African Anthropogenic Emissions Inventories for gases and particles from 1990 to 2016

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Conclusion:

- This work provides detailed regional estimates **of BC, OC, SO2, NOx, CO, NMVOC** for the period **1990-2016** in yearly **0.125°x0.125°** maps

Main results for 1990 – 2016 emissions

- **Global increase** of anthropogenic emissions expect for flaring emissions
- **Biofuel** and open **Waste Burning** are main contributors of anthropogenic pollutant emissions in Africa
- For Biofuel particle emissions, **fuel wood** is the main contributor mainly used in **residential** sector.
- For Fossil Fuel particle emissions, **Diesel** is the main contributor mainly used in **traffic sector** and other combustion engine.

On going works

- Works on **Uncertainties** and future projections are on going
- **Mitigation of emissions** will be focused with improvement of cook stoves, on elimination of high emitters in traffic sector, improvement of fossil fuel quality.

METHOD

Anthropogenic source inventories: fuel consumptions (FC) are combined with emission factors (EF) to derive emission inventory at the country level. ***E = FC * EF***

❑ FC DATA

For 1990-2014

✓ United Nations database (UN) 1990-2014, 54 African countries and 22 fuels

✓ International Energy Agency data (IEA) 1990 – 2014, 28 African countries and all other are aggregated

✓ Local data (Environment Ministry of Côte d'Ivoire, SIE Côte d'Ivoire, SIE Benin, SIE Togo, SIE Sénégal …)

- For 2015-2016

Hubert's procedure for segmentation of time series was used ⟶ FC data were extrapolated from 2014 to 2020 based on trends for each fuel by sector and country

- For two wheels vehicles

Two-wheel numbers and FC were obtained based on Assamoi and Liousse, (2010) works: literature and DHS data

- Waste burning

$WB = P \times MSWp \times Pfrac \times Bfrac = WB_{residential} + Wb_{dump}$ (IPCC guideline, Wiedinmyer et al., 2014)

❑ EF DATA

Provided from new ground field measurements (Keita et al., in preparation) and literature

METHOD

FLARING EMISSIONS INVENTORY

- **Gas Flaring volume**:

- NOAA DMSP **1992-2011** (Elvidge et al., 2009)

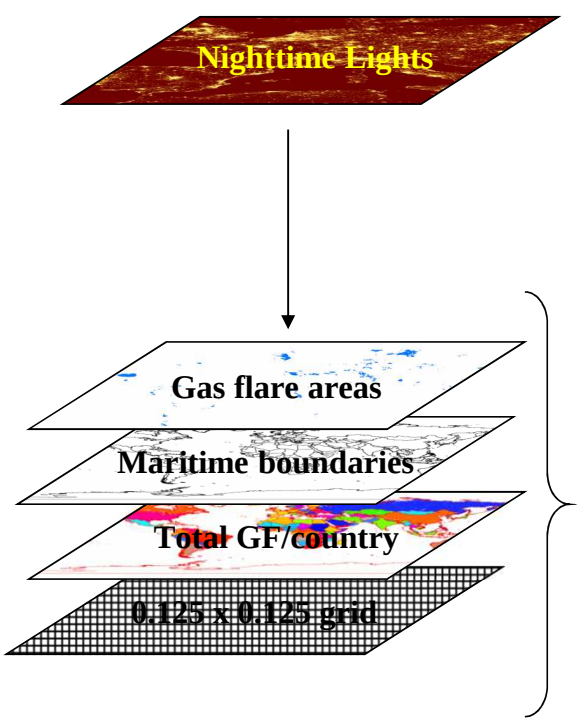
- NOAA VIIRS **2012-2015**

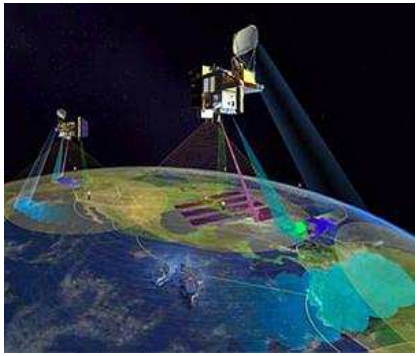
(Elvidge et al., 2015)

- **Emission factors (EFx)**

EFx provided from literature (see Doumbia et al., submitted)

DMSP: Defense Meteorological Satellite Program
VIRRS: Visible Infrared Imaging Radiometer Suite





http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html

Method was validated for Nigeria with real ground data

Gas Flaring
volumes / country / 0.125x0.125

$X_{flaring} = GF_{Volume} * EF_X$

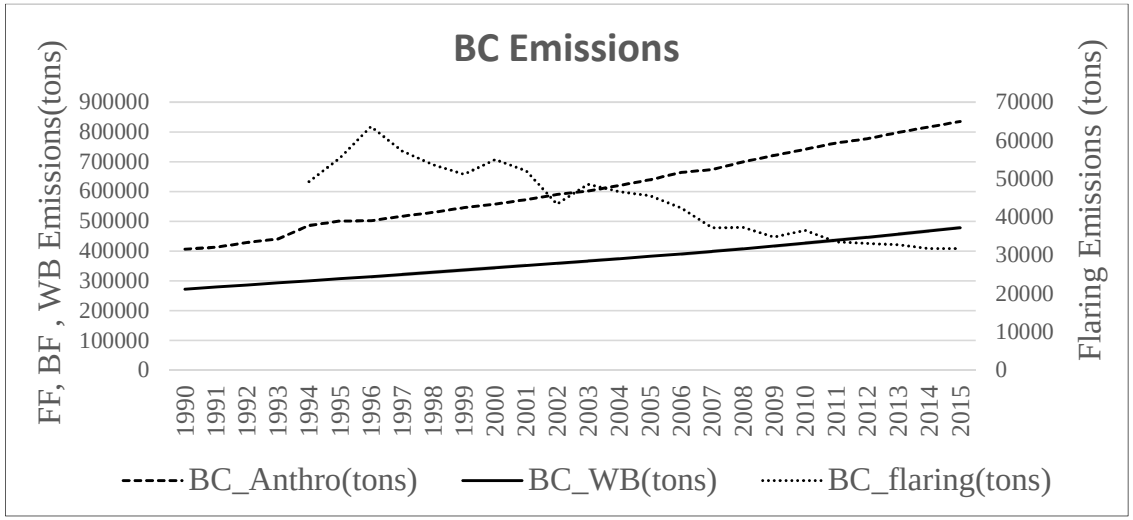
(Doumbia et al., submitted)

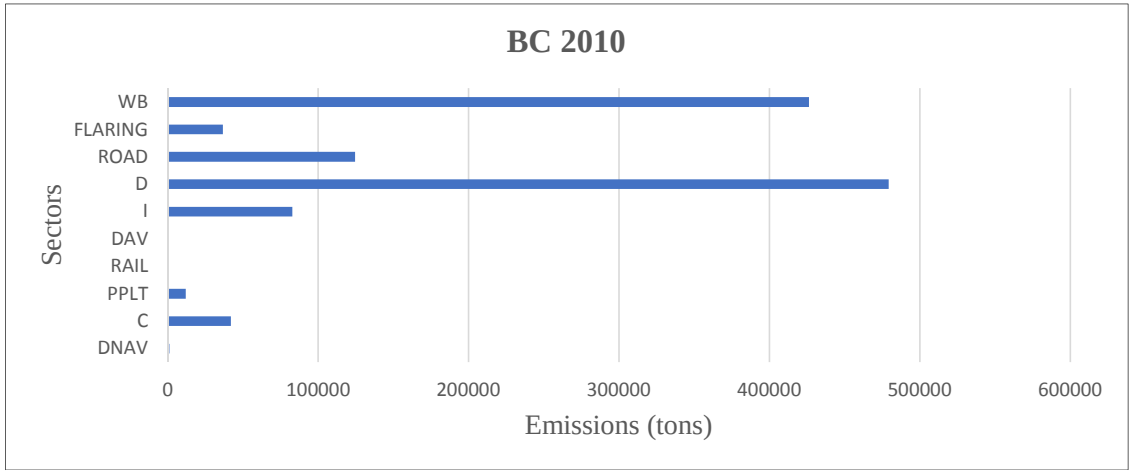
SPATIAL DISTRIBUTION OF EMISSION

- Population density given by CIESIN (Gridded Population of the World Future Estimate: GPWFE)
- African country road networks given by Africa infrastructure, (2009)
- African power plant networks given by Africa infrastructure, (2009)

RESULTS: emission trend and sector contribution

BC emission trend and sector contribution





- BC emissions:

- Increase of FF, BF and WB.
- Decrease of Flaring emissions globally.

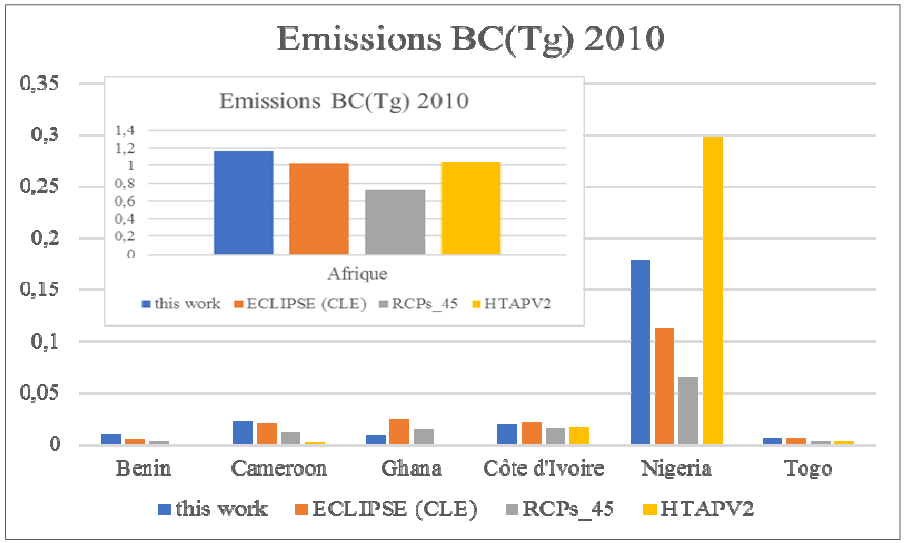
- Total BC Africa 2010 :

Relative predominance (Keita et al.(2) in preparation

- domestic (**40%**)
- waste burning (**35%**),
- road traffic (**10%**),
- industry (**7%**),
- gas flaring (**3%**)
- other sector (**5%**).

RESULTS: comparison and spatial distribution

COMPARISON WITH PREVIOUS INVENTORIES



- **With global inventories**:

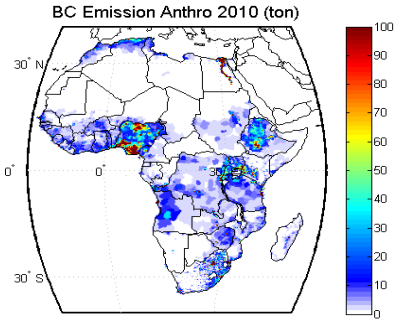
African level: maximum differences of **40%** in **2010**
Our BC inventory is globally higher
C**ountry level**: various trends exist

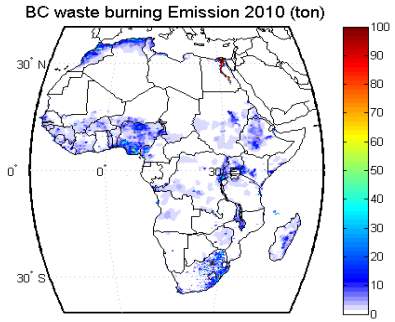
- **With Liousse et al. (2014) (**African regional inventory for **2005**)

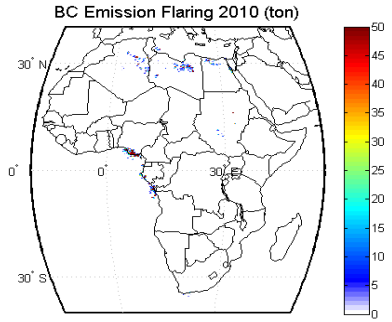
  Our FF and BF emissions are almost similar for BC (**0.64 to 0.68TgC**) and more important for CO (**64.43 to 58.6 TgC**).

This can be explained by the updating of fuel consumption data base and also by the use of new emission factors.

SPATIAL DISTRIBUTION OF BC 2010 EMISSIONS







Total BC 2010 emissions in Africa

- **FF and BF** : (0.74 Tg C) → **61.6%**
  (BF : 57.9% wood , FF: 17.8% diesel)
- **WB** : (0.43 Tg C) → **35.4%**
- **Flaring** : (0.036 Tg C) → **3%.**
- **Nigeria** : the most contributing country.

REFERENCES

- Assamoi, E.-M. and Liousse, C.: A new inventory for two-wheel vehicle emissions in West Africa for 2002, Atmos. Environ., 44(32), 3985–3996, 2010.
- Elvidge, C. D., Ziskin, D., Baugh, K. E., Tuttle, B. T., Ghosh, T., Pack, D. W., Erwin, E. H. and Zhizhin, M.: A Fifteen Year Record of Global Natural Gas Flaring Derived from Satellite Data, Energies, 2(3), 595–622, doi:10.3390/en20300595, 2009.
- Elvidge, C. D., Zhizhin, M., Baugh, K., Hsu, F.-C. and Ghosh, T.: Methods for global survey of natural gas flaring from visible infrared imaging radiometer suite data, Energies, 9(1), 14, 2015.
- Liousse, C., Assamoi, E., Criqui, P., Granier, C. and Rosset, R.: Explosive growth in African combustion emissions from 2005 to 2030, Environ. Res. Lett., 9(3), 035003, 2014.
- Wiedinmyer, C., Yokelson, R. J. and Gullett, B. K.: Global Emissions of Trace Gases, Particulate Matter, and Hazardous Air Pollutants from Open Burning of Domestic Waste, Environ. Sci. Technol., 48(16), 9523–9530, doi:10.1021/es502250z, 2014.

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