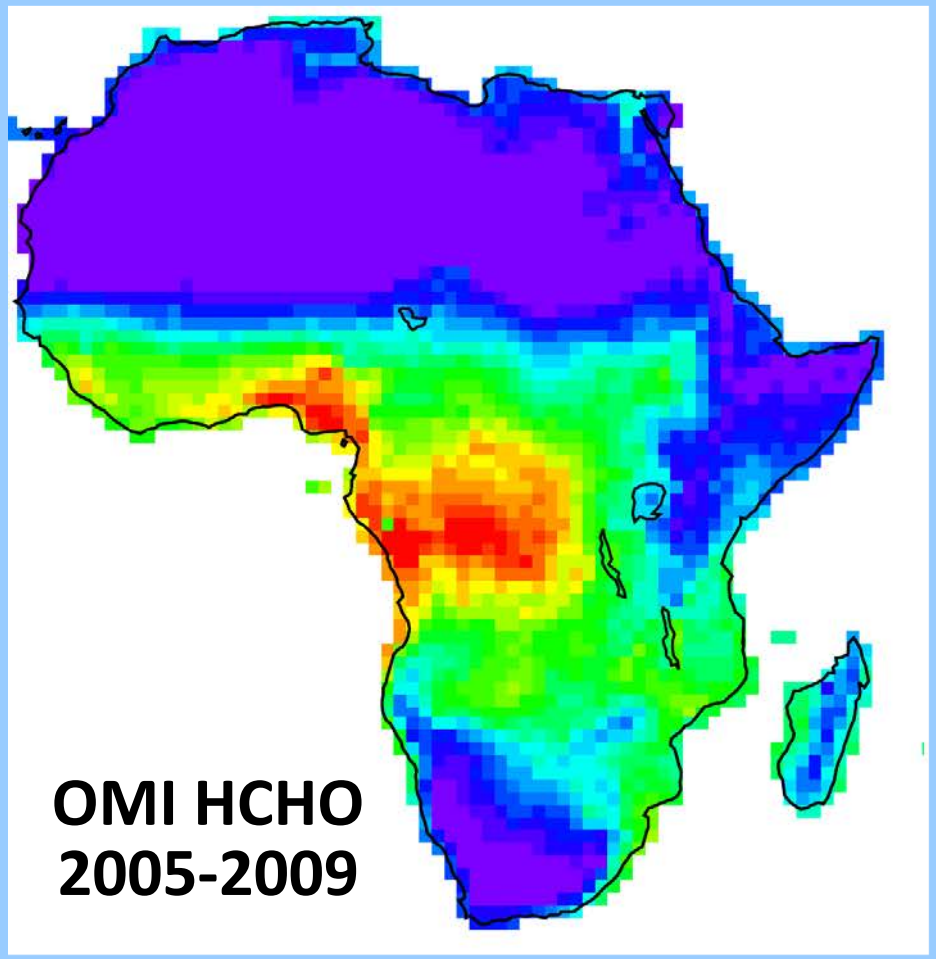
Impact of Economic Growth in Nigeria on Regional Air Quality



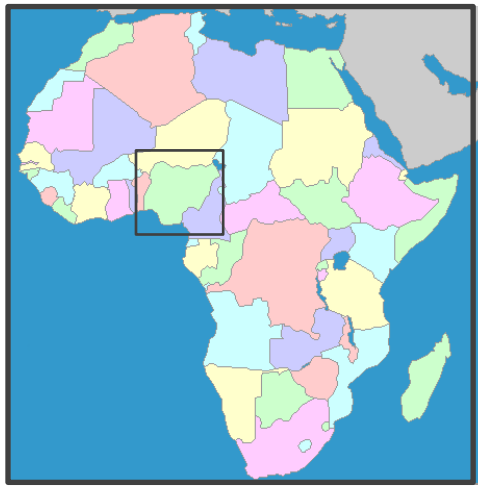
Eloïse Marais

D. J. Jacob, K. Wecht, C. Lerot, T. P. Kurosu, K. Chance

EGU, Vienna, 2013

Geography of Nigeria

Region of interest

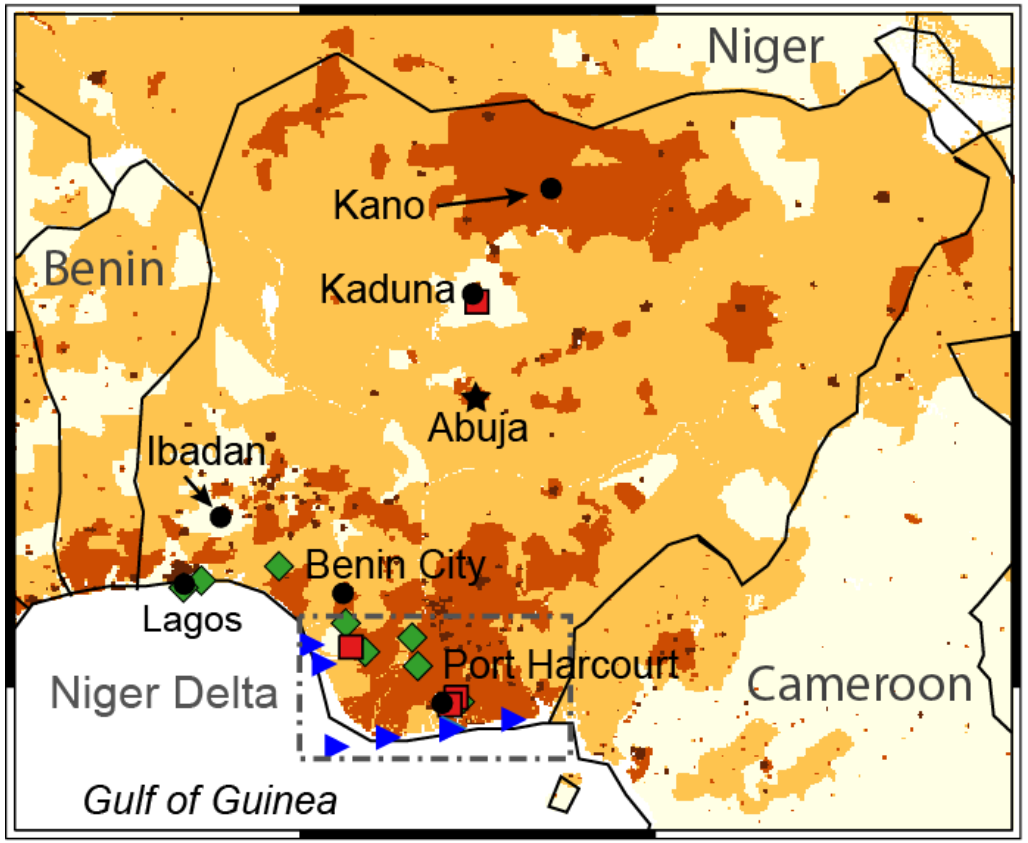


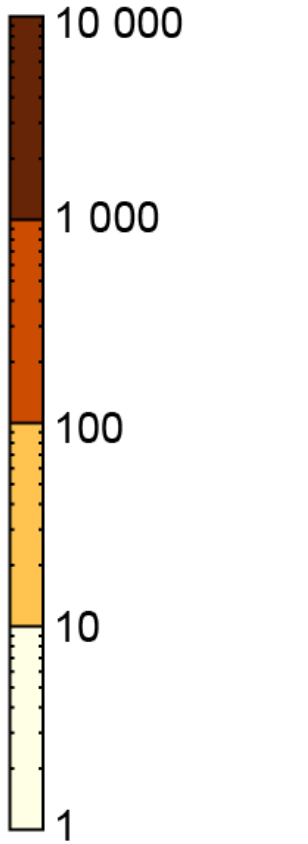
Population:

170 million (2.6% yr^{-1})

GDP:

USD 273 billion (7% yr^{-1})



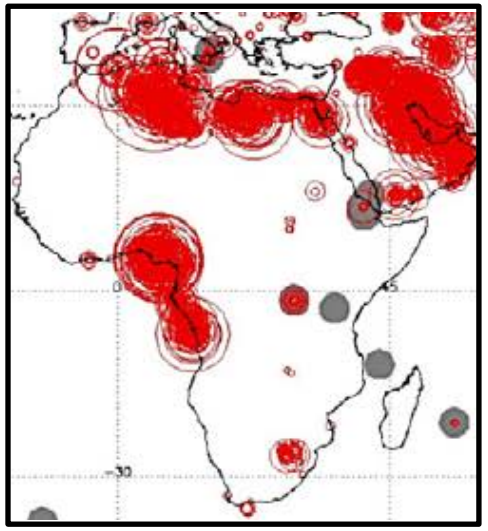


★ Capital (Abuja)
● Cities > 1.5 million people
■ Oil Refineries
▶ Export terminals
◆ Power Plants

Squandered Resources

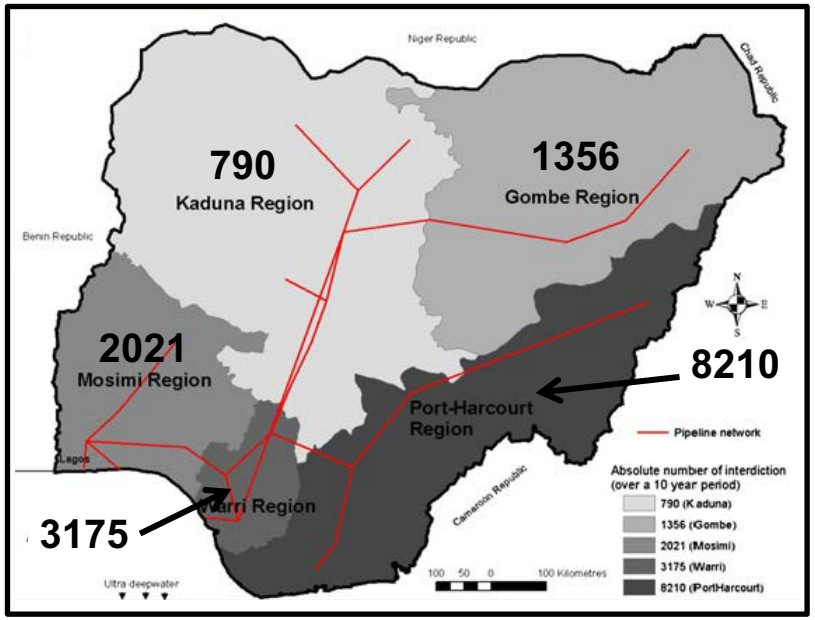
	Crude Oil	Natural Gas
Produced	2.1 million bbl/d	28 billion m^3
Wasted	0.1-0.4 million bbl/d	70% flared

AATSR flare hotspots



[Casadio et al., 2012]

Pipeline sabotages (1999-2008)



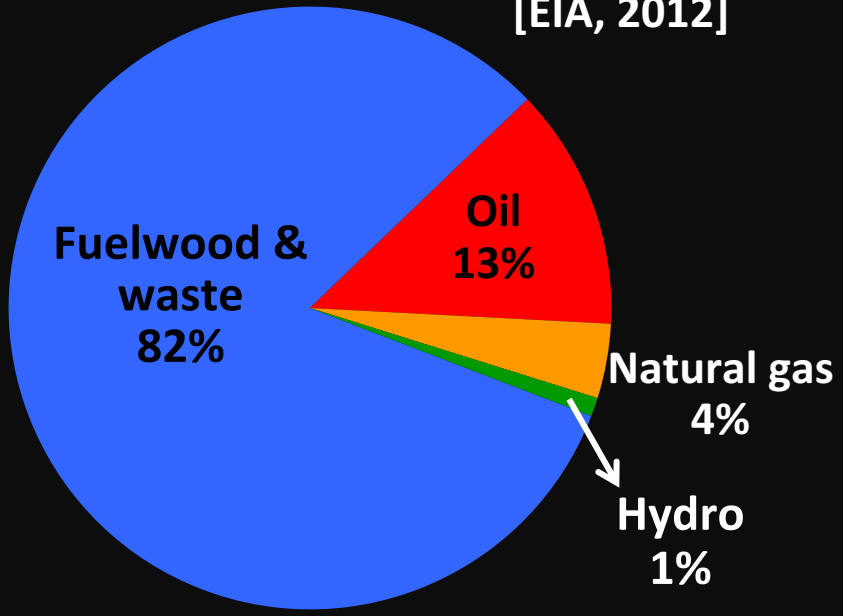
[Anifowose et al., 2012]

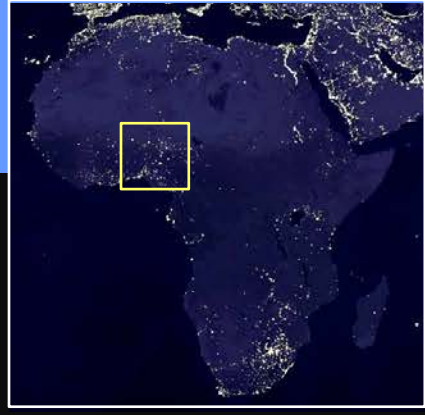
Illegal Oil Refining

A Country in the Dark

Nigeria's Energy Mix (2010)

[EIA, 2012]



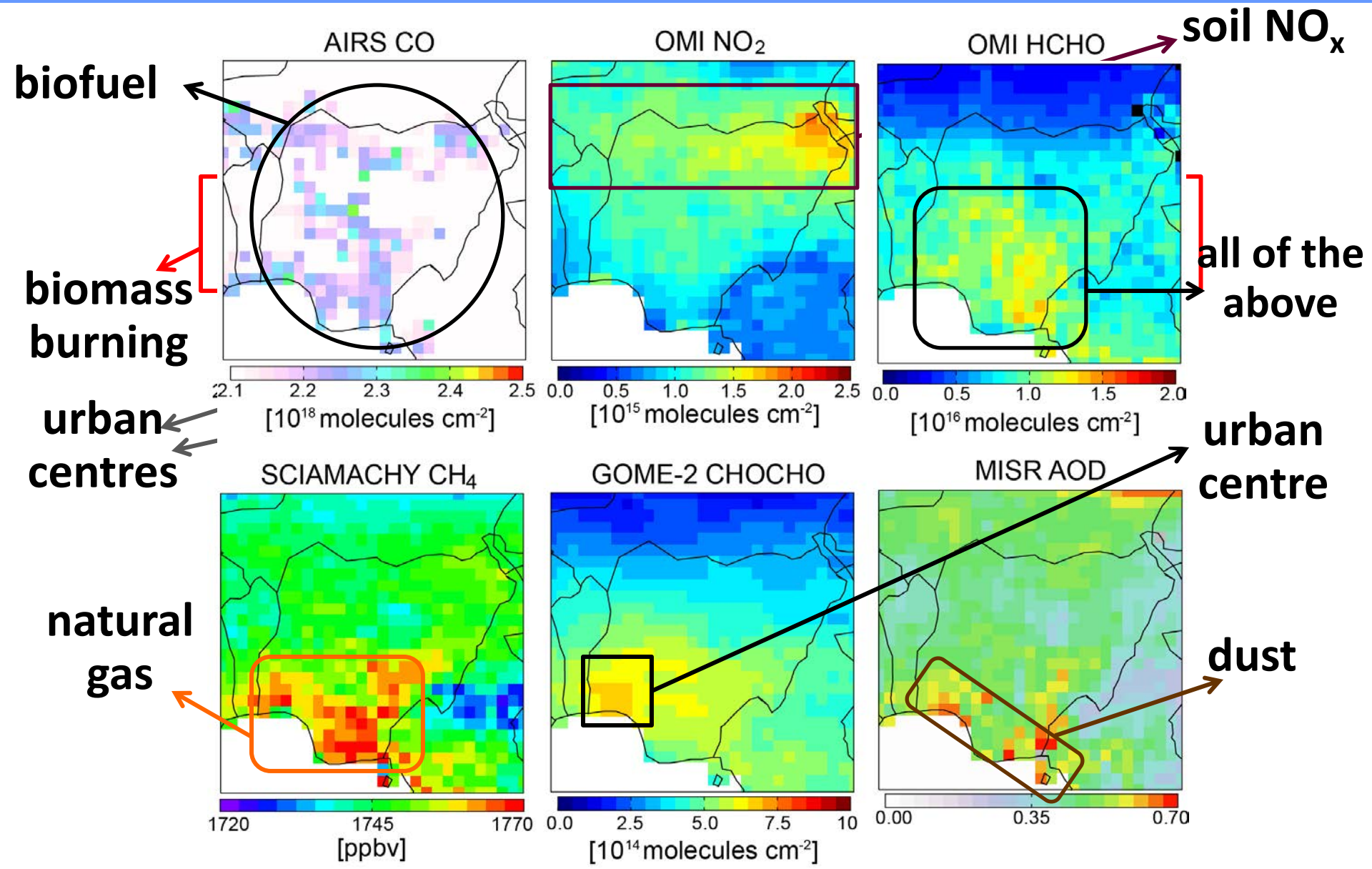


Earth Lights

Crude exported: **81%**

Refined petroleum imported: **49%**

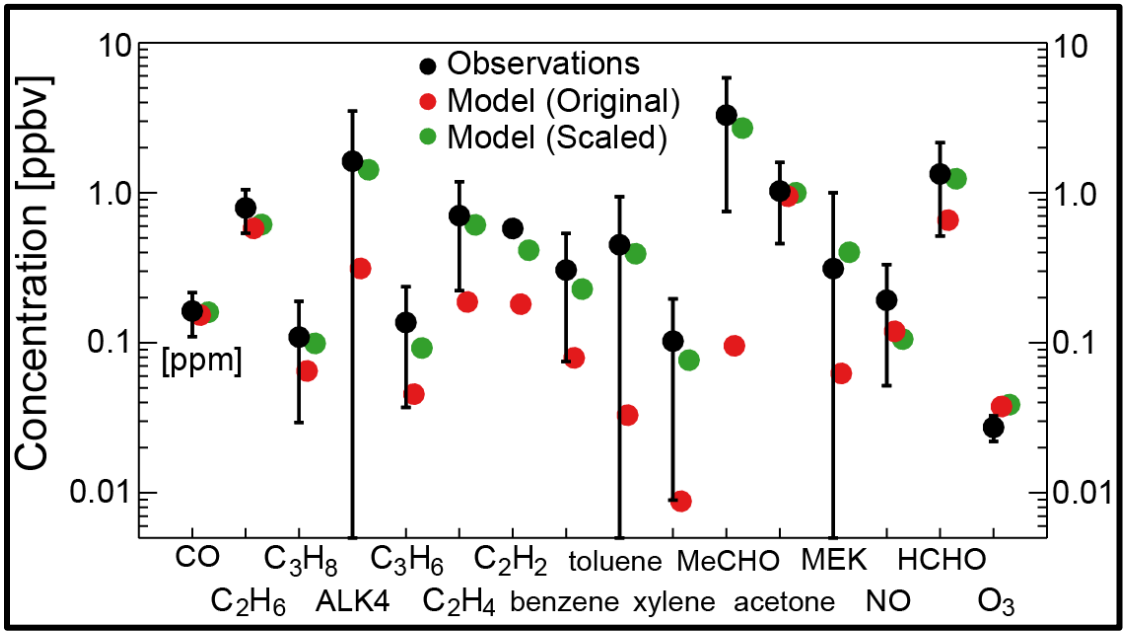
Air Quality in Nigeria



Air Quality in Nigeria

AMMA Aircraft Observations

8 August 2006 (15h00-17h00) [Hopkins et al., 2009]



GEOS-Chem with RETRO NMVOC and EDGAR NO_x emissions **before** and **after** emissions scaling.

benzene/toluene = **0.6**; **>1**, & **0.5**

Oxidation product **HCHO** increases

Very low NO_x: 1.3±1.3 ppbv

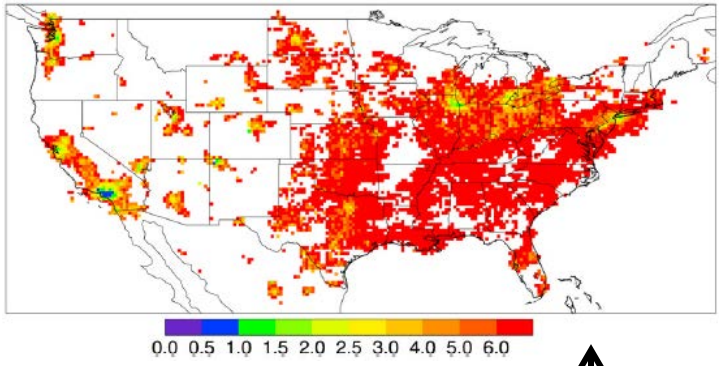
OMI HCHO/NO_2 (Ratio)

Ratio > 2 → **NO_x-limited**

Ratio < 1 → **NO_x-saturated**

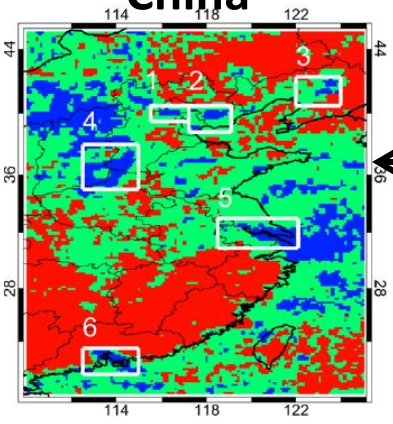
Lagos Ratio = 4-5

United States



Duncan et al., 2010

China



Witte et al., 2010

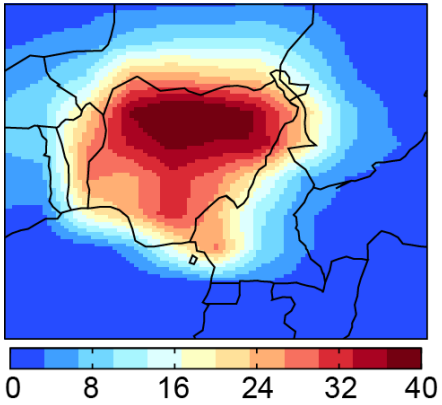
Nigeria's Prosperous Future (2050)

	TODAY	2050	Comments
Energy per capita [GJ/capita]	30	76	China's 2012 value is 76 GJ/capita
Population [millions]	170	390	World Bank and UN projections
NO_x Emissions [Tg NO_x]	0.3	10	Energy from coal, oil & gas

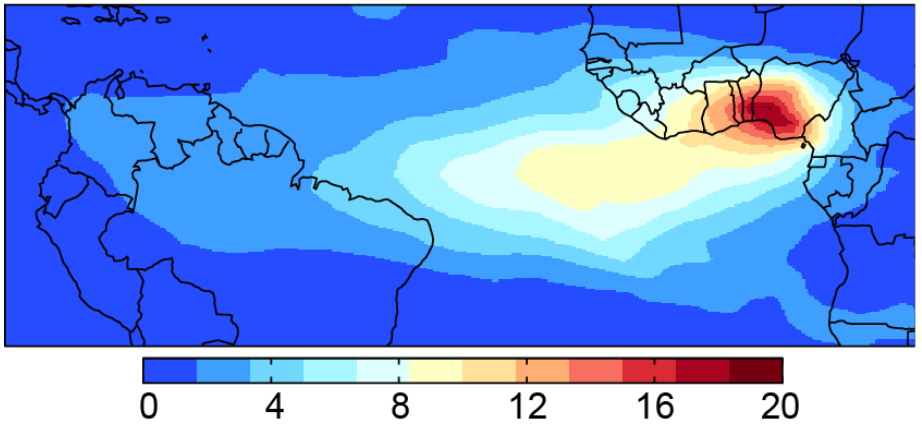
GEOS-Chem

ΔO_3 [ppbv] (July 2006)

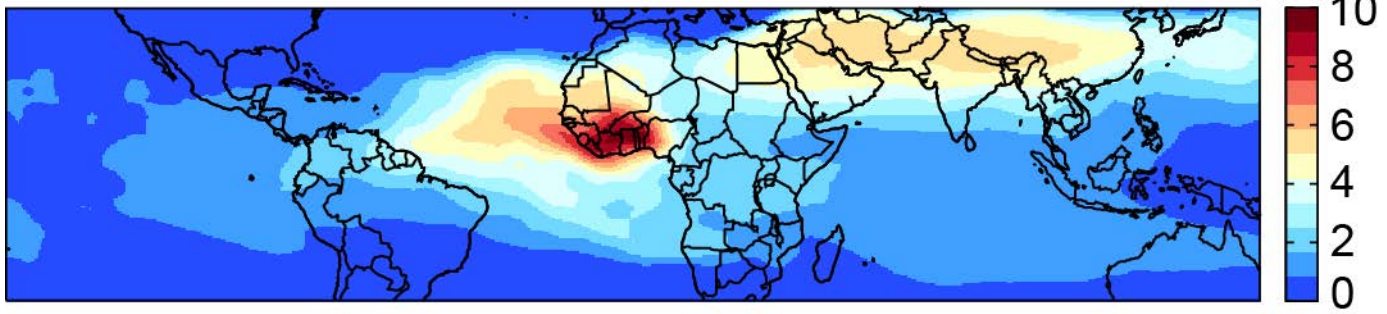
Below 900 hPa



600 hPa (African Easterly Jet)



200 hPa (Tropical Easterly Jet)



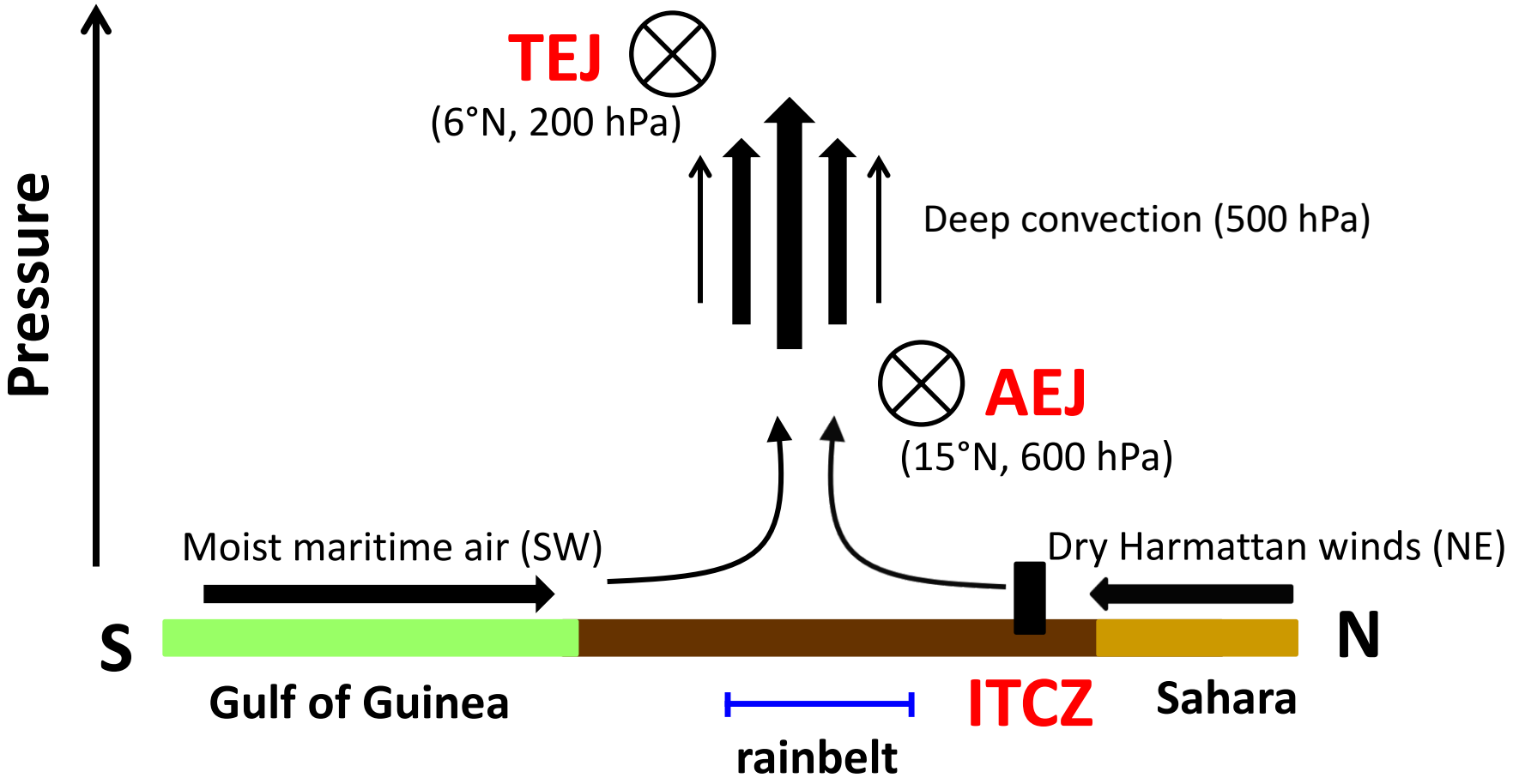
Concluding Remarks

- Nigeria has an unusual anthropogenic emissions mix: **high NMVOCs**, **low NO_x** (inefficient combustion; oil and gas leaks; inadequate power supply).
- O_3 in **NO_x-limited** Nigeria is sensitive to changes in NO_x emissions
- A prosperous Nigeria would require an efficient and reliable fuel source, leading to an **increase in NO_x emissions**.
- Impact of future NO_x emissions on **surface O_3** is low in southern Nigeria (well ventilated) and high in northern Nigeria (pollutant transport with onshore winds)
- Mid- and upper-tropospheric enhancement in O_3 is transported with the **African Easterly Jet** and **Tropical Easterly Jet**, respectively.

Supplementary Slides

Synoptic-scale Meteorology

The West African Monsoon over Nigeria in August



Nicholson, 2009