



# Urban and peri-urban vegetation can improve air quality in Mediterranean areas

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# La contaminación asfixia las grandes ciudades

UK failed to meet NO2 limits for 2013, latest figures show  
September 29, 2014

UK's Government's submission to European Commission shows that only five out of 43 zones met limits set for last year

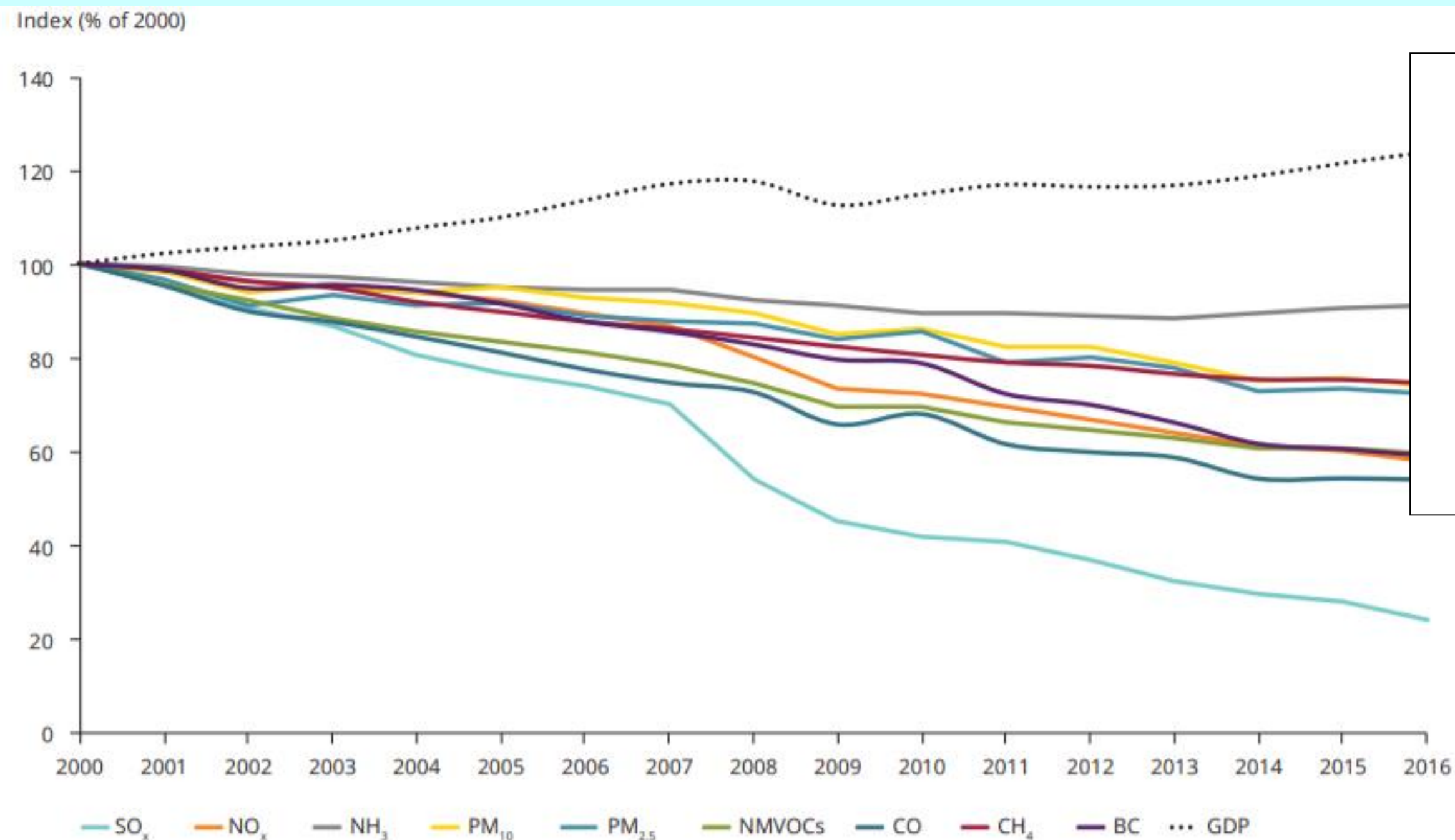
Only five of the UK's 43 air quality zones were compliant with EU annual mean limits for nitrogen dioxide in 2013, according to the UK government's submission on air quality to the European Commission.

The five zones which met the annual mean limit for NO2 of 40 micrograms per cubic metre (ug/m3) in 2013 were: Blackpool Urban Area; Preston Urban Area; Highland; Scottish Borders; Northern Ireland.

Twenty-eight zones in the UK meanwhile failed to meet the annual mean limit for NO2 in 2013, although 12 of these were in fact within the annual mean plus margin of 10 micrograms per cubic metre.



Development in EU-28 emissions, 2000-2016 (% of 2000 levels)



## Air pollution still too high across Europe

News 29 Oct 2018

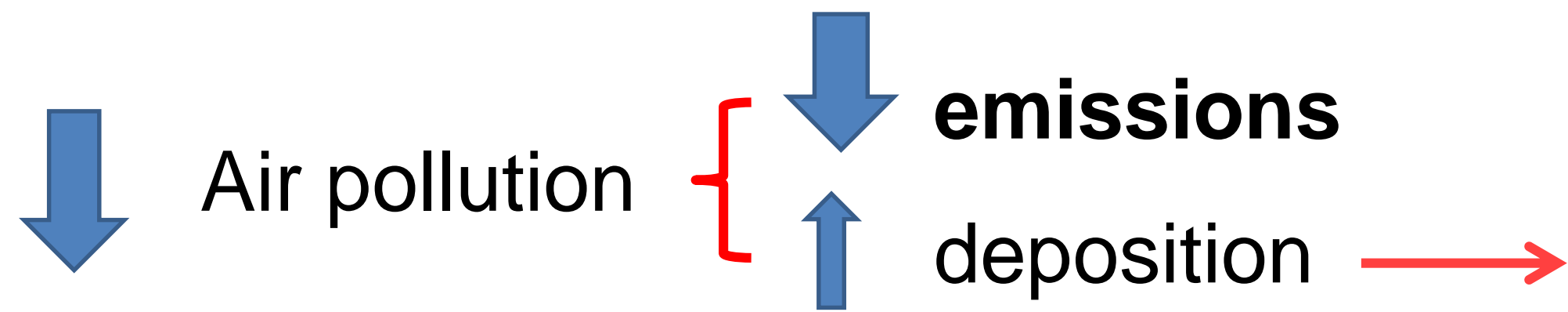
Despite slow improvements, air pollution continues to exceed European Union and World Health Organization limits and guidelines, according to updated data and information published by the European Environment Agency (EEA). Air pollution still poses a danger to human health and the environment.

European Environment Agency

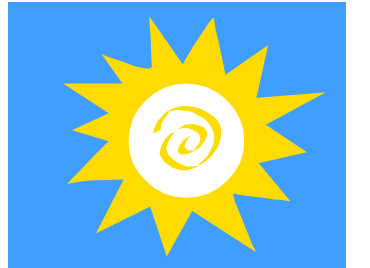




# Influence of urban vegetation in air pollution



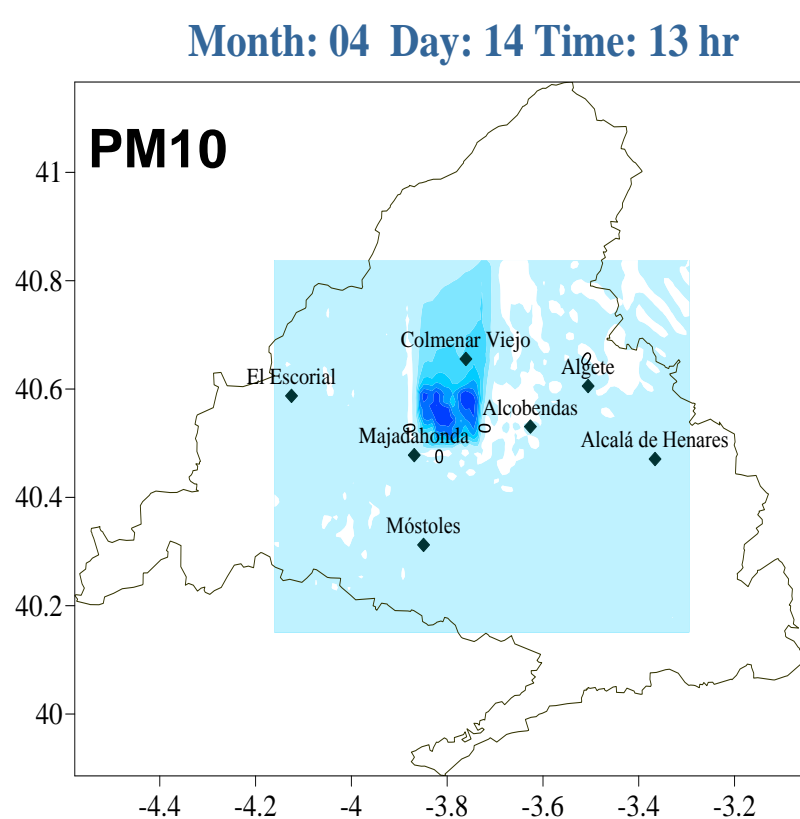
In Mediterranean environments, atmospheric deposition is dominated by dry deposition



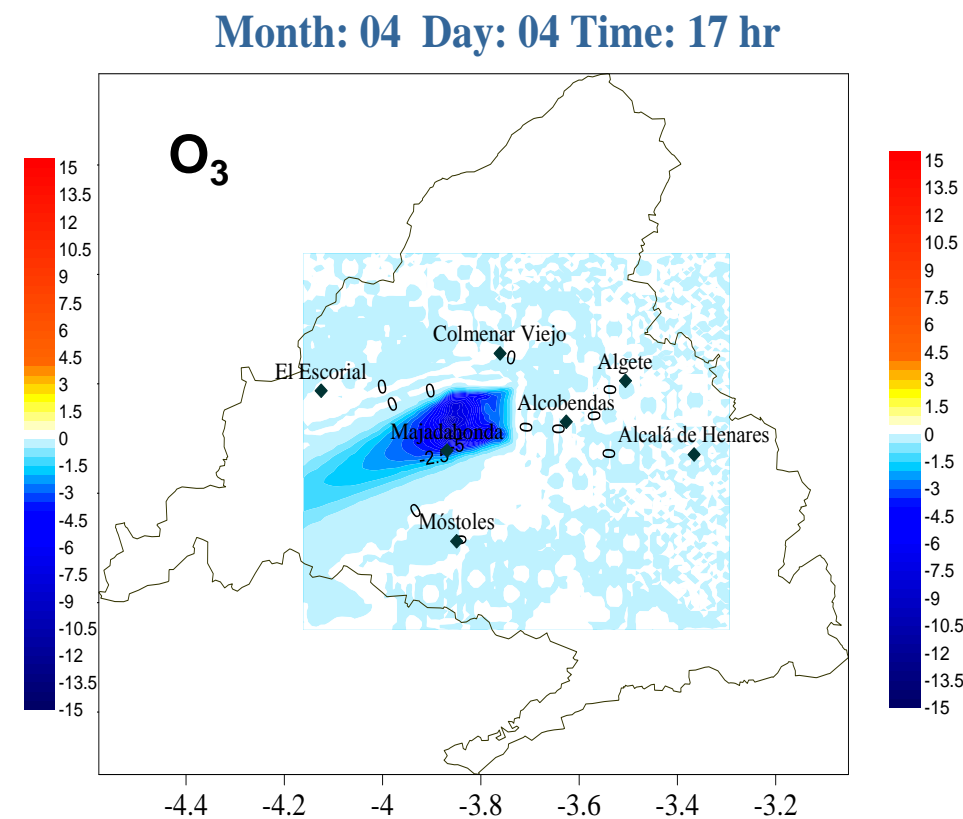
## Vegetation:



- ✓ increases dry deposition through
  - increasing deposition surfaces
  - stomatal uptake
- ✓ indirect removal of air pollutants modifying microclimate



PM10 (microgr/m3) Difference: BASE CASE (BC) - PARDO



Ozone (microgr/m3) Difference: BASE CASE (BC) - PARDO

## Models estimate air pollution removal by vegetation at city scale but... what happens at smaller scale?



Con la contribución  
del instrumento  
financiero LIFE  
de la Comunidad  
Europea.

# RESPIRA - Life+

## Reduction of exposure of cyclists to urban pollutants

### General objective RESPIRA:

The main goal is to demonstrate that the urban air pollution intake by cyclists, and pedestrians, can be reduced by using new technologies and other options in urban planning, urban design, and mobility management.



Socios



Colaborador





# RESPIRA - Life+

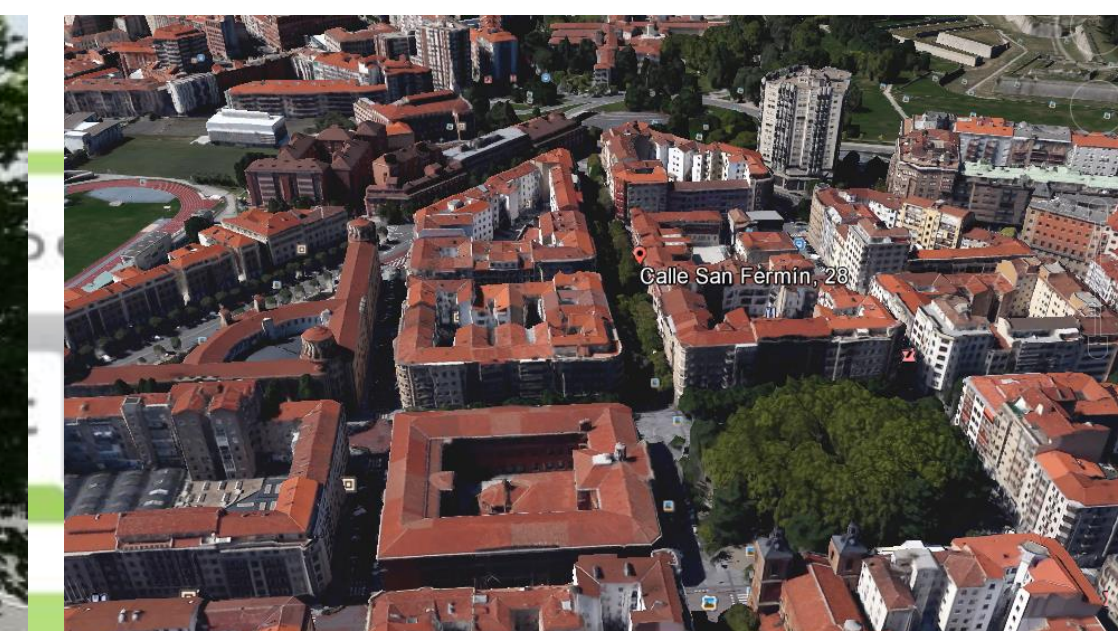
## Reduction of exposure of cyclists to urban pollutants

### General objective RESPIRA:

The main goal is to demonstrate that the urban air pollution intake by cyclists, and pedestrians, can be reduced by using new technologies and other options in urban planning, urban design, and mobility management.

### Quantify air quality improvement by urban vegetation:

- The role of urban vegetation on air quality in areas without emission sources
- The effectiveness of vegetation barriers at reducing exposure to atmospheric pollution
- The effect of roadside trees on the air quality in street canyons





# Role of urban vegetation in areas without emission sources

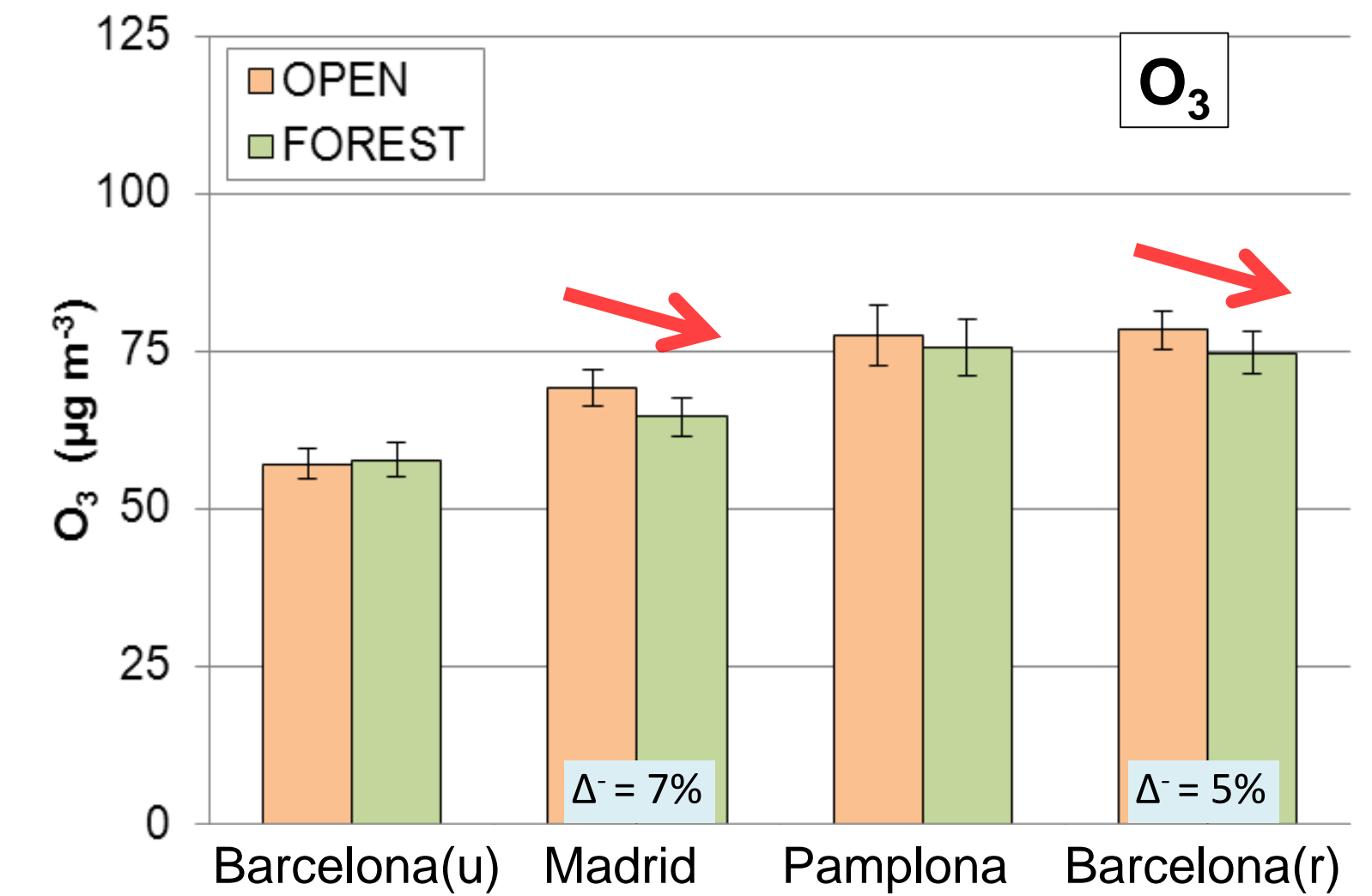
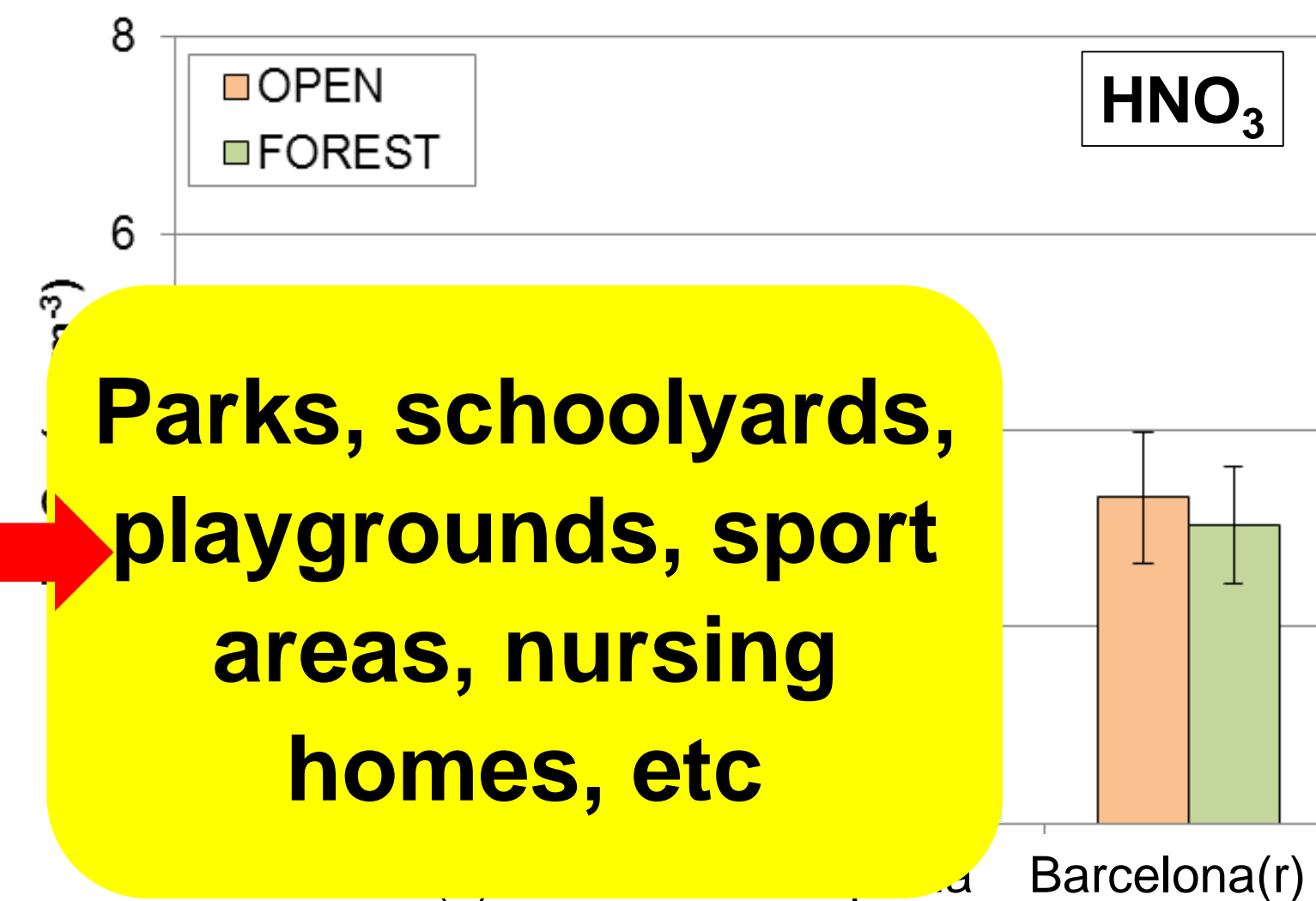
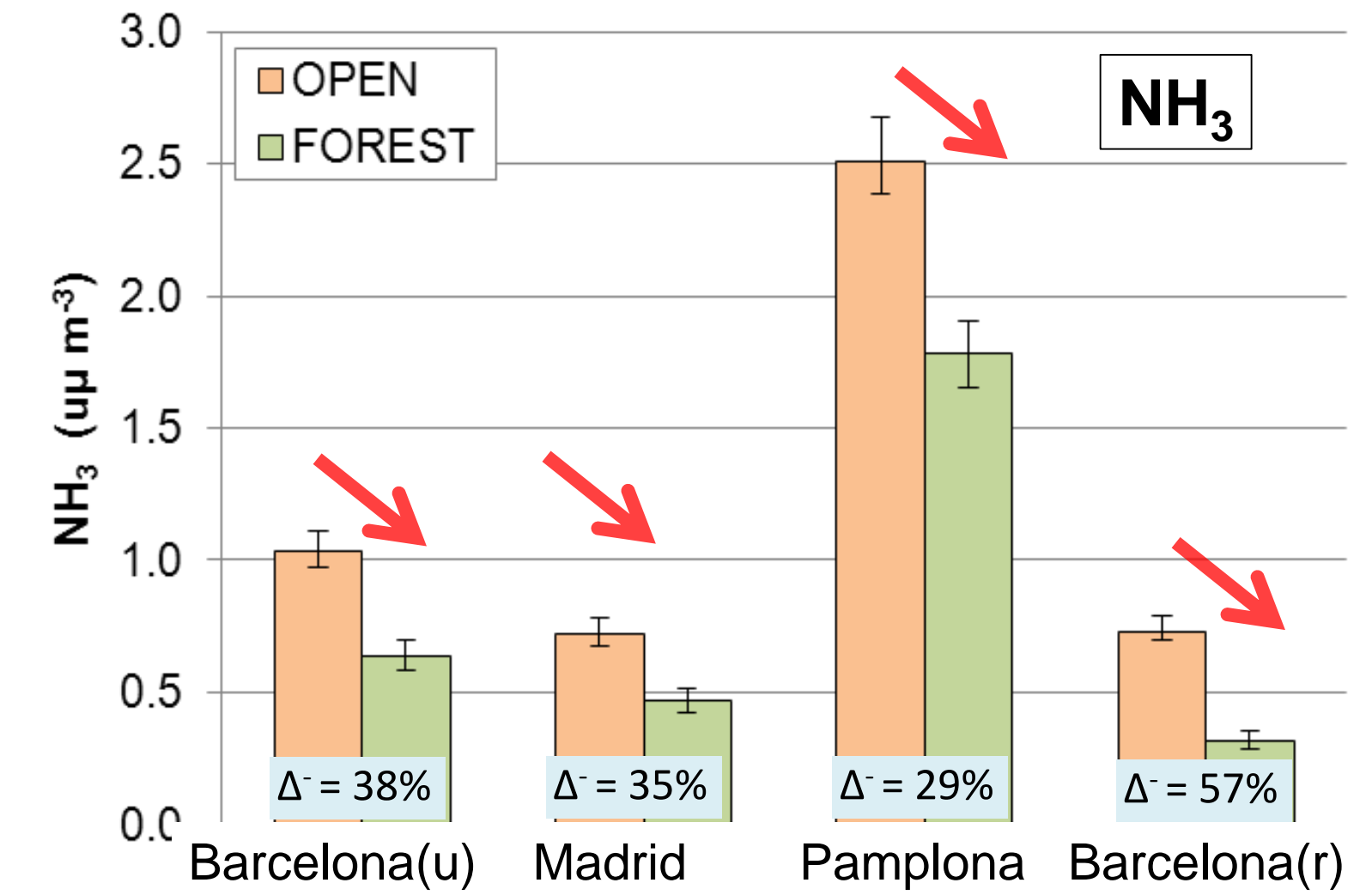
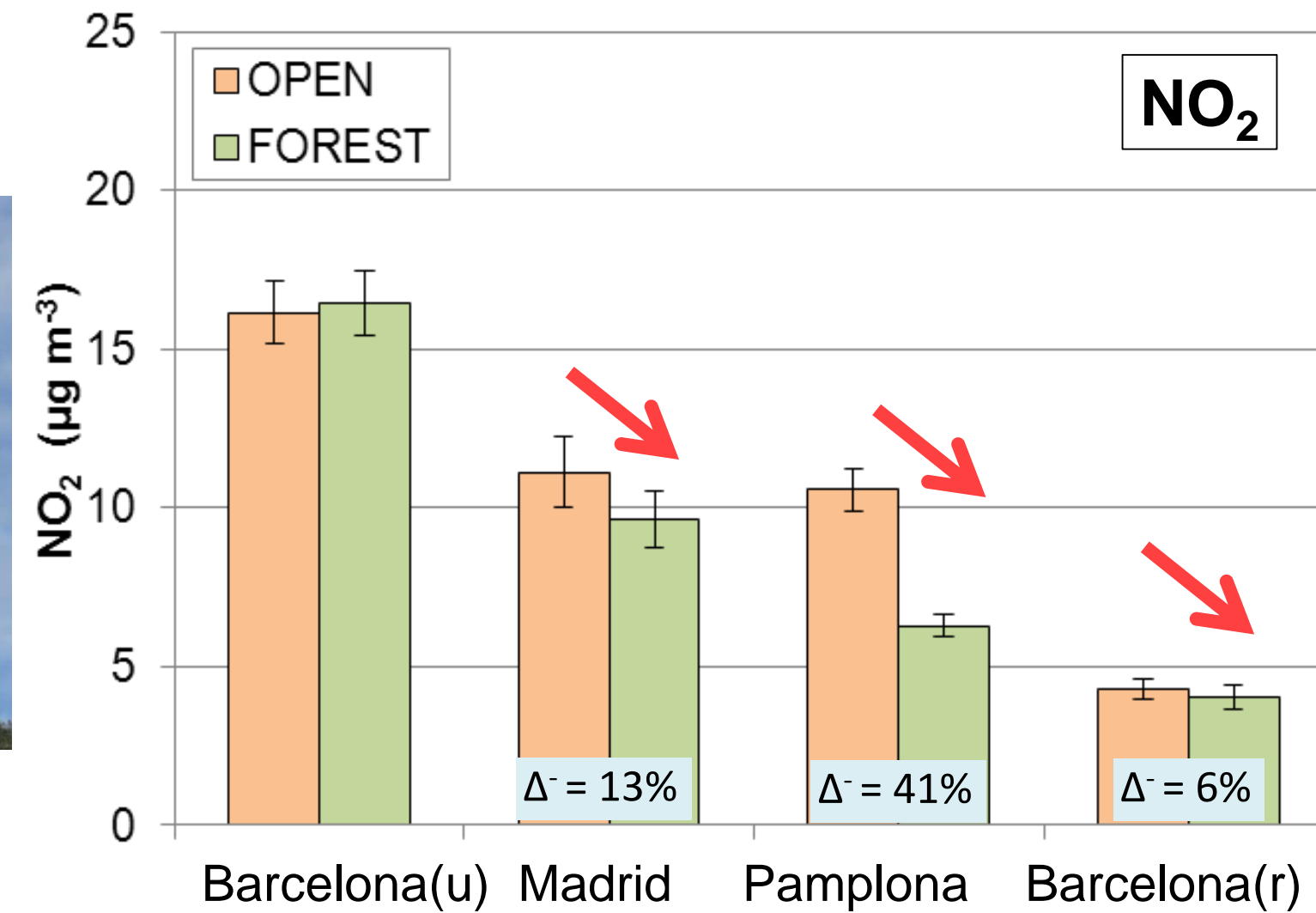
below canopy



open field plot



Passive samplers:  $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{NH}_3$ ,  $\text{HNO}_3$   
biweekly during two years

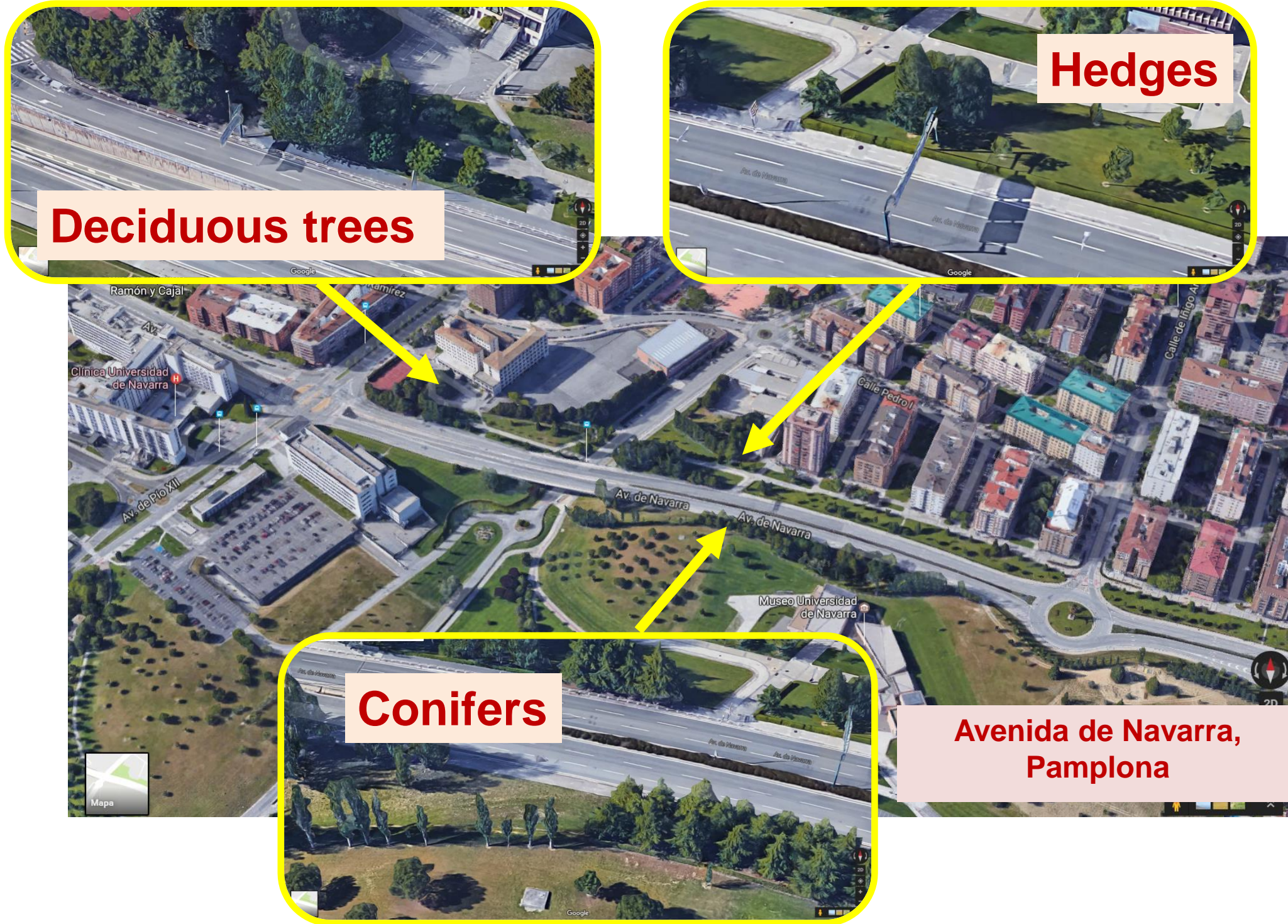


**Air pollutant concentrations decrease under vegetation canopy**

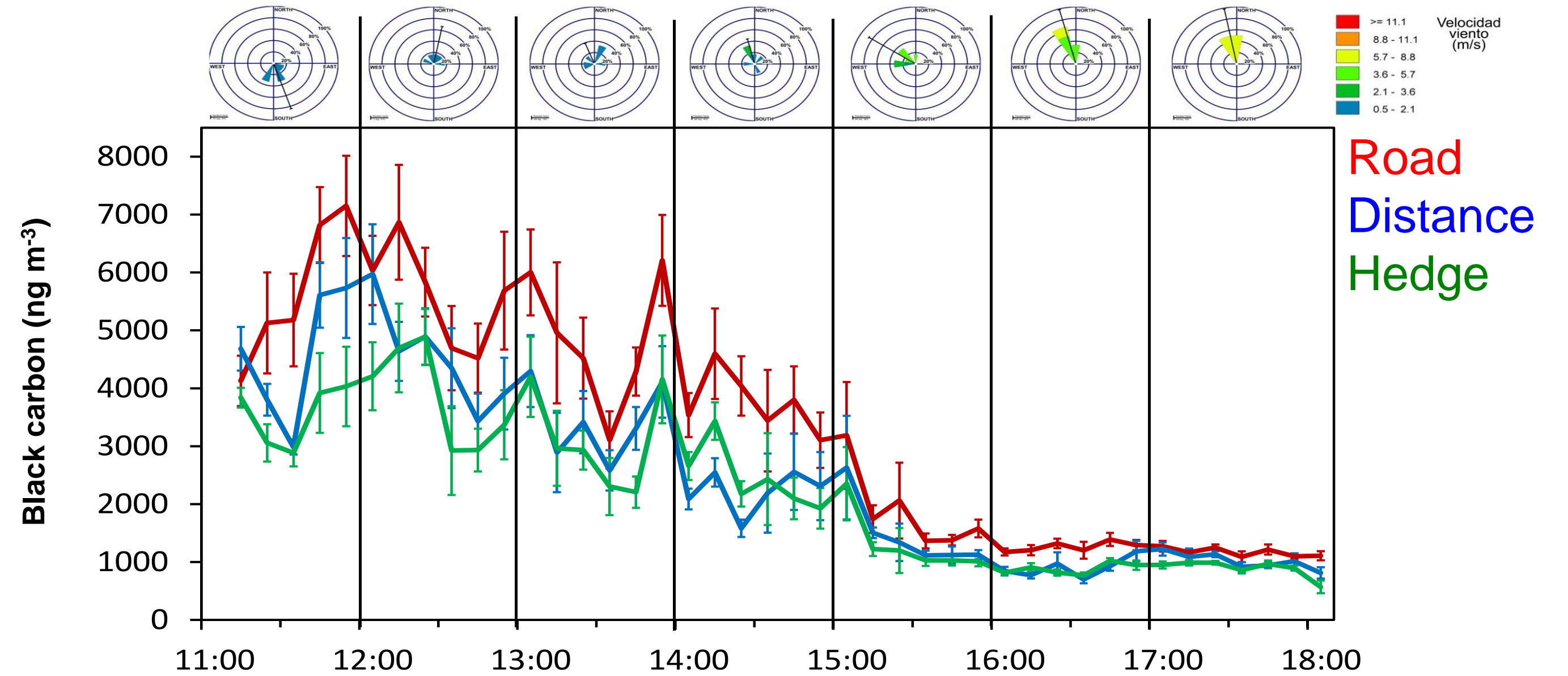
**Parks, schoolyards, playgrounds, sport areas, nursing homes, etc**



# Effectiveness of vegetation barriers for reducing exposure



Avenida Navarra, hedges (18/May/2016)

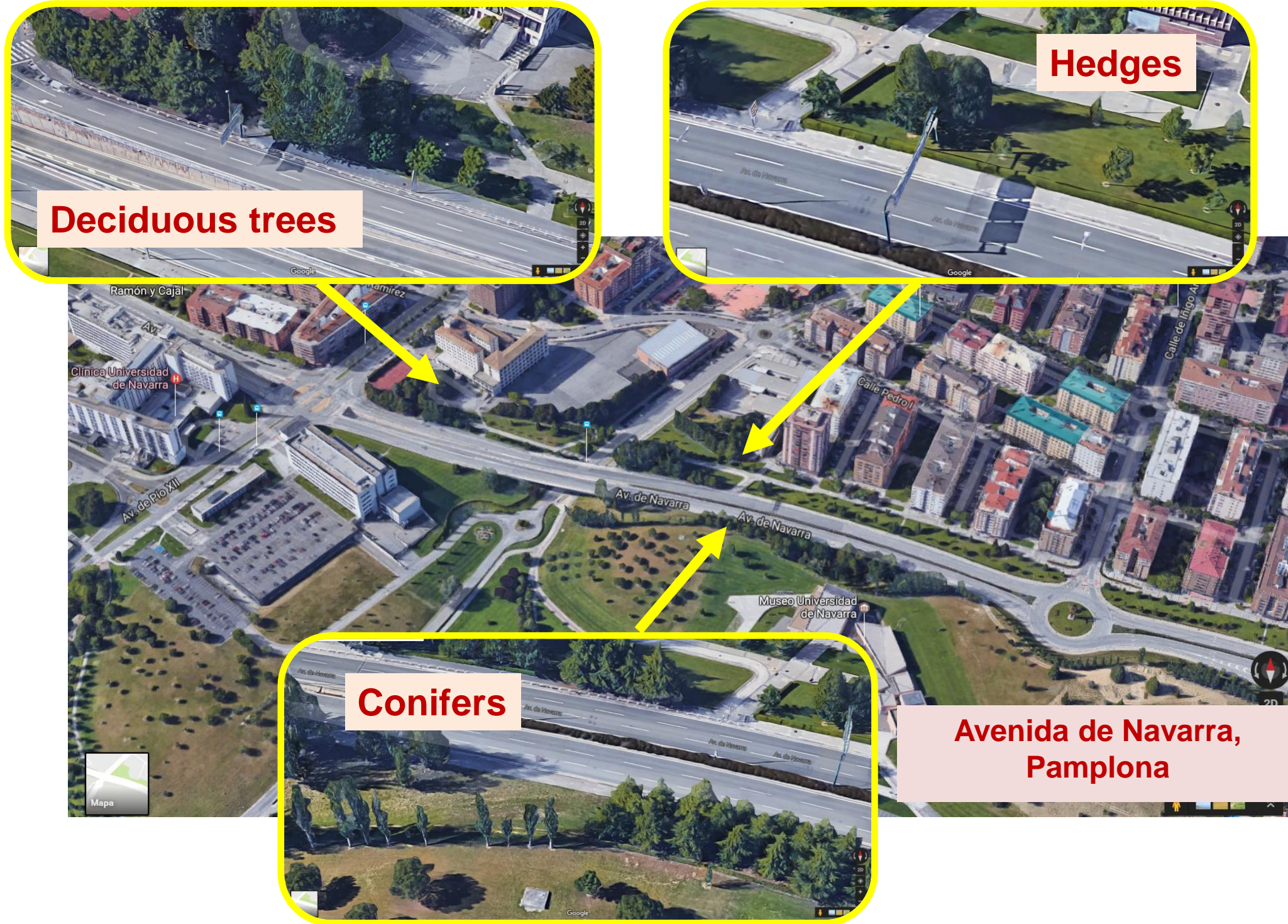


**Black carbon**  
microAeth® AE51  
aethalometer

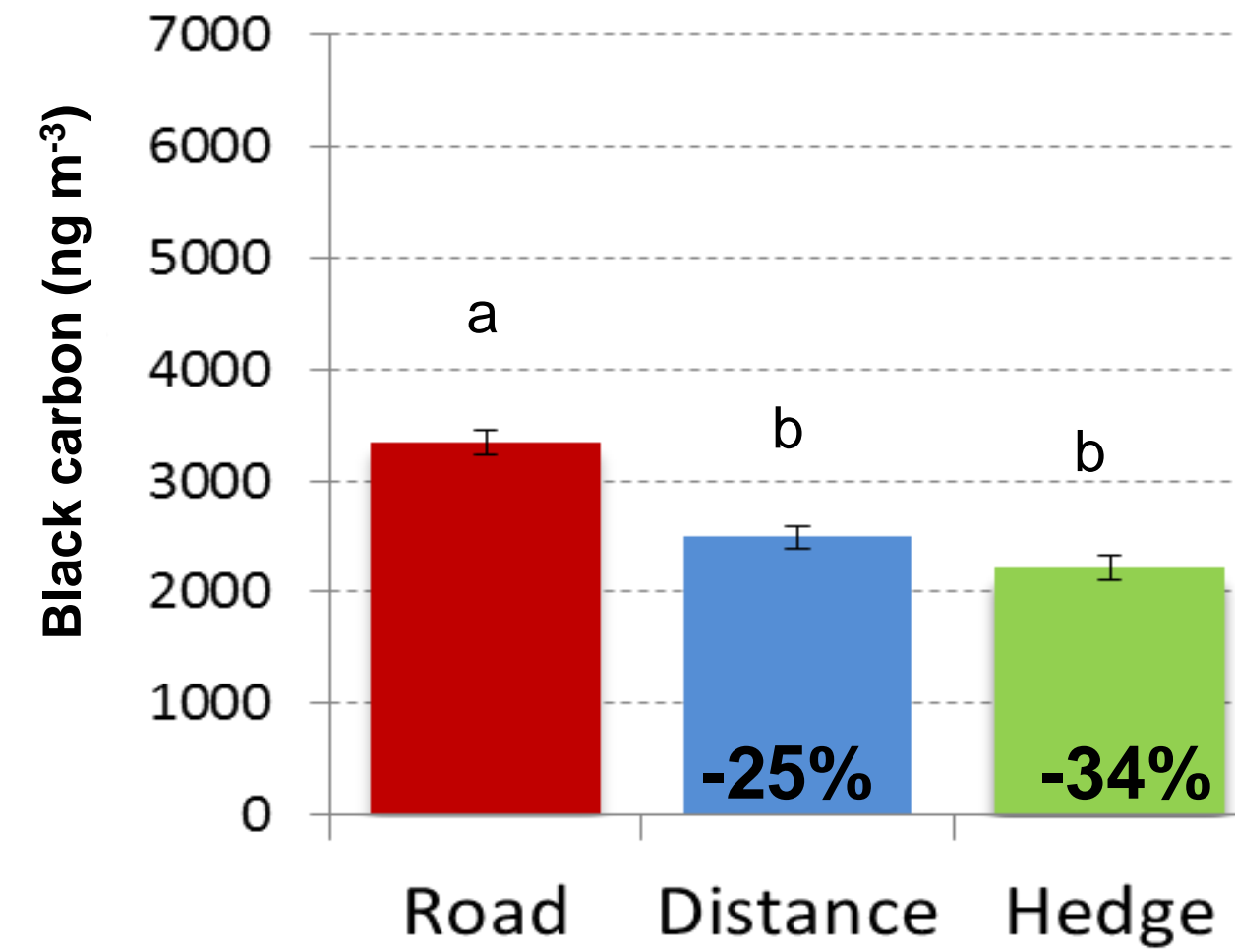




# Effectiveness of vegetation barriers for reducing exposure



## Hedges

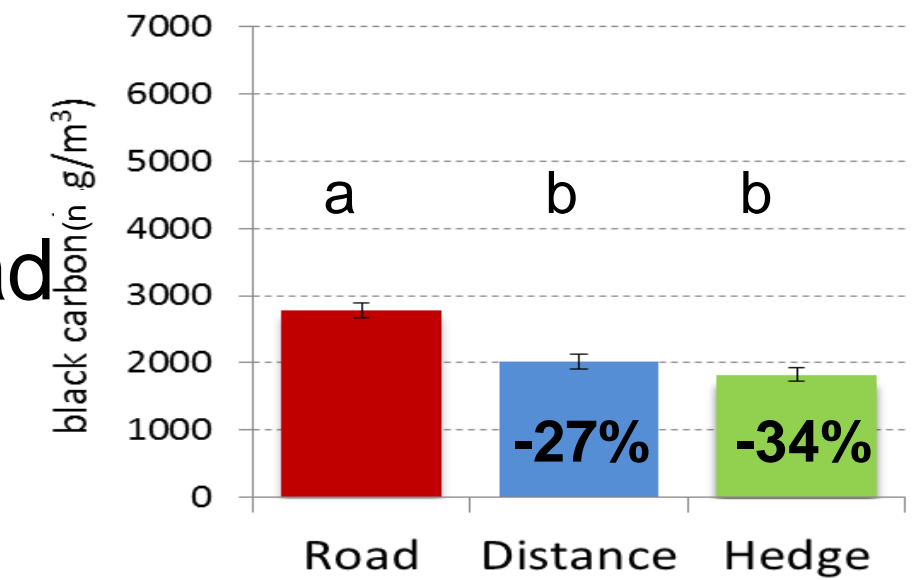
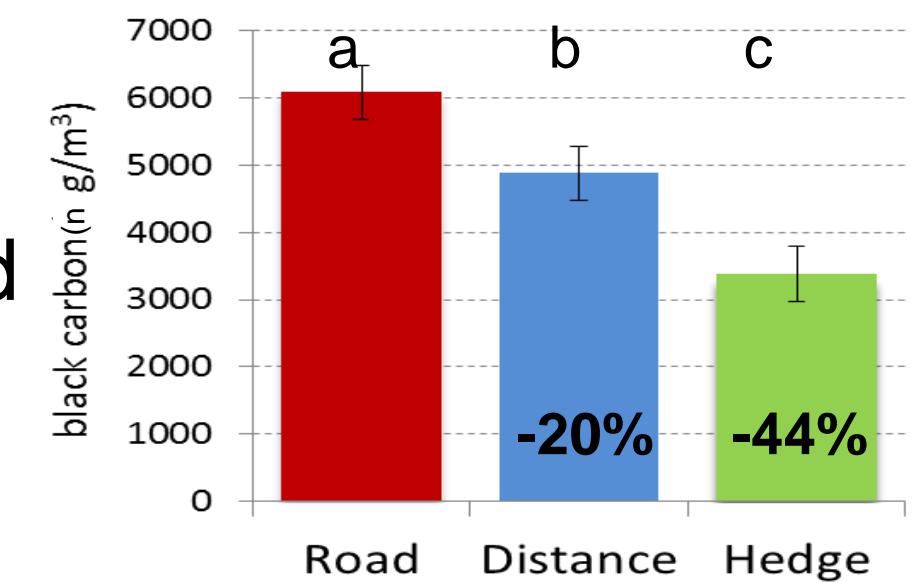
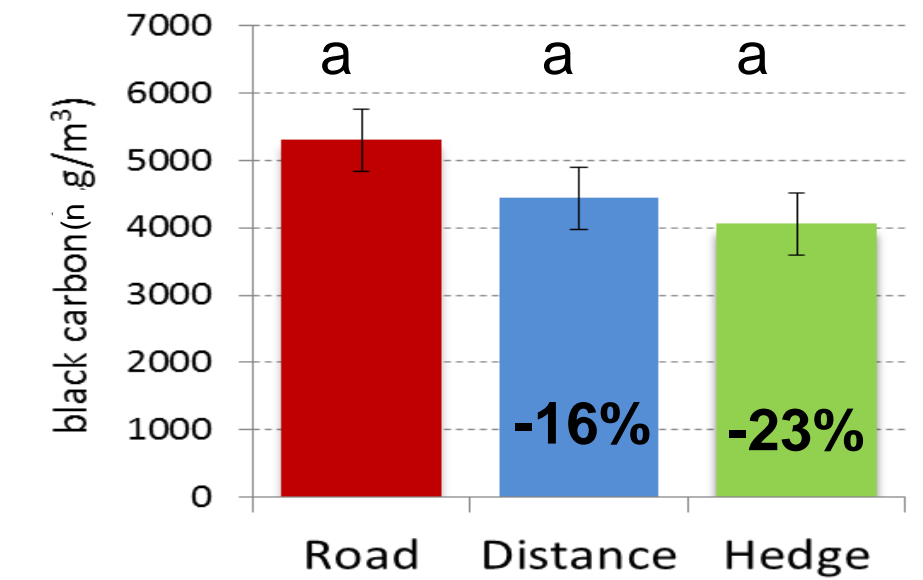


Calm  
(v < 0.5 m/s)

From road  
(SW)

Efficiency hedges: 7-24%

Parallel to road  
(NWSE)



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aethalometer



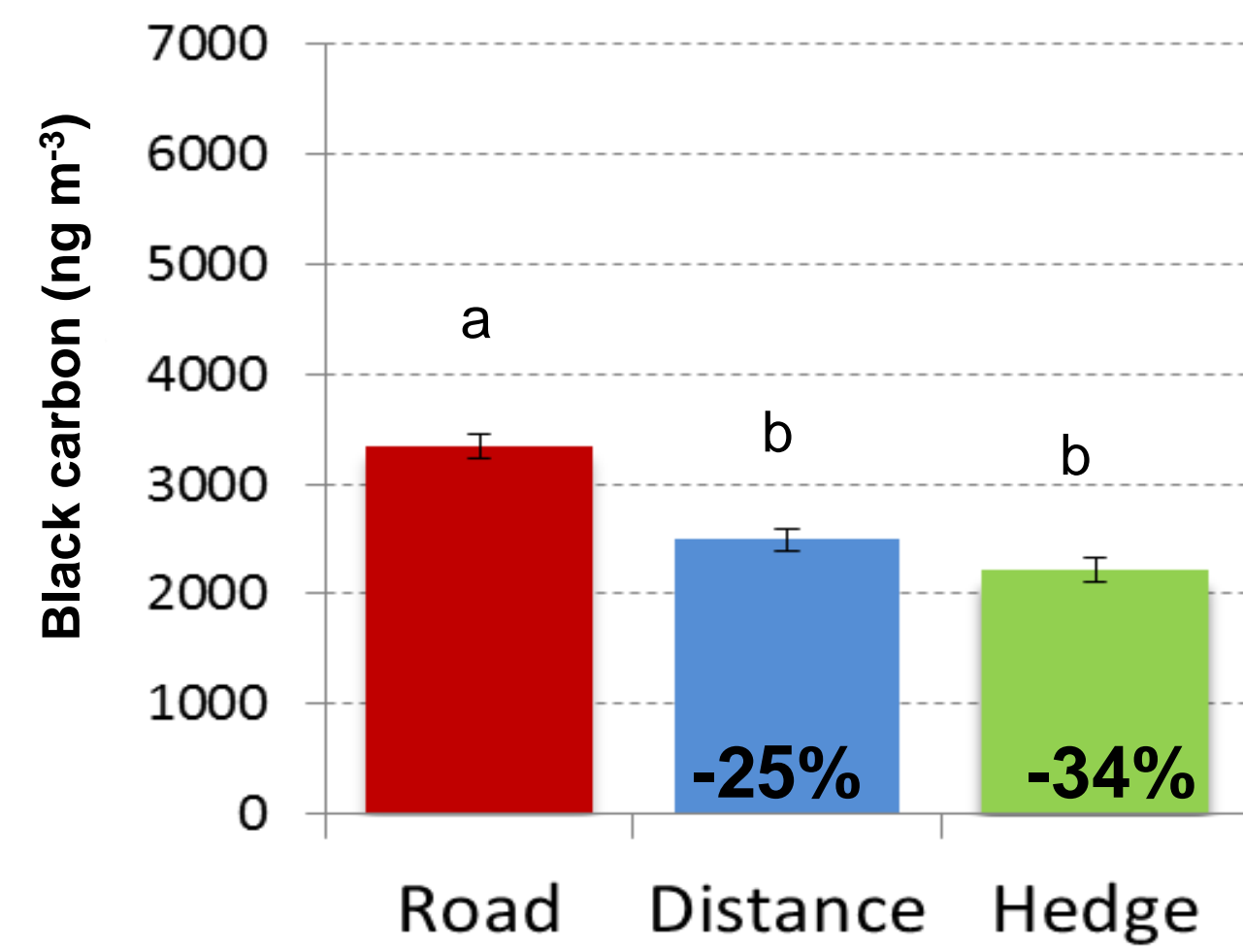




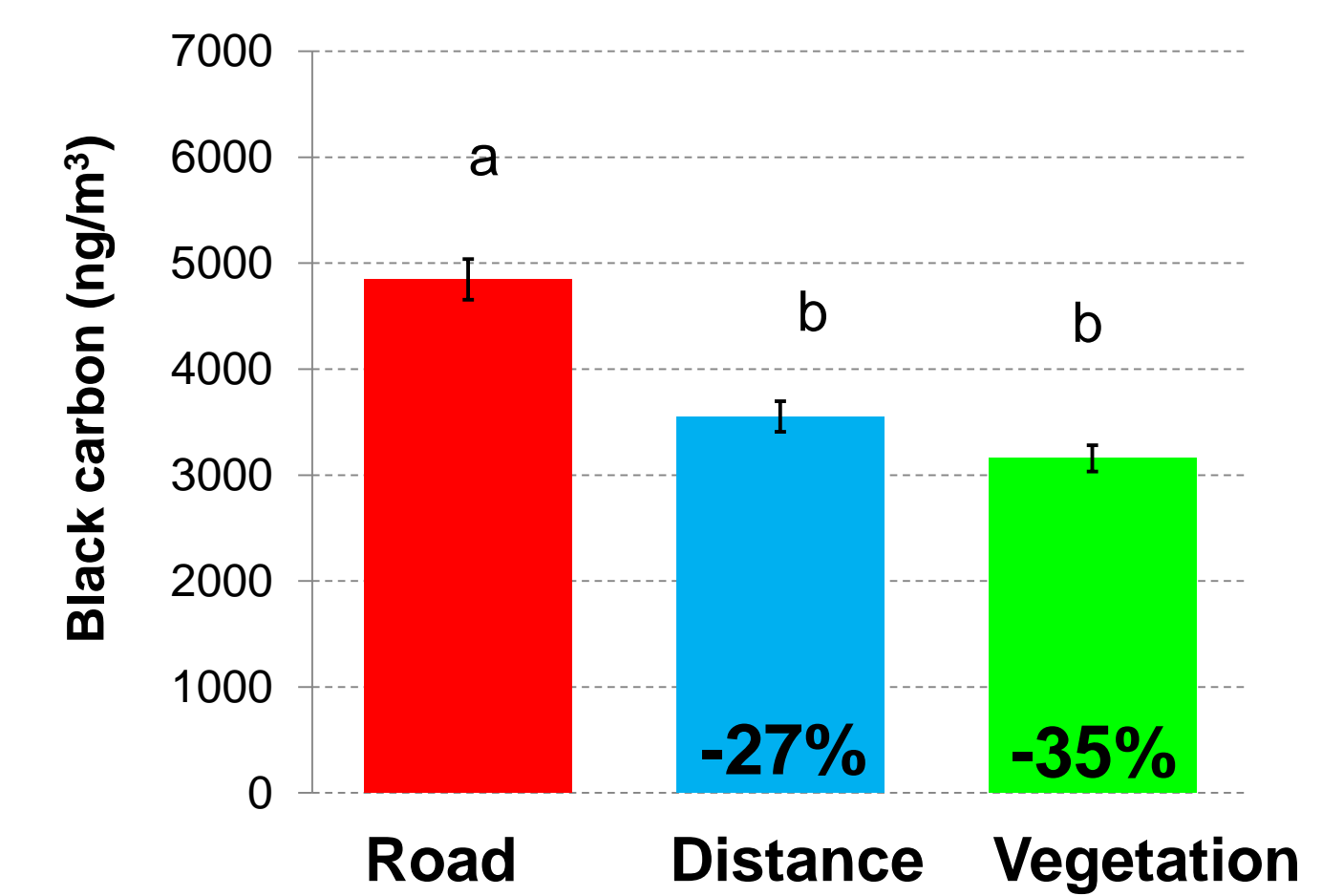
# Effectiveness of vegetation barriers for reducing exposure



## Hedges



## Deciduous trees



Efficiency hedges: 7-24%

Efficiency trees: 1-11%



**Black carbon**  
microAeth® AE51  
aethalometer



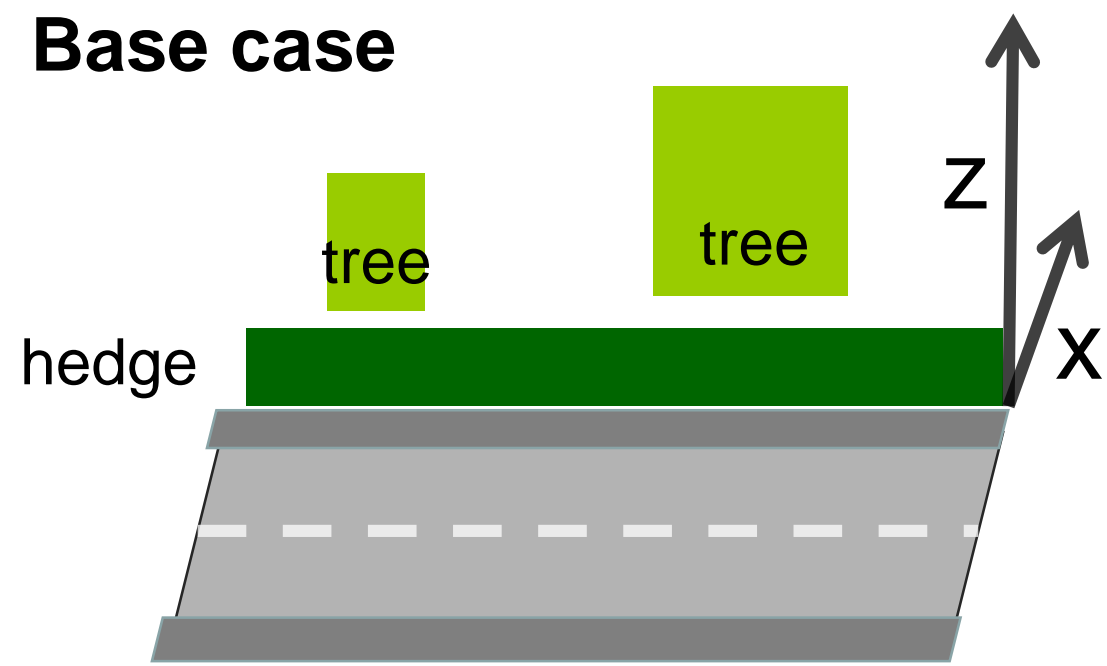
**Vegetal barriers are effective at reducing air pollutant exposure**

**Bike lane, pedestrian areas, schoolyards, playgrounds, etc**

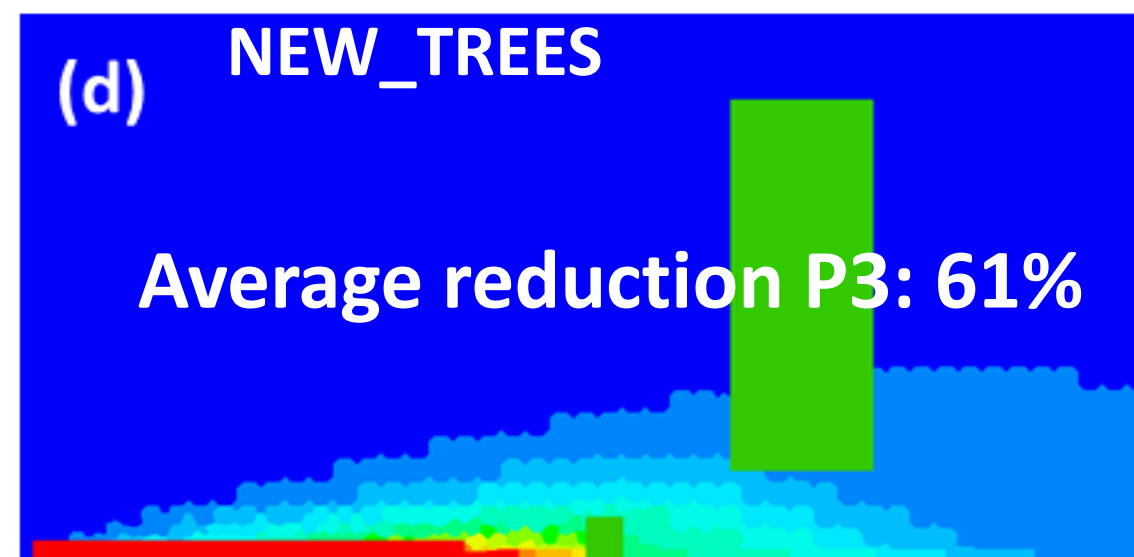
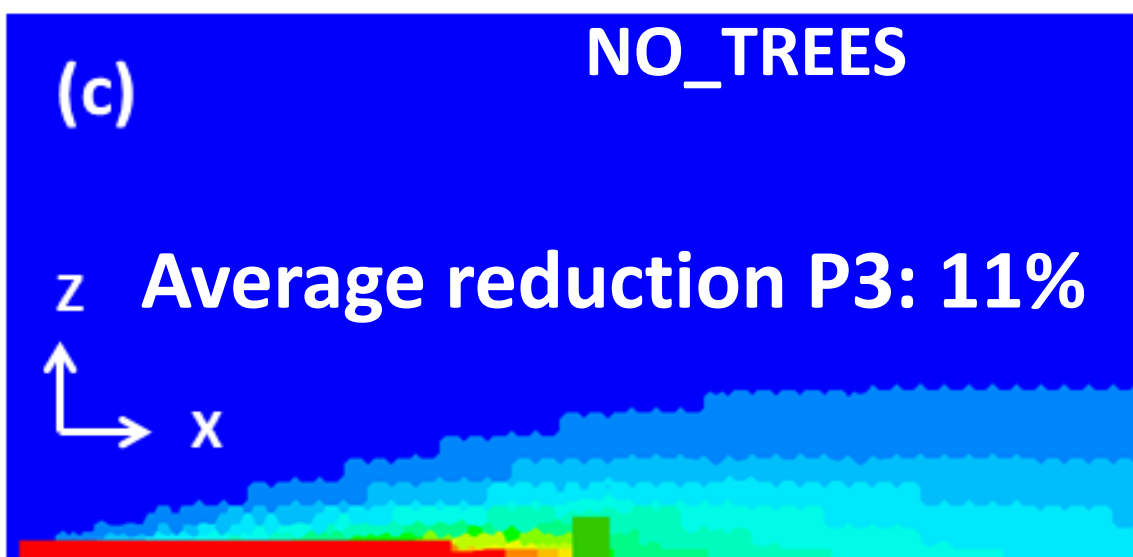
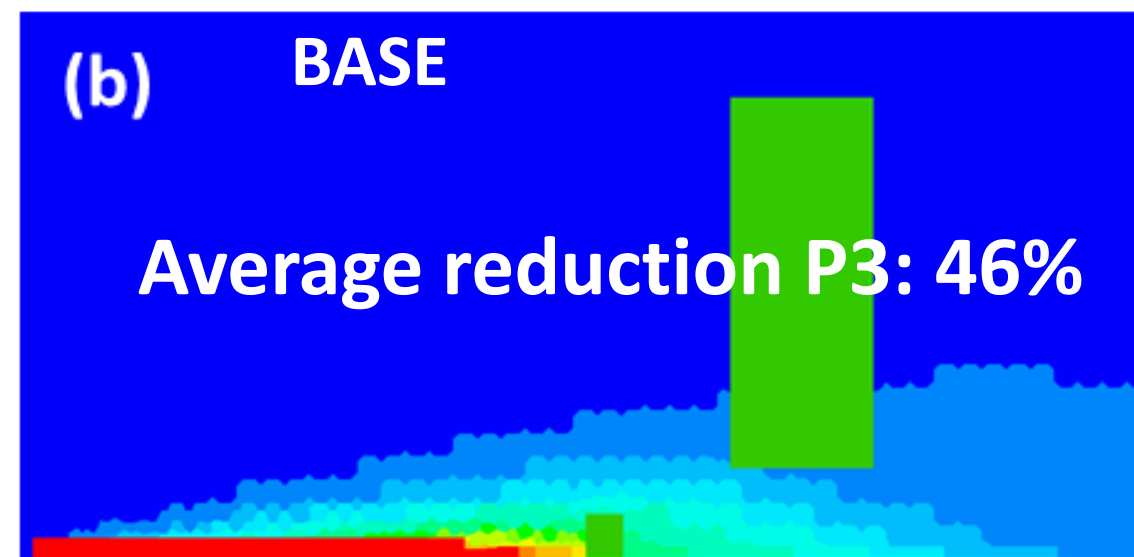
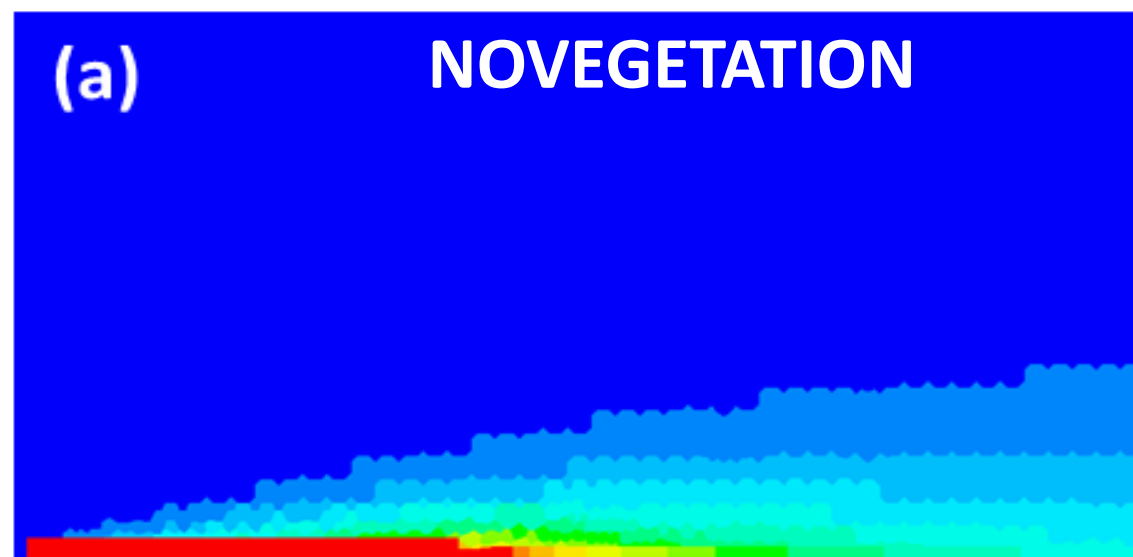


# Effectiveness of vegetation barriers for reducing exposure

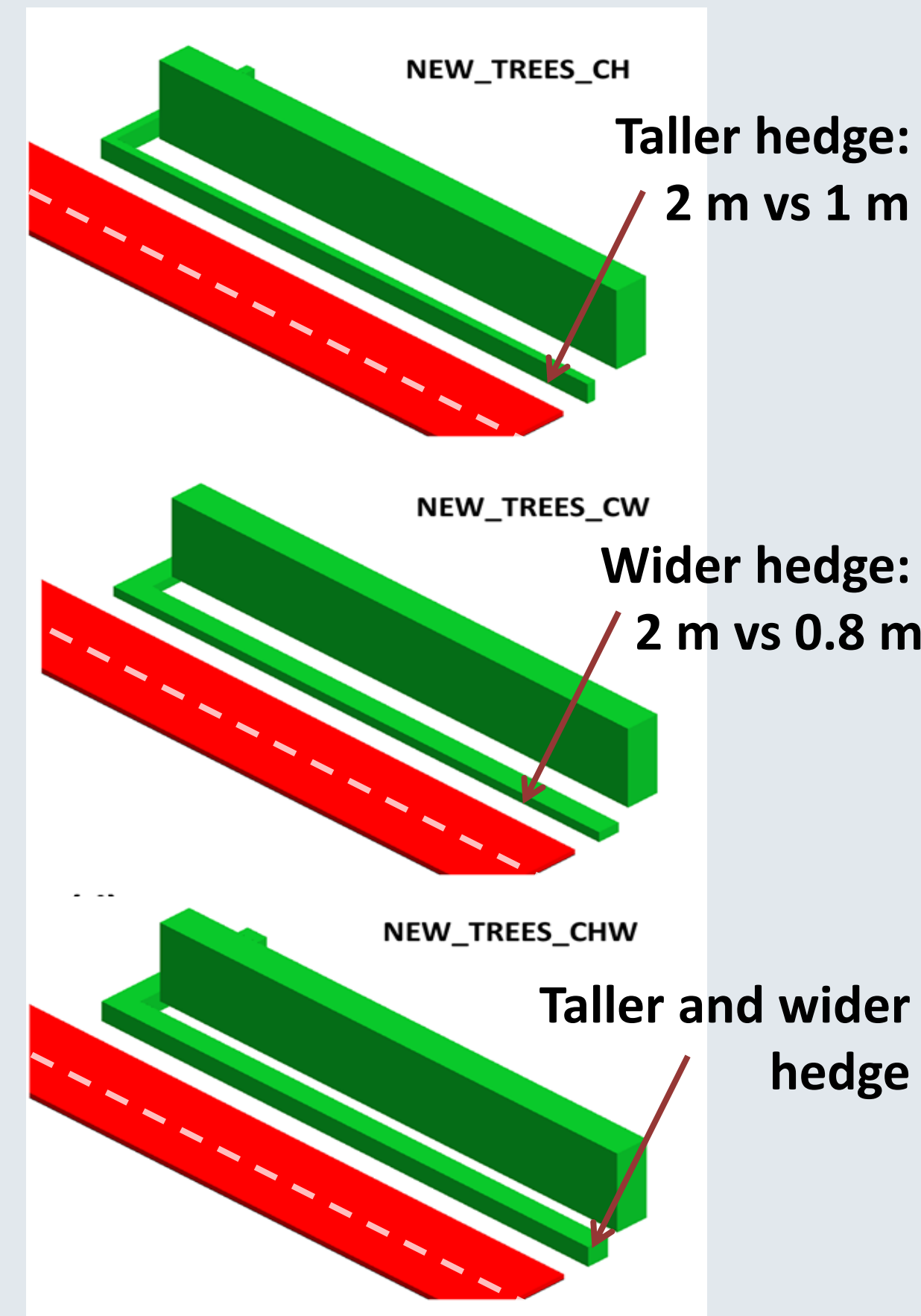
## Modelling scenarios with CFD (Computational Fluid Dynamics) model (STAR-CCM+ )



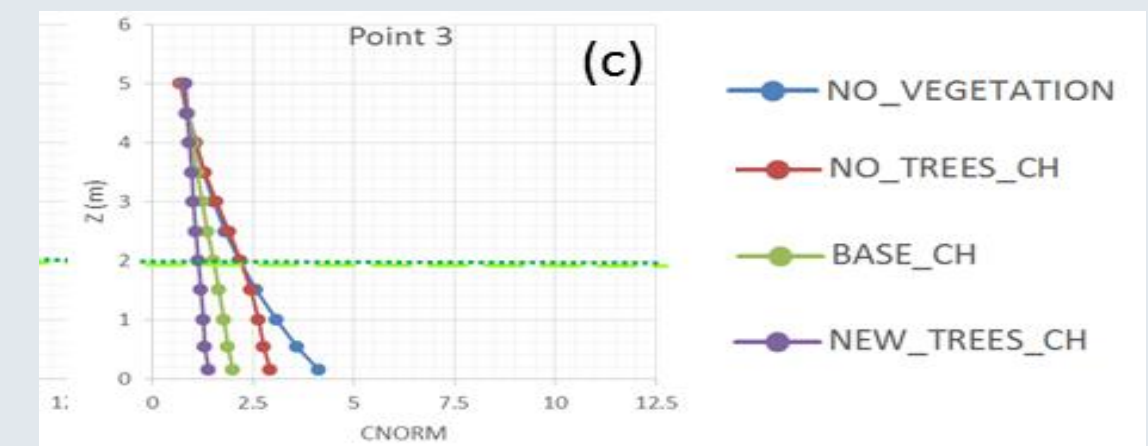
- Base case
- No vegetation
- Hedge but no trees
- Hedge with a line of trees



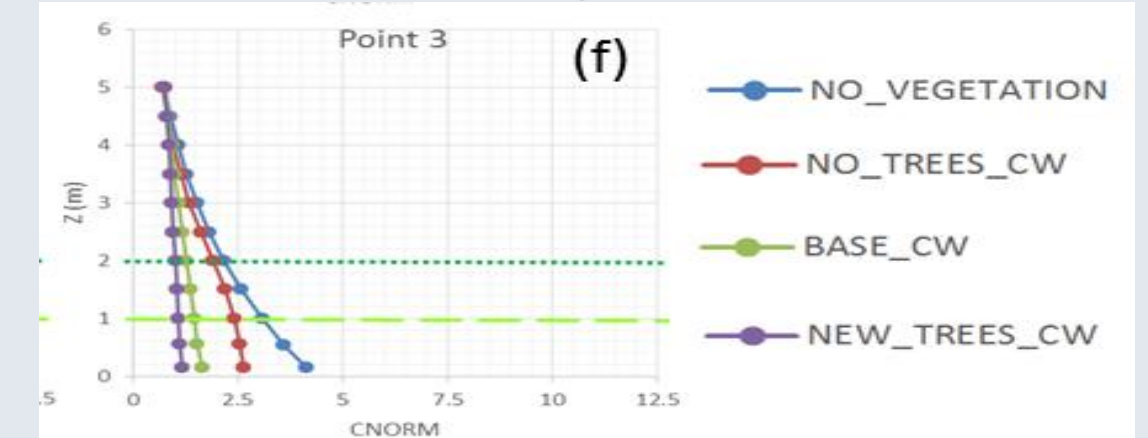
## Effect of hedge size



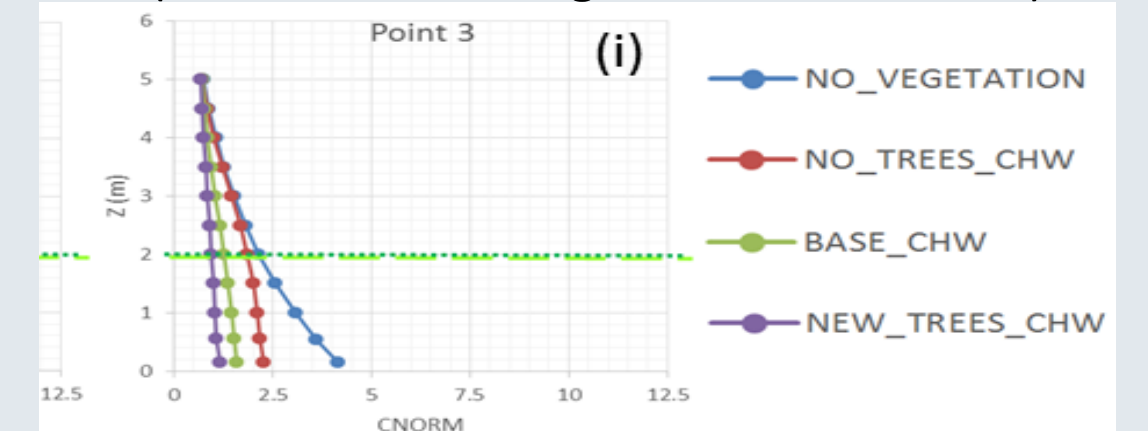
Average reduction of **taller-hedge + trees** vs NO\_VEGETATION below the tree base at P3 = 59% (16% for taller hedge and without trees)



Average reduction of **wider-hedge + trees** vs NO\_VEGETATION below the tree base at P3 = 65% (24% for wider hedge and without trees)



Average reduction of **taller-wider-hedge + trees** vs NO\_VEGETATION below the tree base at P3 = 66% (33% for wider hedge and without trees)





# Effect of roadside trees in street canyons



## Pamplona



Meteorology  
Black carbon  
microAeth® AE51  
aethalometer

Tafalla st

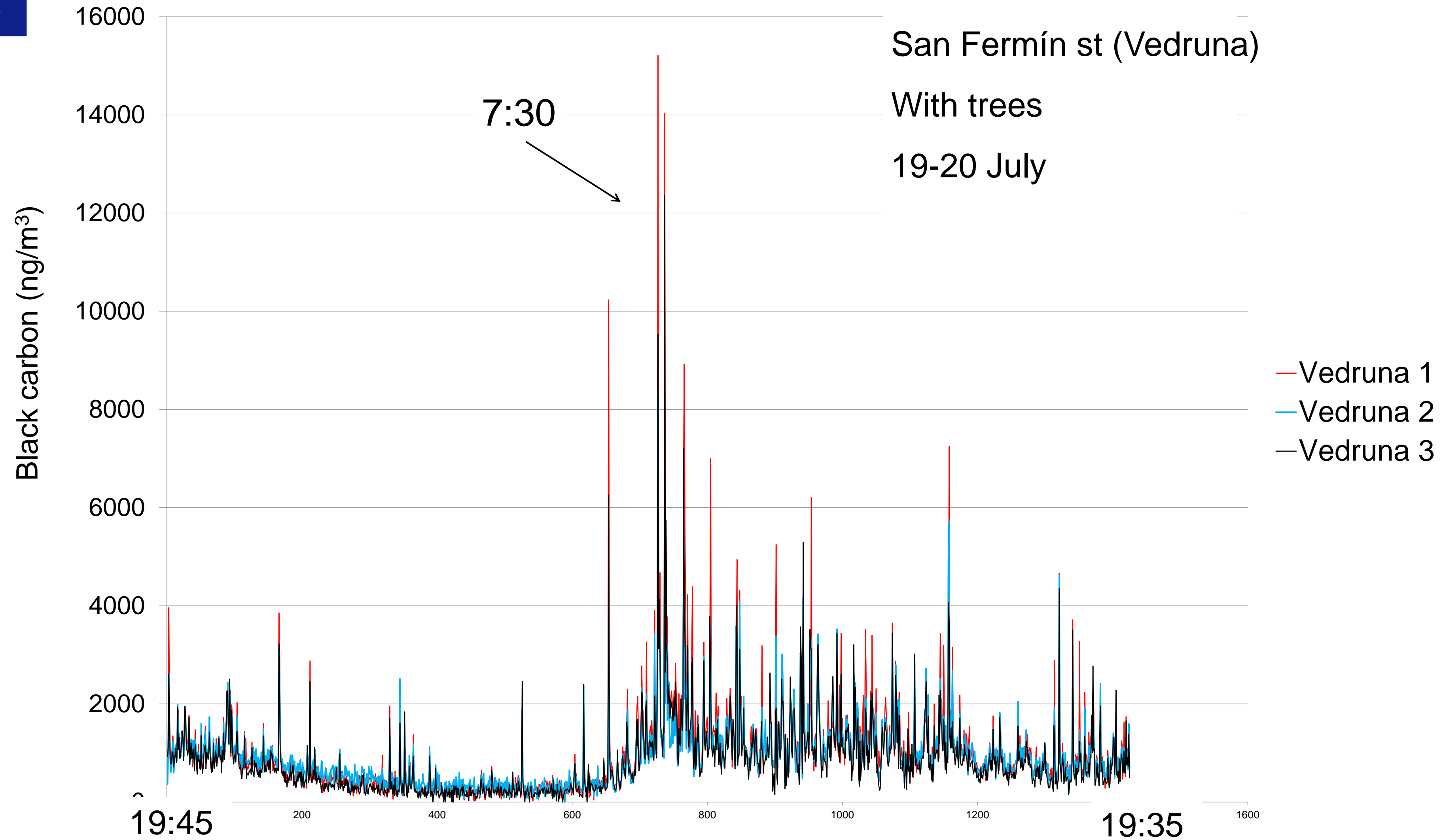


San Fermín st





# Effect of roadside trees in street canyons





# Effect of roadside trees in street canyons



## San Fermin st. with trees

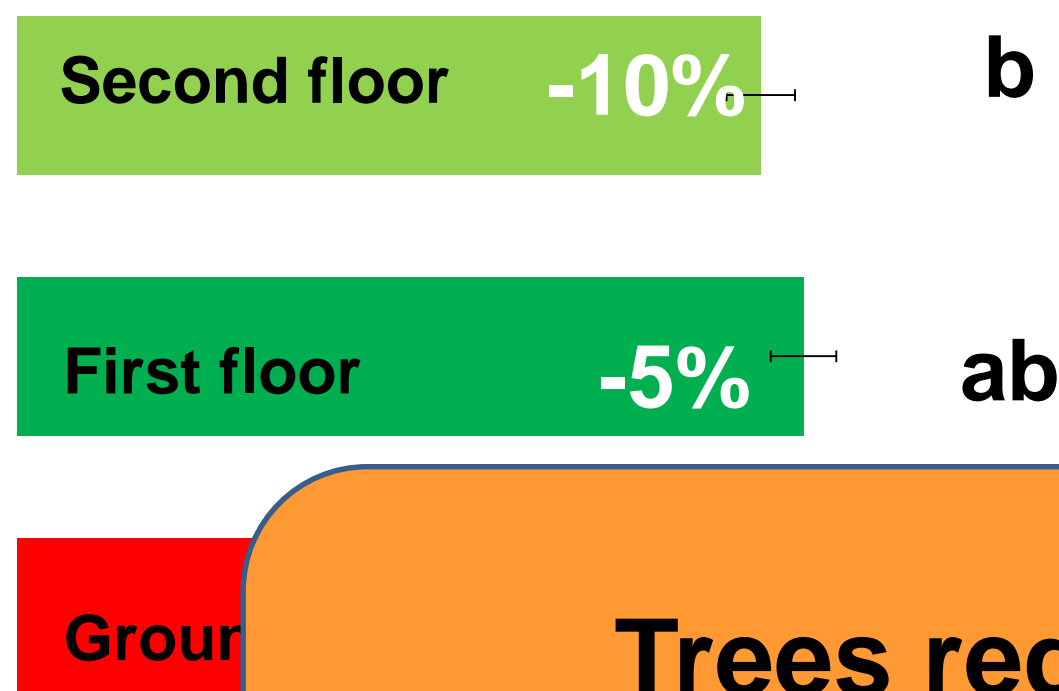
Wind (>0.5 m/s)  
28%



Calm (<0.5 m/s)  
72%



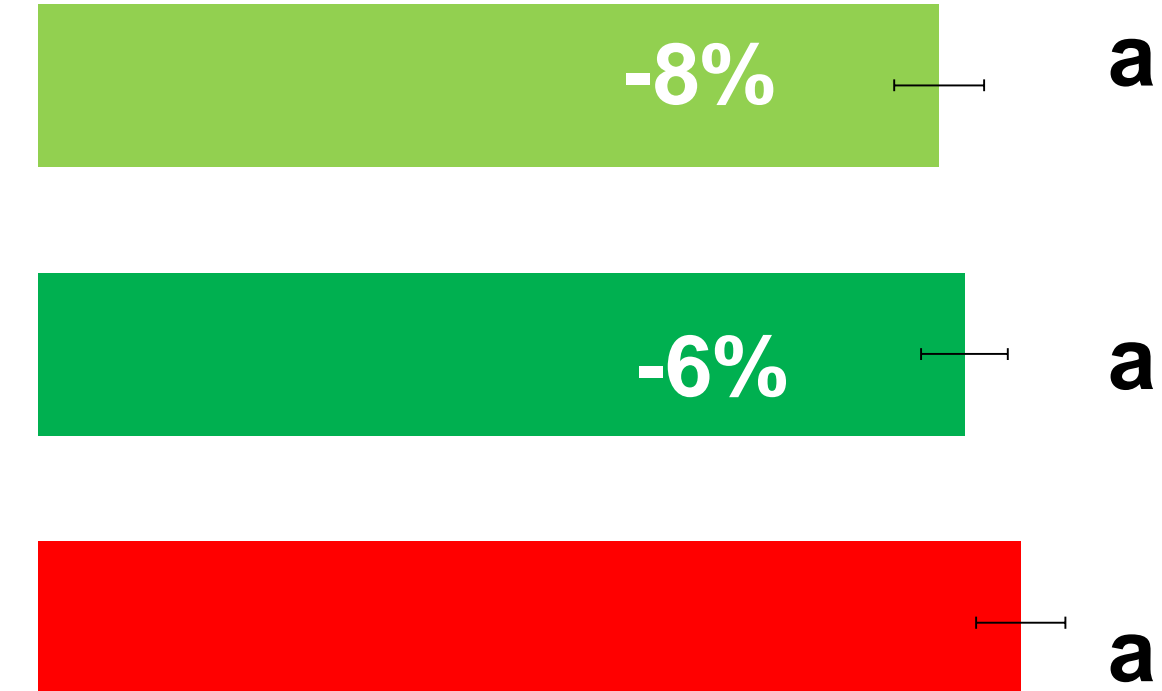
Black carbon (ng/m<sup>3</sup>)



Black carbon (ng/m<sup>3</sup>)



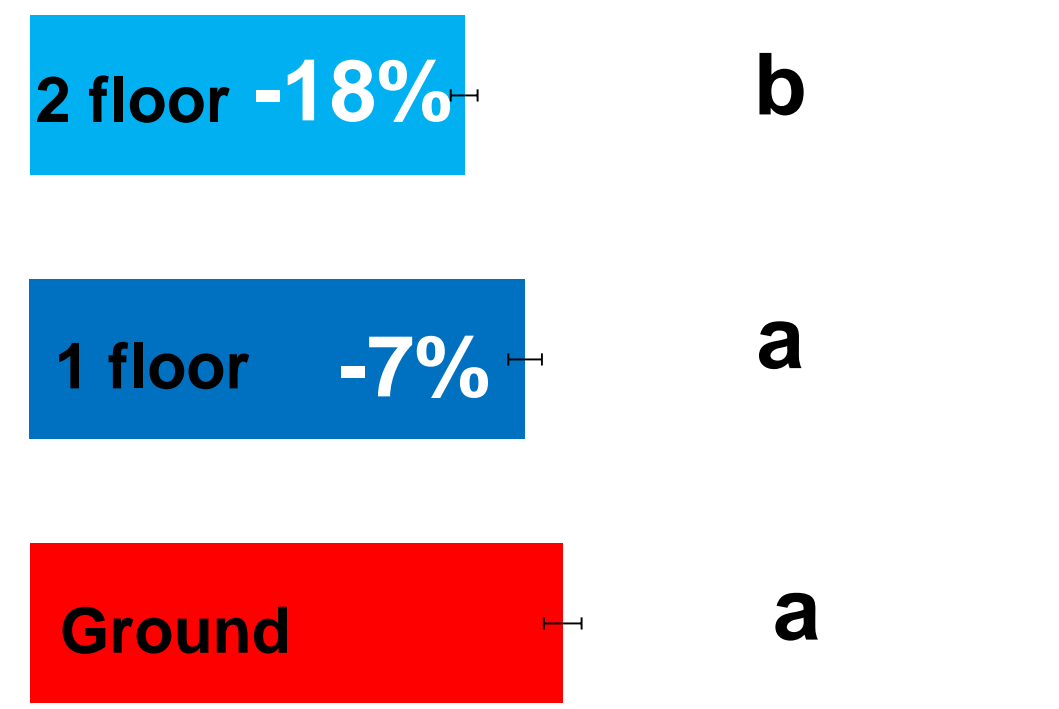
Black carbon (ng/m<sup>3</sup>)



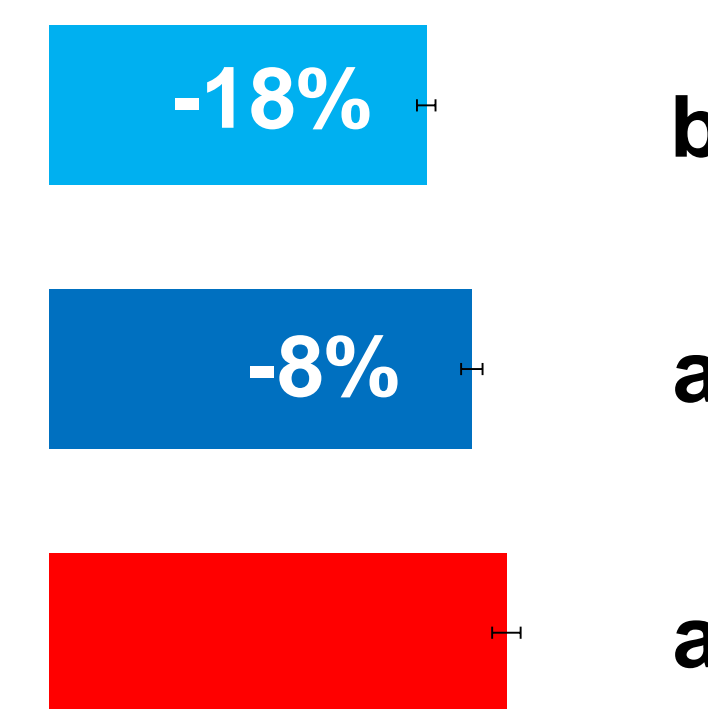
Trees reduce upward transport of vehicle emissions and increase air pollution within canopy

## Tafalla

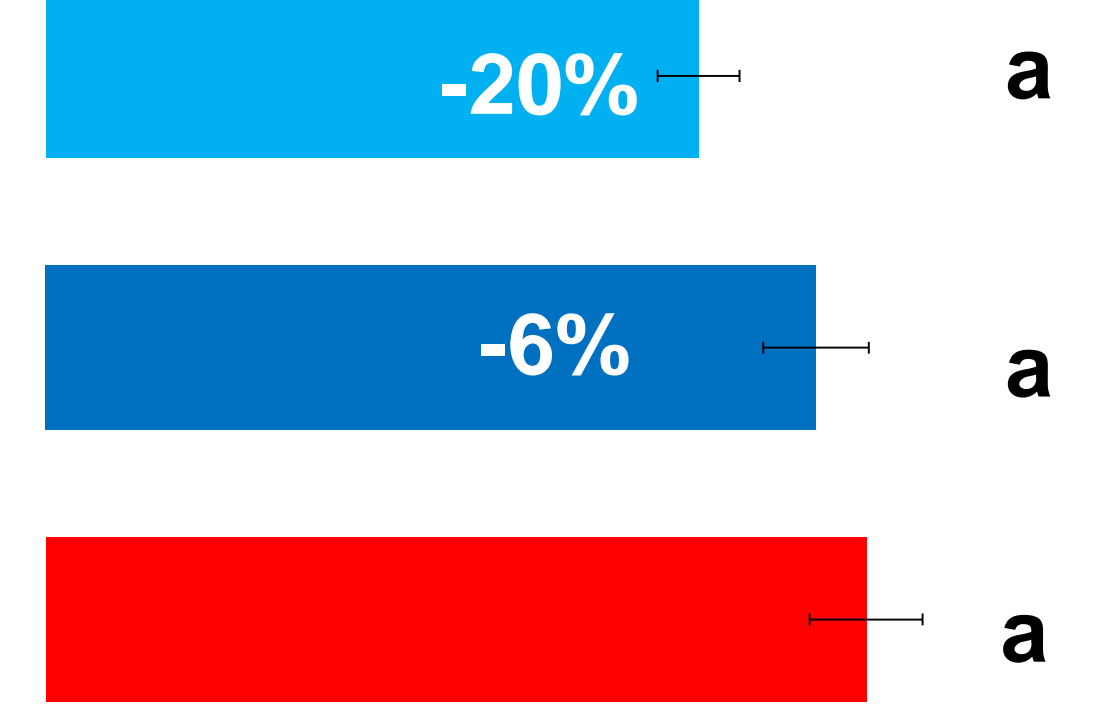
Black carbon (ng/m<sup>3</sup>)



Black carbon (ng/m<sup>3</sup>)



Black carbon (ng/m<sup>3</sup>)



Calm (<0.5 m/s)  
22%





## Urban vegetation and air quality

- ✓ Models are good tools to evaluate the effects of urban vegetation on air quality but experimental data are also needed
- ✓ Air pollutant concentrations decrease under vegetation canopy in areas with no emission sources
- ✓ Vegetal barriers are effective at reducing air pollutant exposure
- ✓ Attention!: trees reduce ventilation in street canyons with traffic and can worsen air pollution
- ✓ Urban vegetation represents a good strategy for reducing air pollution exposure in the cities, if **appropriate selection** of species and **good management** and **design** to guarantee **vitality**. BUT other strategies are needed for improving air quality: **reduce traffic!**



Thank you!  
Grazie!

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