What impact does online grocery shopping have on urban transport?

Simulating location choice, passenger and freight transport in Berlin

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German grocery retail accounts for 32 % of total turnover in retail.

In Berlin, people travel 334 million times per year for shopping purposes.

In Germany, online shopping in grocery retailing grows by 20 % annually.

Which impact will this have on urban transport?

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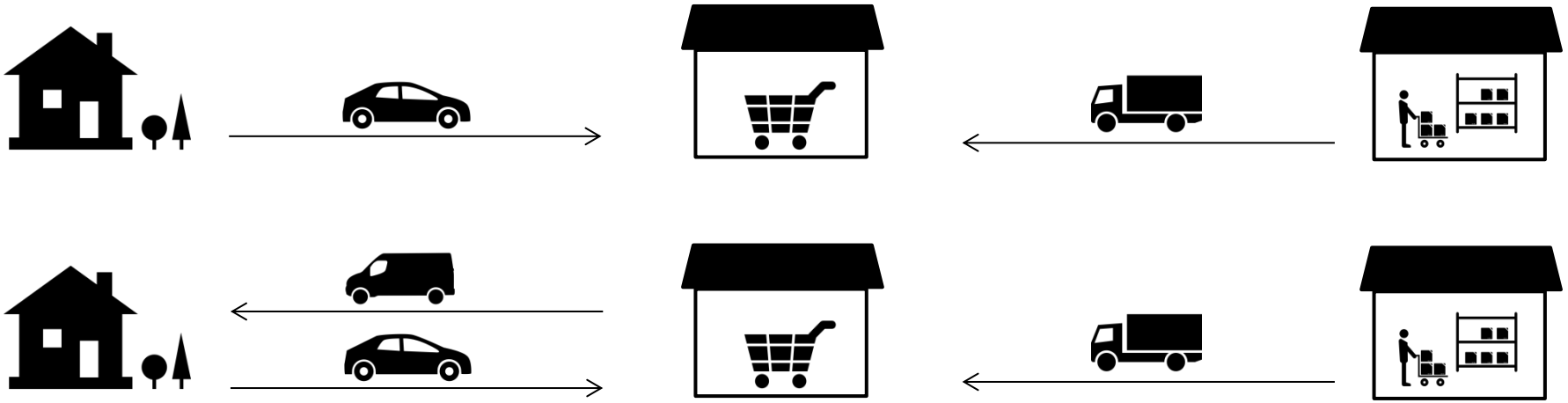
How does urban transport change with increasing grocery online retail?



How much will private shopping trips and delivery trips change and how will this affect the environment?

State of research

- Only few studies look at both passenger and freight transport related to retail (e.g. Suel & Polak, 2017; Gonzalez-Feliu et al., 2012; Goodchild et al., 2017)
- Most studies find that online-shopping in terms of home delivery or proximity delivery has high potential to reduce emissions, even for groceries (e.g. Rotem-Mindali & Weltevreden 2013)

- Effects of and on the transport network such as congestion and trip-chaining are considered only in few studies
- Several studies only take into account car-related trips
- No study applies agent-based models and has the potential to include substitution with other activities
- No study considers emissions arising from the refrigeration of food

Integrate passenger travel demand and freight transport models

How does urban transport change with increasing grocery online retail?

How does urban transport change with increasing grocery online retail?

Hypothesis: Home deliveries decrease total emissions since deliverers optimize tours better than individual consumers.

Will private shopping trips decrease and delivery trips increase and if so how much and how will this affect the environment?

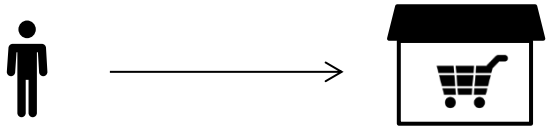
Scenarios

2030 BAU - Business as usual:

Berlin

Traditional shopping trips only

Delivery of POS only



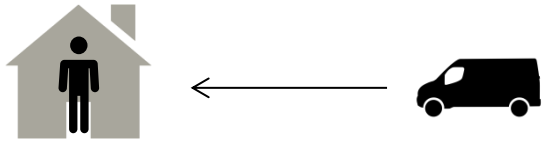
Increasing number of grocers

2030 EC - E-Commerce:

Berlin

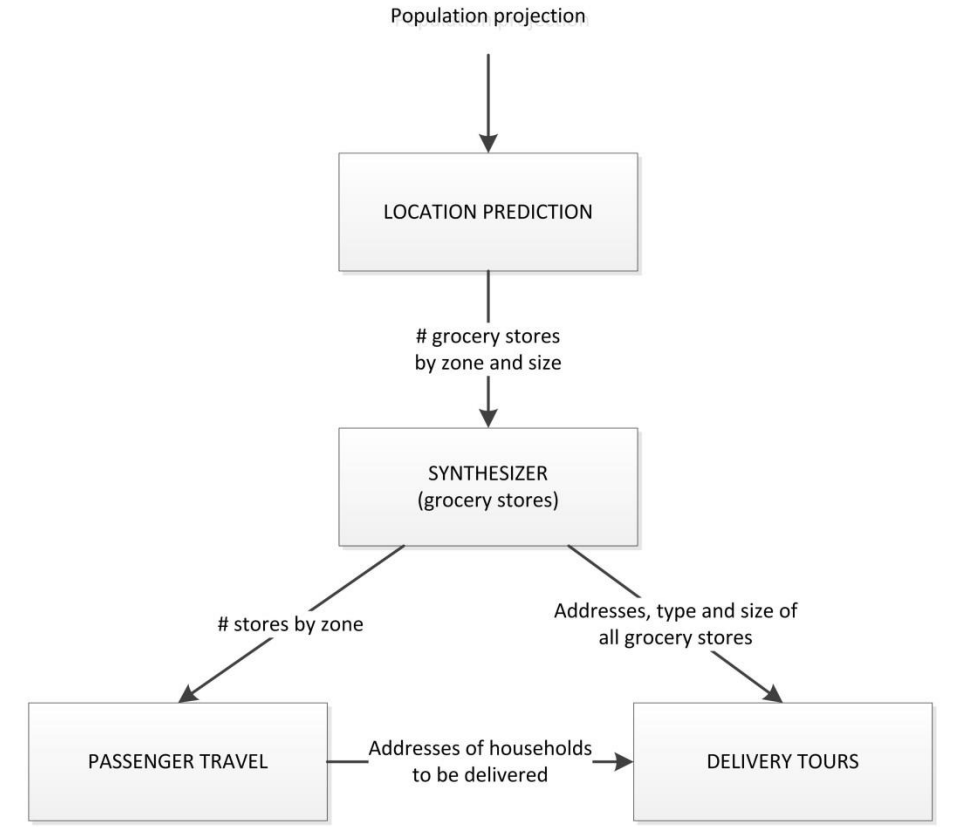
3 % of shopping trips substituted by home deliveries

Delivery of POS and households



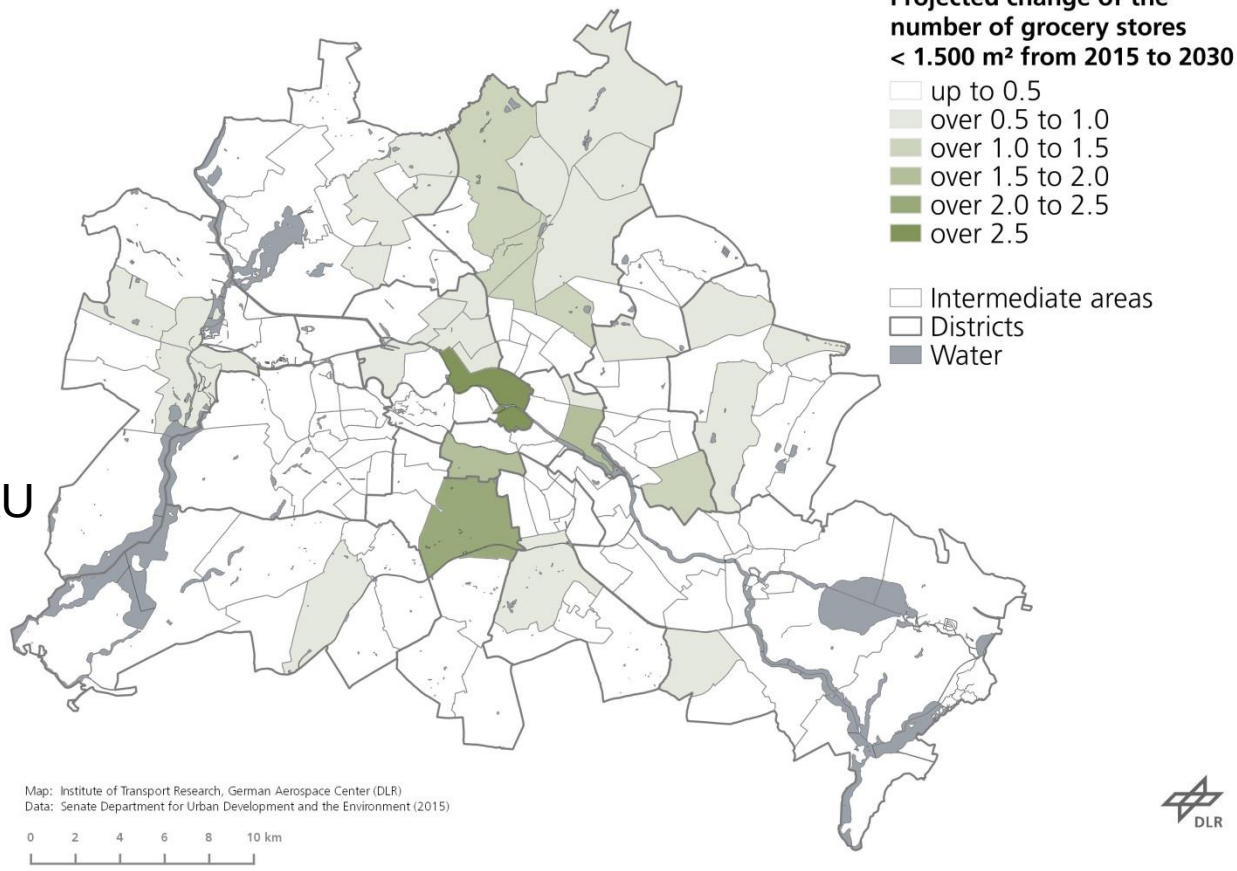
Decreasing number of grocers

Methodology



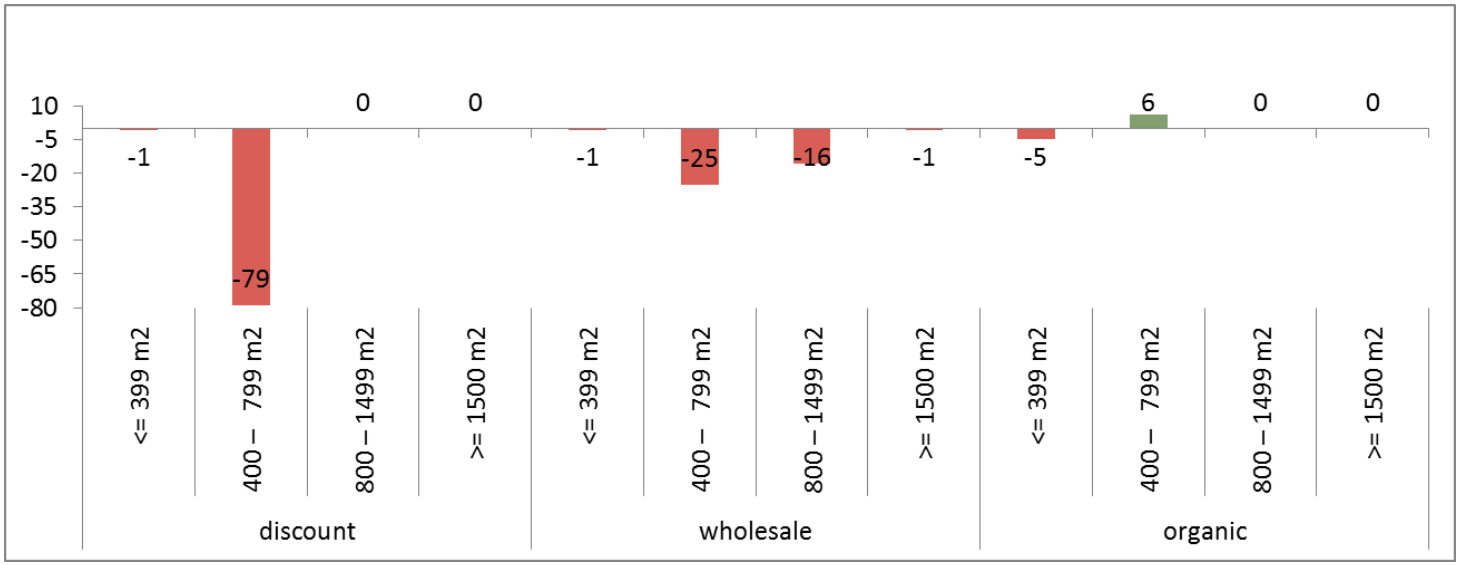
Location prediction

- Poisson regression of 1,152 retail stores
- Small and large stores
- Calibrated constants
- Population growth
- Number of transit stops and retail stores and traffic constant
- From 2015 to 2030 BAU number of stores increases to 1,224 (+ 6 %)
- Resulting pattern is plausible



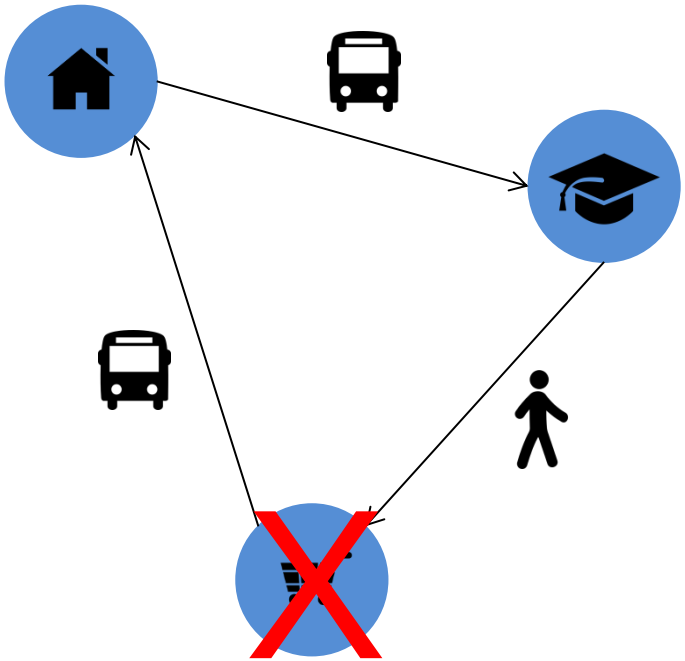
SYNTHESIZER

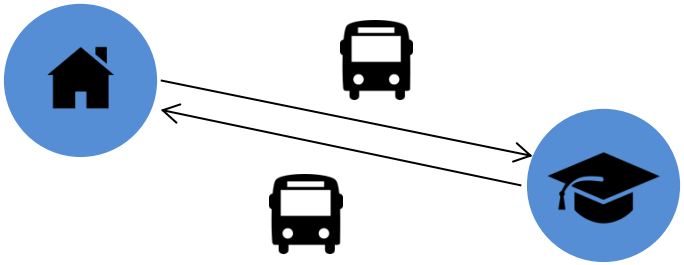
- Disaggregation of number of stores by intermediate area and adding of retail format by iterative proportional fitting
- Seed data: Berlin retail survey; marginal totals: location prediction
- For 2030 EC we removed 10 % of the locations -> new marginal sums
- Number of stores in 2030 EC: 1,102
- Resulting pattern (by type) is plausible



Passenger travel
Approach

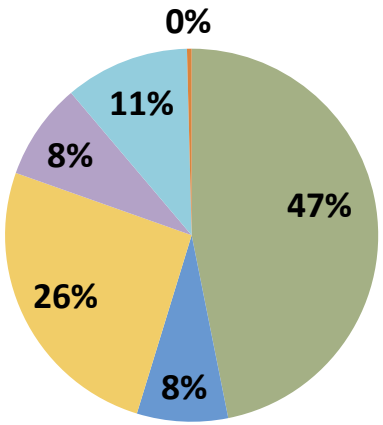
- Assumption: reduction of shopping trips by 3 %
- Agent-based transport model ‚TAPAS‘: simulation of years 2010 and 2030
- Saved number of short-term shopping trips and distance by mode
- Copy faster mode



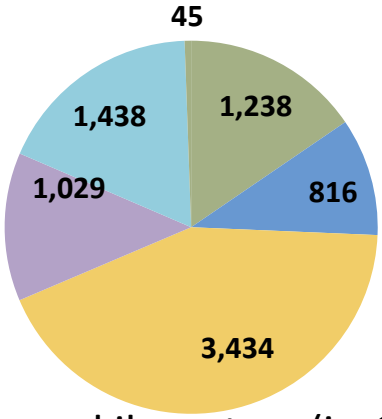


Passenger travel
Results

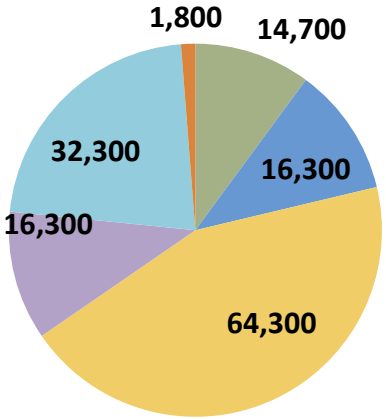
- daily needs (2/3 of shopping trips)
- Reduction amounts to about 63,700 VKT (about 2 %)
- But reduction in non-motorized transport also 31,000 kilometers
- Saved distance in passenger transport substantial



Mode choice



Person kilometers (in 10^3)

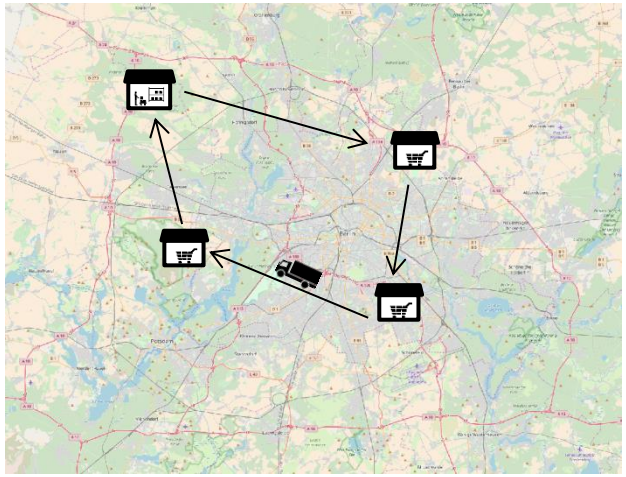


Saved distance (in km)

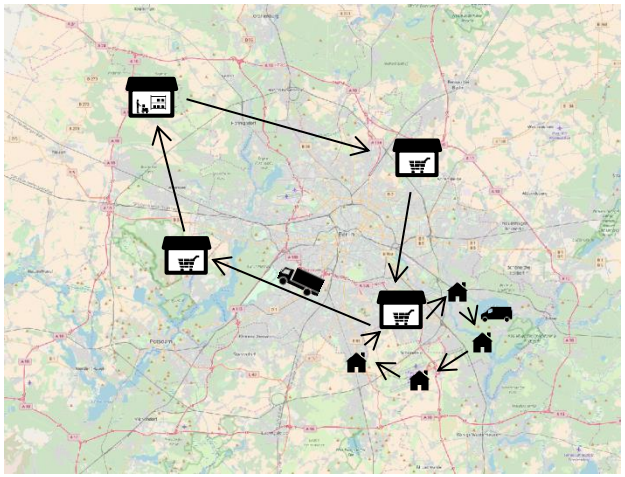
Delivery tours
Method

- Tour planning software jsprit and conversion to MATSIM format
- Delivery to households carried out by small vehicles with max weight of 3.5t
- All vehicles equipped with refrigerator unit to keep food cool
- Total VKT: 15,760; transport CO2-emissions: 3.9 t; total CO2-emissions: 12.2 t

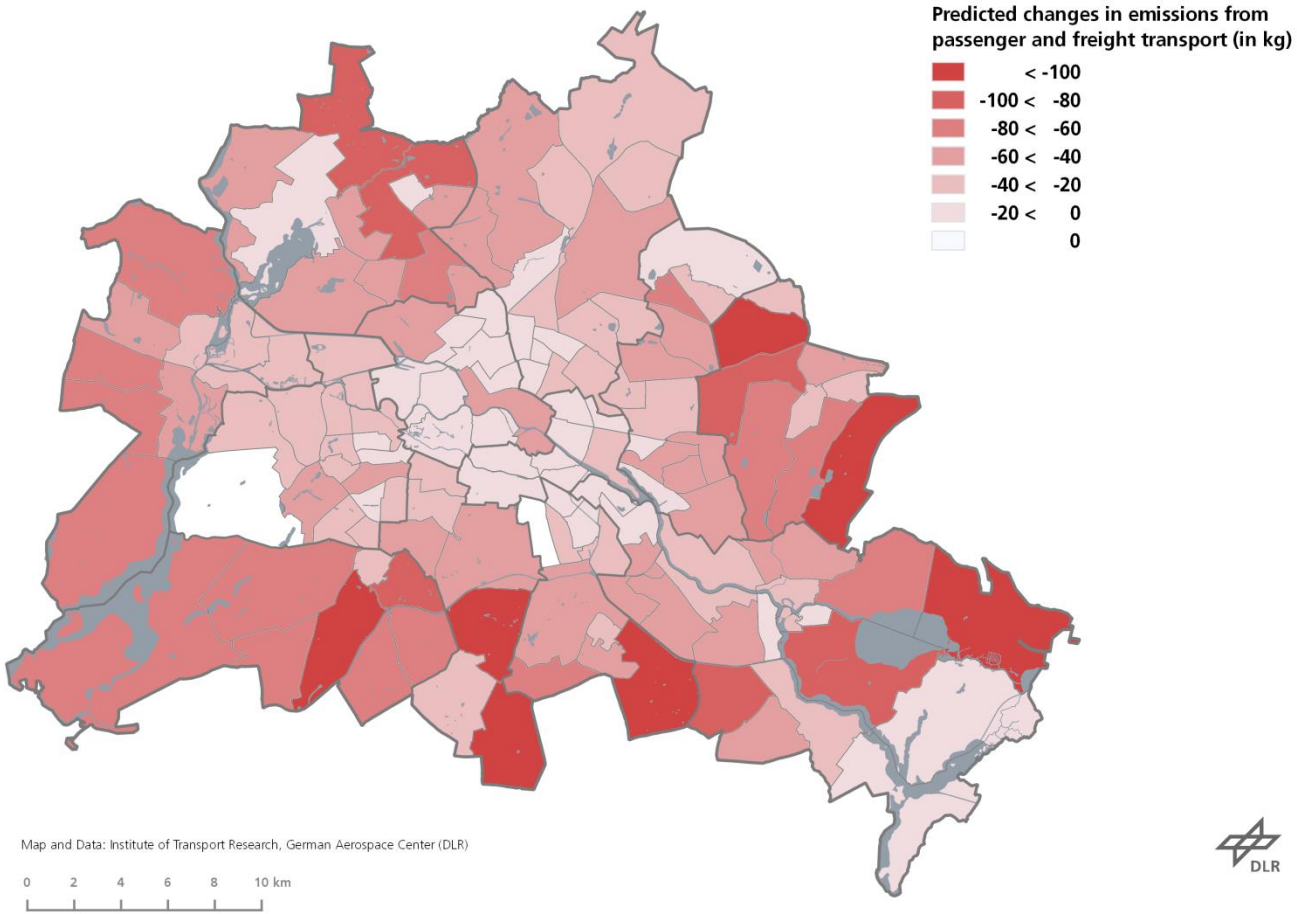
2030 BAU



2030 E-Food



Emissions (1)



- 48,000 VKT saved
- Decrease in emissions caused by fewer shopping trips is significant and outweighs increase due to additional delivery tours: -5.36 t
- Occurs more at the edge of the city

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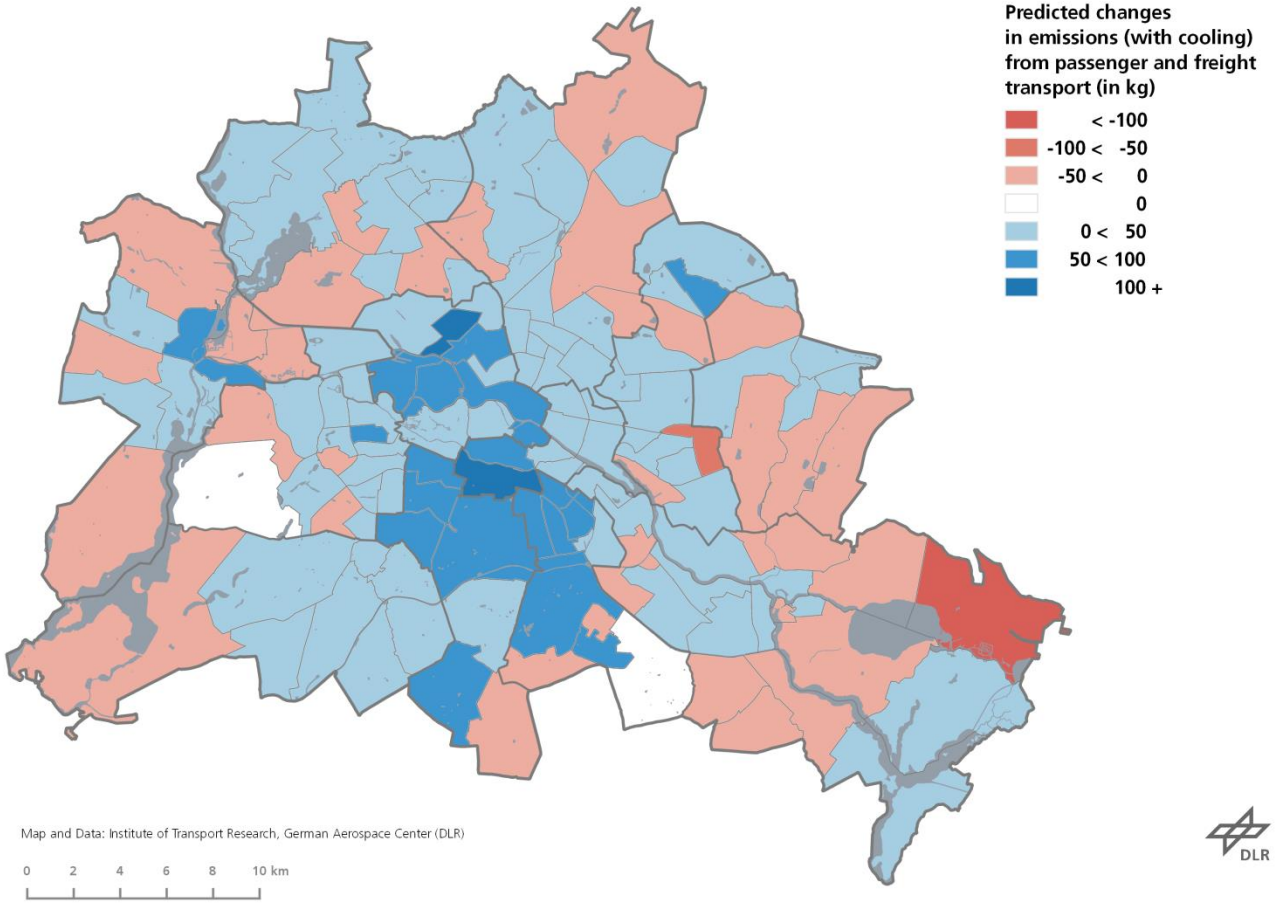
Emissions (2)



- Increase in emissions caused by vans with refrigerator units is significant and exceeds decrease in passenger transport: +2,96
- Increase affects urban areas

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Discussion

Conclusion

- Simulation-based methodology to helps assess effects of increasing grocery online-retail on passanger and freight transport and related emissions
- Parameters in the models can be changed
- Results indicate: reduction in passenger transport exceeds increase due to delivery, this applies also to transport-related emissions; emissions including refrigeration increase in total

Implications

- Home deliveries in grocery shopping is not a sustainable measure for reducing grocery shopping-related emissions when considering food chilling
- Policies must support the development and adoption of new vehicle technologies such as e-trucks or autonomous delivery services
- Pickup points provide another solution to reduce consumer trip distances and number of tour stops
- Where, when and how must food be chilled?

Discussion

Limitations

- Assumptions on decrease of the number of grocers and trips substituted
- No consideration of substitution between different channels
- No activity substitution
- Simplistic assumptions about the assignment of households to stores and energy consumption of refrigeration units

Future research

- Location prediction based on discrete choice
- Include channel choice and substitution
- Include substitution between activities
- Test other politicy measures

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Thank you!

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