Transatlantic Transport of Pollution from Africa to the Amazon Basin

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

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.

**Land cover and population density map of South America**

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

[Andreae et al., 2015]
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

<table>
<thead>
<tr>
<th>Type</th>
<th>Density (g cm(^{-3}))</th>
<th>Refractive index</th>
<th>MAE(^a) (m(^2) g(^{-1}))</th>
<th>AAE(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black carbon</td>
<td>Base</td>
<td>1.8</td>
<td>1.95–0.79i</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>1.8</td>
<td>1.95–0.79i</td>
<td>12</td>
</tr>
<tr>
<td>Organic carbon</td>
<td>Base</td>
<td>1.3</td>
<td>1.53–0.006i</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>Biofuel</td>
<td>1.7–0.023i</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open fire</td>
<td>1.7–0.017i</td>
<td>0.5</td>
</tr>
<tr>
<td>Dust</td>
<td>Base</td>
<td>2.5–2.65</td>
<td>1.56–0.0014i</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>2.5–2.65</td>
<td>1.56–0.0014i</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) 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


- 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

$r = 0.73$ between model dust and observed coarse aerosol

**Time series of observed and simulated aerosol chemical components at ATTO 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

- 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

- Consistency 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]
• 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!