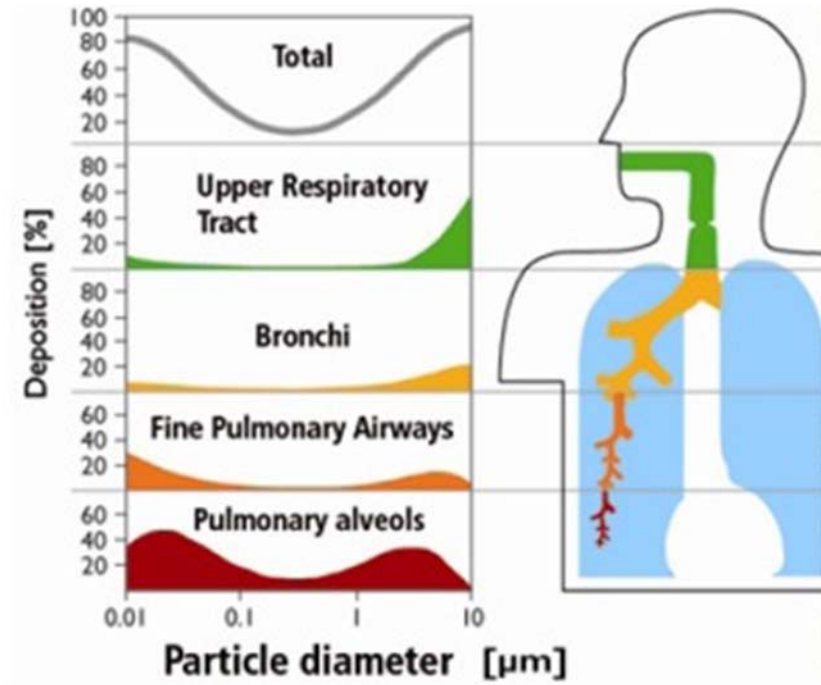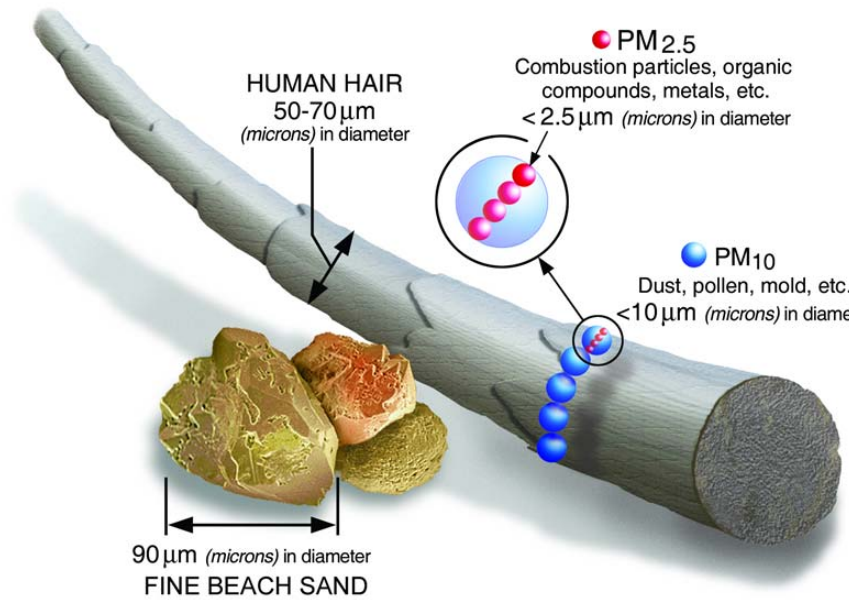# Experimental and modelling study of the filtering capacity of green wall species

Tess Ysebaert[1], Griet Walpot[1], Siegfried Denys[1]
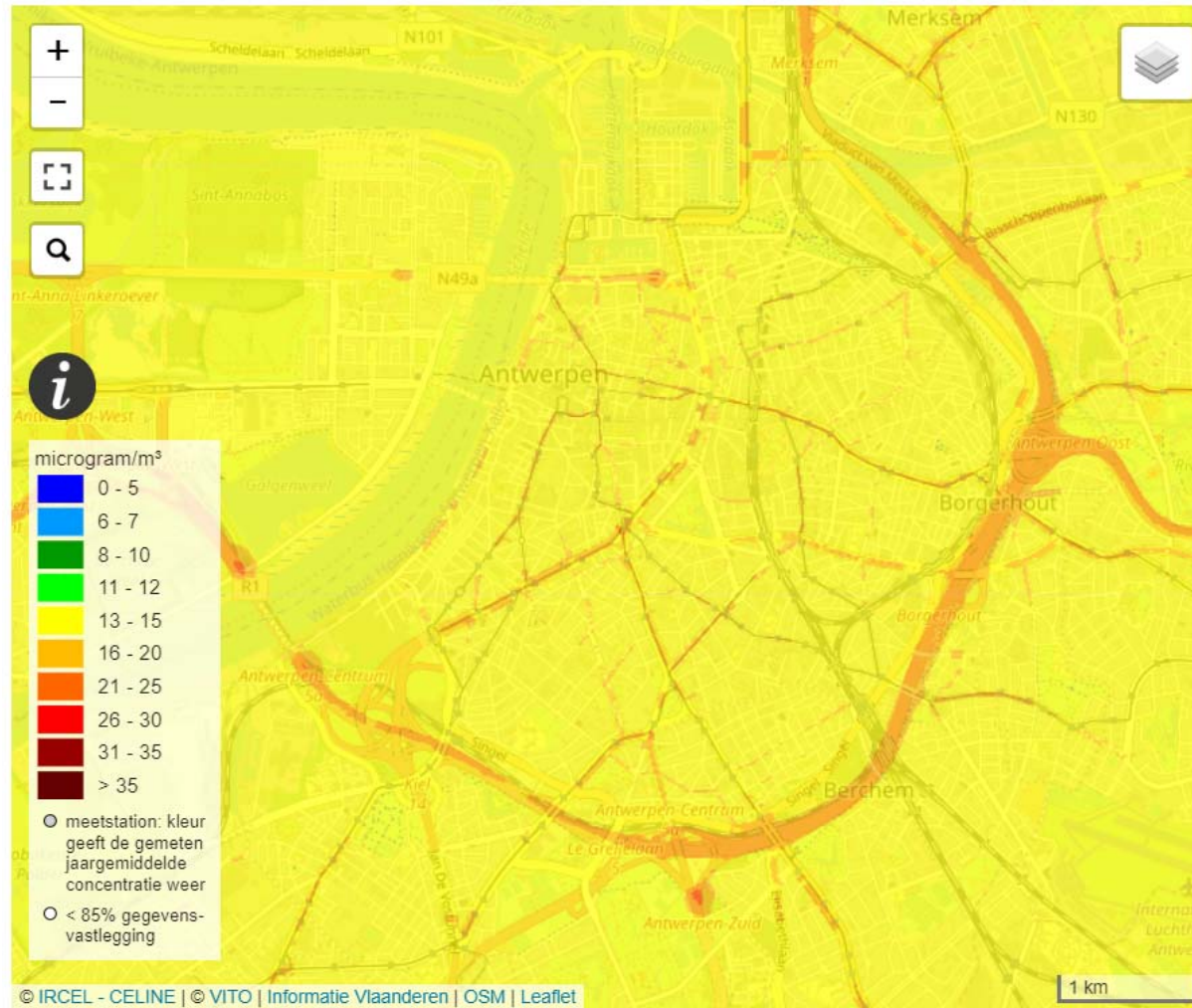
1. Sustainable Energy, Air and Water Technology, Department of Bioscience Engineering, University of Antwerp, Belgium

Sustainable Energy,
Air & Water Technology
University of Antwerp
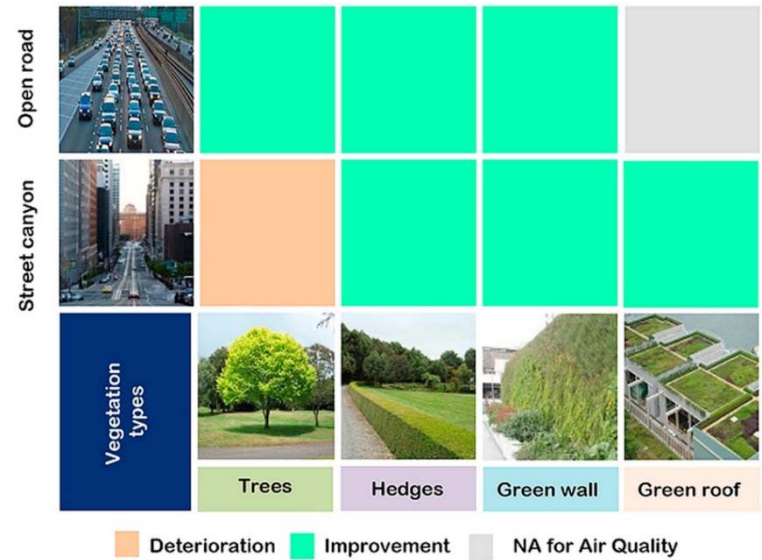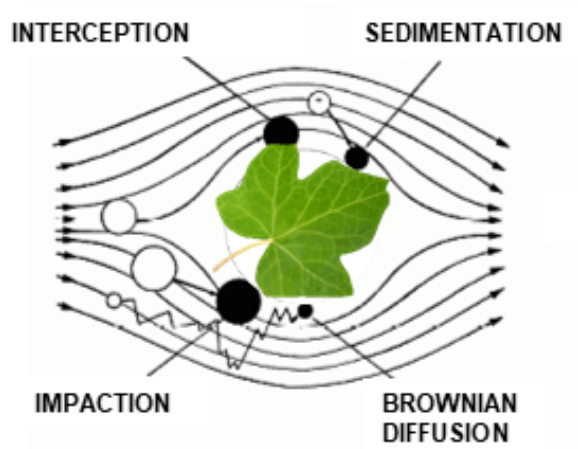
The air we breathe

Sources: (1) EPA; (2) ICAO

The air we breathe

Source: VMM

Nature-based solutions

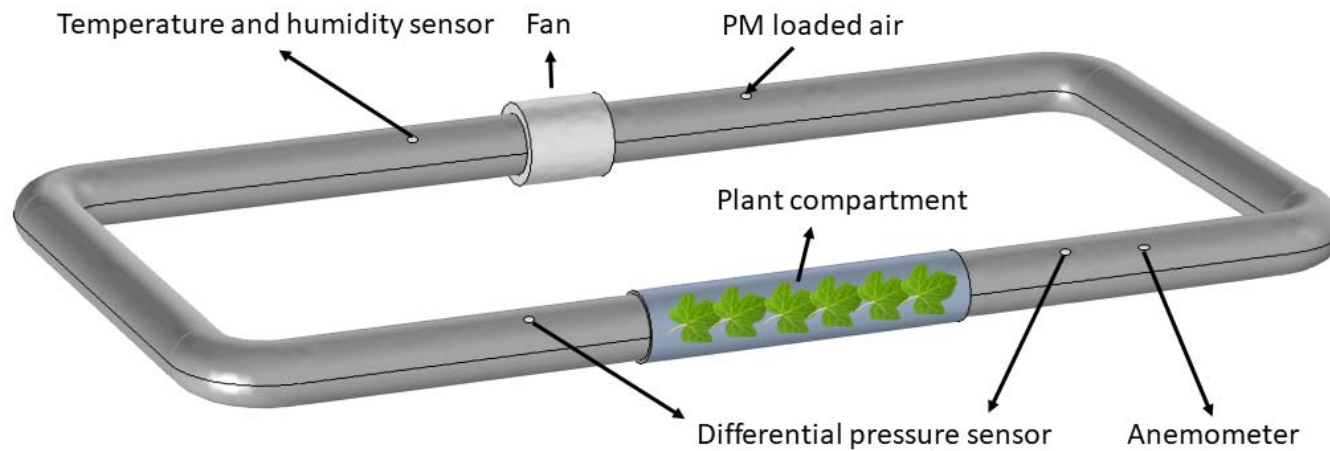Abhijith, K. V. *et al.* (2017). *Atmospheric Environment*.

Quantitative impact of urban green is unknown:

- Too simplified models

- Large uncertainties in deposition velocity and resupension fraction

Model framework for PM deposition on urban green → particle dispersion

Air flow model

Temperature and humidity sensor   Fan   PM loaded air
Plant compartment
Differential pressure sensor   Anemometer

- Bulk flow: k-ω turbulence model
- Vegetation: porous medium (spatial averaging)
  - Brinkman equations with Darcy-Forchheimer drag
  - Input: porosity ($\rho \sim 0.9$), permeability ($\kappa \sim 10^{-5}$-10^{-6} m^2), Forchheimer drag ($\beta_F \sim 0.5$-5 kg m^{-4})

R^2 of 0.98 for both velocity and pressure
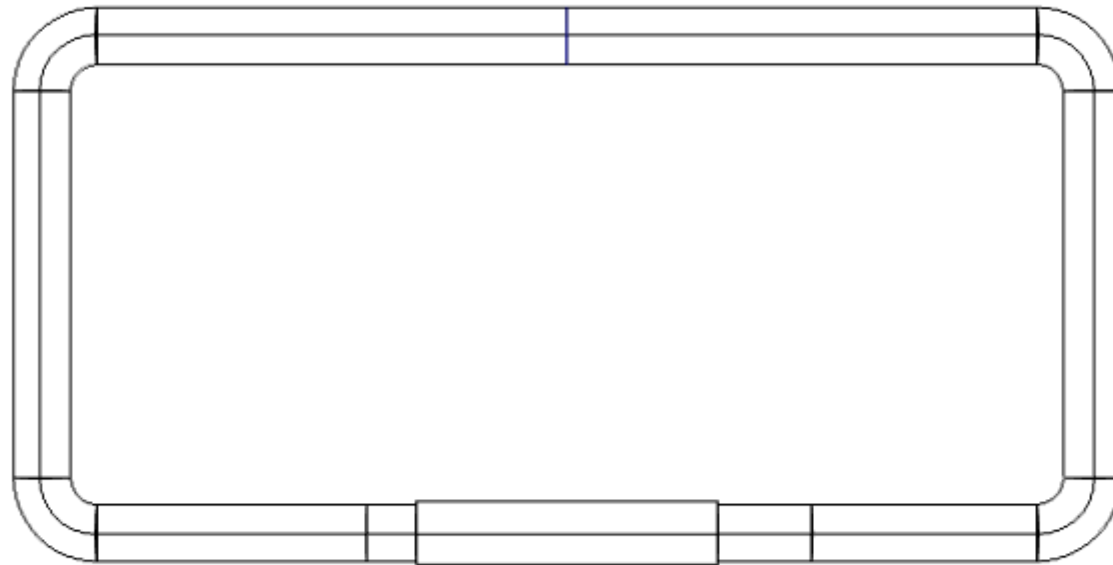
Particle dispersion model

Lagrangian particle tracing:

$$\frac{d}{dt}\left(m_p u_i\right) = F_{total}$$

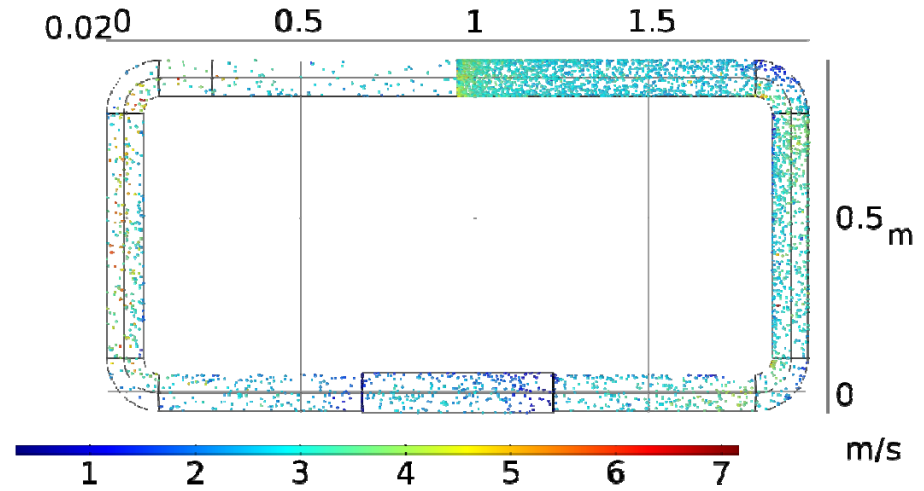- Assumption: only drag force (Stokes model)
- Input:

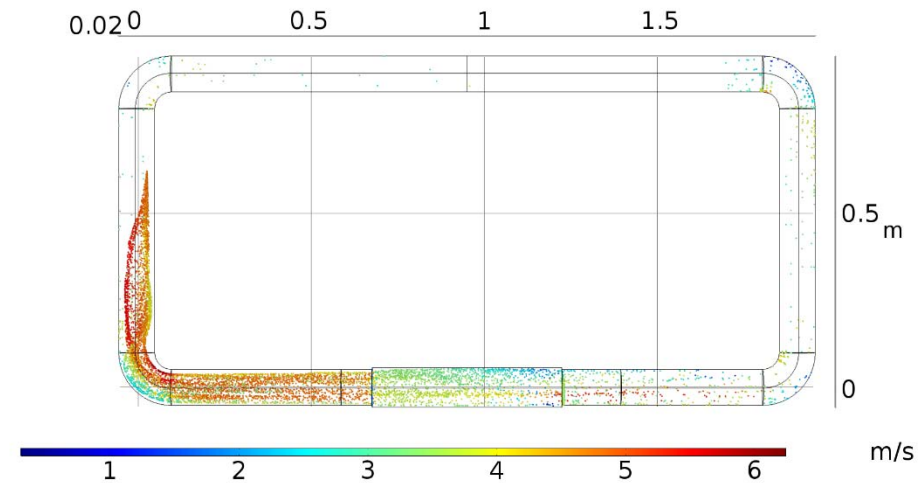| Variable	Value	Unit
Aerodynamic diameter	2.5	µm
Density	820	kg m^{-3}
Number of particles	10,000	

Animation

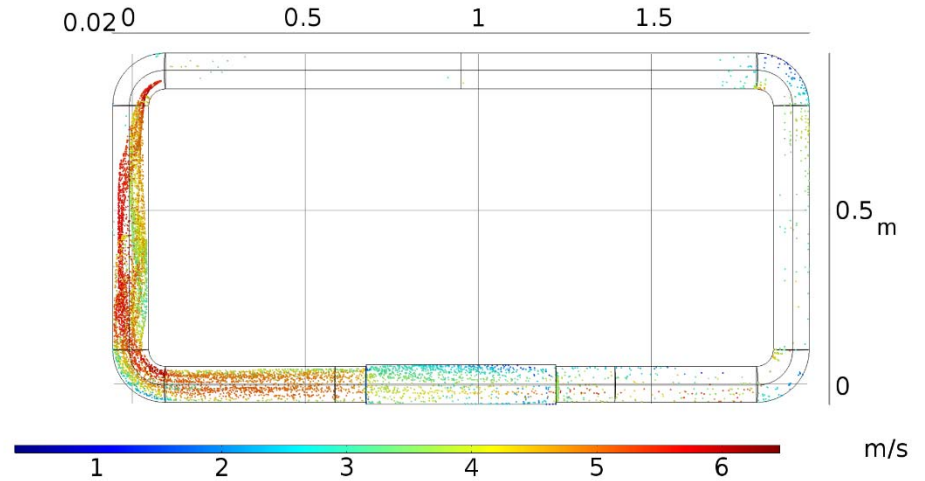# Impact of configuration (1)

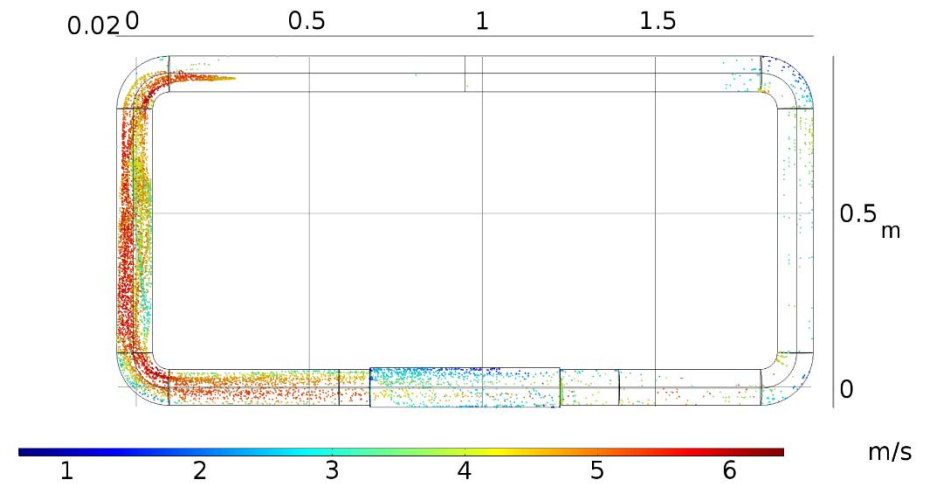No plants

Plants with $\rho = 0.9955$

Impact of configuration (2)

Plants with ρ = 0.9964

Plants with ρ = 0.9973

Conclusions and future

The complex interaction between plant-atmosphere can be studied with Comsol Multiphysics®

Future:
- Inclusion of particle removal by vegetation by adding a sink term to the Lagrangian framework
- Spatial averaging method was validated by Koch *et al.* (2018) → further validation with real PM emissions generated with an experimental setup
- Determine the driving parameters of PM deposition with the model framework

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