



Development and evaluation of a regional African anthropogenic emission inventories for gases and particles for 2005 and 2030

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Thanks to different african institutes and persons for all the regional emission data

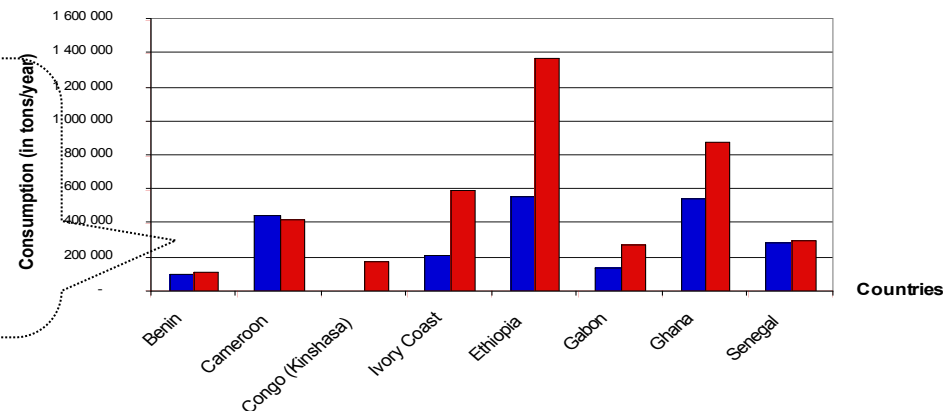
Paper in preparation

❖ Preliminary...

- First AMMA modeling (ORISAM-TM4 & RegCM3) have used global fossil fuel and biofuel source inventories to study african aerosol impact with problems to reconstruct AOD along the Guinean Gulf (*Tummon et al., 2010 and Malavelle et al. 2010 with RegCM3*)
- Discrepancies on diesel consumption

➡ Important discrepancies between global inventory and regional zoom obtained with Africaclean database for the traffic emission inventory

DIESEL CONSUMPTION BETWEEN TWO DATABASE : UN (GLOBAL) AND AFRICACLEAN (REGIONAL)



❖ This study (Assamoi PhD)

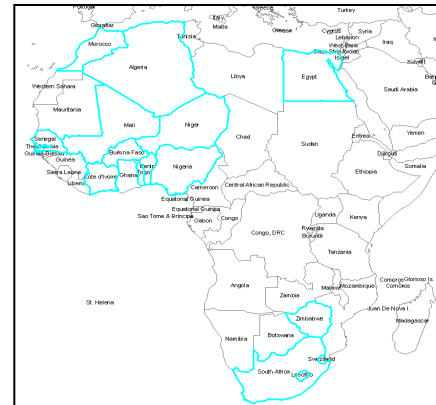
- Develop a new regional anthropogenic inventory for gases (CO, CO₂, NO_x, SO₂ and NMVOC) and particles (BC and OC) with regional specificities for 2005
- Projections in the future (2030) with scenarios (REF/CCC/CCC*)

❖ Methodology to develop african FF and BF inventories for 2005

➔ A bottom up inventory : $E(kg) = C(t) \times EF(kg/t)$
with activity sectors : **traffic/domestic/industry/power plant**

❑ Data consumption

➔ Local inquiries including Africaclean results
(**13** answers / **27** african countries)



➔ **Assamoi & Liousse (2010)** for two-wheel inventory with measured EF



➔ **where** no available data :

- United Nations database for **fossil fuel** (traffic, industry and domestic)
- International Energy Agency data (power plants)
- Updated Brocard (1996) for **biofuel** (fuelwood and charcoal)

❑ Emission factors depending on fuel/activity sectors/technology

→ *A proxy method for technology and norms by using GDP : developed/semi-developed/developing countries*

→ *Data from :*

- AMMA 2005 campaign in Cotonou (Guinot et al. 2011)
- POLCA 2009 campaigns in Dakar and Bamako
- Junker and Liousse (2008)
- Bond et al. (2004)



❑ « Regional » resolution grid for mapping emission (country => regional distribution)

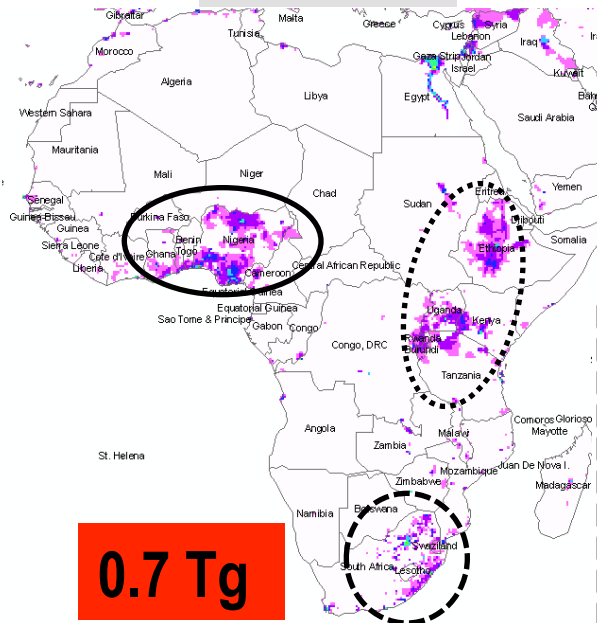
→ 0.25°x 0.25°(SEDAC : <http://sedac.ciesin.columbia.edu/>)

❖ Future gases and particles projections over Africa

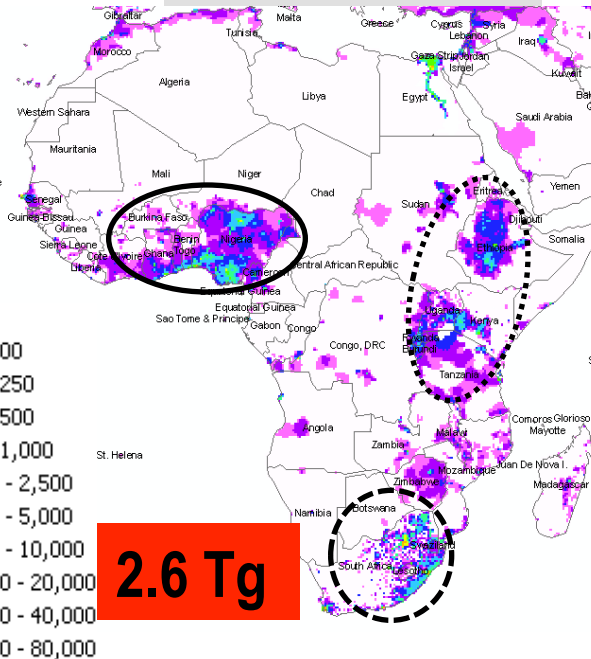
- ❑ New projections by using our present new regional inventory of 2005 and the **POLES** model (Criqui et al.) including both **fossil fuel and biofuel consumption** (fuel/activity).
 - **Reference (REF) scenario** : Reflect the state of the world with what is actually (2000) embodied as environmental policy objectives
 - **CCC scenario** : Introduction of carbon penalties as defined by Kyoto for 2010 and a reduction of 37 Gt of CO₂ in 2030.
 - **CCC* scenario** :
 - **West Africa** : two stroke replaced by four stroke vehicles
 - **South Africa** : fuel consumption projected following conditions of semi developed countries
 - Emission factor of **animal waste** burning : low part of the range
- ❑ Emission factors
 - **EFs for the Reference scenario : equal to today' s**
 - **Reduction of EF for the CCC scenario** :
 - **Developed countries** : based on removal efficiency forecast by the IIASA Rains model
 - **Semi-Developed countries** : EFs of developed countries of 1997
 - **Developing countries** : EFs of semi-developed countries of 1997

❖ Example for BC

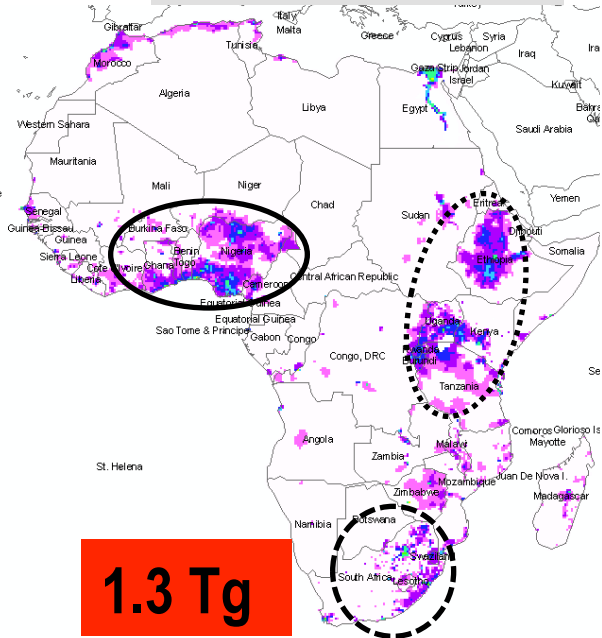
BC 2005



BC 2030 REF



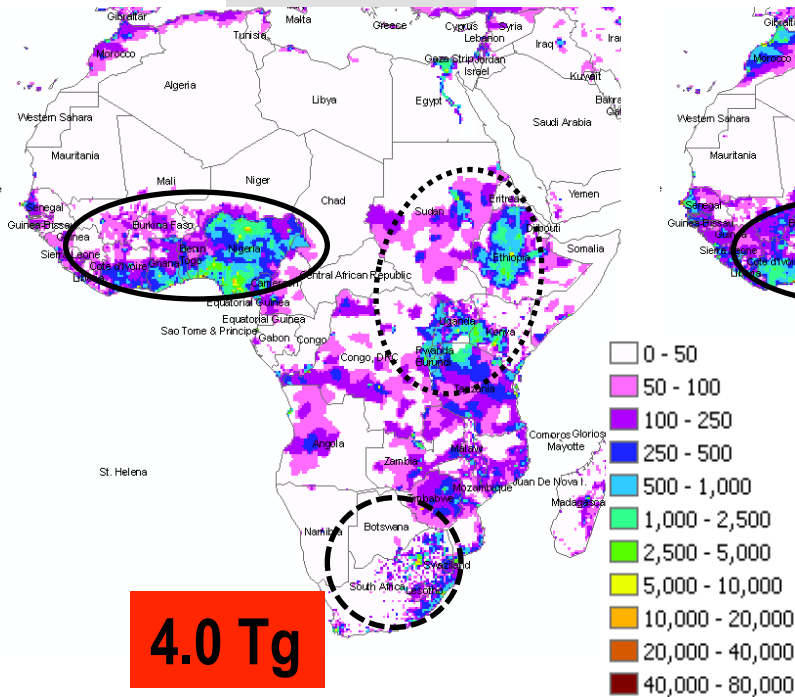
BC 2030 CCC*



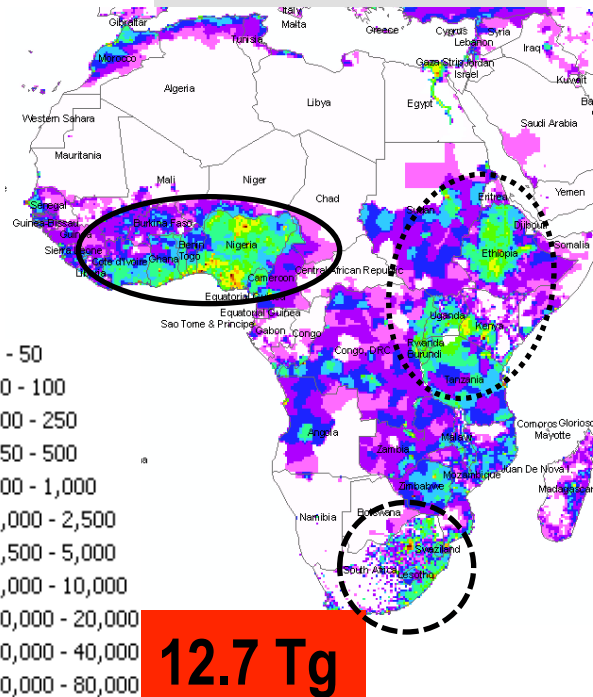
- Maximums emissions over West Africa, East Africa and South Africa
- West Africa (Lagos) and South Africa (Johannesburg) are clearly impacted by Kyoto protocol (**-100% CCC*** vs **REF**) → coal and diesel

❖ Example for OC

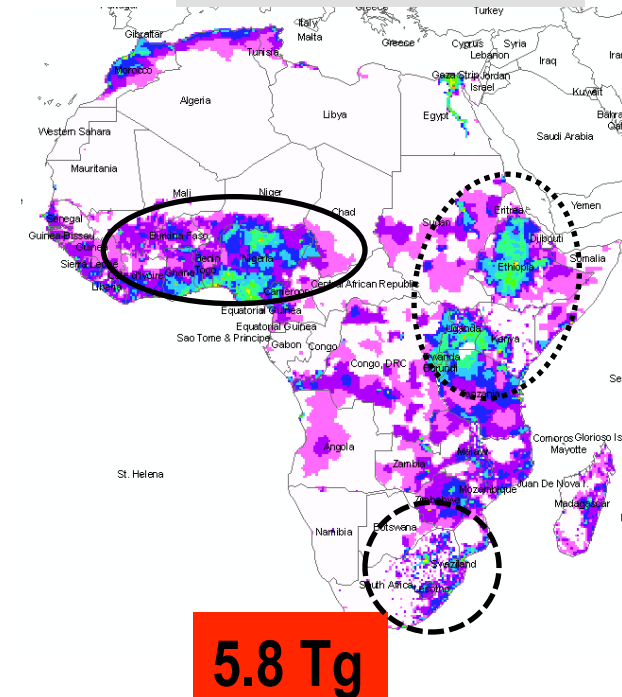
OC 2005



OC 2030 REF

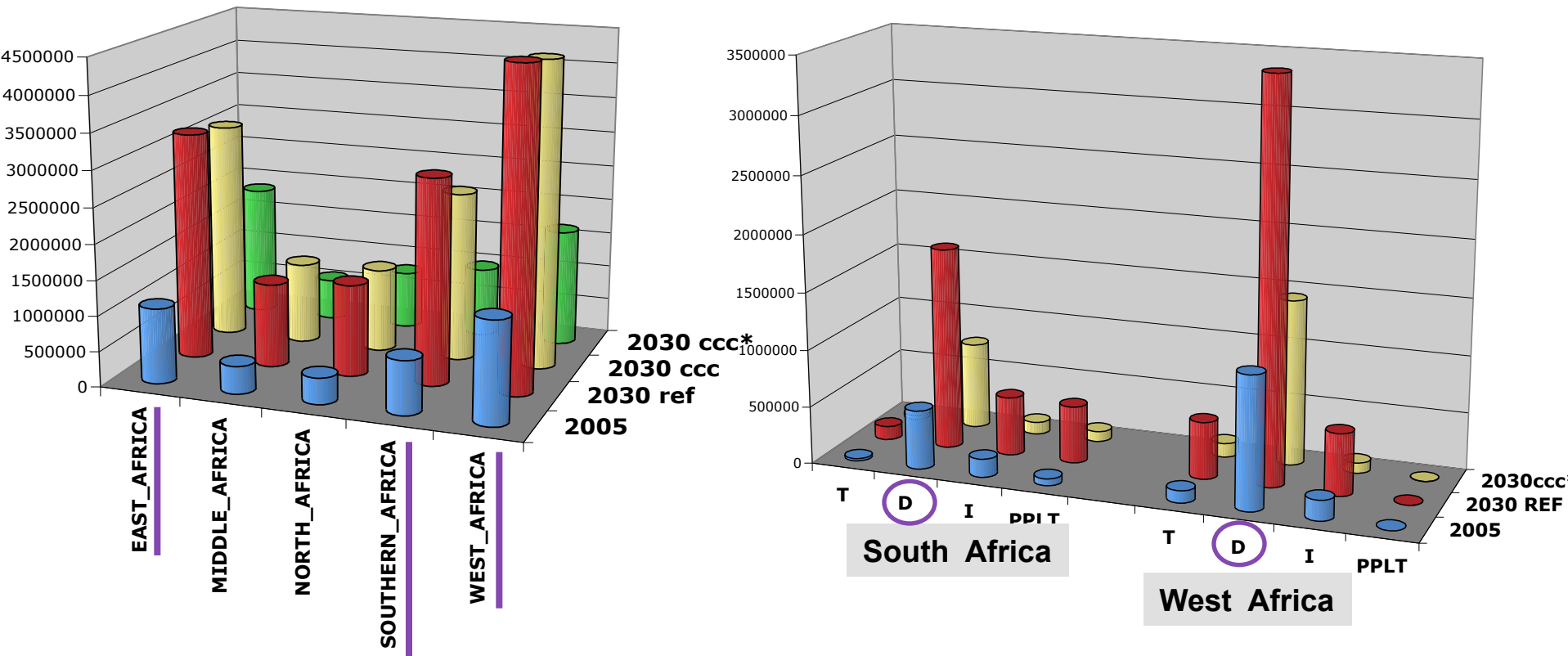


OC 2030 CCC*



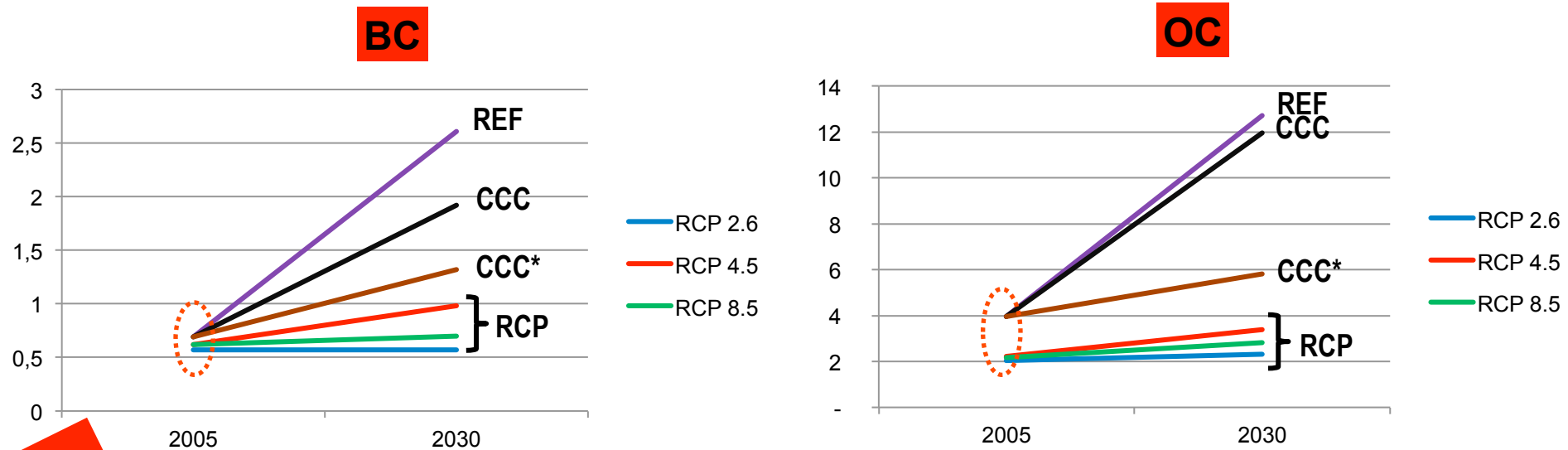
- Maximums emissions over West Africa, East Africa and South Africa
- OC emissions increase in REF vs 2005 (+271%) and decrease in CCC* vs REF (-54%)

❖ Results detailed by activity sector / region for OC



- Most impacted areas : East, West and Southern Africa
- REF scenario ~ CCC scenario
- Strong decreases due to **CCC*** scenario
- Relative importance of activity sector
- Domestic sector is predominant everywhere
- Importance of Industry and Power Plant in South Africa

❖ Comparison with RCP (IPCC inventory) for particles (BC and OC)



BC

- Small differences in 2005 for BC
- Evolutions clearly marked between our projections and IPCC
- Our african inventory (mean) represents **11%** of total global inventory (IPCC) in 2005 and **22%** in 2030

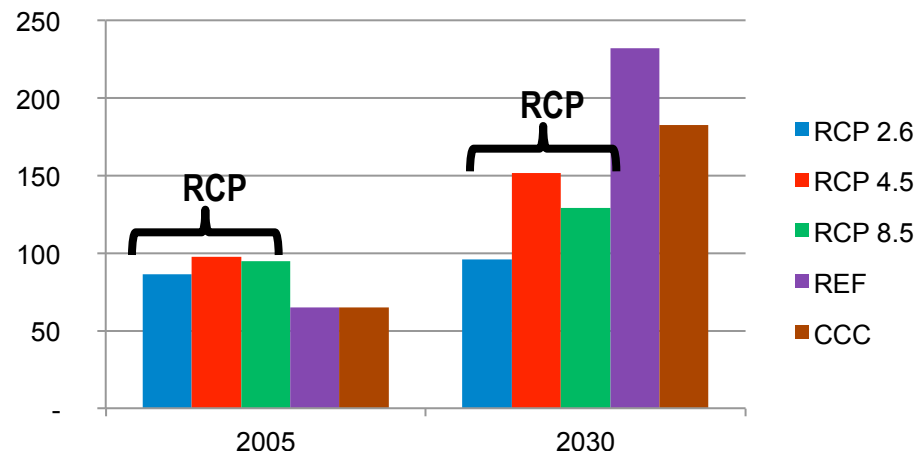
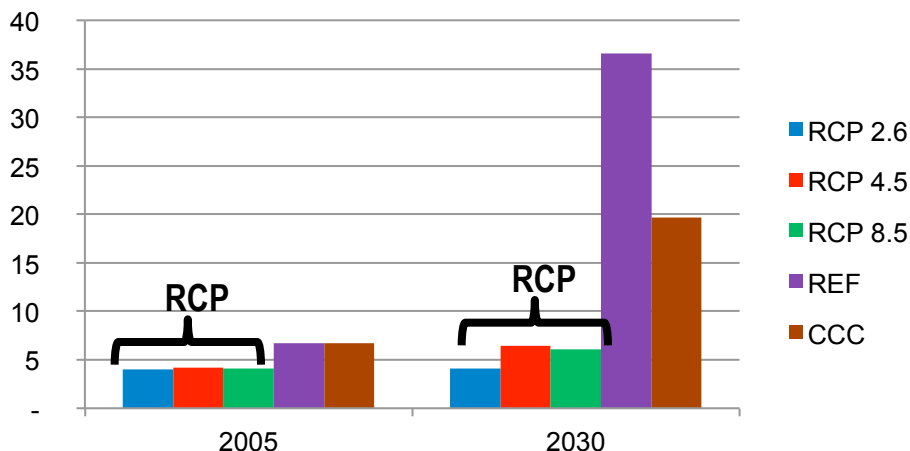
OC

- High differences in 2005 for OC
- Evolutions clearly marked between our projections and IPCC with similarities between **RCP 4.5** and **CCC***
- Our african inventory (mean) represents **41%** of total global inventory (IPCC) in 2005 and **39%** in 2030

❖ Comparison with RCP (IPCC inventory) for gases (NO_x, CO, SO₂ and NMVOC)

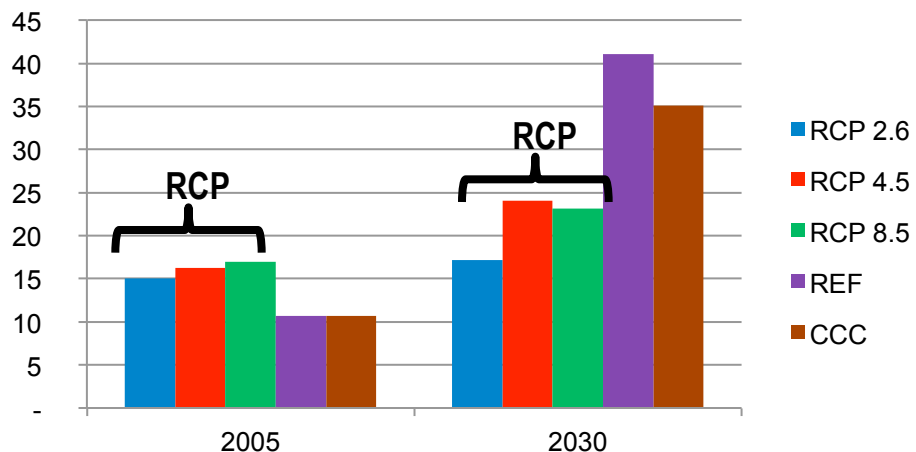
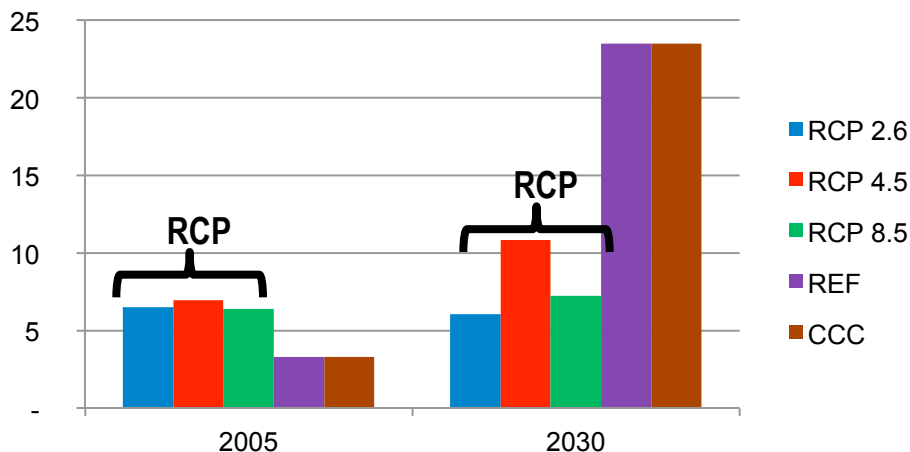
NO_x

CO



SO₂

NMVOC



- 2005 : small differences between our inventories and RCP → **+30%** for NO_x and **-20% to -50%** for CO, SO₂ and NMVOC
- 2030 : ratio Liousse/RCP → **1.7** for NMVOC and **5.1** for NO_x

❖ Conclusion and perspectives

❑ Emission inventory :

- **2005** : regional specificities (two-wheel strokes, EF, charcoal making,...) → sector domestic
- **2030**: high emissions than 2005 but CCC* reduces by 2 emissions in REF

❑ Need link regional/global : regional inventories different than ACCMIP and RCP

On going ...

❑ Emission inventory improvement :

- **South Africa**: in the frame of GDRI program, improvement of *domestic fire* (townships) and *power plant emission* inventories through emission factor measurements and *better regriding* (collab. K. Pienaar, S. Picket CSIR)
- **Northern Africa**: local emission inventories (Charmex)
- **West Africa**: to develop an inventory for « flaring » emissions



❑ To develop a framework for the follow up of fuel consumption, vehicle counting... in Africa

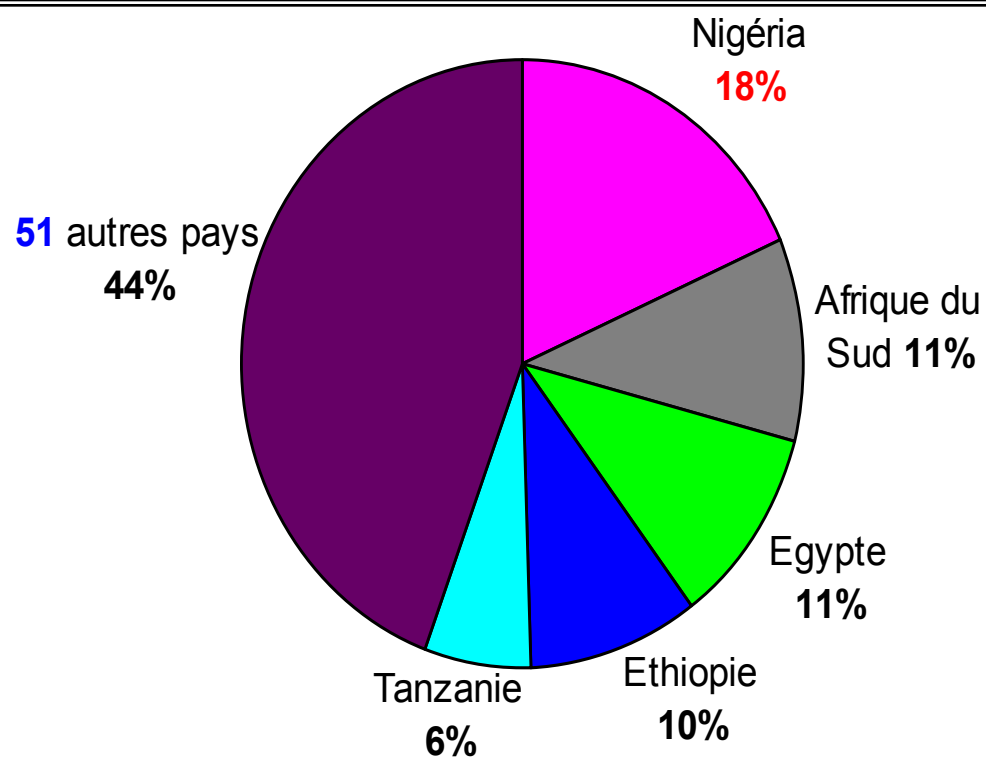
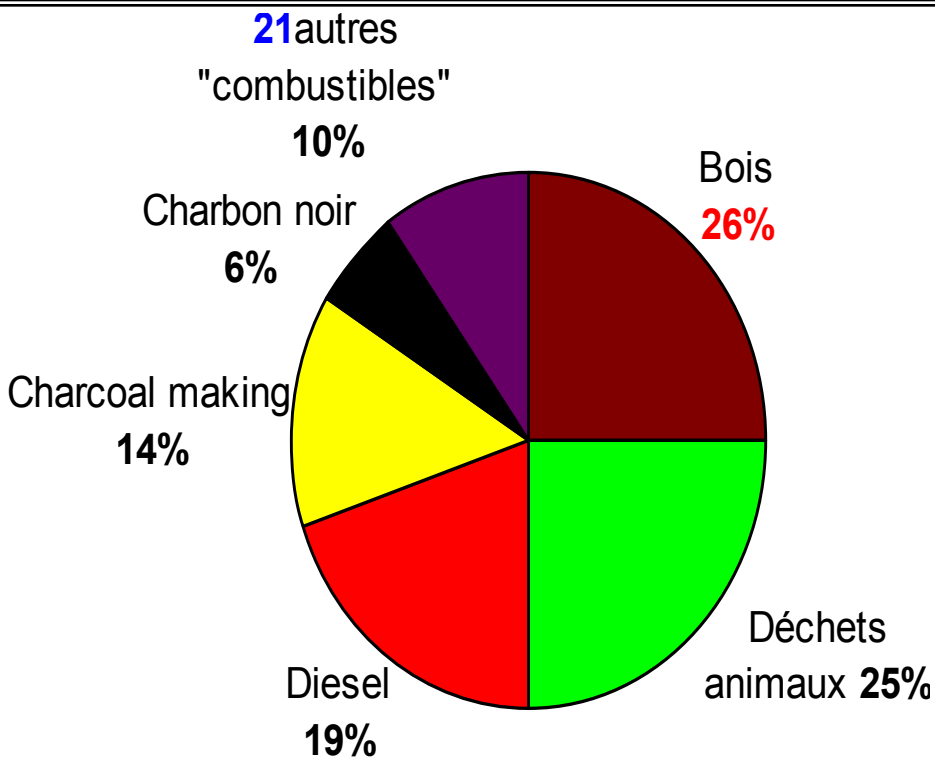
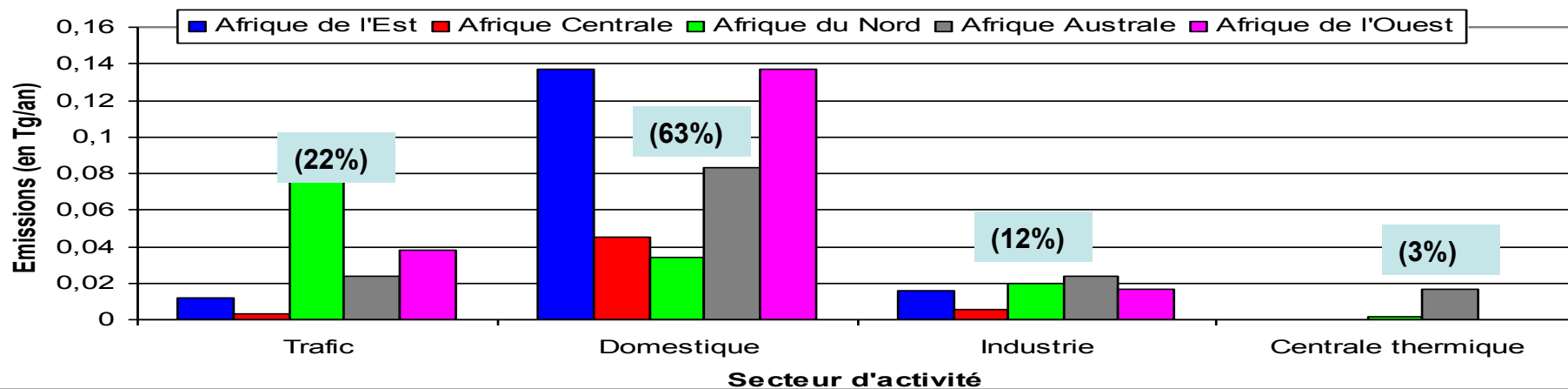
❑ Link to international programs : a regional office GEIA will be soon opened in Africa (GEIA conference, 2012)

❑ Impacts of african emission inventories

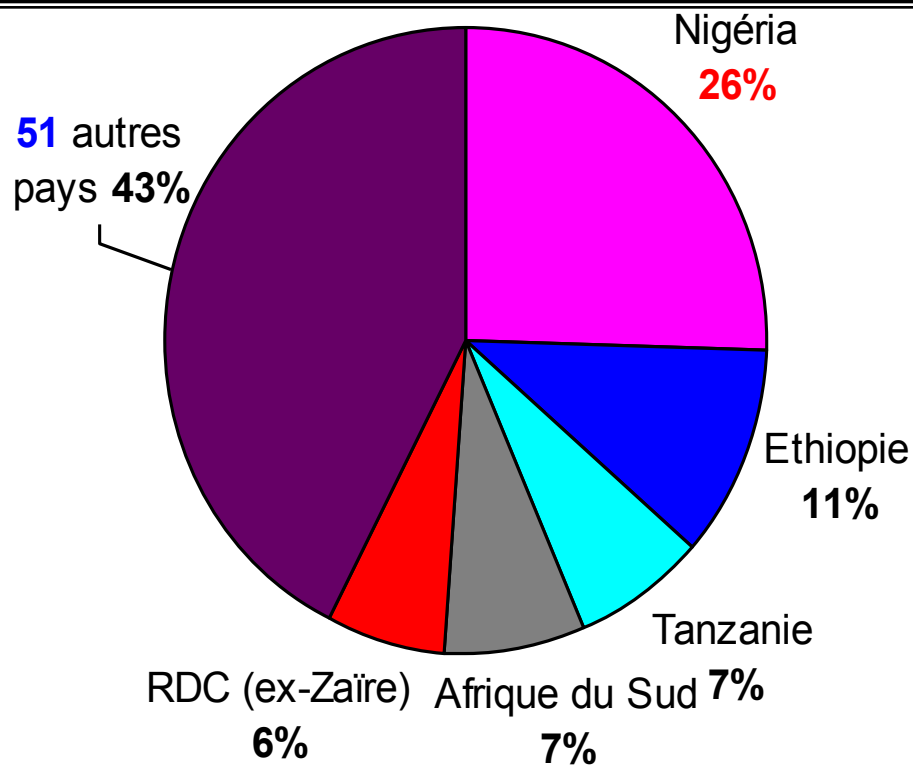
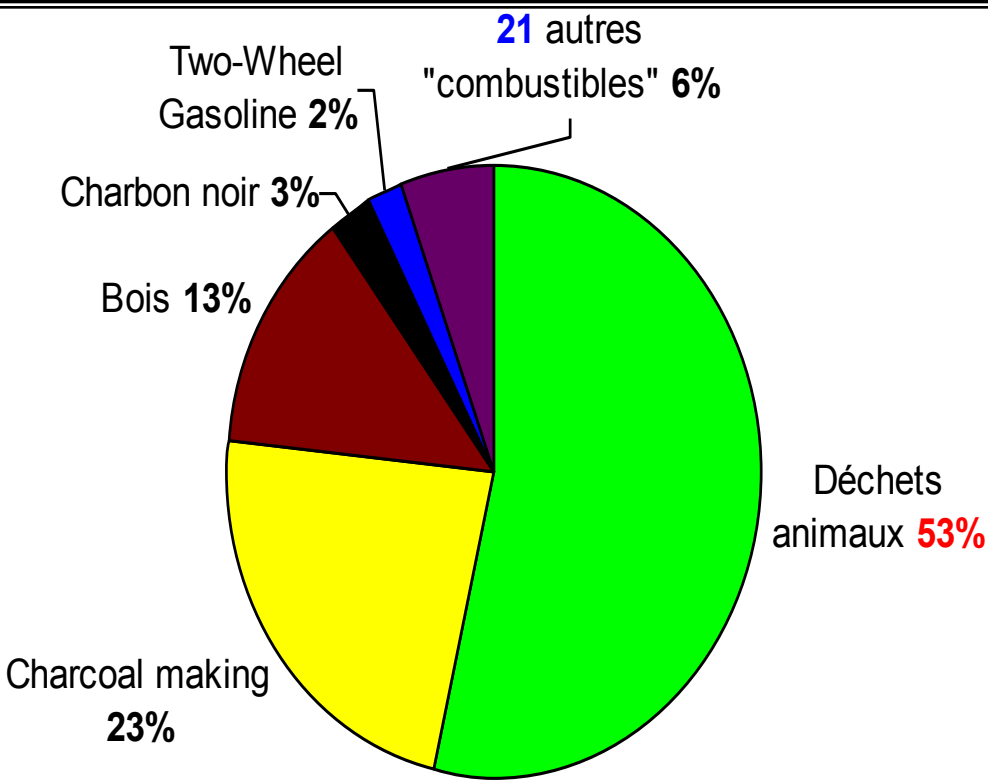
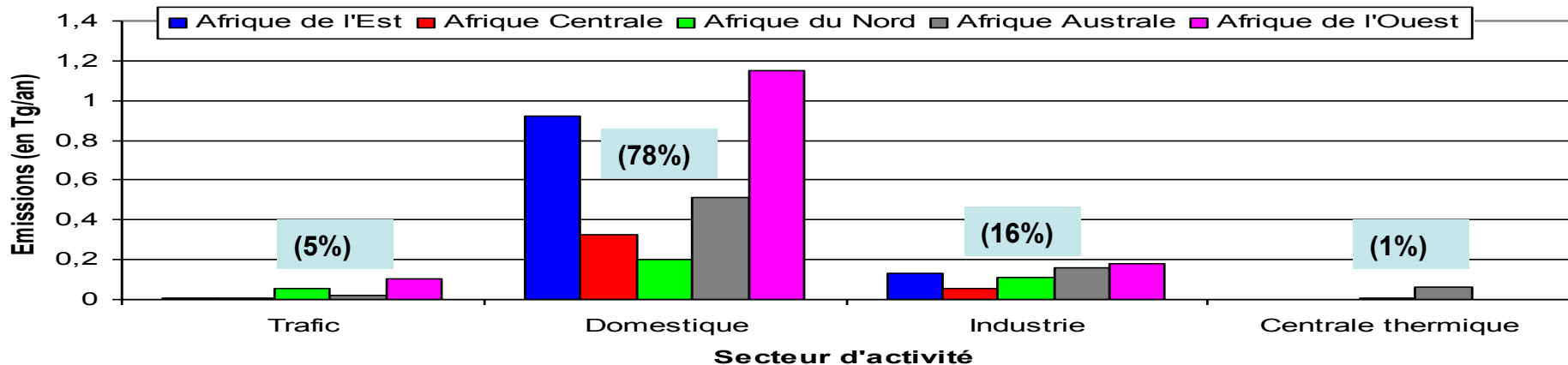




Emissions de carbone suie par région géographique et par secteur d'activité en Afrique en 2005



Emissions de carbone organique primaire par région géographique et par secteur d'activité en Afrique en 2005



Algorithme de construction des inventaires d'émissions

