Air quality in the Czech Republic and use of modelling for AQ mapping & planning

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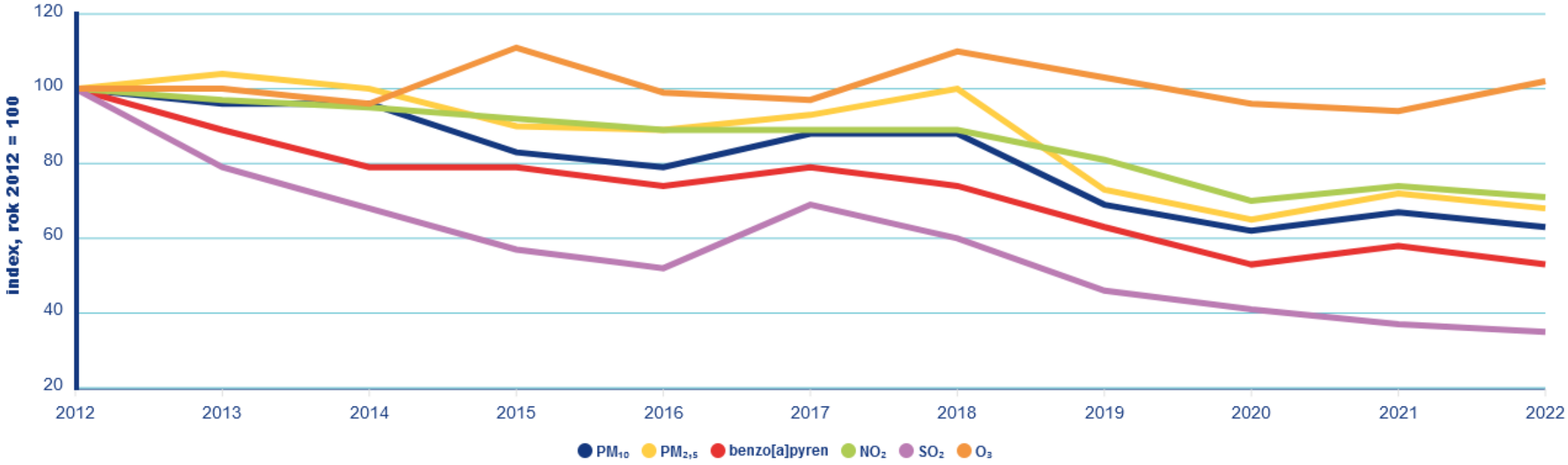
Outline

- **Air quality status**
- **AQ mapping methodology**
- **Models used for AQ mapping**
- **AQ planning (regular update of AQ improvement plans)**

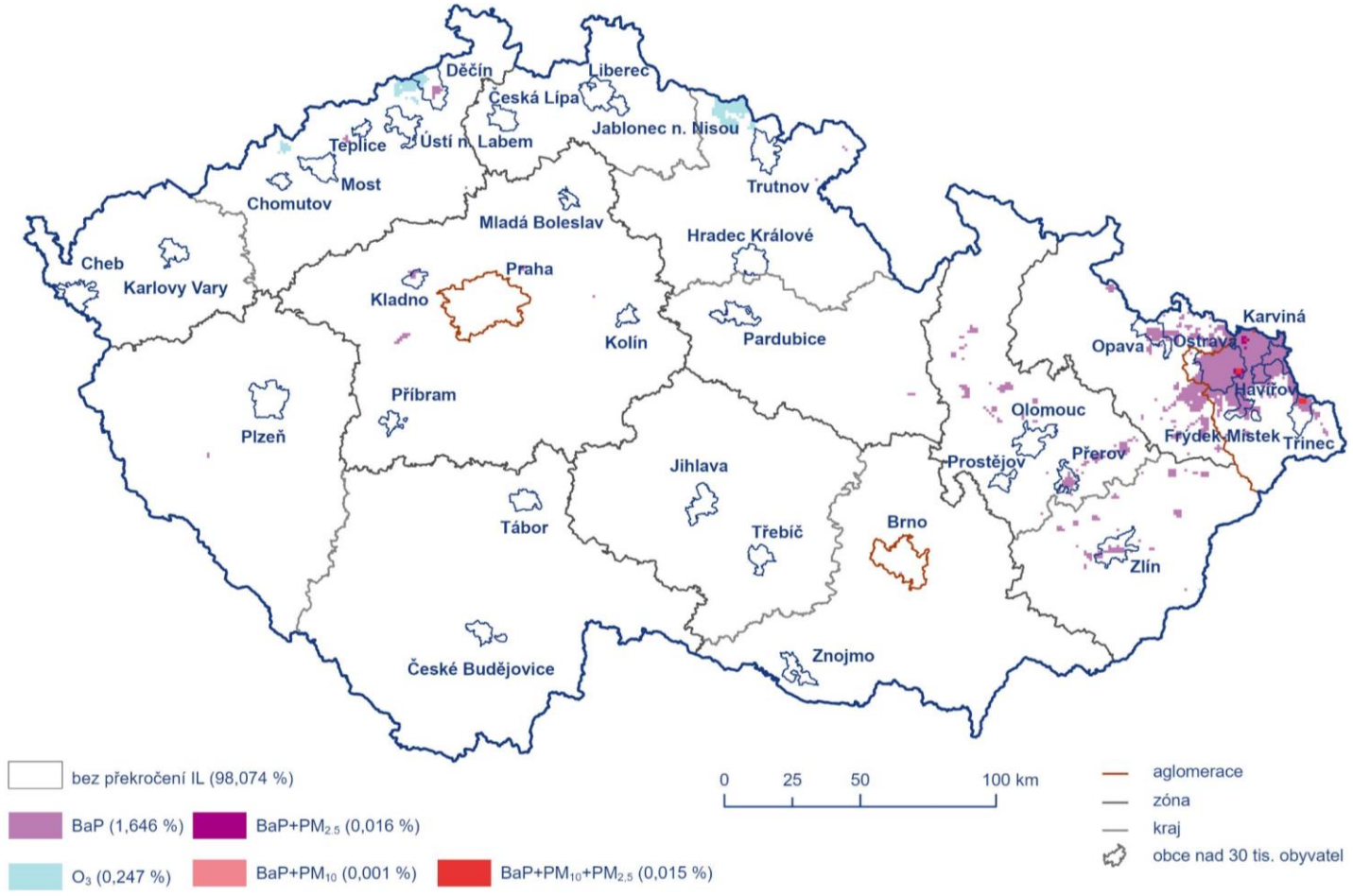
Current AQ in Czech Republic

Trends in concentrations 2012–2022



Current AQ in Czech Republic

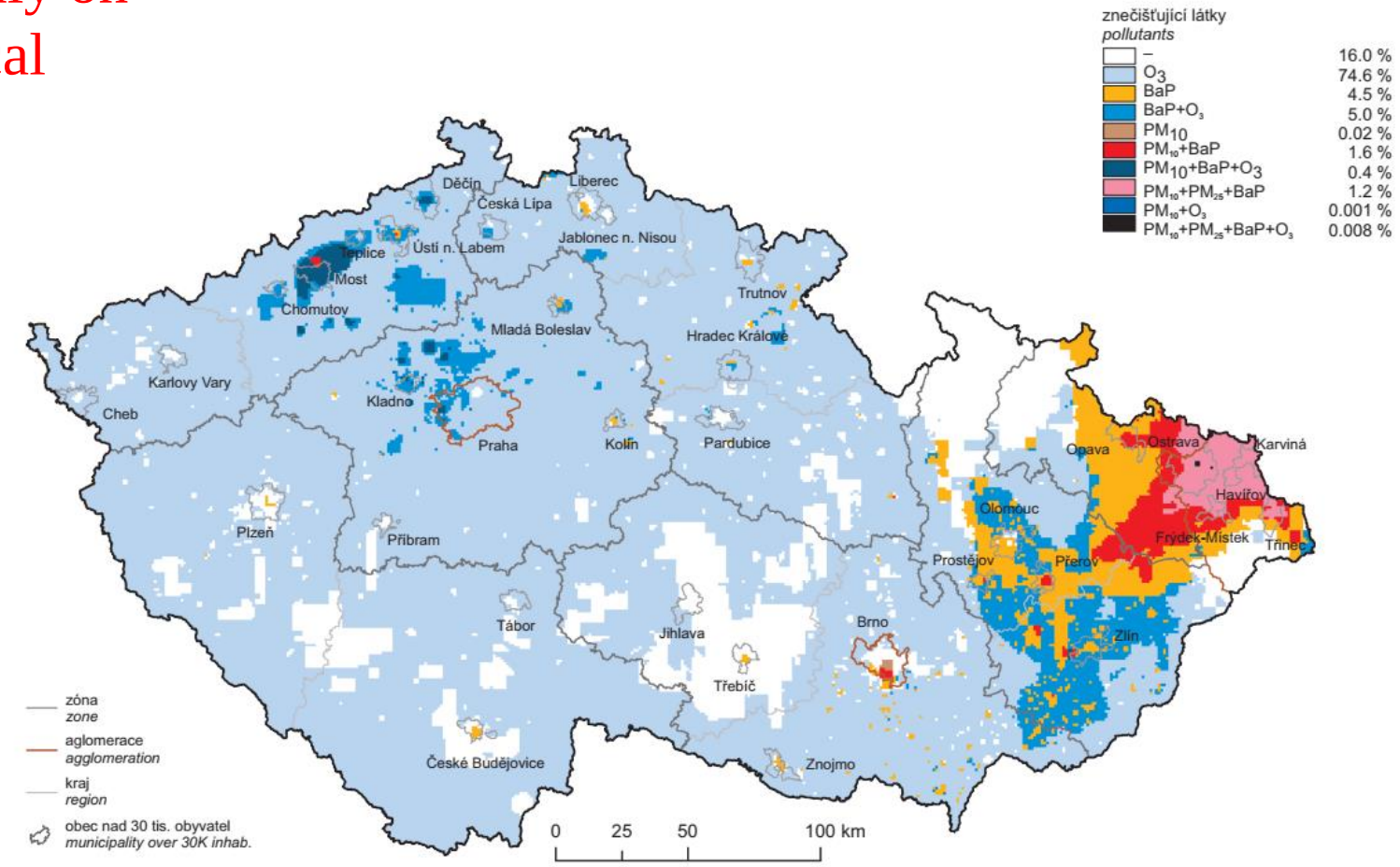
Areas with exceedance of AQ limits for health protection in 2022



Current AQ in Czech Republic

Areas with exceedance of AQ limits for health protection in 2018

Depend mainly on meteorological conditions…



Air quality mapping methodology

Similar to one used by EEA

Primary data – basic information for the mapping

- **pollutant concentrations measured at stations** (⇒ local data + limited amount).

Supplementary data

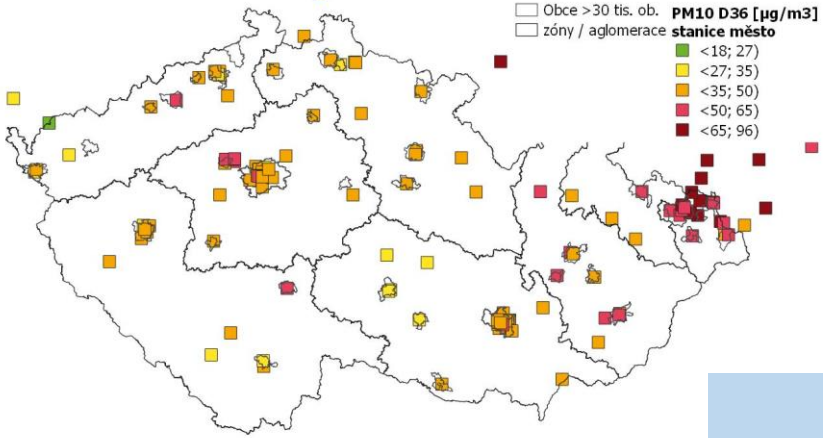
- complex information about the whole area,
- regression relationship with measured concentrations,
- mostly output from **dispersion model, elevation, emission maps, or satelite imaginery**

Combination of primary and supplementary data

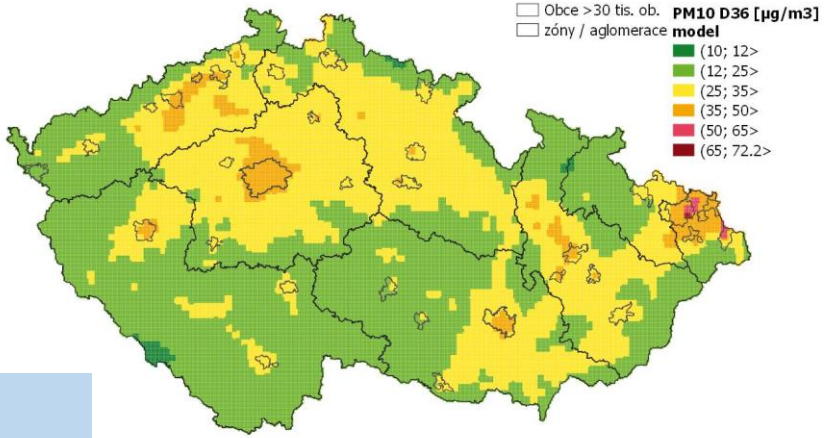
- **linear regression followed by interpolation of residuals (deviations in the place of measurements),**
- **urban and rural maps (layers) are constructed separately** and subsequently **merged using the population density.**

AQ mapping methodology – linear regression

Station measurements (urban/rural)



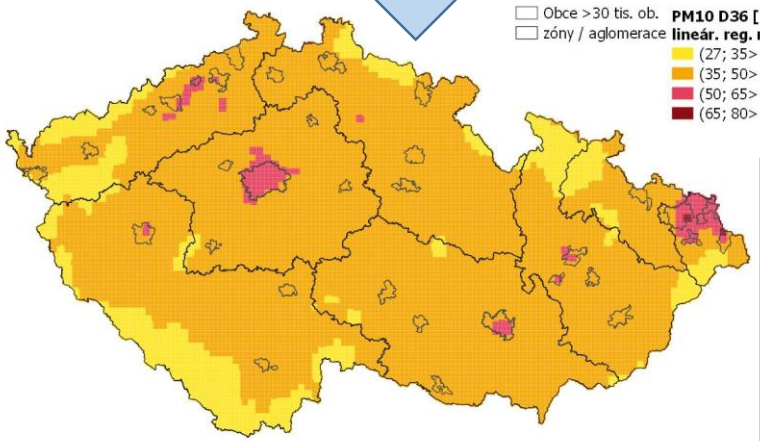
Model (X_i)



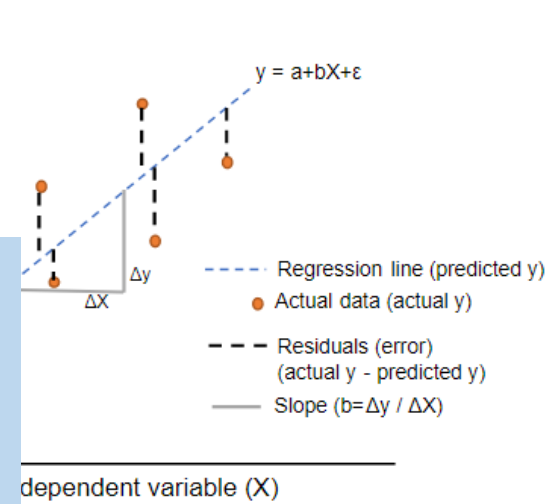
Linear regression

Model corrected by linear regression

$$c + \sum a_i \cdot X_i(s_0)$$

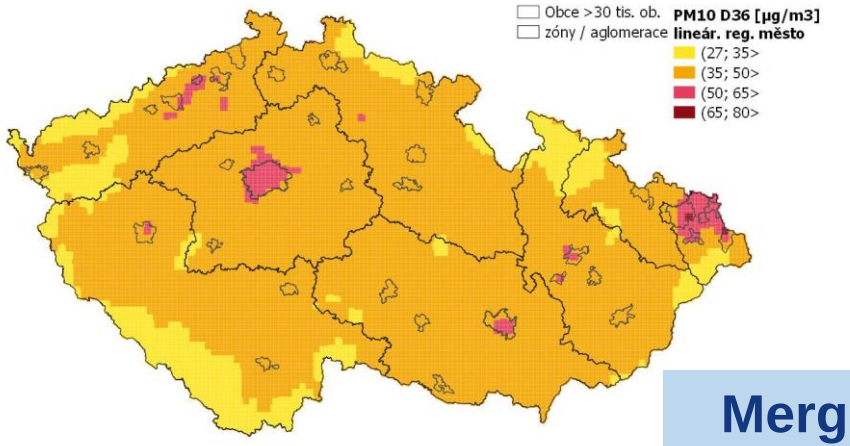


Residuals – remaining biases of corrected model from observations

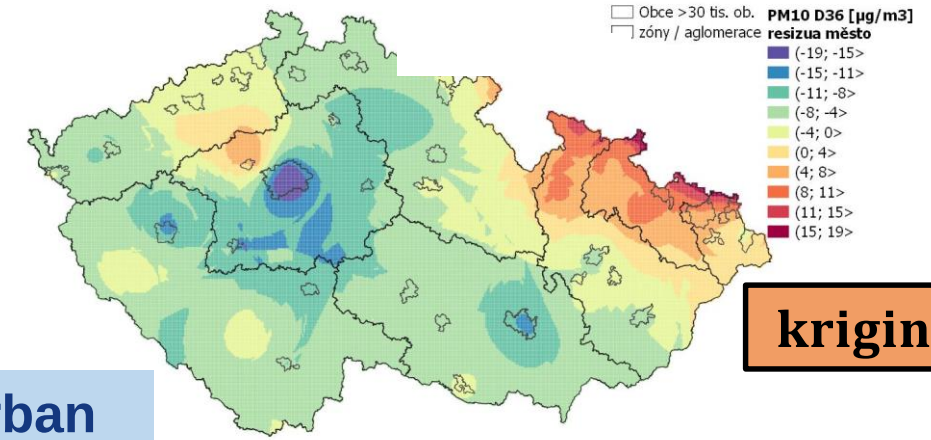


AQ mapping methodology – interpolation of residuals

Model corrected by linear regression

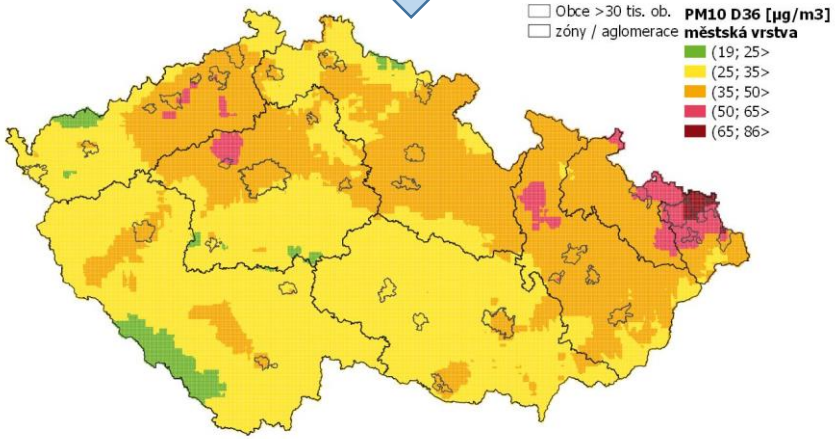


Interpolated residuals ($\hat{R}(s_0)$)



kriging, IDW

Merging → final urban and rural layer

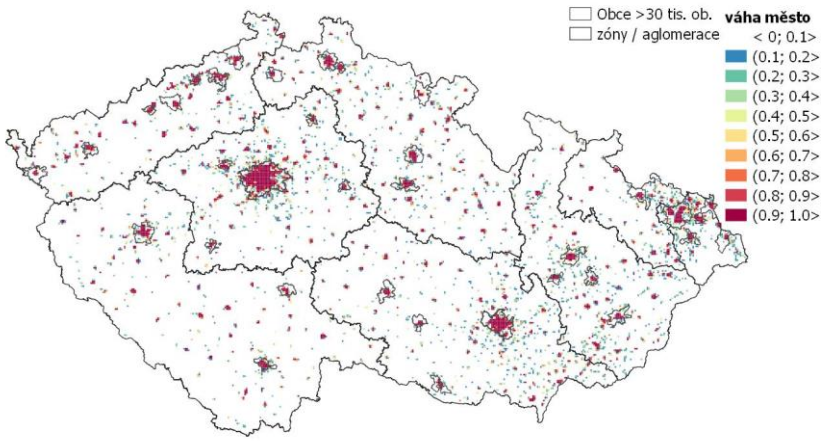


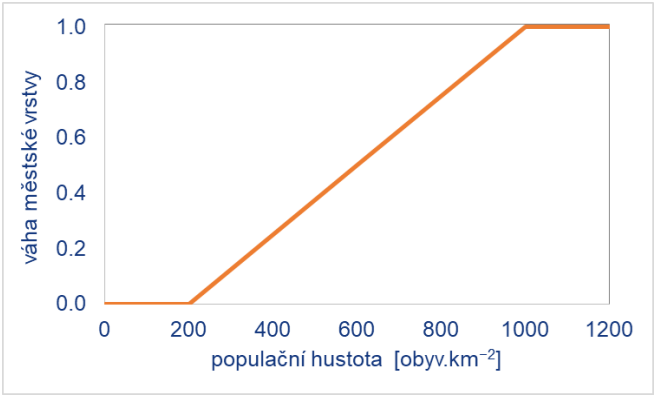
$$\hat{Z}(s_0) = \\ = c + \sum a_i \cdot X_i(s_0) + \hat{R}(s_0)$$

If the interpolation method used does not respect values measured at the stations, additional interpolation of residuals by the IDW method may follow.

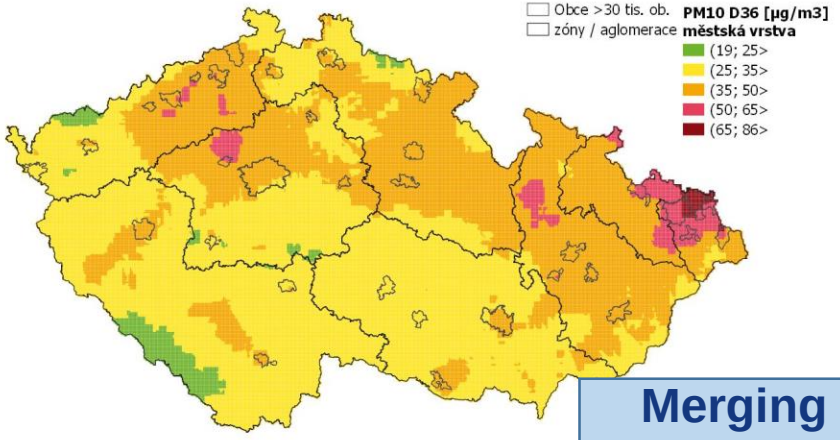
AQ mapping methodology – merging of layers

Weight of urban layer

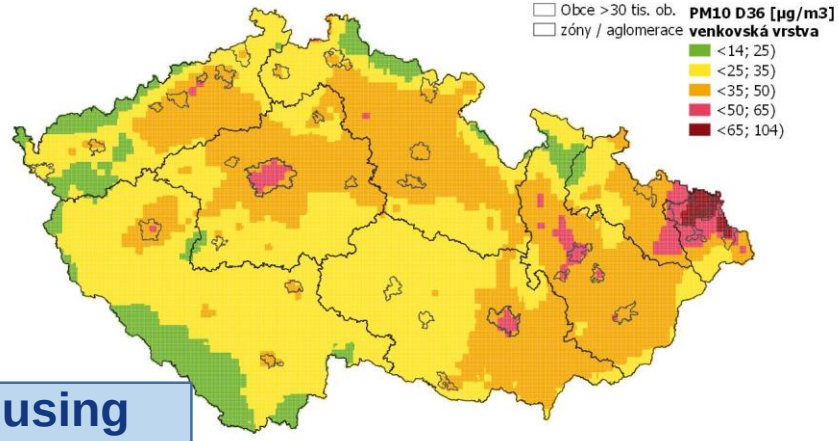




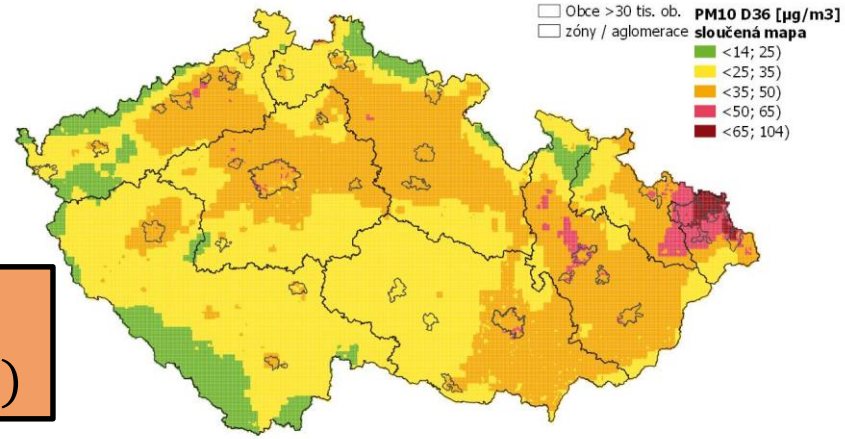
Urban layer



Rural layer



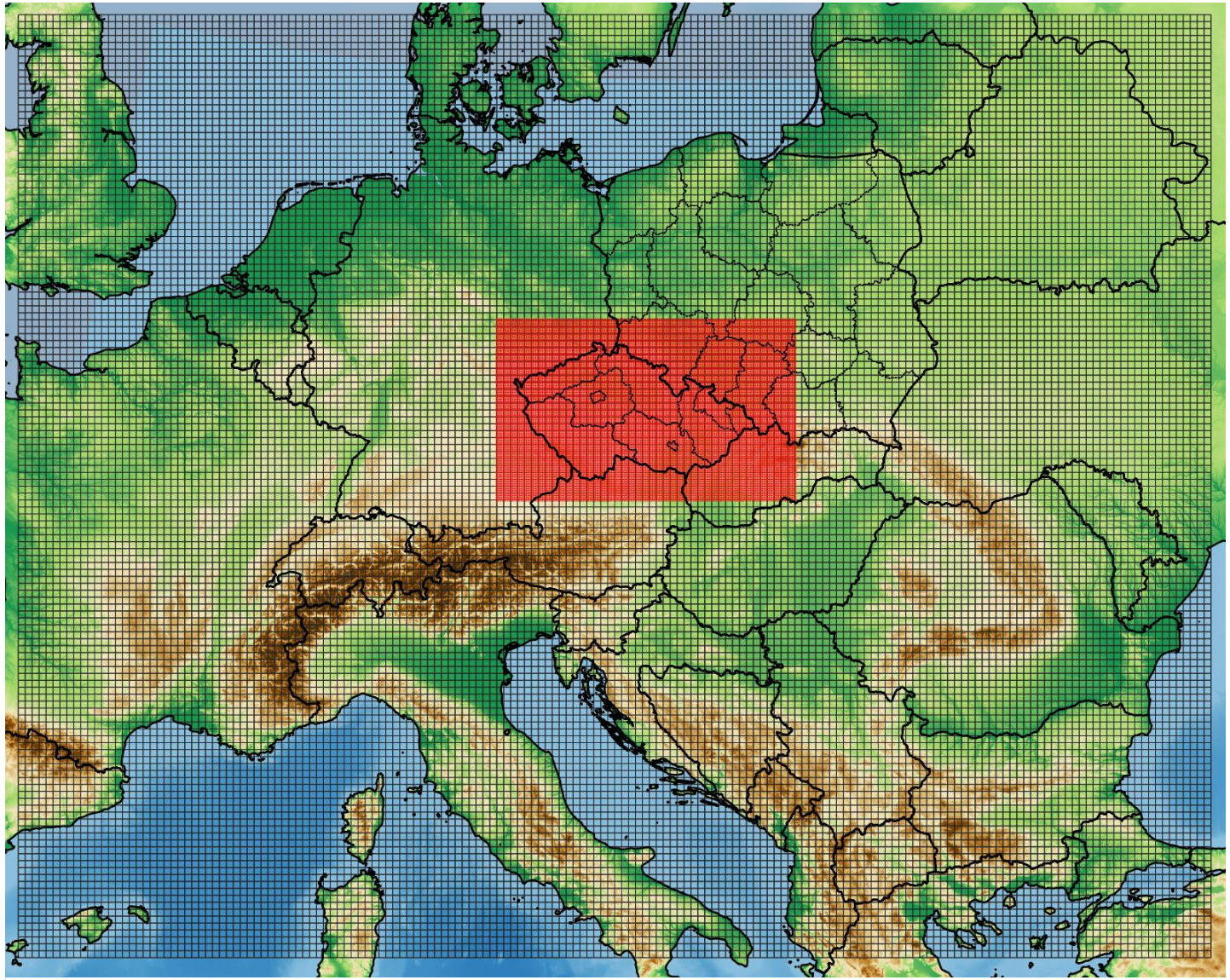
Merging using population density



Urban and rural layer can (depending on interpolation used) reproduce station observations merged layers generally not.

$$\hat{Z}_{urban} \cdot weight_{urban} + \\ + \hat{Z}_{rural} \cdot (1 - weigt_{rural})$$

AQ modelling



- CTM model CAMx (2 domains with 14.1 and 2.3 km resolution)
- Emissions: Czech inventory, Polish inventory (KOBiZE), CAMS, EMEP (BaP+HMs)
- Boundary: WACCM / EMEP IFS / constant

Regular exchange of emissions used for modelling

Český hydrometeorologický ústav

Updates of AQ plans

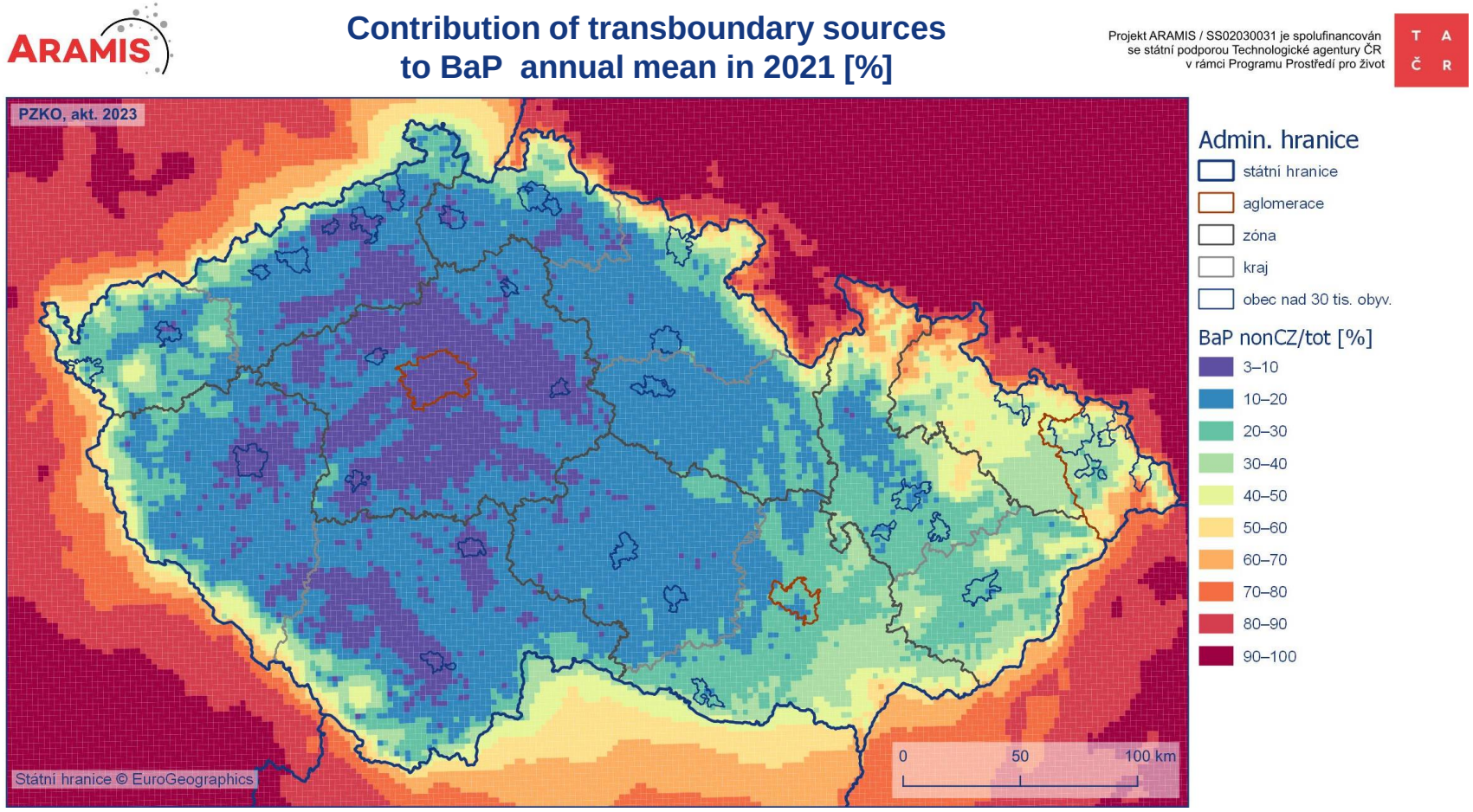
- Emission scenarios
  - agreed with Ministry of Environment
  - evaluated by CAMx model
  - comparison of reference and scenario runs with the same meteorology

$$C_{scenario} = C_{ref} \frac{model_{scenario}}{model_{ref}}$$

AQ map combining stations and model data

Updates of AQ plans – source apportionment

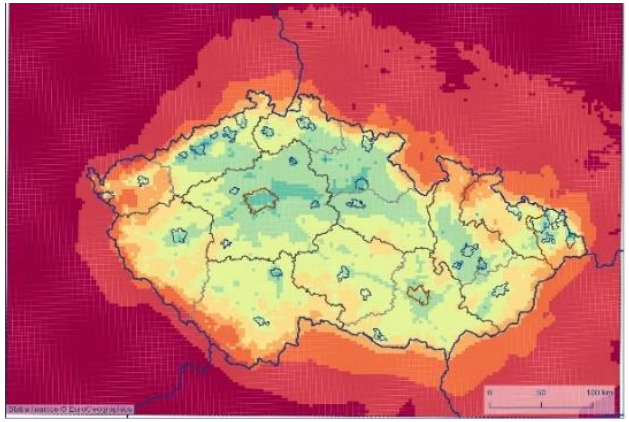
BaP – only as passive tracer in CAMx bounded to PM_{10}



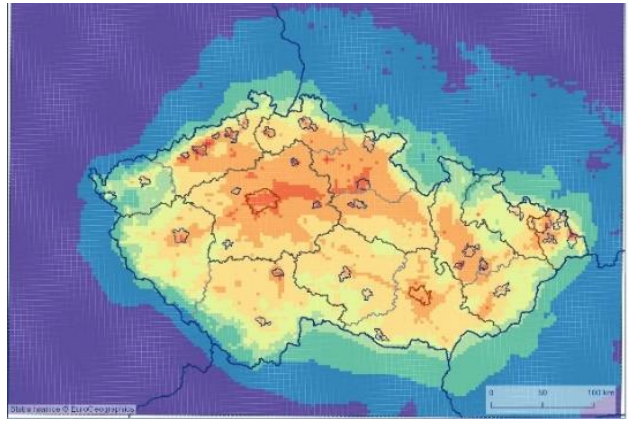
Updates of AQ plans – source apportionment

PM_X – CAMx-PSAT tool (modelling done by Charles university)

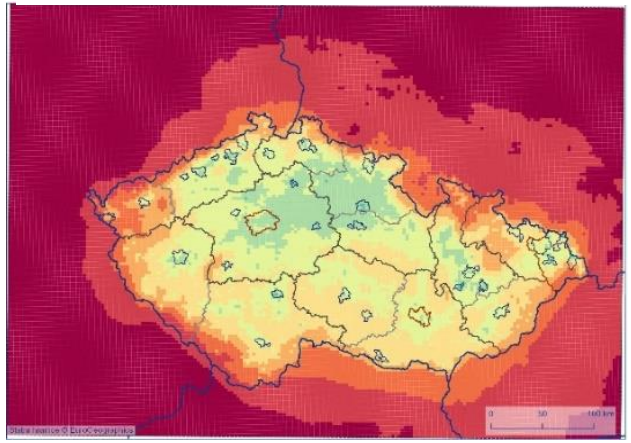
Contribution of non-CR to PM_{10} annual mean [%]



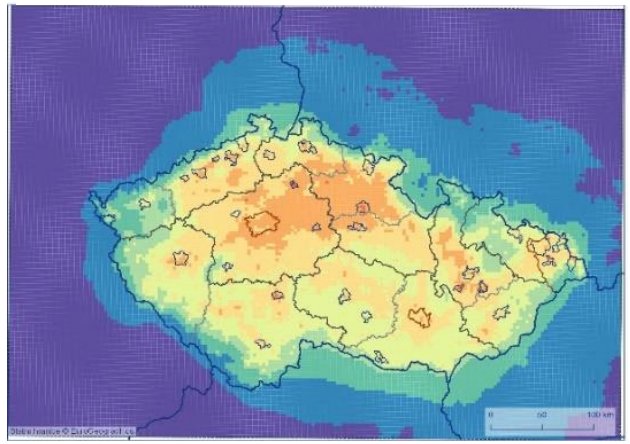
Contribution of CR to PM_{10} annual mean [%]



Contribution of non-CR to $PM_{2.5}$ annual mean [%]



Contribution of CR to $PM_{2.5}$ annual mean [%]



Thank you for attention!

References

CHMI‘s Yearbooks of Air pollution in the Czech Republic: https://www.chmi.cz/files/portal/docs/uoco/isko/grafroc/grafroc_GB.html (English versions stopped with year 2021). Czech versions available at https://www.chmi.cz/files/portal/docs/uoco/isko/grafroc/grafroc_CZ.html

Details on AQ mapping (in Czech) can be found for example in CHMI publication ***Systém sběru, zpracování a hodnocení dat v roce 2022.*** *Znečišťování a kvalita ovzduší, atmosférická depozice a skleníkové plyny.* WWW: https://www.chmi.cz/files/portal/docs/reditel/SIS/nakladatelstvi/assets/system-sberu-2022.pdf