
# Estimating the lifetime of black carbon in rural air

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# 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 < 1μm
- Removed by rainfall

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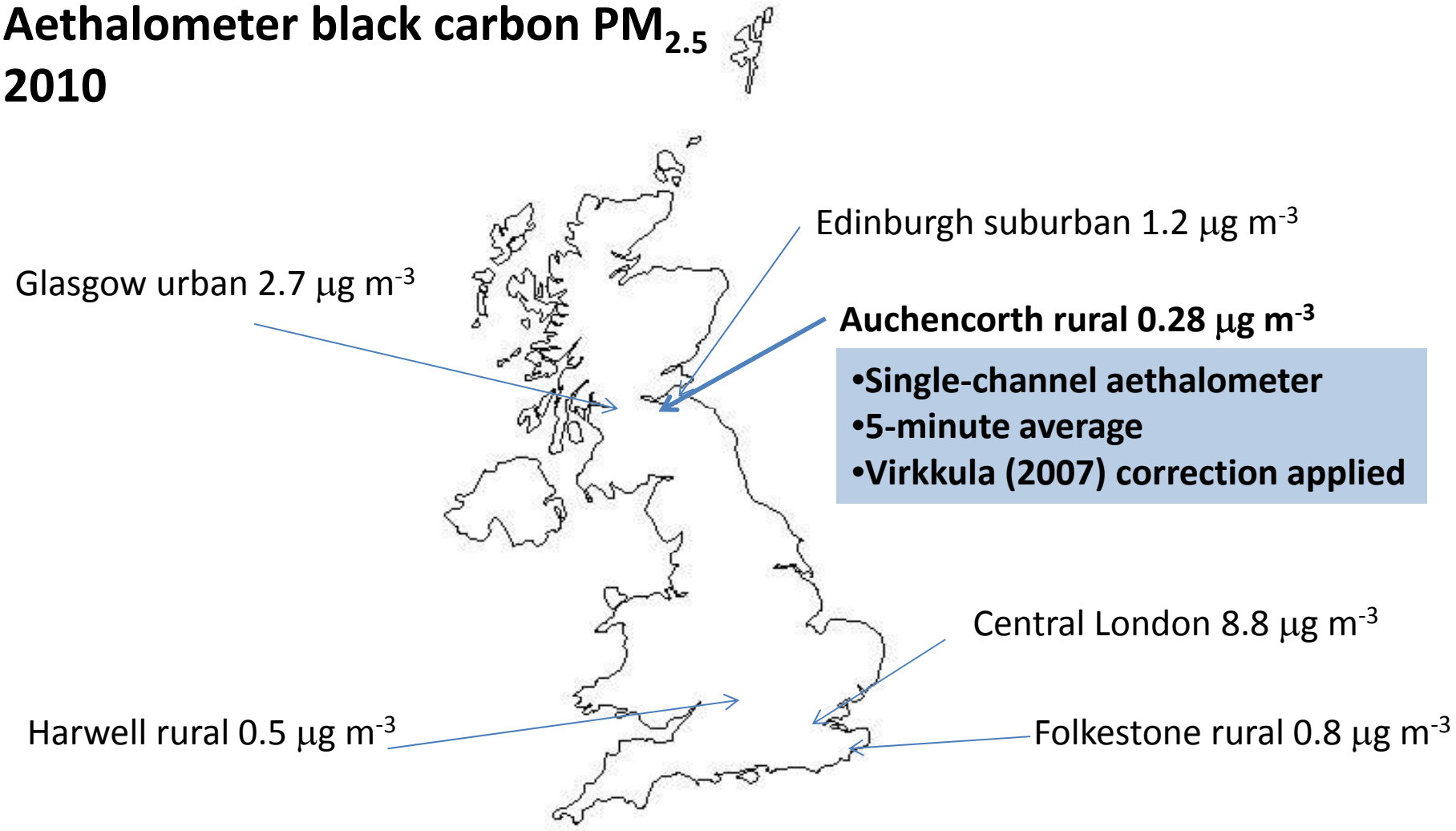
# WHERE?

**EMEP ‘supersite’ at Auchencorth Moss, southern Scotland**

# CONTEXT

## Aethalometer black carbon $PM_{2.5}$ 2010

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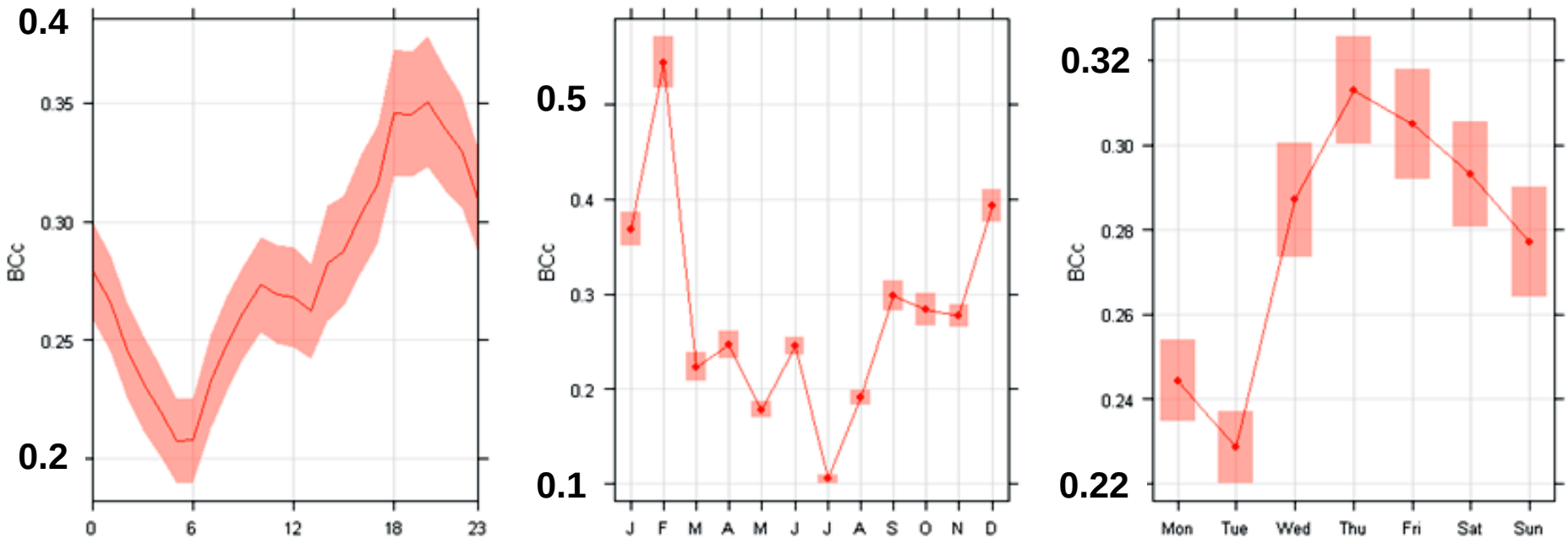
Butterfield et al., 2011. NPL Report AS63

# OVERVIEW – concentration in μg $m^{-3}$




**0 6 12 18** **Jan Jun Dec** **M T W Th F Sa Su**

**hourly** **seasonal** **day of week**

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

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plots by openair (Carslaw & Ropkins, 2010)

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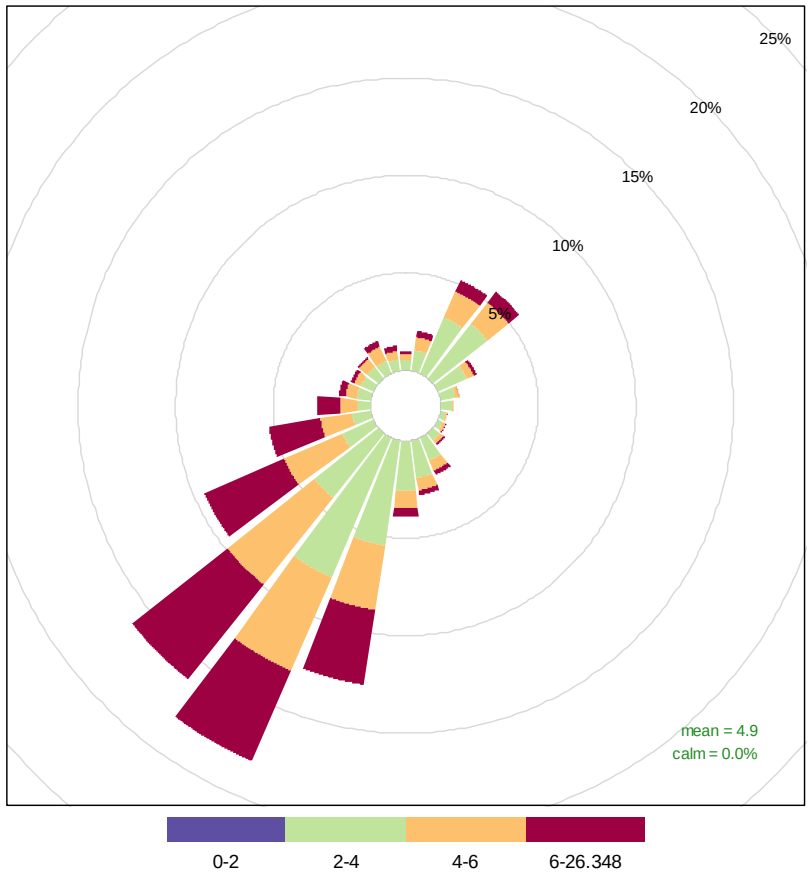
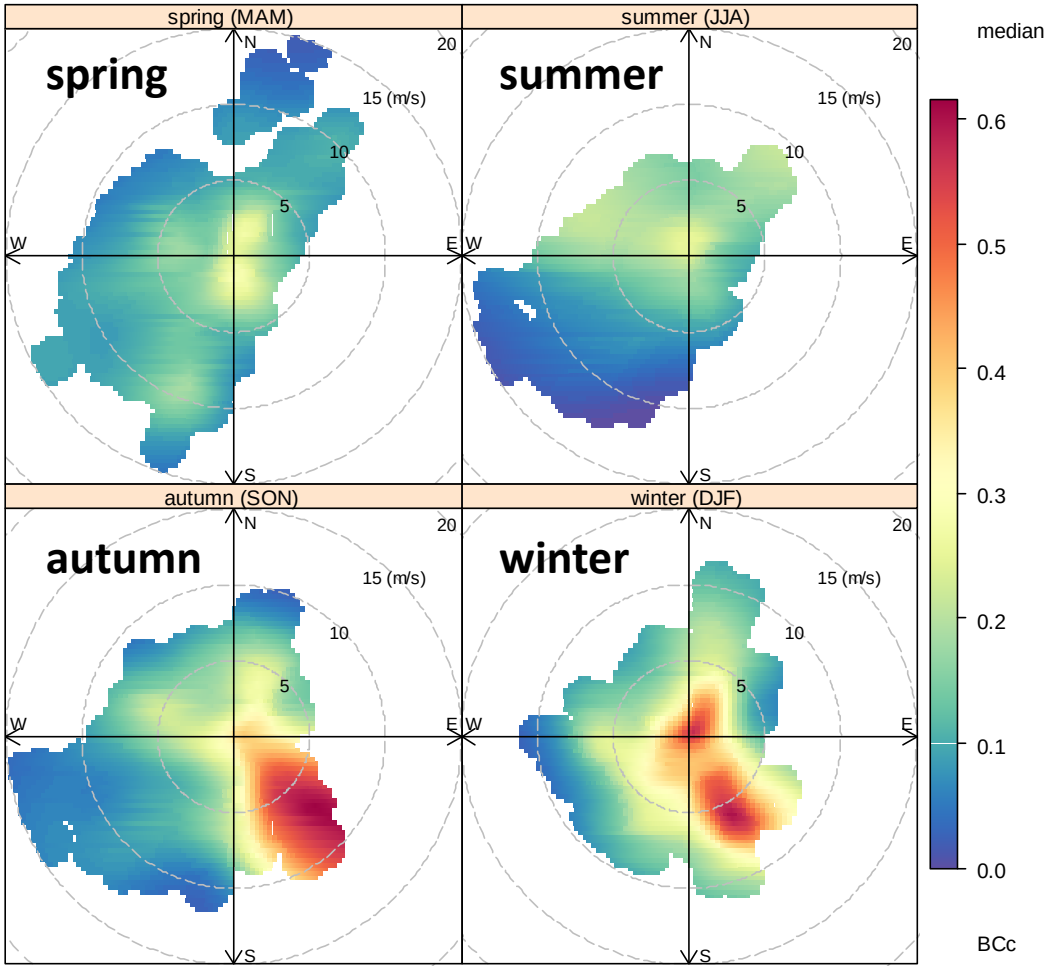



Wind frequency
(colour bars denote wind speed)




Black carbon by season
(median concentration)

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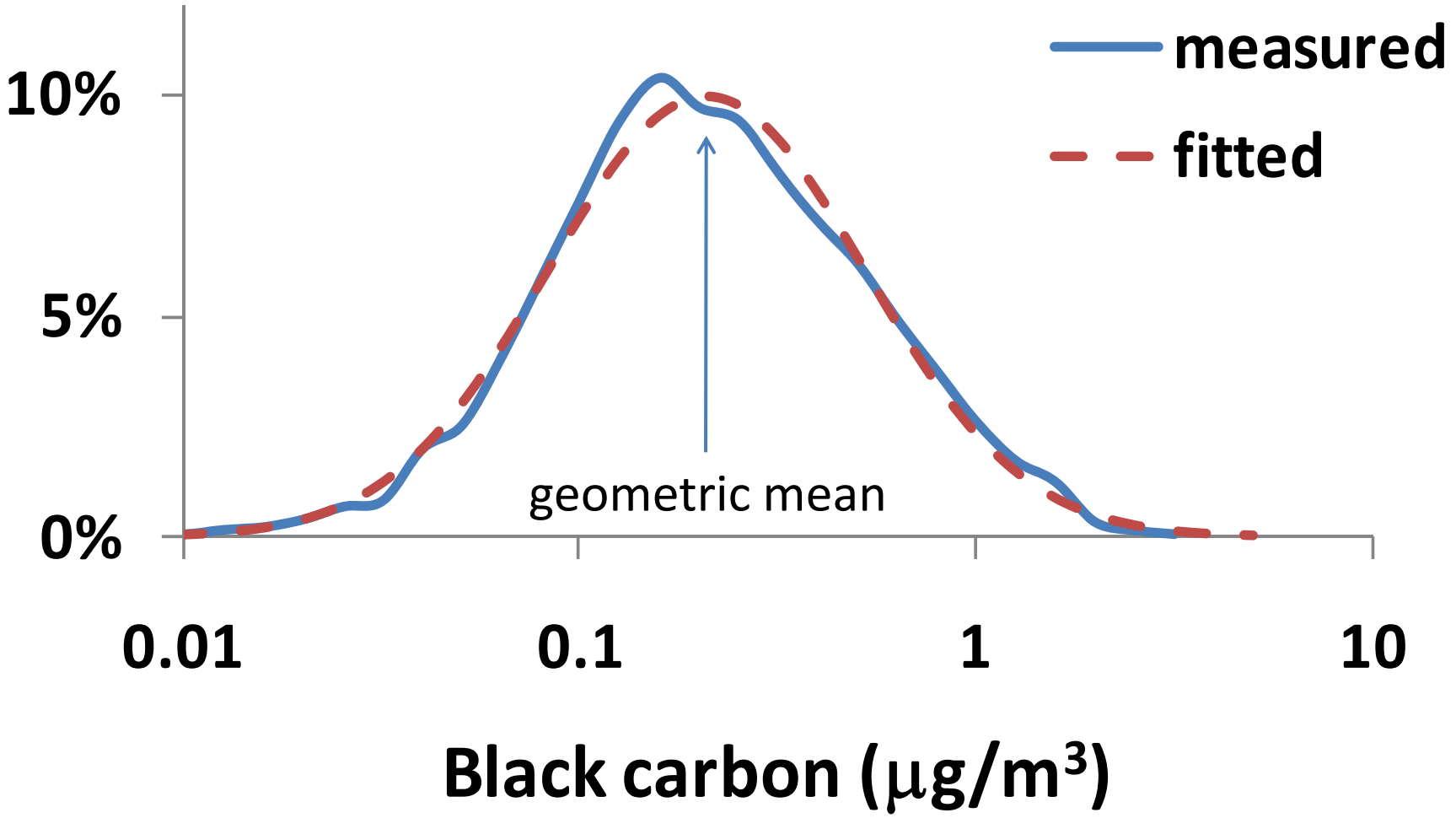
# Frequency distribution of BC

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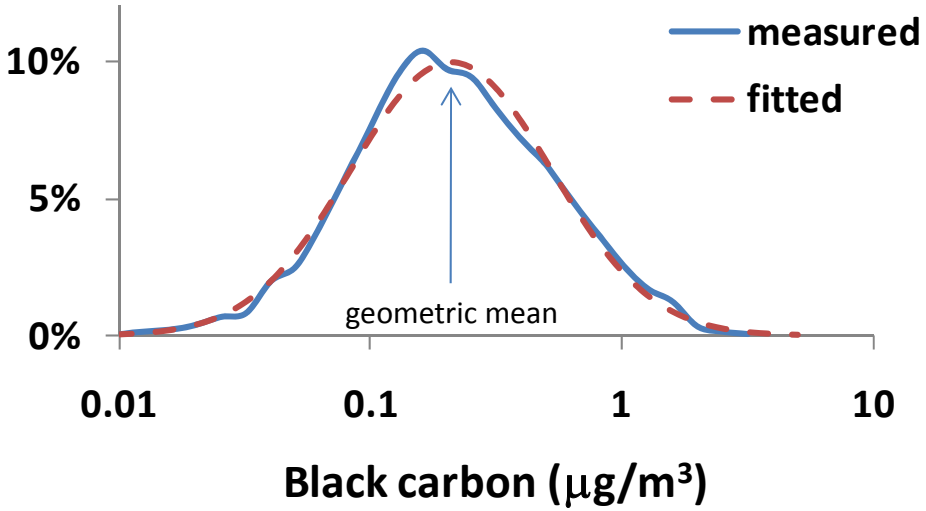
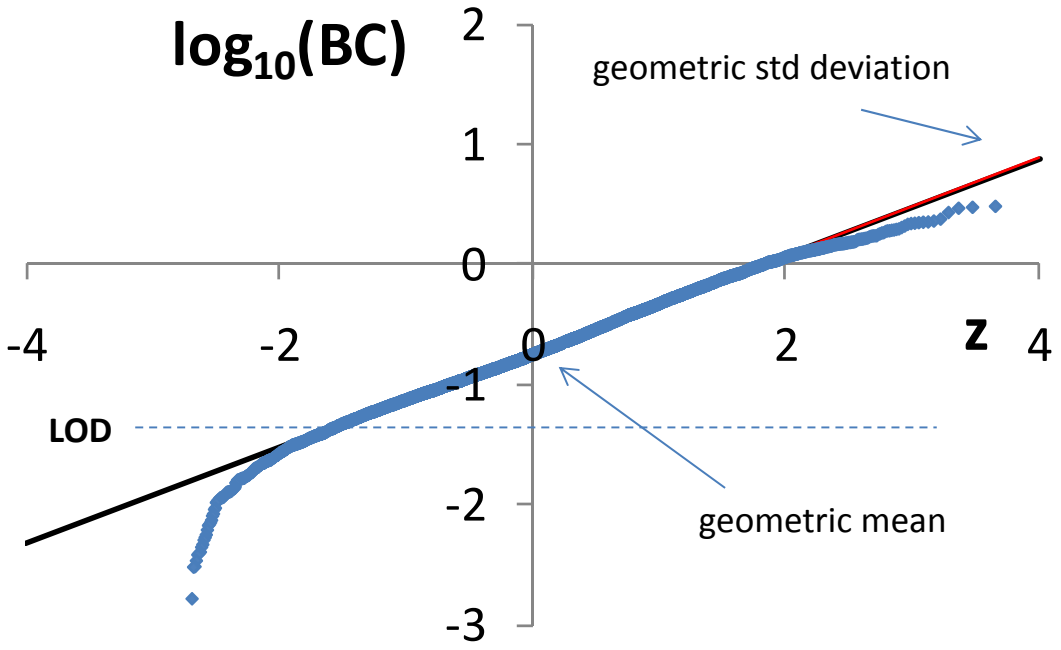



standard normal variate (z)

LOD is 0.03 µg $m^{-3}$

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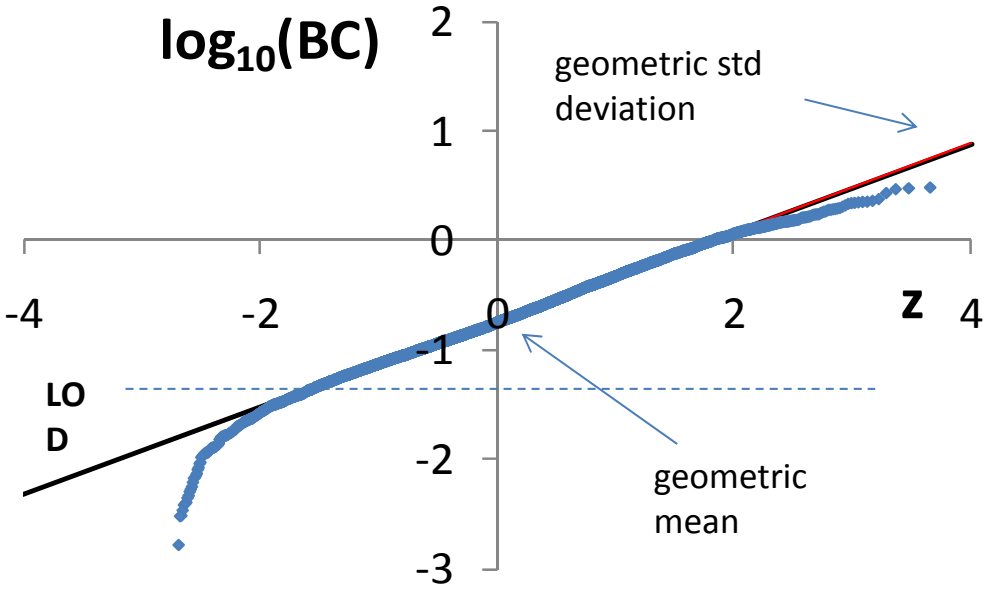
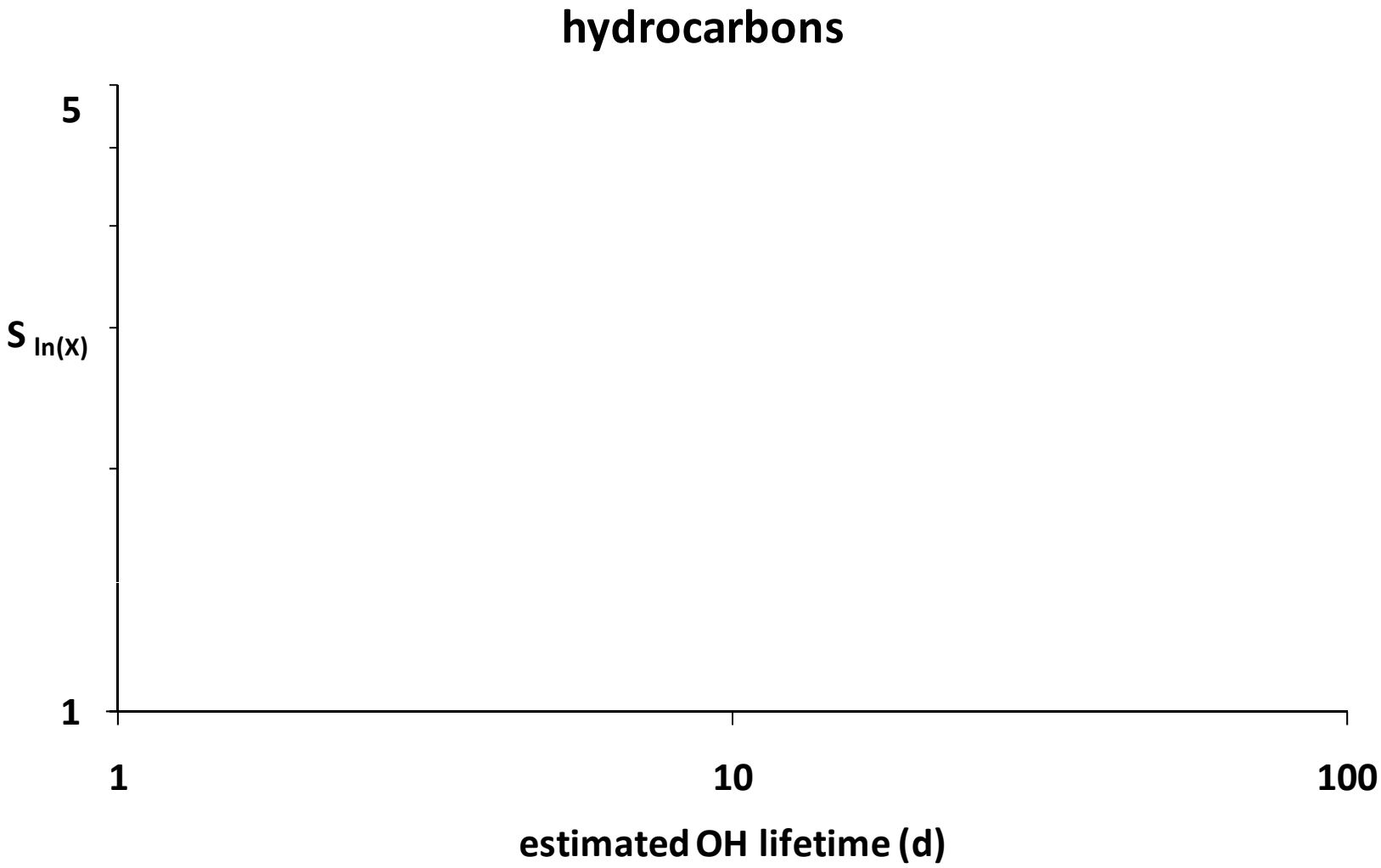
# Frequency distribution of BC

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

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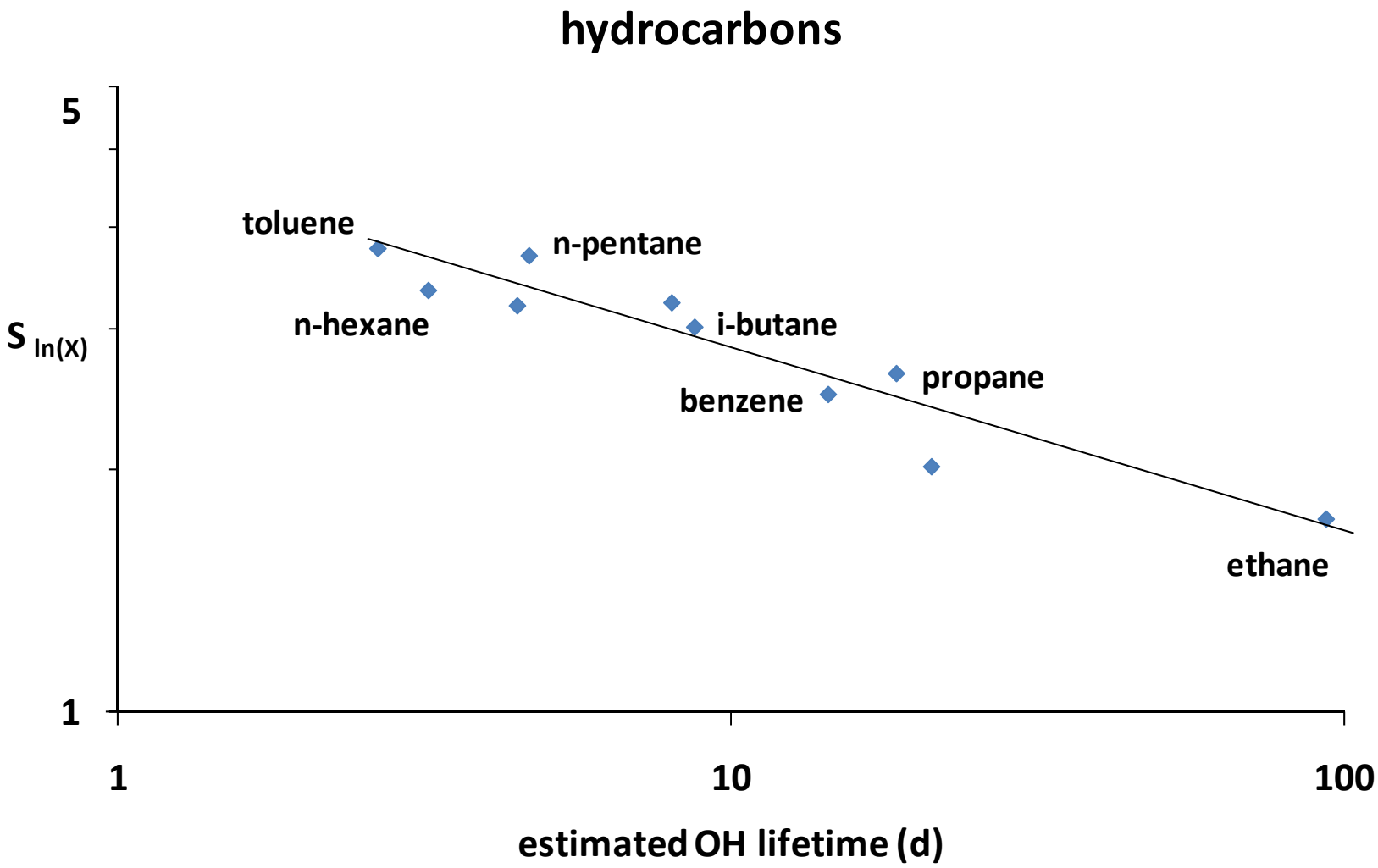
# Lifetime

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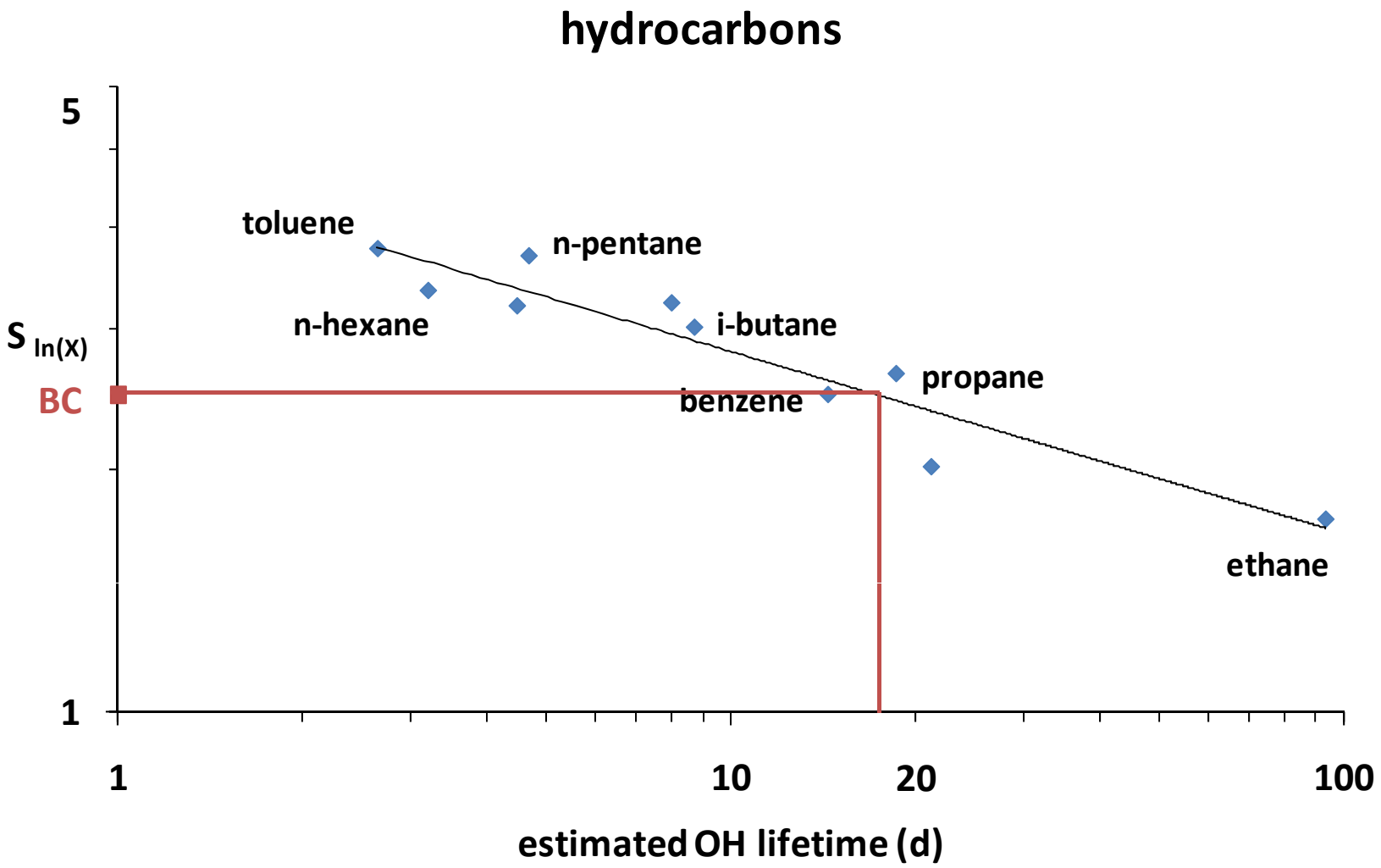
# Lifetime

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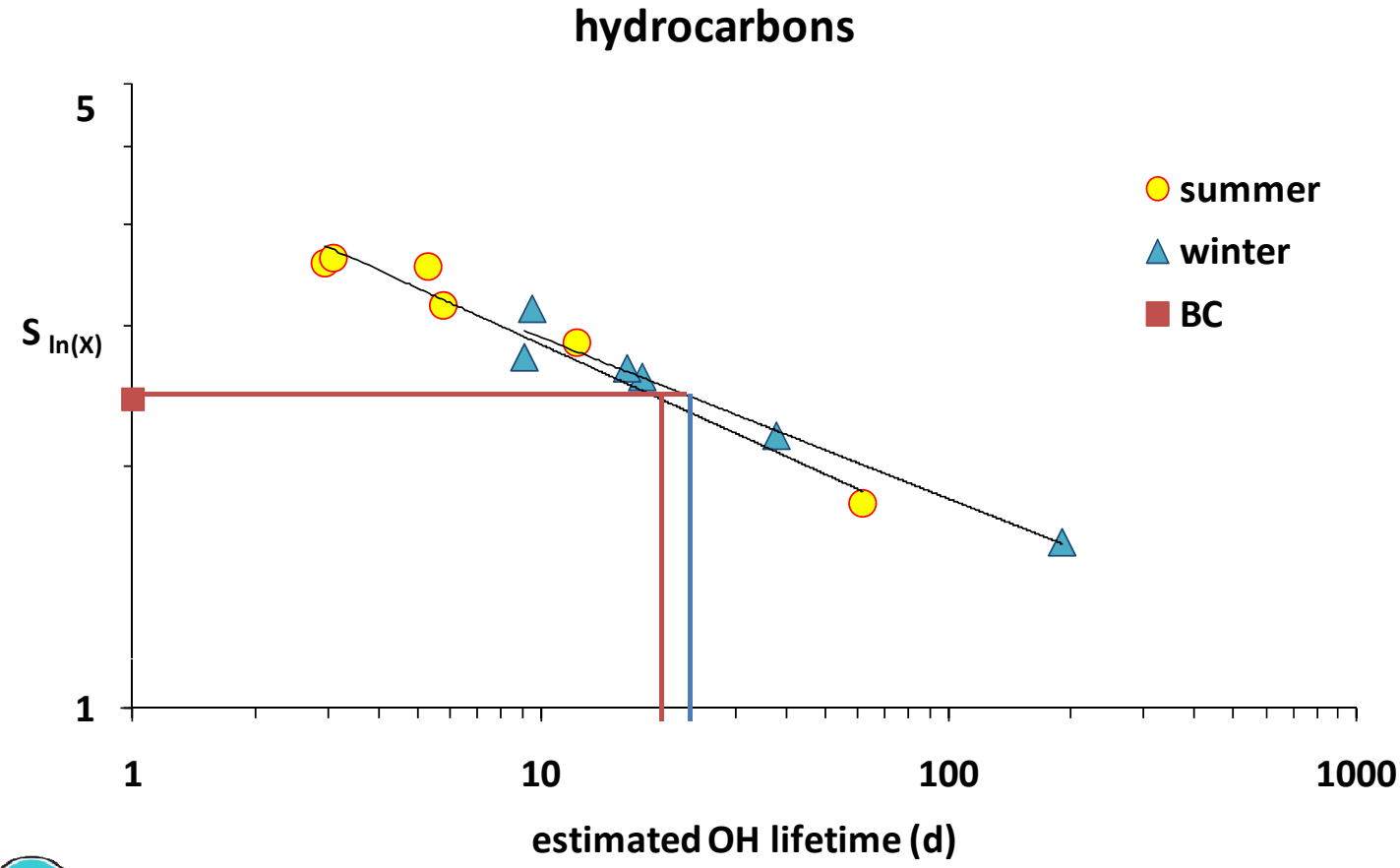
# Lifetime

Lifetime depends on assumed OH concentration (7 x $10^5$ $cm^{-3}$)

Comparison of summer and winter (10.5 or 3.5 x $10^5$ $cm^{-3}$ )

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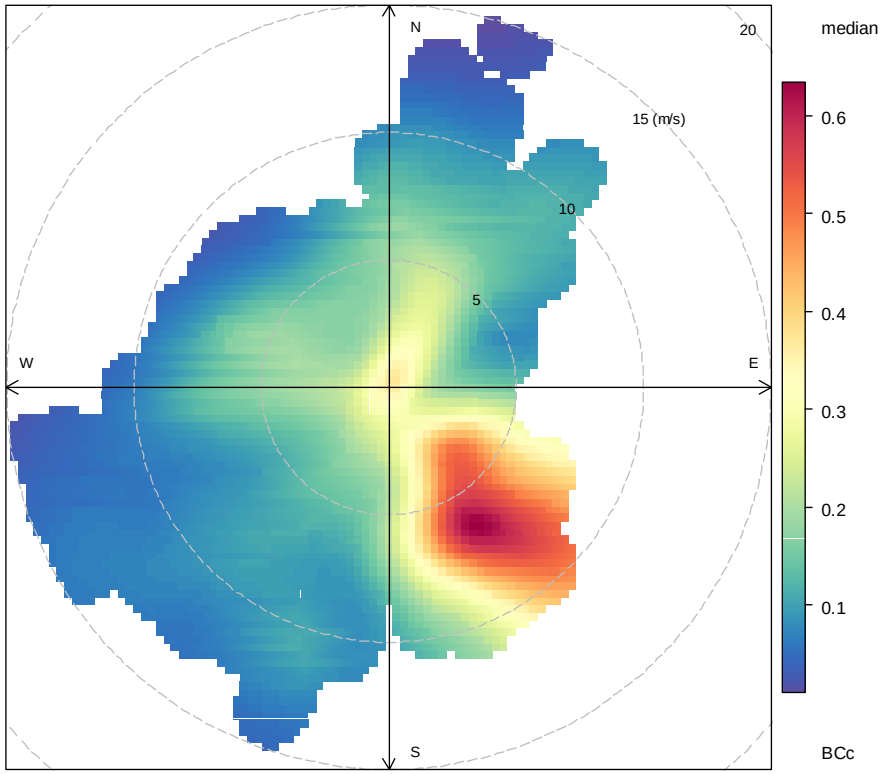
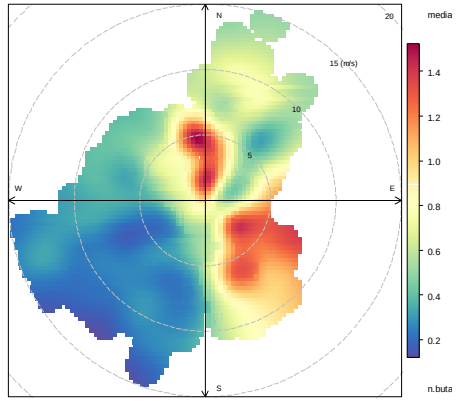
**Hydrocarbon lifetime changes by factor of 3, but BC hardly changes**

# Lifetime – directional data

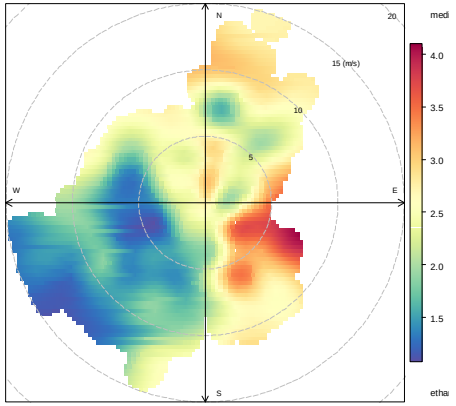



Black carbon

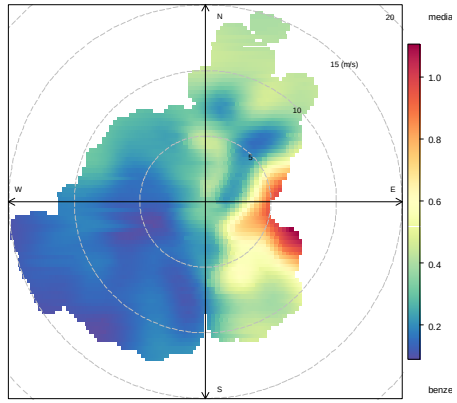
Median concentrations by wind direction and speed




n-butane




ethane




benzene

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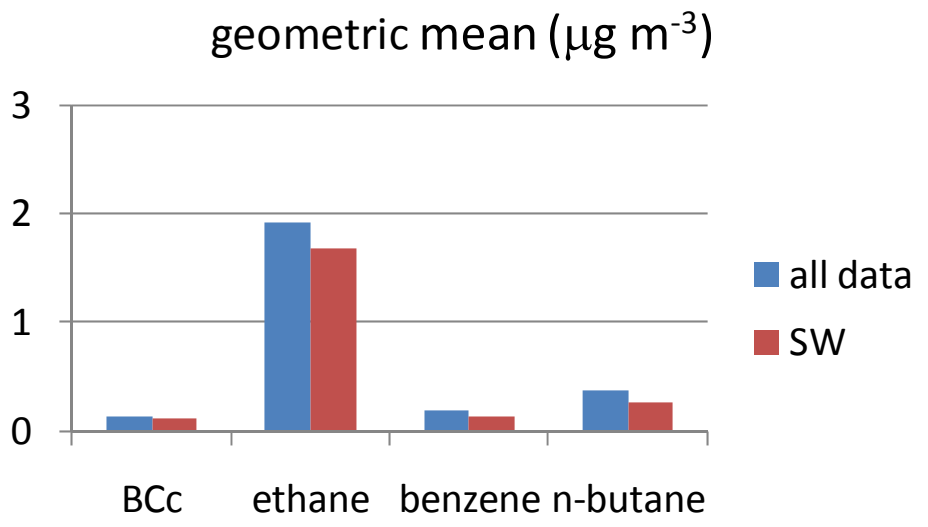
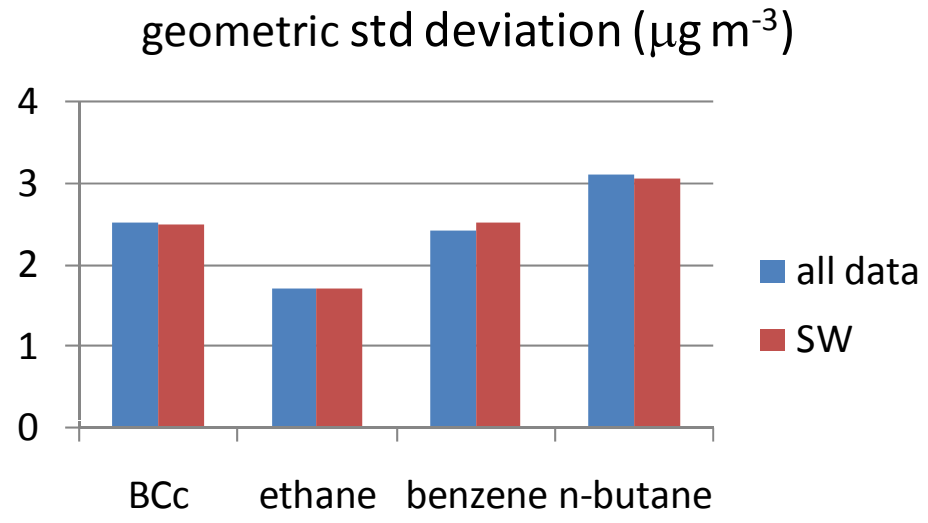
# Lifetime – directional data

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.

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# 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


**Acknowledgements**

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**References**

Jobson, B. T., et al. (1998*). Journal of Geophysical Research-Atmospheres* 103(D11): 13557-13567.

Carslaw, D., Ropkins, K. (2010). *Open-source tools for analysing air pollution data.* Environmental Research Group, King’s College London.

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