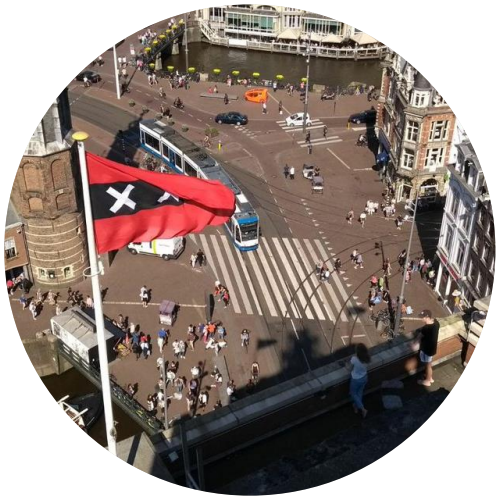
Reflections on Urban Meteorology

Ruisdael Science Day 14 October 2022 – Green Village, Delft

Gert-Jan Steeneveld



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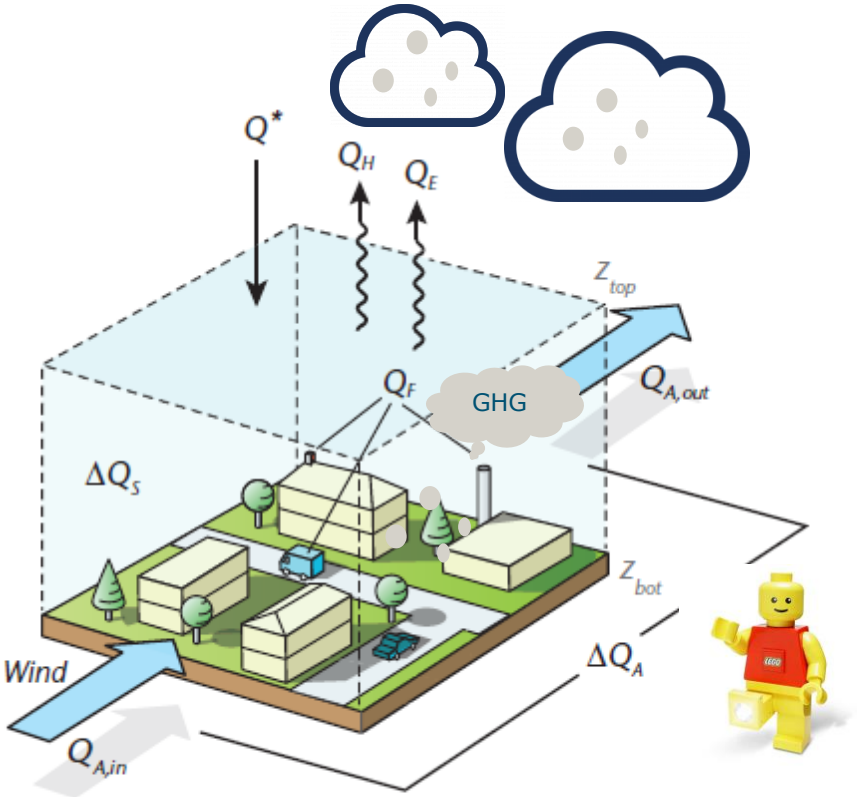
What are we talking about?

- Surface energy and radiation balance
- Cloud and rain modification
- Greenhouse gas sources
- Air quality
- Humans!

What did we learn?



$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A$$

Oke et al 2017

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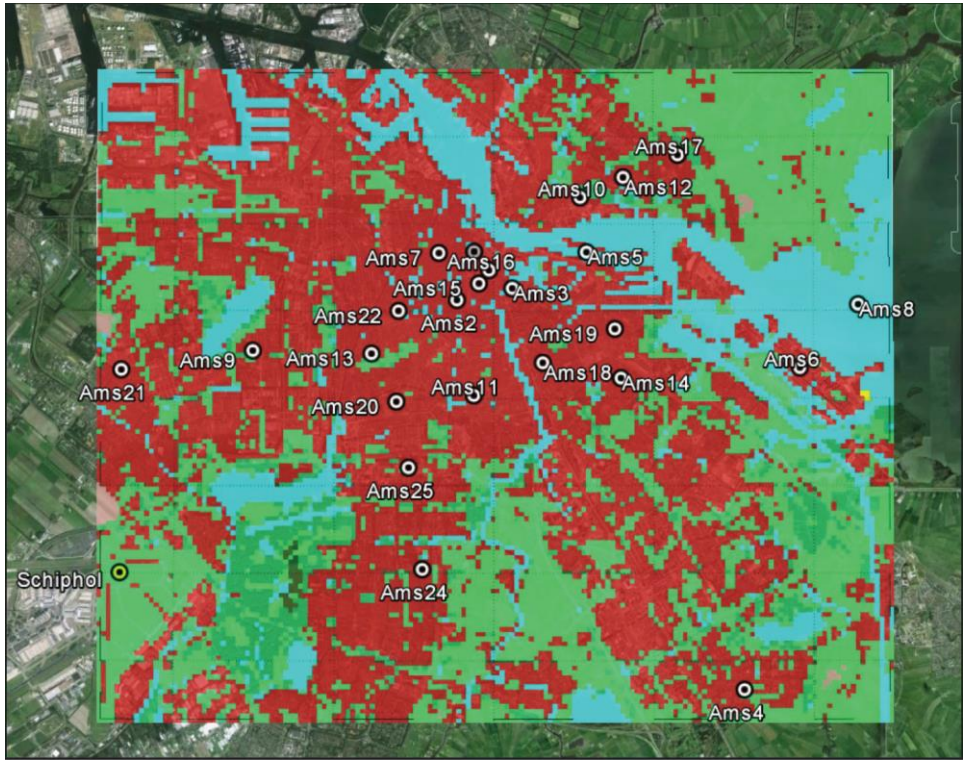
Amsterdam Atmospheric Monitoring Supersite (AAMS)



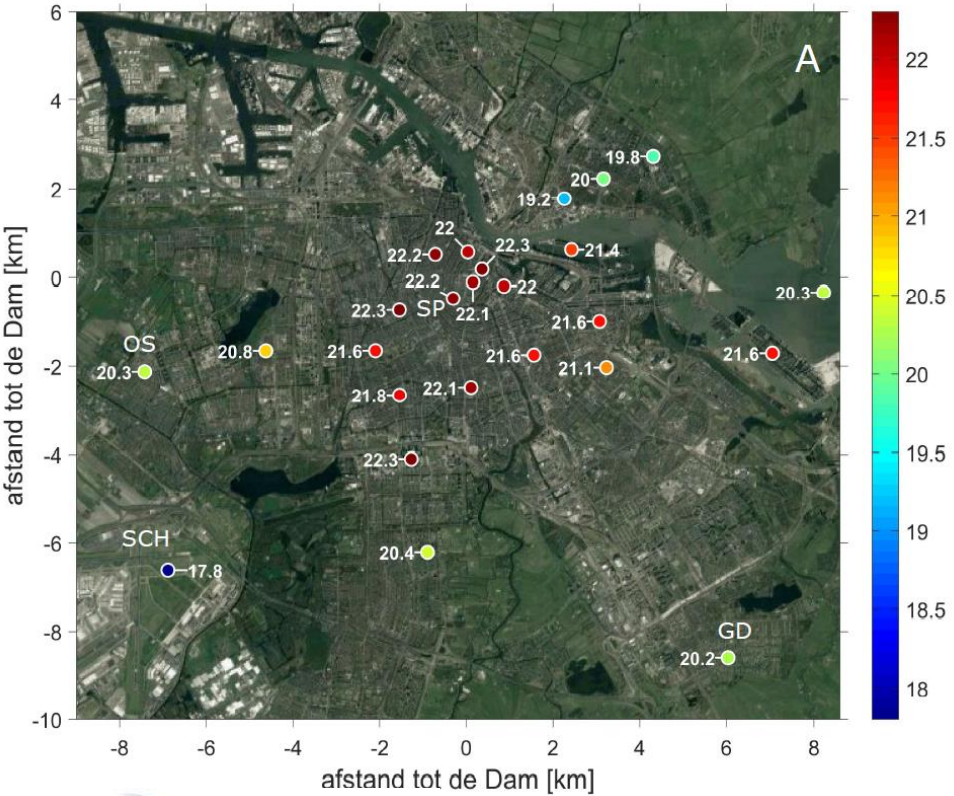
24 stations meteo stations – street level:
Temperature,
Spec Humidity
Wind speed and variability
Precipitation and black globe temp

Fluxes
Scintillometer (H, LE)
Radiation balance
Sonic station (H, LE, CO2)

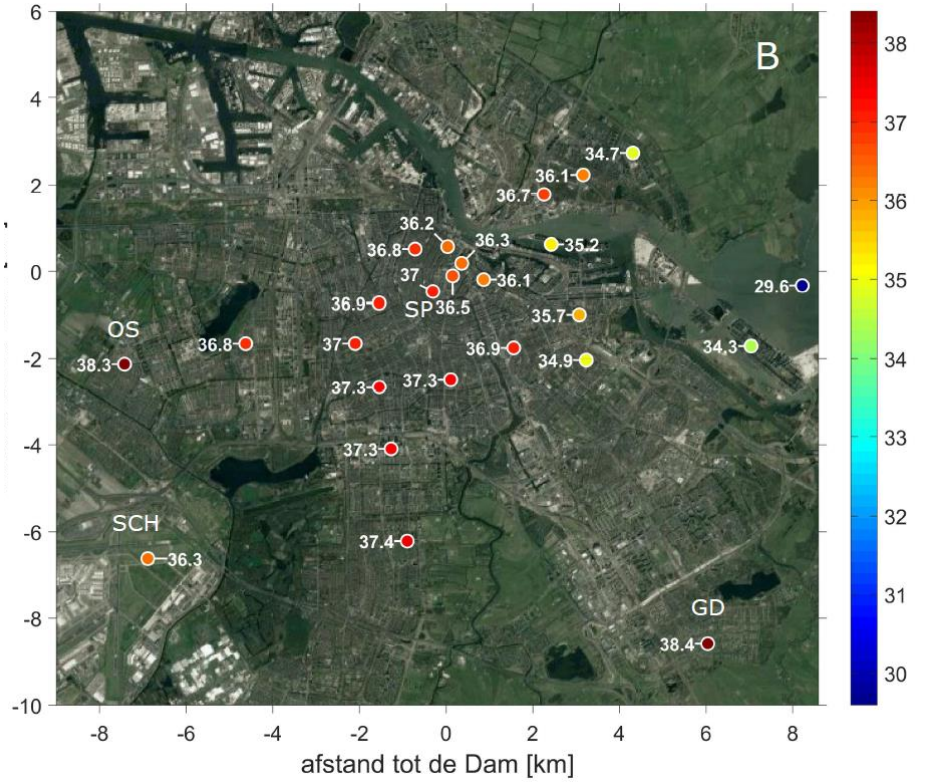
Ruisdael observatory

Ronda, R.J., G.J. Steeneveld, B.G. Heusinkveld, J.J. Attema, and A.A.M Holtslag, 2017: Urban fine-scale forecasting reveals weather conditions with unprecedented detail, Bulletin of the American Meteorological Soc., **98**, 2675–2688.

Minimum temperatures 25 Jul 2019

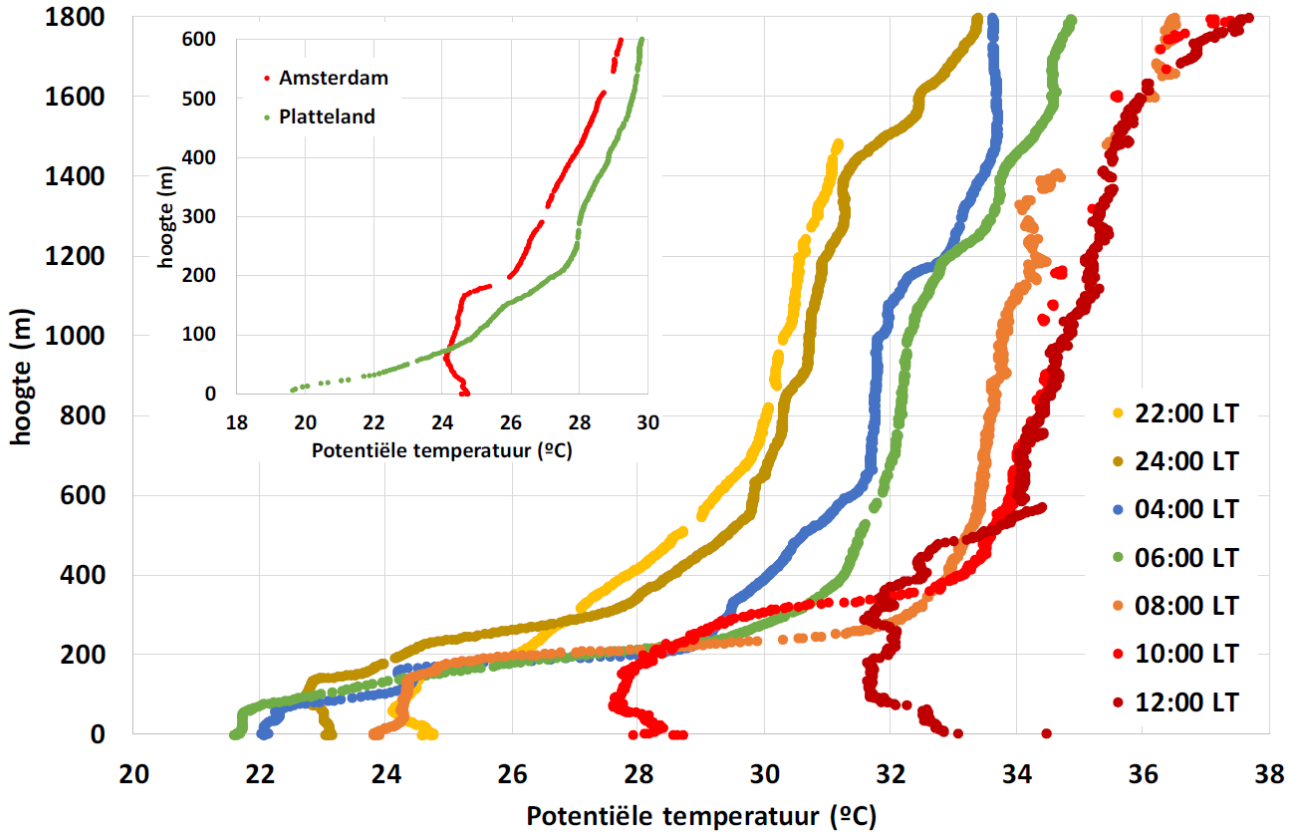


Maximum temperatures 25 Jul 2019



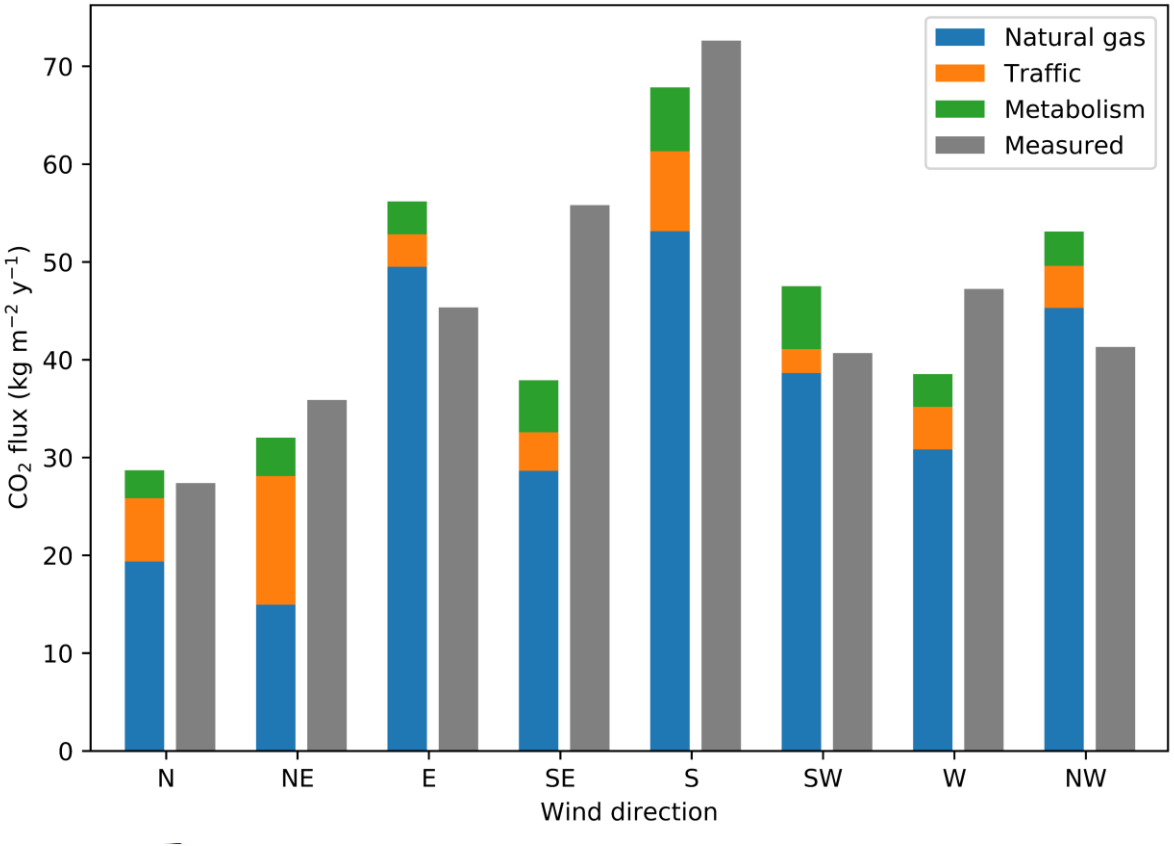
Ruisdael observatory

Intensive field campaign: Balloons, 23&24 Jul 2019



Analog structure found in Ruisdeal urban campaign 2-Sept '22

CO_2 monitoring. Match with emission database?

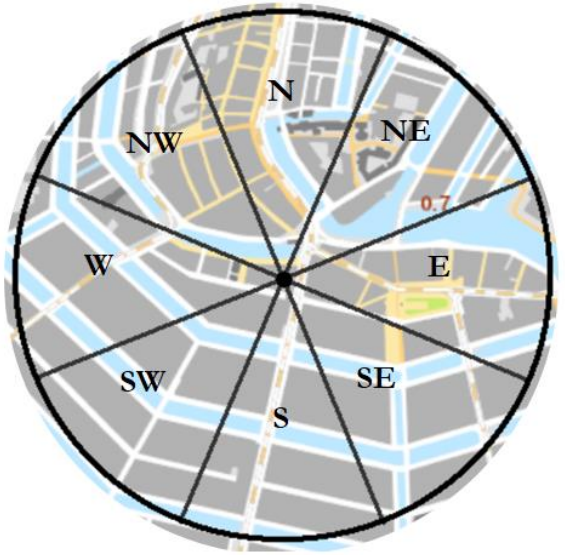


Measured

45 kg CO_2 m^{-2} yr^{-1}

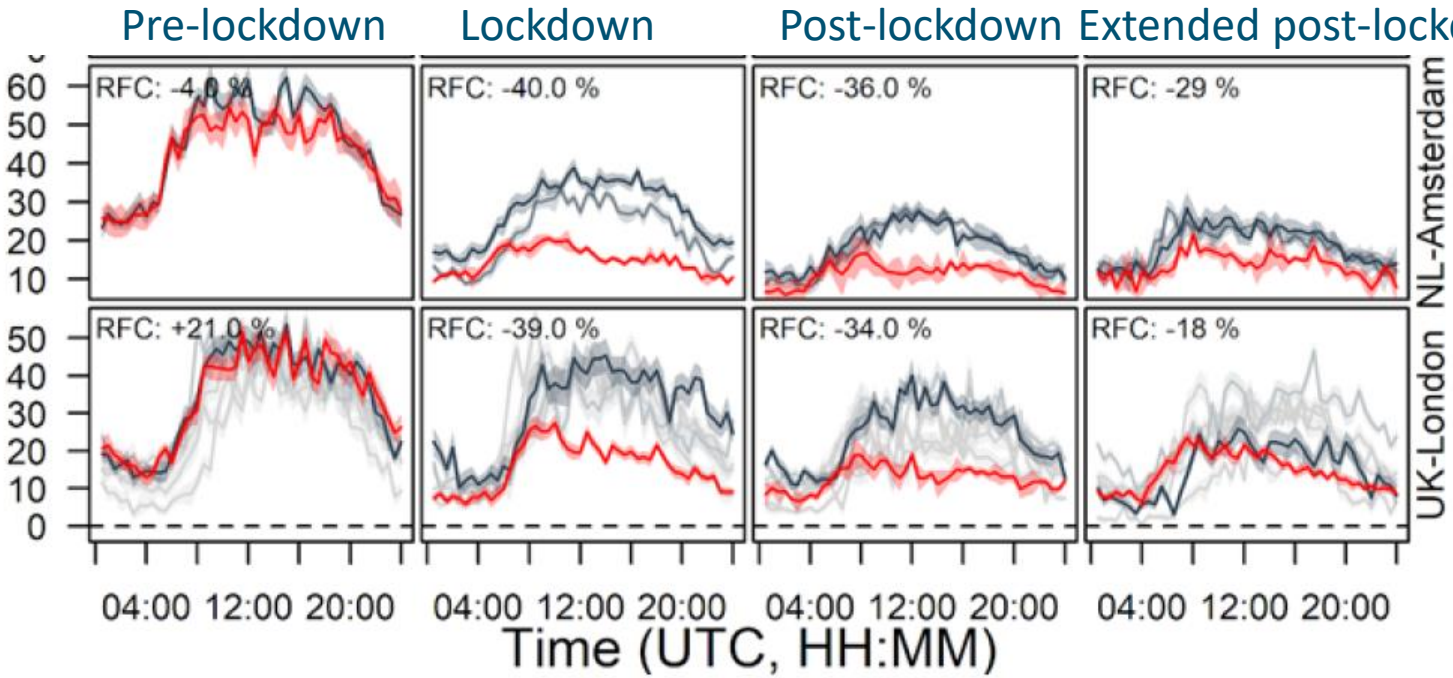
Estimated

47 kg CO_2 m^{-2} yr^{-1}



Van der Horst 2019

Impact COVID-19 lockdown on measured CO2 flux reduction in Amsterdam



2020, earlier years

Intercomparison of 13 cities across Europe

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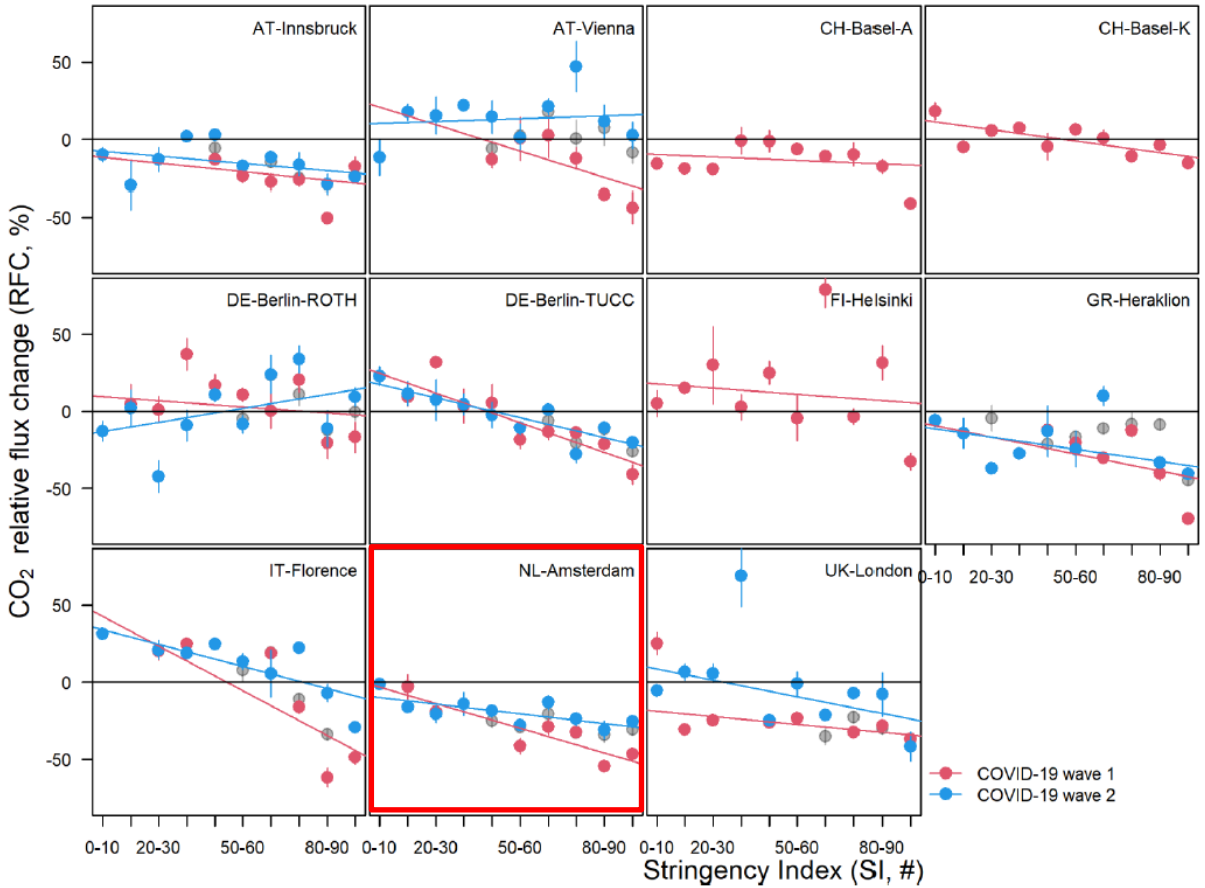
Nicolini et al, 2022, Sci Total Env

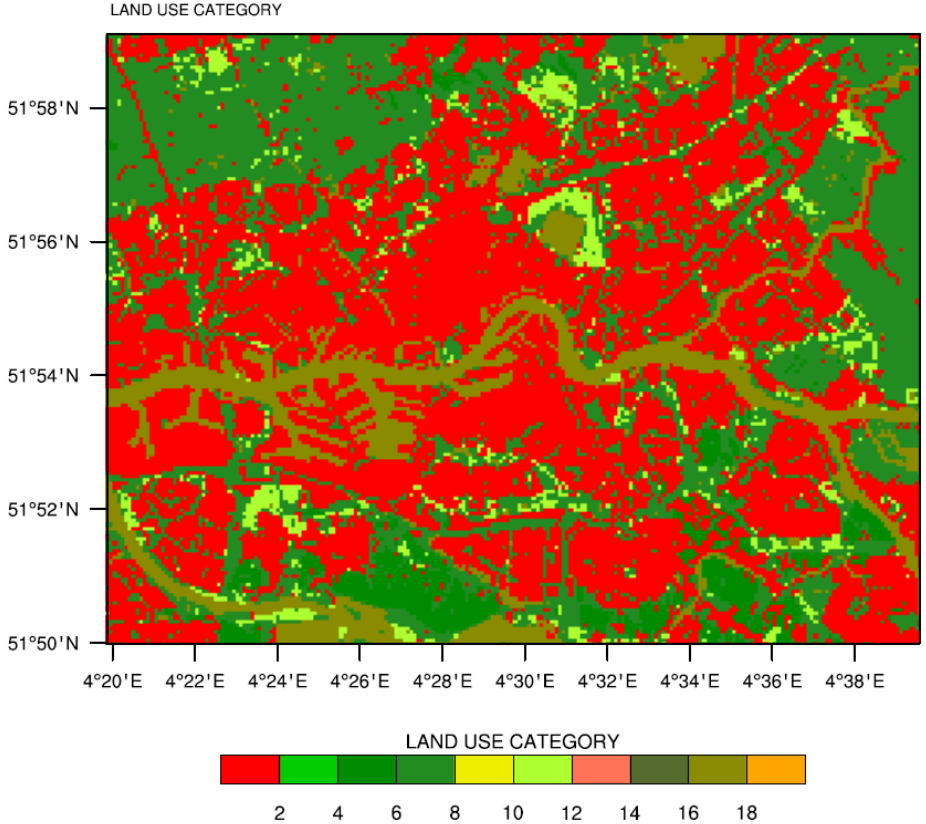
CO_2 monitoring: COVID lockdowns



Nicolini et al, 2022

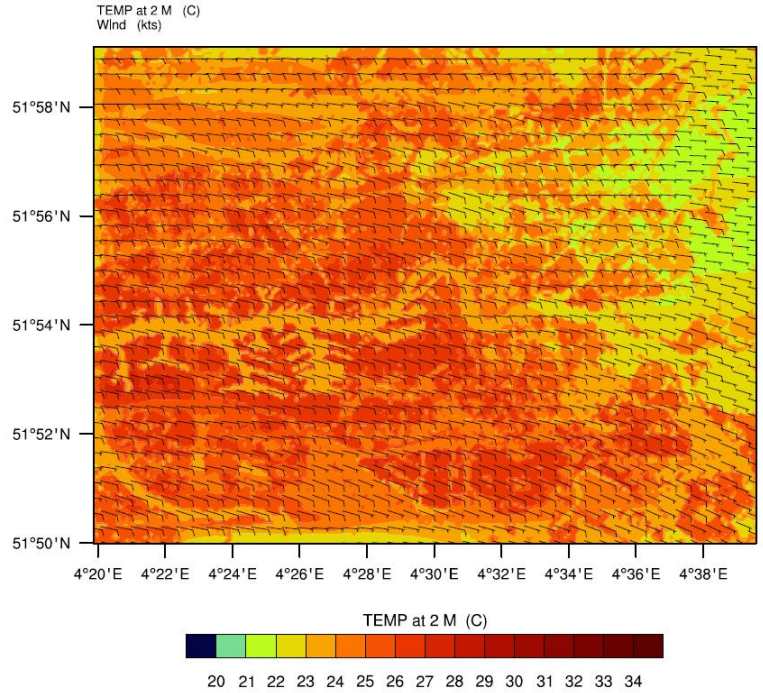
High resolution modelling efforts.

Rotterdam @ 100 m heatwave 2019: 23-25 Jul 2019



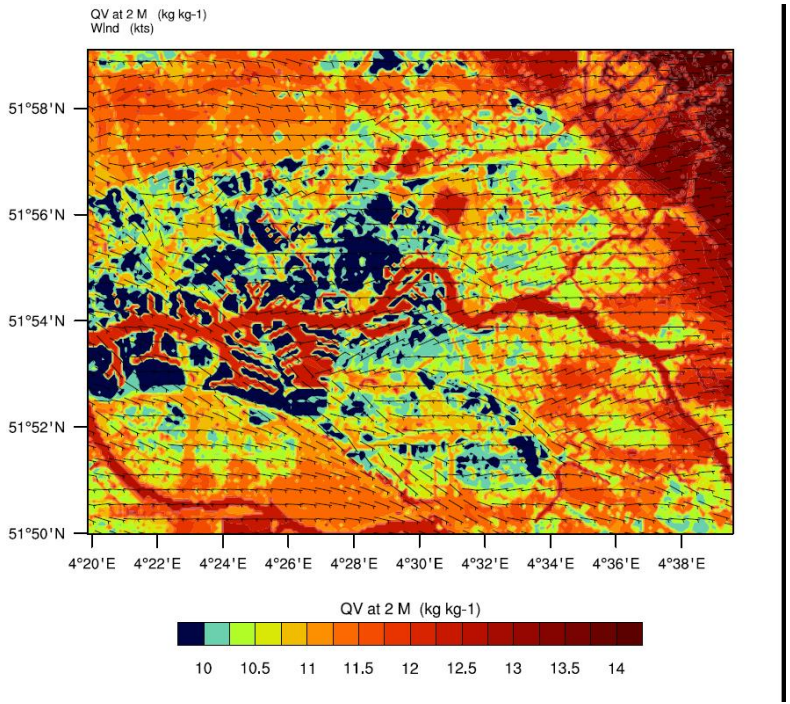
Rotterdam @ 100 m heatwave 2019: 23-25 Jul 2019

2-m temperature



23 Jul 2019 22:00

Spec humidity



23 Jul 2019 17:00

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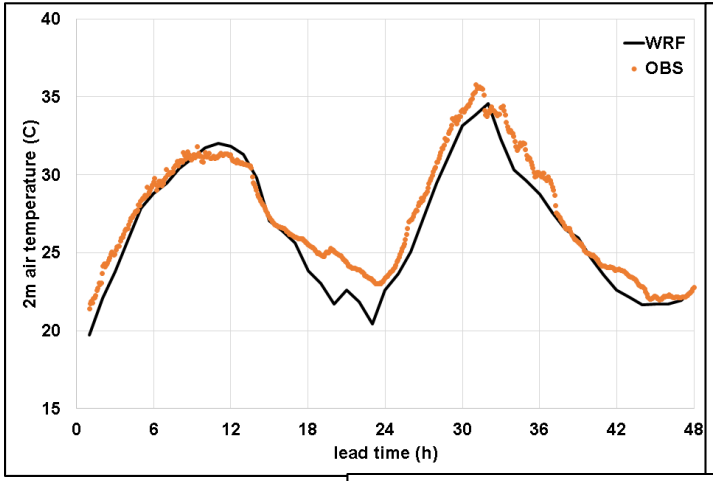
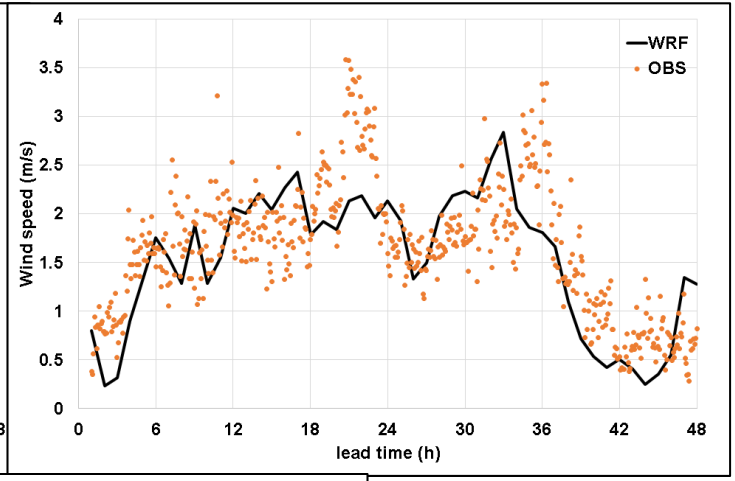
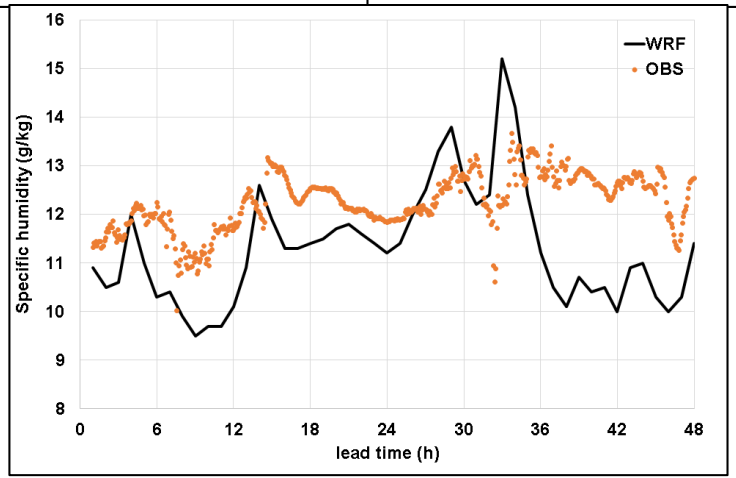
Rotterdam @ 100 m heatwave 2019: 23-25 Jul 2019







Validation
Weather station
Delfshaven

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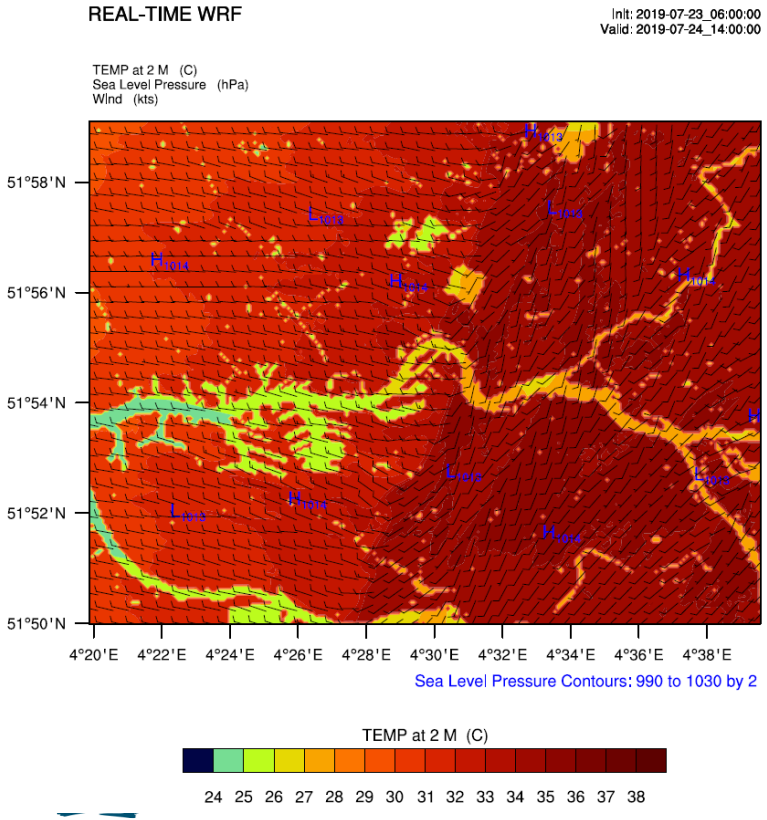
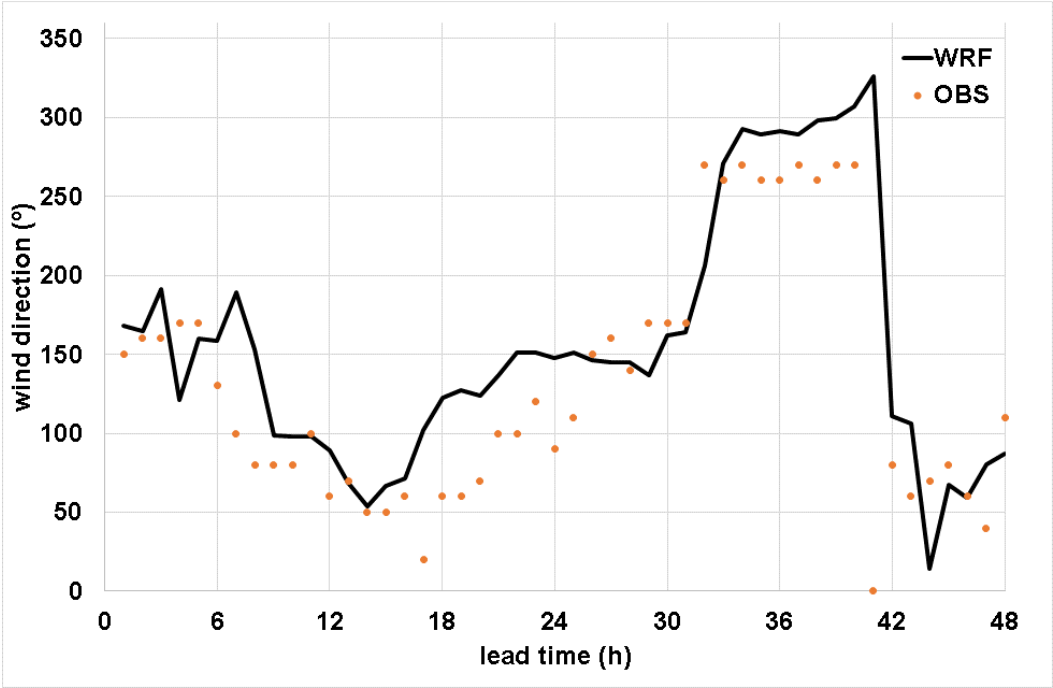
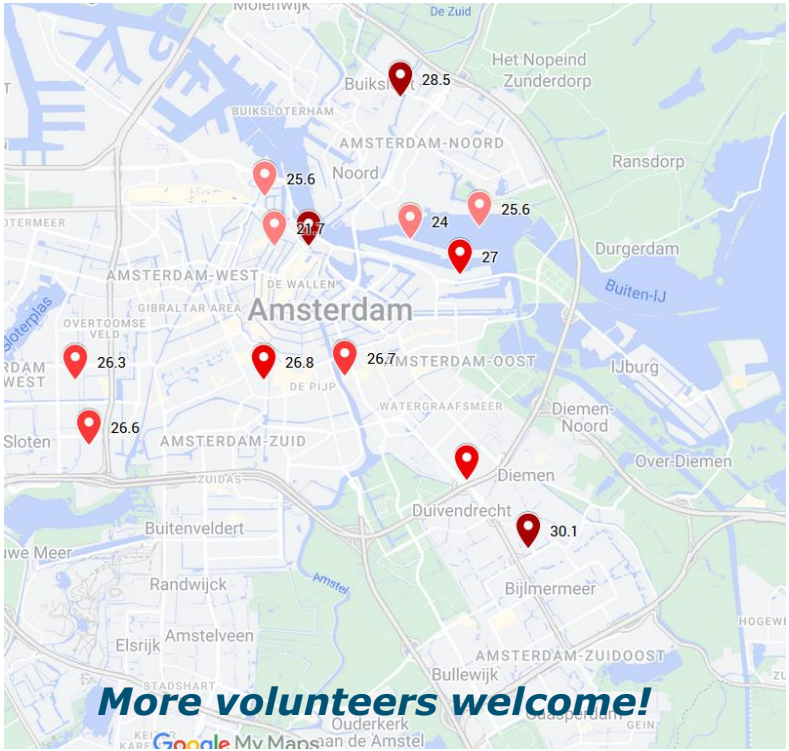
Rotterdam @ 100 m heatwave 2019: 23-25 Jul 2019: Sea breeze





I-CHANGE

Living Lab for Amsterdam to measure **indoor air temperatures** in addition to AAMS



Social component: do people change behaviour, with developed knowledge?

Use data for initialization NWP models

Compare expensive and cheap models for indoor temp.

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Indoor T_{min} 20 July 2022

Challenges ahead

Meteorology of emerging urban surfaces

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Challenges ahead

Meteorology of emerging urban surfaces

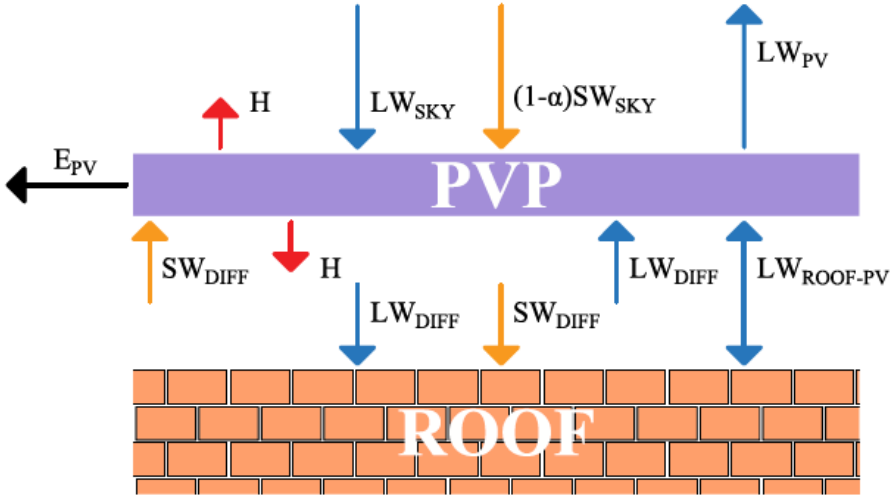
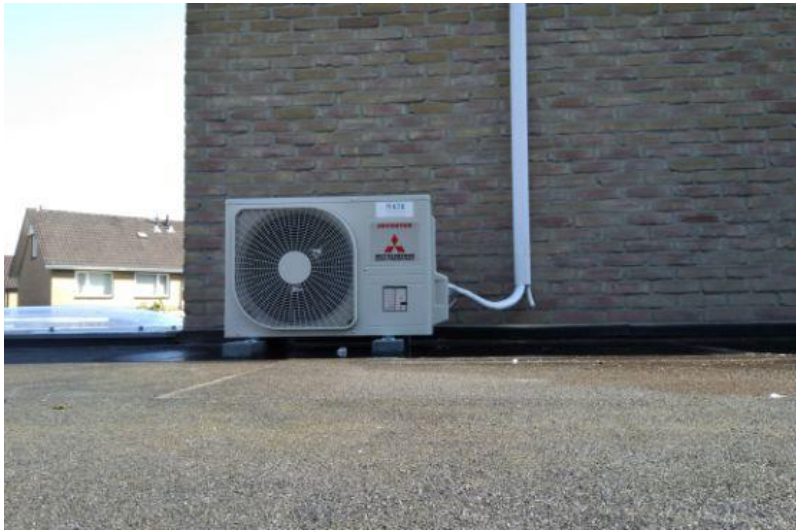


Figure 1. Photovoltaic panel design, with a schematic representation of the energy exchanges with the underlying roof and the environment (SW_{DIFF} e LW_{DIFF}).

Zonato et al, 2021

Challenges ahead

Meteorology of emerging urban surfaces



Coupling to building energy model to urban atmospheres

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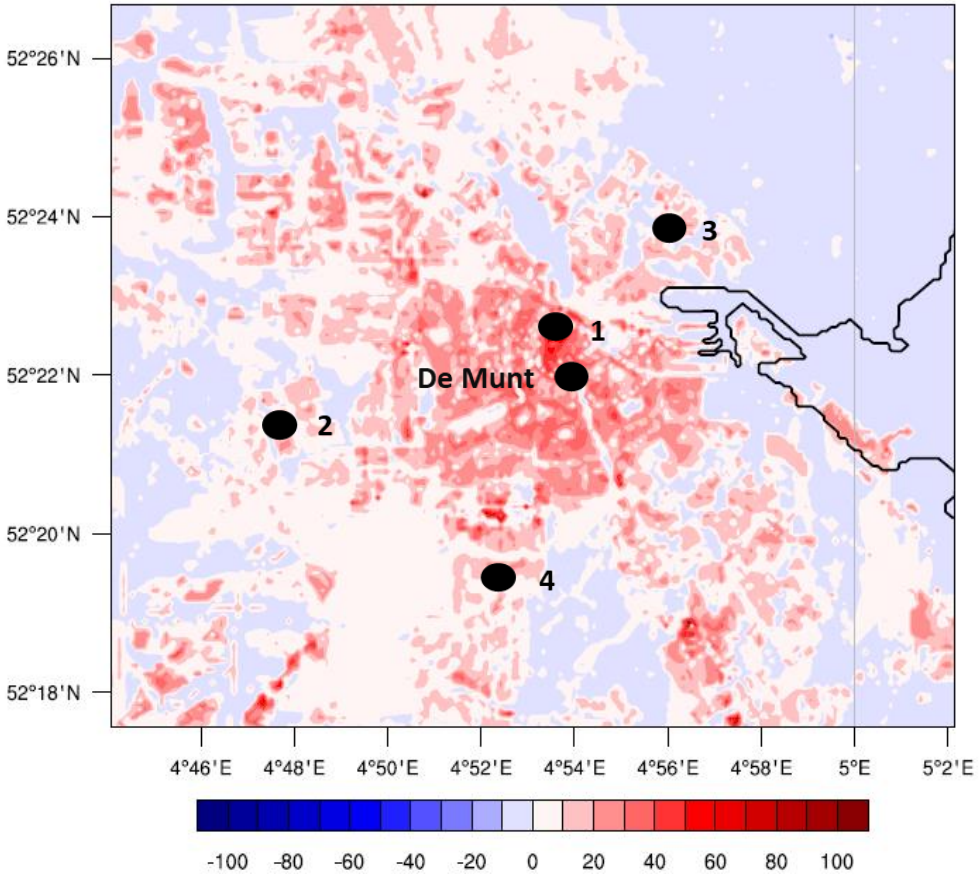
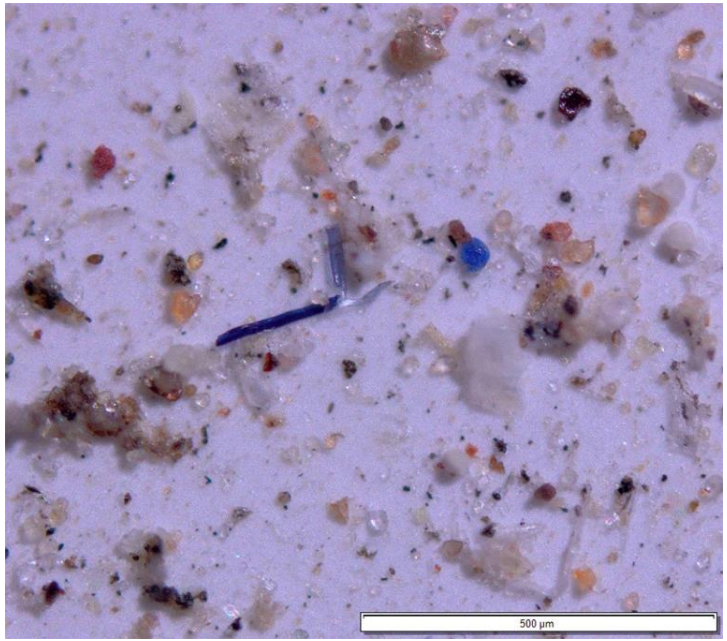


Surface sensible heat flux difference @ night (AC-NO AC) in W/m2. T_{night} up by ~1.5K

Challenges ahead

Electric and hybrid cars to increase and to be responsible for 85% of the microplastic surface emission

Meteorology of emerging pollutants



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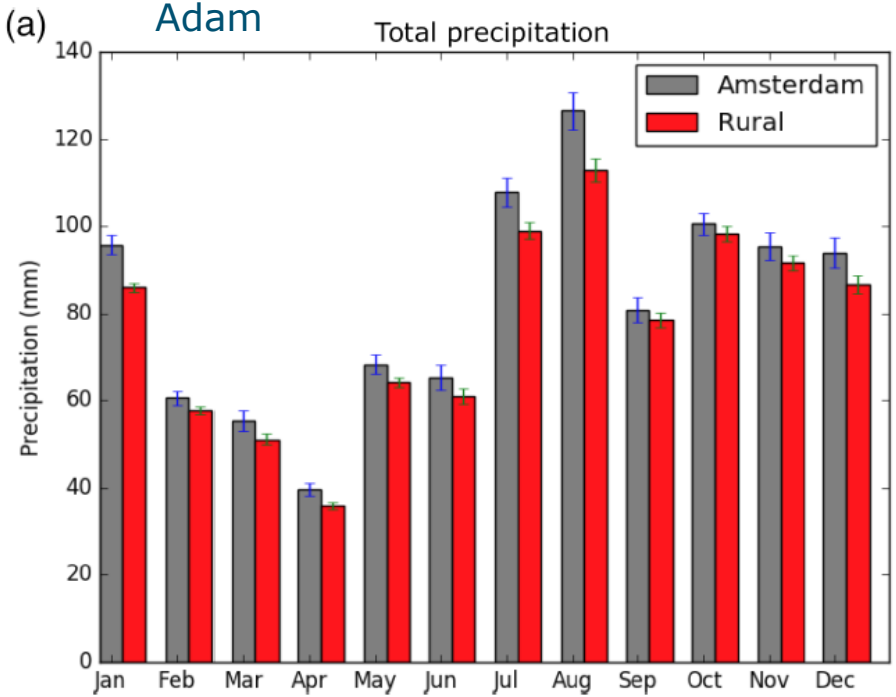
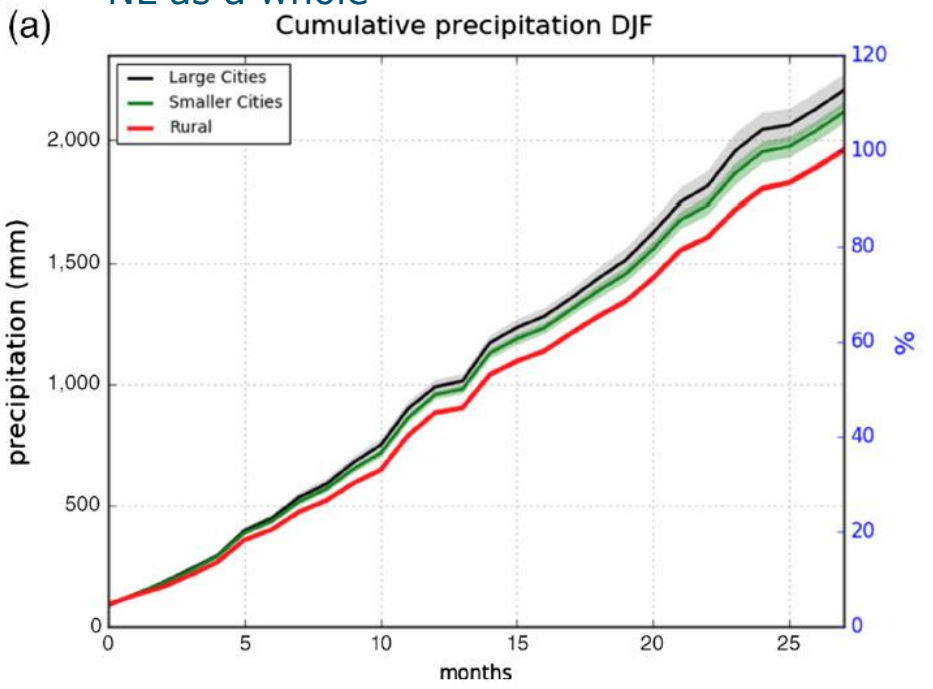
Lim, 2021

Challenges ahead: Mechanisms behind enhanced urban precipitation

Adam



NL as a whole



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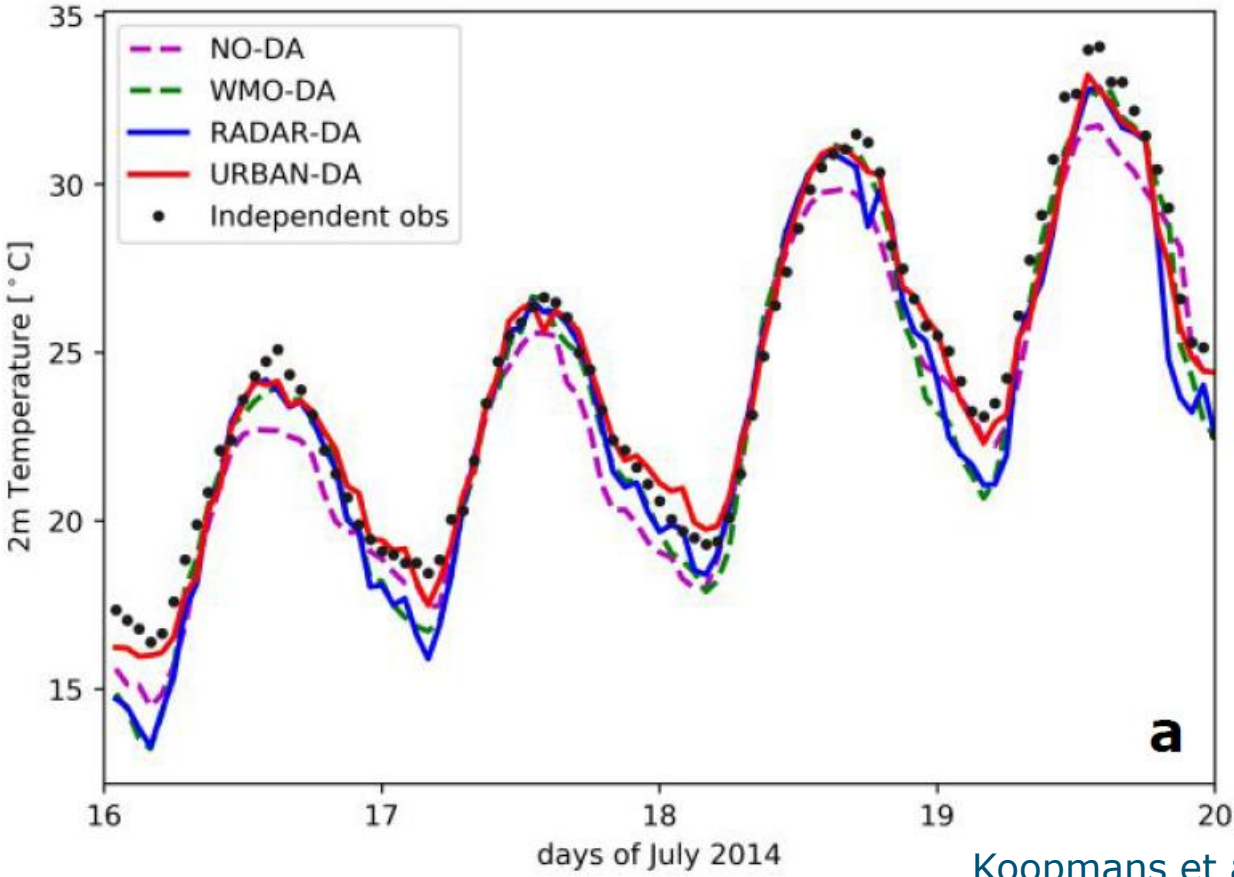
Climatology KNMI radar

Manola et al, 2020

Challenges ahead: Data assimilation at street level



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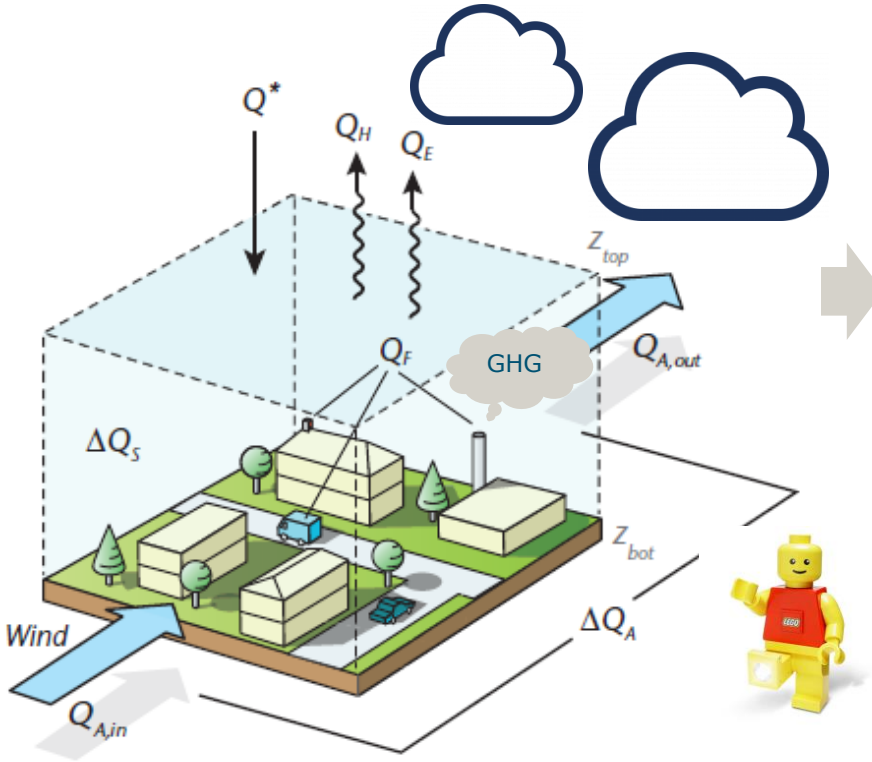
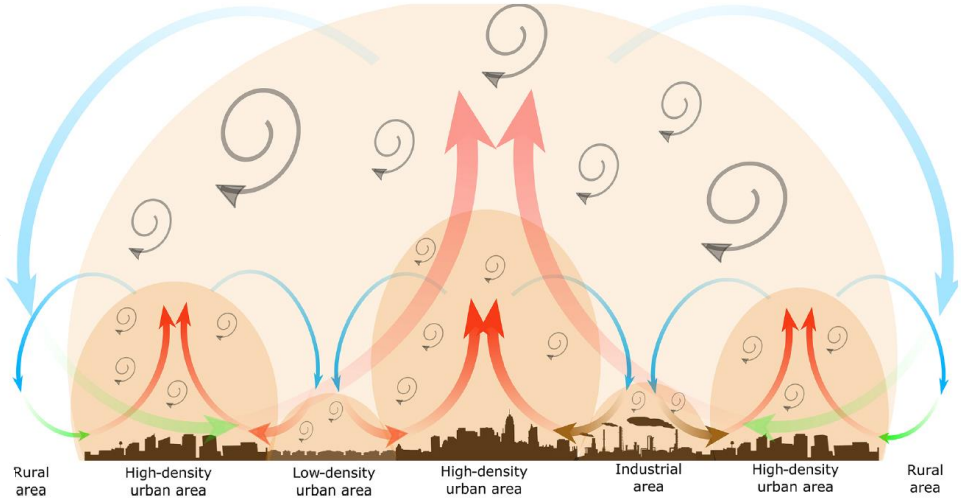
Koopmans et al.,2022

From single city to Gigacity approach?





$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A$$

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Kulmula et al, 2021

Thank you!