

Maximizing the information content from hyperlocal air quality networks – low cost and reference

Lekan Popoola, Rod Jones

Yusuf Hamied Department of Chemistry
University of Cambridge, UK

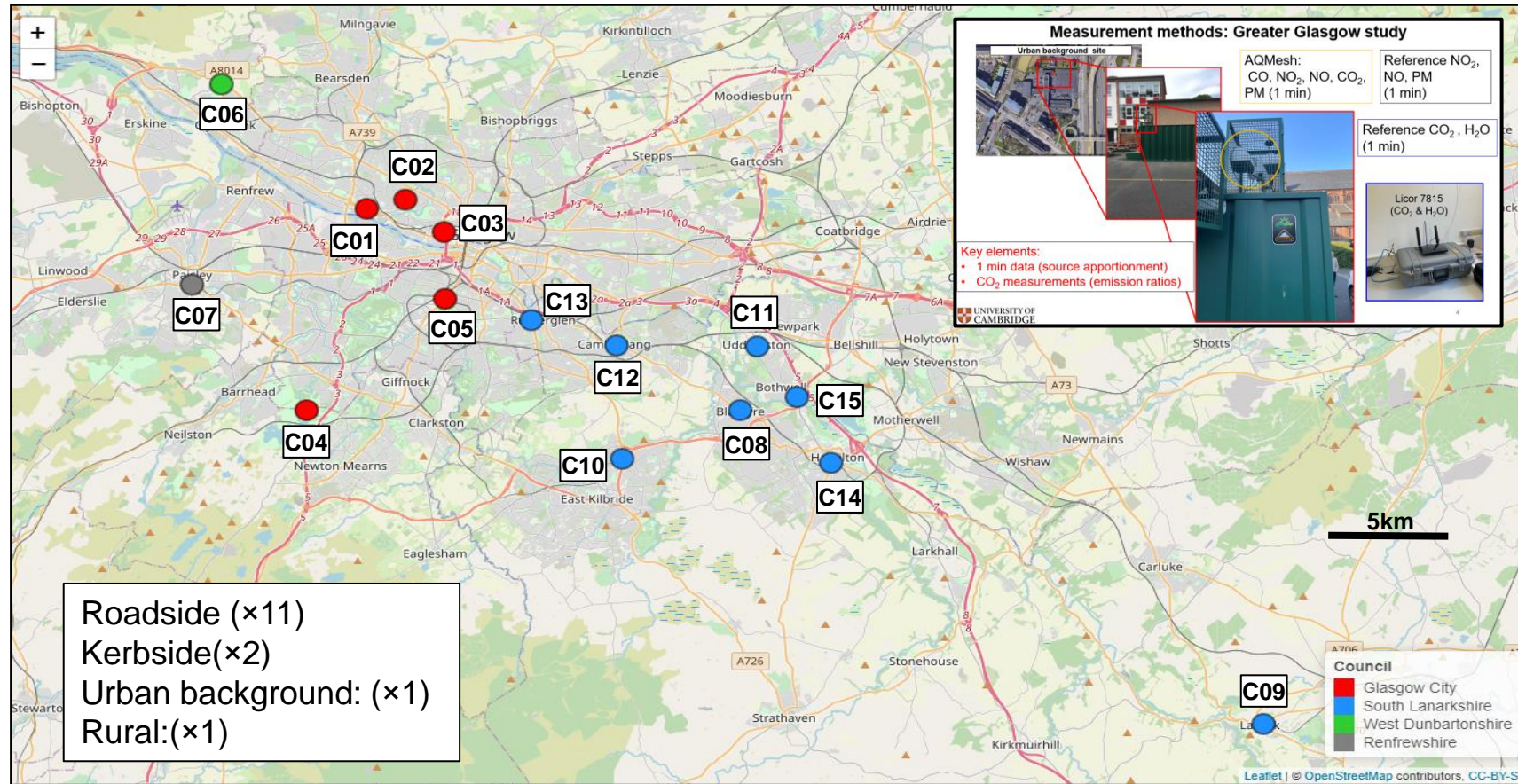
..... and the Glasgow Air Quality Study Team

oamp2@cam.ac.uk

Talk Outline

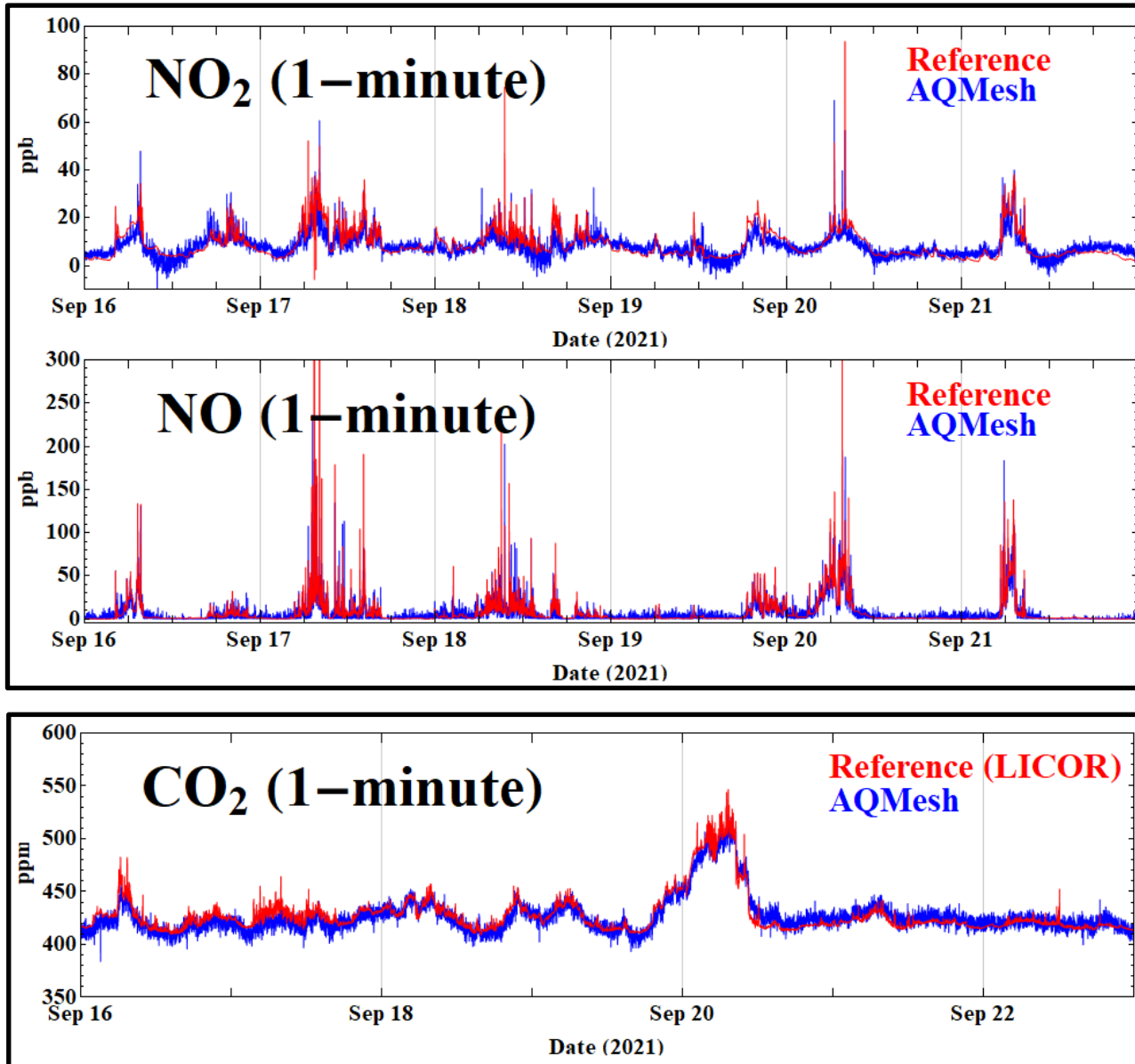
- ❑ Introduction: Greater Glasgow Air Quality (AQ) network study
- ❑ Measurement methods: reference and low-cost air quality devices (AQMesh)
- ❑ A new analysis approach using high time resolution (1-min) atmospheric data
 - ⇒ Source apportionment: local *vs.* non-local signals
 - ⇒ Concept of emission ratios
- ❑ Results from the Glasgow AQ study
- ❑ Summary and reflections

Map of Glasgow AQMesh and Reference network (15 collocated sites)



- Reference stations configured to acquire 1-min data
- AQMesh co-located with each reference site
- CO₂.....

Example of 1-min ref vs AQMesh co-location: NO, NO₂ and CO₂

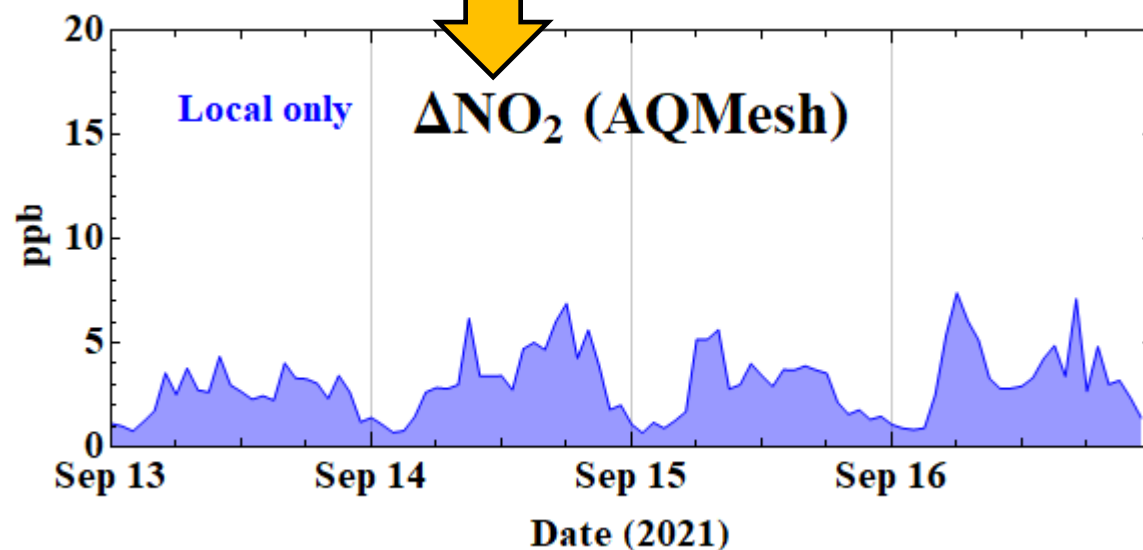
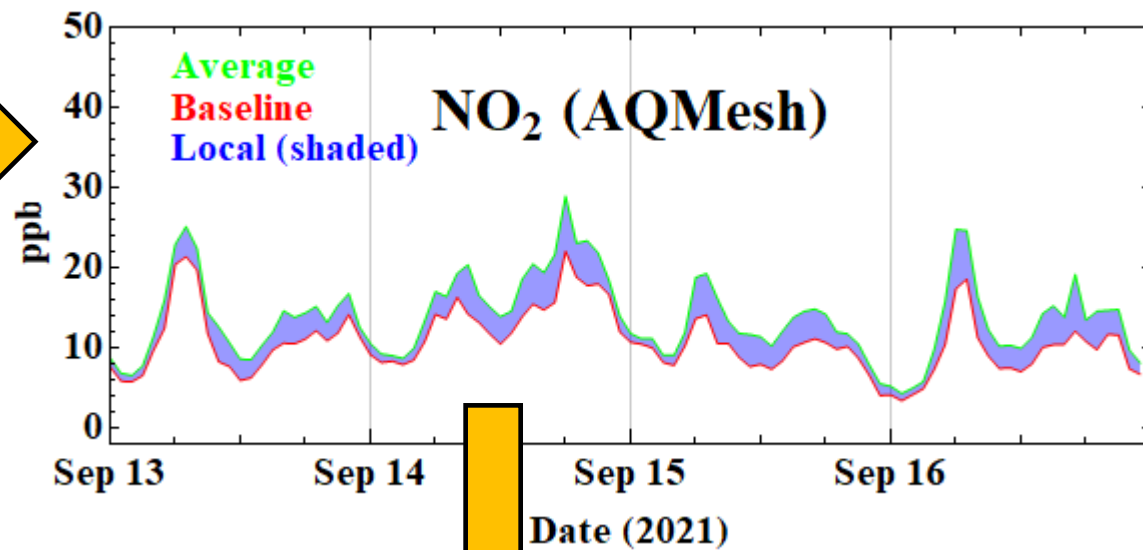
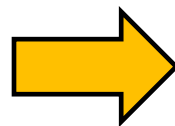
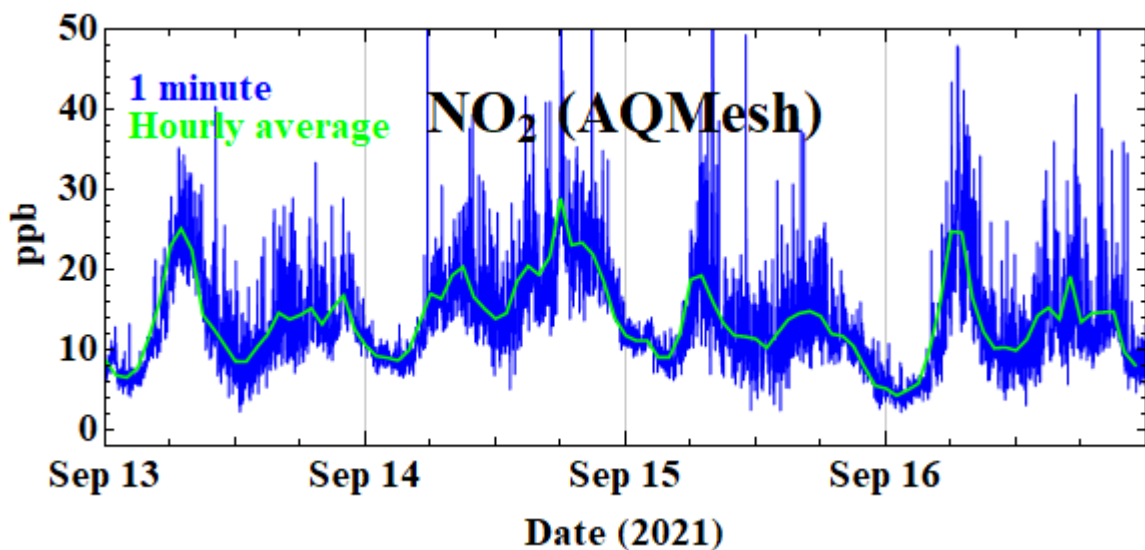


Good agreement between AQMesh and reference for gas species NO₂

Ditto NO, CO₂...

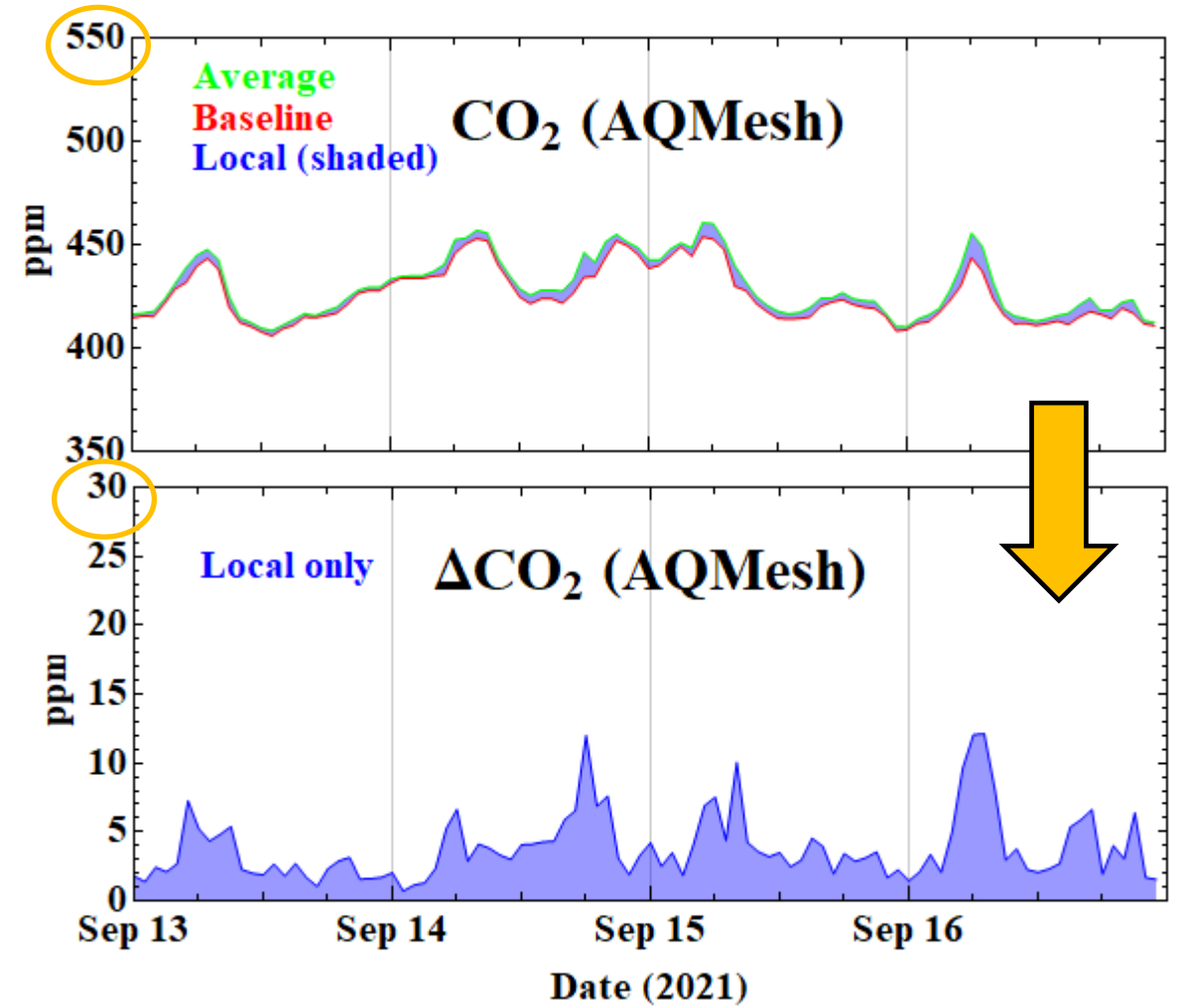
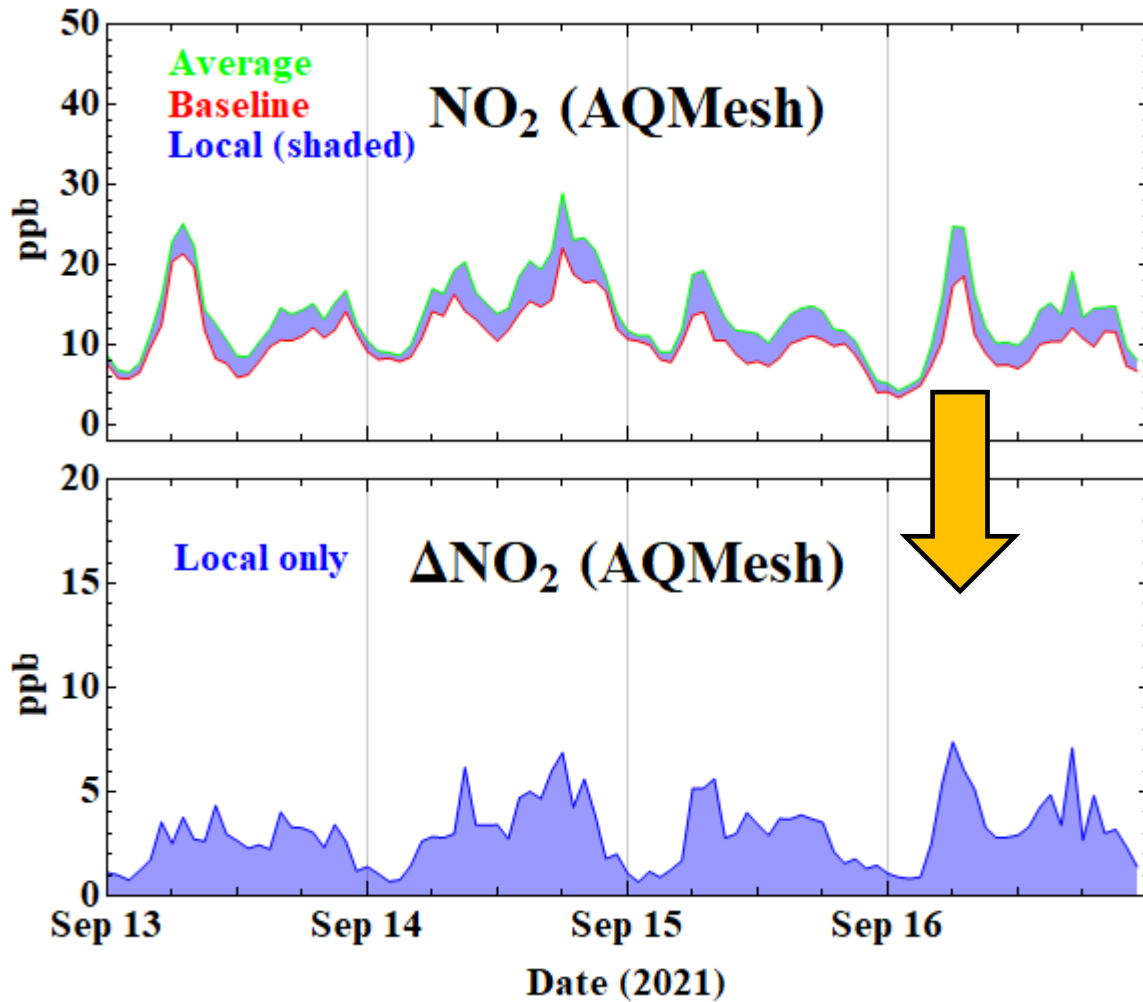
Note that data presented in talk: NO_x, CO₂ (AQMesh devices) and PM_{2.5} (reference instruments). Recall the network is collocated for the two methods

(1) source apportionment



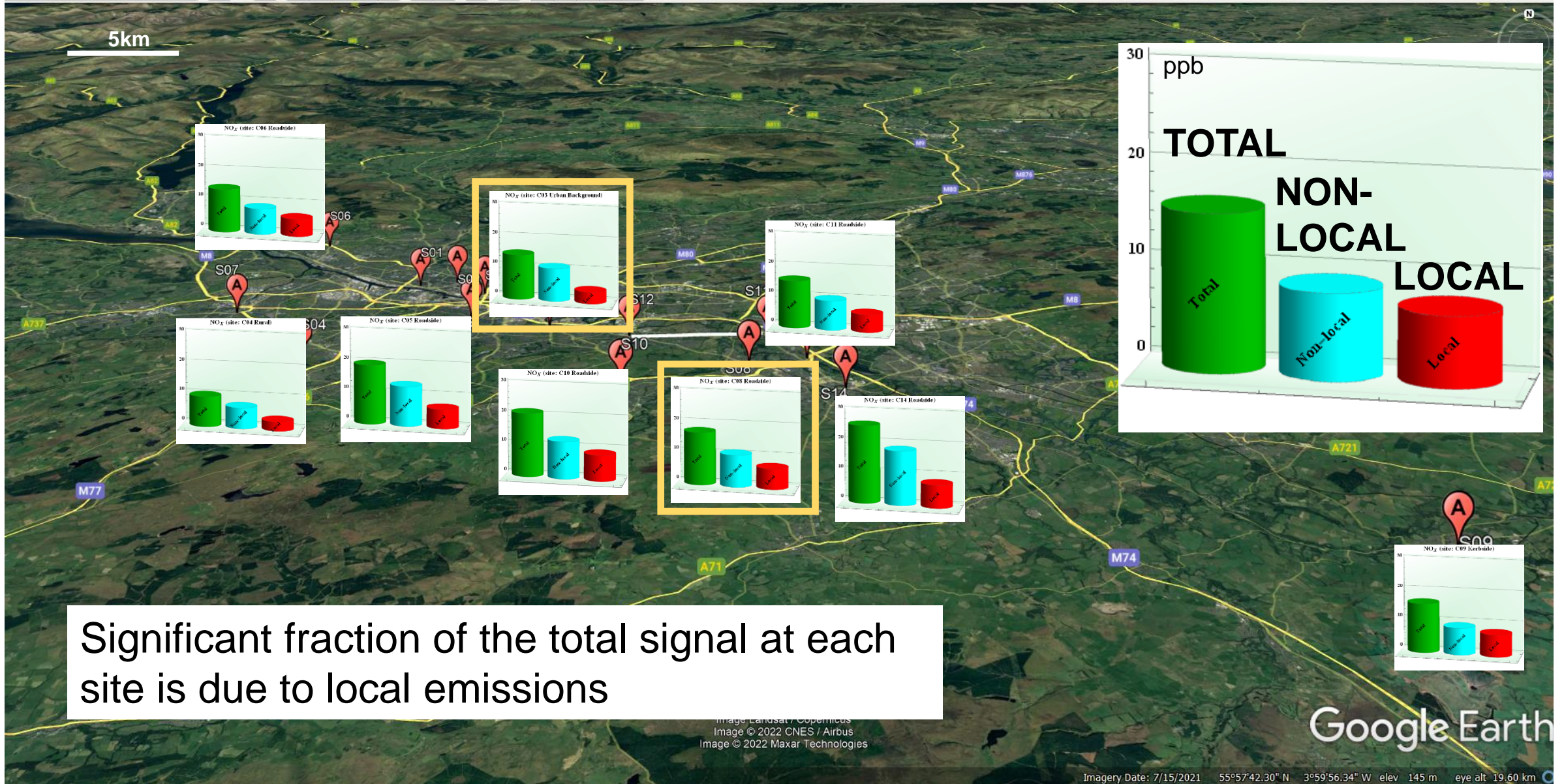
Repeat process for all sites in a network

(2) emission ratios

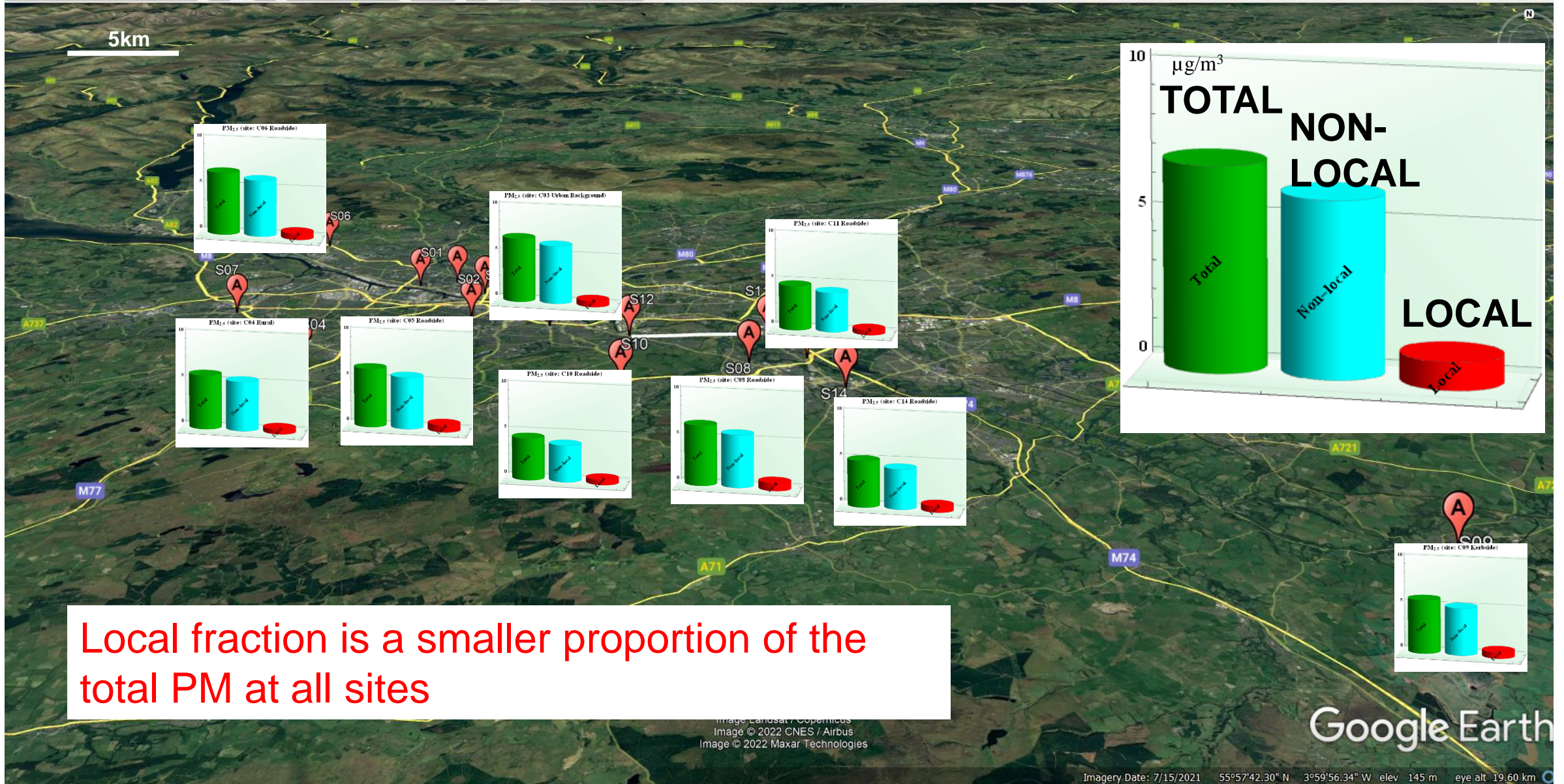


- Emission ratio (ER) = $\Delta\text{NO}_2 / \Delta\text{CO}_2$ in ppb/ppm or g/kg
- ER is a fingerprint for combustion sources
- **Requires CO_2 monitoring within the network**

Glasgow network source apportionment September 2021: NO_x

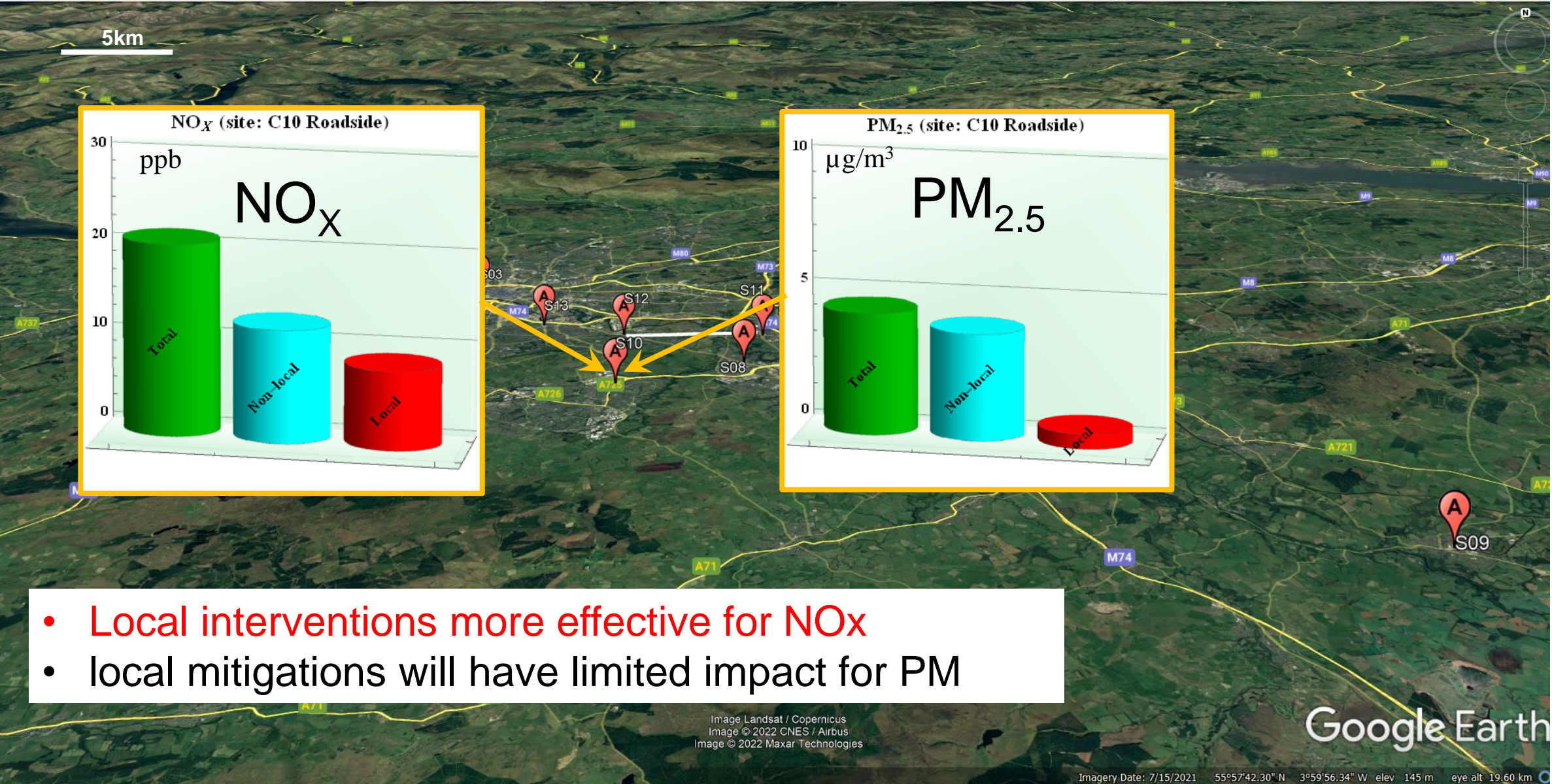


Glasgow network source apportionment September 2021: PM_{2.5}

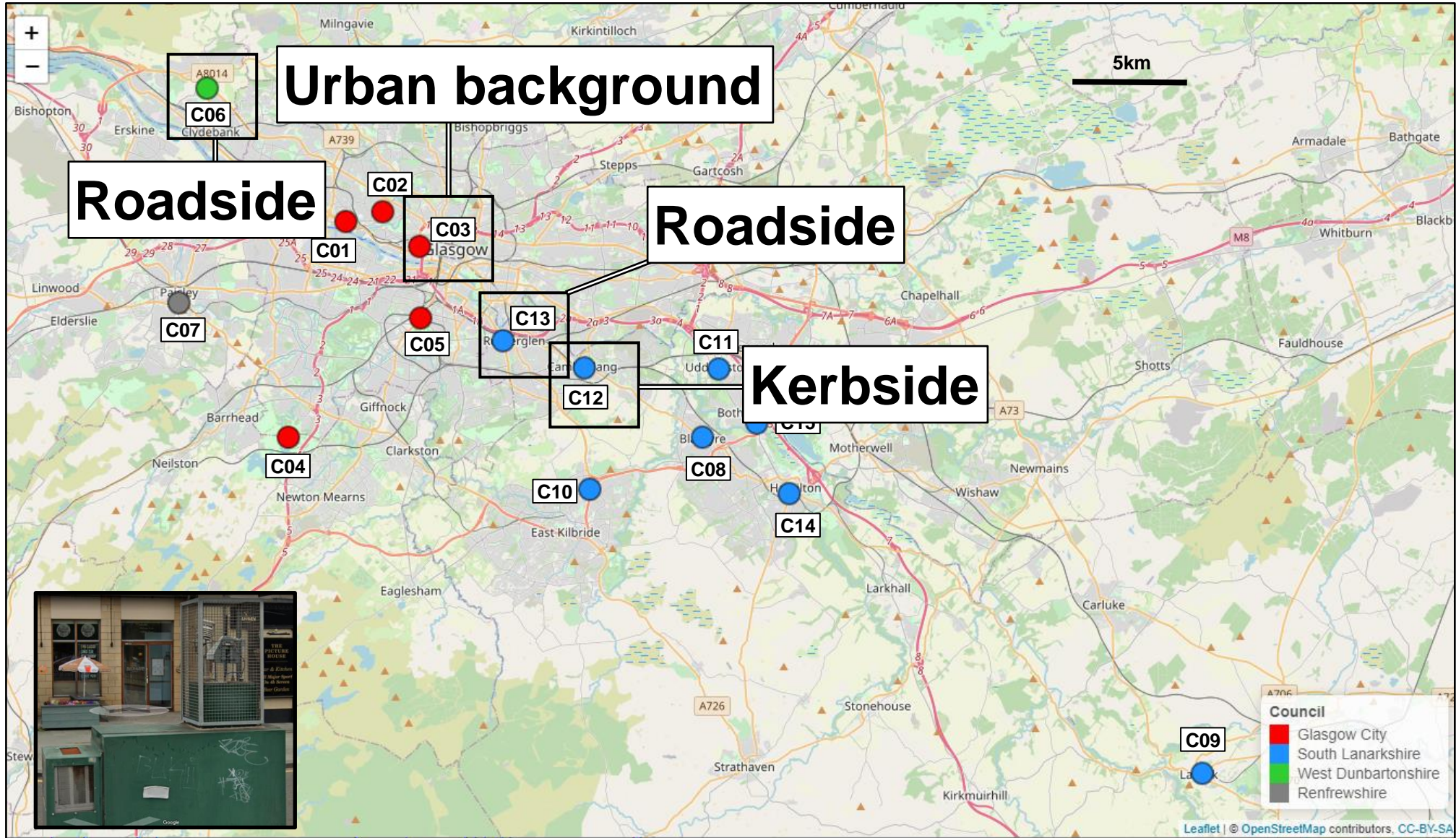


Local fraction is a smaller proportion of the total PM at all sites

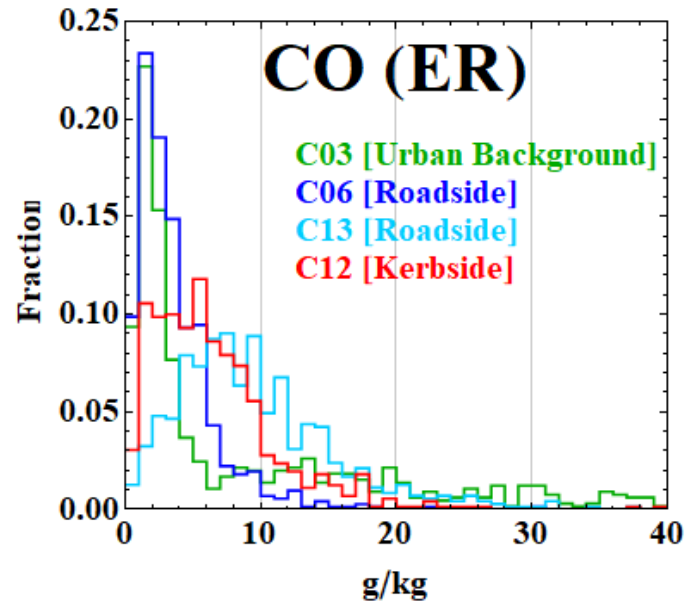
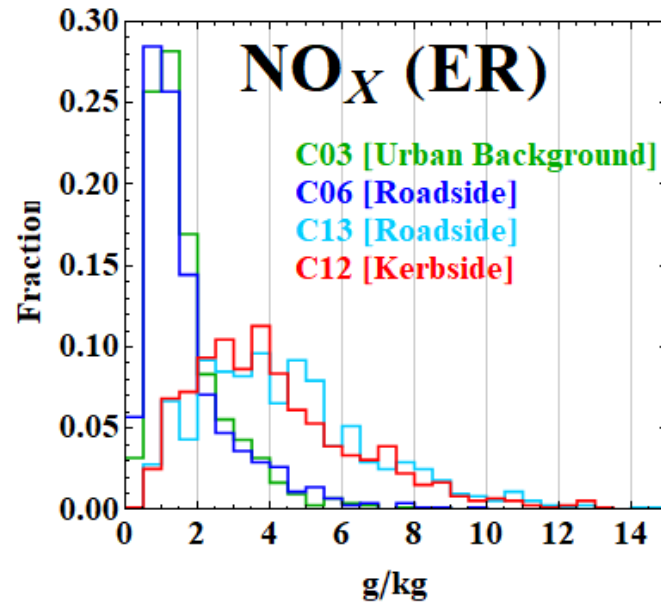
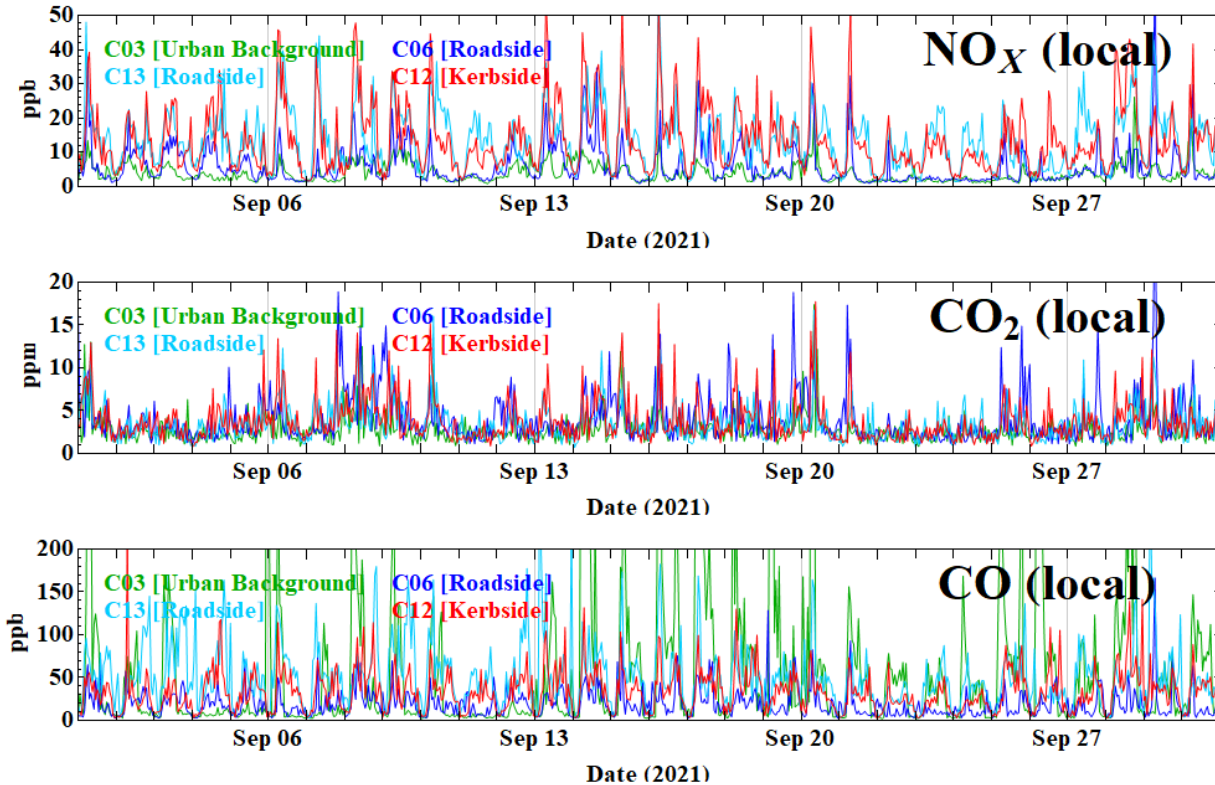
Glasgow network source apportionment September 2021: NO_x & PM_{2.5}



Example of ER analysis from subset of Glasgow network



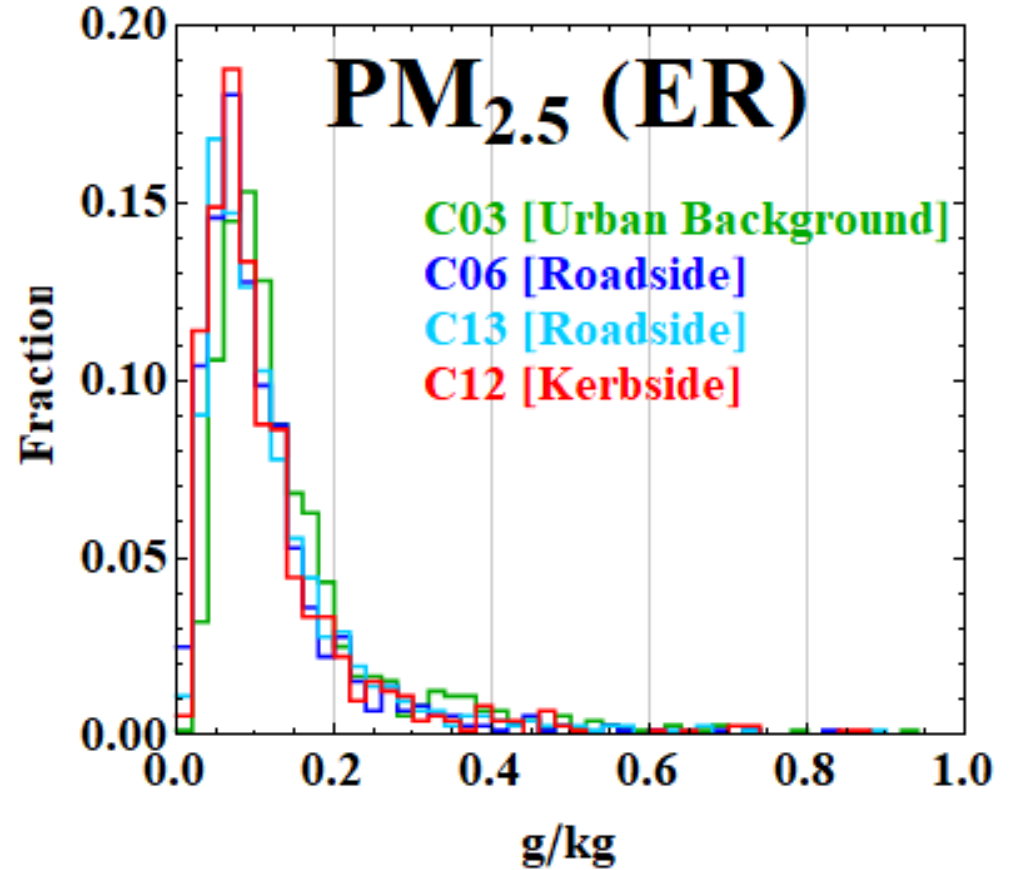
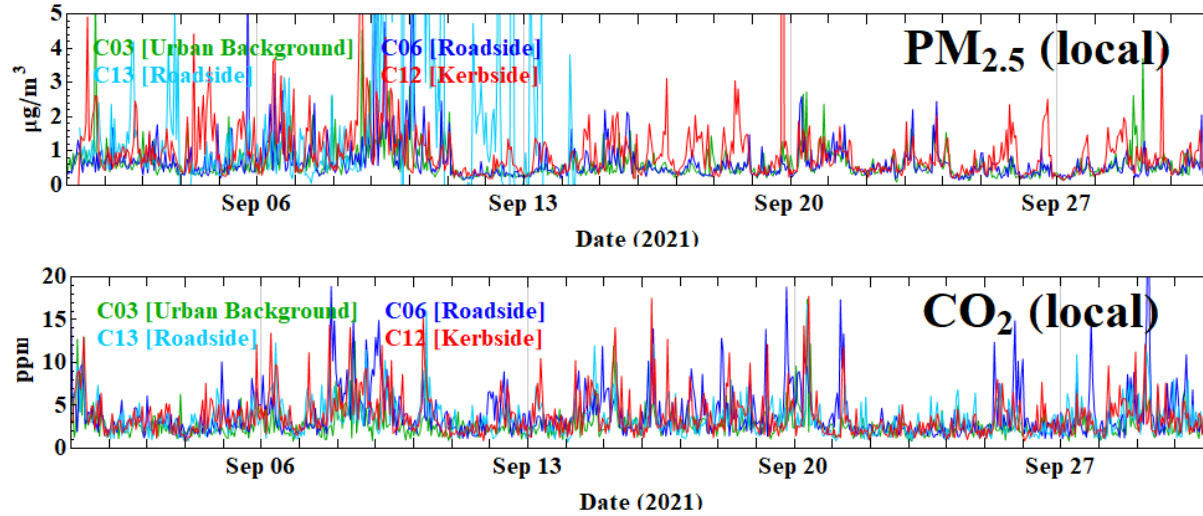
Emission ratio distribution at four typical ambient sites NO_x & CO (AQMesh)



- Clear correlations of NO_x, CO (and PM) with CO₂.....
- Sites differ (incl. the 2 roadside sites!)
⇒ Site definitions too simplistic?

Emission ratio distribution at four typical ambient sites (1-month data)

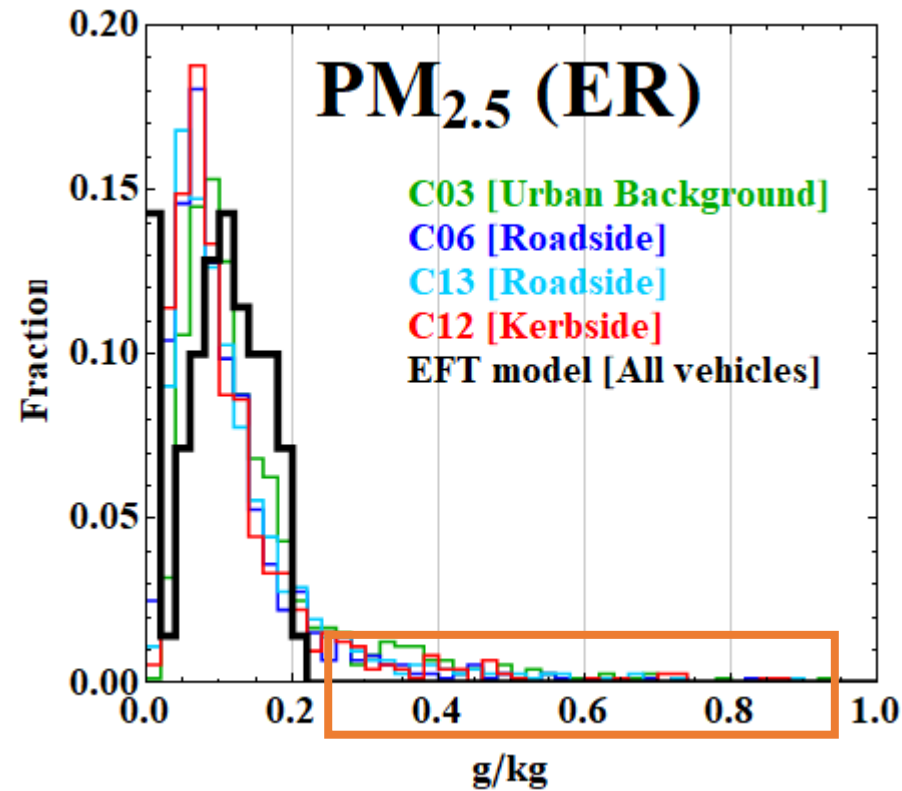
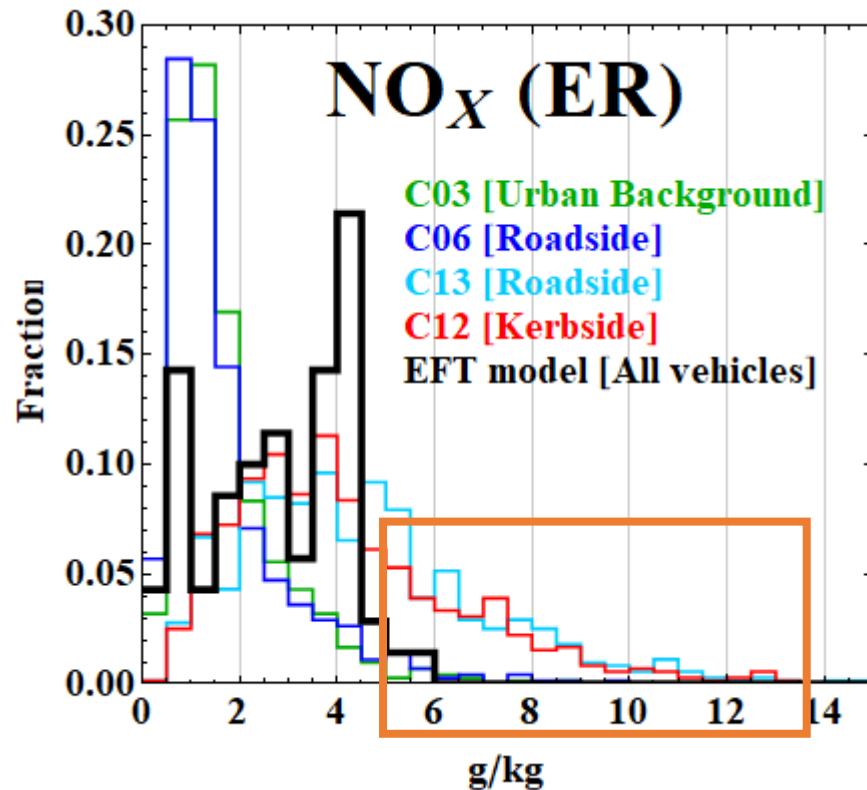
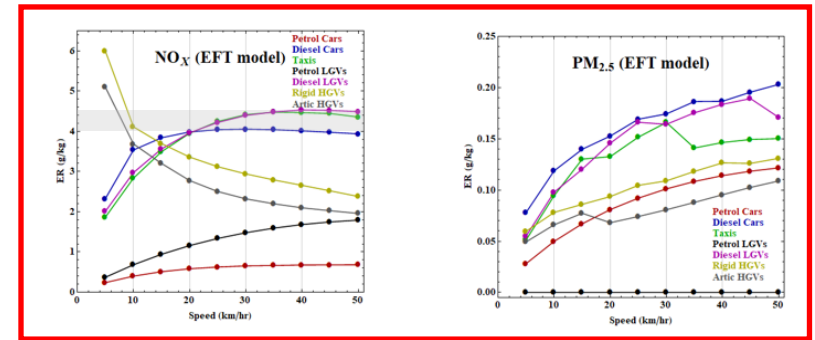
PM_{2.5} (ref PM to AQMesh CO₂)



- Less variability in distribution between sites *cf.* gases - little local fraction - direct PM_{2.5} fraction from traffic small
(Fresh particle emission often in ultrafine fraction?)

Comparison of EFT model vs observations (NO_x & PM_{2.5})

- EFT model does not simulate higher ERs for NO_x and PM_{2.5} *older vehicles in real world?*
- Low NO_x ER mode not seen in EFT....
- ER for PM_{2.5} generally similar in magnitude...



⇒ quantification of real-world emissions...

Summary

- Glasgow air quality (AQ) study with *reference network* reporting at 1-minute
- High time resolution data allows source apportionment (and *emission ratio* analysis but only *if CO₂ monitored*)
- Source attribution analysis show where to target local interventions
⇒ *Effective for NO_x, less so for PM*
- Emission ratio analysis presenting new insights into traffic fleet type, drive pattern, robust evaluation of policies (fleet compliance)

Closing thoughts

Study shows potential of high time resolution (1-min) AQ data

⇒ *information content missed by current operational practices*

⇒ include CO₂ in reference networks?

Thank you for listening

Acknowledgments

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