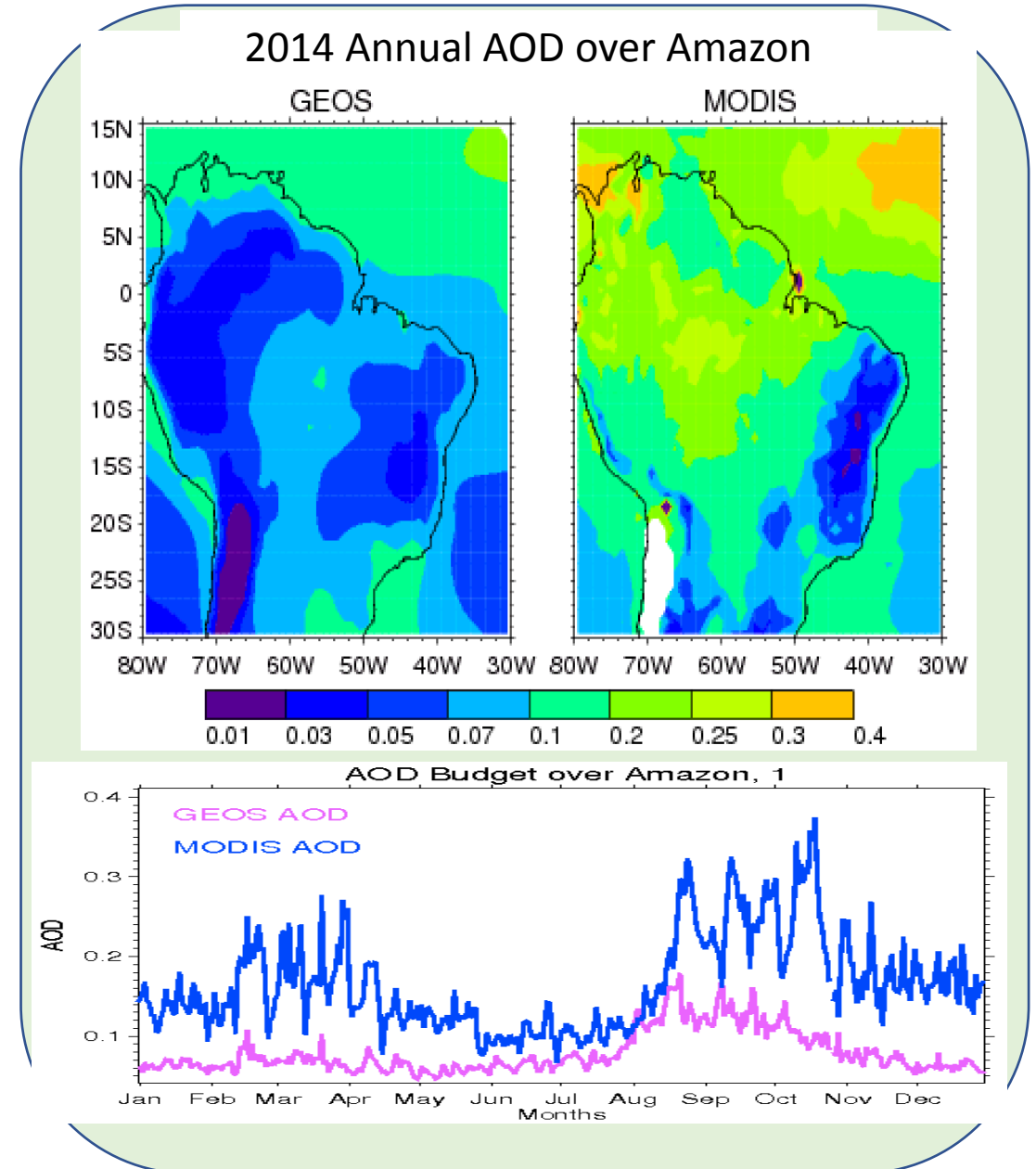# Improvement of aerosol simulation over Amazon

Huisheng Bian, Anton Darmenov, Pete Colarco, Mian Chin, Dongmin Lee, Fanwei Zeng, Donifan Barahona, Eunjee Lee, Randal Koster, and Hongbin Yu
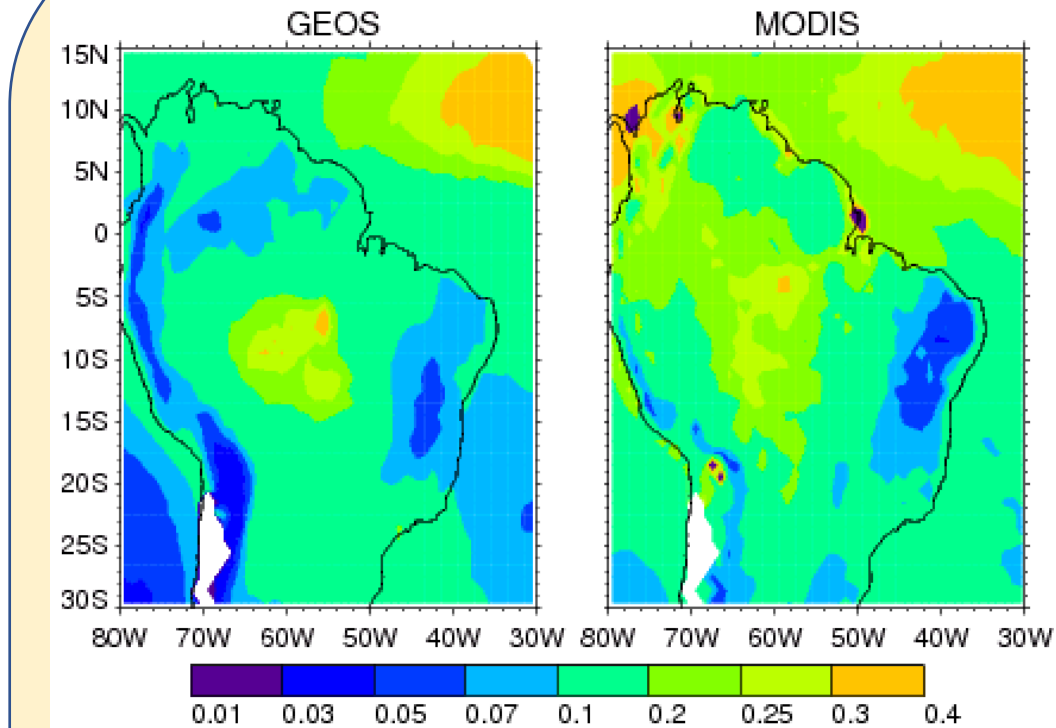
Aerocom Workshop
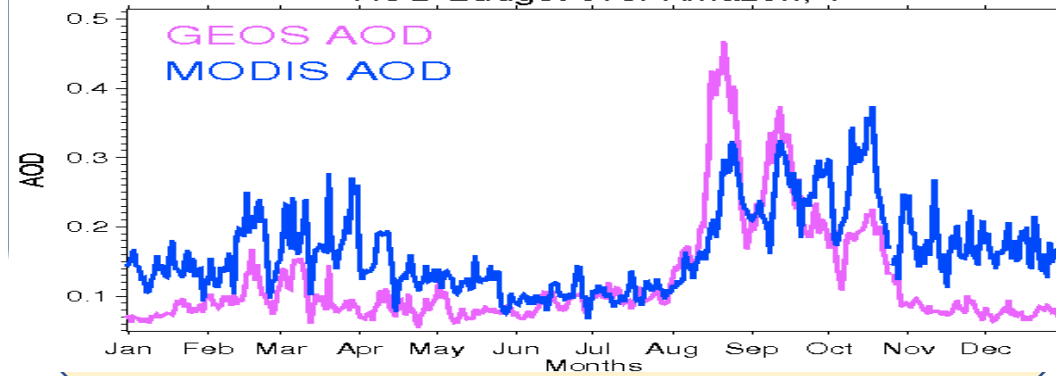September 26, 2019

**Motivation**

What we start with



2014 Annual AOD over Amazon

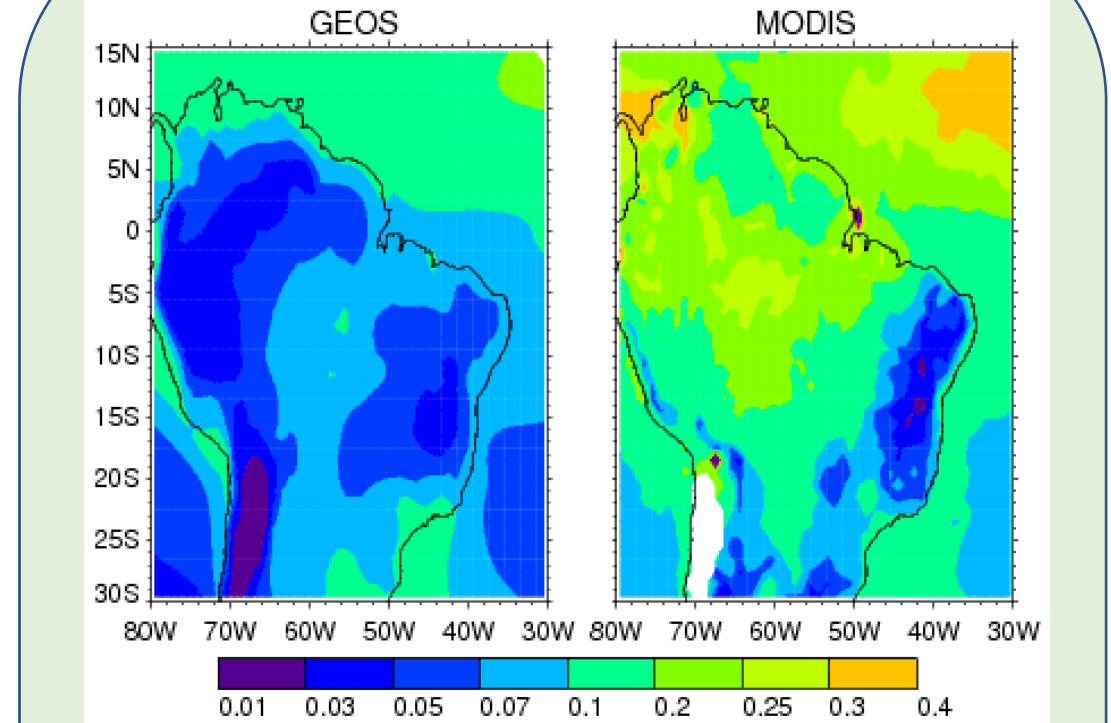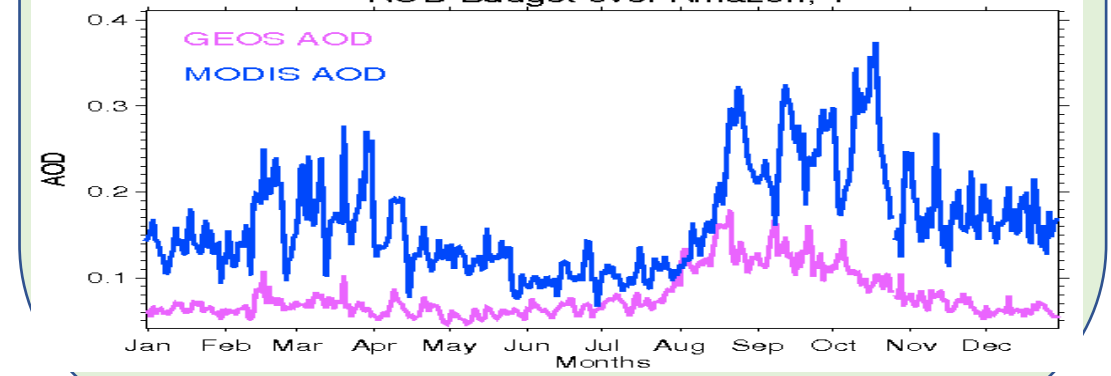# What we have now

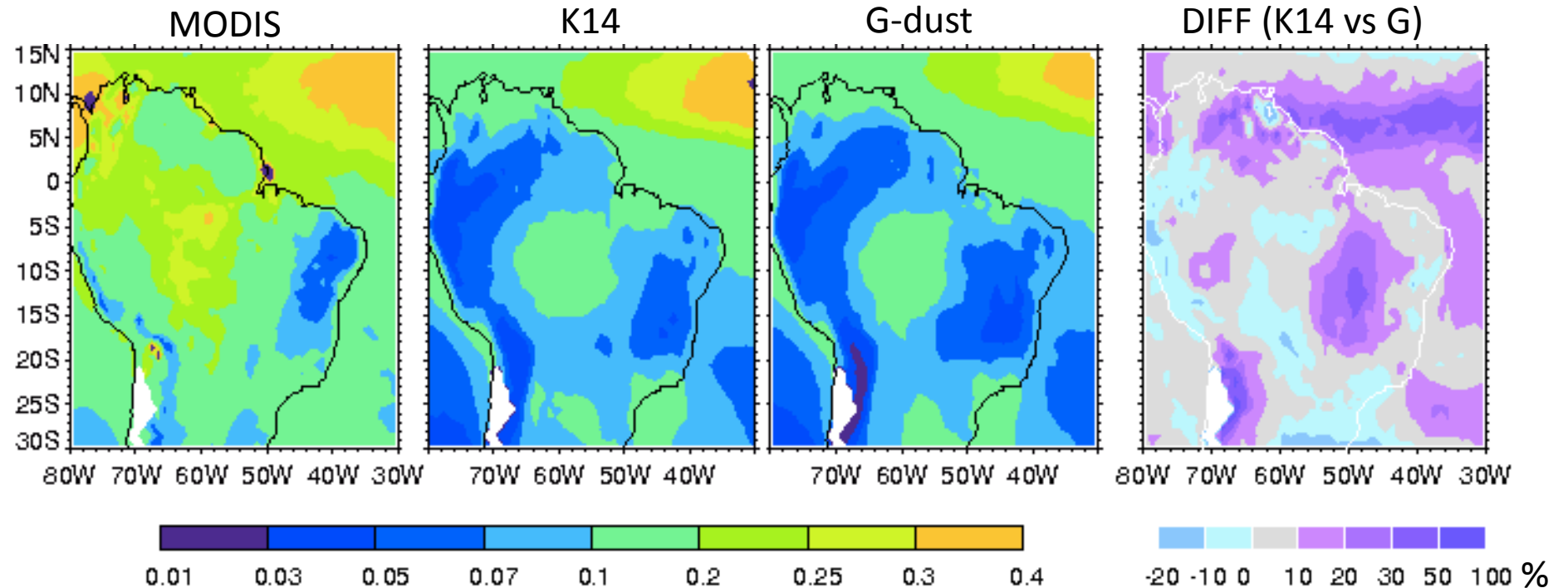## 2014 Annual AOD over Amazon



# What we start with

## 2014 Annual AOD over Amazon
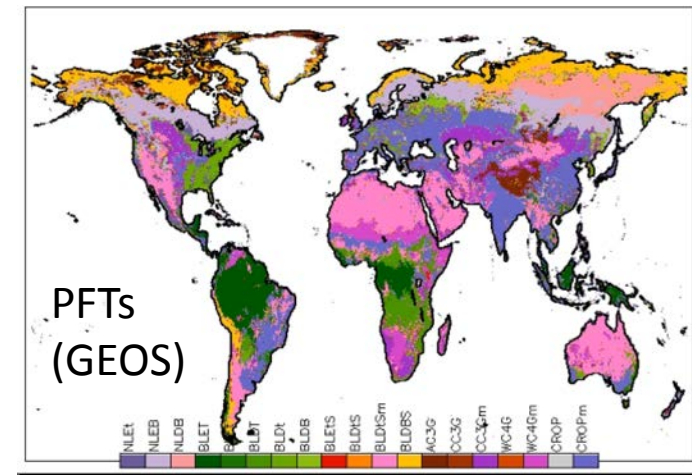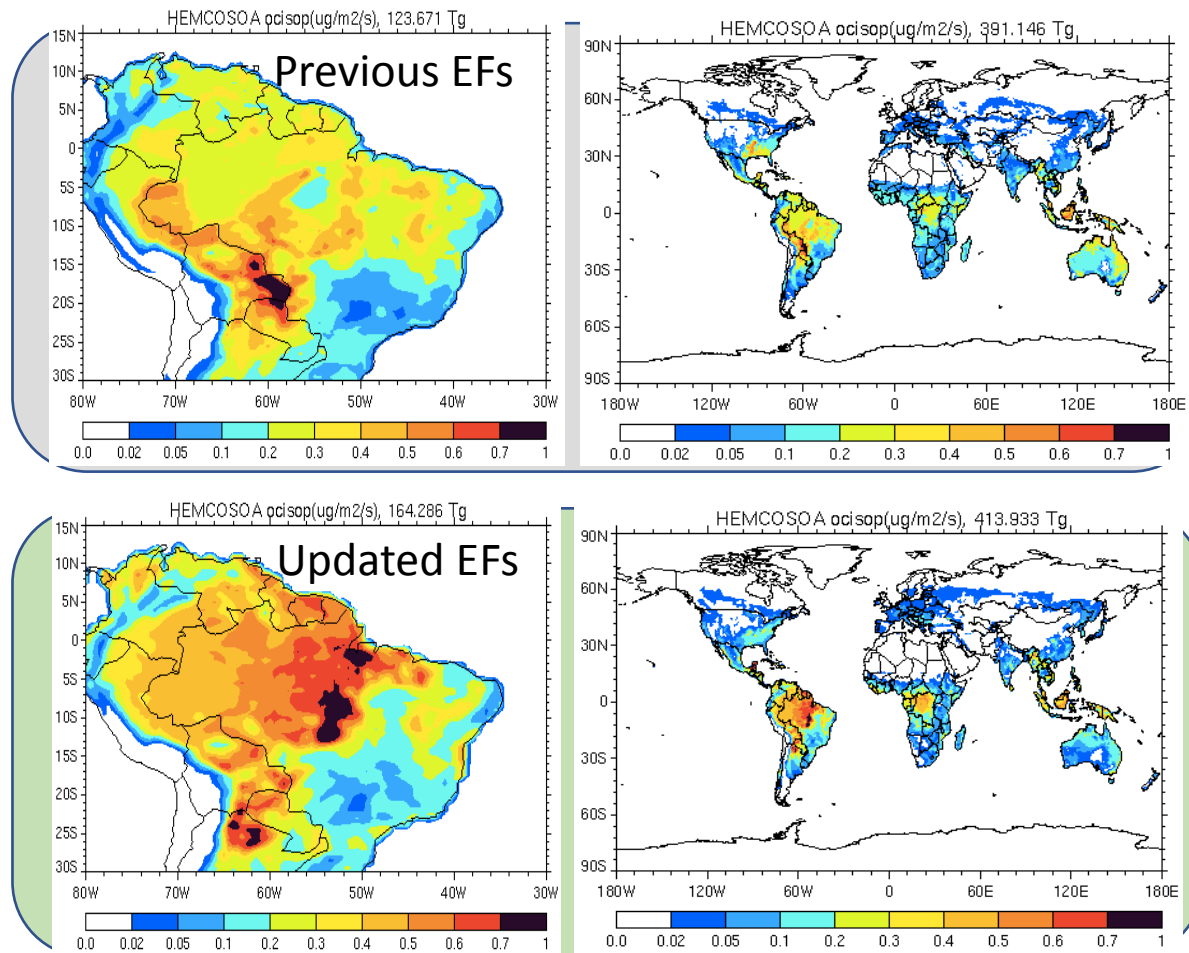
# 1. Dust emission or dynamic transport

Dust emission: K14 vs Ginoux's
GEOS dynamic field: Jason vs Icarus

## Annual AOD over Amazon



- Both K14 and G-dust show Africa dust transport ➔ <u>indicate that the new GEOS dynamic field</u> improves the Africa dust trans-Atlantic transport.

- Both dust emissions turned to ~2500 Tg/yr
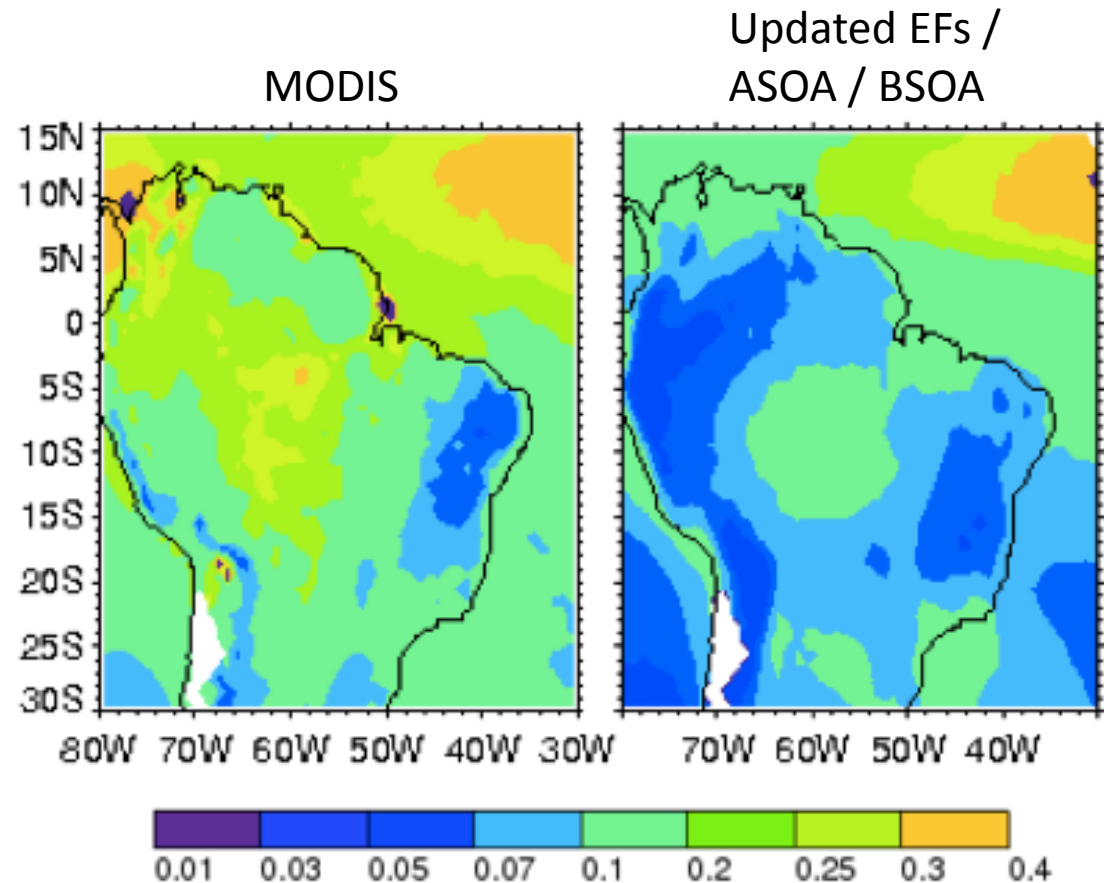
# 2. SOA: biogenic from MEGAN



PFTs (GEOS)

| | Amazon | | | Global | | |
|---|---|---|---|---|---|---|
| Emi (Tg/yr) | isop | mont | BG | isop | mont | BG |
| Update EFs | 171.4 | 41.1 | 9.3 | 412.9 | 99.1 | 22.3 |
| Previous EFs | 127.5 | 30.8 | 6.9 | 390.2 | 93.7 | 21.1 |
| Change by | 34.5% | 33.5% | 34.7% | 5.8% | 5.7% | 5.7% |

## 2. SOA:
## ASOA and BSOA  ➡ increase Amazon total OA by ~25%

(Hodzic and Jimenez, 2011, GMD)

**Annual AOD over Amazon**

MODIS

Updated EFs /
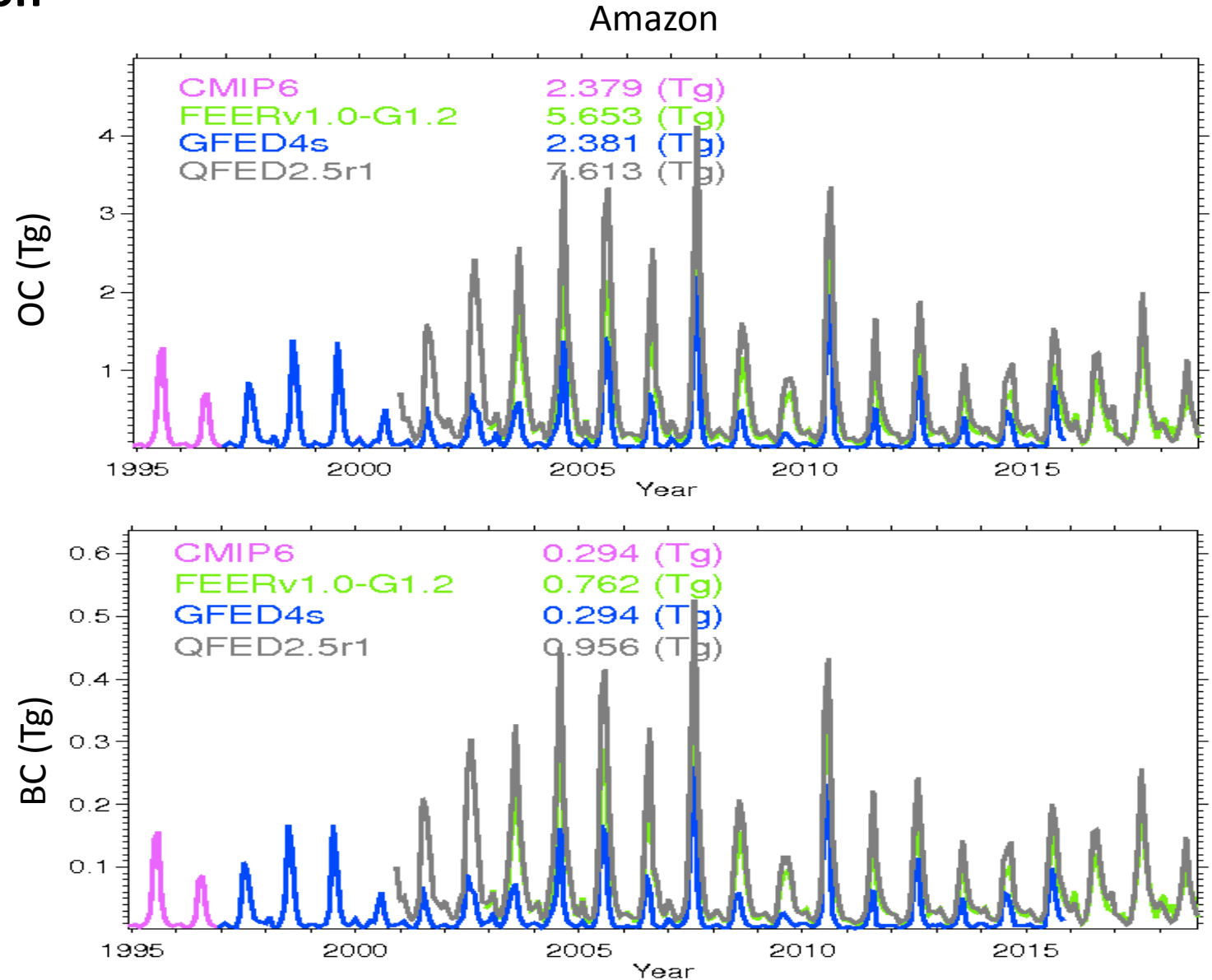ASOA / BSOA

# 3. Biomass burning over Amazon

Amazon OC and BC BB emissions
from 4 inventories

CMIP6 (GFED4s): lowest
QFED:                highest

Low and high differ
more than 3x

Amazon



CMIP6        2.379 (Tg)
FEERv1.0-G1.2   5.653 (Tg)
GFED4s        2.381 (Tg)
QFED2.5r1      7.613 (Tg)

CMIP6        0.294 (Tg)
FEERv1.0-G1.2   0.762 (Tg)
GFED4s        0.294 (Tg)
QFED2.5r1      0.956 (Tg)

# Annual AOD over Amazon



Model GEOS BB emission:

3xGFED  vs  GFED
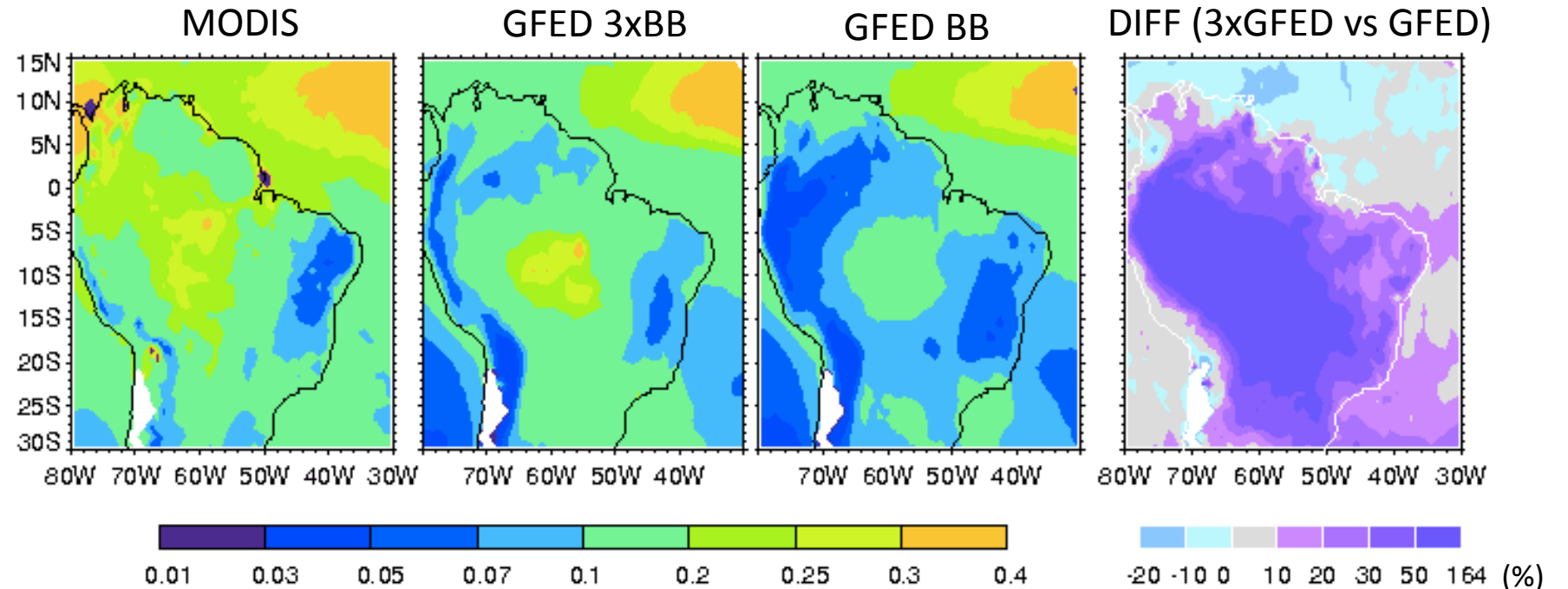
- Enhance GFED4s emission by 3x give a better GEOS-MODIS AOD agreement

- Annual MODIS AOD is derived using daily MODIS AOD and the model GEOS AOD is sampled with MODIS daily AOD
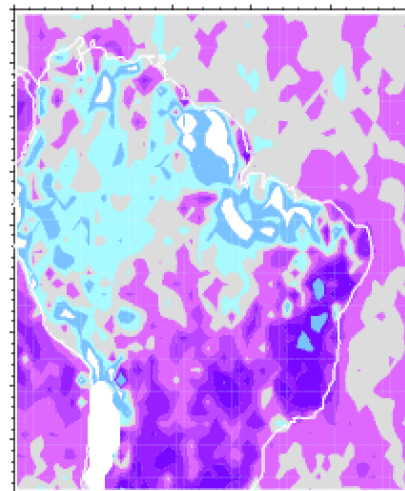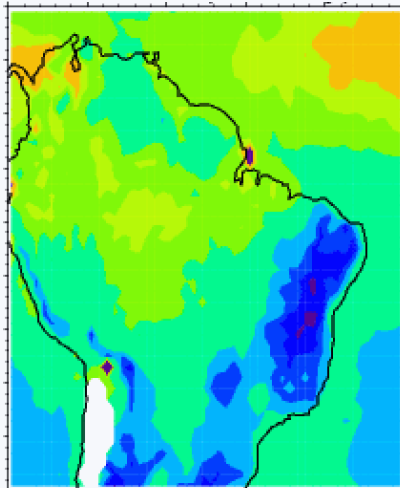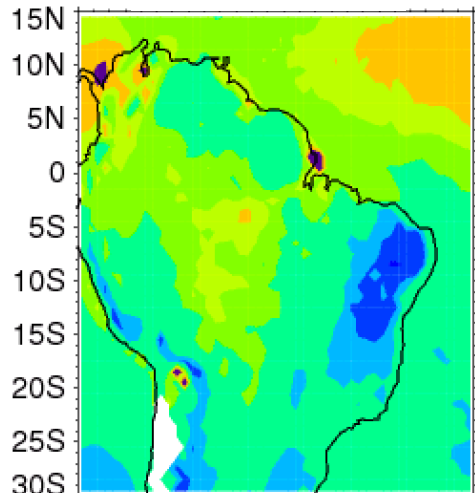
# Annual AOD over Amazon
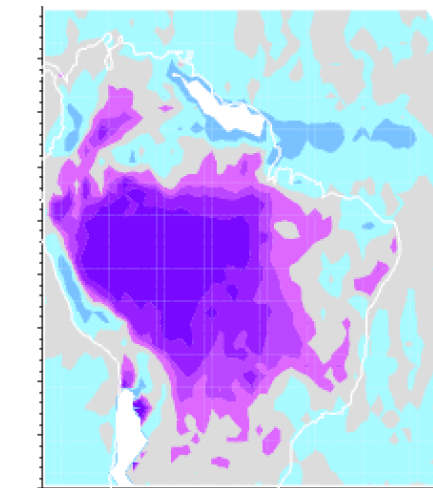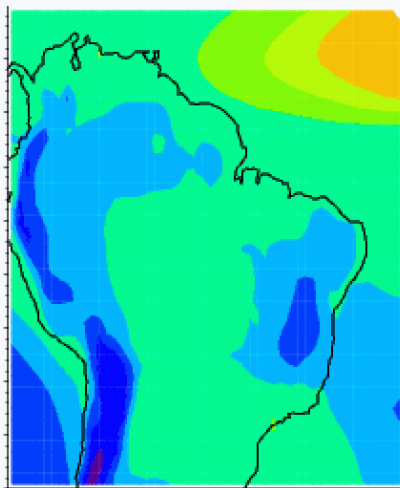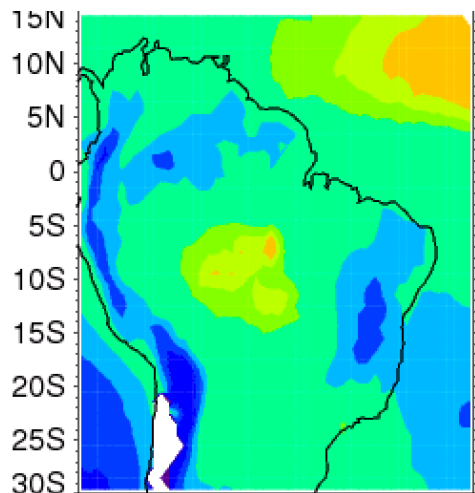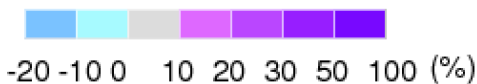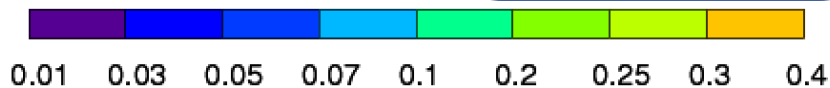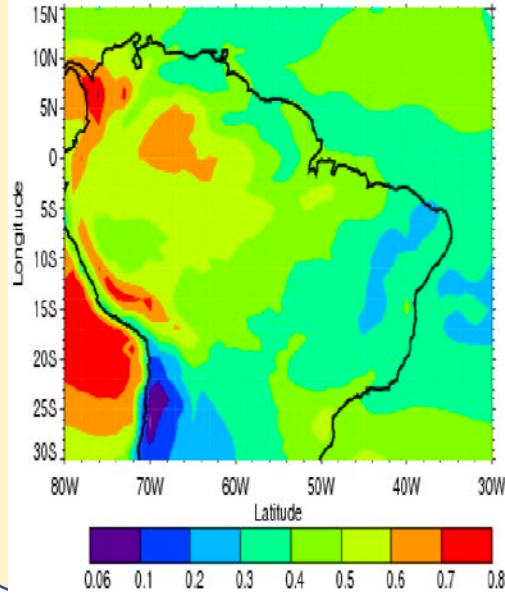


**Sampling Issue**

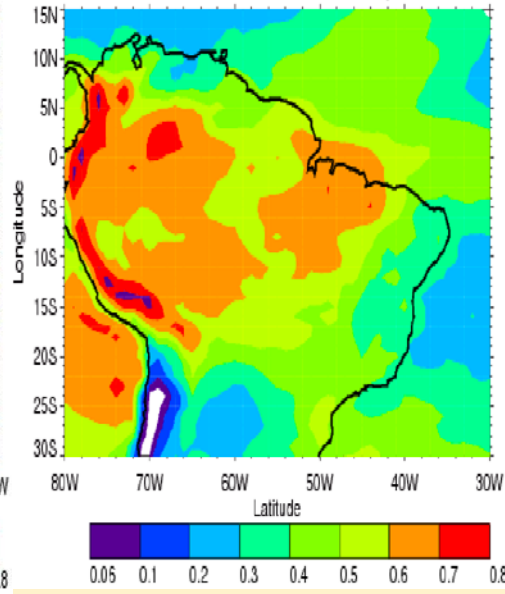Sampling on **daily** MODIS data (left column)

Sampling on **monthly** MODIS data (middle column)

GEOS results based on 3xGFED

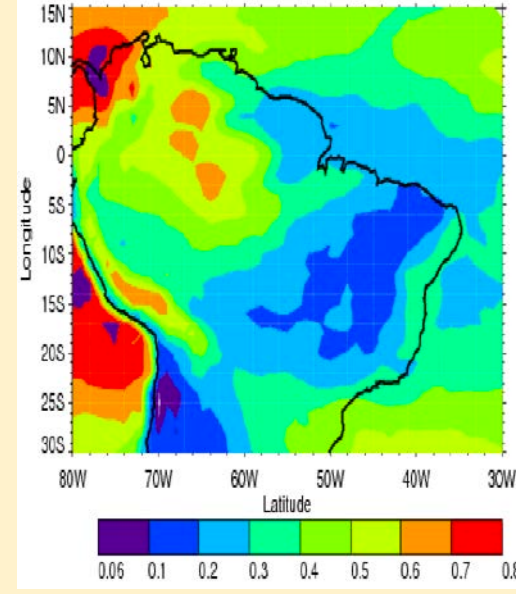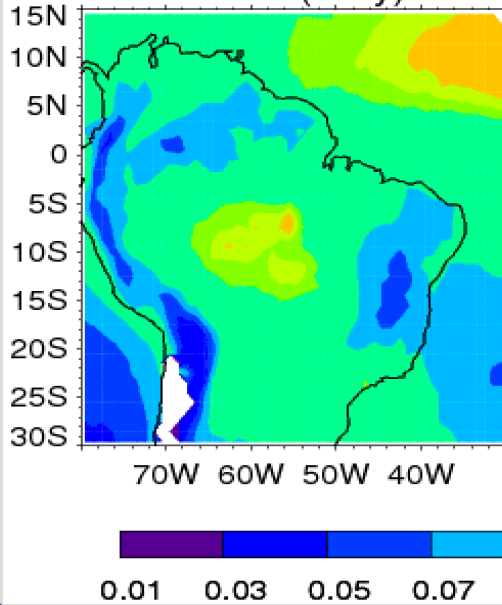| Jan-Dec (2014) | Feb-Apr | Aug-Oct |
|---|---|---|

**Cloud cover over Amazon From MODIS**
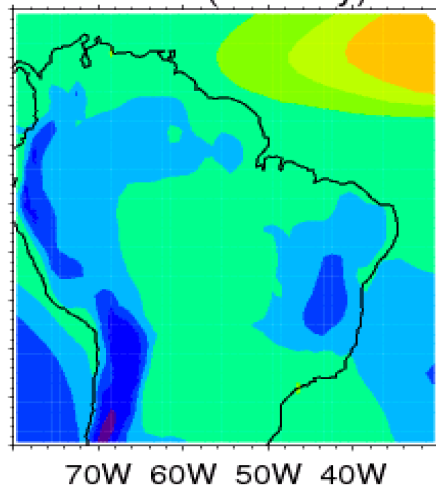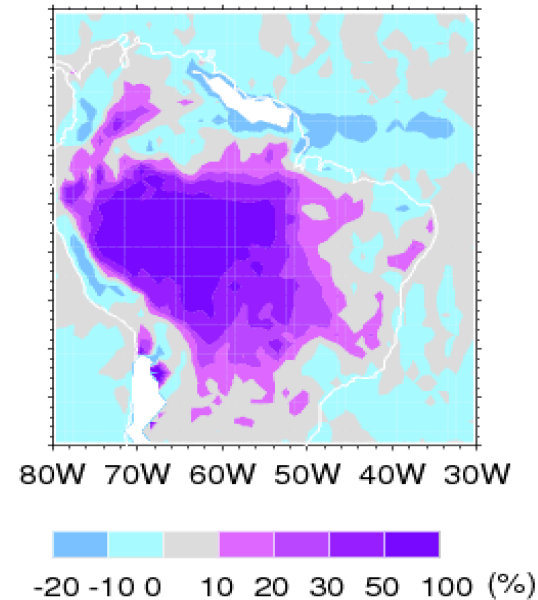
**Annual AOD over Amazon From GEOS with different temporal sampling**

# Comparison of surface aerosol concentrations between GEOS and ARM at Manaus, Brazil during 2014 (GoAmazon campaign)



**BC**

BC (GEOS) = 190 ng/m3
rBC (ARM) = 216
eBC (ARM) = 554

**OA**

OA (GEOS) = 3.6 ug/m3
OA (ARM) = 5.0

**SO4**

SO4 (GEOS) = 0.36 ug/m3
SO4 (ARM) = 0.63

**NH4**

NH4 (GEOS) = 0.13 ug/m3
NH4 (ARM) = 0.19

**NO3**

NO3 (GEOS) = 0.26 ug/m3
NO3 (ARM) = 0.23
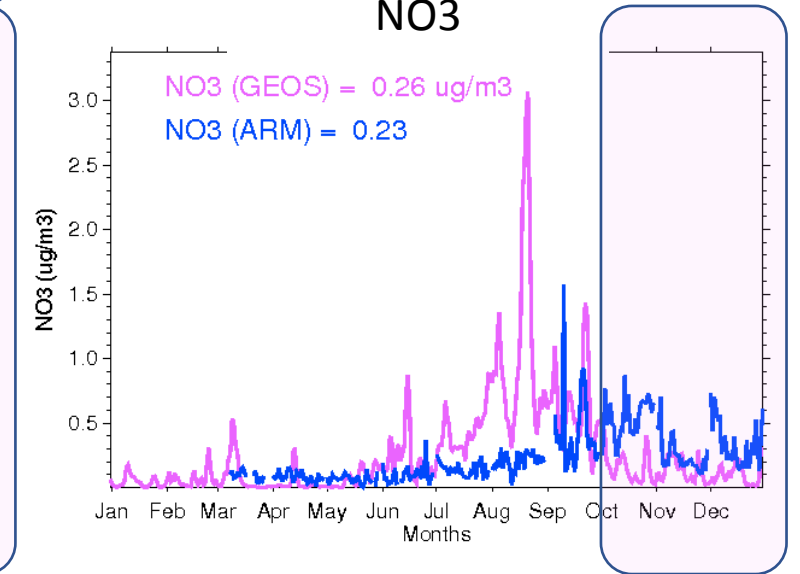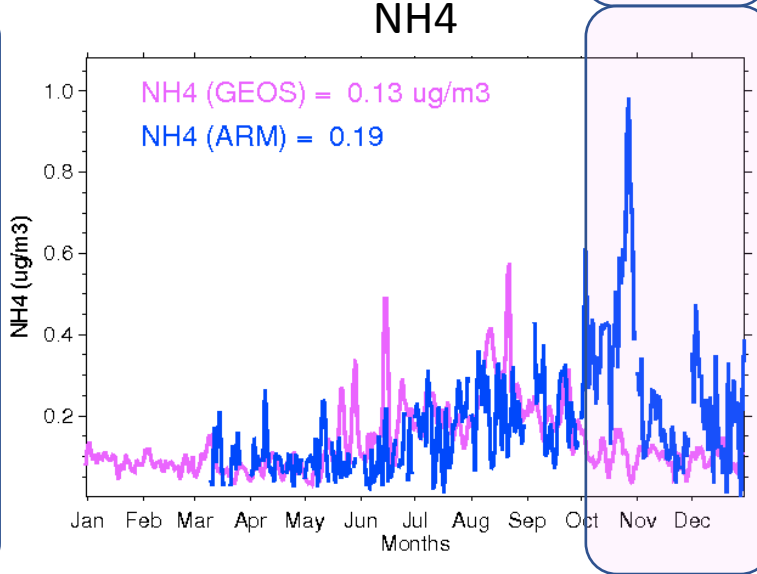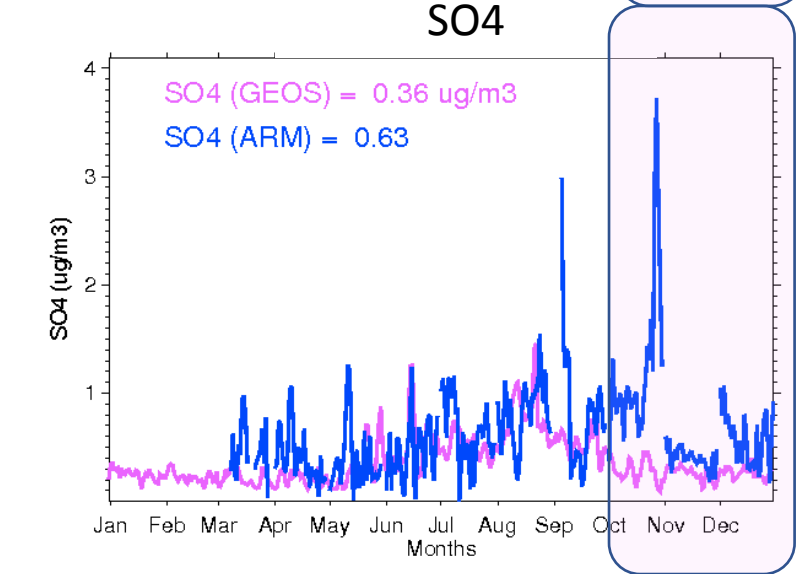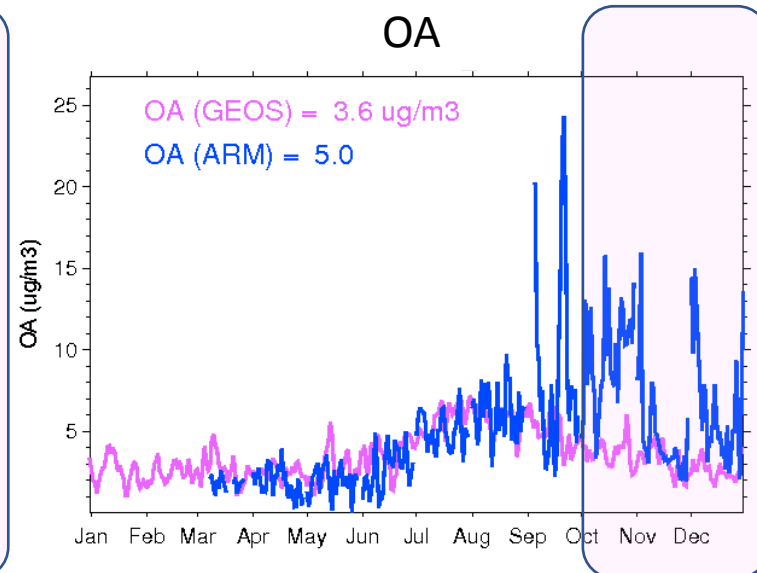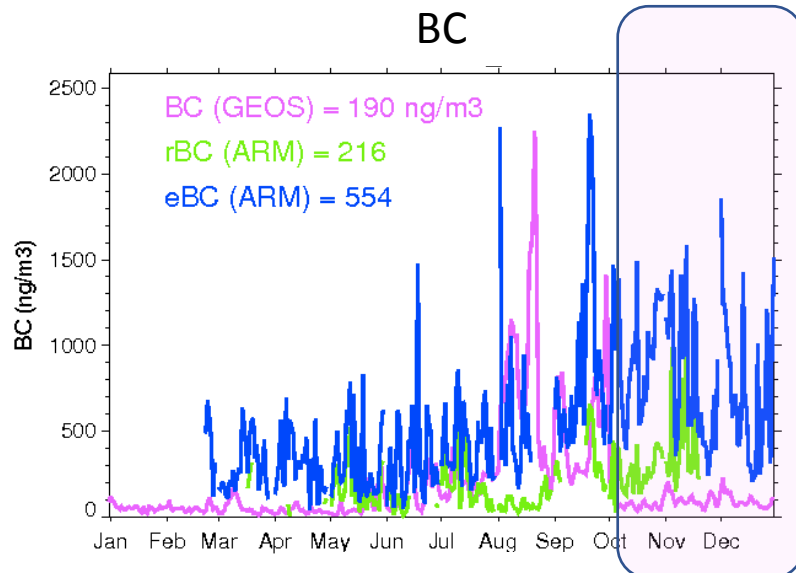
- The GEOS aerosol concentrations are generally lower than ARM's except NO3

- ARM eBC is more than double of rBC

- **GEOS miss fires during Oct - Dec**

# AOD from GEOS, MODIS, and AERONET at stations of Alta_Floresta and Arica
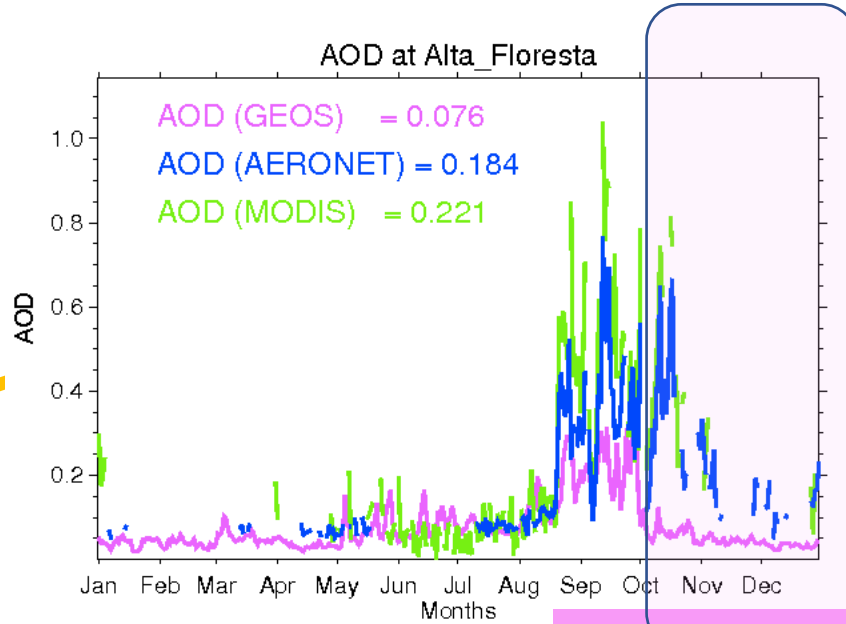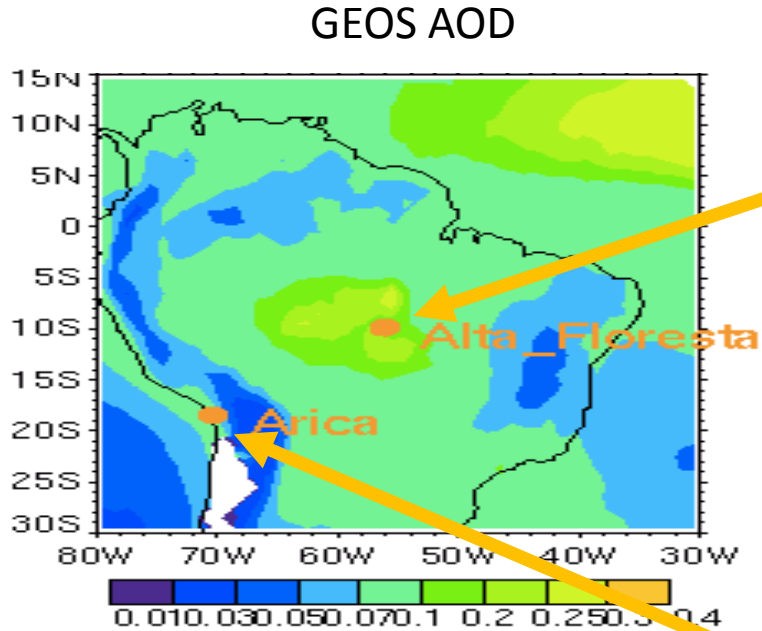


GEOS AOD

AOD at Alta_Floresta

AOD (GEOS)    = 0.076
AOD (AERONET) = 0.184
AOD (MODIS)   = 0.221

**GEOS miss fires during Oct –Dec !!!**

AOD at Arica
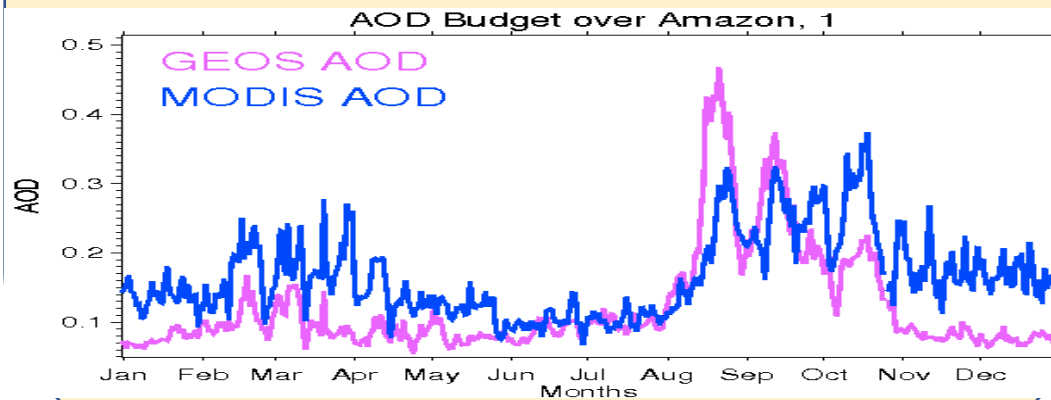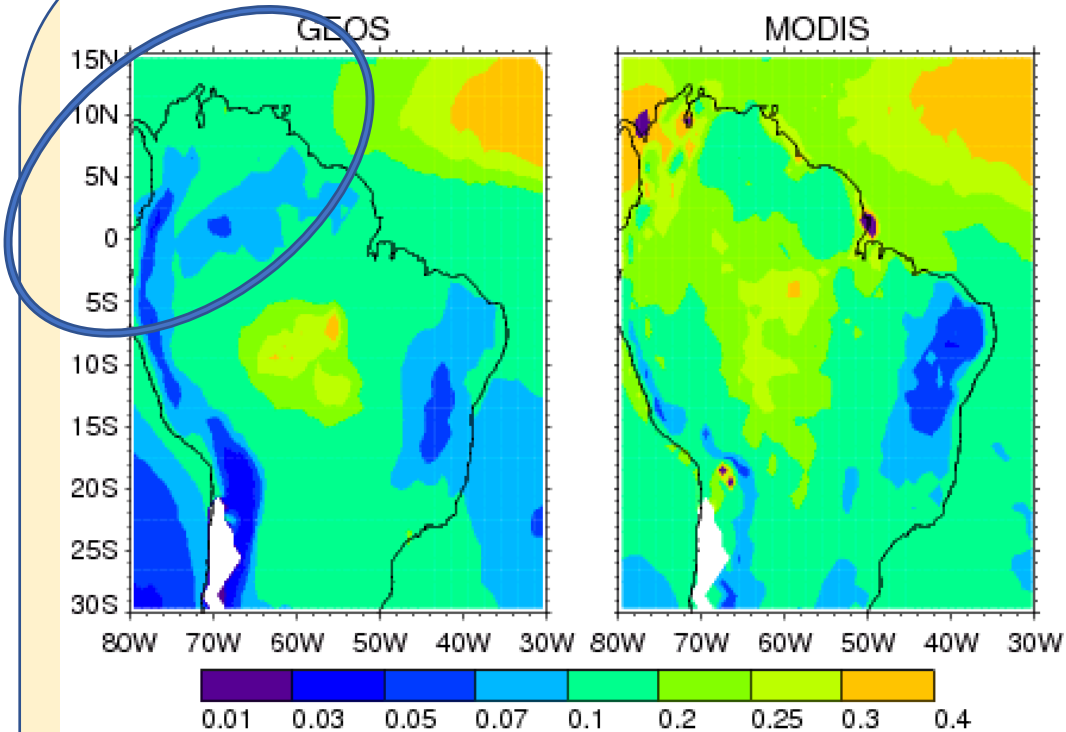
AOD (GEOS)    = 0.132
AOD (AERONET) = 0.188
AOD (MODIS)   = 0.215

# What we have now



2014 Annual AOD over Amazon

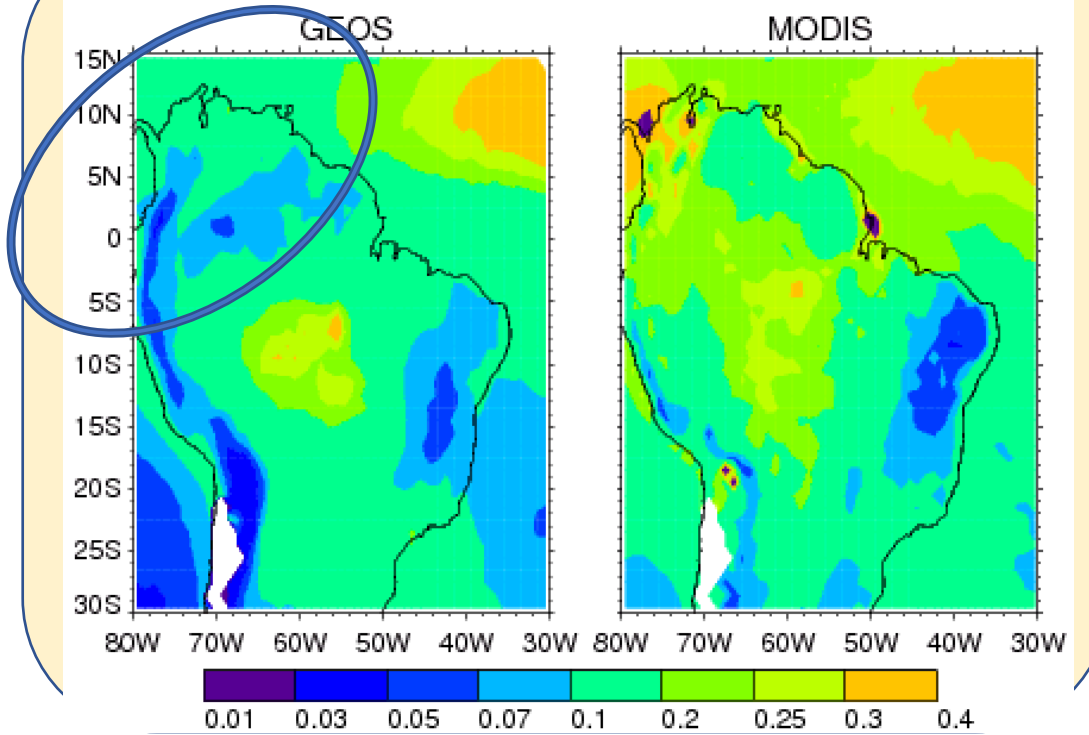AOD Budget over Amazon, 1
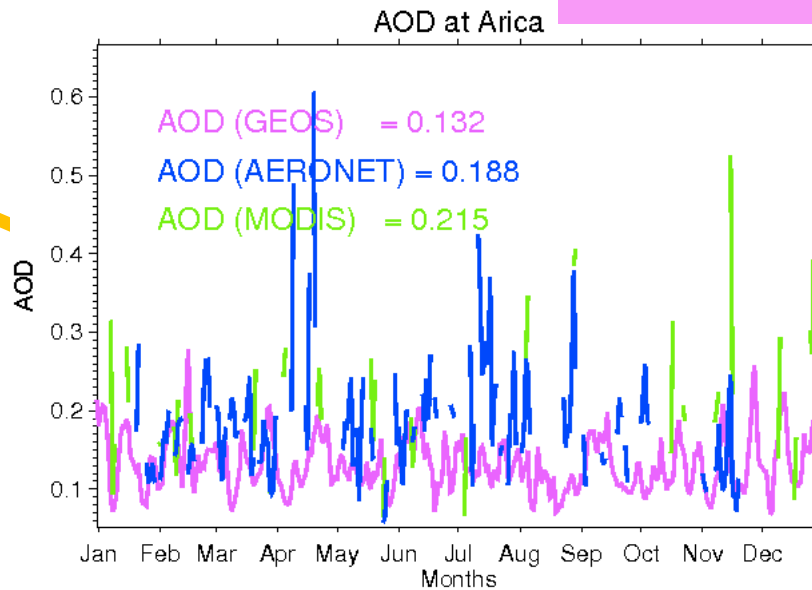
## Summary

- Improve GEOS aerosol simulation over Amazon via: 1). use a new dynamic framework; 2). add ASOA/BSOA and use MEGAN and update VOC EFs for biogenic SOA; and 3). enhance GFED4s BB emission by 3x.

- The improvements are supported based on the model and measurement comparisons (i.e. aerosol concentrations from ground station measurements and AOD from MODIS retrieval).

- More improvements still needed for 1). missing capture BB during Oct-Dec; 2). missing capture AOD over northwest Amazon; and 3). potential underestimating background SS AOD.
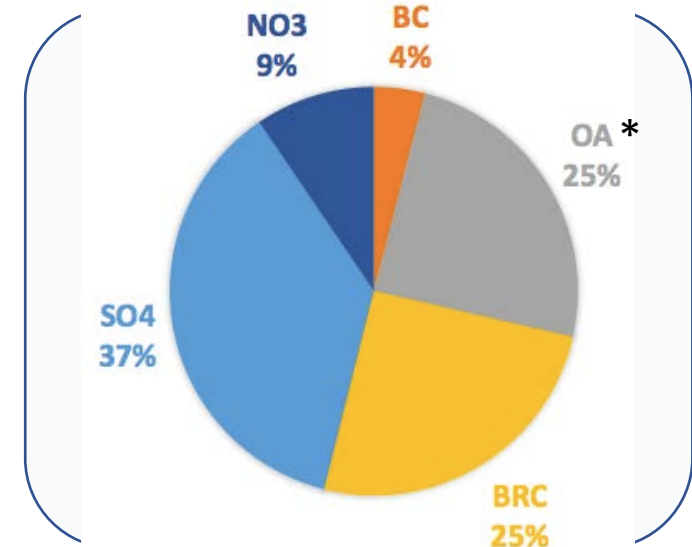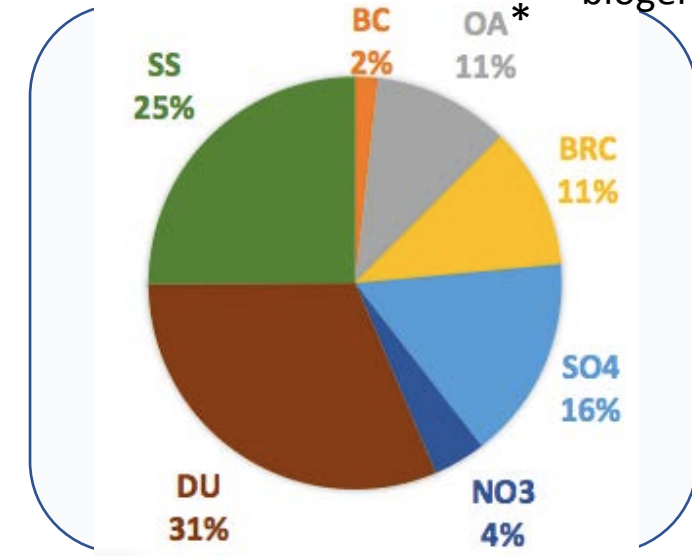
# What we have now

## 2014 Annual AOD over Amazon



## AOD over Amazon



Exclude dust/sea salt

*OA includes all SOAs (e.g. biogenic SOA, ASOA, and BSOA)

Include dust/sea salt

- There are large contributions from sulfate/nitrate

- Dust/Sea Salt dominate the overall AOD over Amazon => investigate SS AOD