

Preliminary results PM1.0 levels near a residential road in Zagreb

*Z. B. Klaić, Z. Pasarić
M. Stojnić, K. Ružman and I. Smiljanić*

*Andrija Mohorovičić Geophysical Institute,
Department of Geophysics, Faculty of Science,
University of Zagreb, Zagreb, Croatia
zklaic@rudjer.irb.hr*



Outline

1. Introduction
2. PM1.0 measurements
3. Meteorological data
4. Traffic density data
5. Preliminary results and conclusions

1. Introduction

Airborne particulate matter (PM):
dust, dirt soot, smoke, and liquid droplets suspended
in the atmosphere

Particle sizes & physical and chemical characteristics:
determined by the formation processes & subsequent
reactions in the atmosphere



Particles diameters - from a few nm (the size of molecular clusters) up to about 100 μm (small enough to be suspended in the air for an appreciable time)



An early simple trimodal model of Whitby (Whitby , 1978; John, 2001) - three distinct size modes:

- 1) Nuclei (size between 0.005 and 0.1 μm);
- 2) Accumulation (size range from 0.1 to 2 μm); and,
- 3) Coarse (size above 2 μm).

Fine particles = {
Nuclei mode
+
Accumulation
mode



1. NUCLEI MODE (diameters between 0.005 and 0.1 μm) :

- Smallest in both size and mass concentration;
- Transient \Rightarrow is important only in the immediate vicinity of sources;
- Contains the highest number of particles;
- Formed by photochemical reactions on gases in the atmosphere and by combustion.

2. ACCUMULATION MODE (diameters from 0.1 to 2 μm) :

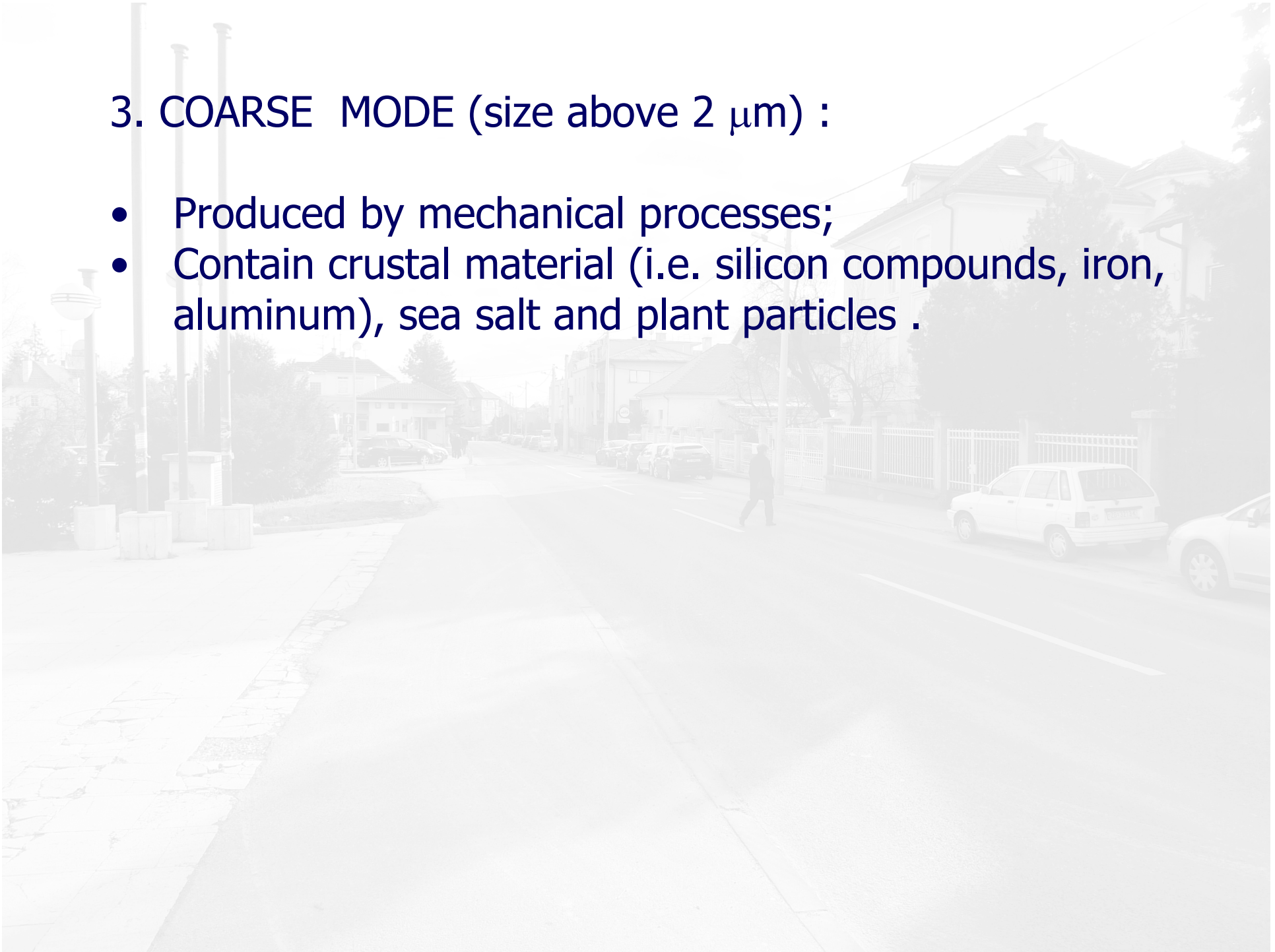
- Produced by complex reactions of gasses emitted into the atmosphere during fossil fuel combustion (i.e., gasses containing sulfur, nitrogen and organic compounds) \Rightarrow mainly anthropogenic.
- Contains most of the fine particle mass.

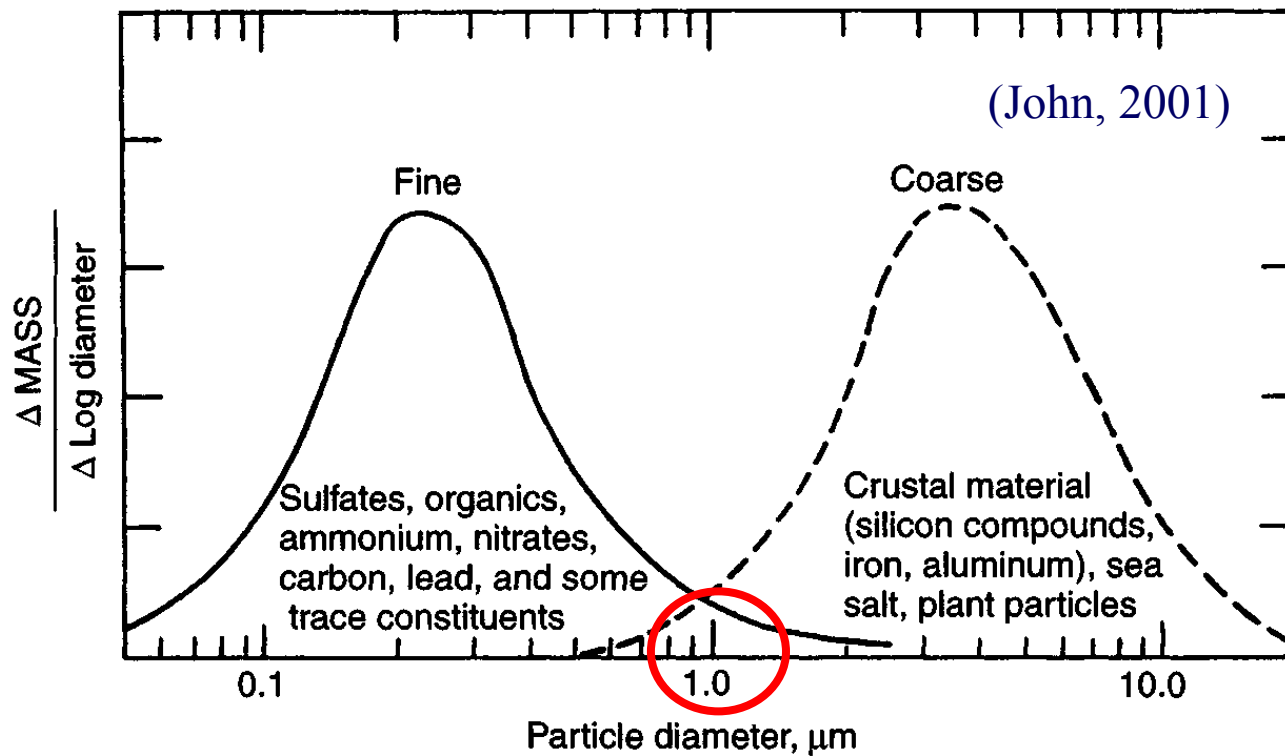


Typically in urban aerosol fine particles (nuclei + accumulation mode) mainly originate from combustion. They comprise sulfates, organic ammonium, nitrates, carbon, lead, and some trace constituents

3. COARSE MODE (size above 2 μm) :

- Produced by mechanical processes;
- Contain crustal material (i.e. silicon compounds, iron, aluminum), sea salt and plant particles .





This study – the effects of the traffic density and meteorological conditions on the PM_{1.0} levels in the vicinity of residential street.

2. PM1.0 measurements



The Model 8520 DustTrak™ Aerosol Monitor (TSI, Inc., Shoreview, MN, USA)

Enables the measurements of concentrations of **PM1.0**, PM2.5 and PM10 at resolution of 1 s.



Measuring site:

- Northern, residential;
- ≈ 1.5 km far from the city centre
- At the N-S oriented road;
- The road:
 - Inclined toward the S
 - two lanes of opposite direction, separated by the centerline.

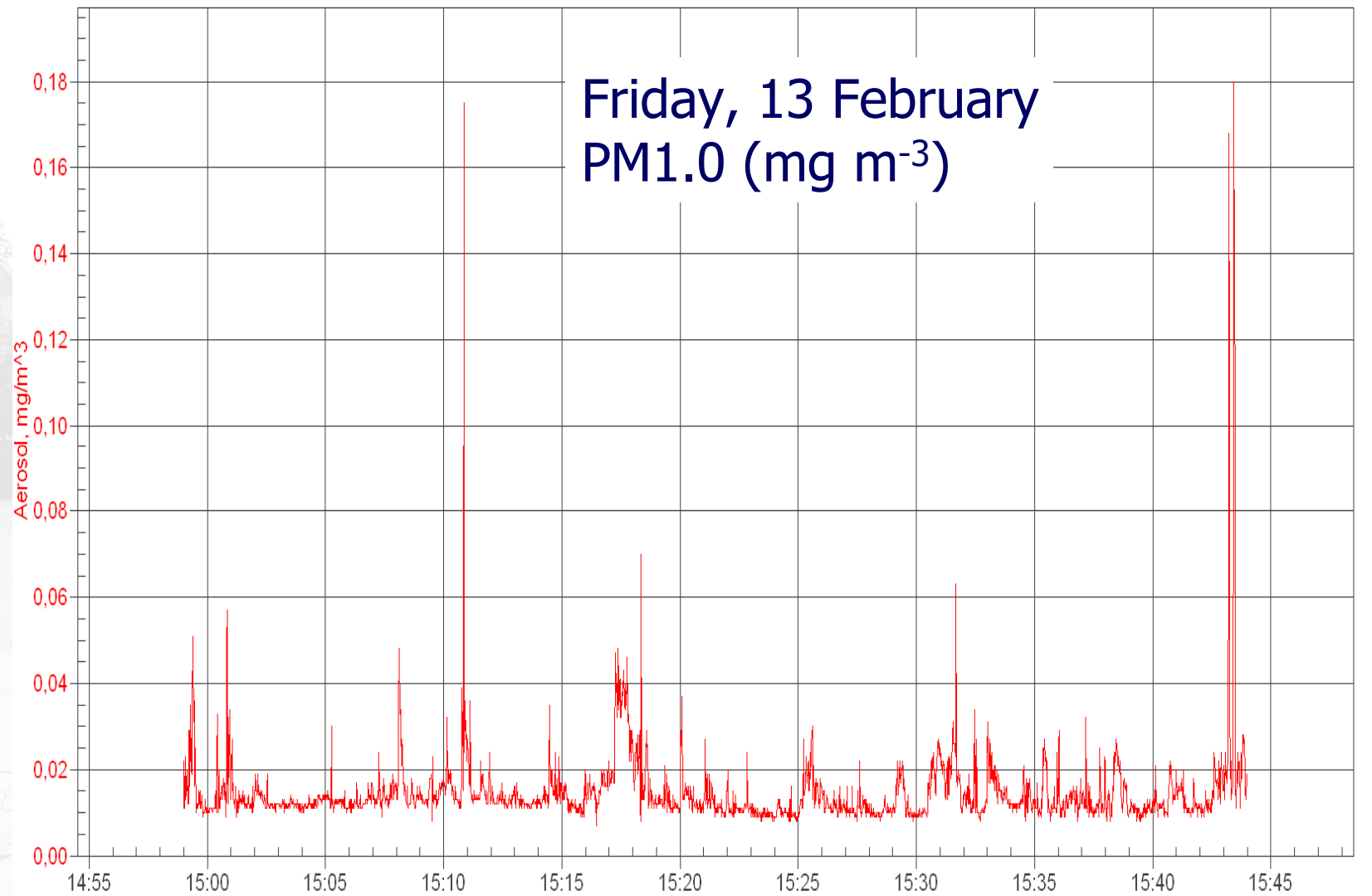
IZ – industrial zone of Zagreb

- Ten 45-min time series of PM_{1.0} concentrations at 1 s resolution
- 13 – 19 February 2009



- 160 m north of the bus stop
- The instrument - at the eastern pavement, 0.5 m away from the road edge, and 12.5 m west of the Campus building.
- The instrument inlet at 1.7 m above the ground (\approx inhalation height), perpendicular to the roadway.

Example – one 45-min time series at resolution of 1 s



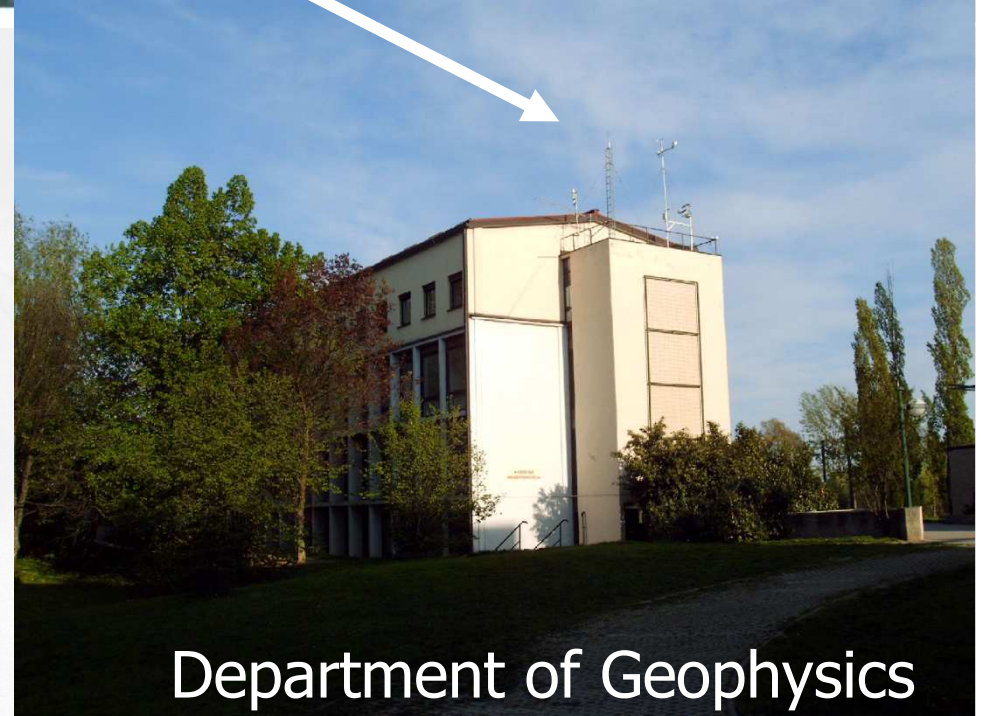
3. Meteorological data



Automatic meteorological station META 2000 (AMES, Brezovica, Slovenia) \approx 50 m east of the PM1.0 measuring site

1-min averages of:

- Temperature
- Relative humidity
- Global radiation
- Air pressure
- Horizontal wind speed
- Vertical wind speed








Department of Geophysics

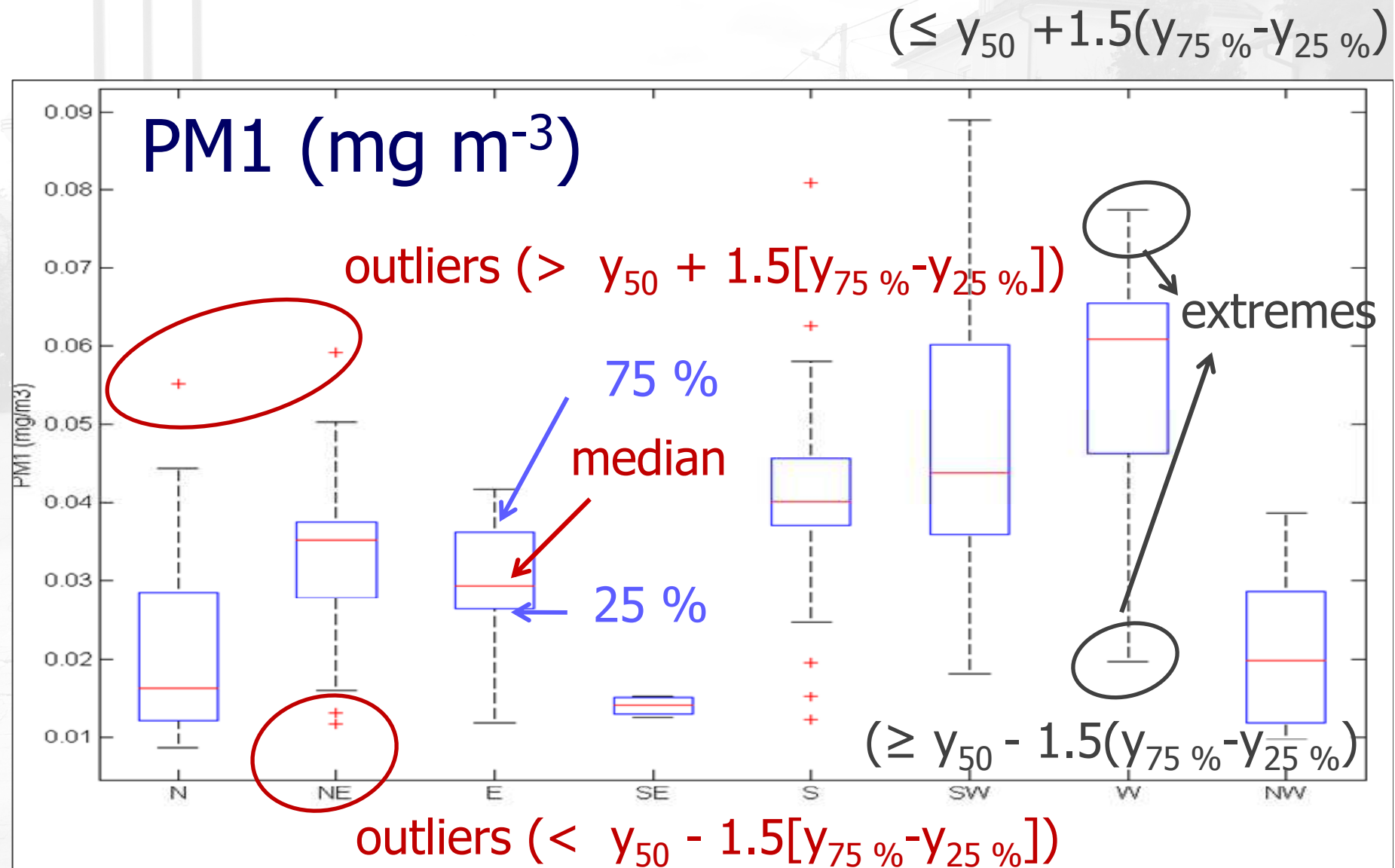
4. Traffic density data



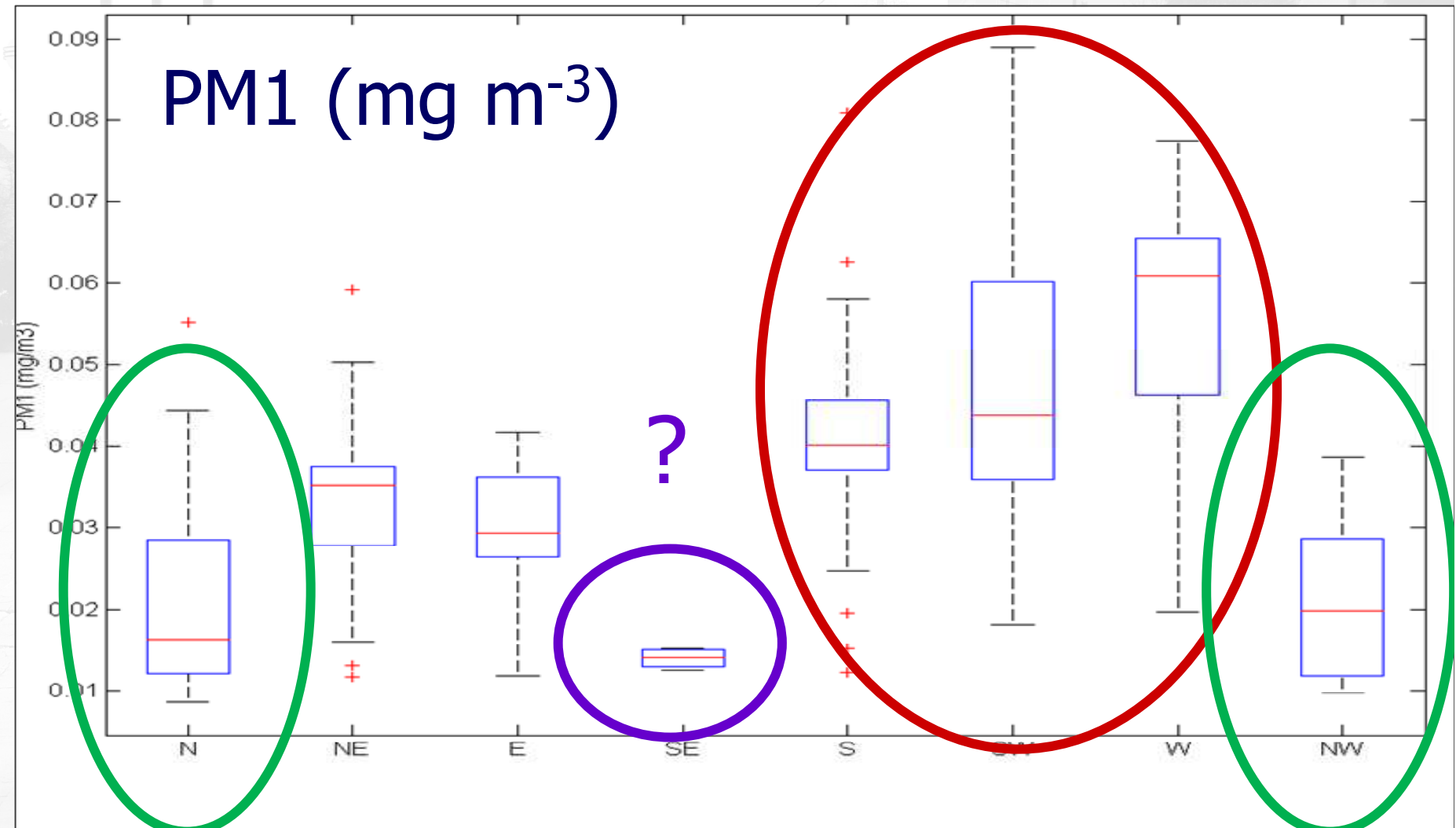
Assumed weighting coefficient (based on suggestion of the Centre for Vehicles of Croatia)

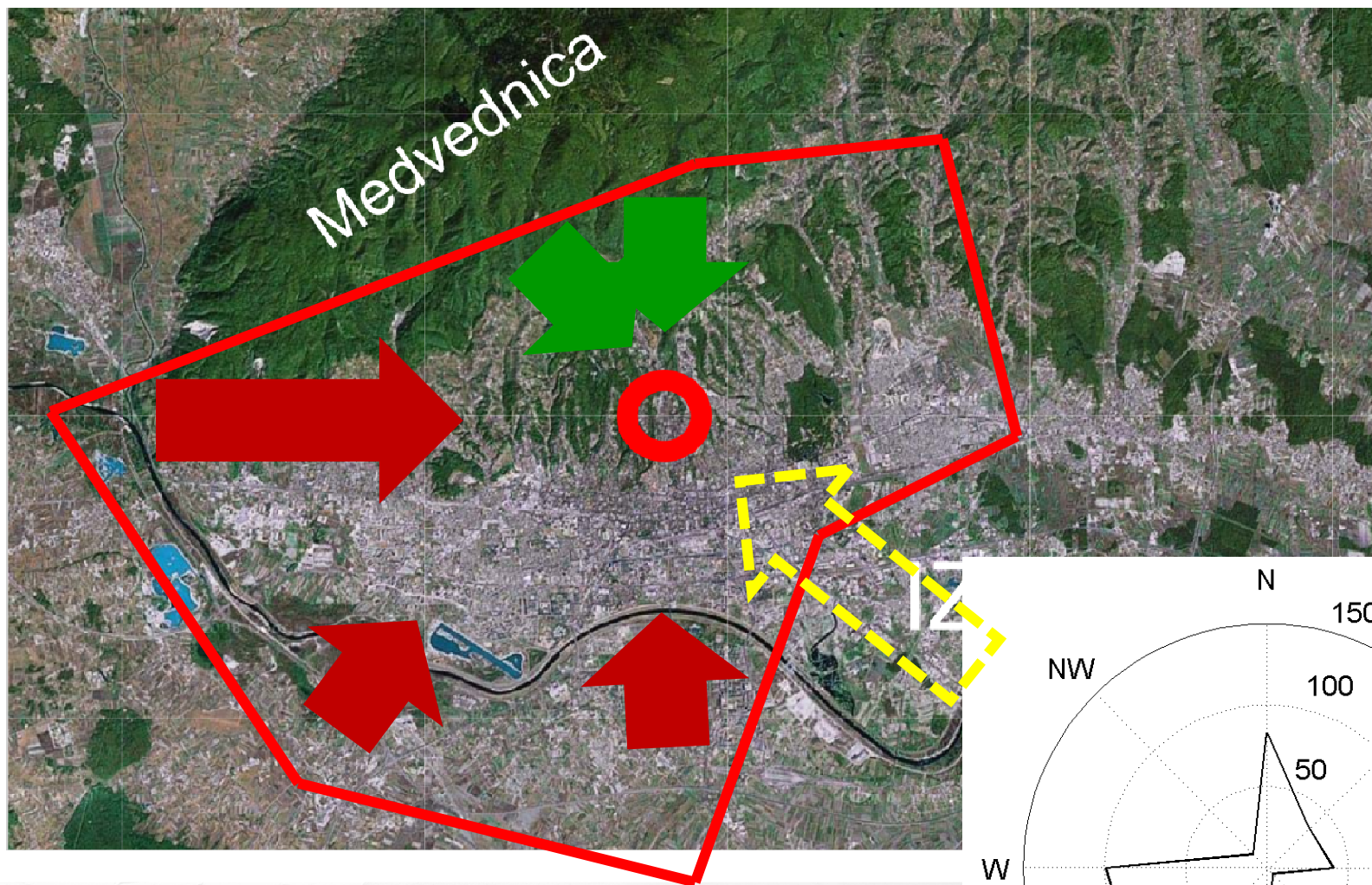
Type of vehicle	Assumed fuel consumption (l/100 km)	Weighting coefficient
Car 	8	1
Terrain - car 	12	1.5
Van 	16	2
Truck 	25	3.125
Bus 	30	3.75

5. Preliminary results and conclusions

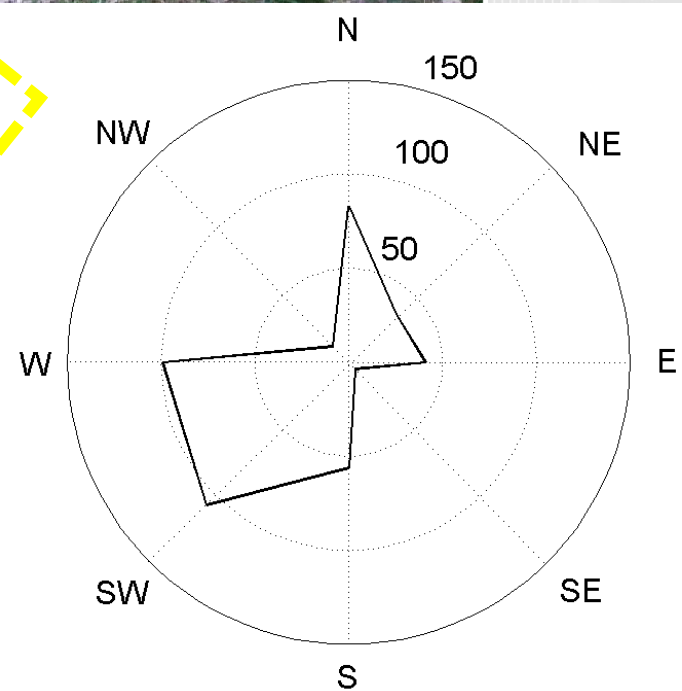


Wind directions





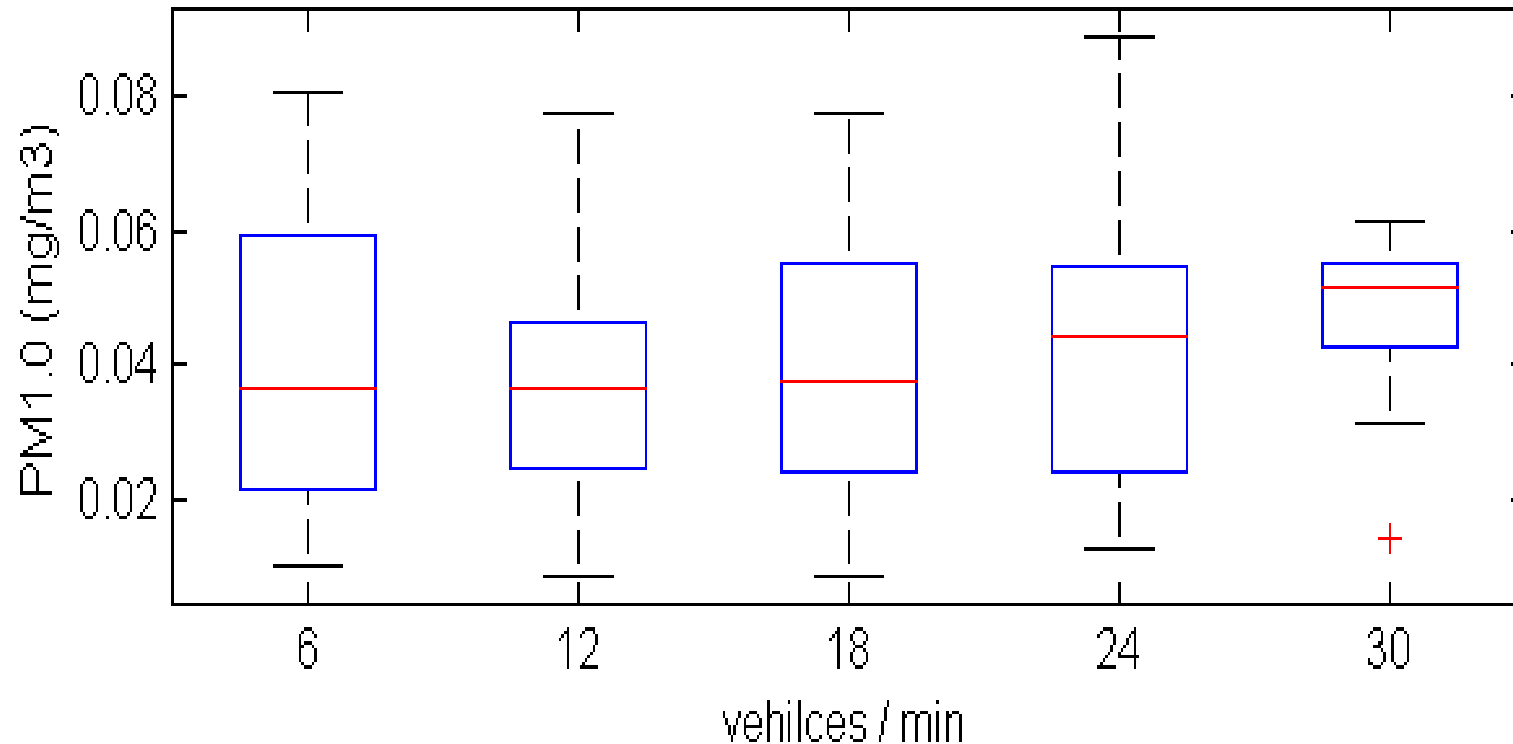
Mean PM1 concentration



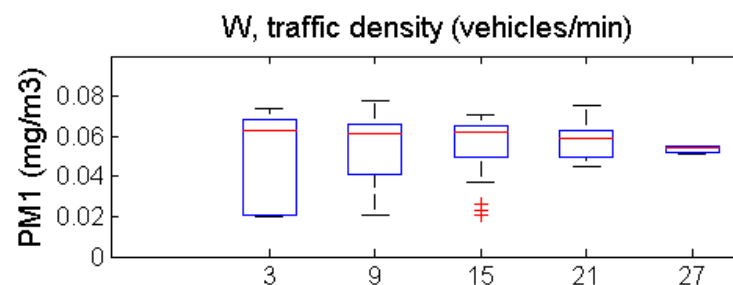
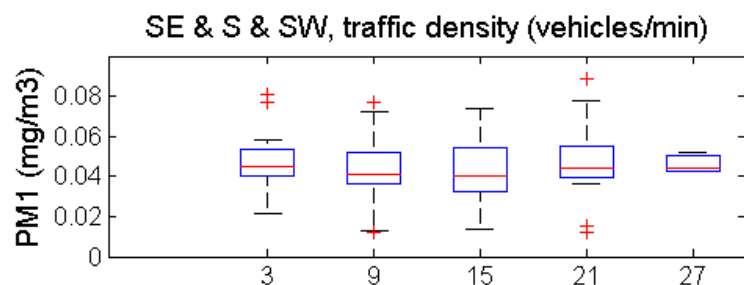
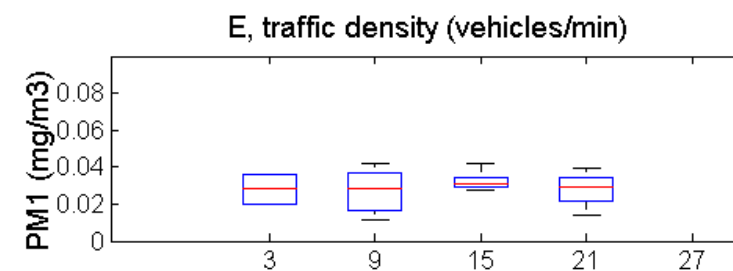
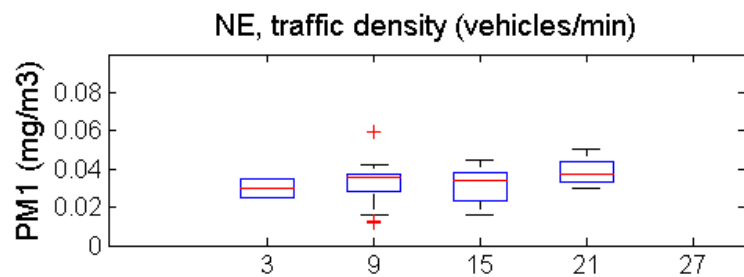
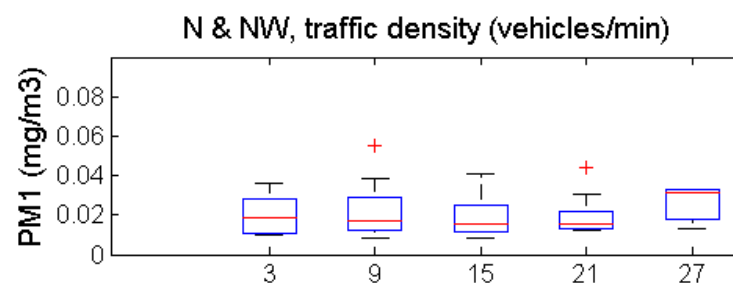
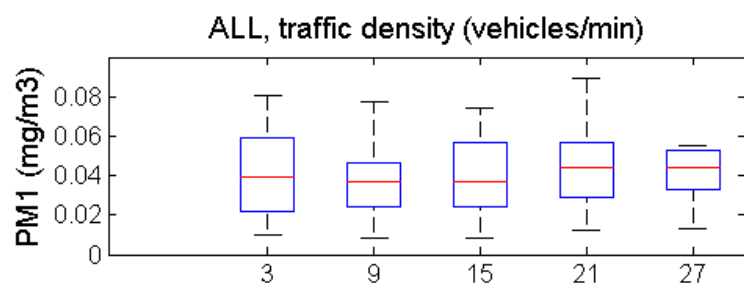
Absolute frequency of wind direction

Wind direction	<i>Absolute freq.</i>
all	439
N + NW	95
NE	36
E	41
SE + S + SW	168
W	99

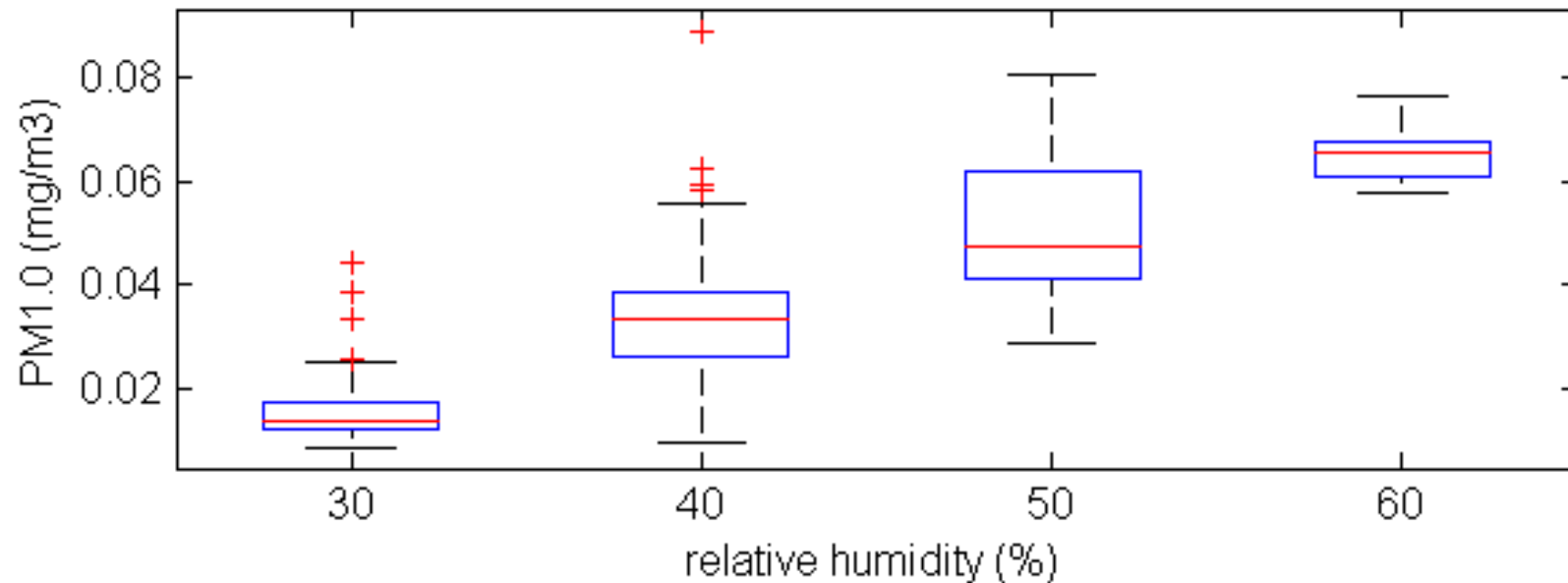
Traffic density



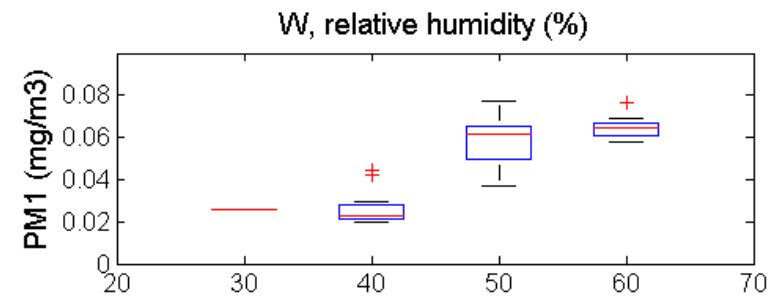
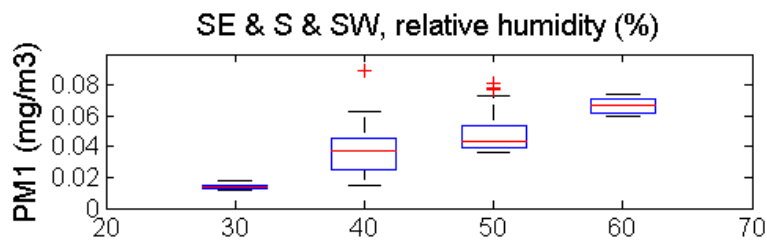
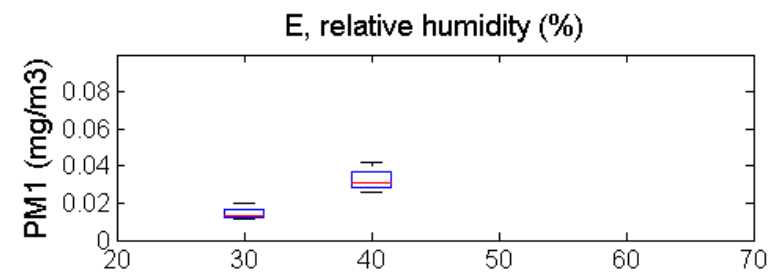
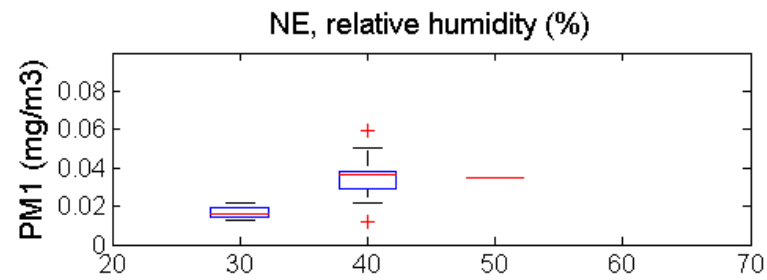
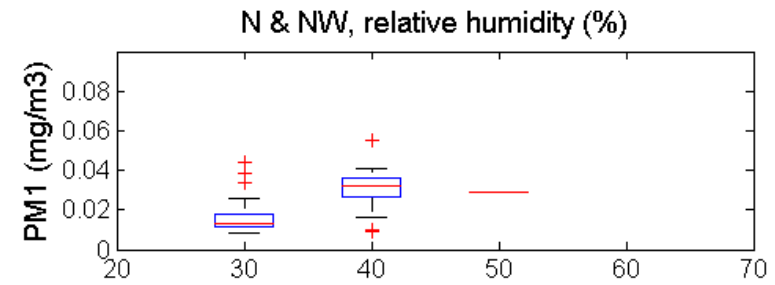
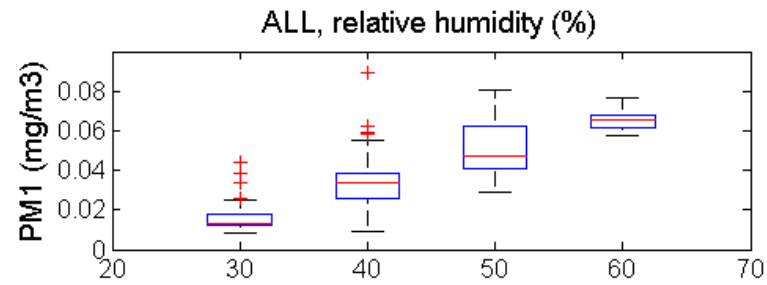
⇒ PM1.0 concentrations increase with the traffic density but only if the number of vehicles is above 18 vehicles / min (\approx 1000 vehicles / hour); otherwise concentrations are dominated by other sources and processes (e.g. by the transport of pollution from the city centre).



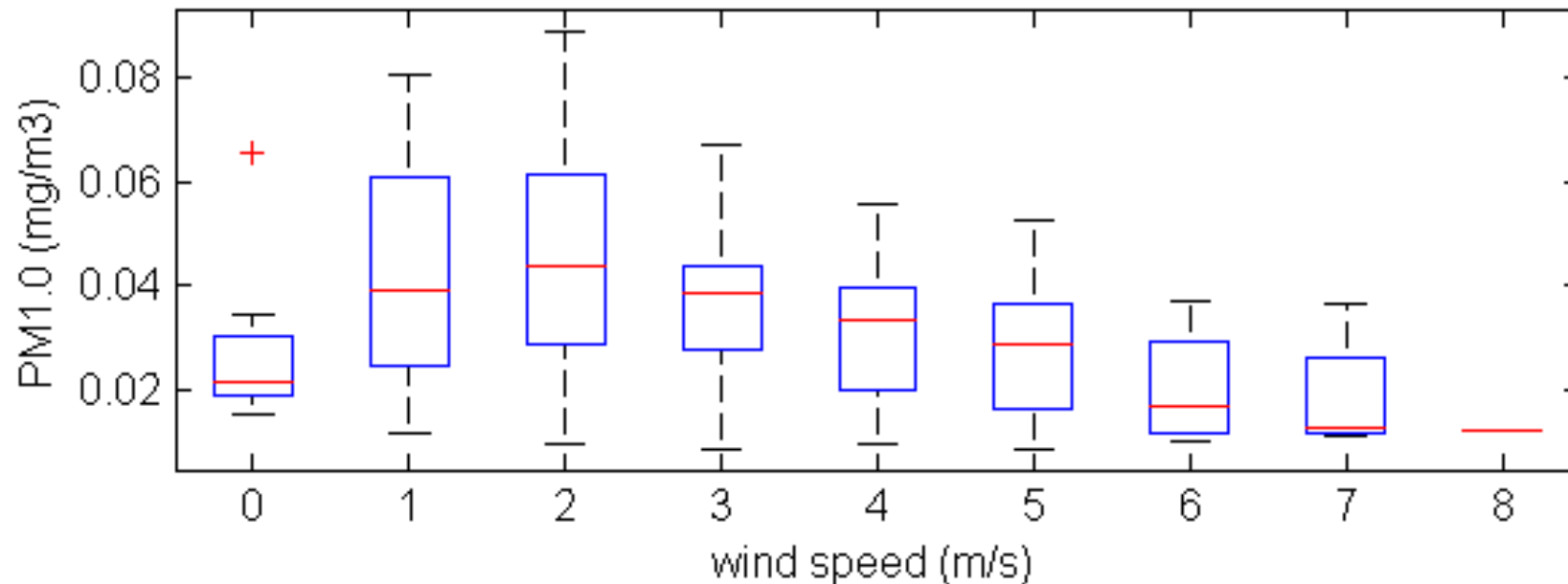
Relative humidity



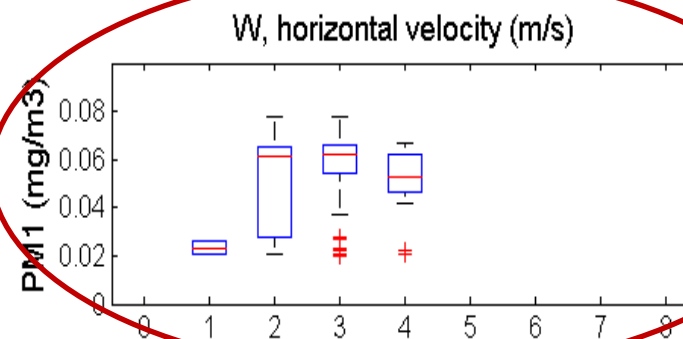
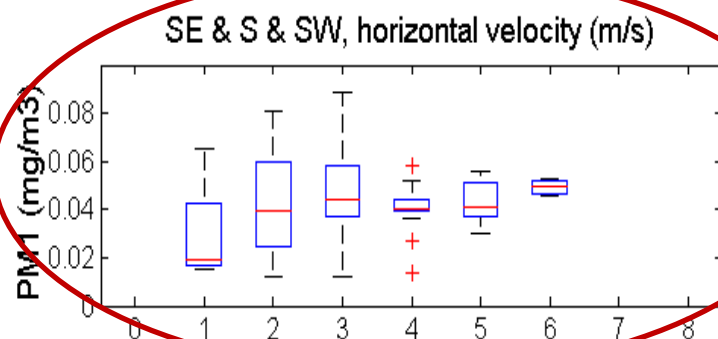
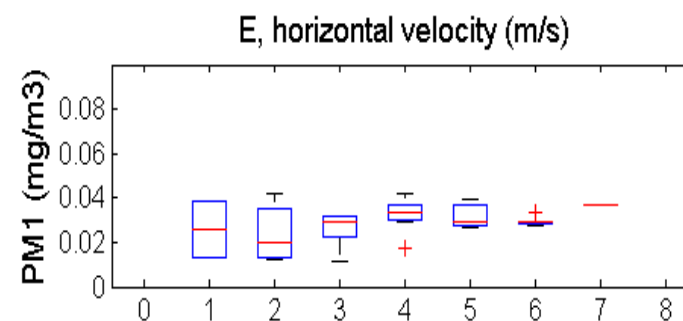
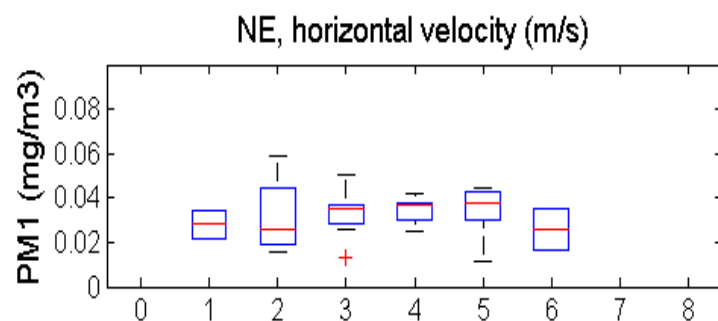
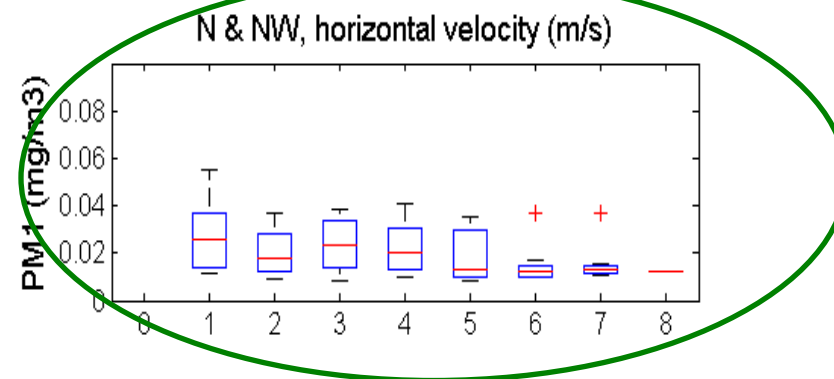
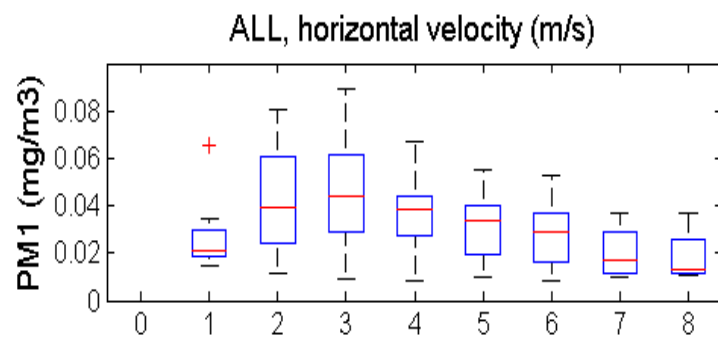
⇒ PM1.0 concentrations clearly increase with the relative humidity ⇒ It is in accordance with the formation of accumulation mode in the wet phase under presence of sulfur.



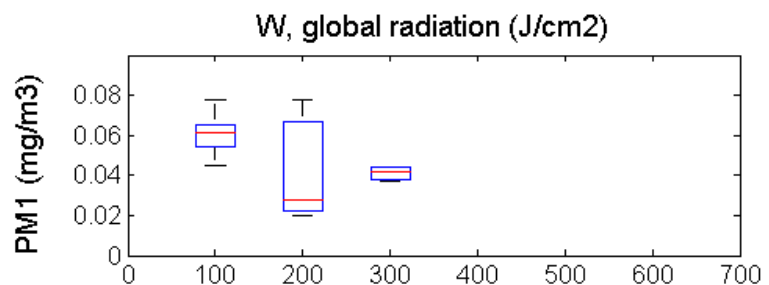
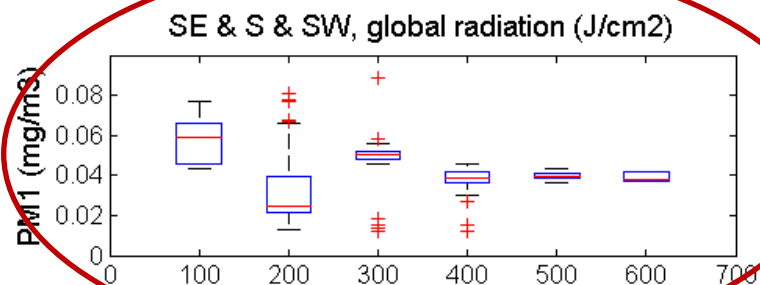
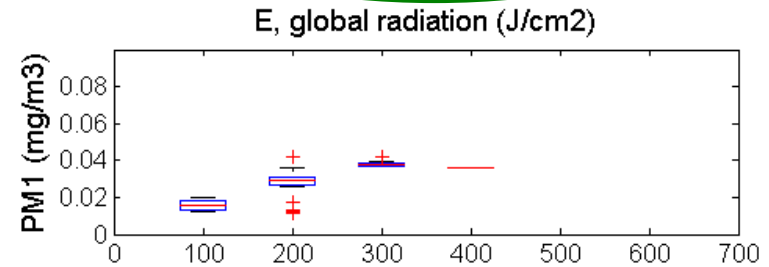
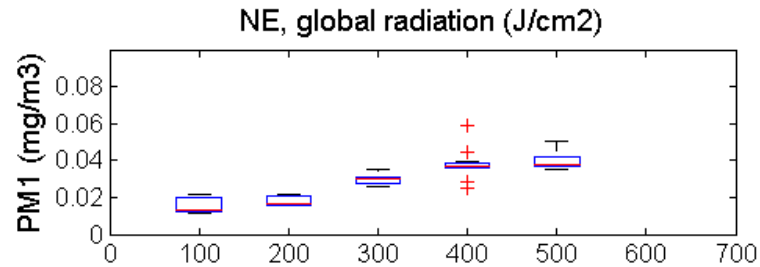
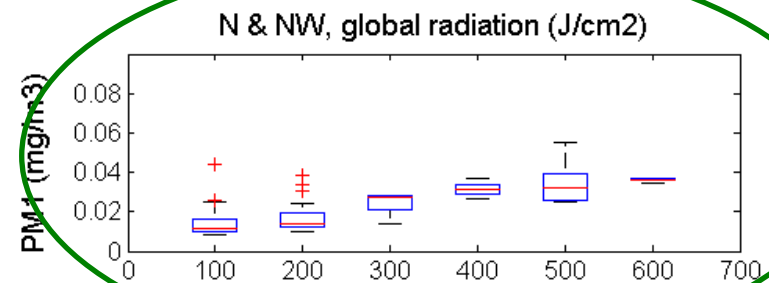
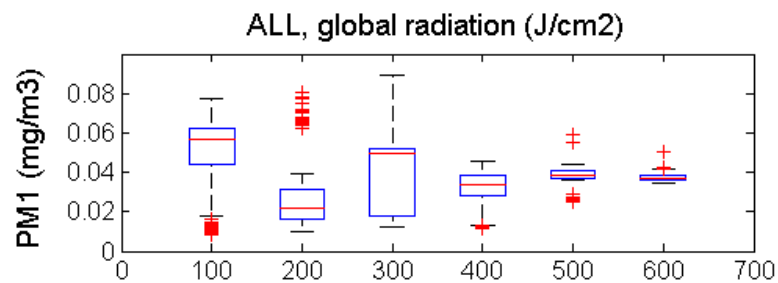
Wind speed



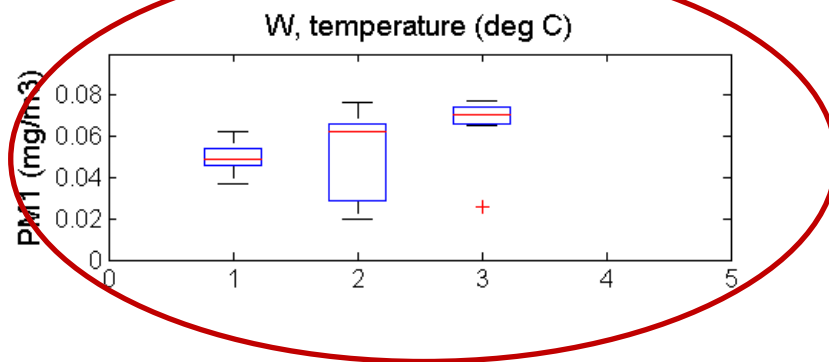
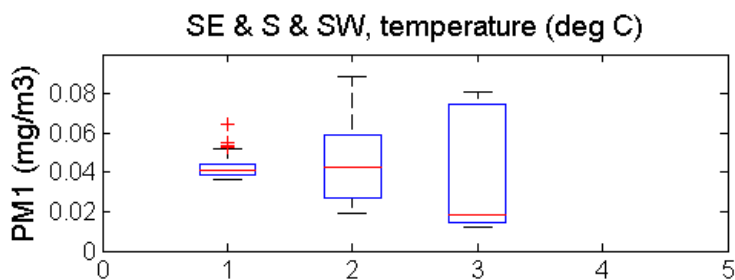
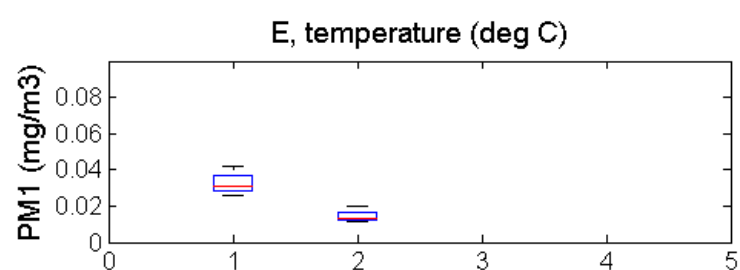
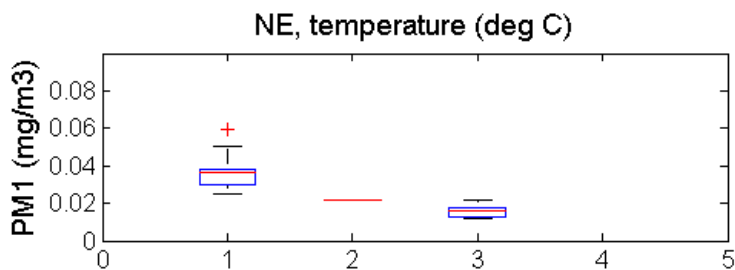
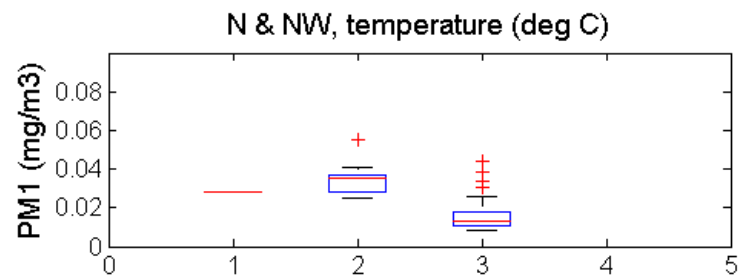
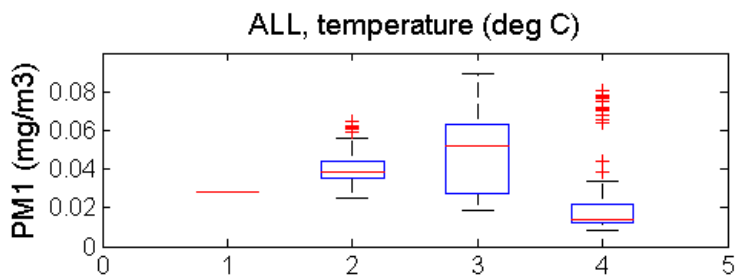
⇒ PM1.0 concentrations decrease with the horizontal wind speed for speeds above 2.5 m s⁻¹. For weaker wind speeds, pollutant dilution due to ventilation is dominated by other processes thus, resulting in the strengthening of PM1.0 concentrations.



Global radiation



Temperature





**THANK YOU FOR YOUR
ATTENTION**