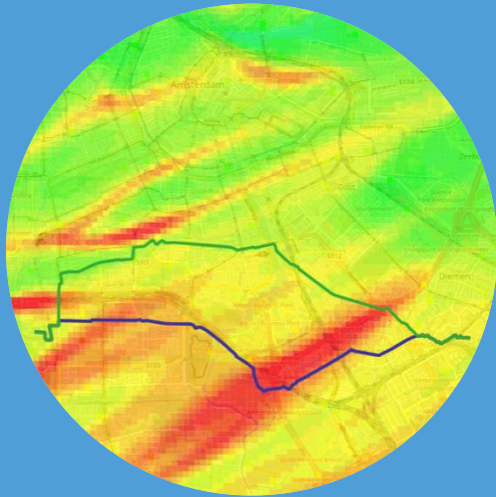


Healthy Urban Route Planner

A Route Planner with a special impedance

2 November 2017, Corné Vreugdenhil



Project Info

- Stimulus Project 2016 (AMS-Institute)



- Parties:

- Meteorology & Air Quality, WUR
- Geo-Information and Remote Sensing, WUR
- GGD Amsterdam
- Fietsersbond Amsterdam



WAGENINGEN UNIVERSITY
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The problem



DIGITALE KRANT SERVICE

Het Parool *Vrij, Onverzeerd*
HOME AMSTERDAM STADSGIDS

Amsterdam meest vervuilde stad van Nederland

A busy city street scene. In the foreground, a motorcyclist is riding a black scooter. The street is paved with cobblestones and has black and white striped bollards. In the background, there are many pedestrians, some walking and some on bicycles. The buildings are multi-story and have a classic architectural style.

Route alternatives



Let's build a route planner for citizens to find a more healthy route!

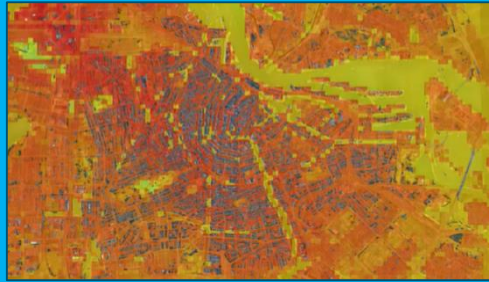
	Route 1a	Route 1b	Route 2a	Route 2b
7h	62%	112%	65%	68%
8h	100%	144%	100%	98%
9h	109%	145%	106%	94%
10h	88%	117%	80%	71%
16h	111%	156%	103%	98%
17h	131%	195%	133%	131%
18h	137%	216%	141%	145%
19h	144%	217%	144%	151%

Project Overview

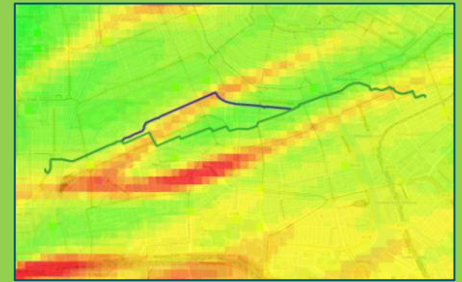
Mapping Air Quality Sources



Weather Research and Forecasting –Chemistry model



Route Planner Development

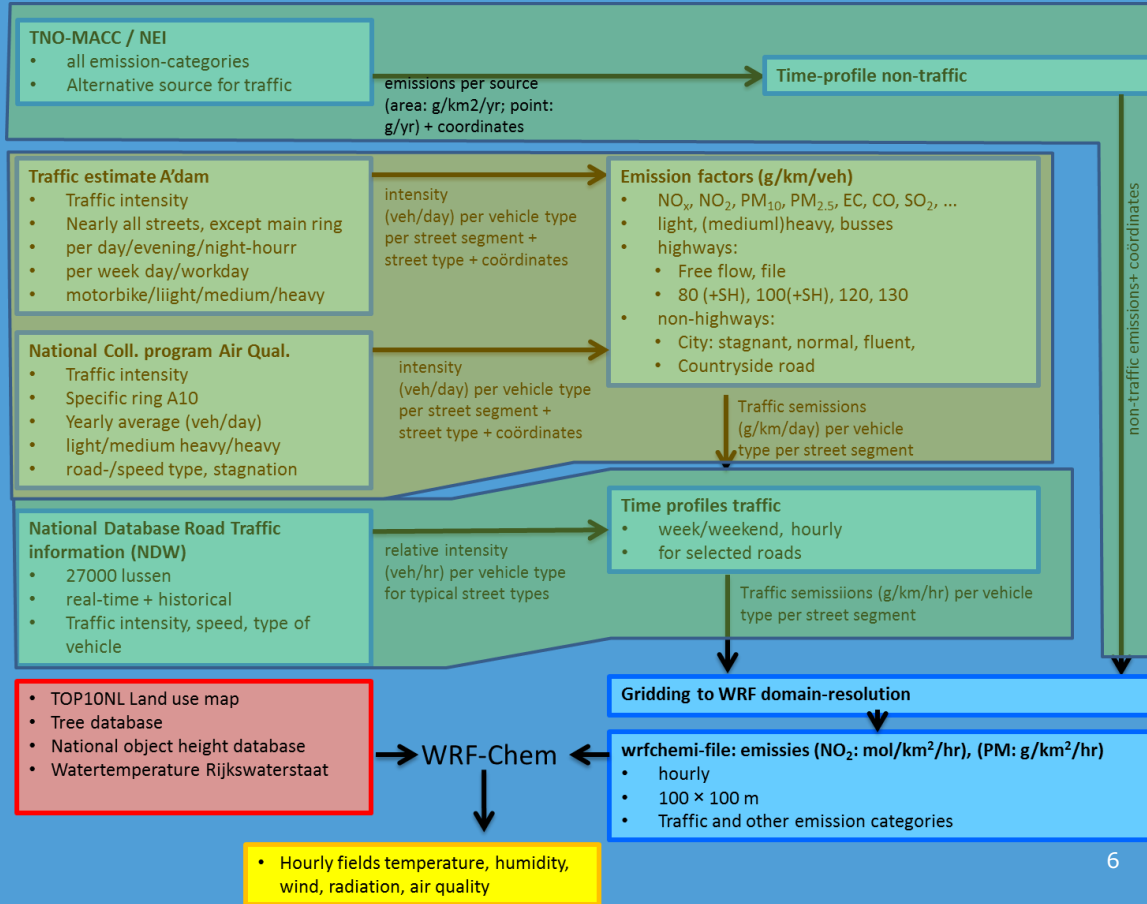


Air quality source maps

Daily air quality and heat maps

Mapping Air Quality Sources

- Emissions from Traffic: Observed traffic intensities (road counting loops)
- Non-traffic emissions: TNO-MACC / NEI



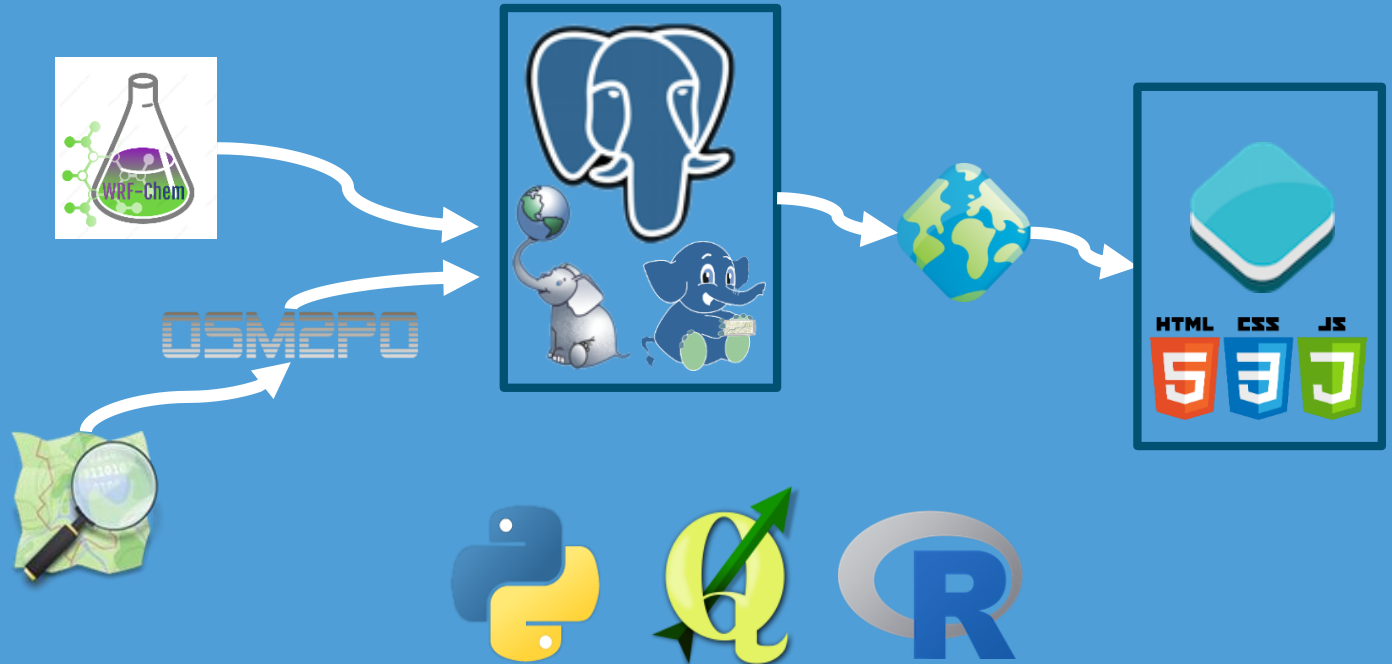
Weather Forecasting

WRF-Chem model: (Weather Research and Forecasting)

- Atmosphere and air quality model
- Includes urban canopy model and emissions
- Applied for Amsterdam, **hourly maps** with **100 m resolution**
- Atmospheric variables, amongst others **temperature** and **Nox concentration**

Route Planner Development

- Open source data & software based



Route Planner Development

- Open source data & software based
- Routing algorithm: Traditional Dijkstra with adapted cost-definition
 - Time dependent impedance variable (simulation day & hours)
 - Impedance = weather variable * length of segment
- Weather variable =
 - Temperature (Coolest Route) or,
 - NOx concentration (Cleanest Route)

HURP – the web application

The Healthy Urban Route Planner

This route planner provides cyclists and pedestrians a way to plan the most healthy route through the city of Amsterdam.

[Project Information](#) | [Contact](#) | [AMS-Institute](#)

Control Panel

Date of simulation: 2017-08-28

Time of departure: 13:00 ▾

Display weather map

Temperature

AirQuality (NOx)

Clear Routes

Recalculate Routes

Clear Map

Reload Map

Route Statistics

Time: 23.7 minutes

Distance: 5.94 km

Shortest Route

Average Temperature: 25.3 °C

Average NOx: 21.49 µg/m³

Time: 23.7 minutes

Coollest Route

Distance: 5.94 km

Average Temperature: 25.3 °C

Average NOx: 21.49 µg/m³

Time: 24.3 minutes

Cleanest Route

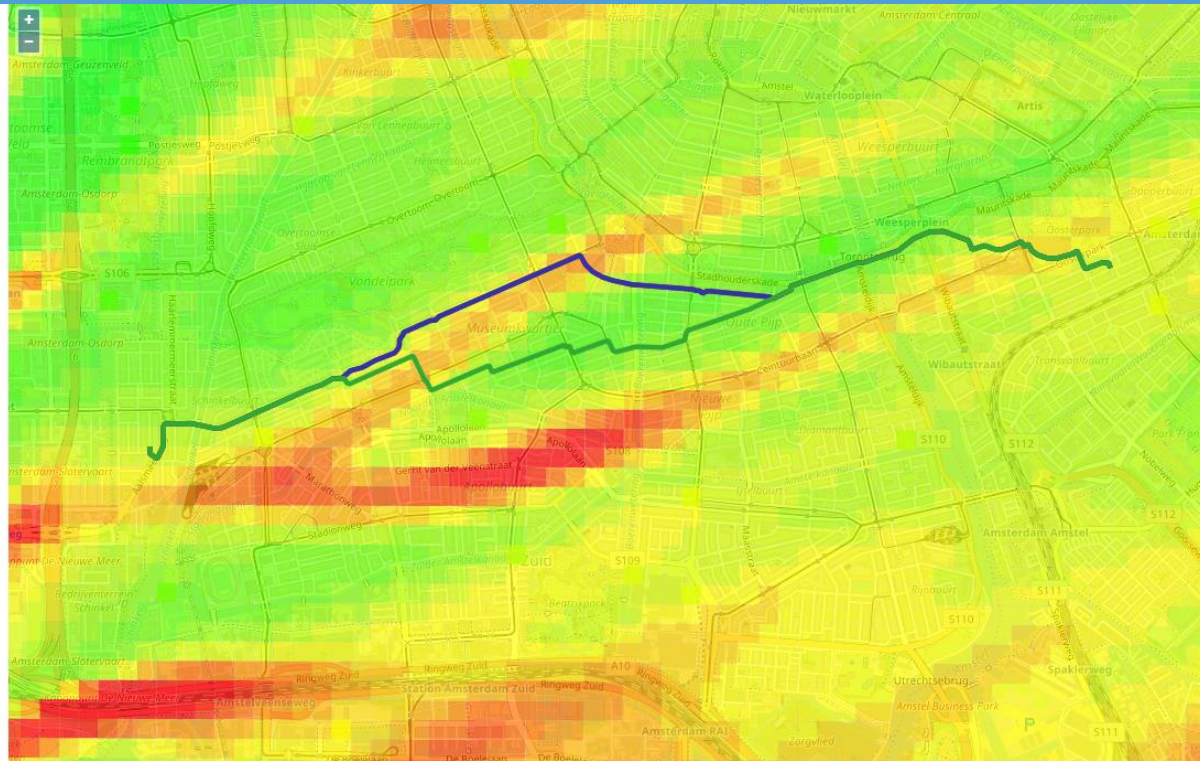
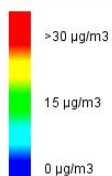
Distance: 6.07 km

Average Temperature: 25.2 °C

Average NOx: 20.91 µg/m³

Map Legend

Modelled NOx concentration (µg/m³)



HURP – the web application

The Healthy Urban Route Planner

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[Project Information](#) | [Contact](#) | [AMS-institute](#)

Control Panel

Date of simulation: 2017-08-28

Time of departure: 13:00

Display weather map: Temperature

AirQuality (NOx)

Route Statistics

Time: 38.4 minutes

Distance: 9.60 km

Shortest Route Average Temperature: 25.0 °C

Average NOx: 25.60 µg/m³

Time: 38.4 minutes

Distance: 9.60 km

Coollest Route Average Temperature: 25.0 °C

Average NOx: 25.60 µg/m³

Time: 41.9 minutes

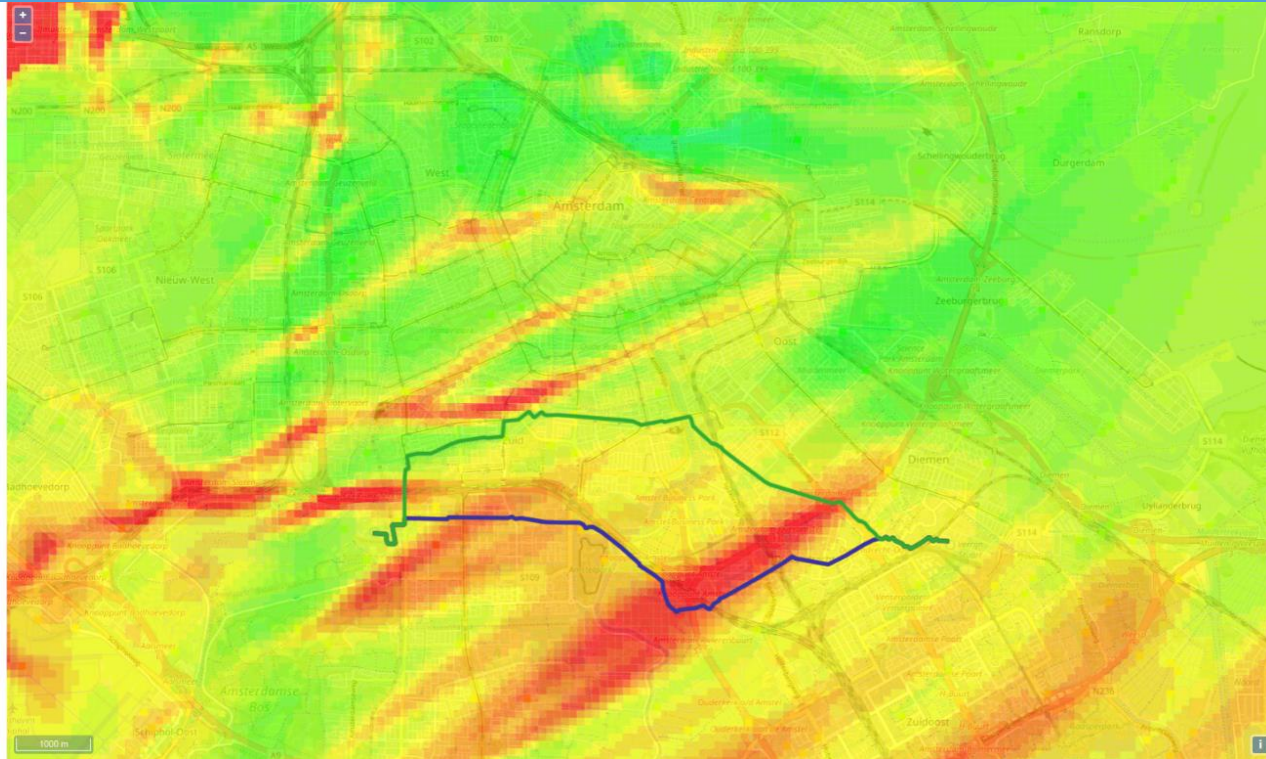
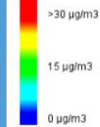
Cleanest Route Distance: 10.48 km

Average Temperature: 24.8 °C

Average NOx: 22.86 µg/m³

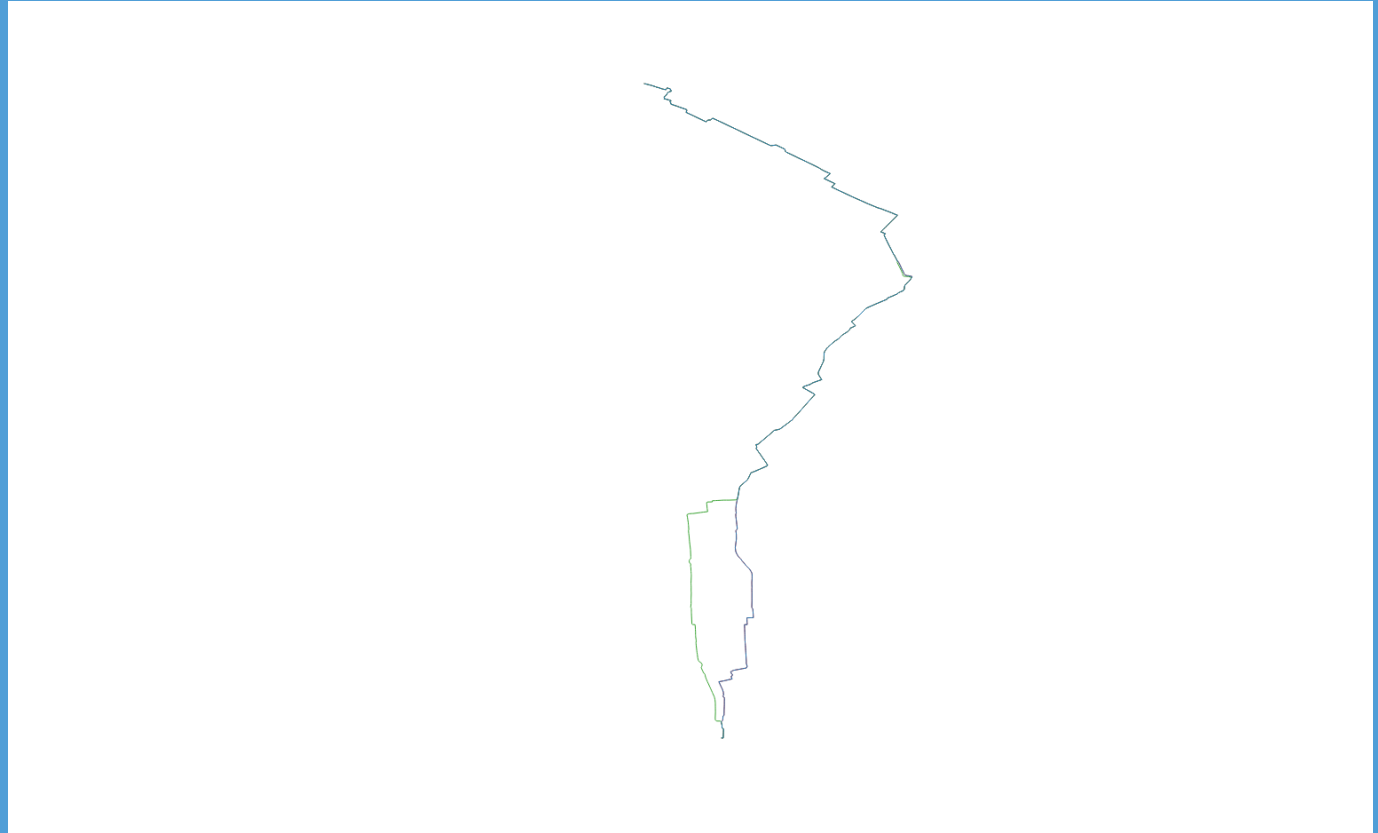
Map Legend

Modelled NOx concentration (µg/m³)



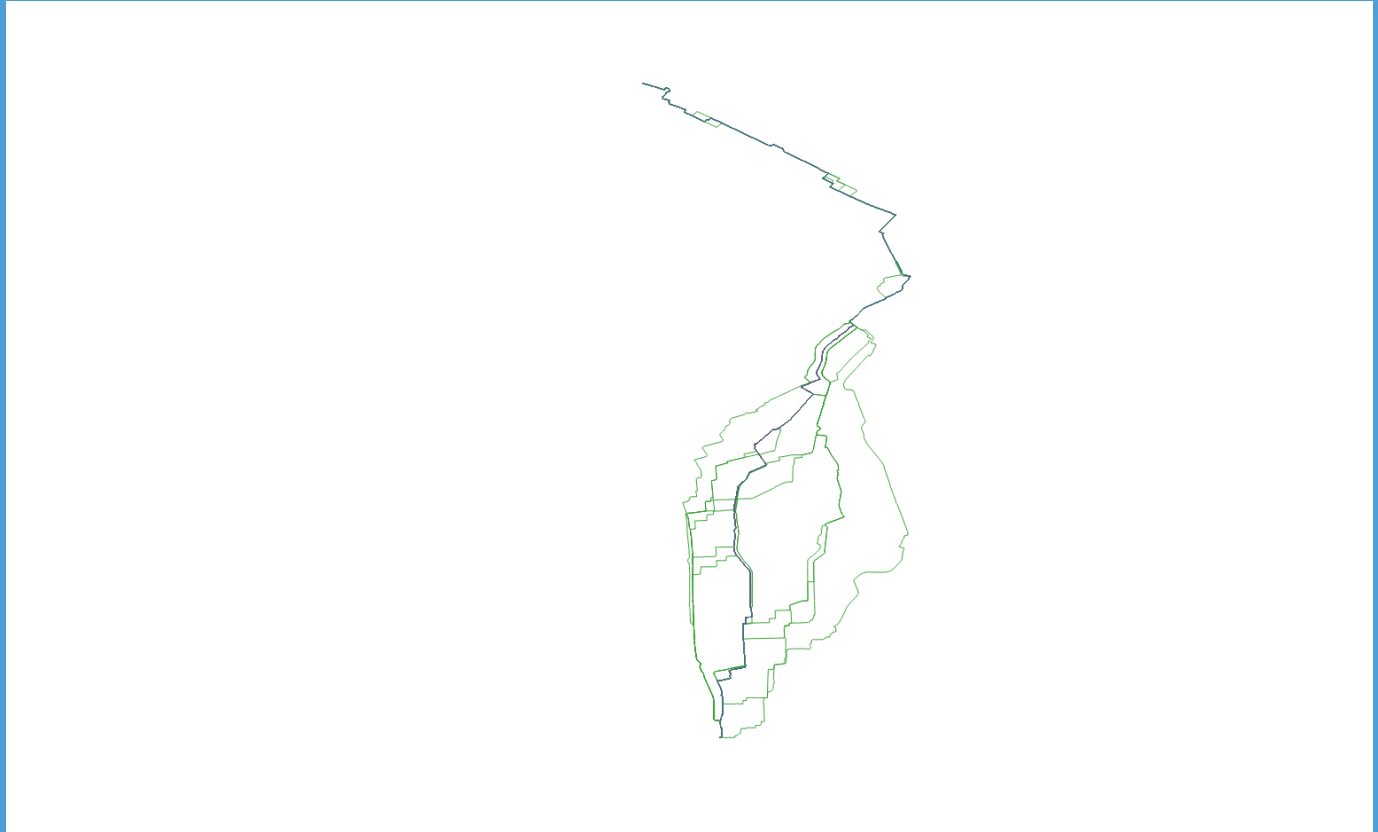
Monte Carlo analysis on HURP

- 1 begin-end
- 1 simhour
- 3 route types



Monte Carlo analysis on HURP

- 1 begin-end
- 24 simhours
- 3 route types



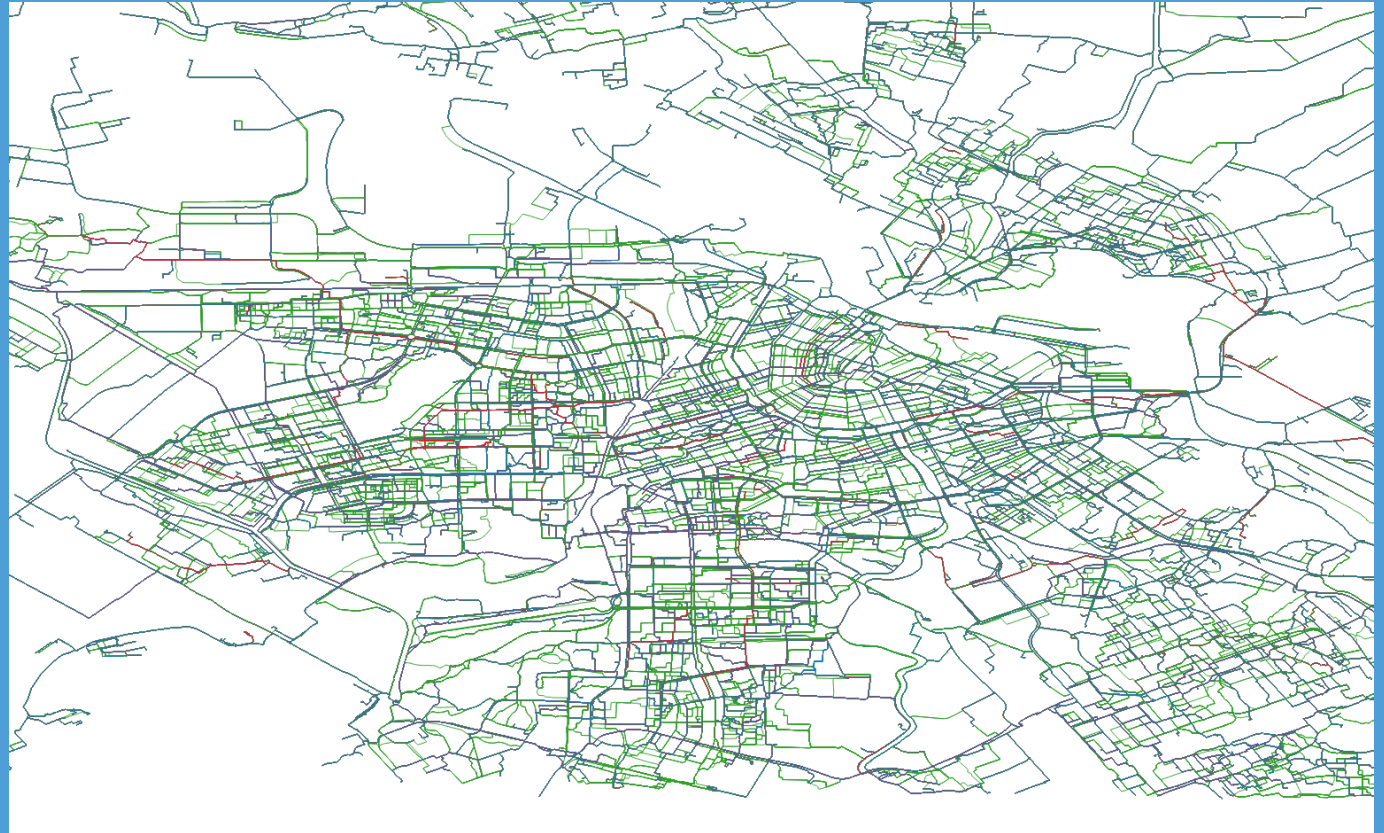
Monte Carlo analysis on HURP

- 10 begin-end
- 24 simhours
- 3 route types



Monte Carlo analysis on HURP

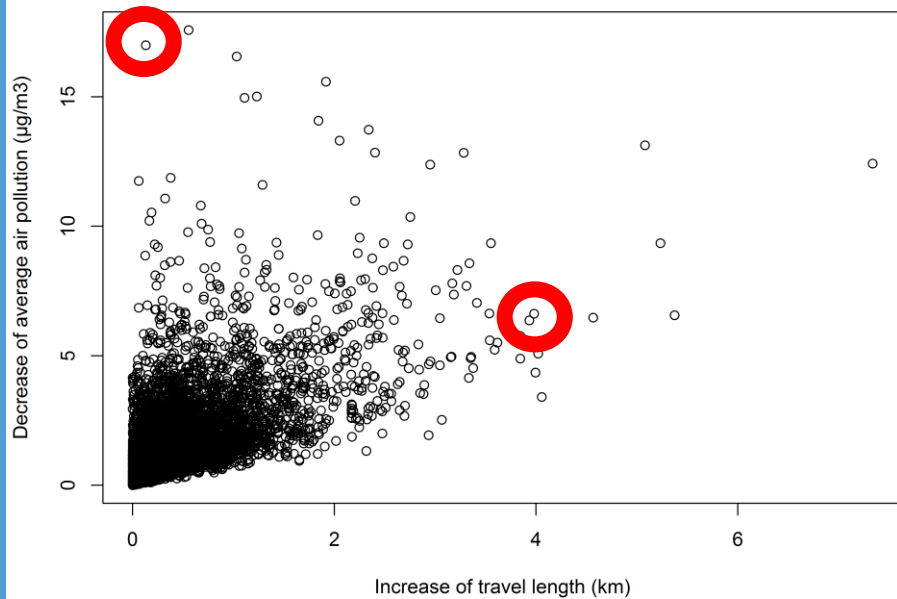
- 1000 begin-end pairs
- 24 simhours
- 3 route types



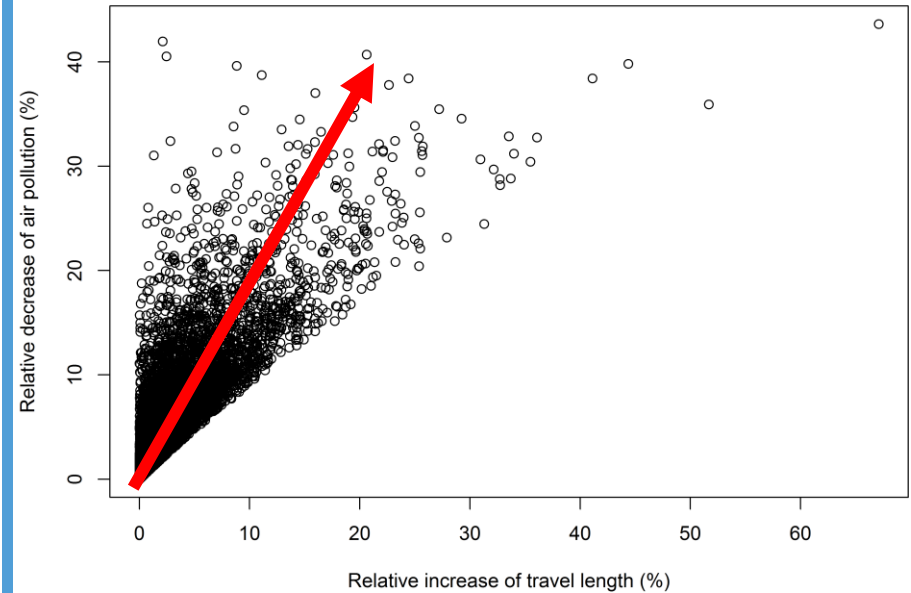
Results of Monte Carlo Analysis

Air pollution

Shortest Route vs. Cleanest Route 20170828



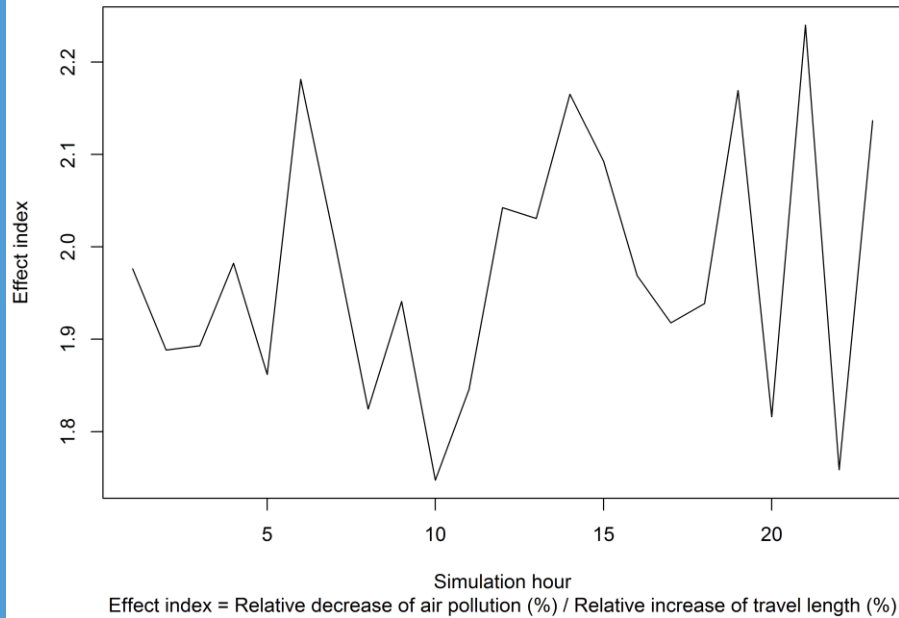
Shortest Route vs. Cleanest Route 20170828



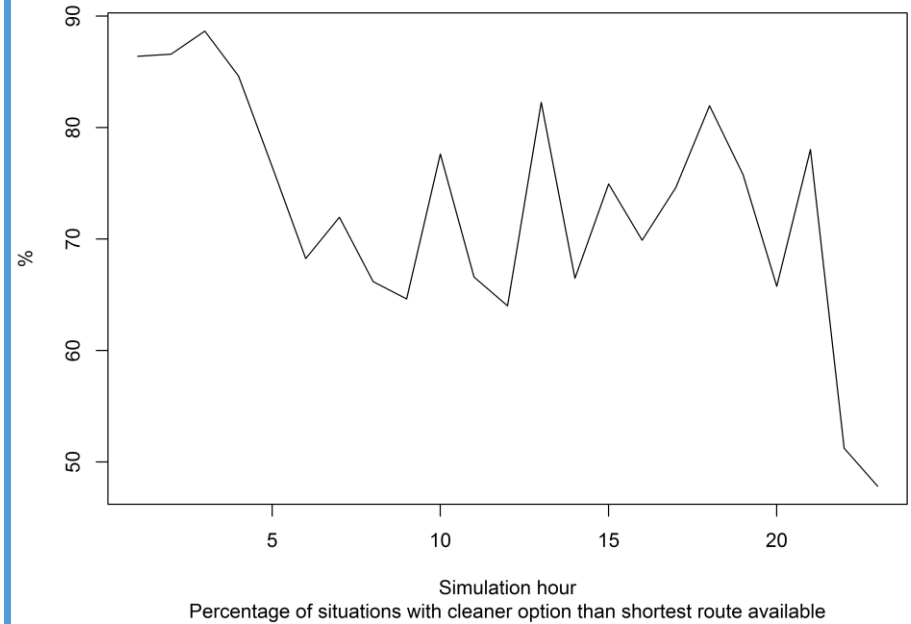
Results of Monte Carlo Analysis

Air pollution

Shortest Route vs. Cleanest Route 20170828

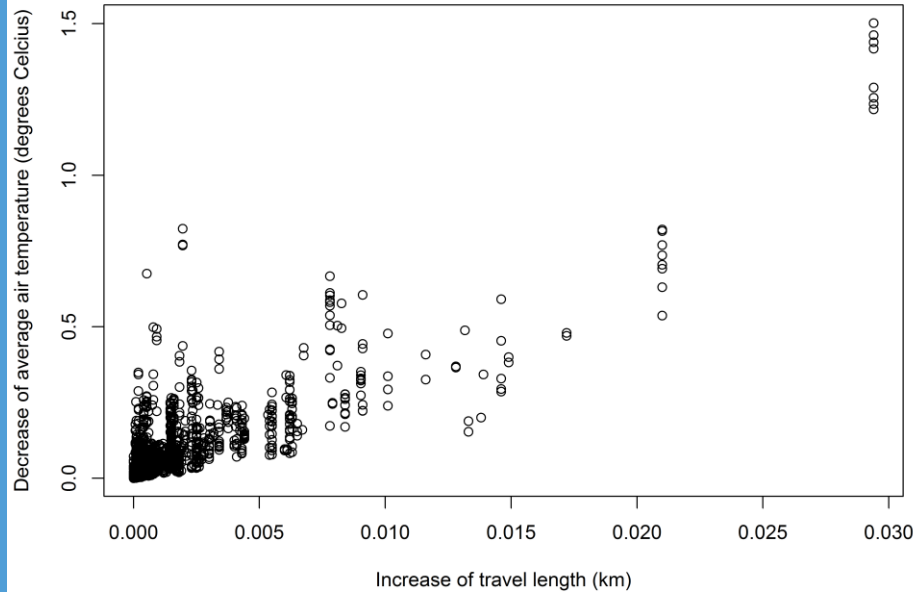


Shortest Route vs. Cleanest Route 20170828

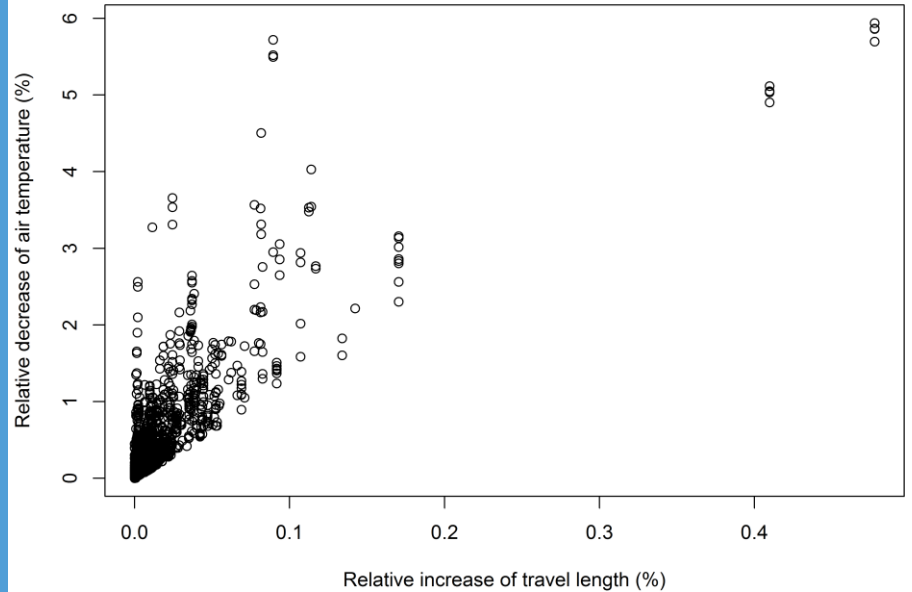


Results of Monte Carlo Analysis Temperature

Shortest Route vs. Coolest Route 20170828

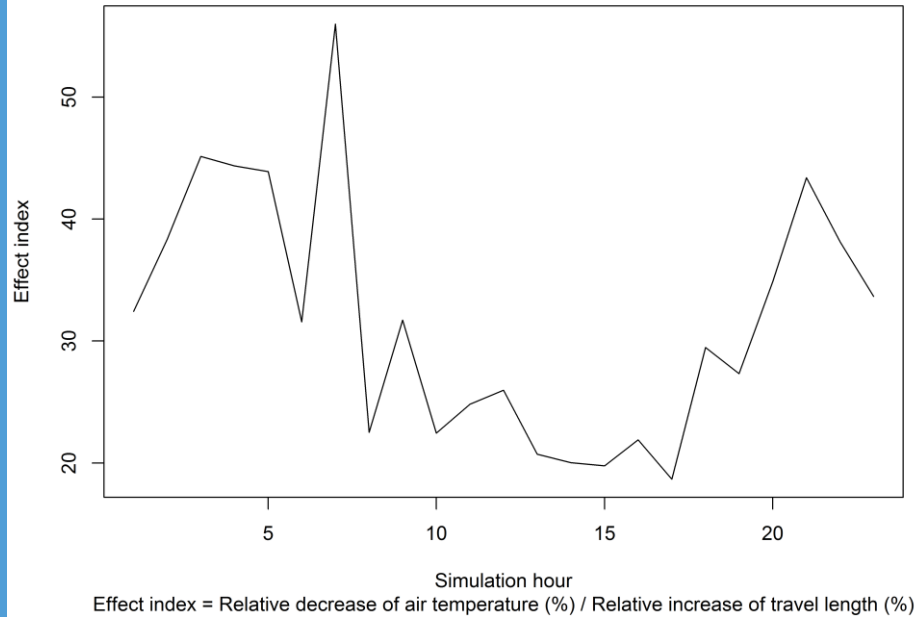


Shortest Route vs. Coolest Route 20170828

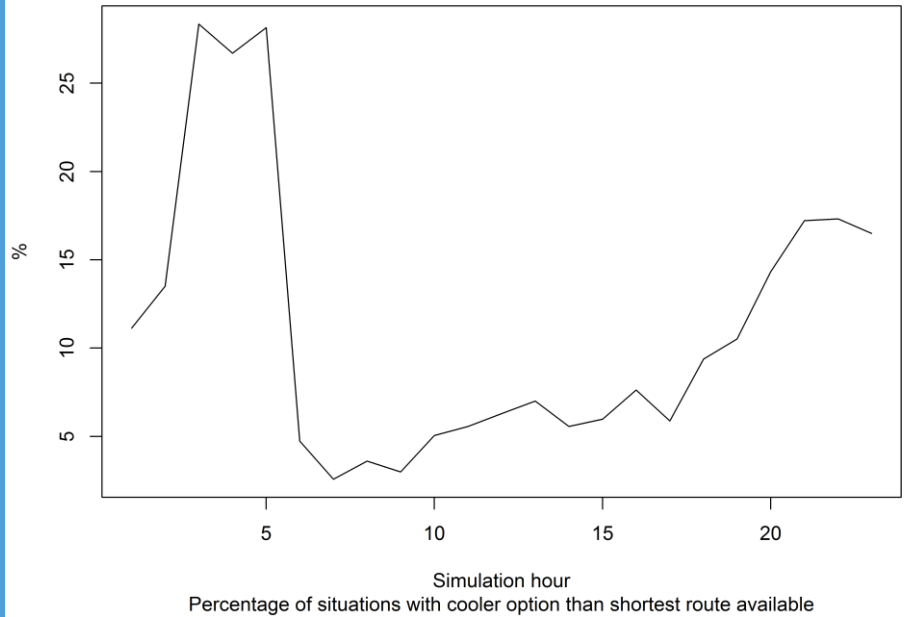


Results of Monte Carlo Analysis Temperature

Shortest Route vs. Coolest Route 20170828



Shortest Route vs. Coolest Route 20170828



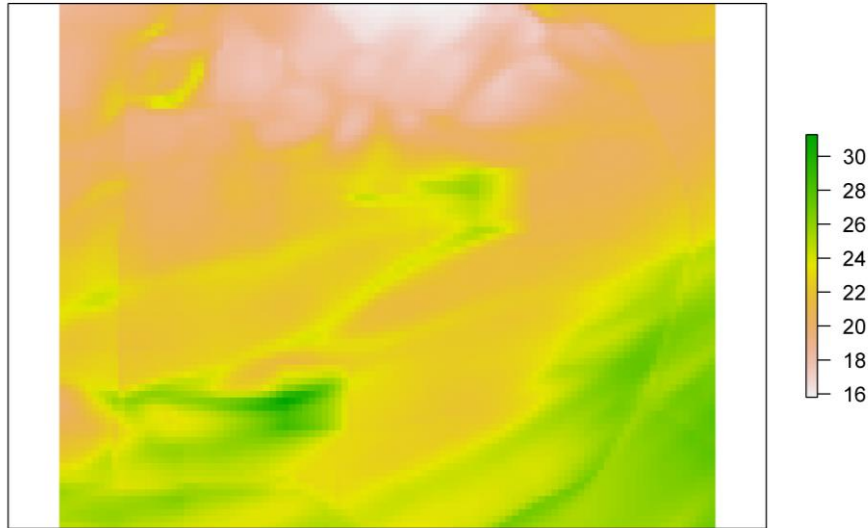
Preliminary results

- NOx concentration:
 - ~ 70 % of cases a 'cleaner' alternative

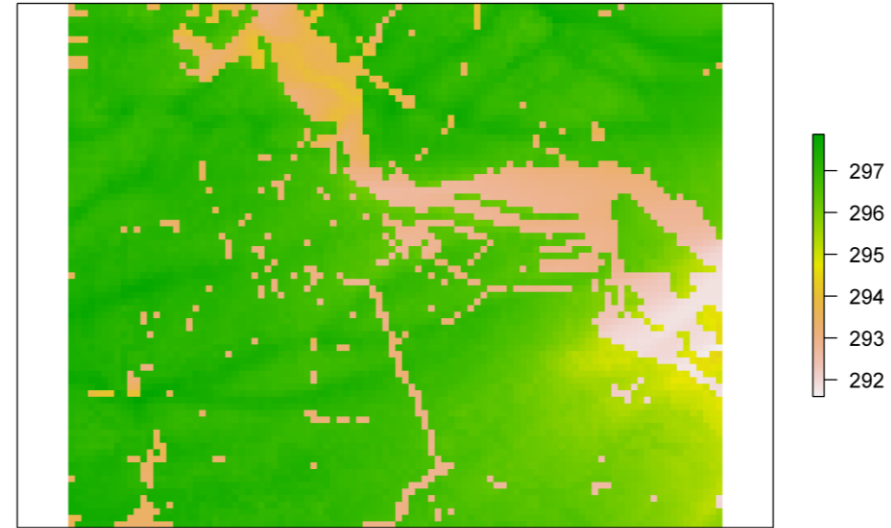
- Temperature:
 - Only ~10-20 % of cases a 'cooler' alternative found
 - Larger effect, but rarely a cooler alternative

Larger influence due to larger spatial variability?

NOx concentration (ug/m3) | 12 h | August 28, 2017



Temperature (Kelvin) | 12 h | August 28, 2017



Discussion

