BAY UFP

BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

finanziert durch
Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

Particle number concentrations (PNC) and health effects in the Bavarian centres of the German National Cohort (NAKO): Augsburg and Regensburg

Annette Peters (PI), Kathrin Wolf, Marco Dallavalle, Alexandra Schneider, Regina Pickford, Susanne Sues, Jens Soentgen, Simonas Kecorius, **Josef Cyrys**, Susanne Breitner-Busch

EFCA Conference 2024, Brussels

July 3rd, 2024

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIA Universität Augsburg Wissenschaftszentrum Umwelt

HELMHOLTZ MUNICH

BayUFP: Bavarian Project Network ULTRAFINE PARTICLES

BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

BAY UFP

BAYERISCHER
PROJEKTVERBUND
ULTRAFEINE PARTIKEL

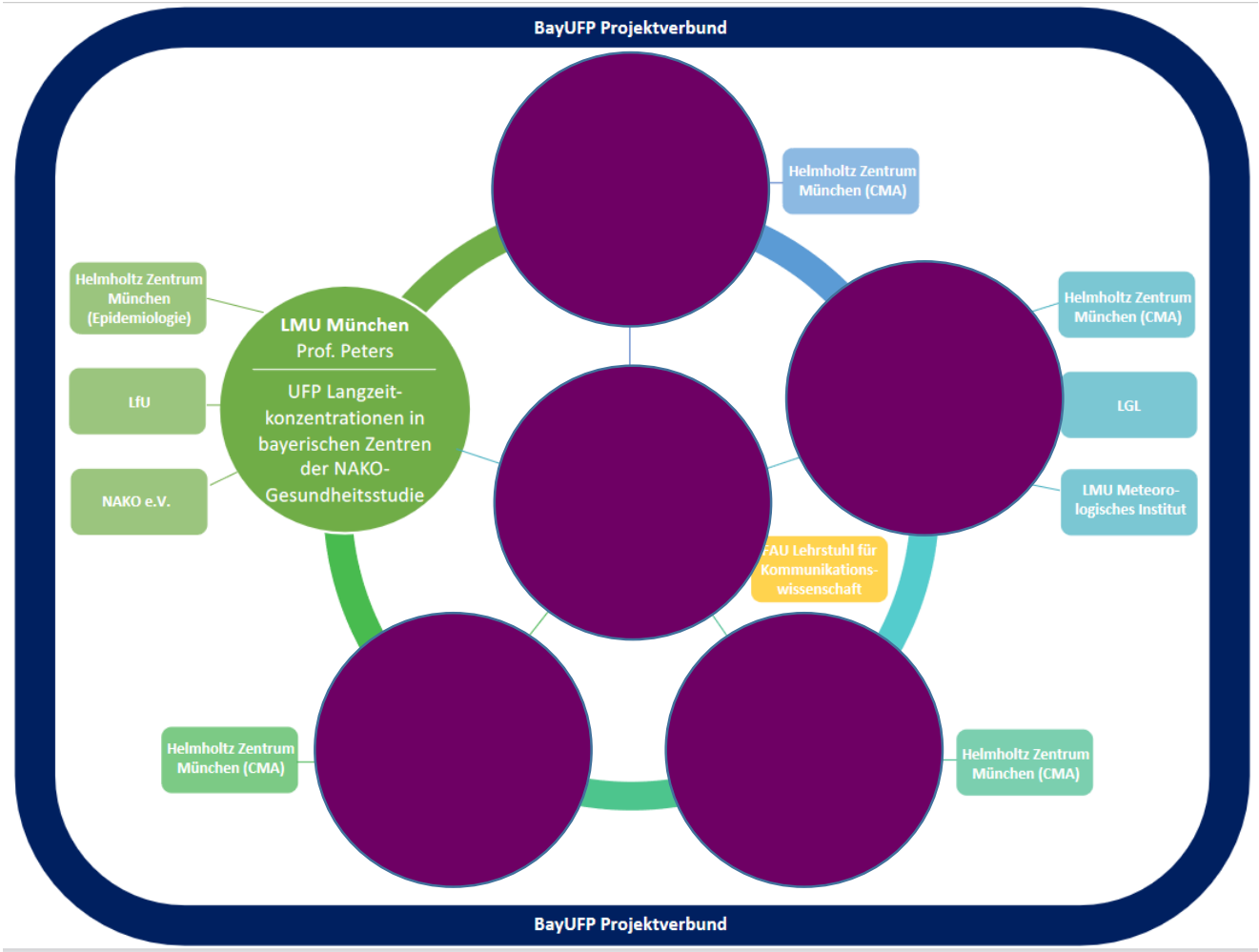
https://www.ultrafeinepartikel.de/

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
UNIA Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

UFP@NAKOBayern: Long-term exposure to UFP and health effects in Bavarian centers of the German National Cohort (NAKO)

BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

! Studies on long-term health effects of UFP are rare !



LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
UNIA Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

Background

- So far no limit values for ultrafine particles (UFP) in the EU

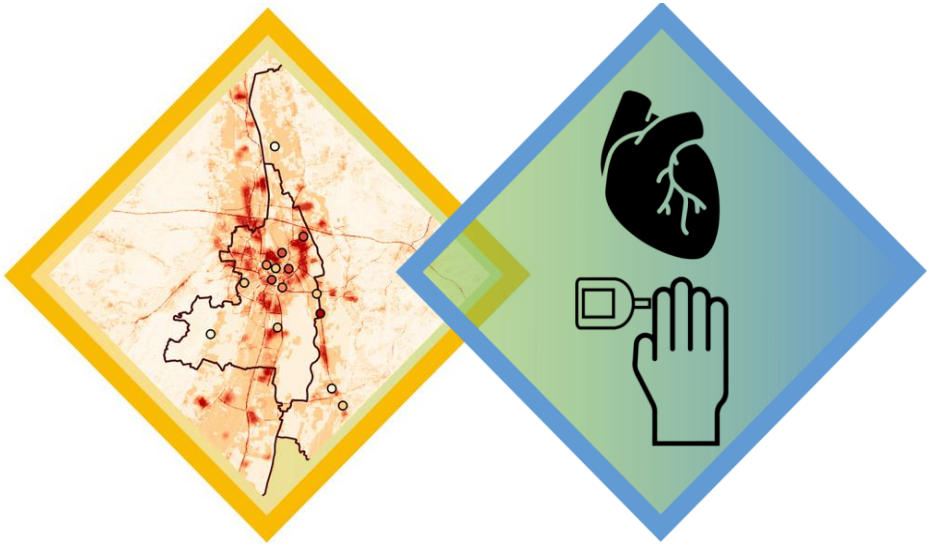
- The reason for this is the lack of data (worldwide) on the long-term UFP exposure of the population and the effects of UFP on health, independent of “classic” air pollutants such as fine particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) or ozone (O_3)

- The few long-term studies conducted to date indicate associations between UFP and cardiovascular morbidity or its biomarkers.

  (e.g. Bai et al. 2019; Downward et al. 2018; Pilz et al. 2018, Vogli et al 2023, Qi et al 2024).

Work packages

WP1: Exposure WP2: Health effects



1) To model the spatial distribution of particle number concentration (PNC) in the Augsburg and Regensburg regions
2) To analyse the associations between long-term exposure to PNC and cardiometabolic risk markers as well as the prevalence of cardiometabolic diseases in participants of the German National Cohort (NAKO)

Modeling the spatial variation of PNC

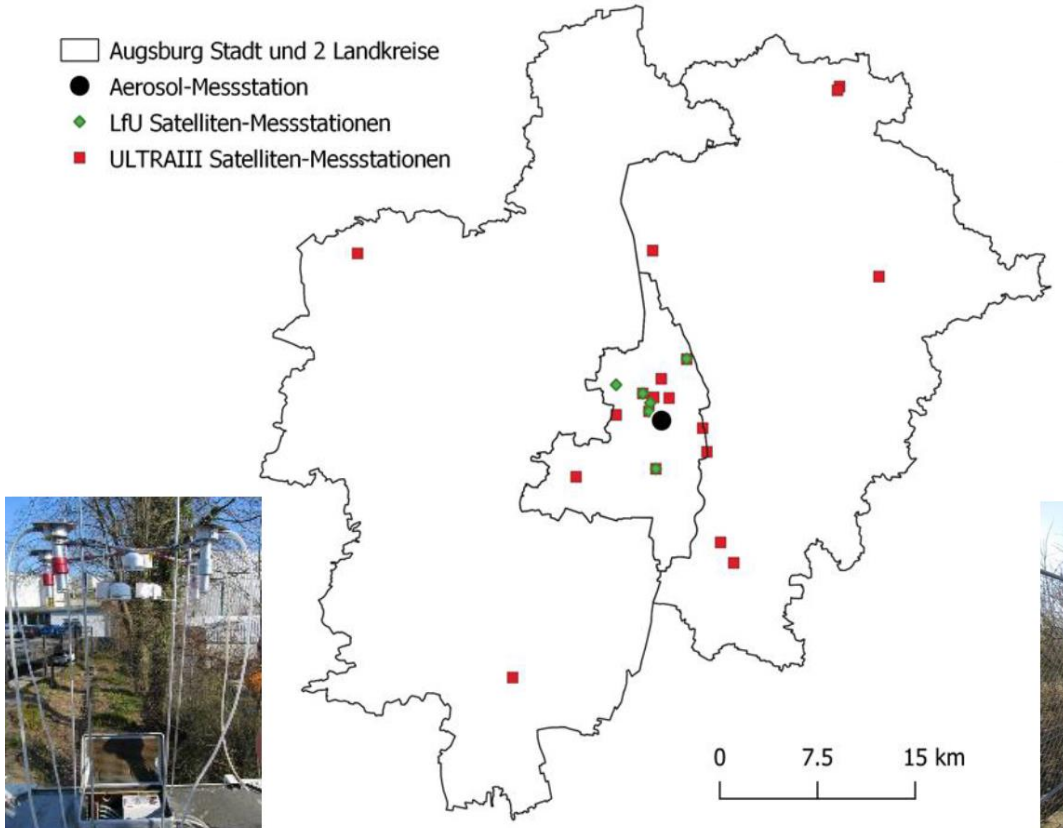
- Update and refine of land use regression (LUR) model for PNC (as indicator for UFP) for Augsburg, Germany, based on previous measurements and new predictors:
  - “ENVIRONMENTAL NANOPARTICLES AND HEALTH“ (ULTRA III; 2014 - 2015)
  - „Influence of Local Sources on the Spatial and Temporal Distribution of UFP in Augsburg, Germany (LfU Project, 2017)

Exposure

Modeling the spatial variation of PNC

BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

20 sites in ULTRA III (2014/15)
6 sites in LfU project (2017)
1 continuous site (reference site)

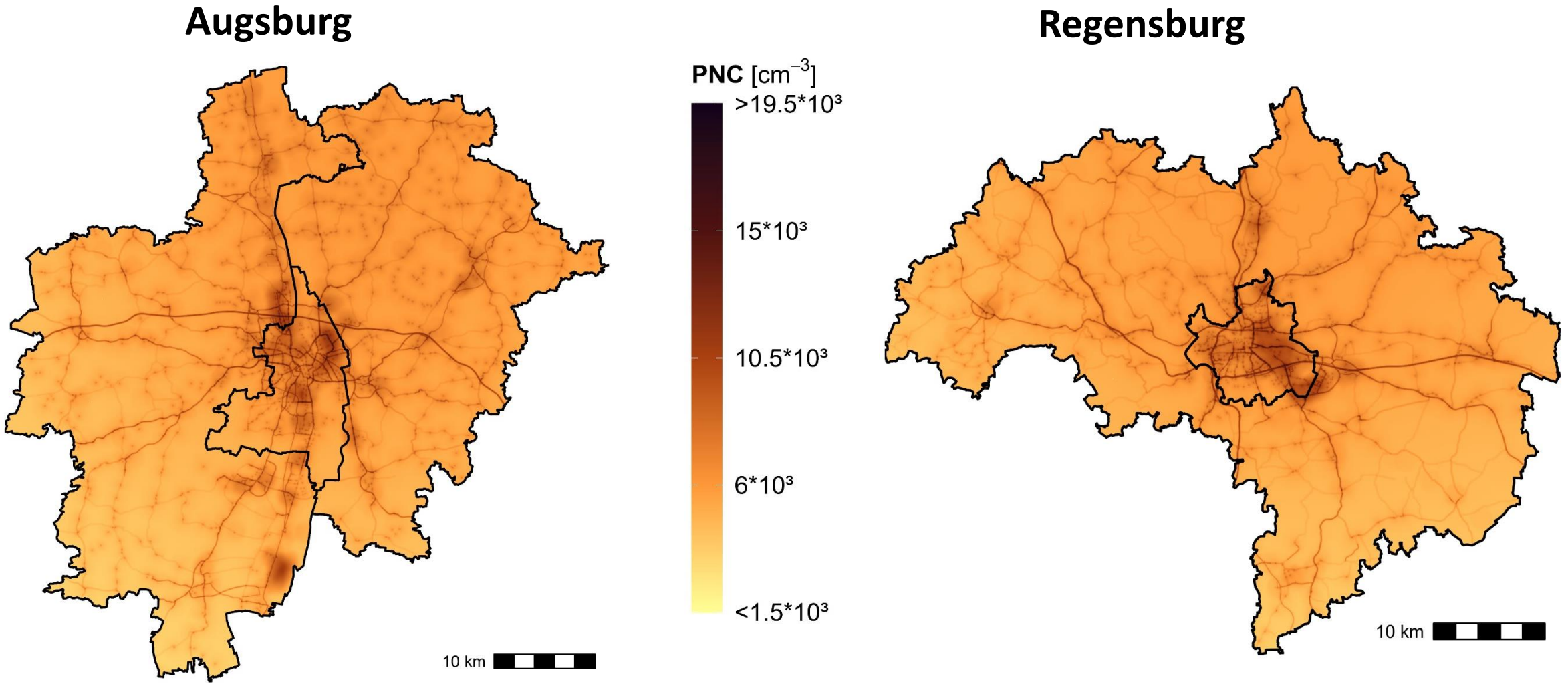


- Joint processing and temporal adjustment of the measurements
- Selection of further predictors and optimization of the model
  → Different model approaches tested
- Implementation of the “best” model to Regensburg
  → Calculation of the selected predictors for the Regensburg area

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
UNIA Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

Estimated PNC concentrations in the Augsburg and in the Regensburg area

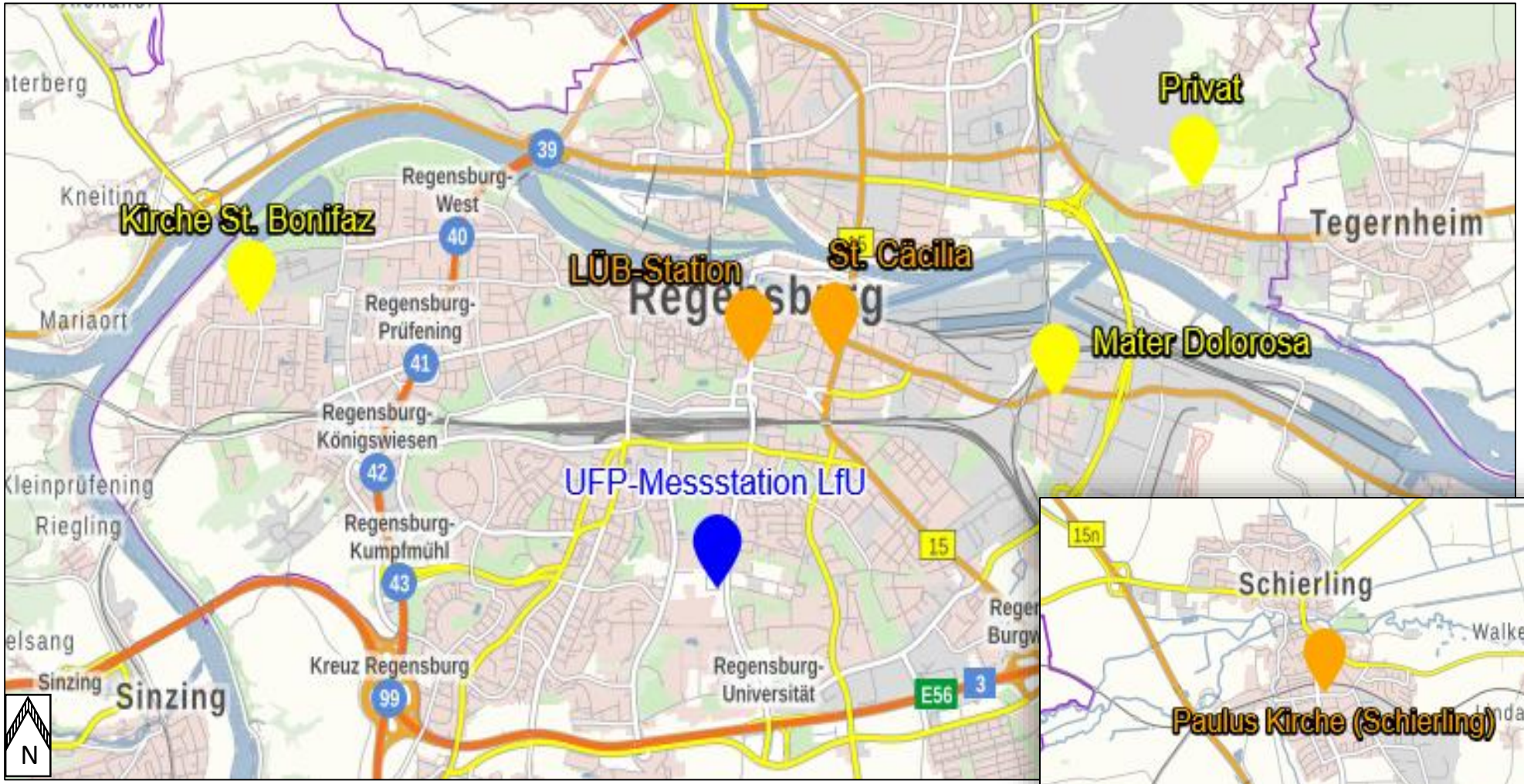
BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL



LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

Validation of the LUR model for Regensburg: Determination of PNC annual average values at 6 locations and LFU reference site

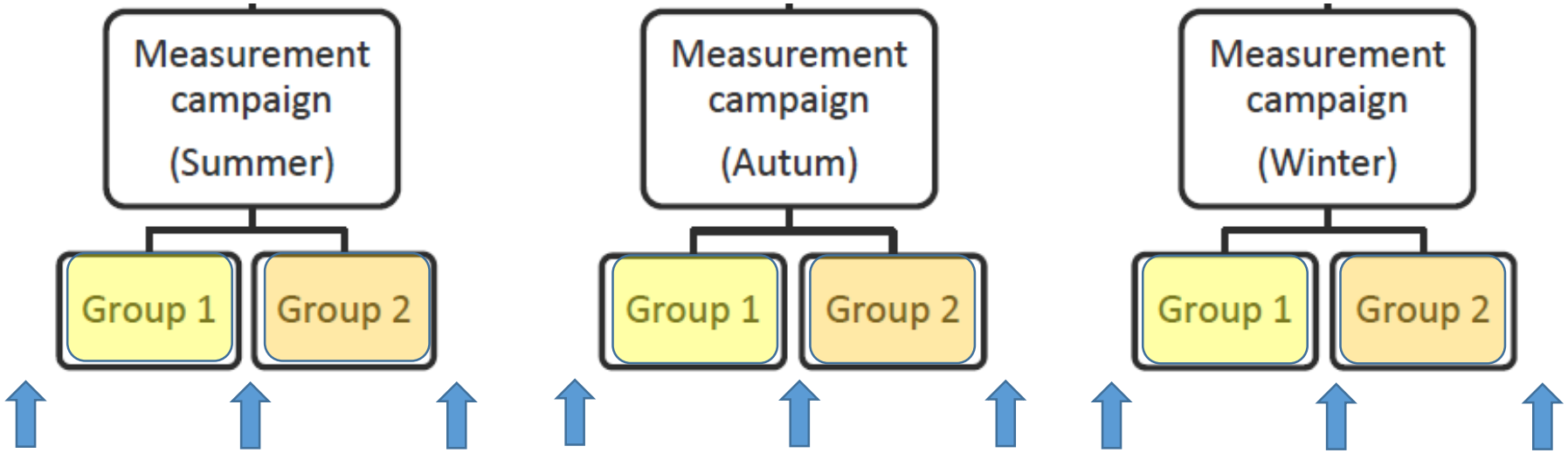
BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL



- Group 1
- Group 2
- Reference site (UFP measurement station of LfU)

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

Validation of the LUR model for Regensburg: Determination of PNC annual average values at 6 locations



Each measurement campaign consisted of:

- Comparison measurements at the beginning of each measurement campaign (approx. 1 week)
- Measurement round group 1 (2 weeks)
- Comparison measurements between the measurement rounds (approx. 1 week)
- Measurement round group 1 (2 weeks)
- Comparison measurements at the end of the measurement campaign (approx. 1 week)

UFP reference measurement station (comparison measurements)

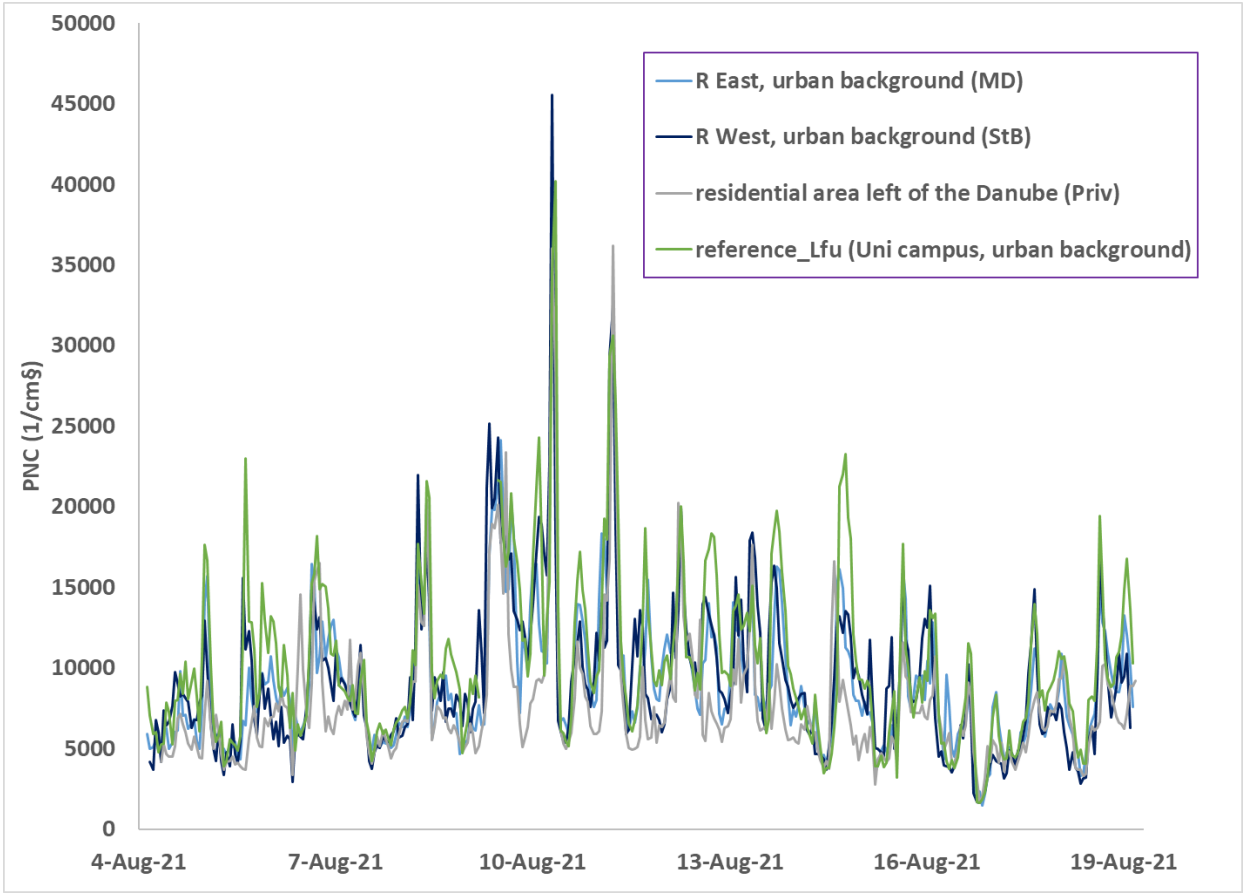
All three CPCs in the grid box next to the UFP measurement station of the Bavarian State Agency for Environment (University of Regensburg)

On the roof of the network station (LfU) in the city center of Regensburg

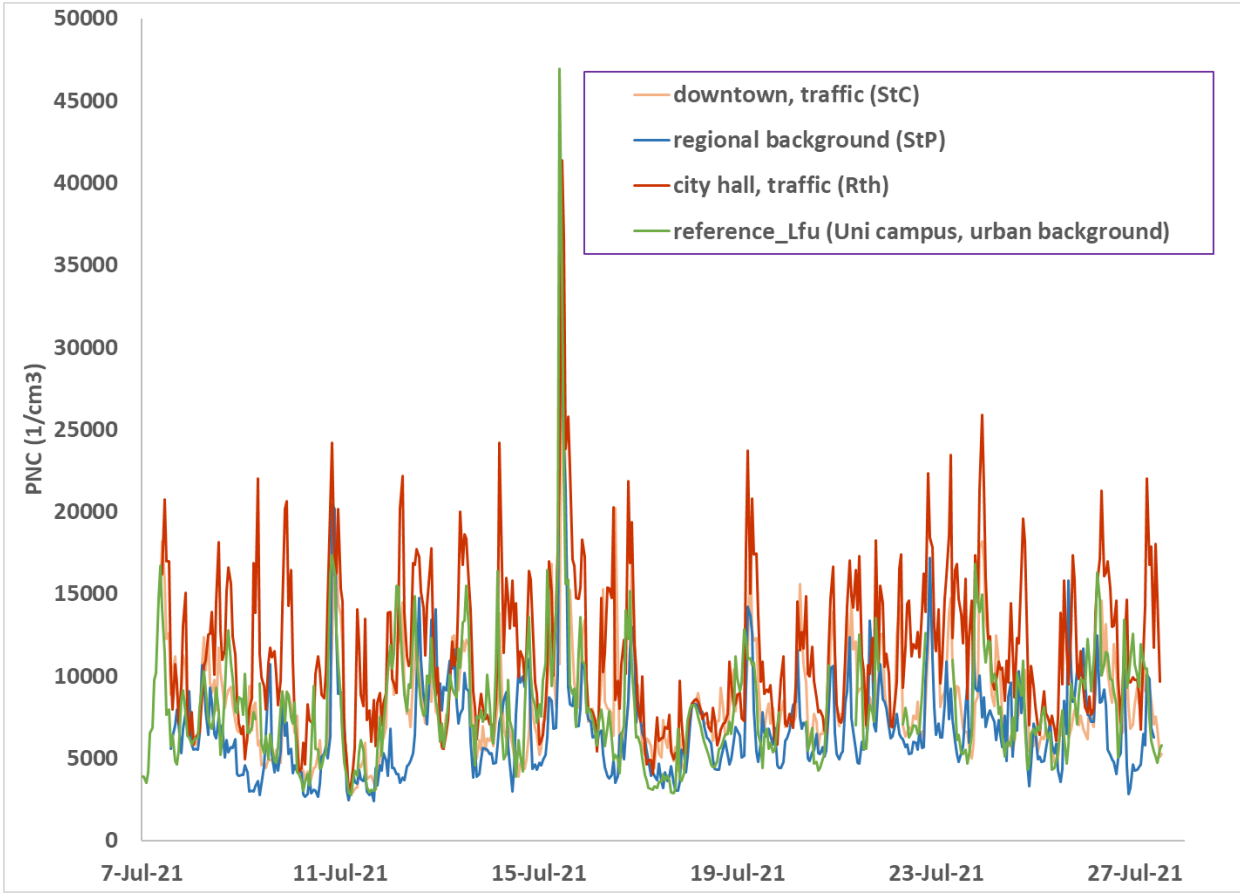
Measurement campaign summer

BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

Group 1

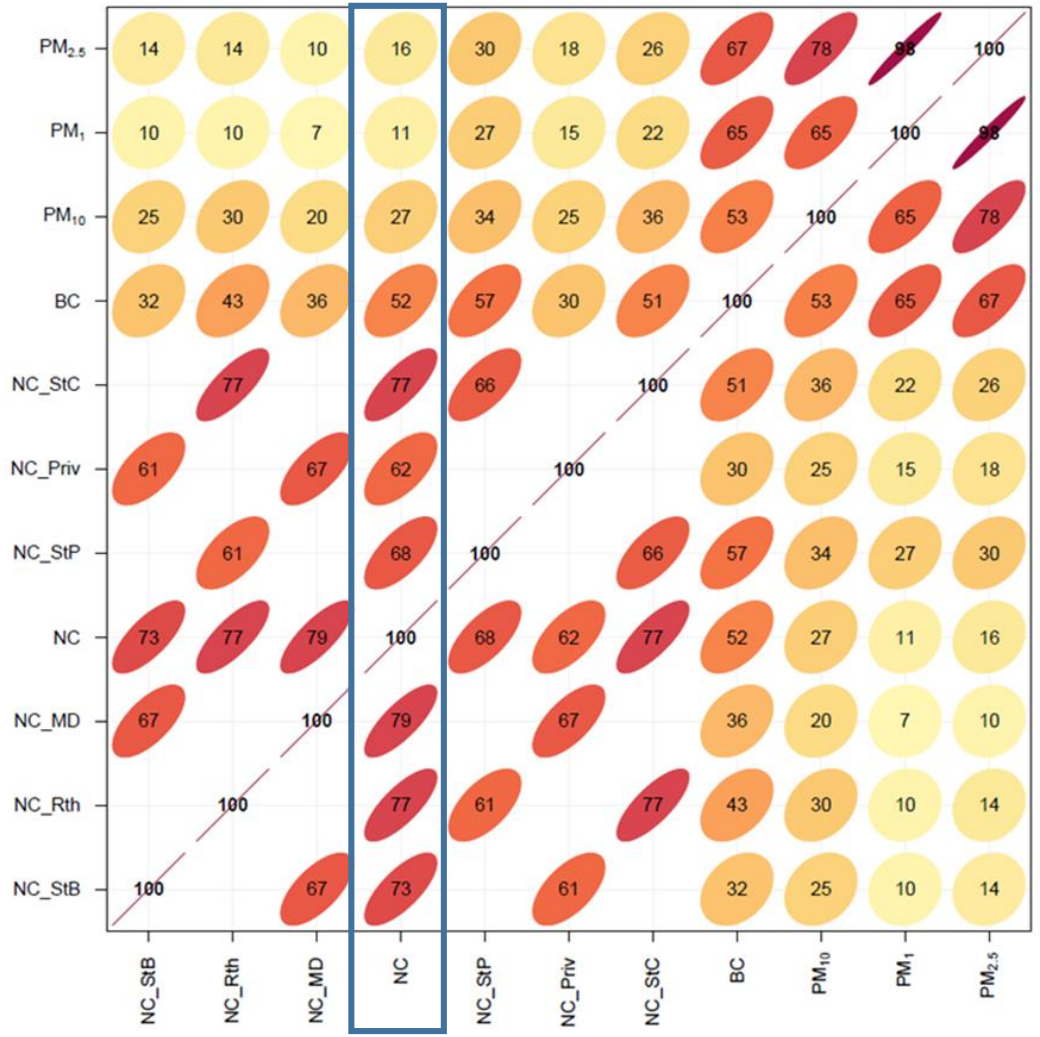


Group 2



LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
UNIA Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

Pearson correlation coefficients

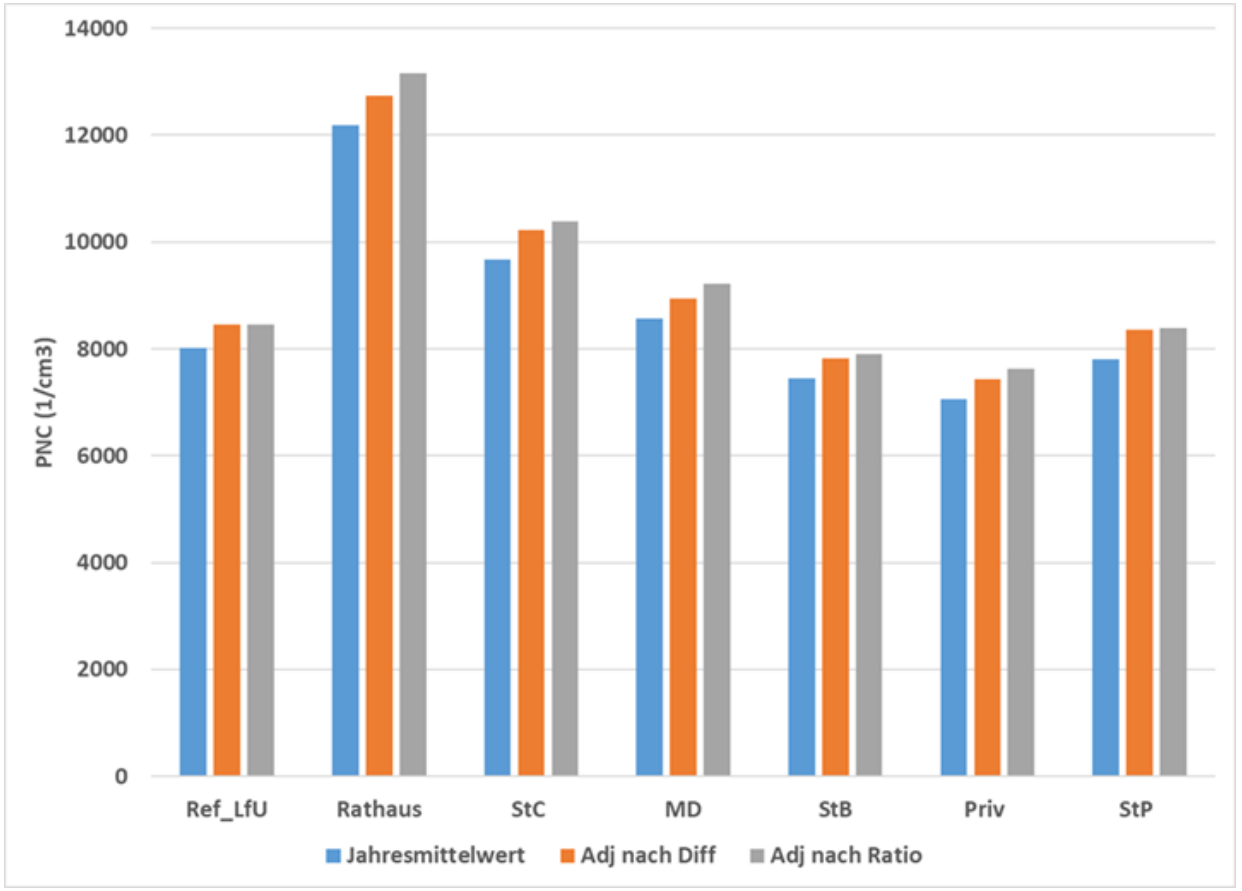


- Moderate to high correlations between the PNC values at the satellite sites and the reference measurement station (LfU)
- Low to moderate correlations between PNC and other PM metrics (PM_{10}, $PM_{2.5}$, $PM_{1.0}$, BC)

Annual means (adjusted for temporal variation)

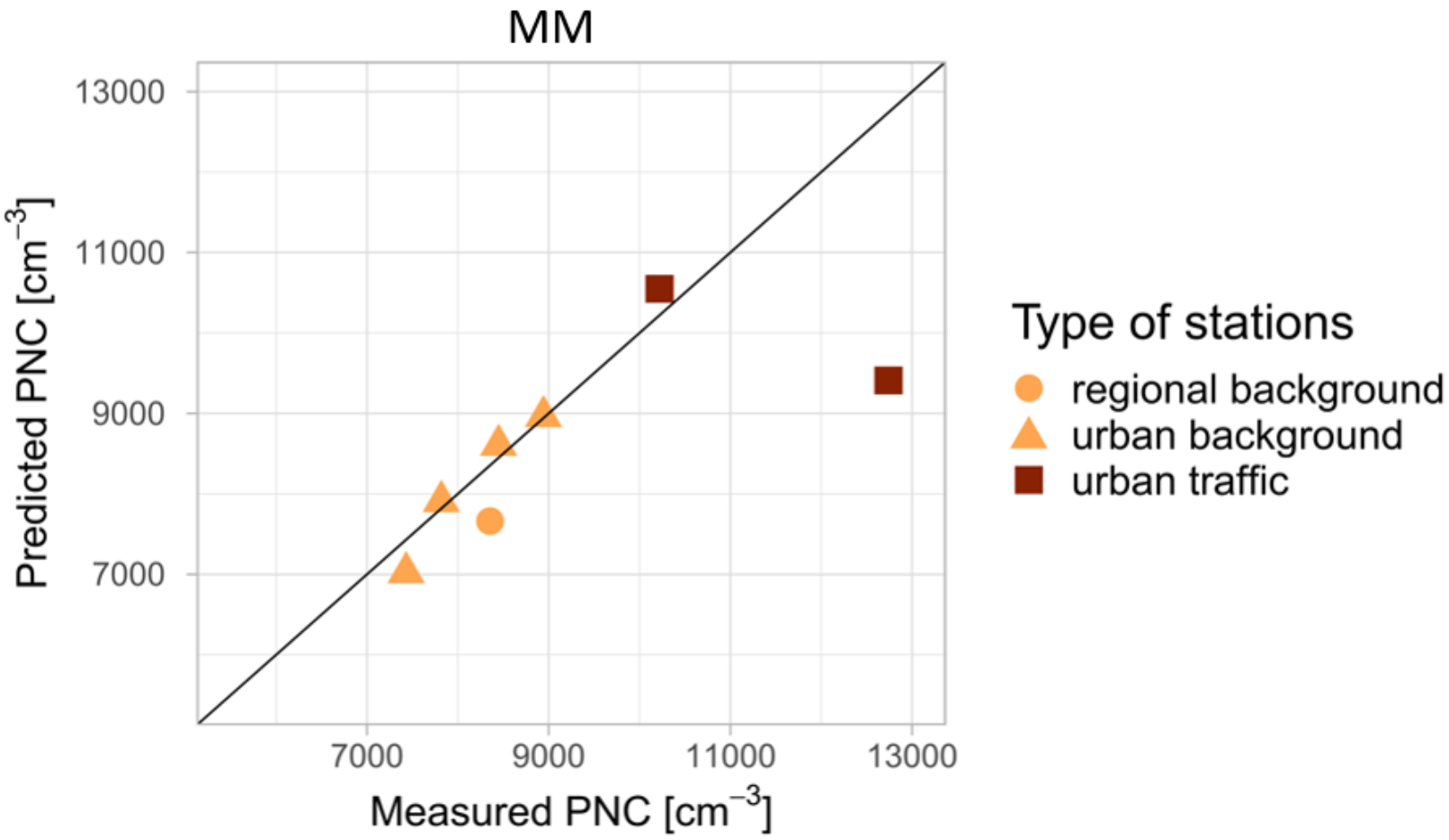
BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

PNC (1/cm³)	Sampling Sites						
	Ref_LfU	Rathaus	StC	MD	StB	Priv	StP
PNC-annual means	8012	12192	9671	8573	7449	7062	7805
Adj by Diff Method	8449	12742	10221	8943	7818	7431	8355
Adj by Ratio Method	8449	13161	10394	9210	7907	7621	8392



LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
Universität Augsburg Wissenschaftszentrum Umwelt
HELMHOLTZ MUNICH

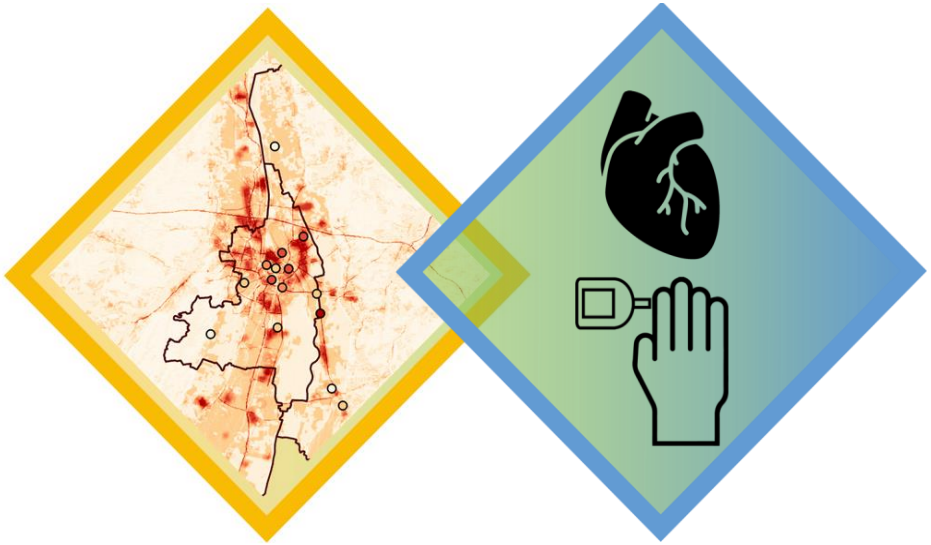
Comparison of measured and predicted PNC at the monitoring sites in Regensburg



Dallavalle et al., in preparation

Work packages

WP1: Exposure WP2: Health effects



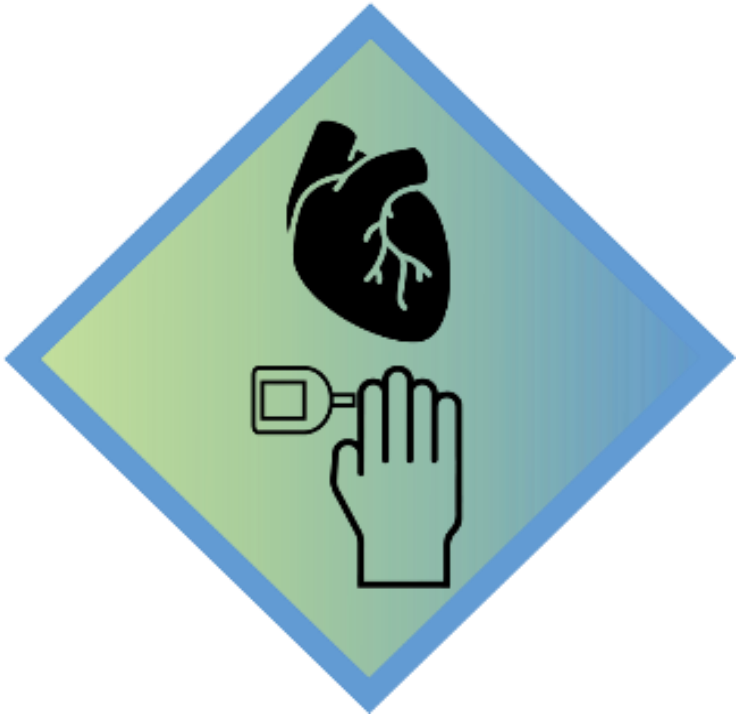
1) To model the spatial distribution of particle number concentration (PNC) in the Augsburg and Regensburg regions
2) To analyse the associations between long-term exposure to PNC and cardiometabolic risk markers as well as the prevalence of cardiometabolic diseases in participants of the German National Cohort (NAKO)

Selected long-term health effects

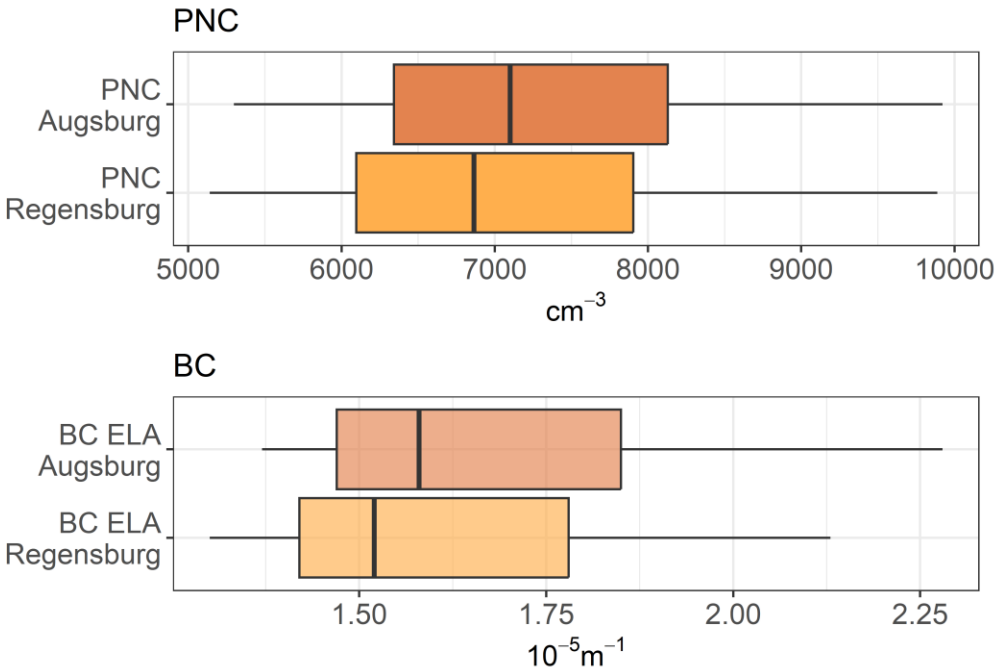
Data from German National Cohort (NAKO):
Augsburg and Regensburg:

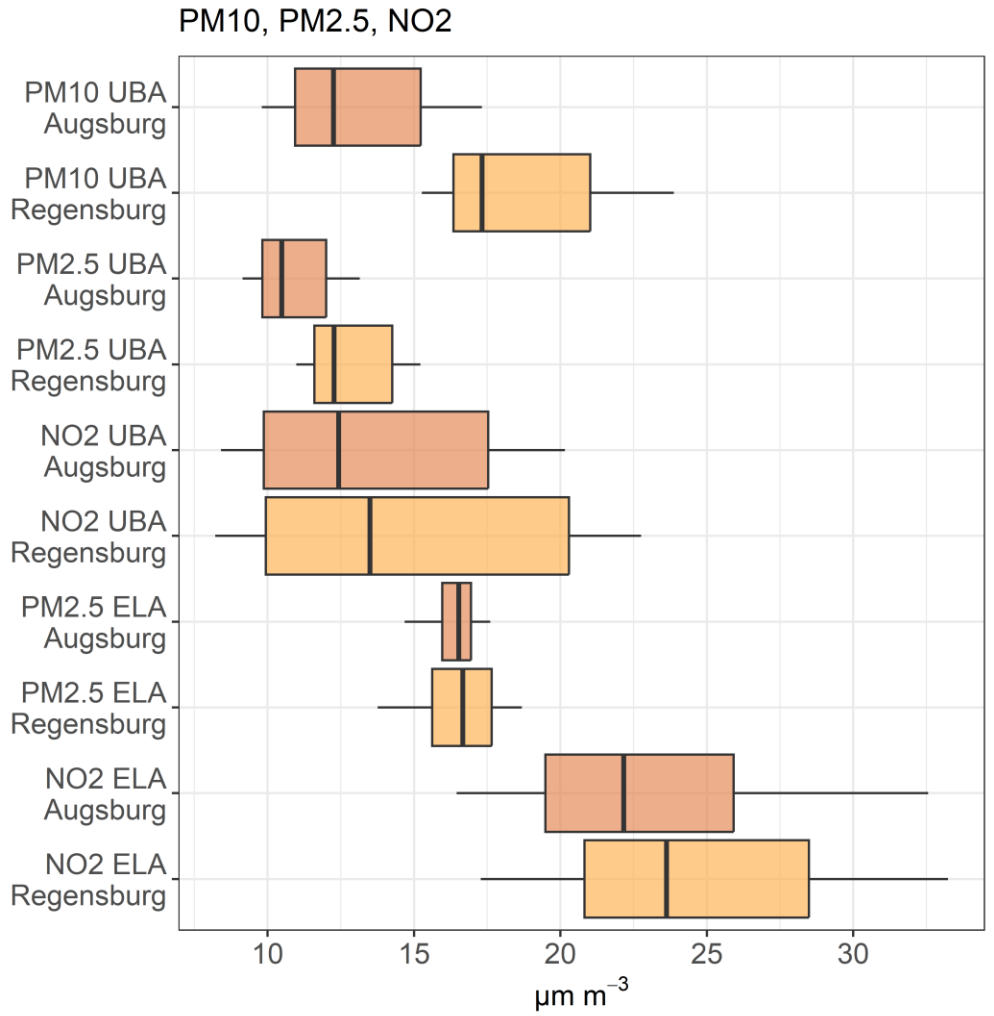
- Cardiometabolic risk markers: blood pressure, pulse rate, glucose, and other
- Frequency of cardiometabolic diseases: high blood pressure (hypertension), myocardial infarction, strokes and diabetes
- Information on region, age, gender, body mass index, smoking status, marital status, employment status, physical activity and alcohol consumption

Health effects



Exposure of the study population to PNC and other air pollutants





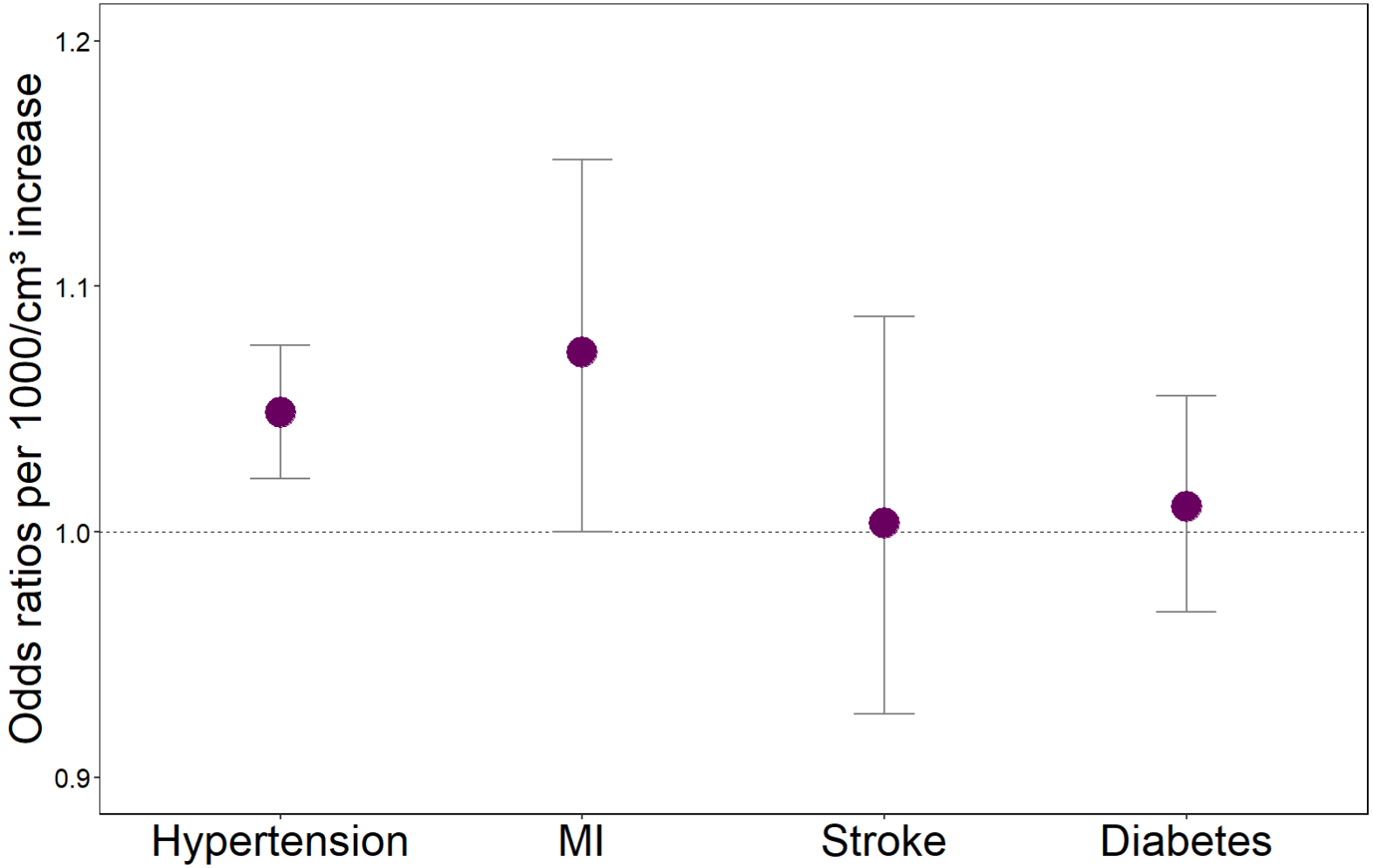
UBA Model:

2km*2km; 2014

ELAPSE Model:

100m*100m; 2010

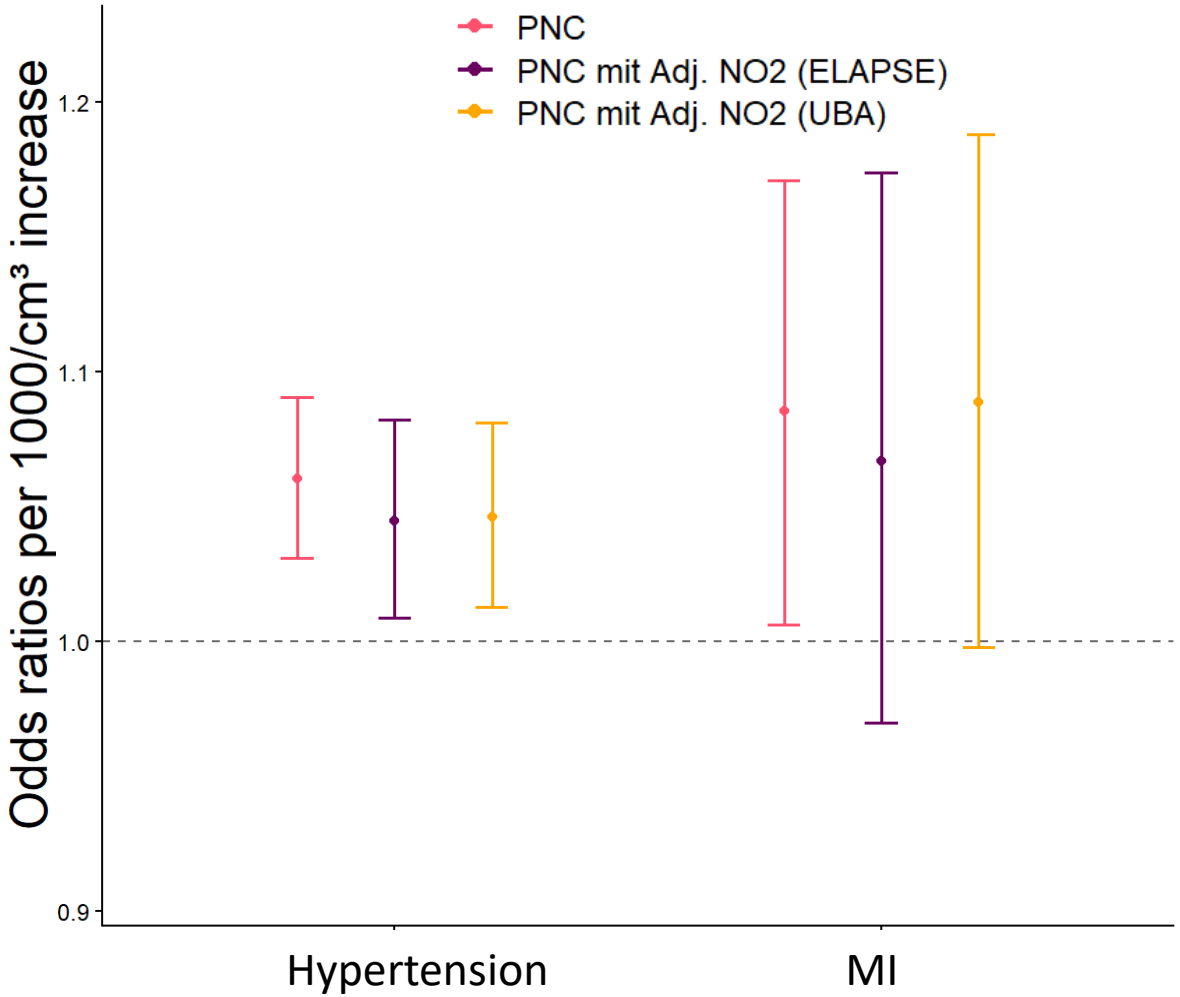
PNC and cardiometabolic diseases

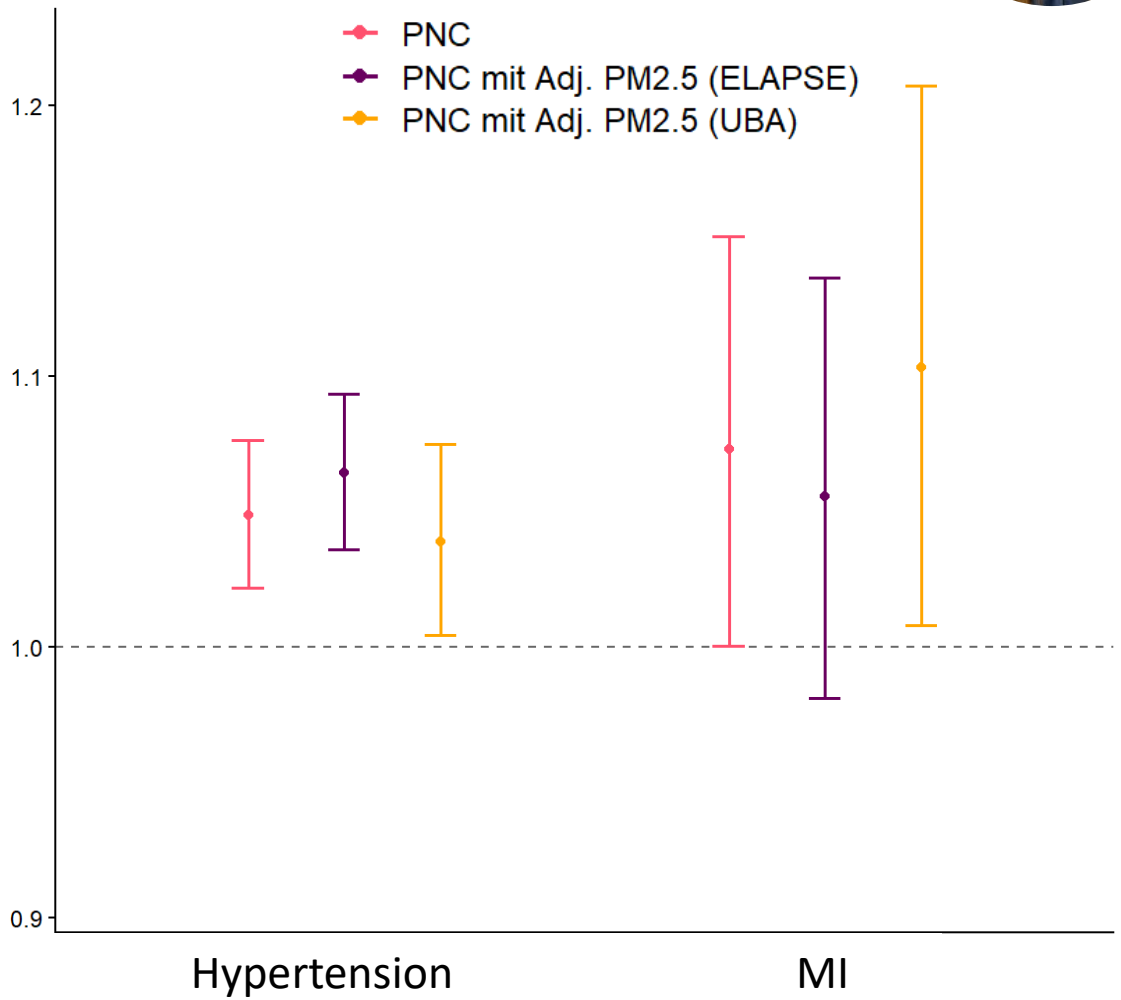


- Increase in the odds ratio for hypertension by 5%
- Risk for prevalent myocardial infarction increases 7.4%
- No associations between PNC and strokes or diabetes prevalence

Breitner-Busch et al unpublished

Odds ratios for cardiometabolic diseases – two-pollutant models





Breitner-Busch et al unpublished

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIA Universität Augsburg Wissenschaftszentrum Umwelt

HELMHOLTZ MUNICH

Summary I (exposure)

- In this study we used particle number concentration (PNC) to estimate long-term exposure to UFP
- LUR models from one city can transferred to another city if the geographic features and spatial variability of the predictors across the two study areas are comparable
- Measurements should be carried out to validate the transferred models
- The exposure to PNC was above 10,000 particles/cm^3 in 4% of the NAKO participants

Summary II (health effects)

- We found associations between long-term exposure to high PNC and the prevalence of high blood pressure as well as myocardial infarction
- The results were stable after adjustment for fine particles and NO_2
- Further analysis are ongoing

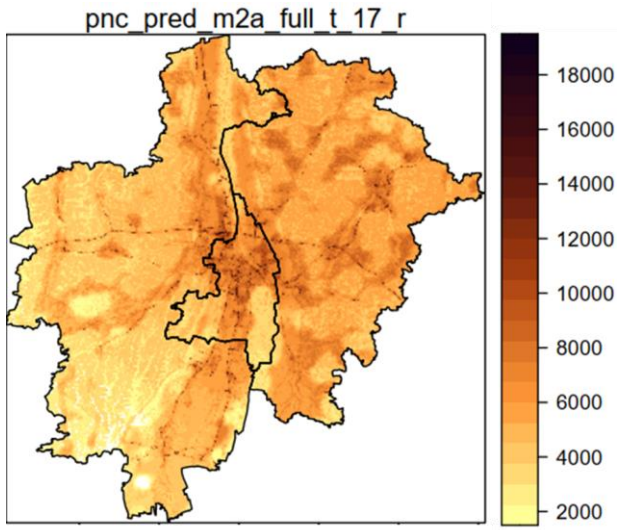
Acknowledgements to the modeling and measurement teams as well as to the entire project team

BAY UFP
BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

Modeling team

Kathrin Wolf

Marco Dallavalle



Measurement team

Susanne Sues

Simonas Kecorius

LMU

Annette Peters (PI)

Susanne Breitner-Busch

LMU München:

Susanne Breitner-Busch

Gabriele Kölbl

Annette Peters

Helmholtz Munich, EPI:

Josef Cyrys

Marco Dallavalle

Simonas Kecorius

Regina Pickford

Alexandra Schneider

Kathrin Wolf

University Augsburg, WZU

Jens Soentgen

Susanne Sues

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIA Universität Augsburg Wissenschaftszentrum Umwelt

HELMHOLTZ MUNICH

BAY UFP

BAYERISCHER PROJEKTVERBUND ULTRAFEINE PARTIKEL

finanziert durch
Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

Thank you for your attention

Further information about the project network can be found on the homepage:

www.ultrafinepartikel.de

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

UNIA Universität Augsburg Wissenschaftszentrum Umwelt

HELMHOLTZ MUNICH