Measurement of NO_x and CO Fluxes from a Tall Tower in Beijing

Freya Squires
University of York
fs673@york.ac.uk

NERC
SCIENCE OF THE ENVIRONMENT

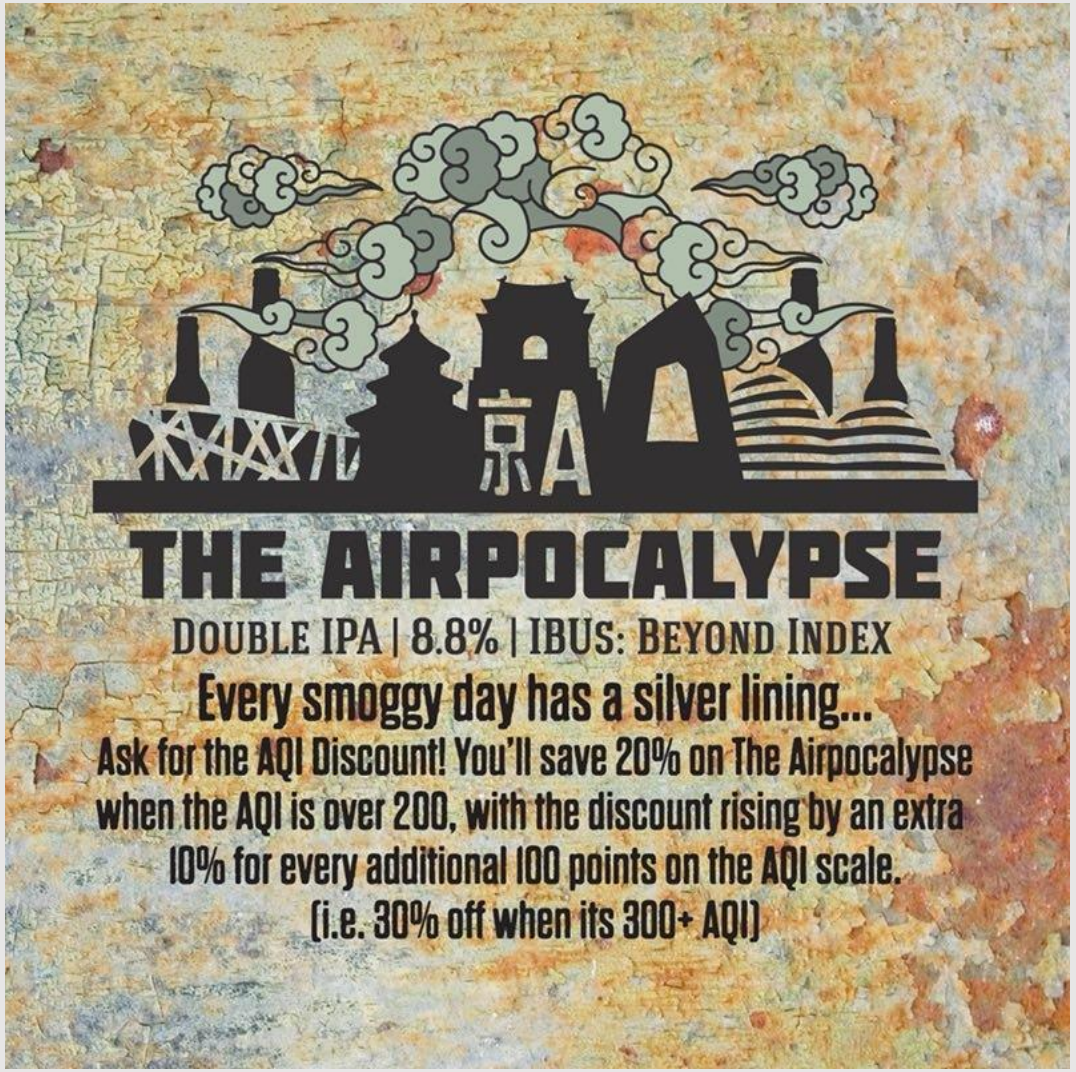
WACL
Wolfson Atmospheric Chemistry Laboratories

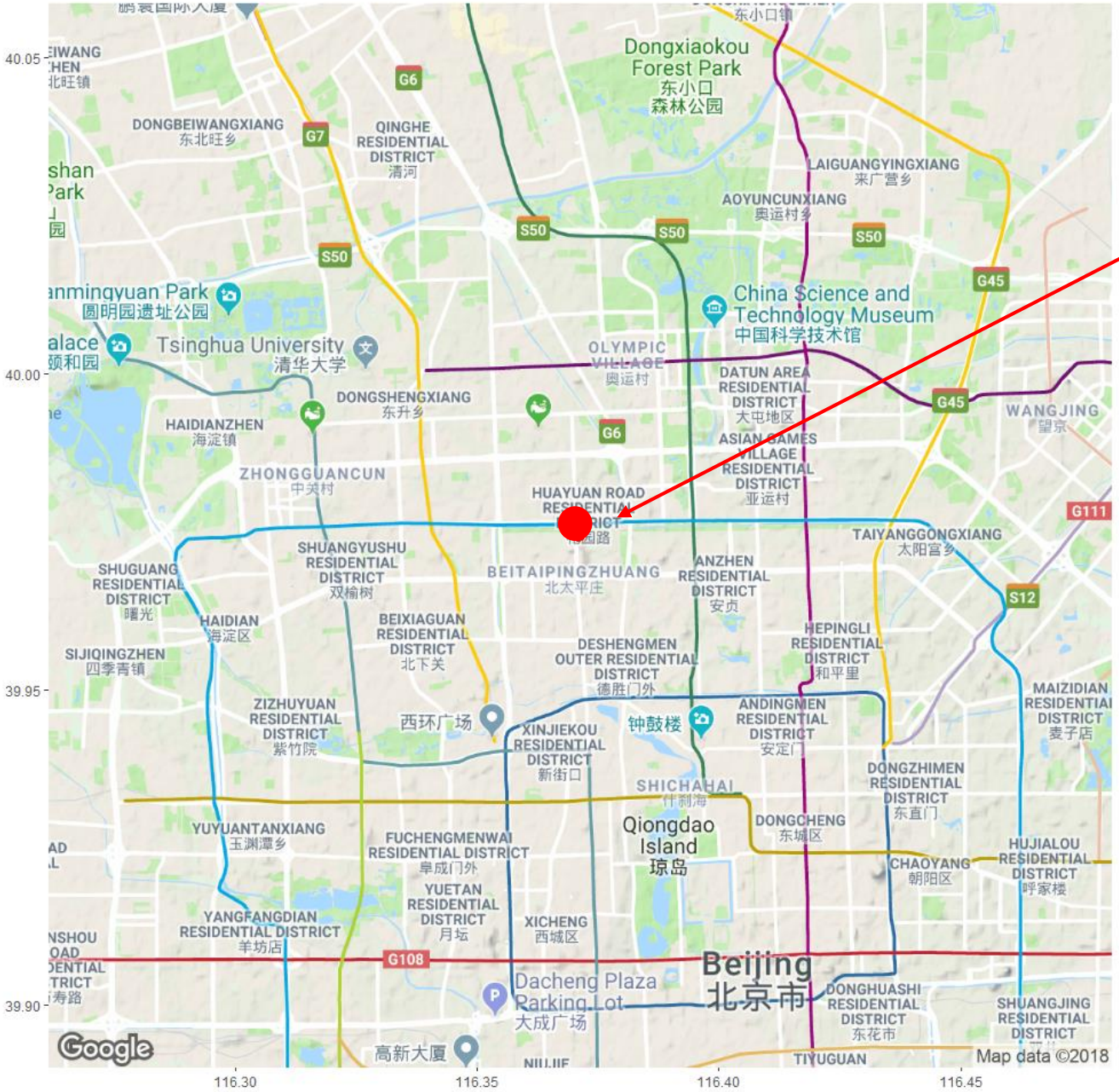
UNIVERSITY of York

Air pollution? Never heard of it!

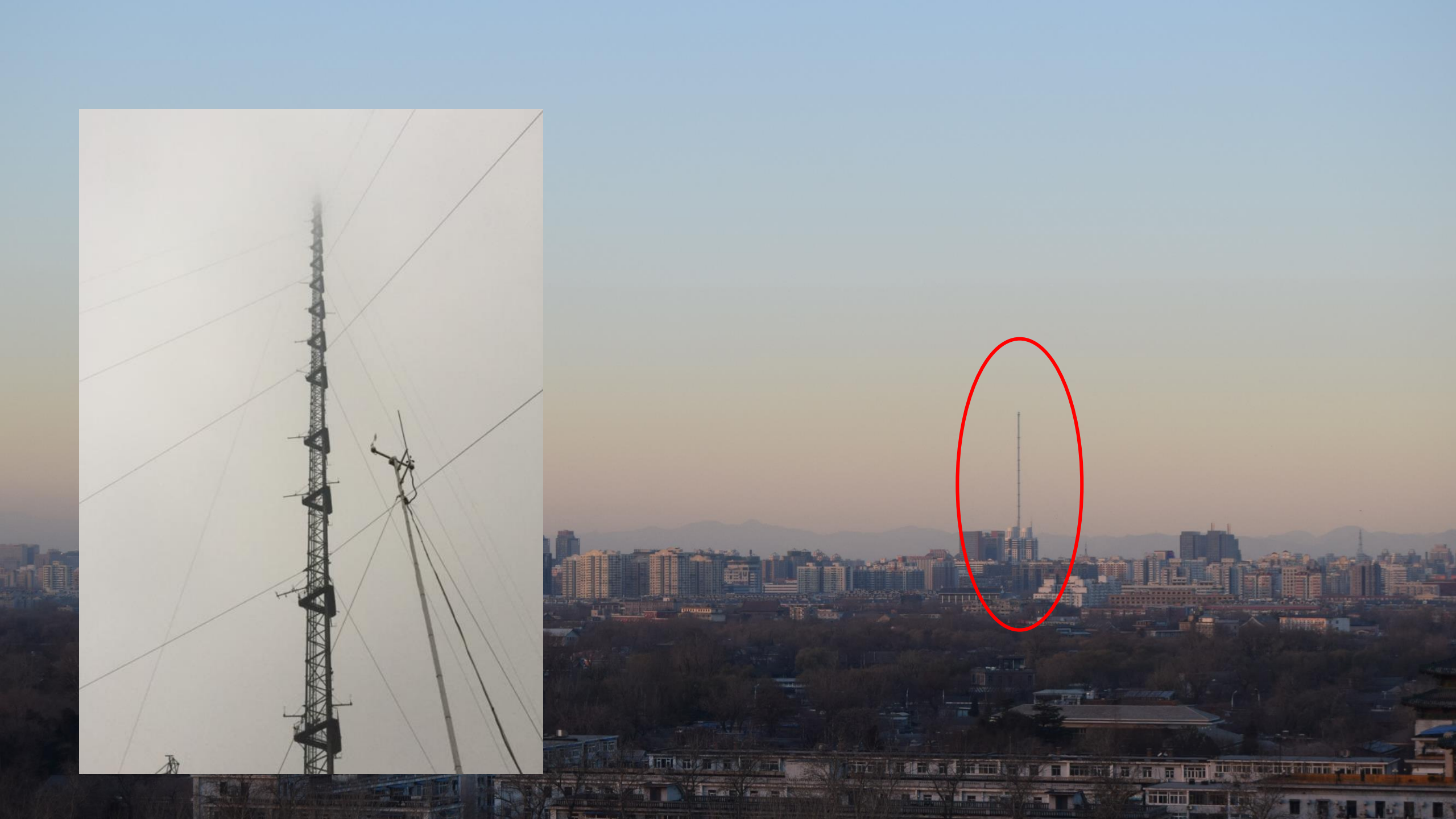
Why do we care about air pollution?

- Pollutant emissions impact on human health (in 2010, 1.2 million premature deaths were attributed to outdoor air pollution in China).
- Many pollutants influence climate (i.e. through aerosol or ozone formation).
- Air pollution can influence the price of beer!





Institute for Atmospheric Physics



Experiment

2 campaigns; **Winter** (05/11/2016–11/12/2016) and **Summer**(22/05/2017–25/06/2017).

- NO_x measured with fast chemiluminescence instrument (Air Quality Designs).
- CO measured with fast resonance fluorescent instrument (AeroLaser).
- Wind data (Gill Windmaster Pro Sonic Anemometer).

Flux Measurements

Difference between instantaneous and mean vertical wind speed

$$F = \overline{w'c'}$$

Difference between instantaneous and mean pollutant concentration

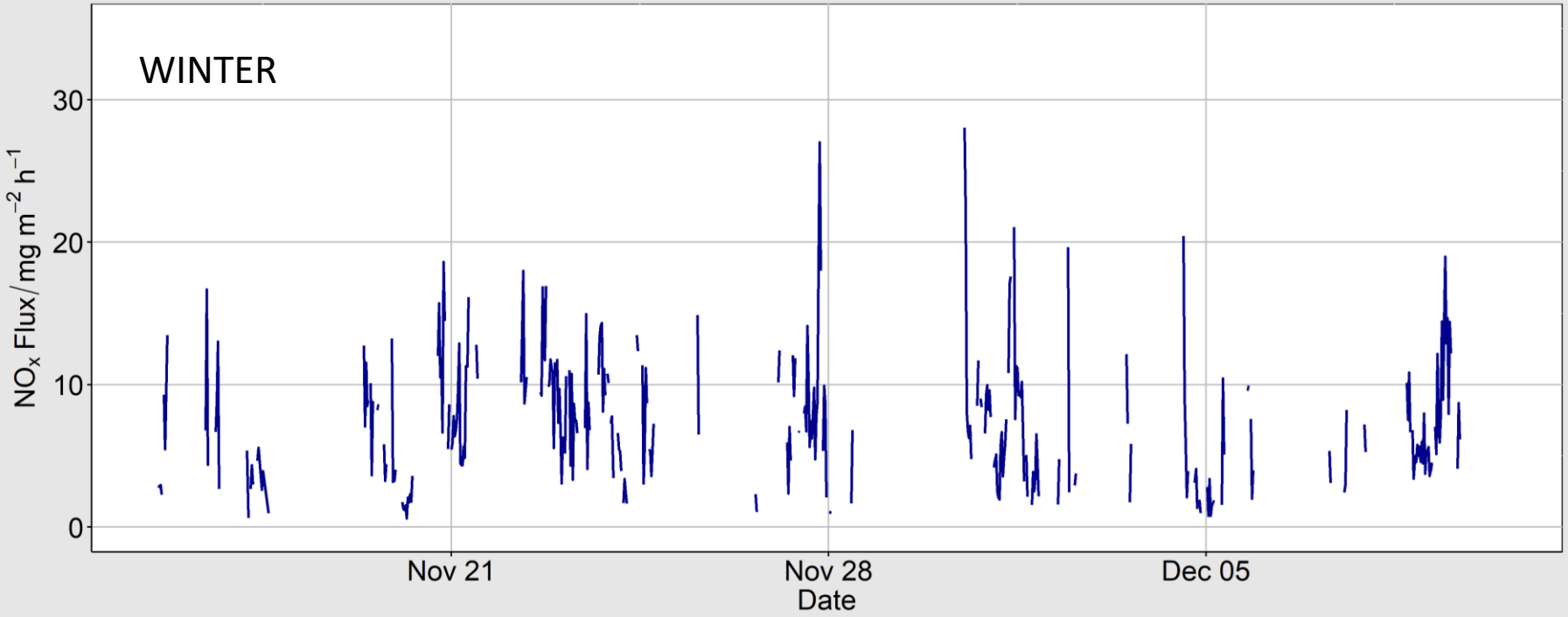
Flux measurements enable us to quantify NO_x and CO *emission* and therefore identify emission sources!

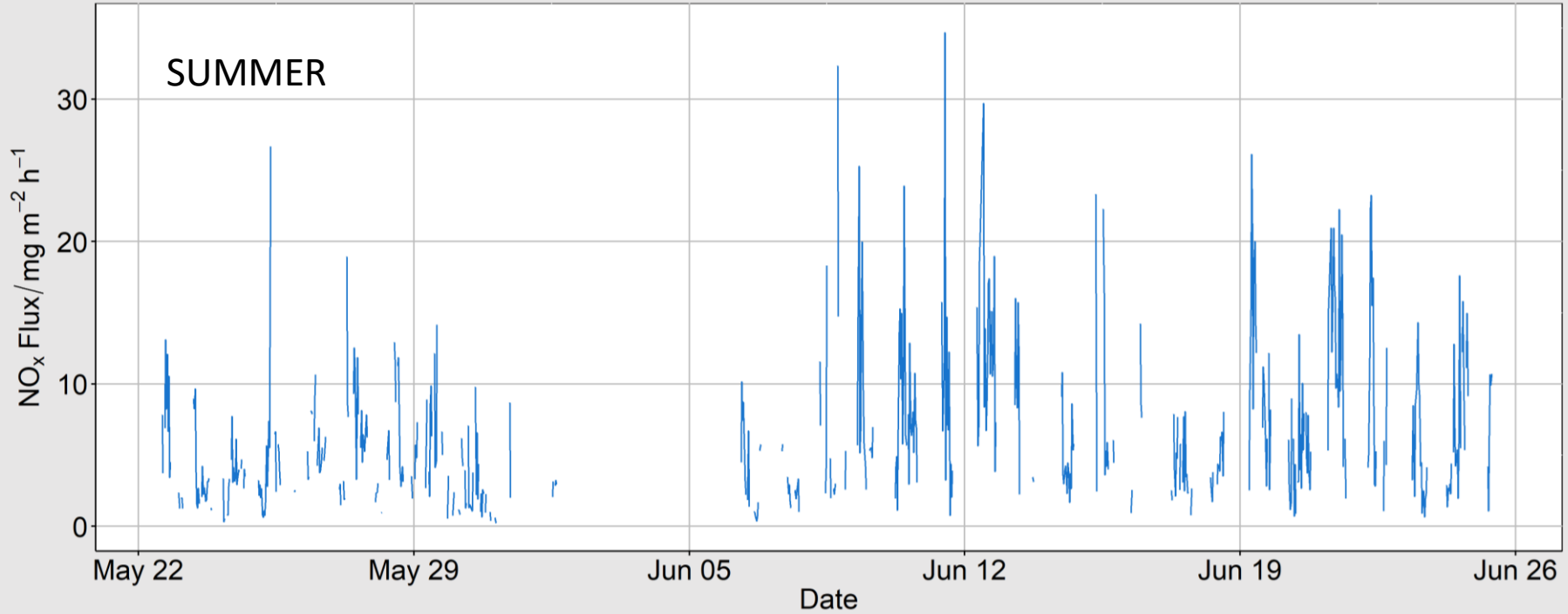
Eddy Covariance

Image source: Burba, G., 2013. Eddy Covariance Method for Scientific, Industrial, Agricultural and Regulatory Applications: a Field Book on Measuring Ecosystem Gas Exchange and Areal Emission Rates. LI-COR Biosciences, Lincoln, USA

Assumptions

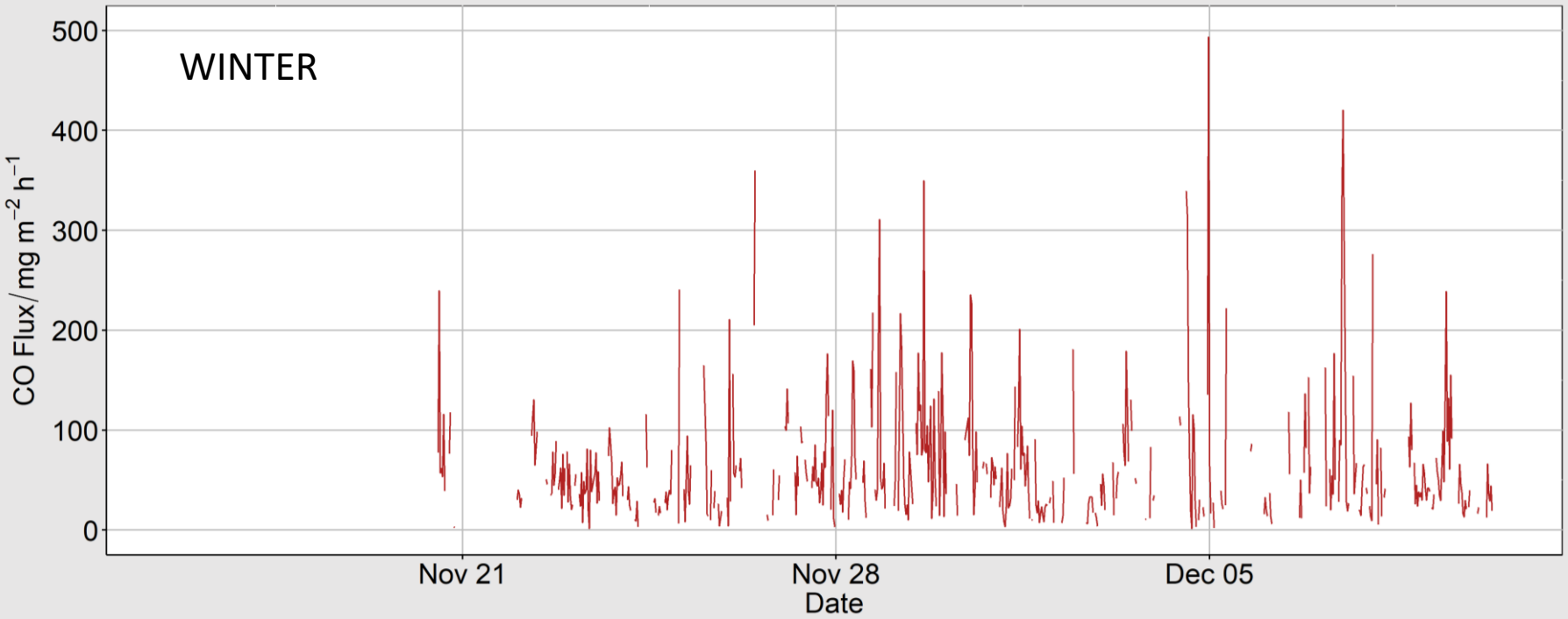
- Measurements are carried out within the boundary layer.
- Flux is fully turbulent – most of the net vertical transfer is done by eddies.

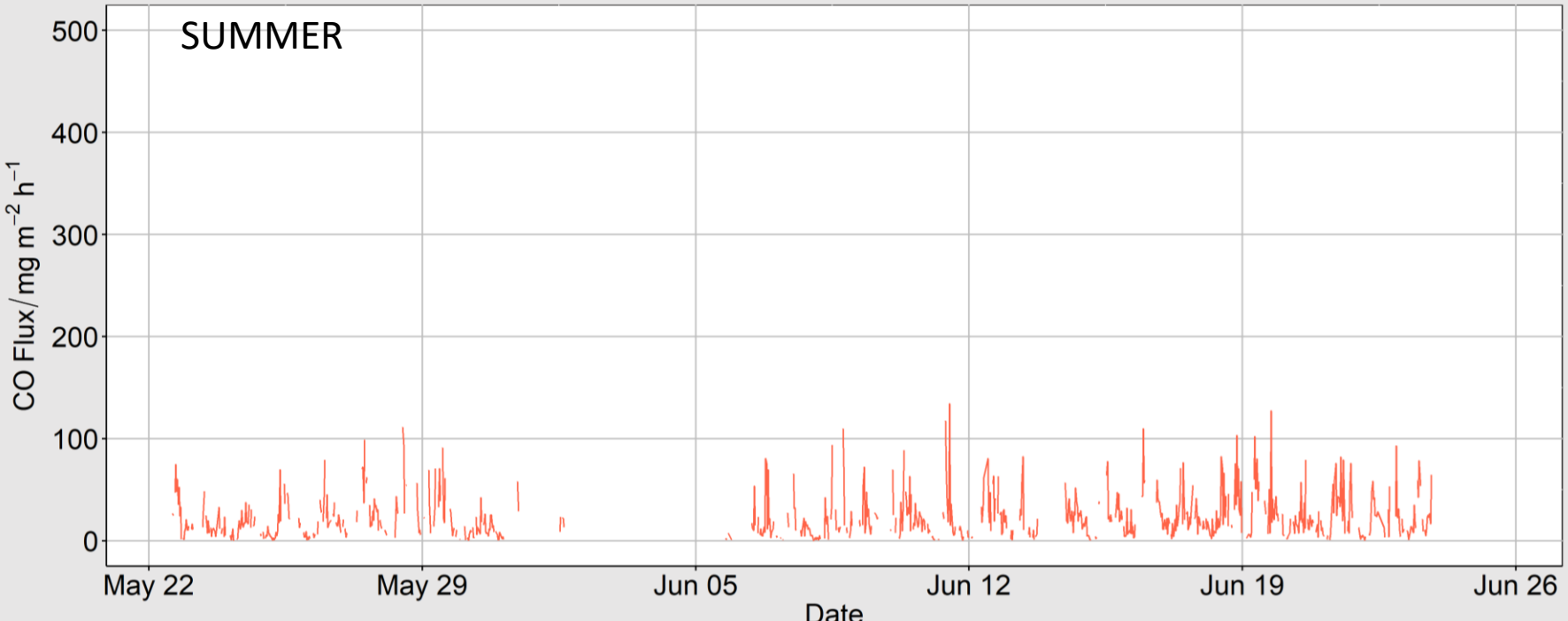




NO_x Emission Time Series

- Winter has more data gaps (lack of turbulence) and due to some instrument issues.
- Magnitude very similar between the two campaigns, suggesting common sources during the campaigns.

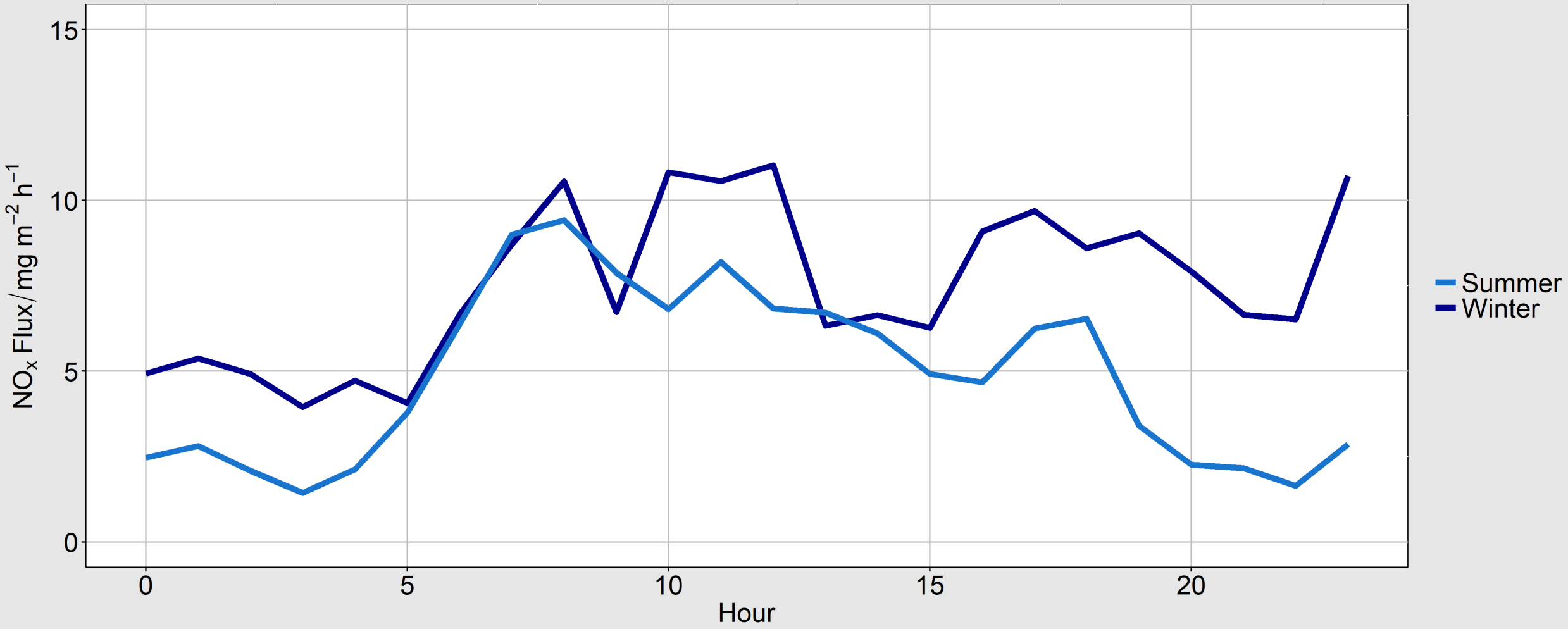




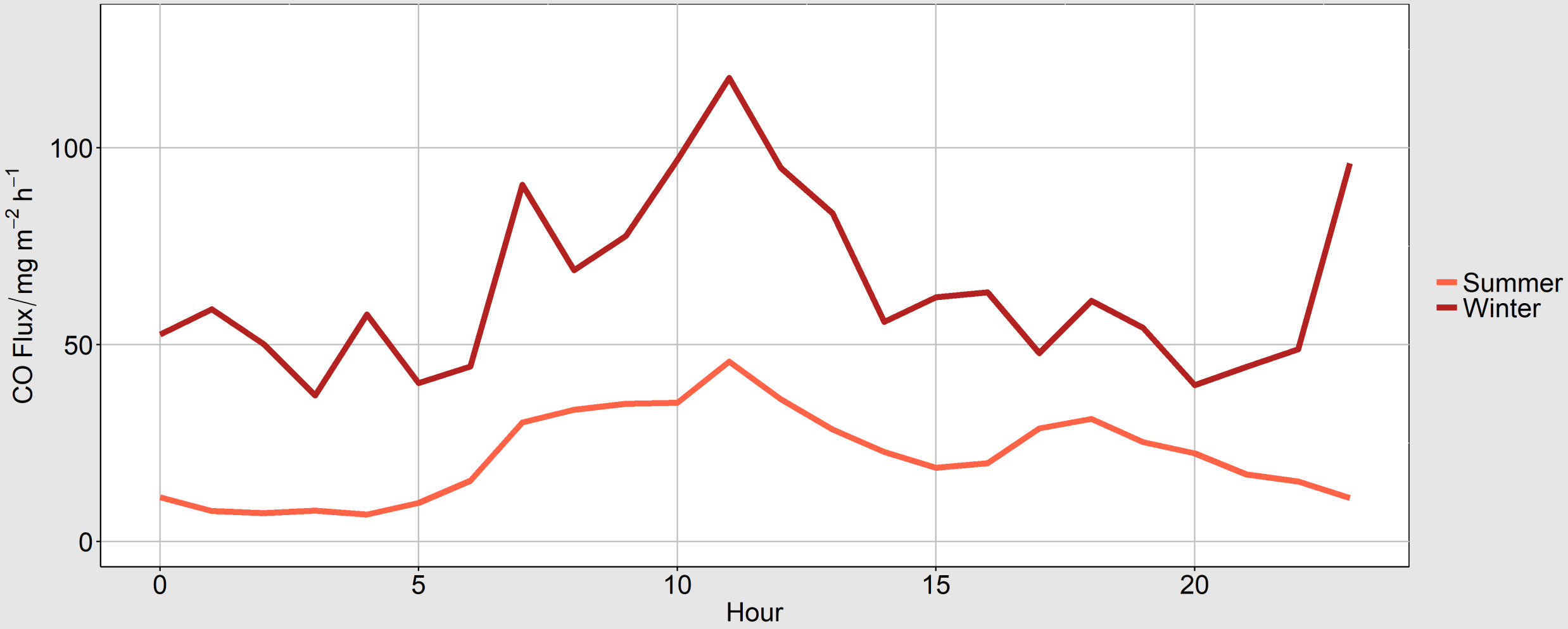
CO Emission Time Series

- Delayed in getting the CO instrument online so data gaps at start of the campaign.
- Additional source in winter. Emissions seem to be ~3 times higher in winter (on average).

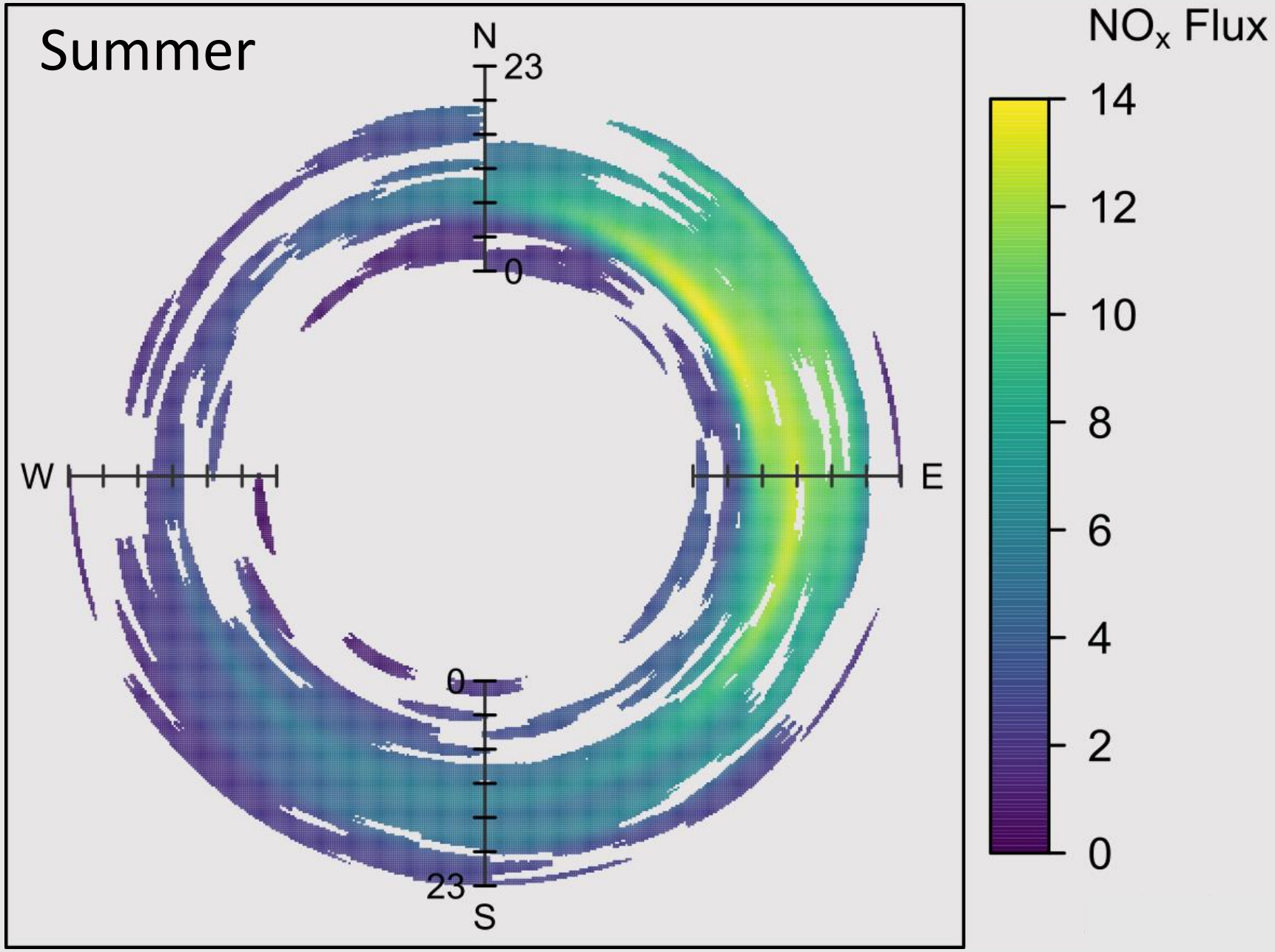
NO_x Emission Flux

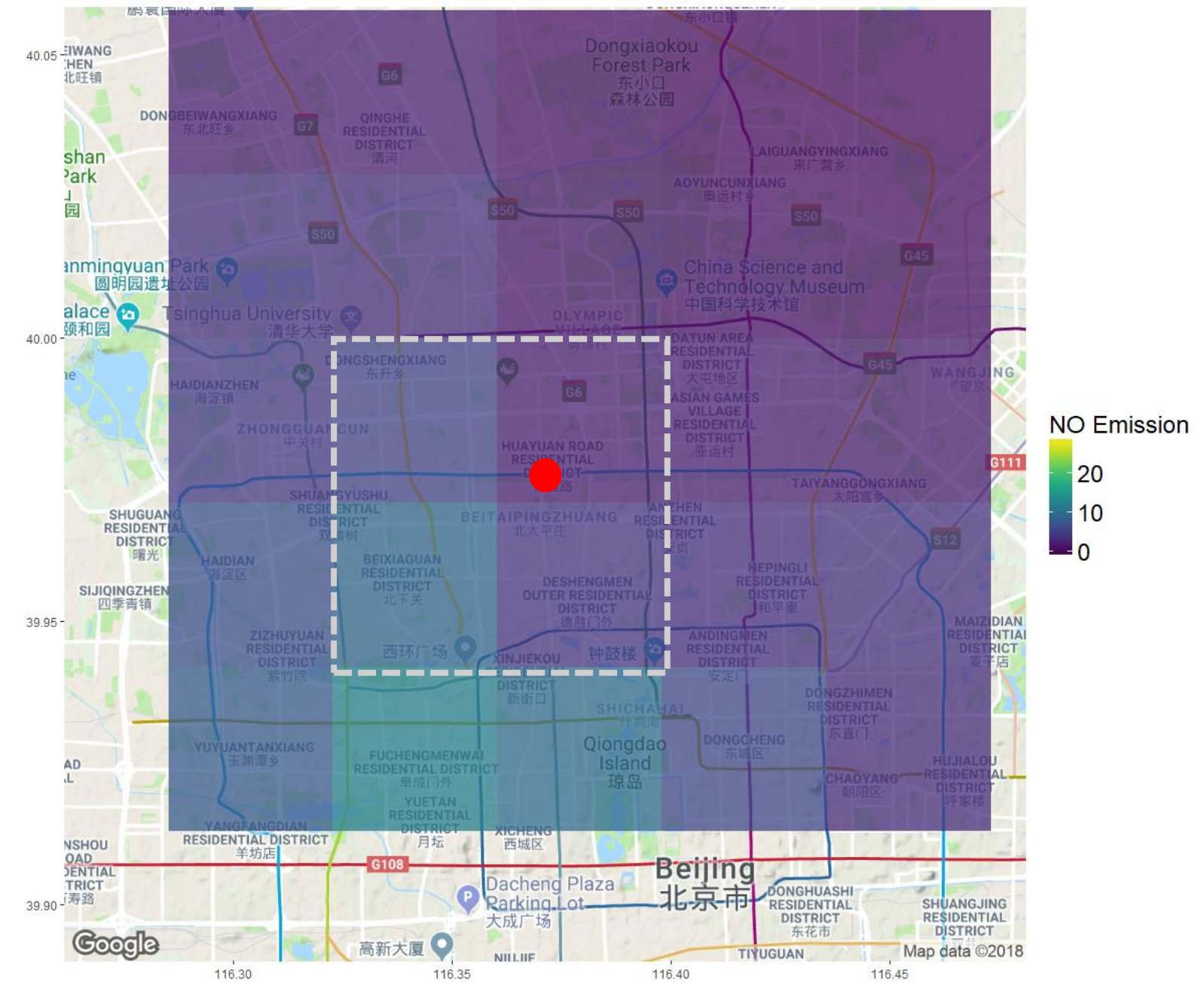


CO Emission Flux



Consider wind direction…

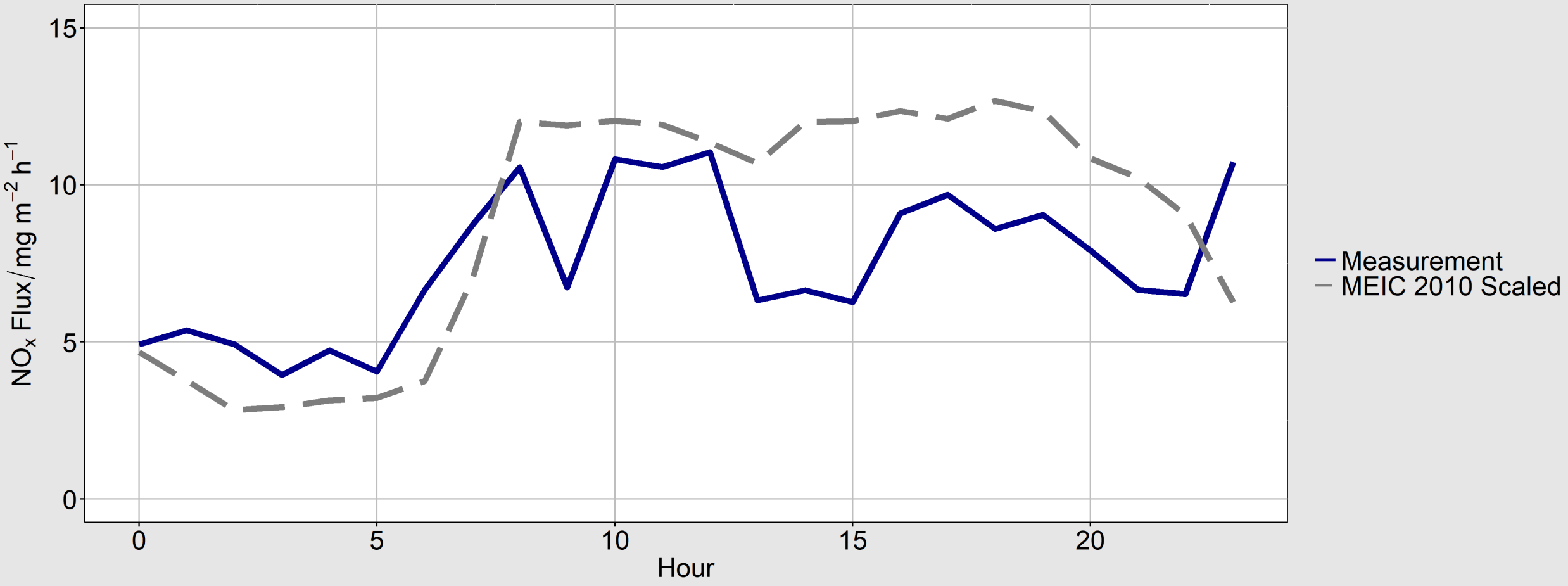




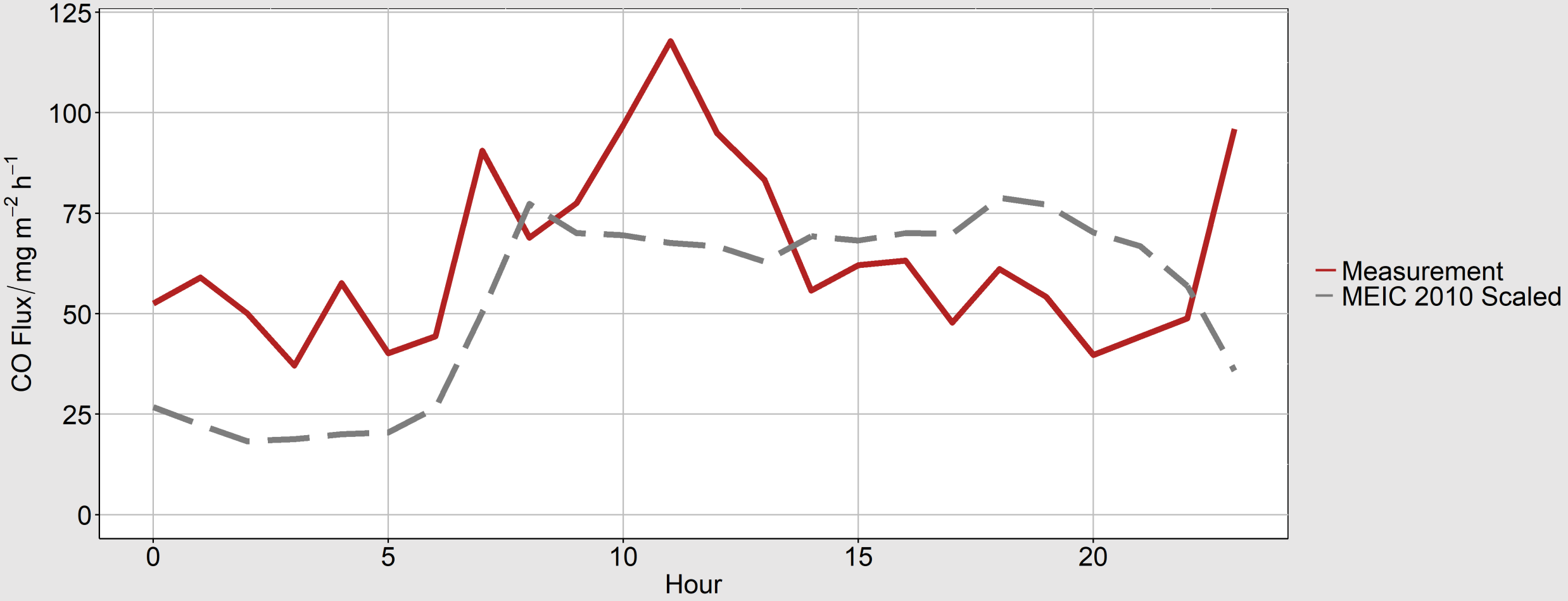
MEIC

- October 2010 Multi-Resolution Emissions Inventory for China (MEIC).
- 3 km^2 resolution.
- Scaled down by 25 % to reflect expected change in NO_x emission for October 2016.
- Average emission from surrounding 4 squares and multiplied by time-of-day scaling factor.

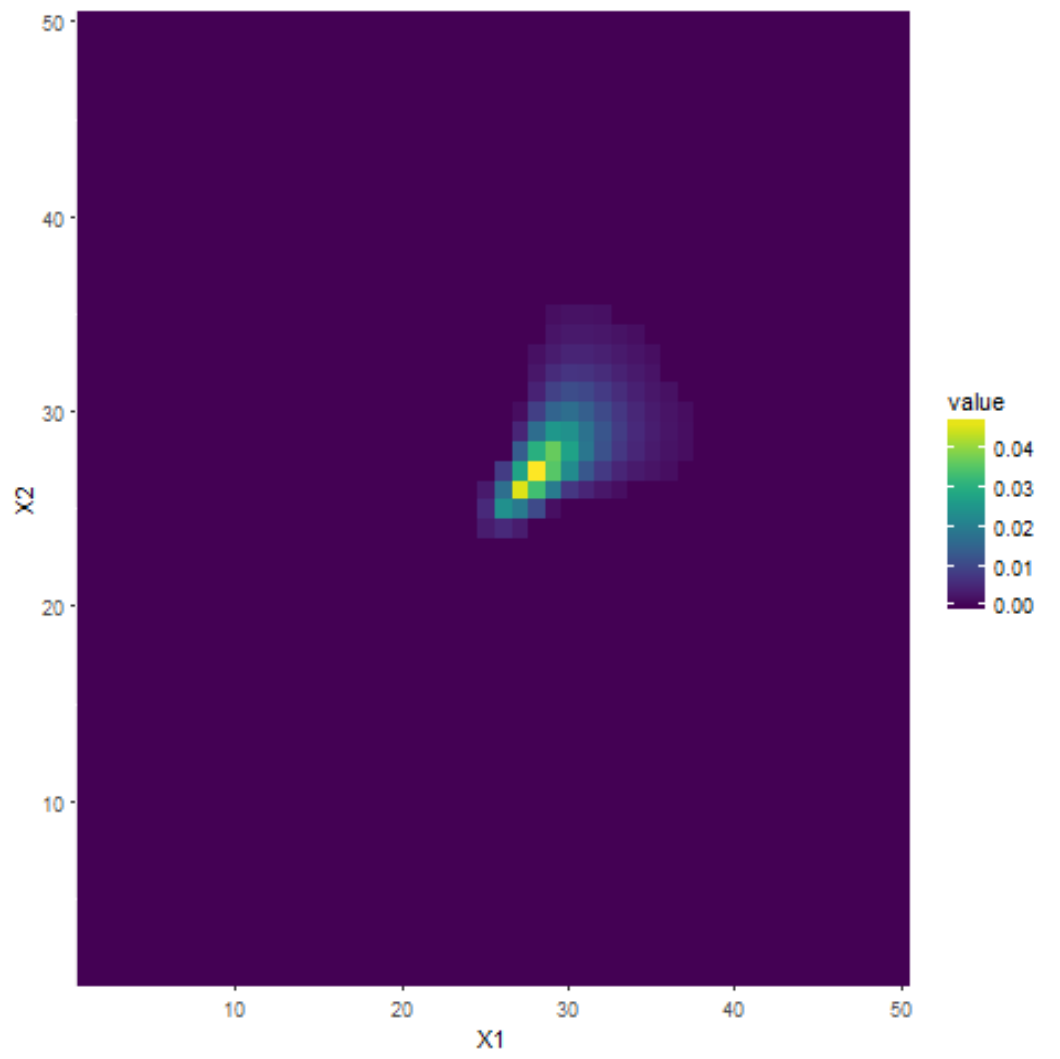
NO_x Emission Flux and MEIC Inventory



CO Emission Flux and MEIC Inventory

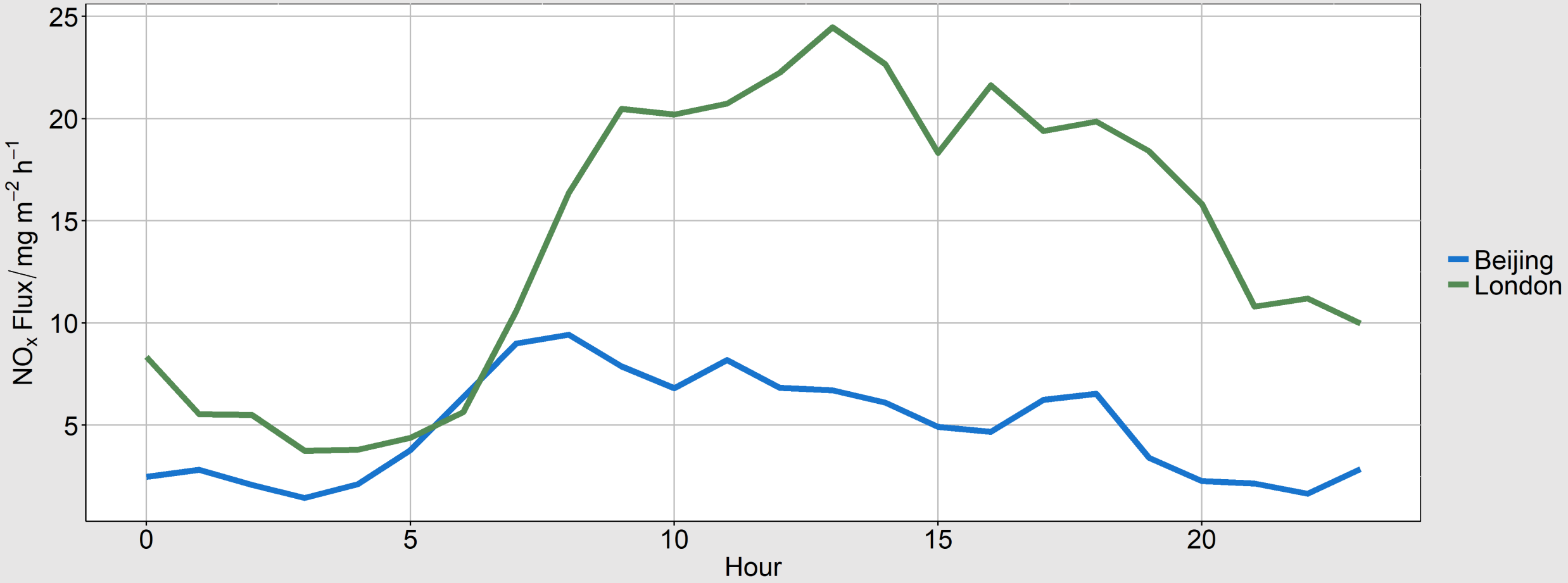


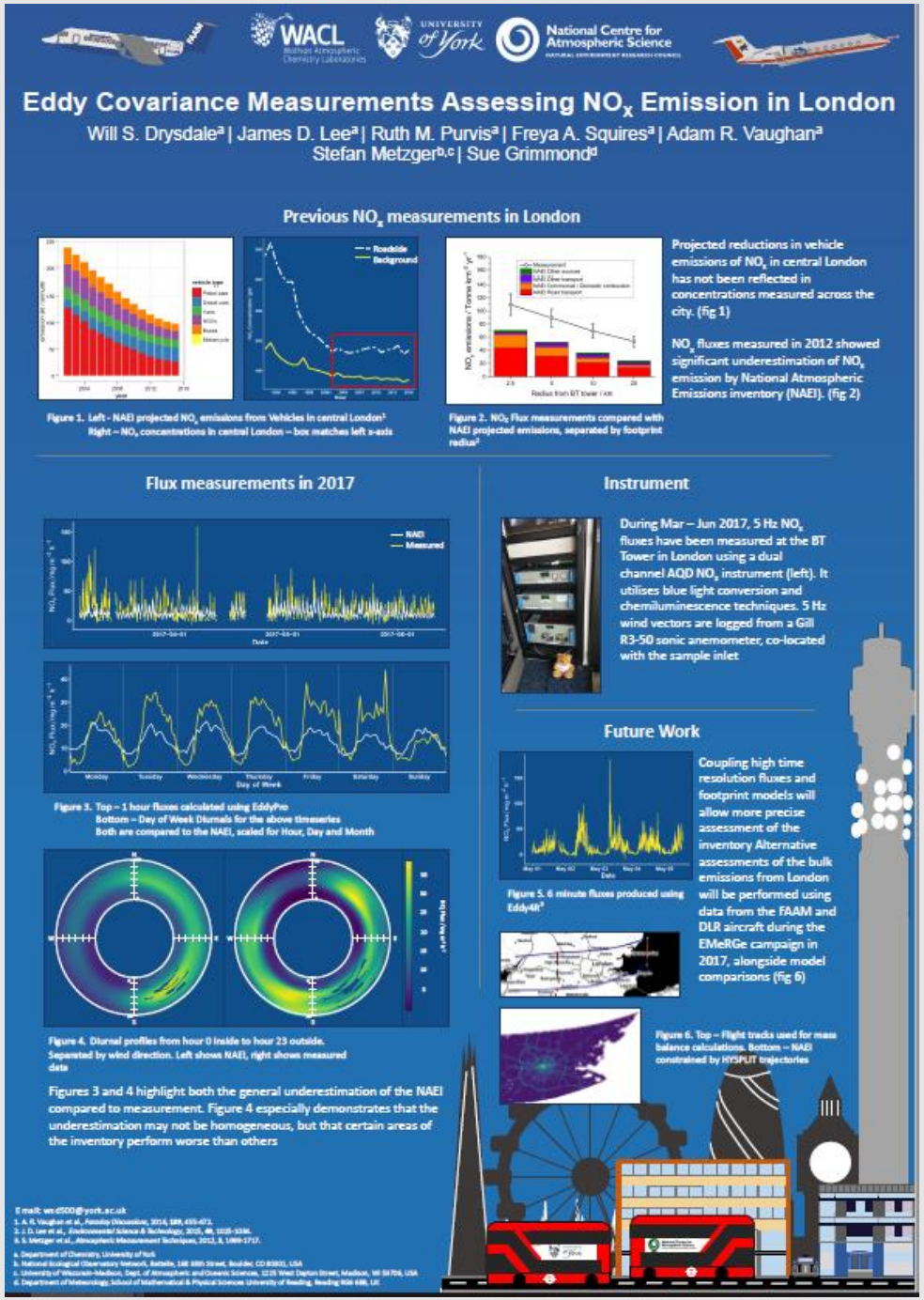
Next steps



- Parameterisation of the backward Lagrangian model of Kljun et al. (2002, 2004) described in Metzger et al. (2012, 2013).
- Create a weighting matrix that predicts the ground influence of a particular cell contributing to the observed emission flux.
- Footprint is then calculated by multiplying inventory grid by this weighting matrix.
- Future work will involve this analysis carried out using a higher resolution inventory (1 km^2 resolution for 2013).

Comparison with London (May – June '17)





Will Drysdale

Eddy Covariance Measurements Assessing NO_x Emission in London

Poster Board 14

Acknowledgements

Supervisors James Lee and Jacqui Hamilton.

Adam Vaughan for data processing help.

Will Drysdale for data processing help and London data.

Oliver Wild (University of Lancaster)and Qiang Zhang (University of Tsinghua) for inventory data.

Eiko Nemitz and Ben Langford for sonic data and advice about Eddy Covariance technique (CEH, Edinburgh).