

nilu

Are parents driving air pollution
at schools?

Mobile.TUM Apr 11th 2024



School delivery and pick up

The area around a school becomes a bustling hub during these peak times.

Mode of transport: Some children walk, bike or use public transport to school accompanied by parents, siblings or independently. Others arrive by car.

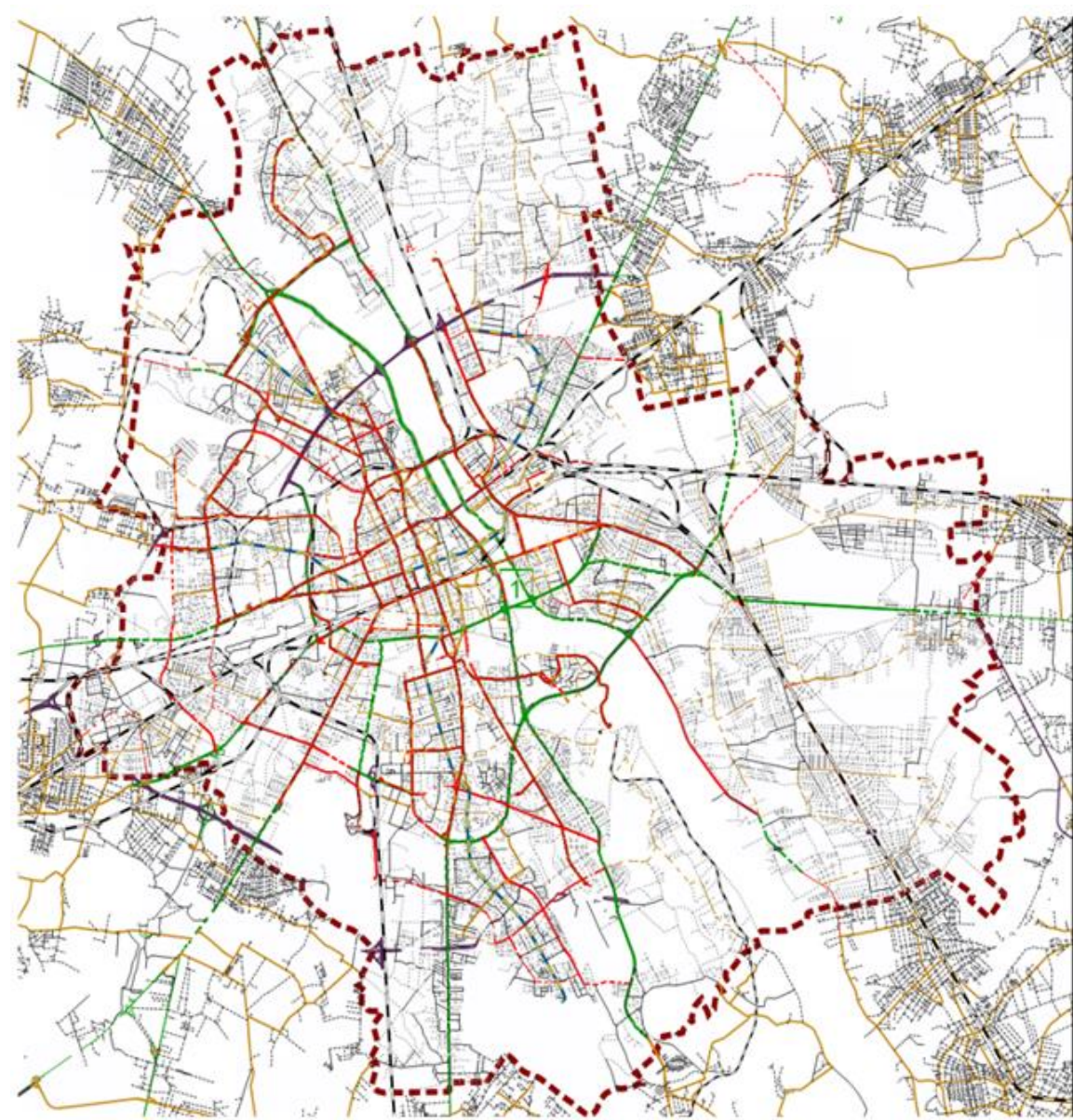
Morning Drop-Offs: Parents arrive at the school during a designated time window. Cars normally have designated drop-off zones.

Afternoon Pick-Ups: As school ends, parents get their kids near the school.

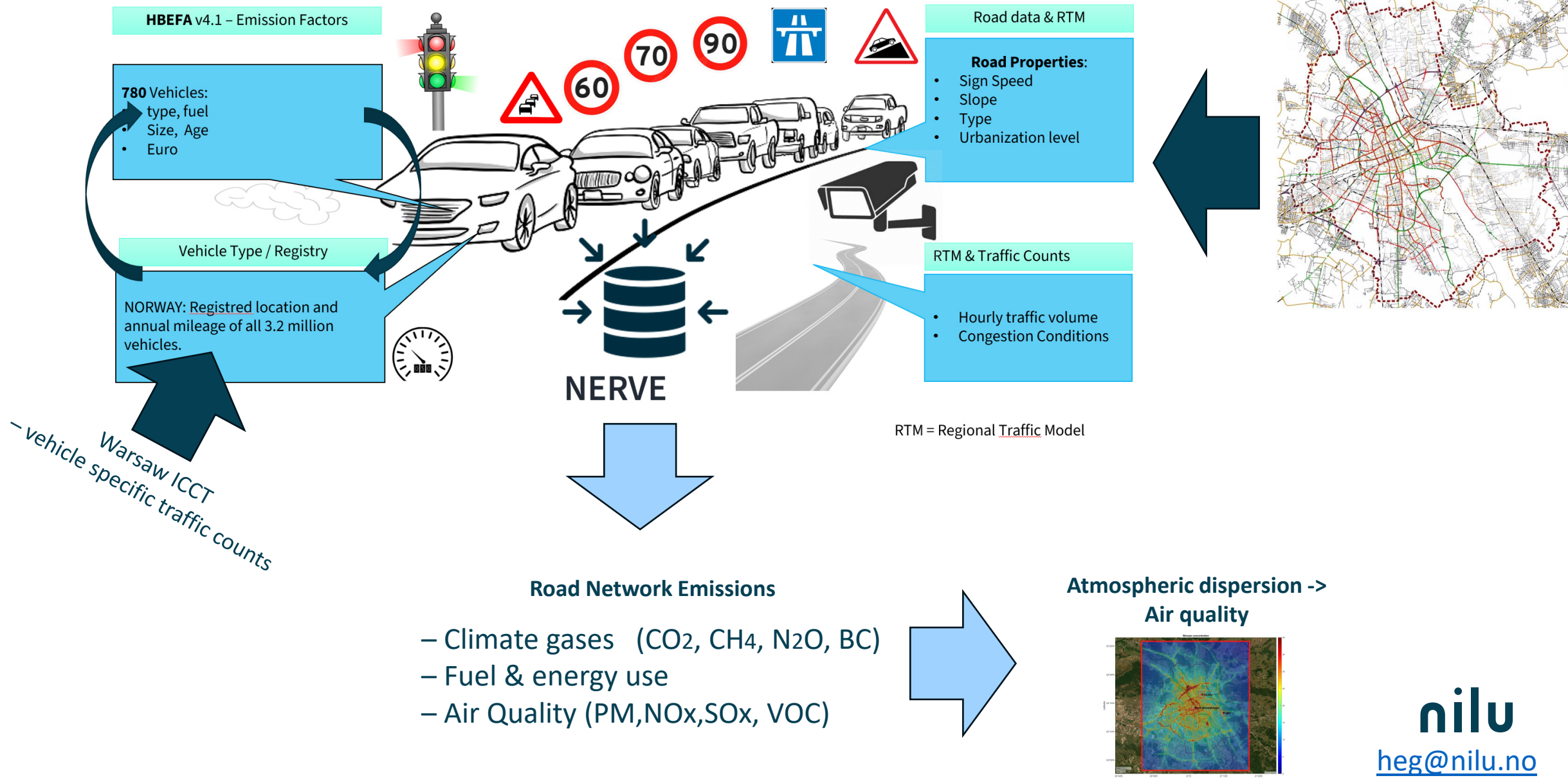


Warsaw traffic

- Traffic modelled with a Regional Traffic Model (MTAW)
- A macroscopic, travel supply – demand model
- Traffic volume and flow on the main road network is well described.
- Missing some granularity around the schools, especially linked to parent-specific behaviour.



NERVE - road link emission calculations



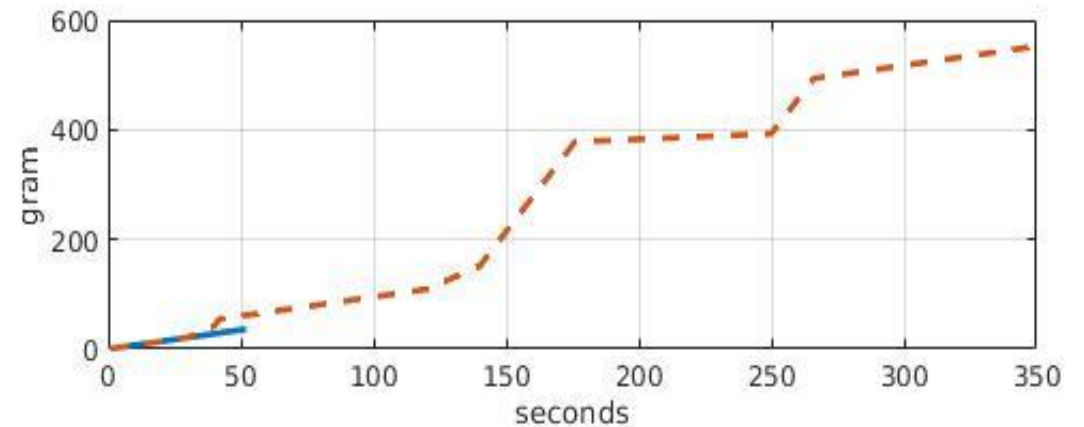
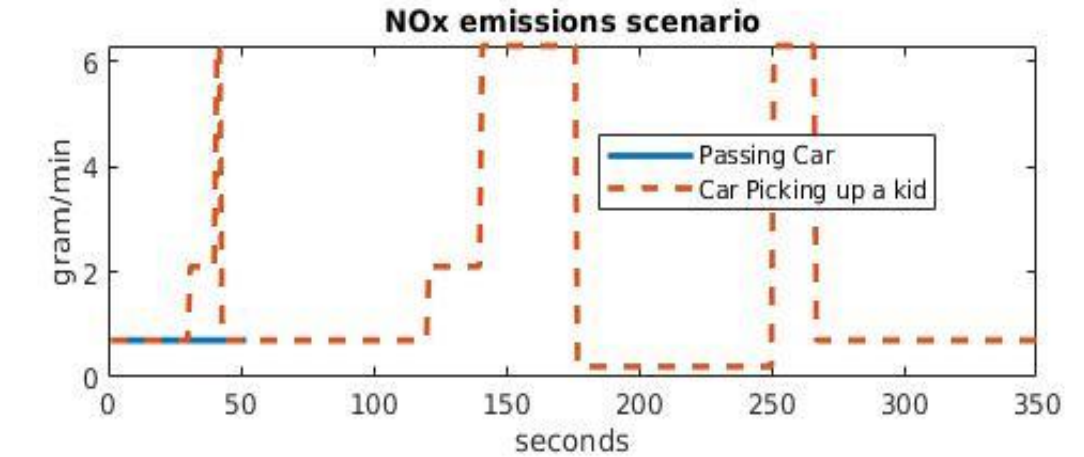
Hypothesis

There are significant emissions from school drop-offs and pick-ups **5-30x** larger than a passing (similar) car that is simulated by the macroscopic models.

Added emissions

Passing Vehicle

- Normal driving
- Extra driving distance
- Parking / Maneuvering
- idling or start
- Own + Other vehicles driving pattern affected



A emission model for excess_parents: **Input data**

Number of pick-ups / drop-off.
Time spent idling and parking.
Time spent cruising for parking.

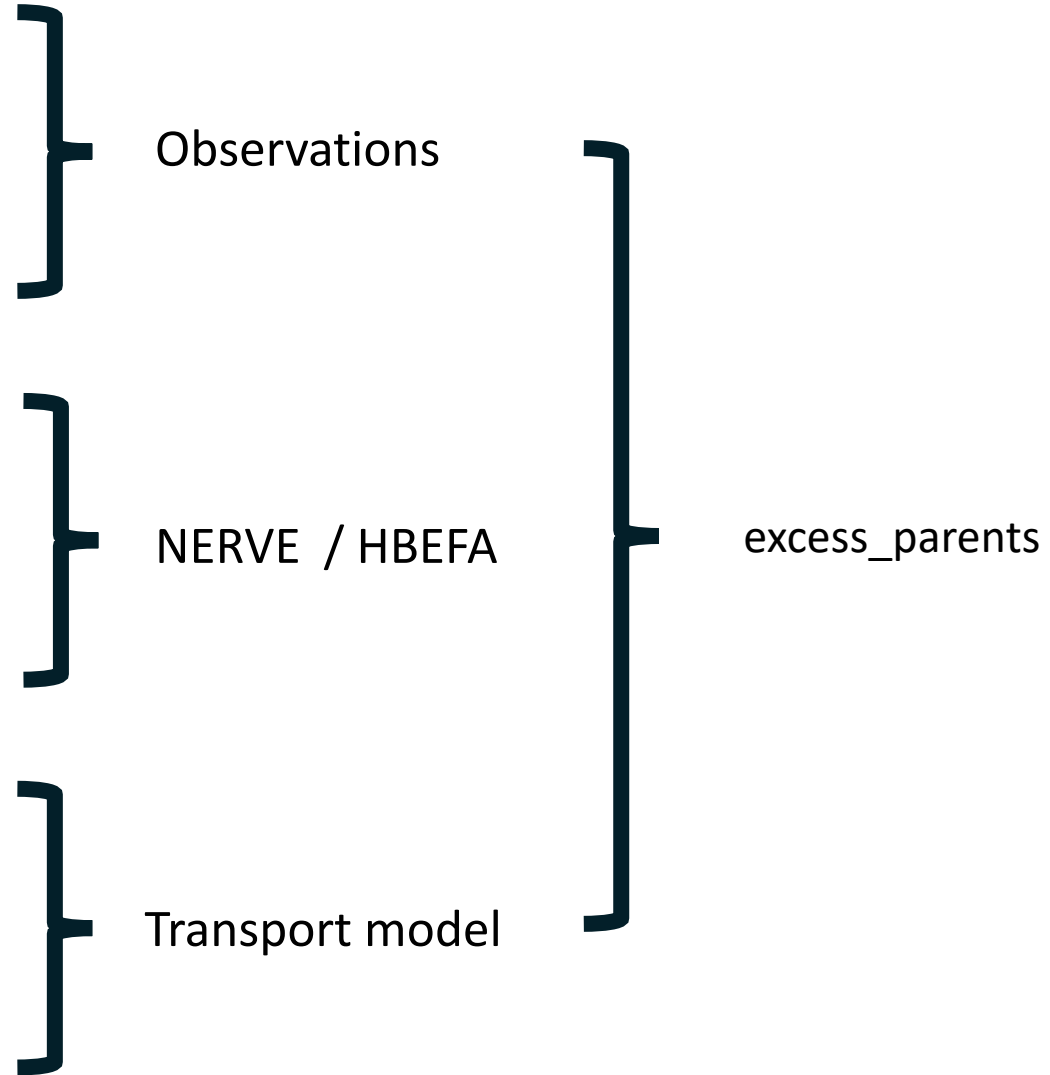
Emission factors for idling and parking.

Emission factors starting and stopping engine.

Emission factors for congested or slow driving.

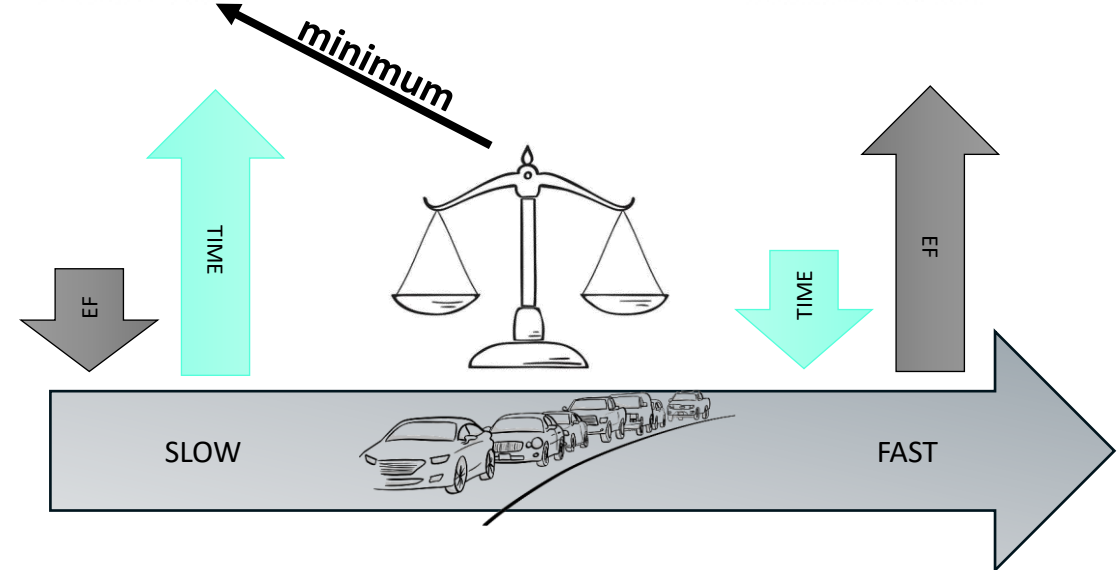
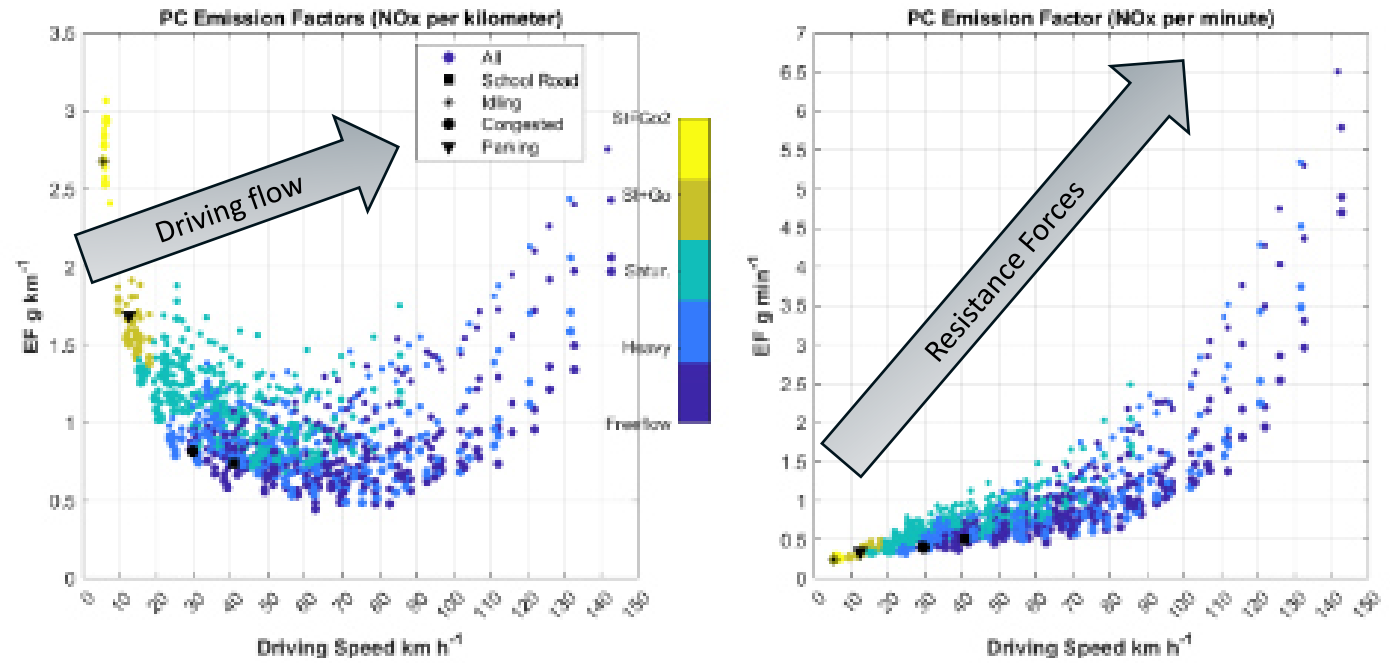
Additional effect: Causing congestion for other vehicles.

Speed drop of other vehicles
Number of roads and vehicles affected



Driving efficiently

- Emissions in an area is a balance between how much time a vehicle spends in the area and how much it is emitting per time.
- Increasing speed reduces time.
- Decreasing speed increases time.



Pilot schools

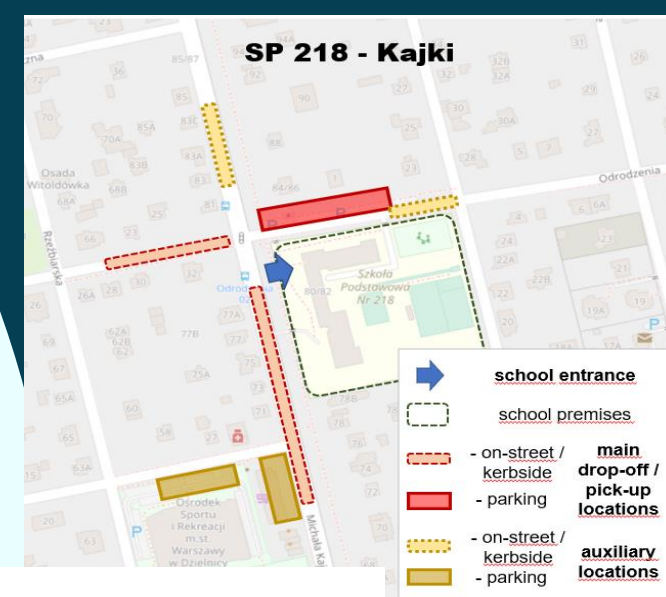
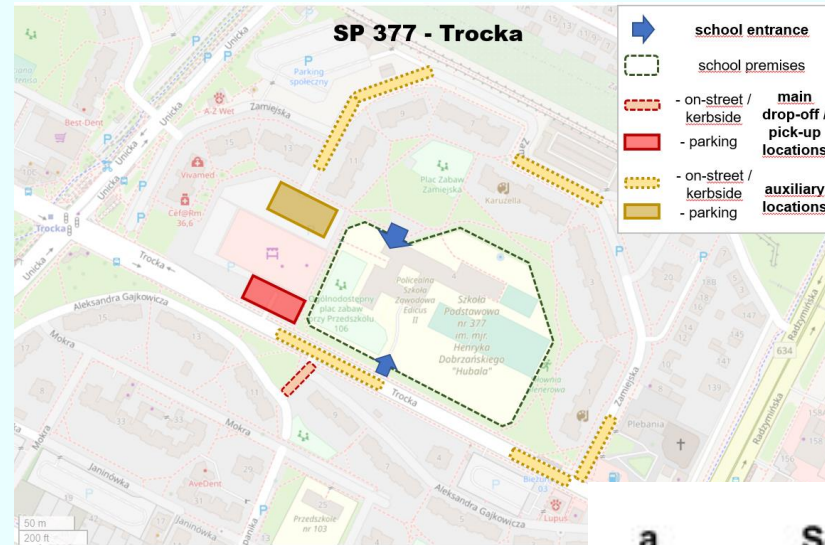
2 urban and 1 suburban schools

Field surveys

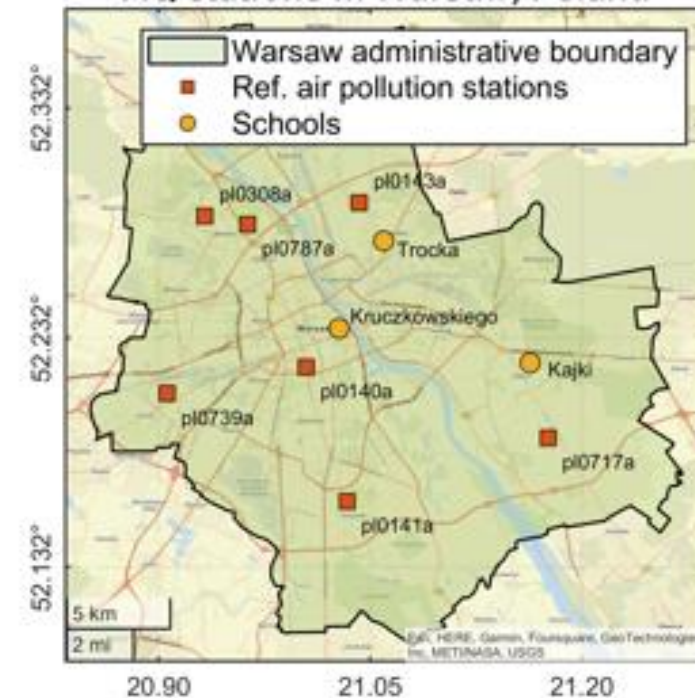
Location, time and idling time of vehicles with kids.

Online questionnaires

Parents answer questions that relates to kids getting to and from school. Mode of transport, distance, vehicel type, idling...



a Schools and reference AQ stations in Warsaw, Poland

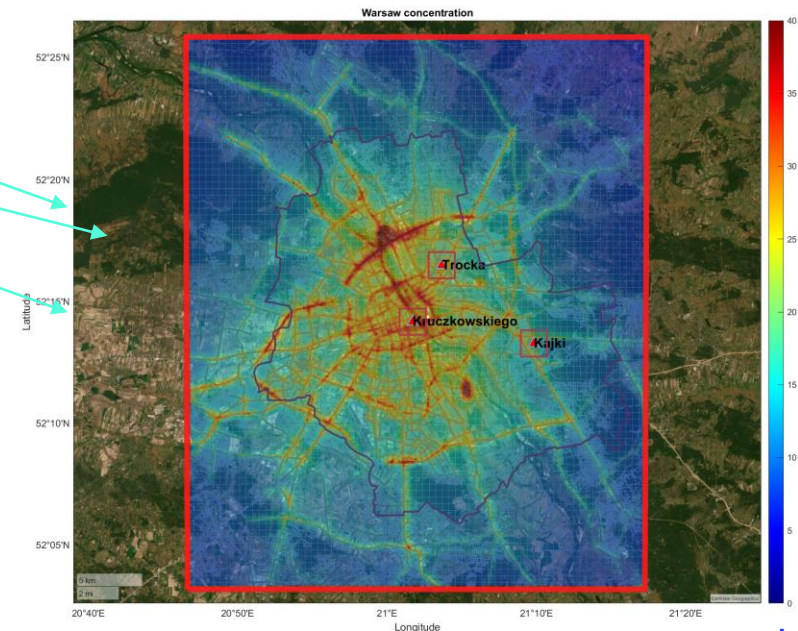
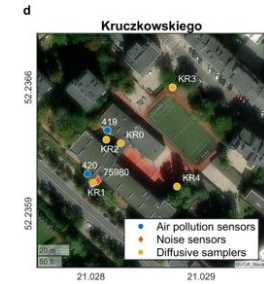
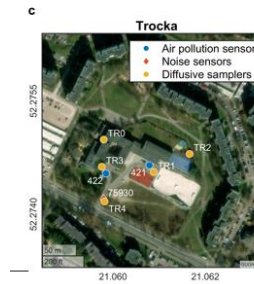
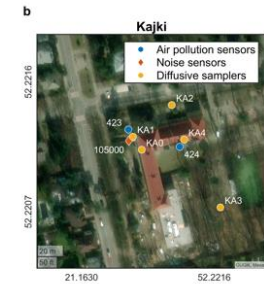
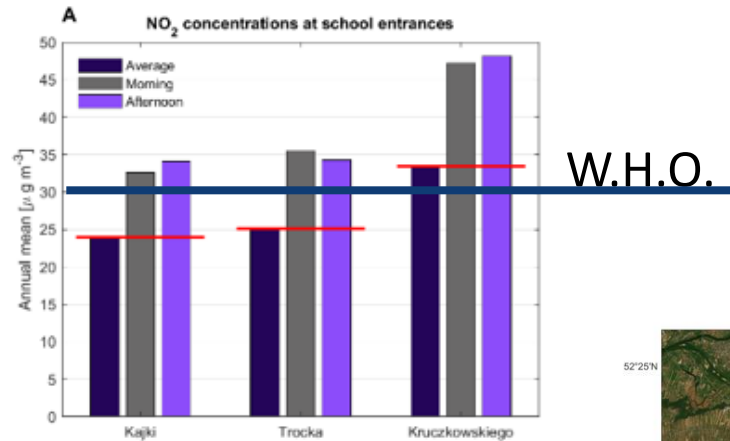


Air pollution @Schools

NO₂: Both model and observations show that there is significant concentrations at schools.

Kids moving around in traffic peak concentration hours.

Very high levels at one of the downtown schools



Observations

Field surveys

- Compliance with parking areas 40-95% between schools.
- Prevalence of idling 25-66%
- Pick up (13 min) takes on average 4x longer than delivery (3 min)
- Road parking interferes with regular traffic.

Online questionnaires

- Compliance with parking areas 90+%
- Prevalence of idling 26-44%
- 21% (11-33) Kids driven to school.

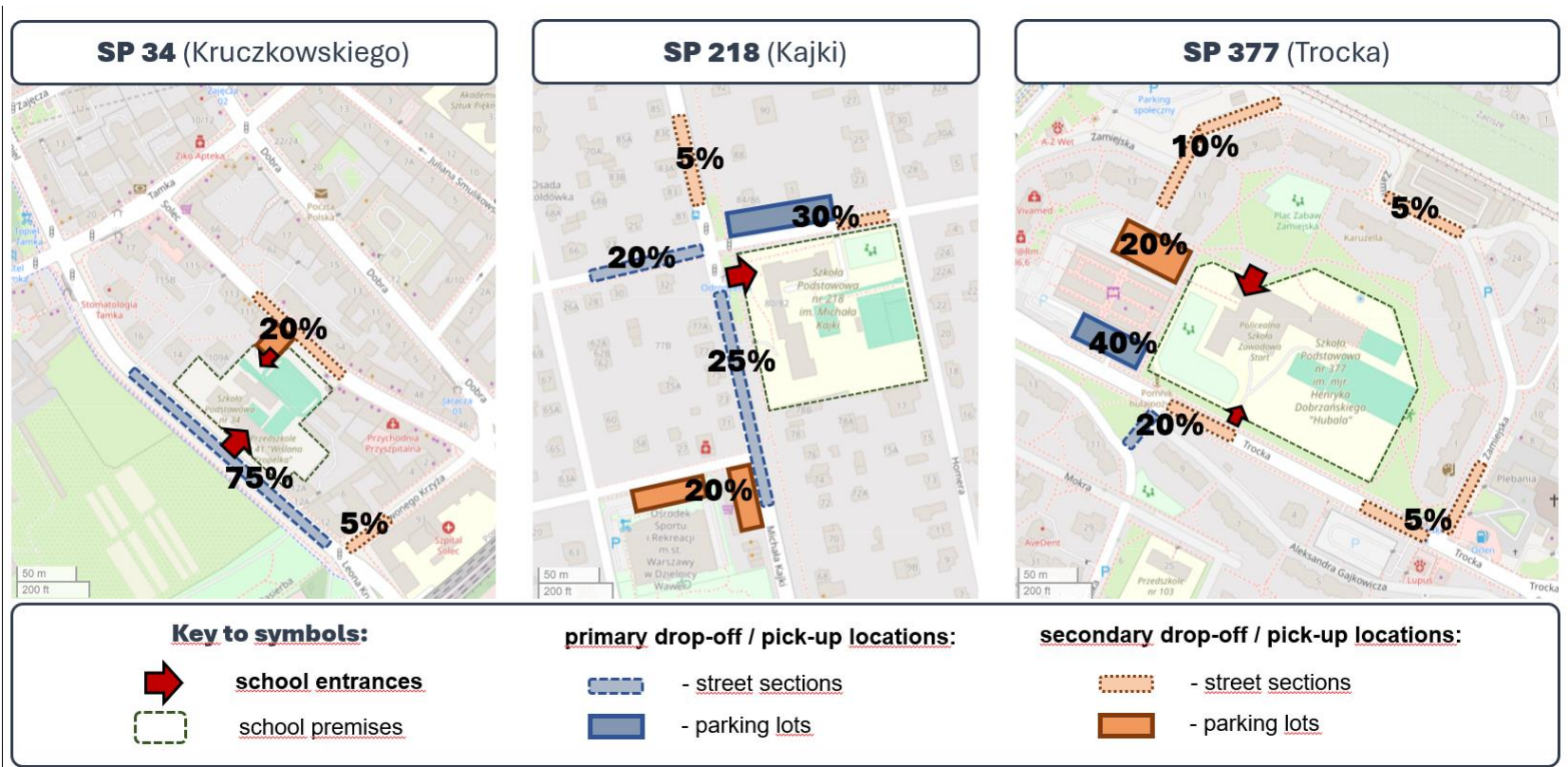


Table 2: Input from surveys to the travel behaviour component of the model

	377 Trocka	218 Kajki	34 Kruczkowskiego	Warsaw school Average
Total no. of kids in school	541	623	435	604
Prevalence of diesel cars	40%	37%	28%	24%
Prevalence of hybrid/electric cars	4.3%	5.9%	7.1%	5.9%
Average car engine volume (cm ³)	1870	1836	1788	1713
Average car age (years)	9.7	8.9	8.1	9.6
Delivery				
Total no. of vehicles delivering children	91	289	90	120
Total no. of kids delivered by car	98	348	100	133
Prevalence of parents idling	26%	39%	44%	37%
Prevalence of parents stopping on the road	3%	25%	16%	16%
Pick-up				
Total no. of vehicles picking up children	90	228	70	109
Total no. of kids picked up by car	93	260	73	121
Prevalence of parents idling	10%	17%	35%	20%
Prevalence of parents stopping on the road	2%	12%	10%	11%
Sample size	209	161	148	229

Source: CoMobility surveys on the representative samples of parents in three project schools and of Warsaw residents, wave 2. Notes: Total number of children in Warsaw primary school comes from the most recent official city of Warsaw's data (for 2020/21 school year). The data on the average Warsaw school come from the survey on the sub-sample of Warsaw residents with children in primary school age and thus are not equal to the weighted averages obtained for the three school samples.

Table 1: Input from in person observations to the travel behaviour component of the model

	377 Trocka	218 Kajki	34 Kruczkowskiego	School Average
Total no. of kids in school	541	623	435	533
Delivery				
Total no. of vehicles delivering children [AM peak hour]	50	112	33	65
Total no. of kids delivered by car - A [AM peak hour]	58	130	38	75
Total no. of kids delivered by car - B [AM est. total]	73	208	50	111
Prevalence of parents idling	25%	46%	66%	43%
Prevalence of parents stopping on (designated) parking places	94%	40%	55%	58%
Average time of parental idling [mins./veh.]	0.7	1.2	1.0	1.0
Average time of parental parking [mins./veh.]	4.2	2.7	2.1	3.0
Average total time of parking [mins.]	210.0	302.4	69.3	193.9
Pick-up				
Total no. of vehicles picking up children [PM peak hour]	13	34	8	18
Total no. of kids picked up by car - A [PM peak hour]	15	39	9	21
Total no. of kids picked up by car - B [PM est. total - excl. 'late pick-ups']	40	117	22	59
Prevalence of parents idling	11%	15%	21%	18%
Prevalence of parents stopping on (designated) parking places	89%	68%	80%	69%
Average time of parental idling [mins./veh.]	3.0	3.8	4.3	3.7
Average time of parental parking [mins./veh.]	11.9	8.1	19.5	13.2
Average total time of parking [mins.]	154.7	275.4	156.0	195.4

Source: CoMobility observations conducted in person, October 2022. Notes: Total number of children in school obtained from the school principal in 2022/23 school year. A - Total number of children delivered/picked up from school is assumed to be approx. 1.2 [kids/veh.], based on the in-vitro observations. B - Total number of children delivered/picked up from school is calculated based on the observed average modal share divided by the observation window width. Average total time of parking is the total number of parental vehicles times the average total parking time. Approximately 25% of parental vehicles are small, 50% are medium size, and 25% - big in all the 3 schools.

Excess emissions

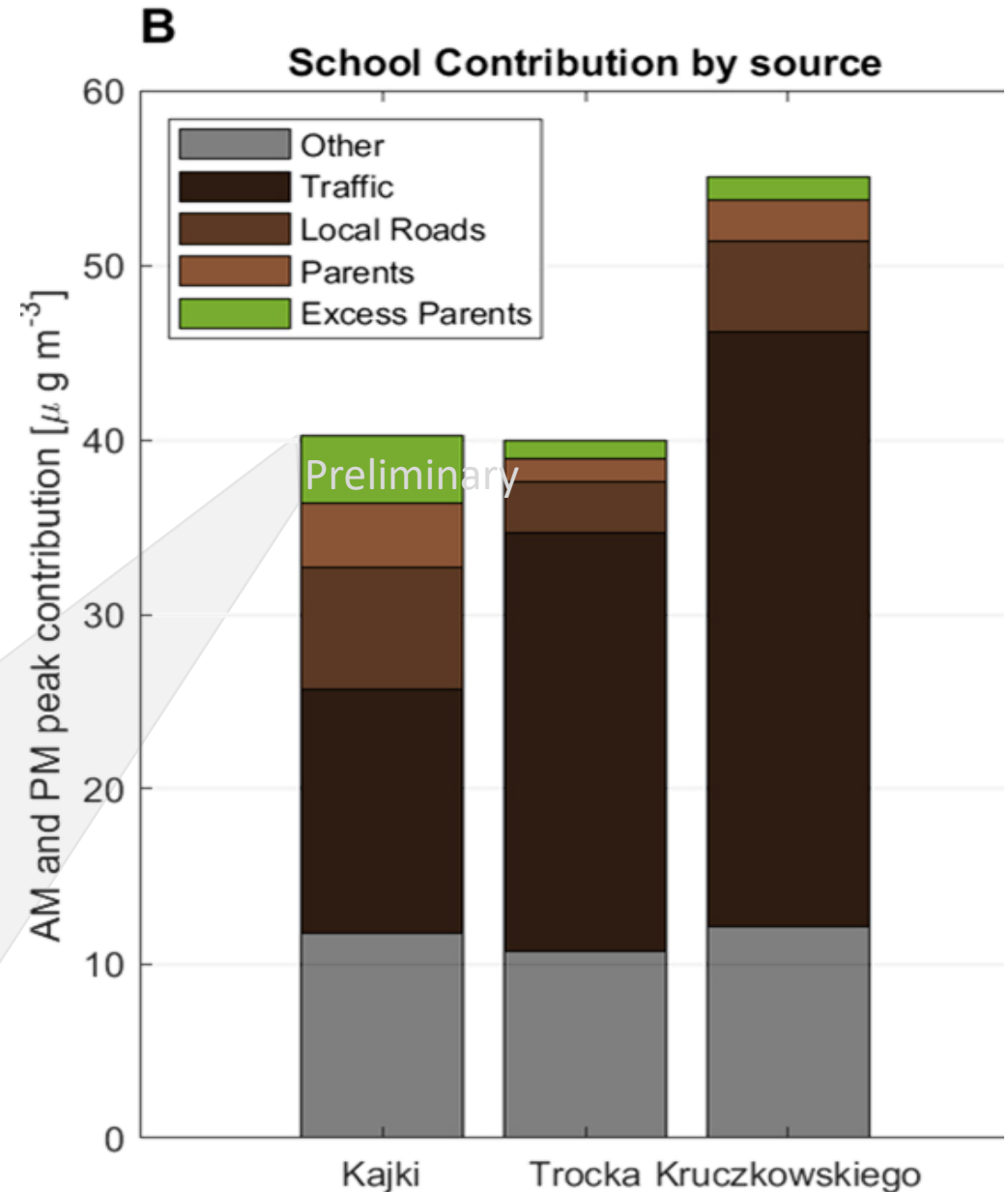
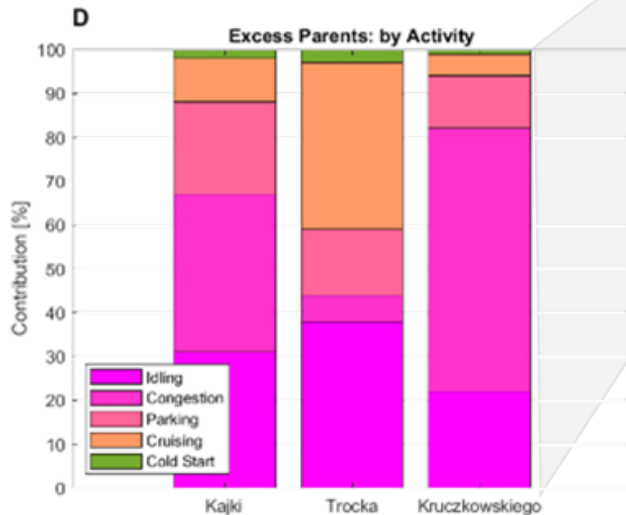
Congestion: Is the largest added emissions as the numbers of vehicles affected is potentially large.

Idling: with a cutoff of 9 sec idling is an important contributor especially PM.

Cruising: Varies with layout, overall small.

Parking: Comparatively small.

Cold start: Negligible.



Mitigation scenarios

Reduced excess emissions:

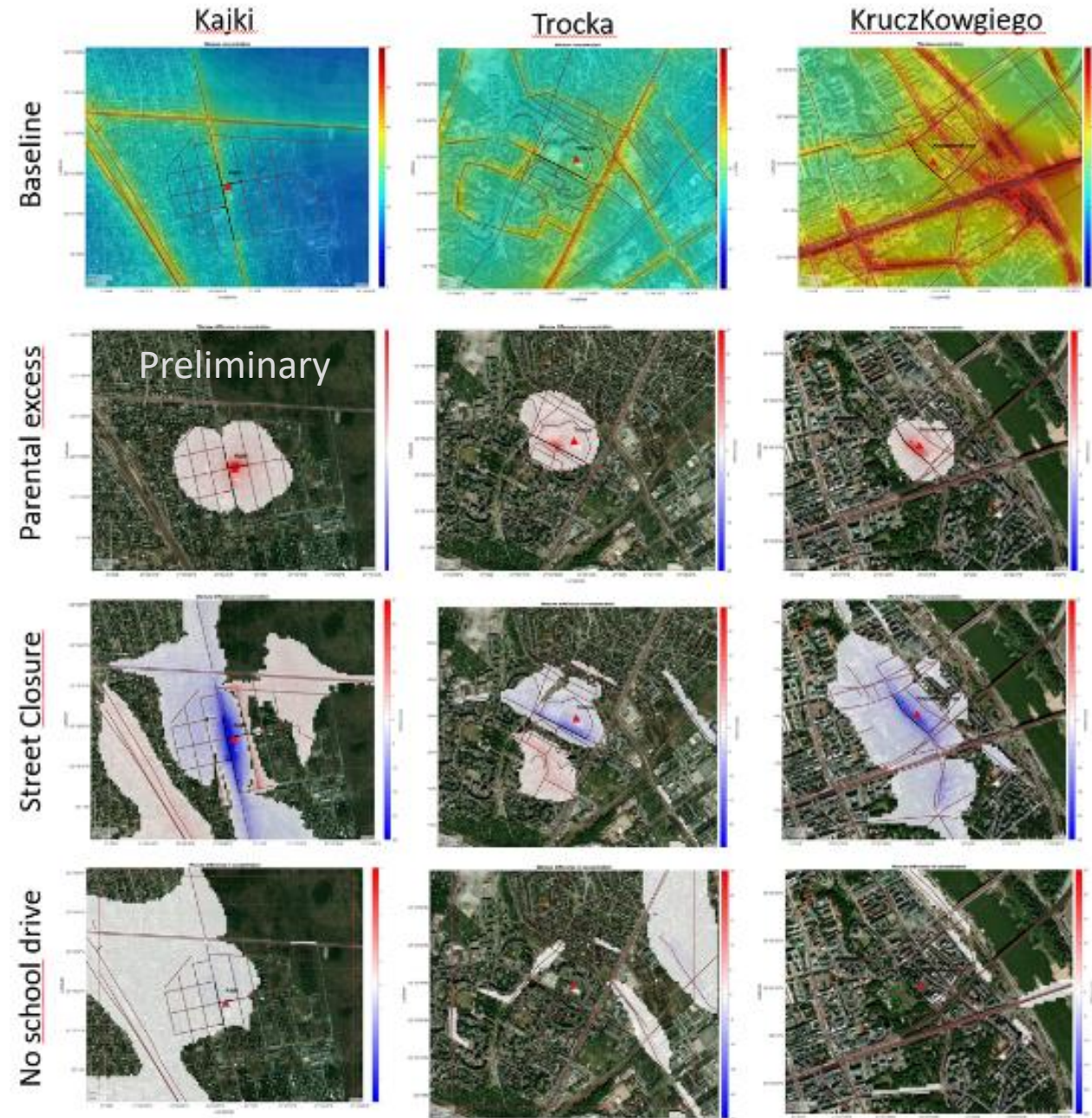
During AM peak excess emissions contribute up to 8-10%. Local effect

Road closure / capacity limitations:

All three schools saw vast improvements, up to 20%. However rerouted traffic contributed to higher concentrations elsewhere.

Reduced parental car driving:

Without parental_excess only very slight improvement overall. Does not target the schools efficiently



Scale up scenarios

Implemented measures at all (208) primary schools in Warsaw

Reduced excess emissions:

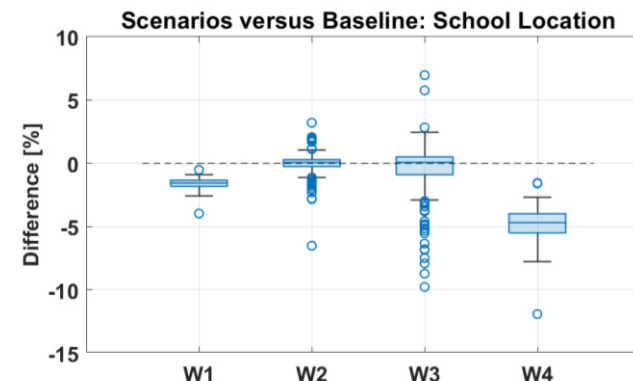
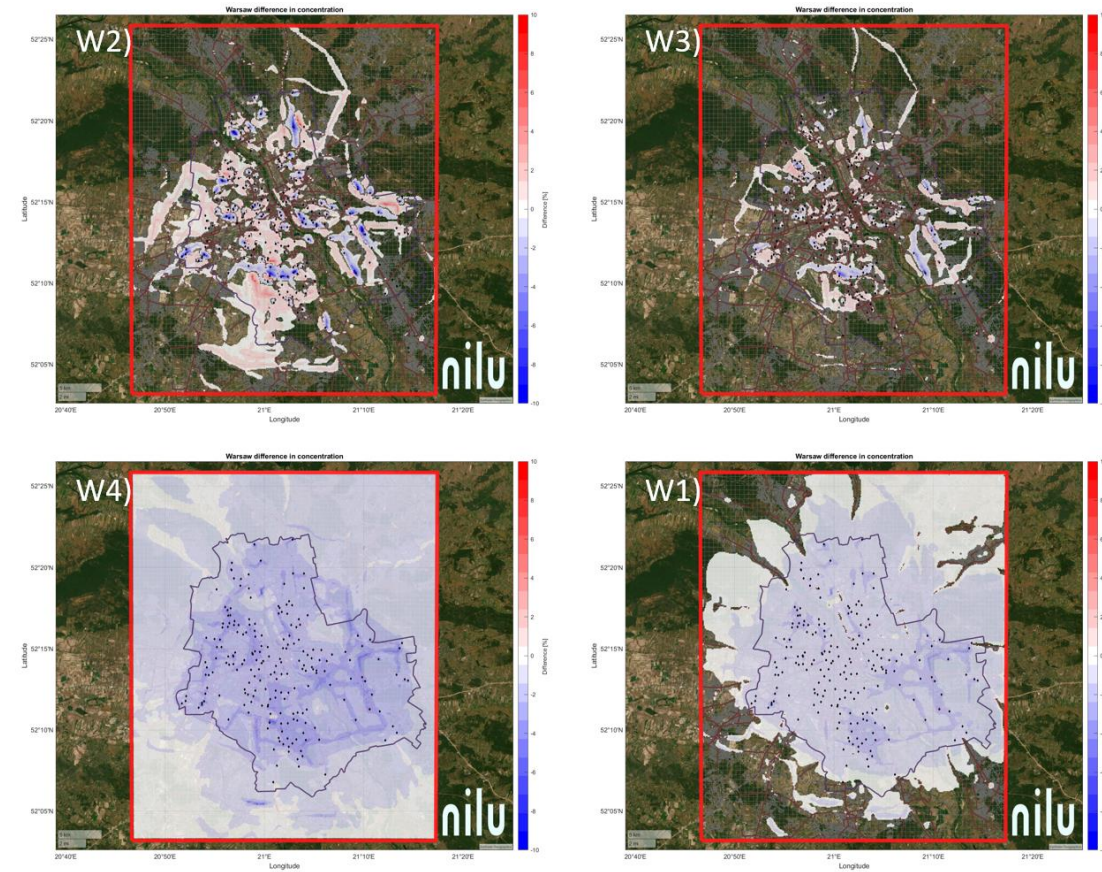
Has a positive effect locally.

Road closure / capacity limitations(W2, W3):

Can be positive locally, but outweighed by increased congestion & longer driving distances.

Reduced parental car driving (W1, W4):

Overall the most positive impacts. Concentrations down up to 10%. Improved traffic flow and AQ all over Warsaw.



Key messages

- Parent driving constitute a significant portion of rush hour driving.
- There are significant excess emissions in the pick up zone from the parents, especially if causing congestion or idling.
- Local reductions are best achieved by improved behaviour through awareness.
- Reducing private car use for school drives as the overall best effect but does not target the schools efficiently unless coupled to other measures.
- In our modelling system closing roads does not seem like a good option as it increases congestion & does not cause significantly fewer to use PC.

All data from project will be published and publicly available



Thank you!

[mobil.TUM 2024 - Presentations - Google Drive](#)

13:45 - 15:15 Parallel Session C1: Environmental justice

