Spatiotemporal variations and sources of NO_x in Accra, Ghana

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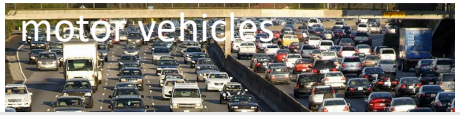
NO_x (nitrogen oxides): gas air pollutants

- A group of 7 compounds – NO, NO_2, N_2O, N_2O_2, N_2O_3, N_2O_4, N_2O_5

- Sources: combustion related emissions from
  - **Fossil fuel combustion**
  - **biomass burning**



Cities in developed country: tracer of traffic

- Health effects
  - direct: respiratory infections, asthma, etc.
  - indirect: NO_x + VOCs → O_3 + PM (particulate matter)

- WHO guideline
  - Annual mean conc. of NO_2: 40 μg/m^3

Background

Sub-Saharan African cities: **air pollution, the biggest public health issue**

- Complex local emission sources

- Regional influences from Sahara Desert during the Harmattan season (Dry dusty, Nov. – Mar.)

- Lack of monitoring network for pollutants, especially NO_x

Background

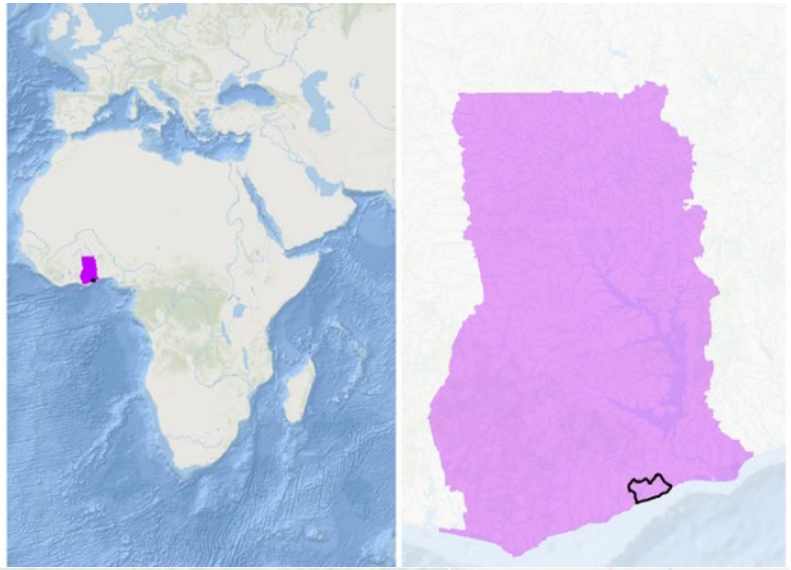
- Accra, capital city of Ghana, expand remarkably in the last two decades
  - **population**: increased almost **3 times** from 2000 to 2019 (1.7 – 5 million)
  - **vehicle numbers***: increased nearly **6 times** from 2005 to 2015
  - **Biomass use** as fuel ~50% (2010 Census)

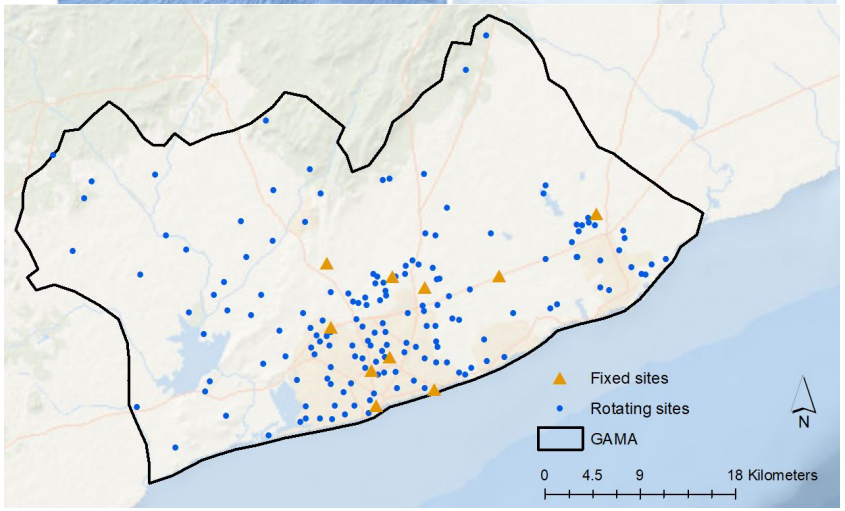
Question: traffic or biomass burning?

* Vehicle number of Ghana

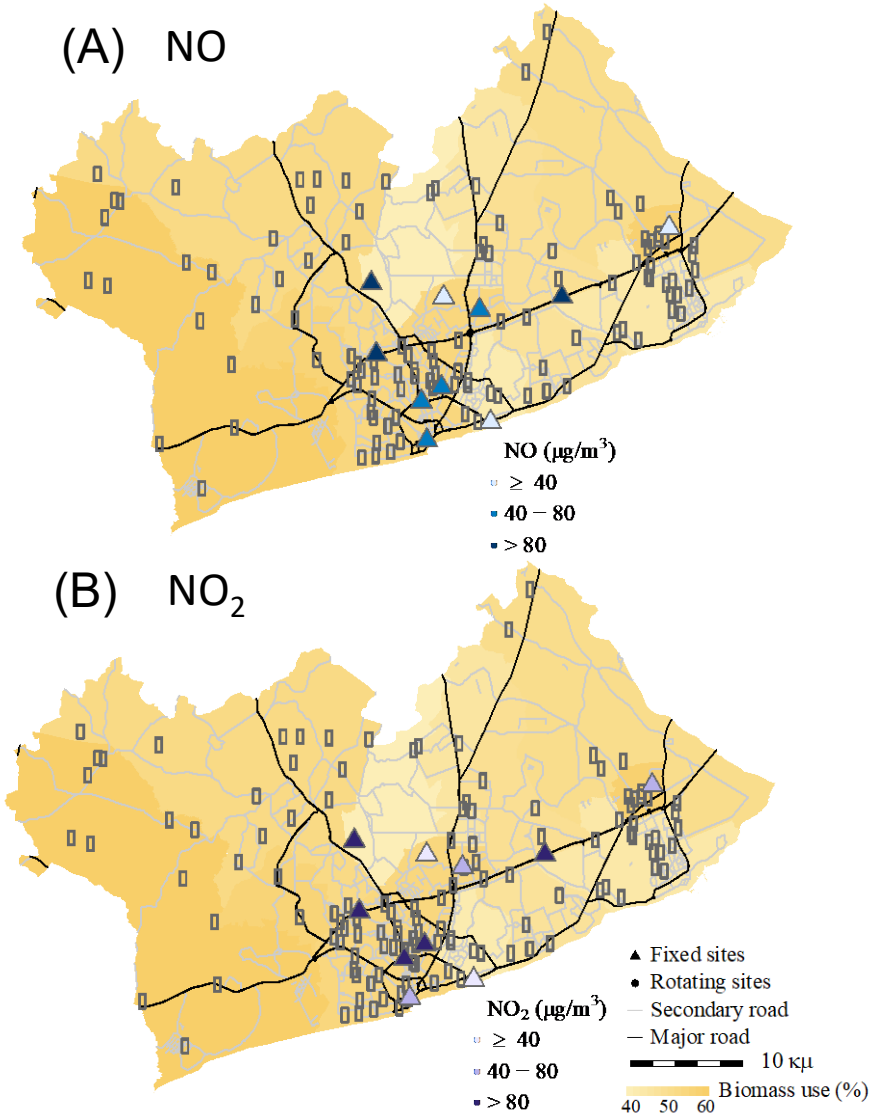
Study design

- Location: Greater Accra Metropolitan Area (GAMA)
- Sampling time: July 2019 – June 2020
- Sampling method: Passive sampler
- Site type: Seasonal changes (non-Harmattan vs Harmattan)
  - Fixed sites (year-long, n=10)
  - Rotating site (week-long, n=140) Spatial variations
    - Commercial/Business/Industrial (CBI) (Traffic)
    - High density residential (HD) (Biomass burning)
    - Medium/Low density residential (LD)
    - Peri-urban background (UB)

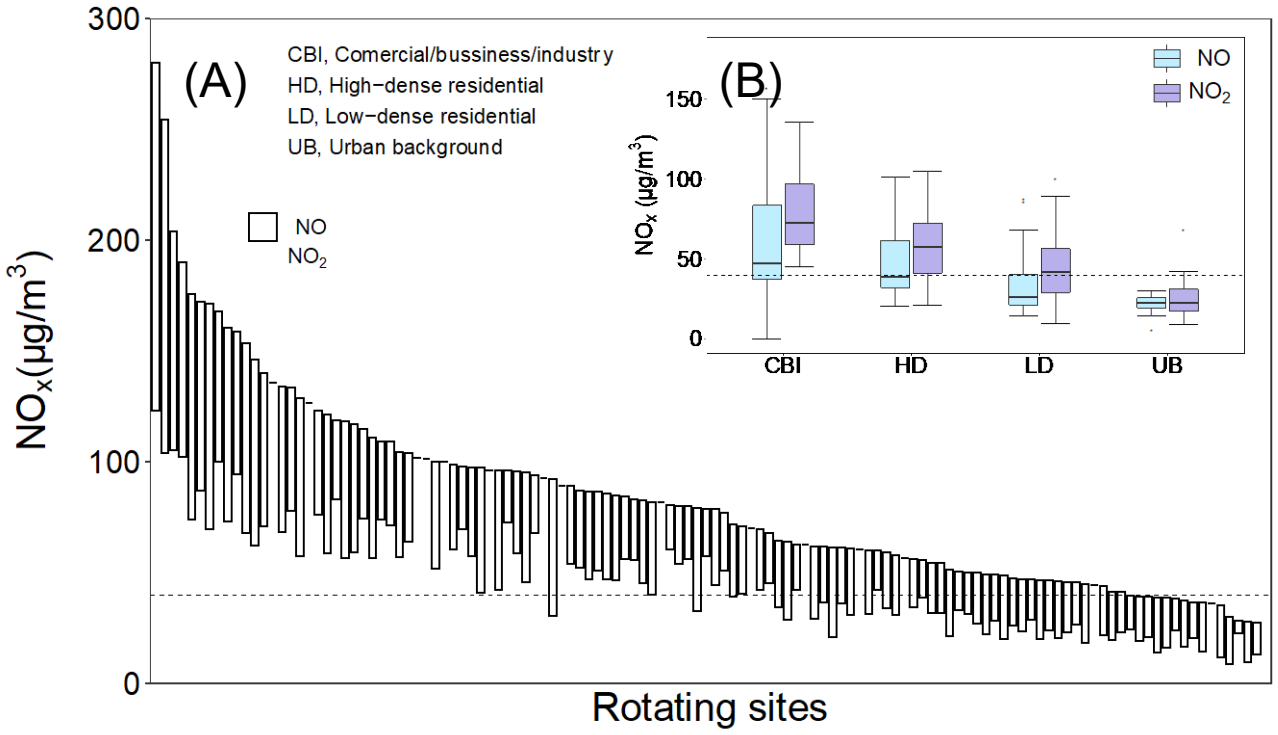




Spatial variation

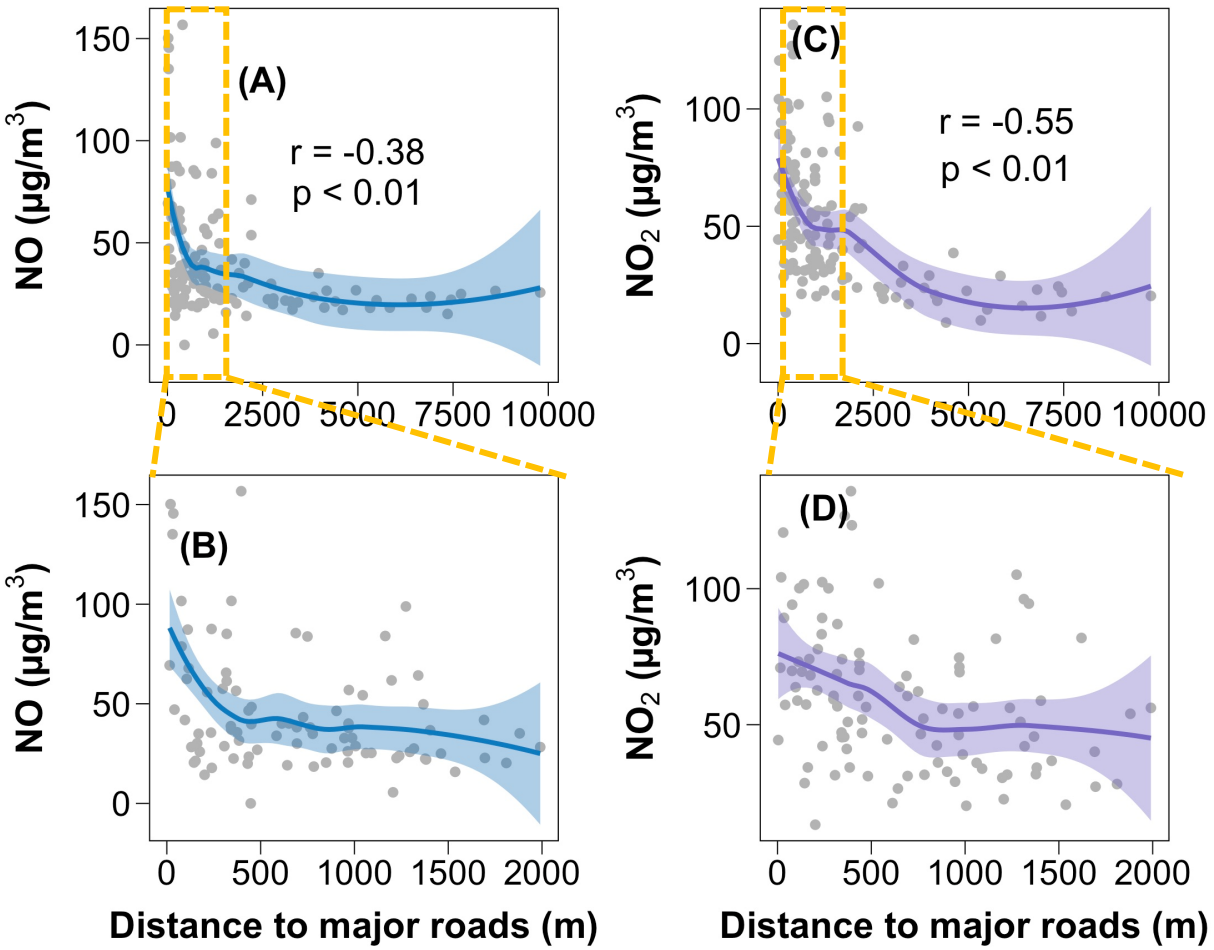


- GAMA average conc.:
  - NO: 39 μg/m³
  - NO_2: 50 μg/m³
- ~60% sites exceed WHO guideline for NO_2
- CBI > HD > LD >UB



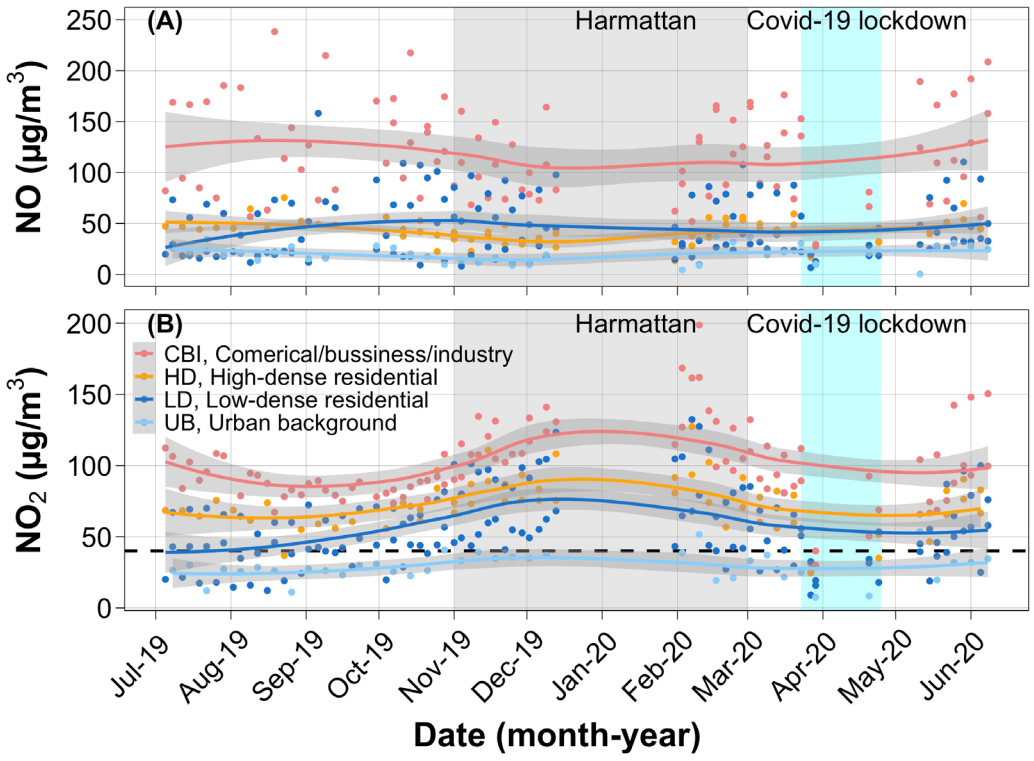
Potential source contributions

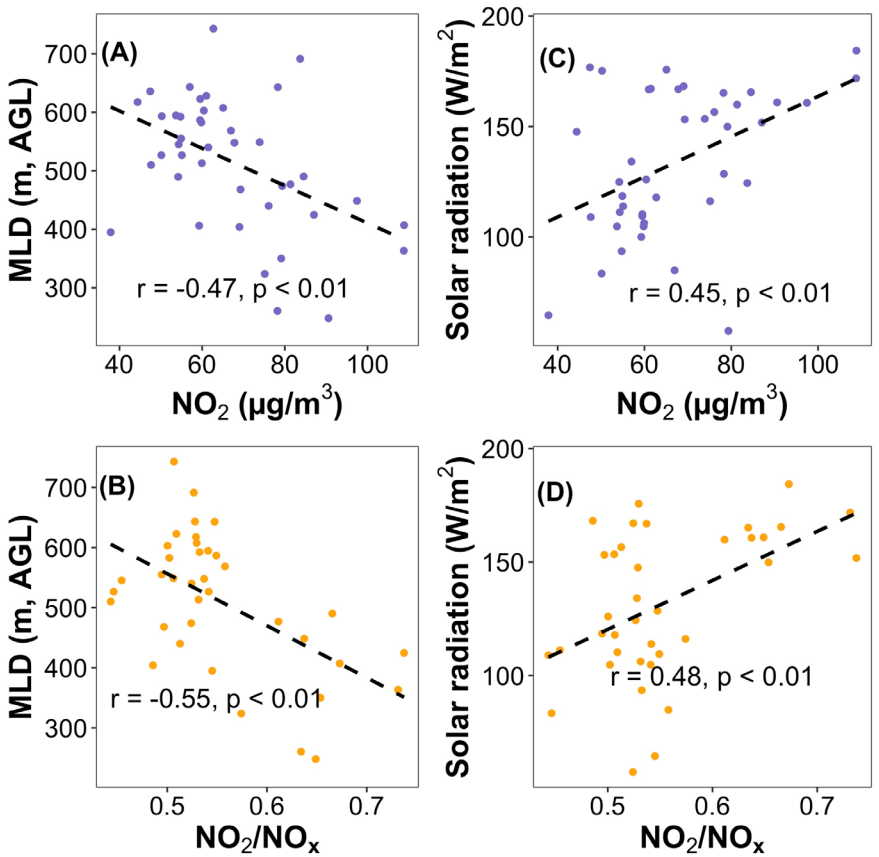
Traffic is the most important source



Temporal variation

- NO – primary emission, little change
- NO_2 – increased significantly during the Harmattan





- Local pollution level was likely enhanced due to lowering of the mixing layer depth
- Secondary formation was likely promoted by higher solar radiation

Summary

- About 60% of sites exceeded the WHO guideline of annual mean of NO_2
- Traffic is still the most important source of NO_x
- Local pollution level got enhanced due to meteorology changes during the Harmattan season

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Thanks for all your attentions!

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