Transatlantic Transport of Pollution from Africa to the Amazon Basin

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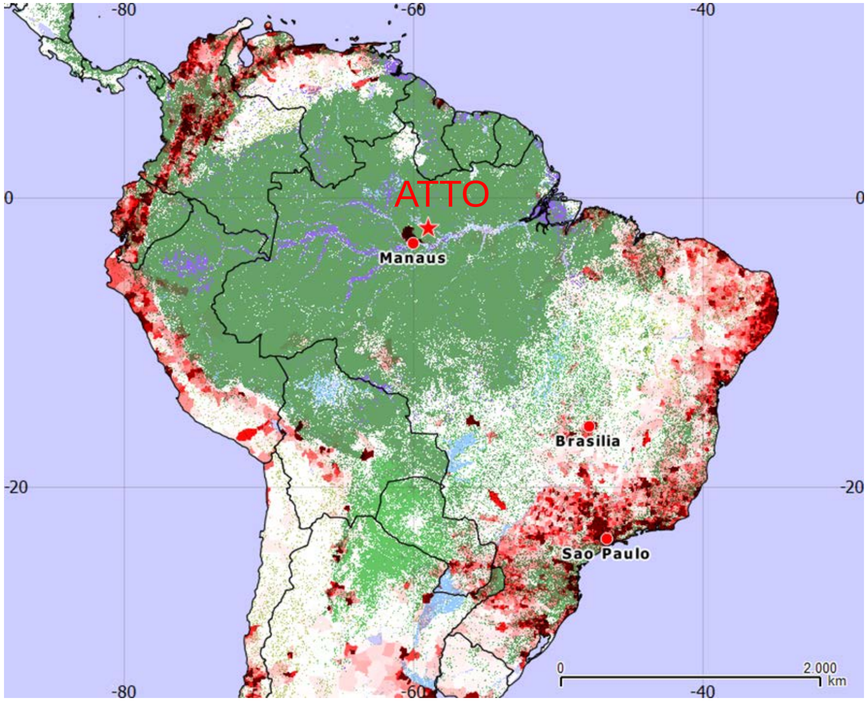
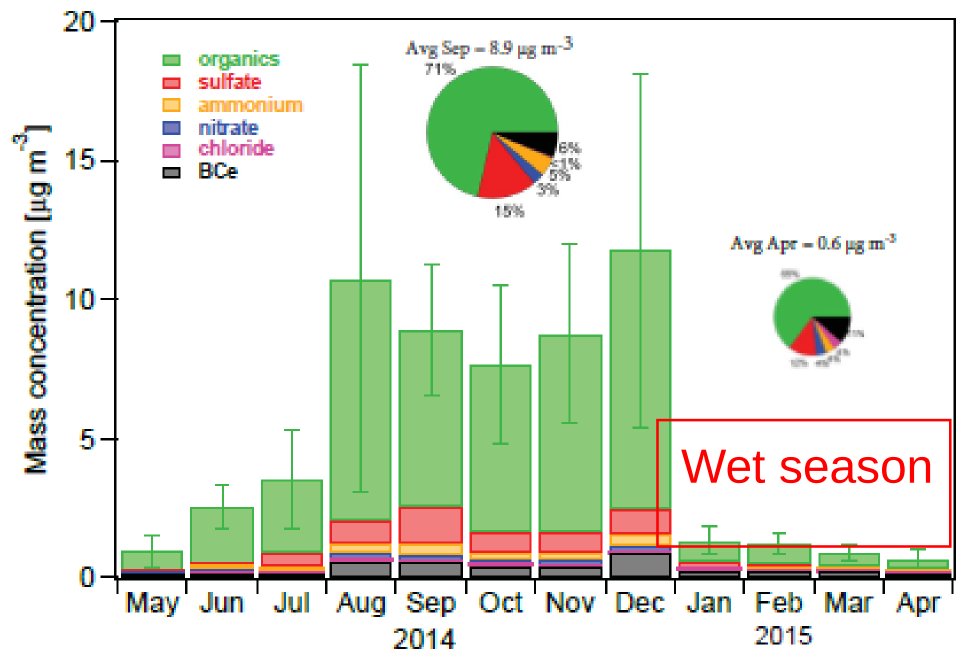
Aerosol composition in the central Amazon Basin



Land cover and population density map of South America

The Amazon Tall Tower Observatory (ATTO) has been set up in a pristine rain forest region in the central Amazon Basin



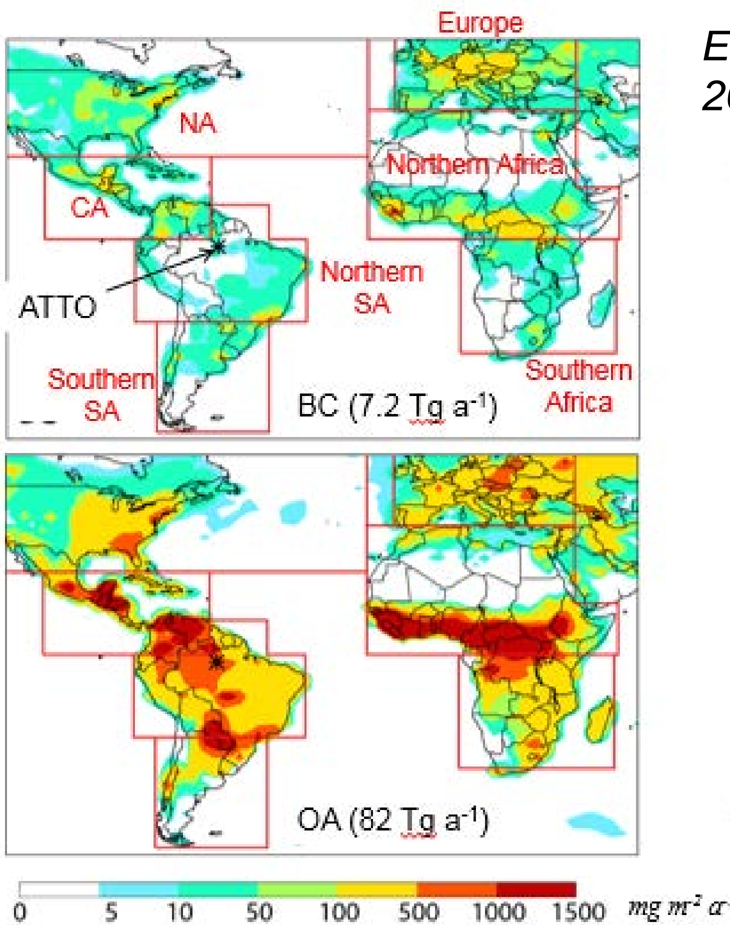
Time series of monthly mean aerosol mass concentrations and chemical speciation at the ATTO site

[Andreae et al., 2015]

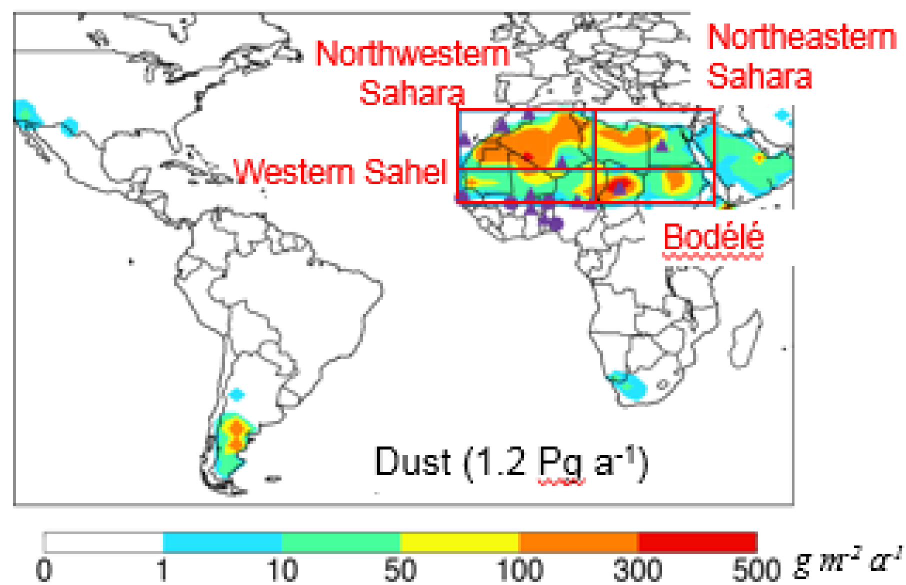
The near-pristine conditions at the ATTO site during the wet season are episodically interrupted by long-range transport of Saharan dust, and/or African biomass burning aerosol

GEOS-Chem model

- Chemical transport model (2˚x2.5˚ with 47 vertical levels)
- Emission: FINN for Biomass burning (Wiedinmyer et al., 2011); Bond et al.[2007] for anthropogenic emission with doubled emission in Russia and Asia ; dust entrainment and deposition (DEAD) mobilization scheme of Zender et al. (2003) for dust emissions



Emissions for BC, OA and Dust in Jan-Apr, 2014



[Wang et al., 2016]

Optical properties of light-absorbing aerosol at 550 nm

Type			Density ($g\,cm^{-3}$)	Refractive index	MAE[a] ($m^2\,g^{-1}$)	AAE[b]
Black carbon	Base		1.8	1.95–0.79*i*	5.9	1.3
	Update		1.8	1.95–0.79*i*	12	0.5
Organic carbon	Base		1.3	1.53–0.006*i*	0.16	0.8
	Update	Biofuel	1.3	1.7–0.023*i*	0.66	2.5
		Open fire	1.3	1.7–0.017*i*	0.5	3.1
Dust	Base		2.5–2.65	1.56–0.0014*i*		
	Update		2.5–2.65	1.56–0.0014*i*		

[a] Mass absorption efficiency.
[b] Absorption Ångström exponent, estimated between wavelength of 400 and 550 nm.

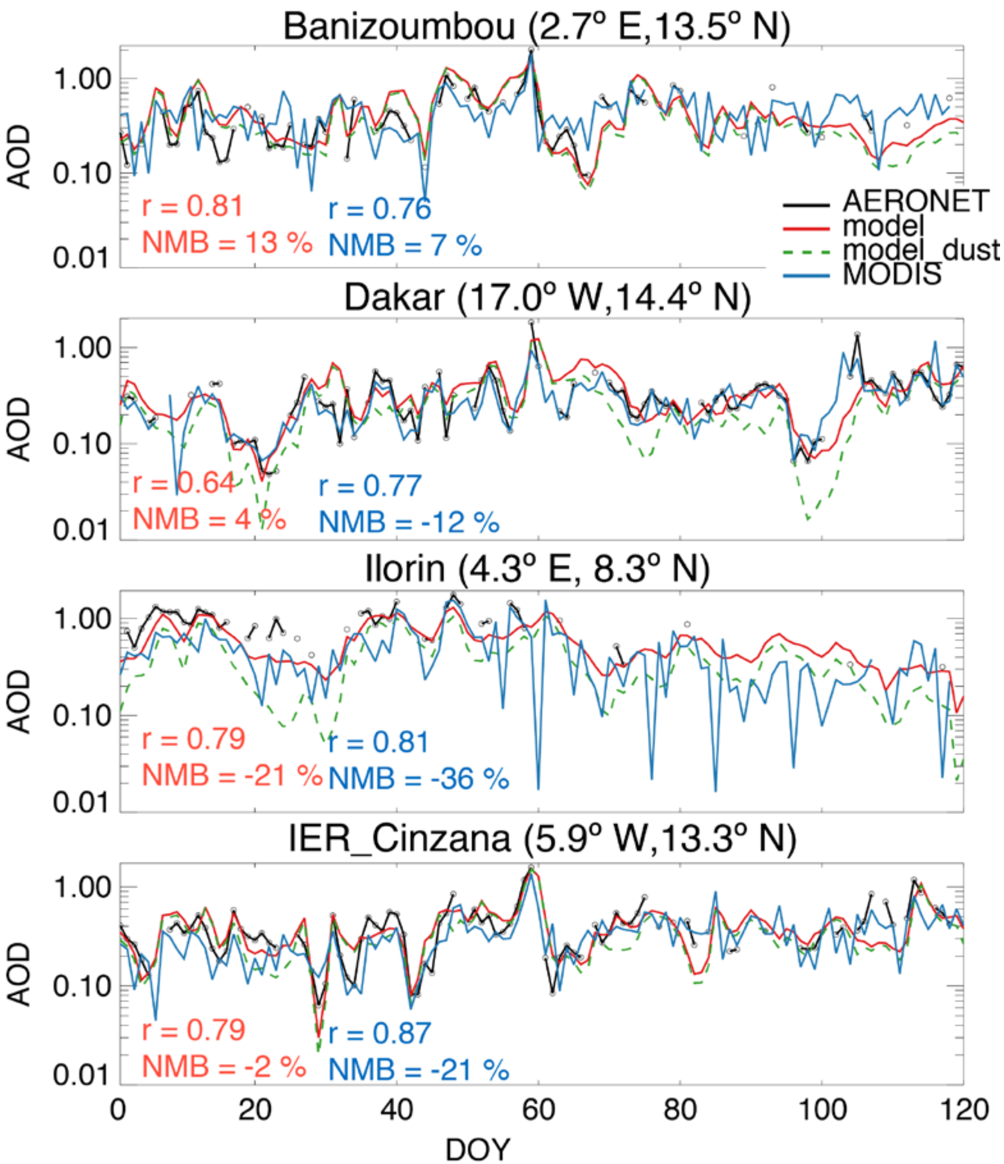
- BC

  Assuming thick coating due to abundance of SOA (Chen et al., 2009; Pöschl et al., 2010).

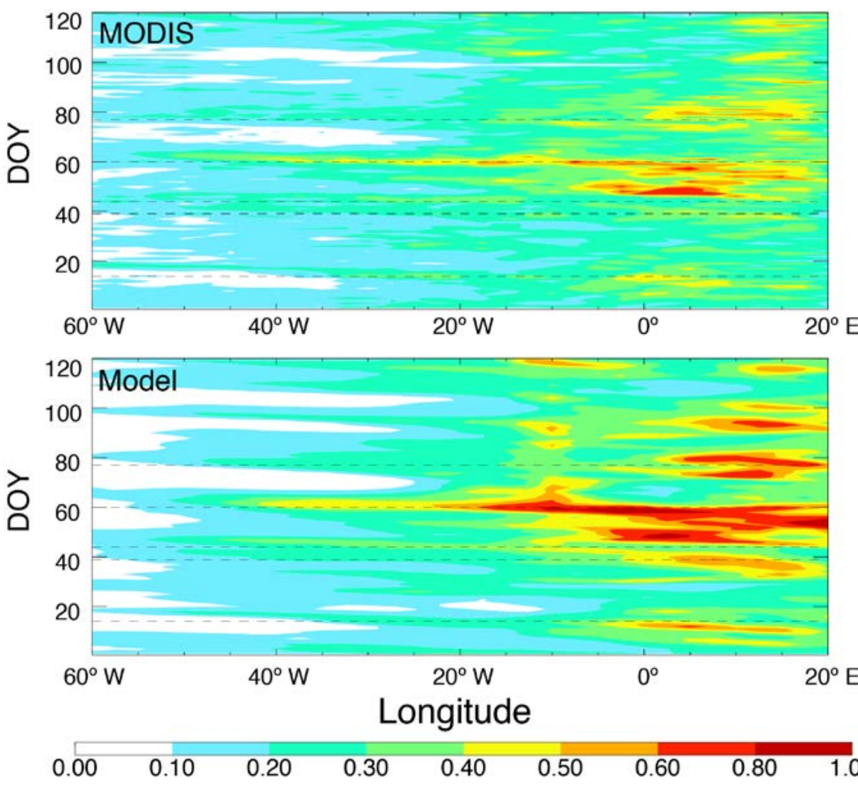
  AAE based on the study by Chung et al. (2012) and Bahadur et al. (2012)
- BrC (brown carbon): parameterize the absorptivity of BrC as a function of emission ratio of BC versus OA (Saleh et al., 2015)

[Wang et al., 2016]

Transatlantic Transport of the African pollution



Time series of observed and simulated AOD at 550 nm in Jan-Apr, 2014.

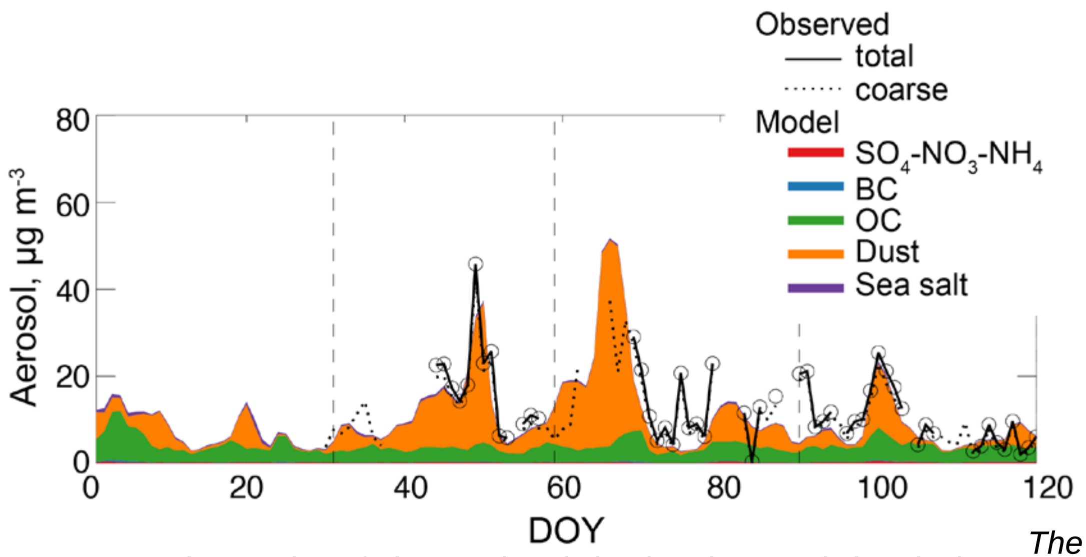


Daily distribution of latitudinally averaged (5°S–25° N) AOD at 550 nm in Jan-Apr, 2014

- Simulated AOD are consistent with AERONET and MODIS AOD
- ~ five events of transatlantic transport of aerosol plumes from northern Africa to South America in Jan-Apr, 2014

[Wang et al., 2016]

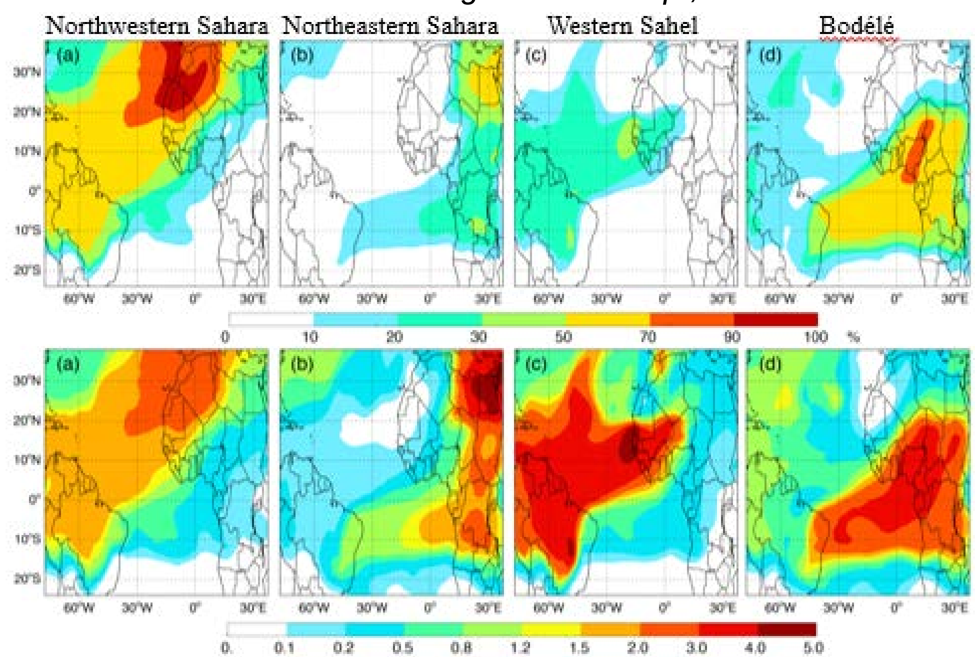
Aerosol arriving at ATTO



Time series of observed and simulated aerosol chemical components at ATTO in Jan-Arp, 2014

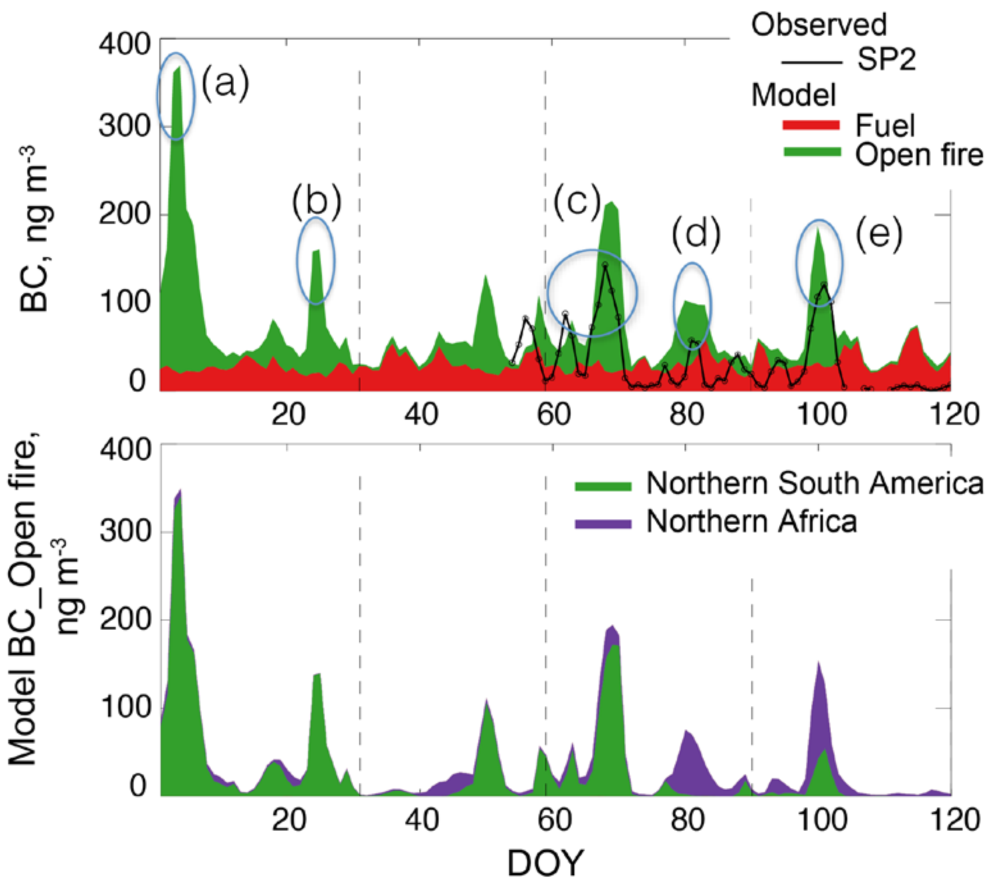
r = 0.73 between model dust and observed coarse aerosol

The contribution to total dust burden (top) and the sensitivity of total dust burden to the emissions (bottom) from four source regions in Jan-Apr, 2014

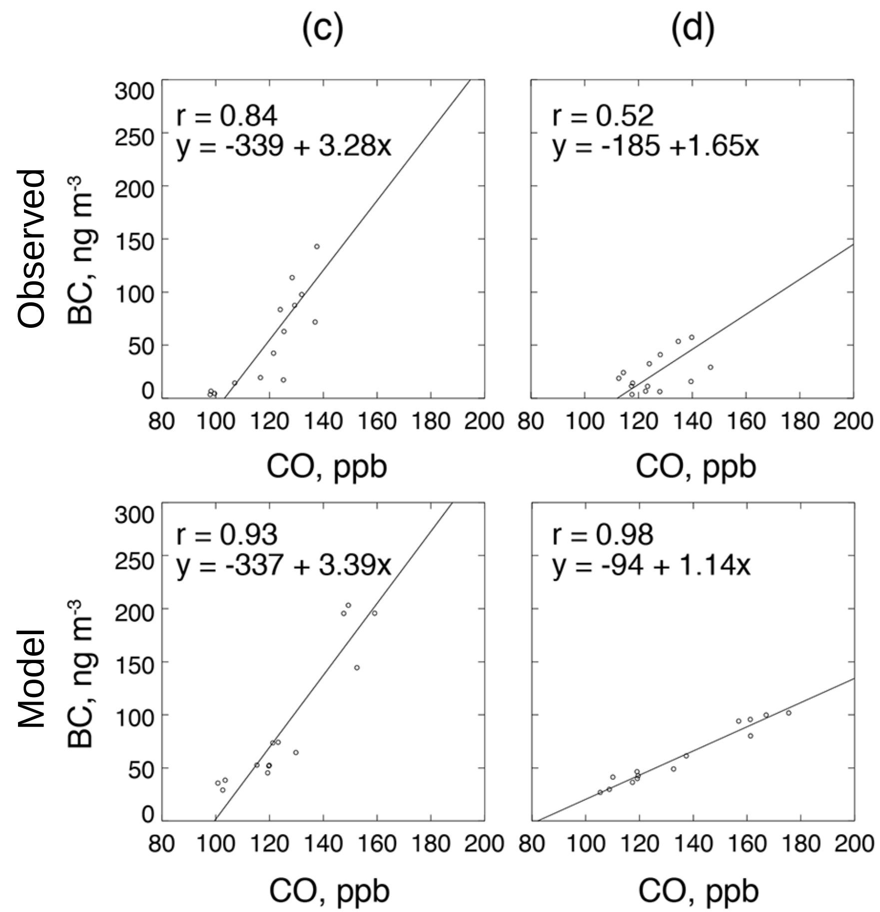


- most sensitive to emissions in the western Sahel, followed by northwestern Sahara
- High sensitivity to Bodélé emissions is limited to eastern Brazil

Aerosol arriving at ATTO



Time series of observed and simulated BC at ATTO in Jan-Arp, 2014

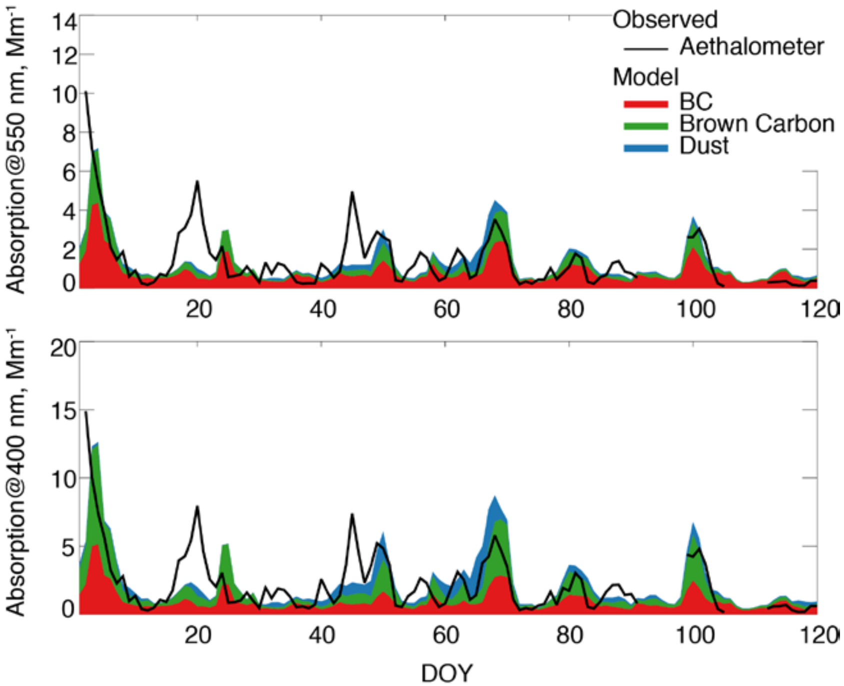


Scatterplots of BC vs. CO concentrations at ATTO for (c)–(d) peaks

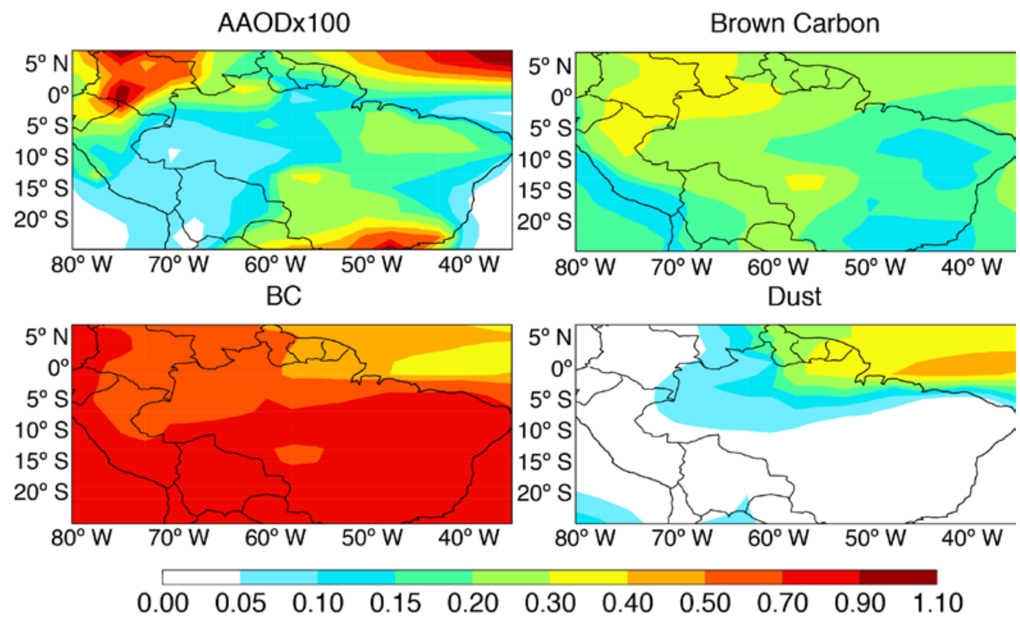
- open fires (from northern SA and northern Africa) are responsible for most variance of observed BC
- a corresponding age of air mass of 11 days for the transport time of African Plumes arriving at ATTO
- BC peaks generally coincide with coarse aerosol peaks, with r of 0.70 and 0.52 in the observed and simulated data, respectively

[Wang et al., 2016]

Aerosol Absorption in the Amazon Basin



Time series of observed and simulated aerosol absorption at ATTO in Jan-Arp, 2014



Model AAOD at 550 nm and the contribution from BC, brown carbon and dust over the Amazon Basin in Jan-Arp, 2014

- Consistence between simulated and observed aerosol absorption and its wavelength dependence
- During the wet season, AAOD over the central Amazon, including the ATTO site, is generally lower than 0.0015.
- More than 50% of AAOD is from BC except for Guyana, Suriname, French Guiana, and northern Brazil, where the influence of dust becomes significant (up to 35 %)

[Wang et al., 2016]

Conclusion

- With daily temporal resolution for open fire emissions and modified aerosol optical properties, our model successfully captures the observed variation in fine/coarse aerosol and BC concentrations as well as aerosol light absorption and its wavelength dependence over the Amazon Basin;
- The model indicates the important influence of the Long-range transport of dust mixed with open fire aerosols on the observed variances of aerosol concentrations and absorption;
- The analysis of correlation and enhancement ratios of BC versus CO suggests transport times of < 3 days for regional fires and 11 days for African plumes arriving at ATTO during the wet season;
- During the wet season, AAOD over the central Amazon, including the ATTO site, is generally lower than 0.0015. More than 50% of AAOD is from BC except for Guyana, Suriname, French Guiana, and northern Brazil, where the influence of dust becomes significant with up to 35 %

Thanks!