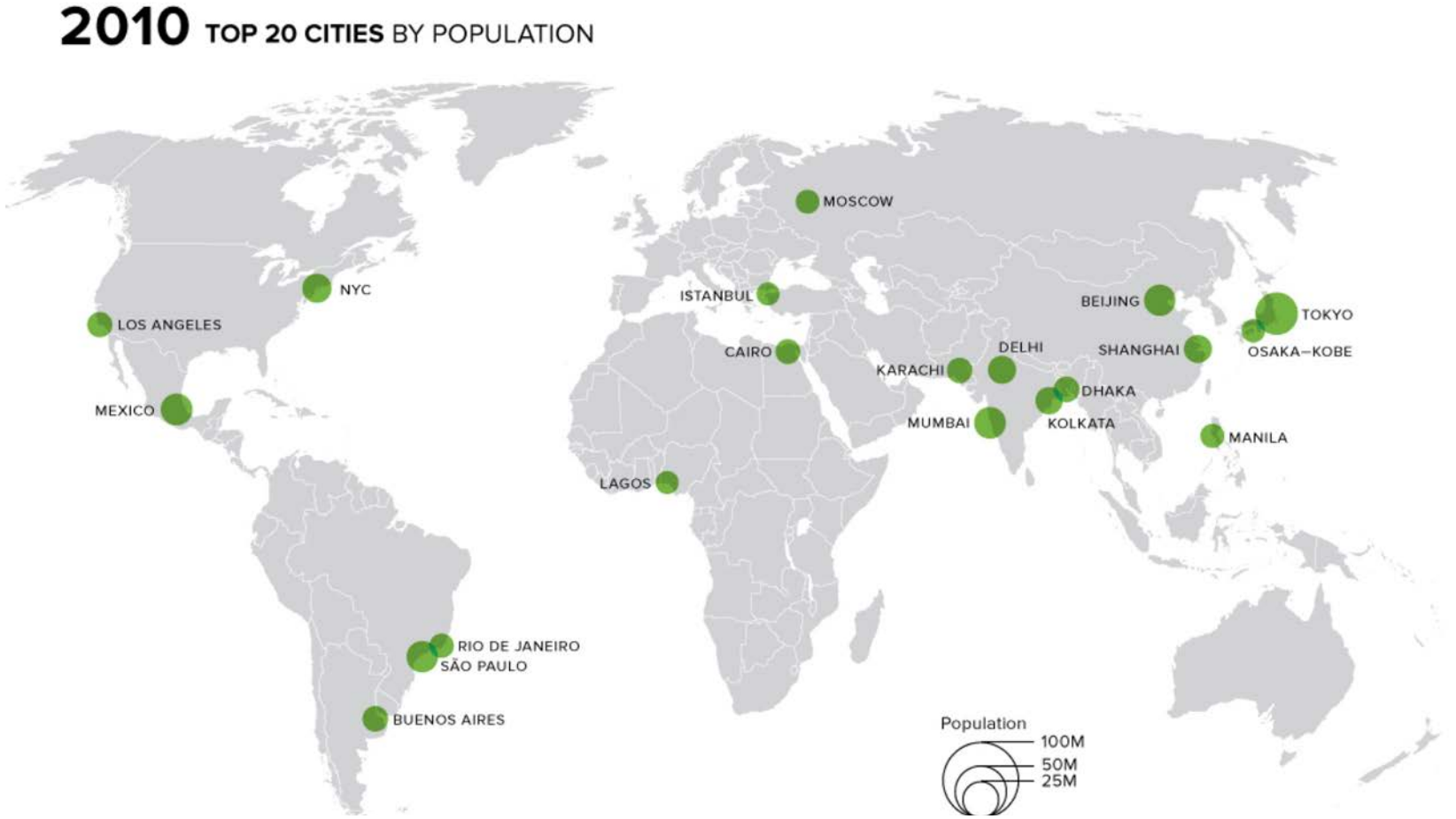
Challenges and Opportunities Developing Emission Inventories for Africa

By 2100, 13 of the 20 largest cities will be in Africa

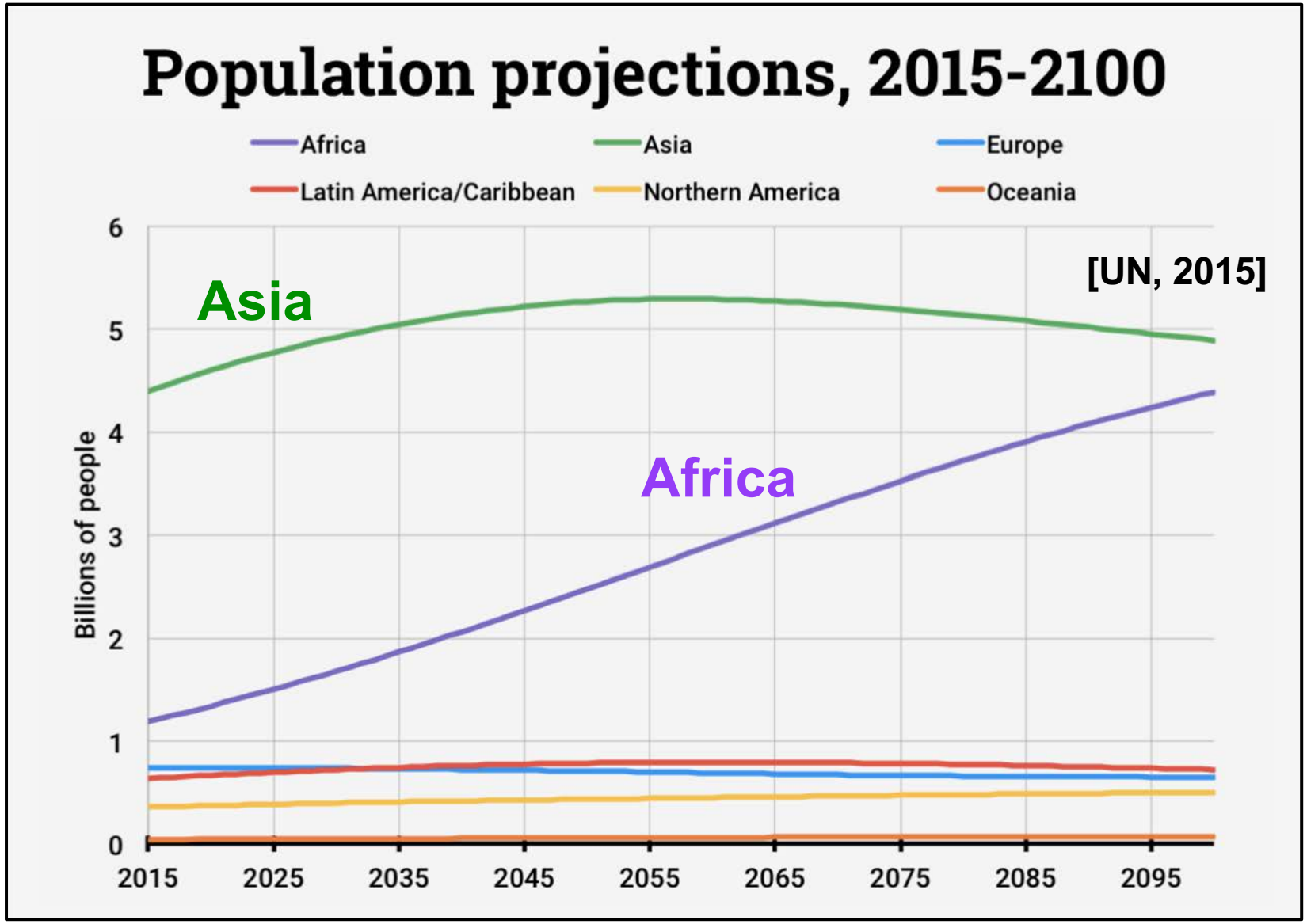


Eloise Marais
(http://maraisresearchgroup.co.uk/)

HEI Webinar
21 August 2019

UNIVERSITY OF LEICESTER

By 2100, Africa's population will rival that in Asia



Africa is the next frontier for development, so understanding pollution sources is imperative

Emission Inventory Development

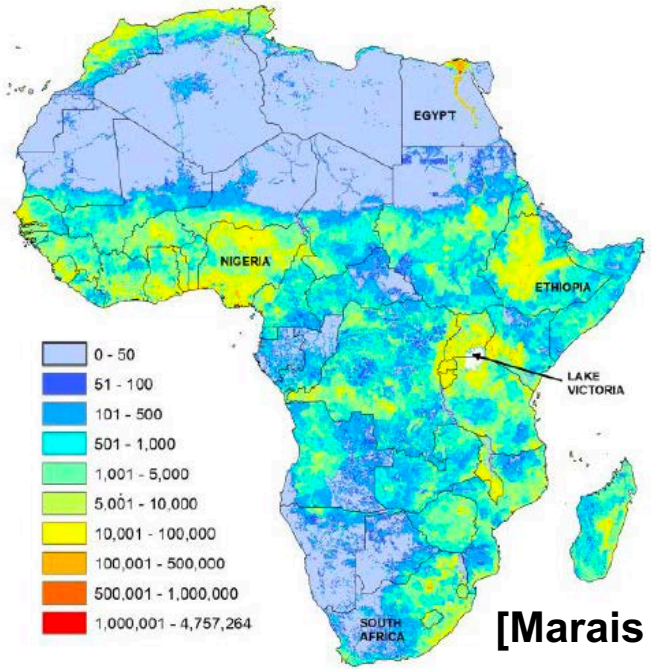
The approach is standard

(1) Estimate Emissions:

Emissions = Activity Factors × Emission Factors

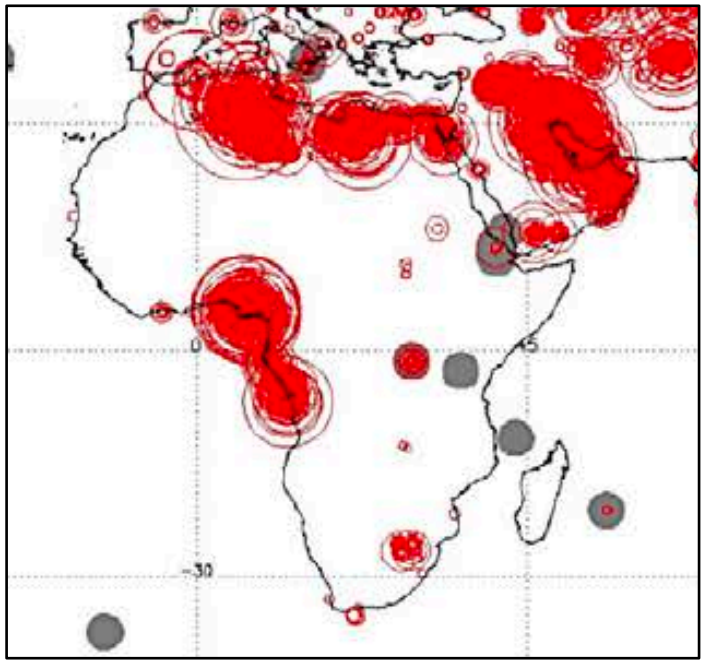
(2) Map Emissions:

Landscan population distribution



[Marais & Wiedinmyer, 2016]

Satellite observations of gas flares

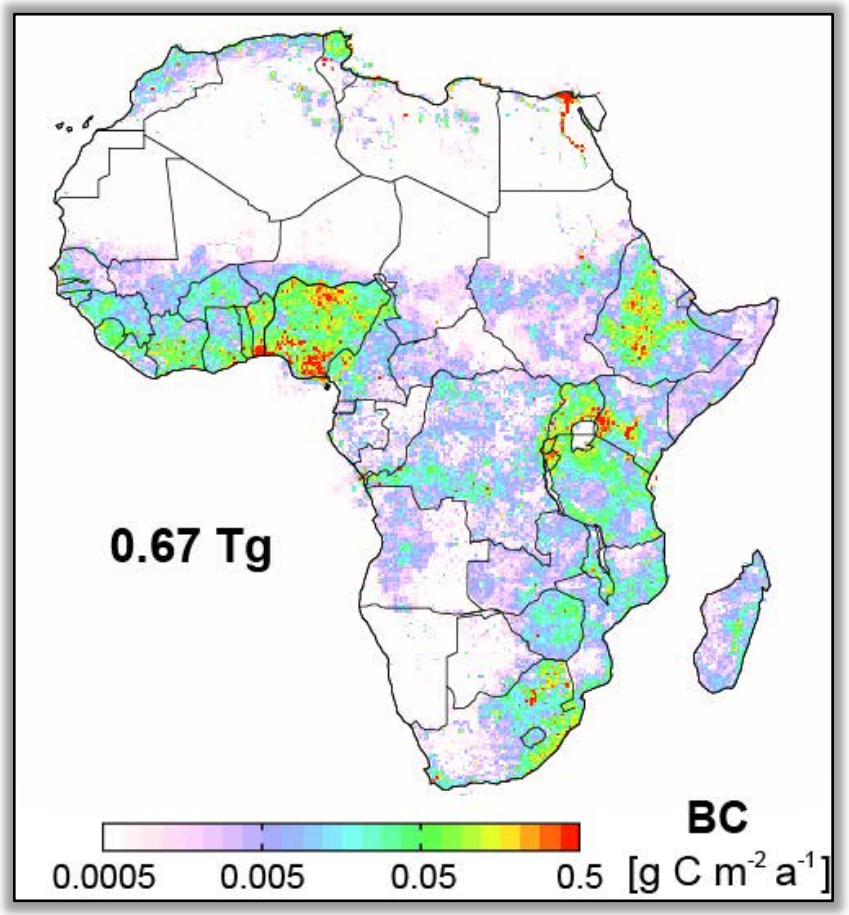


[Cassadio et al., 2012]

But there are Data Gaps and Uncertainty Challenges

Africa has a ubiquitous mix of inefficient pollution sources

Black Carbon

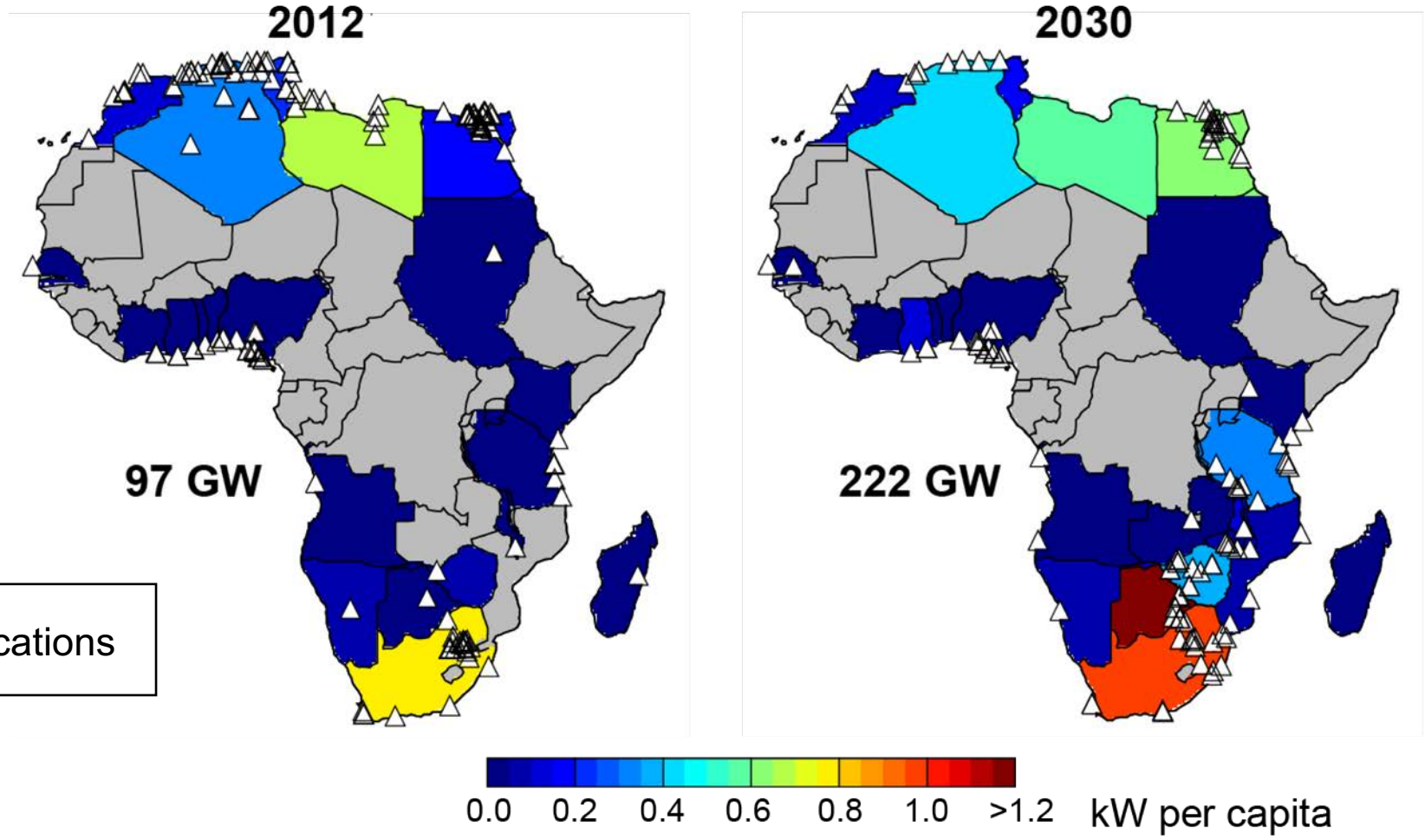


[Marais and Wiedinmyer, 2016]

Regional DICE-Africa inventory developed to address deficiencies in global inventories (available for download: http://maraisresearchgroup.co.uk/dice-africa-data.html)

Africa is in a unique position to avoid dependence on fossil fuels

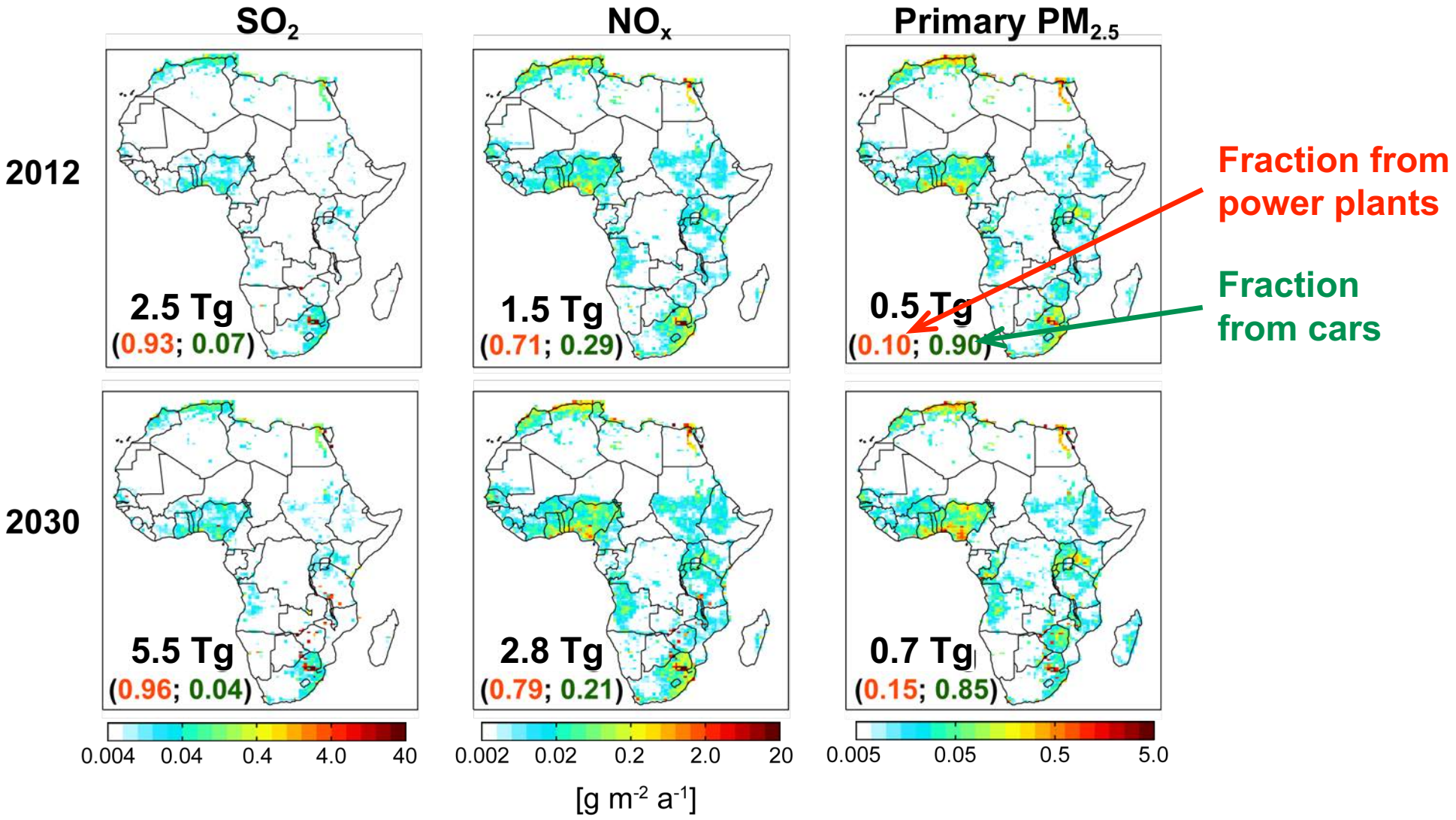
Already substantial investment in fossil fuels for energy and transport



Generating capacity increases by almost 130%, population by 54%

[Marais et al., *submitted*]

Emissions from power plants and road transport



Vehicle emissions from DICE-Africa for 2012 are scaled by population growth to obtain 2030 emissions

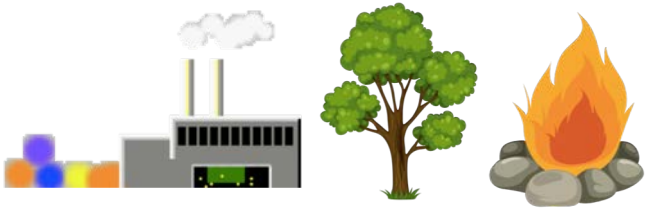
Emissions of SO_2 and NO_x double from 2012 to 2030

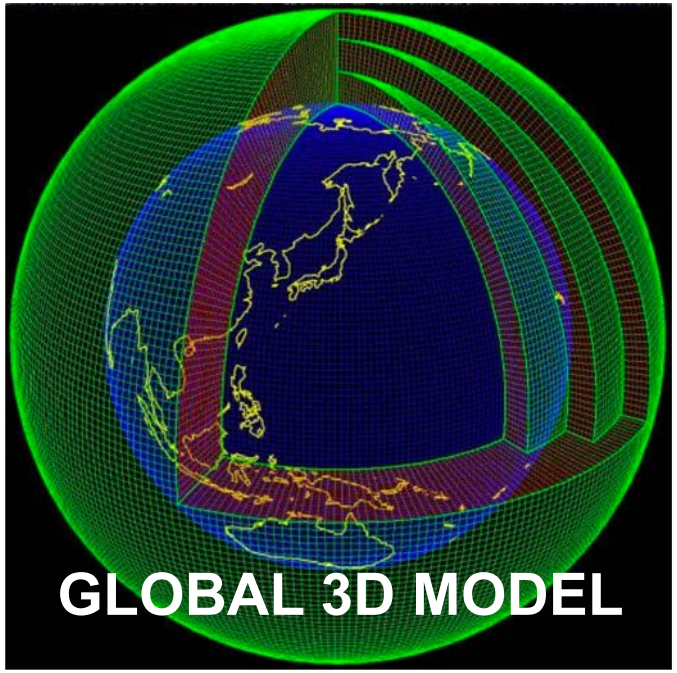
[Marais et al., *submitted*]

Inventory Application to a Chemical Transport Model

GEOS-Chem

Emissions (natural/human)





Offline assimilated meteorology (NASA GMAO)

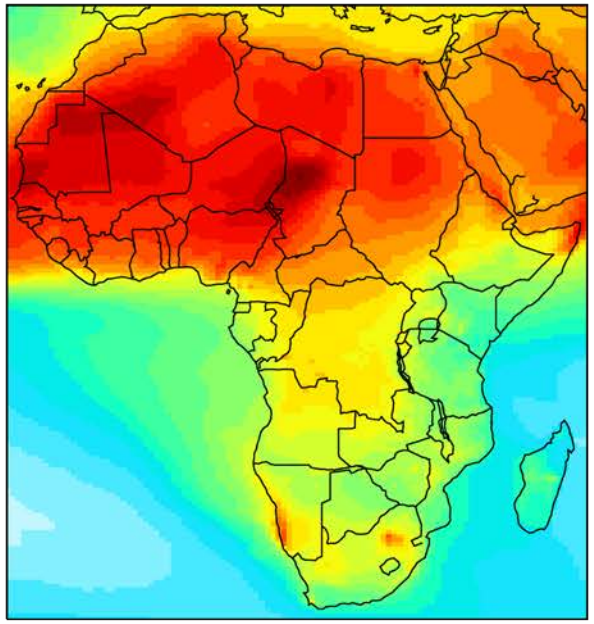
Chemistry
Transport
Dry/wet deposition

3D global/regional atmospheric concentrations

http://acmg.seas.harvard.edu/geos_chem.html

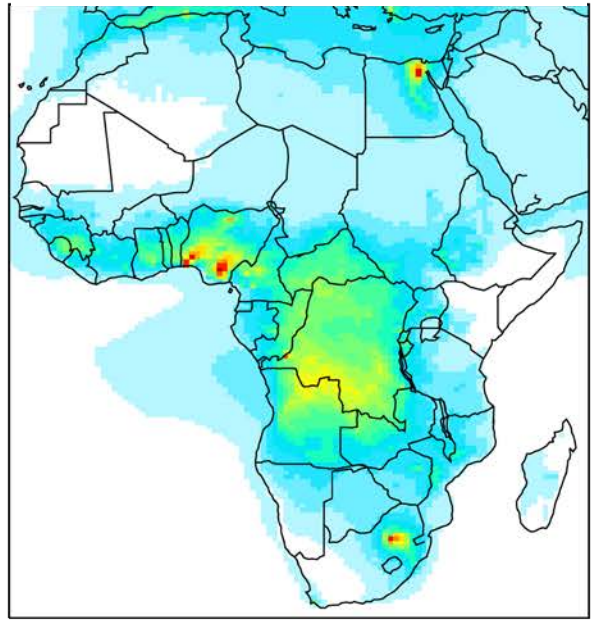
Impact on air quality (annual mean $PM_{2.5}$)

$PM_{2.5}$ in 2012
(all components)



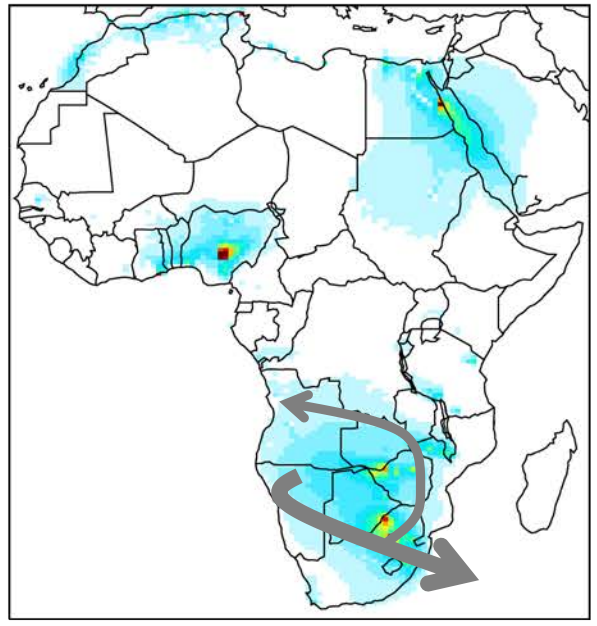
0.40 4.00 40.0 400 [μg m^{-3}]

$PM_{2.5}$ in 2012
(no dust or sea salt)



0 10 20 30 40 [μg m^{-3}]

2030 minus 2012 $PM_{2.5}$



0 2 4 6 8 [μg m^{-3}]
μg m^{-3}

Annual mean fine particle ($PM_{2.5}$) obtained from GEOS-Chem at high spatial resolution

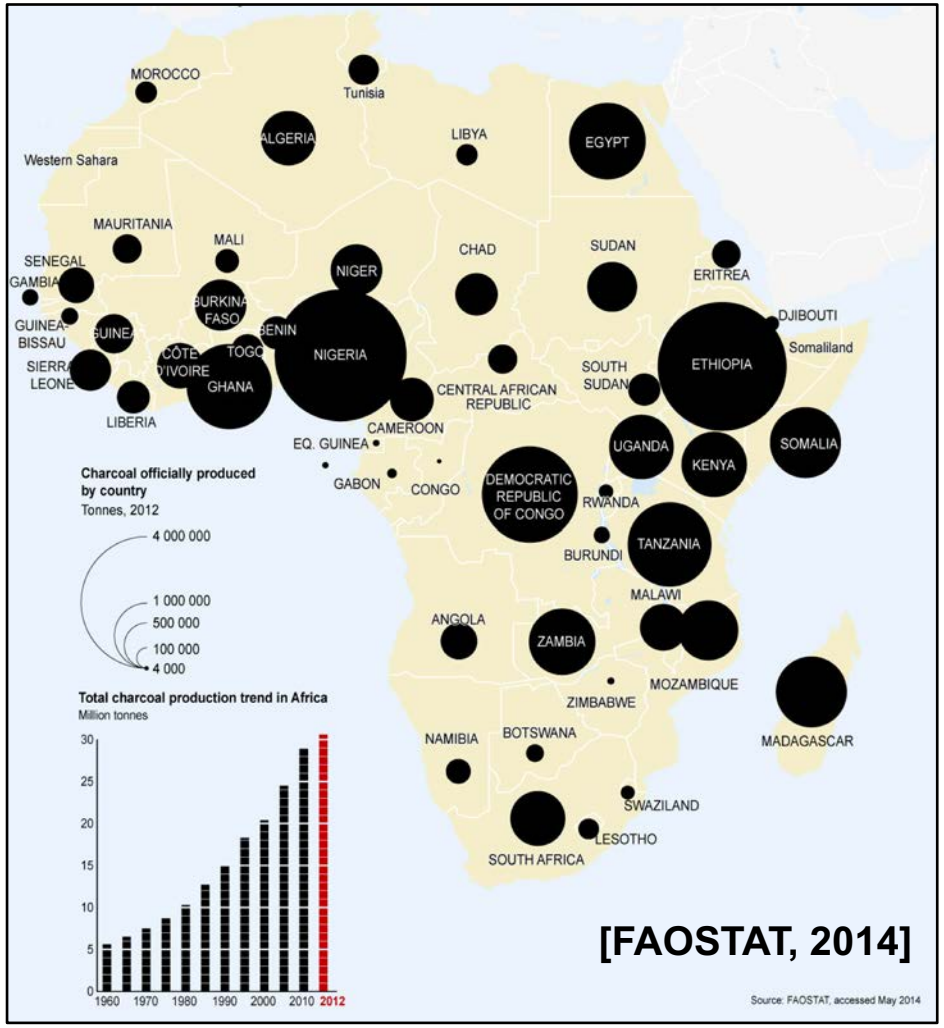
We use this to estimate that **48,000 premature deaths** likely from exposure to future fossil fuel $PM_{2.5}$

[Marais et al., *submitted*]

Impact of Charcoal Production on Air Quality and Climate

Large and dramatic increase in charcoal use, despite an increase in access to electricity

Charcoal Production in Africa



[FAOSTAT, 2014]

6-9% per year increase in production

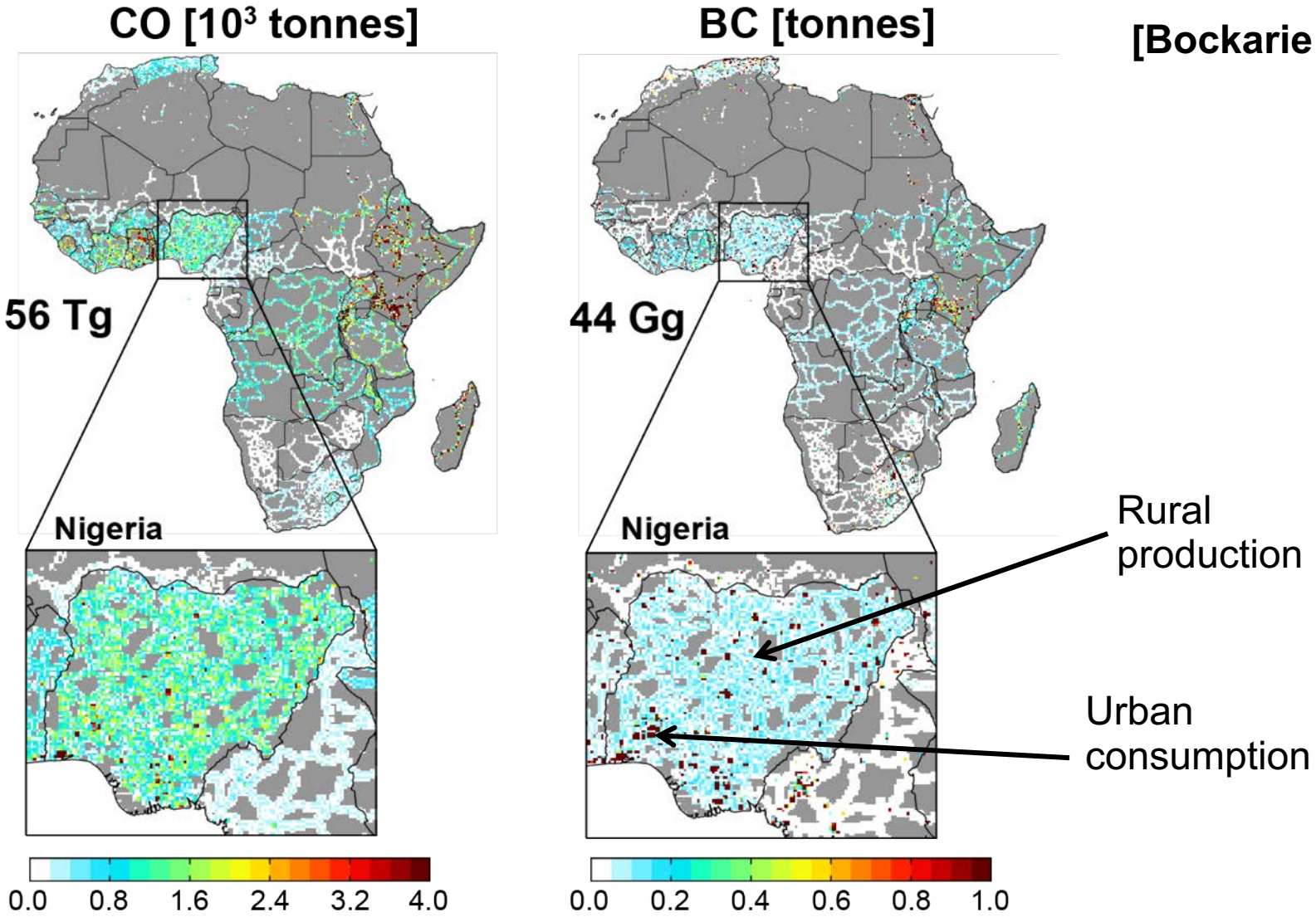
Major export in Somalia fueling civil unrest

Includes plastic burning to initiate combustion

[Bockarie et al., *in prep*]

Updated and improved inventory of charcoal emissions

Pollutant emissions from charcoal production, use and transport



[Bockarie et al., *in prep*]

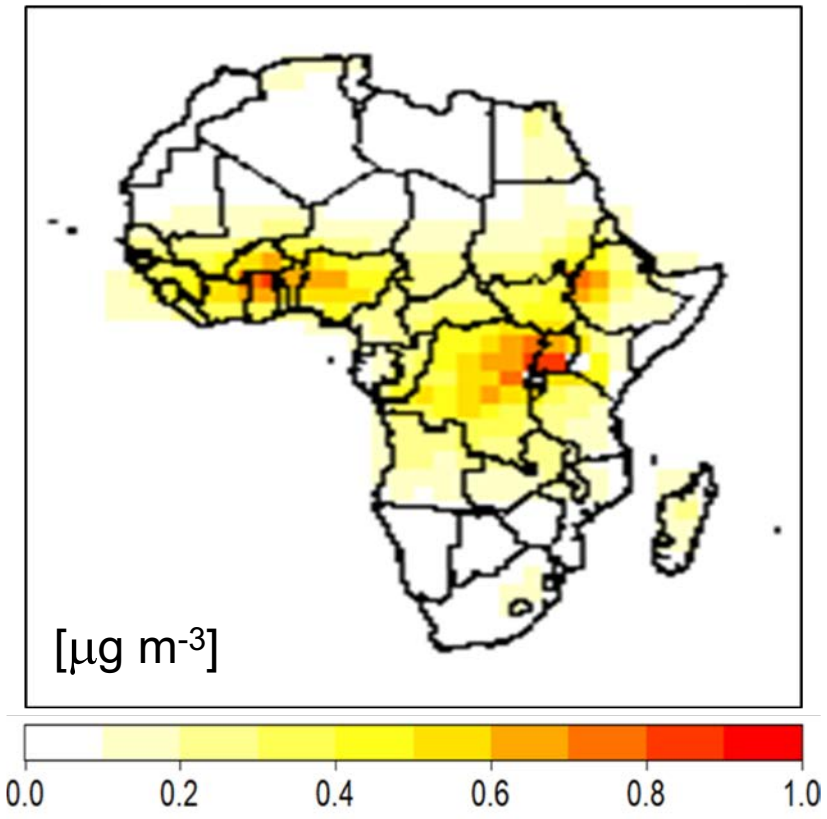
Rural production nearby roads, transport on densely packed diesel trucks, use in urban centres

Impact of charcoal supply chain on local air quality

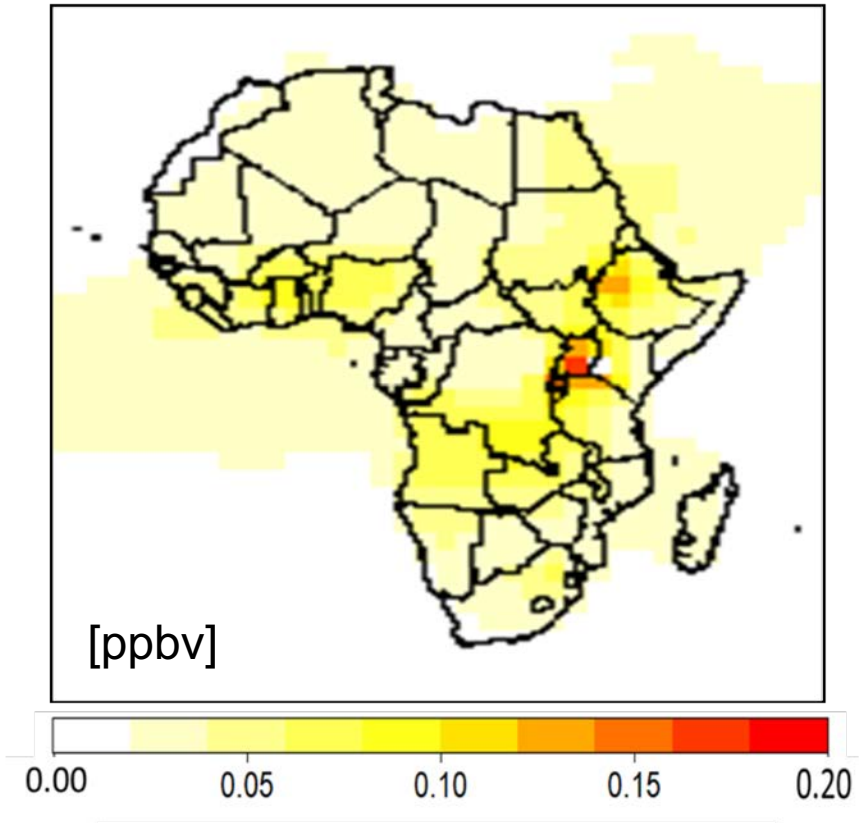
Charcoal contribution to surface concentrations of fine particles ($PM_{2.5}$) and ozone

Maps show difference in GEOS-Chem with and without charcoal emissions

Annual mean $PM_{2.5}$



Annual mean ozone

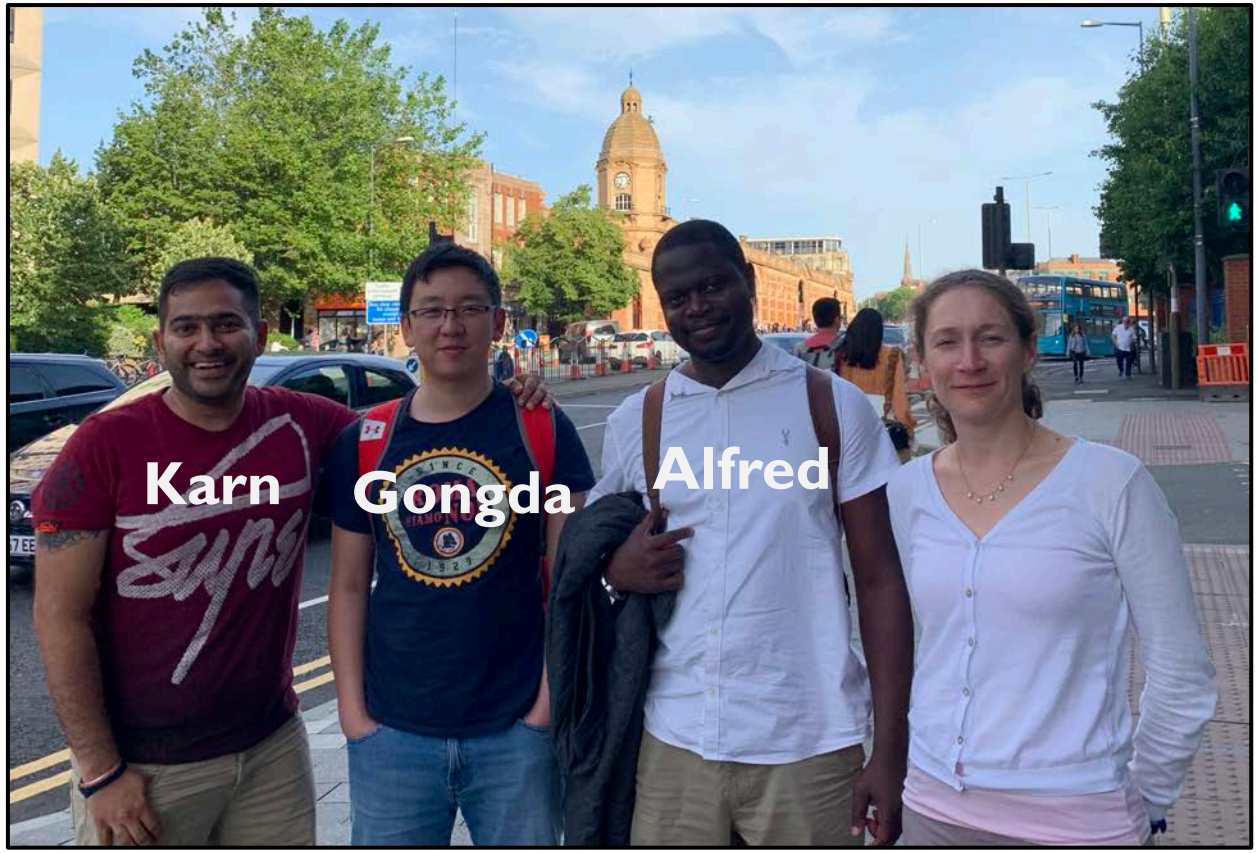


Up to 1 μg m^{-3} contribution to $PM_{2.5}$. Smaller impact on surface ozone. Preliminary results suggest the impact on regional radiative forcing may be large.

[Bockarie et al., *in prep*]

Acknowledgements

Research Group



Collaborators and Contributors

NCAR
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Funding Agencies

NERC
SCIENCE OF THE ENVIRONMENT

EPSRC
Engineering and Physical Sciences Research Council

Funding Opportunities

Newton International Fellowships: https://royalsociety.org/grants-schemes-awards/grants/newton-international/

Marie Curie Individual Fellowships: https://ec.europa.eu/research/mariecurieactions/node_en

Schlumberger Faculty for the Future: https://www.facultyforthefuture.net/

Conference travel grants (e.g. EGU, AGU, IGAC)

Resources

UN Data Portal: http://data.un.org/Explorer.aspx

DICE-Africa emissions: http://maraisresearchgroup.co.uk/dice-africa-data.html

GEOS-Chem: http://acmg.seas.harvard.edu/geos_chem.html

GEOS-Chem output over Africa: http://maraisresearchgroup.co.uk/gcpm25_af.html (coming soon!)