Air Quality and Climate Impact of Charcoal Use in Africa

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Charcoal supply chain

Kilns combustion efficiency < 20%

Large source of CO, NMVOCs, OC, CH_4

Production in rural areas

Unregulated and outdated diesel trucks.

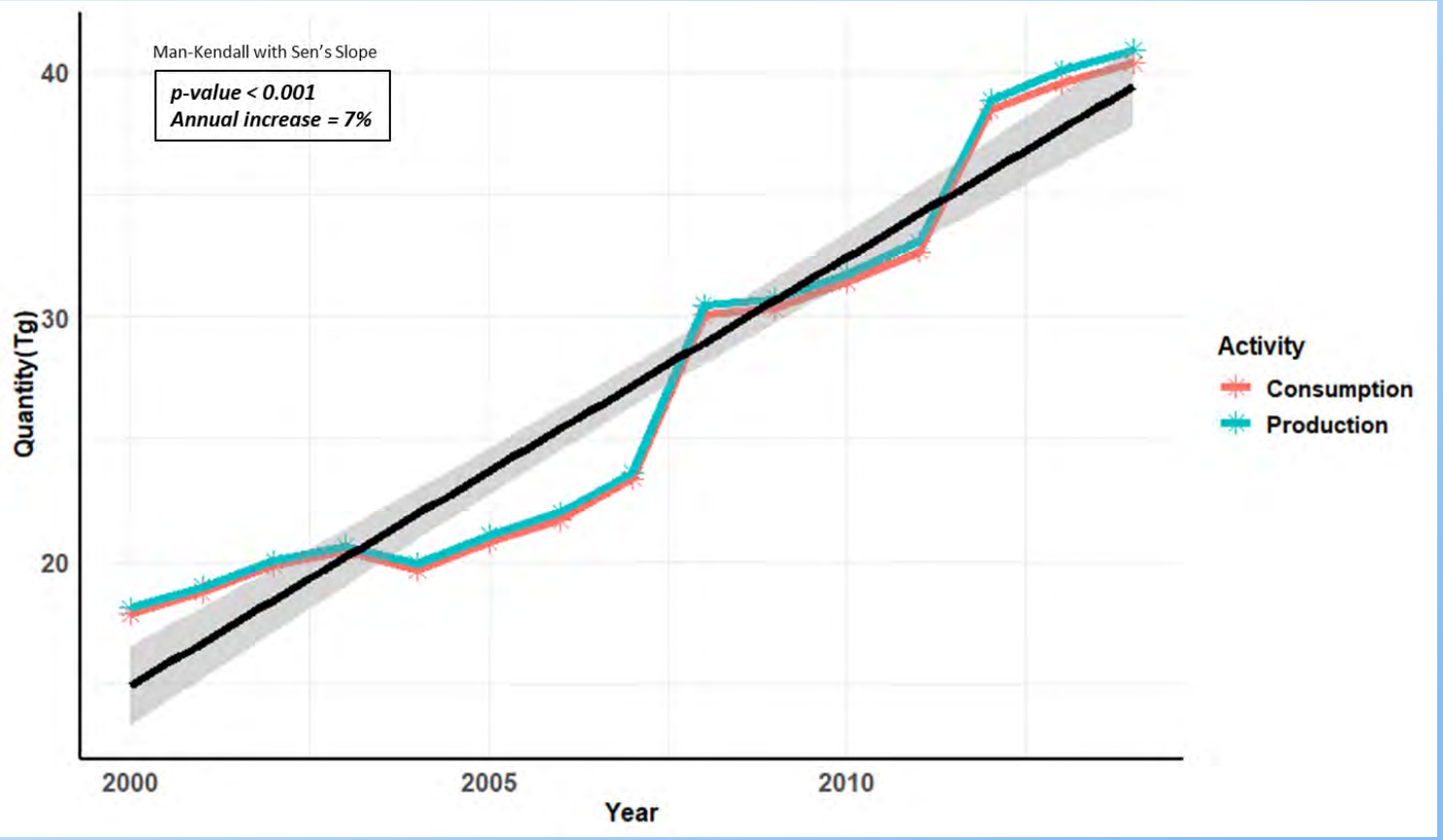
Rural to urban transport

Large source of NO_x and BC

Includes burning of plastic to initiate combustion. Prevalent in slums. Source of HCl

Use in densely populated urban centres

Charcoal Production and Use Trends in Africa (2000 – 2014)



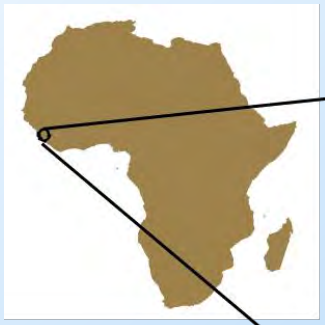
YEAR	CHARCOAL PRODUCTION [Tg]
2014	41.7
2030	82.7

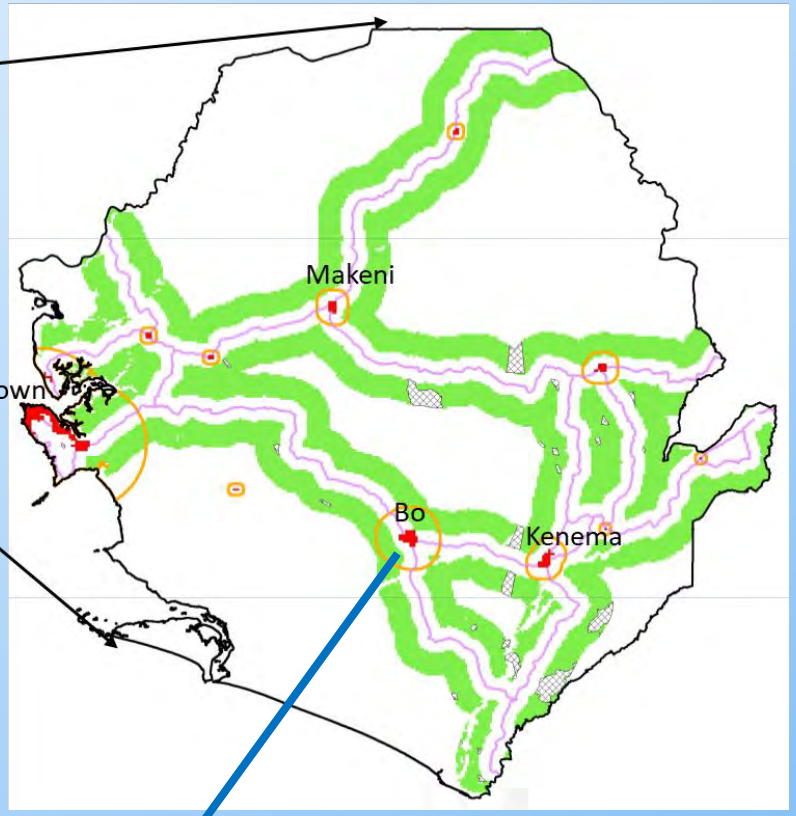
Data source: United Nations energy statistics database (UN, 2017)

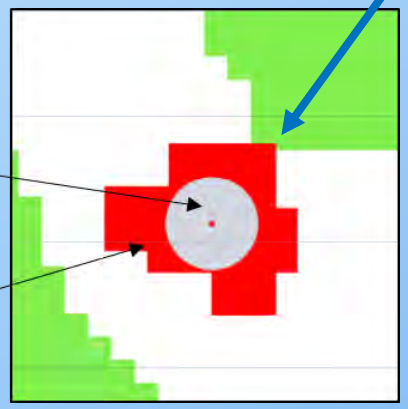
Developing emission inventory

Emission = Activity Data x Emission Factor

Mapping emission activity locations







National Boundary
Consumption
Main Road
Truck Zone
Protected Area
Charcoal Vegetation

Production :
5-15 km from main roads.

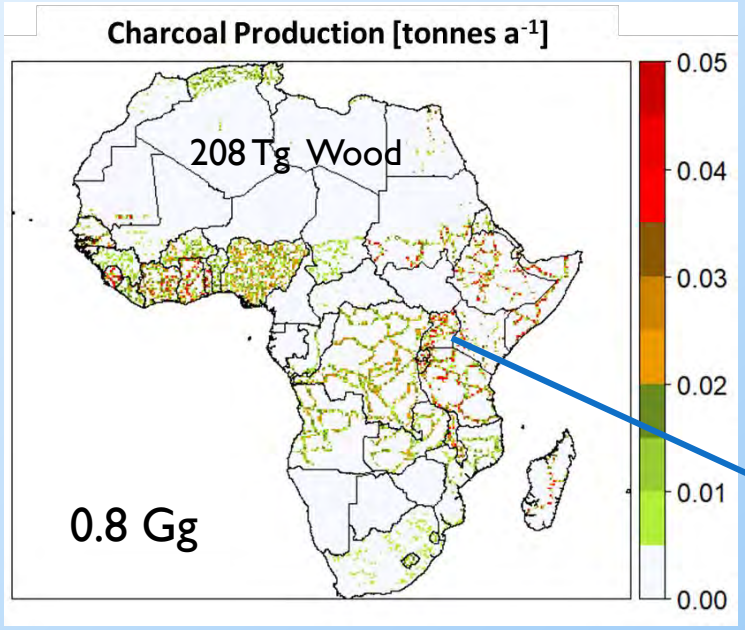
Consumption:
Urban extent determined using road network data

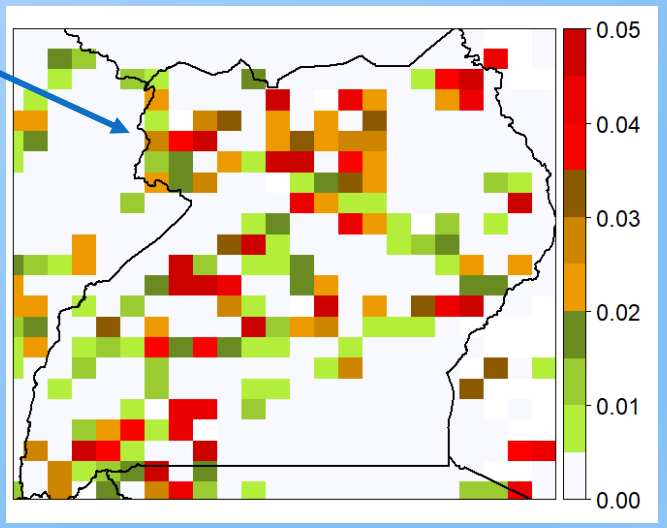
Plastic burning limited to slums.

Trucks:
Mapped around urban centres proportional to population

Spatial distribution of pollutants from the charcoal value chain in 2014

Emission of Black Carbon





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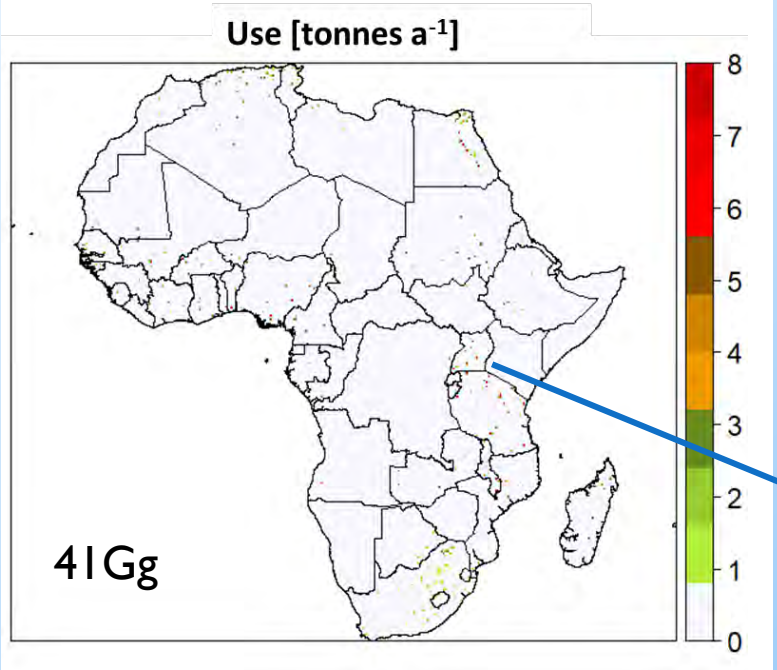

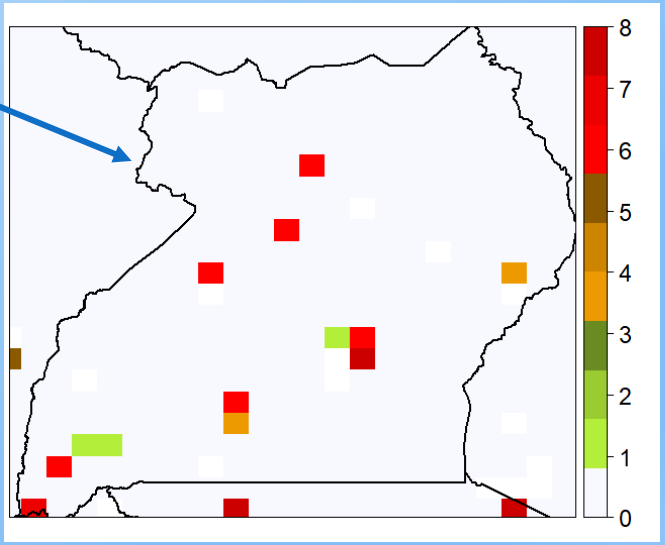

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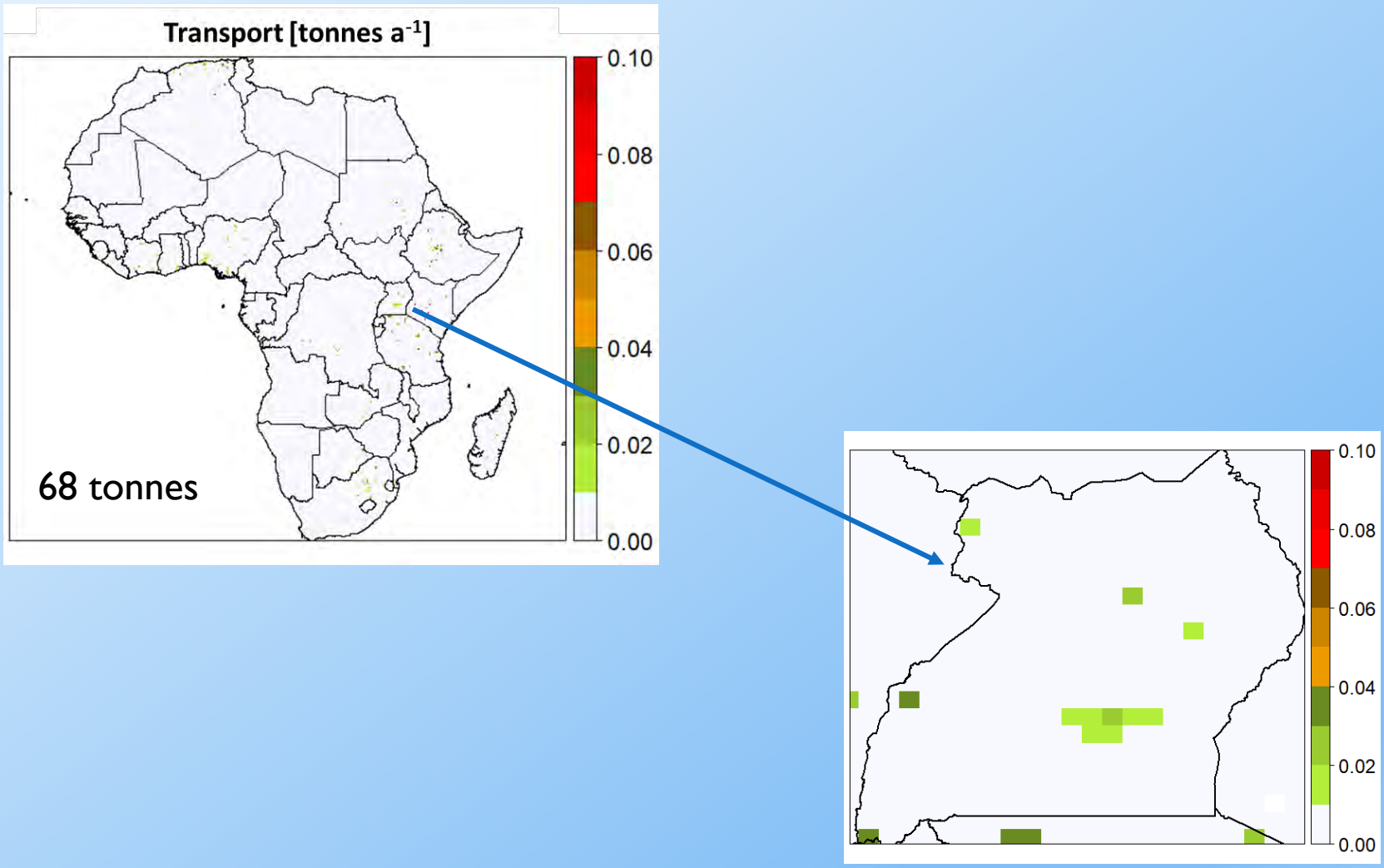
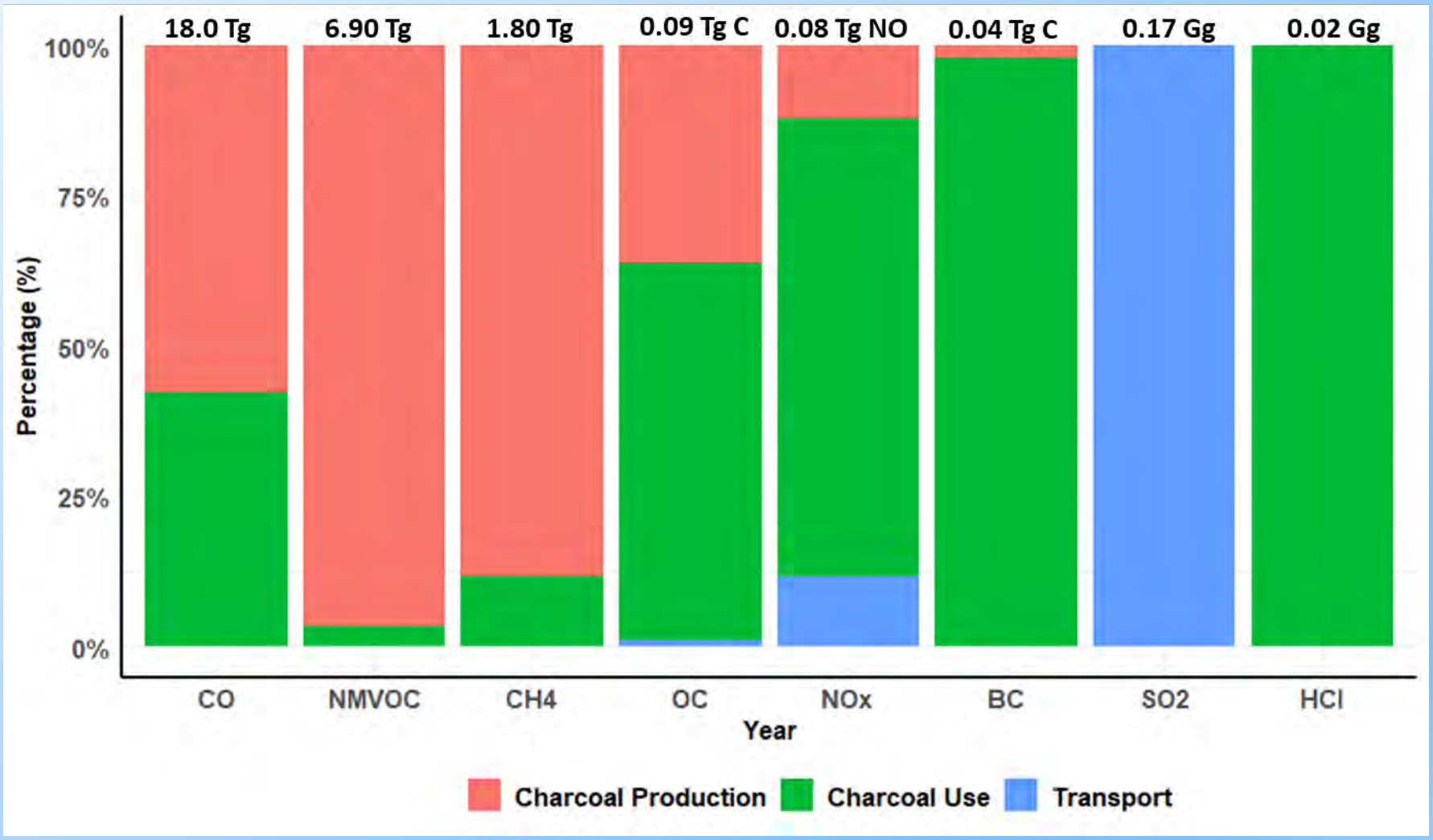


Contribution of the charcoal activity to pollutant emission

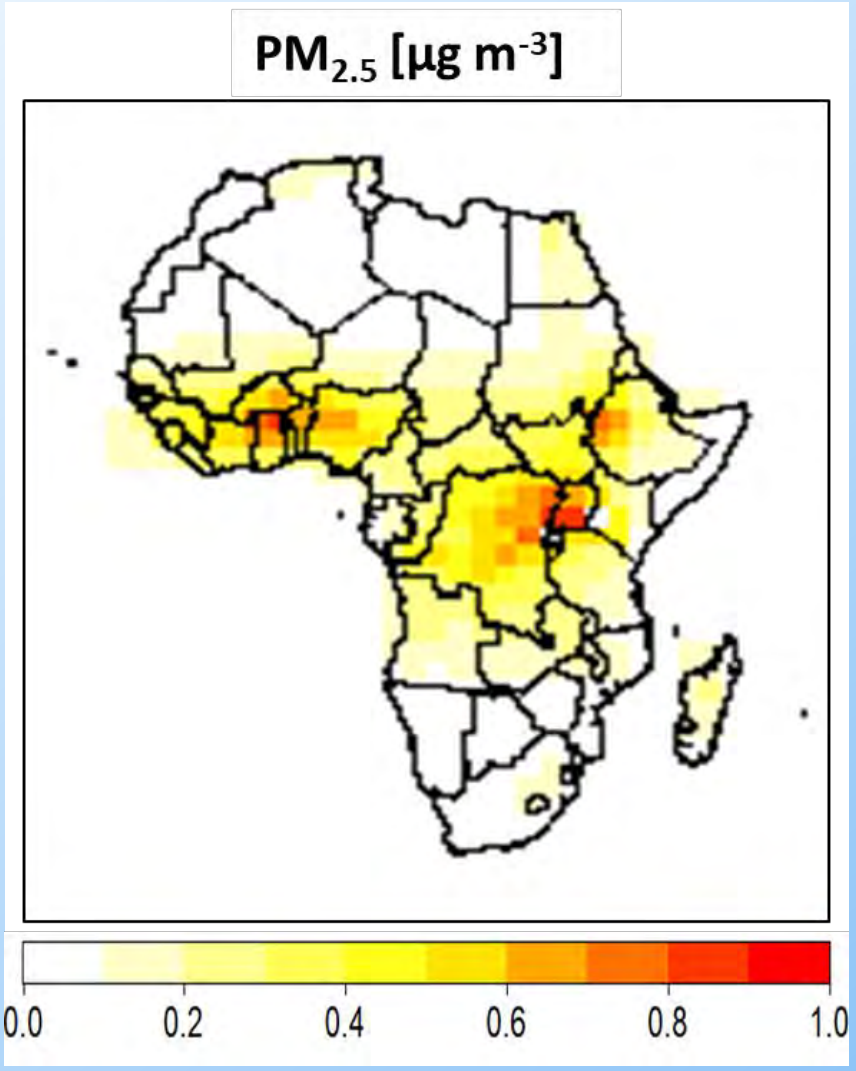


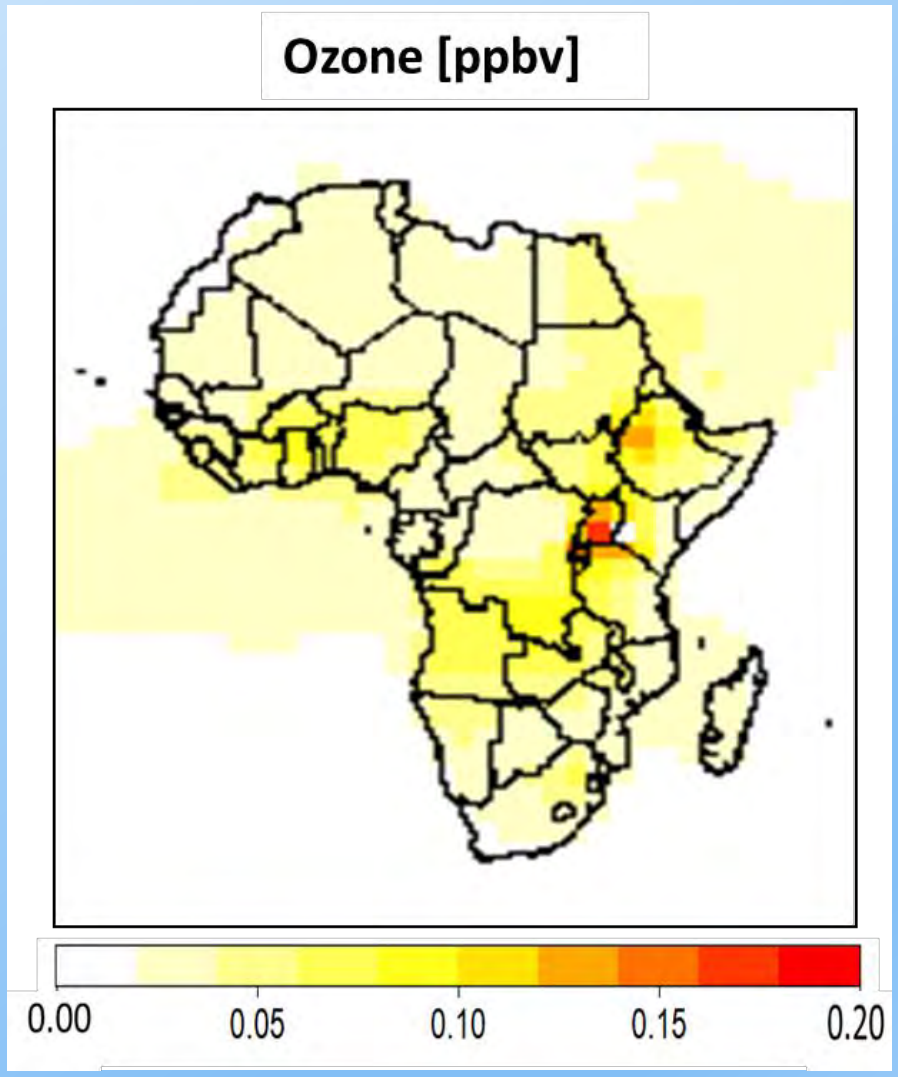
Chemical transport modelling

3D Chemical transport model driven by MERRA -2 meteorology

Grid Resolution: 2^0 x 2.5^0

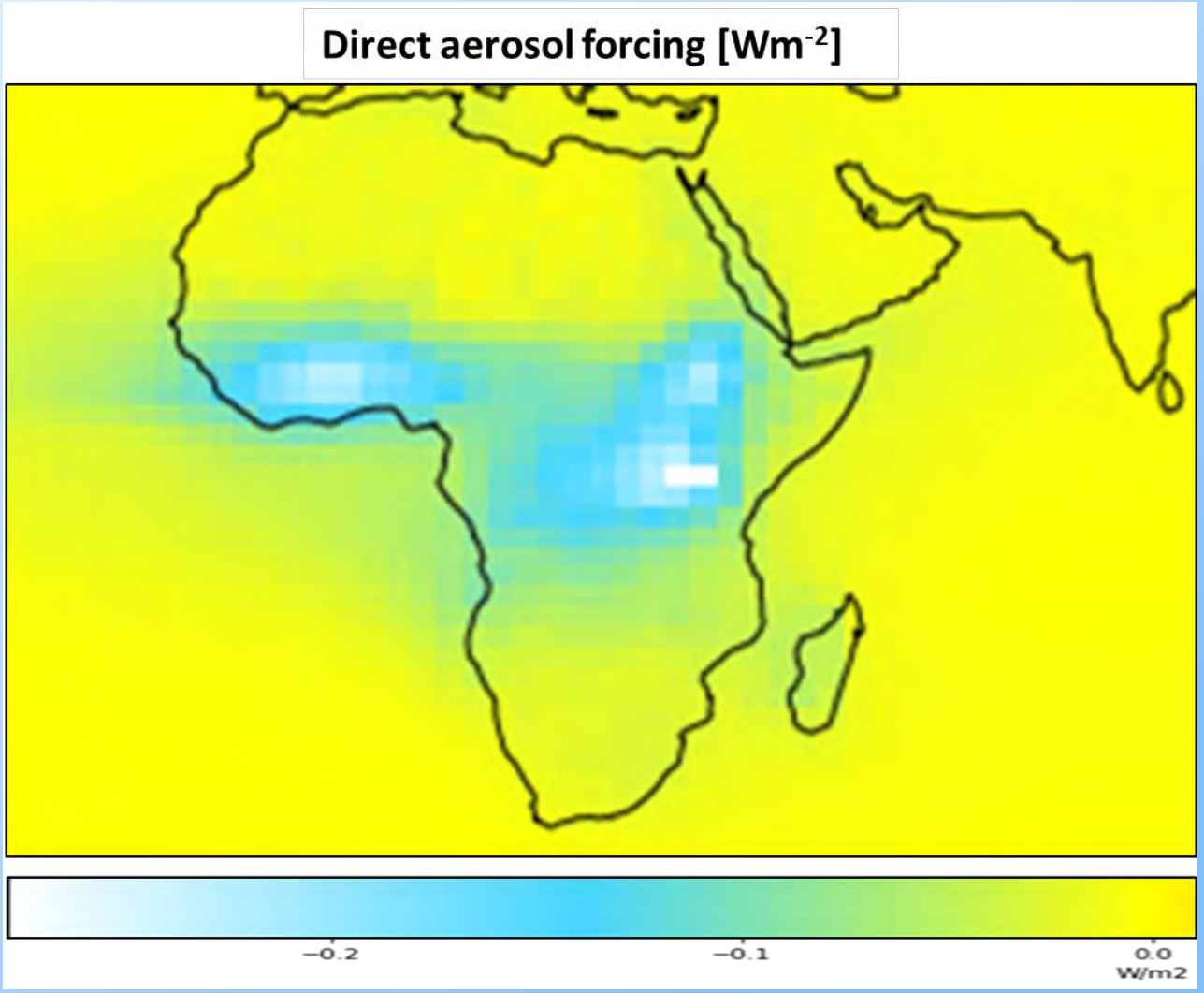
Contribution of Charcoal to $PM_{2.5}$ and O_3 in 2014





$PM_{2.5}$ and O_3 concentrations from charcoal are highest in East and West Africa, with peak values of 1.2 µg m^{-3} and 0.2 ppbv respectively.

Radiative forcing of charcoal in 2014

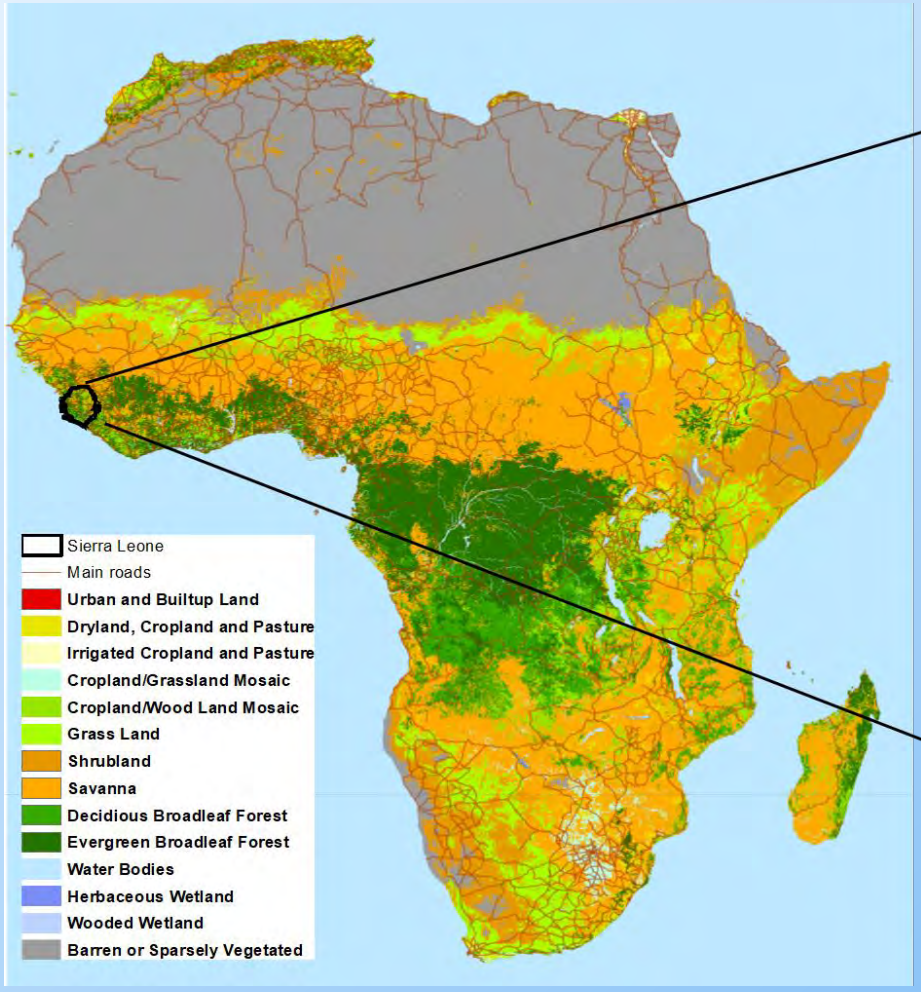


Peak direct aerosol forcing from the charcoal emissions in Africa in 2014 is -0.2 Wm^{-2}.

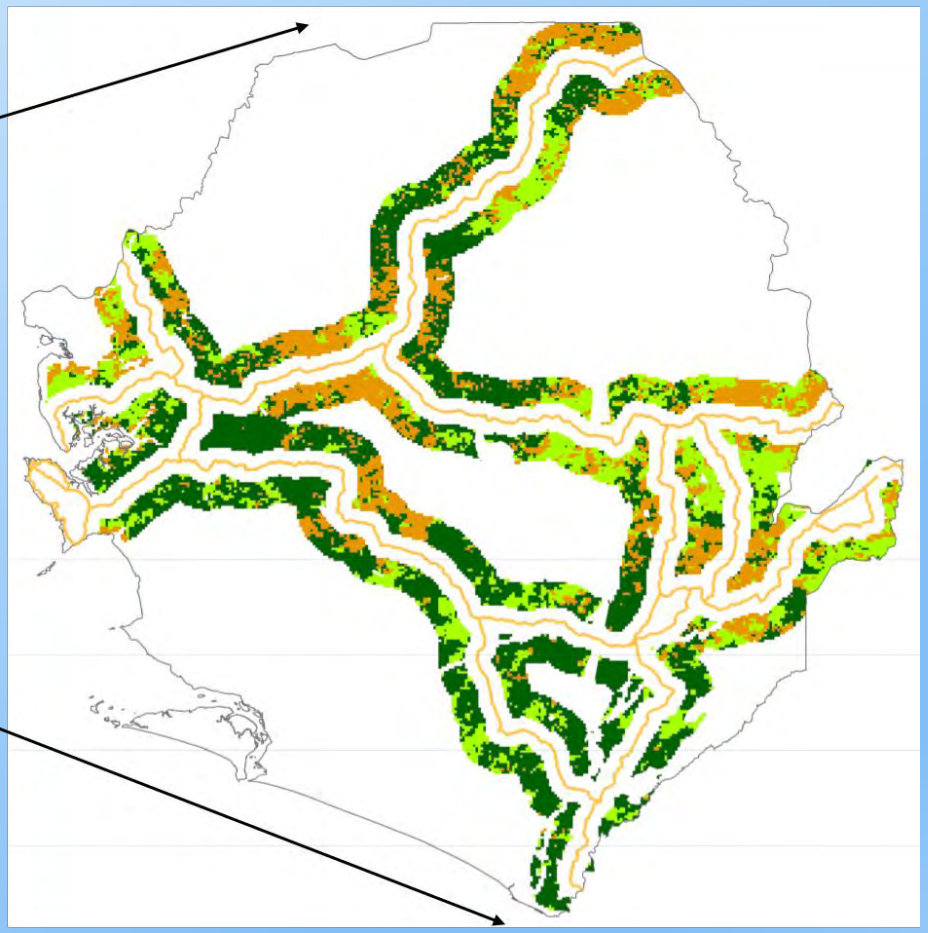
Thank
you

Mapping production zones

Land cover + main roads in Africa



Charcoal production location in Sierra Leone

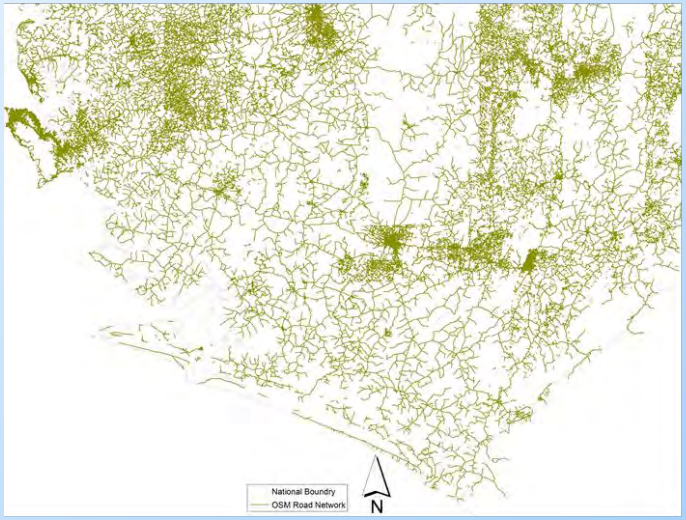


Production:

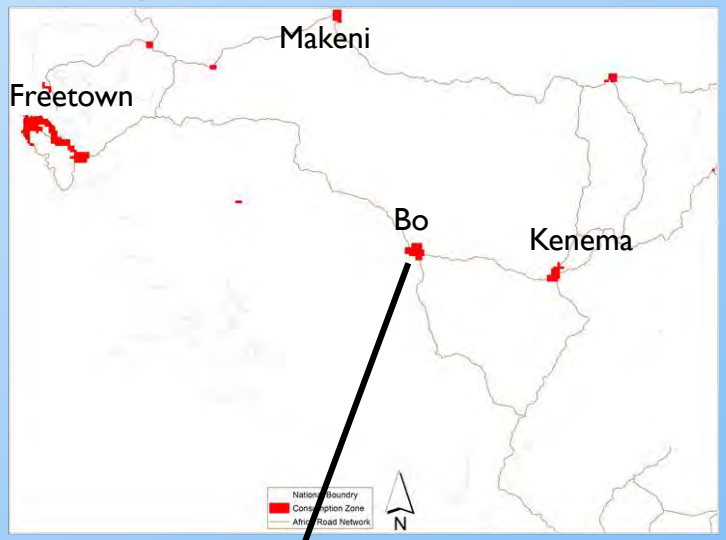
mapped 5 to 15 km from primary roads (Campbell, 1996). We also account for vegetation distribution and protected areas

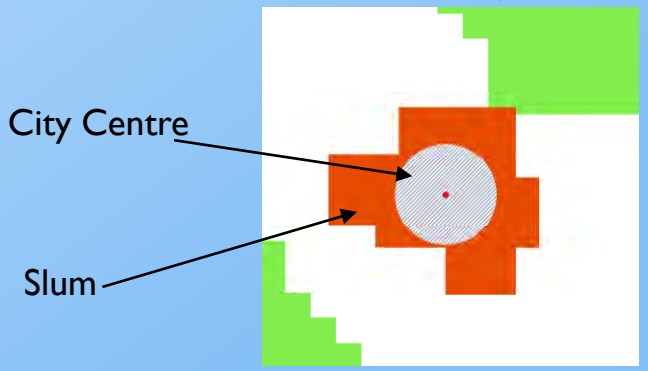
Mapping consumption zones

OpenStreetMap Roads (Sierra Leone)



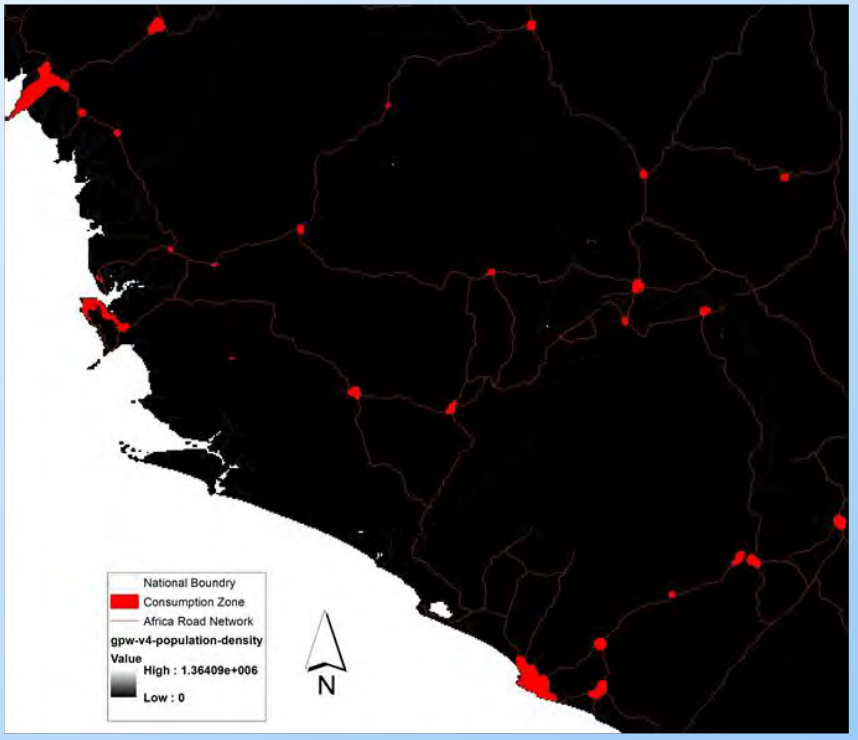
Consumption Locations = Cities



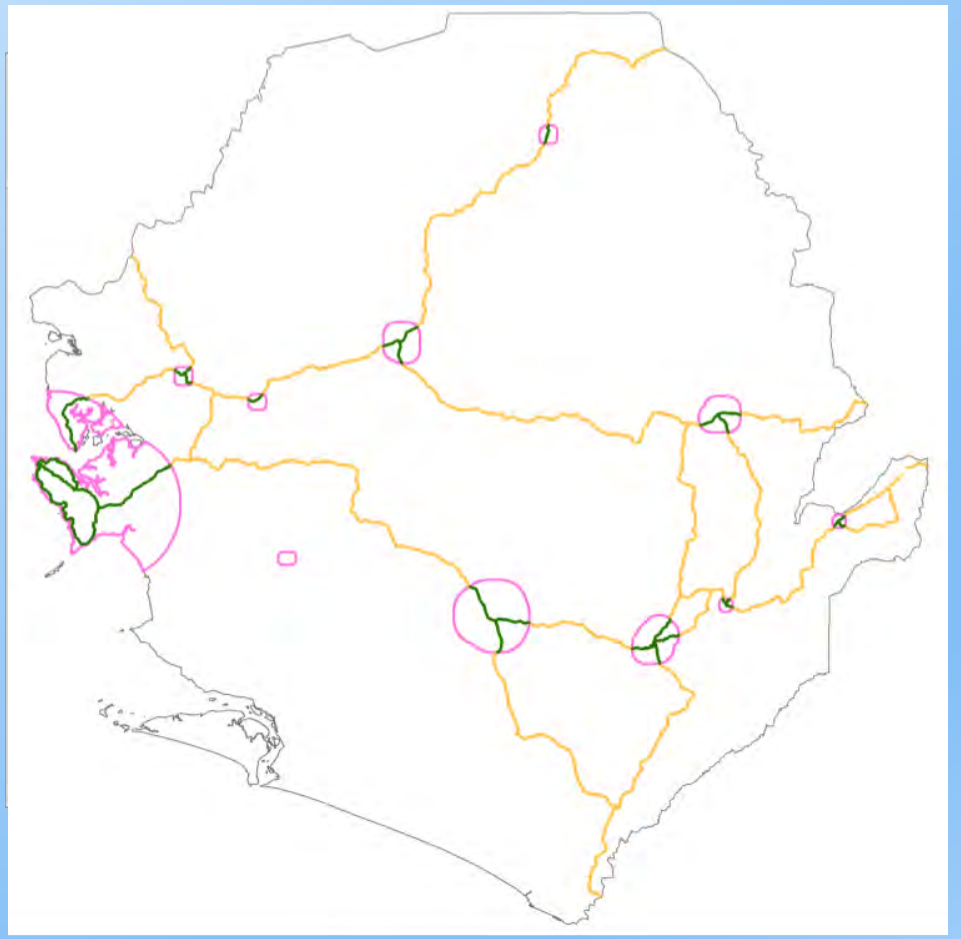


Mapping truck zones

OSM Roads + Population Density Grid

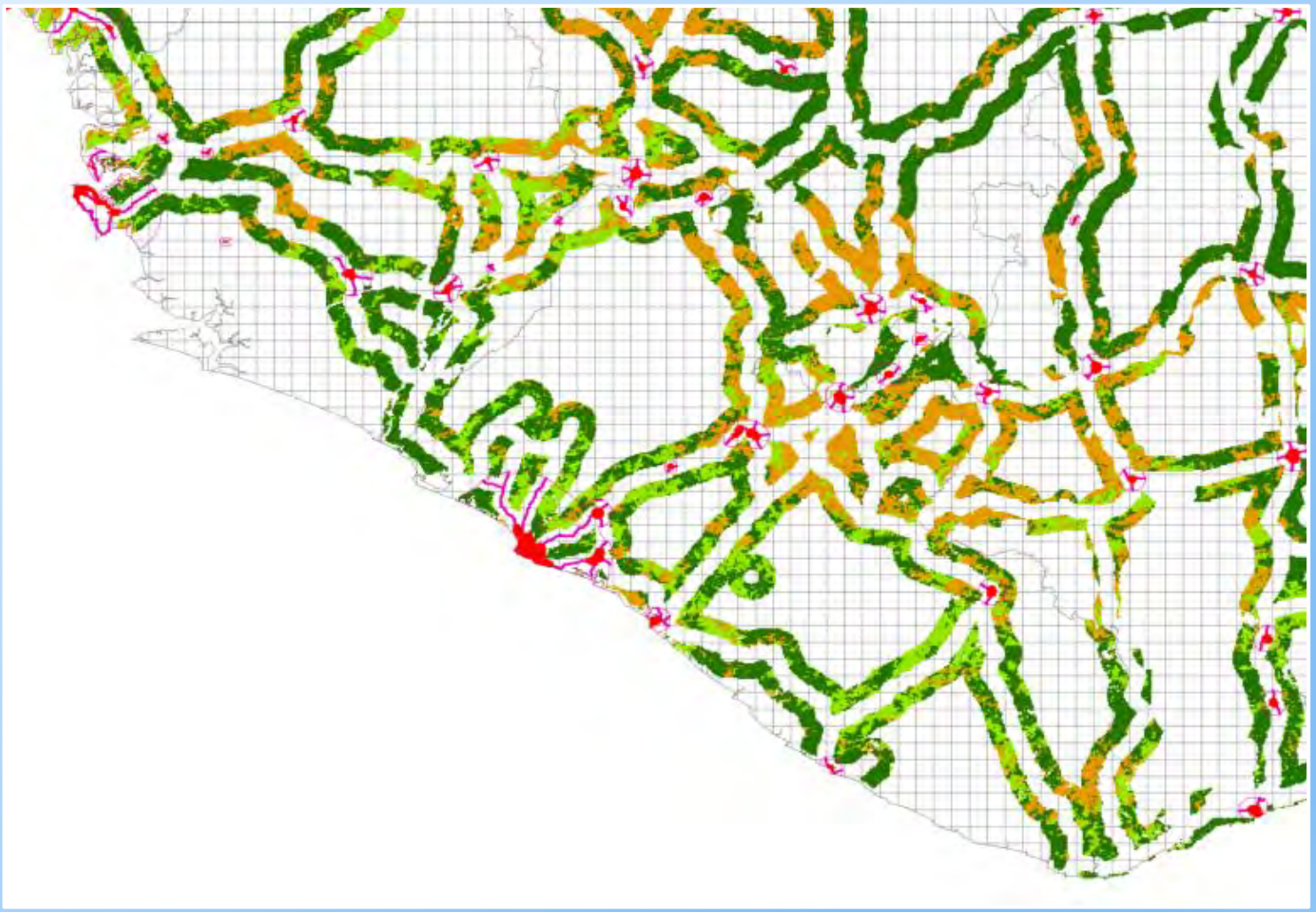


Truck zones and routes in Sierra Leone



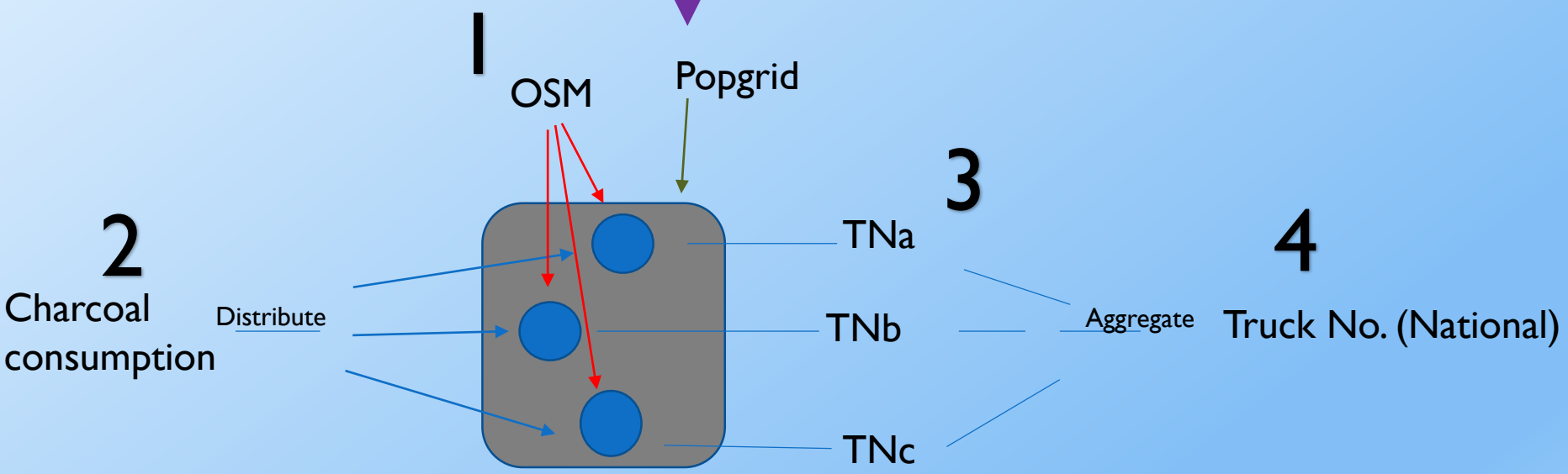
Truck zone (purple), truck route (green), main roads (orange)

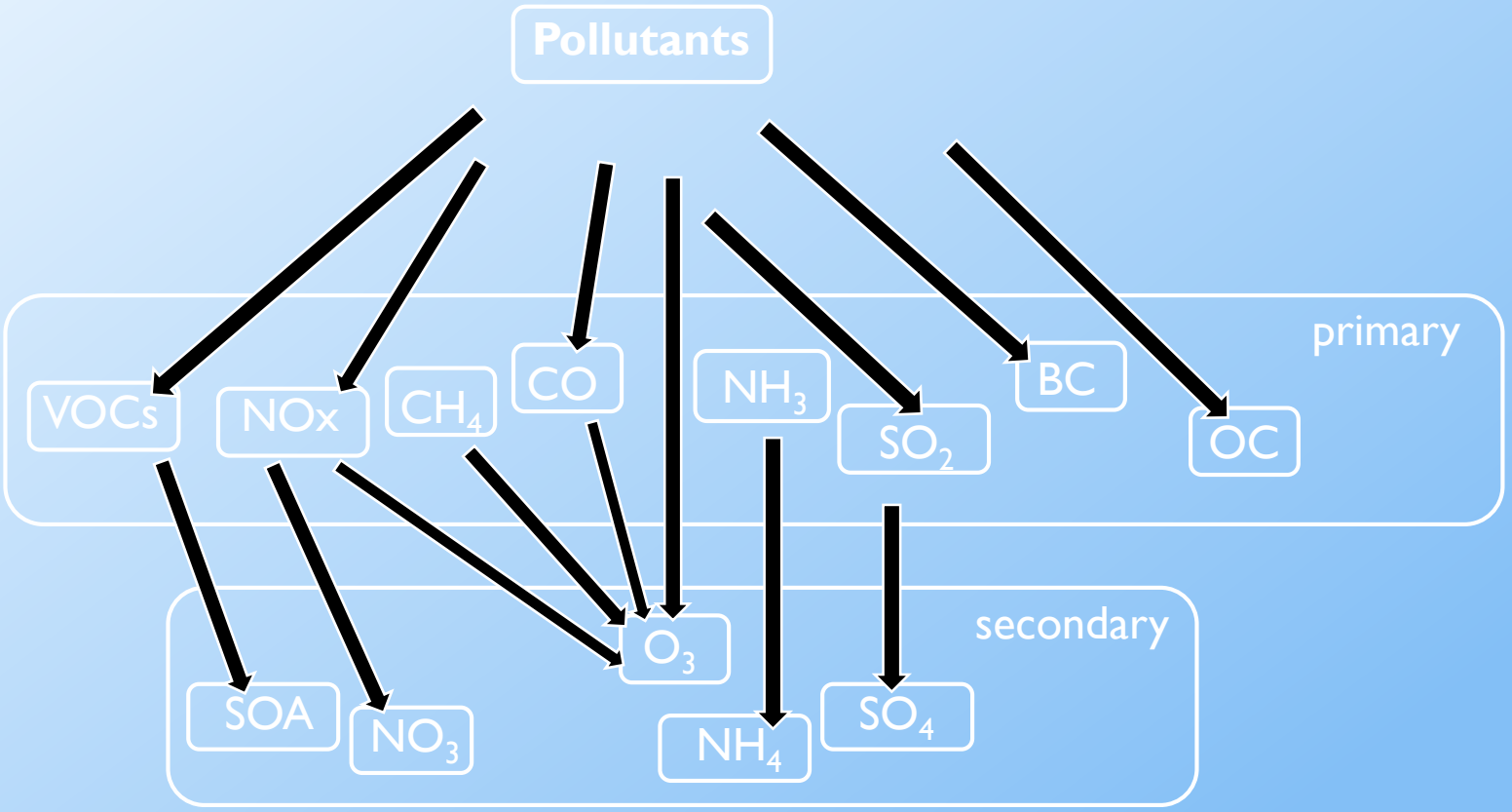
Developing emission inventory



Collecting activity data

Charcoal production (Tg) → United Nations energy statistics
Charcoal consumption (Tg) → United Nations energy statistics
Truck transport (Truck-km) → ???

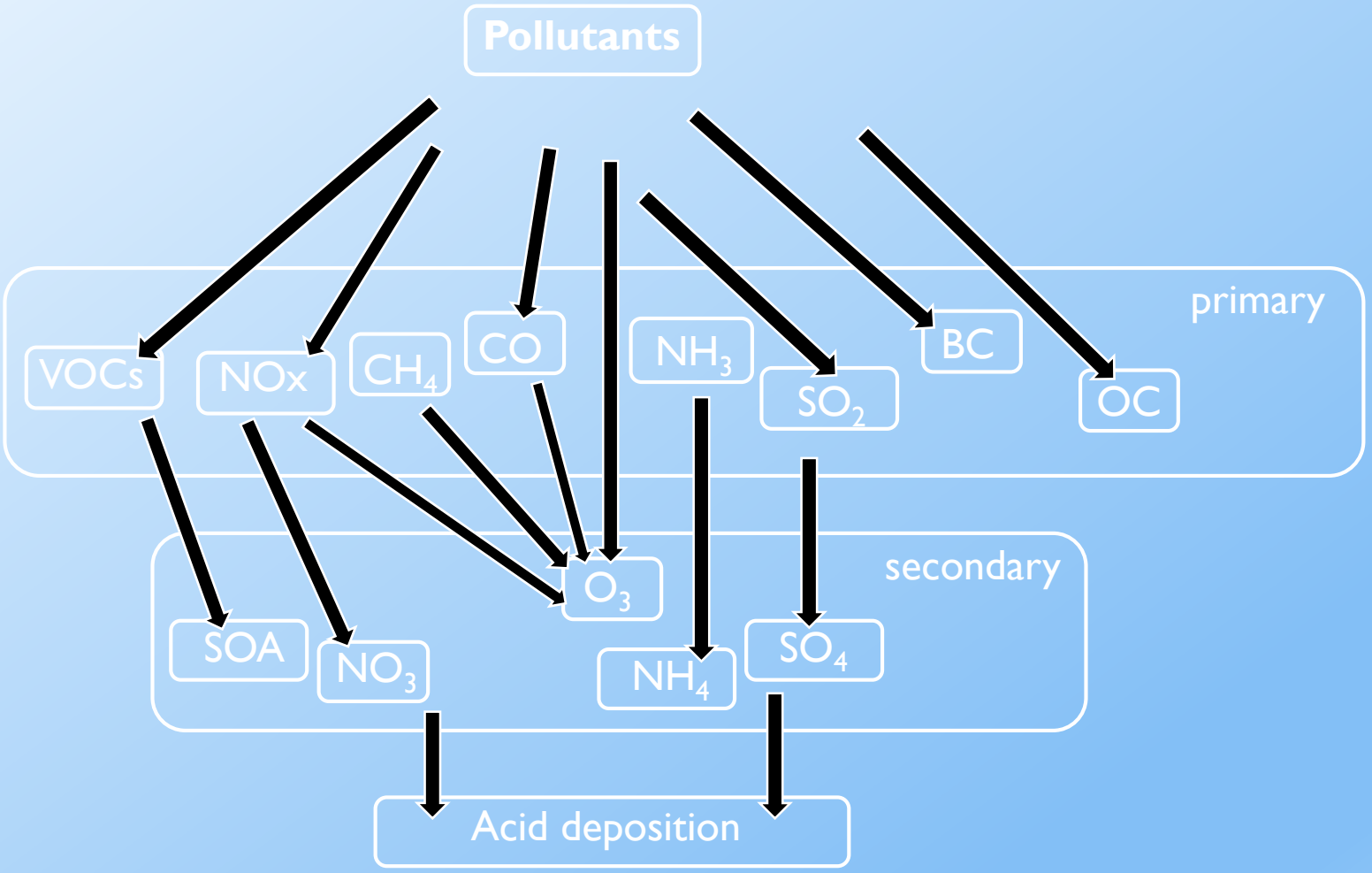




BC = black carbon
OC = organic carbon
CO = carbon monoxide
SO4 = sulphate

NOx = nitrogen oxide
SO_2 = sulphur dioxide
VOC = volatile organic compound
NO_3 = nitrate

O_3 = Ozone
H_2SO_4 = sulphuric acid
HNO_3 = nitric acid
NH_4 = ammonium



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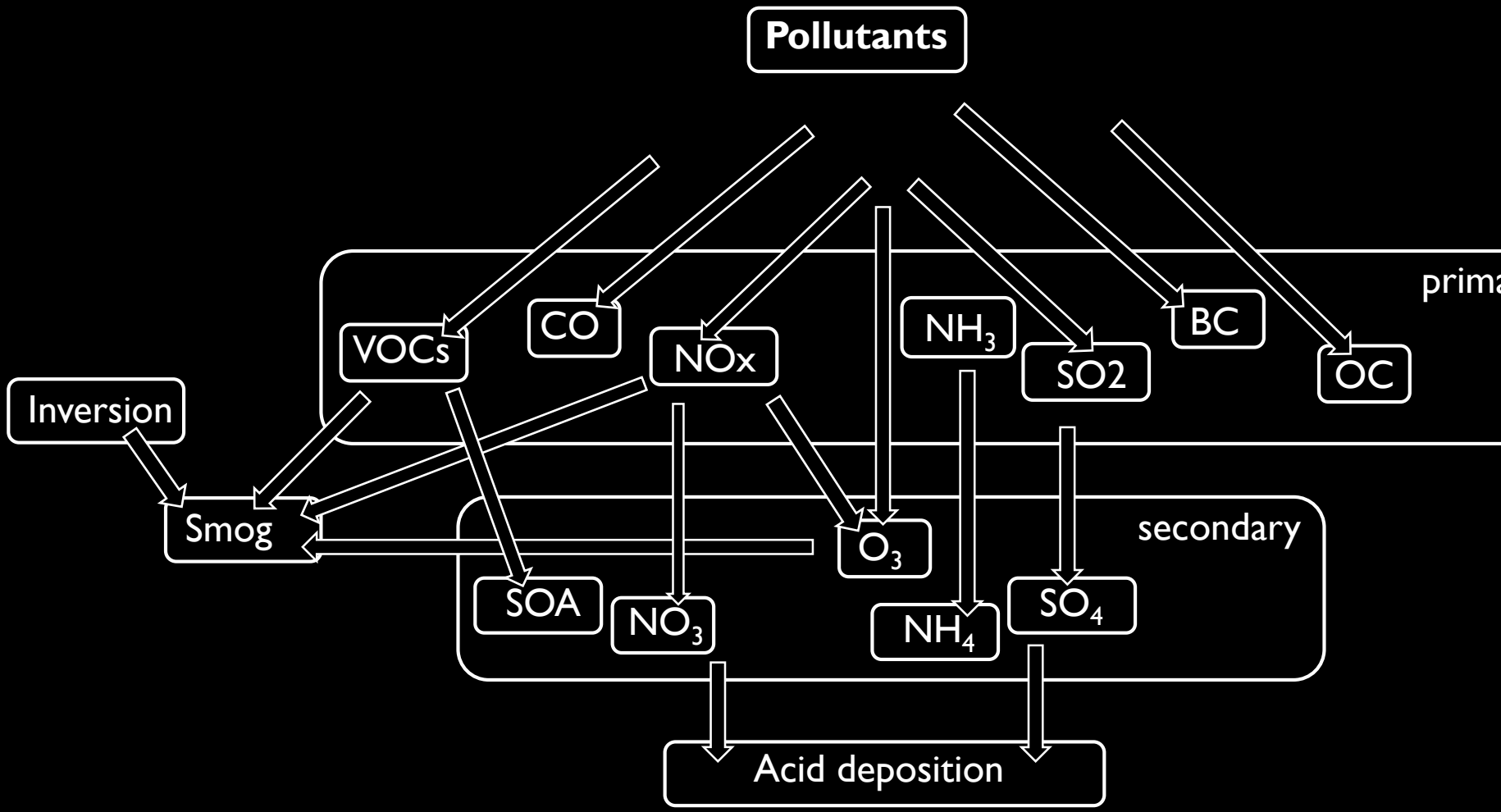

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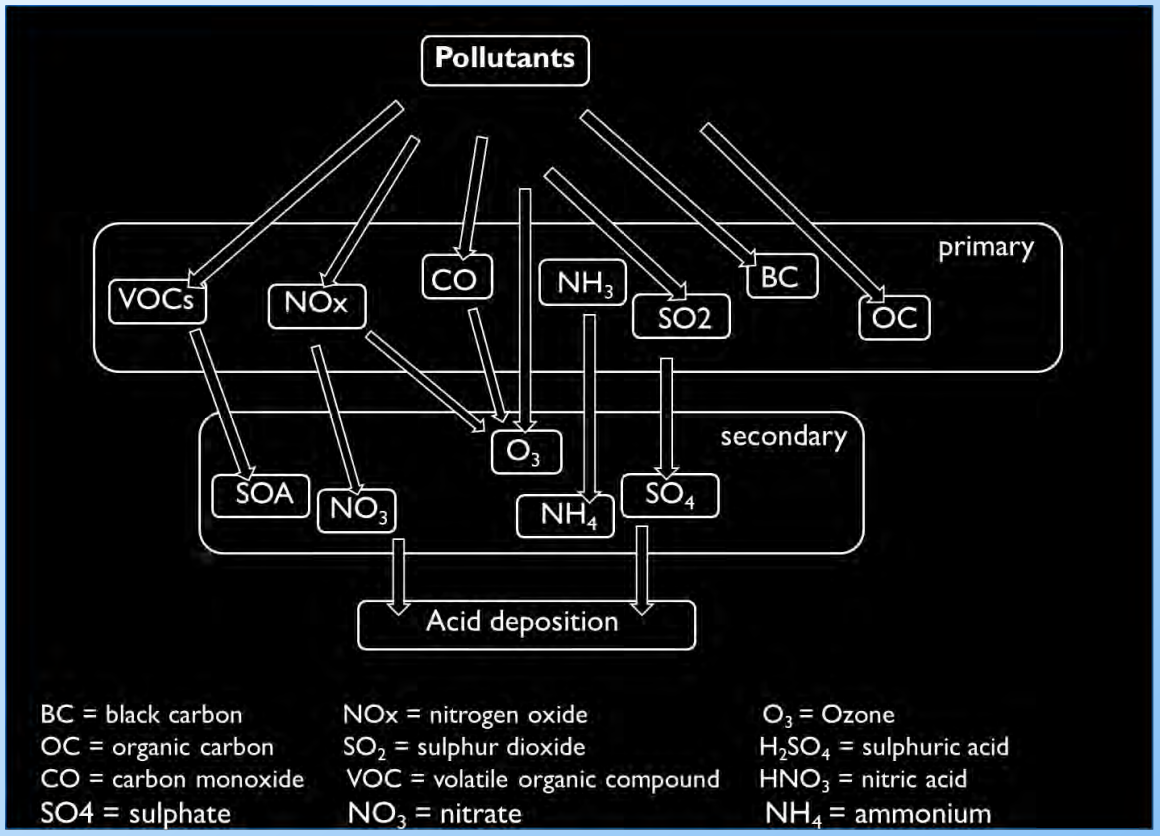
Pollutants
primary
VOCs
NOx
CO
NH3
SO2
BC
OC
secondary
O3
SOA
NO3
NH4
SO4
Acid deposition
BC = black carbon
OC = organic carbon
CO = carbon monoxide
SO4 = sulphate
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