IPENZ Transportation Conference
14th-17th March, 2010, Christchurch

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CHRISTCHURCH NEW ZEALAND

The impact of choice of transport mode on personal pollution exposure

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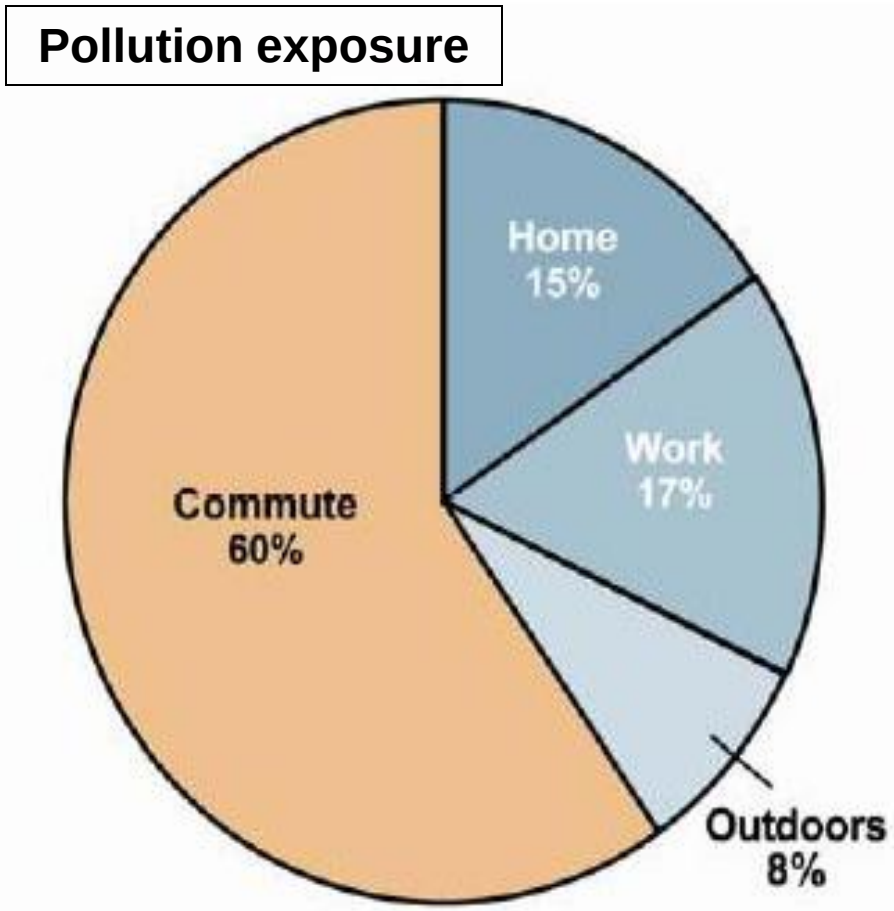
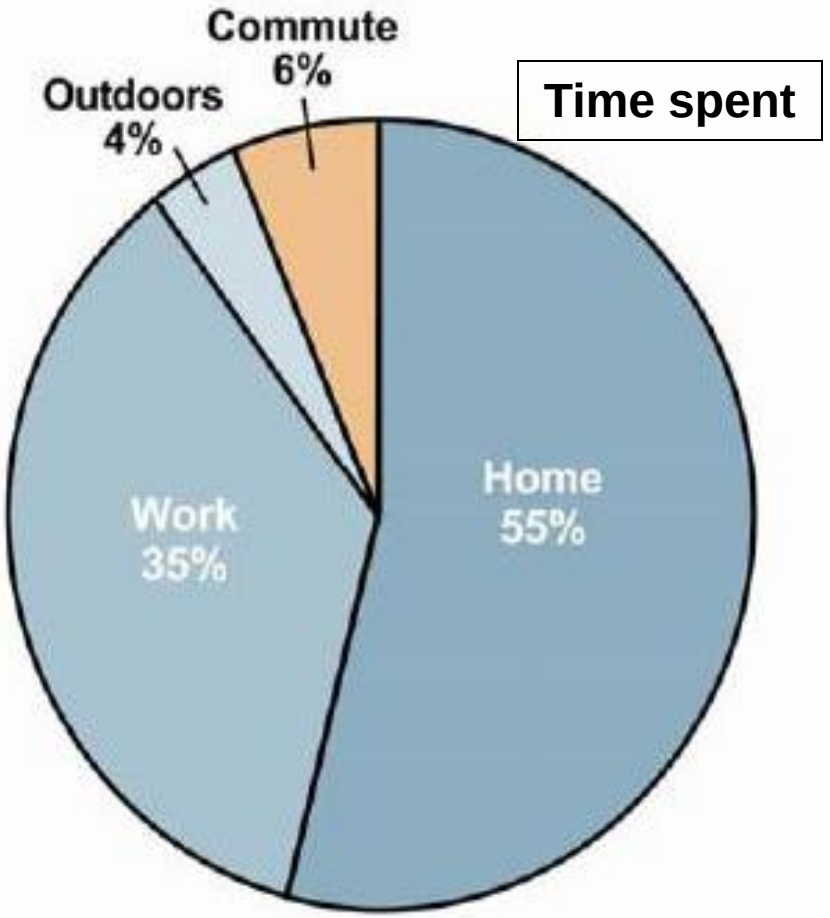
Travel choice and pollution exposure

- Does how you choose to travel affect how much pollution you are exposed to?
  - Exposure is the quality of air around you, not how much you actually breathe in (dose)

- Which is worst?
  - Car
  - Bus
  - Train
  - Bike

Transport & daily personal pollution exposure





(CATF 2008)

Major Findings

- Most studies show car occupant exposure is higher than ambient concentrations & than train, bus, cycling & walking exposure
  - Wiesel *et al*, 1992; Gennart *et al*, 1994; Kingham et al 1998; van Wijnen & van der Zee, 1998; Chertok *et al,* 2004, Boogaard *et al,* 2009
- Some studies report lower levels in cars
  - Kaur *et al*, 2005; Mackay, 2004; Briggs *et al*, 2008

Why?

- Why?
- What about NZ?
  - Fleet composition
  - Vehicle ventilation
  - Proximity of modes
  - Route location & choice

exposure project

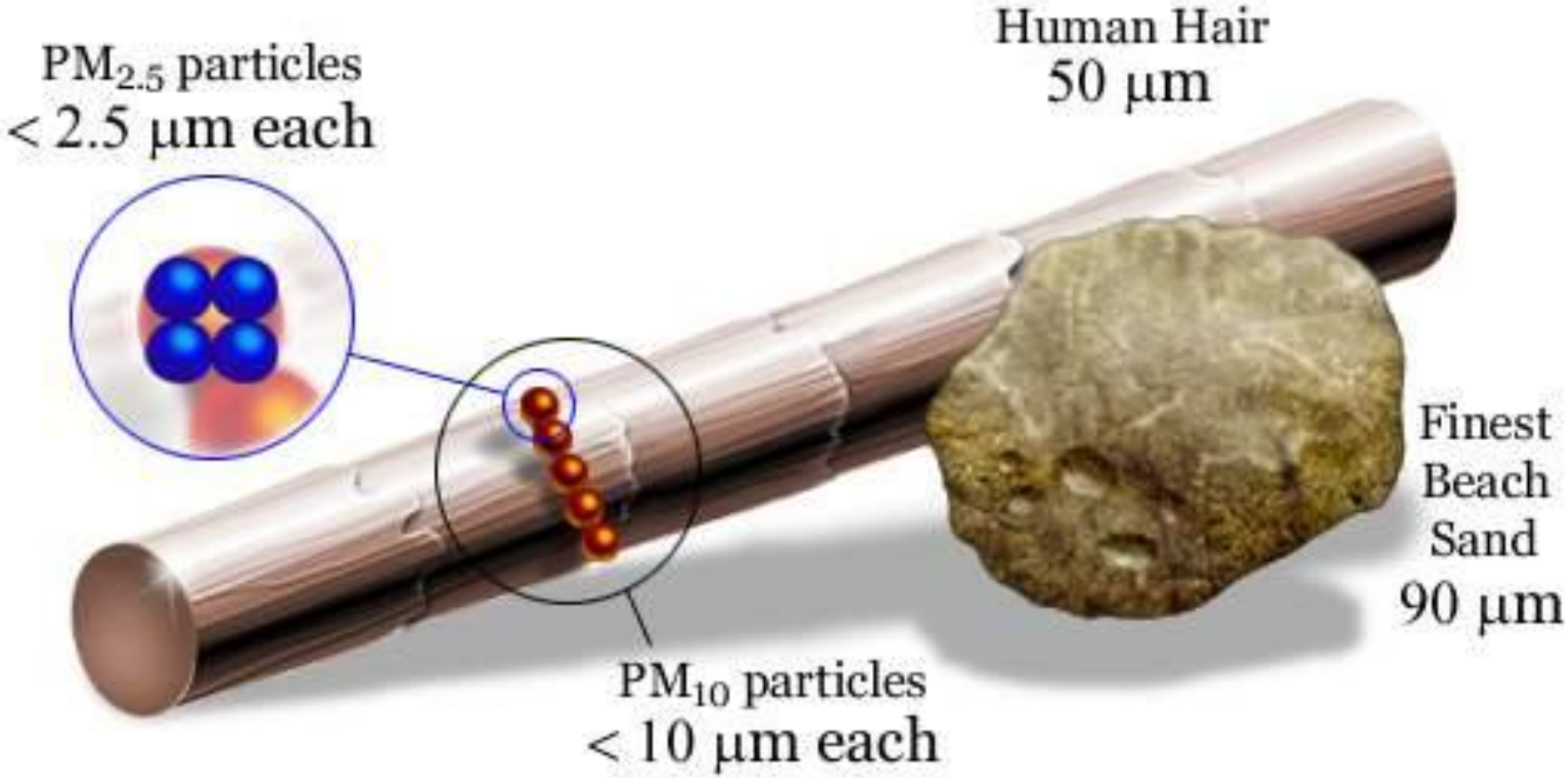
- Independent research funded by the NZTA (TAR 08/01), co-funded by FRST (CO1X0813)
- Universities of Canterbury & Auckland and National Institute of Water & Atmospheric Research (NIWA)
- Objectives:
  - Provide an accurate measure of personal pollution exposure by mode
  - Provide information to inform transport decision making at personal and societal levels
  - Provide a stronger base for advocating consumer change in behaviour

TV coverage

- *Campbell Live* (2/3/09)
  - www.3news.co.nz/Scientists-embark-on-air-pollution-study/tabid/367/articleID/93564/cat/84/Default.aspx

Methods

- Measure key traffic pollutants:
  - Carbon Monoxide (CO), particulate matter (PM_{10}, $PM_{2.5}$, PM_1) & Ultrafine fine particles (UFPs)


$PM_{2.5}$ particles
< 2.5 μm each
Human Hair
50 μm
Finest
Beach
Sand
90 μm
PM_{10} particles
< 10 μm each

Methods

- Measure key traffic pollutants:
  - CO, PM_{10}, $PM_{2.5}$, PM_1 & UFPs
- Busy commuting routes in Christchurch and Auckland

Routes - Christchurch

Inter-modal Journey 1

Inter-modal Journey 2

Routes - Auckland

Inter-modal route

Methods

- Measure key traffic pollutants:
  - CO, PM_{10}, $PM_{2.5}$, PM_1 & UFPs
- Busy commuting routes in Christchurch and Auckland
- Compare different commuting modes:
  - Cyclists – On-road and off-road
  - Car
  - Bus
  - Train (Auckland)
- Using a variety of scientific instruments including particle counters, CO measurers, weather tracking devices and GPS camera phones

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On-Road
7 m away
19 m away
N
42 m

Analyse peak events in GRC Mapper to determine how peaks correlate with activity

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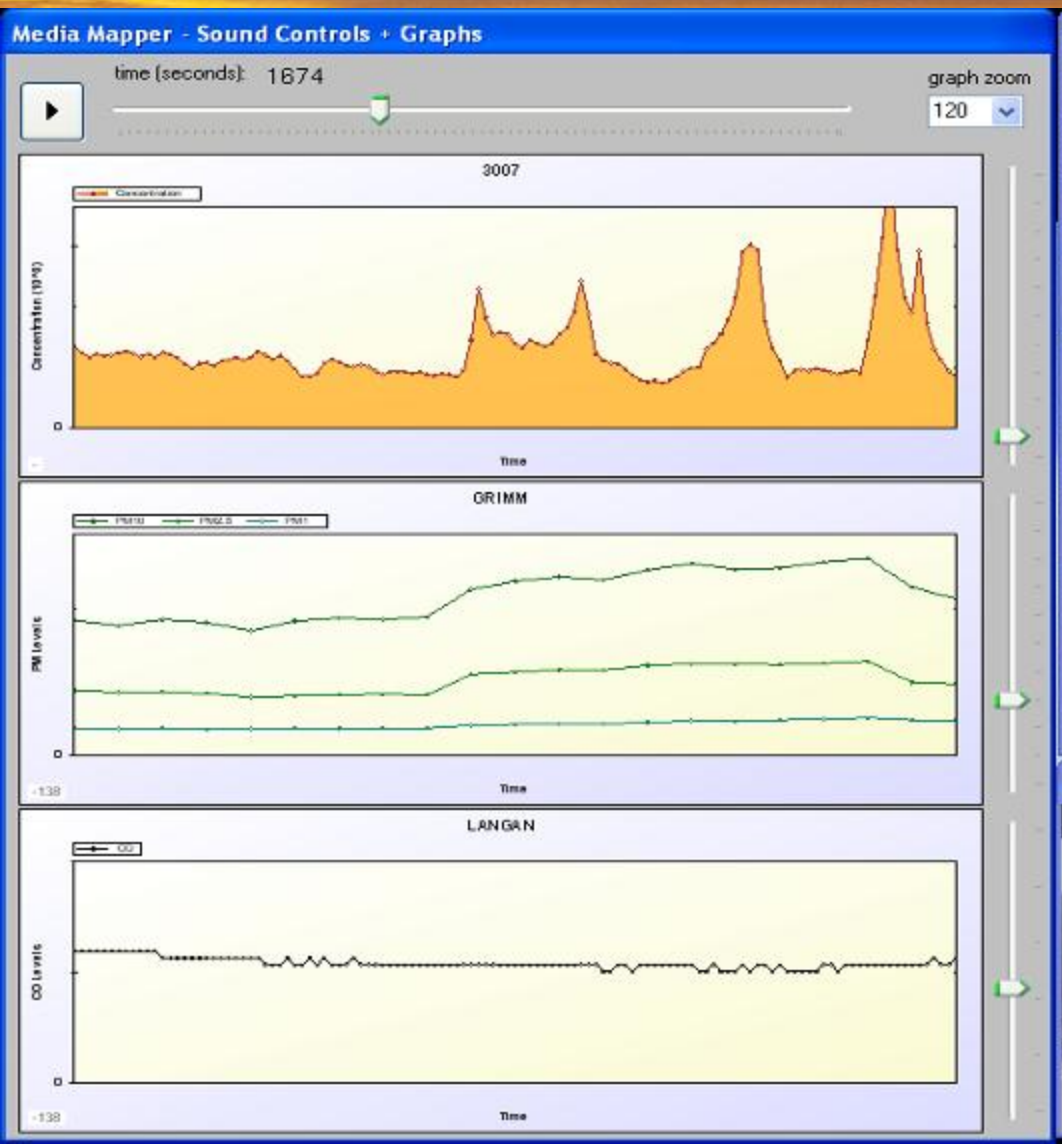
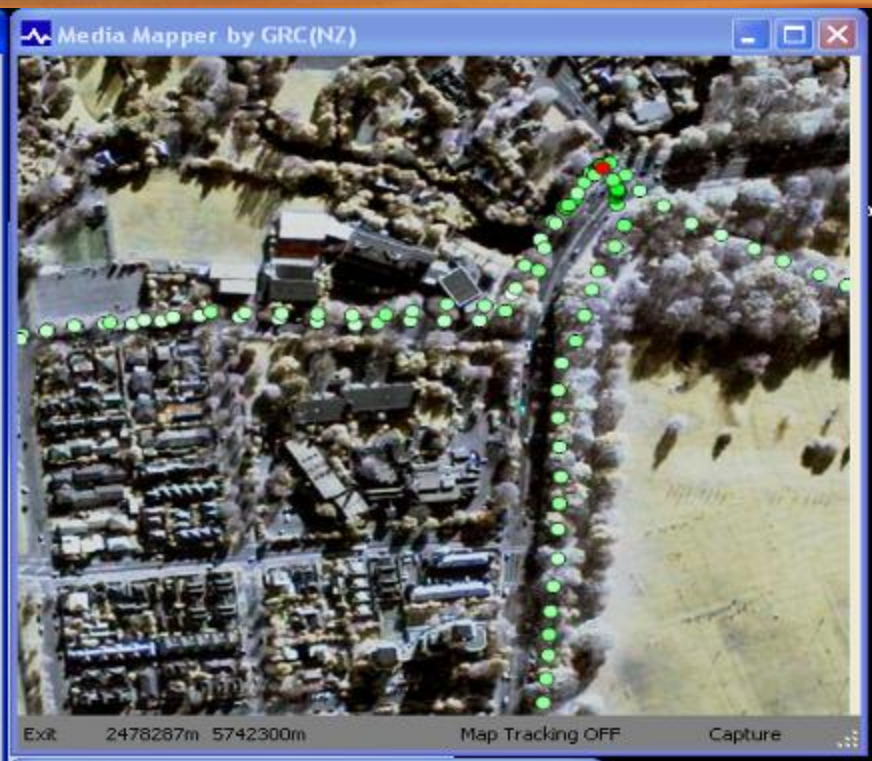
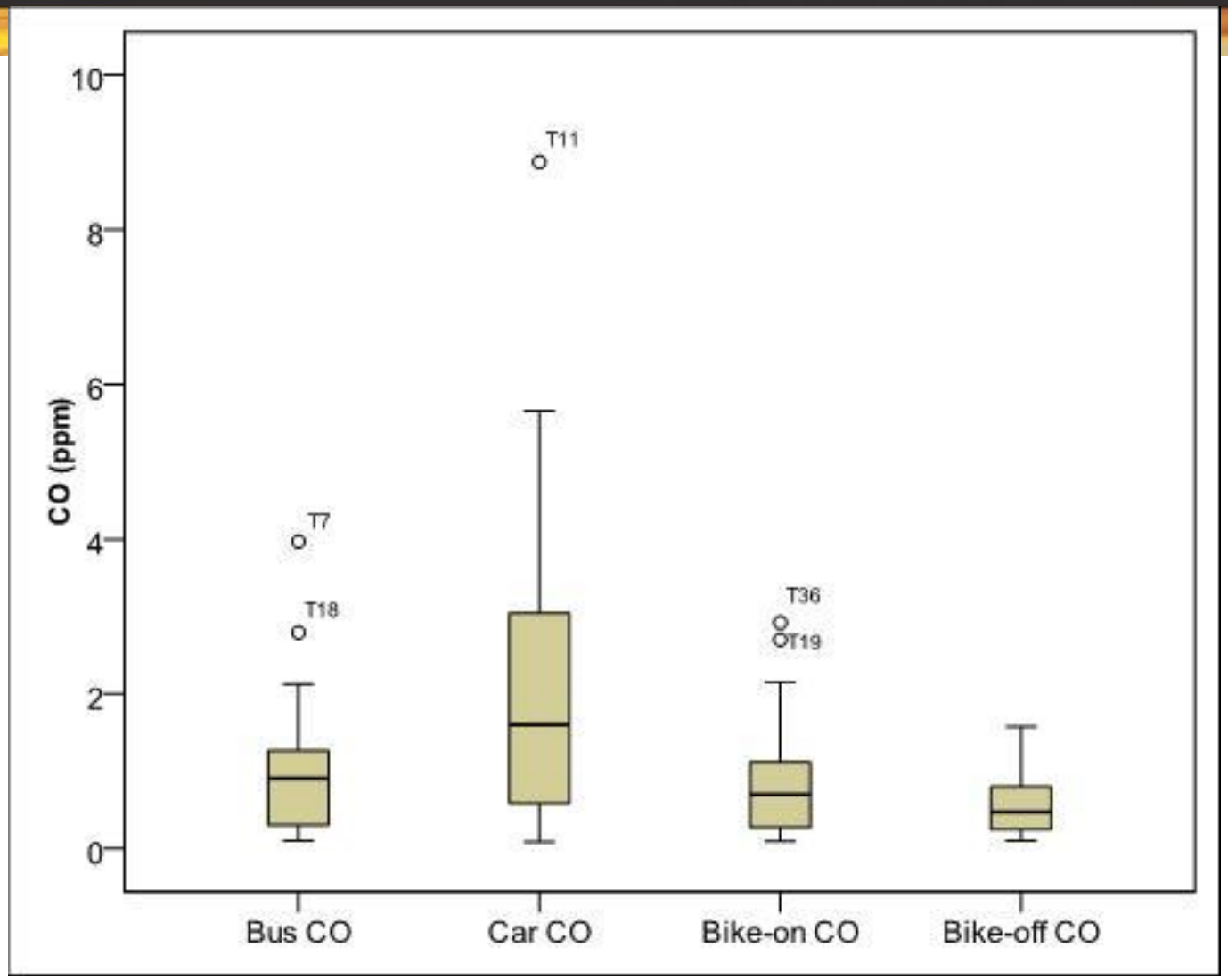




Results

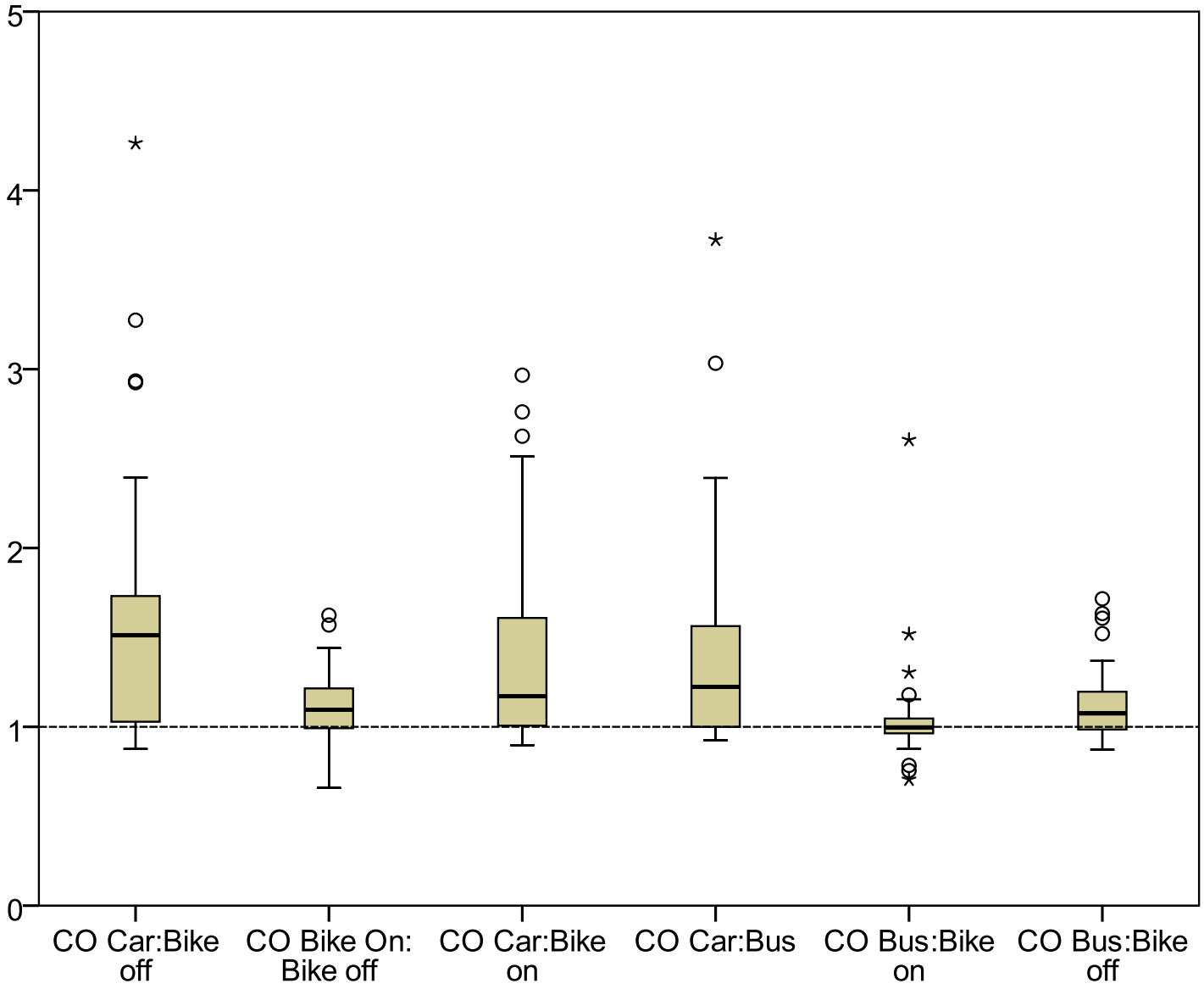
- Comparing means potentially misleading
  - Need to compare simultaneously sampled modes
- Large PM fraction not appropriate indicator of exposure to traffic emissions
  - Off-road (near no traffic) often higher than on-road
  - Resuspended dust

Results – Christchurch CO



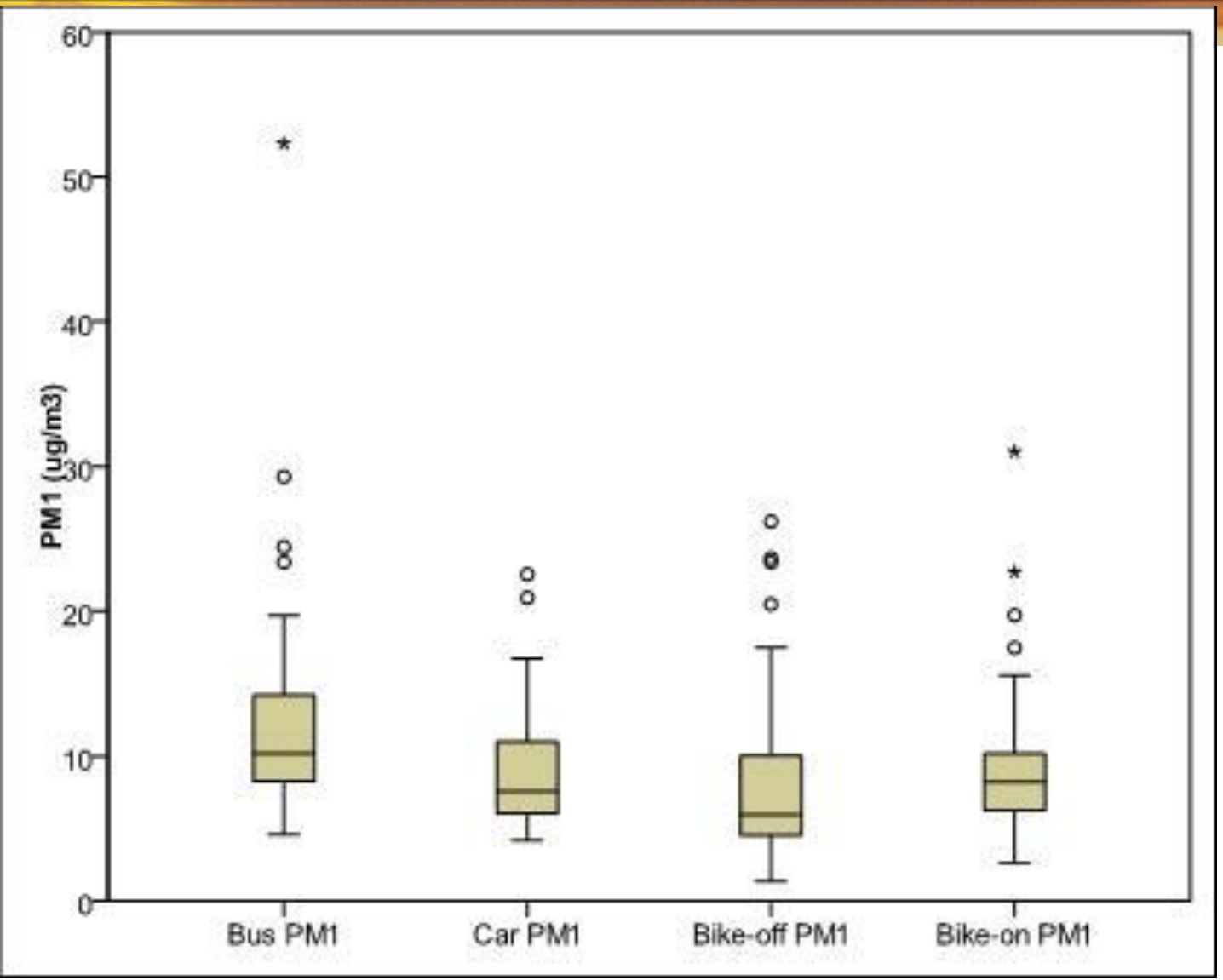
Mean CO levels

Results – Christchurch CO



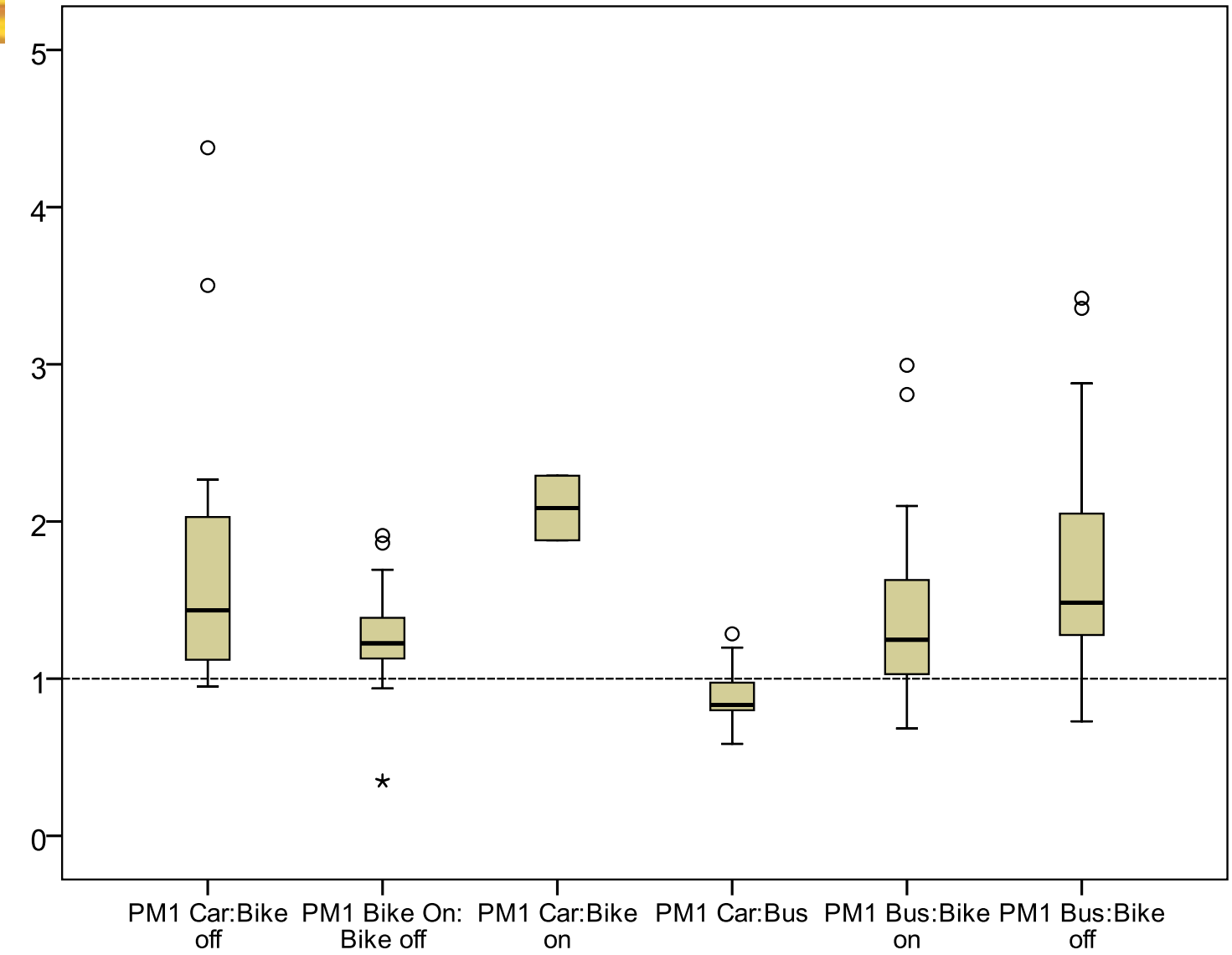
Ratios of CO levels

Results – Christchurch PM_1



Mean PM_1 levels

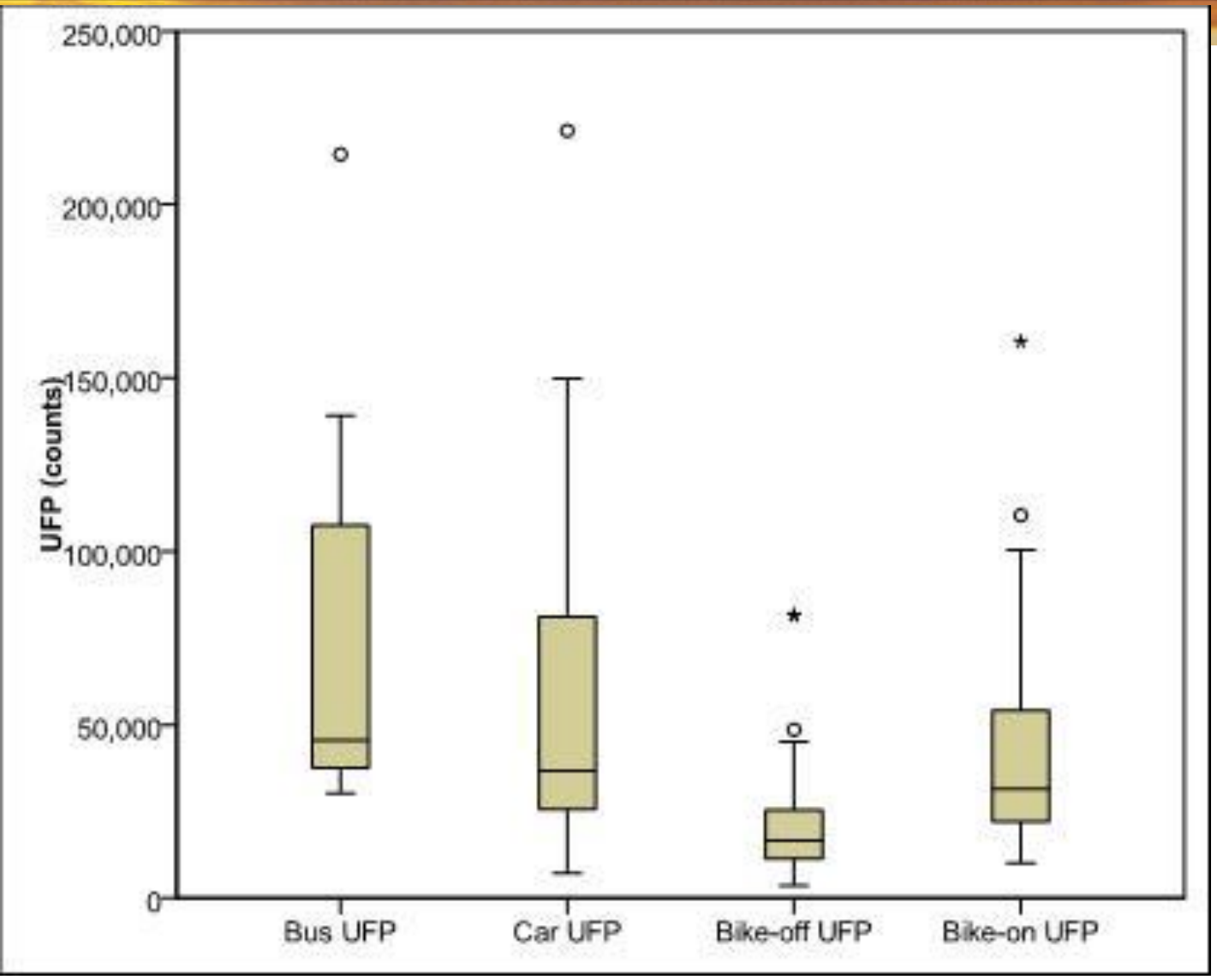
Results – Christchurch – PM_1



Ratios of PM_1 levels

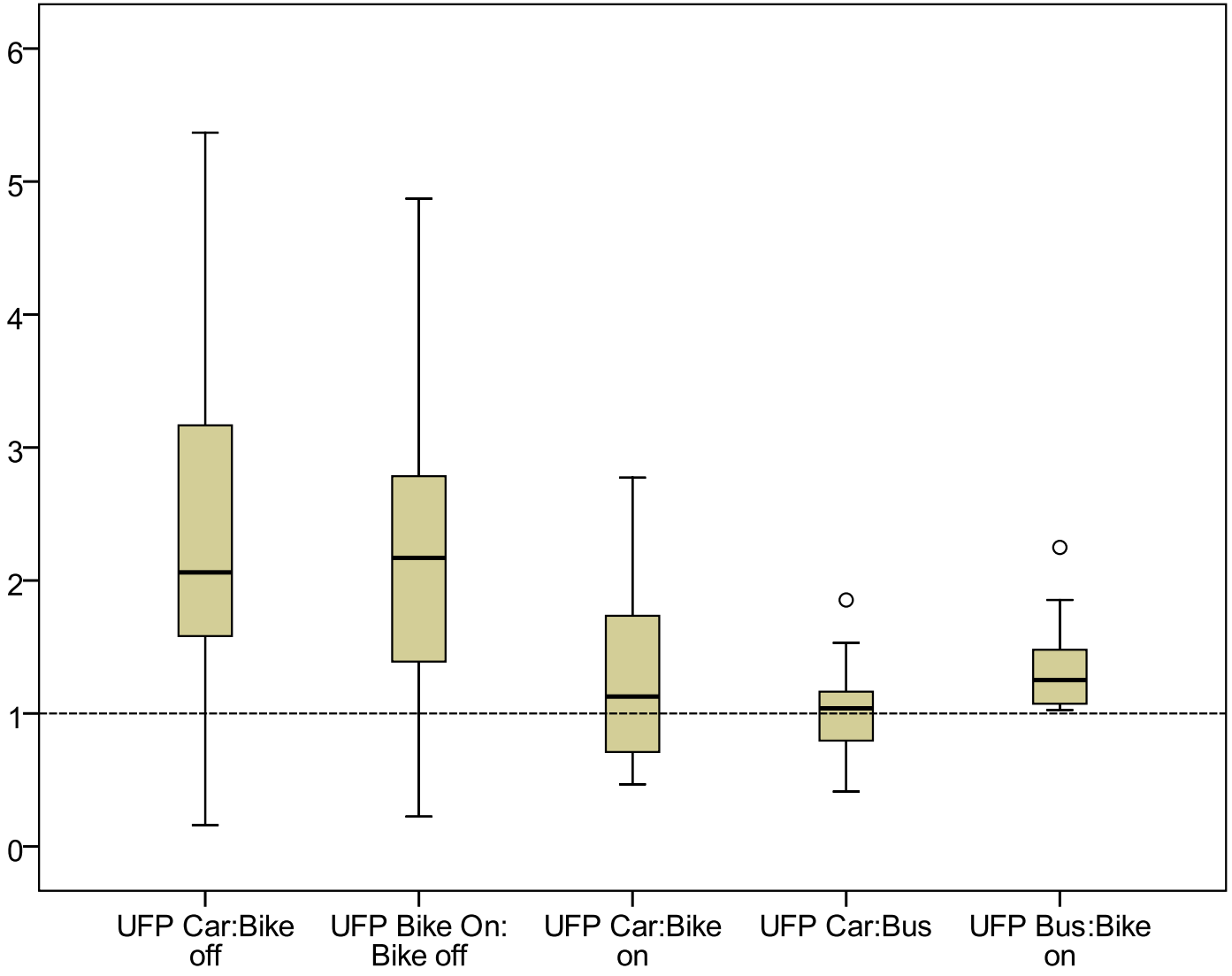
(note: car and on-road bike were only simultaneously measured on two occasions).

Results – Christchurch UFP



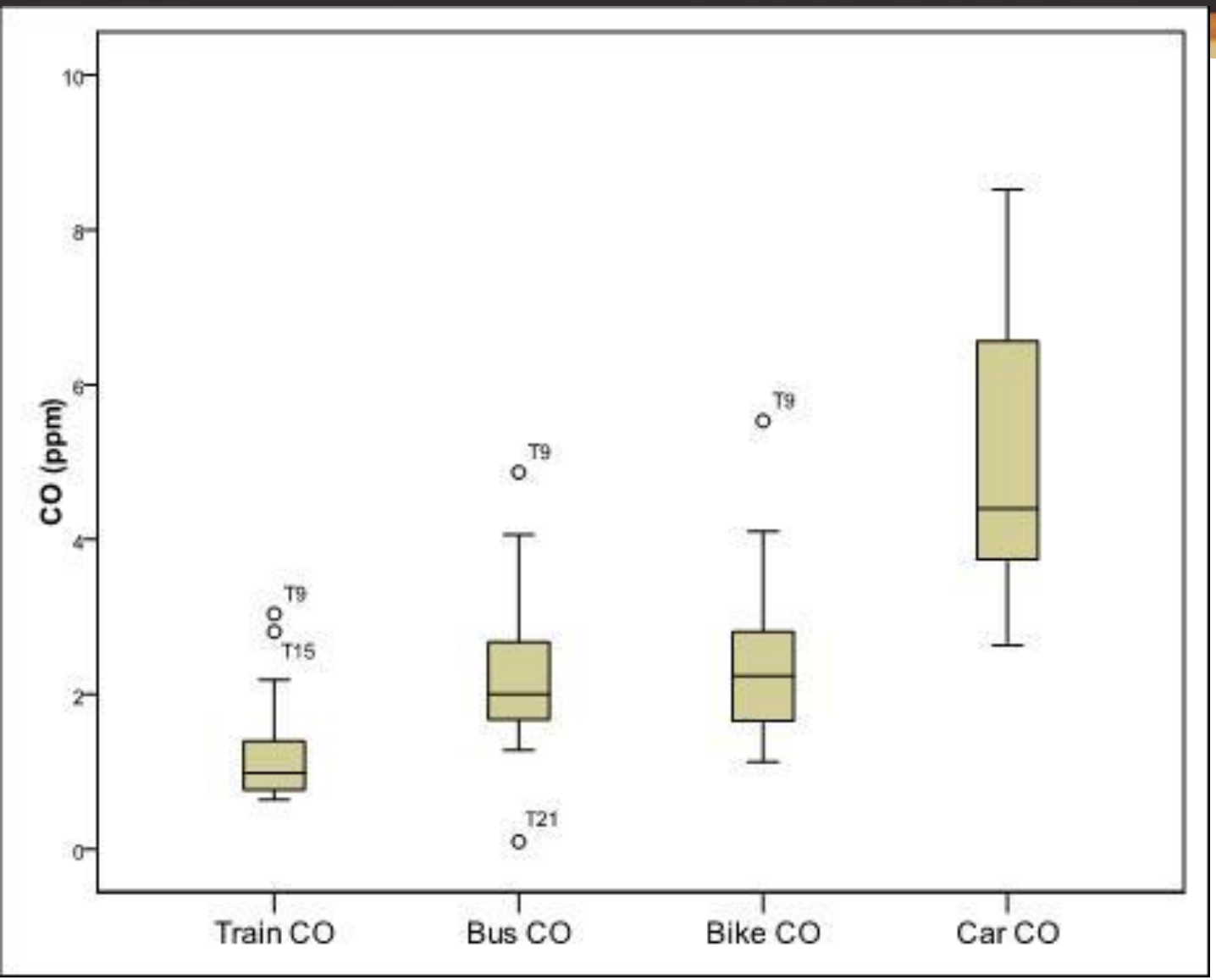
Mean UFP levels

Results – Christchurch – UFP



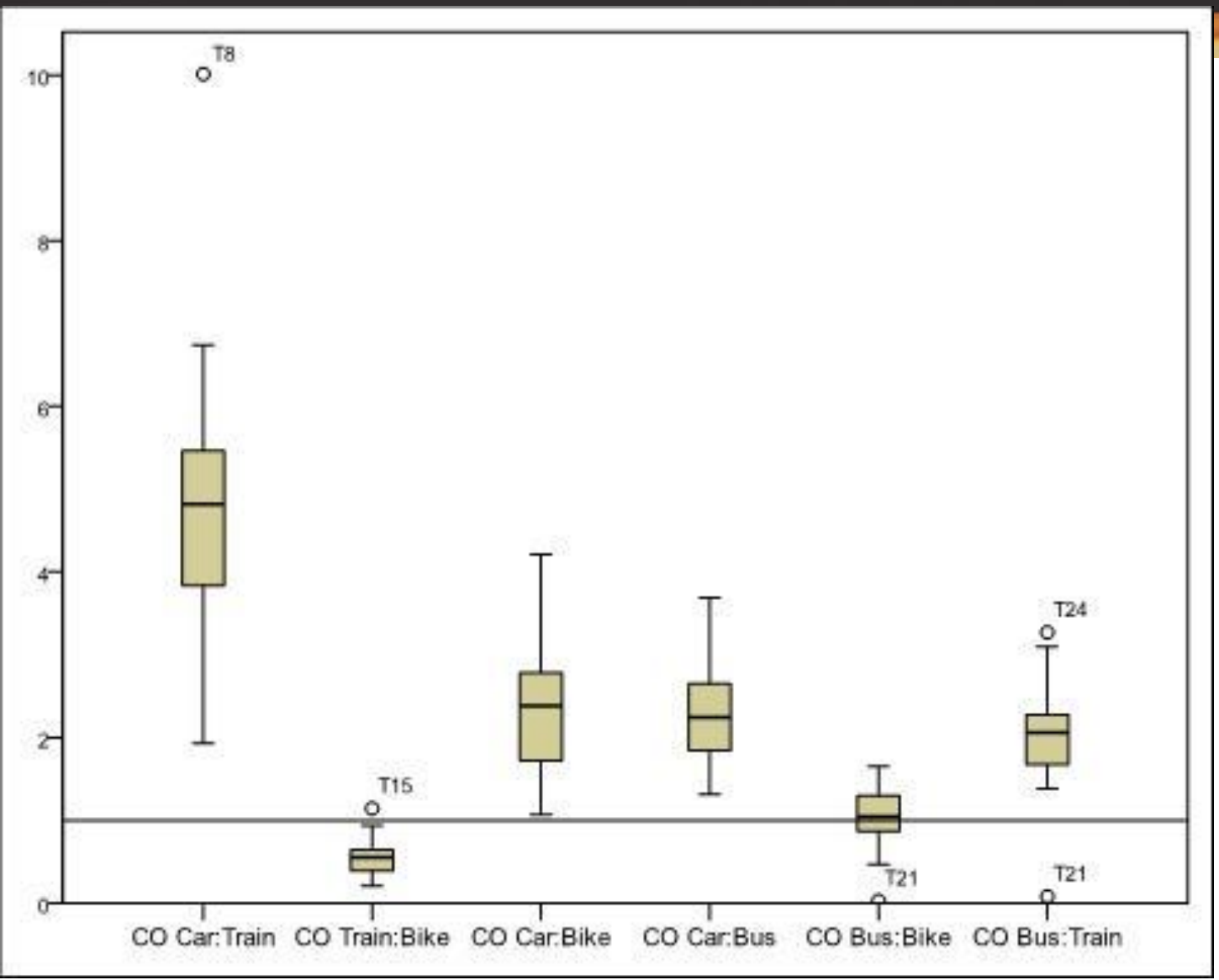
Ratios of UFP levels

Results – Auckland CO



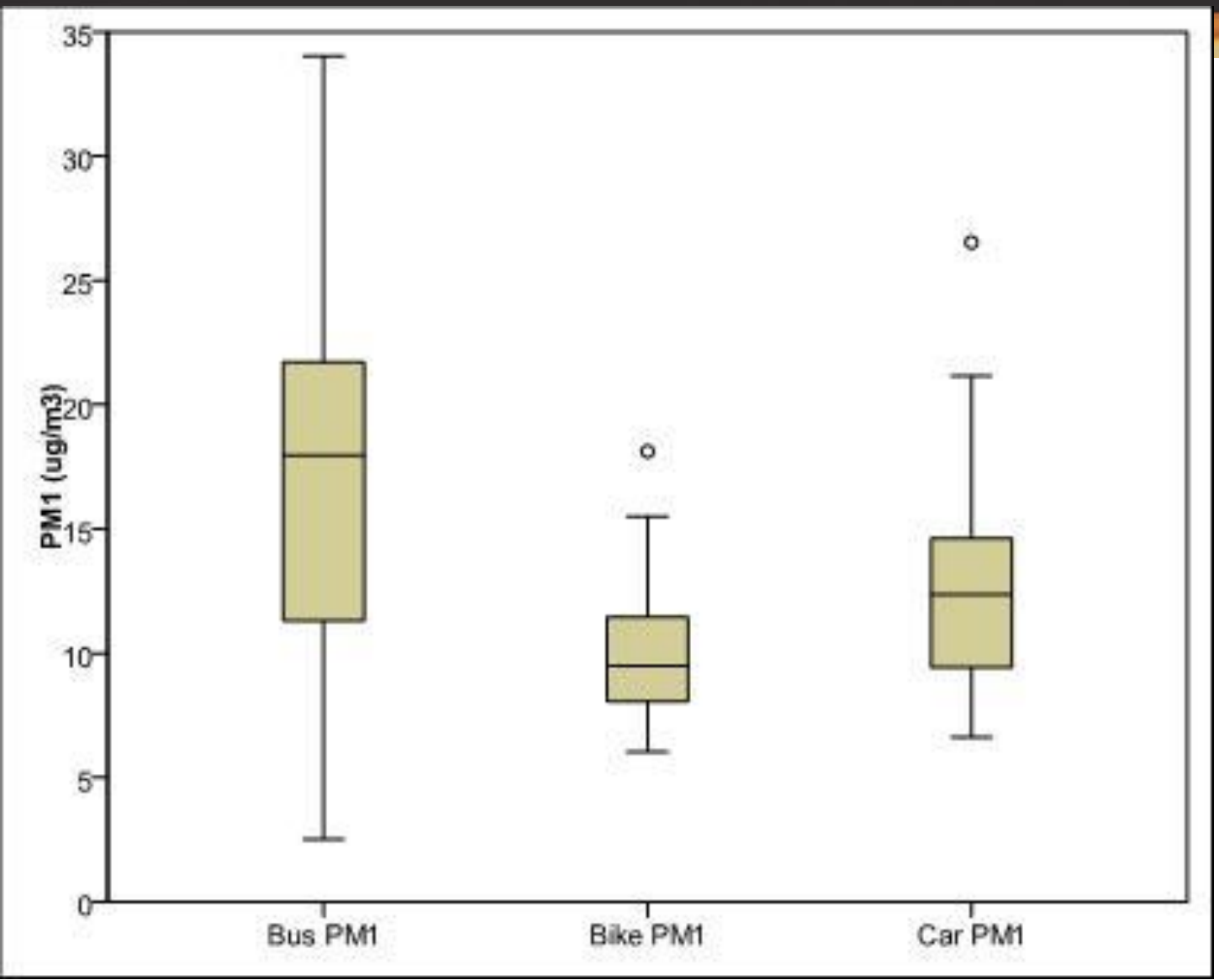
Mean CO levels

Results – Auckland CO



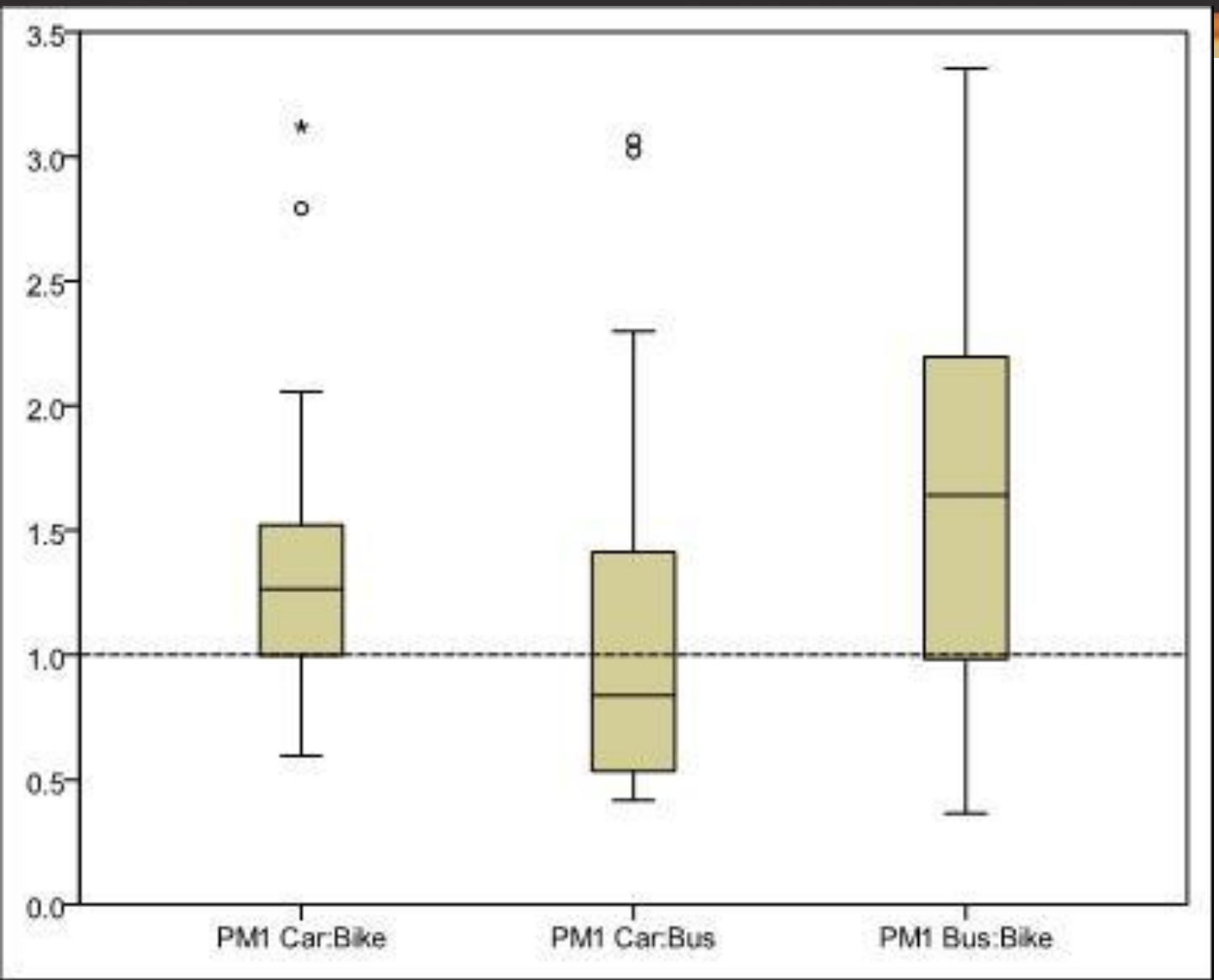
Ratios of
CO levels

Results – Auckland PM_1



Mean PM_1 levels

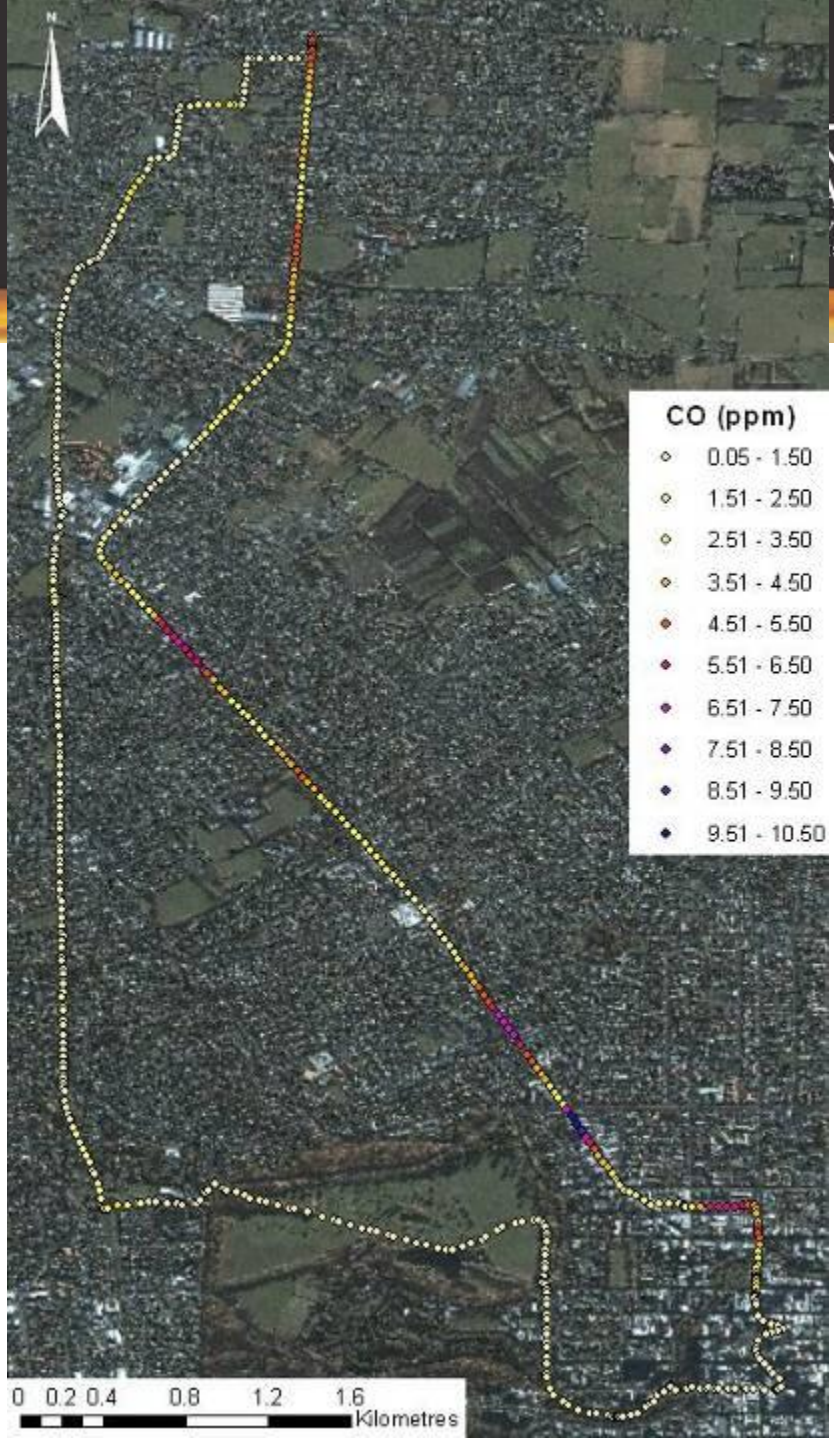
Results – Auckland – PM_1



Ratios of PM_1 levels

Cyclist exposure

- Christchurch
  - CO off- vs on-road

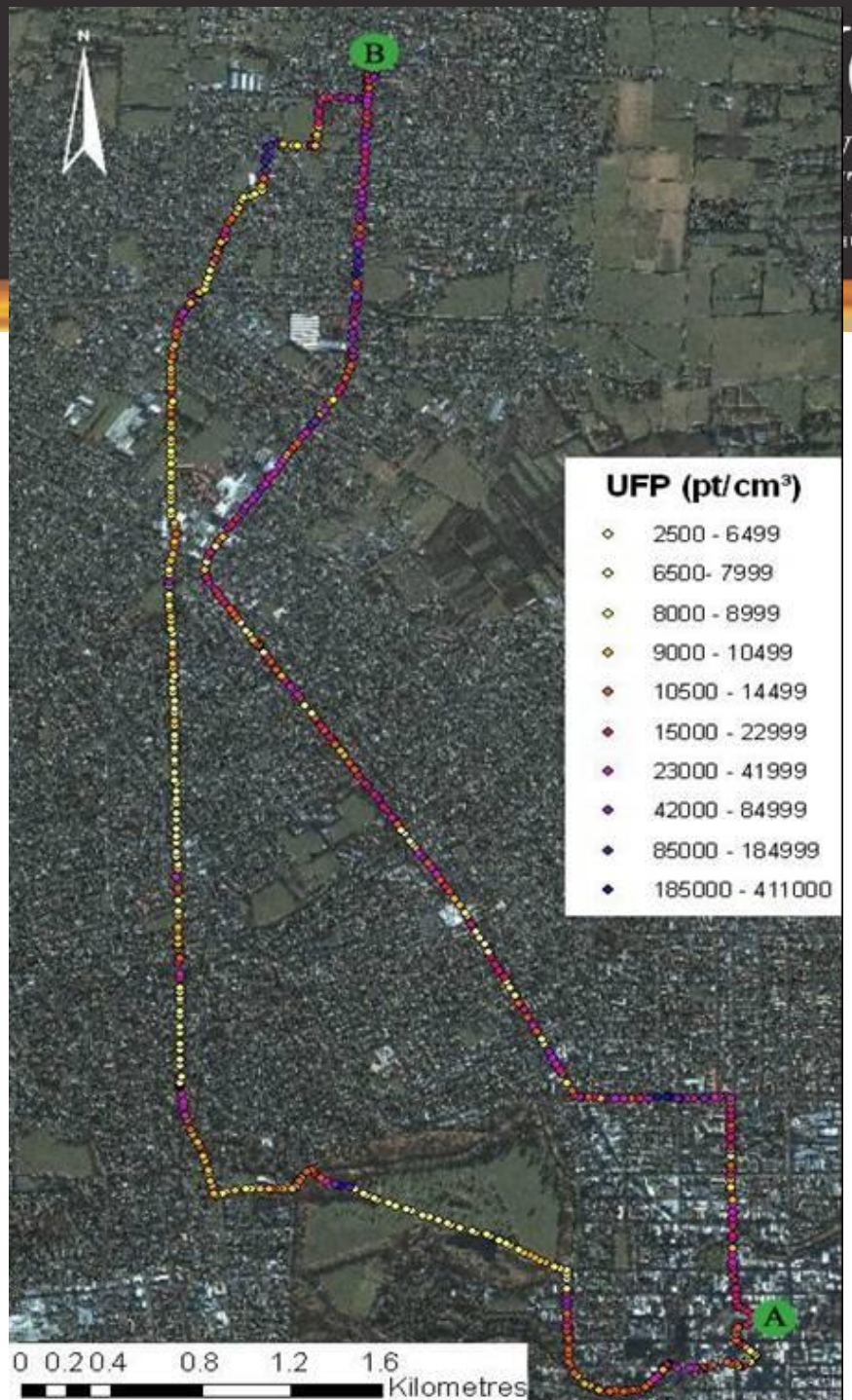


Cyclist exposure

- Christchurch
  - CO off- vs on-road

Cyclist exposure

- Christchurch
  - UFP off- vs on-road



Cyclist exposure

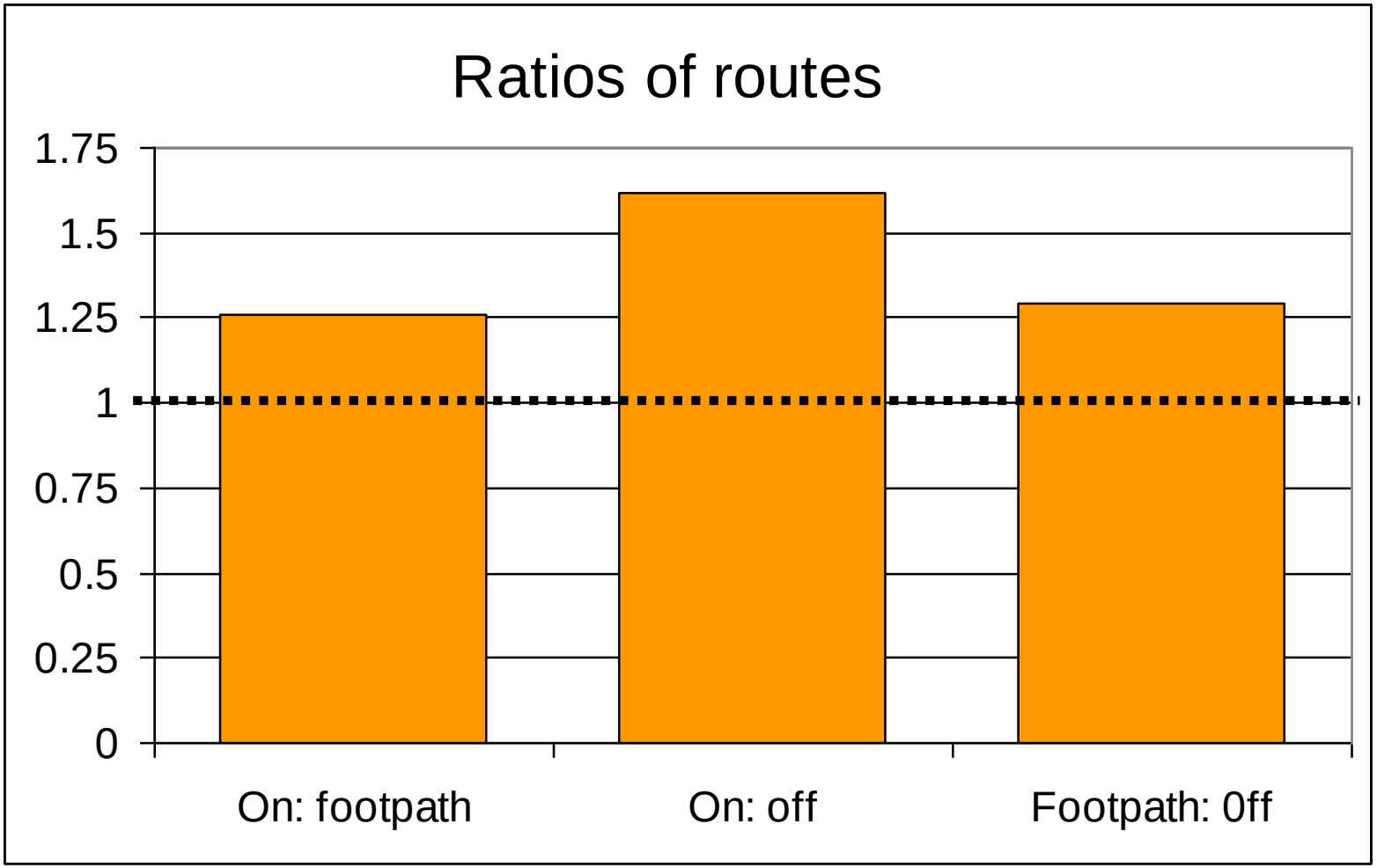
- Christchurch
  - UFP off- vs on-road

Cyclist exposure

- Christchurch - cycling: three route comparison

Preliminary results

- Christchurch - cycling: three route comparison



Key results

- Car drivers are consistently exposed to the highest levels of CO
  - >50% higher than cyclists, >80% higher than bus passengers and nearly 400% higher than train passengers
- On-road cyclists are exposed to higher levels than off-road cyclists
  - CO (60%), PM_1 (20%) & UFP (over 100%)
  - This could have significant policy implications for the location of cycle routes
- Car drivers & bus passengers are exposed to higher average levels of UFP than cyclists
  - However for very short acute exposures (a few seconds) on-road cyclists be exposed to higher peaks
- PM_{10} & $PM_{2.5}$ are poor indicators of exposure to vehicle emissions

Conclusions

- How you choose to travel does affect the amount of pollution you will be exposed to
  - Cars seem to be exposed to most
  - Doesn’t account for respiration (dose)
  - Cyclists away from road less than on road

Possible policy implications

- Better knowledge
- Inform planning decisions
  - Design of enclosed transport environments
  - Cycle route location
- Public awareness
  - Informed decision making about modal choice
  - Basis for advocating change