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SOURCE APPORTIONMENT OF PARTICULATE MATTER ($PM_{2.5}$) IN THE UK (INCLUDING COOKING EMISSIONS)

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CONTENT

- Source apportionment by receptor modelling
- The ClearfLo experiment in London
- Results of Chemical Mass Balance (CMB) Model
- Comparison with AMS-PMF data

Receptor Modelling

- Use of air quality data to infer the sources responsible for measured pollution levels (opposite of dispersion modelling!)

- Receptor modelling of airborne particles depends upon an assumption of mass conservation

$$C_i = \sum^{j} f_{i,j}\, g_j$$

where C_i = airborne concentration of component, *i*

$f_{i,j}$ = mass fraction of component *i* in particles from source, *j*

g_j = mass of particles from source *j* in an air sample

- Analysis of many air samples for multiple chemical components is necessary

Types of Receptor Modelling of Particulate Matter

There are two main types

- **<u>Chemical Mass Balance</u>**
  - Requires only one air sample, although better results are obtained with more
  - Requires knowledge of chemical composition of particles from each source ($f_{i,j}$)
  - Varies g_j for all chemical components to obtain best fit to mass conservation equation

- **<u>Multivariate Statistical</u>**
  - Principal Component Analysis widely used, but Positive Matrix Factorization (PMF) has advantages and is more frequently utilised
  - Requires no advance knowledge of source chemical composition
  - Requires many separate samples, and identifies temporal correlations of components (e.g. Na and Cl in sea salt) in a multidimensional space.

Receptor Modelling with CMB Model

- Uses organic molecular markers and trace elements to apportion the carbonaceous component of $PM_{2.5}$

- Source apportionment of the entire $PM_{2.5}$ is conducted using the Pragmatic Mass Closure Model

- Results have been processed for winter air samples collected at at LNK and HAR

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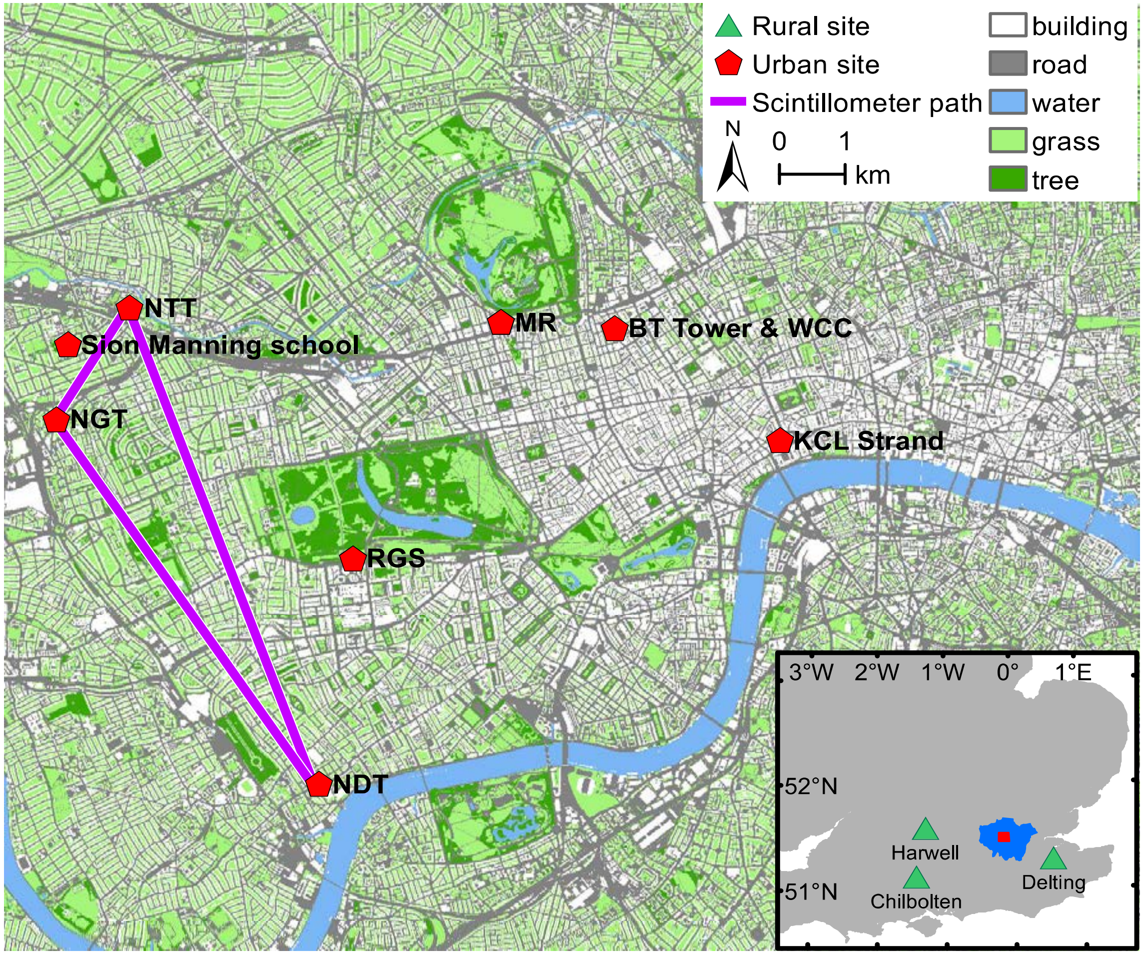
ClearfLo Measurement Site



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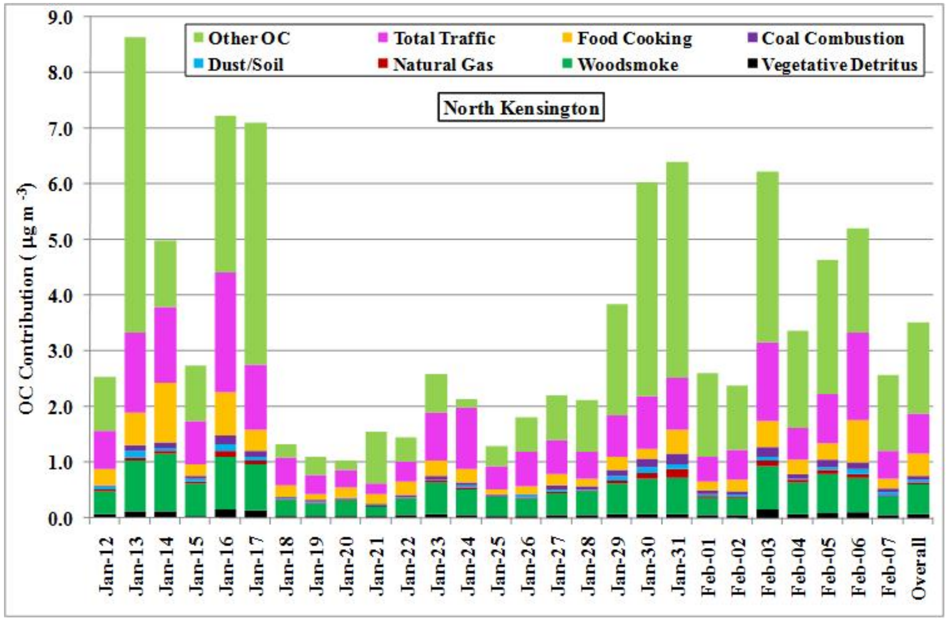
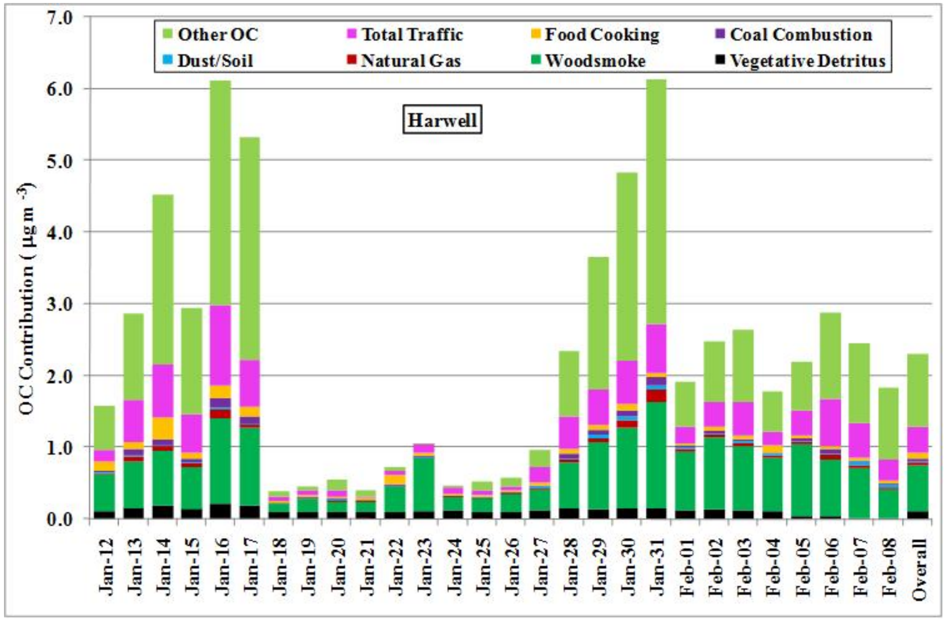
NK Site During ClearfLo (1)

NK Site During ClearfLo (2)

Daily OC Source Contributions at NK and HAR





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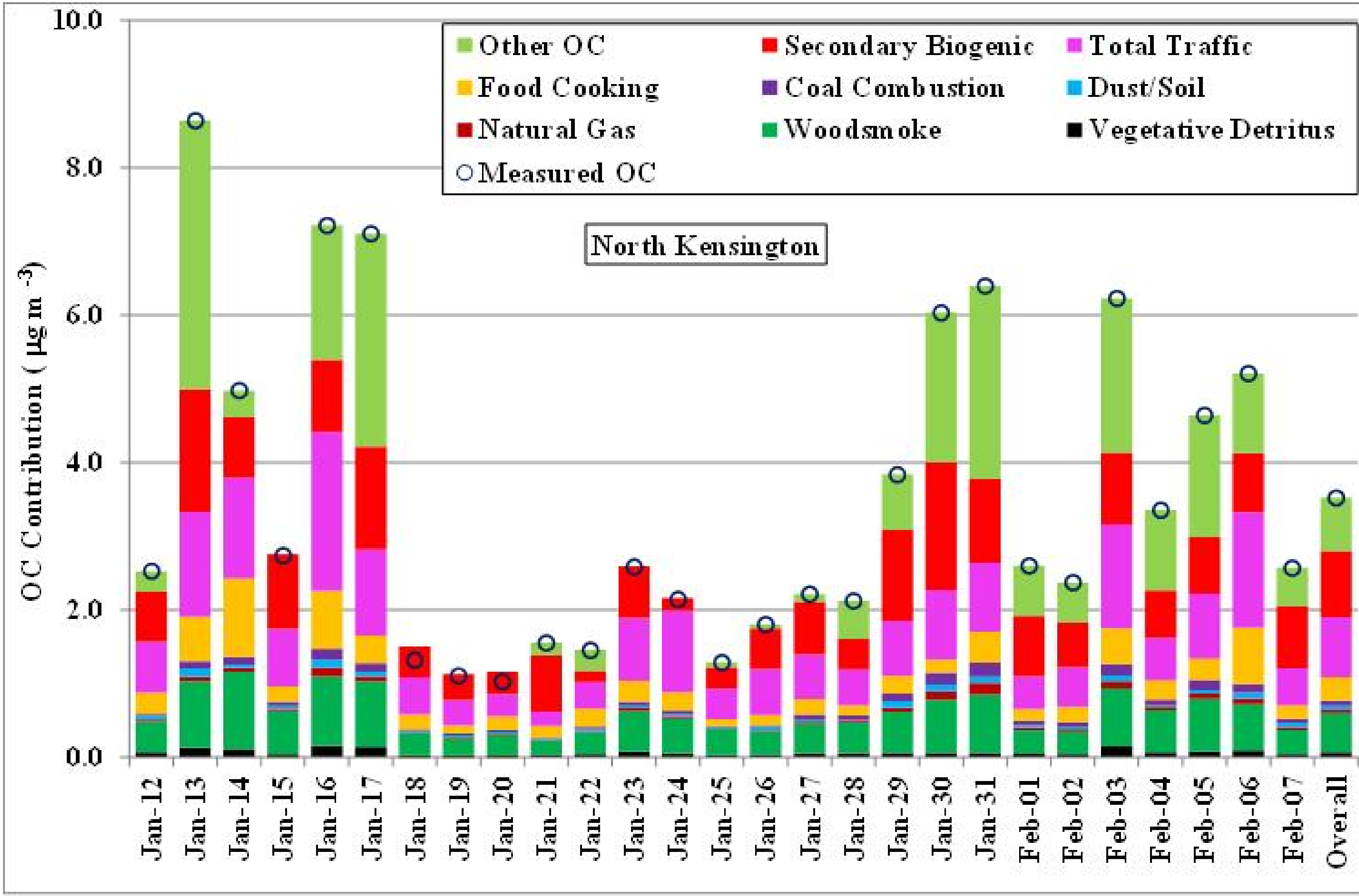
Daily OC Source Contribution Estimates with Secondary Biogenic Components at NK



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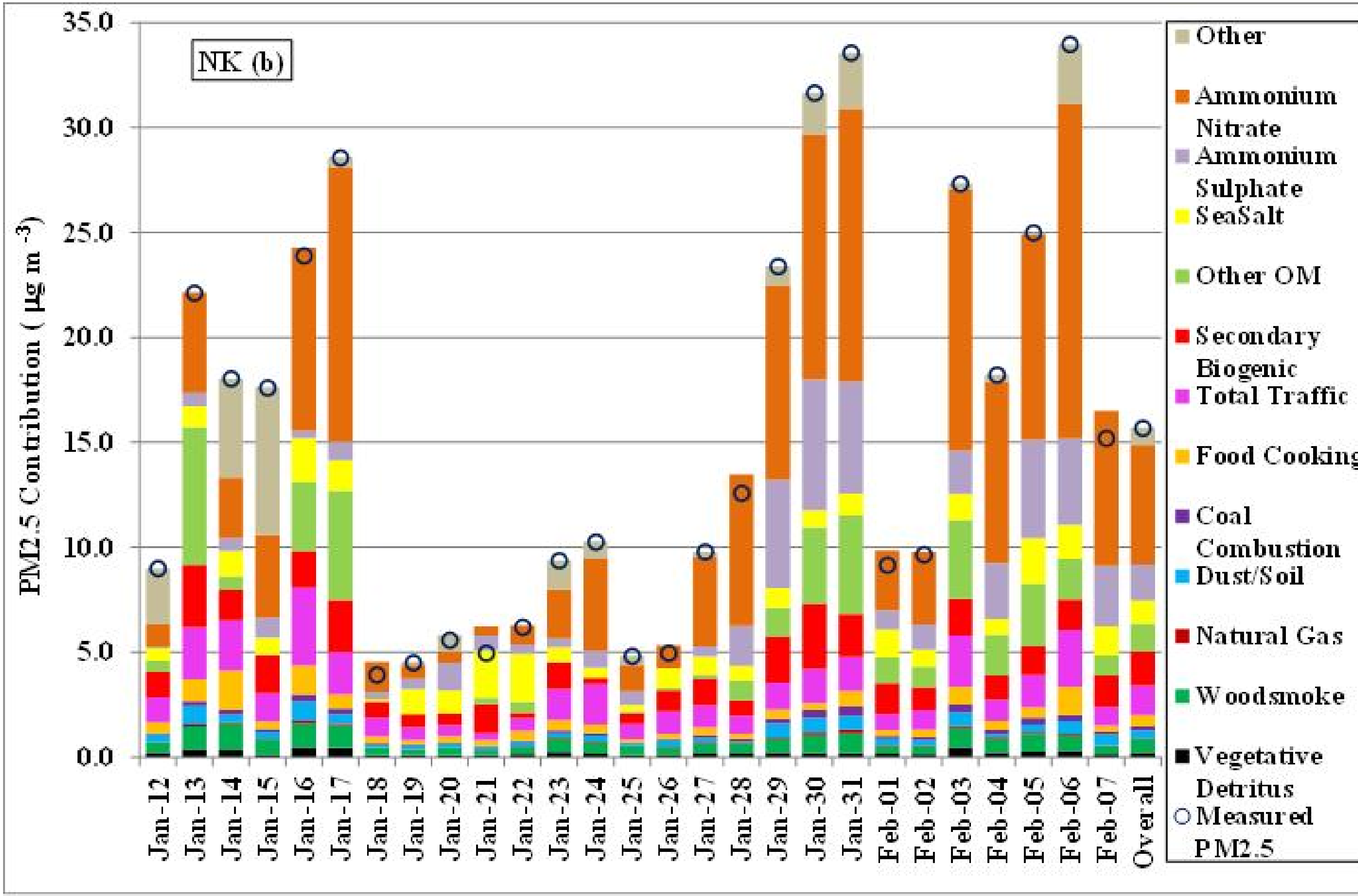
Daily $PM_{2.5}$ Source Contribution Estimates with Secondary Biogenic Components at NK



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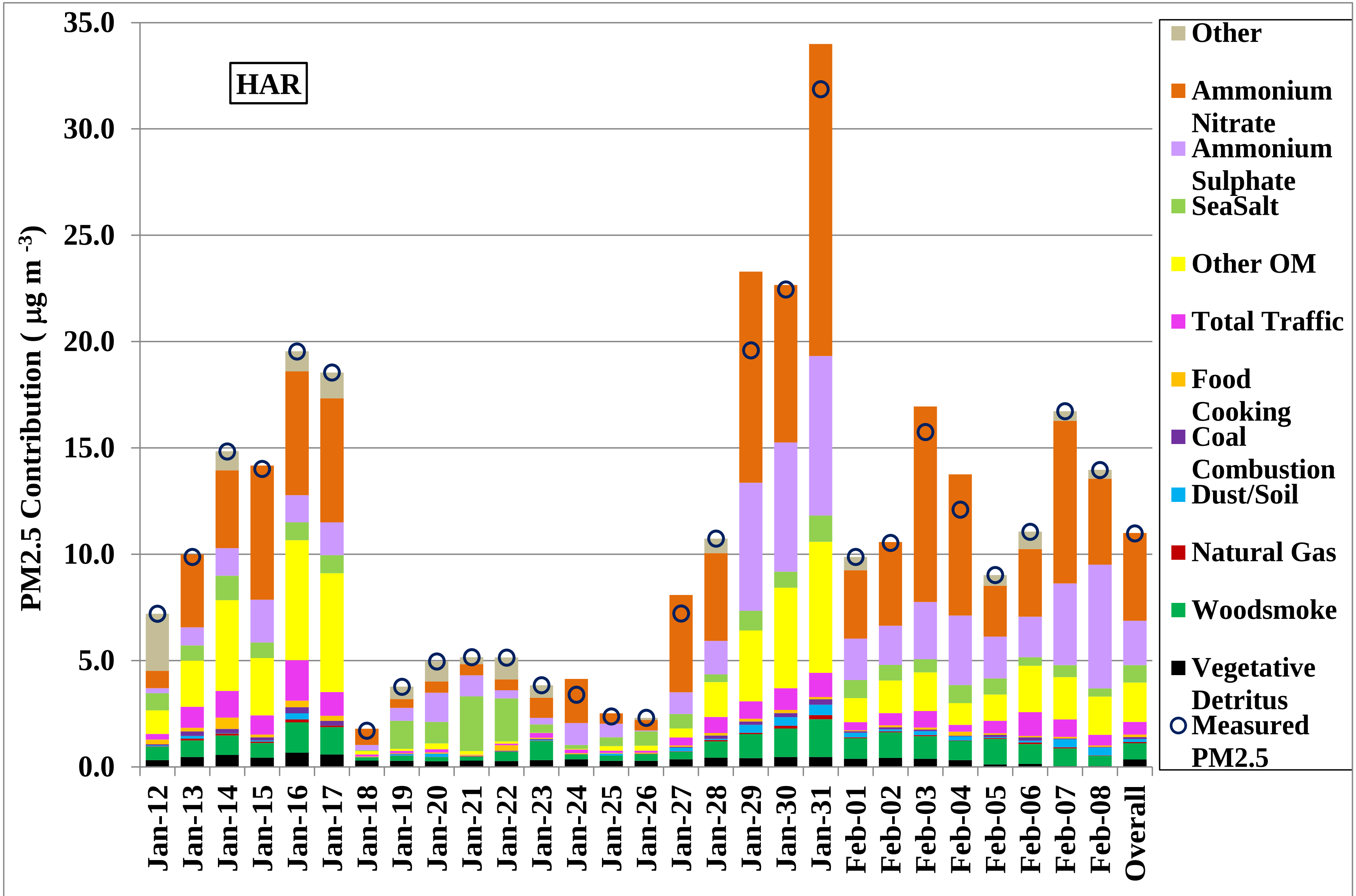
Daily $PM_{2.5}$ Source Contribution Estimates at HAR



SELECTED MEAN CONTRIBUTION TO $PM_{2.5}$ MASS ($\mu g\ m^{-3}$)

	NORTH KENSINGTON	HARWELL
COOKING	0.69 (4%)	0.13 (1%)
WOODSMOKE	0.64 (4%)	0.76 (7%)
TRAFFIC EXHAUST	1.26 (8%)	0.61 (6%)
SULPHATES AND NITRATES	8.0 (51%)	6.2 (56%)
$PM_{2.5}$ MASS	15.7	11.0

COMPARISON WITH AEROSOL MASS SPECTROMETER (AMS)

- AMS operated by University of Manchester.
- Instrument generates a continuous mass spectrum of non-refractory atmospheric particles of < 0.8 µm diameter ($PM_{0.8}$).
- The mass spectral dataset is disaggregated into source contributions using the PMF program.
- Work in London (Regents Park) as part of the REPARTEE campaigns attributed ~ 1.25 µg m^{-3} to cooking, and ~ 1.0 µg m^{-3} to solid fuel burning.

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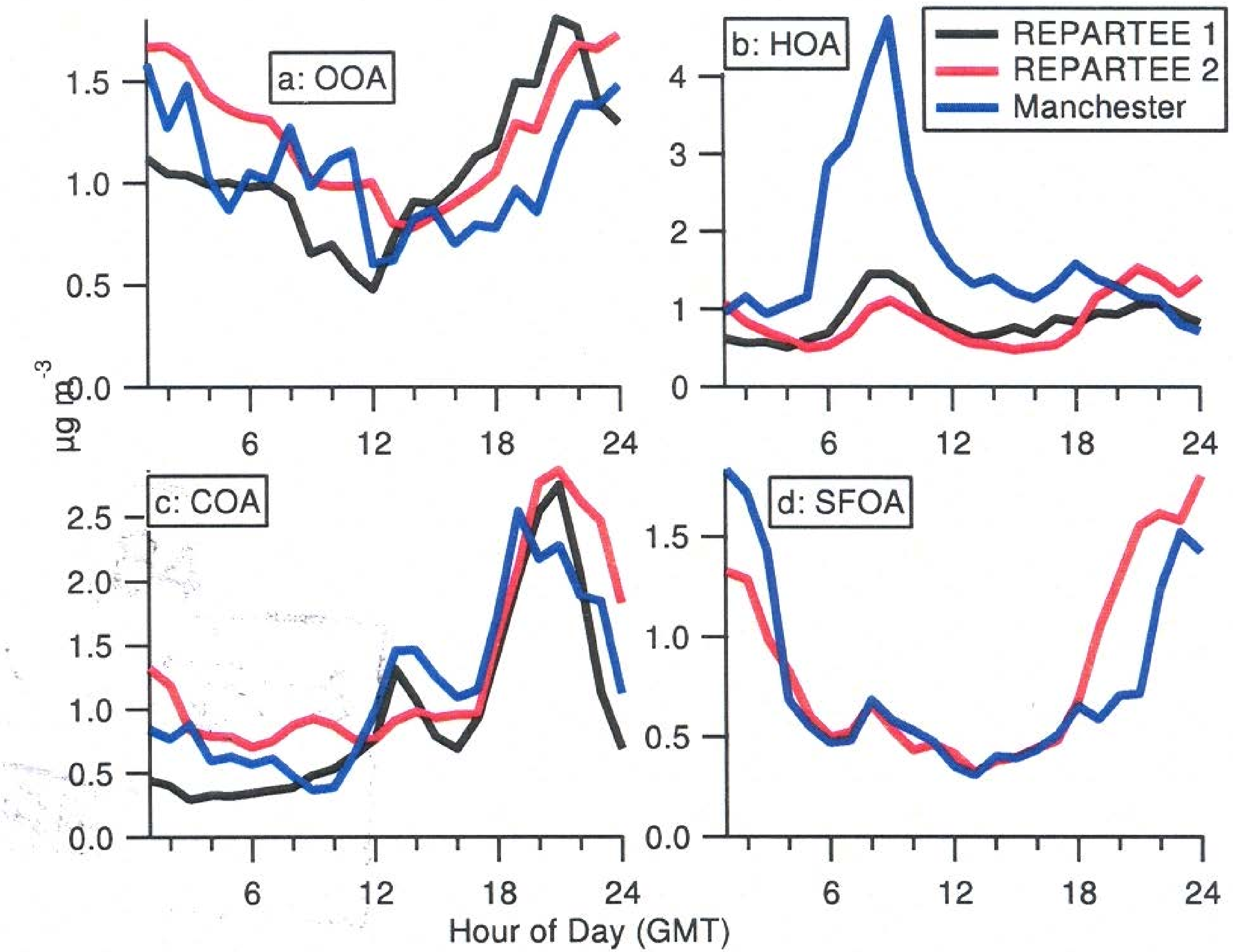
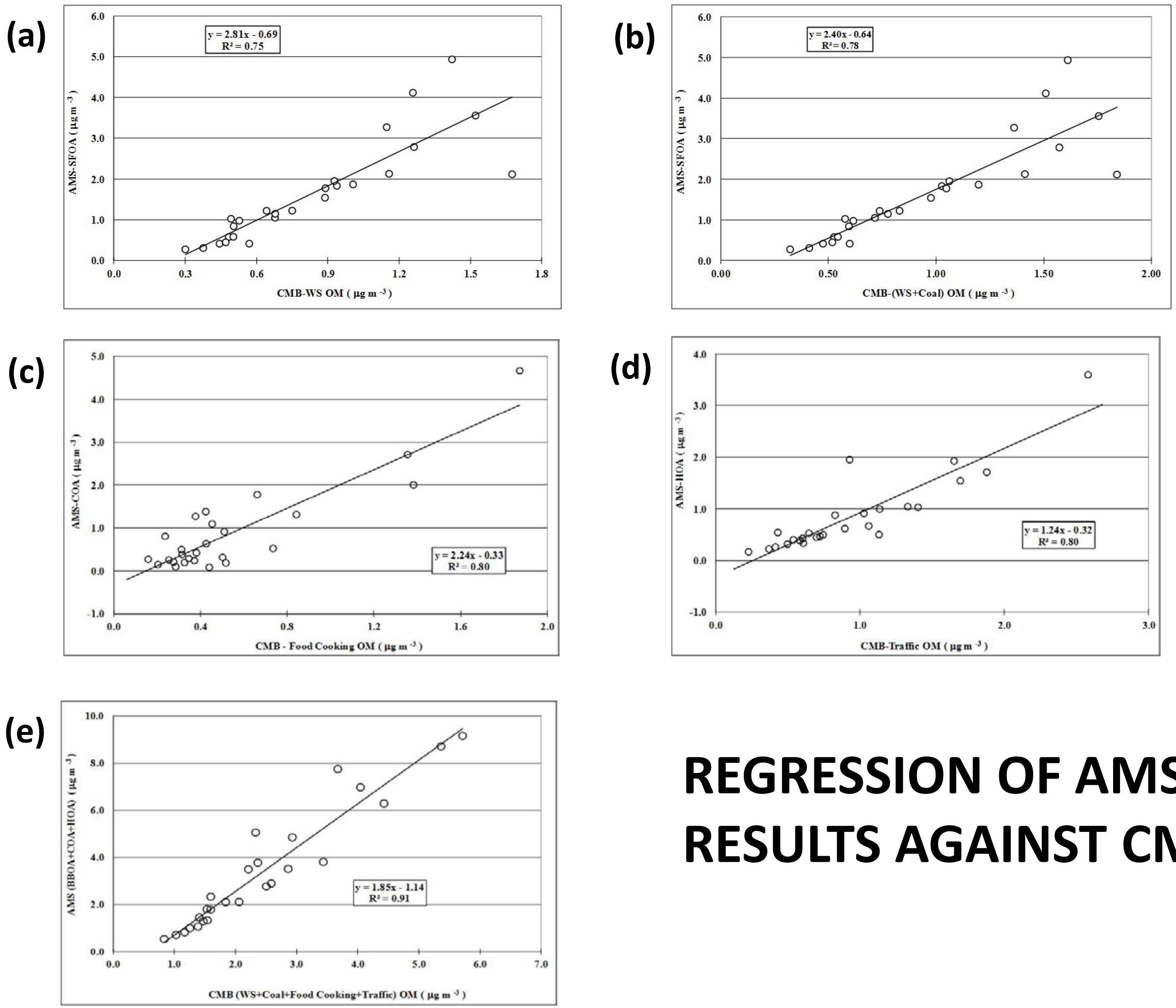
Median Diurnal Profiles of the Factors from the Three Campaigns (from J.D. Allan et al., ACP, 10, 647-668, 2010)





REGRESSION OF AMS FACTOR RESULTS AGAINST CMB DATA

CONCLUSIONS

- Progress is being made in quantifying the smaller sources contributing to $PM_{2.5}$ mass.
- The different methods correlate well, but do not agree on absolute mass contributions.
- Based upon current knowledge, the contribution of food cooking to $PM_{2.5}$ is relatively small (<5%) but may be greater in areas with many restaurants.

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