What is the modelling community looking for in the next generation of traffic models?

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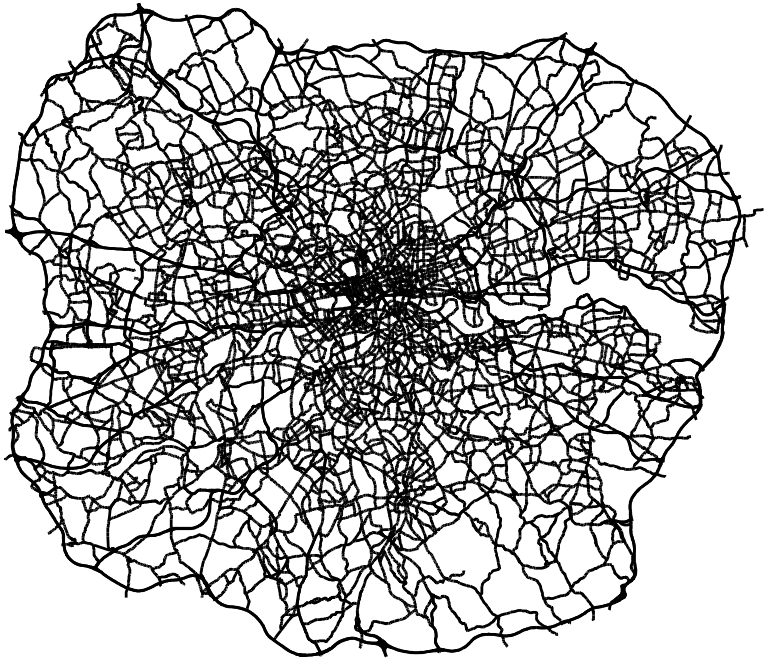
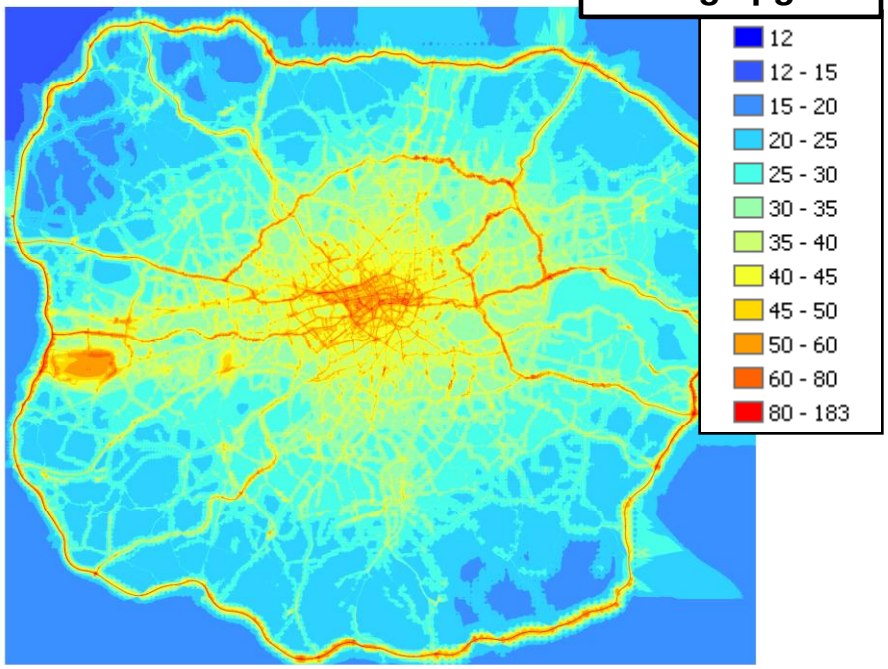
- **Current status** of traffic and emissions data used in local air dispersion models
- **Obvious omissions**!
- **Potential improvements** to air dispersion modelling, focusing on data available from new traffic and emissions modelling techniques
- **Concluding remarks**

Current status

- Source of emissions data for atmospheric dispersion modelling for London is the LAEI
- Focus on major road traffic sources that are modelled explicitly – similar issues apply to minor roads, rail and aircraft

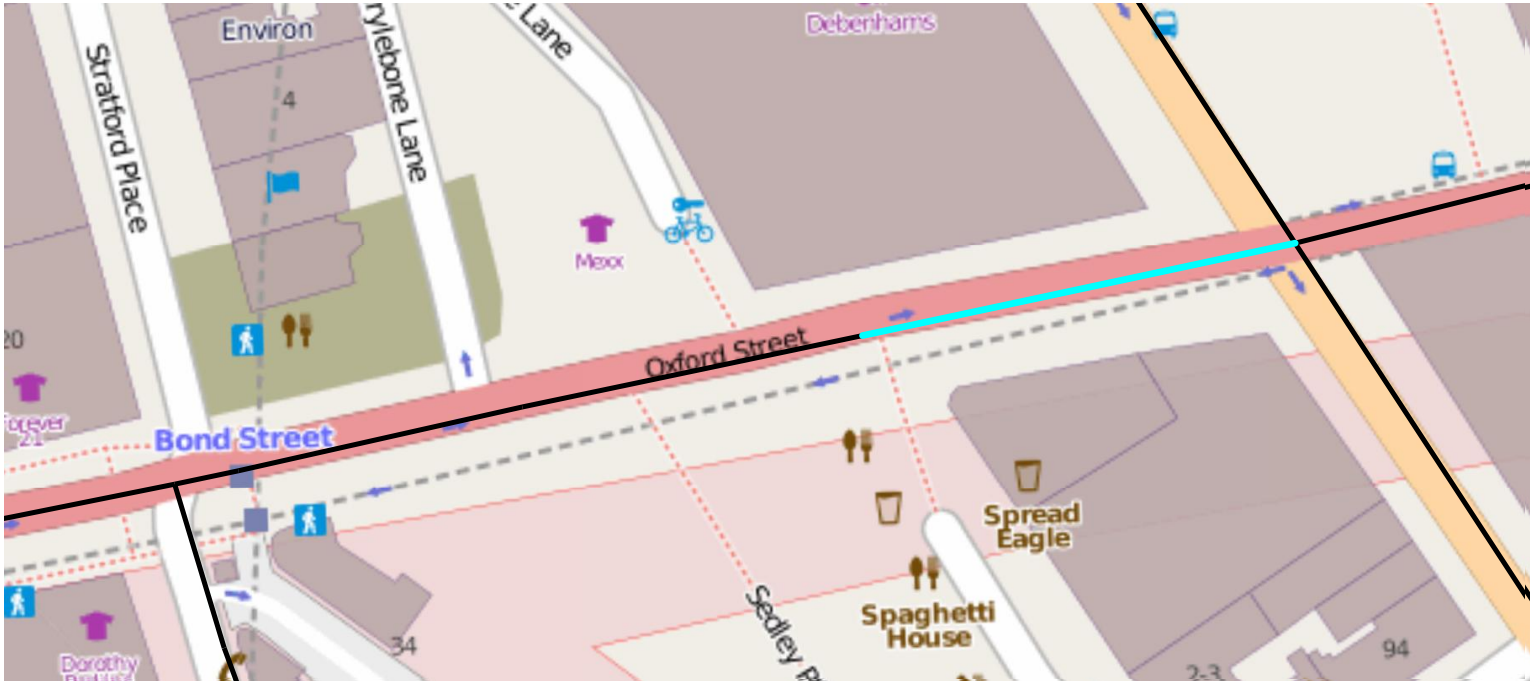
Major road sources from LAEI





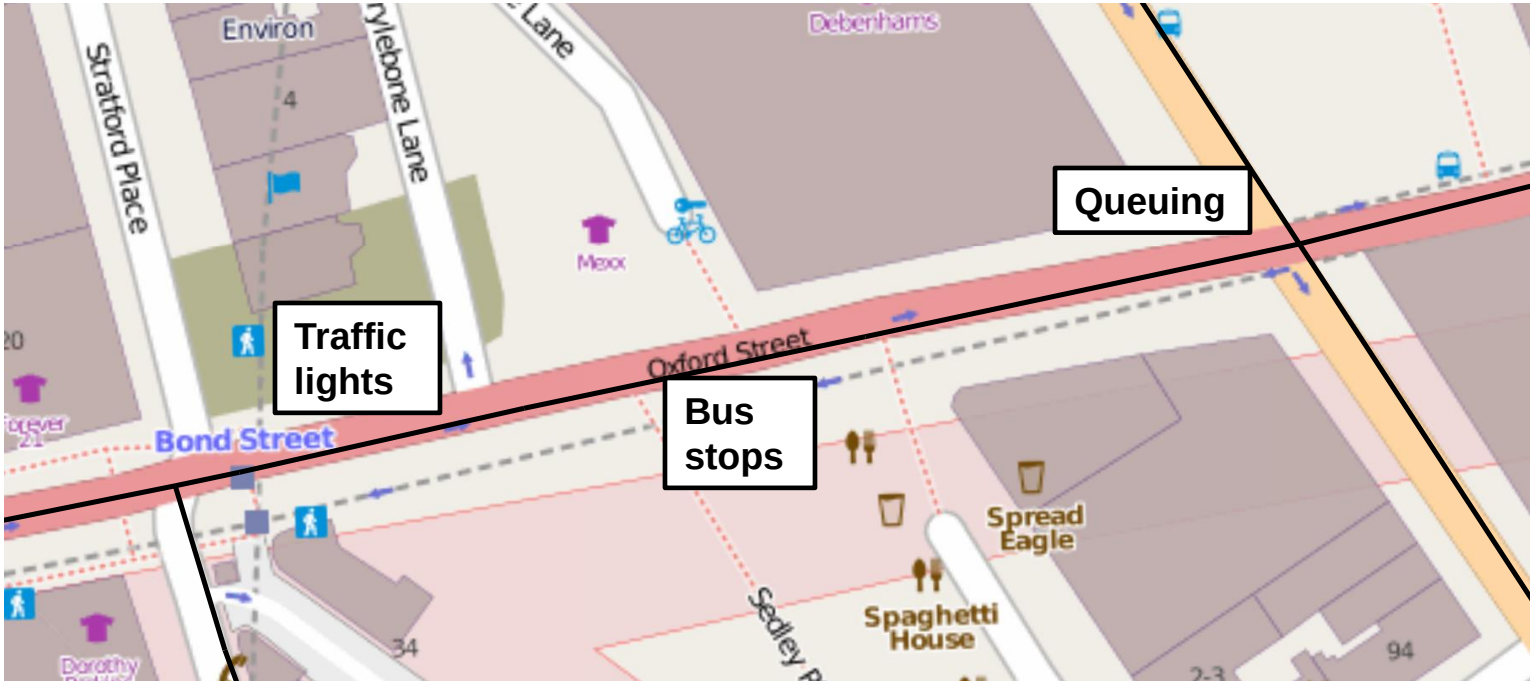
Current status: spatial resolution

- Look at a single road in the LAEI, for instance Oxford Street
- The LAEI provides traffic data as output from the traffic model, in links (some links have more than 2 vertices)
- The relevant traffic information (speeds, flows) do not vary along neighbouring links



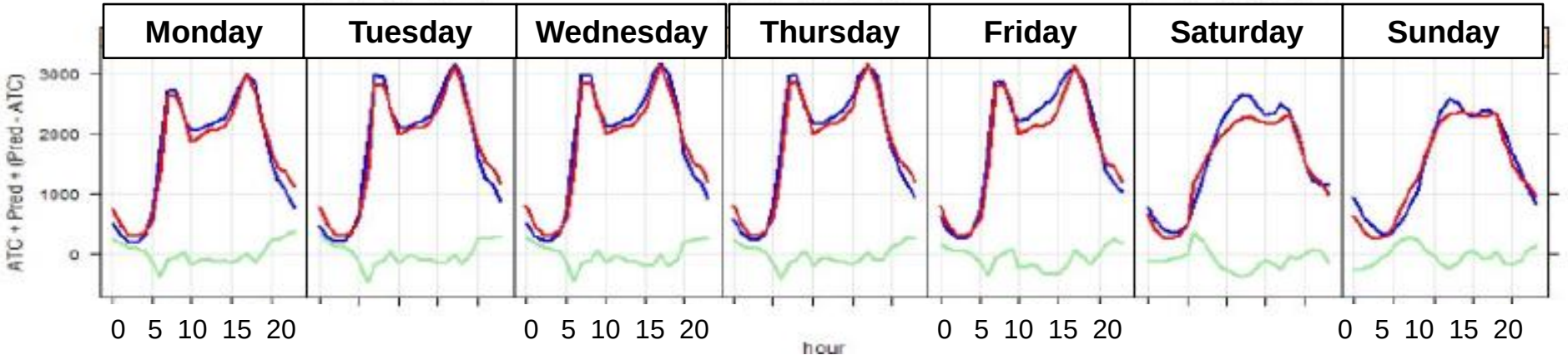
Current status: spatial resolution

- For dispersion modelling, if speeds and flows don't vary, then the emissions are the same for all links - so links are combined
- Away from junctions predicted concentrations along the road are approximately the same
- So any link-related detail from the traffic model is omitted from the dispersion modelling



Current status: temporal resolution

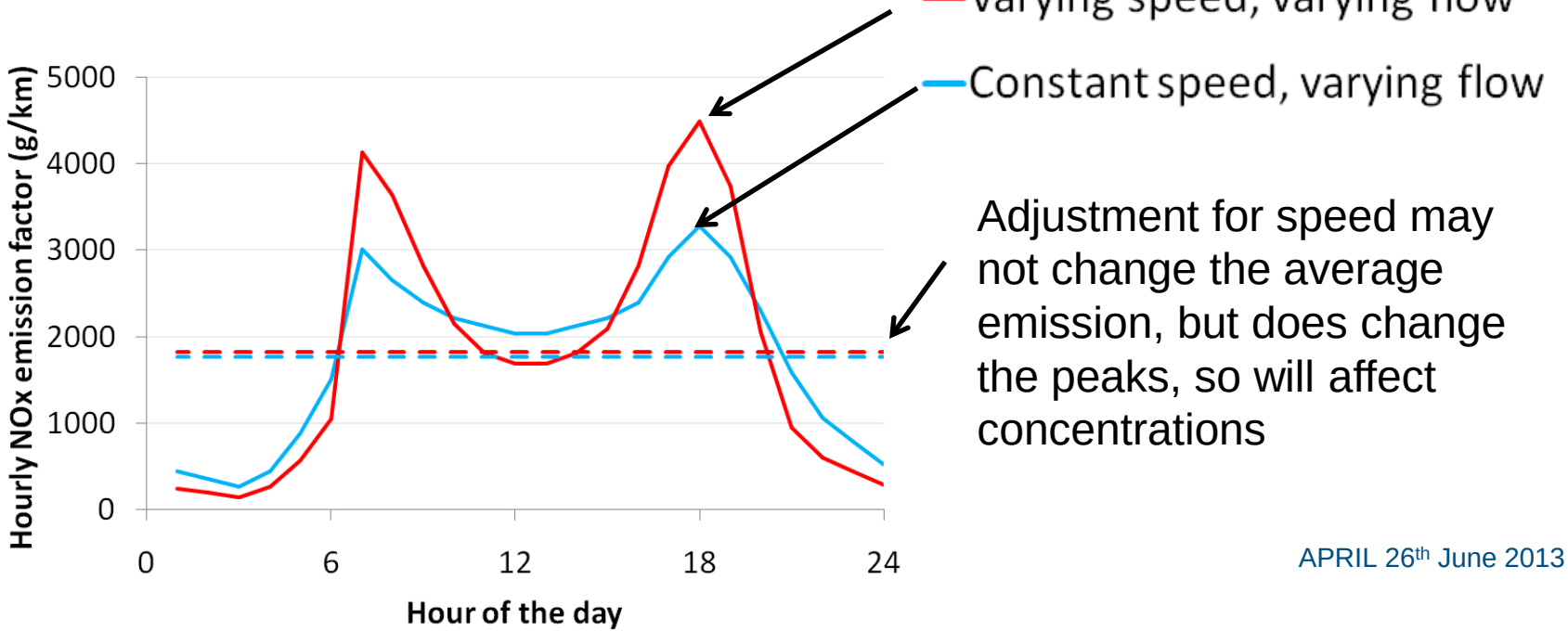
- The same emission rates result in different ground level concentrations at different times of the day (eg variations in wind speed, chemistry effects)
- Even annual average calculations will be wrong if no temporal variation in emissions are included
- LAEI includes:
  - Annual ***Average*** Daily Traffic and
  - ***Average*** speeds



Daily, diurnal hourly traffic flow variations (plot from LAEI documentation, profiles not provided in LAEI)

Current status: temporal resolution

- In the ADMS dispersion models, concentrations are modelled on an **hourly** basis.
- 3 diurnal profiles of emissions are included: Average weekday, Saturday, Sunday
- Diurnal profiles calculated based on:
  - Available ATC or traffic model data
  - Adjustment for speed variations
  - Fleet composition (rarely included)



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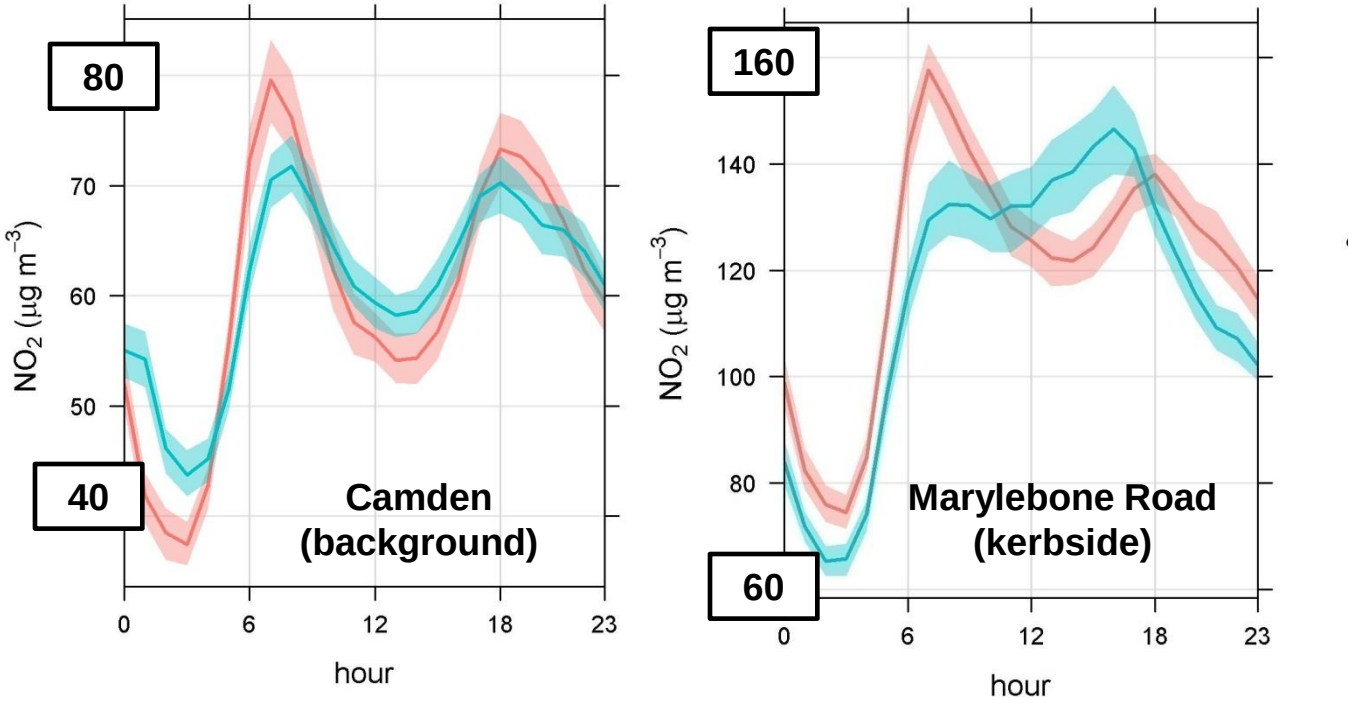
  Including flow ***and*** speed variations leads to emissions variations of up to a factor of 2 at peak times, which can lead to significant differences in modelled concentrations
- The profiles can be assigned on a ***road-by-roads basis***, but more generally ***average profiles*** are used, for instance 'central', 'inner' and 'outer' London, plus motorways.
- Monthly profiles can also be included
- Alternative to diurnal profiles: detailed hour-by-hour emissions, 8760 values

Current status: temporal resolution

- Clearly, these average profiles are not appropriate for use at all sites

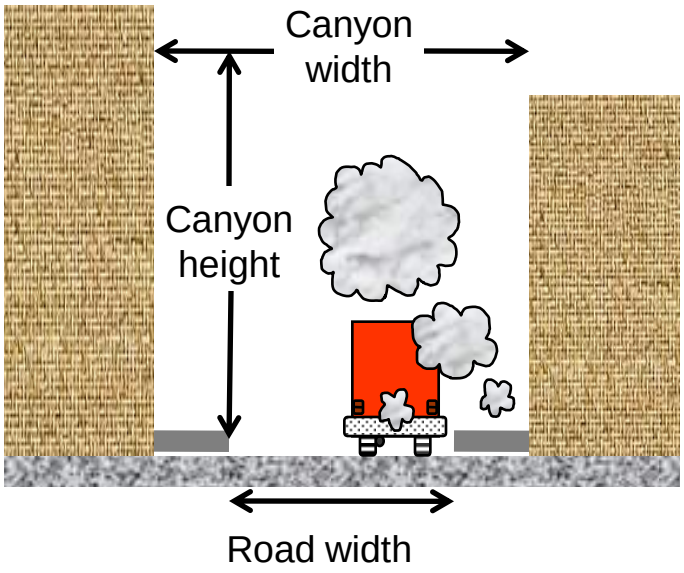
Average diurnal temporal variation of NO_2 at selected sites

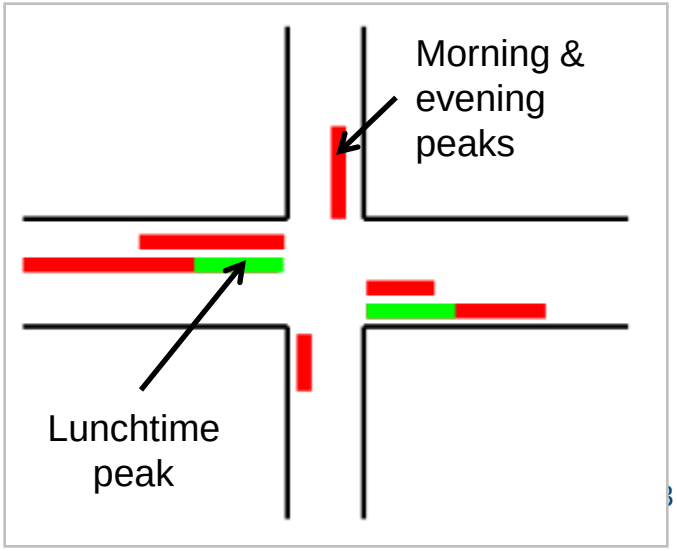


- There are at least 7 ‘enhanced’ sites in London (including Marylebone Road) where there are ATCs, ANPRs (Euro classes) and periodic manual counts.
- Are these data downloadable from London Air?

Obvious omissions!

Item	Current approximation
Diurnal profiles of traffic counts & speed	General profiles assumed
Road widths	Assume width based on road type (A road, B road etc)
Canyon heights and widths	Ad hoc information, where available
Lane-by-lane traffic data	Ad hoc information, such as bus lanes, where available
Speed variation by vehicle type	Ad hoc information, such as slower bus speeds
Road gradients and elevations	Rarely included, unless very detailed study performed
Queuing/idling/traffic congestion	Included for detailed modelling



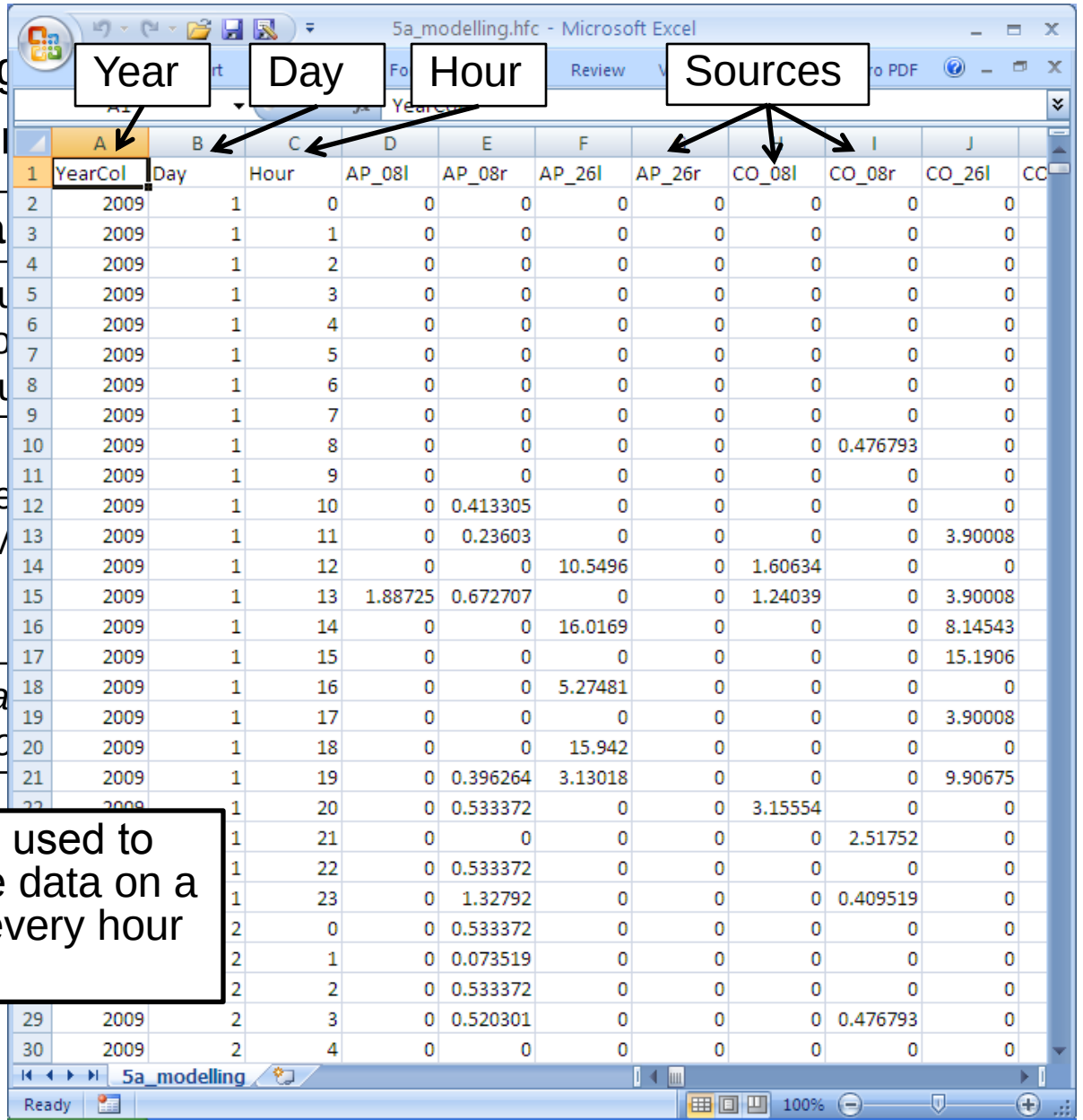


Potential improvements: emissions data

- Air dispersion modelling
- Emissions data are the

Scale	Exa
Large-scale strategic modelling	Popu expo calcu
Detailed studies	Asse AQM new
'Micro' modelling	*Deta at ho*

The '.hfc' file can be used to enter emissions profile data on a link-by-link basis for every hour of the year.



	A	B	C	D	E	F	G	H	I	J
1	YearCol	Day	Hour	AP_08l	AP_08r	AP_26l	AP_26r	CO_08l	CO_08r	CO_26l
2	2009	1	0	0	0	0	0	0	0	0
3	2009	1	1	0	0	0	0	0	0	0
4	2009	1	2	0	0	0	0	0	0	0
5	2009	1	3	0	0	0	0	0	0	0
6	2009	1	4	0	0	0	0	0	0	0
7	2009	1	5	0	0	0	0	0	0	0
8	2009	1	6	0	0	0	0	0	0	0
9	2009	1	7	0	0	0	0	0	0	0
10	2009	1	8	0	0	0	0	0	0.476793	0
11	2009	1	9	0	0	0	0	0	0	0
12	2009	1	10	0	0.413305	0	0	0	0	0
13	2009	1	11	0	0.23603	0	0	0	0	3.90008
14	2009	1	12	0	0	10.5496	0	1.60634	0	0
15	2009	1	13	1.88725	0.672707	0	0	1.24039	0	3.90008
16	2009	1	14	0	0	16.0169	0	0	0	8.14543
17	2009	1	15	0	0	0	0	0	0	15.1906
18	2009	1	16	0	0	5.27481	0	0	0	0
19	2009	1	17	0	0	0	0	0	0	3.90008
20	2009	1	18	0	0	15.942	0	0	0	0
21	2009	1	19	0	0.396264	3.13018	0	0	0	9.90675
22	2009	1	20	0	0.533372	0	0	3.15554	0	0
23	2009	1	21	0	0	0	0	0	2.51752	0
24	2009	1	22	0	0.533372	0	0	0	0	0
25	2009	1	23	0	1.32792	0	0	0	0.409519	0
26	2009	2	0	0	0.533372	0	0	0	0	0
27	2009	2	1	0	0.073519	0	0	0	0	0
28	2009	2	2	0	0.533372	0	0	0	0	0
29	2009	2	3	0	0.520301	0	0	0	0.476793	0
30	2009	2	4	0	0	0	0	0	0	0

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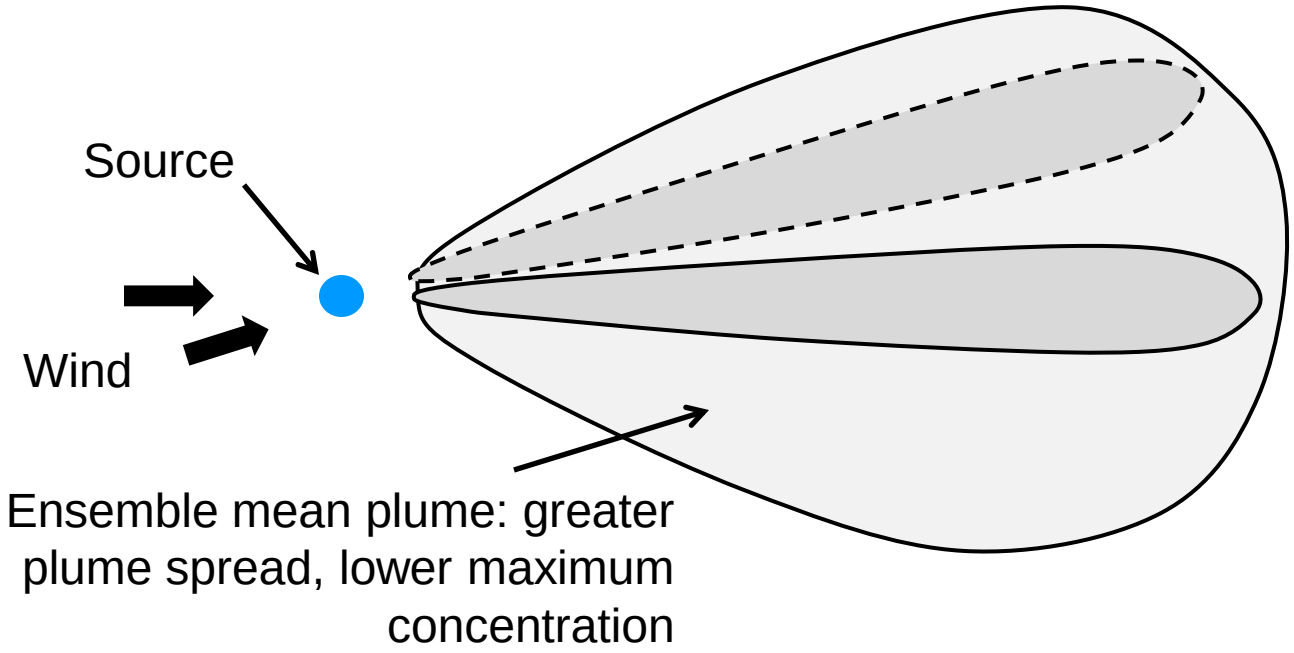
Potential improvements: 'Micro-scale' dispersion modelling

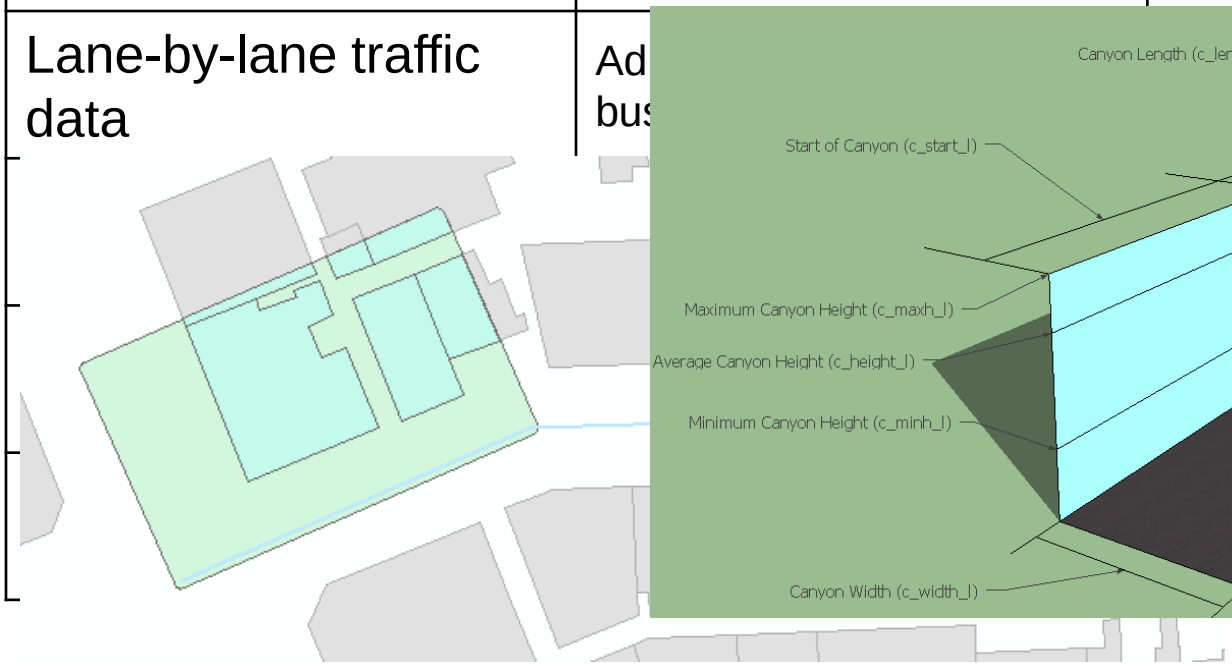
- Dispersion models predict ensemble averages i.e. they average over variations in meteorology and emissions to predict concentrations averaged over 1 or more hours

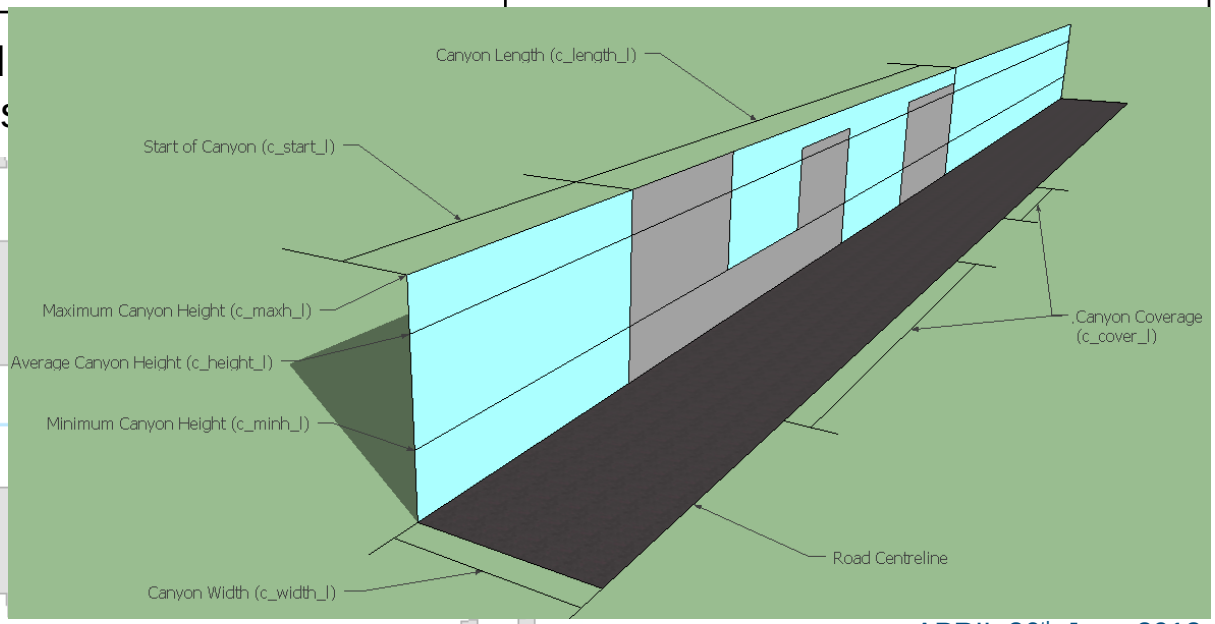


- In order to perform 'micro-scale' dispersion modelling, fluctuations have to be taken into account; results given in terms of probabilities of exceedence of a threshold concentration

Potential improvements: associated data

Item	Current approximation	Possible data sources?
Diurnal profiles of traffic counts & speed	General profiles assumed	Enhanced monitoring sites (specific site data only), Traffic modelling (road-by-road)
Road widths	Assume width based on road type (A road, B road etc)	GIS analysis of 3D buildings dataset with improved road centreline data
Canyon heights	Ad hoc information, where available	
Lane-by-lane traffic data	Ad bus	





Potential improvements: other issues

- Another non-linear effect in the relationship between emissions and concentrations is **Vehicle Induced Turbulence** (VIT)

$$\sigma_v = b\sqrt{\frac{\sum_{i=1}^{i=m} N_i U_i A_i}{W}}$$

σ_v = VIT
m = number of vehicle categories
N_i = number of vehicles
U_i = vehicle speed
A_i = vehicle cross section
W = road width
b = parameter

  i.e. flows and speeds are required explicitly in the air dispersion model to calculate VIT – these are currently estimated using a back calculation when detailed emissions are imported into the model.
- Emissions from a range of vehicles are usually grouped together. But these vehicles may have different **exhaust heights**. The source height is an important parameter in dispersion modelling - and significantly effects ground level concentrations.
- **Non-exhaust emissions**

Concluding remarks

- Concentrations are not linearly dependent on emissions so average speed/flow data are not sufficient
- Spatial variation of emissions:
  - Current LAEI has many links with the same average flows and speeds
  - Link by link variations from traffic/emissions models would generate variations dependent on local driver behaviour (eg junctions, bus stops, queuing)
- Temporal variation of emissions:
  - Current LAEI includes average speed and flows on each link, so general temporal variations are derived
  - Traffic/emissions models should be able to provide this detail on a link by link basis
- Simplifications of spatial/temporal data may be necessary depending on the resolution of output required
- Other related data eg road widths, canyon heights are independent of emissions, but can significantly affect concentrations
- 'Micro-scale' dispersion modelling requires new approaches