Assessing variations in roadside air quality with sampling height

26th March 2014

Introduction

- Study commissioned by the Scottish Government to investigate roadside air quality versus height.
- Progress so far.
- Some initial results.
- Work still to be carried out.

The Study

"The study will investigate how Air Quality varies with height and aims to:

- ***Determine the relationship between height from pavement and Air Quality.***
- ***Investigate the relationship between mobile and fixed sampling methods.***
- ***Examine diurnal and seasonal variations in Air Quality.***

The outputs will help inform Air Quality policy in Scotland."

The Team

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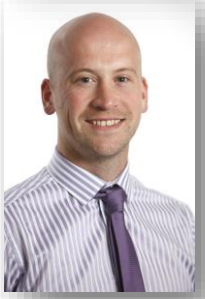
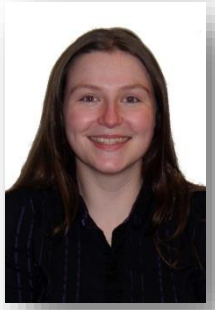
Sam Copsey

Brian Stacey

Stephen Stratton



David Hector



Susannah Telfer

Stephen Gray

The Equipment

Species	Sampling Method/Analyser
$PM_{2.5}$ (Automatic)	Lighthouse IAQ 3016 $PM_{2.5}$ analyser
$PM_{2.5}$ (Gravimetric)	Harvard-PEMS + BGI pump (Personal Exposure Monitor)
Black Carbon	Magee MicroAeth AE51
Ultrafine Particles	Philips Nanotracer
NO_2, SO_2, CO and O_3	AQMesh
CO_2	COZIR Optical Sensor
Benzene	Pumped tube sampling
Meteorology	Lufft WS600 (WS+WD+T+H+P+RF)
Video and GPS	Roadhawk
Data Acquisition	Weblogger with 3G telemetry

The Location – Why Glasgow?

- Glasgow is Scotland’s largest city.
- Glasgow City Centre combines a variety of urban environments within walking distance.
- Glasgow City Centre is busy, both in terms of road traffic and people.
- Ricardo-AEA Scotland office, Blythswood Square.

So Far…

- Literature Review
- Testing
- One Co-location
- One Sampling Run

Findings - Literature Review

- No study was found that incorporated mobile sampling with sampling at more than one height.
- The review focussed on but was not restricted to the following types of study:
  - Air quality versus height.
  - Mobile monitoring.
  - Personal exposure.
- Research indicates that a pollutant gradient does exist at heights below 3 m above ground level, but that the following factors will affect the vertical profile:
  - Meteorology.
  - Topography.
  - Distance from emissions source.
- Methodology outlined for the study was validated.
- Sampling heights defined as 168 cm above ground level for the average height of an adult above the age of 16 years in Scotland; and 80 cm for a child in a buggy.
- Highlighted problems that we might encounter.

Sampling Regime

- Predetermined route.
- 8 mobile sampling exercise (2 weekend days).
- 6 co-location exercises, sampling at an automatic monitoring site.
- Carried out over six months.

Sampling Route

Street name	Description of street on route	Approximate Length of street within study route (miles)
Hope Street	Busy urban canyon orientation south to north (partially restricted to buses and taxes)	0.42
Sauchiehall Street	Urban pedestrian precinct orientation west to east	0.16
Buchanan Street	Urban pedestrian precinct orientation north to south	0.22
St Vincent Street	Busy urban canyon orientation west to east	0.10
George Square	Busy urban street orientation west to east	0.14
George Street	Busy urban canyon orientation west to east	0.14
Montrose street	Busy urban canyon orientation north to south	0.11
Ingram Street	Busy urban street orientation west to east	0.18
High street	Busy urban street orientation north to south	0.21
Saltmarket	Busy urban street orientation north to south	0.34
Clyde Street/Broomielaw	Busy Urban street orientation east to west	0.44
Oswald Street	Busy urban street orientation north to south	0.16

Map data ©2013 Google

Ricardo-AEA Office

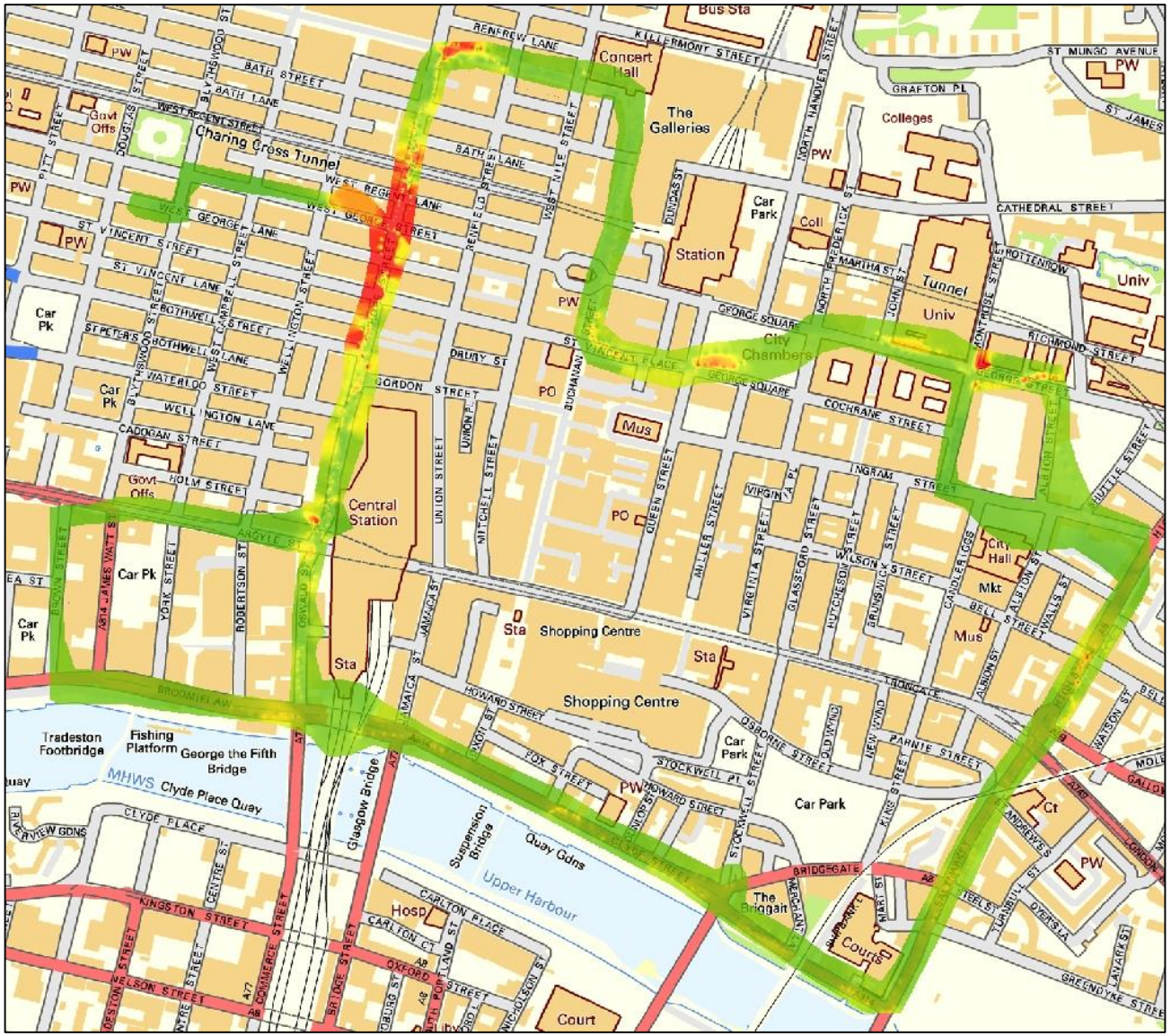
Mobile Monitoring Video

Some Results - $PM_{2.5}$

Contains Ordinance Survey data © Crown copyright and database right 2011.

Black Carbon

RICARDO-AEA



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Ultrafine Particles

RICARDO-AEA

N Particles cm^{-3}

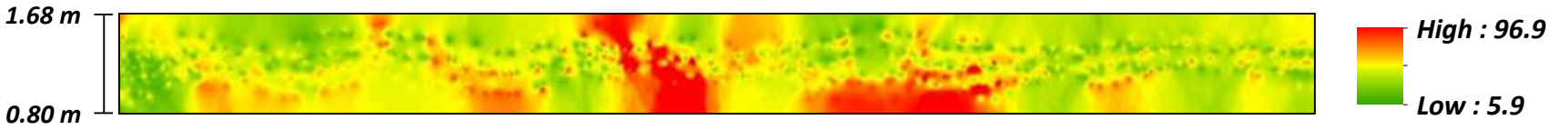
High : 157339

Low : 3802

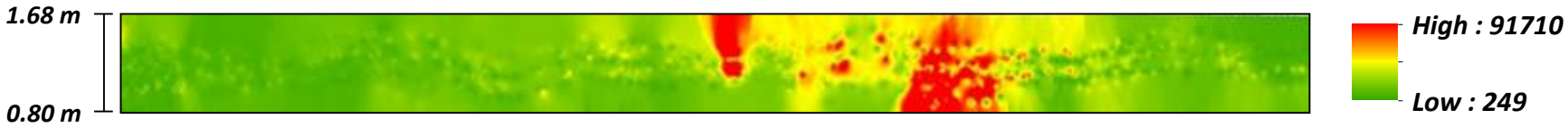
Vertical Profile – Hope St

RICARDO-AEA

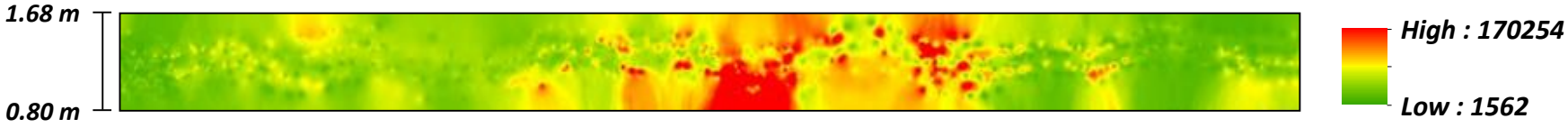
$PM_{2.5}$ (μg m^{-3})



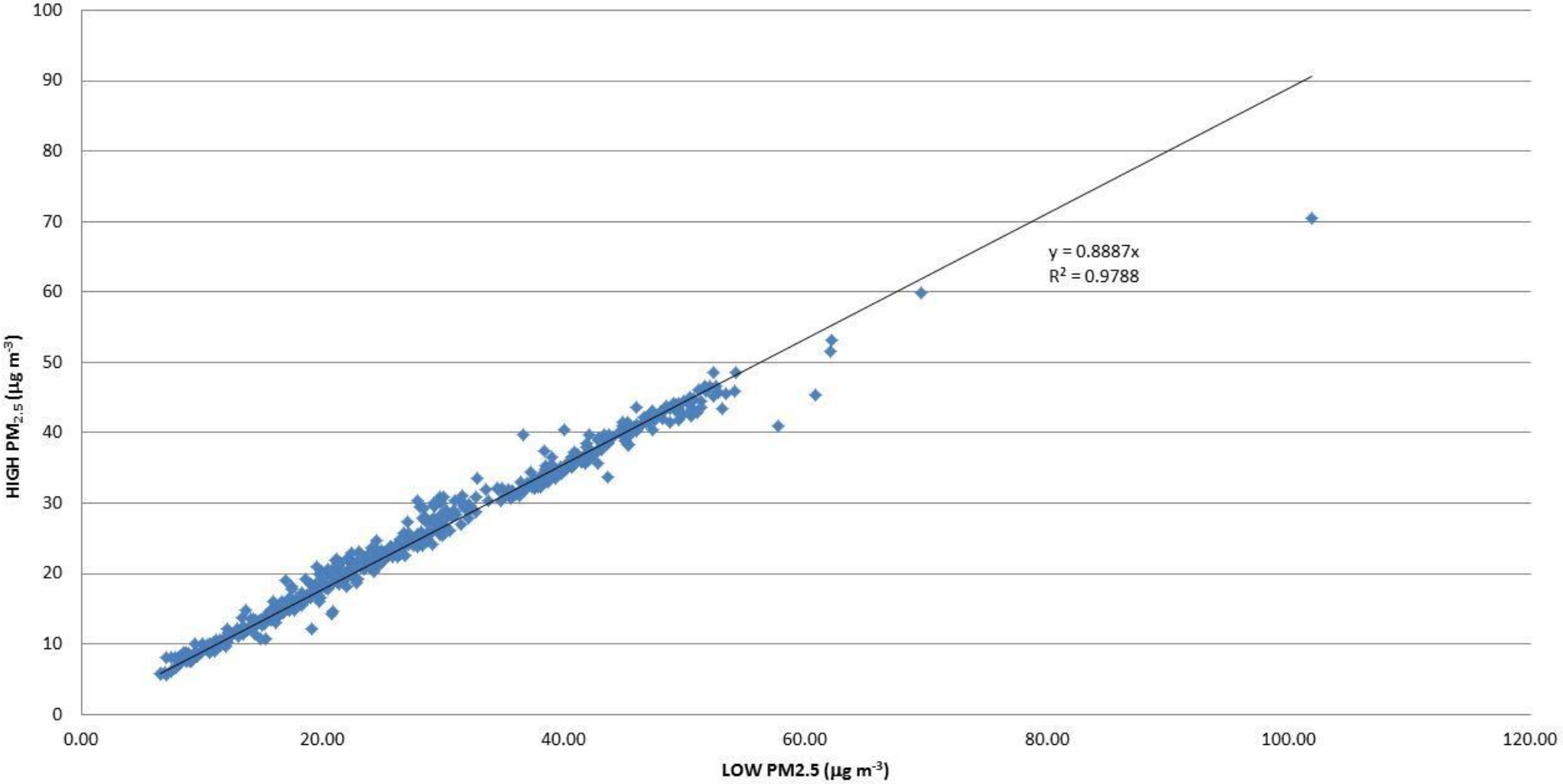
Black Carbon (ng m^{-3})



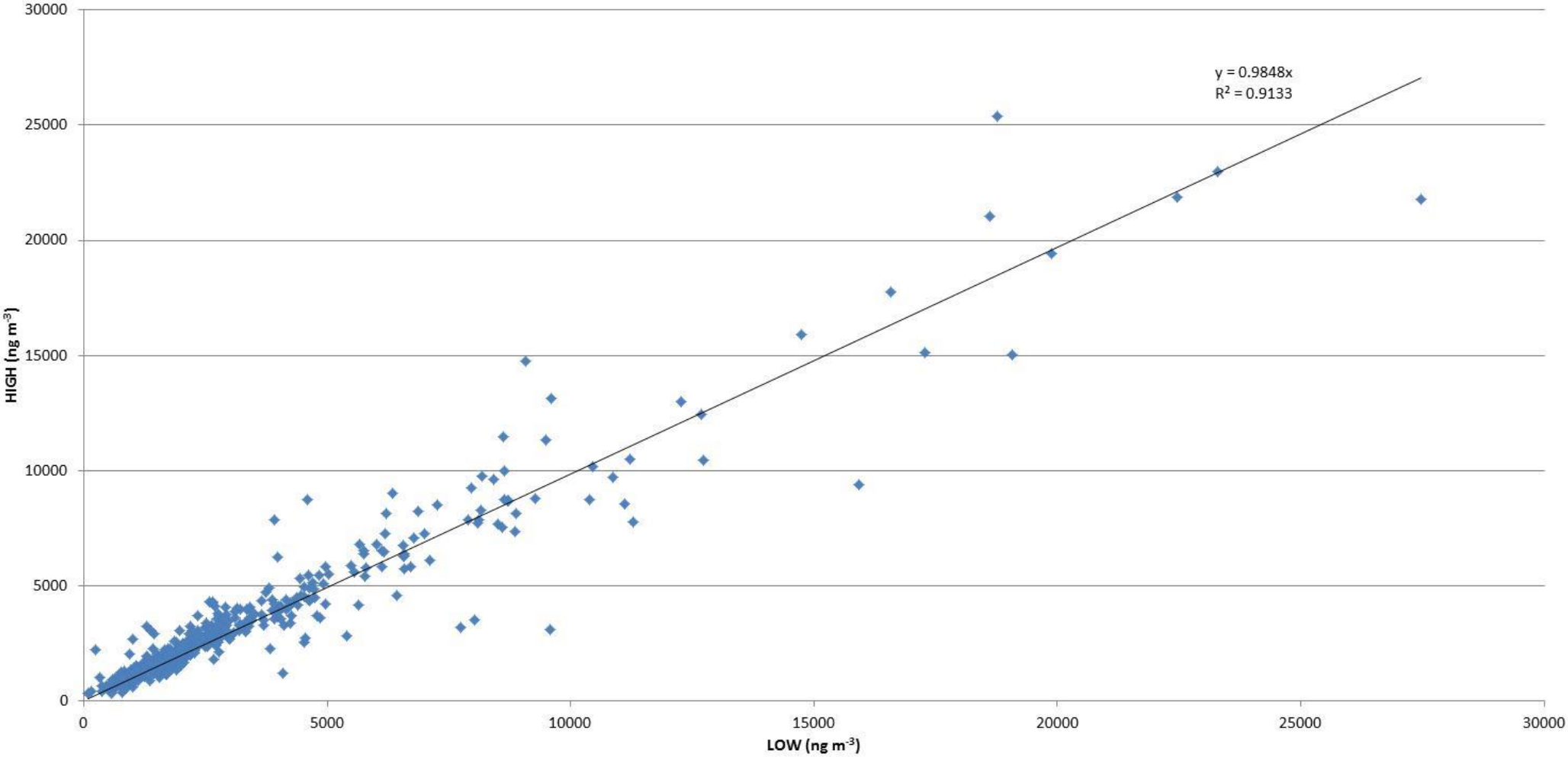
Ultrafine Particles (N cm^{-3})



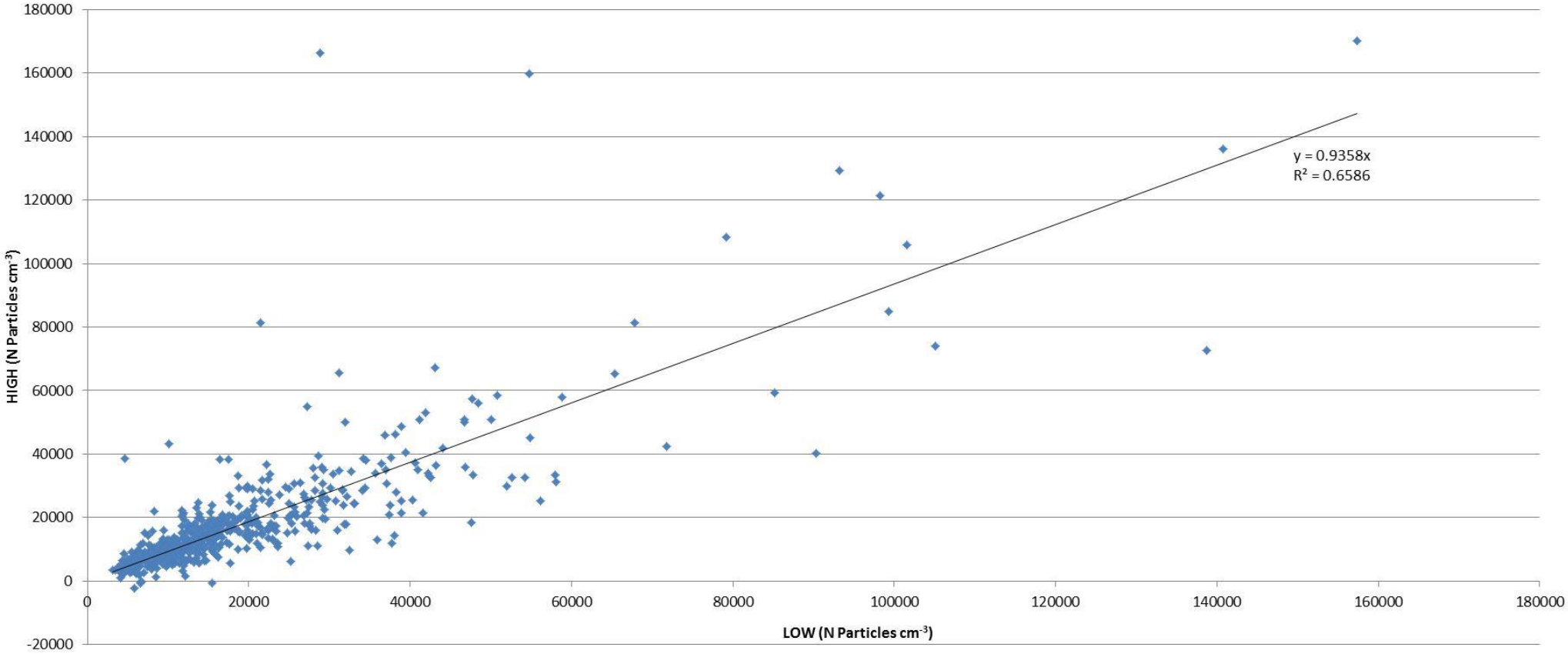
$PM_{2.5}$ vs Height



Black Carbon vs Height



UFP vs Height



A lot of work still to be done…

- Characterisation of response between each pair of samplers.
- Calibration of sampler response using automatic fixed (reference equivalent) monitoring techniques/sites e.g. Hope St AURN.
- Analysis of pollutant concentrations within different microenvironments e.g. street canyon compared to open street environments.
- Diurnal and seasonal variations.
- Cross pollutant correlations.
- Met conditions and the impact on pollutant concentrations.

Finally…

- This type study, combining mobile monitoring with monitoring at more than one height, has no been carried out before.

- Collecting a lot of data!

- Very early, but initial results indicate that a concentration gradient exists.

Comments/ Questions?

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