RESEARCH AND DIALOGUE
FOR SUSTAINABLE SOCIETIES

Hourly Roadside Traffic Emissions from Bottom-up Inventory for the City of Berlin

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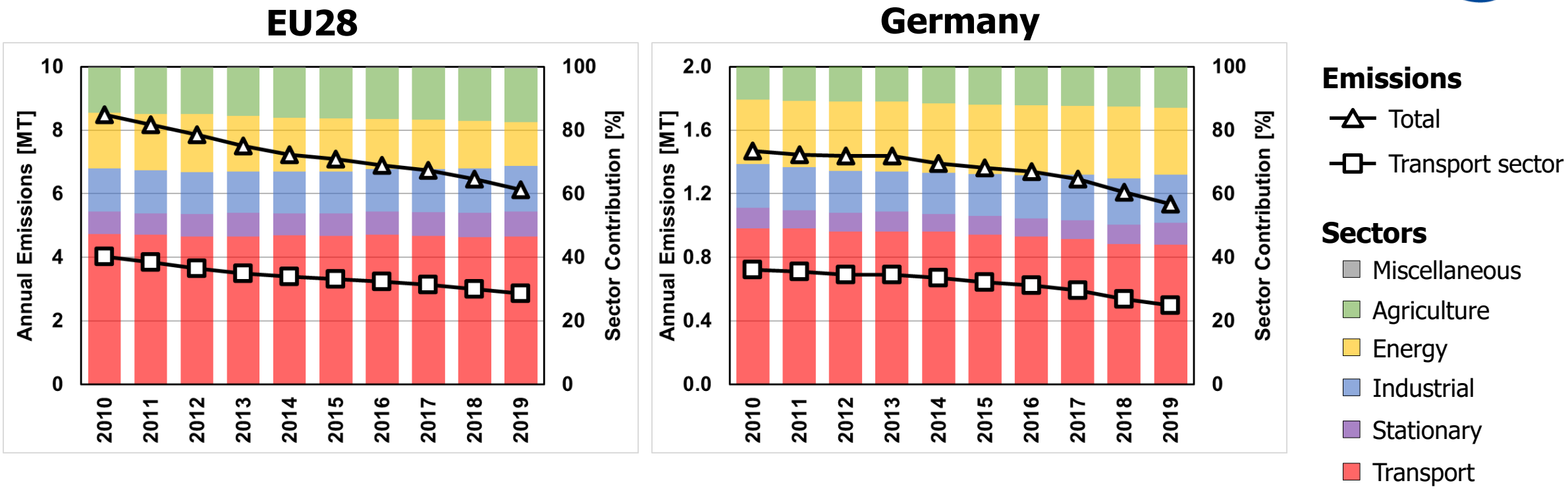
Transport (still) significant NO_x contributor to EU airborne pollutants



- ☑ Emission levels generally decreasing in both EU and Germany
- ☒ Transport accounts for over **40%** of **NO_x** contributions in EU *and* Germany
- ☒ German transport **NO_x** contribution **19%** within EU transport sector (**8.8%** of EU total)

Comprehensive urban air quality modelling & observation at IASS

Traffic activities

Emission factors

Meteorological data

Yeti

Coupled meso- to urban scale model

Colocation & field calibration

Low cost sensors

Reference detectors

Model evaluation

Pollutant exposure

Mitigation policies

Scope of presentation

Roadside traffic emissions data

- Yeti bottom-up traffic inventory (Chan et al, 2022)
- Annual aggregate comparison (NO_x / PM_{10} / CO / HC)

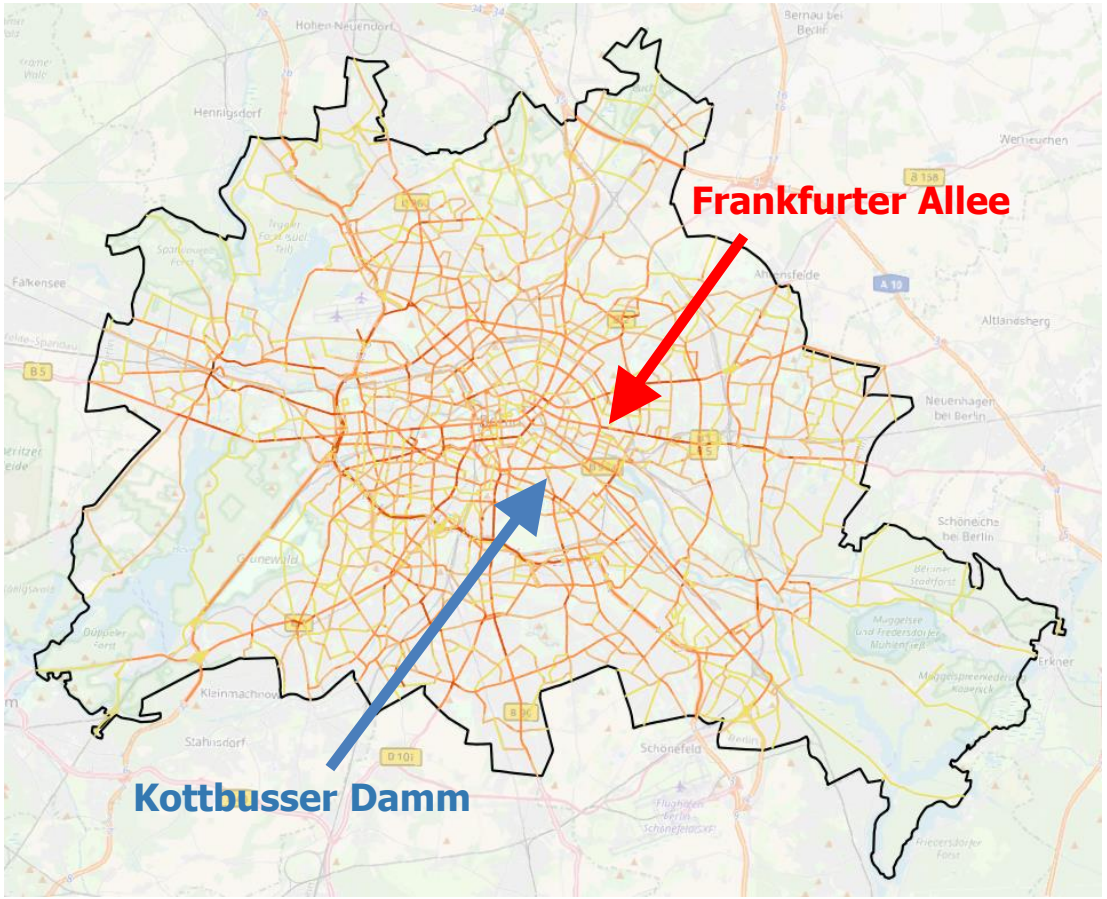
Berlin measurement campaigns

- Frankfurter Allee, 2018-08 (Schmitz et al, submitted)
- Kottbusser Damm, 2022-02 (Schmitz et al, 2021)

Comparing LCS concentration and Yeti Emissions

- Compatibility with roadside emission model data
- Focus on NO / NO_2 / NO_x

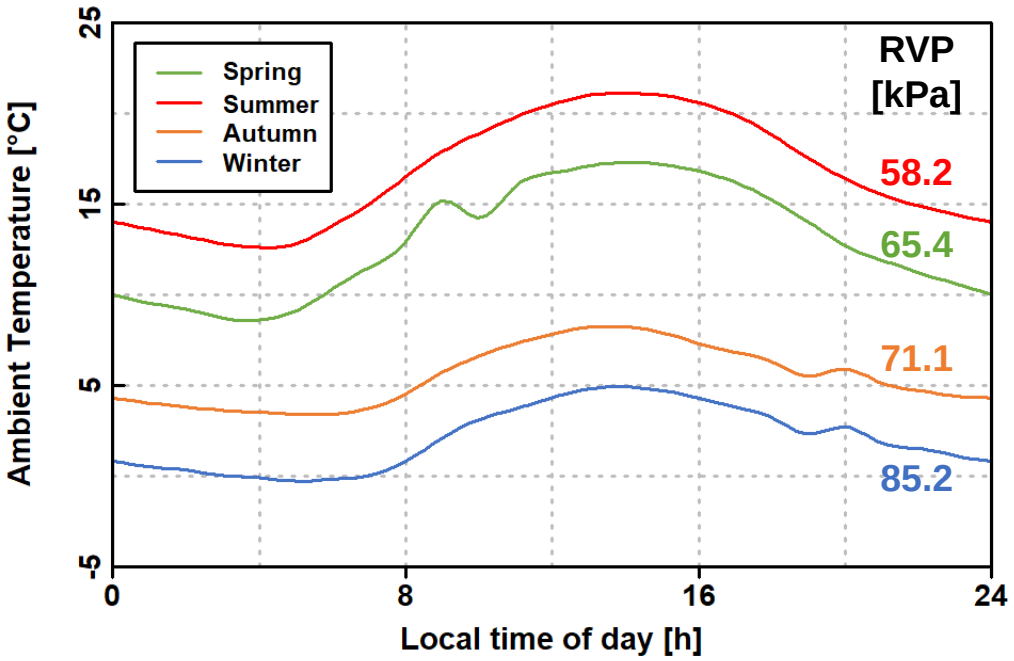
Mean annual aggregate daily roadside NOx emissions for Berlin generated by Yeti ▶



Yeti emissions comparison with official inventory (2015)

Official 2015 inventory (Diegmann et al, 2020)

- Available for NO_x, PM_{10}, CO, and HC (hydrocarbons)
- Using HBEFA 3.3 under VDI directive 3782/7 (2020)
- Yeti compares well except non-exhaust PM
  - ▷ Using emission factors from HBEFA 4.1



Annual daily aggregate emissions comparison and breakdown

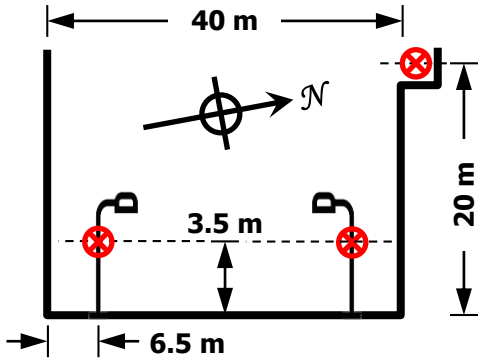
Emissions [tonnes/day]	NO_x	PM_{10}	CO	HC
Official inventory 2015	15.94	1.50	37.78	6.78
Yeti 2015 (HBEFA 3.3)	15.25	0.97	33.83	7.60
Yeti emissions breakdown				
Hot run	14.72	0.21	11.18	1.80
Cold excess	0.53	0.03	22.65	5.03
Evaporative diurnal	- -	- -	- -	0.62
Evaporative hot soak	- -	- -	- -	0.04
Evaporative running losses	- -	- -	- -	0.11
Non-exhaust PM	- -	0.74	- -	- -

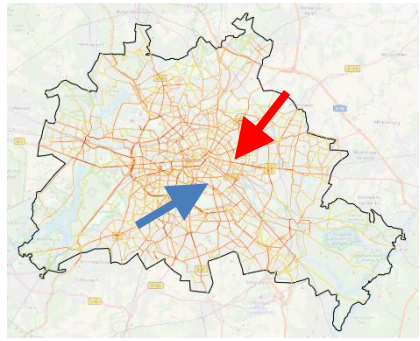
◄ Mean seasonal diurnal temperature profiles and RVPs for Germany

Measurement campaigns summary

Frankfurter Allee (Schmitz et al, submitted)

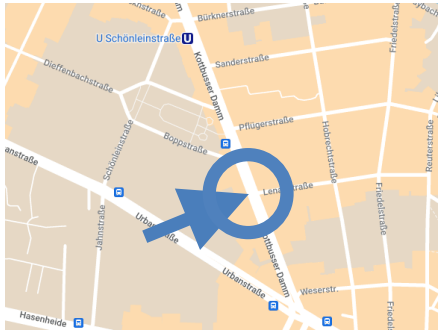
- Trunk road
- East-West
- August 2018

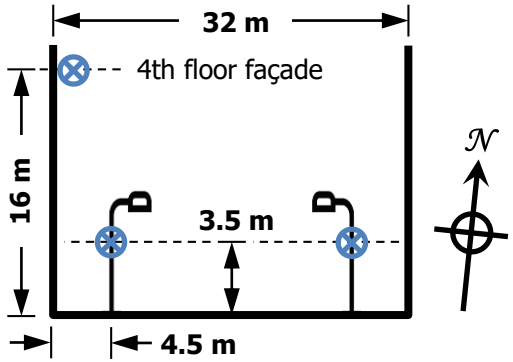




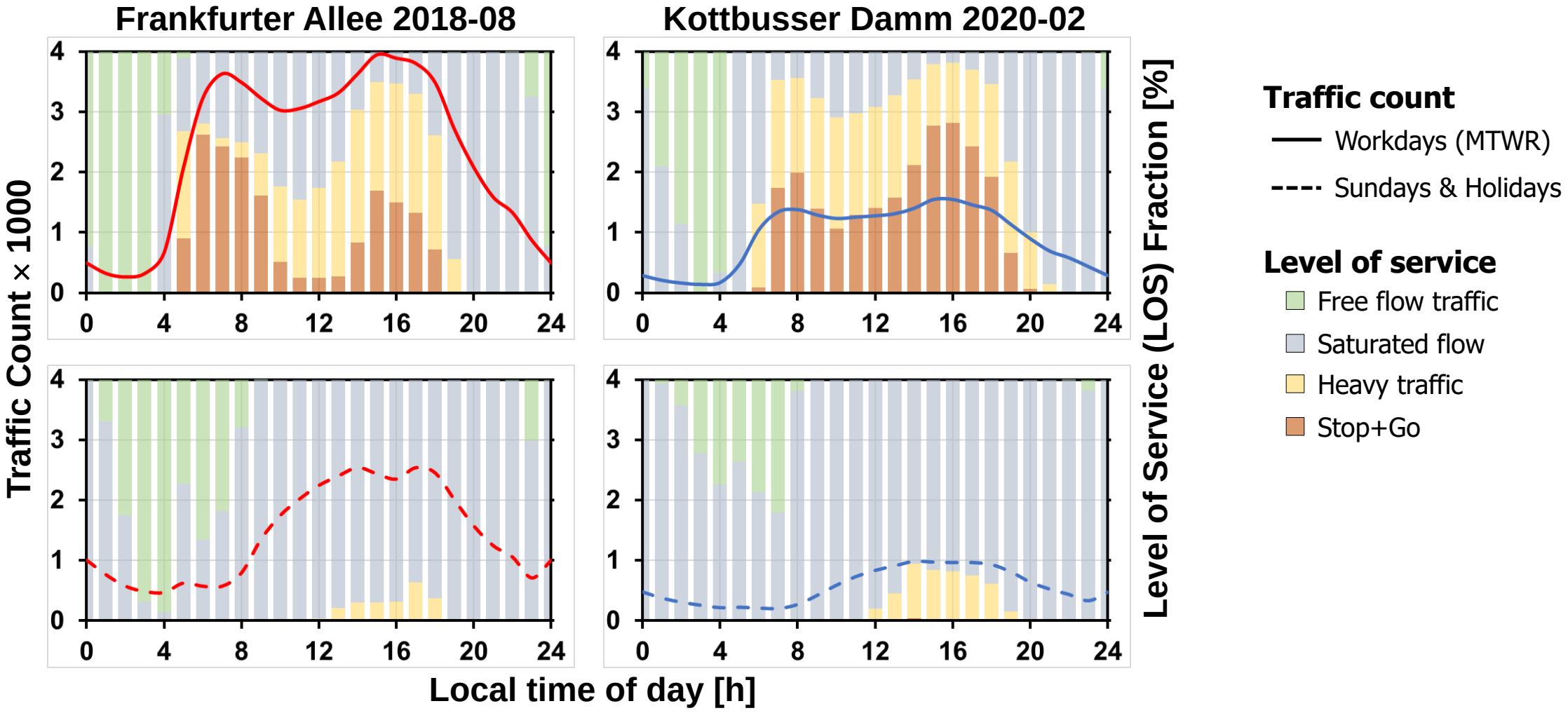
Kottbusser Damm (Schmitz et al, 2021)

- Distributor
- North-South
- February 2020

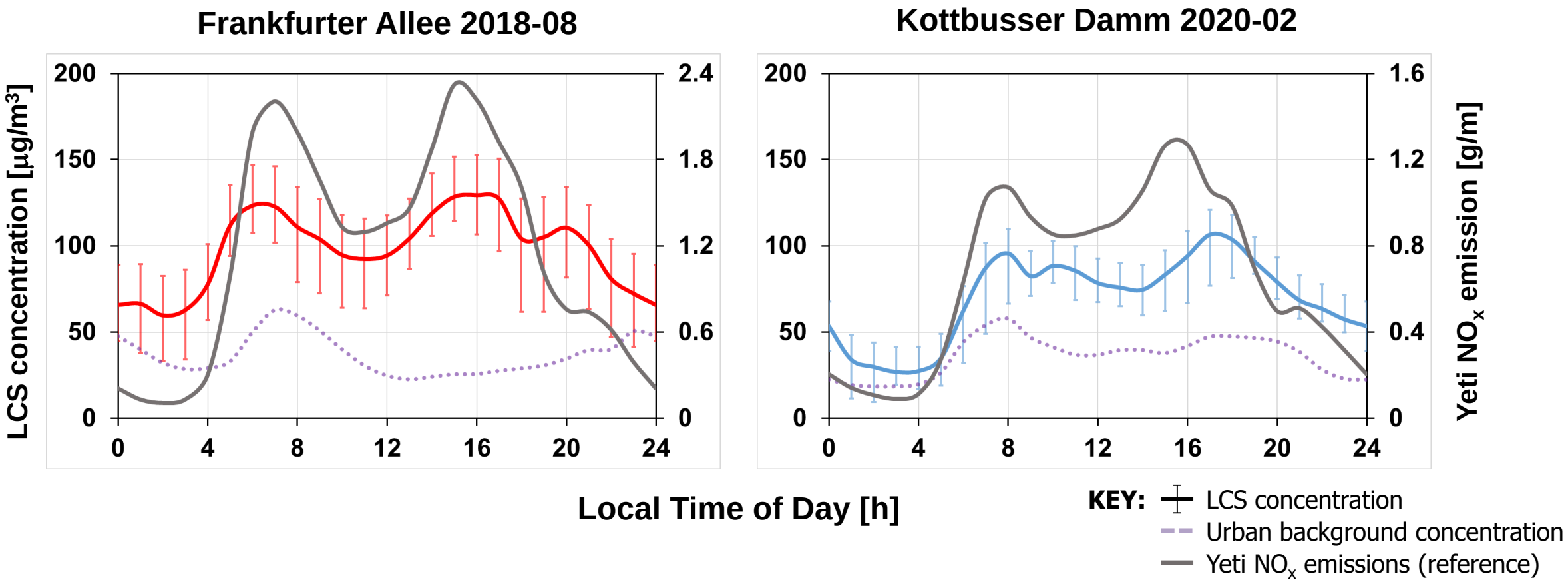




Modelled traffic activities during measurement campaigns

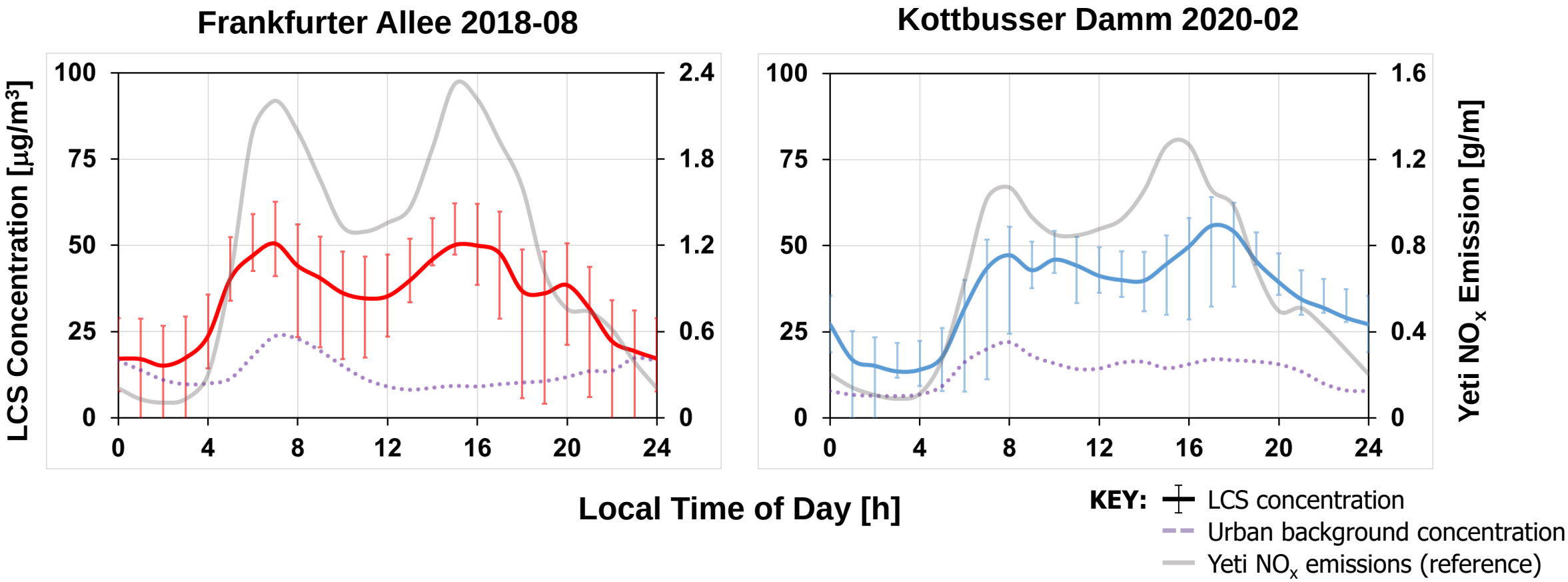


LCS concentrations & Yeti emissions –Weekdays (MTWR) NO_x



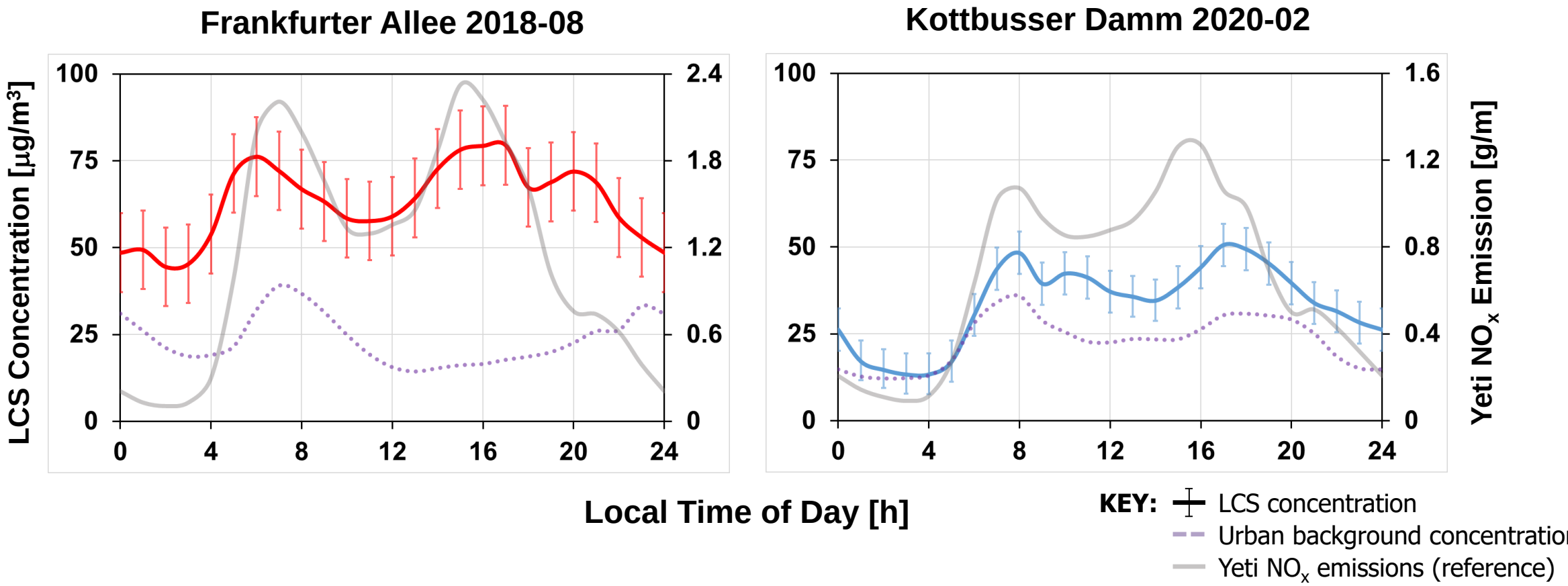
- LCS concentration correspond roughly to traffic emission profile
- Differences in peak locations indicate local variation in traffic activities

LCS concentrations & Yeti emissions – Weekdays (MTWR) NO



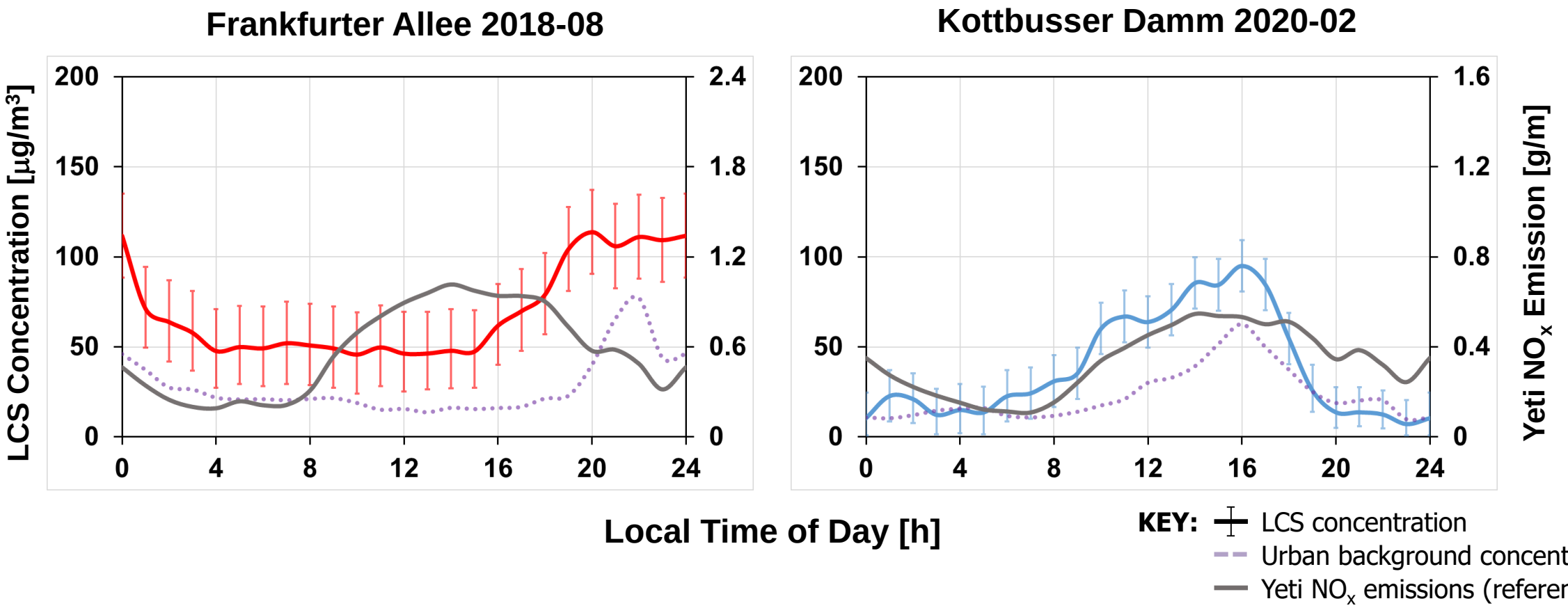
- Morning [NO] peak coincides with rise in traffic emission
- Suppression of evening peak partially due to O_3 interaction

LCS concentrations & Yeti emissions – Weekdays (MTWR) NO_2



- Higher [NO2]/[NOx] in Frankfurter Allee than Kottbusser Damm
- Morning peak possibly also due to lower vertical mixing
- Effects of NO2 photodissociation into NO and O(3P) in morning peak

LCS concentrations & Yeti emissions – Sundays & Holidays NO_x



- Summer evening peak not considered in Yeti emissions (end of school holidays)
- Small LCS sample size (only 4 days and no additional holidays)

Concluding remarks

Comprehensive air quality programs

- Bottom up inventory tool Yeti (Chan et al, 2022)
- LCS measurements (Schmitz et al, 2021)

Modelled traffic emissions

- Scalable HBEFA-based framework
- Hourly road-level traffic emissions
- Compatible with officially aggregated inventory

LCS measurement campaigns

- Frankfurter Allee (Aug 2018)
- Kottbusser Damm (Feb 2020)

Yeti emissions & LCS concentrations for NO_x

- Compares well for Weekdays (MTWR)
- Deviations for Sundays & Holidays attributed to
  - ▷ Sample size during observational periods
  - ▷ Discrepancies between local and mean traffic activities

Future work

- Numerical modelling
  - ▷ Dispersion and secondary pollutant formation
- Accompany local traffic counts
  - ▷ Data fusion / agent-based model
- Expand field calibration to other pollutants (e.g., PM_{10})

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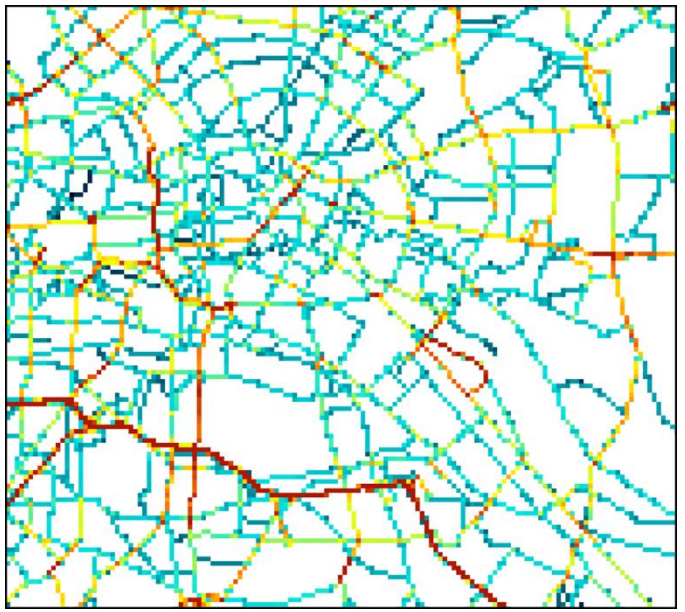
◀ Earthsense Zephyr® LCS

▼ Gridded Yeti NO_2 emissions for WRF-Chem



References

- Caeseiro & von Schneidemesser (2021) Sci Data 8:287
- Chan et al (2018) Proc IGAC 15
- Chan et al (2022) GMD-2022-147
- Diegmann et al (2020) Modellrechnungen zur Zweiten Fortschreibung des Berliner Luftreinhalteplans, IVU GmbH
- EEA (2021) National Air Polluant Emissions www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-5
- Kuik et al (2017) GMD 9(12):4339-4363
- Kuik et al (2018) ACP 18:8203-8225
- Schmitz et al (2021) Environ Res Lett 16(8):084031
- Schmitz et al (2021a) Atmo Meas Tech 14(11):7221-7241
- Schmitz et al, in preparation
- VDI (2020) VDI 3782 Blatt 7

Image credits

Comprehensive urban air quality

- Mesoscale model: Kuik et al (2017) GMD 9(12):4339-4363
- Emission factors: iNFRAS archives
- Urban model: Chan et al (2018) Proc IGAC 15
- LCS: Earthsense™ Archives
- Detector: ACOEM™ Archives
- Evaluation: Kuik et al (2018) ACP 18:8203–8225
- Exposure: Caseiro & von Schneidemesser (2021) Sci Data 8:287

Scope

- Berlin NOx emissions: Adopted from Chan et al (2022)

Measurement campaigns

- Photographs: S.A. Schmitz
- Minimap: Adopted from Chan et al (2022)

Contact

- LCS: Earthsense™ Archives
- Gridded emissions: Chan et al (2022)