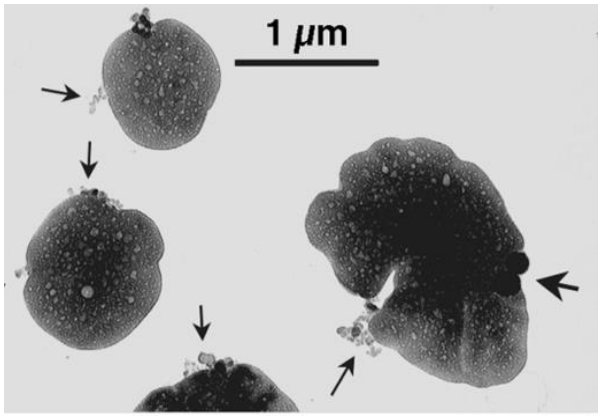


Modélisation de la pollution par le trafic à Bruxelles

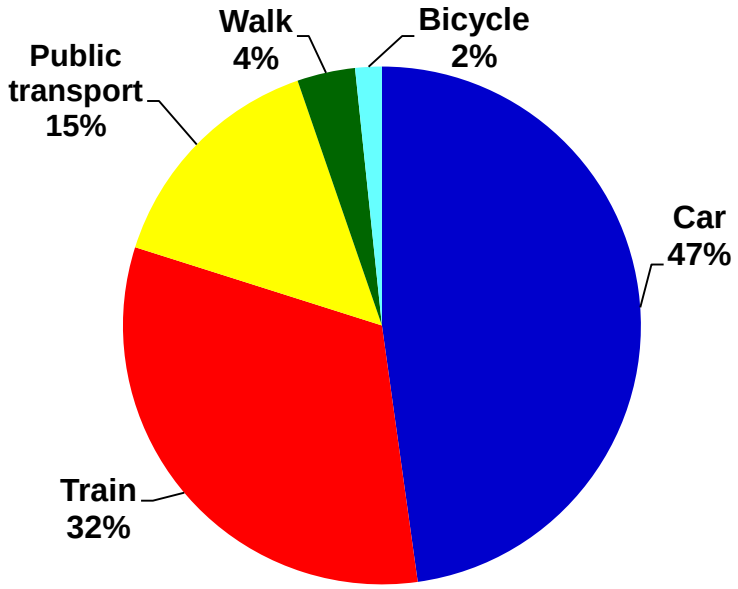
Priscilla Declerck, Thierri de Vos, Billie Heene, Olivier Brasseur

Laboratoire qualité de l'air - Bruxelles Environnement

EXTRACAR
9 May 2016, Liège

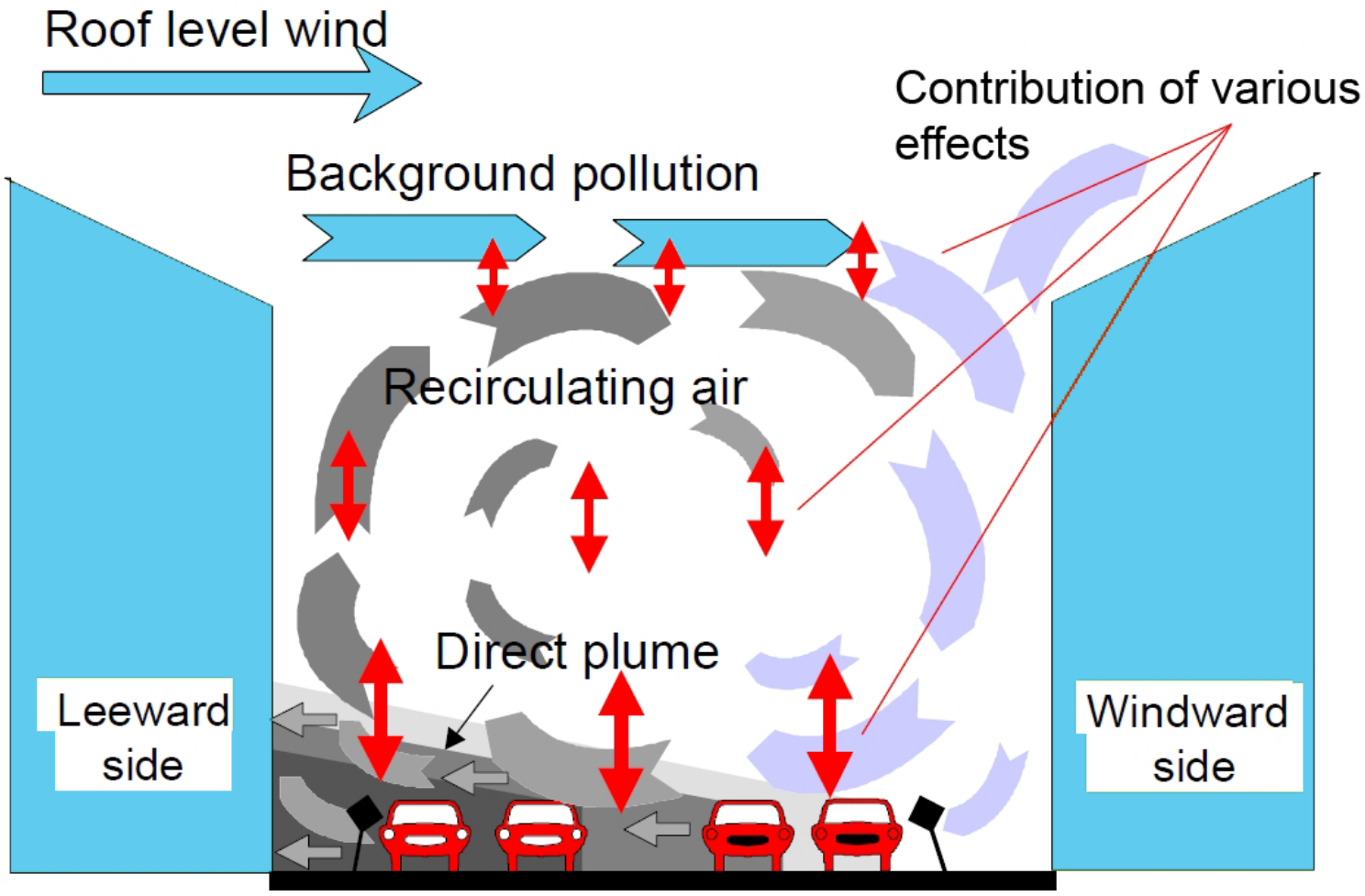
Introduction

- ✓ The Brussels-Capital Region:
  - A dense urban Region consisting of 19 municipalities
  - Approximately 1.1 million inhabitants
  - Population has grown fast over the last decade, and is still growing (+ 1.2%)
  - Economic heart of Belgium – more than 370.000 commuters enter the city every day
- ✓ Extremely dense transport network
  - ⇨ Traffic related air pollution
  - ⇨ Challenges concerning mobility



CANyon Street model for Black Carbon ($CANS_{BC}$)

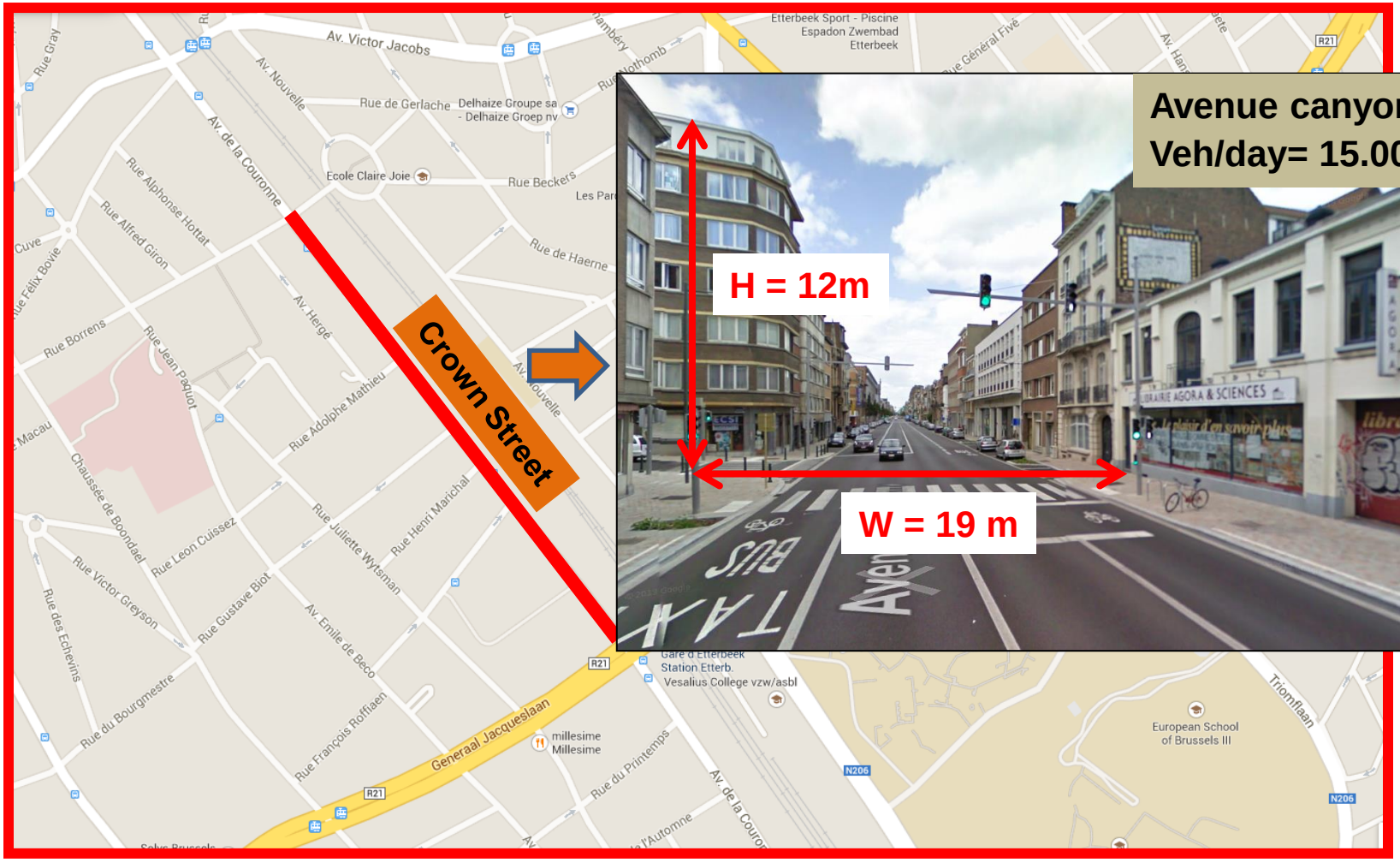
based on the approach of the Operational Street Pollution Model (OSPM)



- ✓ $CANS_{BC}$: no chemical module
- ✓ Input data:
  - Meterological data:
    - ➢ Wind direction
    - ➢ Wind velocity

    } @ a height of 30m (Molenbeek)
  - Urban background:
    - ➢ BC conc. from the urban background station of Uccle
  - Traffic emissions
    - ➢ Depending on vehicle countings
    - ➢ Temporal resolution of 15'
    - ➢ Vehicle speeds were kept constant

Direct validation: the Crown Street


Crown Street
Avenue canyon
Veh/day= 15.000
H = 12m
W = 19 m
Av. Victor Jacobs
Av. de la Couronne
Rue de Gerlache
Delhaize Groupe sa - Delhaize Groep nv
Ecole Claire Joie
Rue Beckers
Rue de Haerne
Rue Alphonse Hottat
Rue Alfred Giron
Rue Borrens
Av. Hergé
Rue Adolphe Mathieu
Rue Jean Paquot
Chaussée de Boondael
Rue Léon Cuissez
Rue Victor Greyson
Rue Gustave Biot
Rue Juliette Wytsman
Rue Henri Maréchal
Av. Emile de Beco
Rue des Echevins
Rue du Bourgmestre
Rue François Roffiaen
Generaal Jacqueslaan
millesime
Millesime
Rue du Printemps
Av. de la Couronne
Etterbeek Sport - Piscine
Espadon Zwembad
Etterbeek
Gare d'Etterbeek
Station Etterb.
Vesalius College vzw/asbl
European School of Brussels III
Triomflaan
R21
N206
librairie
AGORA
LIBRAIRIE AGORA & SCIENCES
TAXI
BUS

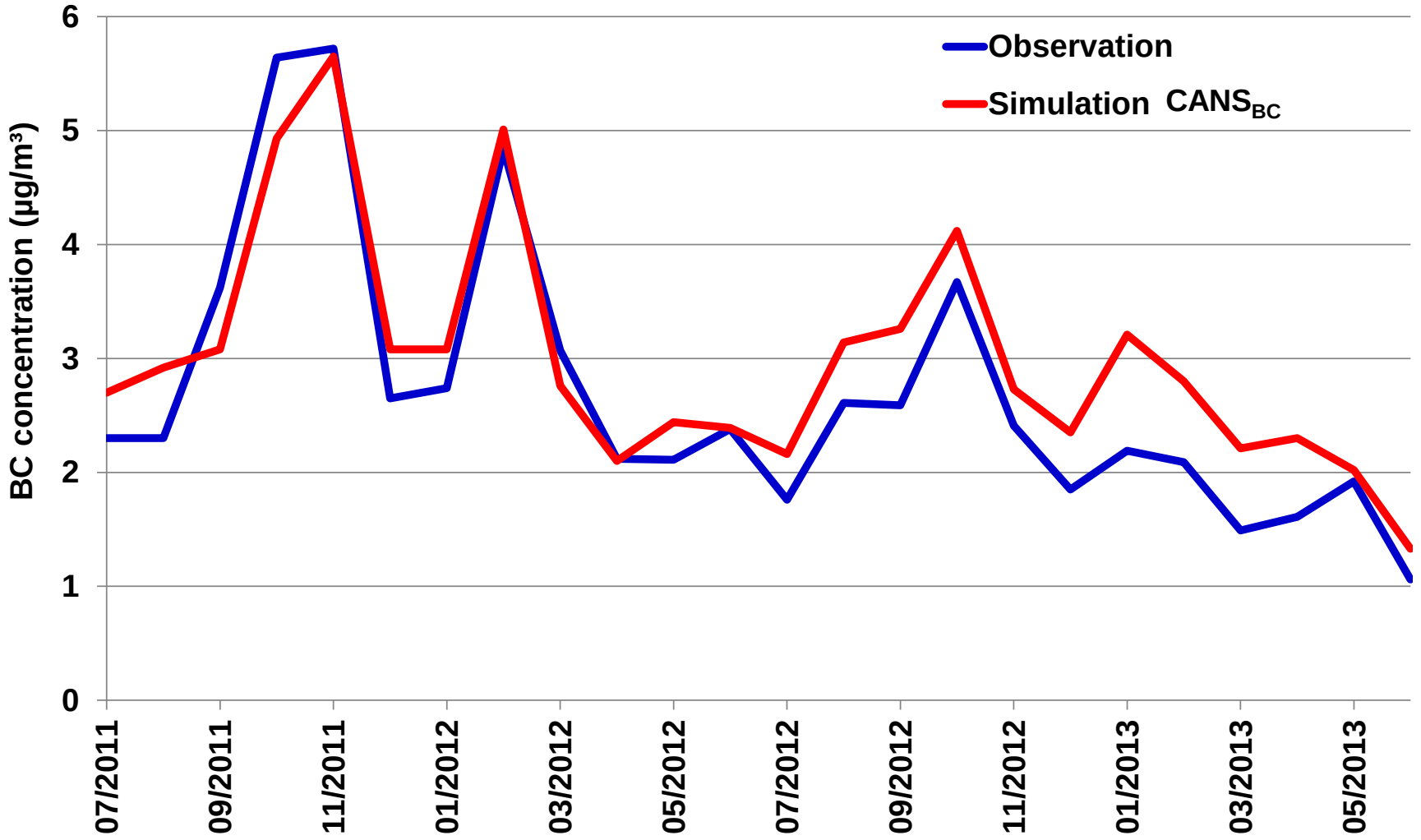
✓ AIMS

- Monthly evolution: variable meteorological conditions
- Half-hourly evolution: variable traffic emissions
- Sensitivity to the wind direction: capability of estimating the local contribution to BC concentrations

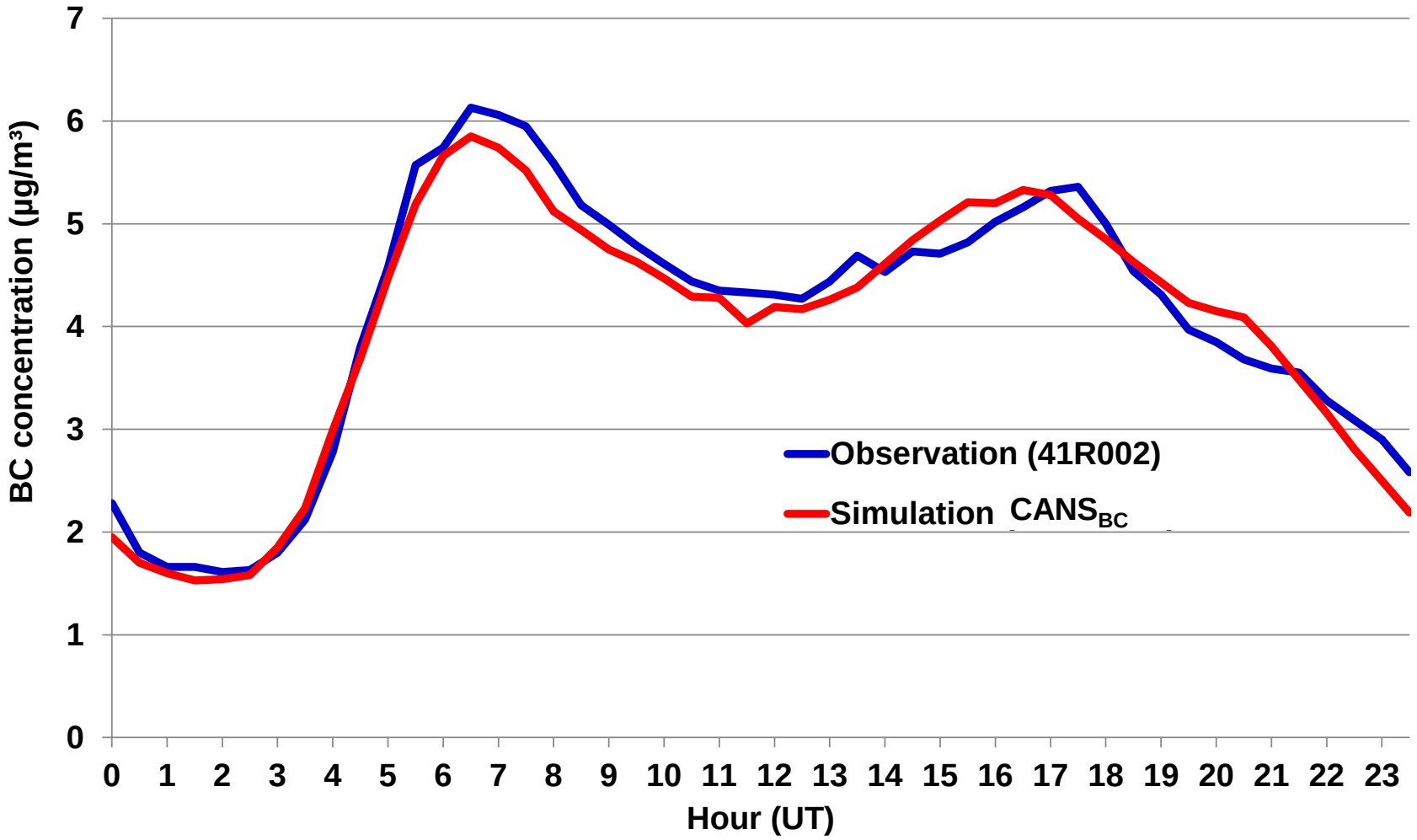
✓ Specifications

- Two years simulation period: 7/2011 – 6/2013
- Observed BC concentrations: fixed BC measurement station in the Crown Street
- Simulated BC concentrations: $CANS_{BC}$

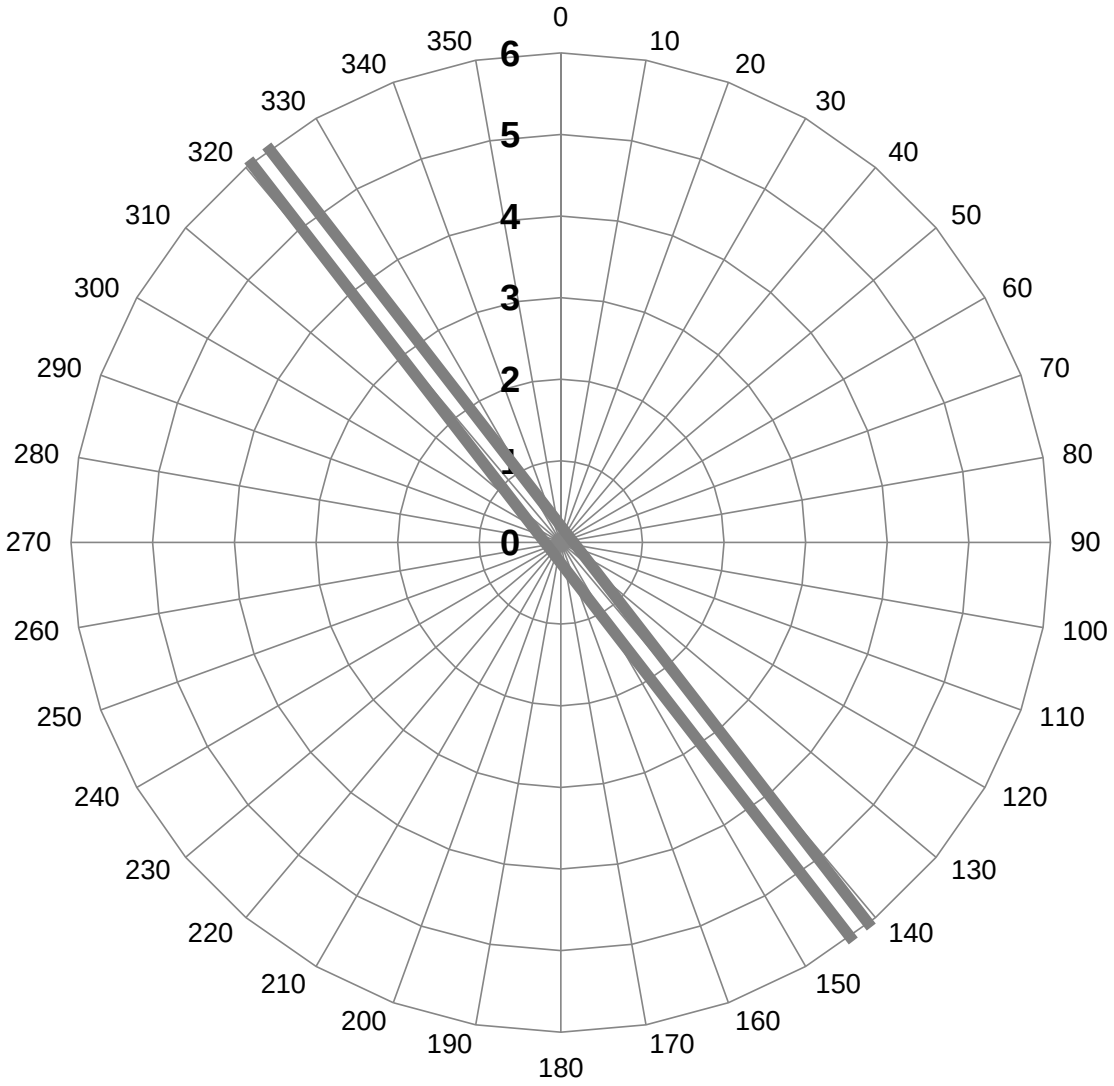
Monthly evolution



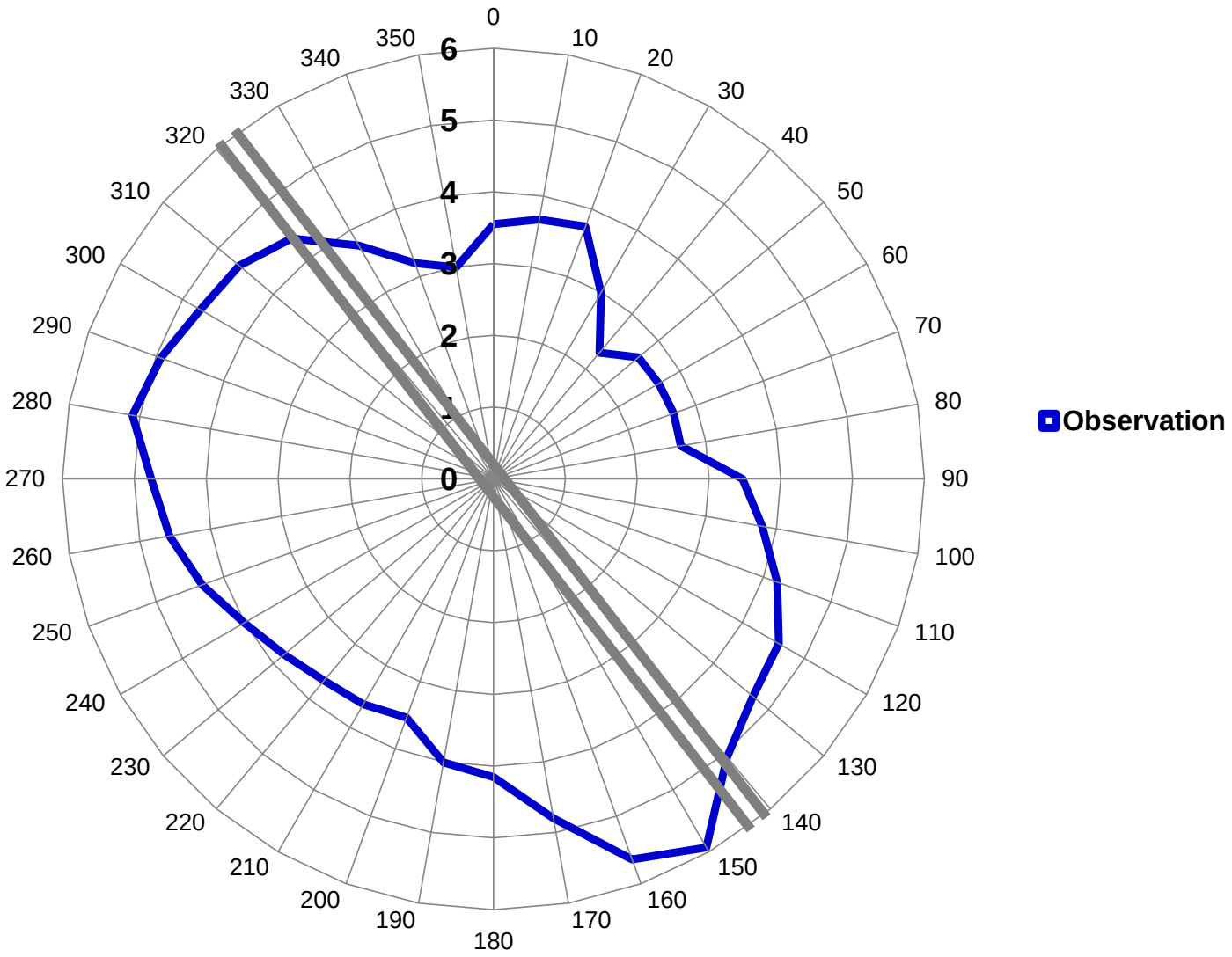
Diurnal evolution



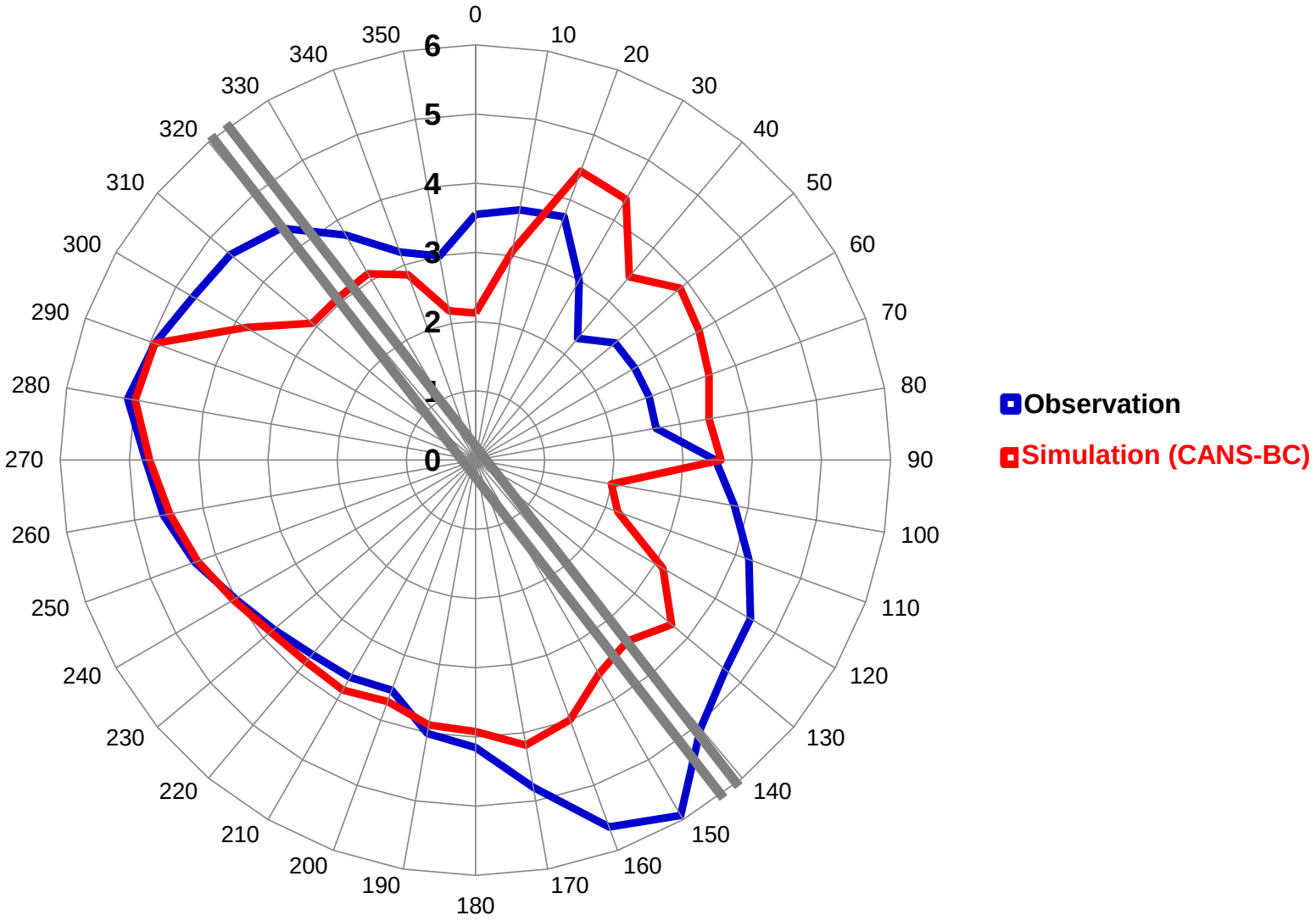
Sensitivity to wind direction



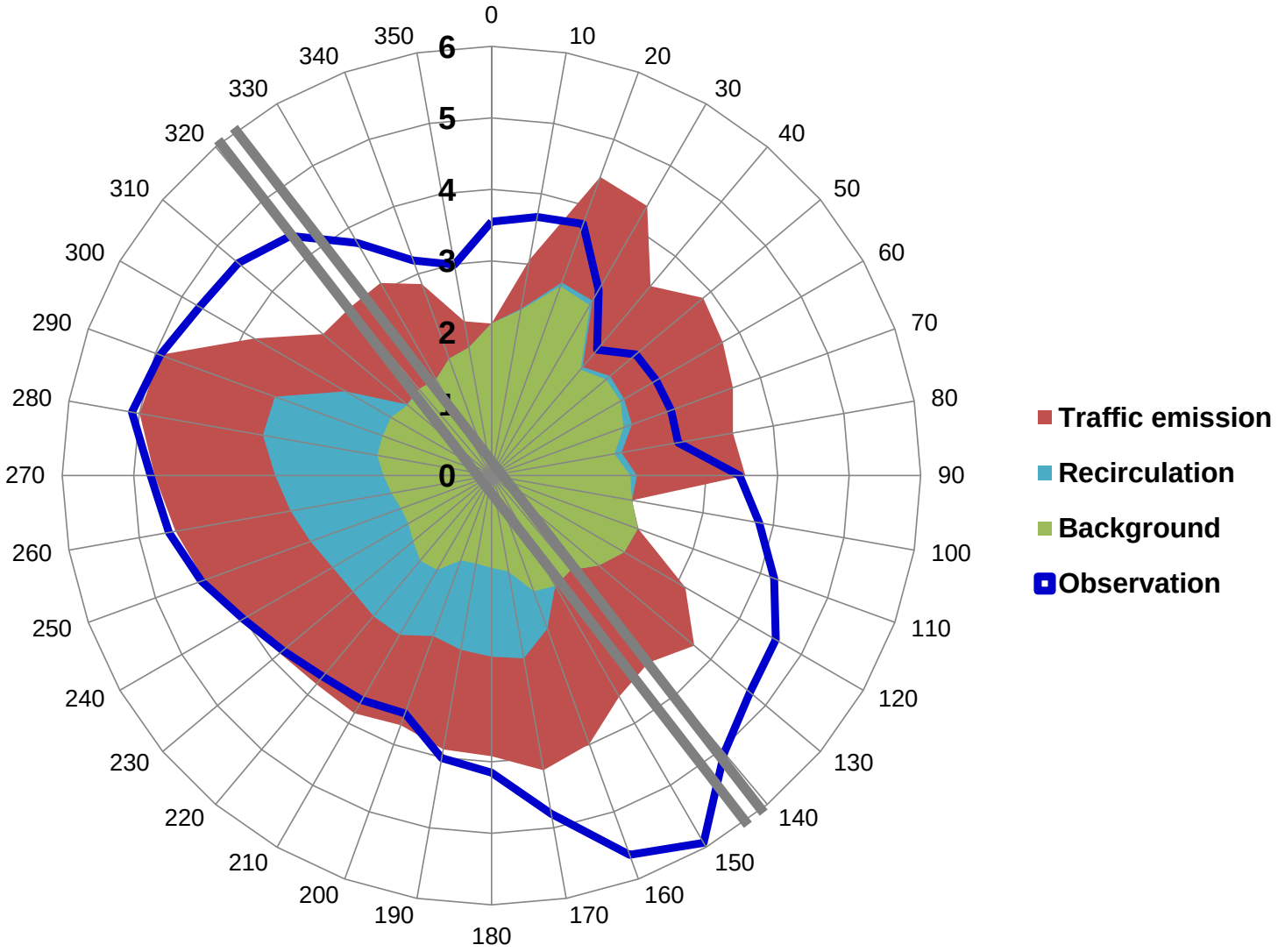
Sensitivity to wind direction



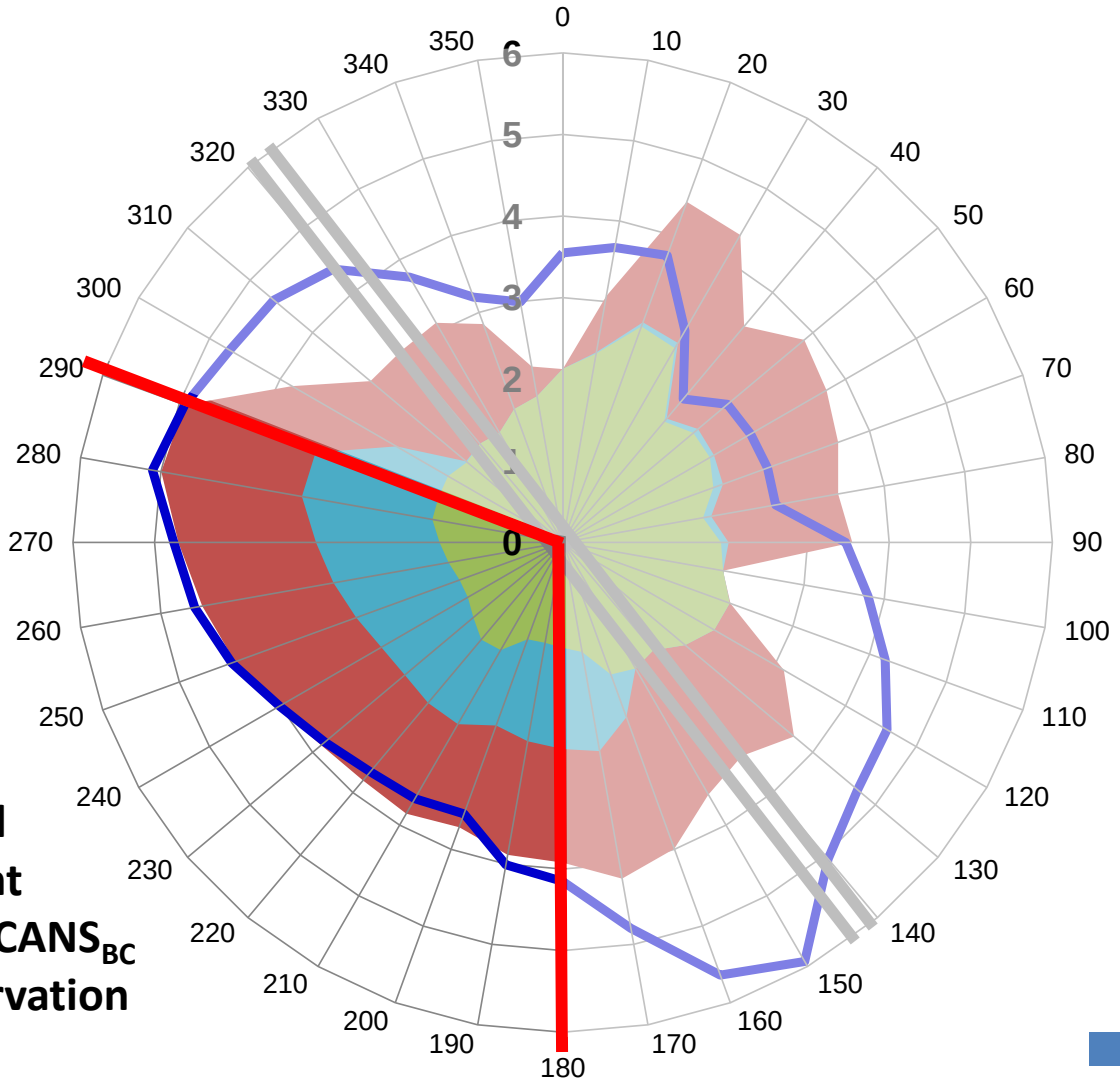
Sensitivity to wind direction



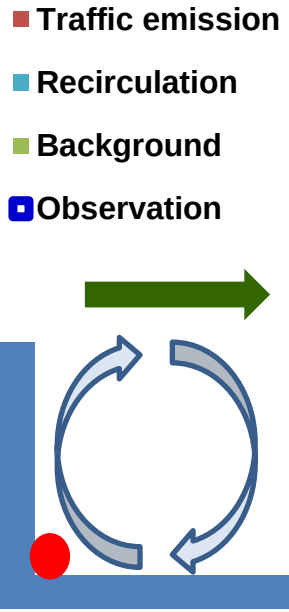
Sensitivity to wind direction



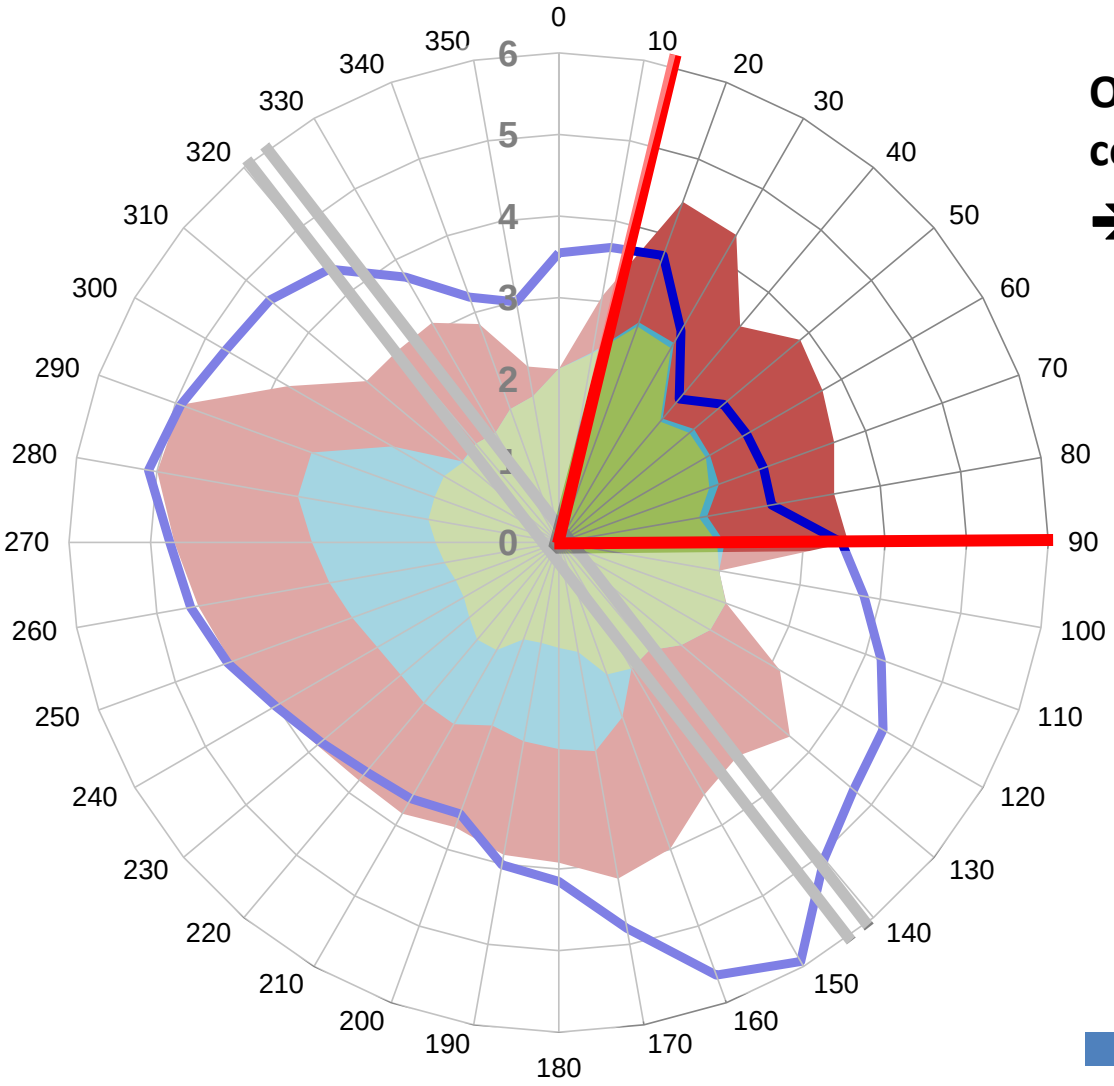
Sensitivity to wind direction



Very good agreement between CANS$_{BC}$ and observation



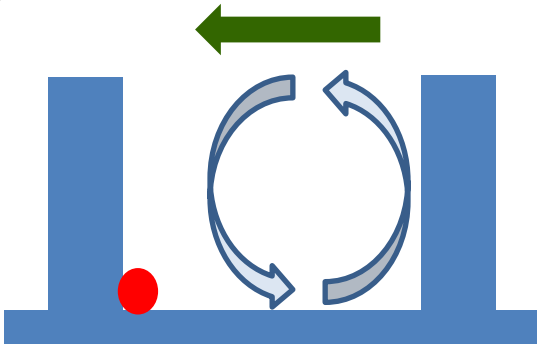
Sensitivity to wind direction



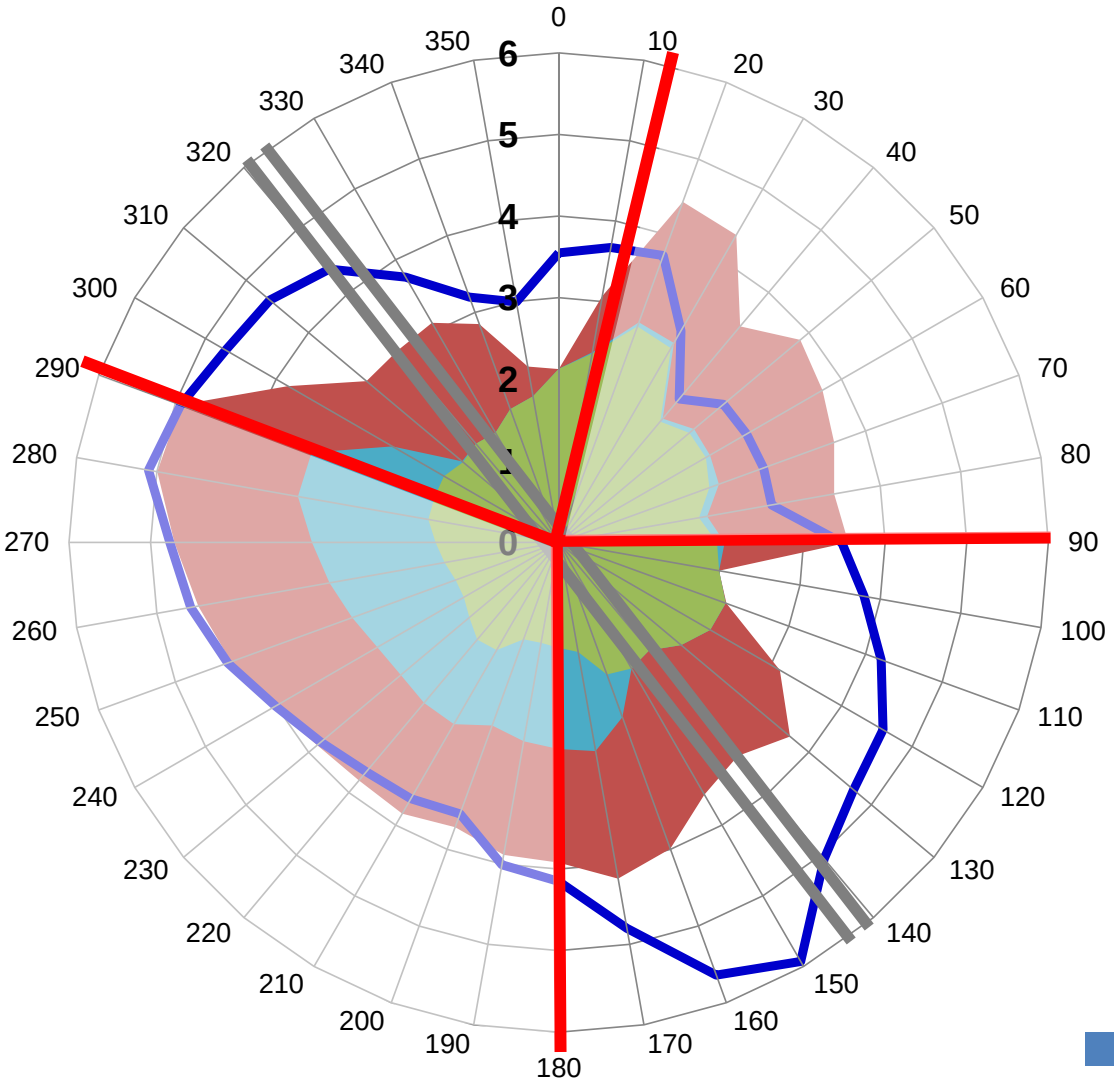
Overestimated BC concentrations

➔ **overestimated local contribution**

- **Traffic emission**
- **Recirculation**
- **Background**
- **Observation**



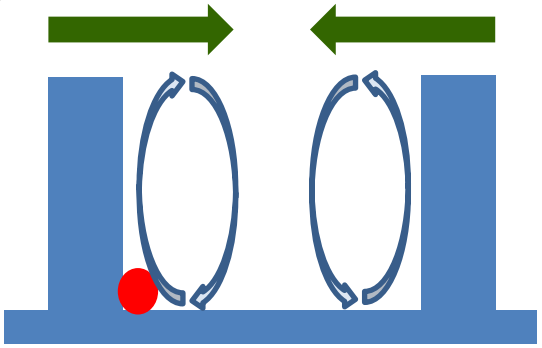
Sensitivity to wind direction



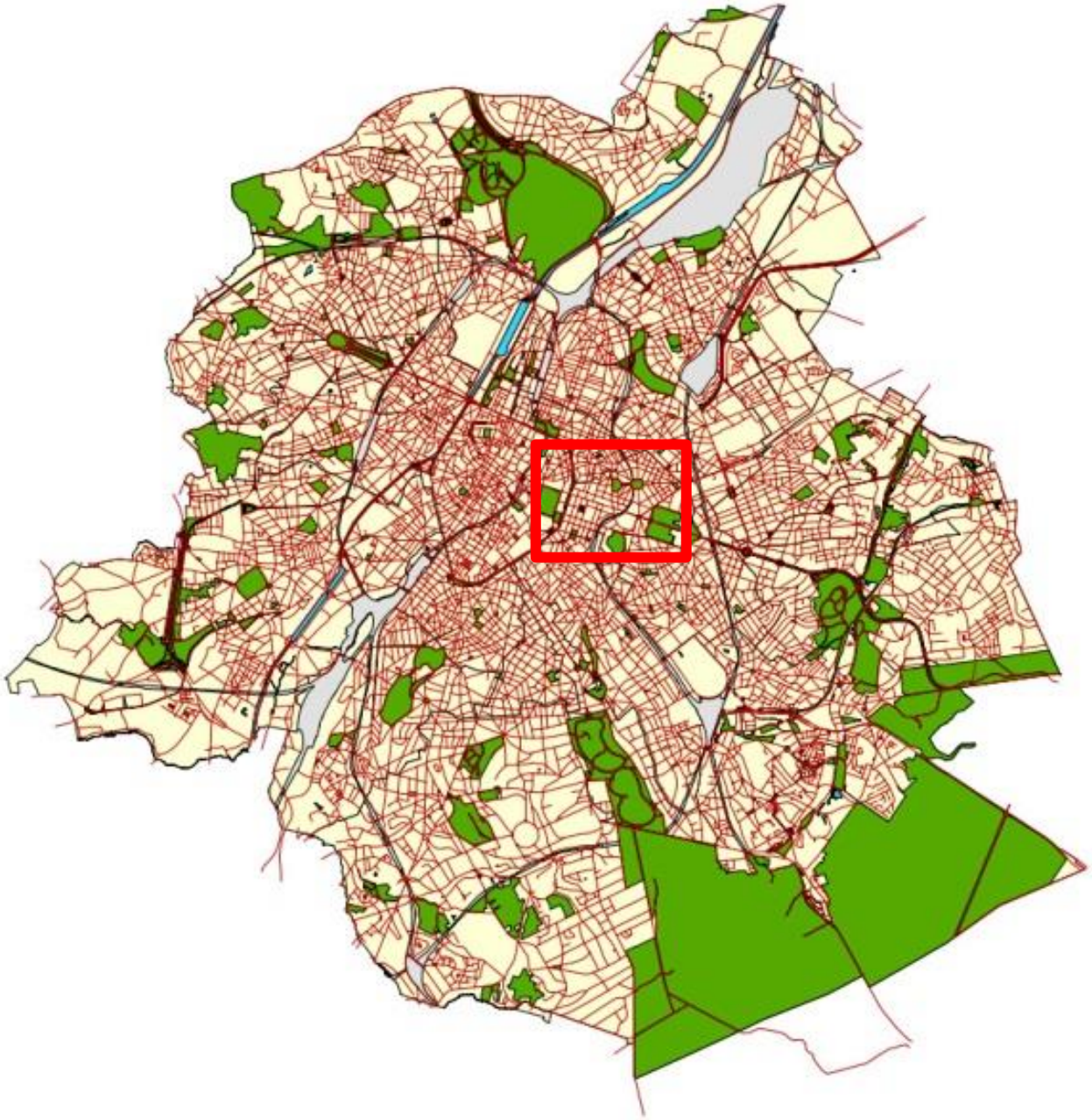
Underestimated BC concentrations

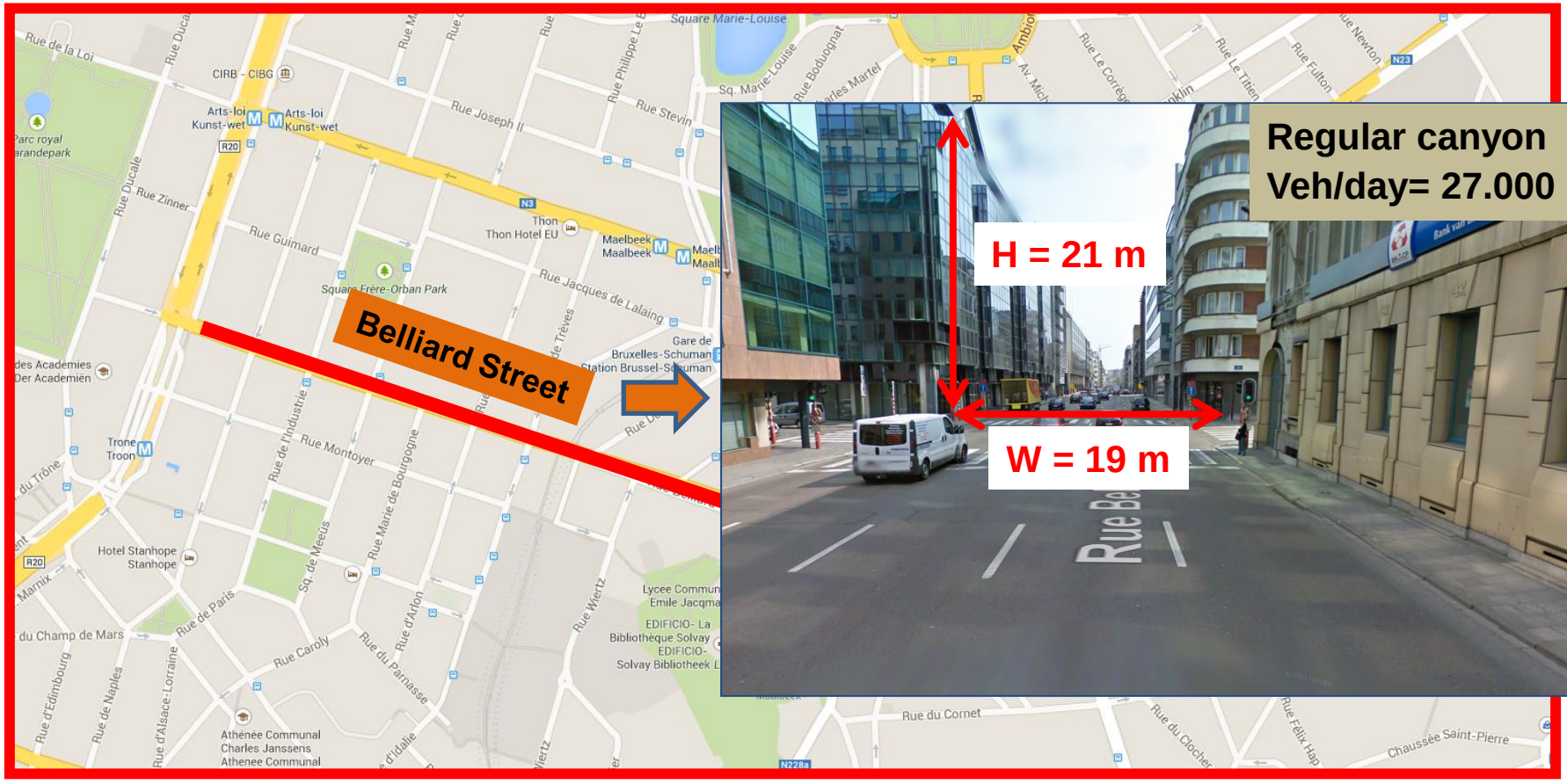
➔ **too weak recirculation and local contribution?**

- **Traffic emission**
- **Recirculation**
- **Background**
- **Observation**



Indirect validation: the Belliard street




Belliard Street
Regular canyon
Veh/day= 27.000
H = 21 m
W = 19 m
Square Marie-Louise
CIRB - CIBG
Arts-loi
Kunst-wet
Rue Joseph II
Rue Stevin
Rue Ducale
Rue Zinner
Rue Guimard
Thon
Thon Hotel EU
Maelbeek
Square Frère-Orban Park
Rue Jacques de Lalaing
Gare de Bruxelles-Schuman
Station Brussel-Schuman
Trone
Troon
Rue Montoyer
Rue de l'Industrie
Hotel Stanhope
Stanhope
Rue de Paris
Rue Caroly
Rue du Parnasse
Rue d'Arlon
Rue Wiertz
Rue du Cornet
Chaussée Saint-Pierre
Athénée Communal
Charles Janssens
Athenee Communal

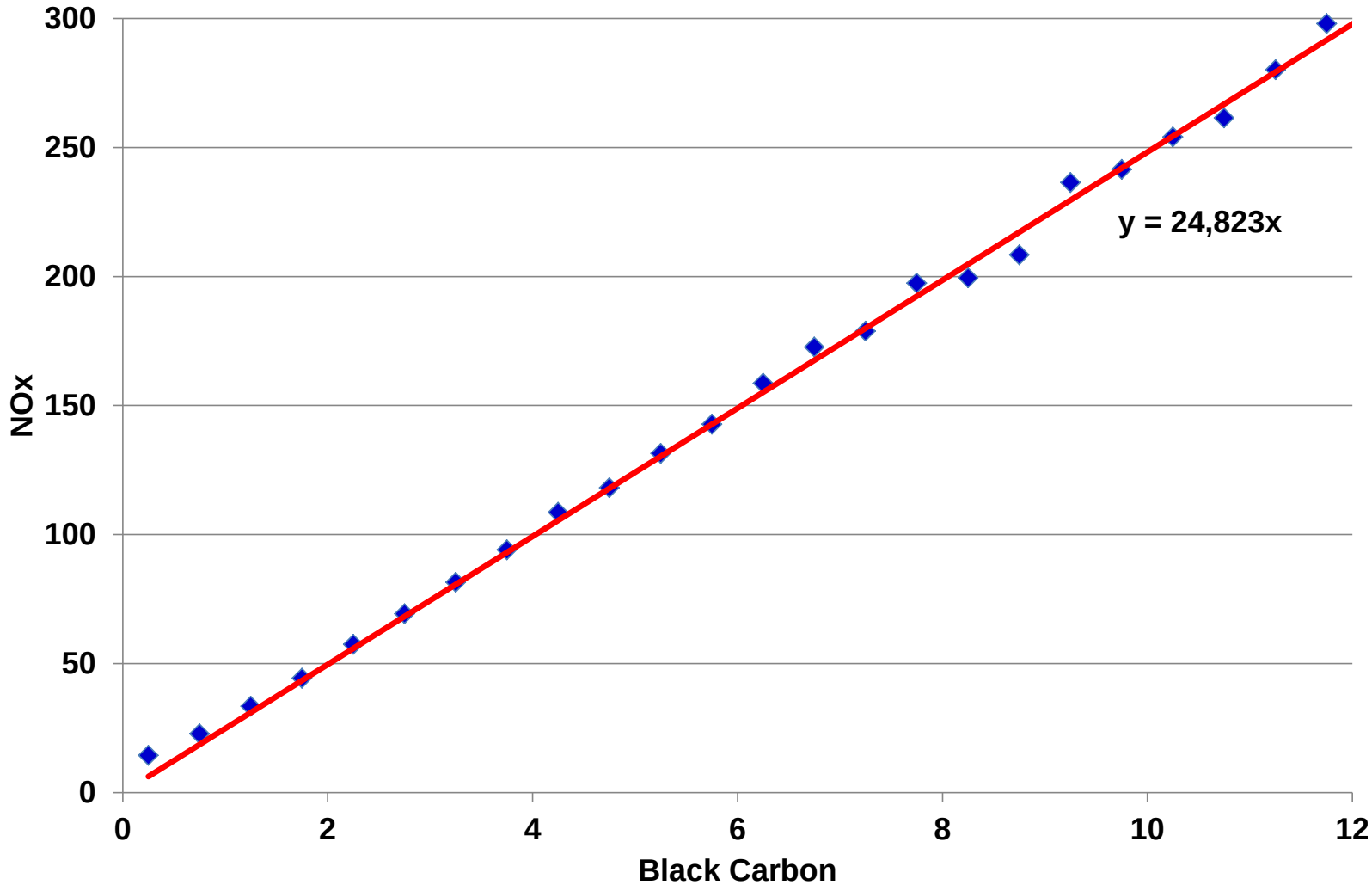
✓ AIM

- Validate simulated BC concentrations based on the linear relation between BC and NOx

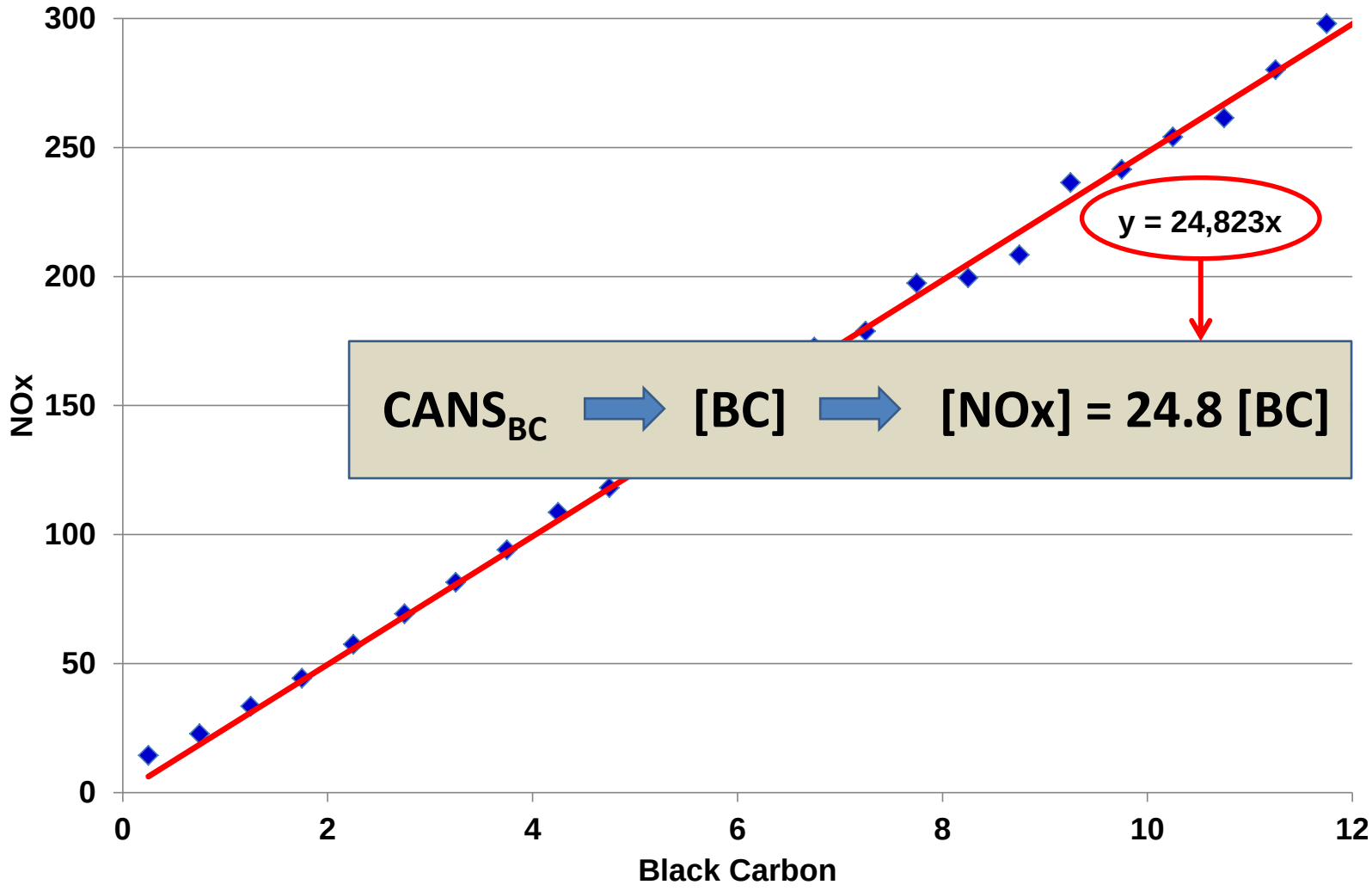
✓ Specifications

- Simulation period: 11/2012 – 6/2013
- Observed NOx concentrations: fixed NOx measurement station in the Belliard Street
- Simulated BC concentrations: $CANS_{BC}$

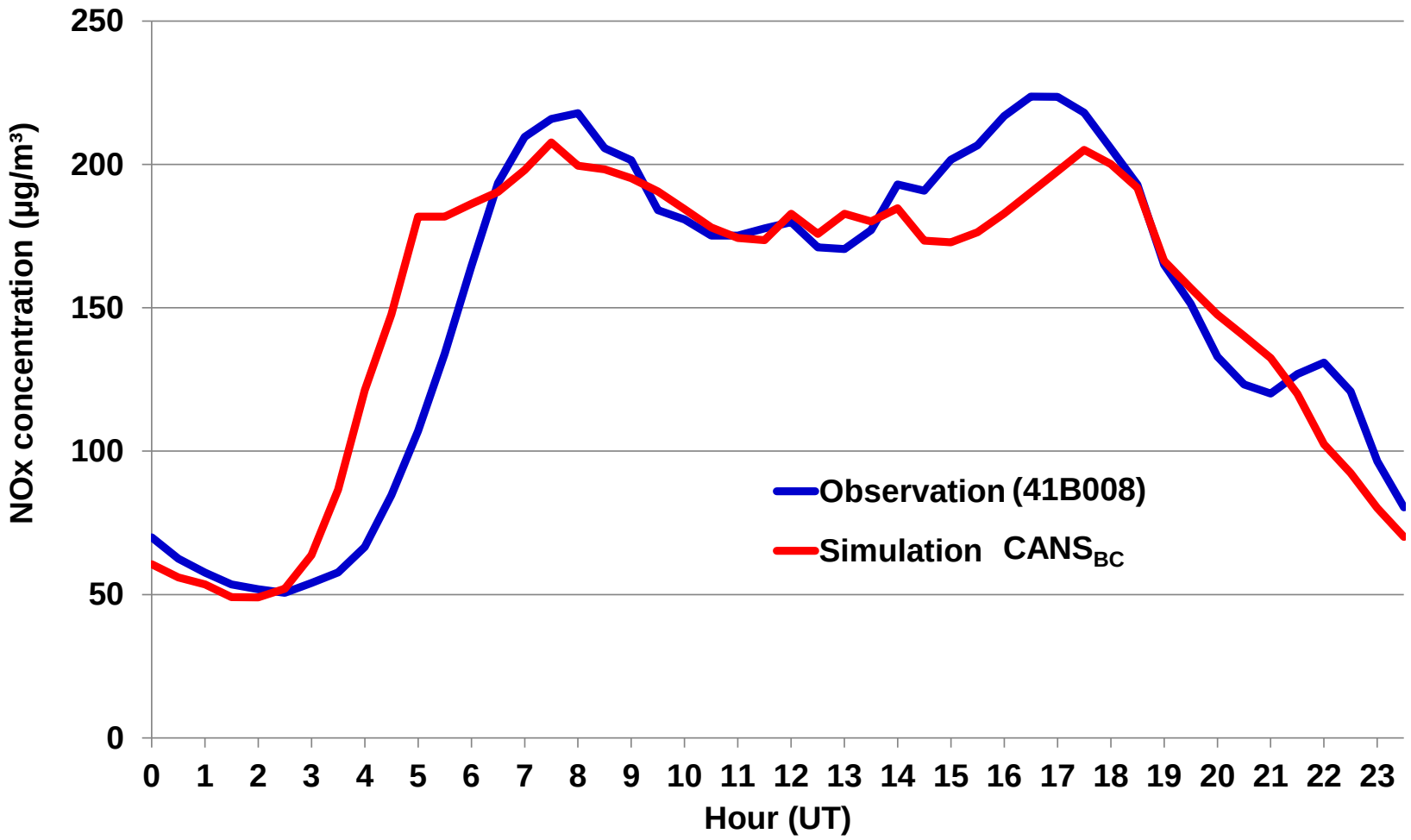
Relation between BC and NOx



Relation between BC and NOx



Diurnal evolution



Direct validation: the Boulevard Anspach


Boulevard Anspach
Avenue canyon
Veh/day= 14.000
H = 22m
W = 27m
Église Sainte-Catherine
Sint-Katelijnekerk
Place Sainte-Catherine
Sint-Katelijneplein
De Brouckère
European Union
Rue du Fossé aux Loups
Rue de la Braie
Rue des Chartreux
Fin de siècle
Rue Van Artevelde
Rue des Pierres
Rue du Lombard
Rue de la Violette
Rue du Midi
Manneken Pis
Rue des Bogards
Rue Duquesnoy
Gare de Bruxelles-Central
Brussel Centraal
Cantersteen
Rue des Sols
Mont des Arts
Kunstberg
Galerie Ravenstein
Google

- ✓ AIMS
  - Sidewalk: left vs right

- ✓ Specifications
  - Simulation period: 18 days at rush hours (morning and evening)
  - Observed BC concentrations: mobile BC measurement using AE51 aethalometer
  - Simulated BC concentrations: $CANS_{BC}$

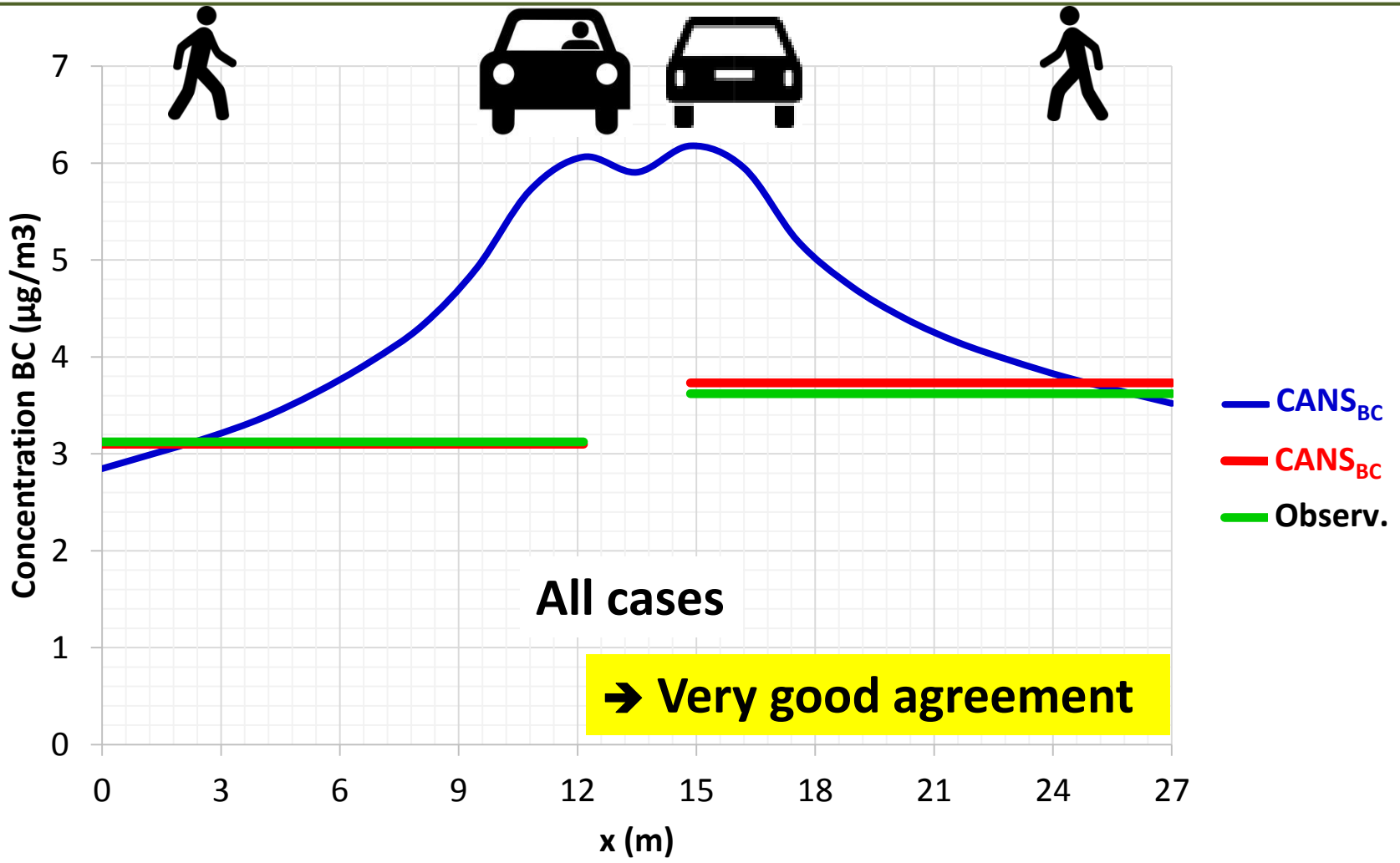
Sidewalk: left vs right

Spatial variations of BC concentrations along sidewalk

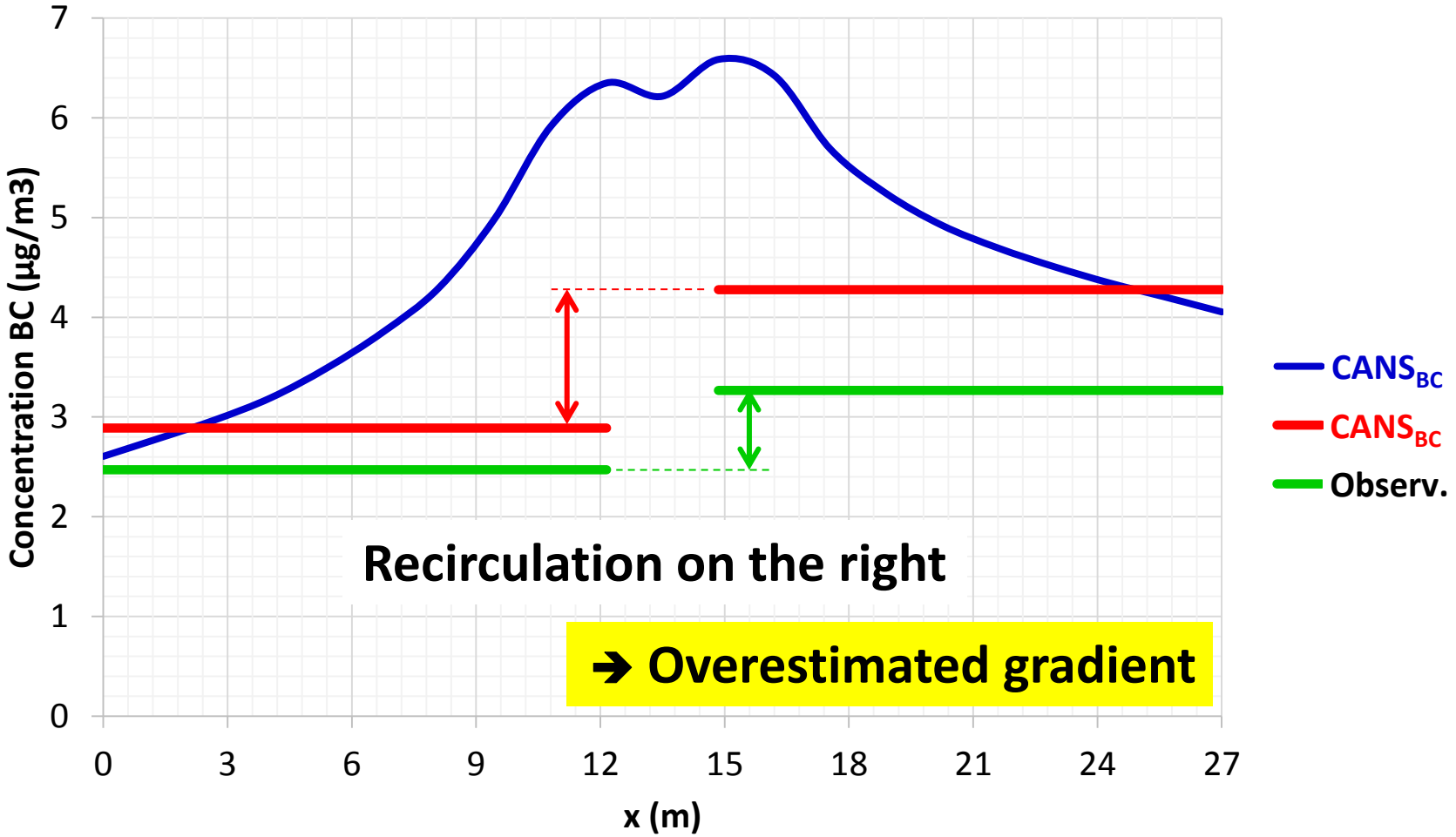
Stop/start at traffic lights

Consider
« averaged sidewalk »

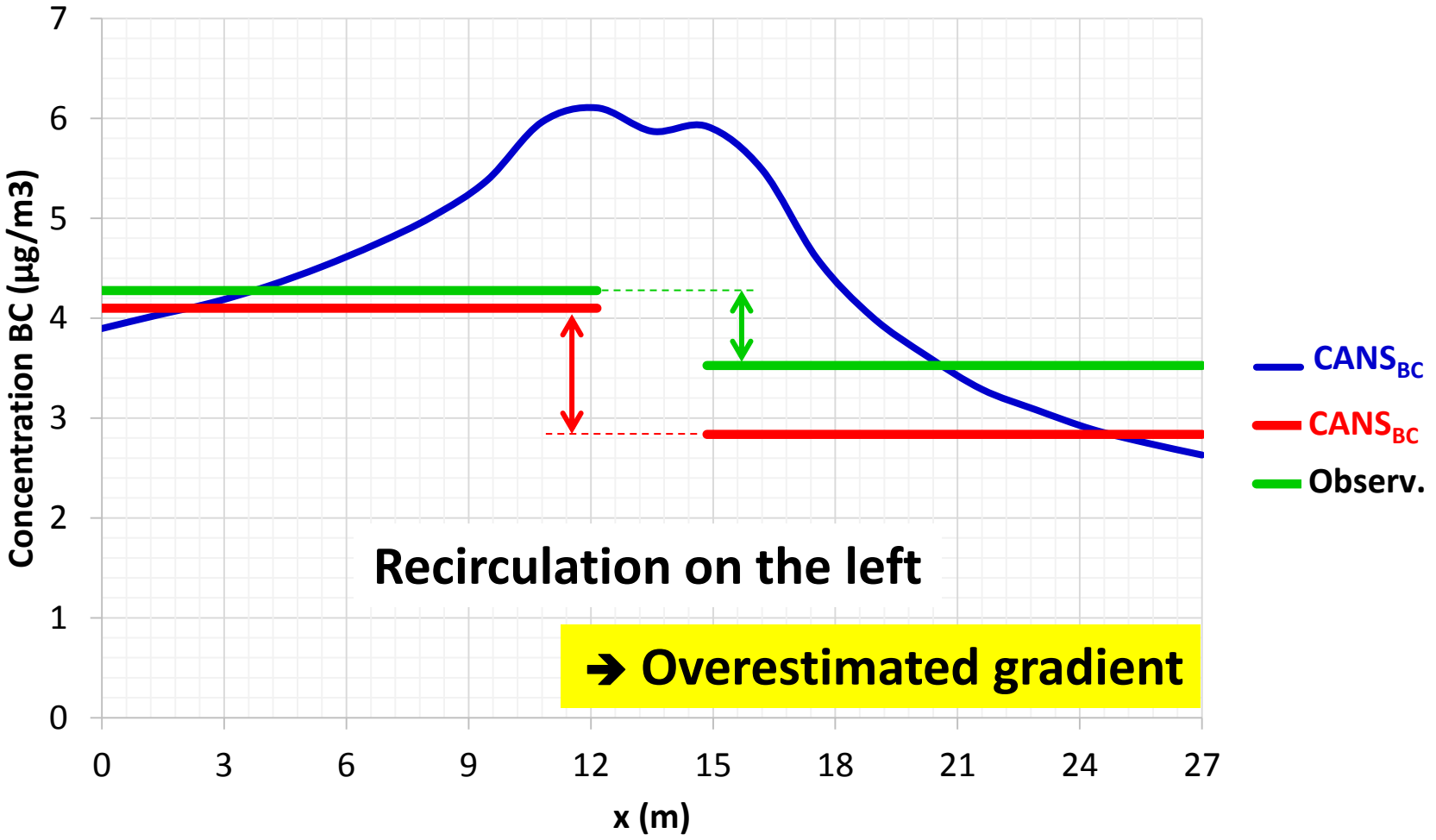
Sidewalk: left vs right



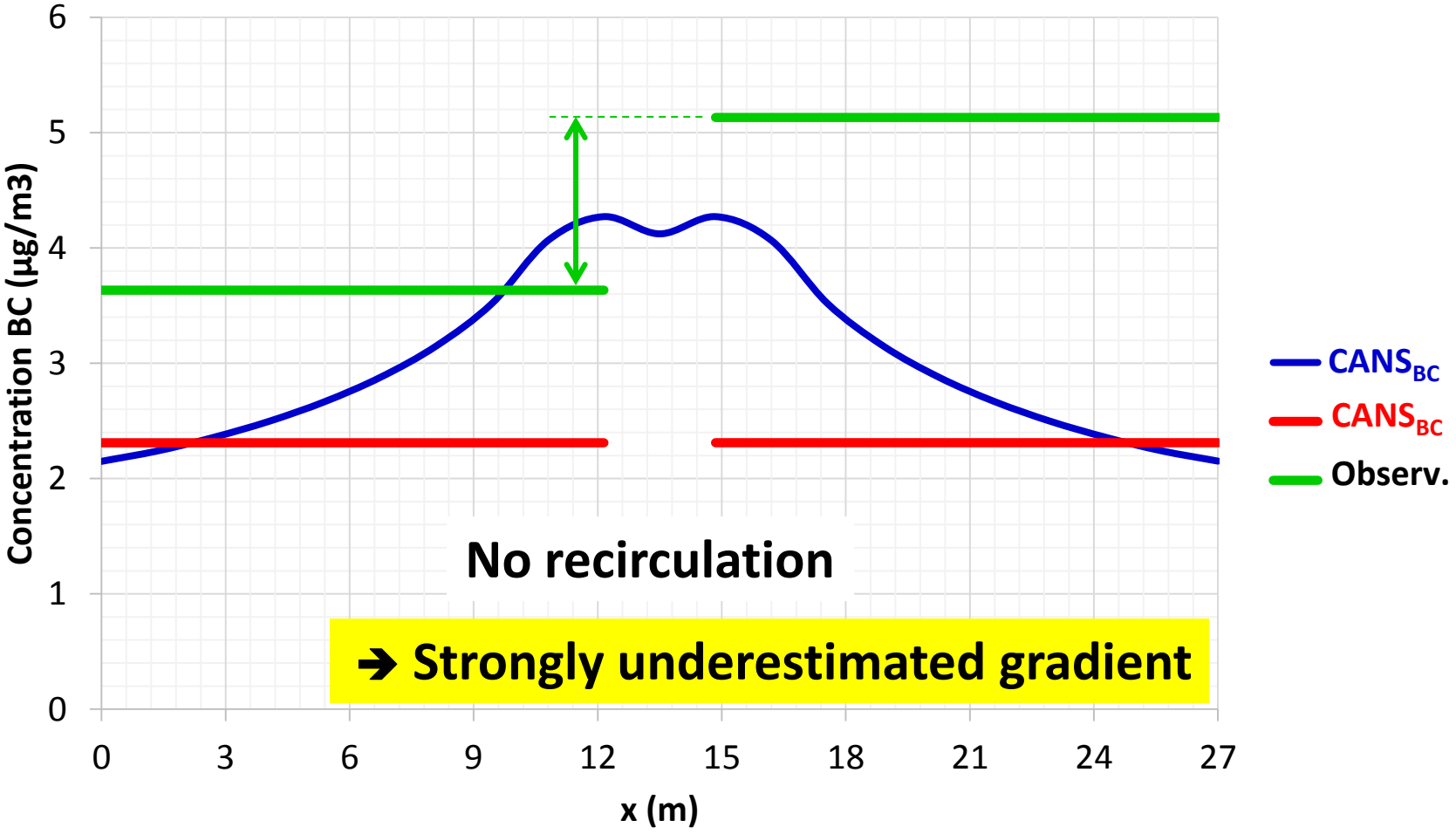
Sidewalk: left vs right



Sidewalk: left vs right



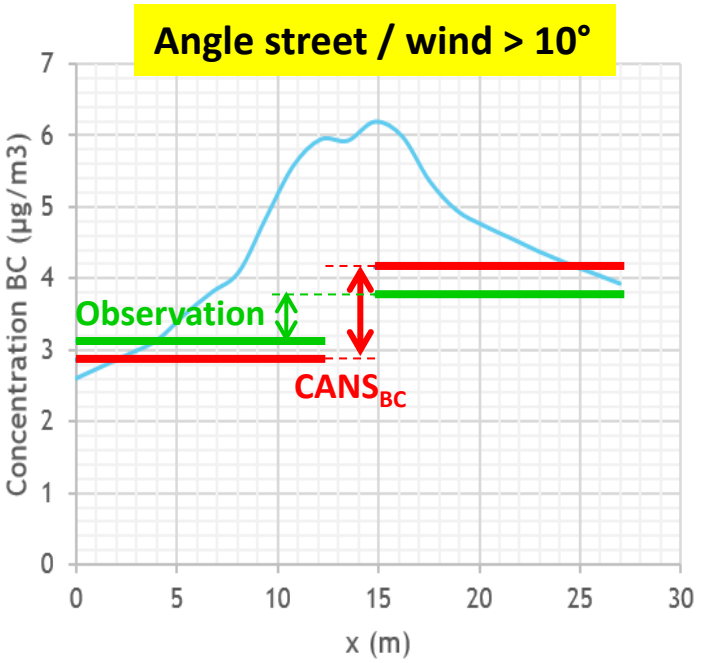
Sidewalk: left vs right

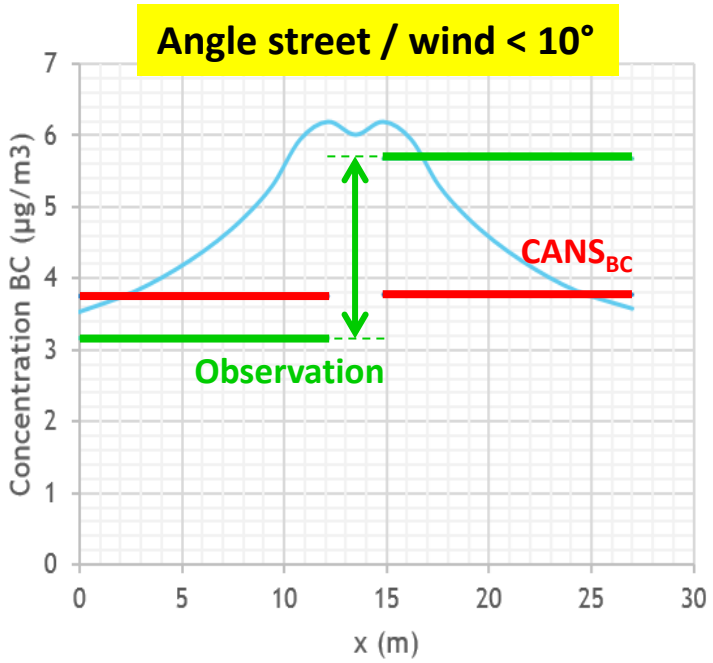


Sidewalk: left vs right

No recirculation if:

- **Weak wind (< 2 m/s) : left/right gradient correctly simulated**
- **Wind direction close to street axis:**





Conclusions

✓ Validation tests showed that $CANS_{BC}$:

- Performs well **at annual scale** in simulating average **monthly and diurnal BC evolutions**

⇨ The model correctly handles:

- the **meteorological conditions**
- the variation in **traffic emissions**

- Is suitable to accurately simulate BC concentrations in canyon streets of the BCR if:
  - Accurate estimate of traffic emissions (counting, driving mode, emission factors, …)
  - Vehicle speeds → turbulence generated by vehicles

- Able to simulate the **gradient of BC concentration between left and right sidewalks** …

  … but **improvements are needed** when the wind direction is close to the street axis.

Thank you for your attention