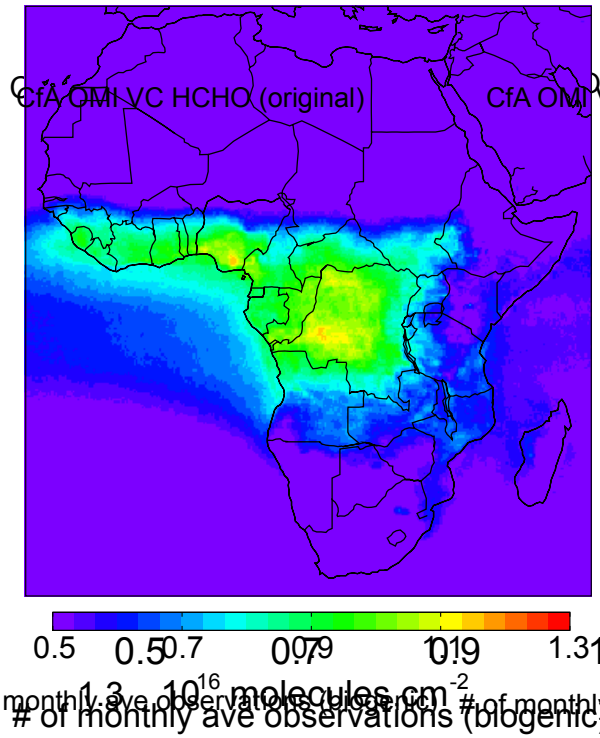
Shedding light on air quality in Africa using the Aura observation platform

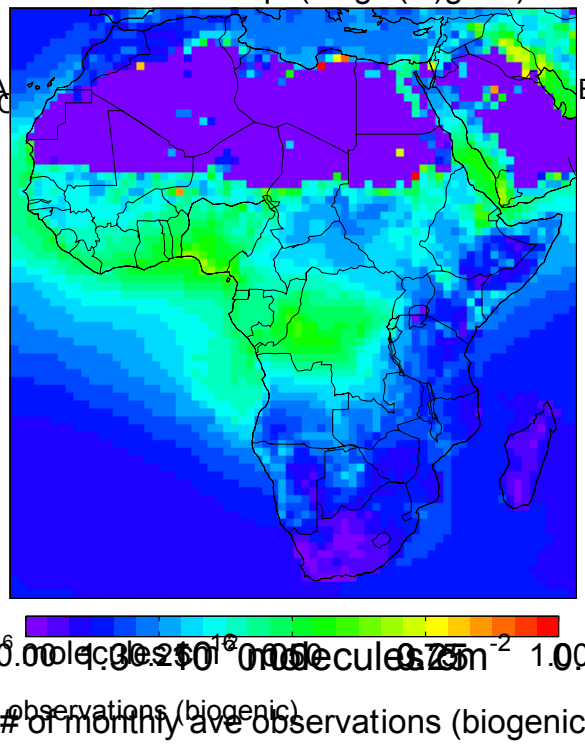
E. A. Marais (emarais@seas.harvard.edu)

D. J. Jacob, T. P. Kurosu, G. González Abad, K. Chance, L. Zhang, C. C. Miller

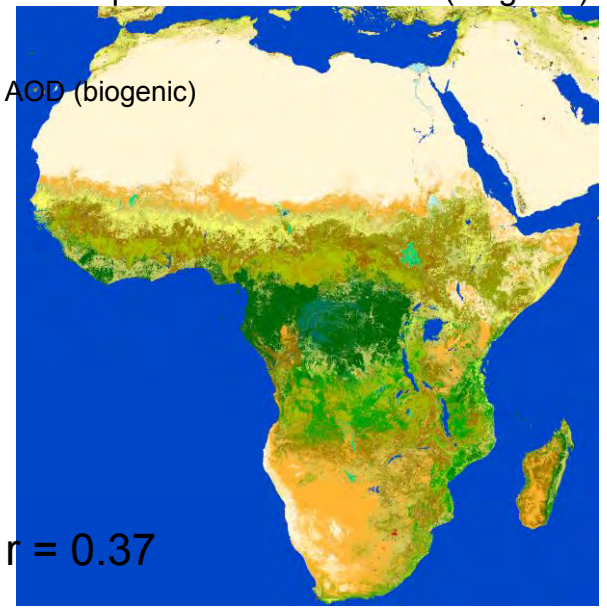
OMI VC HCHO (2005-2012) (Abad et al., 2014)



MODIS AOD (2005-2012) (C005, L3, Levy et al., 2010)



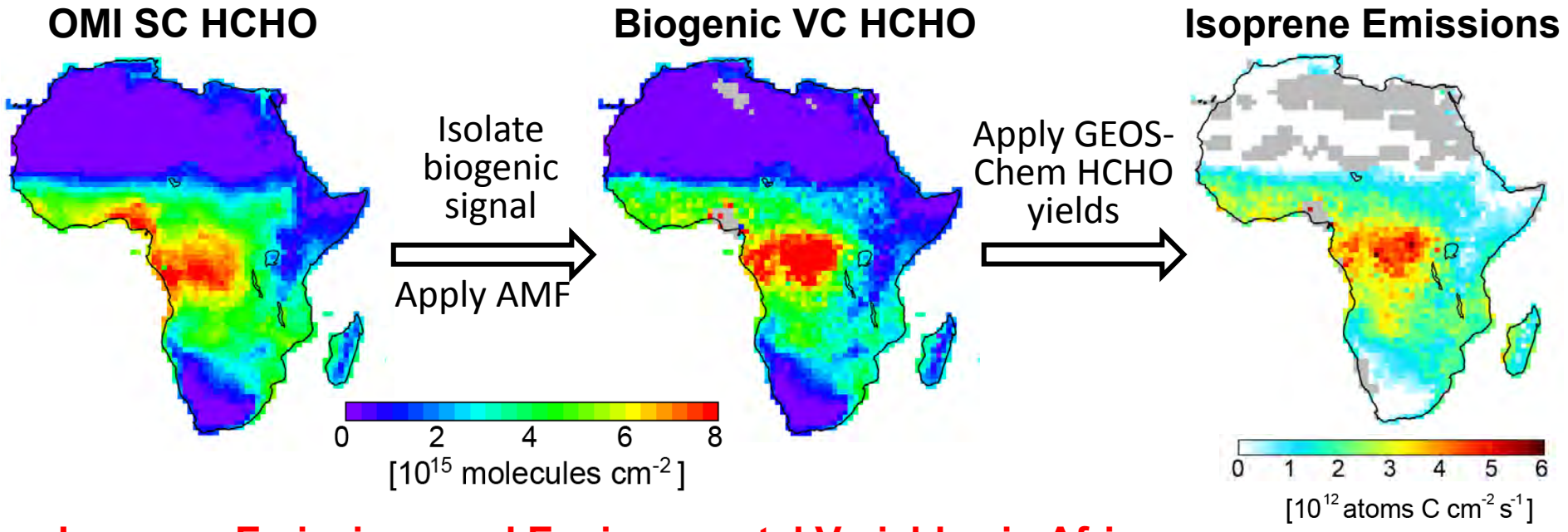
Land Cover (ESA GlobCover) (http://postel.obs-mip.fr)



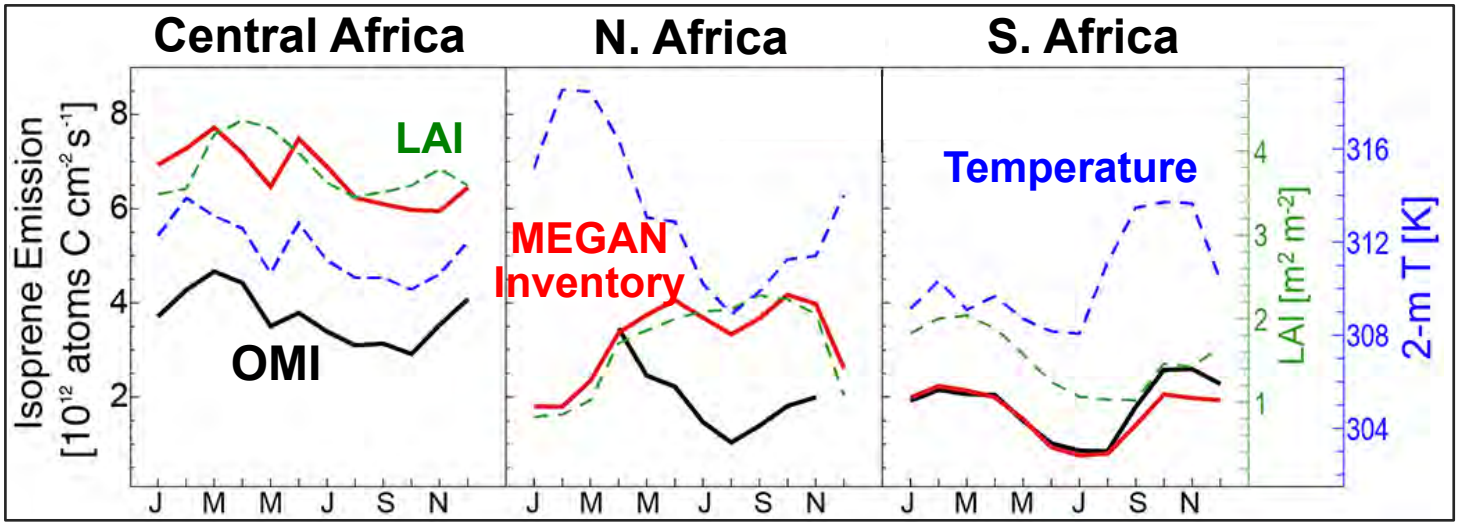
HCHO sources include seasonal open fires, anthropogenic influences (**Nigeria**), and biogenic (**isoprene emissions**).

Isoprene emissions from vegetation in Africa

Isoprene is a reactive volatile organic compound with climate and health effects



Isoprene Emissions and Environmental Variables in Africa



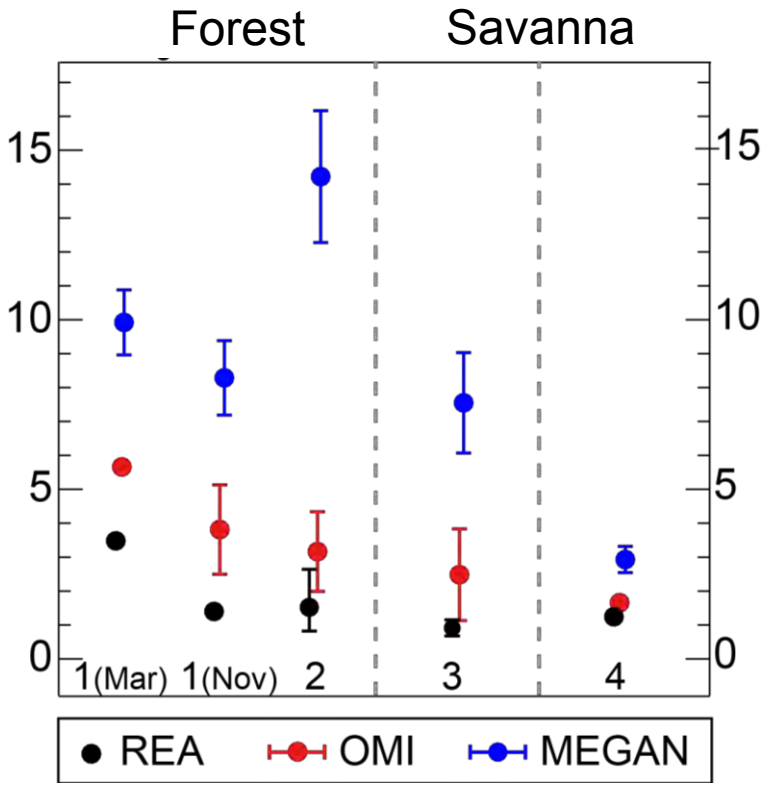
Temperature and **LAI** are dominant environmental drivers in Africa

Marais et al. (2012; 2014a)

Isoprene emissions from vegetation in Africa

OMI-derived isoprene emissions are more consistent then MEGAN with field observations

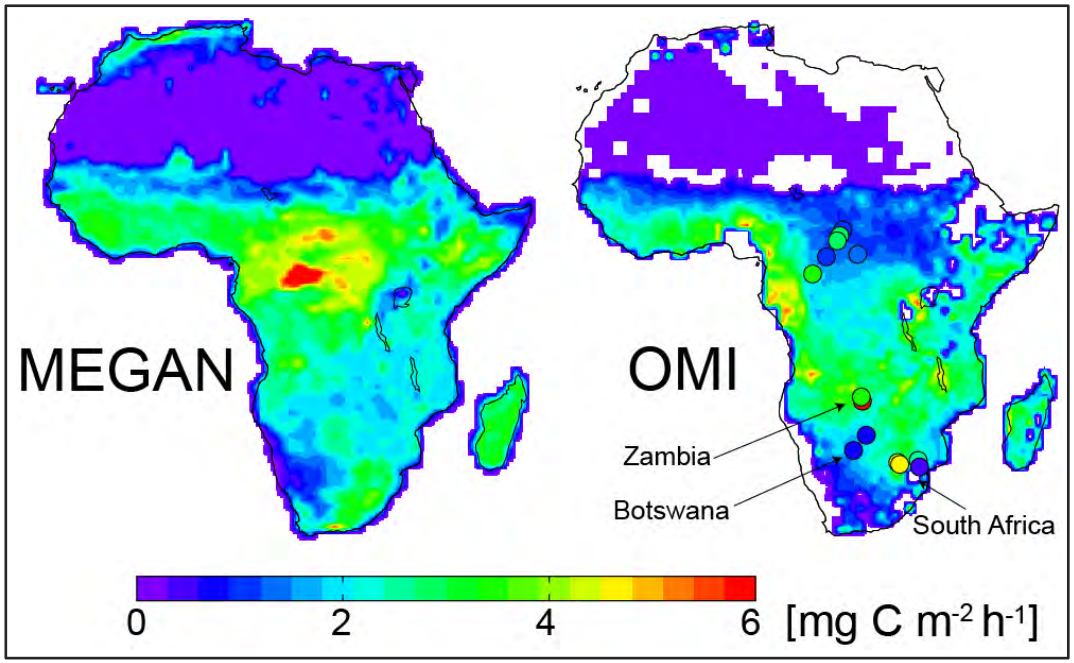
Isoprene emissions (E_{ISOP})
[10^{12} atoms C cm^{-2} s^{-1}]



Marais et al. (2014a)

MEGAN: $$E_{ISOP} = E_0 \times \gamma$$

Isoprene emissions at standard conditions (E_o)

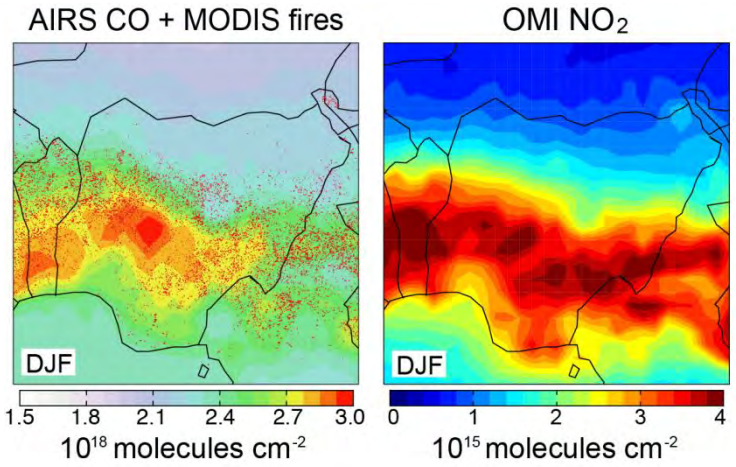


Isoprene emissions are **70 Tg C** in our update inventory (MEGAN gives 104 Tg C)

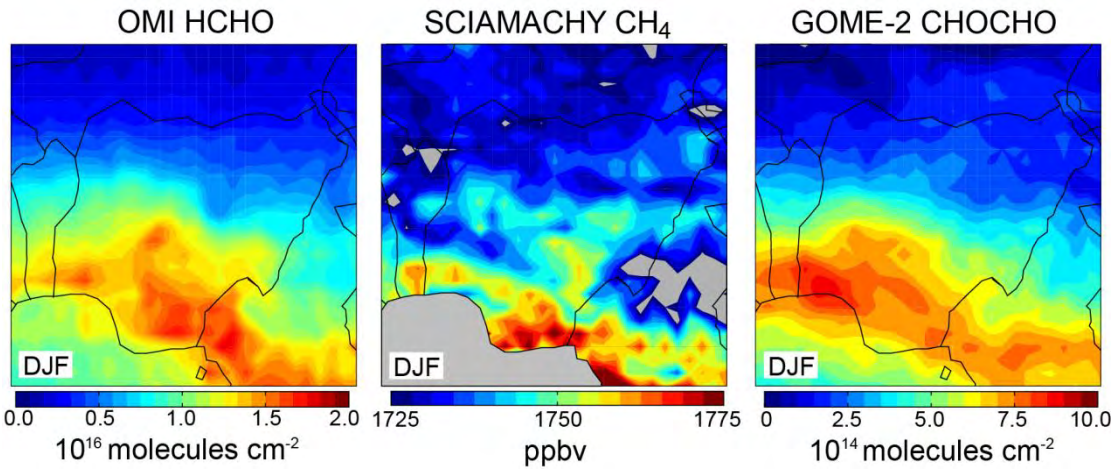
Atmospheric ozone pollution in Nigeria

Nigeria (pop. 170 million) has inefficient combustion, large sources of NMVOCs and is experiencing rapid economic and population growth.

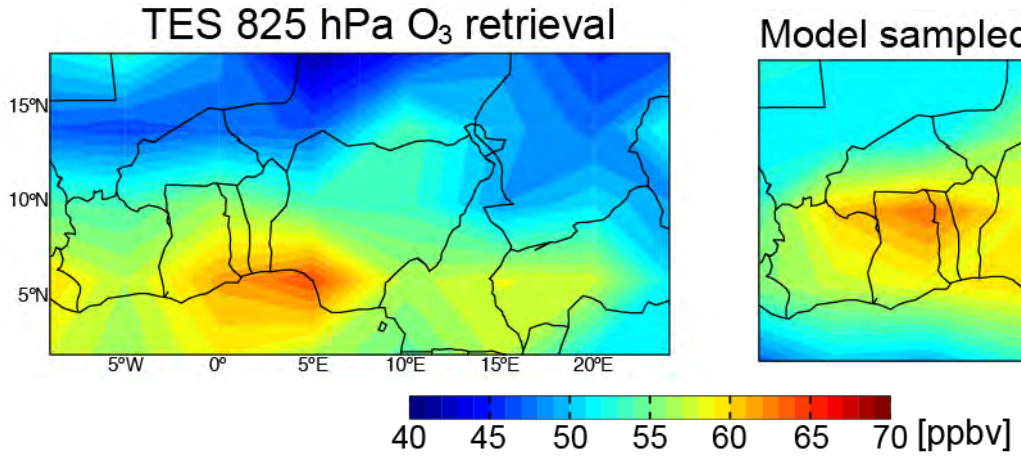
Seasonal open fires



Anthropogenic Volatile Organic Compounds



Implications for atmospheric ozone pollution (DJF in 2006)

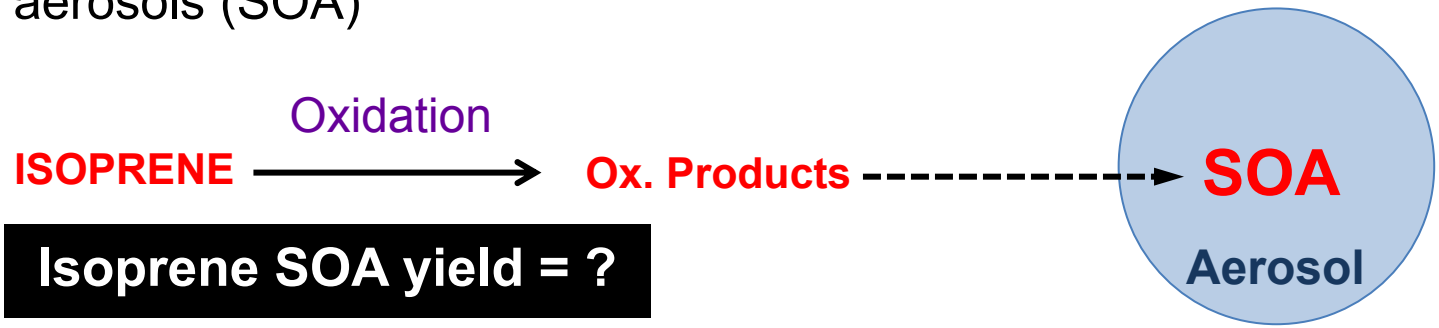


GEOS-Chem DJF
surface O_3 > 70 ppbv

Marais et al., 2014b

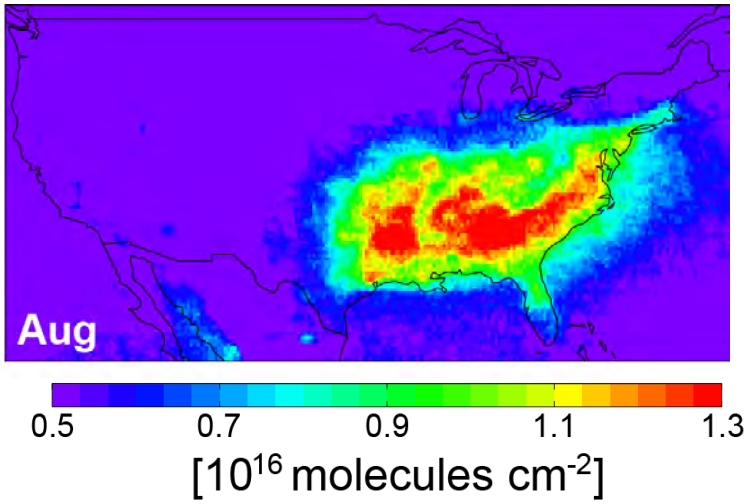
Aerosol yields from isoprene

Isoprene oxidation products partition to the aerosol phase and form secondary organic aerosols (SOA)

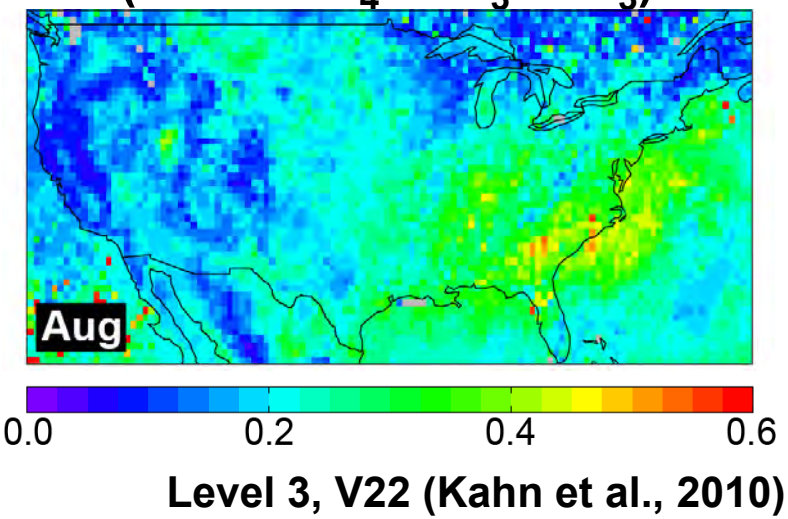


Convert satellite **AOD-HCHO relationship** to a yield of SOA from isoprene (use summertime observations in the **southeast US (SEUS)** as a test bed)

OMI HCHO (2005-2012) (biogenic signal)



MISR AOD (2005-2012) ($SOA+SO_4+NO_3+NH_3$)



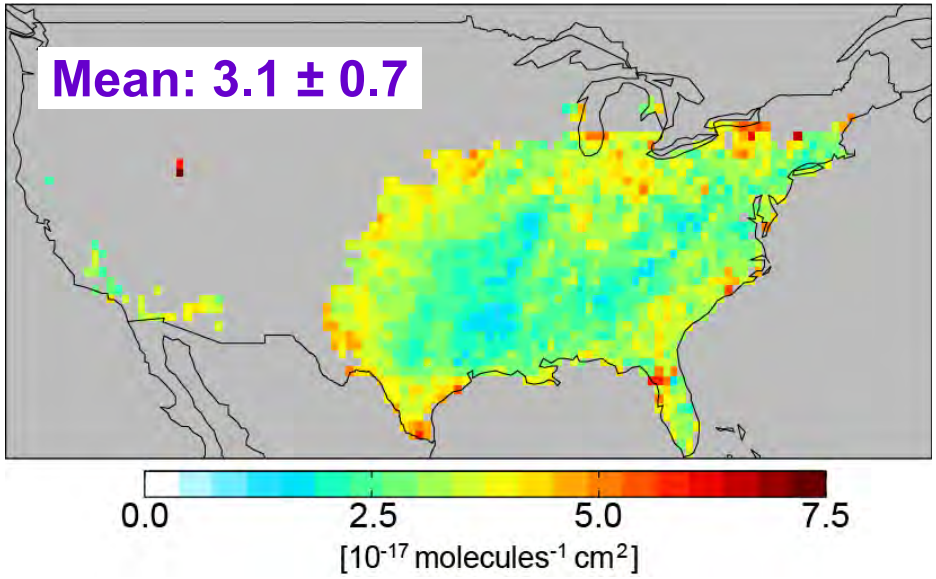
Level 3, V22 (Kahn et al., 2010)

Aerosol yields from isoprene (SEUS)

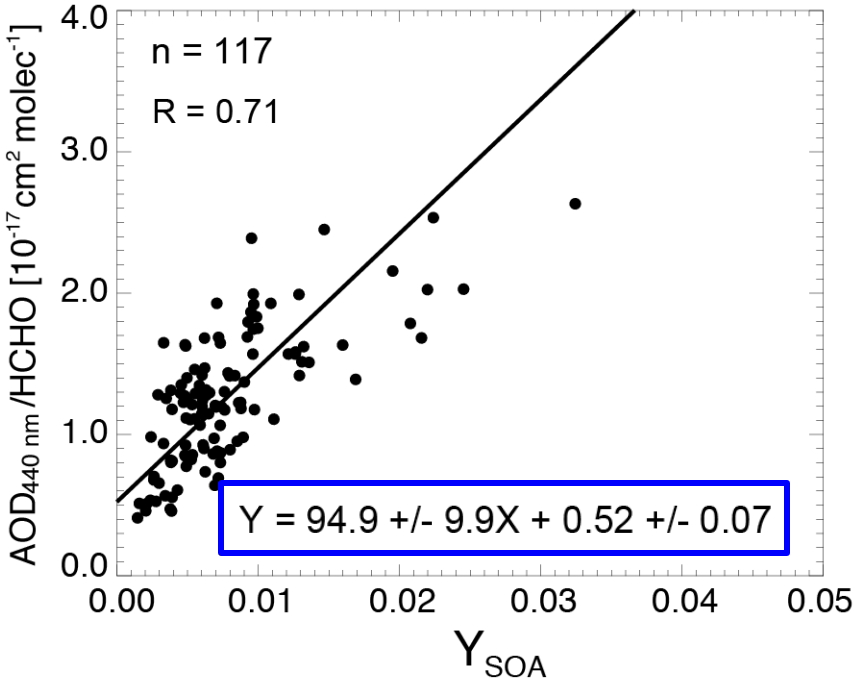
Obtain yields of isoprene SOA with satellite observations of HCHO from OMI and AOD from MISR and MODIS

MISR AOD:OMI HCHO (August)

(Scenes with Ω_{HCHO} > 5 x 10^{15} molec cm^{-2})



GEOS-Chem Transfer Function



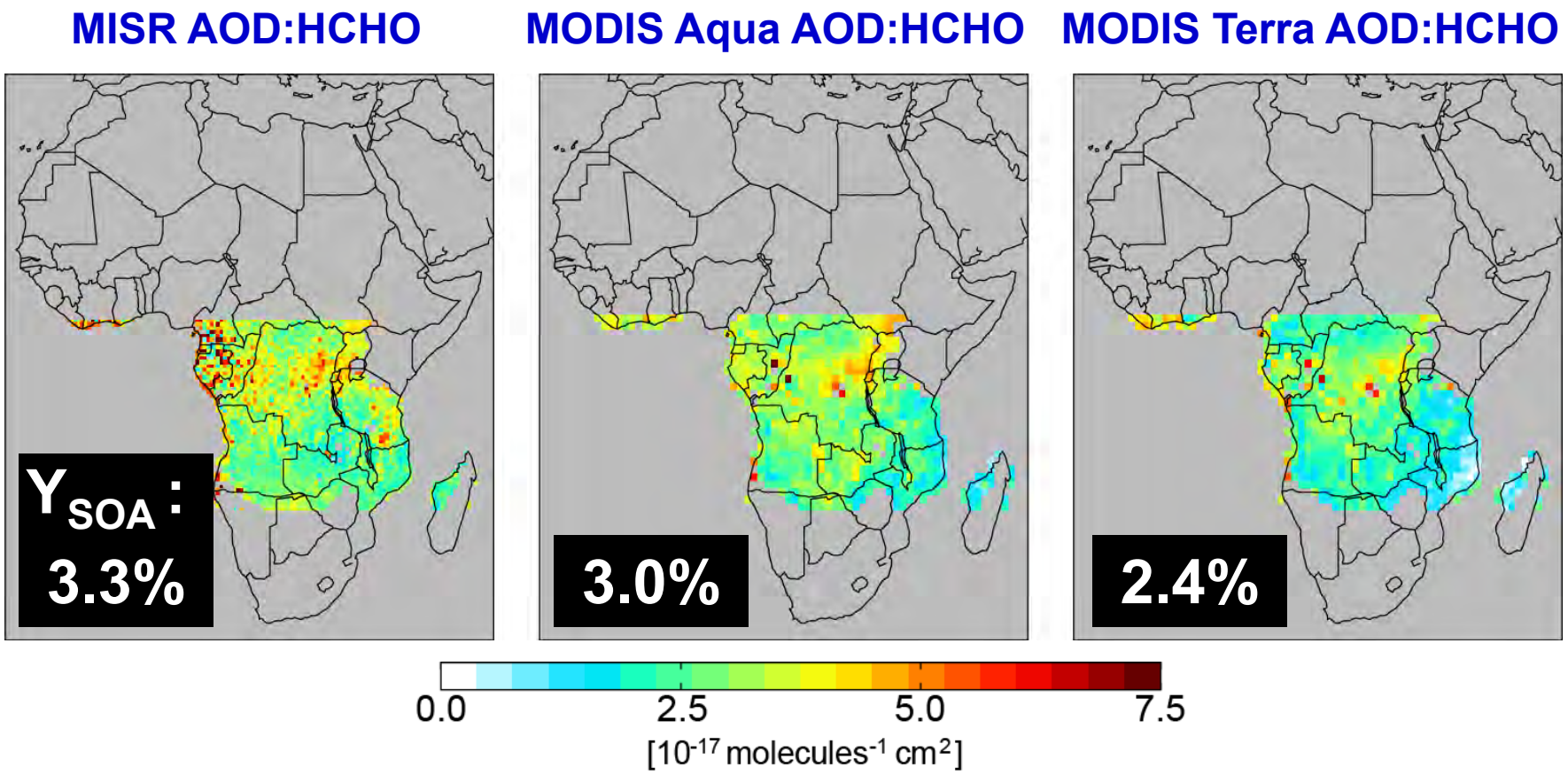
Y_{SOA} = 2.7% for the SEUS in August obtained with MISR AOD

MODIS Aqua average = **3.0 ± 0.8 x 10^{-17} (2.6%)**

MODIS Terra average = **2.7 ± 0.7 x 10^{-17} (2.3%)**

Aerosol yields from isoprene (Africa)

Satellite AOD:HCHO ratio in **Africa** for scenes filtered for biomass burning



Satellite-derived yields fall within the range from chamber studies (1-10%).

Slightly **higher yields** obtained over **Africa** than SEUS, as AOD is similar for the two regions, but the biogenic signal over Africa is lower.

Conclusions and Ongoing Work

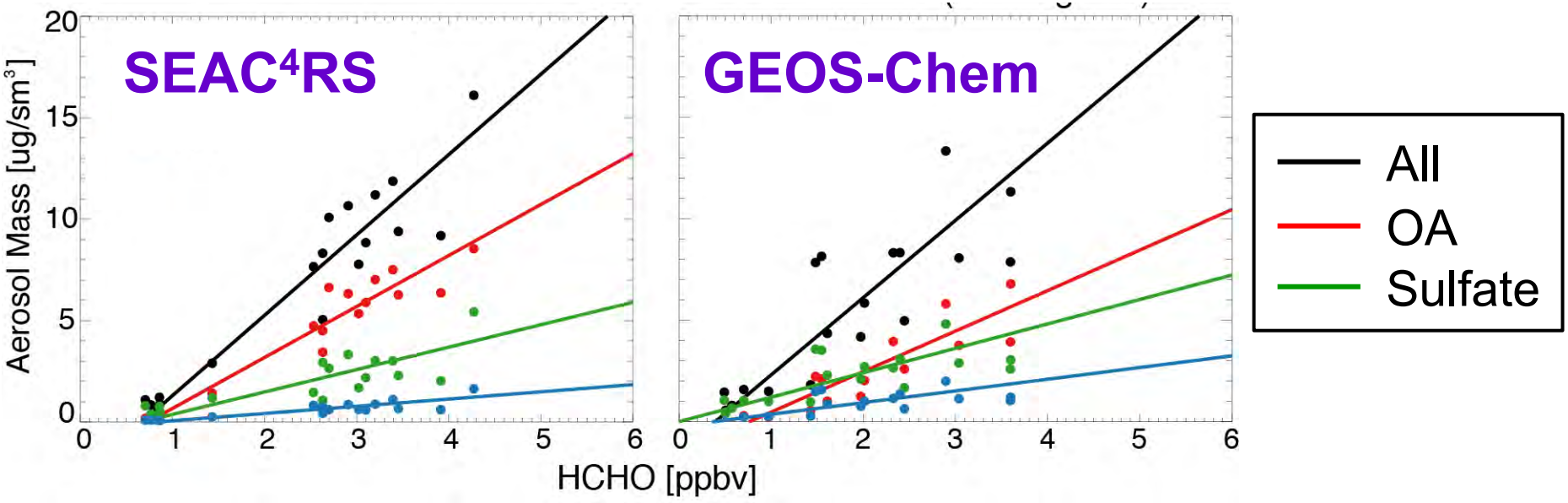
OMI HCHO and coincident observations from Aura (and other NASA satellites) have been effectively used in Africa to:

1) Quantify **isoprene emissions** in Africa
2) Identify temperature and LAI as dominant drivers of **isoprene seasonal variability**
3) Estimate NMVOC emissions and provide constraints to evaluate **atmospheric ozone pollution** in **Nigeria**
4) Obtain **isoprene yields of SOA** representative of the ambient atmosphere for Africa and the SEUS

NEXT: Evaluate the **climate impact** of isoprene using our updated isoprene SOA yields

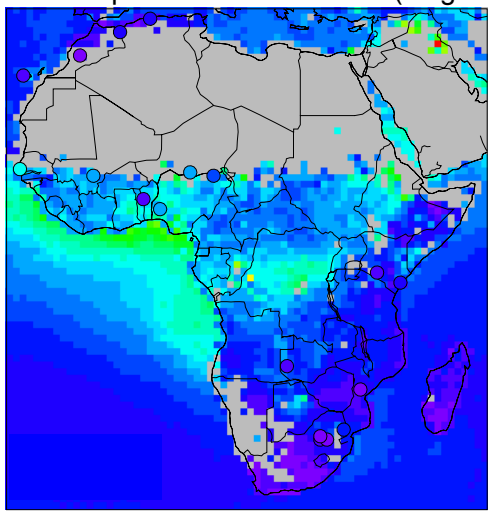
Supplementary Slide: Aerosol yields from isoprene

GEOS-Chem captures the HCHO-AOD relationship over the US, but not Africa

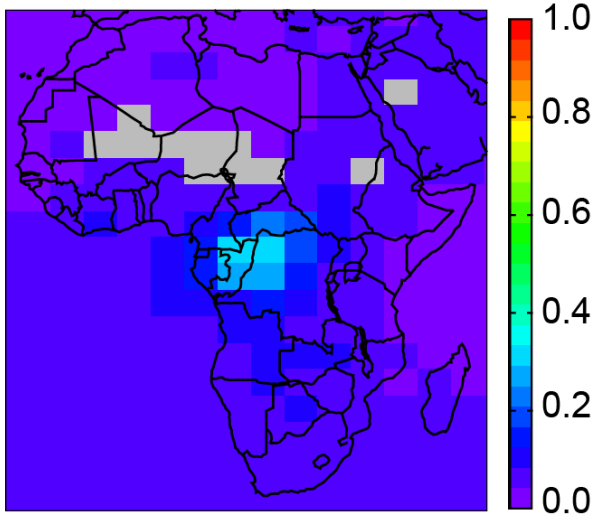


MODIS biogenic AOD

MODIS Aqua & AERONET AOD (biogenic)



GEOS-Chem (10*AOD)



GEOS-Chem biogenic AOD:HCHO is an order of magnitude too low in Africa.