The sensitivity of model results to local effects

Christine McHugh

Cambridge Environmental Research Consultants

DMUG, November 2004

CERC

ADMS-Urban used in this study &

- Beijing, China: planning the large-scale development for the 2008 Olympics
- Shanghai, China: city planning, traffic sources
- Hong Kong, China: city planning, traffic and airport
- Liaoning Province in China: industrial, heating and area sources
- Budapest, Hungary: decision making and air quality forecasting, large industrial sources and traffic
- Strasbourg, France: air quality assessment, traffic sources
- Rome, Italy: real time traffic management or “now-casting”, traffic sources
- Bologna, Italy: assessment of new tram system, traffic sources
- California, USA: traffic sources

CERC

⇨the elements of a good modelling study

- The usual care over all the data (including monitoring), rubbish in ⇨ rubbish out
- Model local effects:
  - **Bus stops**
  - **Traffic queues**
  - **Car parks**
  - **Street canyons**
  - **Slopes**
- Use a deterministic model, with chemistry

CERC

…this talk

- A typical study
  - published data
  - plus local authority input
  - plus site visit
- Using the modelling results, why it is important to get the right answer for the right reasons

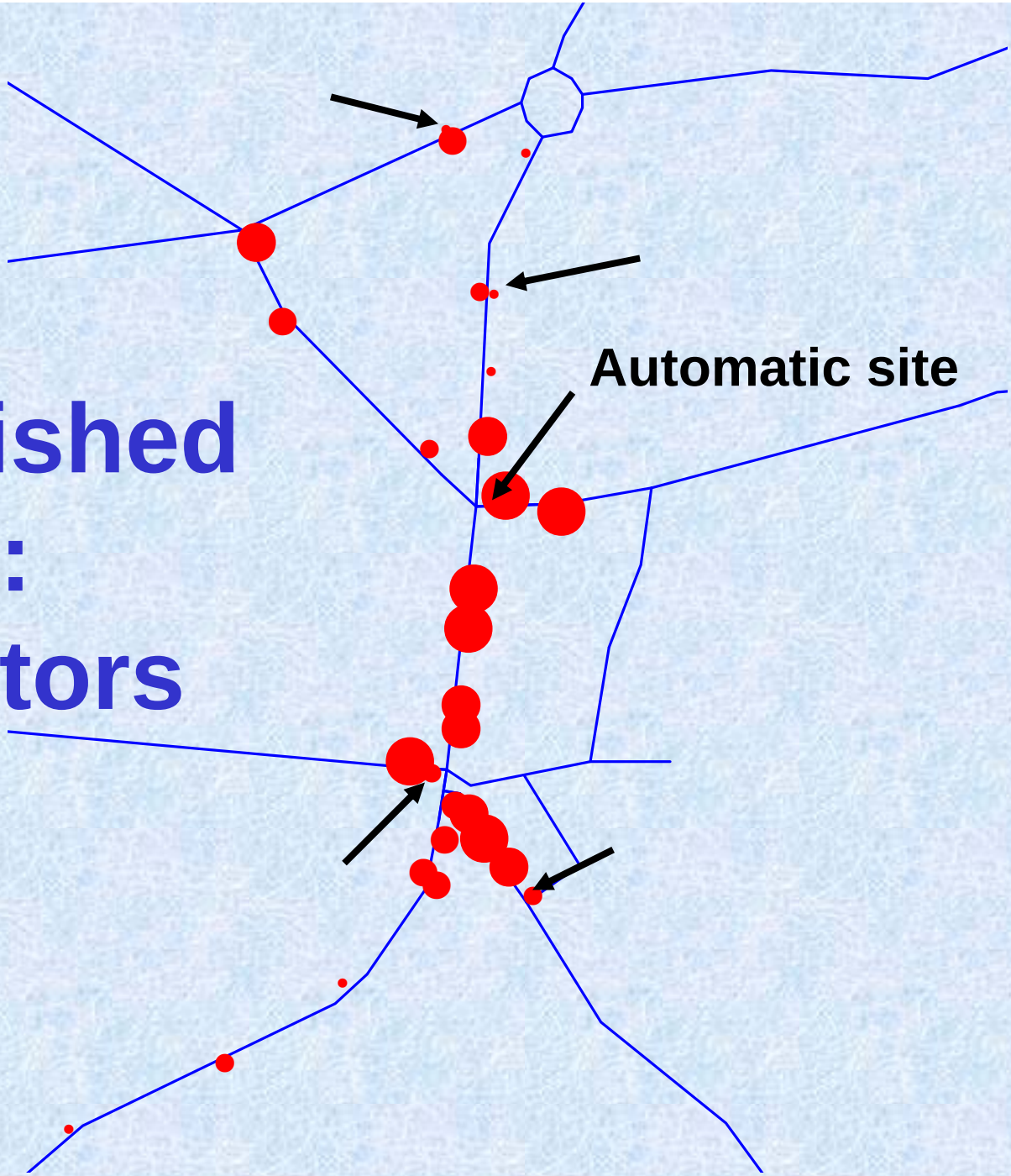
CERC

Published data : general

- Dudley, on the west of the Birmingham conurbation
- November 2002-August 2003**
- 29 monitors (1 automatic) for 20 months
- Recorded values of annual average NO_2 between 33 and 59 $\mu g/m^3$. UK & EU objective = 40 $\mu g/m^3$.
- AADT up to 17,000 vehicles per day where concentrations were highest

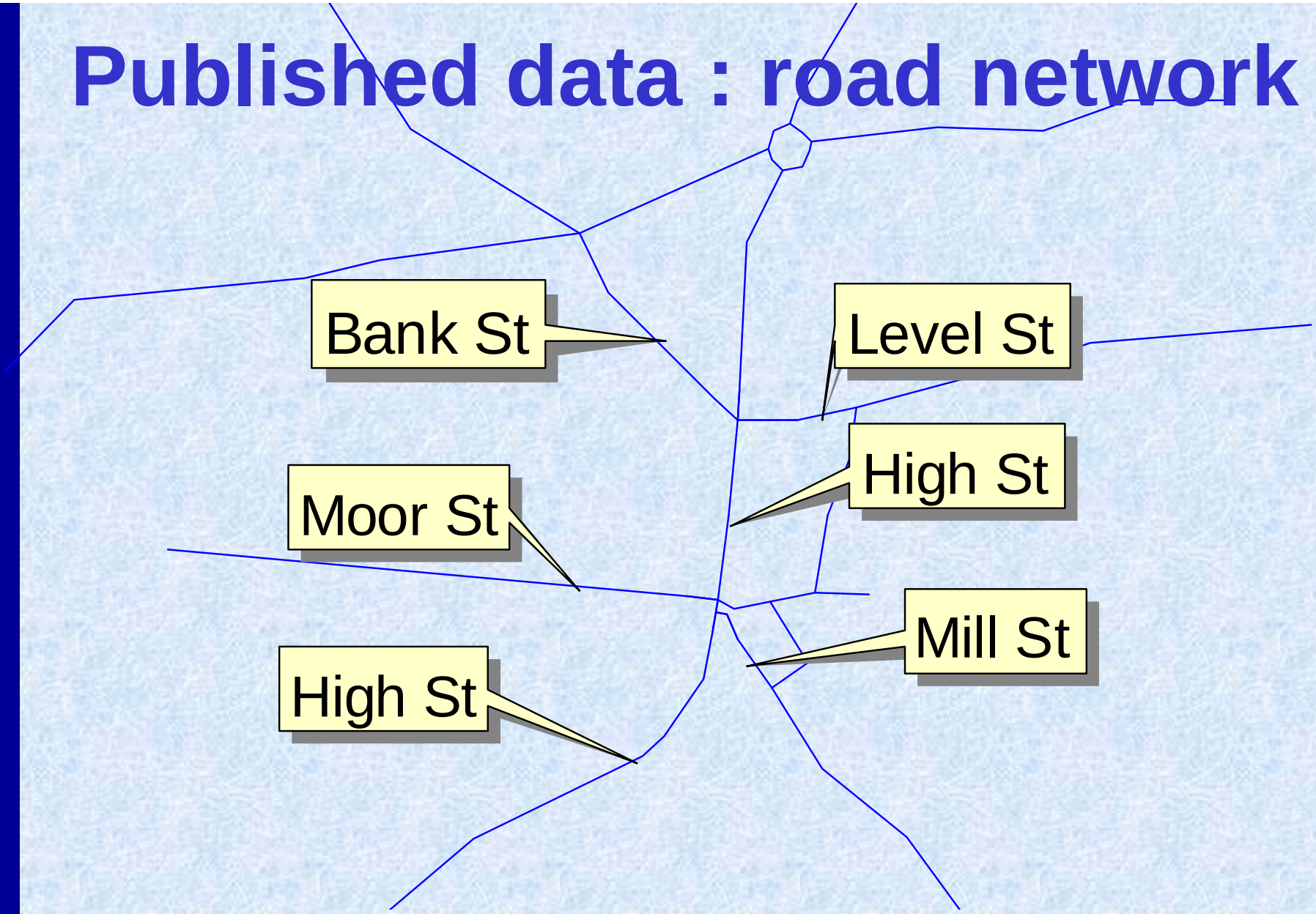
CERC

Published data : Monitors



CERC

Published data : road network



CERC

Published data : roads

- Traffic models, speeds of 16 or 32 km/hr
- Road widths – assumed to be 16m
- Canyons – no information

CERC

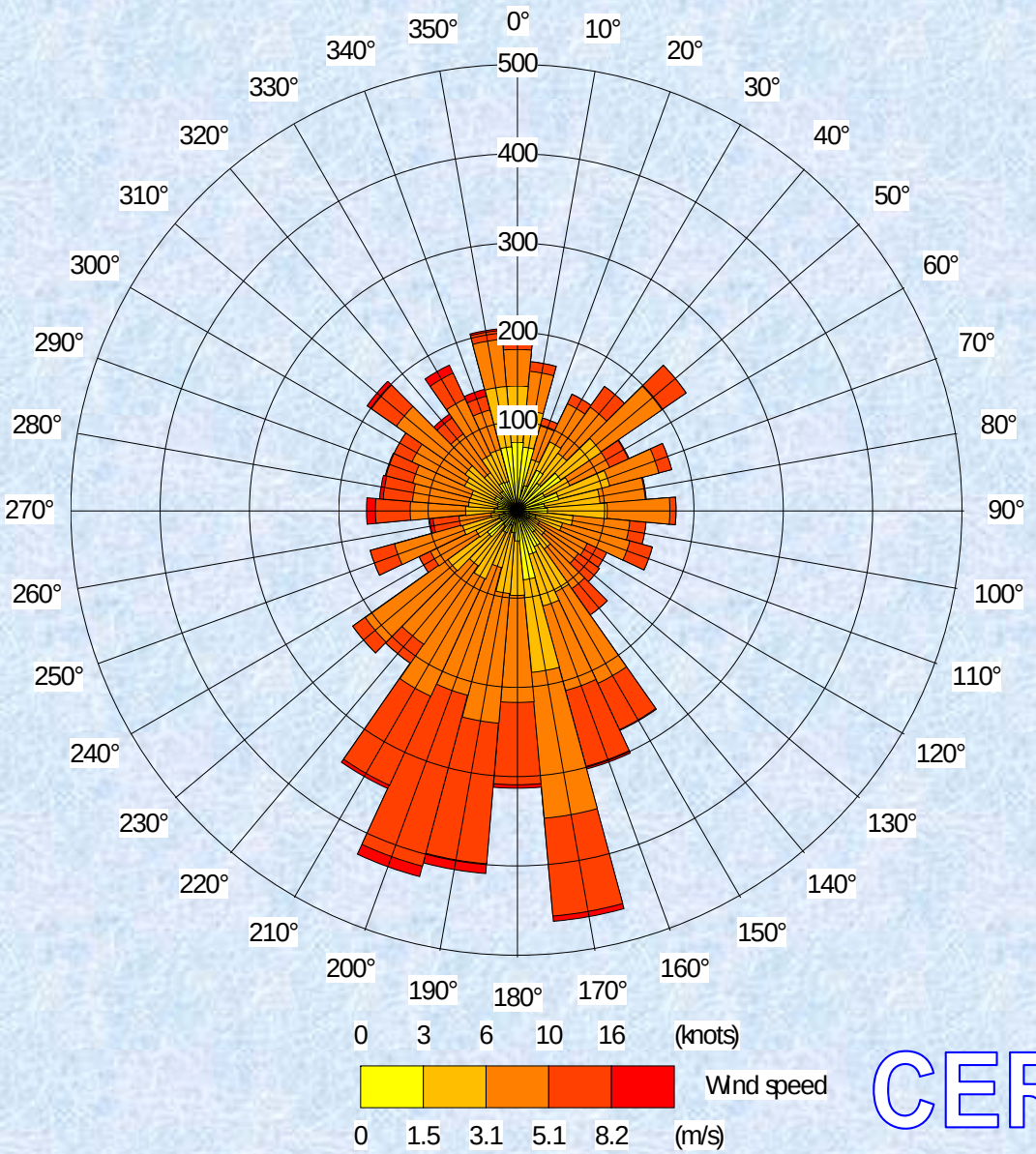
The study: background data

- Dudley, west Birmingham
- Monitored values of annual NO_2 between 33 and 59 $\mu g/m^3$.
- Dudley annual background = 25.8$\mu g/m^3$
- Used hourly data from Birmingham airport annual background = 31.9$\mu g/m^3$
- Decreased NO_X, NO_2, increased O_3

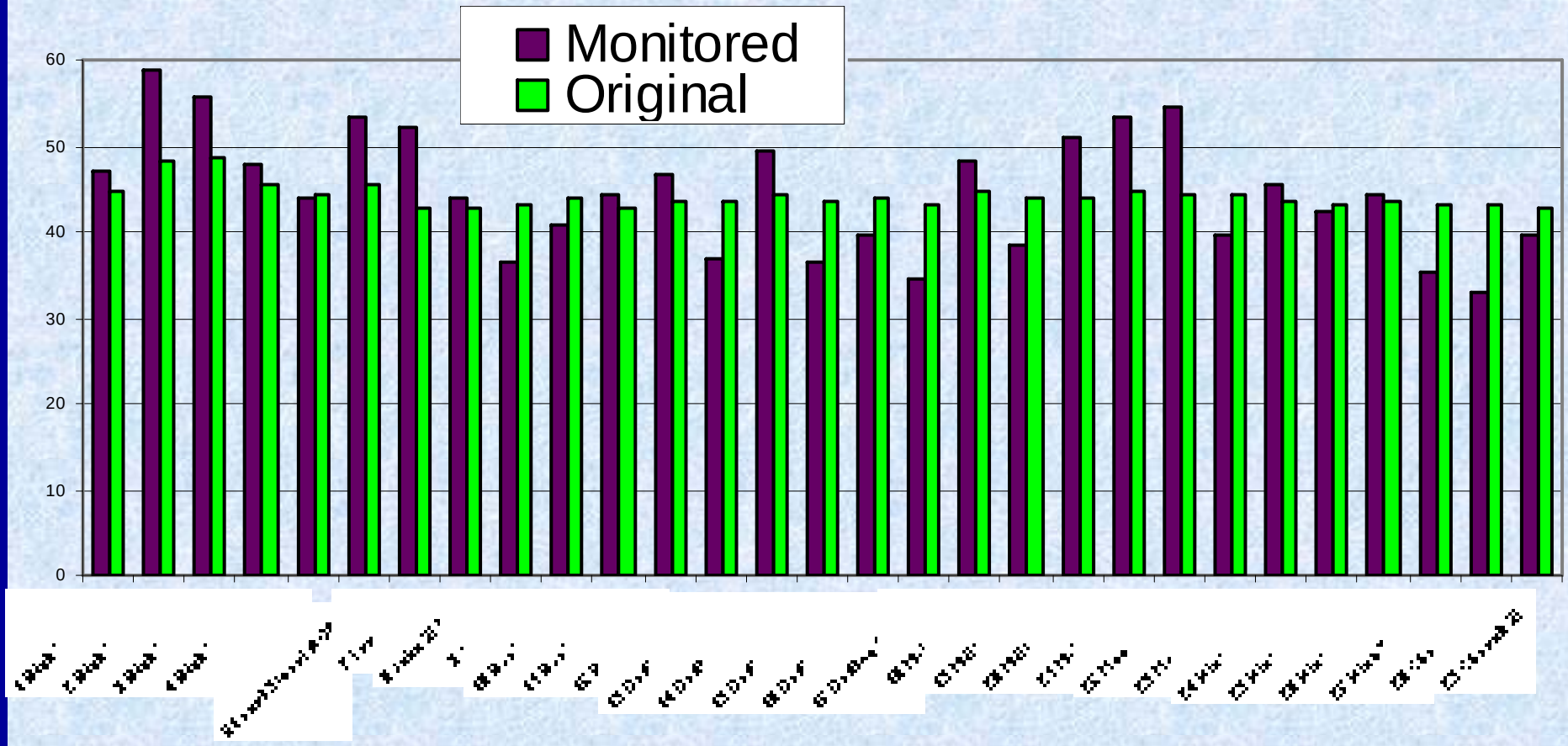
CERC

The study : met data

- Coleshill (Birmingham airport), 9km to the east of Dudley



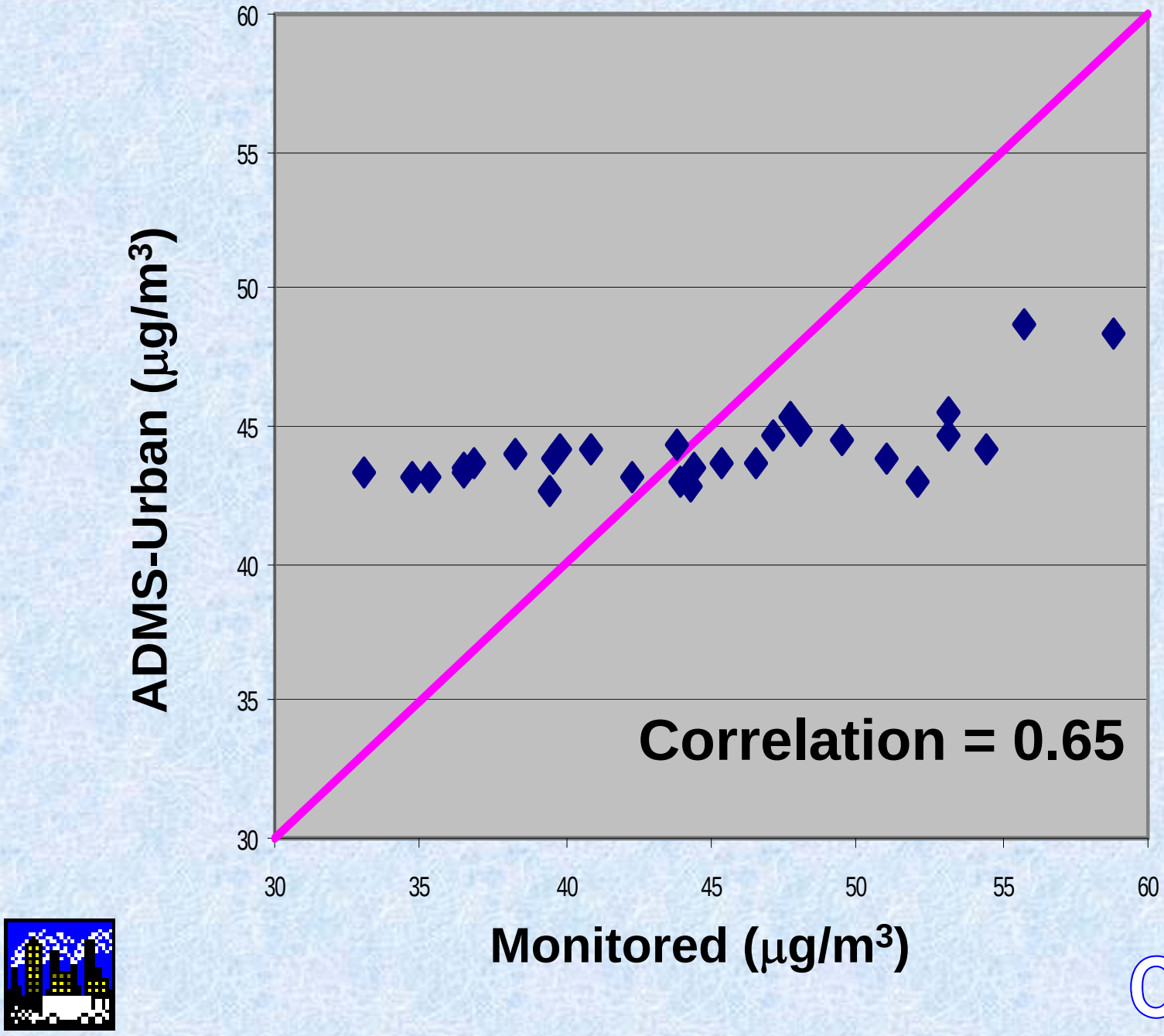
CERC



Average monitored = 44.6 μg/m³

Average modelled = 44.1 μg/m³

CERC


ADMS-Urban (µg/m³)
60
55
50
45
40
35
30
30
35
40
45
50
55
60
Monitored (µg/m³)
Correlation = 0.65

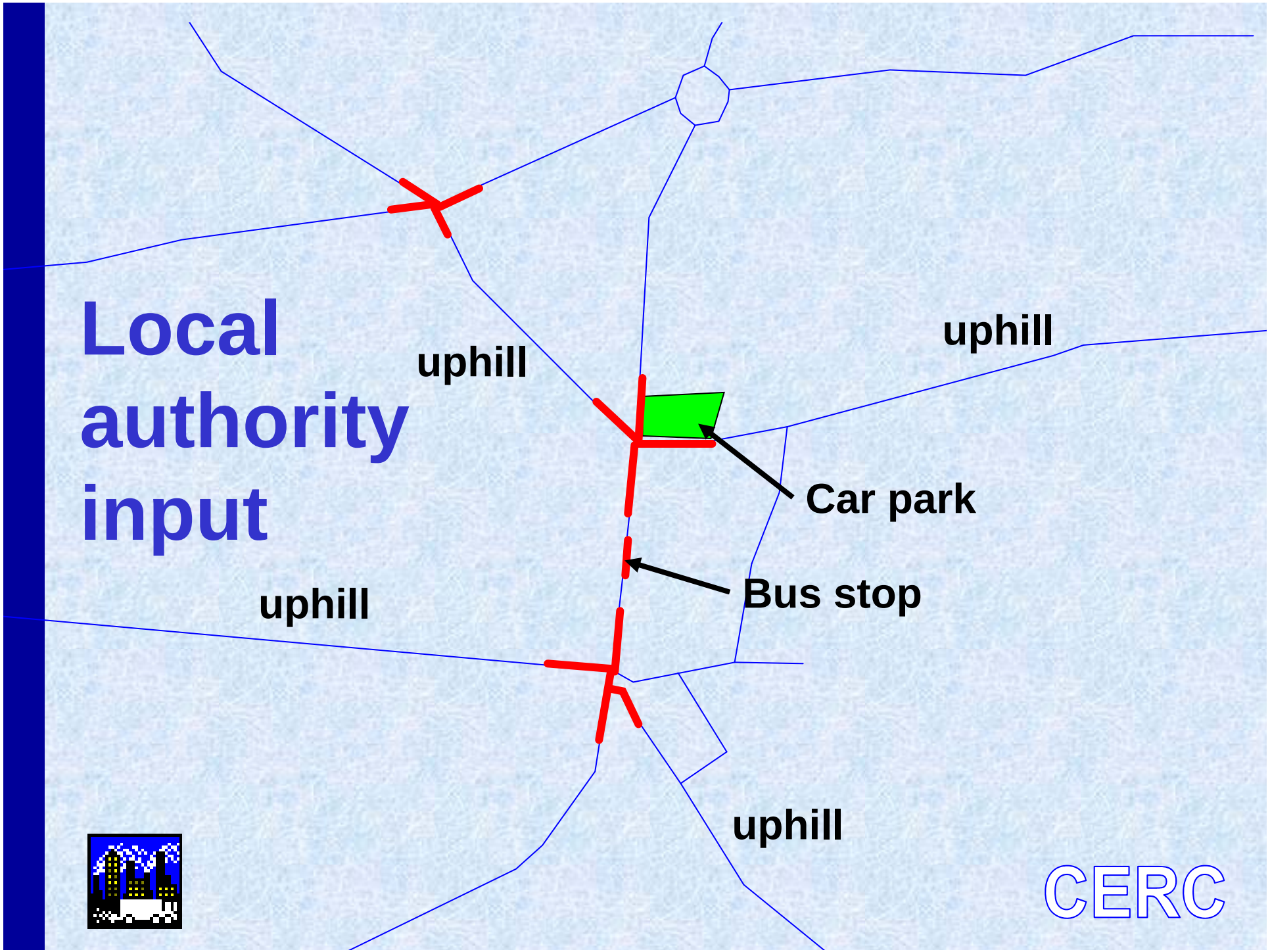
CERC

Local authority input

- The High Street runs along a ridge so some roads are on a gradient
- More detailed information on road widths and canyon heights in some places
- Queues at junctions
- Car park at Level St, location of the automatic monitor
- Bus stop near highest reading monitors

CERC

Local authority input



CERC

Mill Street, narrow road, canyon


Moor Street gradient

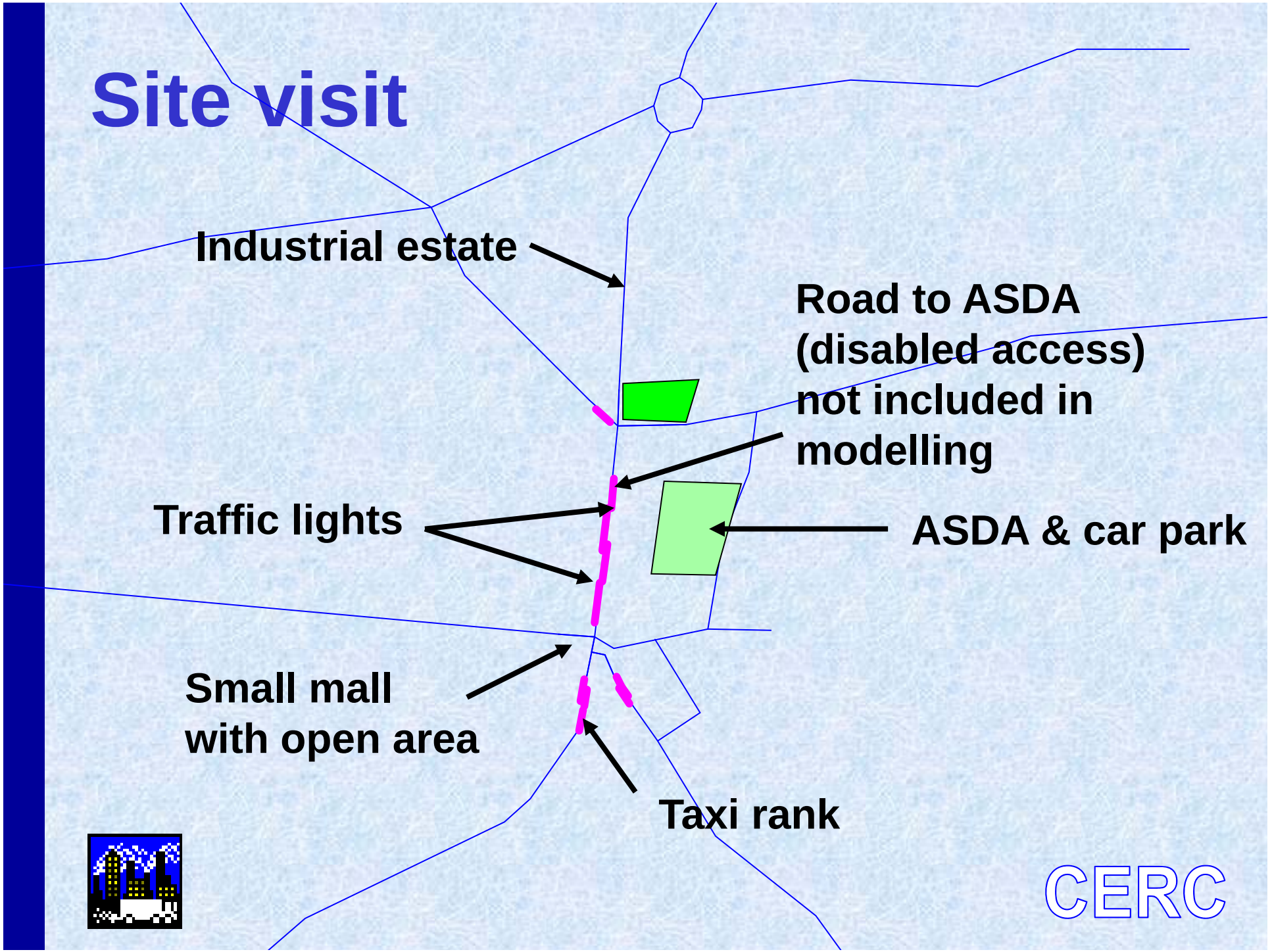
Site visit

- High St. is stop-start. There are 2 sets of traffic lights, one either side of the bus stop.
- Located other bus stops
- Even at 10.30am on a weekday morning there were long queues
- ASDA store and car park just off the High St. Small access road not included.
- Taxi rank

CERC


THE BRIERLEY
HILL FLORIST
01384 482244

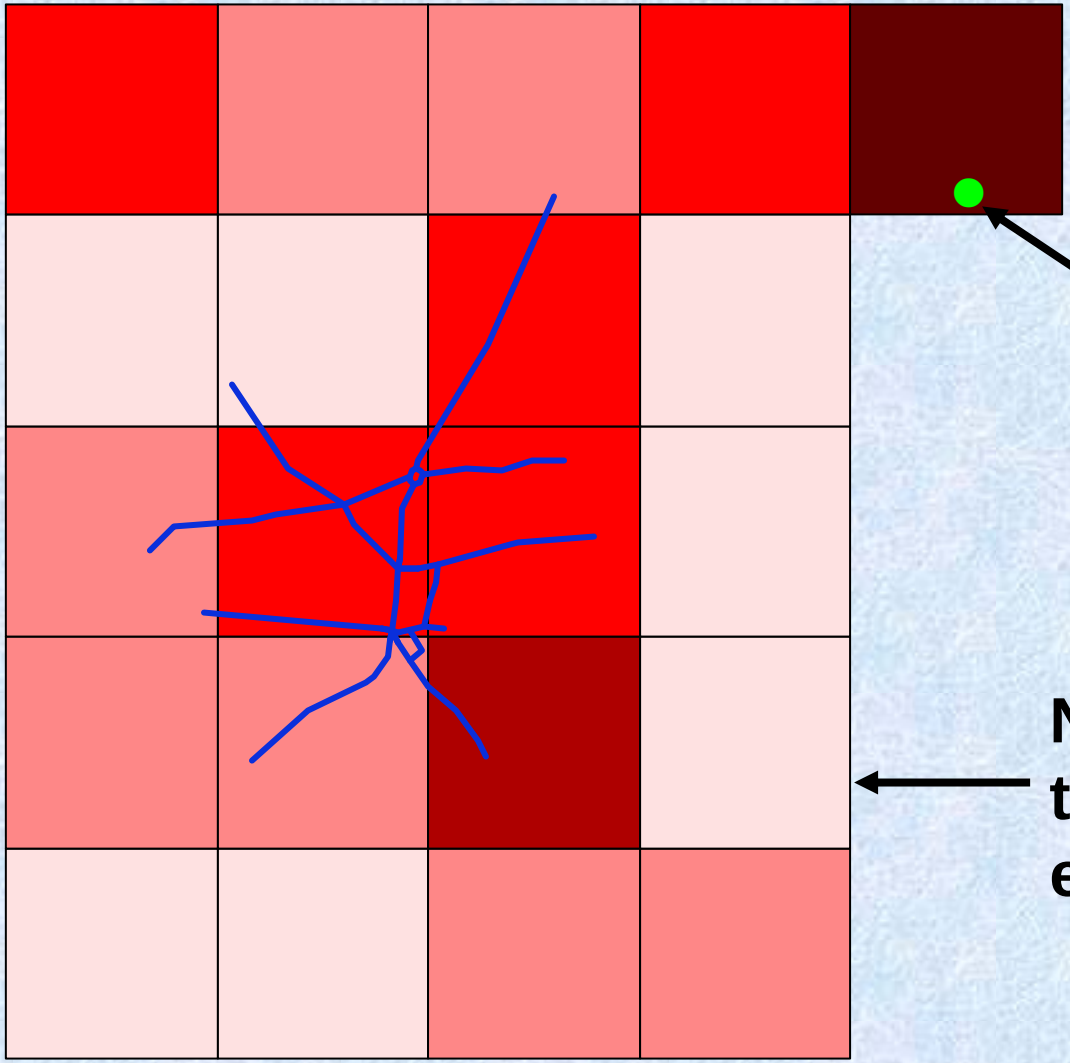
Site visit



CERC


MOOR CENTRE
MOOR CENTRE
POST OFFICE
POST OFFICE
Peacocks
Peacocks
Birmingham Midshires
MOOR STREET

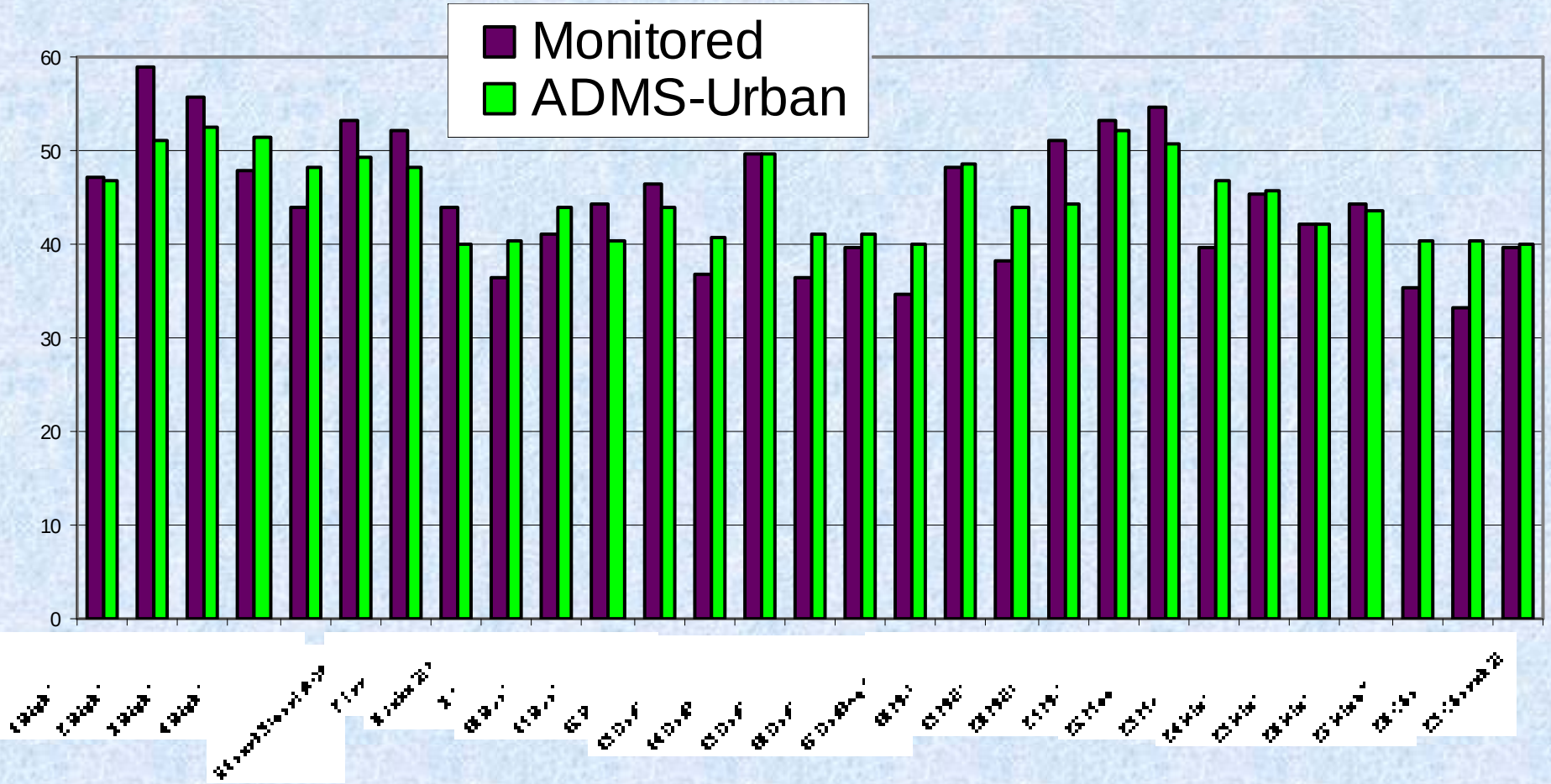
All the sources modelled



Part A (industrial source)

NAEI grids of total emissions

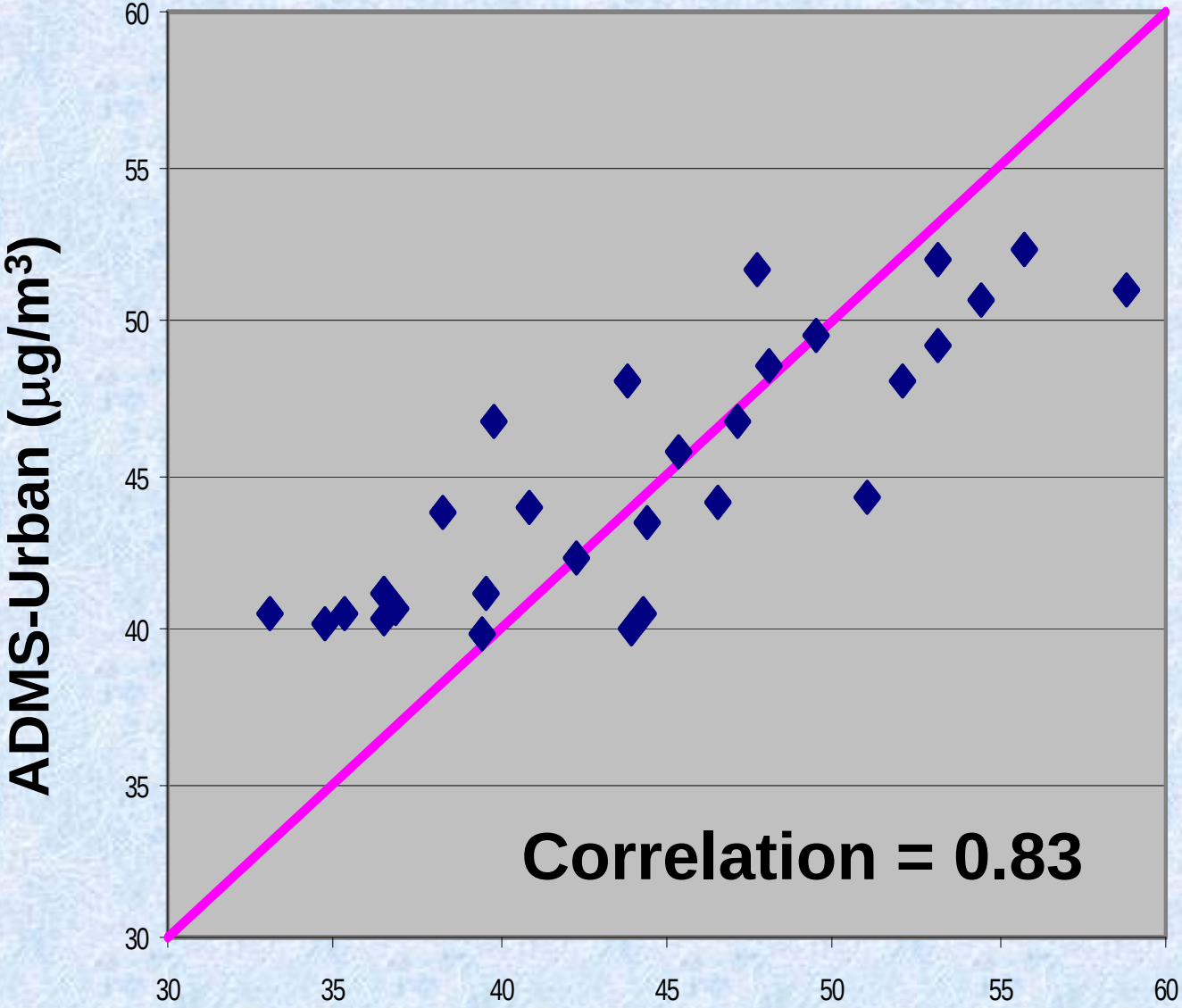
CERC



Average monitored = 44.6 μg/m³

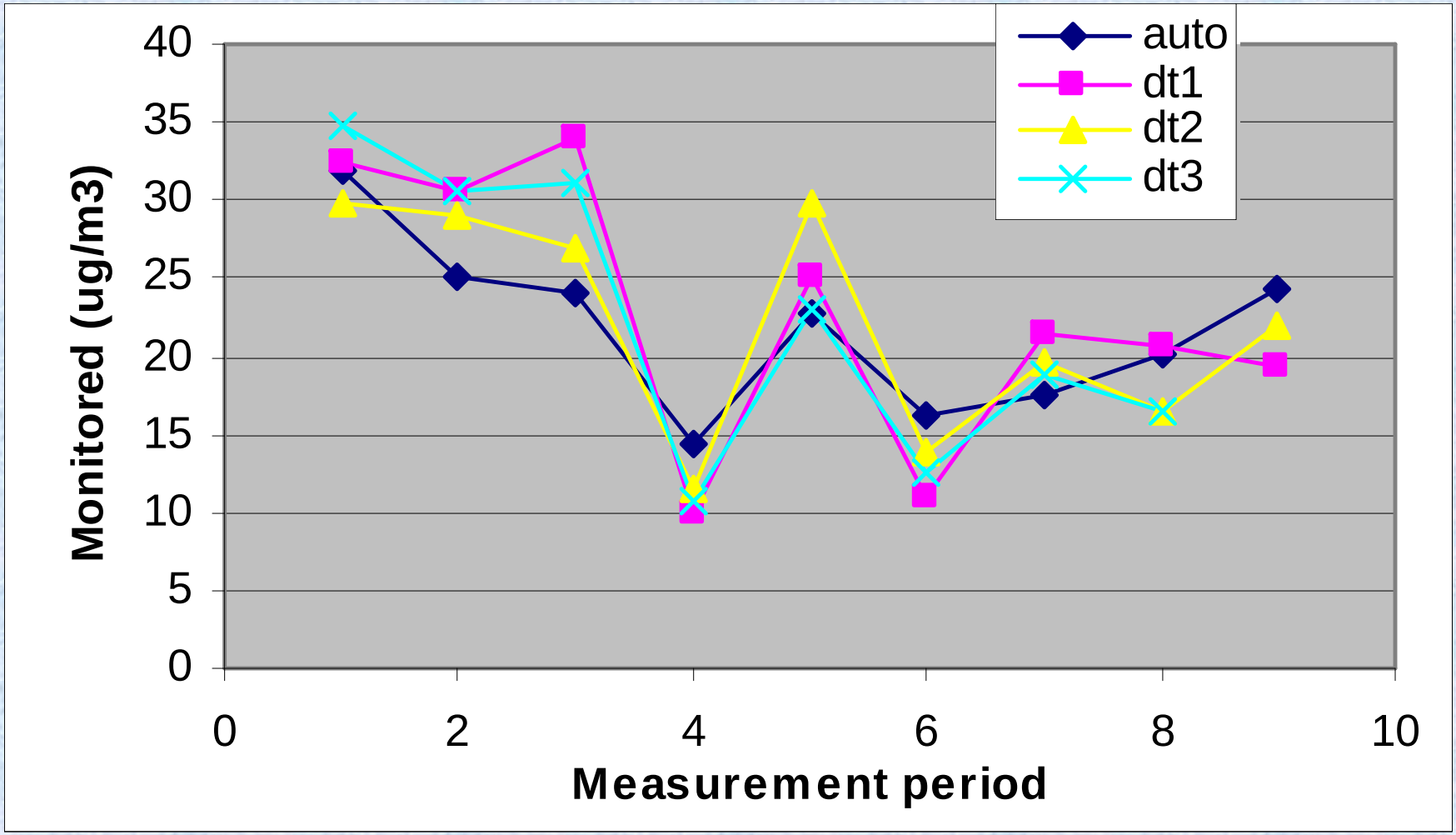
Average modelled = 45.1 μg/m³

CERC


ADMS-Urban (µg/m³)
60
55
50
45
40
35
30
30
35
40
45
50
55
60
Monitored (µg/m³)
Correlation = 0.83

CERC

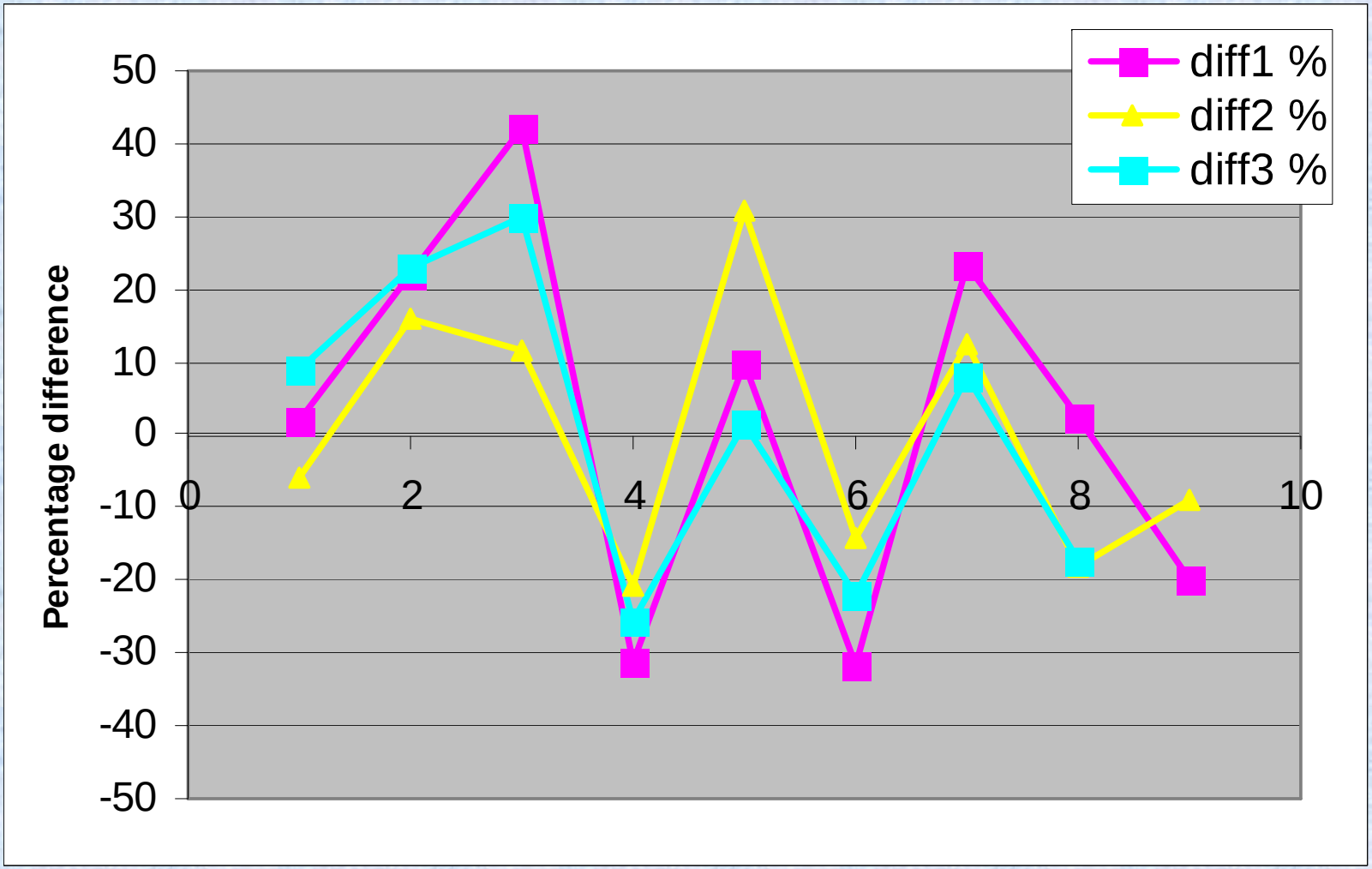
Diffusion tubes



- The range of values monitored by each diffusion tube is greater than that of the automatic monitor

CERC

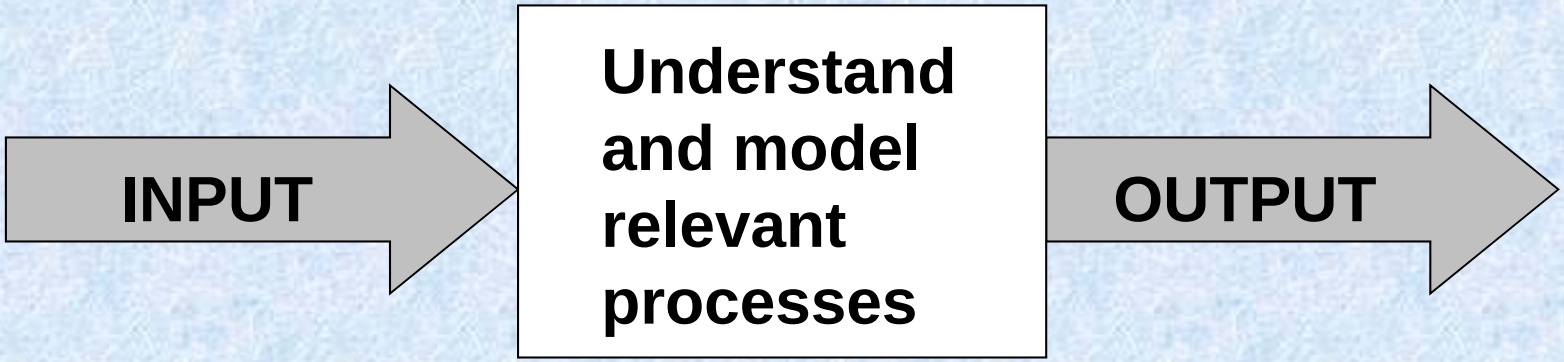
Diffusion tubes



- The percentage difference is up to 43%

CERC

Deterministic model



- Considers the input
  - Emissions
  - Ambient background
  - Meteorology
  - etc
- Calculates the output
- Alternatives e.g. statistical model

CERC

Deterministic model

- If a deterministic models satisfies the conservation equations
  – conservation of mass
  – there is a limit to how wrong the results can be

CERC

Modelling chemistry

- GRS (Generic Reaction Set) chemistry scheme to model reactions taking place for the background pollutants and the specified emissions
- No empirical relationships used. No separate consideration of background and kerbside contributions and concentrations
- **Approach: use the best available model of what's happening & model as a whole**
- Use the GRS scheme with trajectory model if more of the urban area were modelled

CERC

Why it matters

- Important to get the right answer for the right reason
- Correct source apportionment/attribution
- In assessing future trends you consider
  - the changes in background pollutants
  - changes due to your action plan's effect on local sources of emissions
- Danger of
  - Complacency – assume change in background greater than it will be
  - Too drastic action – attempt to reduce local emissions further than required

CERC

Why it matters (cont)

- The original study grossly under-estimated compared with monitored data
- Concluded that modelled concentrations of NO_2 needed to be multiplied by an adjustment factor of about 12.
- Incorrect attribution will lead to incorrect conclusions about how to improve air quality

CERC

Further work

- More local effects e.g Part B sources?
- Location of monitors – is there an effect due to mounting on building face?
- More detailed information on buses and queues
- Idling emissions
- Better assessment of effect of gradient
- % HGV too low?

CERC


222
TRAVEL
WEST MIDLANDS
WALSALL
Pensnett
Wordsley
B 4179
Quarry Bank
Cradley Heath
Merry Hill
Level St car park, site
of automatic monitor

Further work

- Ideally
  - have background data from more than 1 site
  - model Greater Birmingham grids
  - use trajectory model to model the change in background concentration
- Model the effect of hills?
- Use new NAEI gridded emissions
- Model developments e.g. 1 sided canyons

CERC

Conclusion

- Take care over the input data
- Monitored concentrations are related to emissions
- Include relevant local effects
  - **Bus stops**
  - **Traffic queue**
  - **Taxi ranks**
  - **Car parks**
  - **Gradients**
- Model chemistry using the available model of the chemical reactions

CERC