Air Pollutant Emissions in Africa

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AQ in Africa Workshop
8 June 2021

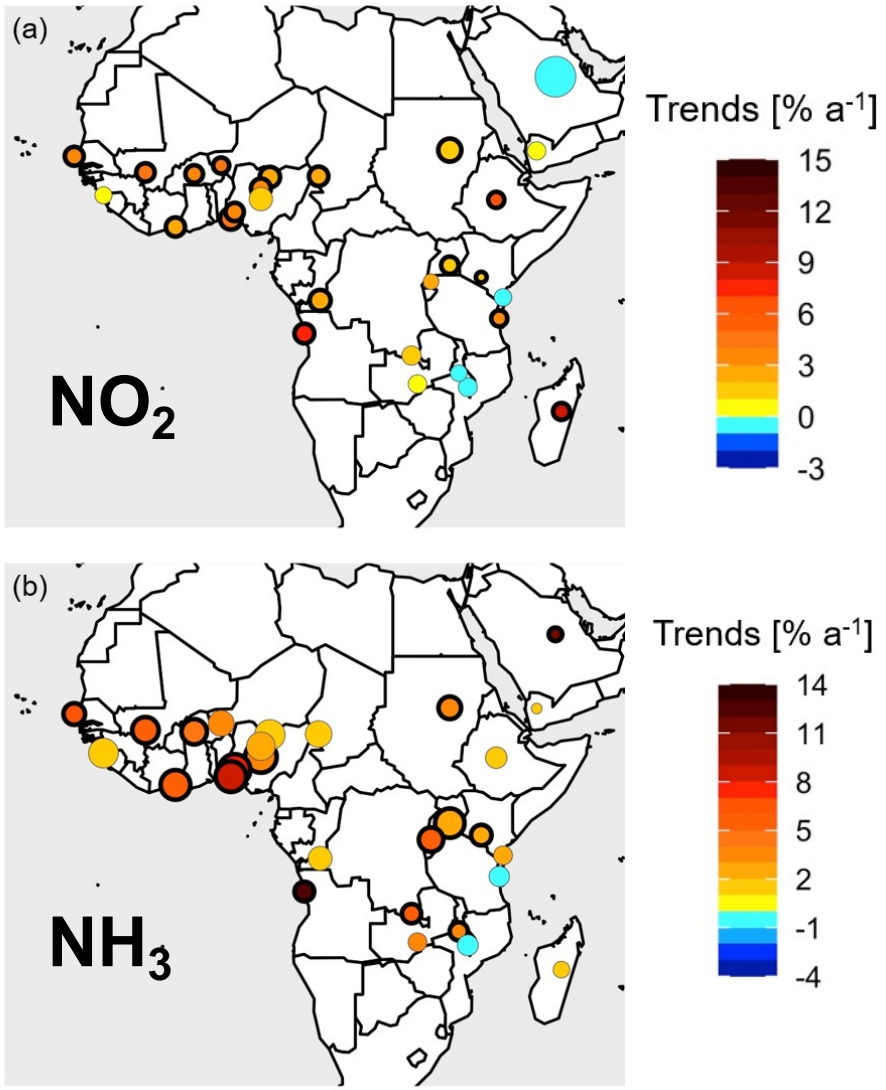
UCL

CIRES

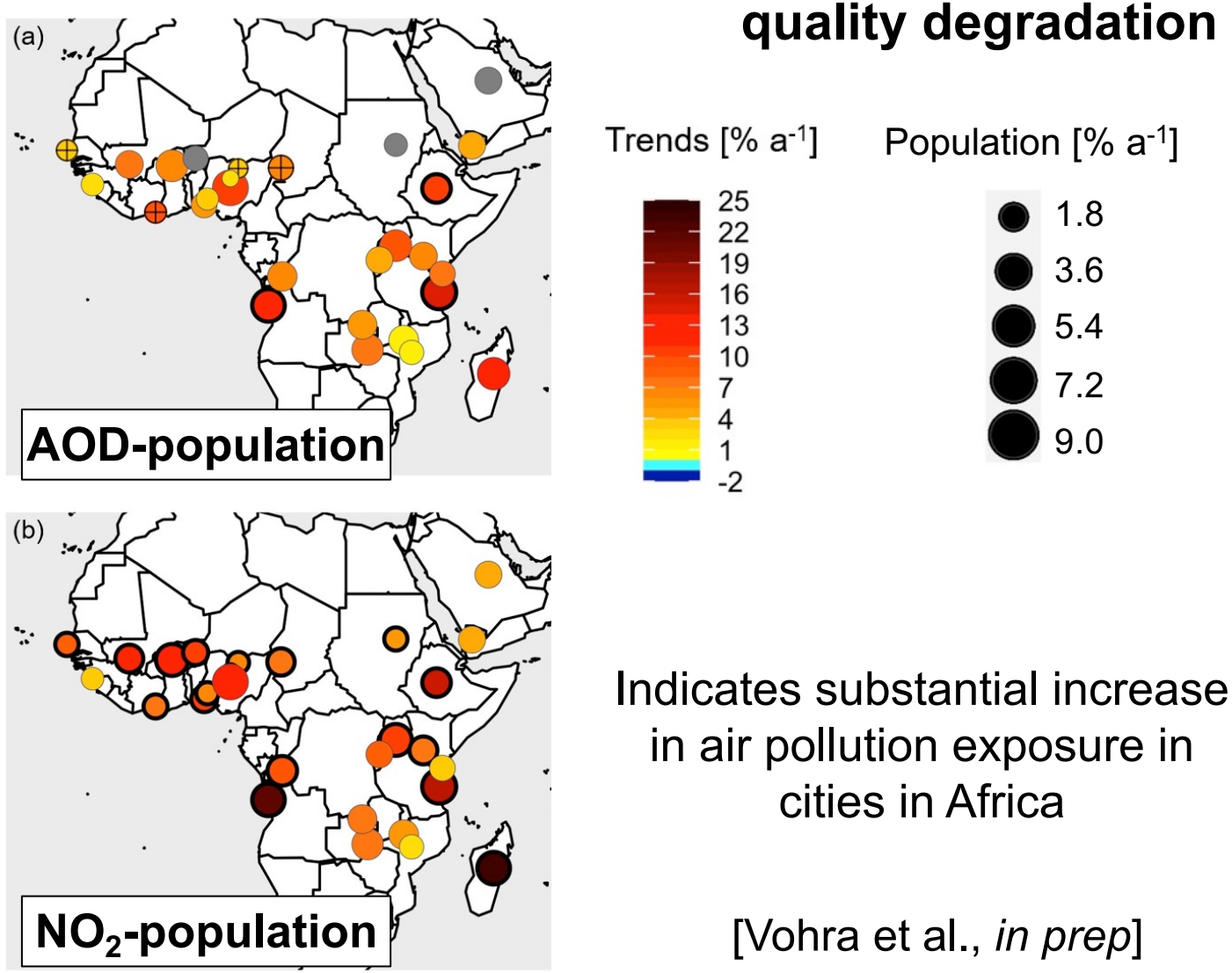
CU Boulder

Rapid changes in air pollution in African cities

Trends in NO_2 and NH_3



Combined effect of population growth and air quality degradation



Indicates substantial increase in air pollution exposure in cities in Africa

[Vohra et al., *in prep*]

Crucial that we better characterize sources contributing to air quality degradation across Africa

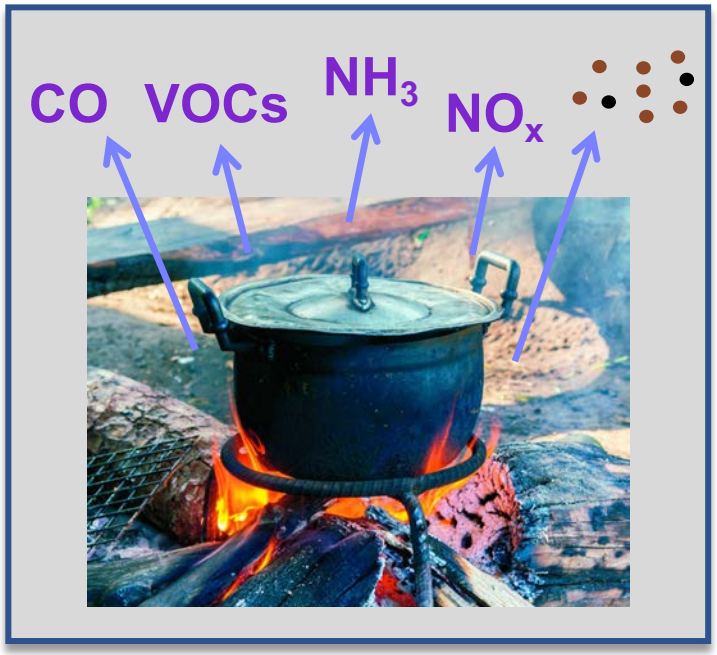
Emissions are mostly from inefficient combustion

Trash & e-waste burning

Solid Biofuels

Flaring

Kerosene



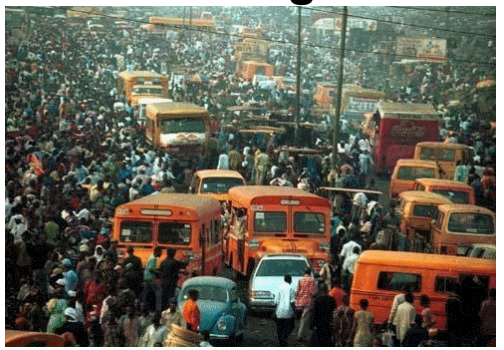
Artisanal Oil Refining

Open biomass burning

Motorbikes

Charcoal production

Cars & congestion

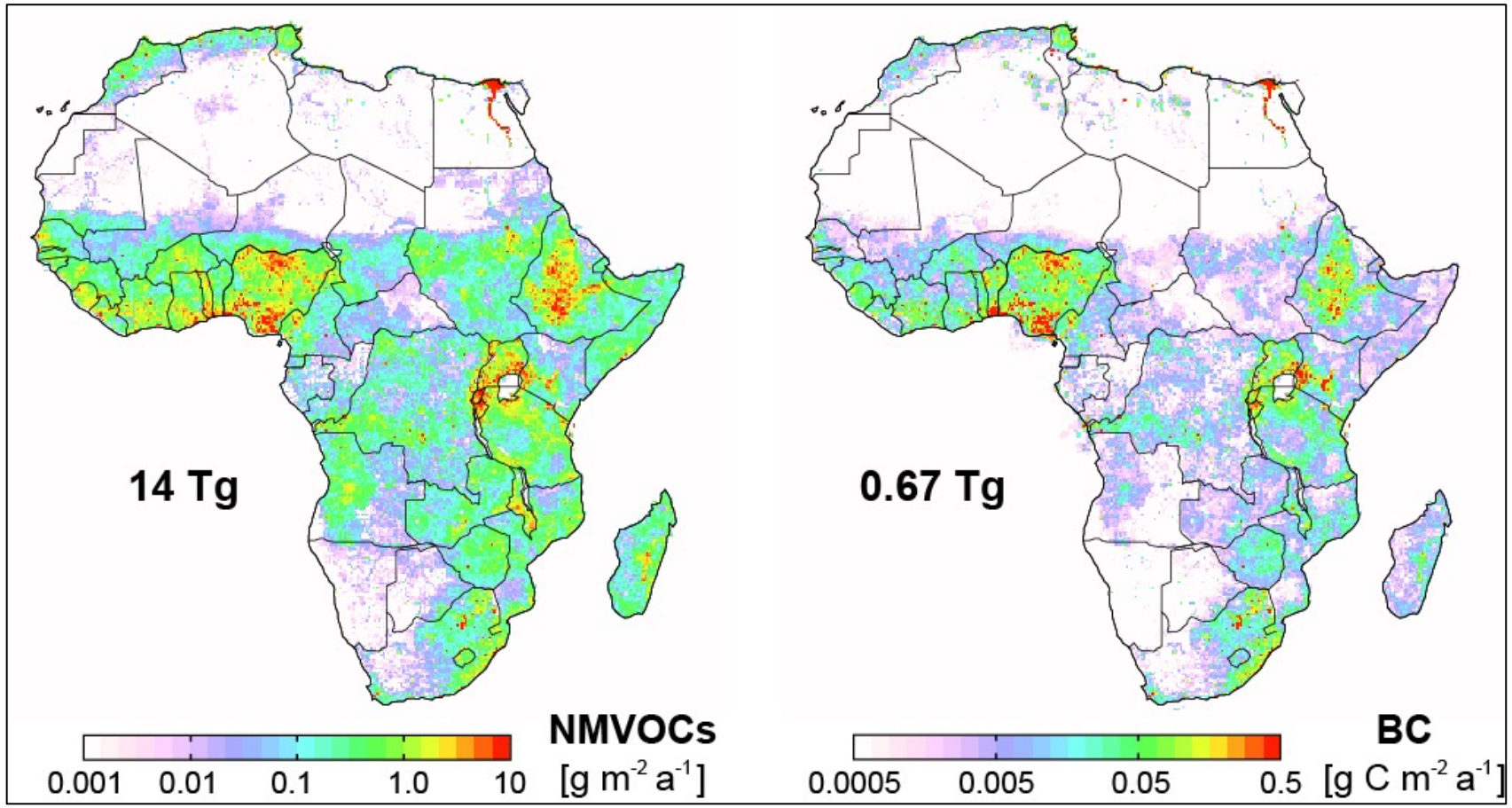


Generators

Capture many of these with the DICE-Africa Inventory

Anthropogenic emissions are diffuse,
but similar in magnitude to emissions from seasonal burning of biomass

DICE-Africa 2006 emissions of NMVOCs and BC



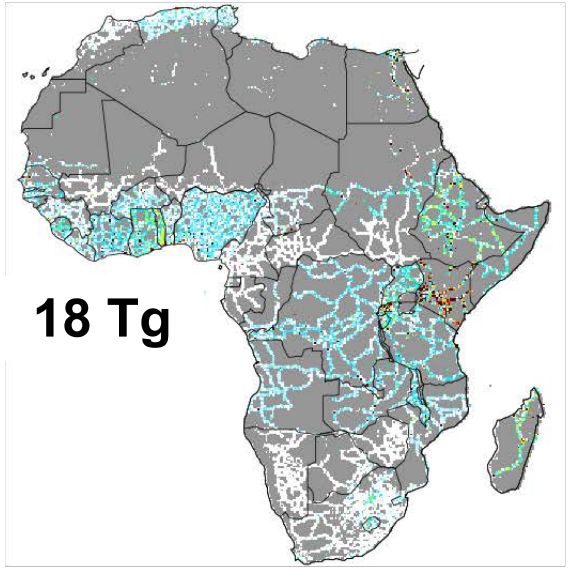
[Marais & Wiedinmyer, 2016]

Solid fuels like charcoal are still dominant energy sources

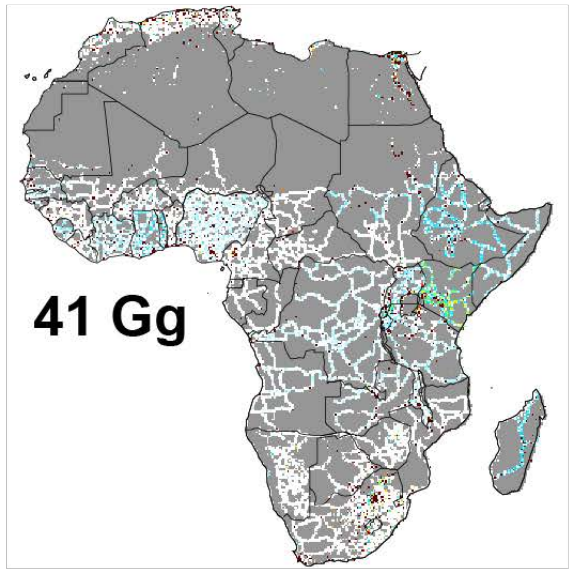
Charcoal production and use is increasing by **7% per year**, as alternate options like LPG are costly, fluctuate in cost, and supplies are unreliable

Charcoal production, transport and use emissions for 2014

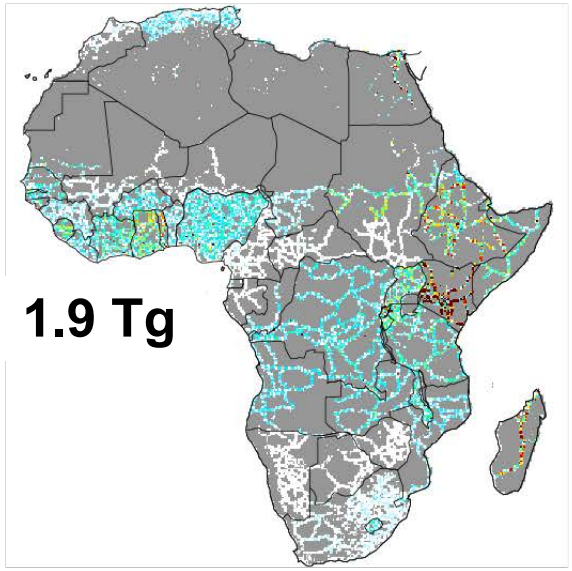
CO [10^3 tonnes]



BC [tonnes]

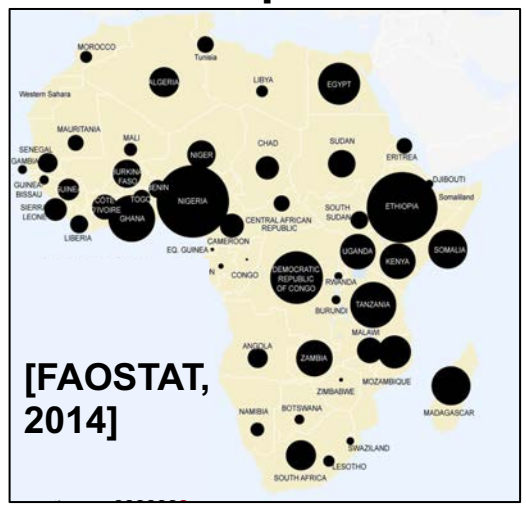


CH_4 [tonnes]



[Bockarie et al., 2020]

Charcoal production hotspots



Charcoal industry emissions for Africa 2014 may double by 2030

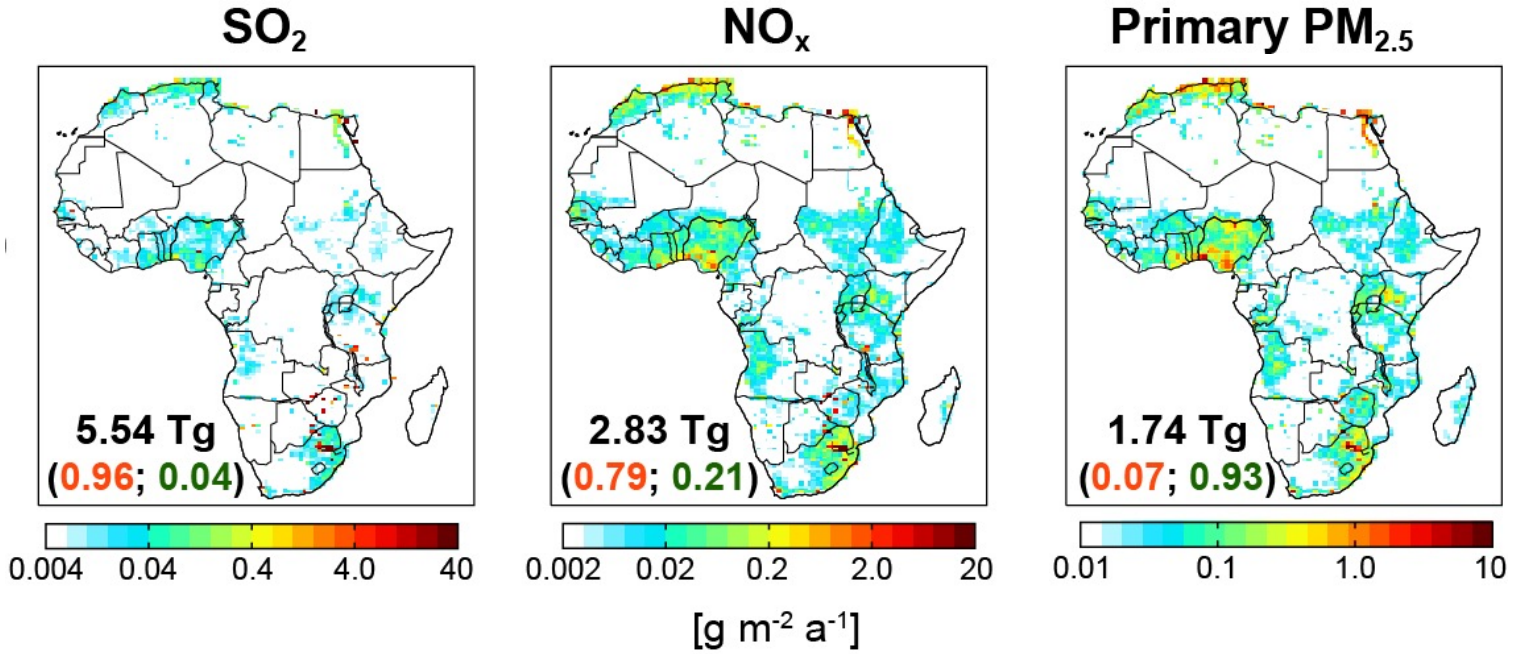
CH_4 emissions, specifically, may outcompete those from open fires in West Africa by 2025

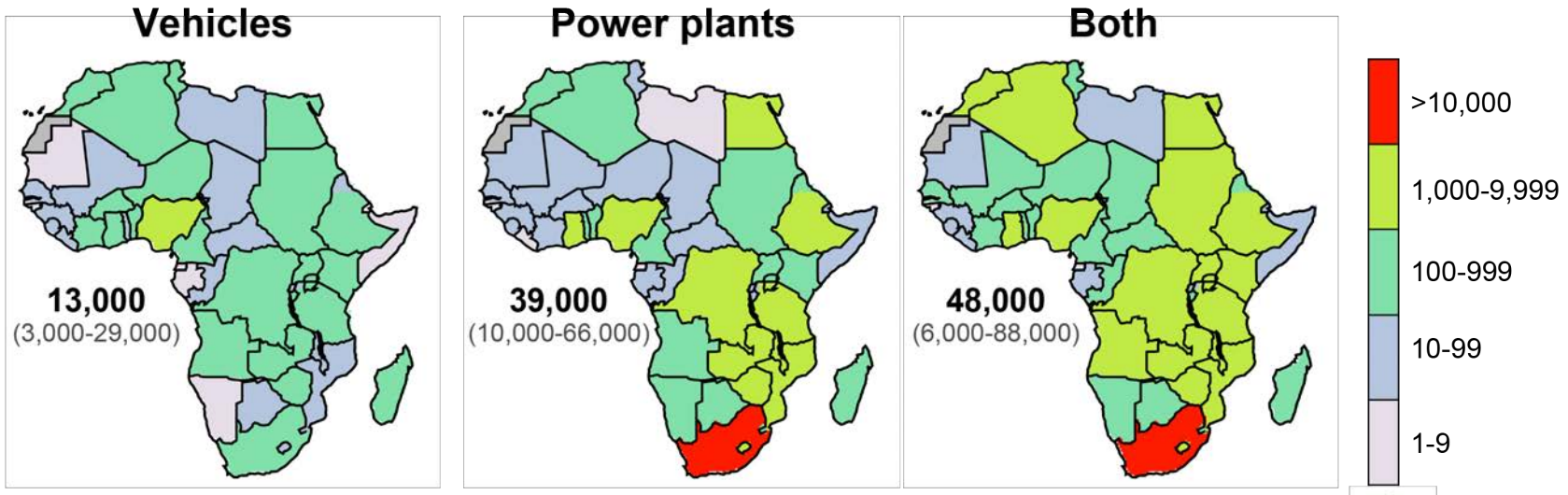
Investment in fossil fuels, despite climate and health impacts

2030 emissions:
all vehicles + power plants
(including powerships)

3-4 likely to be deployed to South Africa

Premature deaths due to future fossil fuel use:
GEOS-Chem $PM_{2.5}$ and Vodonos et al. (2018) concentration-response curve

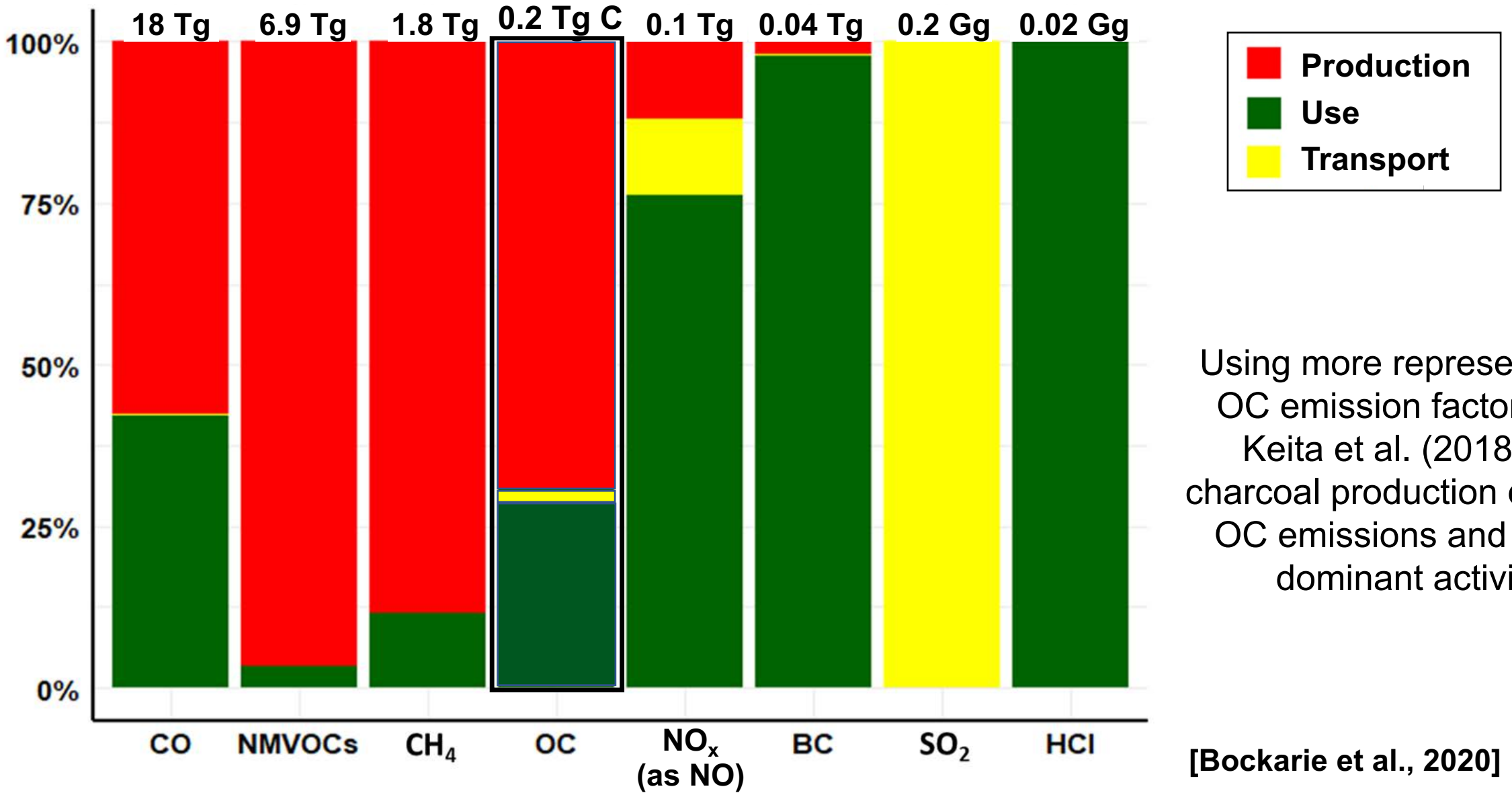




Total premature deaths in Africa: 48,000

Emissions estimates very sensitive to choice of emission factors

Total and relative emissions from charcoal industry activities

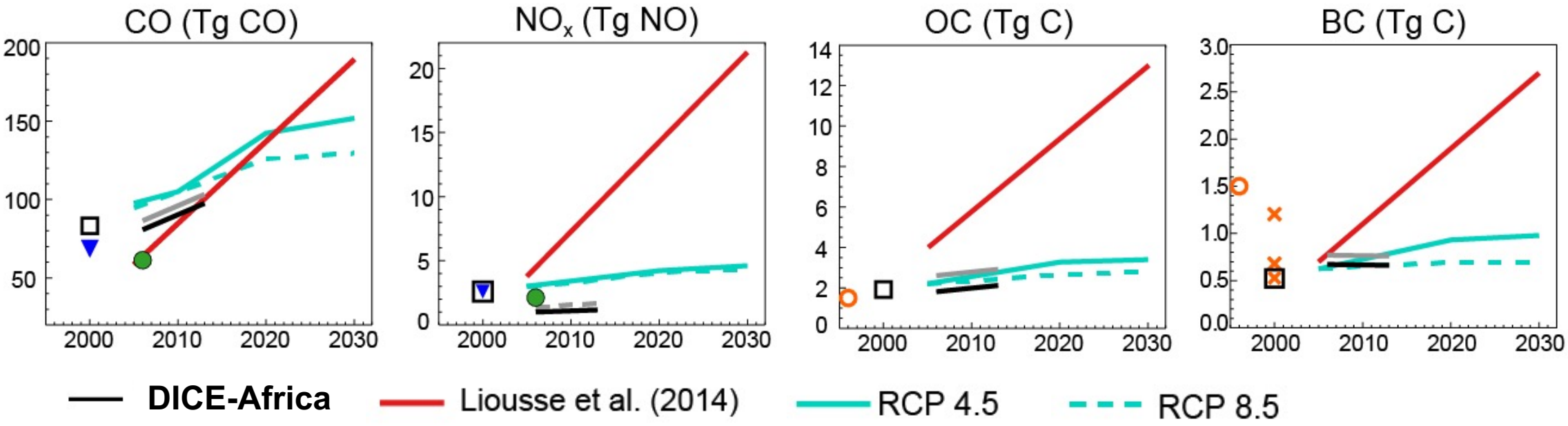


Using more representative OC emission factor from Keita et al. (2018) for charcoal production doubles OC emissions and alters dominant activity

[Bockarie et al., 2020]

Large differences in bottom-up emissions estimates for Africa

Large differences is current emissions estimates leading to wildly different emissions projections



[Marais & Wiedinmyer, 2016]

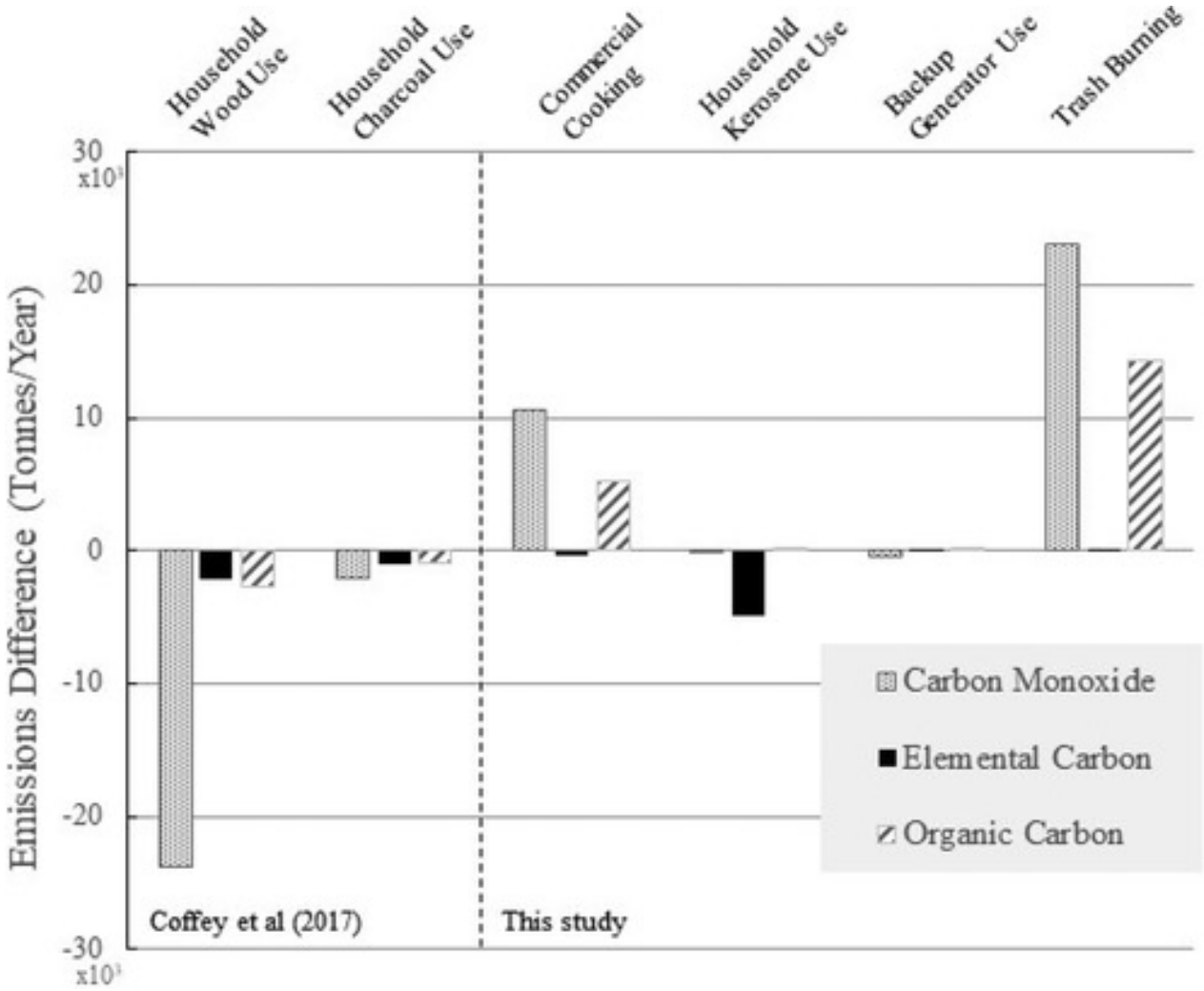
Size of discrepancies indicative of large uncertainties in anthropogenic activity and emissions factors

New Emissions Measurements in West and East Africa

Recent work to update emission factors for key sources

Pfotenhauer et al. *ES&T* (2019) updated emission factors for Sub-Saharan Africa

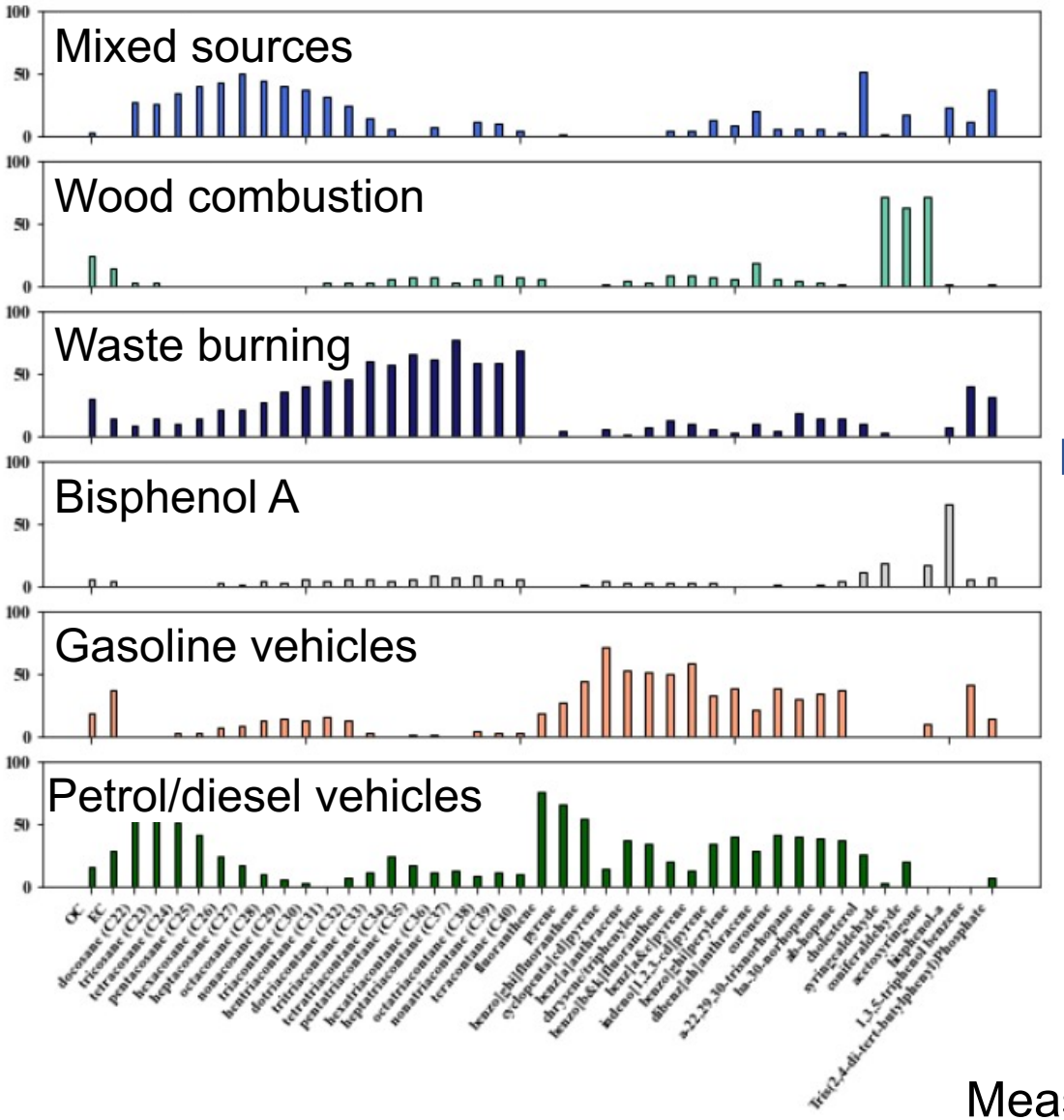
- Trash burning
- Commercial cooking
- Household cooking
- Kerosene lamps
- Generators

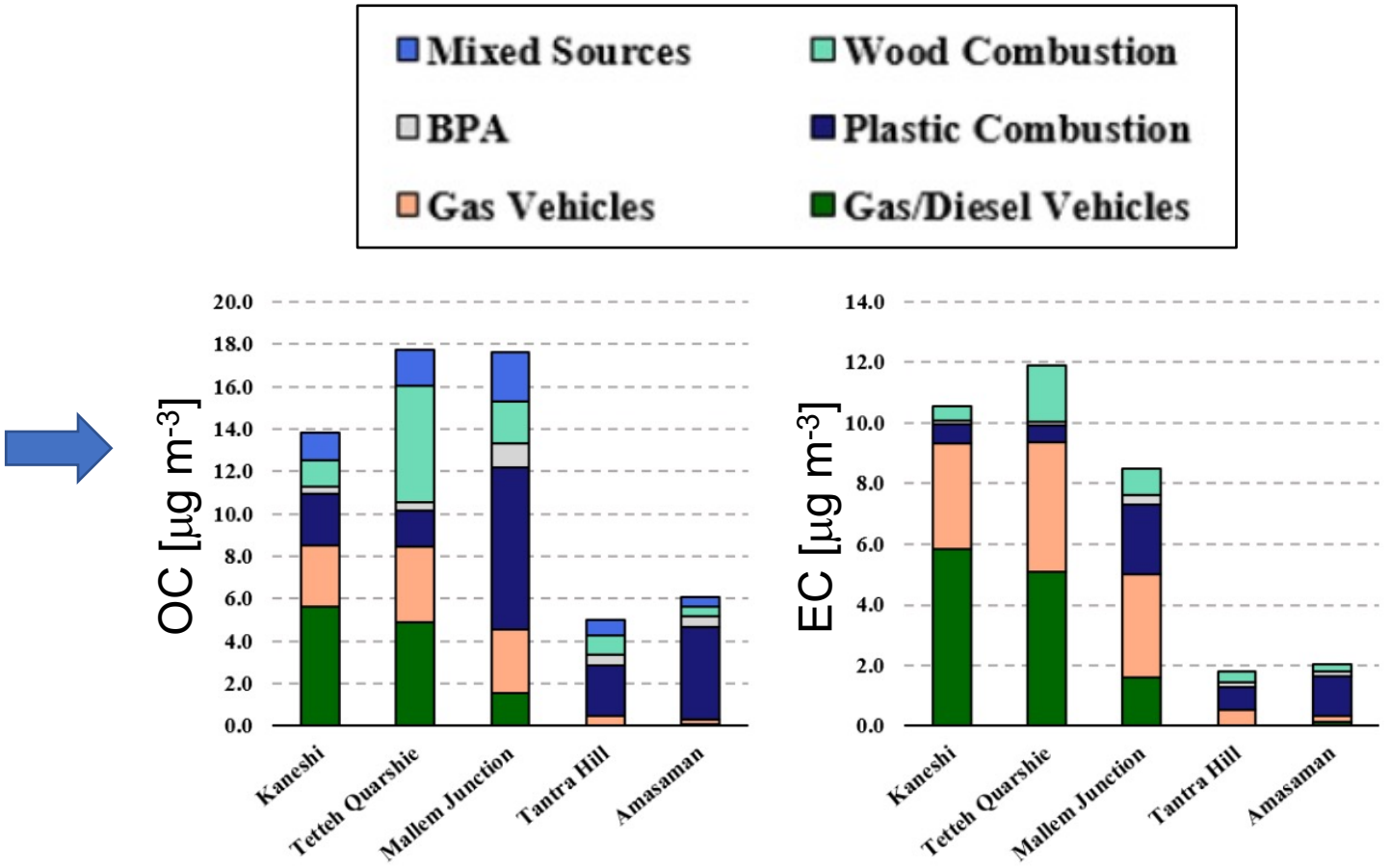


Differences in Ghanaian CO, EC, and OC emissions in kilotonnes between prior and updated emission factors

Source Attribution for Evaluating Emission Inventories

Measurements in Accra and Northern Ghana for source attribution





Sources of EC and OC at roadside sites in Accra, Ghana includes large contributions from waste burning

Measurements by D. Pfotenhauer, E. Coffey, E. and M. Hannigan

Critical Research Needs

- Still large uncertainties regarding general refuse and e-waste burning
- Activity data is typically at the country level, but higher resolution data is needed
- Better guidance is needed regarding temporal variability for input of emissions to models
- Ongoing field and lab measurements are crucial for improved representation of emissions for conditions in Africa
- Need a more extensive network of surface measurements to evaluate and constrain emissions
- Ideally, emissions inventory development should be conducted by individual countries or regions, but this is costly

Other groups developing emissions inventories for Africa

African Anthropogenic Emissions Inventory for gases and particles from 1990 to 2015:
https://doi.org/10.25326/56 (**Cathy Liousse's group**)

Global $CEDS_{GBD\text{-}MAPS}$ inventory uses DICE-Africa as constraints for emissions from 1970 to 2017:
https://doi.org/10.5281/zenodo.3865670 (**Randall Martin's group**)

Relevant Emissions Inventory Resources

Links to relevant datasets:

Inventory of charcoal industry emissions in Africa for 2014 and 2030:

https://doi.org/10.5522/04/14595315.v1

Surface concentrations of $PM_{2.5}$ in Africa in 2012 and 2030 from GEOS-Chem:

https://doi.org/10.5522/04/14595729.v1

DICE-Africa inventory emissions for 2006 and 2013:

https://doi.org/10.5522/04/14595723.v1

Satellite-derived isoprene emissions in Africa from OMI and GEOS-Chem:

https://doi.org/10.5522/04/14595735.v1

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