

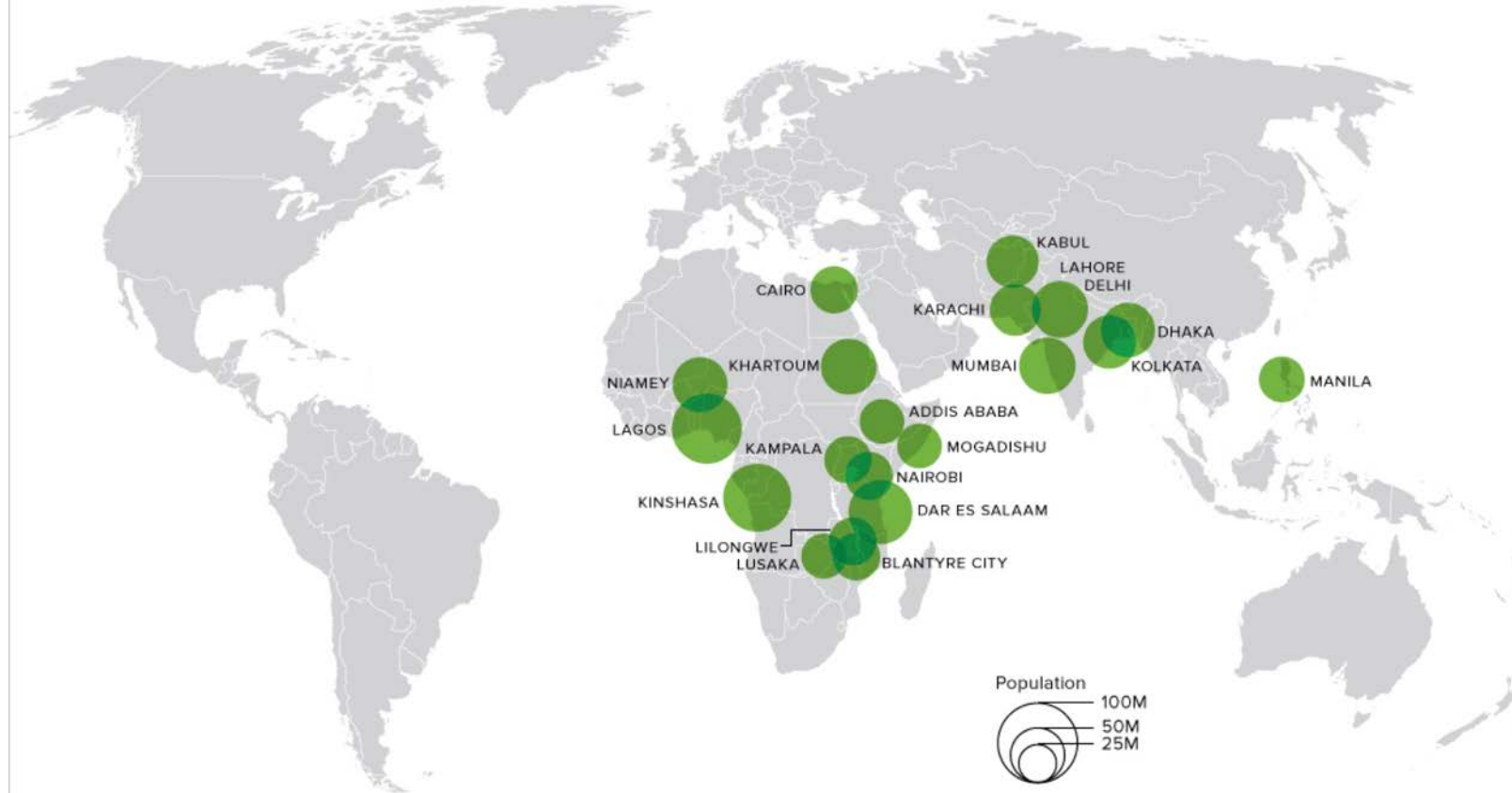


# Challenges and Opportunities Monitoring Air Quality in Africa using Satellite Observations

## THE WORLD'S 20 MOST POPULOUS MEGACITIES (2010 - 2100)

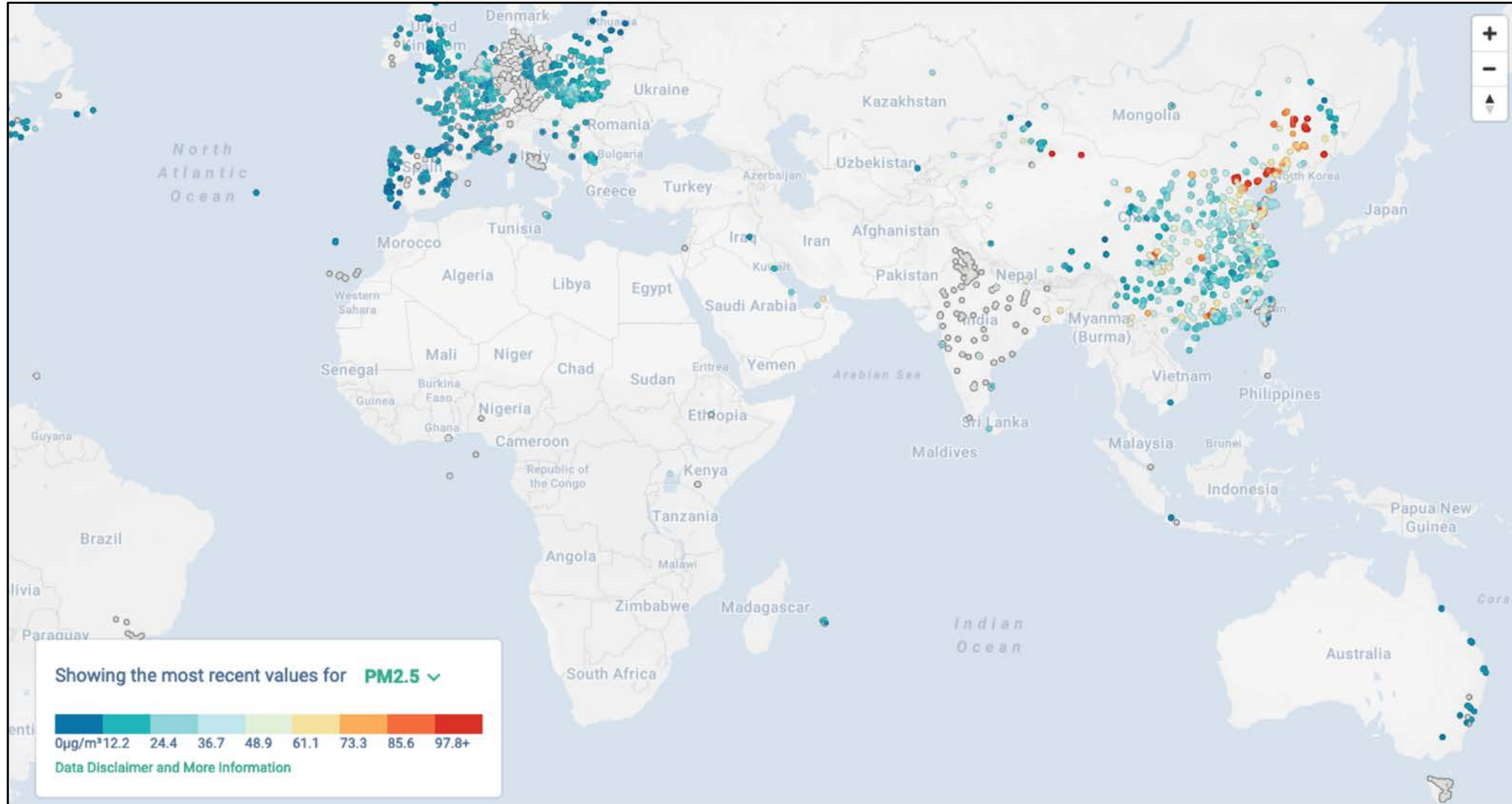
A total of 13 African cities will surpass New York in size over the next 80 years

### 2100 TOP 20 CITIES BY POPULATION



# Severely Limited Surface Measurements

## Distribution of PM<sub>2.5</sub> monitors from openaq.org



[OpenAQ, Accessed 19 March 2019]

# What Role can Satellite Observations Play?

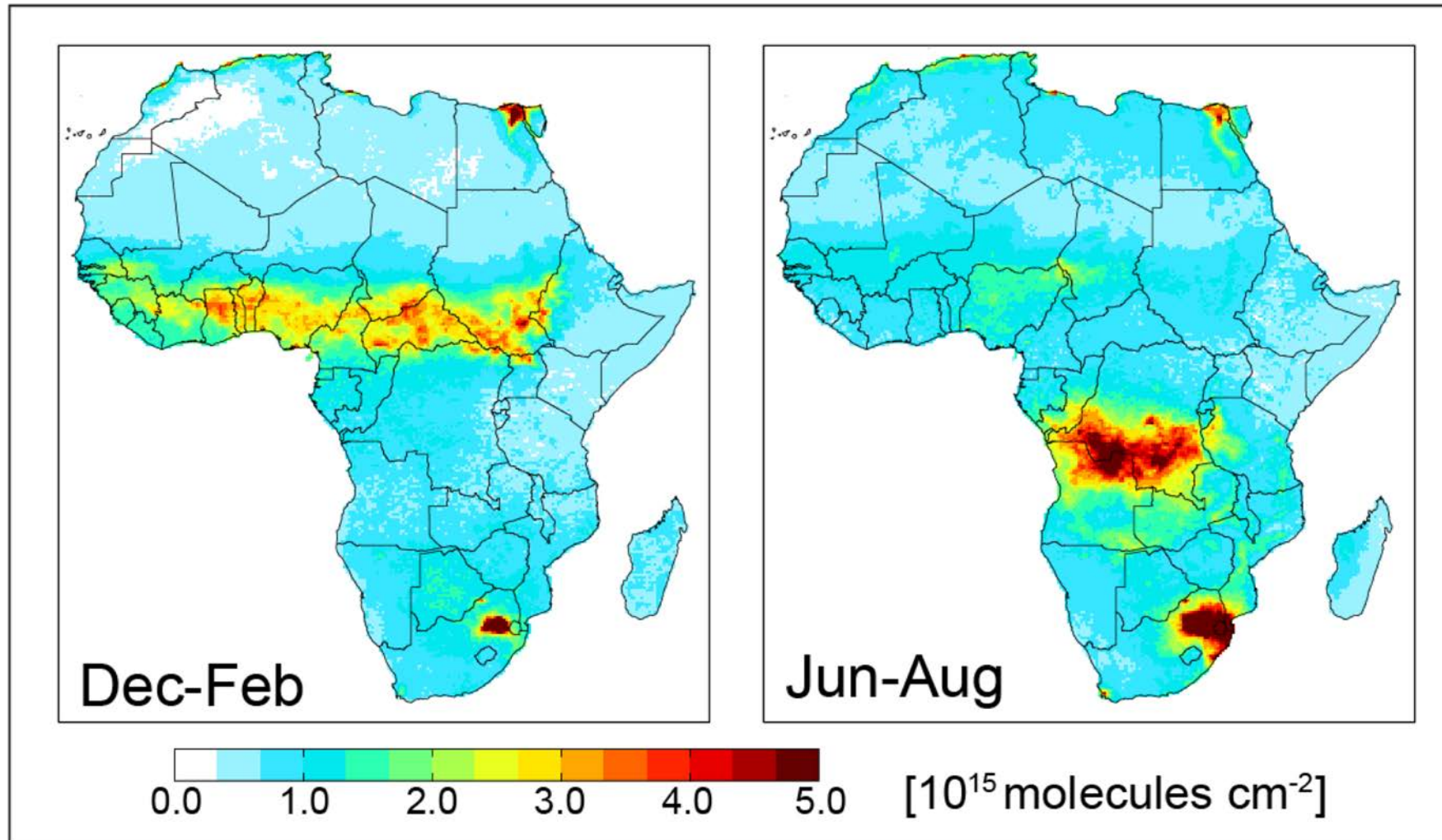


Launch	2004	2017
Overpass	13h30 LT	13h30 LT
Compounds	NO <sub>2</sub> , O <sub>3</sub> , HCHO, SO <sub>2</sub> CHOCHO, AI, AOD	Same as OMI + CH <sub>4</sub> and CO
Resolution	13 km × 24 km	7 km × 3.5 km

Assess long-term changes (**OMI**) and spatial variability (**TROPOMI**) of air pollution in megacities

# Air Pollution in Africa

Seasonal mean tropospheric NO<sub>2</sub> column densities for 2006-2007 dominated by open fires



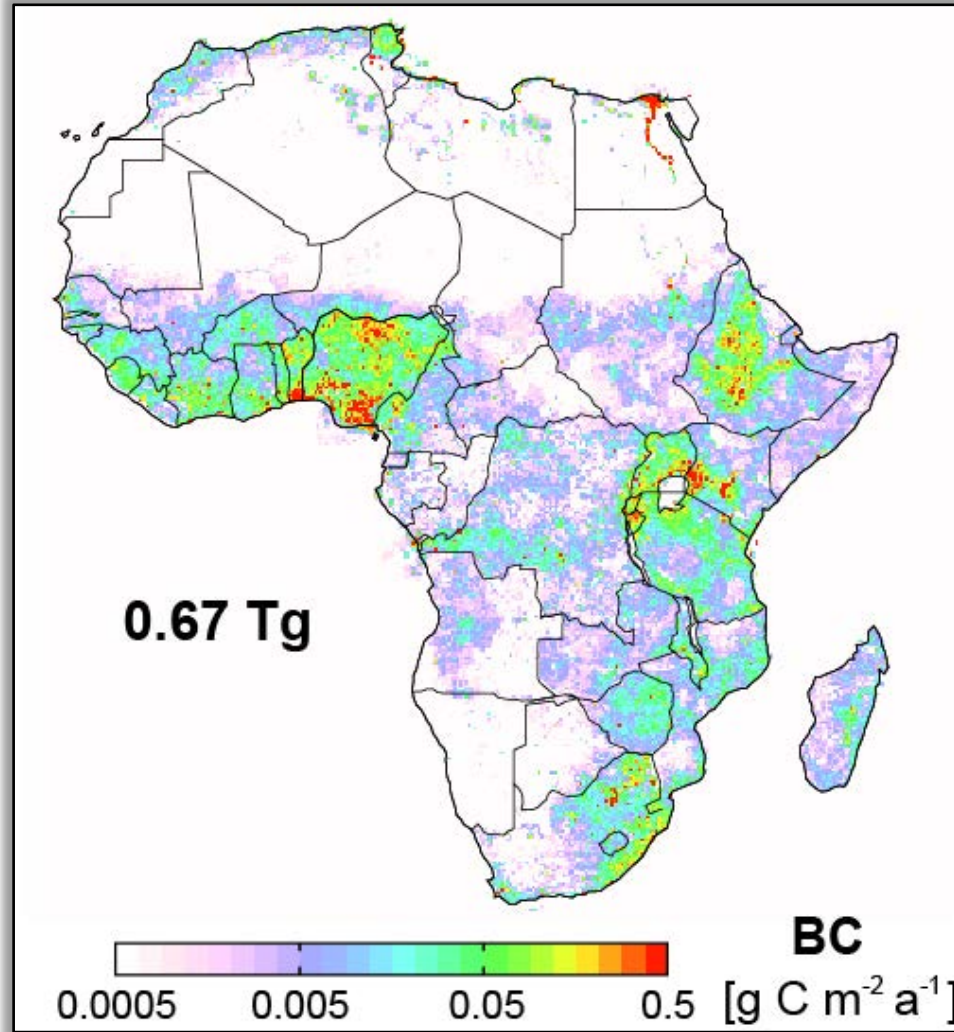
[Adapted from Marais and Chance, 2015]

Anthropogenic sources mostly **diffuse, inefficient combustion**



# Diffuse and Inefficient Combustion Emissions (DICE-Africa)

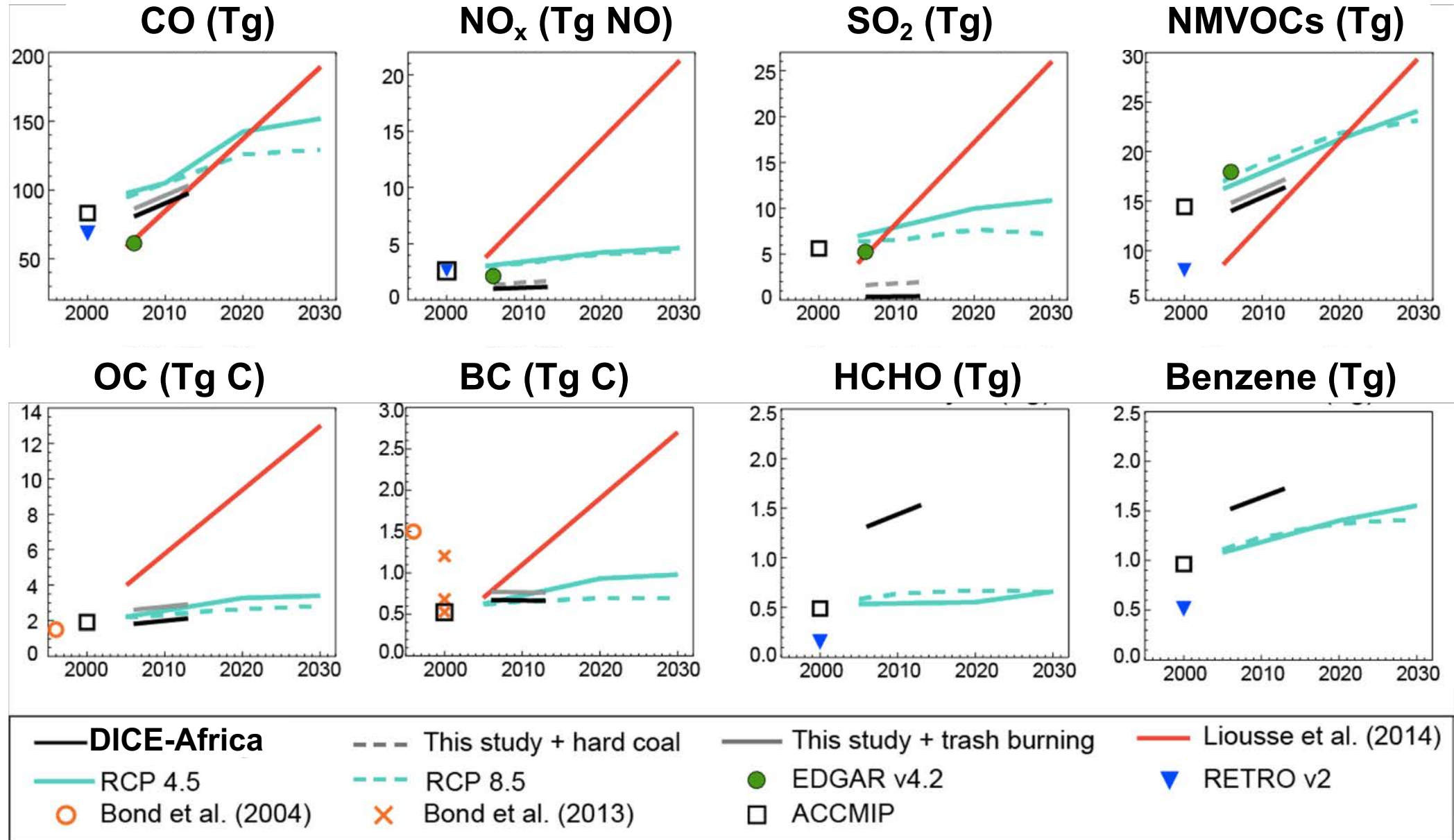
## Black Carbon



[Marais and Wiedinmyer, 2016]

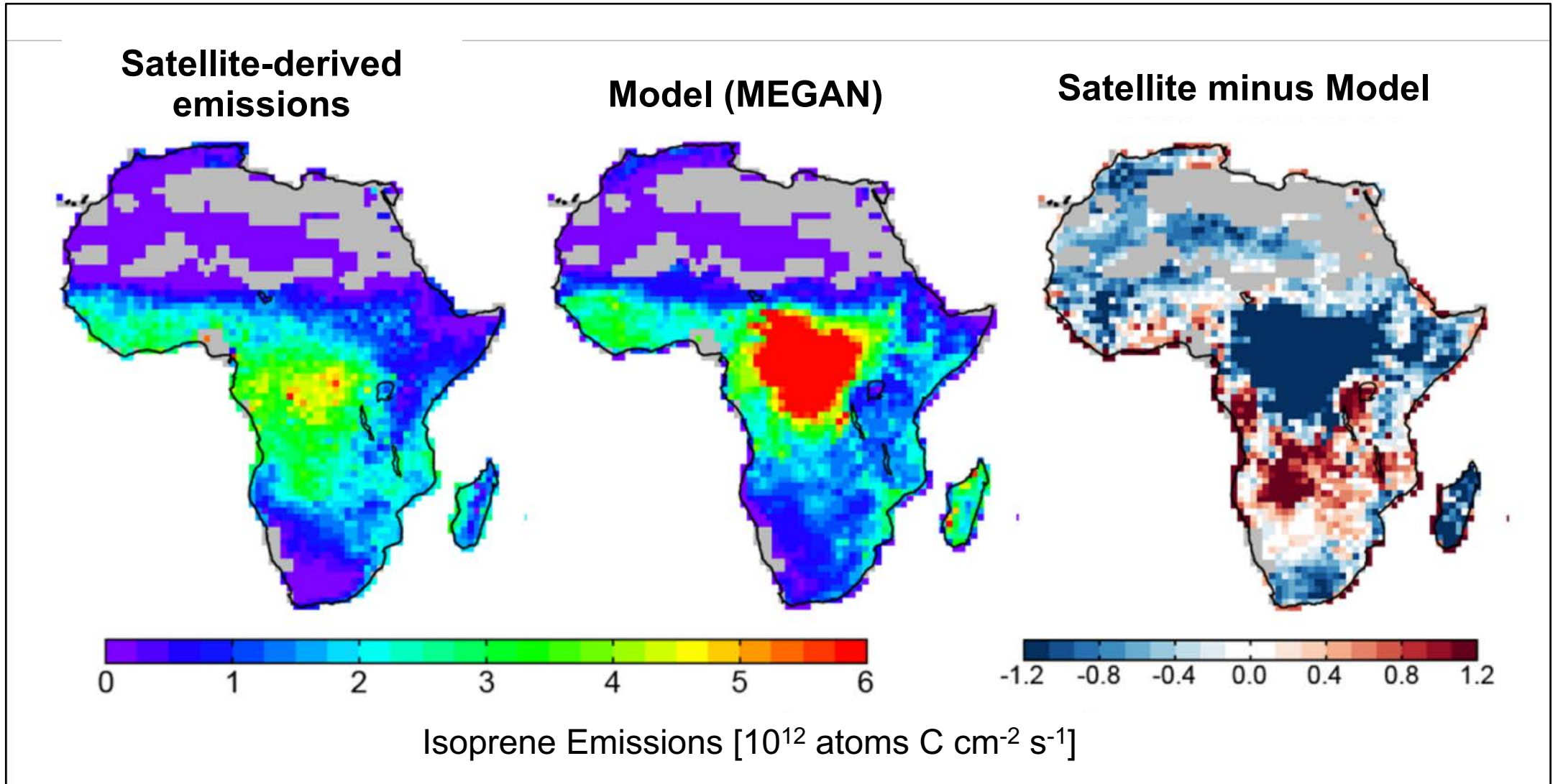
DICE and open fire emissions similar for many pollutants

# Assess Wildly Different Emission Estimates



# Improve Estimates of Natural Emissions

Identify and address glaring inadequacies in state-of-science inventories



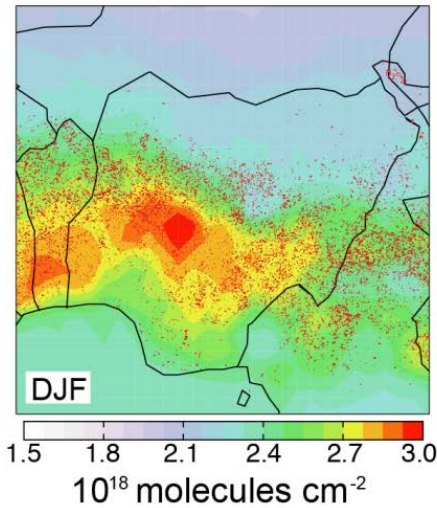


# Identify and Characterize Pollution Sources

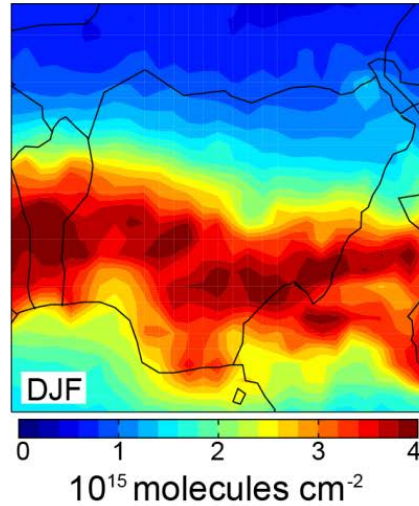
Sources in Nigeria leading to severe ozone pollution in the dry season

## Seasonal Open Fires

CO + fires

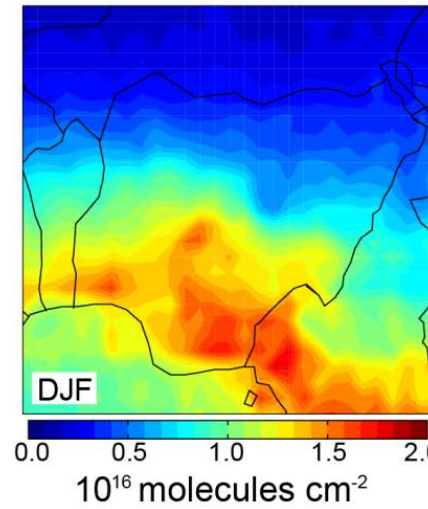


NO<sub>2</sub>

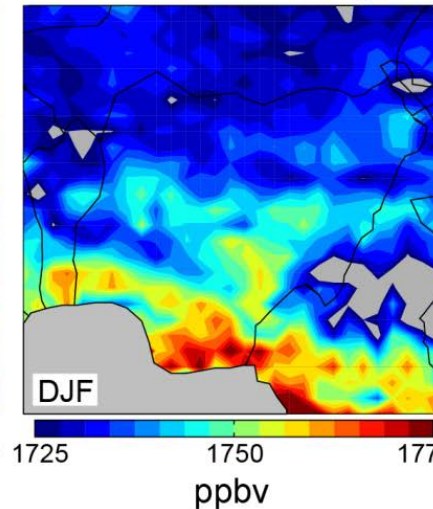


## Anthropogenic Volatile Organic Compounds

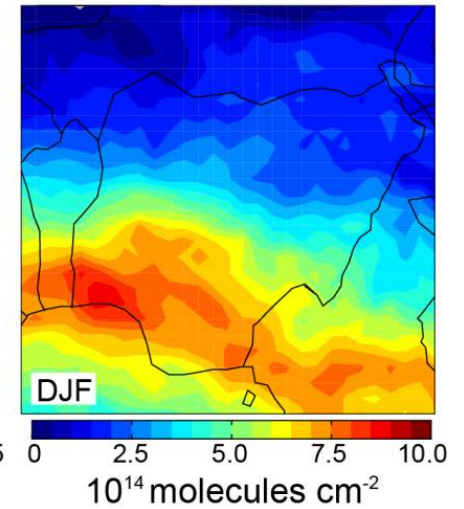
HCHO



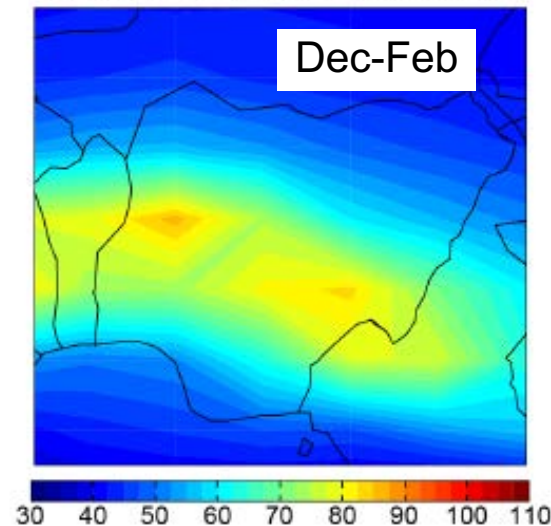
Methane (CH<sub>4</sub>)



Glyoxal



**Seasonal average  
MDA8 ozone [ppbv] from  
GEOS-Chem:**



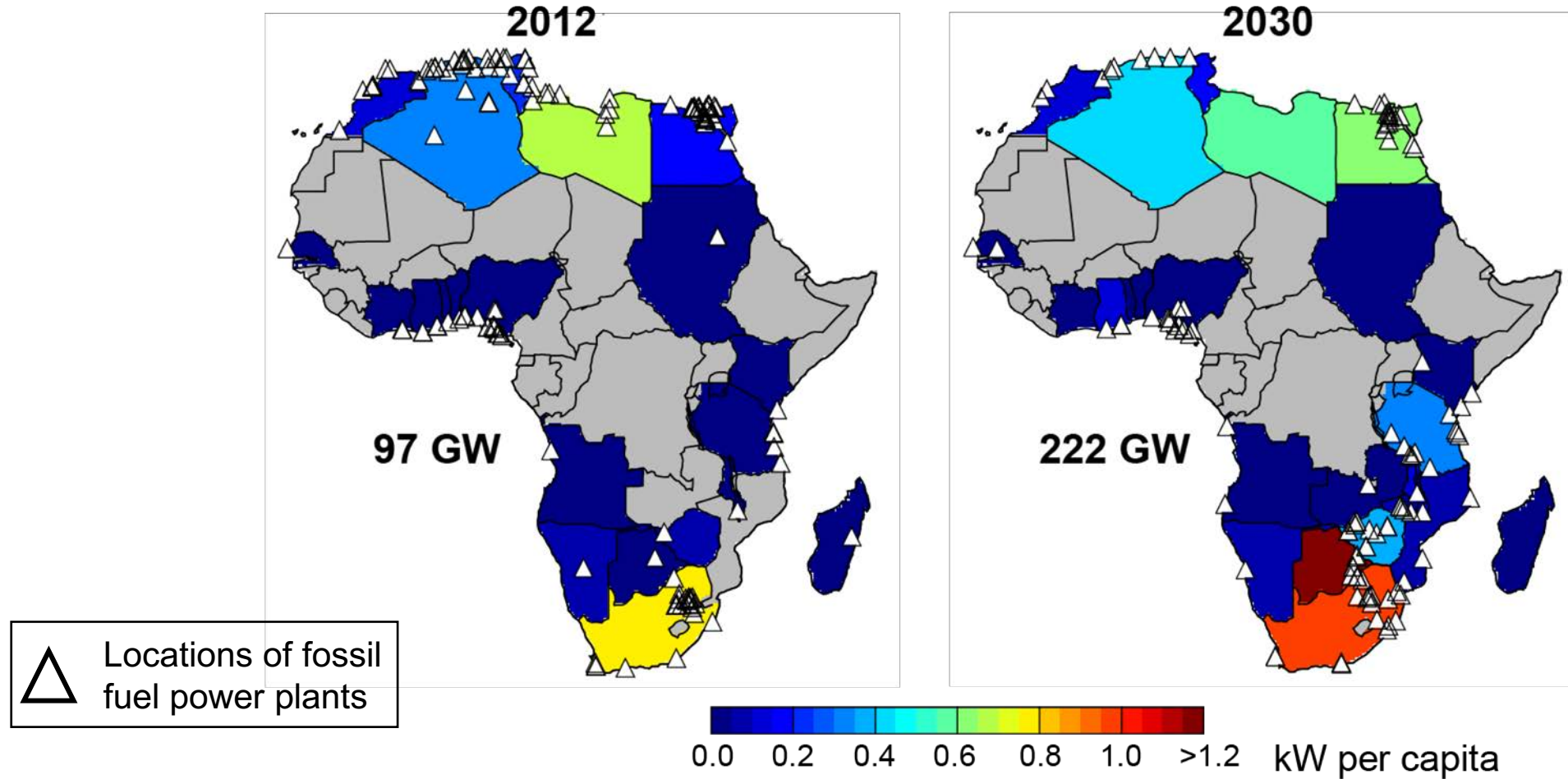
Rapid development without emission controls will further degrade air quality in Nigeria.

[Marais et al., 2014]



# Future Fossil Fuels in Africa

Total and per capita generating capacity from fossil fuels

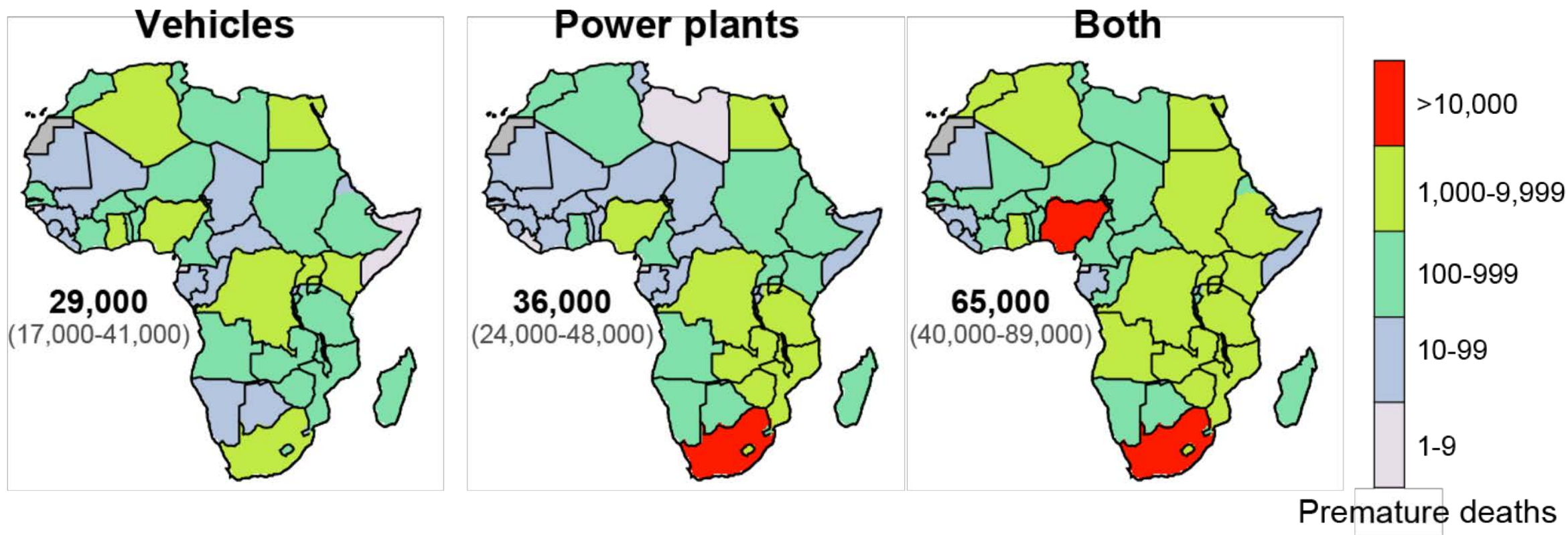


Generating capacity to increase by almost 130% (mostly North and southern Africa)

[Marais et al., *in prep*, 2019]

# Impact of Future Fossil Fuels on Health

Deaths attributable to exposure to PM<sub>2.5</sub> from future fossil fuel use



Total avoidable premature deaths in Africa from exposure to fossil fuel PM<sub>2.5</sub>: **65,000**

[Marais et al., *in prep*, 2019]

# Confirm New Pollution Hotspots

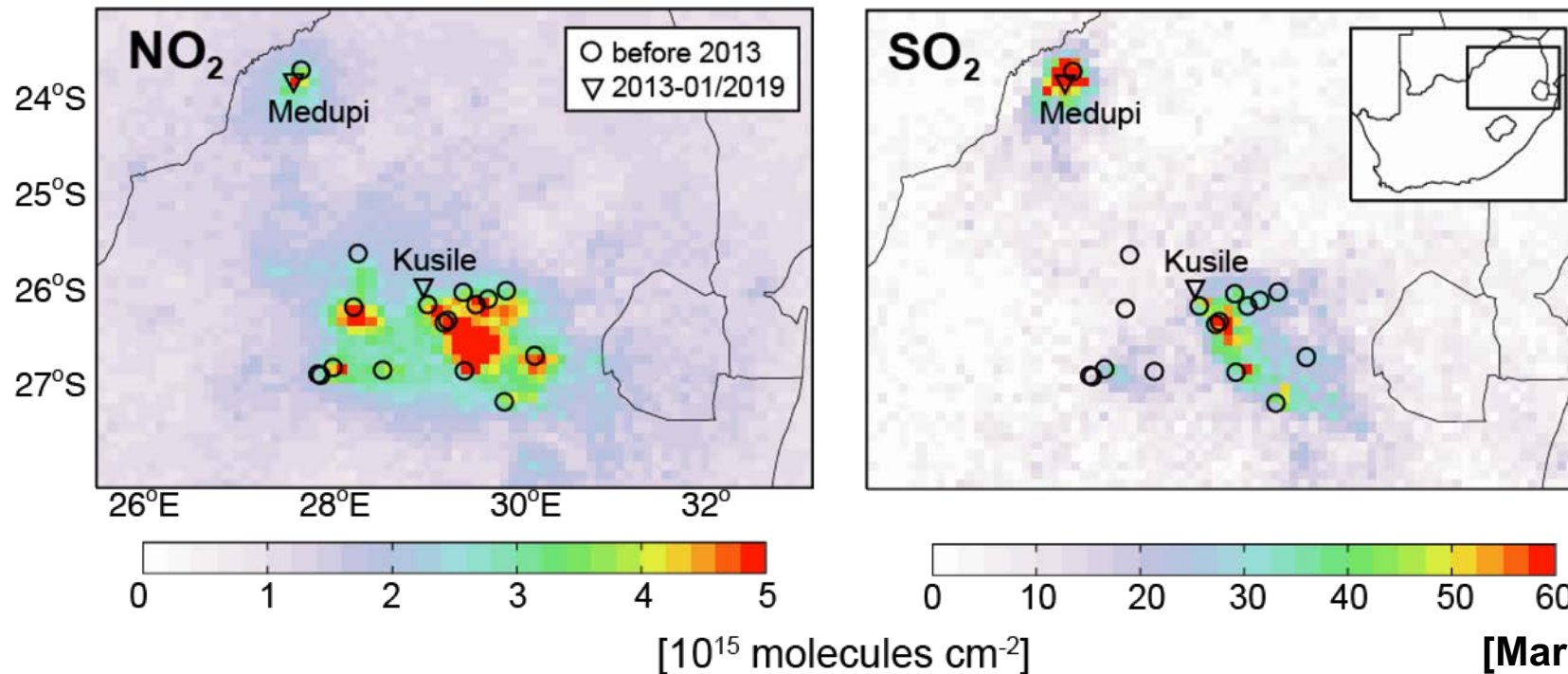


## Medupi:

Largest dry-cooled power plant in the world

**Annual emissions:** 310 Gg SO<sub>2</sub>  
59 Gg NO<sub>x</sub>

TROPOMI NO<sub>2</sub> and SO<sub>2</sub> enhancements over Medupi

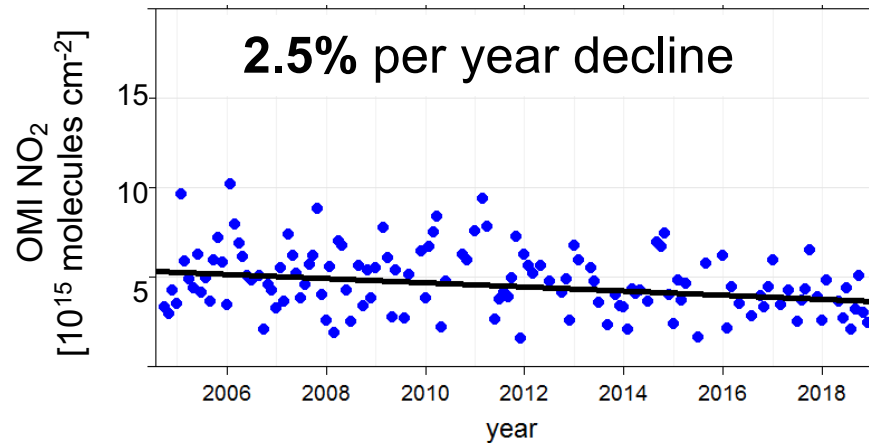


[Marais et al., *in prep*, 2019]

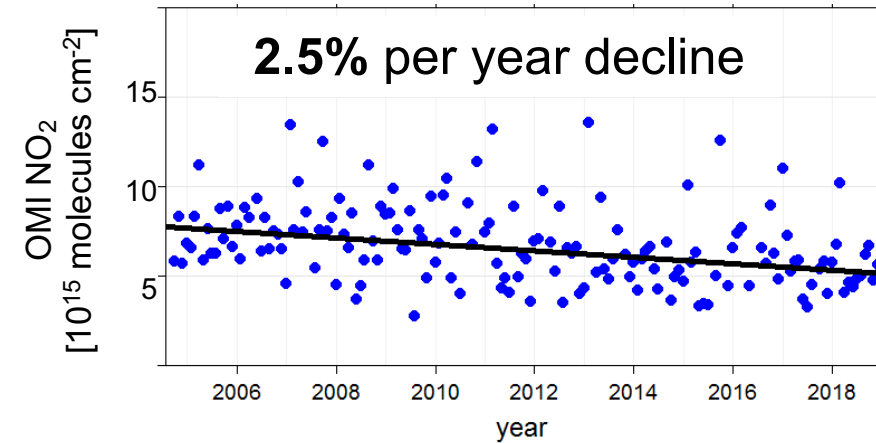


# Assess Changes in Air Quality in Cities

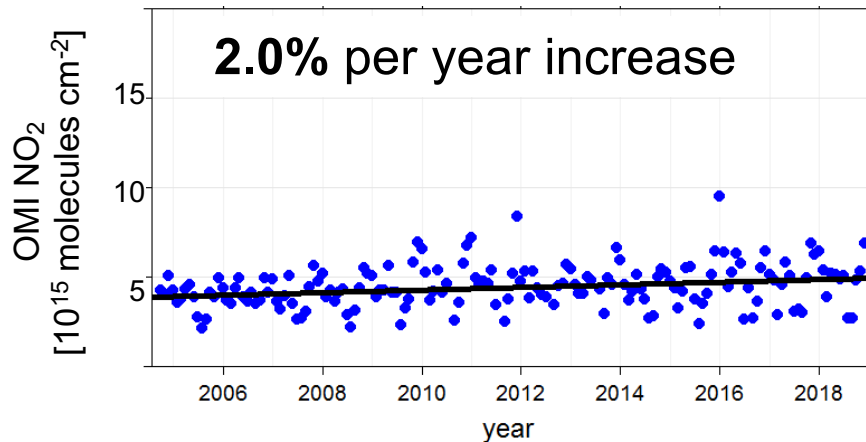
Birmingham (2005-2018)



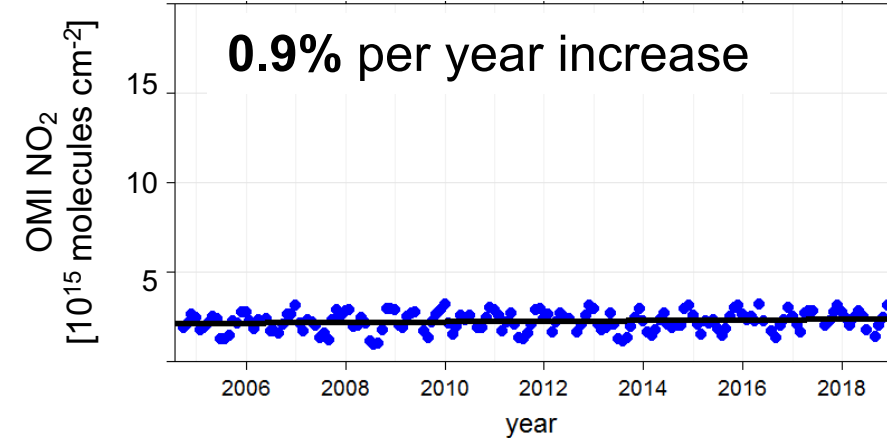
London (2005-2018)



Delhi (2005-2018)



Kanpur (2005-2018)



Now in a position to apply these algorithms to Kinshasa, Lagos, Dar es Salaam, Khartoum, Nairobi

# Acknowledgements

## Graduate Students



## Collaborators



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Research Council

