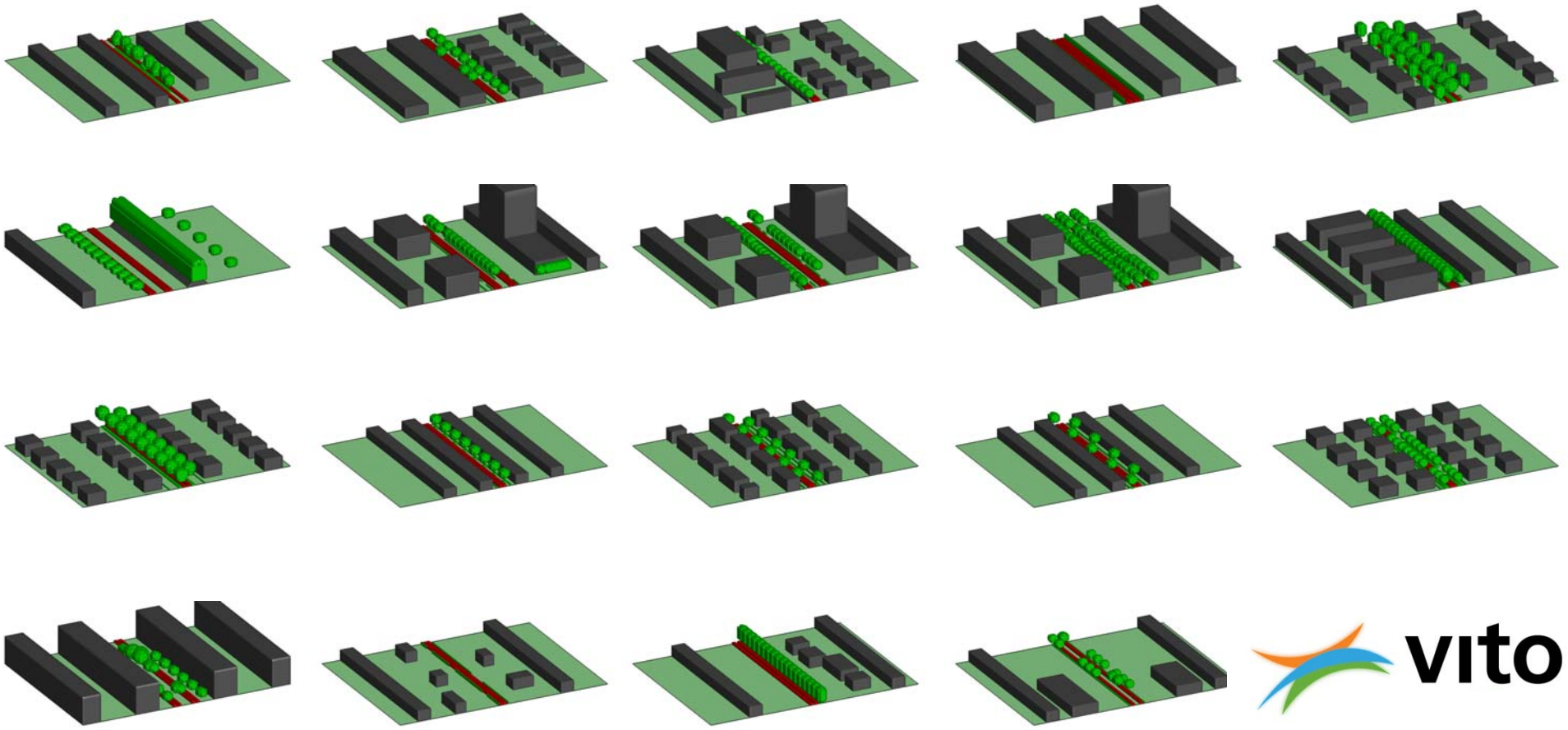
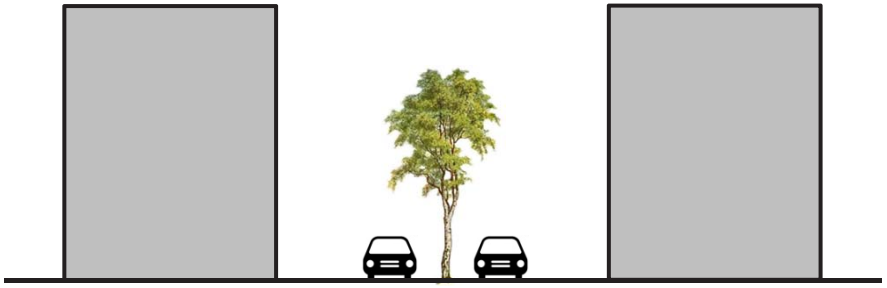


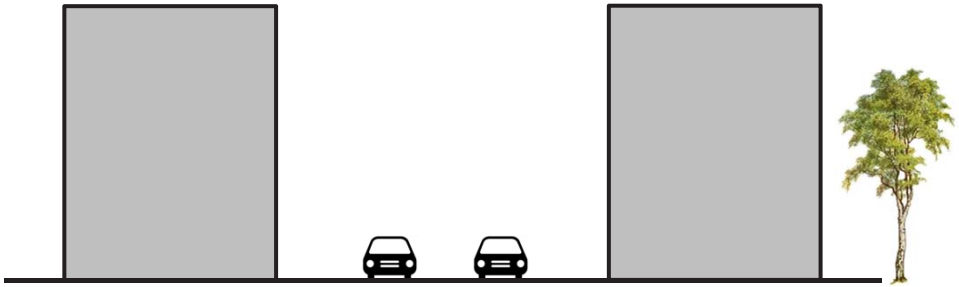
# Improving local air quality: To tree or not to tree?

Peter Vos, Bino Maiheu, Jean Vankerkom, Stijn Janssen
peter.vos@vito.be

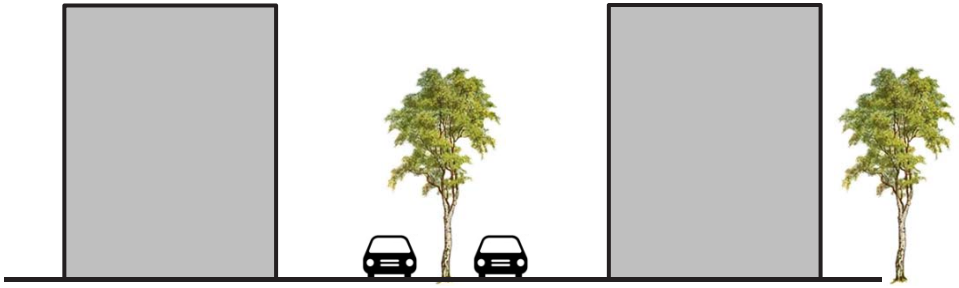
1



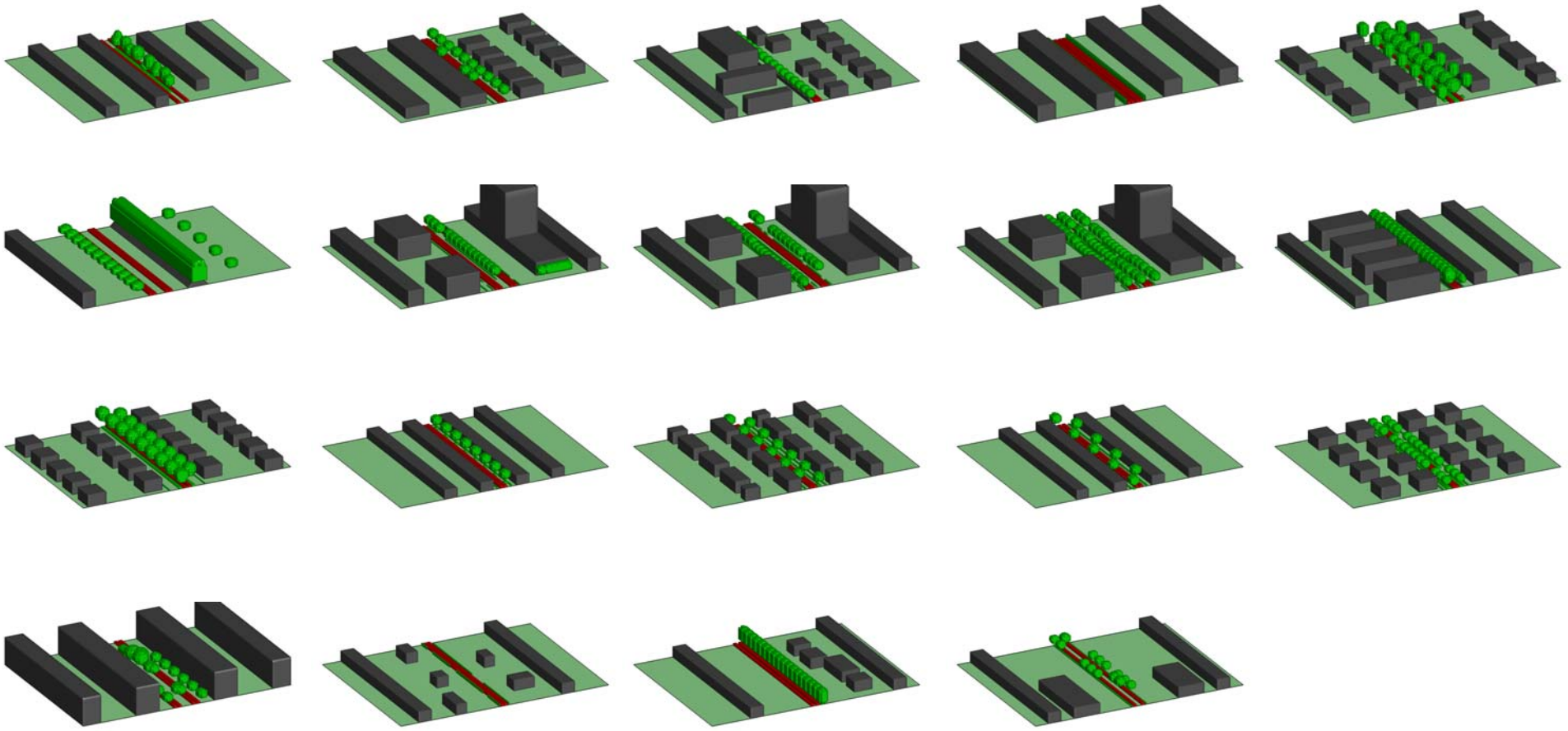
2



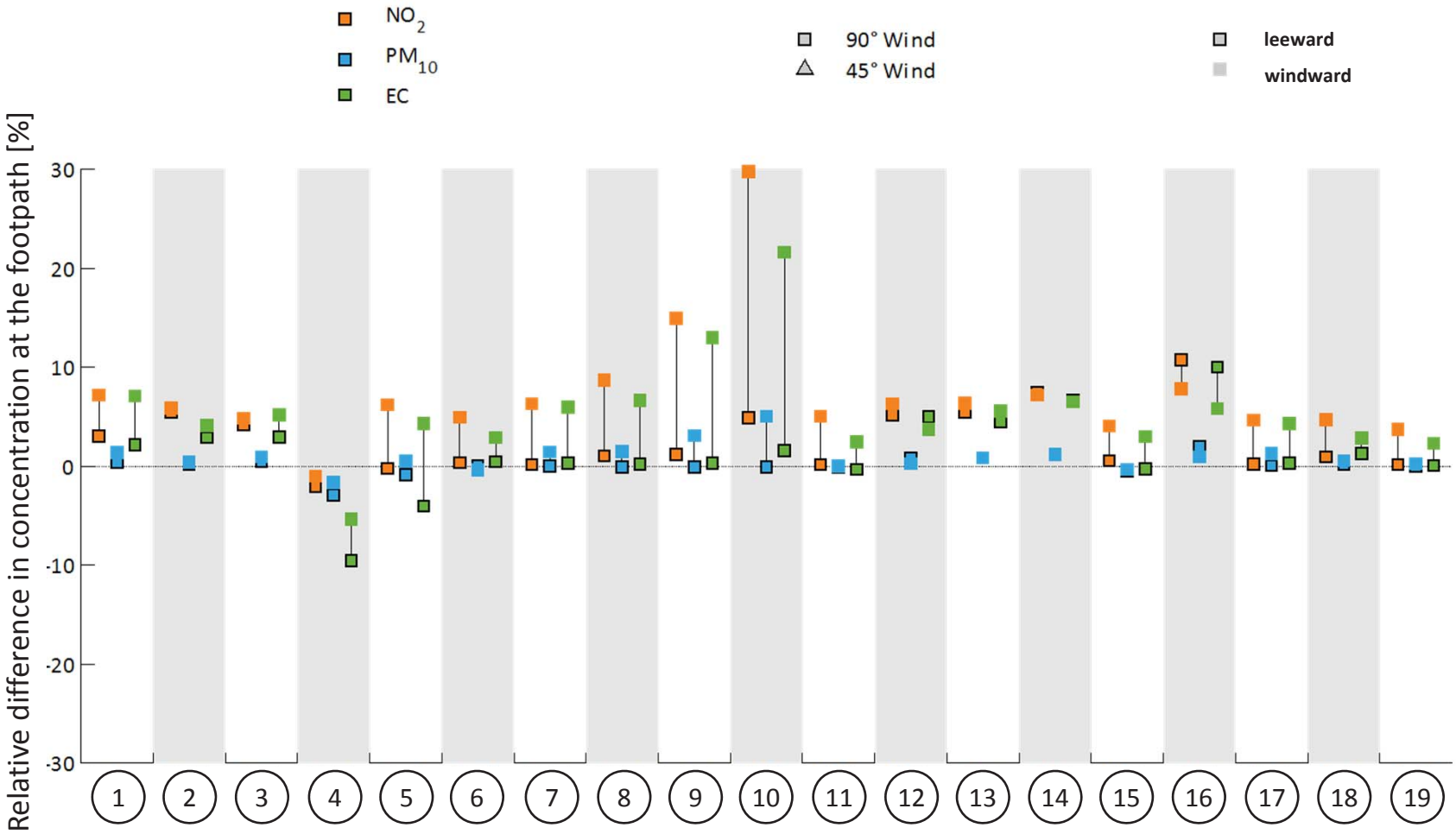
3



**How to effectively use road-side vegetation to improve air quality at busy roads in cities?**

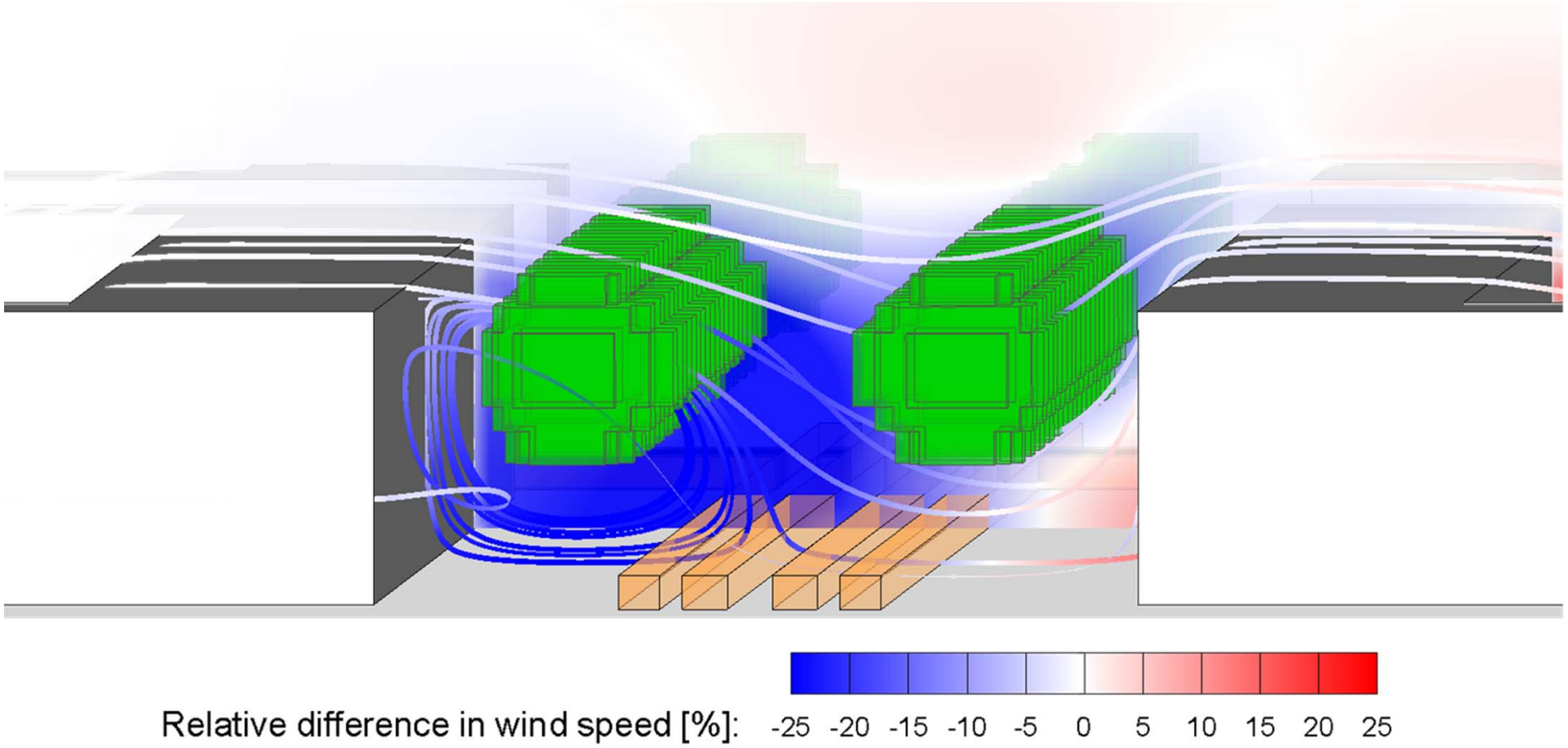


**ENVI-met: CFD – RANS – k epsilon – built-in vegetation module**
**COST 732 guidelines**


NO2
PM10
EC
90° Wind
45° Wind
leeward
windward
Relative difference in concentration at the footpath [%]
30
20
10
0
-10
-20
-30
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

1. Filtering effect: trees absorb pollutants

2. Aerodynamic effect: trees change the wind flow



1. Filtering effect: trees absorb pollutants

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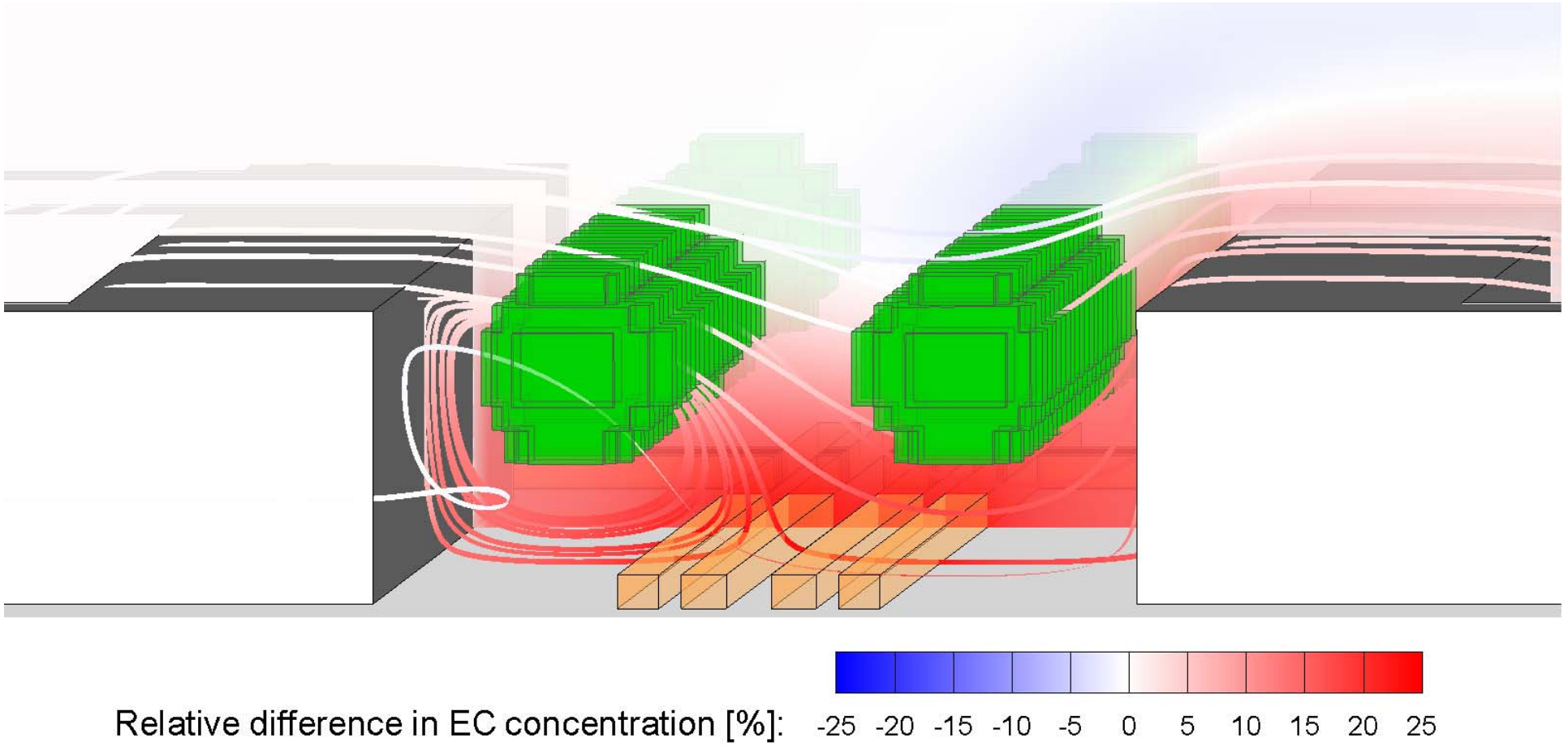
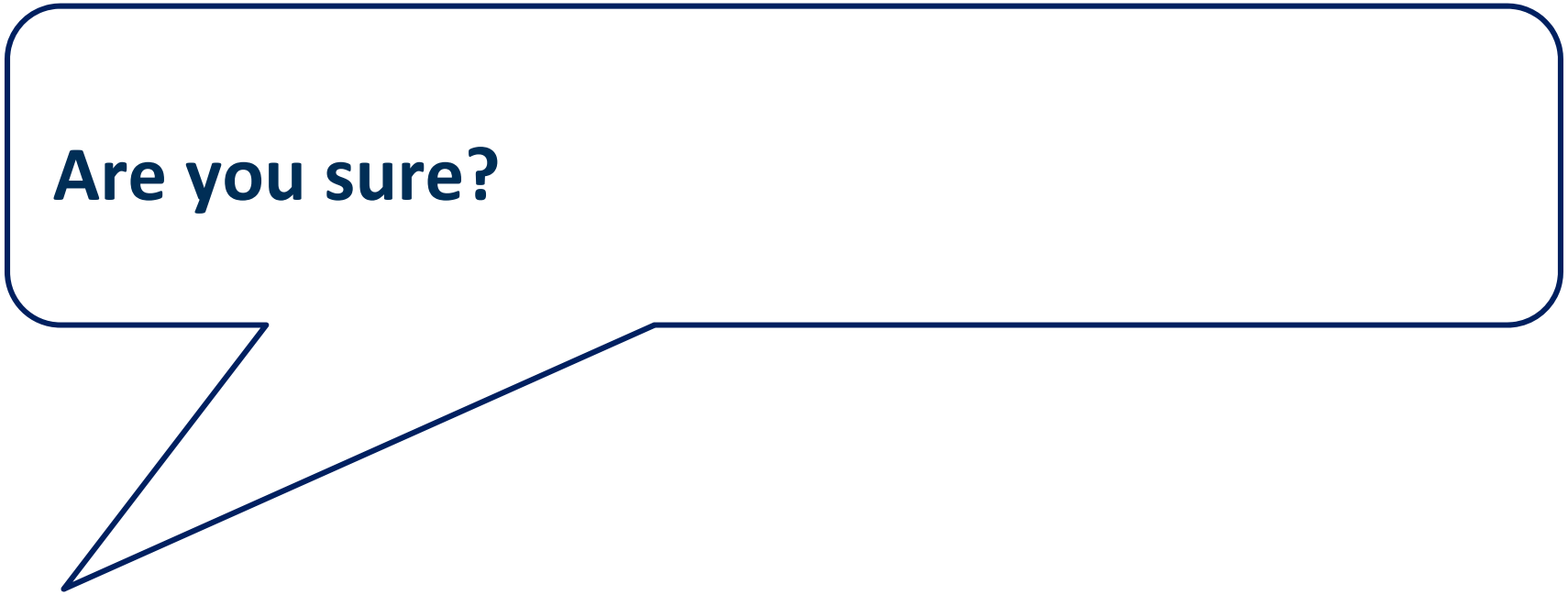
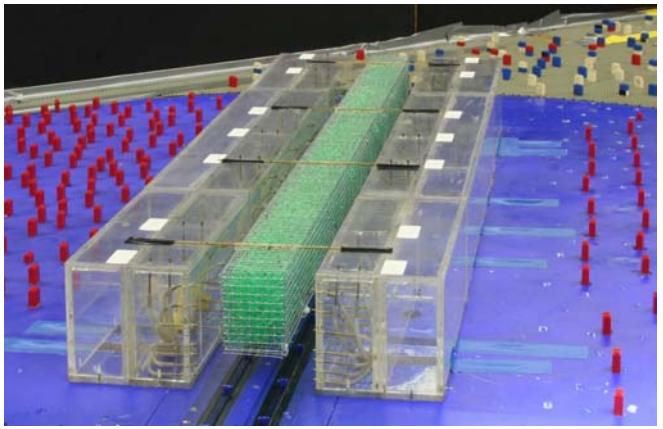



Are you sure?

# VALIDATION/UNCERTAINTY/…

**DID WE DO VALIDATION? No**
Budget/time
Data availability



Source: CODASC

**ENVI-met?**

**UNCERTAINTY? Large!**
Model
Physics (measured deposition speeds varying orders of magnitude)

# VALIDATION/UNCERTAINTY/…

**SOLUTION**

Focus on general trends (more than 250 scenarios/configurations)

**MESSAGE**

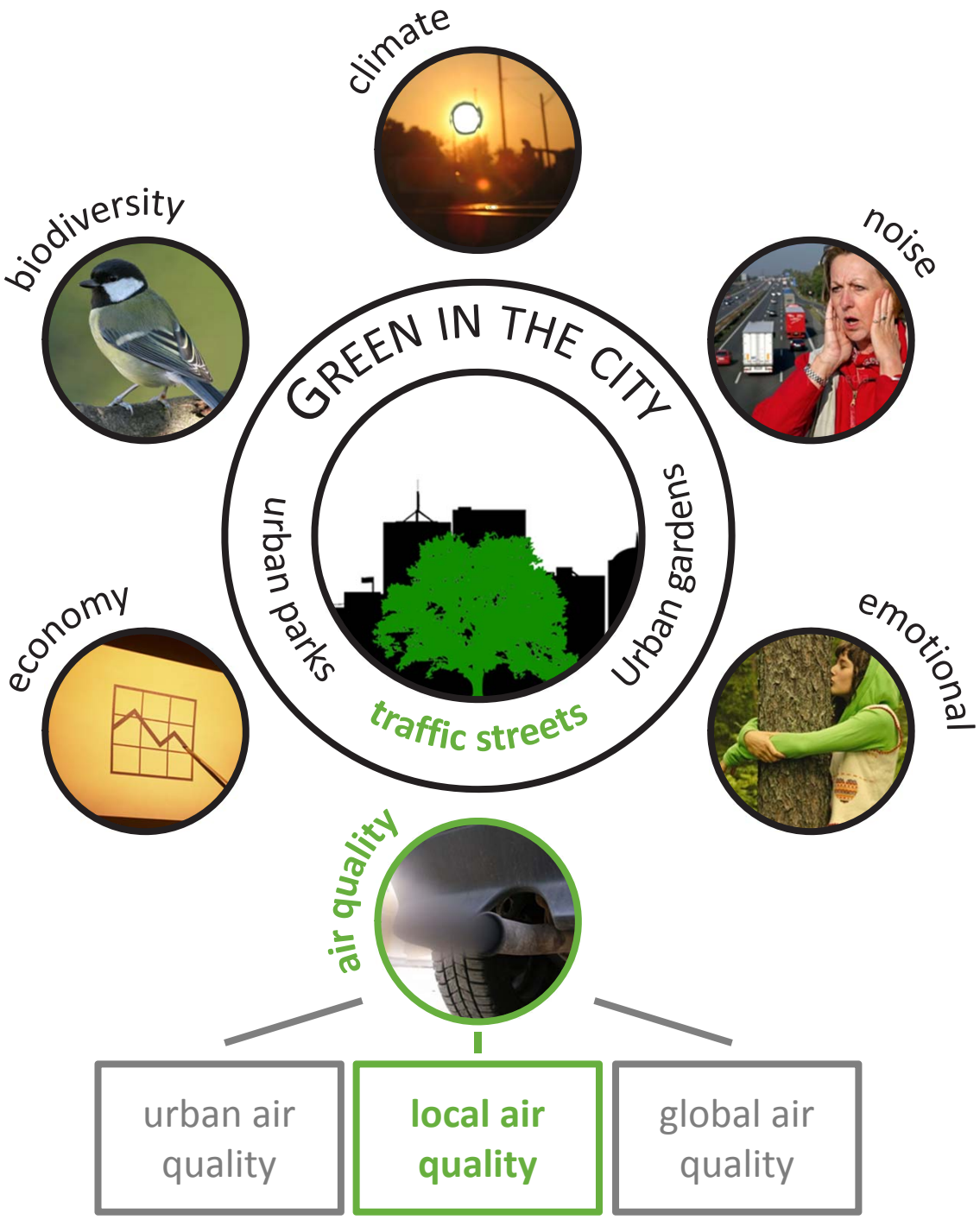
Trees do not improve local air quality next to busy roads

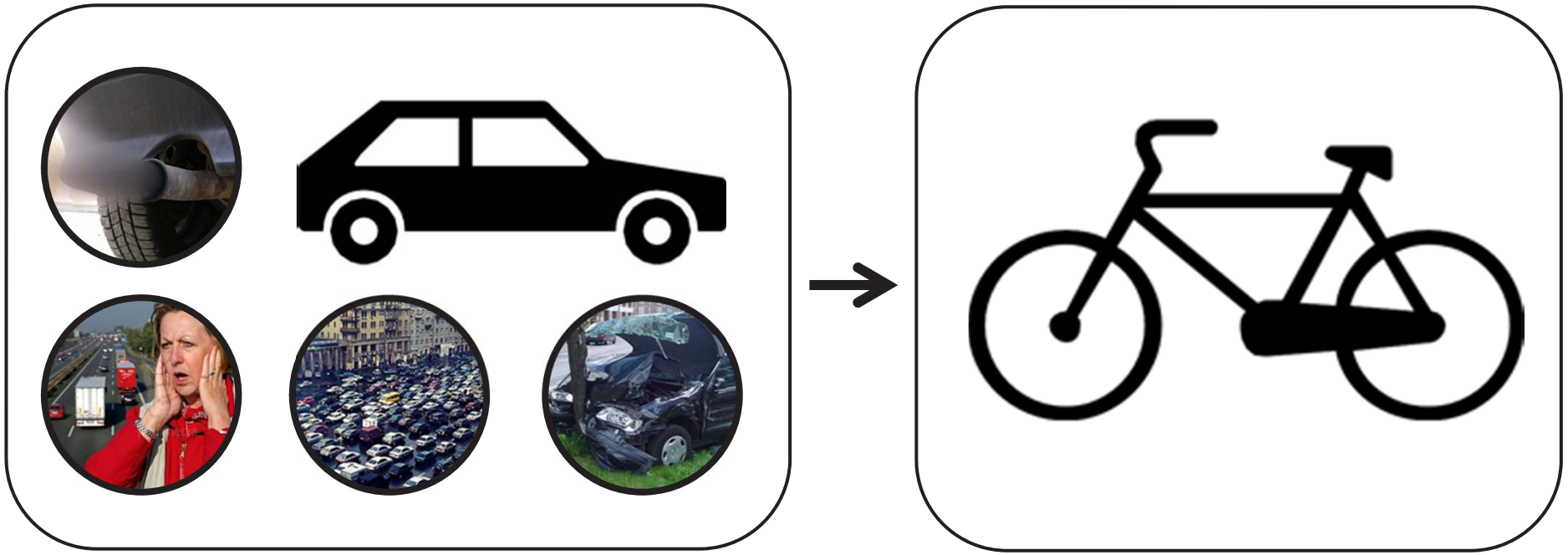
Confirmed by

CODASC

Recent article (Salmond et al., Science of the Total Environment 443 (2013) 287-298)

**Should we cut all trees?**


climate
biodiversity
noise
GREEN IN THE CITY
urban parks
Urban gardens
traffic streets
economy
emotional
air quality
urban air quality
local air quality
global air quality



**… Can we use wall vegetation/green walls?**

ENVIRONMENTAL Science & Technology

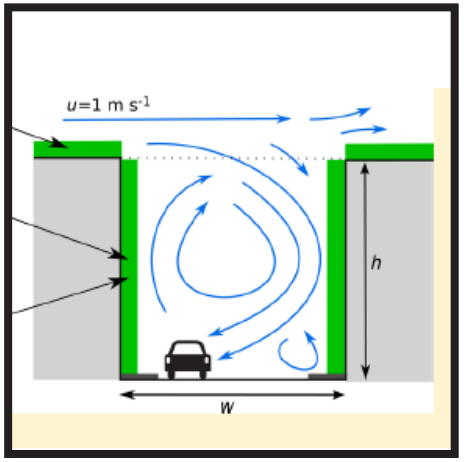
Article

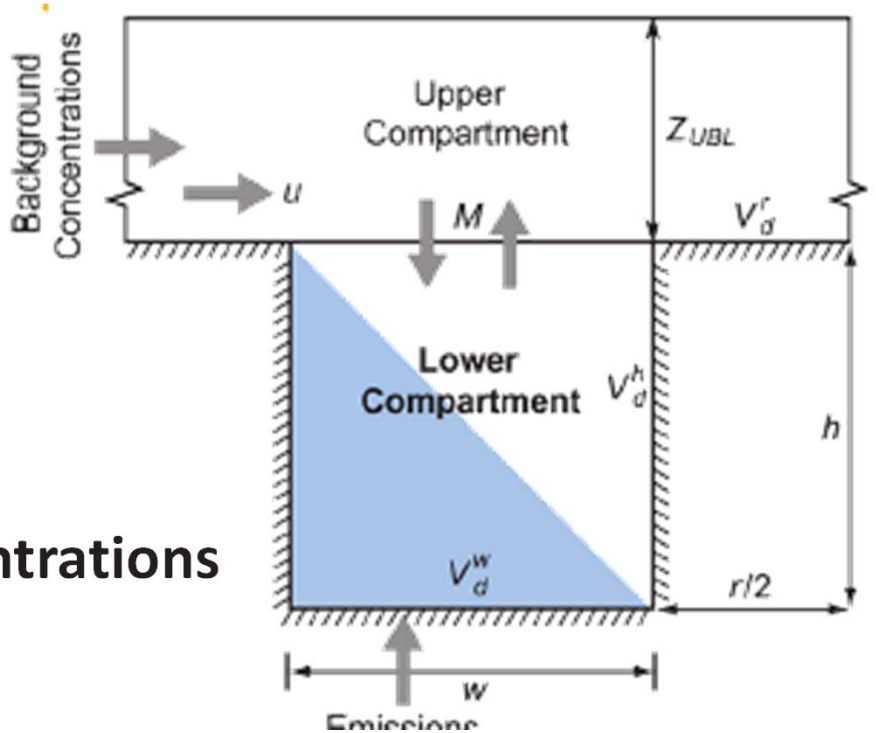
pubs.acs.org/est

# Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons

Thomas A. M. Pugh,*,§ A. Robert MacKenzie,# J. Duncan Whyatt, and C. Nicholas Hewitt

Lancaster Environment Centre, Lancaster University, Lancaster, U.K., LA1 4YQ




**Up to 60% reduction in $PM_{10}$ concentrations (u=0.5m/s; aspect ratio=2)**

**NOT IN LINE WITH OUR EXPERIENCE/EXPECTATIONS**

“negligible filtering effect of vegetation”

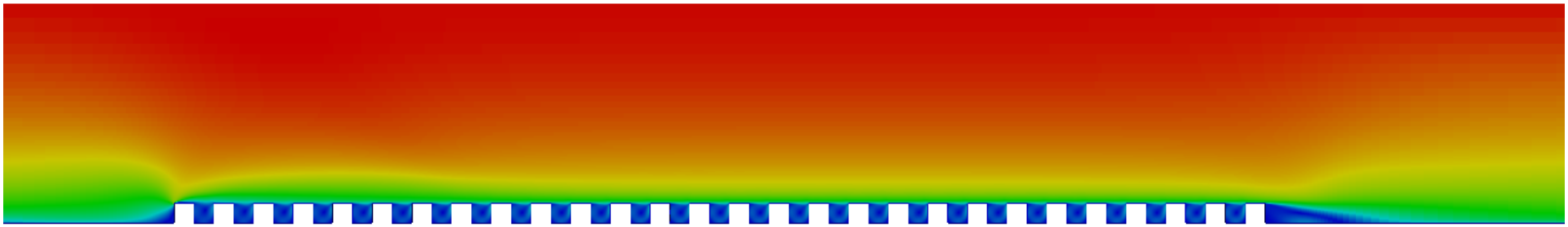
Due to simplicity of box model?

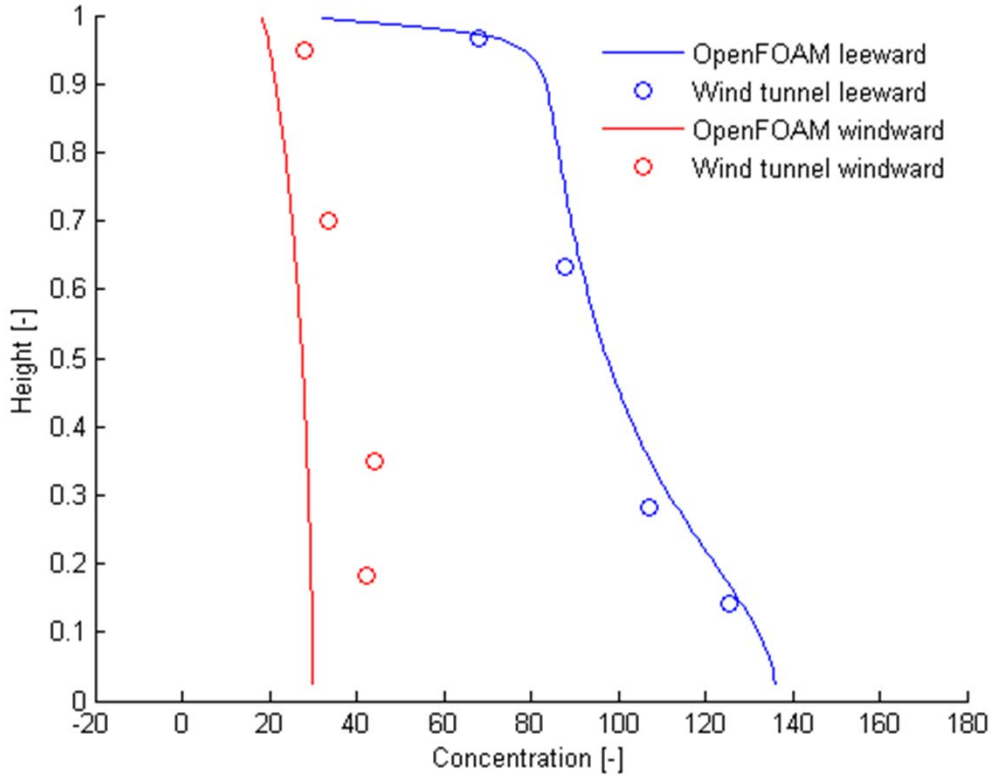
**NOT IN LINE WITH OUR EXPERIENCE/EXPECTATIONS**
“negligible filtering effect of vegetation”
Due to simplicity of box model?

→Reproduction with CFD

**ENVI-met?** OpenFOAM!

**VALIDATION?** Yes! (without vegetation)

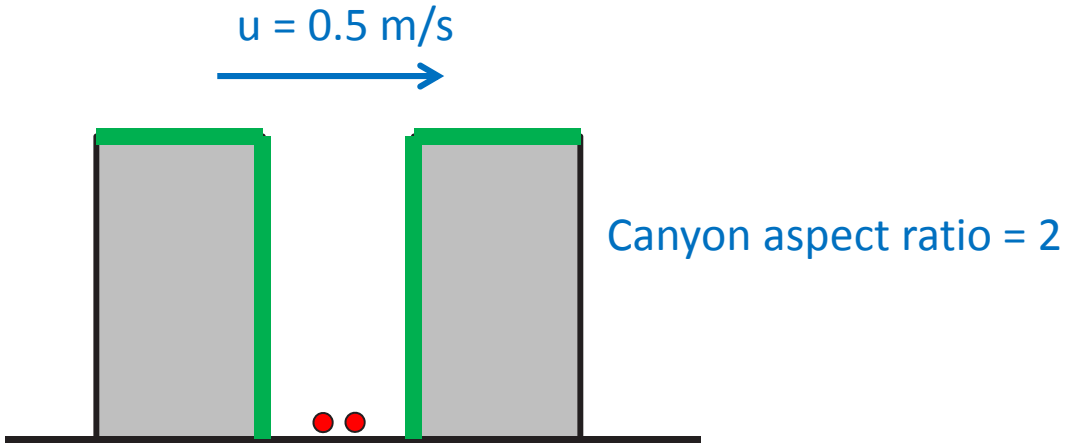




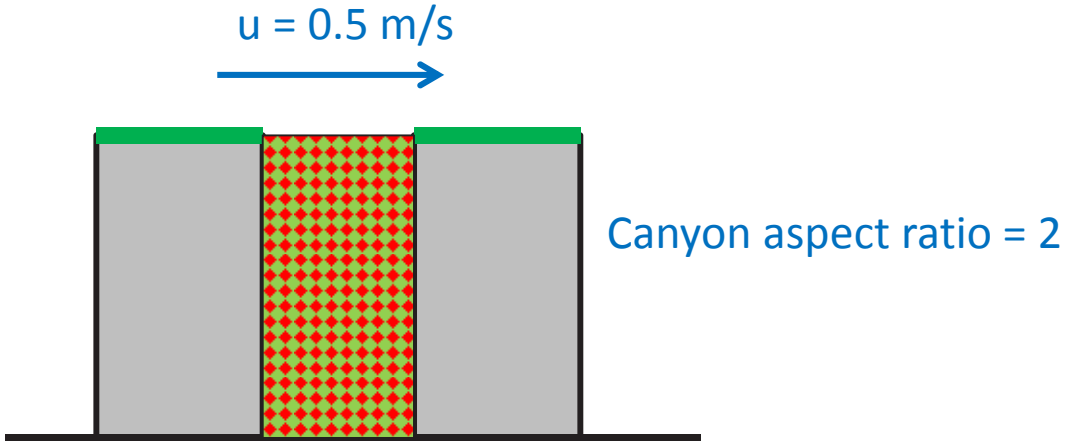

Meroney, R. N., Pavageau, M., Rafailidis, S., & Schatzmann, M. (1996). Study of line source characteristics for 2-D physical modelling of pollutant dispersion in street canyons. *Journal of Wind Engineering and Industrial Aerodynamics*, *62*, 37–56.

## 2 DIFFERENT CFD SIMULATIONS

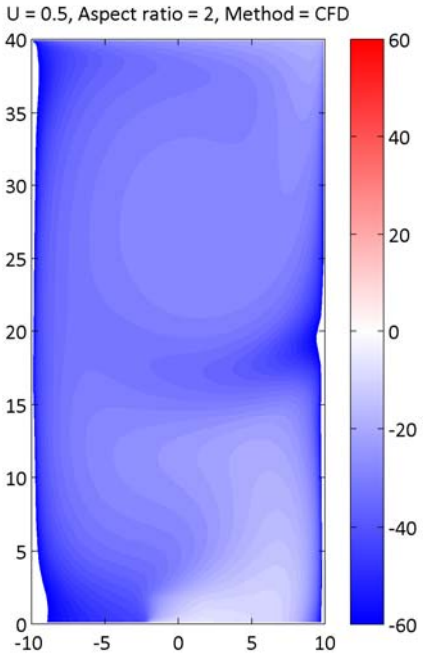
**CFD**: 'normal' set-up

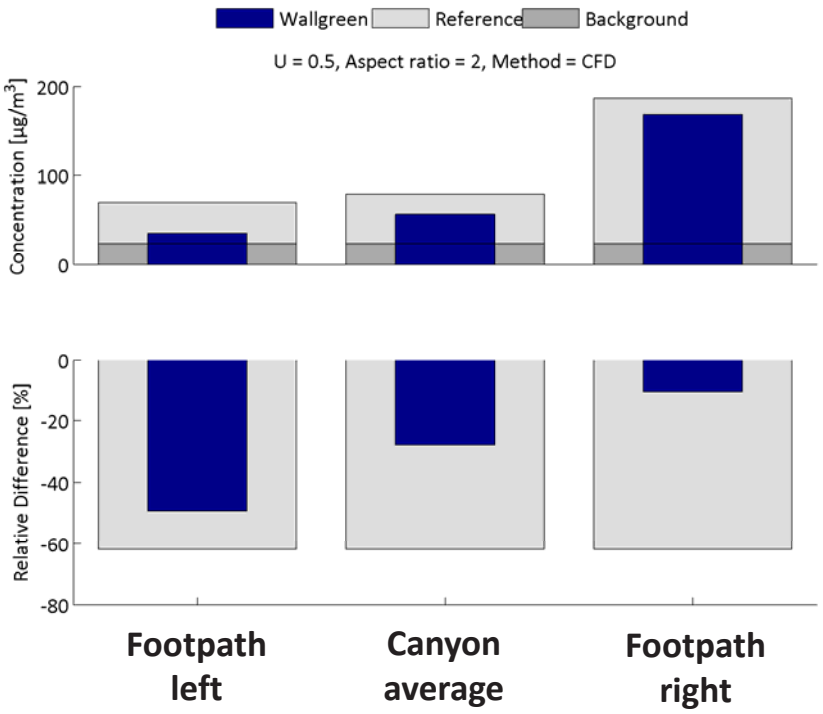



**CFD-BOX**: emissions (traffic) + deposition (vegetation) uniformly spread over entire canyon

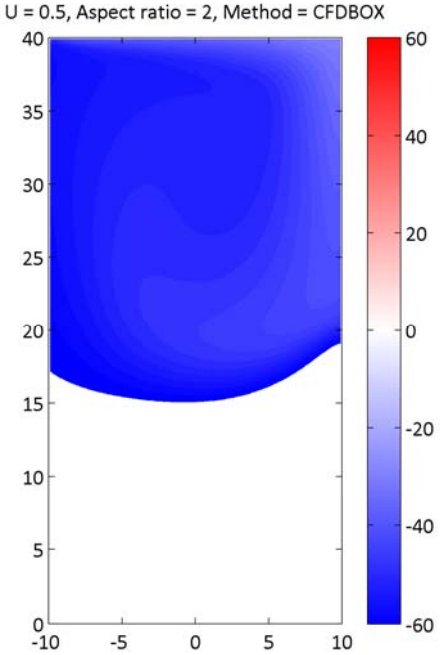


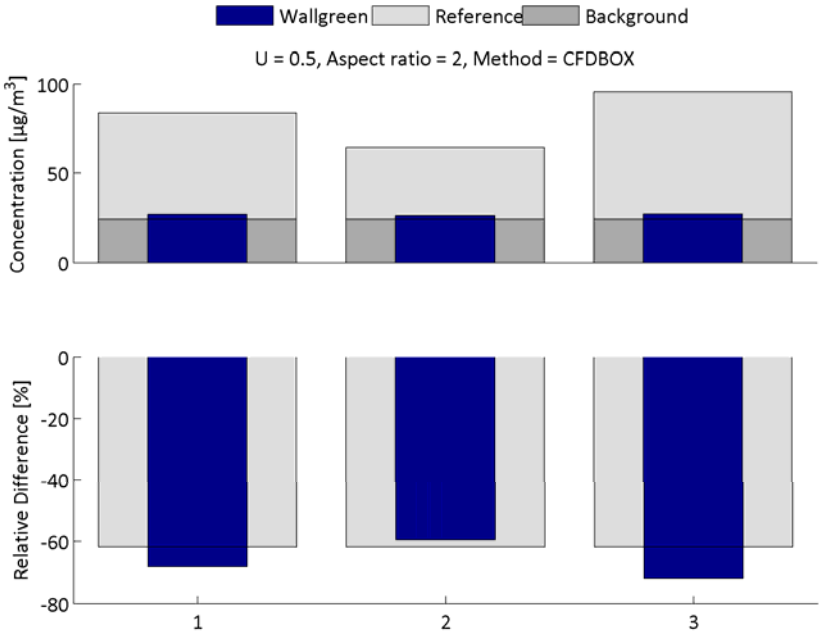
**CFD**


U = 0.5, Aspect ratio = 2, Method = CFD
40
35
30
25
20
15
10
5
0
-10
-5
0
5
10
60
40
20
0
-20
-40
-60


Wallgreen
Reference
Background
U = 0.5, Aspect ratio = 2, Method = CFD
Concentration [µg/m3]
200
100
0
Relative Difference [%]
0
-20
-40
-60
-80
Footpath left
Canyon average
Footpath right

**CFD-BOX**


U = 0.5, Aspect ratio = 2, Method = CFDBOX
40
35
30
25
20
15
10
5
0
-10
-5
0
5
10
60
40
20
0
-20
-40
-60


Wallgreen
Reference
Background
U = 0.5, Aspect ratio = 2, Method = CFDBOX
Concentration [µg/m3]
100
50
0
Relative Difference [%]
0
-20
-40
-60
-80
1
2
3

BOX MODEL CLAIM: **-62%**
CFD-BOX RESULT: **-58%**
CFD RESULT: **-27% (not what we expected)**

**Model simplicity can explain high claim only partly…**

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CFD-BOX RESULT: **-58%**
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**Other factors**
2D vs 3D

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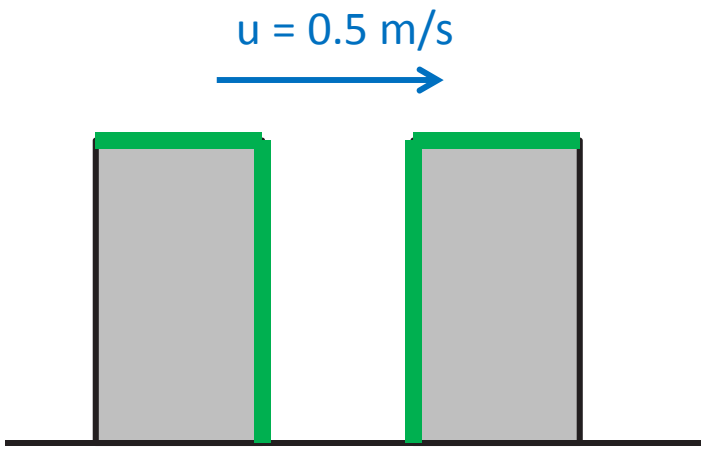
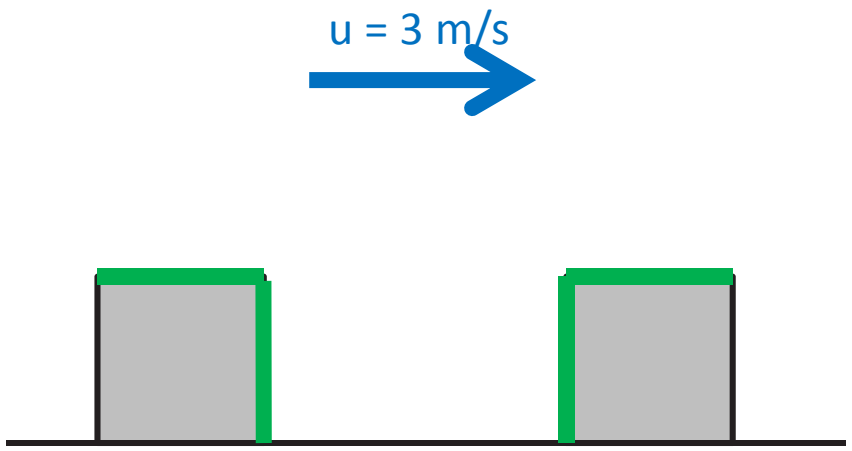
**Model simplicity can explain high claim only partly…**

**Other factors**
2D vs 3D
Input parameters




Fijn stof: **-60%**




Fijn stof: **-3.9%**

BOX MODEL CLAIM: **-62%**
CFD-BOX RESULT: **-58%**
CFD RESULT: **-27% (not what we expected)**

**Model simplicity can explain high claim only partly…**

**Other factors**
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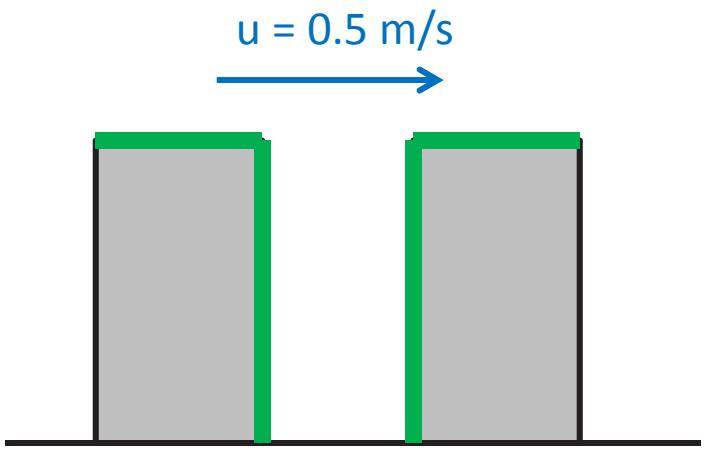
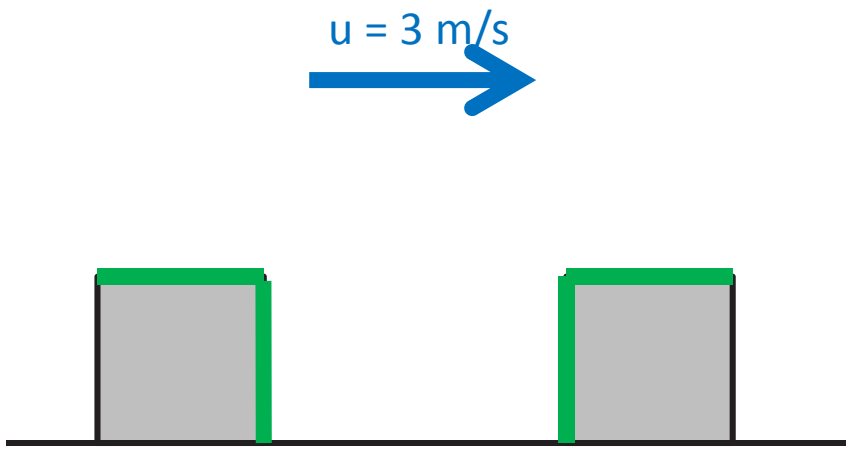



Fijn stof: **-60%**




Fijn stof: **-1.3%**

**CONCLUDING REMARKS ON THE BOX MODEL**

Box model limitations/subtleties acknowlegded by authors

-60% claims misused/misinterpreted by non-scientist

**GREEN WALLS HOLY GRAIL FOR BETTER AIR QUALITY IN STREETCANYONS?**

Probably not…

But potential for AQ improvement

(→ real world measurements needed)

# Questions?

Vos, P. E. J., Maiheu, B., Vankerkom, J., & Janssen, S. (2013). Improving local air quality in cities: to tree or not to tree? *Environmental Pollution*, *in press*.