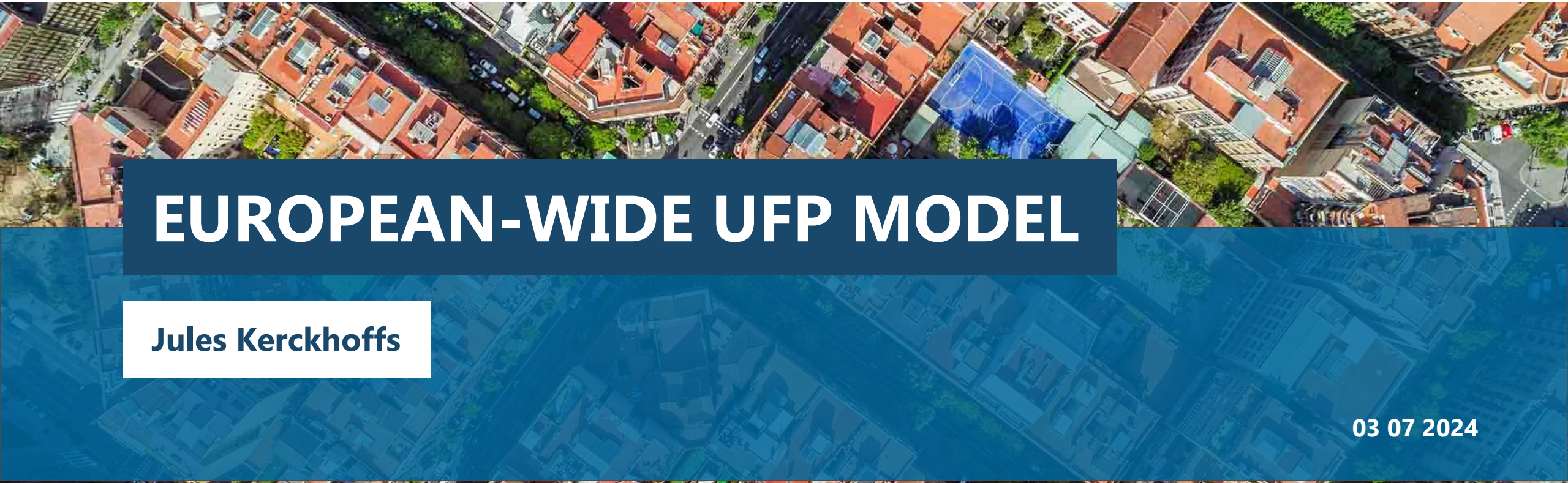
EXPANSE

EXPOSOME POWERED TOOLS

for healthy living in urban settings

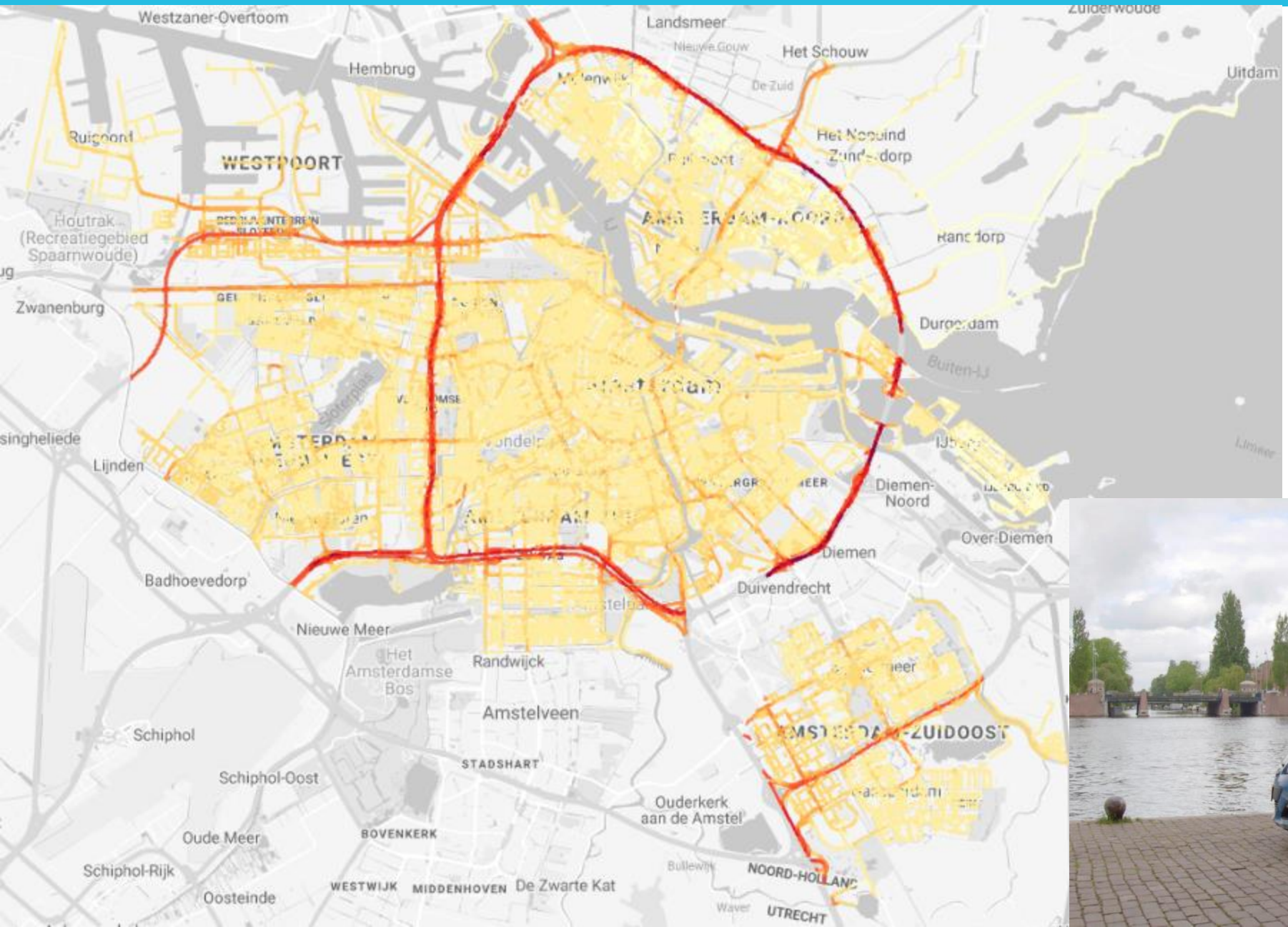


EUROPEAN-WIDE UFP MODEL

Jules Kerckhoffs

03 07 2024

MOBILE MONITORING



MOBILE MONITORING CAMPAIGNS

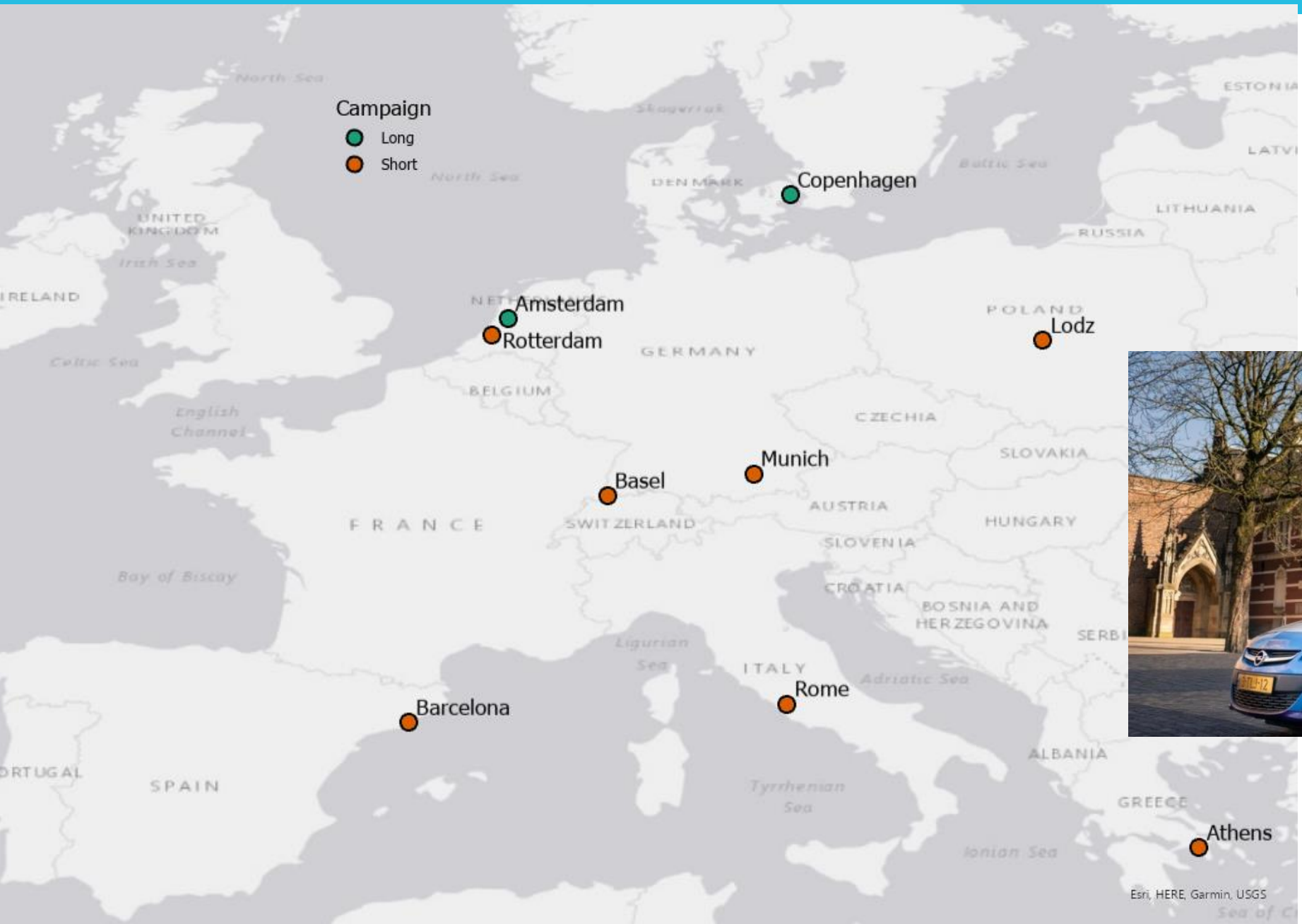


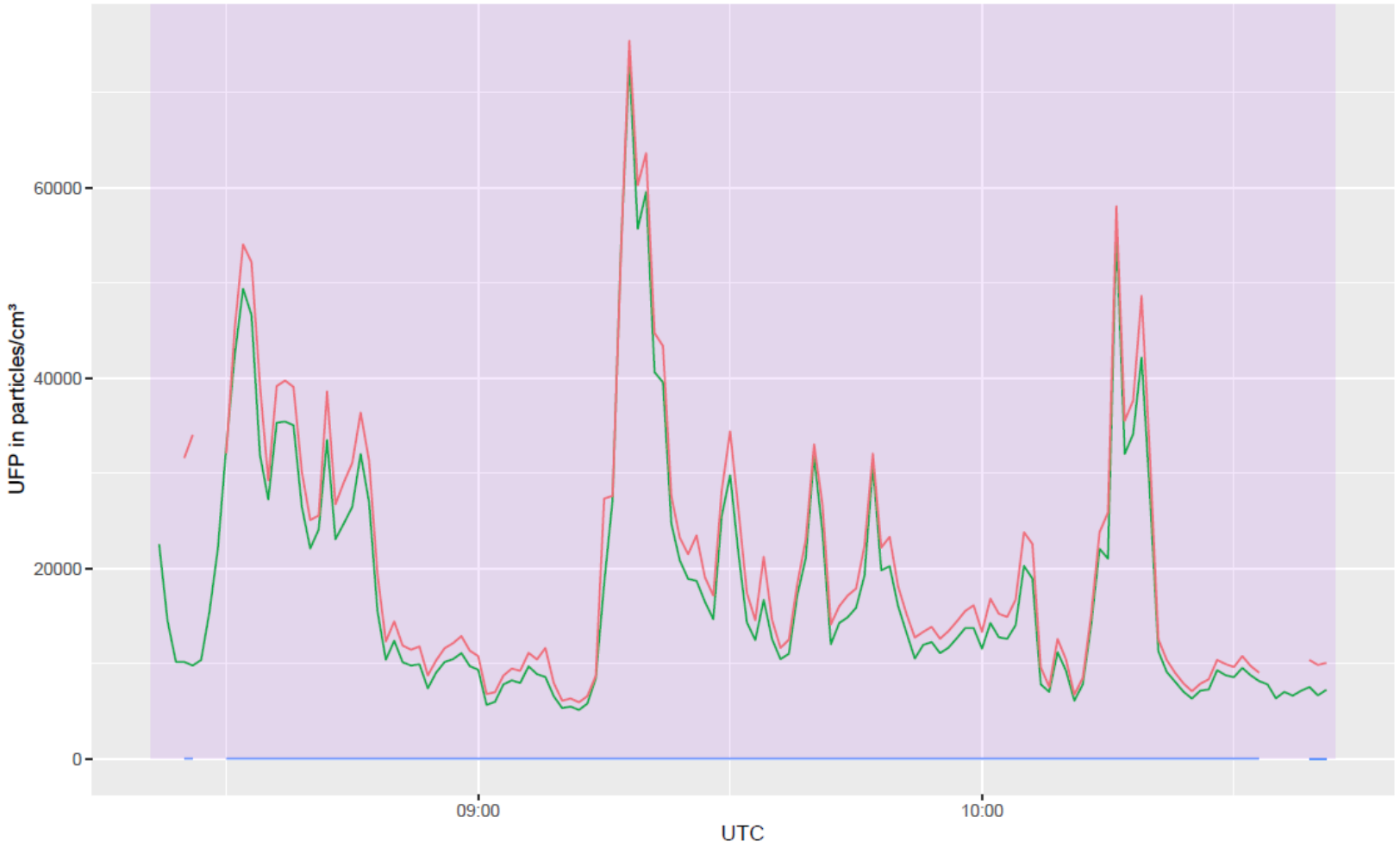
Foto Bas Niemans

MOBILE MONITORING CAMPAIGNS

DATA PROCESSING

- Snapping all 1Hz measurements to nearest road
- Mean of means
- Windsorizing
- Colocations

COLOCATION

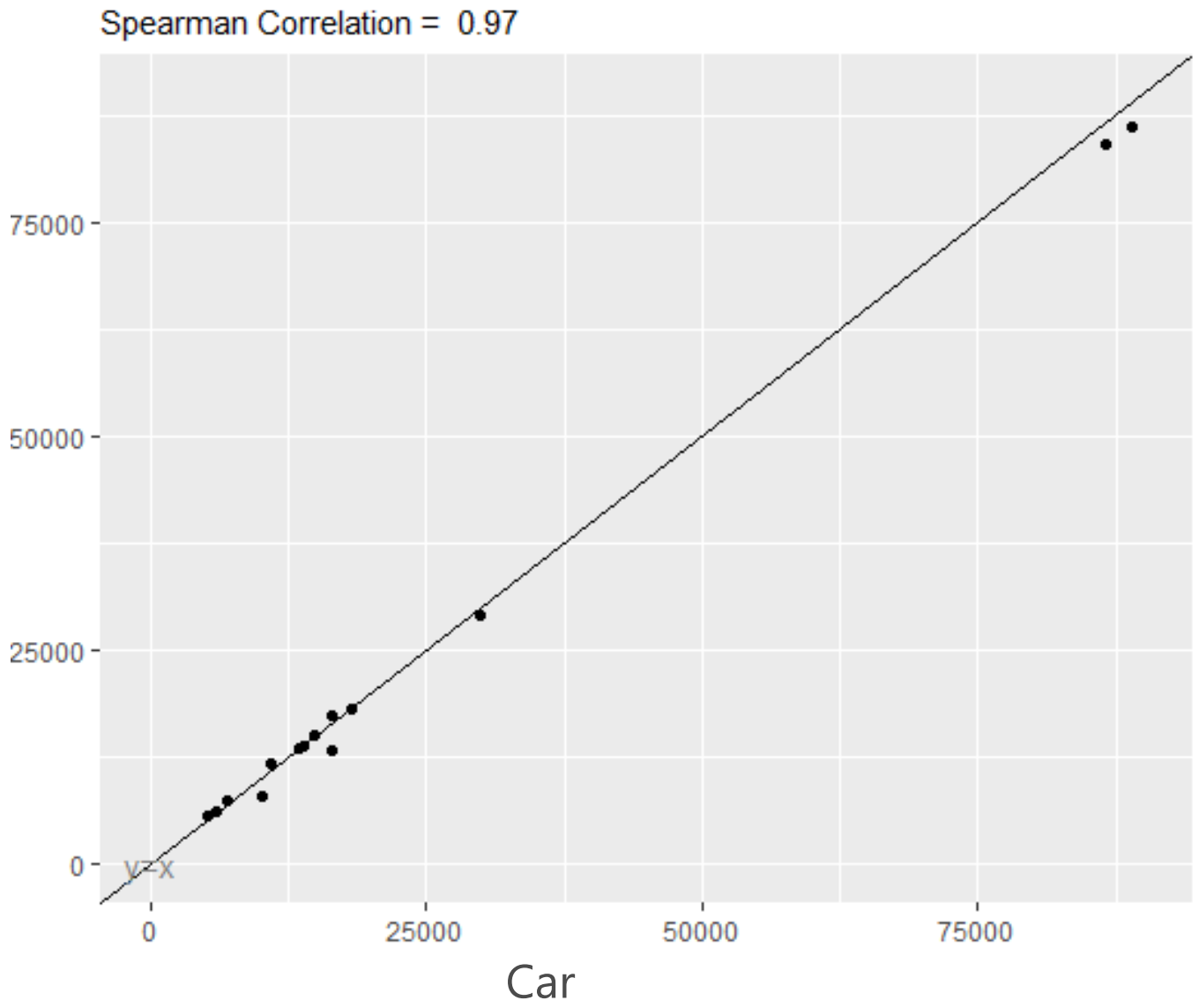


Car

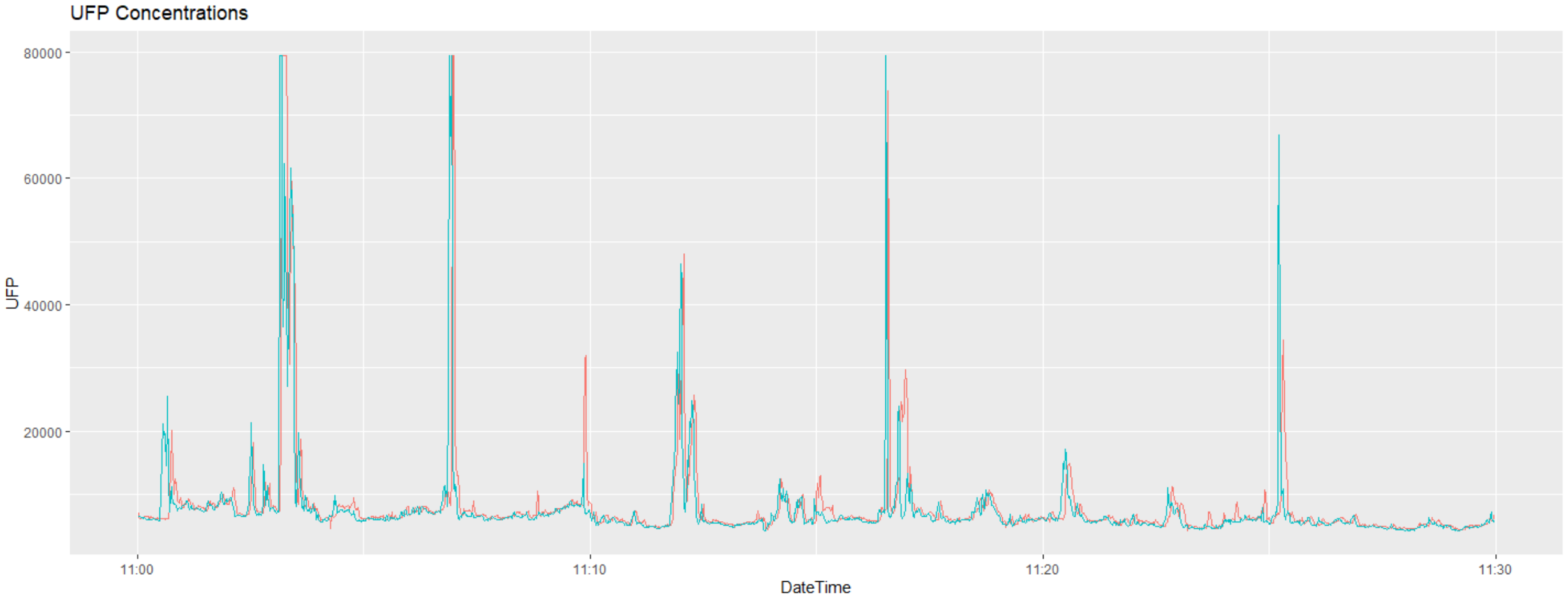
Reference station

COLOCATION

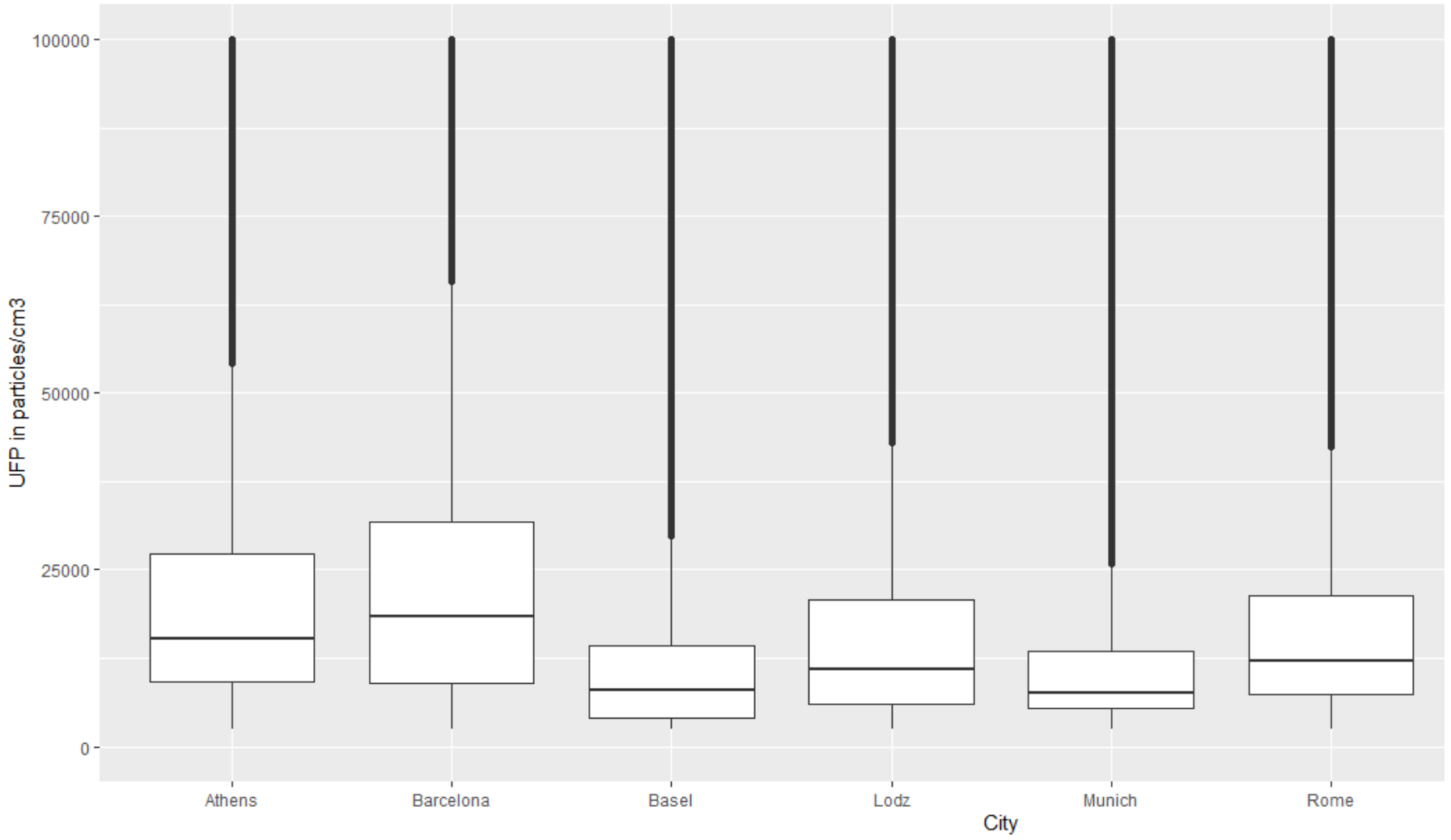
Reference station



UFP MEASUREMENTS WITH 2 CARS



UFP MEASUREMENTS



Predictor variables

Data source	Resolution	Predictor	code	Direction of effects	Buffer size (radius in m) or point estimate	Year of data collection	Included in background deconvolution method
AADT	25m	Annual average daily traffic counts in buffers	aadt_[buffer]	+	50, 100, 200, 300, 400, 500, 700, 1000, 2000, 5000	2019	With buffer ≥ 1km
AADT	5m	Annual average daily traffic counts	AADT_onRoad	+	Point estimates (on centroids of road segments)	2019	No
OpenstreetMaps	25m	Count of restaurants, and fast-food outlets in buffers	FstRst_[buffer]	+ +	25; 50; 100; 300; 500; 1000; 2500; 5000	2020	With buffer ≥ 1km
OpenstreetMaps	25m	Major roadsin buffers All roadsin buffers	mjrRoads_[buffer] allRoads _[buffer]	+ +	50; 100; 200; 300; 400; 500; 700; 1000; 2000; 5000; 10000	2020	With buffer ≥ 1km
GEOSTAT population (2020)	100m	Population per grid cell	Pop2020	+	Point estimates (on centroids of road segments)	2020	No
GEOSTAT population (2020)	100m	Population per grid cell in buffers	pop20_[buffer]	+	100; 300; 500; 1000; 2500; 5000	2020	With buffer ≥ 1km
ERA 5 monthly aggregates from climate reanalysis (Copernicus, 2019; ECMWF, 2019)	0.1° (~12km)	Annual averages from monthly aggregates: • Average temperature at 2m height (Kelvin) • Total precipitation (m) • Average surface pressure (Pa) • Average 10m wind speed (m/s)	temp prep pres wind	+ - + -	Point estimates (on centroids of road segments)	2019	Yes

Predictor variables

Data source	Resolution	Predictor	code	Direction of effects	Buffer size (radius in m) or point estimate	Year of data collection	Included in background deconvolution method
CORINE land cover	100m	Percentage of the land cover types in buffers: • Residential areas • Natural areas • Urban green	res nat ugr	+ - -	100, 200, 300, 400, 500, 600, 700, 800, 1000, 1200, 1500, 1800, 2000, 2500, 3500, 4000, 5000, 6000, 7000, 8000, 10000	2018	With buffer ≥ 1km
CORINE land cover	100m	Percentage of the land cover types in buffers: • Industrial/commercial areas • Ports • Airports	ind por apor	+ + +	1000, 1200, 1500, 1800, 2000, 2500, 3500, 4000, 5000, 6000, 7000, 8000, 10000	2018	Yes
Impervious surface from Copernicus services (Copernicus, 2021b)	100m	Percentage of sealed area in buffers	imd	+	100; 200; 300; 400; 500; 600; 700; 800; 1000; 1200; 1500; 1800; 2000; 2500; 3500; 4000; 5000; 6000; 7000; 8000; 10000	2018	With buffer ≥ 1km
Altitude 90 m SRTM DTM v4 (Jarvis, A., H.I. Reuter, A. Nelson, 2008)	90m	Altitude	alt	-	Point estimates (on centroids of road segments)	Static	Yes
Global UFP estimates	0.1° x 0.1°	UFP estimates from ECHAM/MESSy Atmospheric Chemistry model (EMAC) for the year 2015	CTMufp	+	Point estimates (on centroids of road segments)	2015	Yes

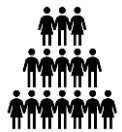
PREDICTOR VARIABLES

Data source	Resolution	Predictor	code	Direction of effects	Buffer size (radius in m) or point estimate	Year of data collection	Included in background deconvolution method
Building density with building height	50m	10m-resolution impervious density data was combined with 100m-resolution building height data	canyon_[buffer] canyonSD_[buffer]	+ +	25, 50, 100, 200, 500	2018	No
Building height	100m	Building height	anbh	+	Point estimates (on centroids of road segments)		No
OpenstreetMaps	5m	Road type: highway, primary, secondary, tertiary, residential roads	roadtype			2020	No
LCZ (Demuzere et al., 2019)	100m	Local climate zone, estimated by random forests with ground-based training data and remotely-sensed data from Landsat and Sentinel-1 SAR data along with other geopstaial data.	lcz		Point estimates (on centroids of road segments)	2016	Yes

TRAFFIC FLOW

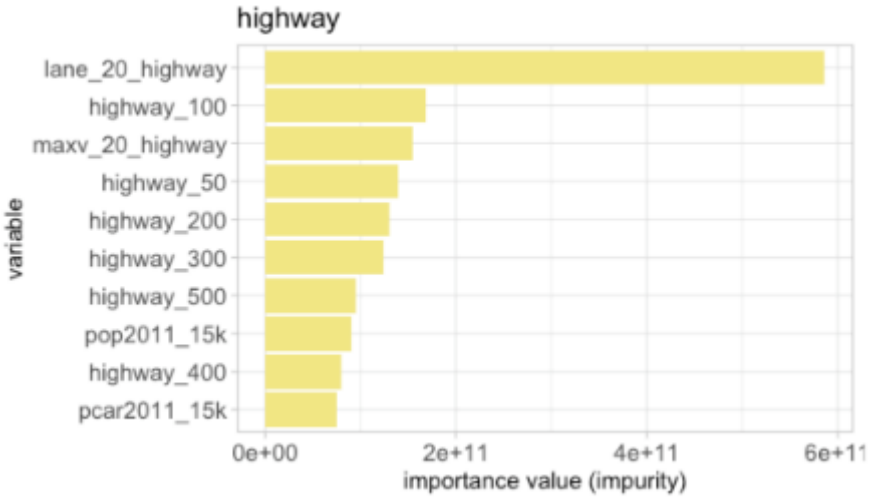
AADT observations

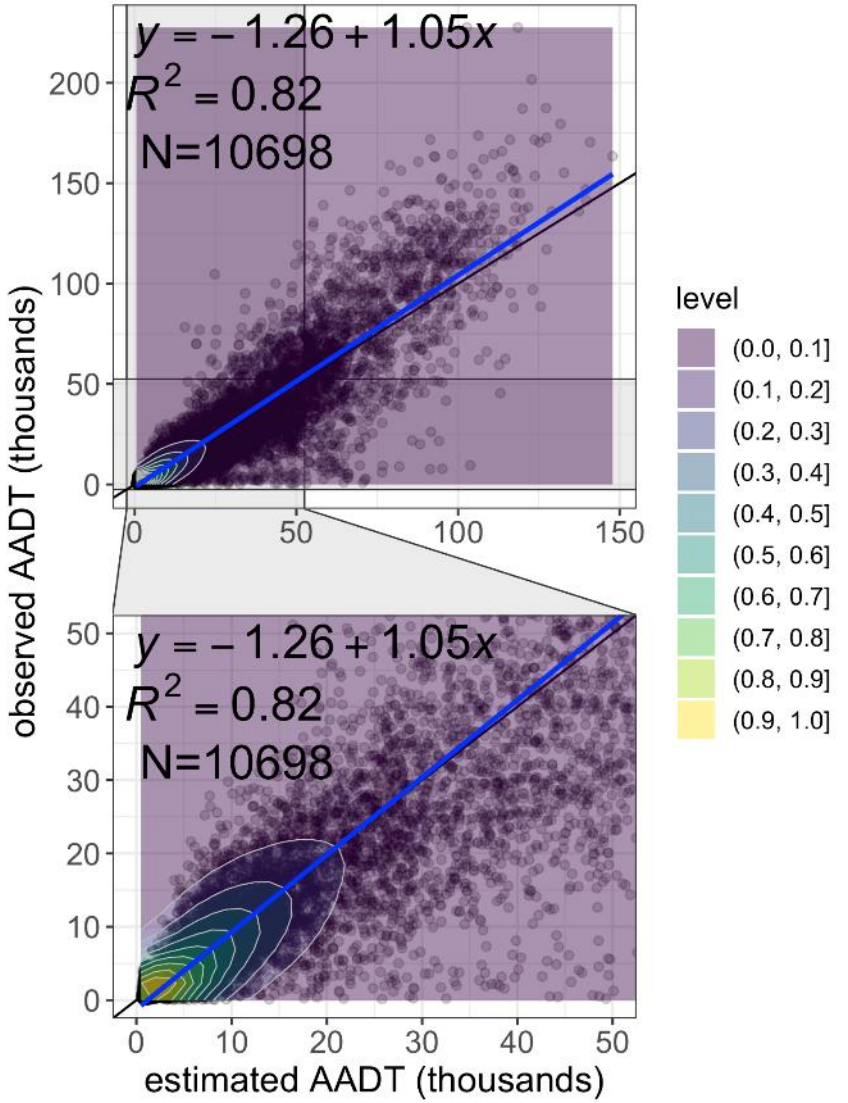
Random forest

$= f ($    $)$

Predictor

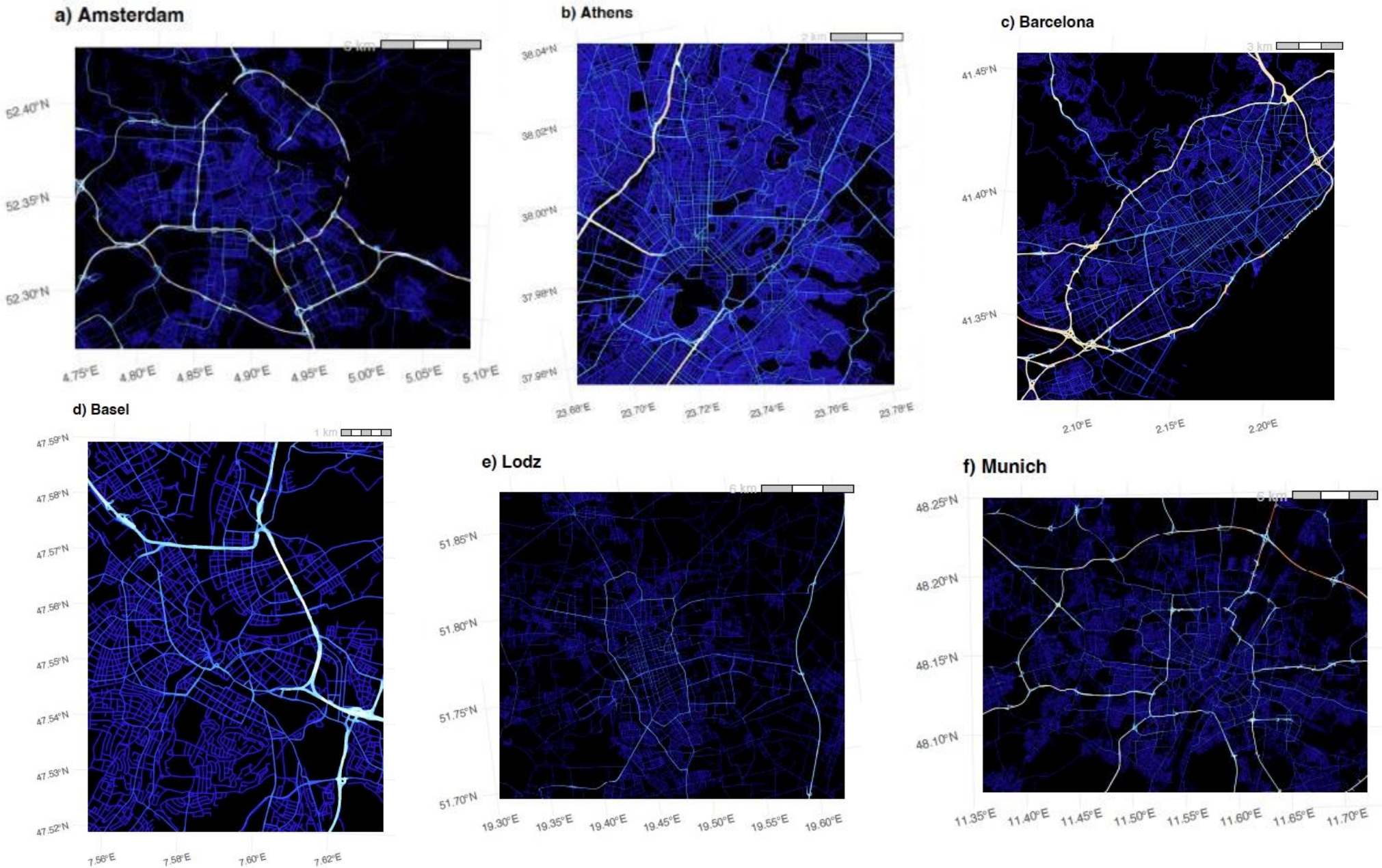
Road traffic model	Road type
Highway	highway (motorway, trunk)
Primary	primary roads
Local	local (secondary, tertiary) roads
Minor	minor (residential, unclassified) roads



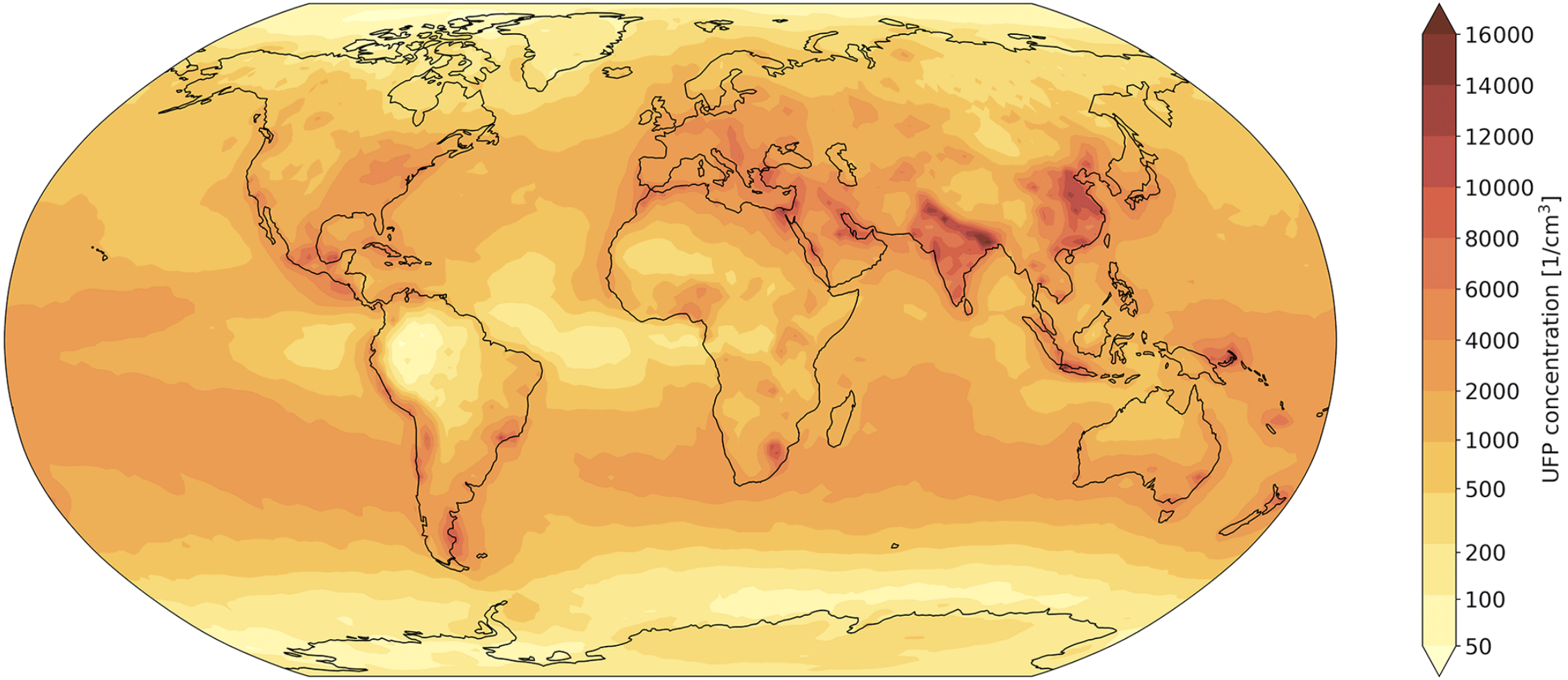


Shen et al (2024), Estimated road traffic flow across Europe improves air pollution modelling (under review)

TRAFFIC FLOW



BACKGROUND UFP CONCENTRATION

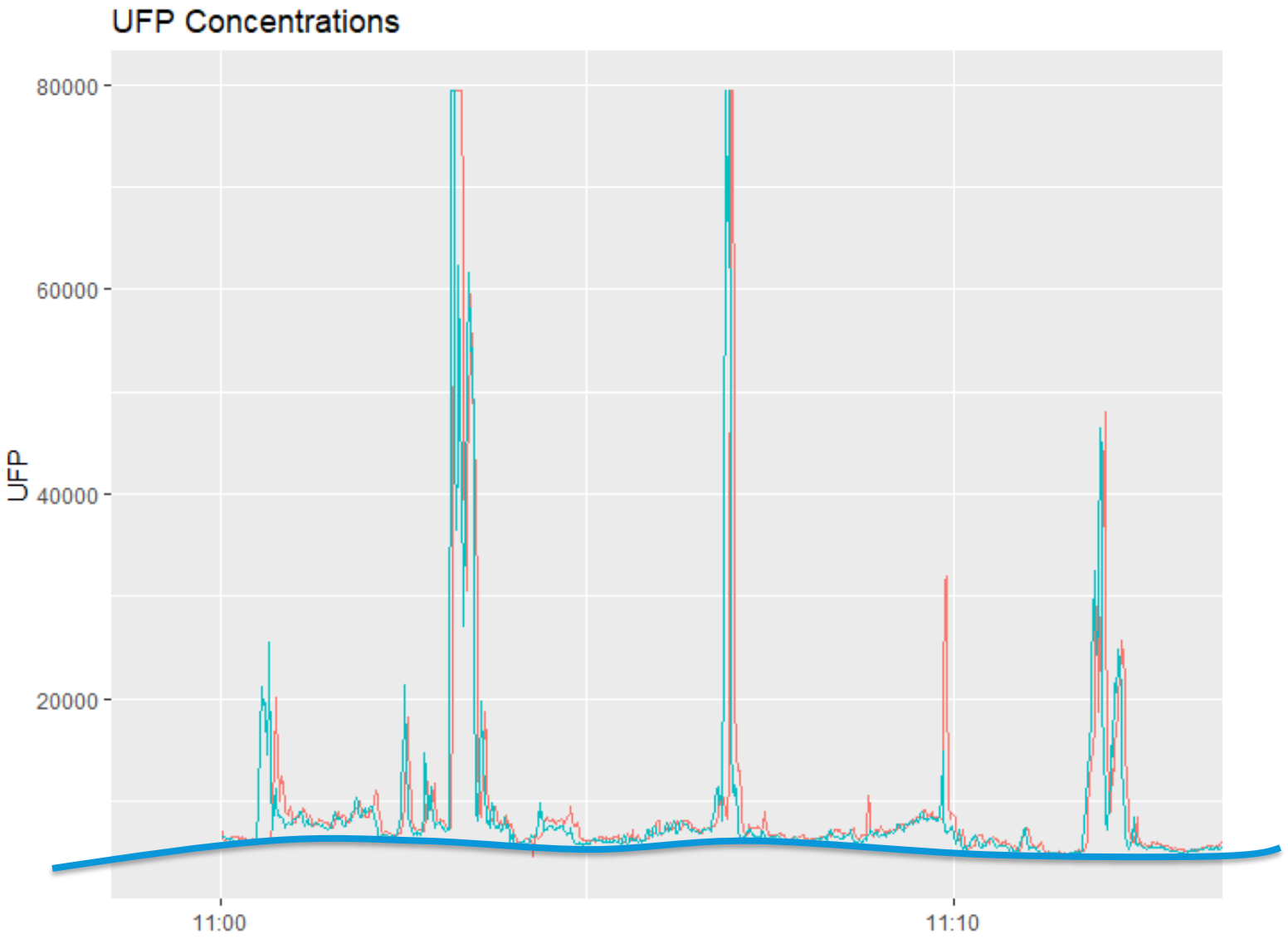


Kohl et al., 2023. Numerical simulation and evaluation of global ultrafine particle concentrations at the Earth's surface

FINAL MODEL

variables	beta	Std.Error	t	P	VIF	increR2
Final	12503.1	264.82	47.21	0.00	NA	NA
AADT_onRoad	0.5	0.00	164.97	0.00	1.60	0.330
CTMufp	0.3	0.02	14.20	0.00	2.72	0.344
alt10_enh	13.1	0.54	24.33	0.00	2.50	0.353
allR_10000	0.0	0.00	11.60	0.00	2.82	0.353
ugr_10000	0.9	0.08	11.39	0.00	2.60	0.354
ind_1000	9.3	1.51	6.20	0.00	1.24	0.354
mjrR_400	1.6	0.05	30.15	0.00	1.90	0.361
FsfRst_500	21.7	2.61	8.34	0.00	1.54	0.362
ind_6000	0.4	0.15	2.69	0.01	1.49	0.362
apor_1000	45.5	8.91	5.11	0.00	1.07	0.362
precip	1042.5	257.09	4.05	0.00	1.25	0.362
por_1500	34.5	1.18	29.30	0.00	1.13	0.367
apor_5000	5.0	0.55	9.07	0.00	1.13	0.367
FsfRst_50	503.3	106.21	4.74	0.00	1.36	0.367
mjrR_2000	0.0	0.01	3.36	0.00	1.75	0.368

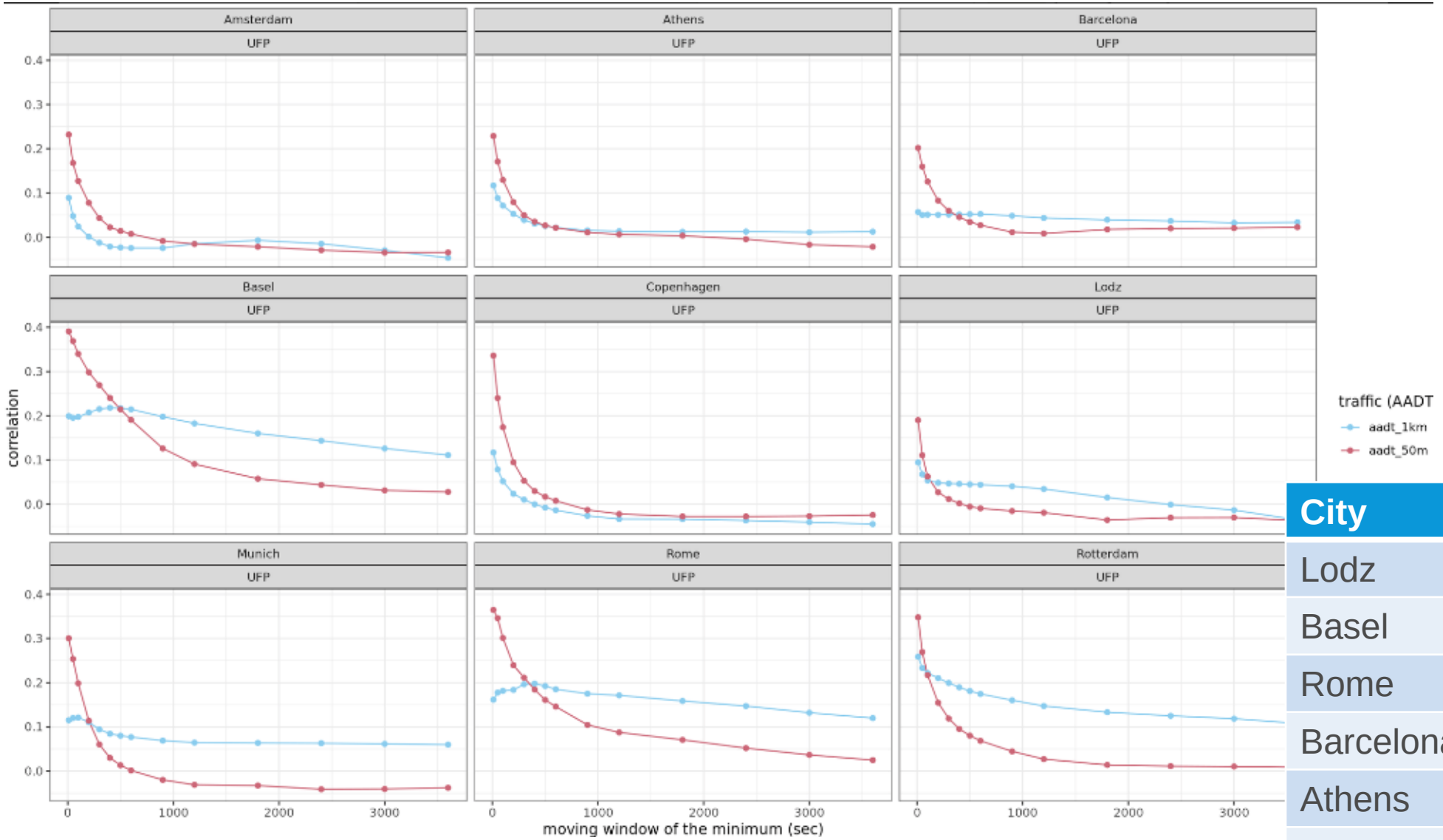
DECONVOLUTION



Moving minimum

Method is based on Brantley et al. (2014) and Shairsingh et al. (2018)

DECONVOLUTION



City	Seconds
Lodz	200
Basel	500
Rome	400
Barcelona	400
Athens	600
Munich	300

DECONVOLUTED MODELS

BACKGROUND

variables	beta	Std.Error	t	P	VIF	increR2
Final	-58775.26	2857.99	-20.57	0.00	NA	NA
por_10000	2.90	0.03	98.21	0.00	2.18	0.151
mjrR_2000	0.06	0.00	20.84	0.00	2.82	0.195
por_1800	15.85	0.30	53.49	0.00	1.40	0.217
temp	226.22	10.09	22.43	0.00	2.63	0.229
precip	1367.92	95.56	14.32	0.00	1.85	0.238
ugr_10000	0.44	0.02	19.96	0.00	2.33	0.239
nat_10000	0.12	0.01	22.58	0.00	2.50	0.241
ind_1000	7.14	0.43	16.65	0.00	1.07	0.244
CTMufp	0.11	0.01	16.04	0.00	2.38	0.245
mjrR_1000	0.15	0.01	23.97	0.00	2.48	0.249
apor_3500	1.04	0.30	3.43	0.00	1.04	0.249

LOCAL

variables	beta	Std.Error	t	P	VIF	increR2
Final	5613.94	120.81	46.47	0.00	NA	NA
AADT_onRoad	0.45	0.00	119.30	0.00	2.27	0.300
mjrR_50	24.93	0.83	30.11	0.00	2.97	0.309
allR_700	0.10	0.01	13.77	0.00	1.69	0.313
mjrR_500	0.37	0.04	9.04	0.00	2.02	0.313
pop20_500	0.03	0.01	2.90	0.00	2.07	0.313
FsfRst_50	632.82	101.73	6.22	0.00	1.36	0.314
FsfRst_500	9.85	2.63	3.75	0.00	1.70	0.314

Combined R^2: 0.35

CONCLUSION AND DISCUSSION

- It is possible to create a European-wide LUR model based on mobile measurements.
  - Urban areas only?
  - Day time only?
  - Spatial clusters of measurements
    - Test interaction with city to verify CTM (and other variables) dealt with spatial variation between cities sufficiently.
      - Coordinates were not helpful
  - Test RF

Foto Bas Niemans

Thanks to:
Youchen Shen
Gerard Hoek
Kees de Hoogh
Roel Vermeulen