AAMG - Royal Society of Chemistry

Monitoring Ambient Air

European Perspective on Particulates and Photo-oxidants

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Recent Developments in Modelling Urban Air Pollution and Interpreting Data

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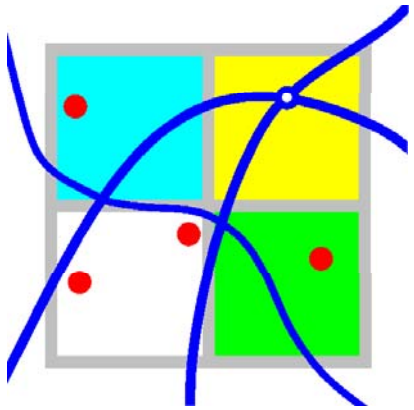
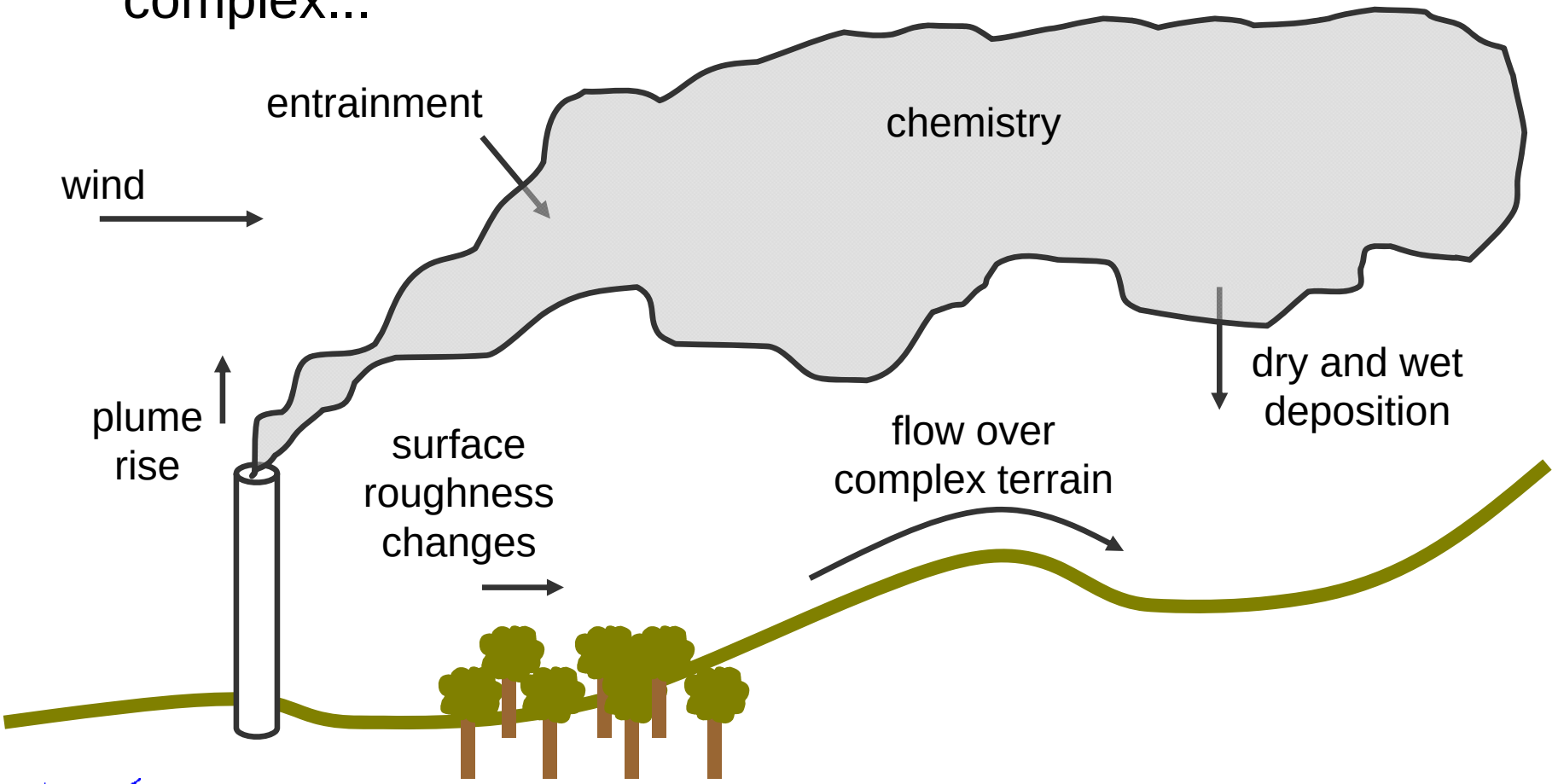


Introduction

- Gaussian plume dispersion models are increasingly complex...



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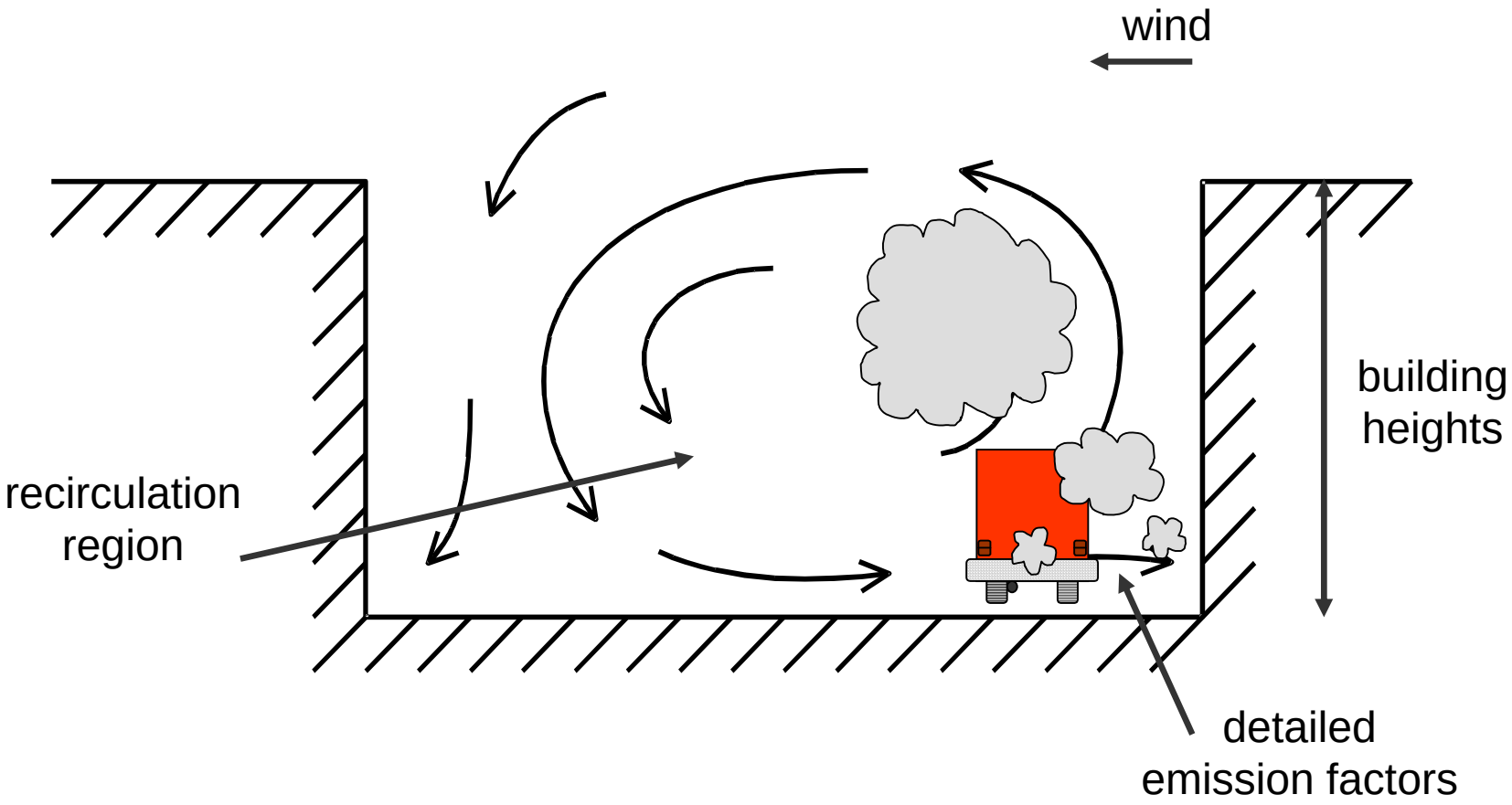

- ...but the results obtained are only as good as the source data that goes into the model.

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Source data

Source of emissions		
road and rail		
industrial (point and area sources)		
commercial and domestic (gridded emissions)		

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Source data

Source of emissions	Associated data	
	Physical parameters	
road and rail	locations, widths, building heights	
industrial (point and area sources)	locations, stack heights, diameters	
commercial and domestic (gridded emissions)	grid locations and dimensions	

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Source data

Source of emissions	Associated data	
	Physical parameters	**Emissions parameters**
road and rail	locations, widths, building heights	speeds, traffic flows, fleet compositions, emissions datasets
industrial (point and area sources)	locations, stack heights, diameters	exit velocity, exit temperature, emissions profiles
commercial and domestic (gridded sources)	grid locations and dimensions	emissions

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What is needed?

- all the emissions data in one place:
  - *validated prior to use* (for example, checking source parameters)
  - *manipulated* (for example, traffic management schemes)
  - *exported* (for example, into air dispersion modelling software)
  - *stored for subsequent use* (for example, greenhouse gas emissions inventories and noise mapping projects)
- EMIT – an atmospheric EMissions Inventory Toolkit

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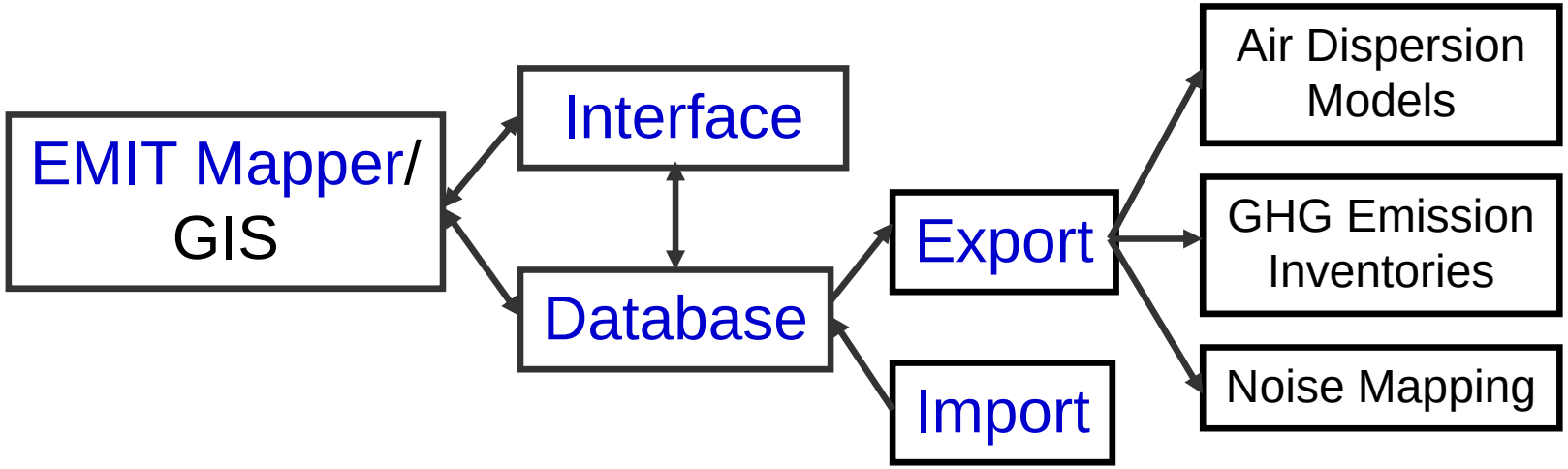
What is EMIT?



- User-friendly, PC-based Microsoft Windows software
- Microsoft Access database (Access 97)
- In-built visualisation tool (EMIT Mapper) as well as links to a Geographic Information System (GIS).

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EMIT source types

- EMIT is a database of pollutant sources
- 6 group types

Group type	Source type	Examples of groups
Major roads	line	Motorways, A roads, B roads
Minor roads	grid	C roads, residential areas
Rail transport	line	Passenger trains, freight trains
Point sources	point	Part A sources, Part B sources
Area sources	area	Industrial areas, car parks
Commercial and domestic sources	grid	Commercial and domestic heating emissions, industrial solvent emissions, natural emissions

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How is the data stored?

structure

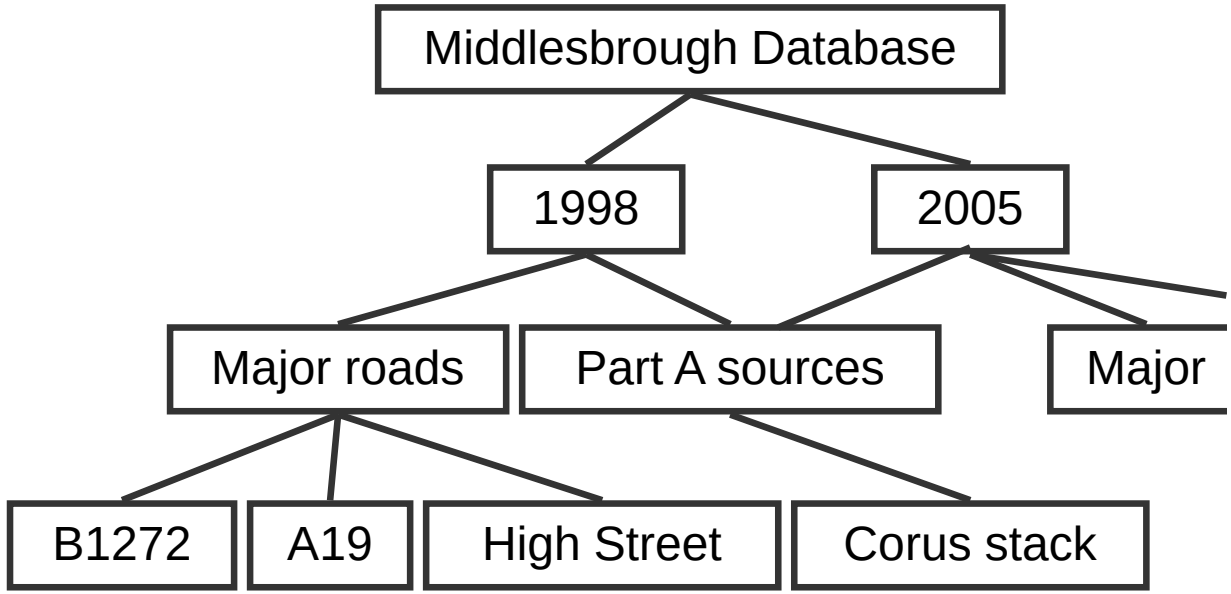
Database

Inventories

Groups

Sources

example



- Tree-like database structure

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Road transport emission factors

- Road transport is major source of pollution
- Urban air dispersion modelling of NO_x, NO_2, particulates etc requires
  - detailed emission factors
  - detailed fleet composition prediction data

Emission factor set	No. of vehicle categories	Examples of categories
EURO	92	Diesel cars (small and large engine engine Pre-EURO, EURO I, EURO II, EURO III, EURO IV)
LRC	8	Petrol cars, diesel cars, petrol LGVs, diesel LGVs, rigid HGVs, articulated HGVs, buses and coaches, motorcyles
DMRB	2	Light and heavy duty vehicles

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Some common tasks

1. *Validation* of source data
   - It is useful to view sources ranked according to emissions
2. *Manipulation* of source and emissions data
   - Sources may be removed – for example an industrial plant closing down, or new sources may be created
   - Various Traffic Management schemes may be investigated, for example creation of a Low Emission Zone (LEZ)
3. *Export* of emissions data
   - For example, to an Urban air dispersion model such as ADMS-Urban

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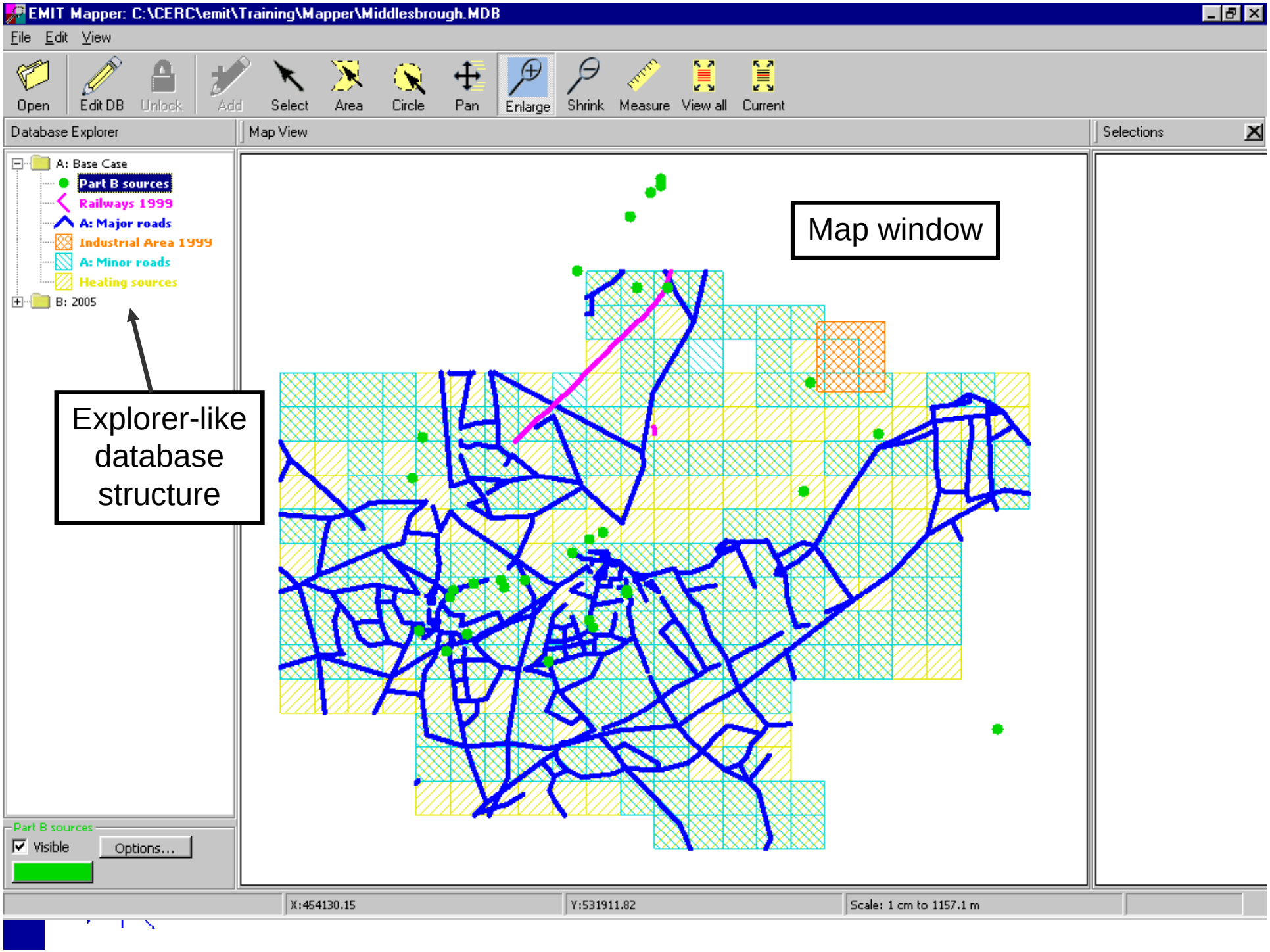
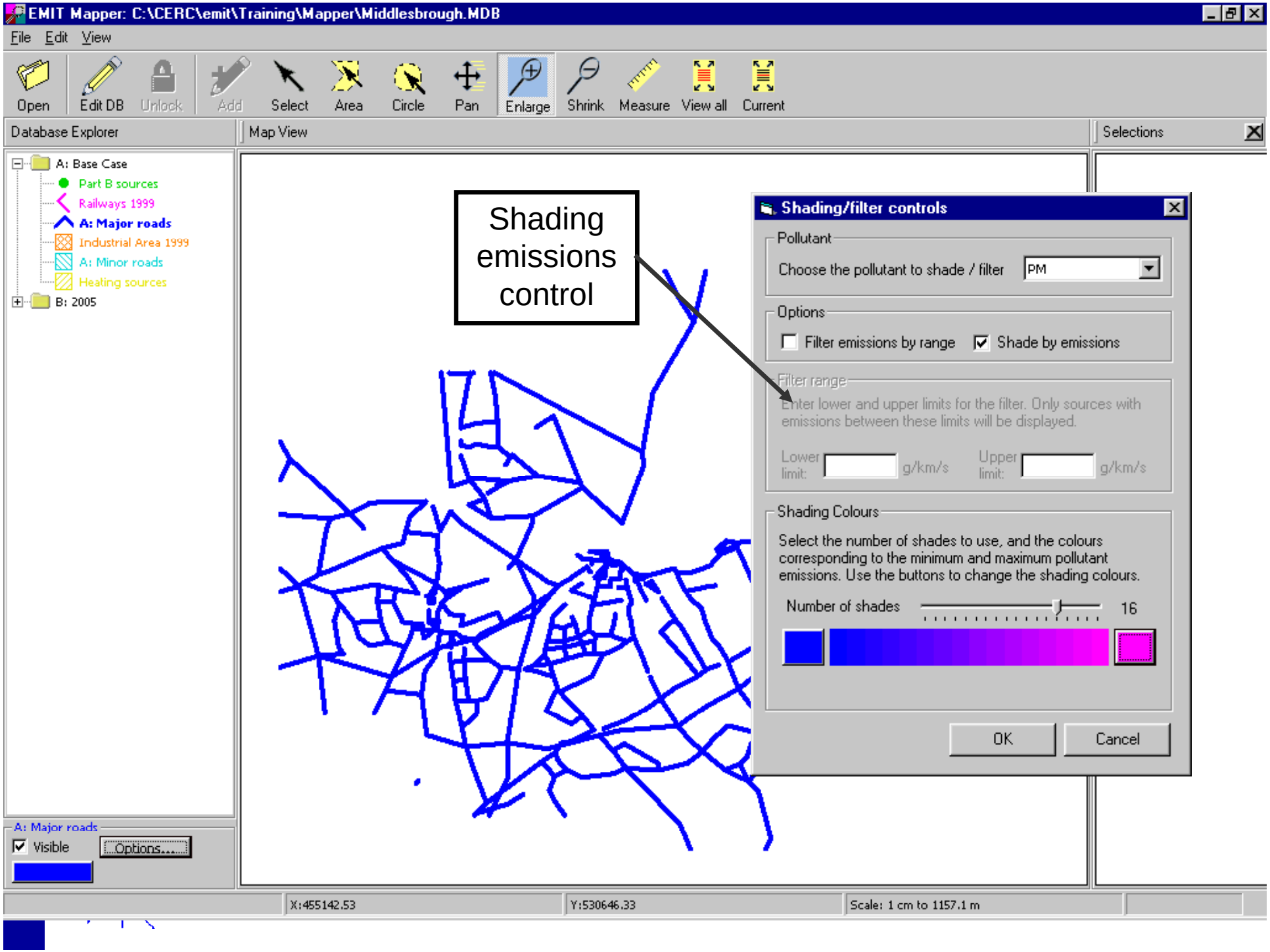
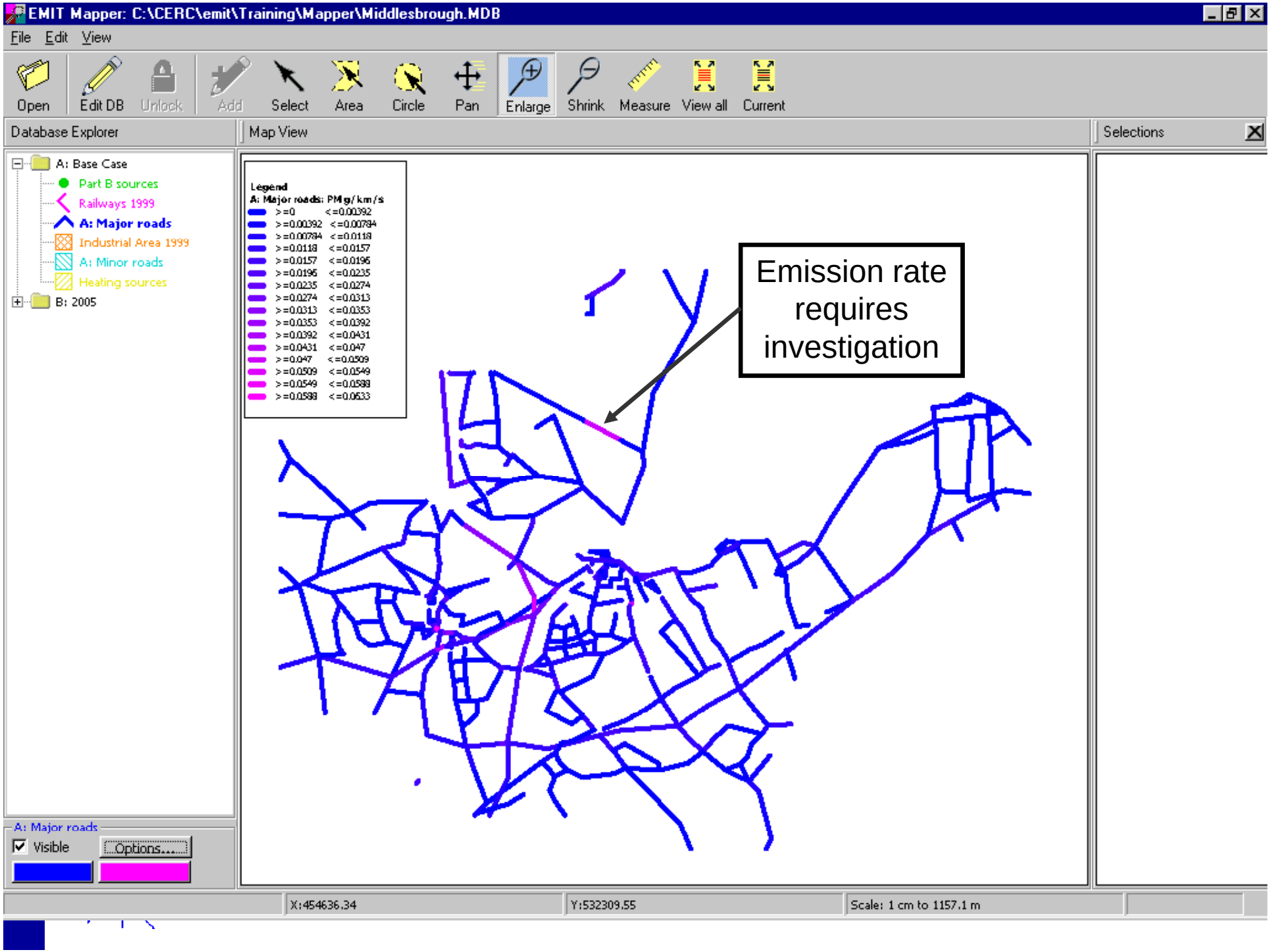
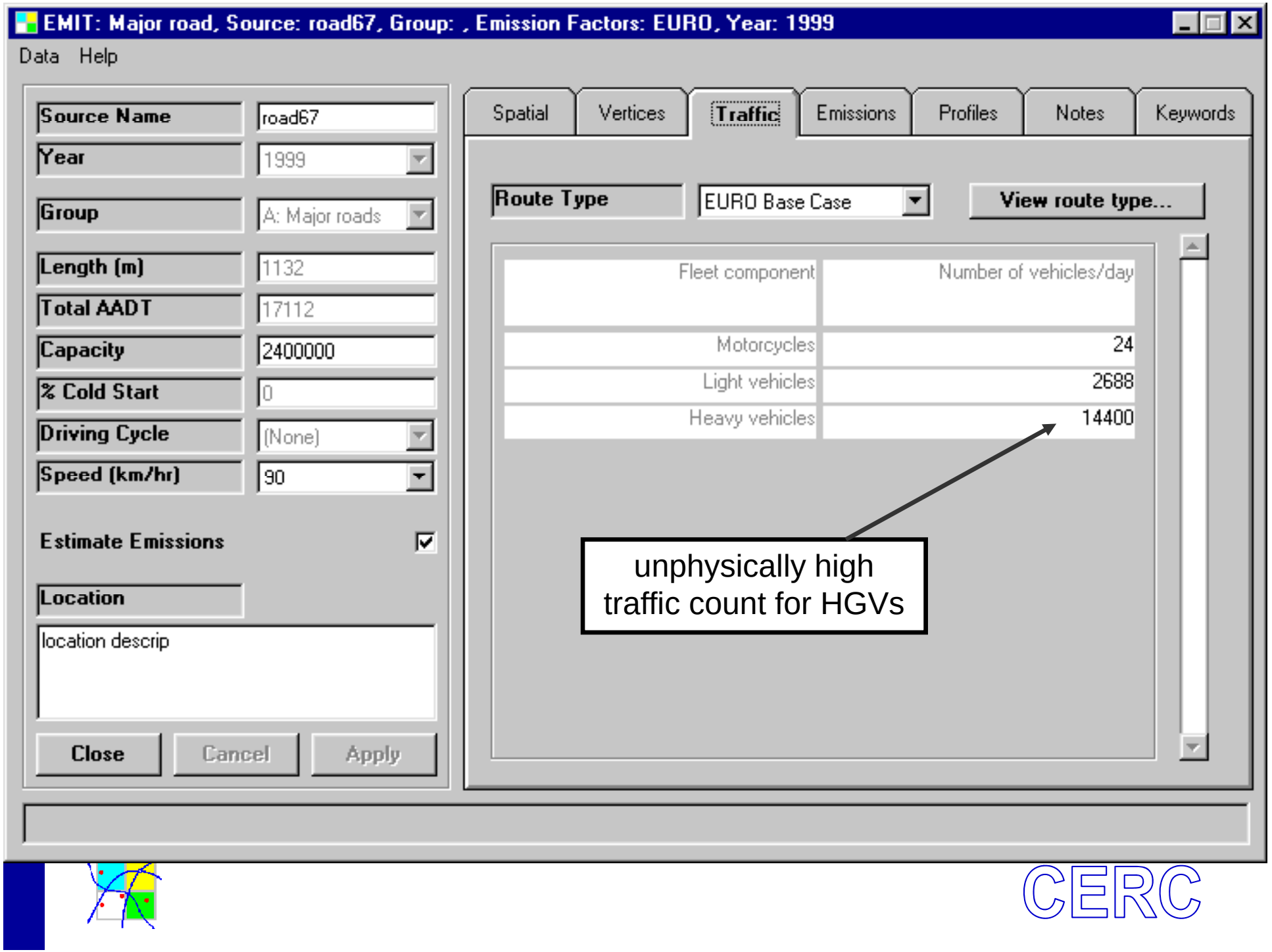

EMIT Mapper: C:\CERC\emit\Training\Mapper\Middlesbrough.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Measure
View all
Current
Database Explorer
Map View
Selections
A: Base Case
Part B sources
Railways 1999
A: Major roads
Industrial Area 1999
A: Minor roads
Heating sources
B: 2005
Map window
Explorer-like database structure
Part B sources
Visible
Options...
X:454130.15
Y:531911.82
Scale: 1 cm to 1157.1 m


EMIT Mapper: C:\CERC\emit\Training\Mapper\Middlesbrough.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Measure
View all
Current
Database Explorer
Map View
Selections
A: Base Case
Part B sources
Railways 1999
A: Major roads
Industrial Area 1999
A: Minor roads
Heating sources
B: 2005
Shading emissions control
Shading/filter controls
Pollutant
Choose the pollutant to shade / filter
PM
Options
Filter emissions by range
Shade by emissions
Filter range
Enter lower and upper limits for the filter. Only sources with emissions between these limits will be displayed.
Lower limit:
g/km/s
Upper limit:
g/km/s
Shading Colours
Select the number of shades to use, and the colours corresponding to the minimum and maximum pollutant emissions. Use the buttons to change the shading colours.
Number of shades
16
OK
Cancel
A: Major roads
Visible
Options...
X:455142.53
Y:530646.33
Scale: 1 cm to 1157.1 m


EMIT Mapper: C:\CERC\emit\Training\Mapper\Middlesbrough.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Measure
View all
Current
Database Explorer
Map View
Selections
A: Base Case
Part B sources
Railways 1999
A: Major roads
Industrial Area 1999
A: Minor roads
Heating sources
B: 2005
Legend
A: Major roads: PM g/km/s
>=0 <=0.00392
>=0.00392 <=0.00784
>=0.00784 <=0.0118
>=0.0118 <=0.0157
>=0.0157 <=0.0196
>=0.0196 <=0.0235
>=0.0235 <=0.0274
>=0.0274 <=0.0313
>=0.0313 <=0.0353
>=0.0353 <=0.0392
>=0.0392 <=0.0431
>=0.0431 <=0.047
>=0.047 <=0.0509
>=0.0509 <=0.0549
>=0.0549 <=0.0588
>=0.0588 <=0.0633
Emission rate requires investigation
A: Major roads
Visible
Options...
X:454636.34
Y:532309.55
Scale: 1 cm to 1157.1 m


EMIT: Major road, Source: road67, Group: , Emission Factors: EURO, Year: 1999
Data Help
Source Name
road67
Year
1999
Group
A: Major roads
Length (m)
1132
Total AADT
17112
Capacity
2400000
% Cold Start
0
Driving Cycle
(None)
Speed (km/hr)
90
Estimate Emissions
Location
location descrip
Close
Cancel
Apply
Spatial
Vertices
Traffic
Emissions
Profiles
Notes
Keywords
Route Type
EURO Base Case
View route type...
Fleet component
Number of vehicles/day
Motorcycles
24
Light vehicles
2688
Heavy vehicles
14400
unphysically high traffic count for HGVs

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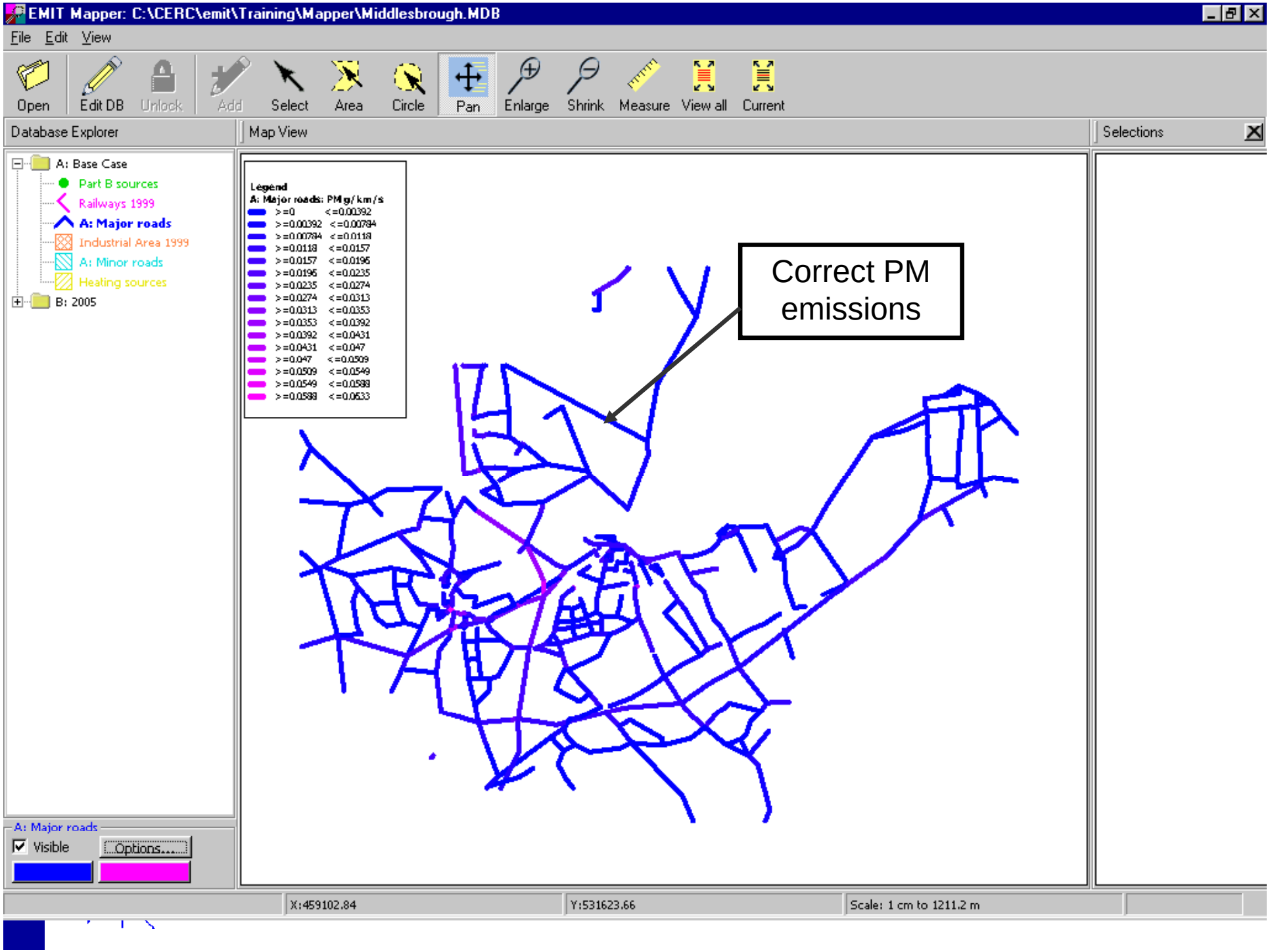
EMIT Mapper: C:\CERC\emit\Training\Mapper\Middlesbrough.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Measure
View all
Current
Database Explorer
Map View
Selections
A: Base Case
Part B sources
Railways 1999
A: Major roads
Industrial Area 1999
A: Minor roads
Heating sources
B: 2005
Legend
A: Major roads: PM g/km/s
>=0 <=0.00392
>=0.00392 <=0.00784
>=0.00784 <=0.0118
>=0.0118 <=0.0157
>=0.0157 <=0.0196
>=0.0196 <=0.0235
>=0.0235 <=0.0274
>=0.0274 <=0.0313
>=0.0313 <=0.0353
>=0.0353 <=0.0392
>=0.0392 <=0.0431
>=0.0431 <=0.047
>=0.047 <=0.0509
>=0.0509 <=0.0549
>=0.0549 <=0.0588
>=0.0588 <=0.0633
Correct PM emissions
A: Major roads
Visible
Options...
X:459102.84
Y:531623.66
Scale: 1 cm to 1211.2 m

Some common tasks

1. *Validation* of source data
   - It is useful to view sources ranked according to emissions
2. *Manipulation* of source and emissions data
   - Sources may be removed – for example an industrial plant closing down, or new sources may be created
   - Various Traffic Management schemes may be investigated, for example creation of a Low Emission Zone (LEZ)
3. *Export* of emissions data
   - For example, to an Urban air dispersion model such as ADMS-Urban

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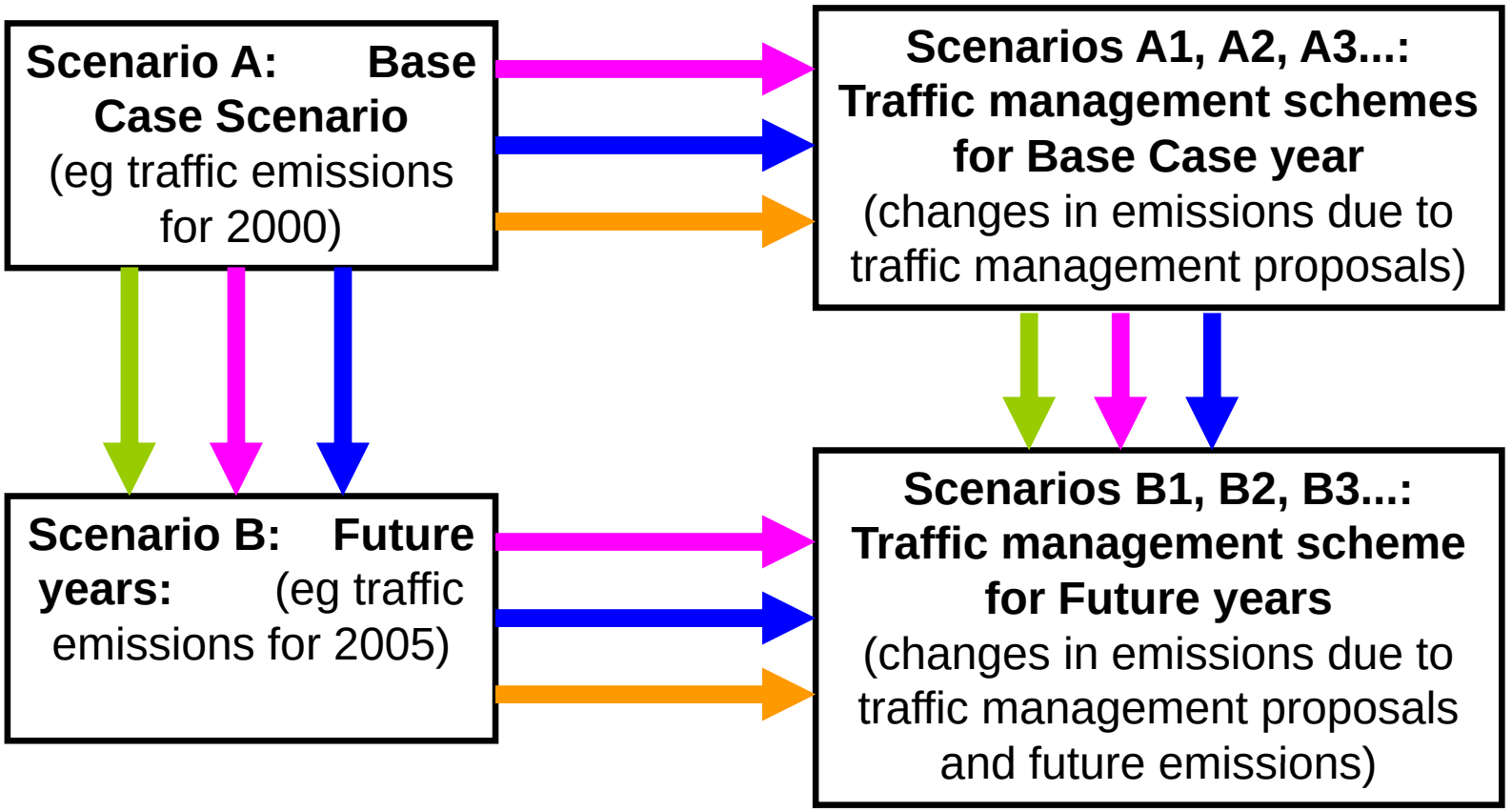
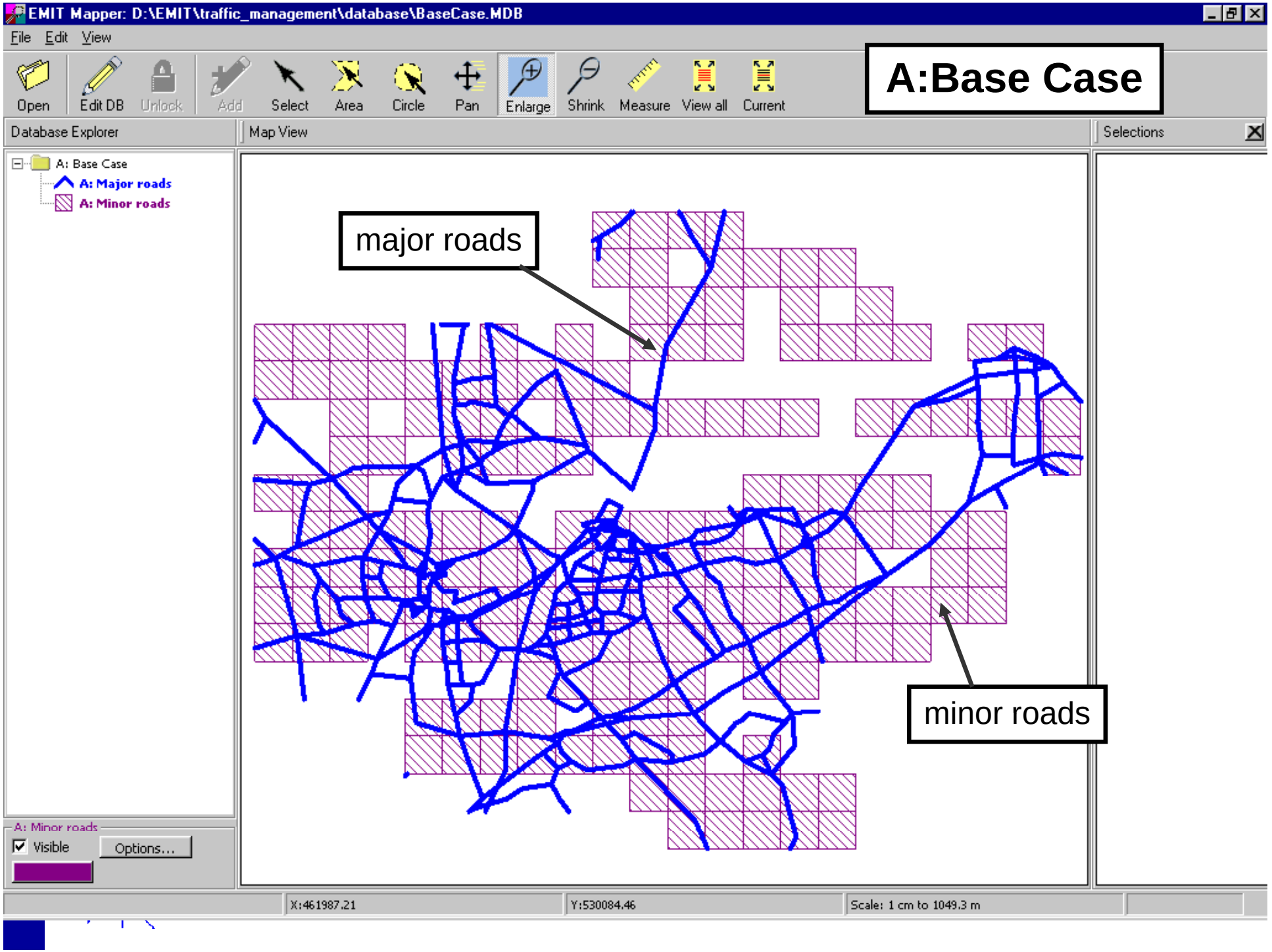
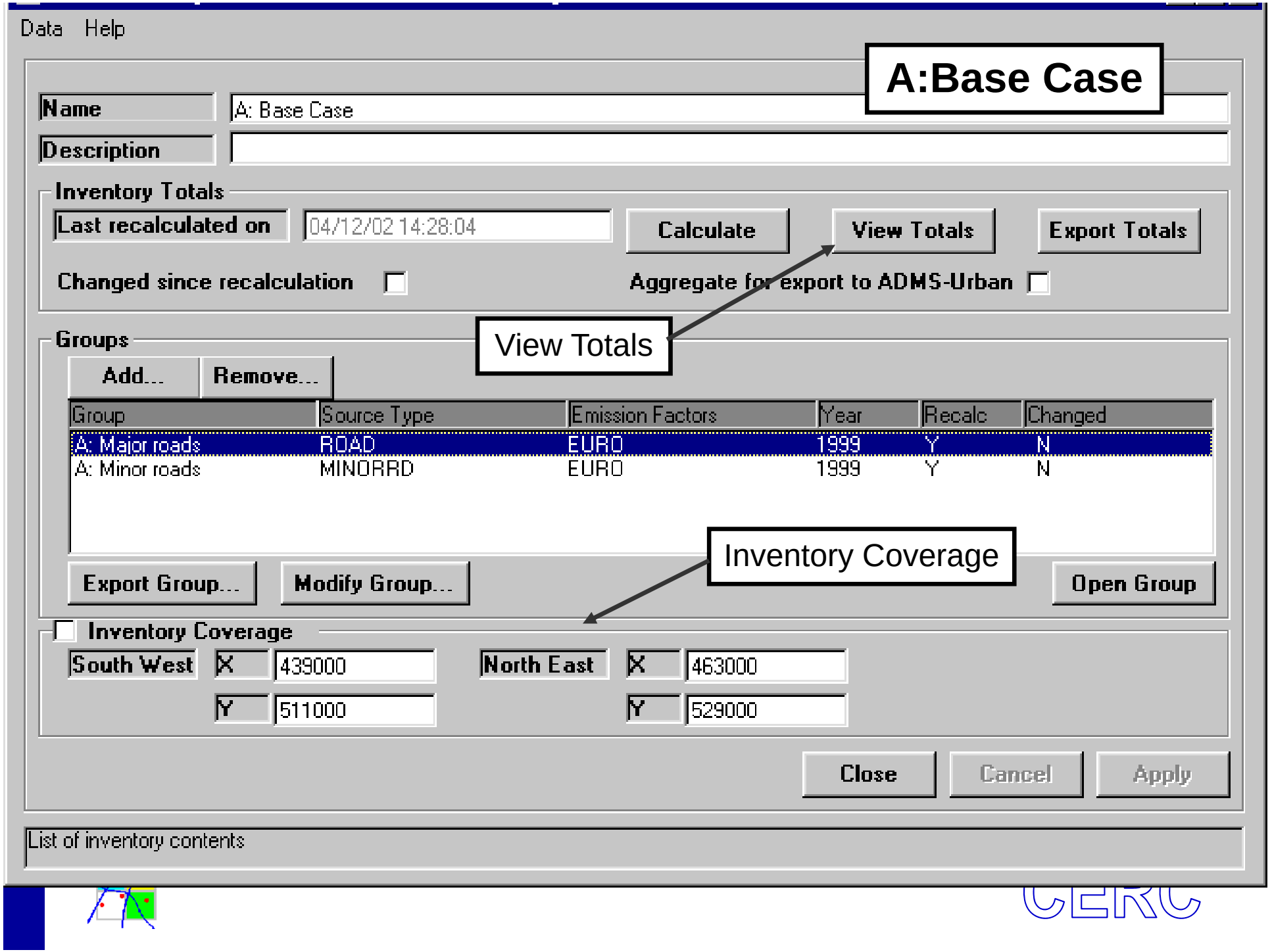
Traffic management schemes




EMIT Mapper: D:\EMIT\traffic_management\database\BaseCase.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Measure
View all
Current
A:Base Case
Database Explorer
Map View
Selections
A: Base Case
A: Major roads
A: Minor roads
major roads
minor roads
A: Minor roads
Visible
Options...
X:461987.21
Y:530084.46
Scale: 1 cm to 1049.3 m


Data Help
A:Base Case
Name
A: Base Case
Description
Inventory Totals
Last recalculated on
04/12/02 14:28:04
Calculate
View Totals
Export Totals
Changed since recalculation
Aggregate for export to ADMS-Urban
View Totals
Groups
Add...
Remove...
Group
Source Type
Emission Factors
Year
Recalc
Changed
A: Major roads
ROAD
EURO
1999
Y
N
A: Minor roads
MINORRD
EURO
1999
Y
N
Inventory Coverage
Export Group...
Modify Group...
Open Group
Inventory Coverage
South West
X
439000
Y
511000
North East
X
463000
Y
529000
Close
Cancel
Apply
List of inventory contents

Emissions Totals: Base Case

Scenario	PM_{10} tonnes/yr		
	Major roads	Minor roads	Total
A: Base Case	22.2	5.7	27.9
A1: Base Case + LEZ			
B: 2005			
B2: 2005 + LEZ			

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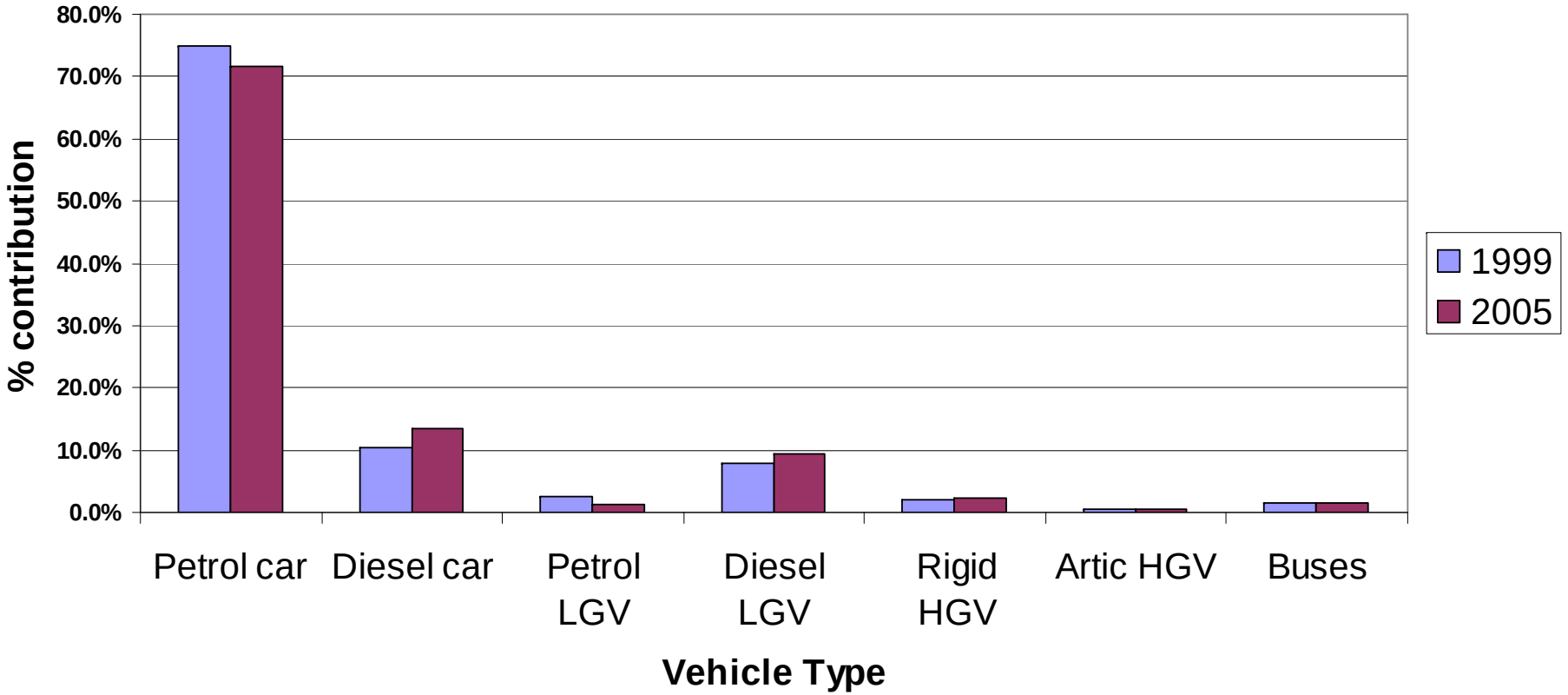
A:Base Case → **B:2005**

Fraction of Traffic flows by vehicle types - Urban roads



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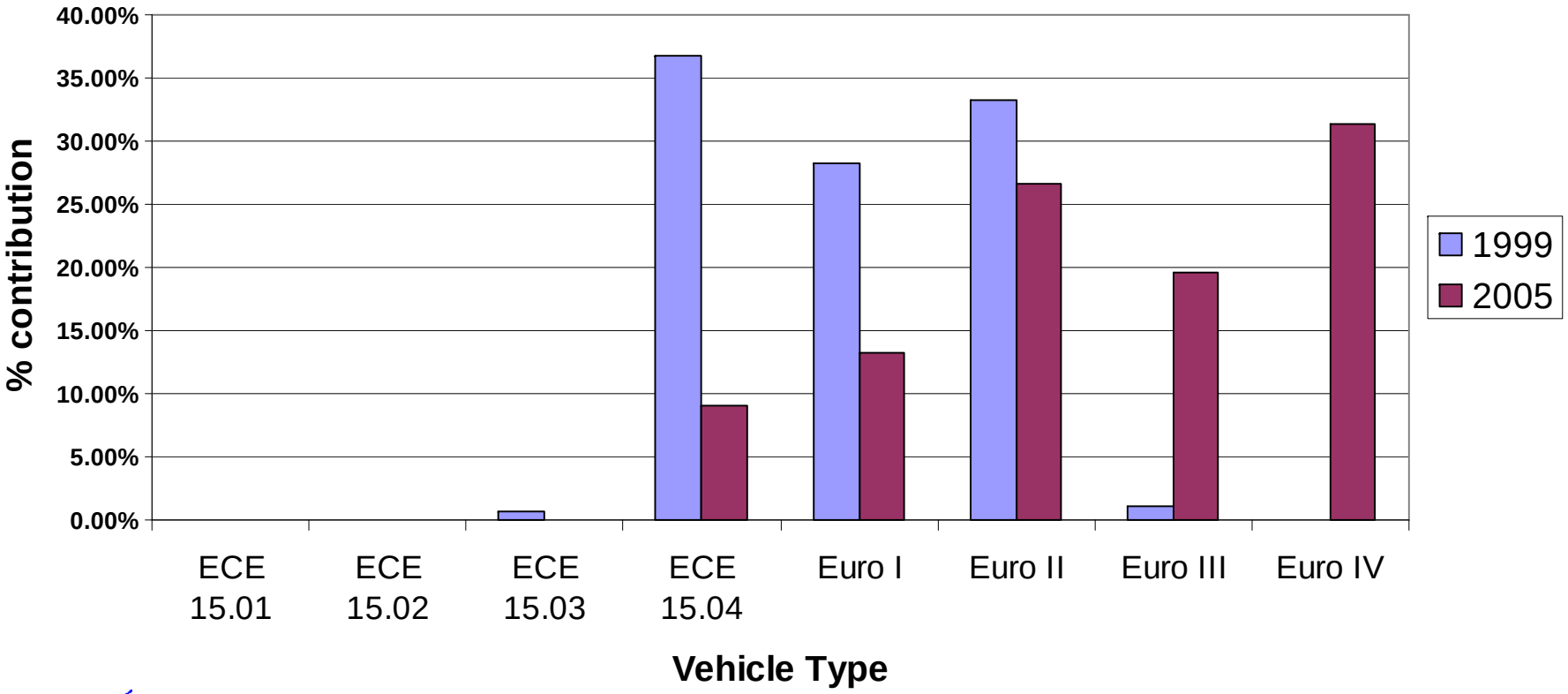
A:Base Case → **B:2005**

Breakdown of Fleet composition for 1999 and 2000 - Petrol cars



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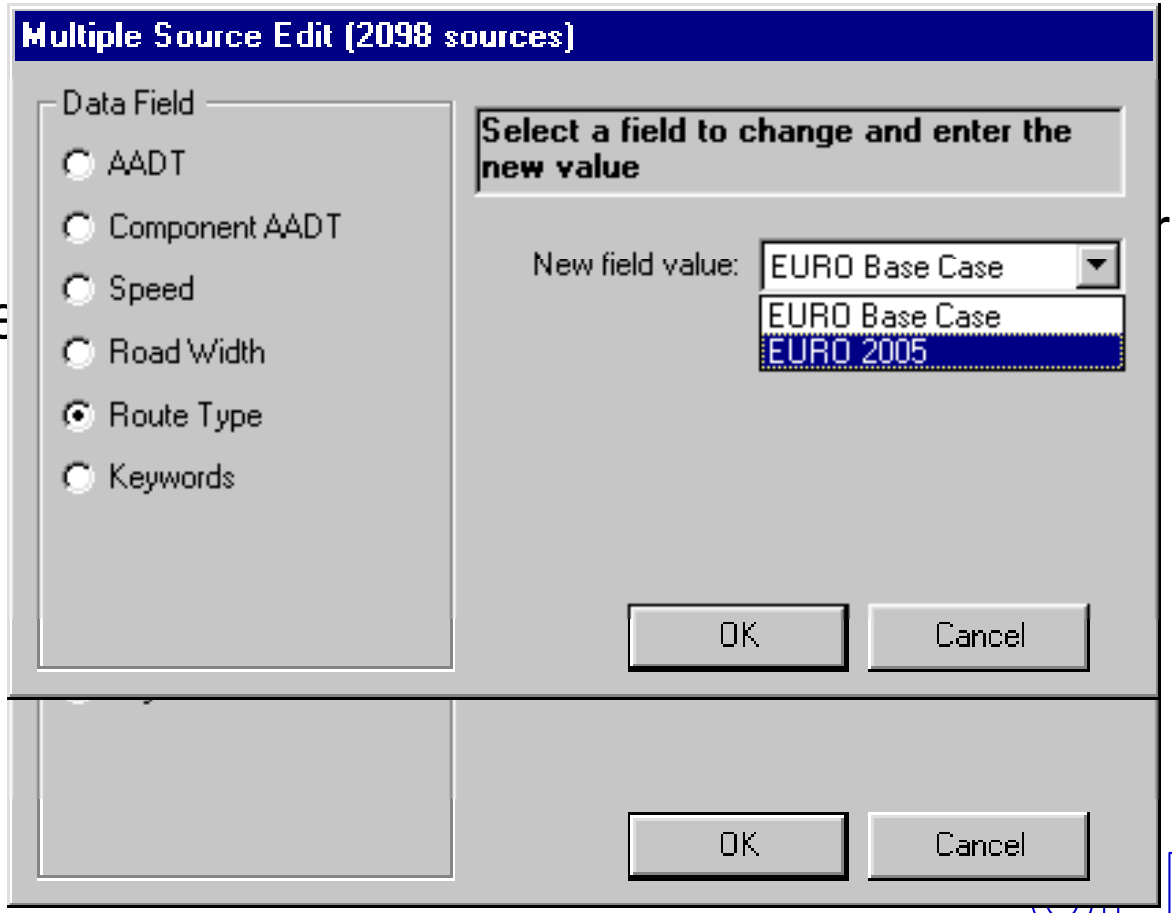
- Apply fleet composition changes
- Traffic flow
- No need to
  year-indepe



Emissions Totals: Base Case and 2005

Scenario	PM_{10} tonnes/yr		
	Major roads	Minor roads	Total
A: Base Case	22.2	5.7	27.9
A1: Base Case + LEZ			
B: 2005	11.1	2.9	14.0
B2: 2005 + LEZ			

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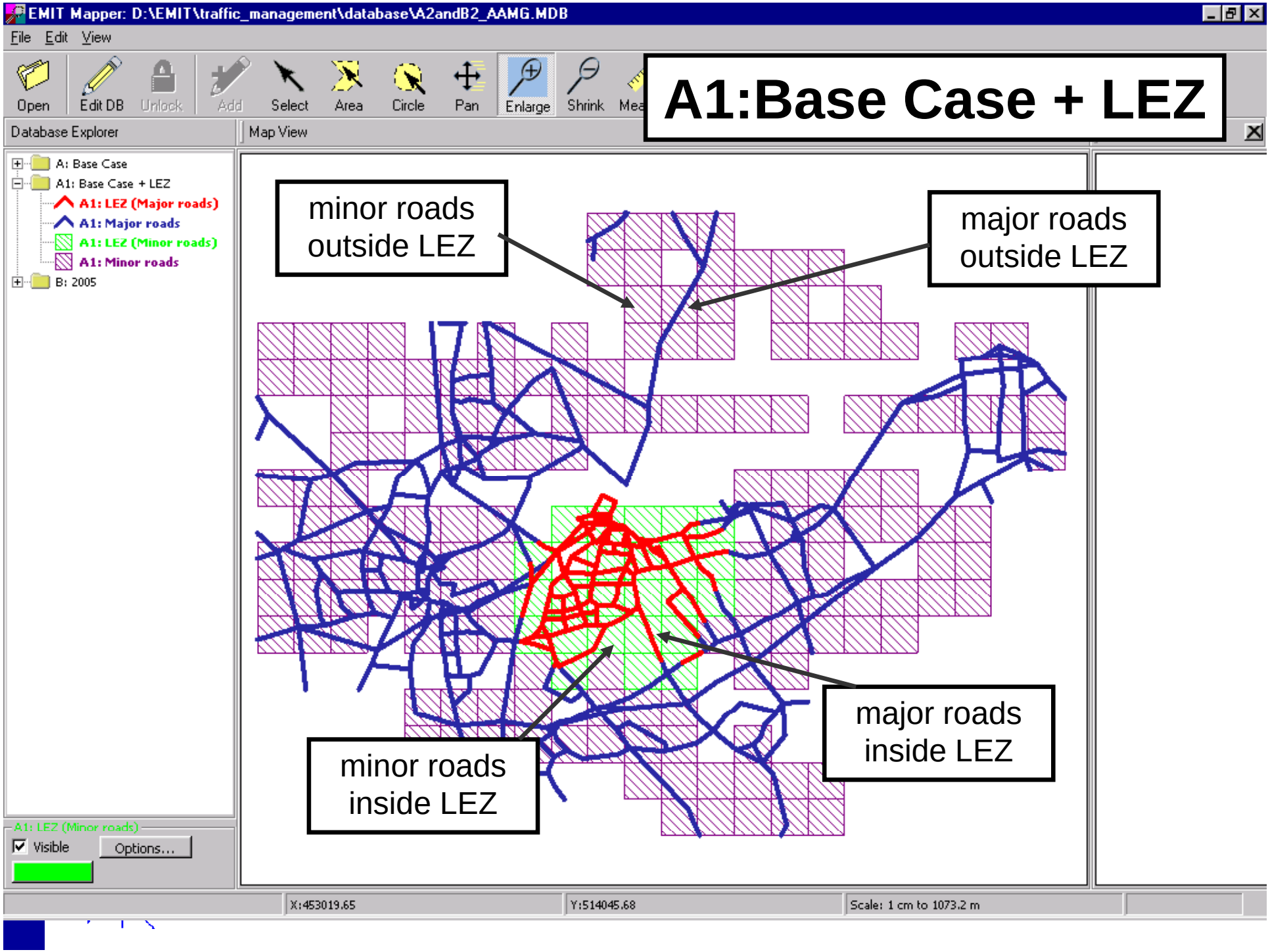
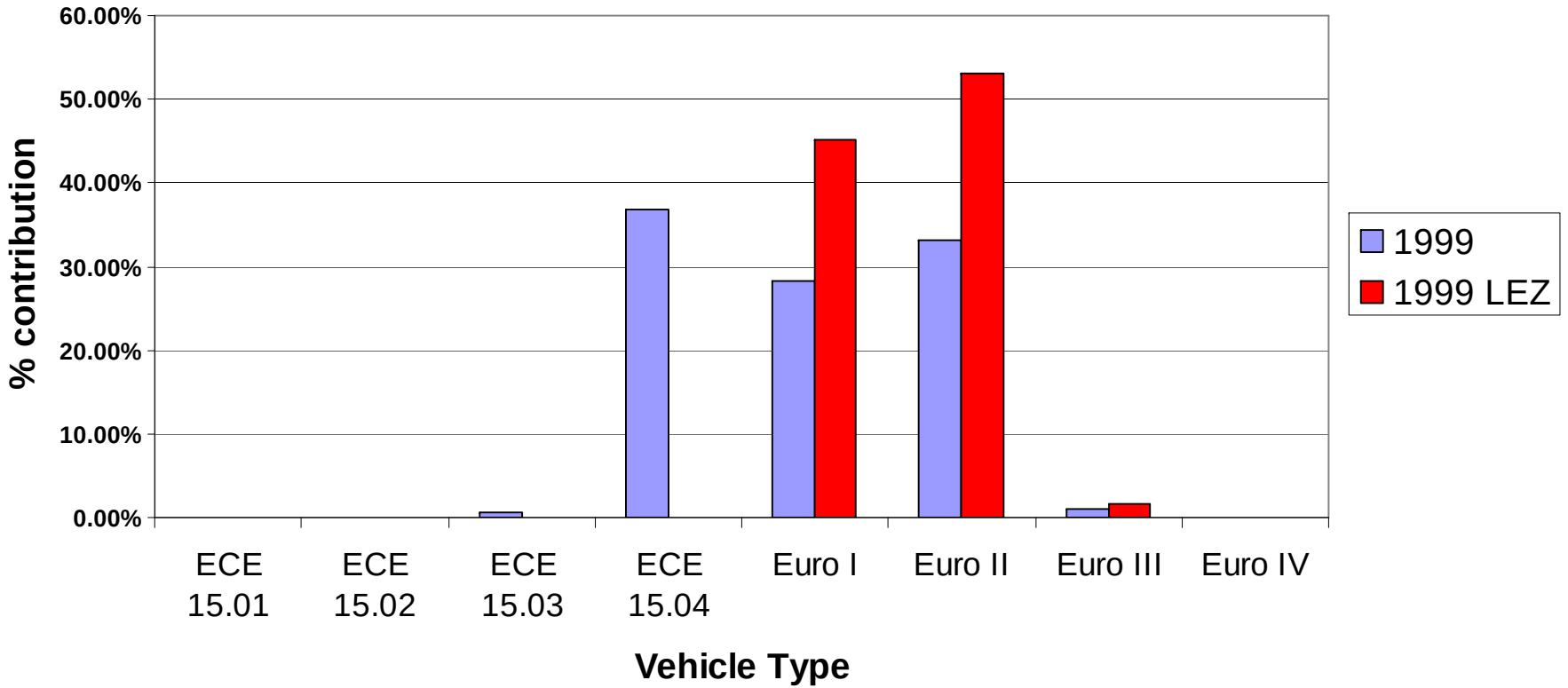

EMIT Mapper: D:\EMIT\traffic_management\database\A2andB2_AAMG.MDB
File Edit View
Open
Edit DB
Unlock
Add
Select
Area
Circle
Pan
Enlarge
Shrink
Database Explorer
Map View
A: Base Case
A1: Base Case + LEZ
A1: LEZ (Major roads)
A1: Major roads
A1: LEZ (Minor roads)
A1: Minor roads
B: 2005
A1: LEZ (Minor roads)
Visible
Options...
A1:Base Case + LEZ
minor roads outside LEZ
major roads outside LEZ
minor roads inside LEZ
major roads inside LEZ
X:453019.65
Y:514045.68
Scale: 1 cm to 1073.2 m

A:Base Case → **A:Base Case + LEZ**

Breakdown of Fleet composition for 1999 and 1999 with LEZ - Petrol cars



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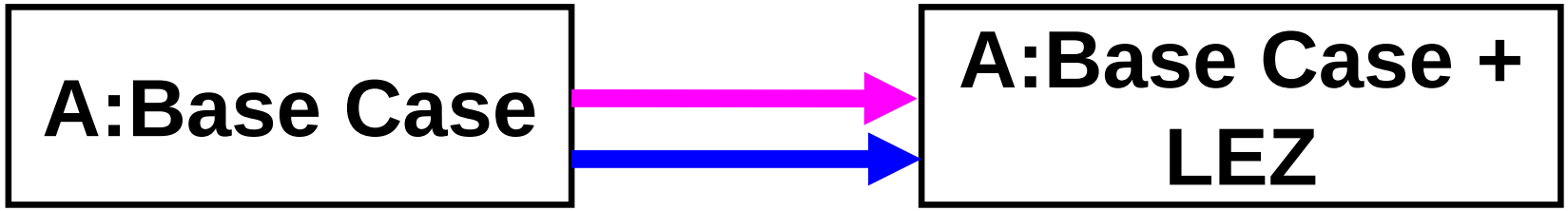

- Apply new route types inside LEZ
- Increase traffic flow outside LEZ and decrease flows inside

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Emissions Totals: A, A1 and B

Scenario	PM_{10} tonnes/yr		
	Major roads	Minor roads	Total
A: Base Case	22.2	5.7	27.9
A1: Base Case + LEZ	20.2	5.4	25.6
B: 2005	11.1	2.9	14.0
B2: 2005 + LEZ			

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Emissions Totals: A, A1, B and B1

Scenario	PM_{10} tonnes/yr		
	Major roads	Minor roads	Total
A: Base Case	22.2	5.7	27.9
A1: Base Case + LEZ	20.2	5.4	25.6
B: 2005	11.1	2.9	14.0
B2: 2005 + LEZ	10.5	2.8	13.3

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3. *Export* of emissions data
   - For example, to an Urban air dispersion model such as ADMS-Urban

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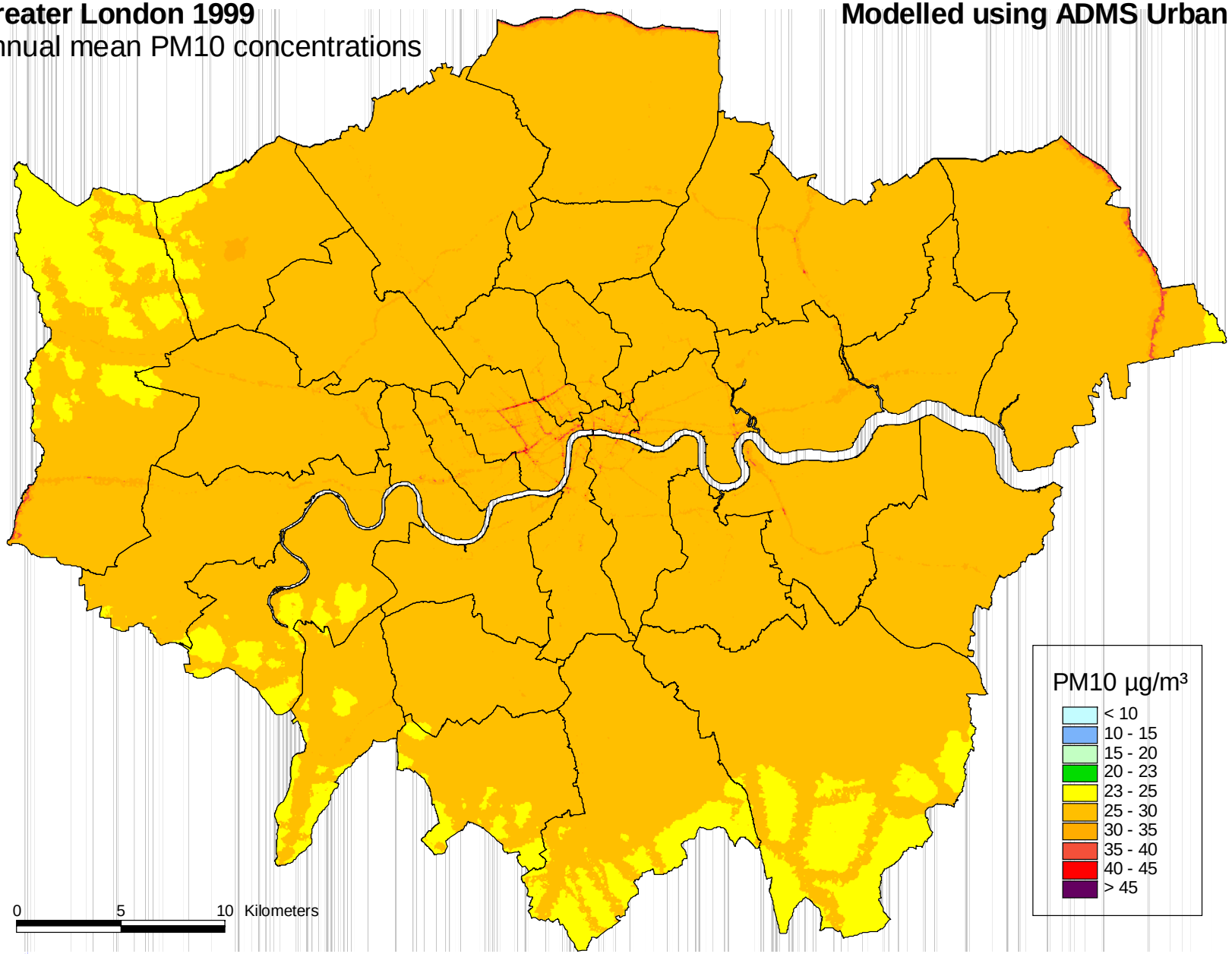
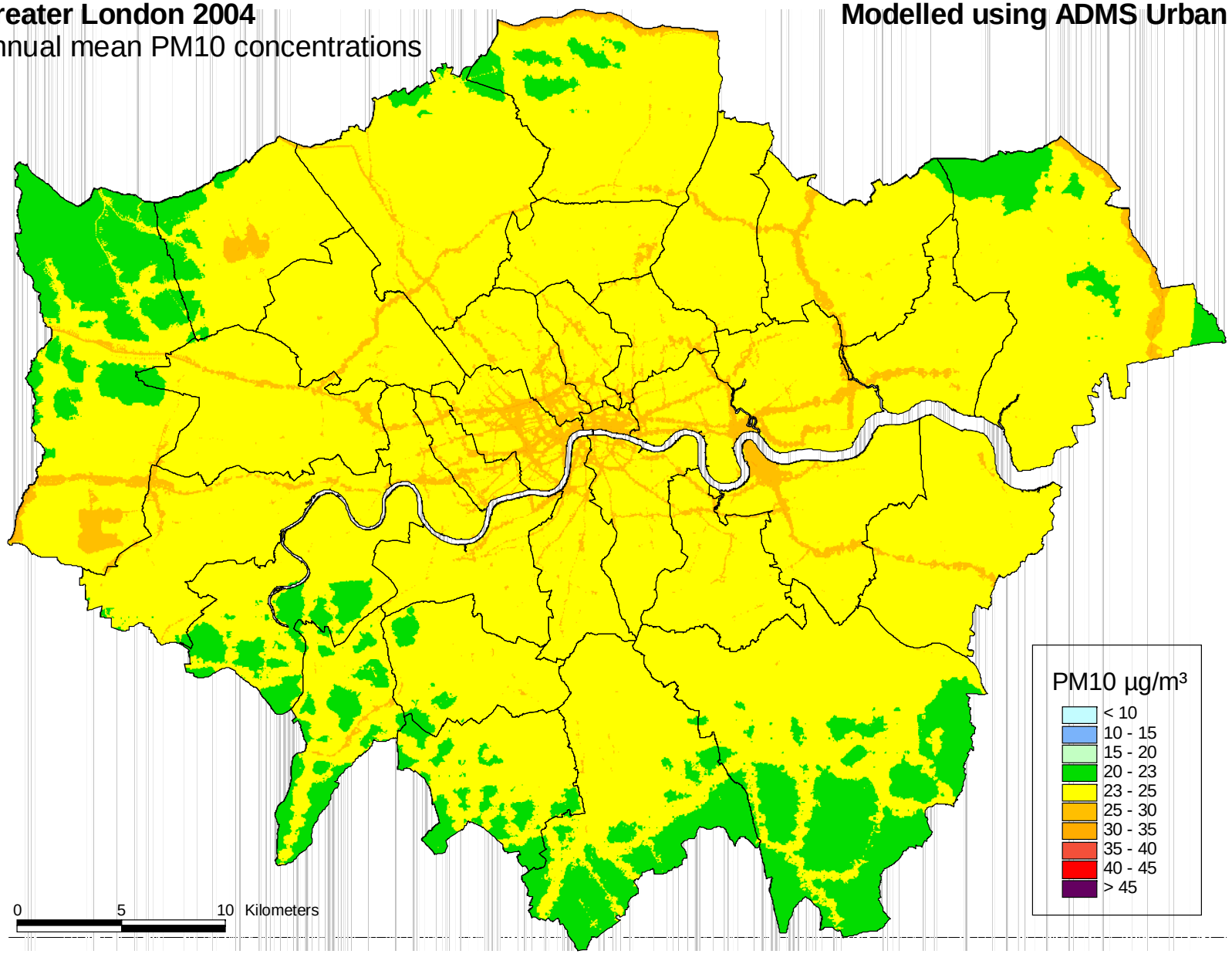
Greater London 1999
Annual mean PM10 concentrations

Modelled using ADMS Urban



Greater London 2004
Annual mean PM10 concentrations

Modelled using ADMS Urban



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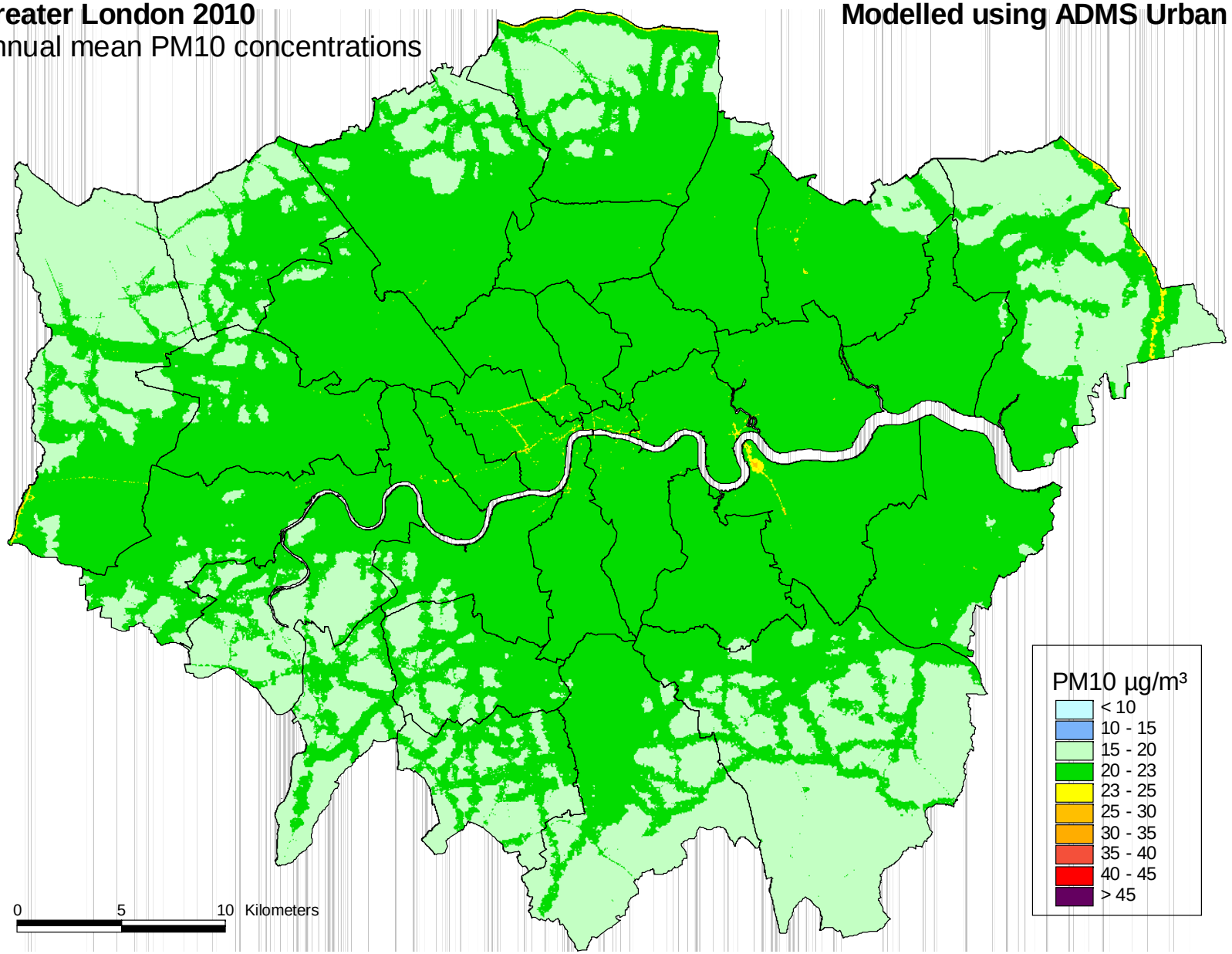
Greater London 2010
Annual mean PM10 concentrations

Modelled using ADMS Urban



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Summary

- Explained why it is necessary to manage emissions
- Shown how EMIT can be used to
  - *validate* source data
  - *manipulate* source data
  - *calculate* emissions totals for various scenarios, for example, future years and traffic management schemes
  - *export* emissions to air dispersion modelling software

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