Aerosol loading in the Southeastern United States: Reconciling surface and satellite observations

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2. What causes the seasonal differences in AOD over the Southeastern U.S.?

- MODIS (Aqua)
- MISR
- CALIOP (Day)
- GEOS-Chem

Winter (DJF)

Summer (JJA)

3. Changes in Surface Concentrations?

- GEOS-Chem captures the spatial and seasonal variation of PM2.5 in the Eastern U.S.
- Surface concentrations exhibit only a fraction of the seasonality observed in satellite column AOD

- Model captures the chemical speciation and the seasonality of surface concentrations
- Observed seasonality mainly due to inorganic species
- Organic Matter (PM1.8-1.0C) is ~35% of PM2.5
- SEARCH network shows similar results, but OM is a larger fraction of PM2.5

4. Increased Water Uptake?

Aerosol optical depth in the model is calculated for a specific wavelength using the extinction efficiency (Q_x), the column mass loading (M), effective radius (r_eff), and particle mass density (p), such that the AOD (τ) is calculated by this equation:

\[ \tau = \frac{3Q_x M}{4\pi r_{\text{eff}} p} \]

aerosol extinction resulting from water uptake is 40% (integrated over the column & assuming sulfate aerosol).

The seasonality in AOD is primarily associated with an increase in aerosol mass aloft, in the lower troposphere (below 700hPa), which is not captured by the GEOS-Chem model.

4.1 Seasonal Difference in RH

Hourly RH values used in GEOS-Chem are highly correlated with observations (R=0.6-0.83 across sites and seasons)

- Mass Extinction Efficiency

5. More Aerosols Aloft?

In regions where there are large biogenic VOC and anthropogenic emissions, high relative humidity, and cloudiness, yields from aqueous formation of SOA can be very significant [Ervons et al., 2008]. Cloudy conditions and enhanced oxidant concentrations in summertime could augment sulfate production.

6. Production in Clouds?

- Cloud liquid water may not be the limiting factor in summertime aerosol production

7. Conclusions

- Satellite observations show a strong summertime enhancement in AOD over the Southeastern U.S. (100-300%)
- This is not simulated by the GEOS-Chem model.
- Seasonal changes in RH/water uptake can only account for up to ~40% of this seasonal difference
- CALIOP profiles suggest that the seasonal change in AOD is associated with an increase in aerosol mass aloft, in the lower troposphere (below 700hPa)
- Our interpretation is limited by the lack of aerosol chemical speciation aloft
- In situ vertical measurements of aerosol composition necessary (upcoming SOAS campaign)