The Impact of motorized Vehicles on Air Temperature in the City of Basel

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Outline

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Project Idea:
Urban Heat Island Phenomenon

What is an Urban Heat Island?

- Urban area experiences higher temperatures than nearby rural areas

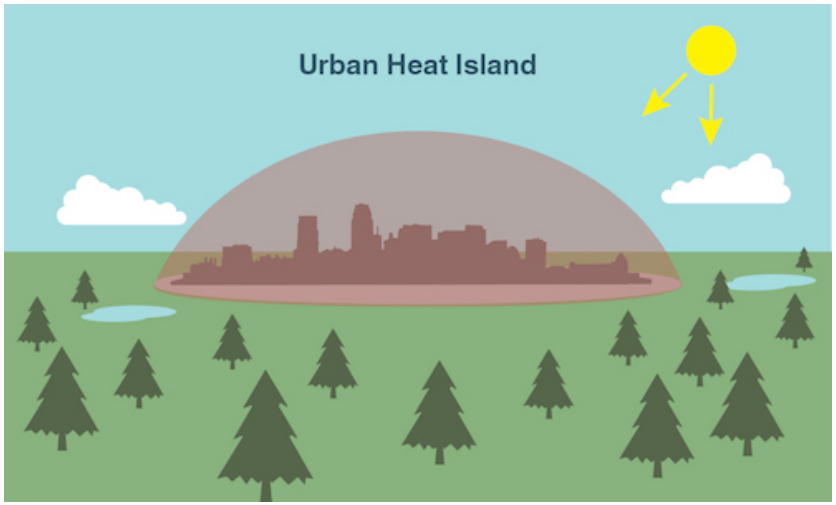

Figure: Illustration of an urban heat island

How are Urban Heat Islands formed?

- Direct cause over urbanisation
- Landscapes cool air, concrete absorb heat
- Heat released from vehicles, machines and industries
- Buildings and roads trap heat

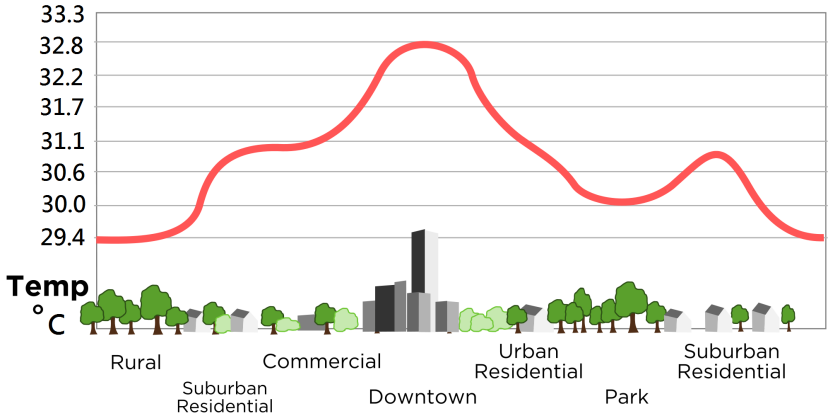

Figure: Urban Heat Island Profile

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Impacts on the Environment

- Bad air and water quality
- Discomfort and danger to human health
- Major contributor to global warming

Goals

- Investigate impact of vehicles on air temperatures in Basel
- Counteract the effect of urban heat islands
- Calculate correlation between vehicle count and temperature measurements
- Visualize traffic and air temperature data sets

Verkehrszähldaten motorisierter Individualverkehr

	ZST_NR	SiteCode	SiteName	DateTimeFrom	DateTimeTo	DirectionName	LaneCode	LaneName
1	235	00000235	235 A3-A35, Grenze CH-F	11. Dezember 2021 23:00	11. Dezember 2021 00:00	von Frankreich	1	Spur 1
2	235	00000235	235 A3-A35, Grenze CH-F	11. Dezember 2021 23:00	11. Dezember 2021 00:00	nach Frankreich	2	Spur 2
3	350	00000350	350 Dreirosenbrücke lokal	11. Dezember 2021 23:00	11. Dezember 2021 00:00	nach Kleinbasel	2	Spur 2
4	350	00000350	350 Dreirosenbrücke lokal	11. Dezember 2021 23:00	11. Dezember 2021 00:00	nach Kleinbasel	1	Spur 1
5	350	00000350	350 Dreirosenbrücke lokal	11. Dezember 2021 23:00	11. Dezember 2021 00:00	von Kleinbasel	4	Spur 4
6	350	00000350	350 Dreirosenbrücke lokal	11. Dezember 2021 23:00	11. Dezember 2021 00:00	von Kleinbasel	5	Spur 5
7	350	00000350	350 Dreirosenbrücke lokal	11. Dezember 2021 23:00	11. Dezember 2021 00:00	von Kleinbasel	6	Spur 6
8	354	00000354	354 Wettsteinbrücke	11. Dezember 2021 23:00	11. Dezember 2021 00:00	1 nach Kleinbasel	1	Spur 1
9	354	00000354	354 Wettsteinbrücke	11. Dezember 2021 23:00	11. Dezember 2021 00:00	2 von Kleinbasel	2	Spur 2
10	402	00000402	402 Hochbergerstrasse 55	11. Dezember 2021 23:00	11. Dezember 2021 00:00	1 von Rhein (1FS mit ÖV-Bus)	1	Spur 1

Table: Verkehrszähldaten motorisierter Individualverkehr section

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Smart Climate Luftklima

	Station-ID	Name	Zeitstempel	Lufttemperatur	Regen in 1 h	Regen in 24 h	Regen in 48 h	Koordinaten
1	0340998E	Grenzacherstrasse	13. Dezember 2021 22:10	2,6 °C	0 mm	1,2 mm	1,2 mm	47.56241, 7.62656
2	0340AD90	Bruderholzallee	13. Dezember 2021 22:10	2,1 °C	0 mm	2,6 mm	4,8 mm	47.53339, 7.59686
3	034001A4	Bahnhof SBB	13. Dezember 2021 22:09	3,4 °C	0 mm	0 mm	0 mm	47.54789, 7.58976
4	034099A1	Hauptstraße	13. Dezember 2021 22:09	2,4 °C	0 mm	0 mm	0 mm	47.60116986, 7.66489405898
5	0340AD92	Oscar Frey-Strasse	13. Dezember 2021 22:09	1,5 °C	0 mm	0 mm	0 mm	47.52929, 7.58641
6	03409FEF	Hauptstraße	13. Dezember 2021 22:09	2,6 °C	0 mm	0 mm	0 mm	47.5926093073, 7.609722018
7	03409964	Schäferrain	13. Dezember 2021 22:09	1,2 °C	0 mm	0 mm	0 mm	47.49462, 7.62441
8	03400396	Fabrikstrasse	13. Dezember 2021 22:08	2,1 °C	0 mm	0,2 mm	0,4 mm	47.54896, 7.54713
9	03409970	Friedrich-Miescher-Strasse	13. Dezember 2021 22:08	1,9 °C	0 mm	0 mm	0 mm	47.57182, 7.56166
10	03409978	Birsstegweg	13. Dezember 2021 22:08	125,0 °C	0 mm	0 mm	0 mm	47.552641, 7.62152

Table: Smart Climate Luftklima section

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Methods used

How was the data cleaned?

Verkehrszählungen

- Removed unnecessary columns (e.g. `LaneName`, `Weekday`)
- Only used approved values
- Split coordinates into longitude and latitude
- Dropped `nan` values

How was the data cleaned?

Luftklima

- Removed unnecessary columns (e.g. `UNIX timestamp`)
- Dropped stations with coordinates 0°/0°
- Split coordinates into longitude and latitude
- Dropped stations with temperatures over 45°C
- Removed `nan` values

Dividing Basel into a grid

Idea:

- Divide Basel into grid
- Calculate average temperature for each cell
- Calculate sum of vehicles for each cell
- Interpolate empty cells

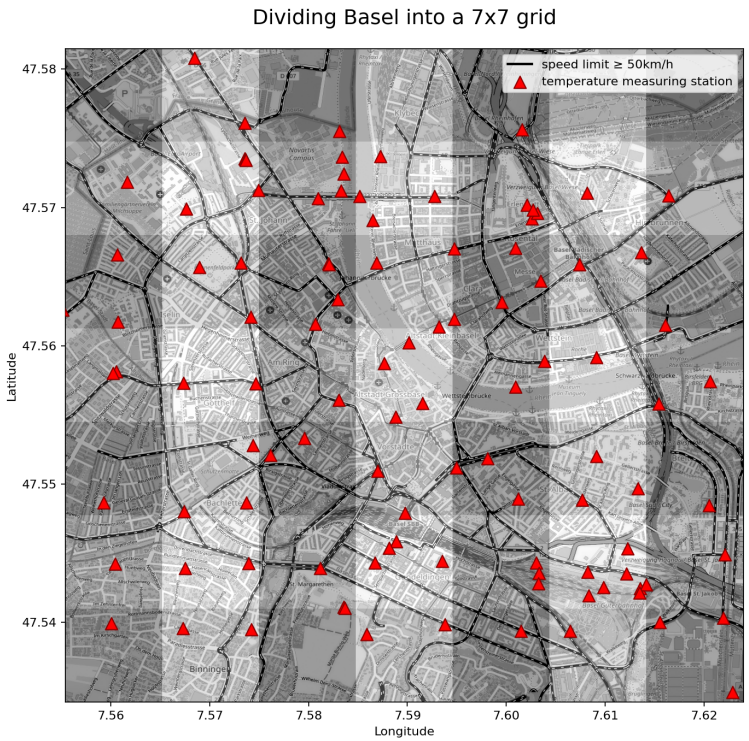

Figure: 7x7 grid

Grid-based approach

⇒ Vary grid size

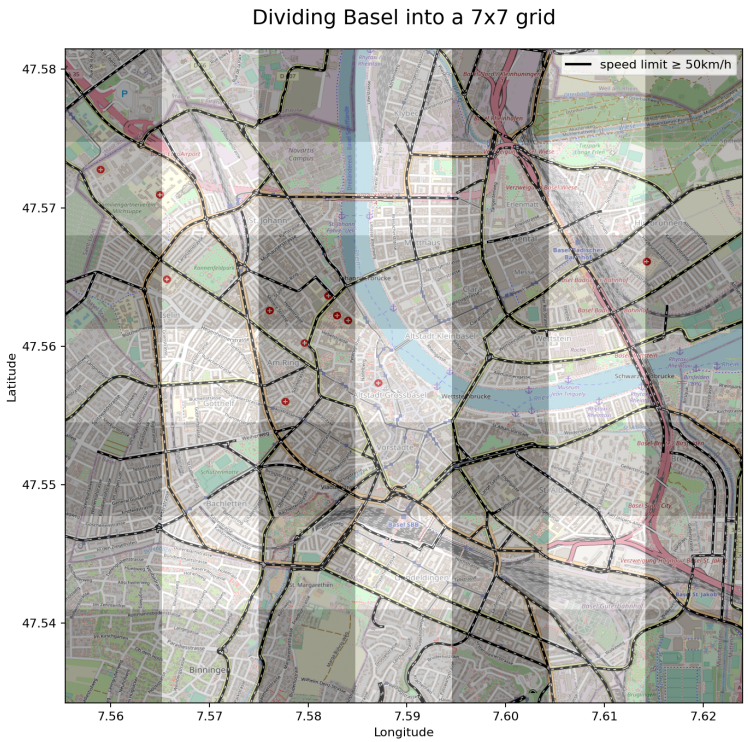

Figure: 7x7 grid

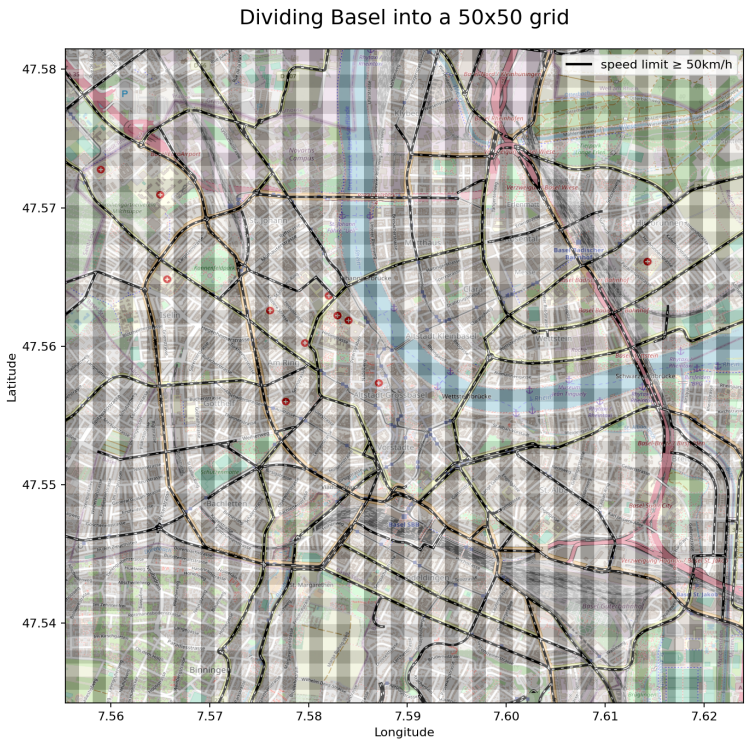

Figure: 50x50 grid

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Plotting average temperature as a grid

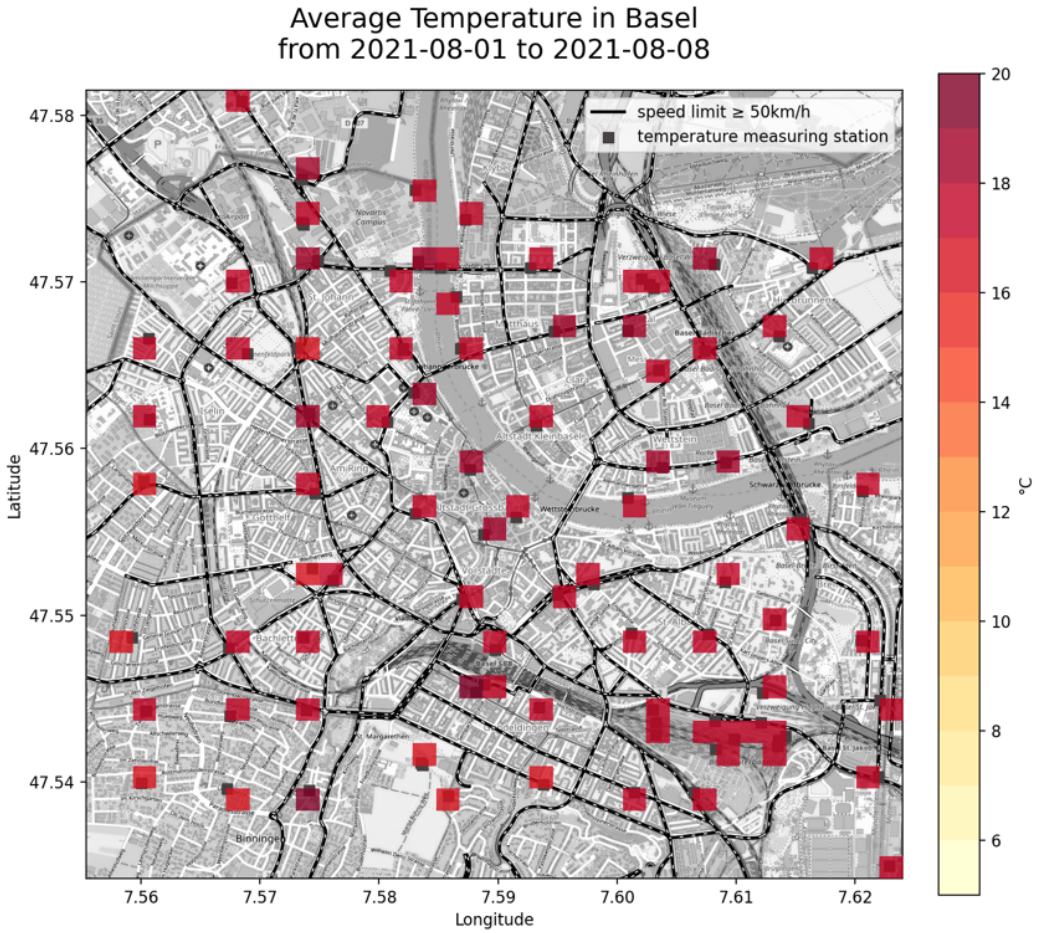

Figure: Avg temperature in grid

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Using interpolation to fill the grid

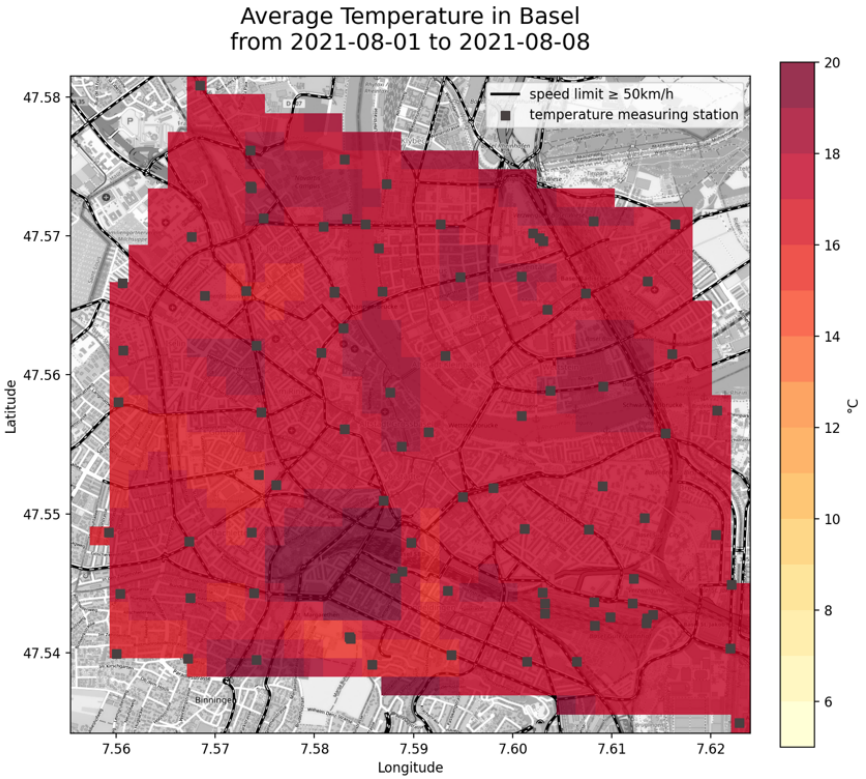

Figure: Cubic interpolation

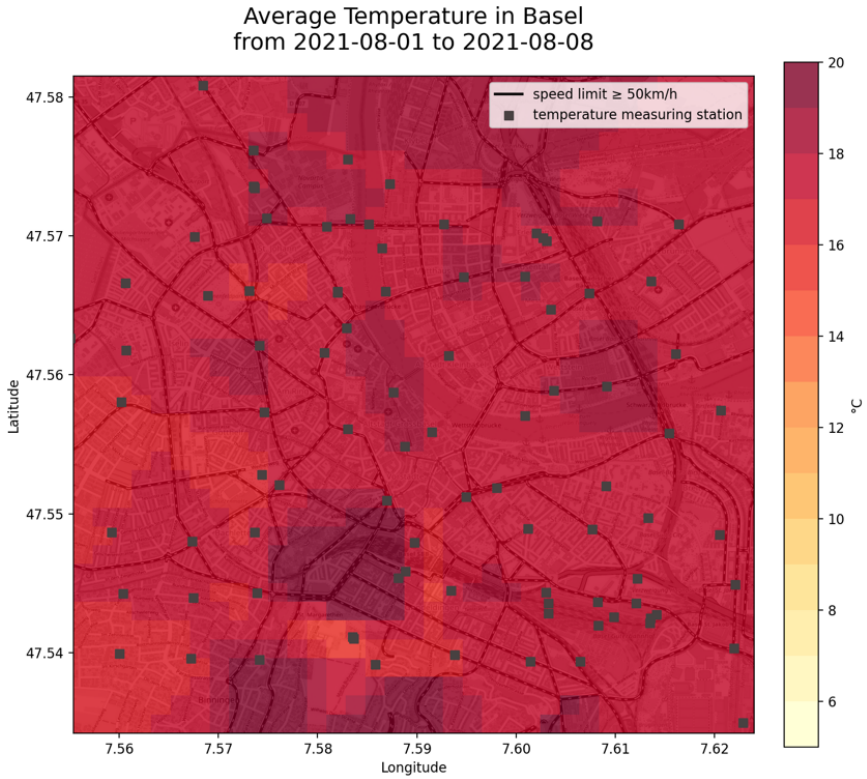

Figure: Cubic interpolation + nearest neighbour

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Two approaches for calculating correlation

Correlation

- Is there a correlation between the number of vehicles and the temperature?
  $\Rightarrow$ If the vehicle count is rising, is the temperature also rising?
  $\Rightarrow$ If the vehicle count is decreasing, is the temperature also decreasing?

Methods

- Using grids (7x7 in our case)
- Only using nearest stations

Calculation of the correlation

How was the correlation calculated?

Temperature	10.2	12.3	14.5	17.7
Time	08:00	09:00	10:00	11:00

Vehicle Count	423	643	536	510
Time	08:00	09:00	10:00	11:00

$$\Rightarrow x = \begin{bmatrix} 10.2 & 12.3 & 14.5 & 17.7 \\ 423.0 & 643.0 & 536.0 & 510.0 \end{bmatrix}$$

Pearson correlation coefficient using `np.corrcoef(`x`)`

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Example plots of the two methods

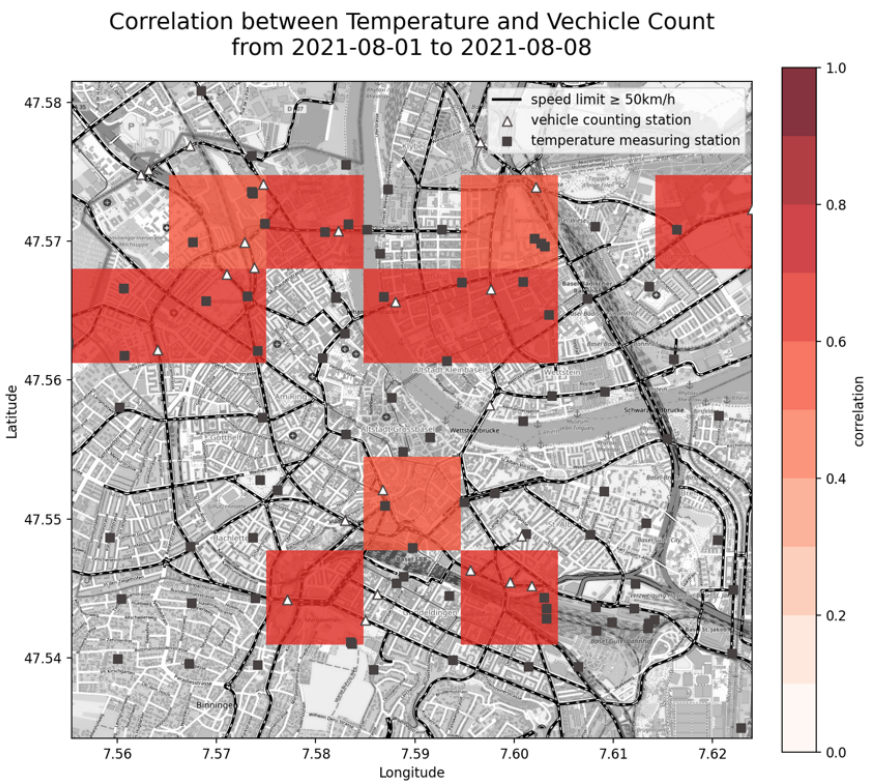

Figure: Correlation with grid

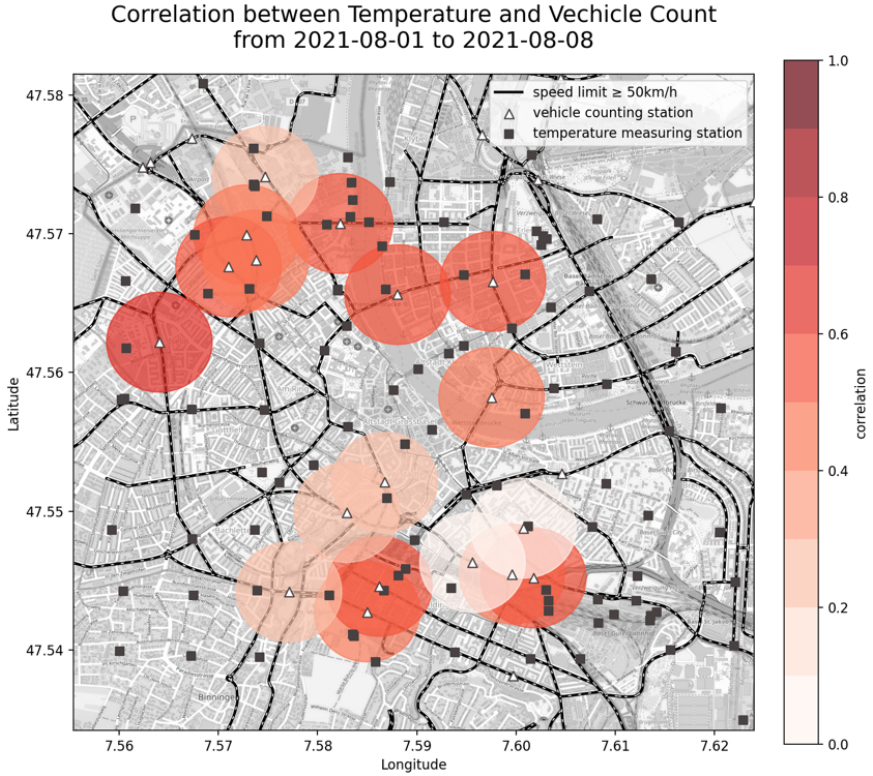

Figure: Correlation with nearest stations

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Results

Results

Time frame: 2020-10-01 - 2021-10-01

- Calculated average temperature per month
- Calculated average daily vehicle count per month
- Calculated correlation between vehicle count and temperature

Correlation between vehicle count and temperature

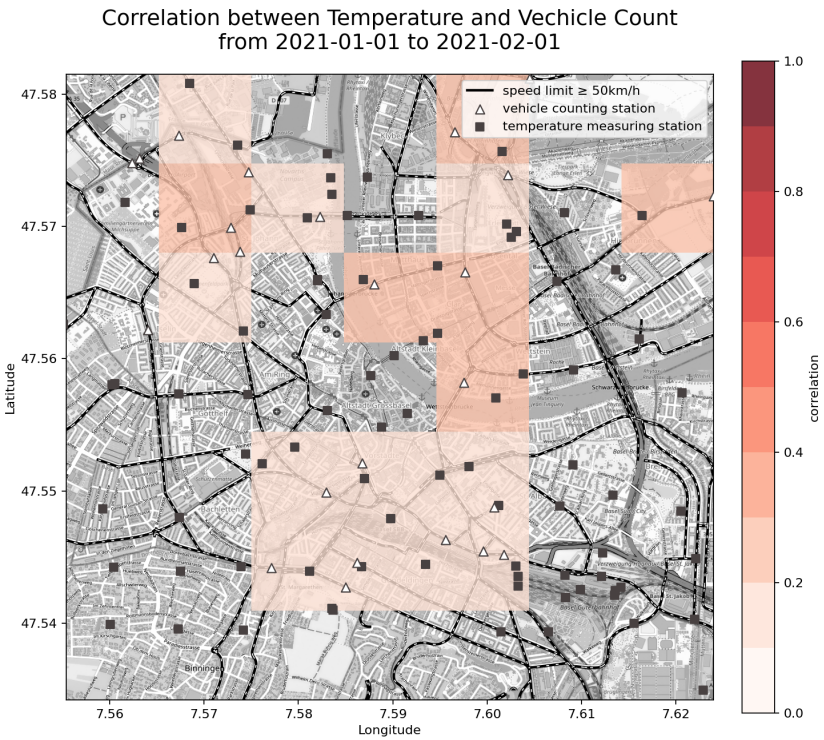

Figure: January 2021

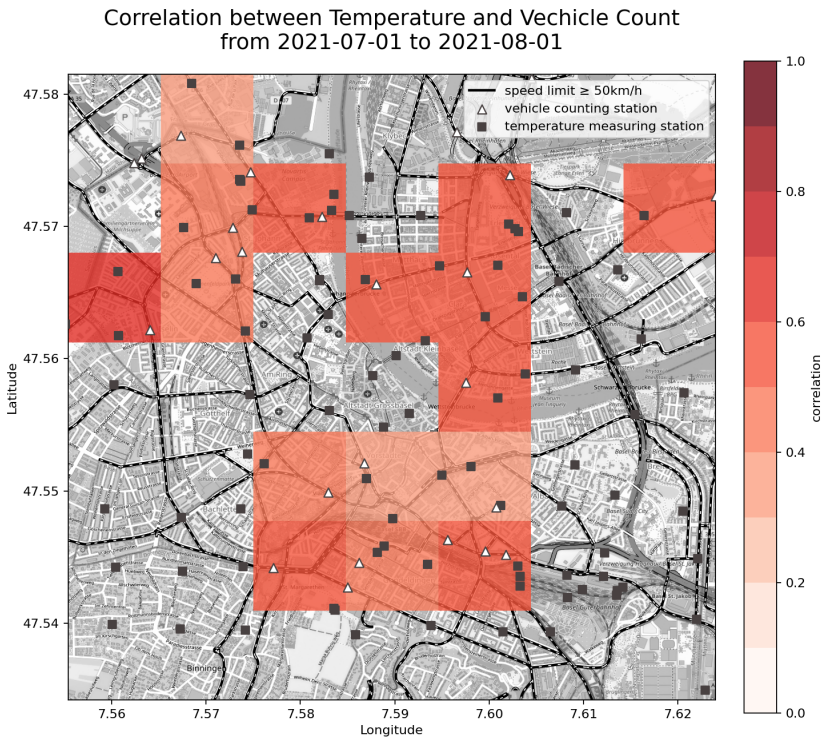

Figure: July 2021

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Interpretation

- No negative correlation
- Weak correlation (0.1 - 0.3) in January
- Strong correlation (0.6 - 0.8) in July
- Stronger correlation in warmer months

Does this make sense or are there some **other factors** that may influence the correlation?

Questioning the correlation

Correlations pretty high:
$\Rightarrow$ Obviously in the night colder and
less vehicles on the streets than during the day

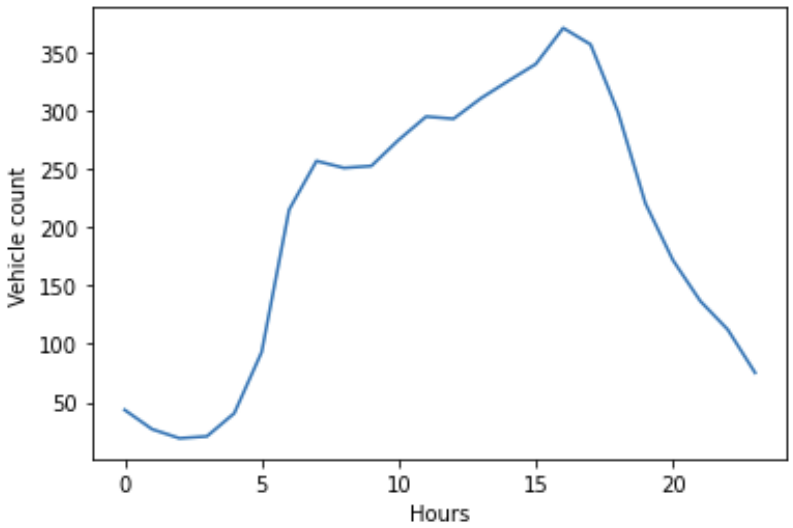

Figure: Vehicle count

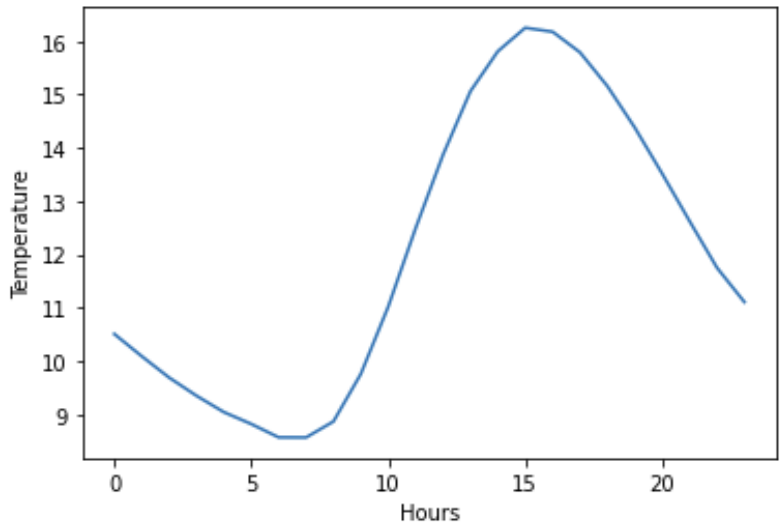

Figure: Temperature

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Questioning the correlation

Summer has higher correlation because...

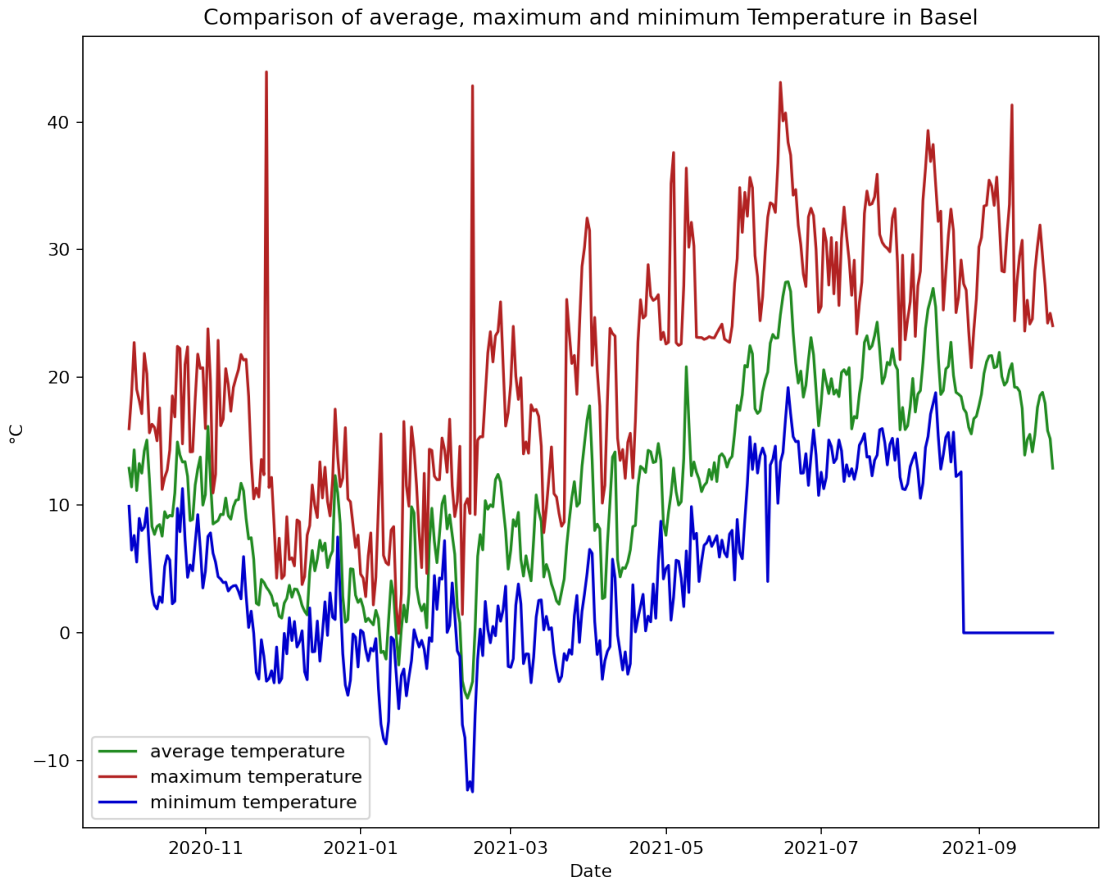

Figure: Minimum, maximum and average temperatures per day

Better approach

Only look at correlation during the day...

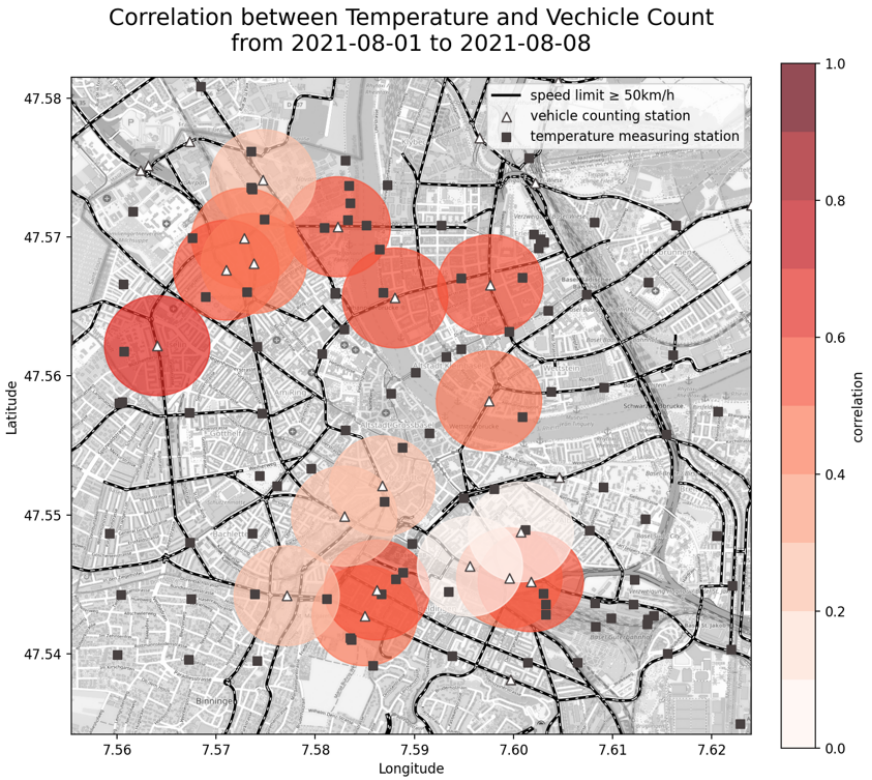

Figure: Correlation over entire day

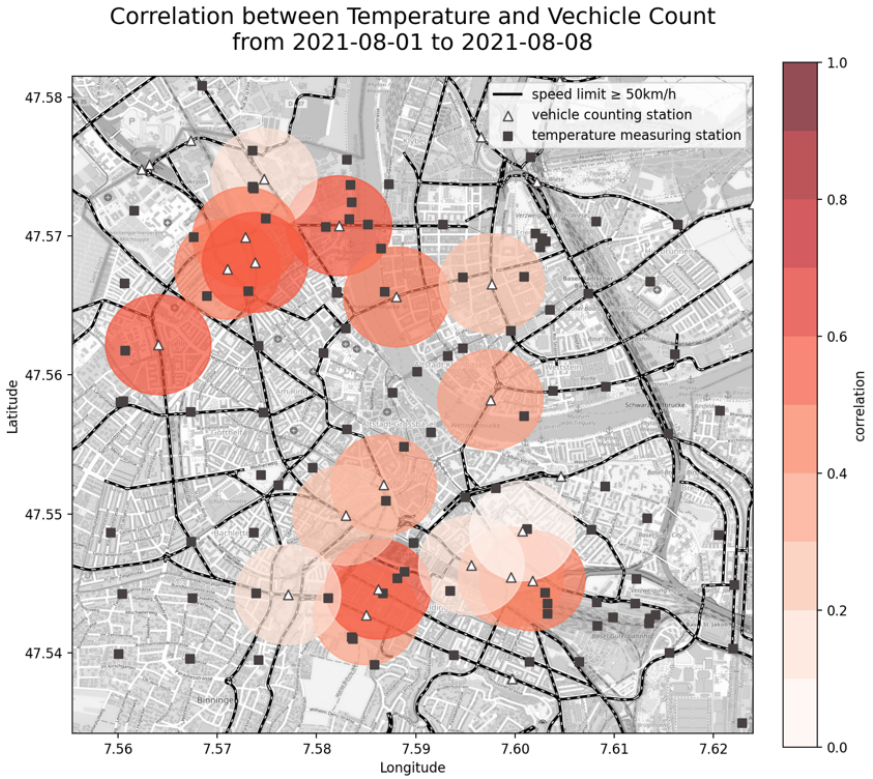

Figure: Correlation from 09:00 to 18:00

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Correlation over a year

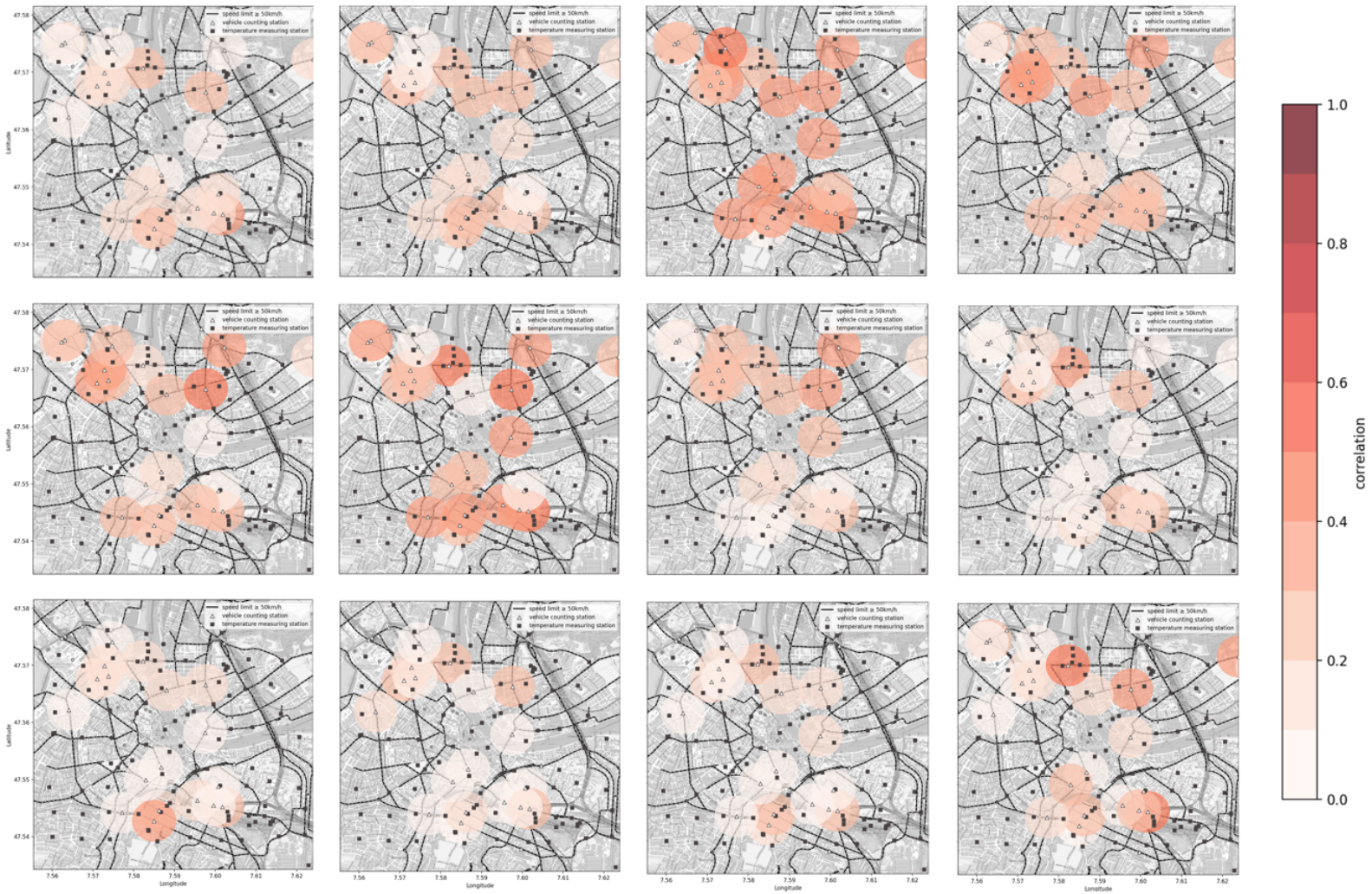

Figure: Monthly correlation from 2020-10 to 2021-10

Urban heat island in Basel?

- Factor out the day-night cycle
- Almost always positively correlated
- Seasons affect correlation
- Areas near big roads have higher correlations
- **Correlation** $\not\Rightarrow$ **causation**

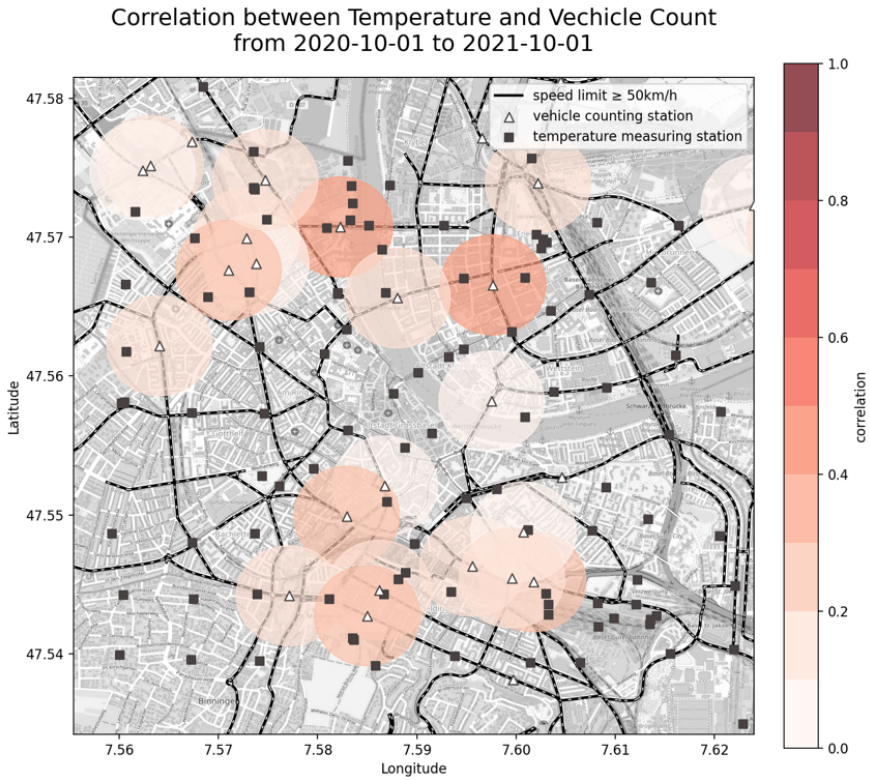

Figure: Correlation over a year

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Reflection

What went wrong and what can be improved?

- More planning in the beginning
- Start questioning high correlation early
- Better data set cleaning

Future Work

- Use additional data sets
- Examine longer time period
- Analyze day and night correlation
- Investigate Basel as an urban heat island

End

Are there any questions?

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