

ICARUS

Integrated Climate forcing and Air pollution Reduction in Urban Systems

NPAHs and OPAHs in the atmosphere of two central European cities: seasonality, urban-to-background gradients and gas-to-particle partitioning

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Over the last years, increasing attention has been given to PAH derivatives, i.e. the nitrated and oxygenated PAHs.

Some NOPAHs are more mutagenic and carcinogenic than their parent PAHs

Several OPAHs cause reactive oxygen species

Unlike PAHs, NOPAHs can be also secondarily formed via oxidative reactions

- 2 participating cities: Brno and Ljubljana
- For each city, one traffic site, one urban background site and one regional site (only for Brno)
- Daily air samples were taken 30 days in winter and 30 days in summer at each of the site with high/low volume air sampler with PM_{2.5} inlet
- In addition, gas phase was also sampled in 7/8 samples at the Brno sites

- Provide novel atmospheric data on NPAHs and OPAHs at each a traffic (T), an urban background (UB) and a rural (R) site collected in winter and summer 2017 at/near Brno (CZ) and Ljubljana (SLO)
- The seasonal and spatial variations of these compounds were investigated. In addition, the importance of gas-particle partitioning concerning the cancer risks was studied

	Winter		Summer	
	Brno	Ljubljana	Brno	Ljubljana
T	30	30	30	30
UB	30	30	30	30
R	8	0	8	0

Target compounds

18 NPAHs

- 1-Nitronaphthalene
- 2-nitronaphthalene
- 3-nitroacenaphthene
- 5-nitroacenaphthene
- 2-nitrofluorene
- 9-nitroanthracene
- 9-nitrophenanthrene
- 3-nitrophenanthrene
- 2-nitrofluoranthene
- 3-nitrofluoranthene
- 1-nitropyrene
- 2-nitropyrene
- 7-nitrobenzoanthracene
- 6-nitrochrysene
- 1,3-Dinitropyrene
- 1,6-Dinitropyrene
- 1,8-Dinitropyrene
- 6-nitrobenzoapyrene

11 OPAHs

- 1,4-naphthoquinone
- naphthalene-1-aldehyde
- 9-fluorenone
- 9,10-anthraquinone
- 1,4-anthraquinone
- 9,10-phenanthroquinone
- benzo-a-fluoren-11-one
- benzo-b-fluoren-11-one
- benzanthrone
- benz(a)anthracene-7,12-dione
- 5,12-naphthacenequinone

- Extraction with (automatic) Soxhlet extractor

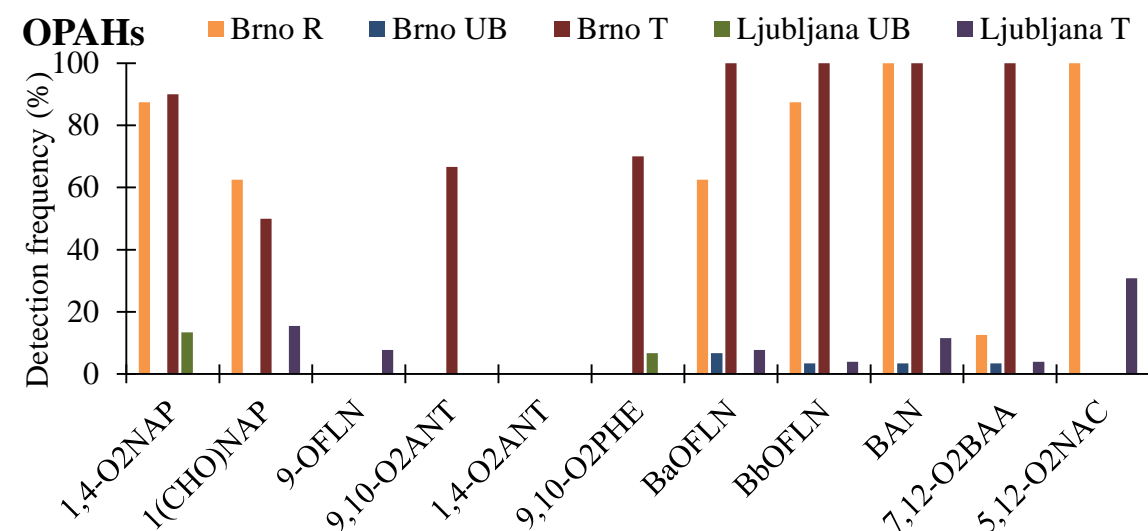
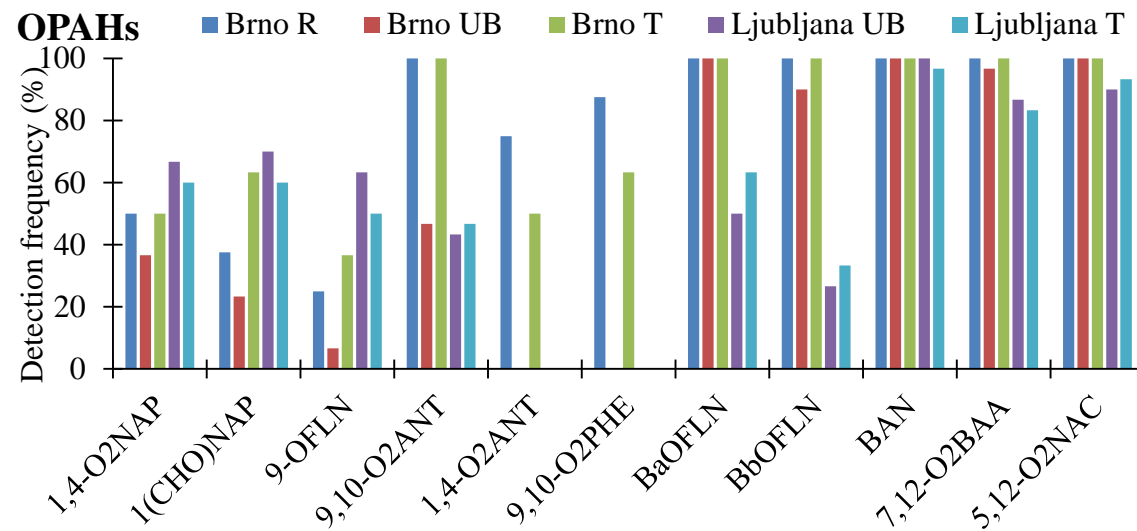
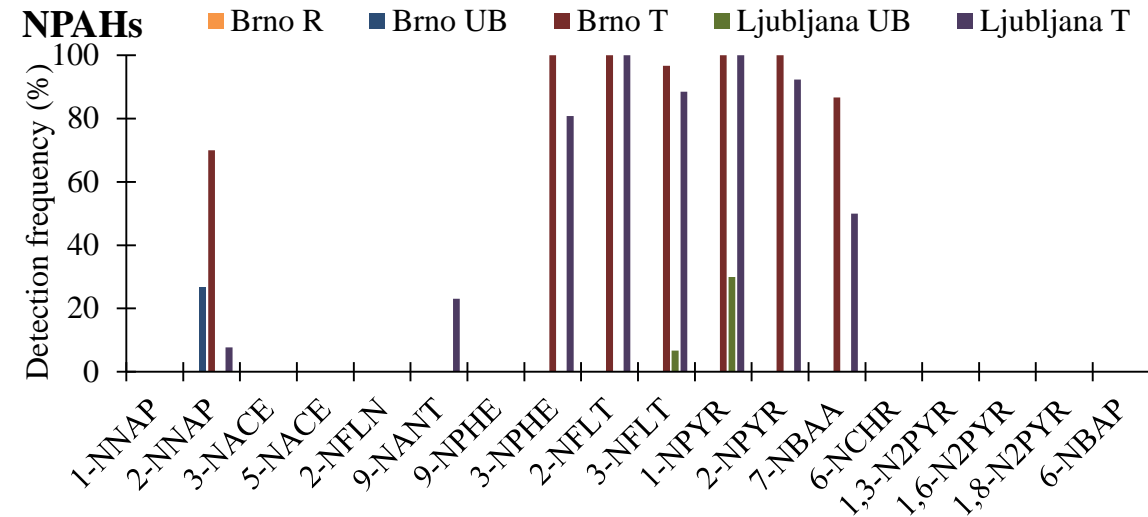
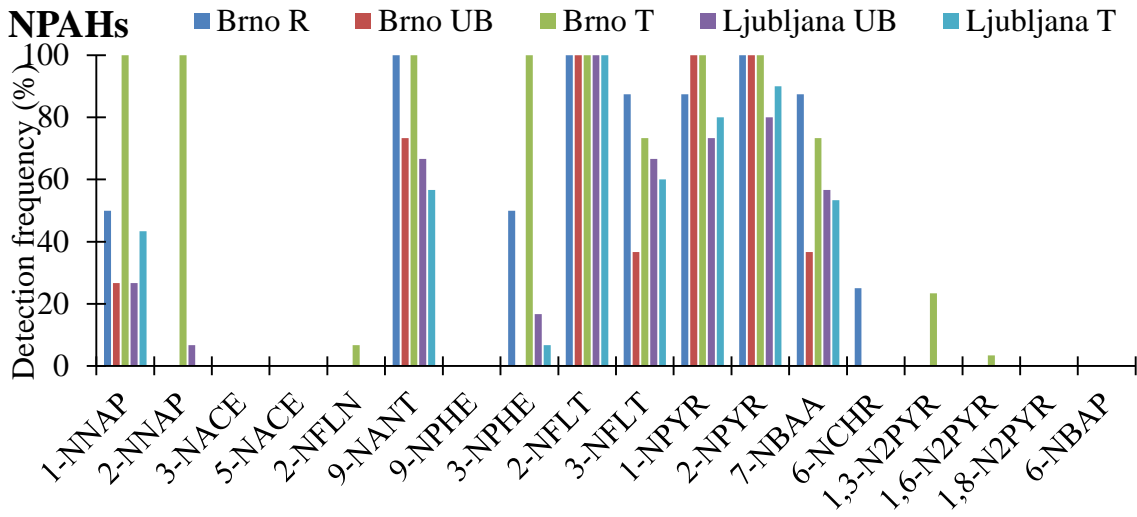


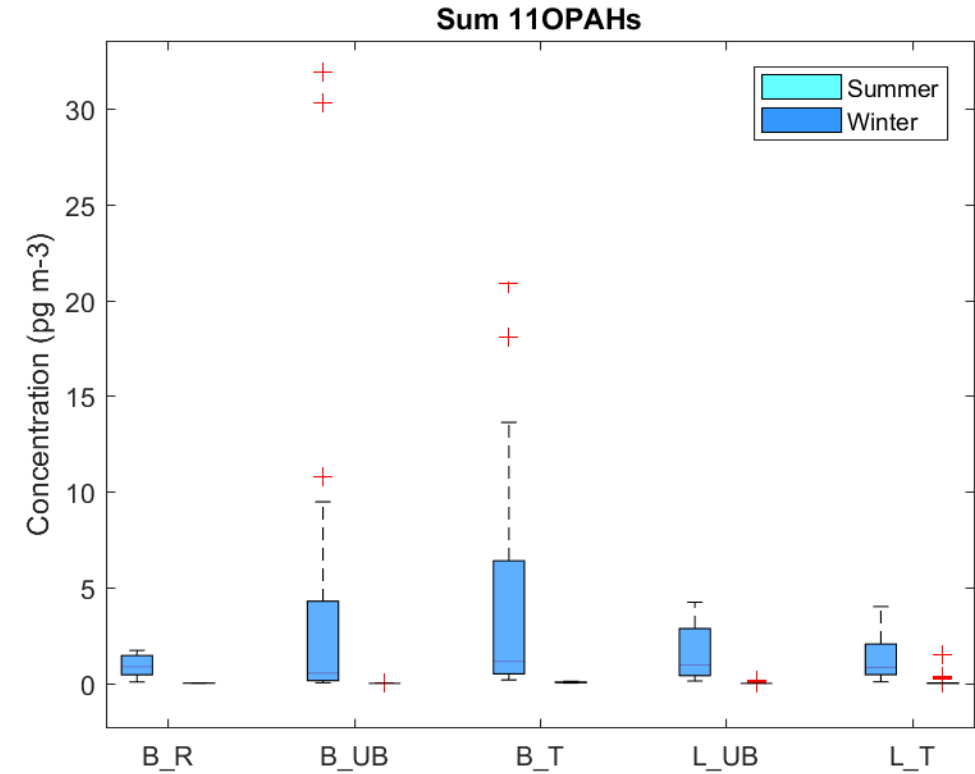
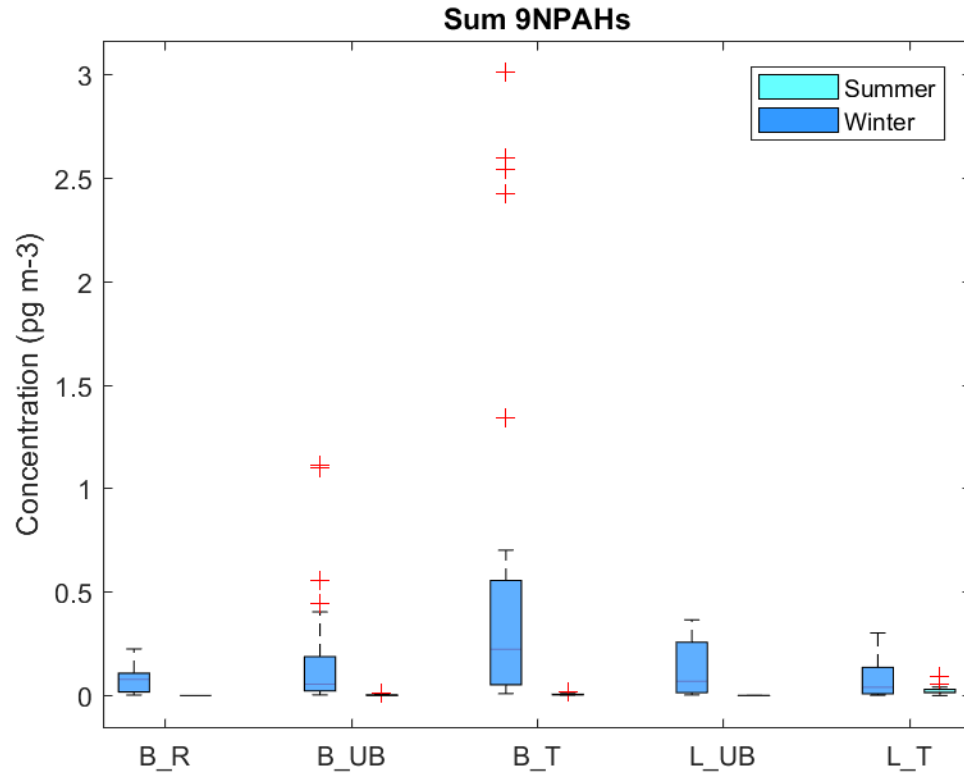
- Clean-up



- Analysis by GC-MS

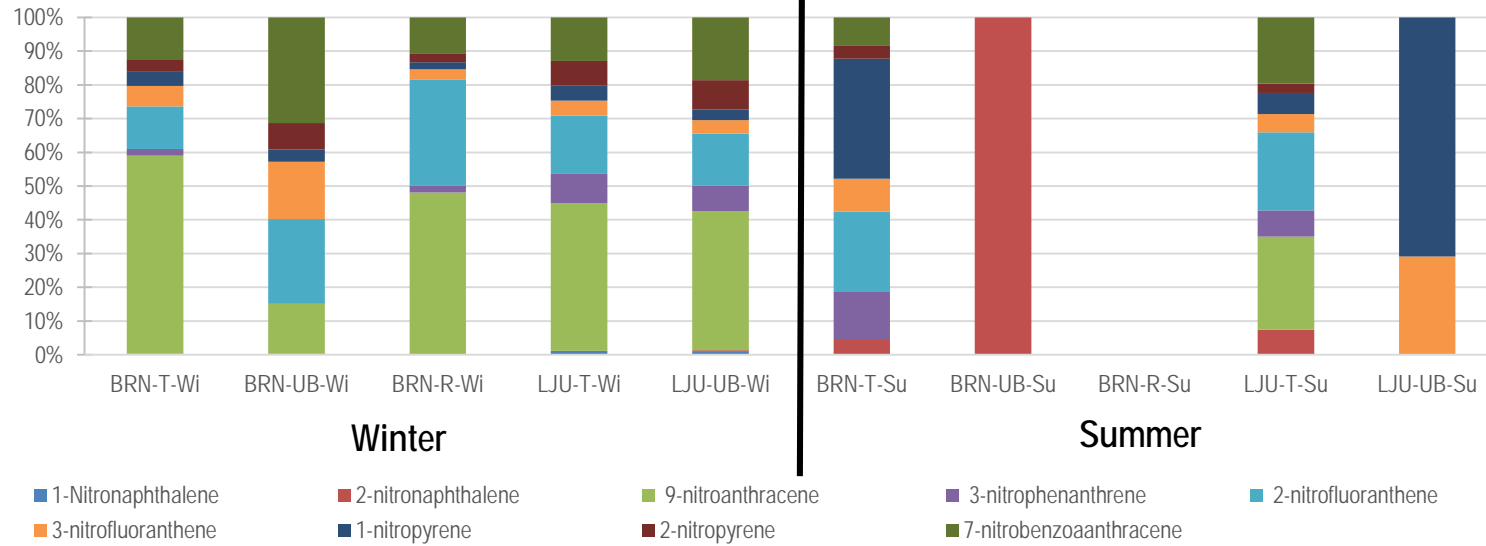






Higher NOPAHs concentrations in winter at all sites
 In Brno, a rural to UB to traffic gradient, but not in Ljubljana

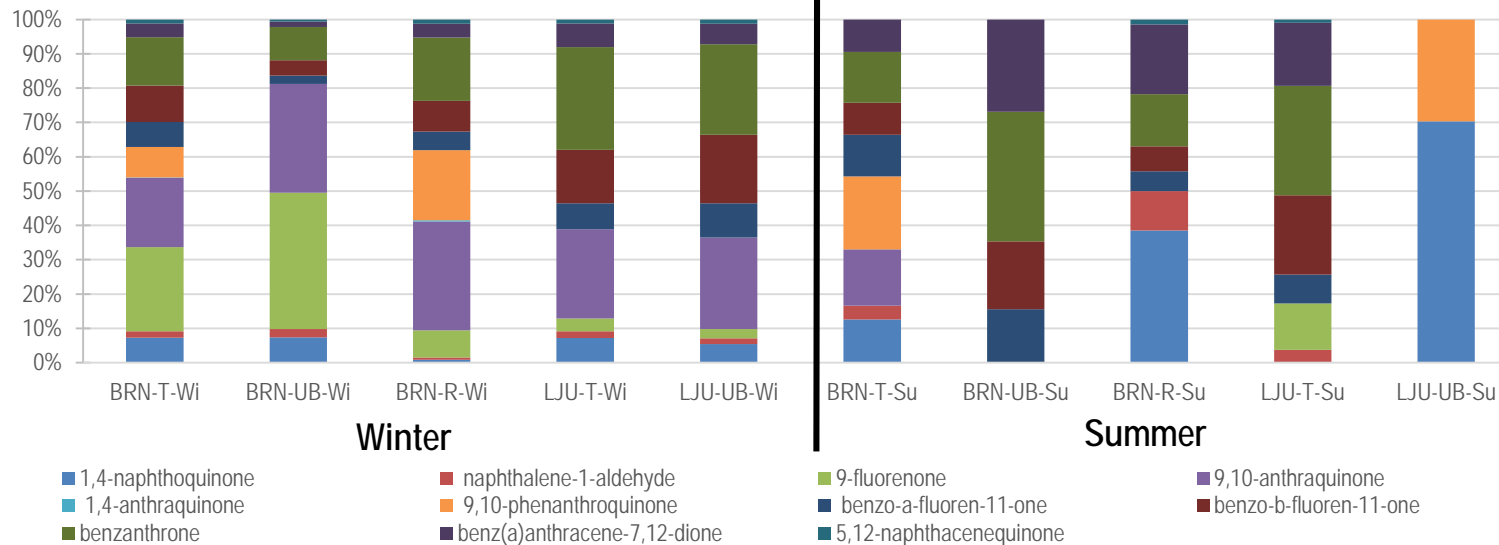
NPAHs



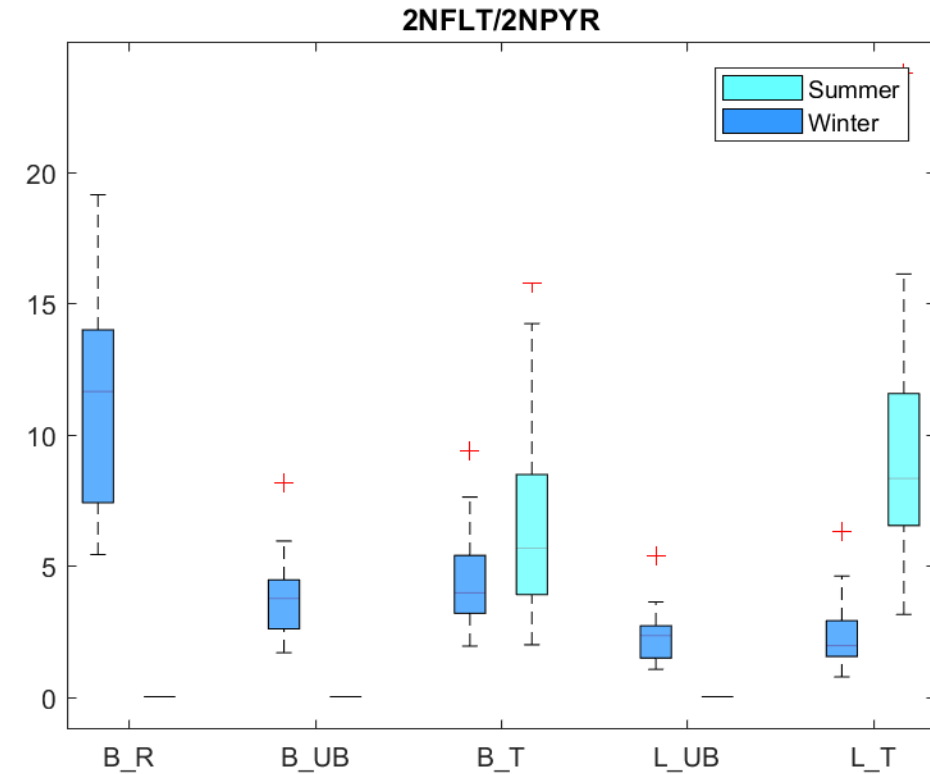
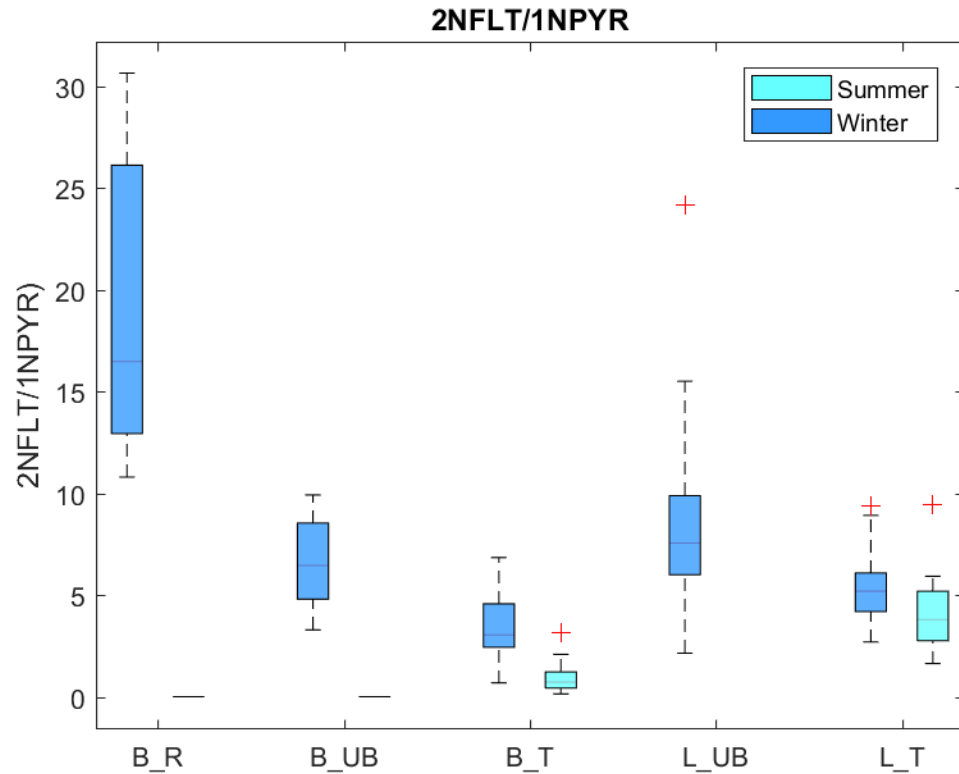
- Different composition profiles between winter and summer

- 9-nitroanthracene, 2-nitrofluoranthene and 7-nitrobenzoanthracene dominated NPAH concentrations

OPAHS



- 1,4-naphthoquinone, 9,10-anthraquinone, benzo-b-fluoren-11-one and benzanthrone dominated OPAH concentrations

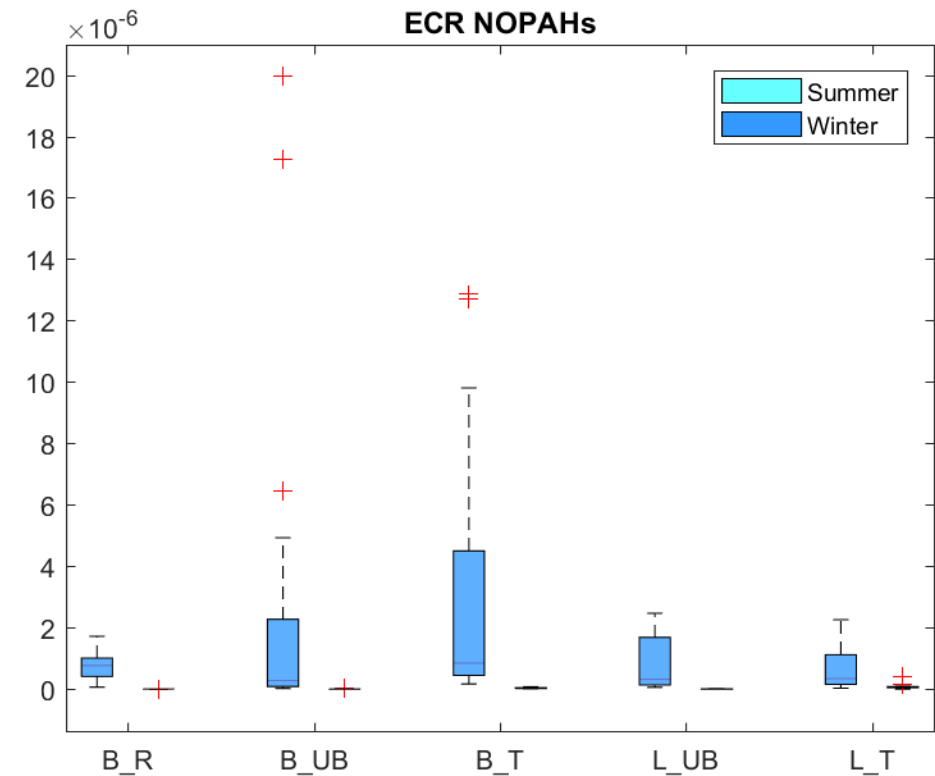


Primary sources at the traffic and UB sites
 Secondary sources at the regional site

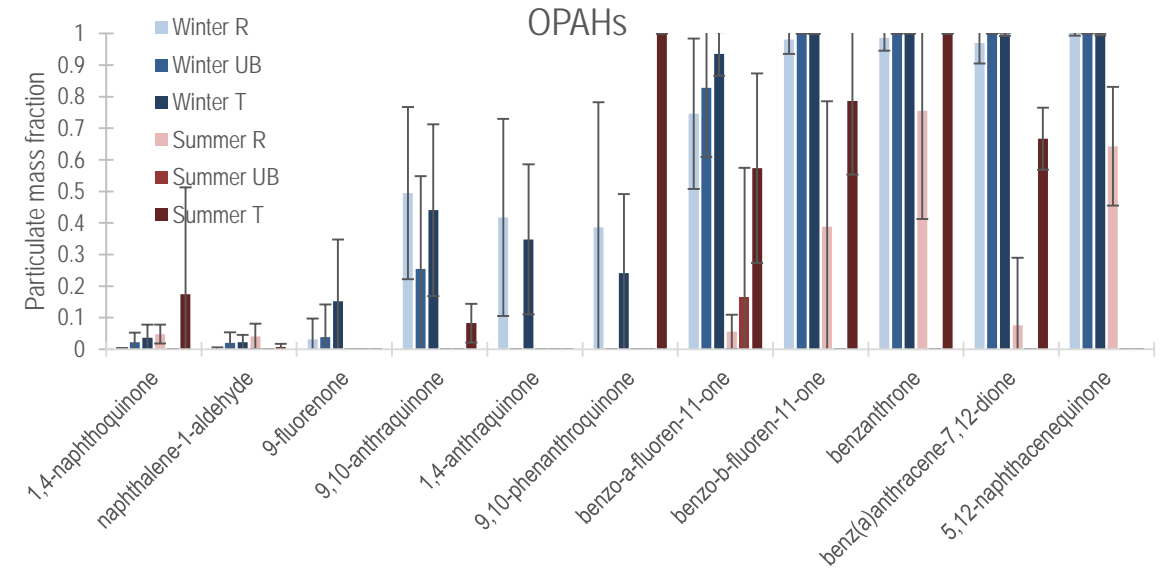
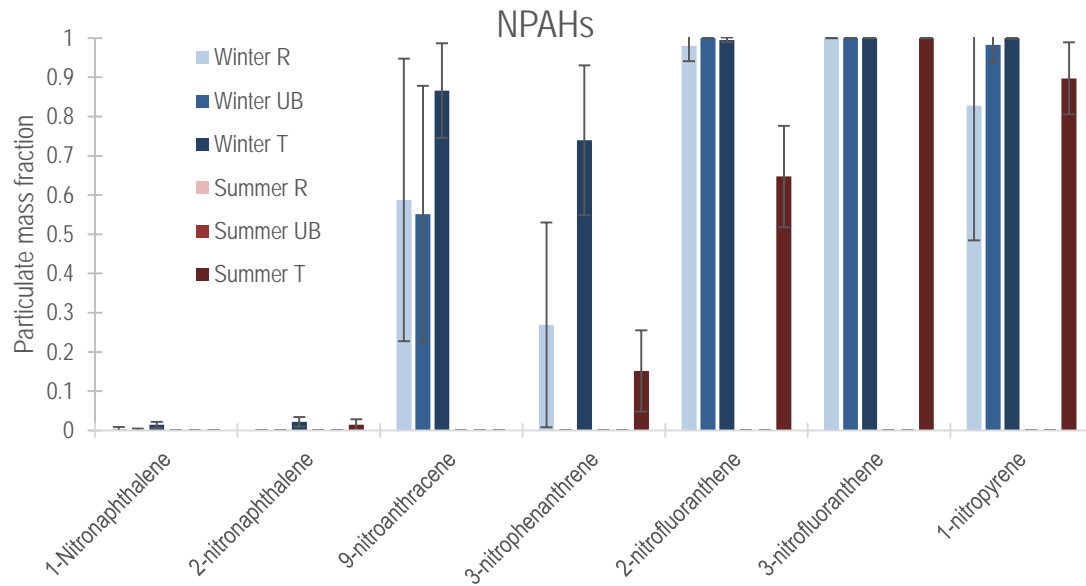
Formation during the day

$$\text{Excess Cancer risk} = \sum(C_{\text{NOPAH},i} \times \text{RPF}_i) \times \text{UR}_{\text{BaP}}$$

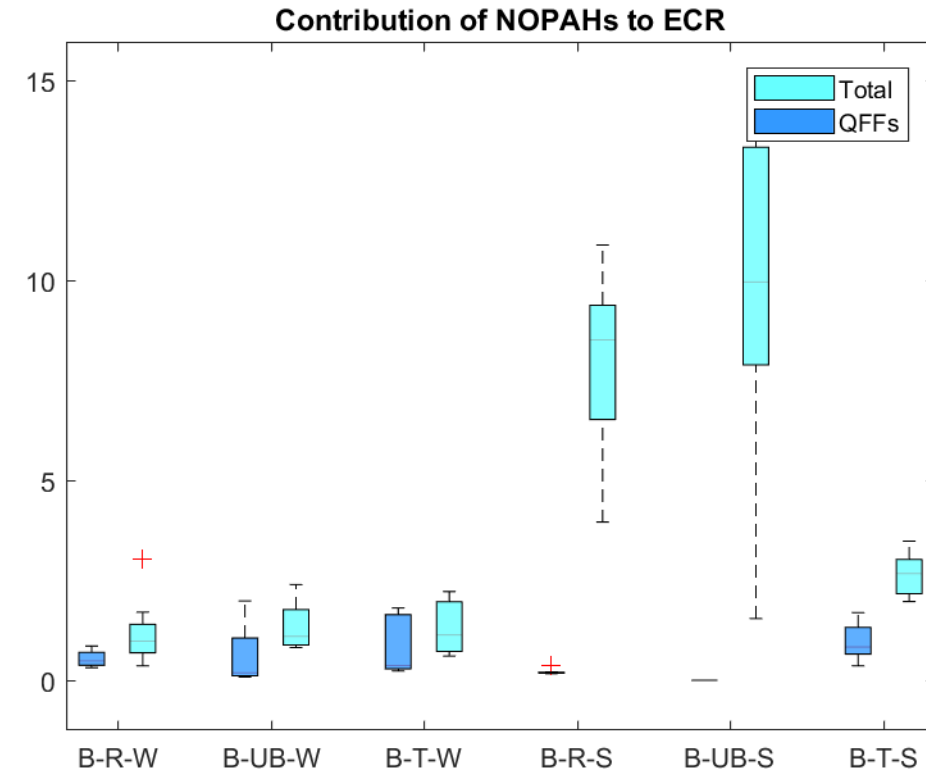
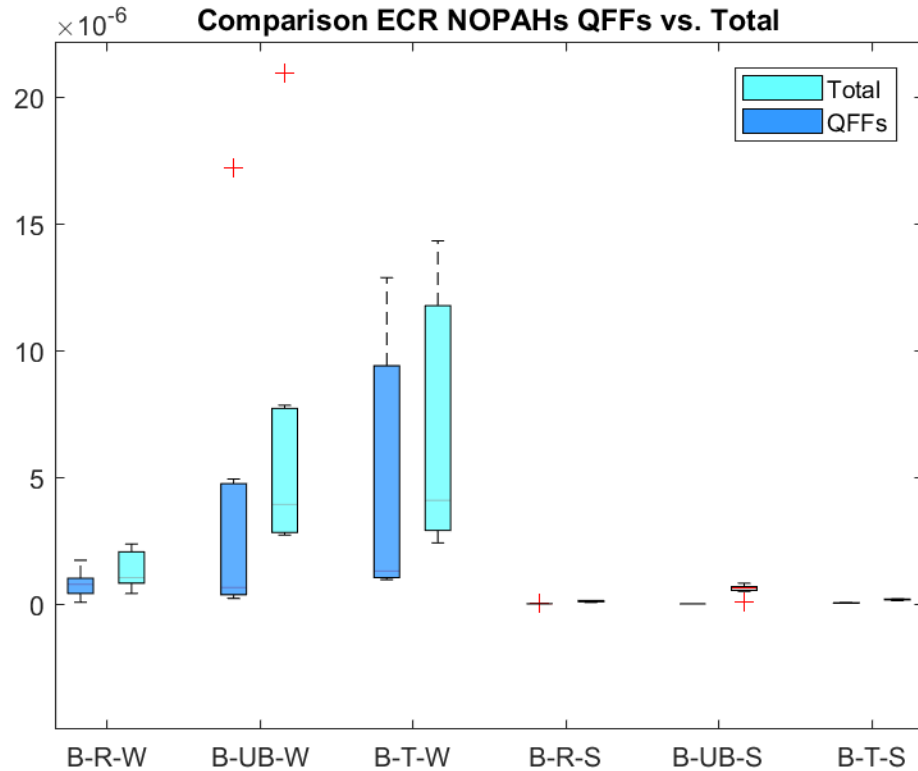
$C_{\text{NOPAH},i}$ = the particulate concentration of NOPAH_i (in ng m⁻³),
 RPF_i = the relative potency factor of PAH_i and UR_{BaP} = the unit risk of exposure to BaP



In winter, cancer risks are significant (i.e. >10⁻⁶)
 Higher cancer risk in Brno compared to Ljubljana



- Gas-particle partitioning followed vapor pressure and showed seasonal variations
- Higher particulate mass fractions at the traffic site for 9-nitroanthracene, 3-nitrophenanthrene, 1-nitropyrene, 9,10-anthraquinone, benzo-a-fluoren-11-one, benzo-b-fluoren-11-one and benzanthrone and benz(a)anthracene-7,12-dione -> emitted as fine particles from traffic and subsequently partitioning
- Unexpected high particulate fractions at the rural site in winter of 9-fluorenone, 1,4-anthraquinone and 9,10-phenanthroquinone



Cancer risks are up to 2x higher when the gas phase is considered

Compared to PAHs, NOPAHs represent a small fraction of total cancer risks when considering only QFFs but can contribute up to 15% when considering also the gas phase

- This study helped to identify those NPAHs primarily emitted from traffic
- This study showed the importance of sampling the gas phase when assessing the cancer risks from inhalation of NOPAHs

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- All colleagues who contributed to that research

Thank you for your attention. Any questions?

