Attribution of Aerosol Absorption

Different ways to look at apportionment:

- Source

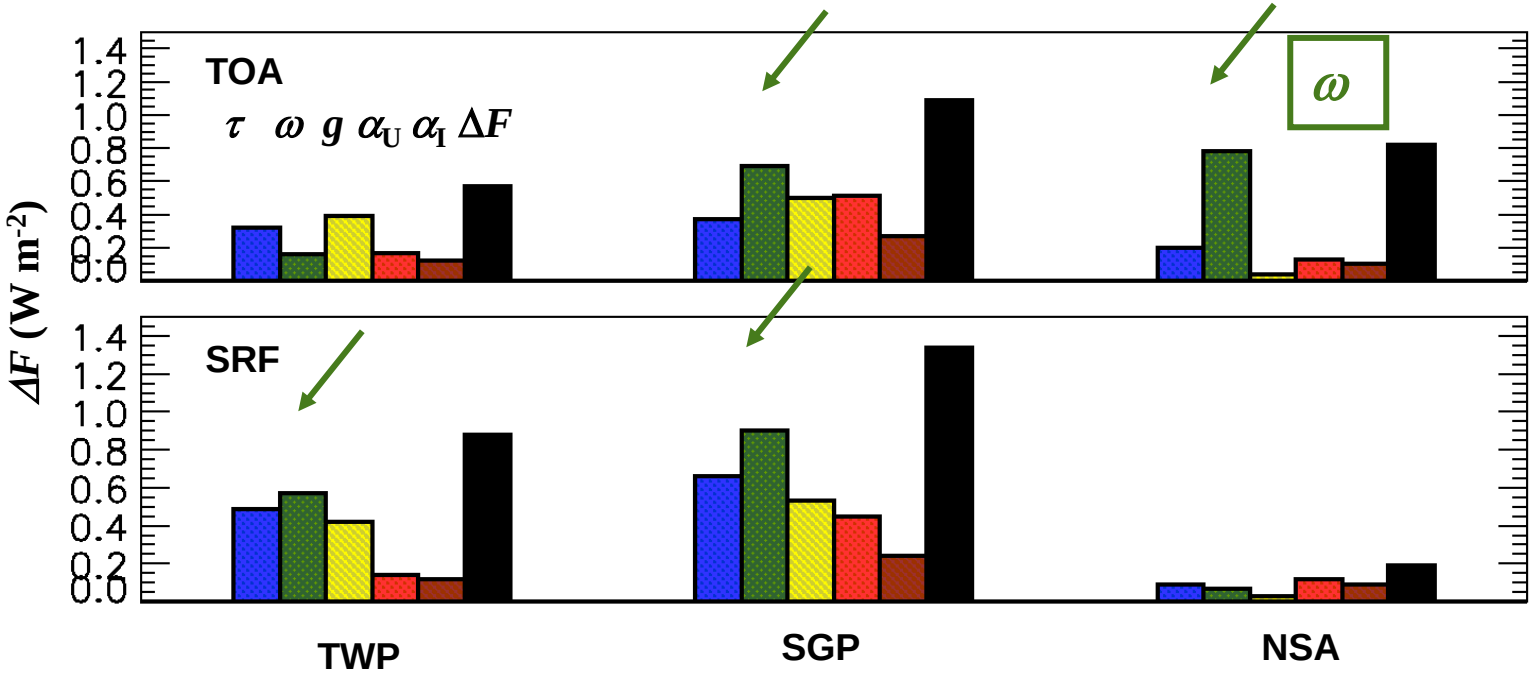
  Geographical

  Process (e.g., industry vs biomass burn (more than one type!))

- Type/species (e.g., BC vs dust)

- Size-resolved

Important to reduce uncertainty in absorbing component of aerosol extinction



$$S_i = \frac{\partial F}{\partial p_i}$$

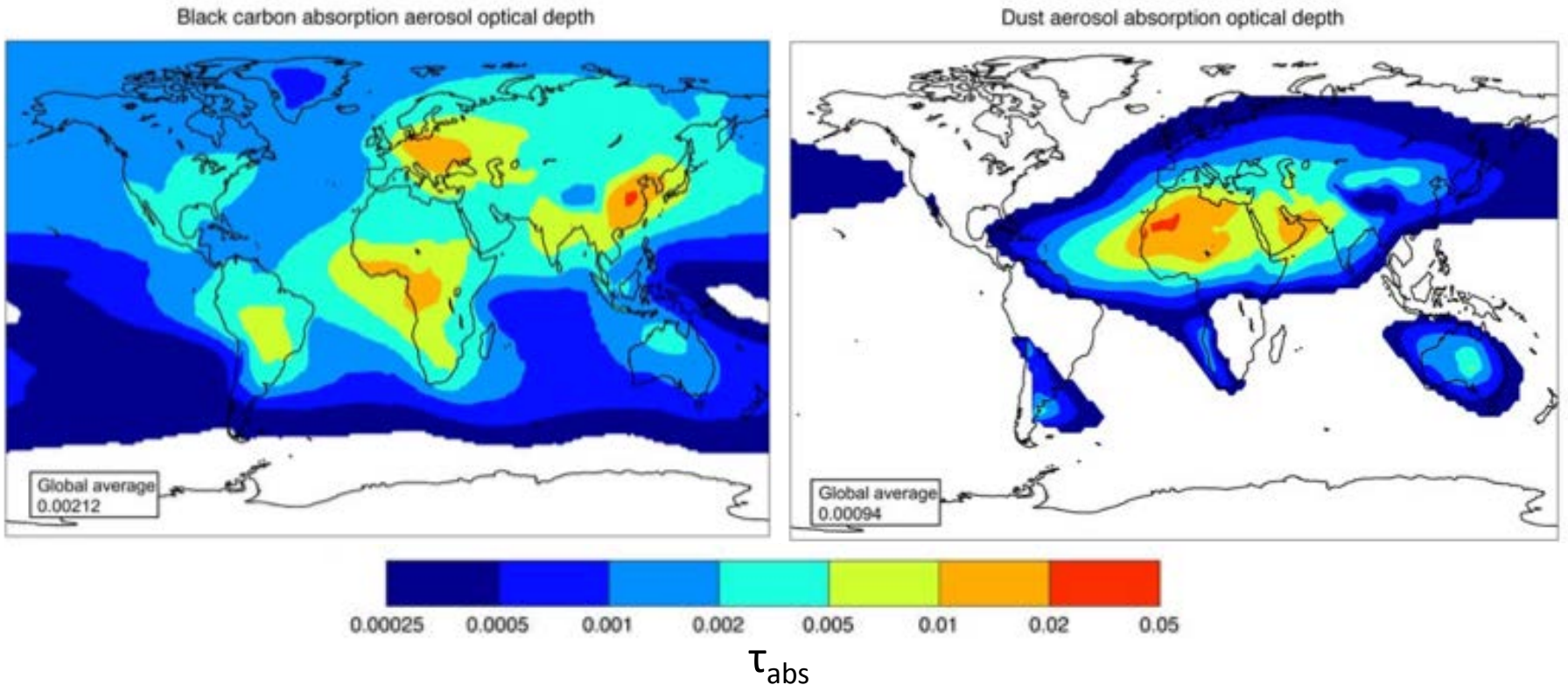
$$\Delta F_i = S_i \Delta p_i$$

$$\Delta p_i = 0.03$$

assumed uncertainty for ground-based in situ measurement represents low end of uncertainty

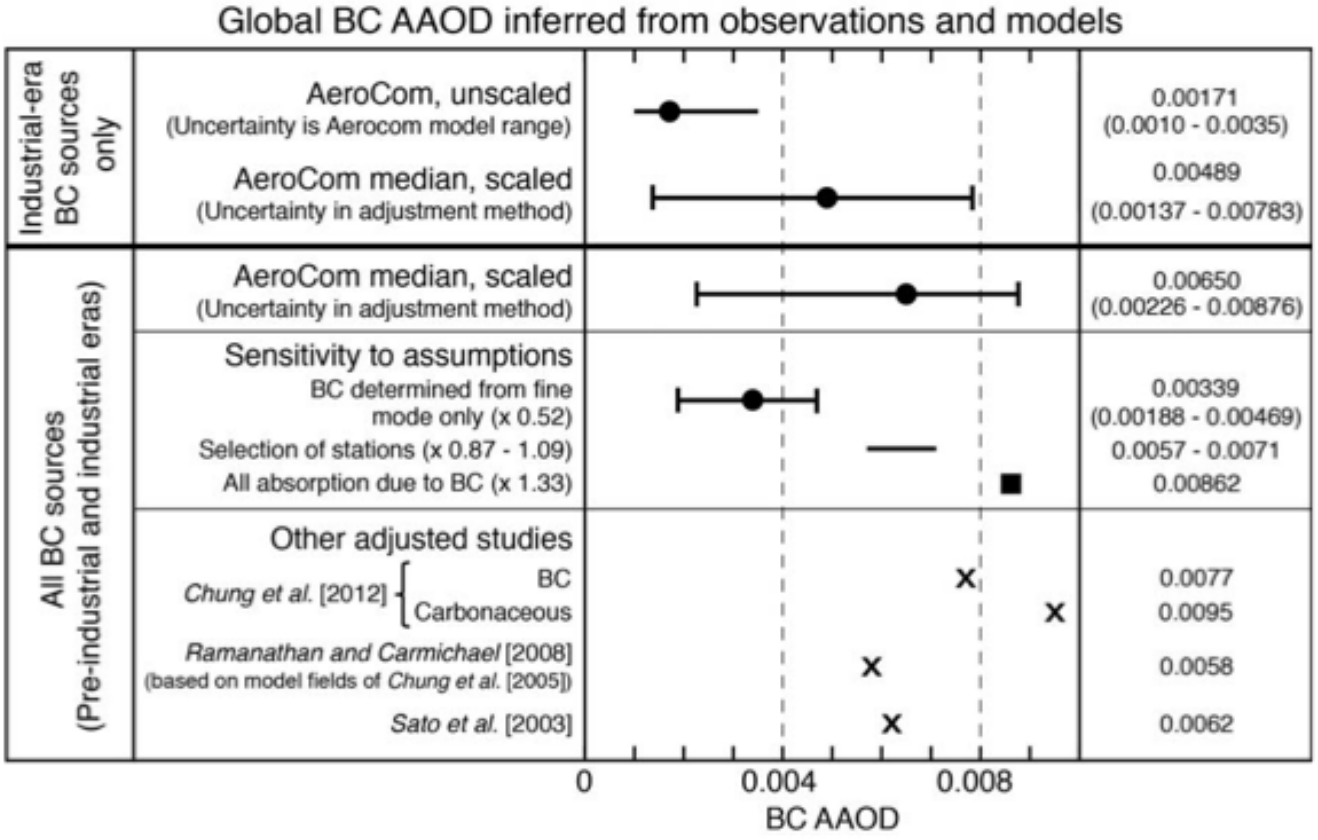
McComiskey et al. 2008

Attribution of radiative forcing to different atmospheric constituents is important for informing policy and model evaluation



Half of the uncertainty in BC radiative forcing has been attributed to separating the contributions of dust and BC to absorbing aerosol optical depth

Bond et al. 2013



Bond et al. 2013

Attribution of τ_{abs} to absorbing aerosol components BC, BrC, and dust

Questions:

- How can ARM measurements be used to determine the fraction of absorbing aerosol components that contribute to the total τ_{abs}?

- How can this information be used to improve estimates of ground- and space-based remote sensing (active and passive) retrievals of τ_{abs}?

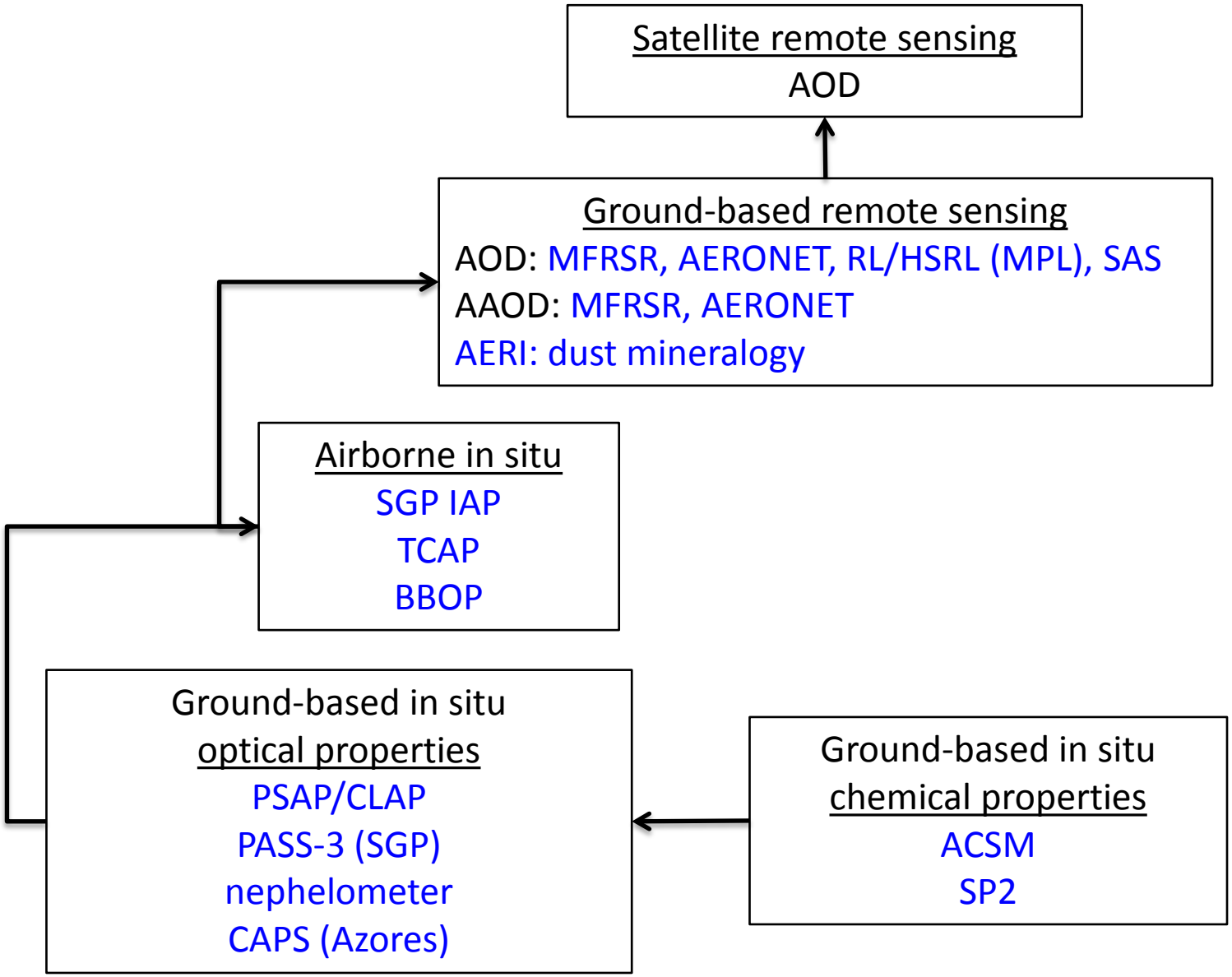
- Can we evaluate existing methods for retrieval of τ_{aBC} from AERONET?

Challenges

- attributing in situ chemical measurements to contribution of in situ observed absorption
- Apportioning chemistry to absorption
- relating in situ observations to column remote sensing observations

- Measurements needs (do we have everything we need)
- Accuracy in (AOD, angstrom, omega?)
- Wavelength needs

Observational Tools



Methods used to determine τ_{aBC} from AERONET

- Method A (Bond et al., JGR 2013)
  - Use AERONET retrieved size distribution and τ_a
  - Assume all absorption for d>1 micron is by dust, for d< 1 micron is by BC
  - Estimate τ_{aD} from retrieved size distribution (d>1 micron) and prescribed dust refractive index
  - $\tau_{aBC} = \tau_a - \tau_{aD}$

- Method B: as in Method A, but
  - Estimate τ_{aBC} from retrieved size distribution (d<1 micron) and retrieved refractive index

- Method C (Chung et al., PNAS 2012)
  - Use spectral information about τ_a from AERONET
  - Assume Angstrom dependence on wavelength λ
  - Apply at $\lambda=\lambda_{550}$ and $\lambda=\lambda_{675}$ using retrieved τ_a and prescribed $\beta_{CA}=1$ and $\beta_D=2.4$ to solve for τ_{aCA} and τ_{aD} at $\lambda=\lambda_{550}$
  - Use same method to partition τ_{aCA} into τ_{aBC} and τ_{aOC}

$$\tau_a(\lambda_{550})\left(\lambda/\lambda_{550}\right)^{\beta} = \tau_{a_{CA}}(\lambda_{550})\left(\lambda/\lambda_{550}\right)^{\beta_{CA}} + \tau_{a_D}(\lambda_{550})\left(\lambda/\lambda_{550}\right)^{\beta_D}$$