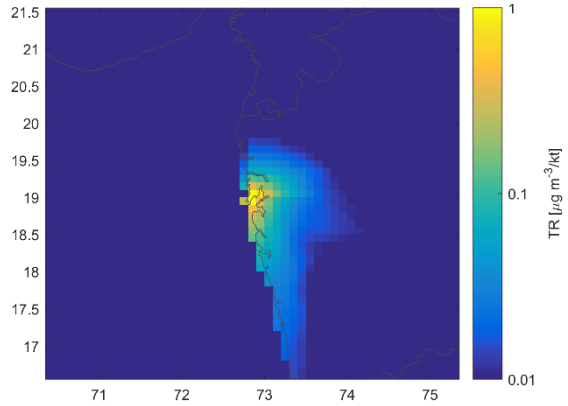
Fine-scale dispersion of low-level PPM emissions

- Examples of dispersion patterns of low-level PPM emissions from cities

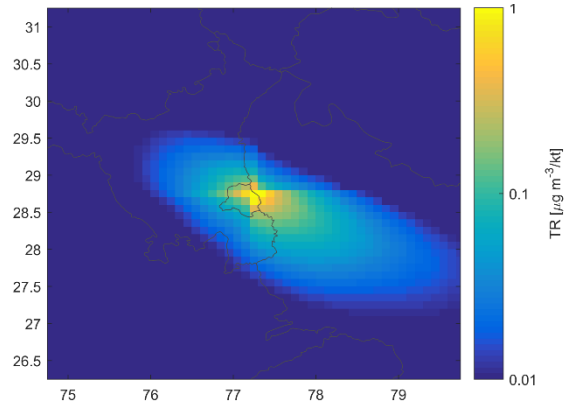
Agra



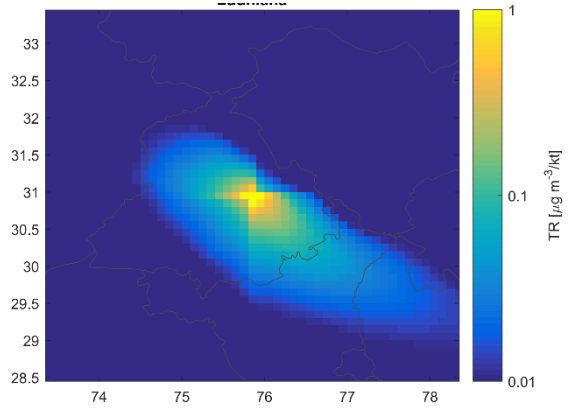
Mumbai



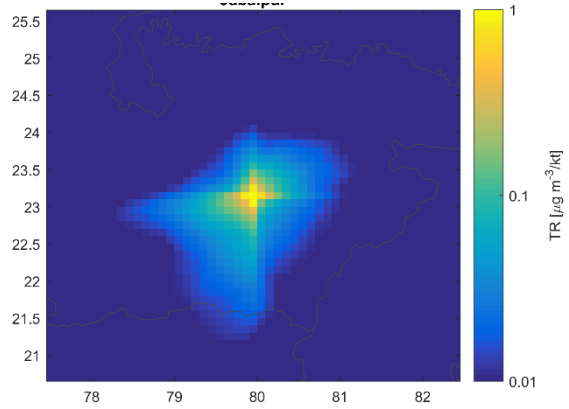
Delhi



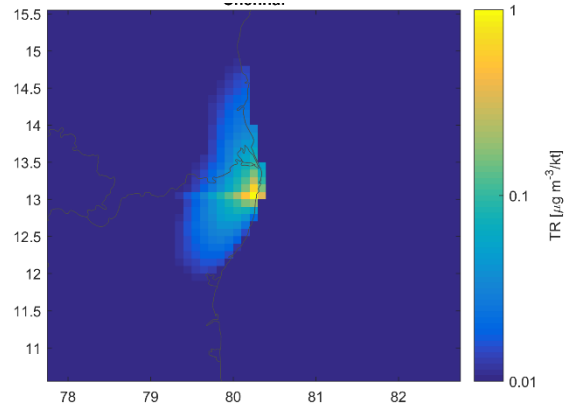
Ludhiana



Jabalpur

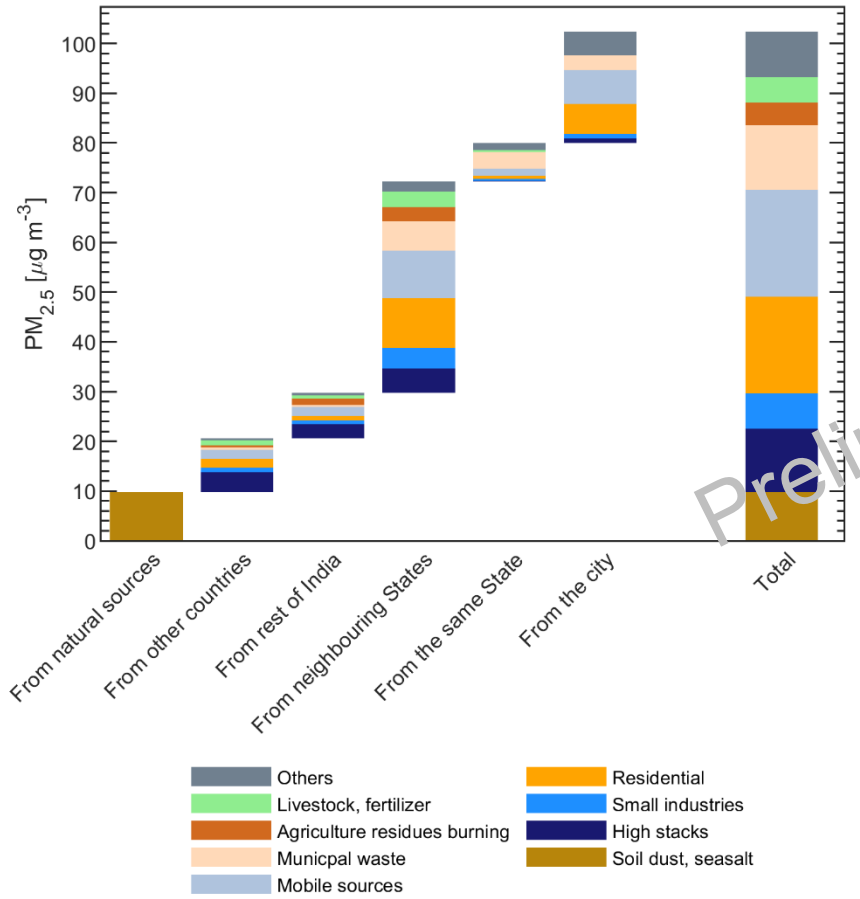


Chennai

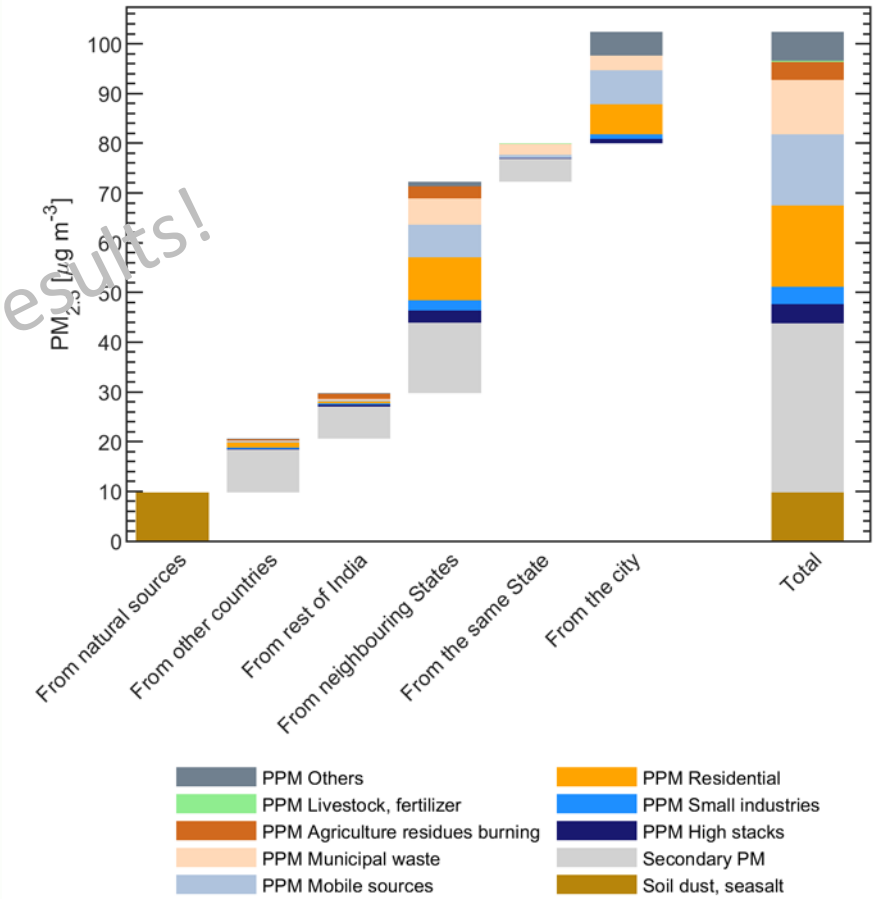


Contributions to city-mean $PM_{2.5}$ in Delhi NCT, 2018

All $PM_{2.5}$ precursor emissions



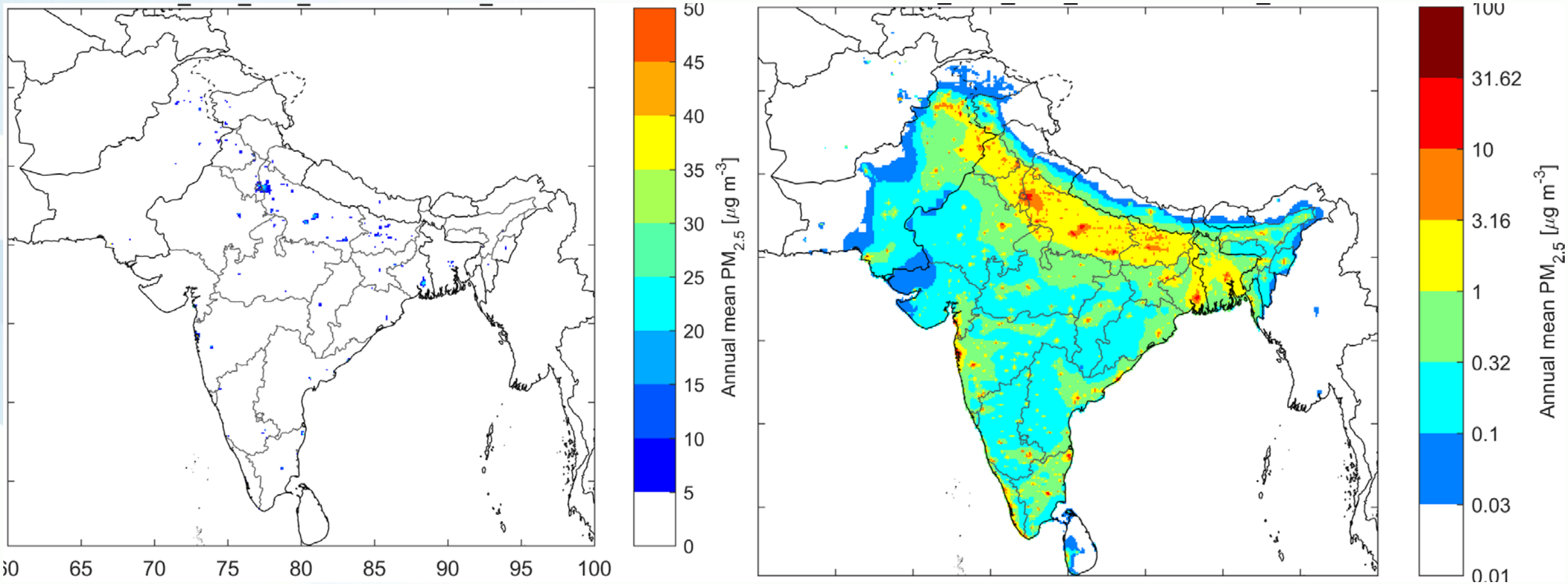
Primary $PM_{2.5}$ vs precursors of secondary $PM_{2.5}$



Computed $PM_{2.5}$ concentrations: Waste burning in cities, 2015

Linear scale

Logarithmic scale



Significant local contributions…

Preliminary results!