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Introduction

Black Carbon(BC) is a carbonaceous material that mainly comes from combustion and is a part of Particulate Matter(PM).

Why Black Carbon emissions?

- Direct exposure to BC as a health threat to humans.

Why London?

- Large city with a dense network of roads and large amount of populations.
- To meet England 10 $\mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ target by 2040.

Why Eddy Covariance?

- To quantify net transfer of BC between the surface and atmosphere, Eddy Covariance(EC) as a direct measurement of turbulent fluxes is used.
- No research in EU Using EC methods to quantify urban BC emissions.

Experimental

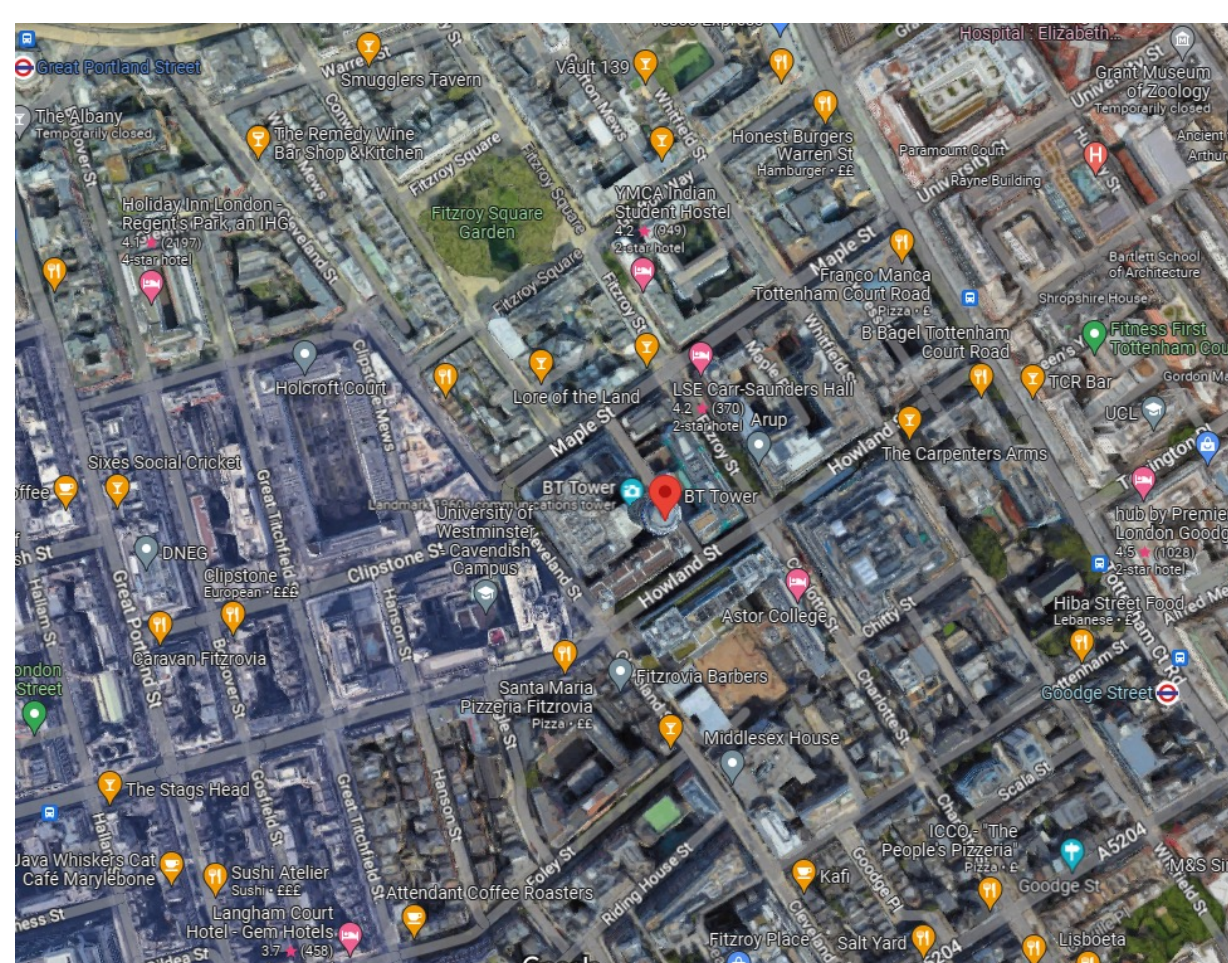
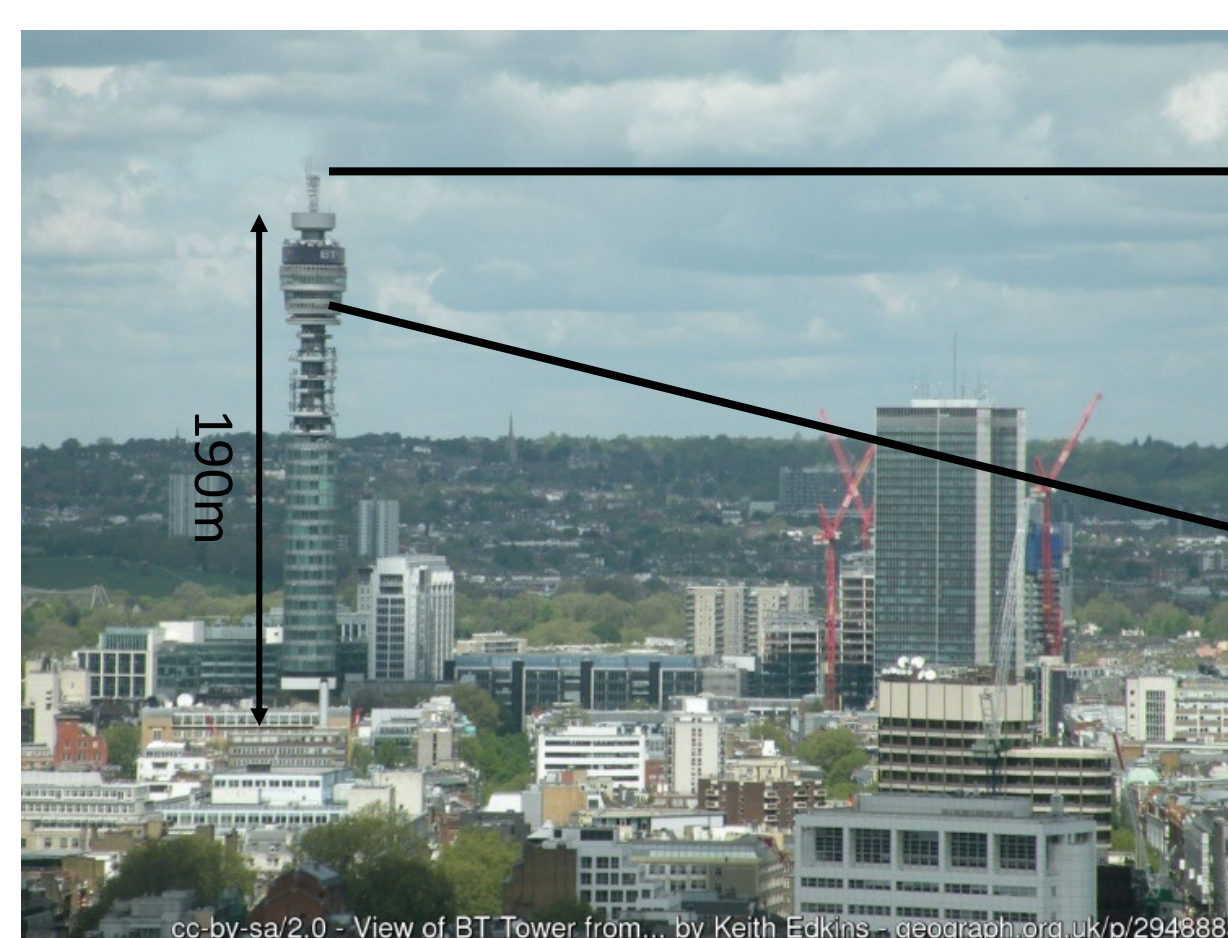


Figure 1. BT tower site Location from Google Maps (© Google Maps 2022)



To quantify BC emissions over central London, two measurements (Summer and Winter) were made on BT tower (**Fig.1**) as a part of Integrated Research Observation System for Clean Air (OSCA) Campaign.

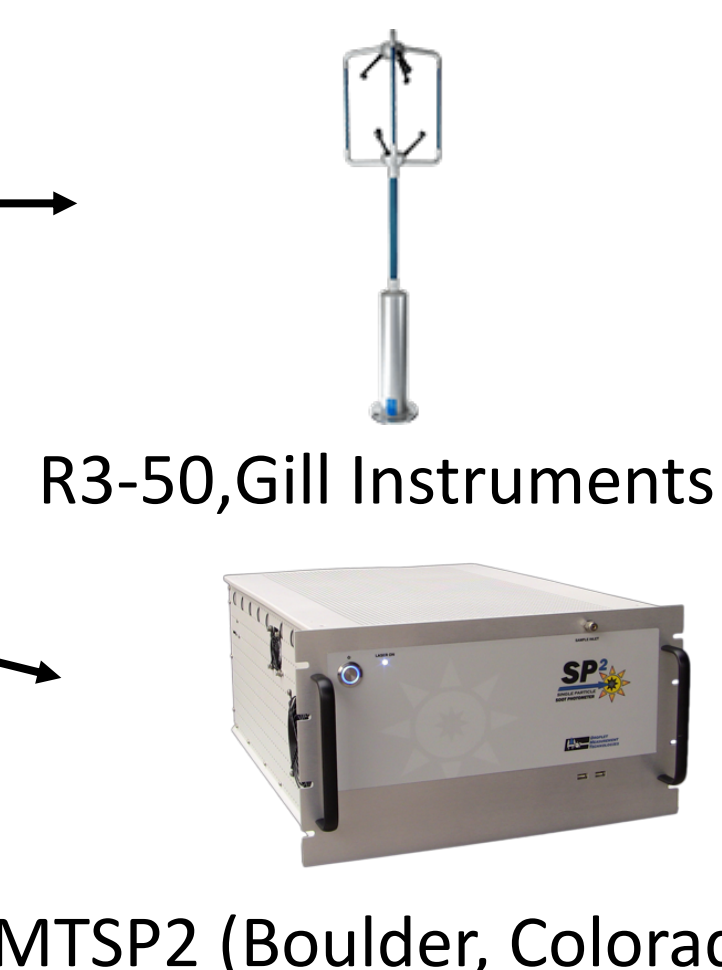


Figure 2. EC system on BT tower (The Photo by Keith Edkins is licensed by CC BY SA)

- Flux Calculation: F_{BC} is BC net flux, W' is vertical wind speed, C'_{BC} is BC concentration
- $F_{BC} = \overline{W'C'_{BC}}$

Results and Discussion

1) Black Carbon Flux

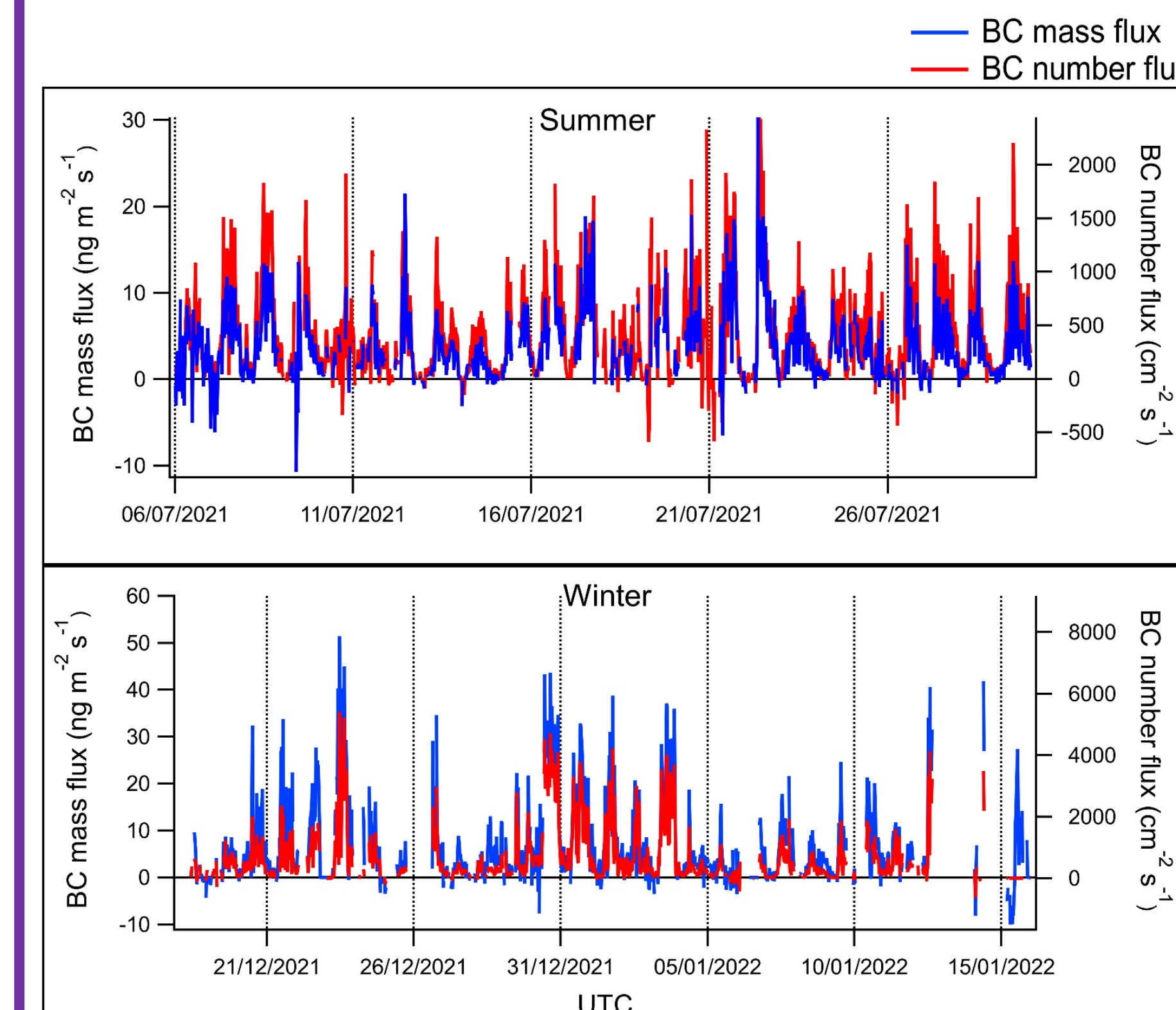


Figure 3. BC number (red) and mass (blue) fluxes time series during winter and summer using 30 minutes averaged interval

- Mainly positive fluxes are observed, indicating net emissions of urban BC. Summer flux is lesser than Winter's due to Covid-19 lockdown
- Hot spot of Summer BC is to NE which is match a combined heat and power (CHP) running by University College London (UCL) (Samuel et al., 2022)
- Hot spot of winter BC is to SW, and the clear track on polar plot indicating there is a point source to the SW.

2) Compared with NOx and Organic Matter (OM) in winter

Fig 6 shows obvious OM emissions and clear band of NOx to the SW.

Fig.7 shows stronger correlation to the SW than other directions on scatter plots in indicating BC may has co-emission source of OM and NOx there. Source may be wood-fired cooking, Non-road-traffic (including CHP). The specific point source is still under investigating.

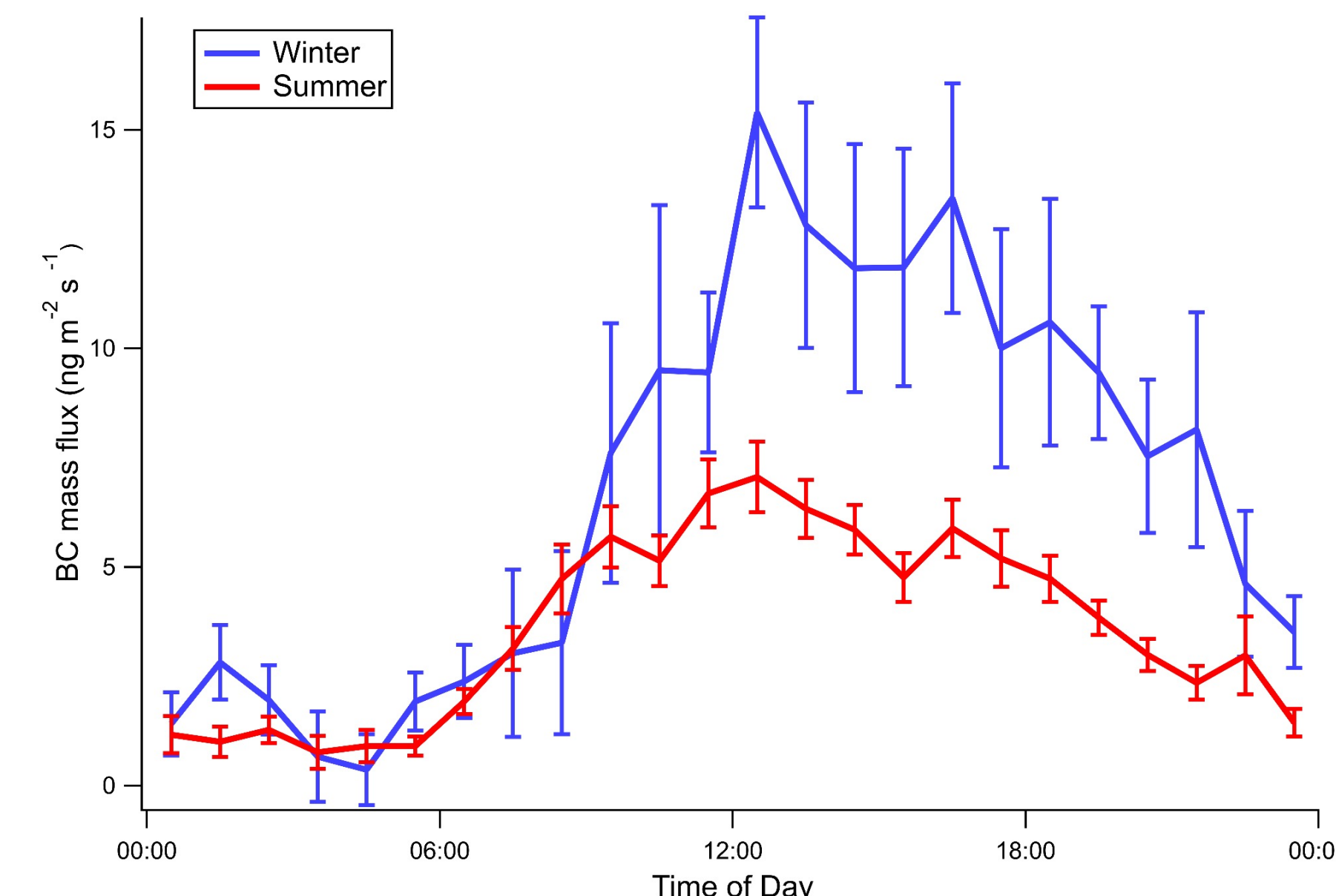


Figure 4. Diurnal profile of BC mass flux in winter (blue) and summer (red) with error bars (standard error)

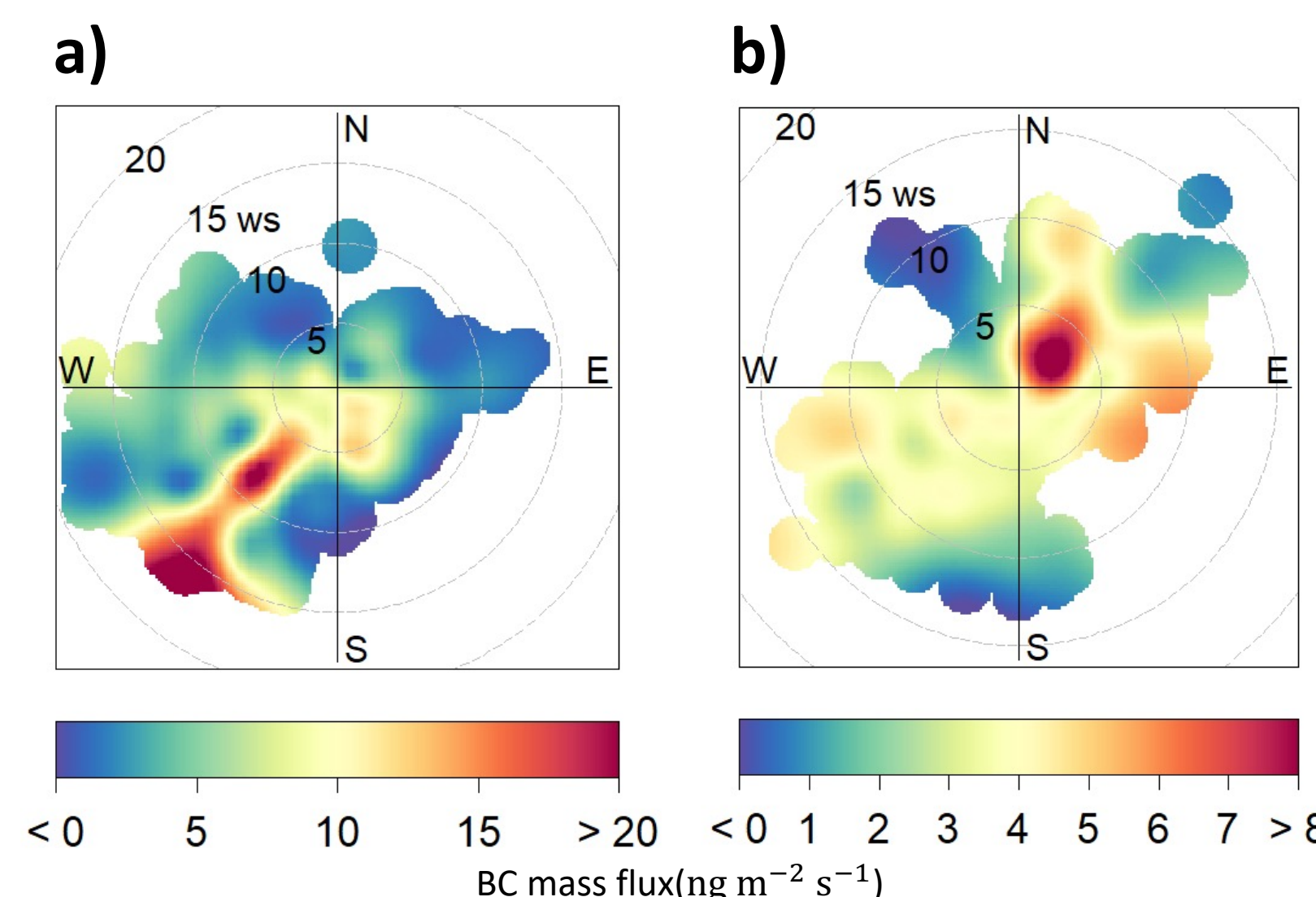


Figure 5. Polar plots of BC in winter (a) and summer (b) using OpenAir software (Carslaw and Ropkins, 2012)

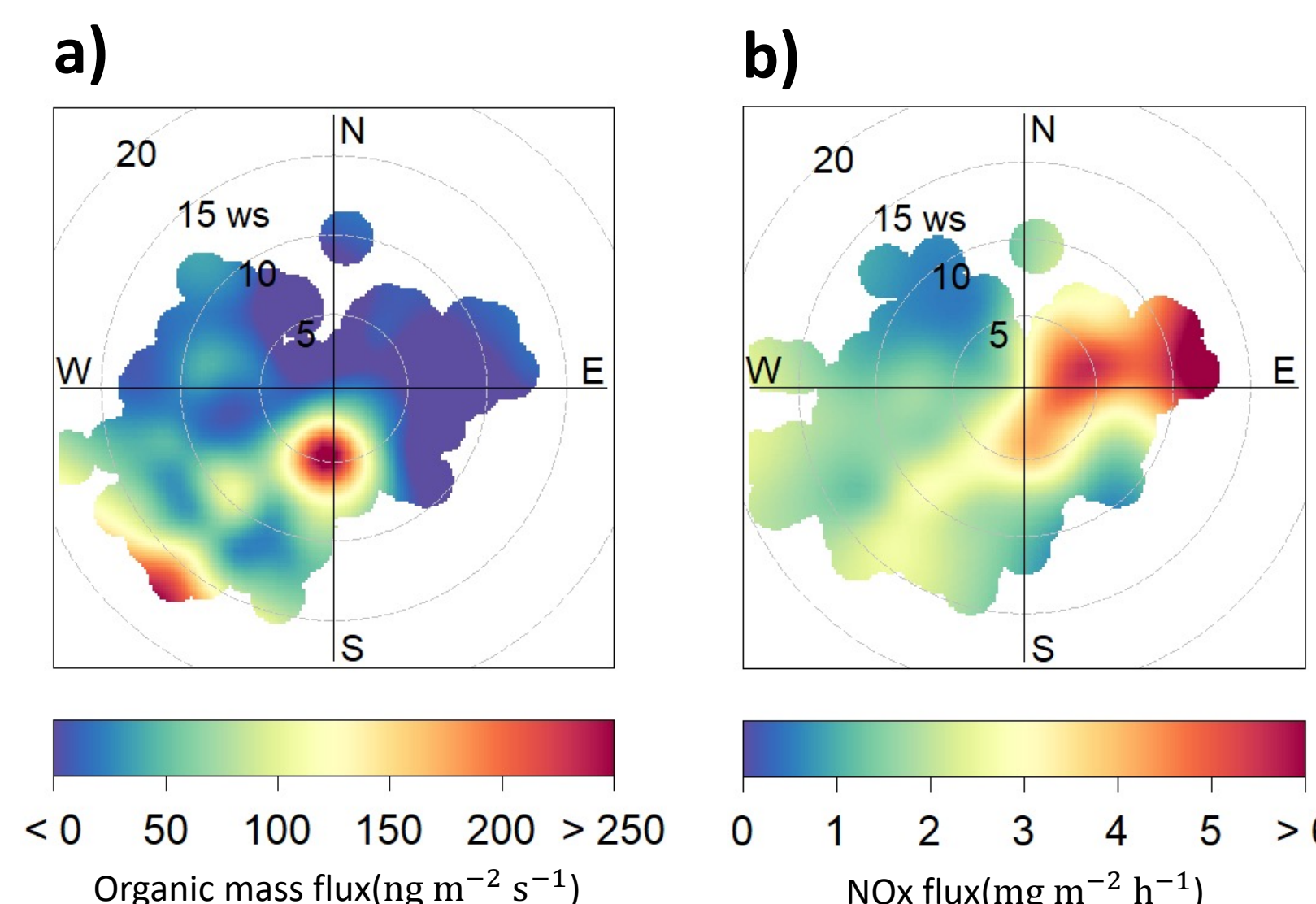


Figure 6. Polar plots of winter OM (a) and NOx (b) fluxes

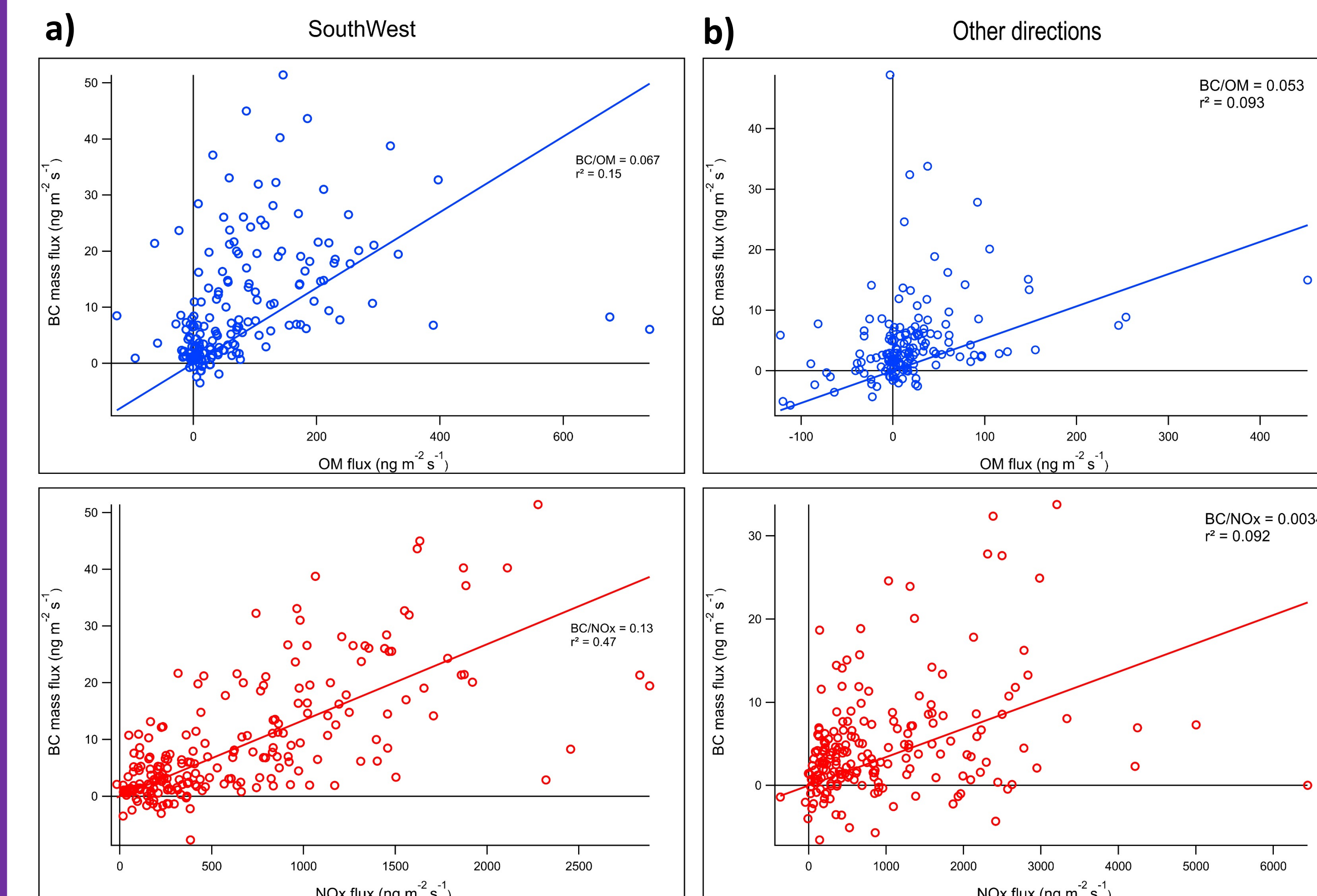


Figure 7. BC fluxes with NOx and OM scattering in Southwest (a) and other directions (b). Using Orthogonal distance regression to investigate the correlations.

Conclusion

BC fluxes were measured using EC method in central London as a part of OSCA intensive project during summer and winter 2021. Averaged BC mass flux is 3.85 $\text{ng m}^{-2} \text{s}^{-1}$ in summer and 6.72 $\text{ng m}^{-2} \text{s}^{-1}$ in winter. Averaged BC number flux is 407.8 $\text{cm}^{-2} \text{s}^{-1}$ in summer and 662.7 $\text{cm}^{-2} \text{s}^{-1}$ in winter.

Preliminary found out BC emissions over London has different dominant source in summer and winter. Summer BC emissions may mainly come from a CHP running by UCL. Winter dominant BC source may be a specific point source to the southwest.

References

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Acknowledgements

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