

Photo: iStockPhoto

Estimating the lifetime of black carbon in rural air

Neil Cape, Mhairi Coyle
Centre for Ecology & Hydrology, Edinburgh, UK

P Dumitrean
AEATechnology, Harwell, UK



WHY?

- Component of Particulate Matter
- Concern for human health
- Most measurements in urban air
- Impact on radiative forcing
- Possible 'quick win' for control strategy
- Long-lived.....mostly $< 1\mu\text{m}$
- Removed by rainfall

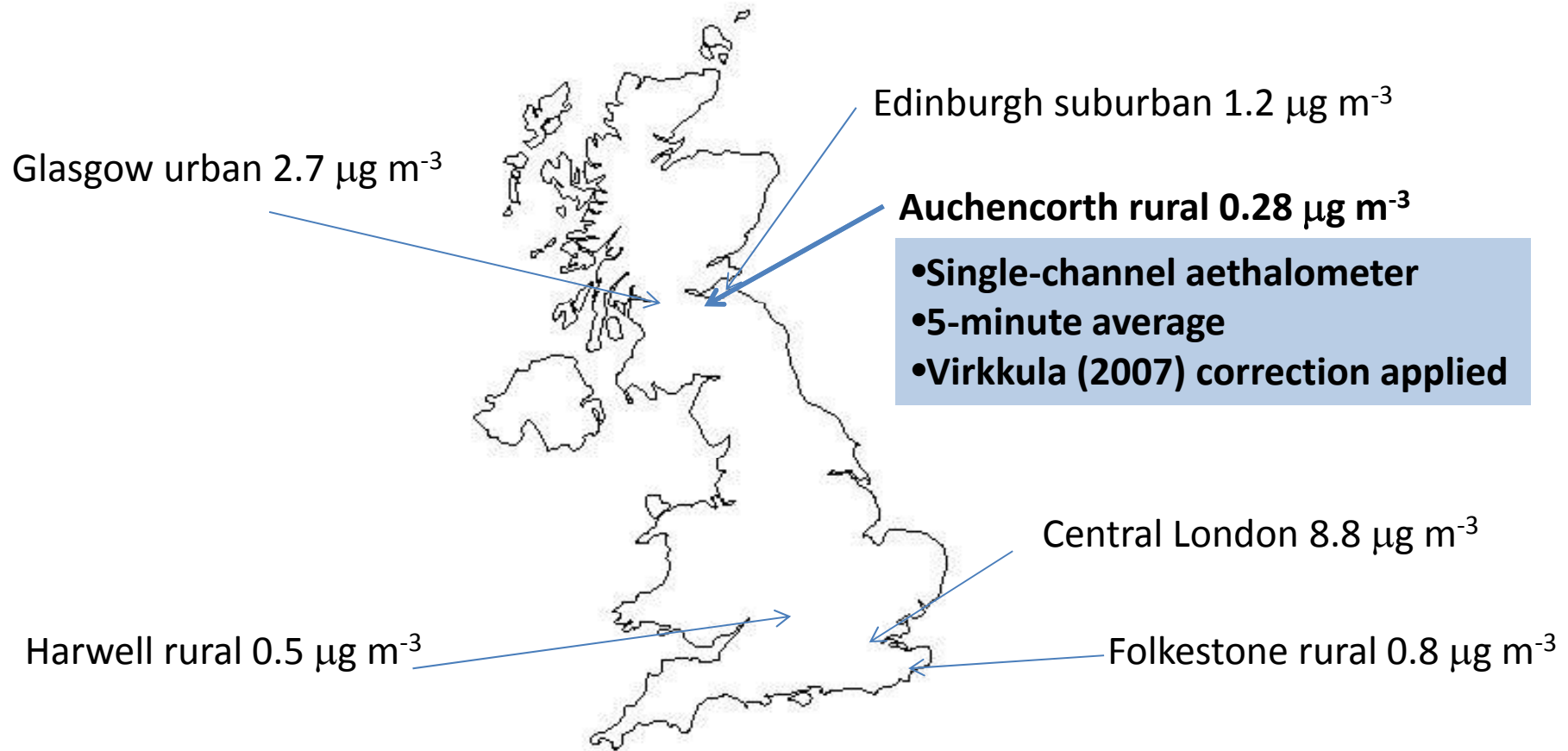
WHERE?

EMEP 'supersite' at Auchencorth Moss, southern Scotland

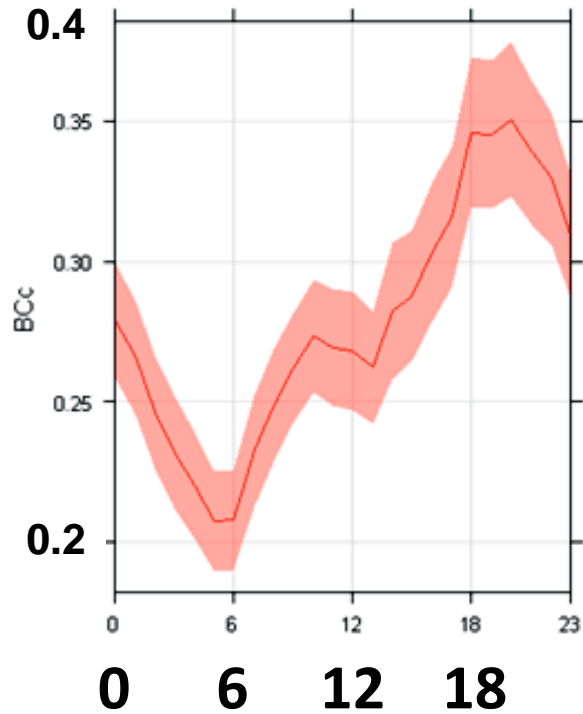


CONTEXT

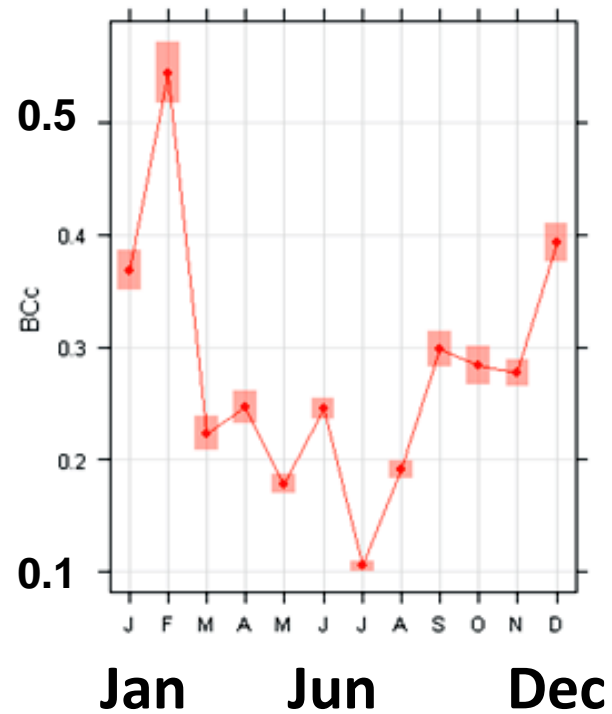
Aethalometer black carbon $PM_{2.5}$ 2010



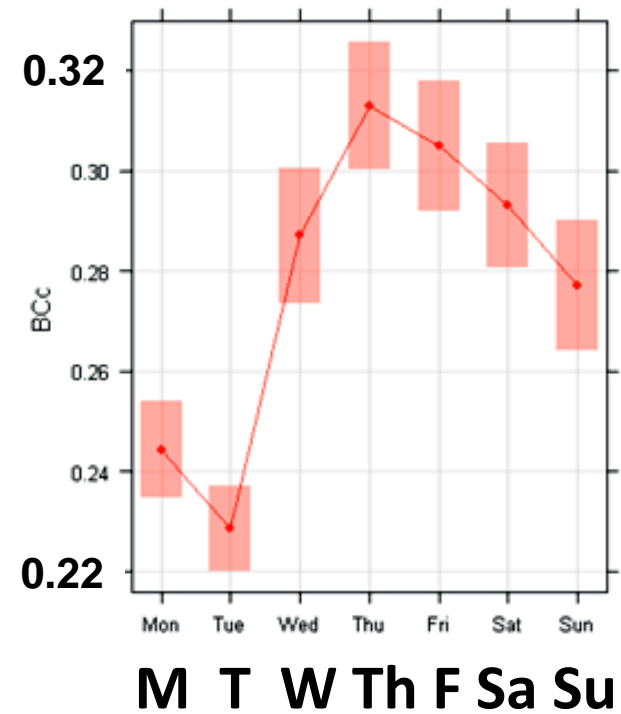
OVERVIEW – concentration in $\mu\text{g m}^{-3}$



hourly



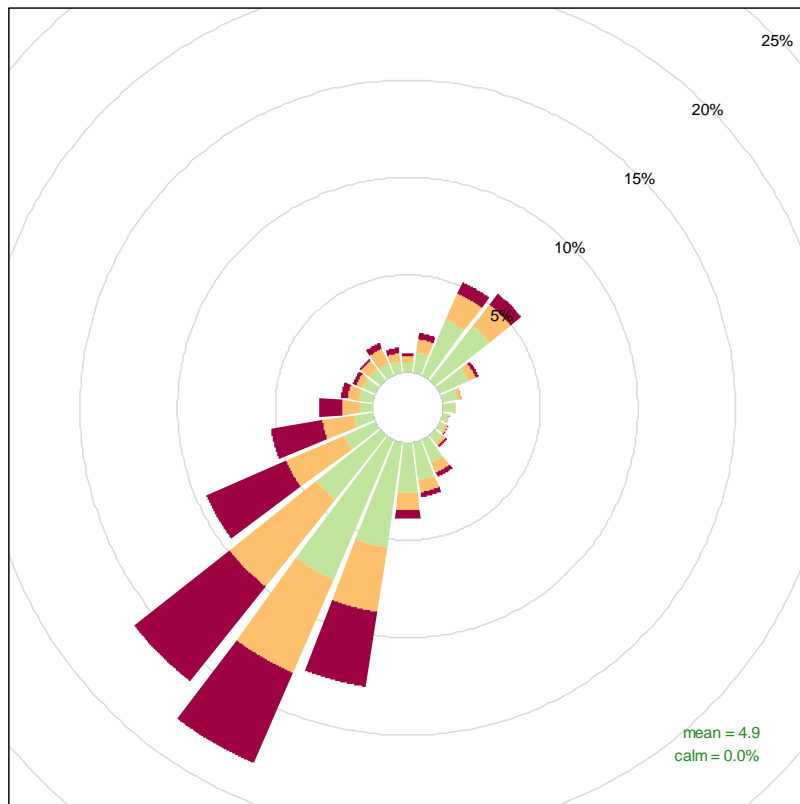
seasonal



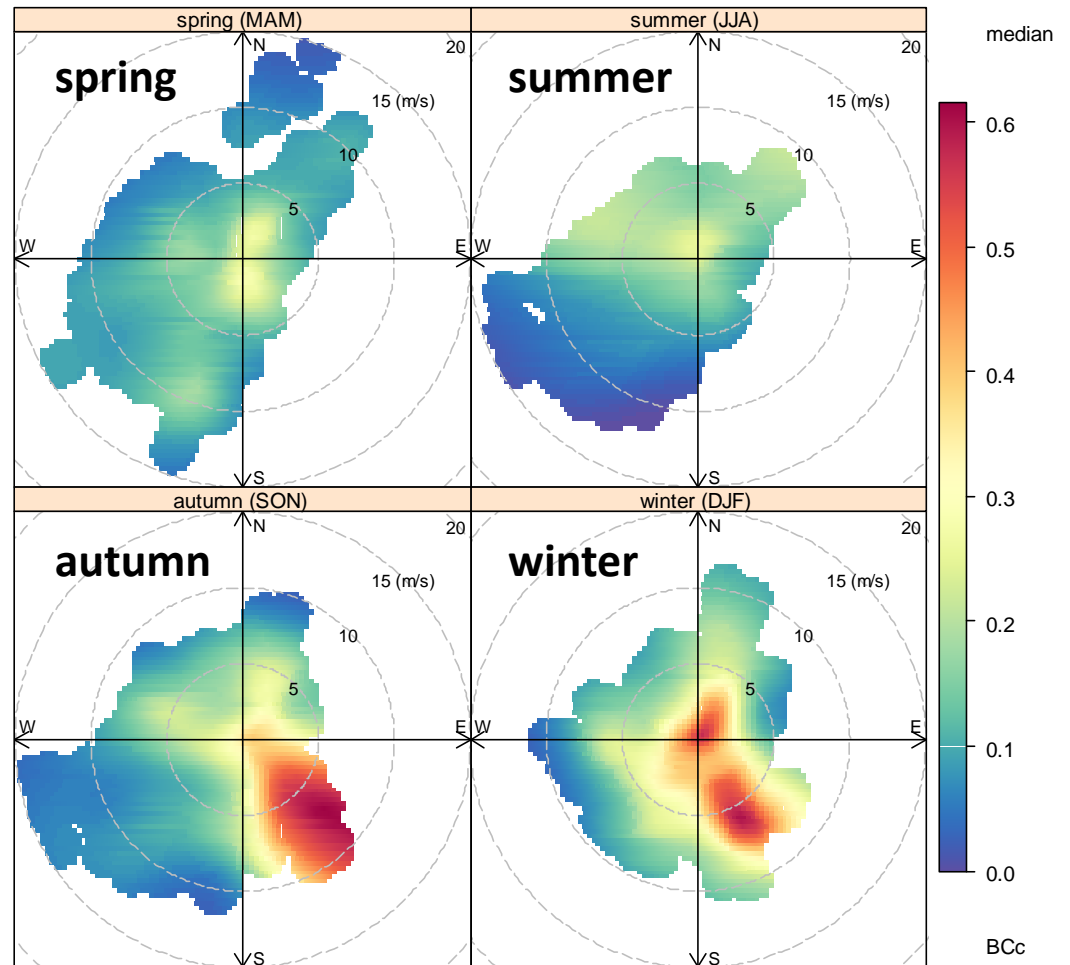
day of week

Average over years 2007 – 2010, wind speed $> 2 \text{ m.s}^{-1}$

OVERVIEW – concentration in $\mu\text{g m}^{-3}$

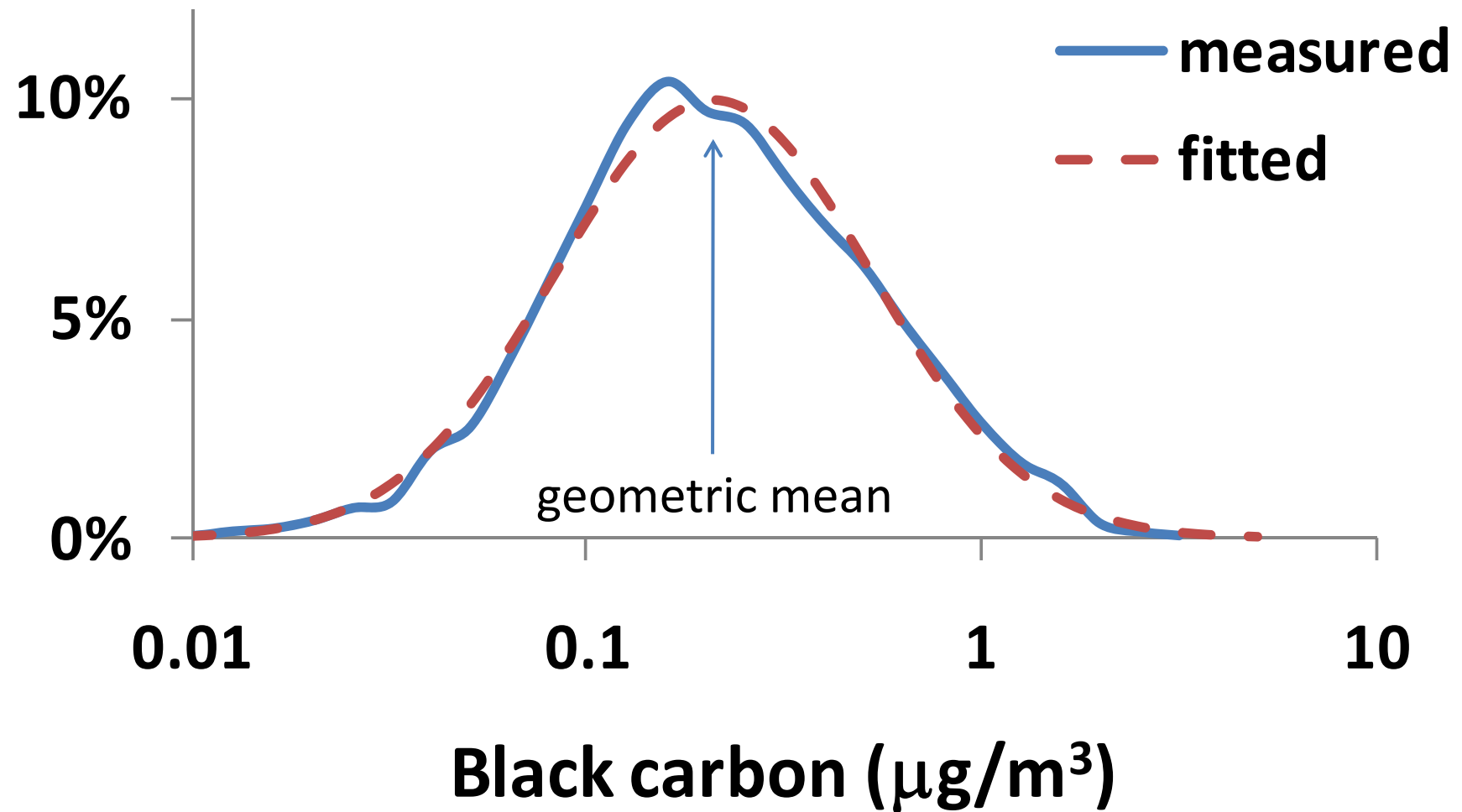


Wind frequency
(colour bars denote wind speed)

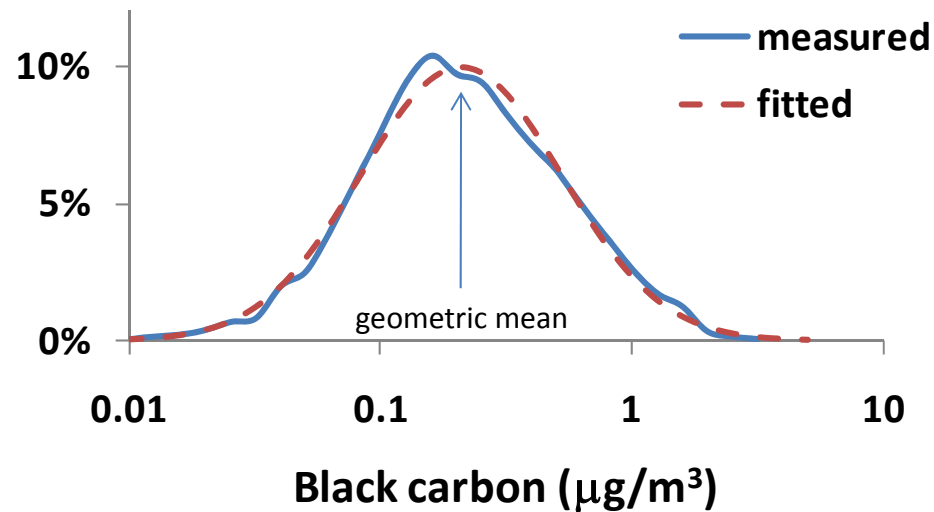


Black carbon by season
(median concentration)

Frequency distribution of BC

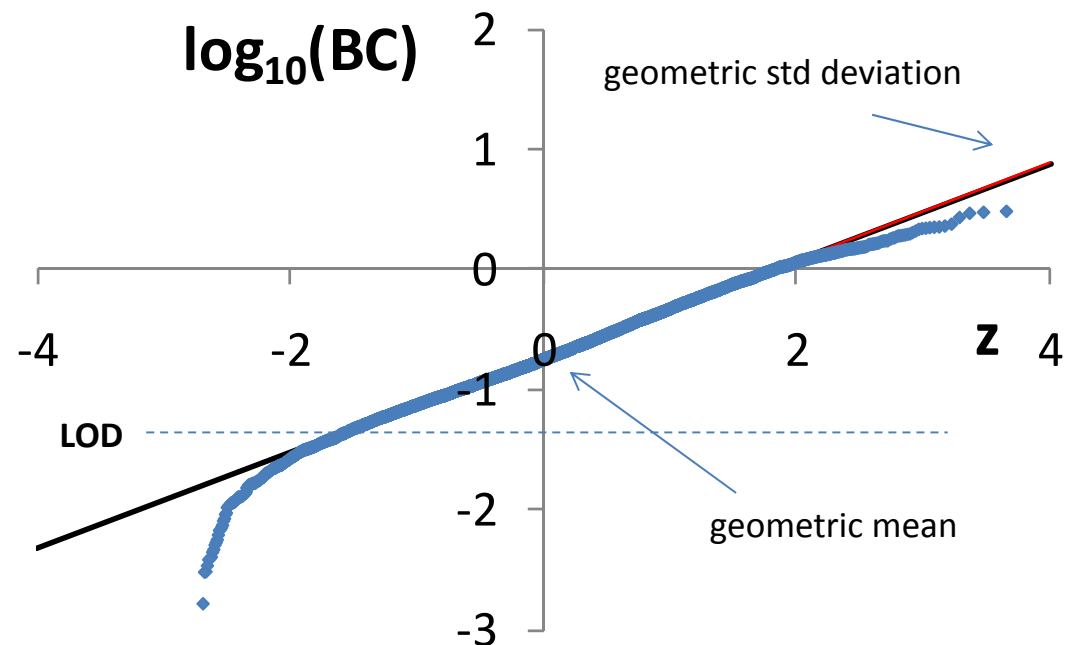


Frequency distribution of BC



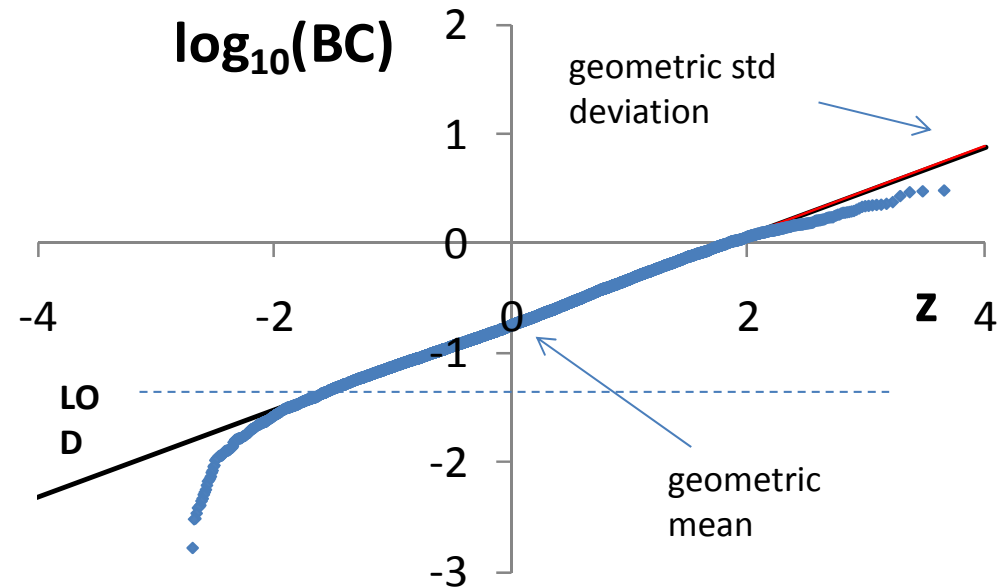
standard normal variate (z)

LOD is $0.03 \mu\text{g m}^{-3}$



Frequency distribution of BC

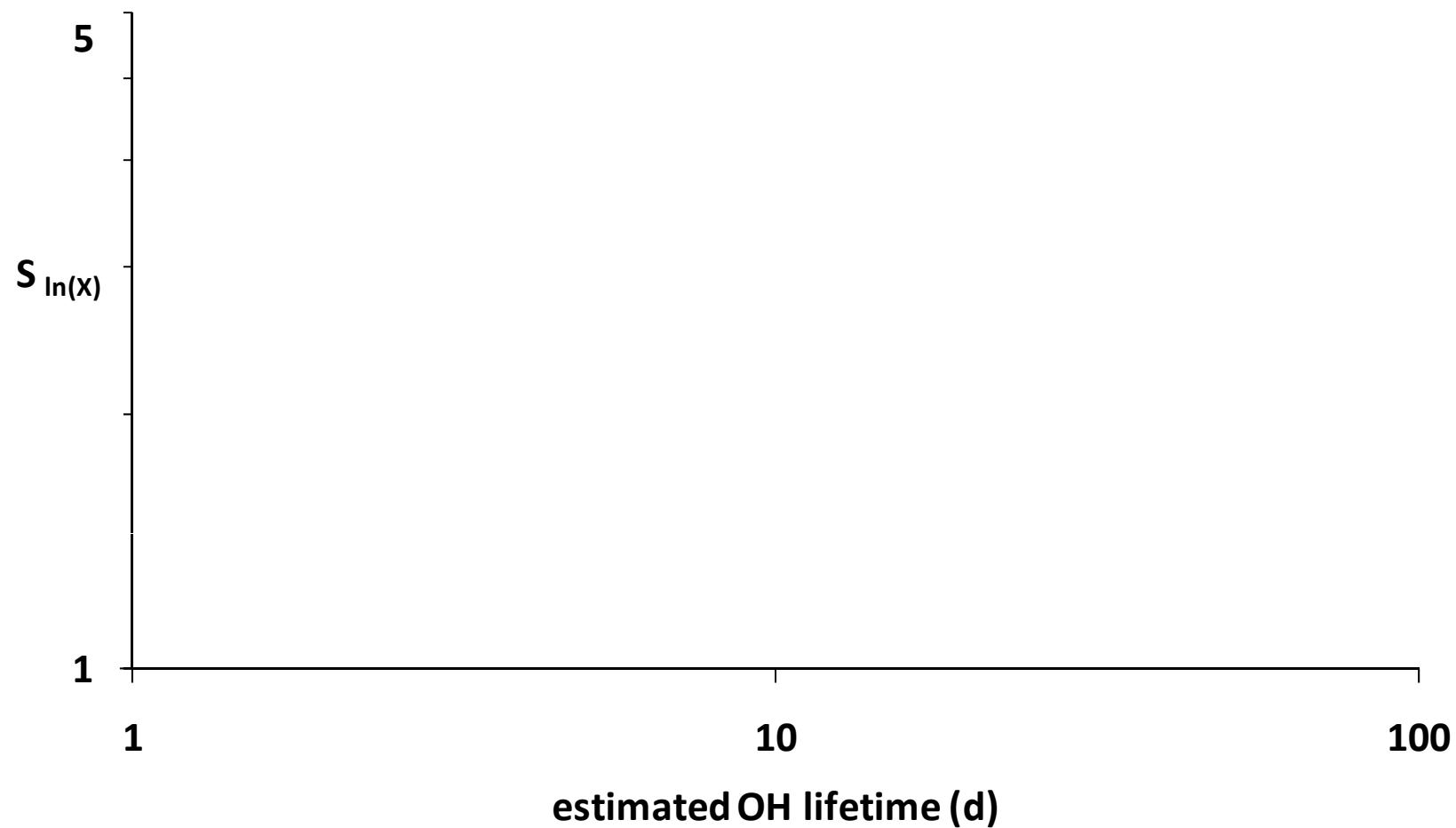
What determines the geometric standard deviation?



Jobson et al. (J Geophys Res 103, 13557 , 1998) showed that **the standard deviation of the logarithm of concentration is proportional to 1/lifetime**

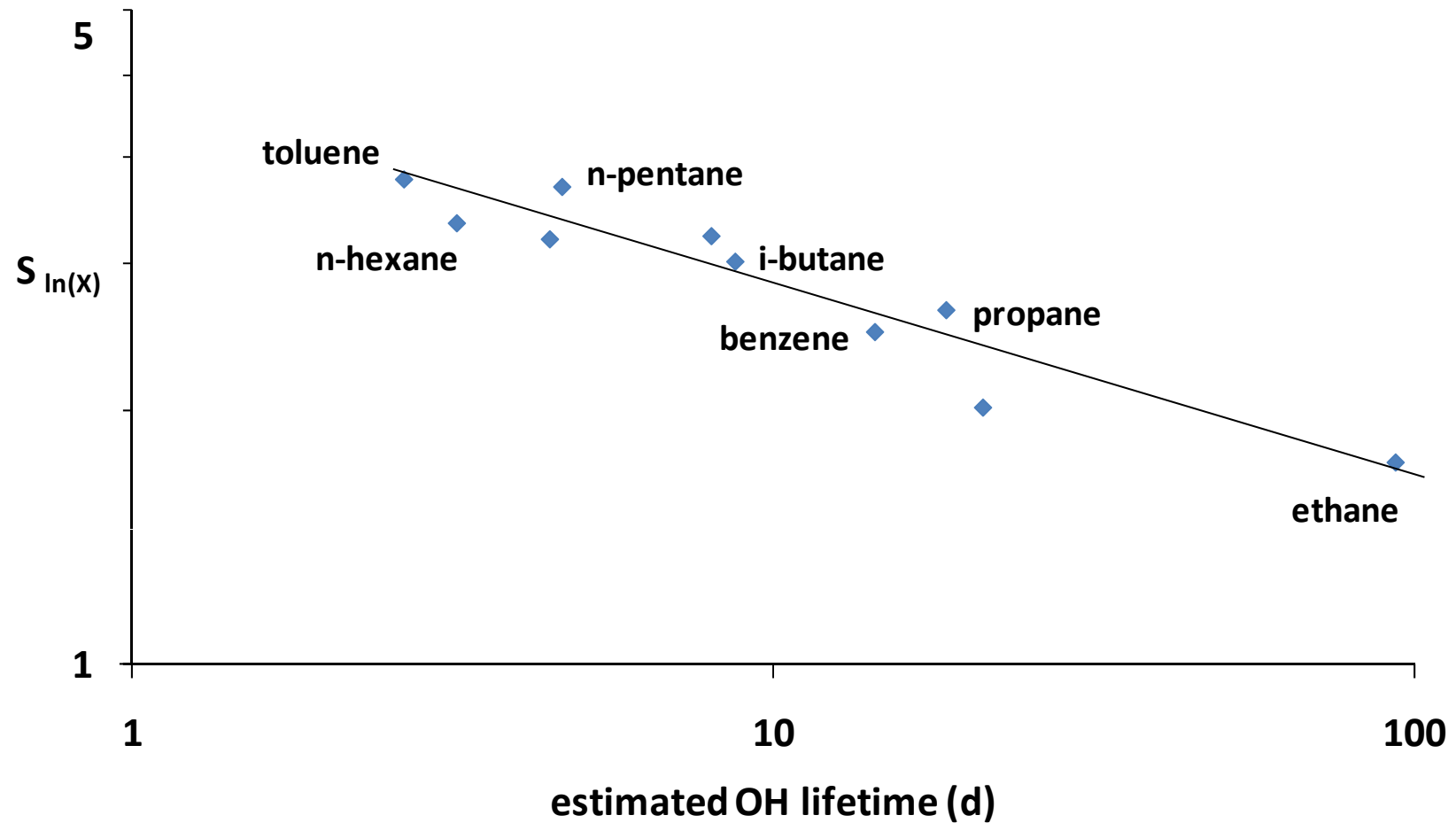
Lifetime

hydrocarbons

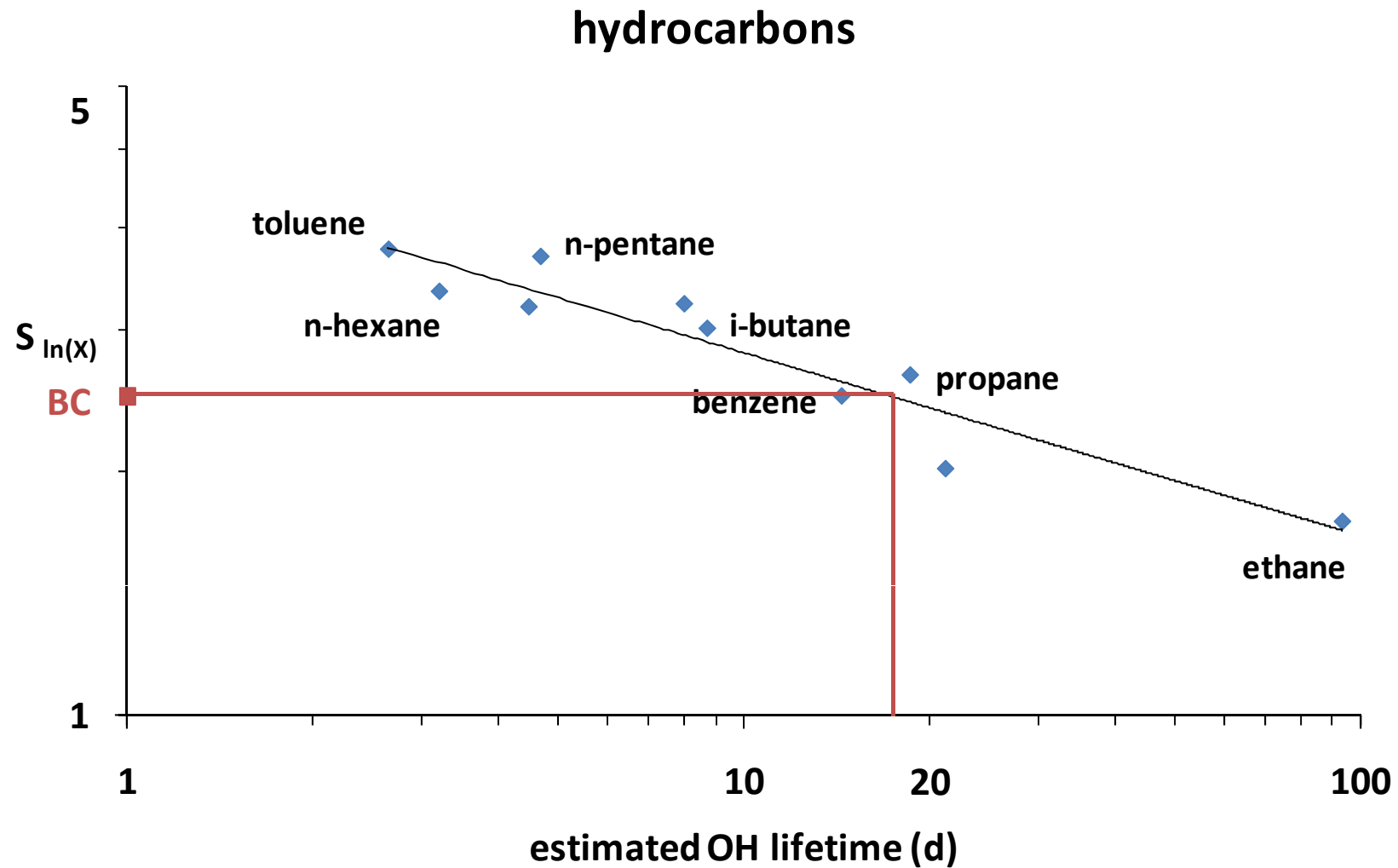


Lifetime

hydrocarbons

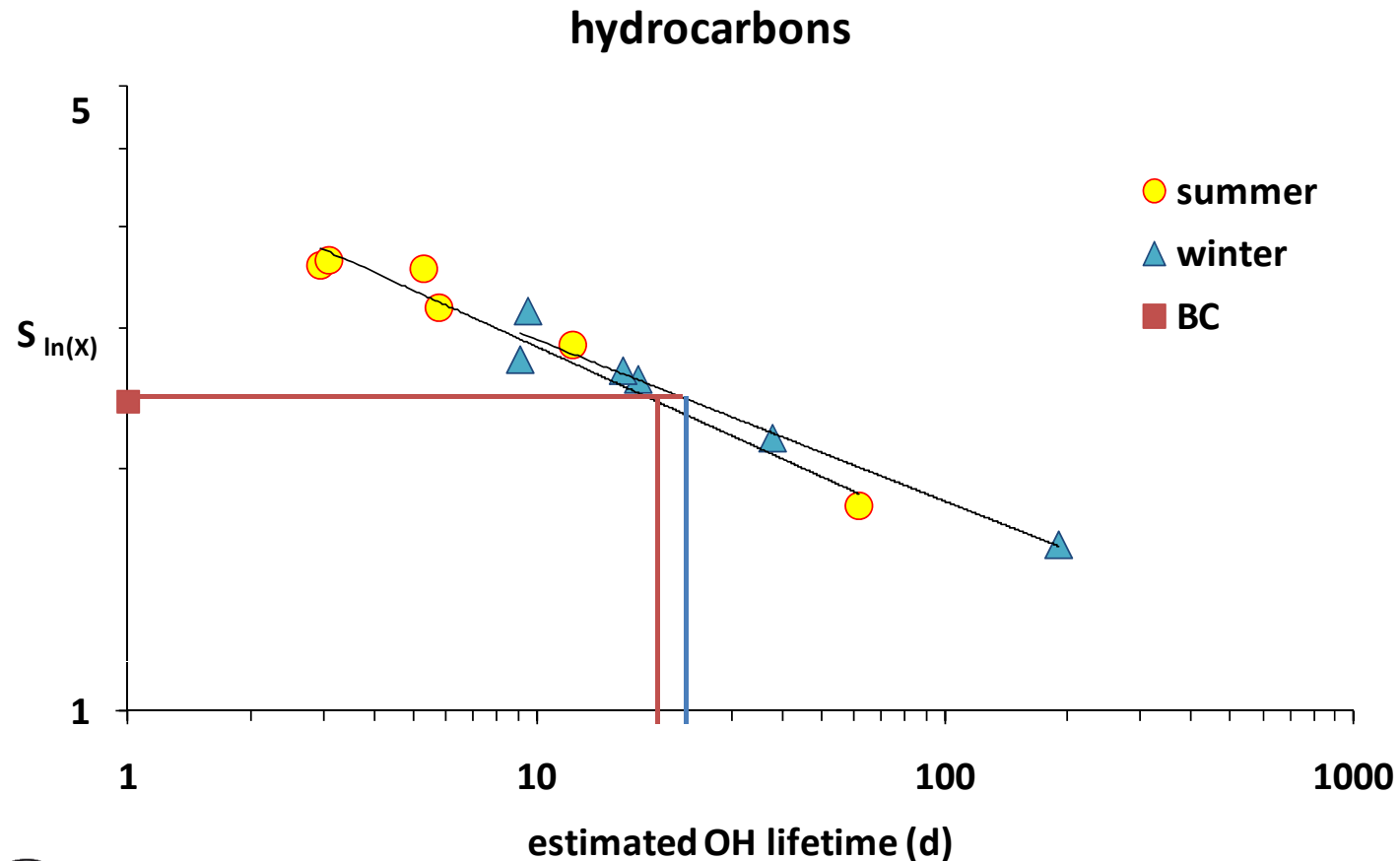


Lifetime

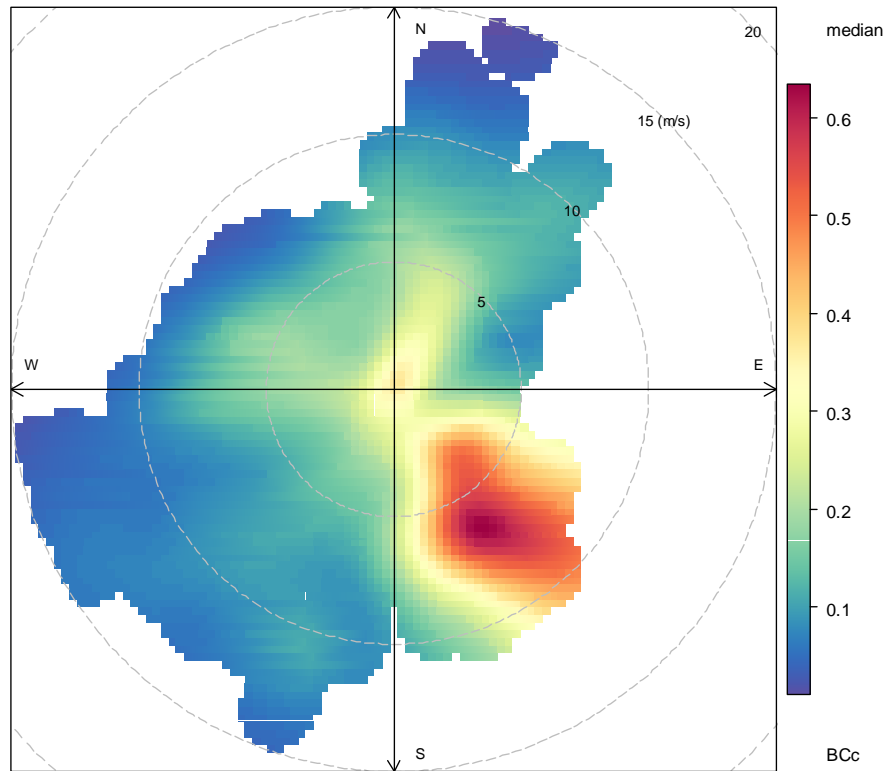


Lifetime

Lifetime depends on assumed OH concentration ($7 \times 10^5 \text{ cm}^{-3}$)
Comparison of summer and winter (10.5 or $3.5 \times 10^5 \text{ cm}^{-3}$)

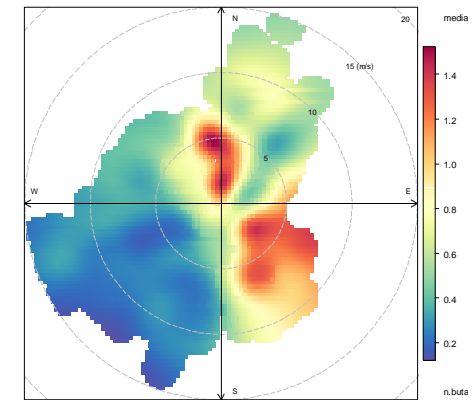


Lifetime – directional data

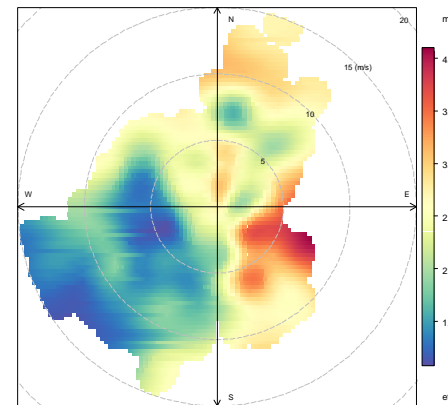


Black carbon

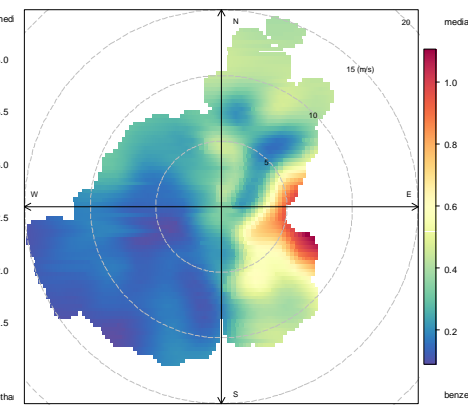
Median concentrations by wind direction and speed



n-butane



ethane

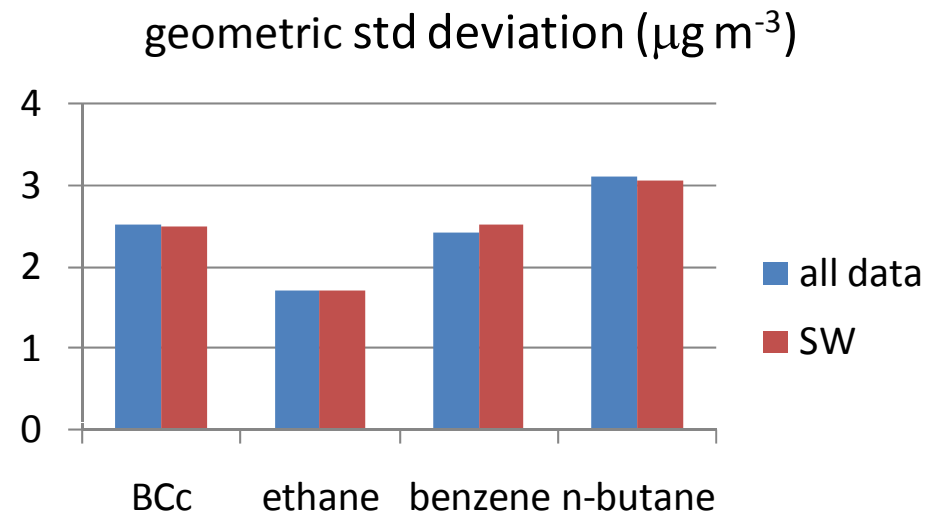
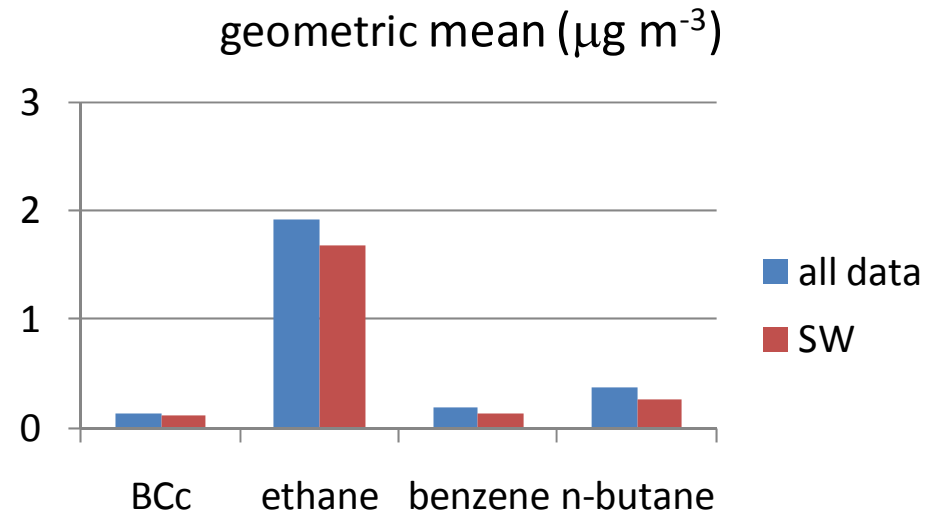


benzene

Lifetime – directional data

Wind direction between south and west accounts for 62% of time.

Although average concentrations are slightly smaller than for the whole dataset, geometric standard deviations are almost identical.



Lifetime - conclusions

BC lifetime is around 20 days,
based on assumed OH concentrations

Lifetime is inversely proportional to assumed (OH)

Site specific

Little variation between summer and winter

Main removal process is rainfall –
summer and winter rainfall amounts at this site
are almost the same



QUESTIONS?

Acknowledgements

The EMEP 'supersites' project is funded by the UK Department for Environment, Food and Rural Affairs (Defra).

References

- Jobson, B. T., et al. (1998). *Journal of Geophysical Research-Atmospheres* 103(D11): 13557-13567.
- Carlaw, D., Ropkins, K. (2010). *Open-source tools for analysing air pollution data*. Environmental Research Group, King's College London.