# Role of particle-scale composition diversity for black carbon absorption

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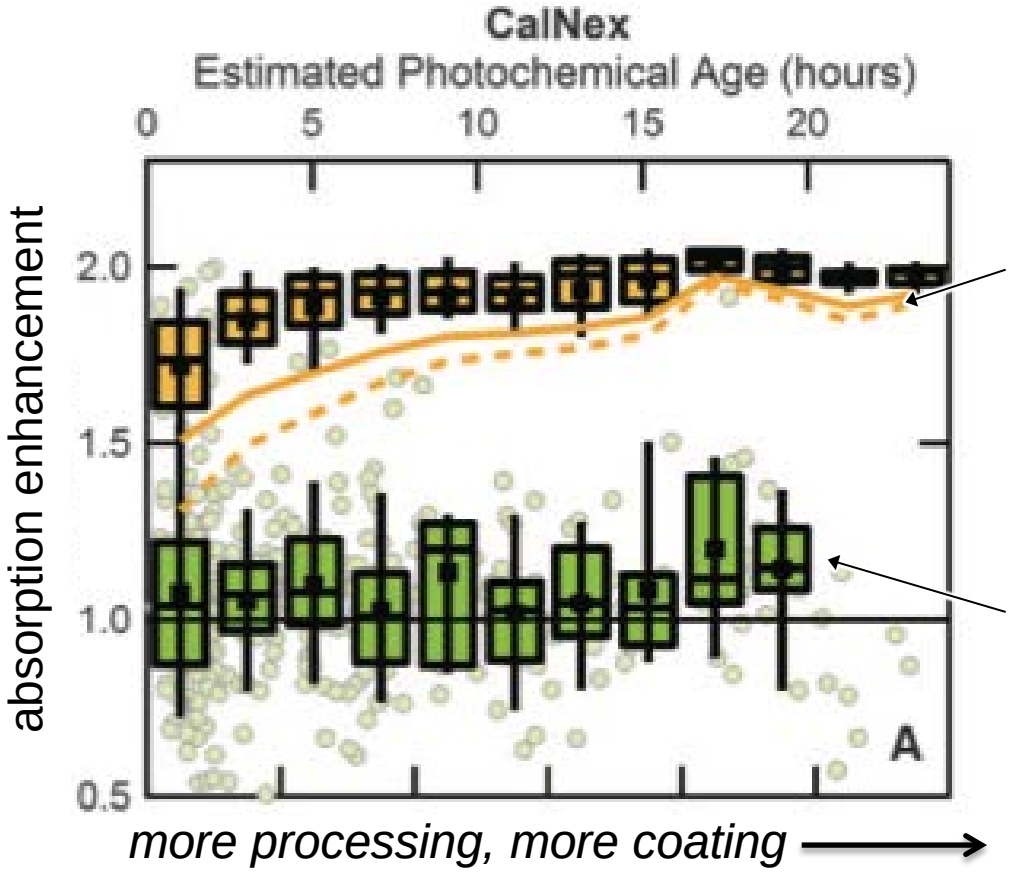
# Discrepancy between modeled and measured absorption per BC mass

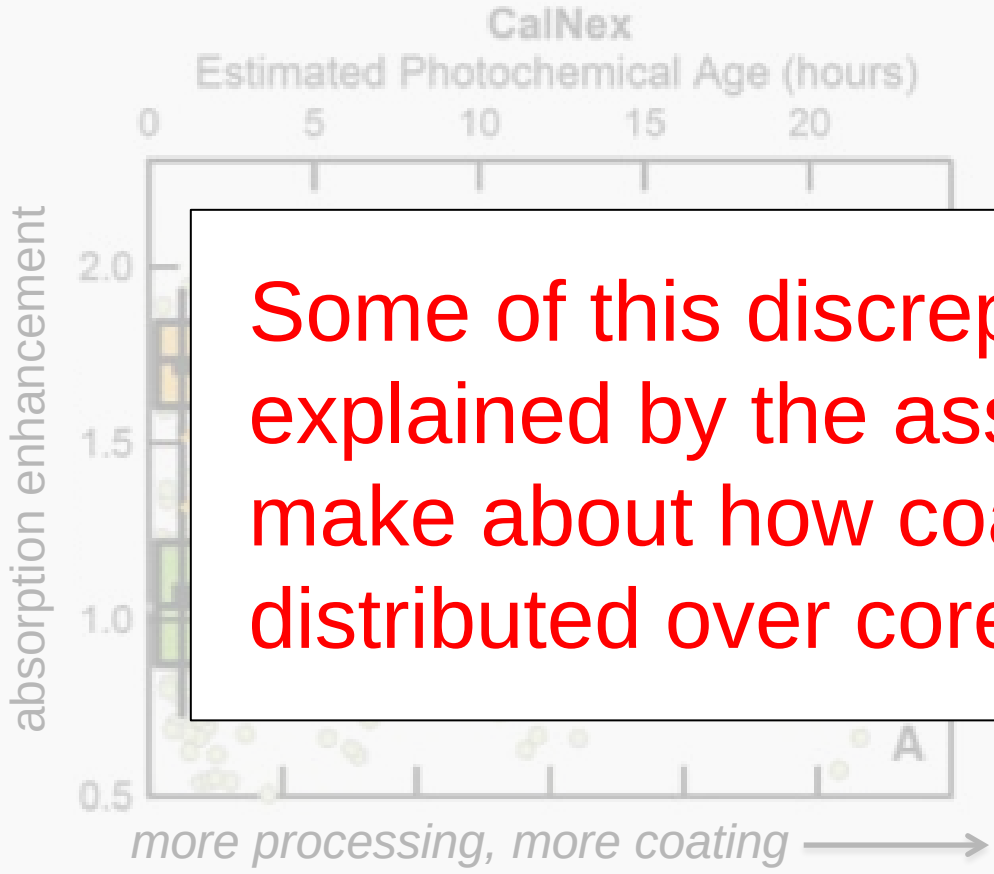



*Models find coatings enhance absorption by BC*

*Observations show weak absorption enhancement*

*Cappa et al., Science 2012*

# Discrepancy between modeled and measured absorption per BC mass




Some of this discrepancy can be explained by the assumptions we make about how coatings are distributed over cores.

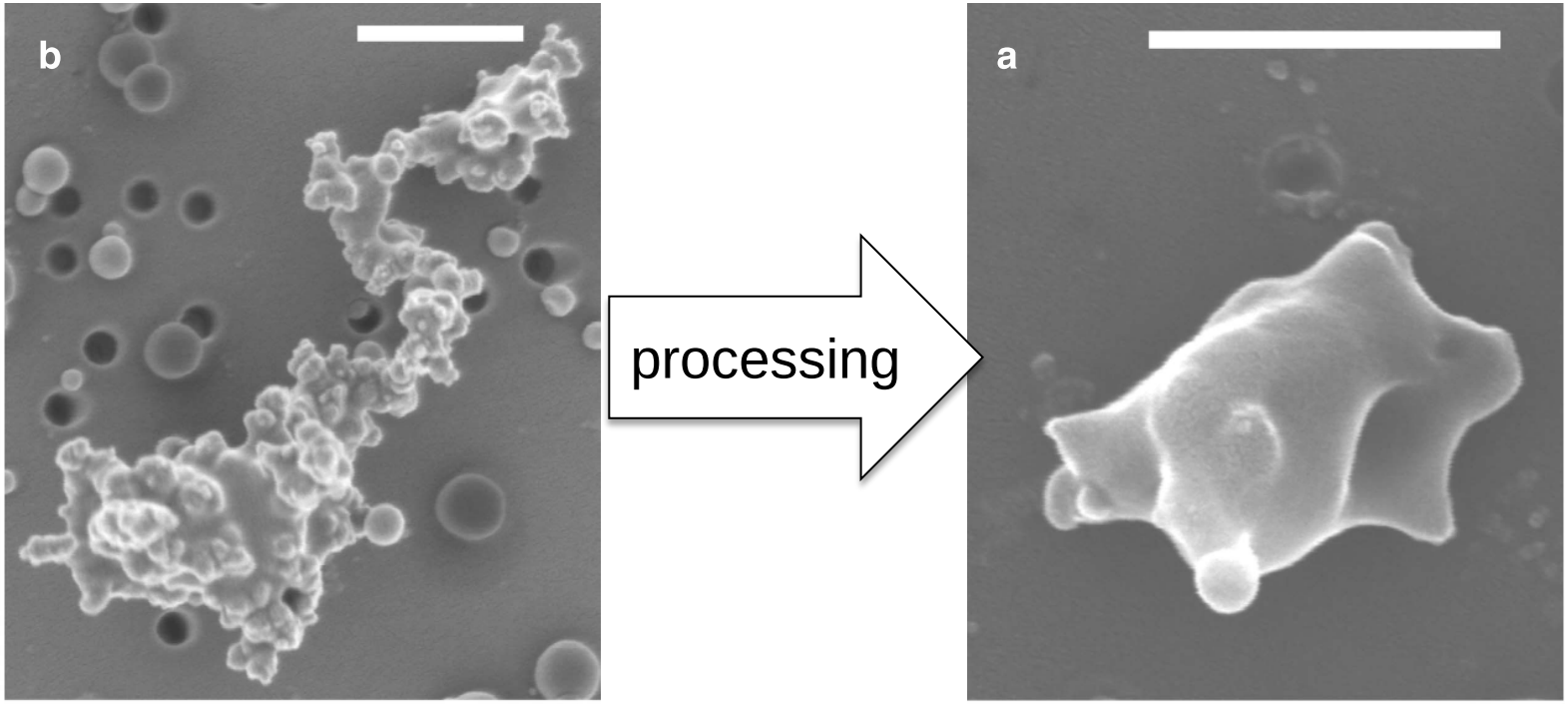
*ngs*
*on by*
*w*
*weak absorption enhancement*

*Cappa et al., Science 2012*

# BC exists in complex aerosol particles, but models simplify particle representation

*thinly coated BC*

*thickly coated, embedded*



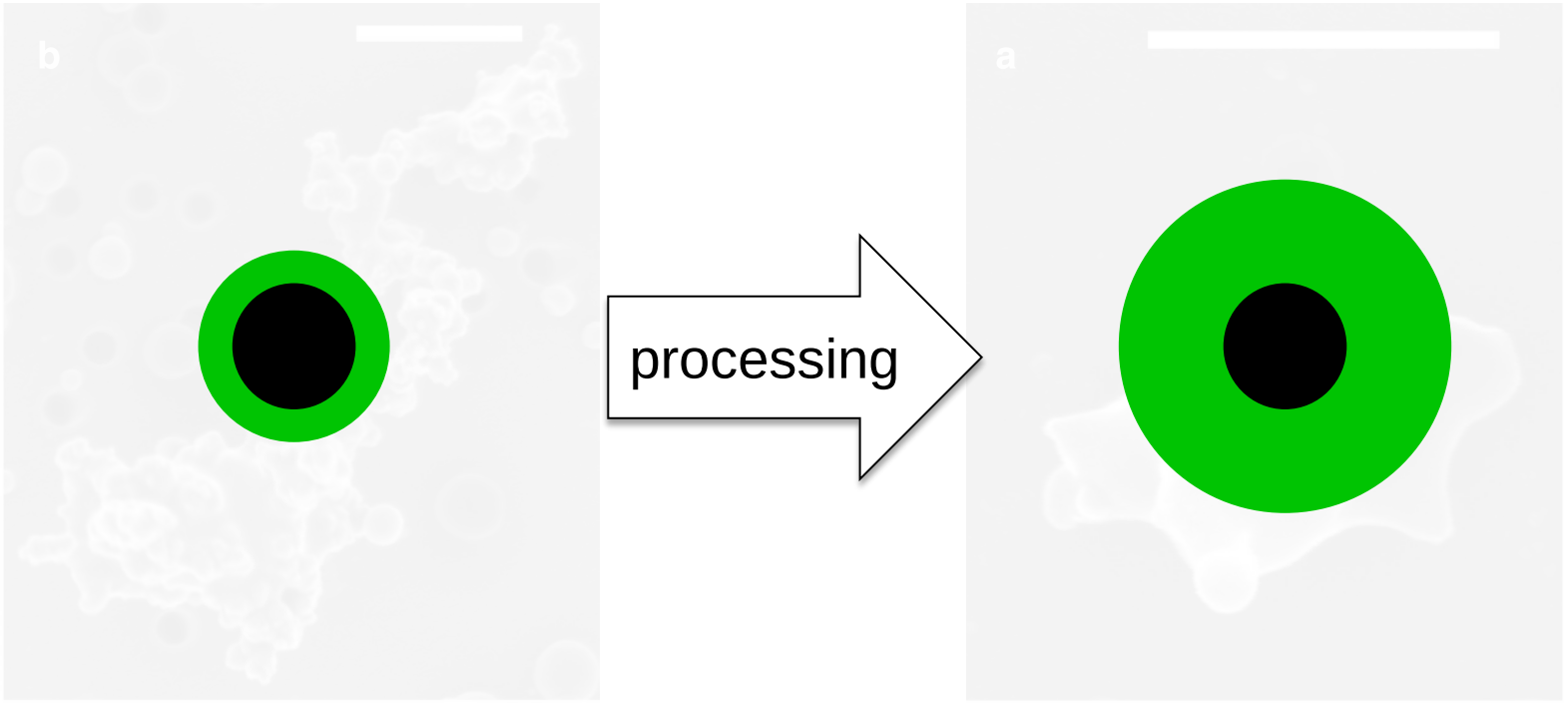

*China et al., Nature Comm. 2013*

Absorption by BC within an individual particle depends on size, shape, and composition

# Treatment of particle morphology may lead to model errors

*thinly coated BC*

*thickly coated, embedded*




*Models often assume BC exists as a spherical core that is uniformly coated by other aerosol*

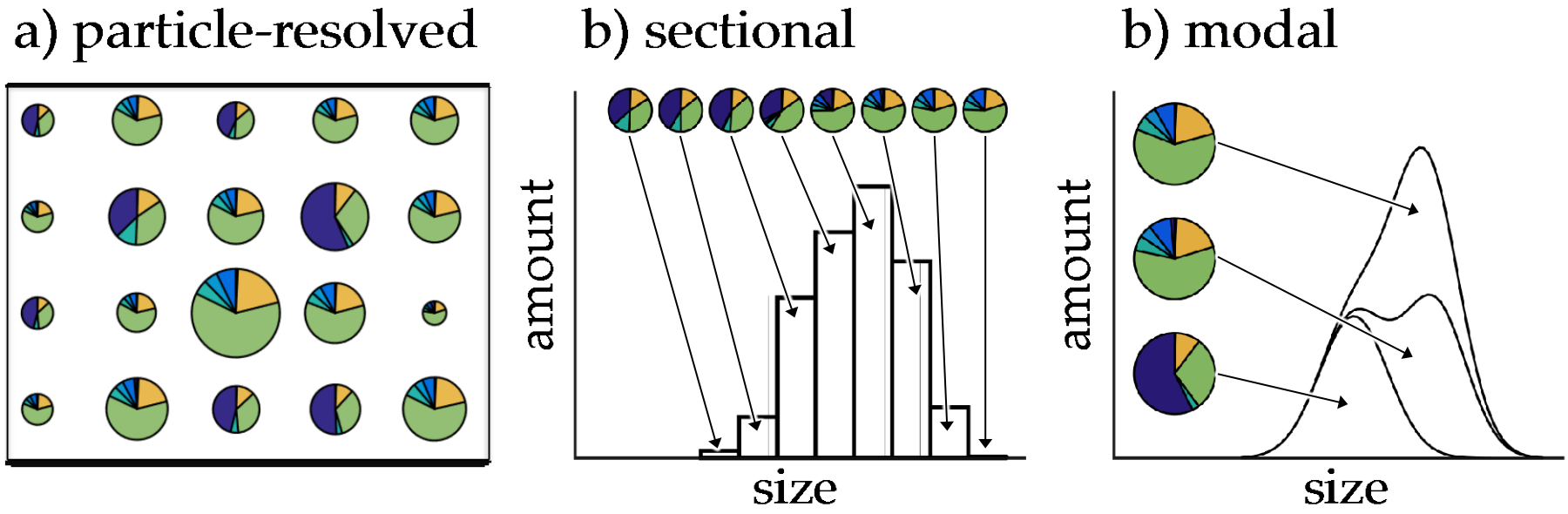
# Treatment of particle morphology may lead to model errors

*thinly coated BC* *thickly coated, embedded*

Here we focus on model error associated with particle composition, not morphology.

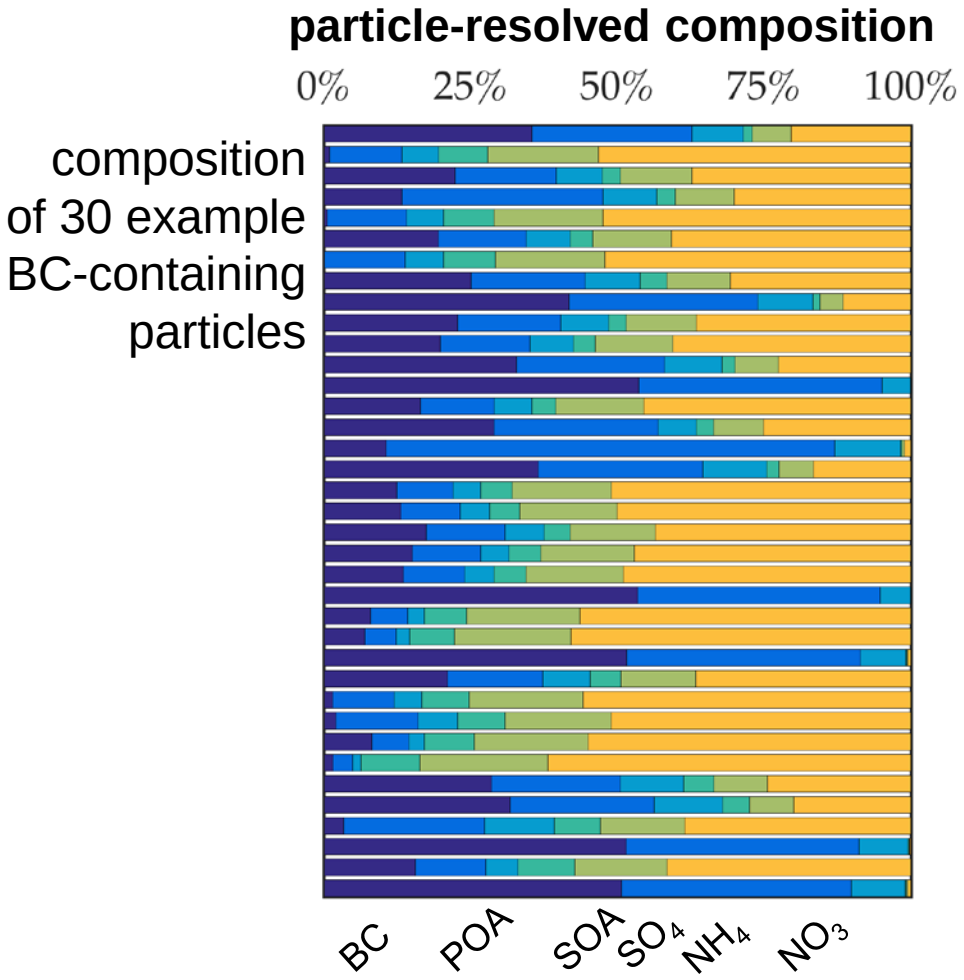
*Models often assume BC exists as a spherical core that is uniformly coated by other aerosol*

# Model absorption by diverse BC populations using particle-resolved model



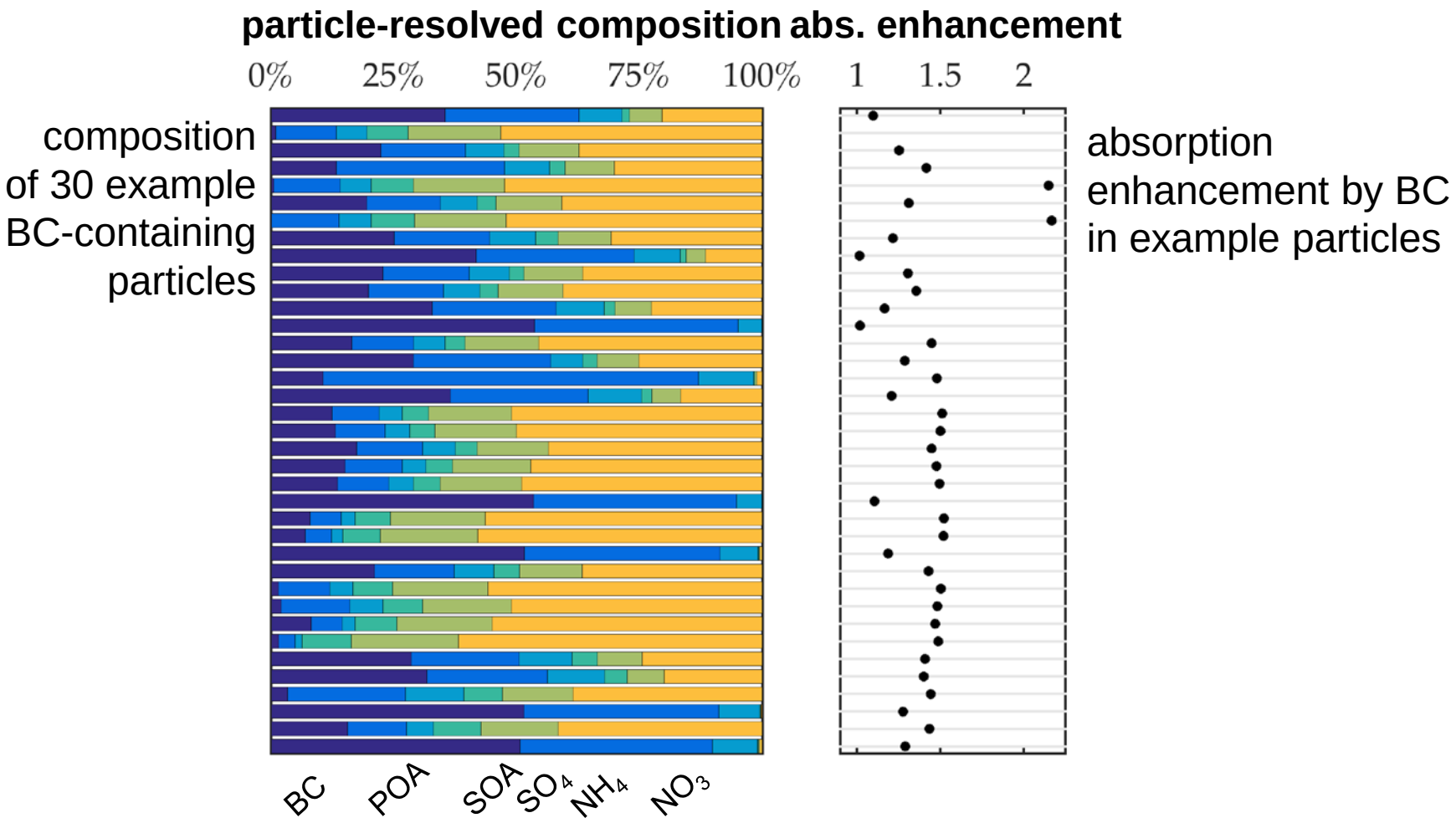

Unlike global aerosol models, particle-resolved model tracks composition of individual particles.

# Diversity in composition affects BC absorption

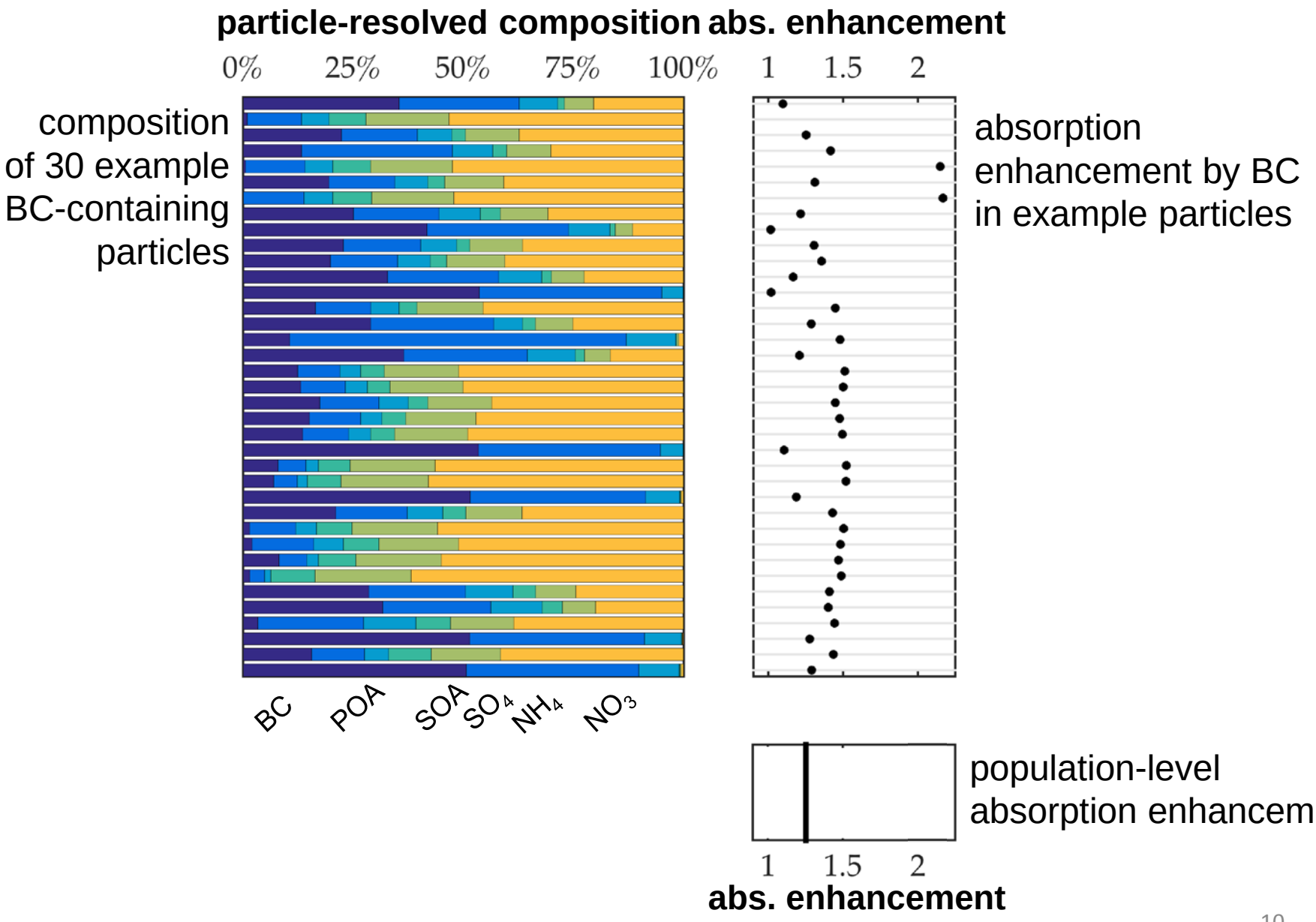



*Particle-resolved model tracks per-particle composition for thousands of particles*

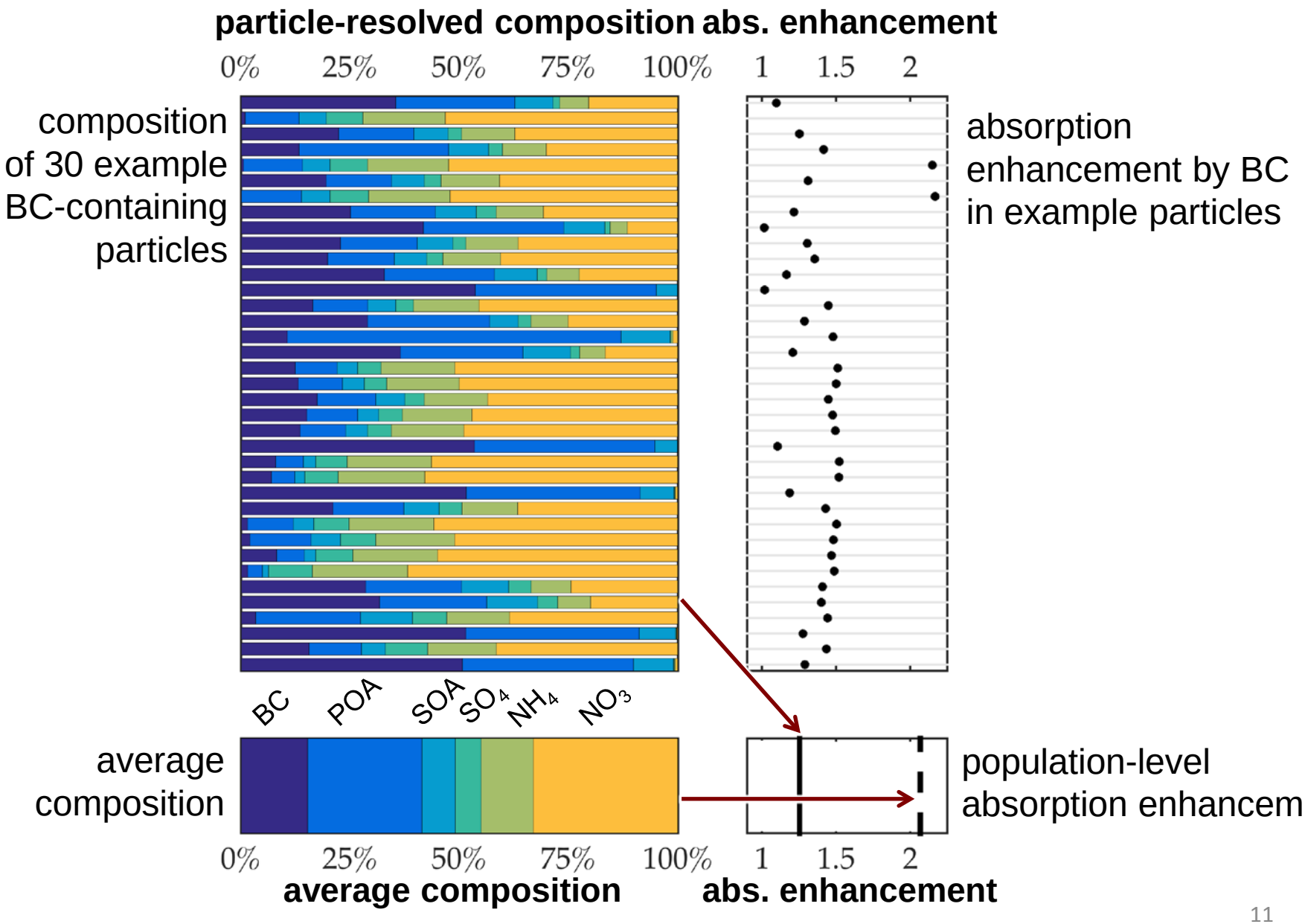
# Diversity in composition affects BC absorption



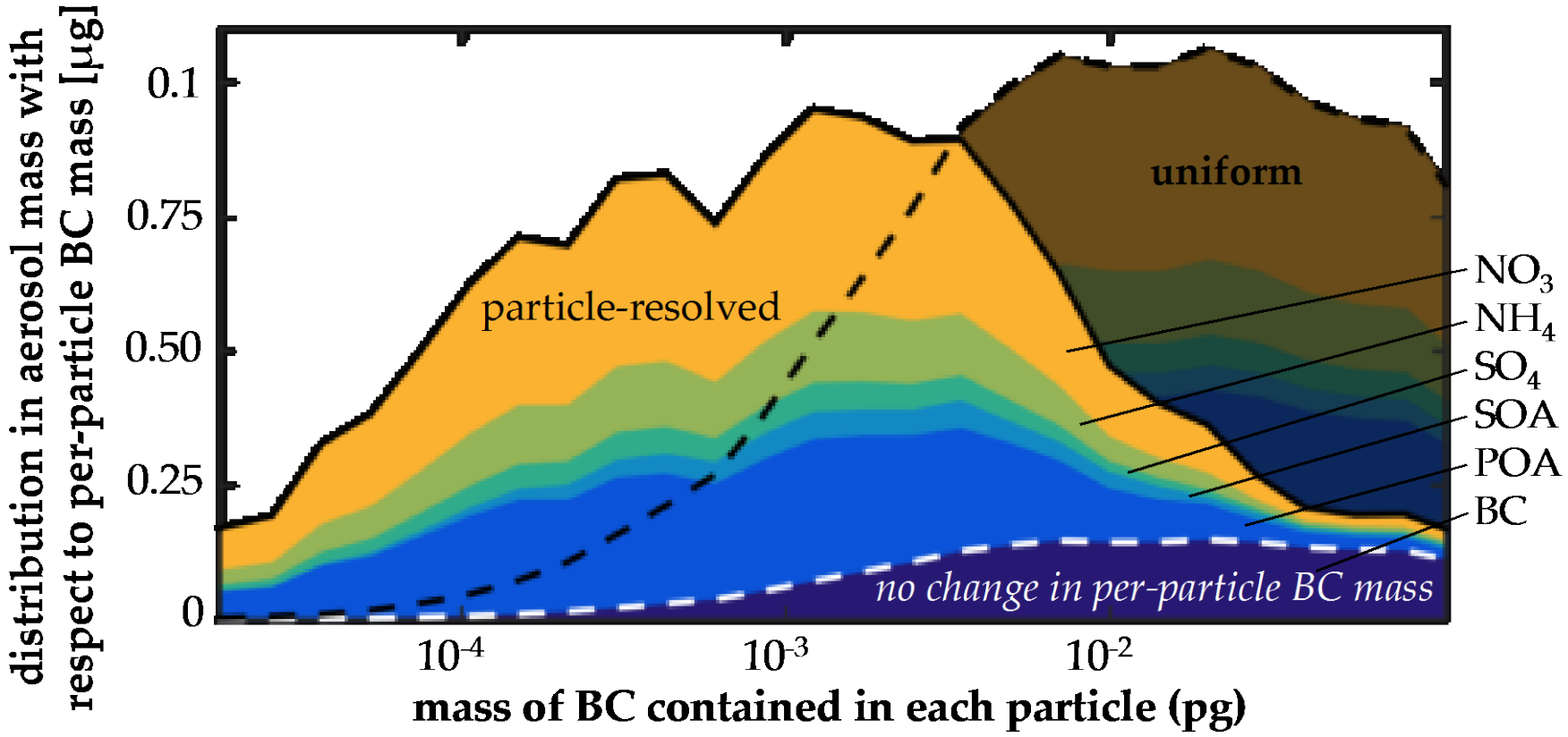
# Diversity in composition affects BC absorption



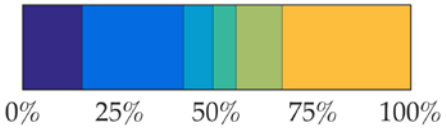
# Diversity in composition affects BC absorption

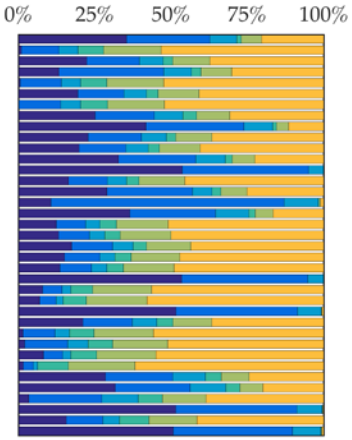


# Why this bias?



# Develop relationship for absorption enhancement that accounts for diversity in particle composition




mass of black carbon

mass of dry coating

composition of coating

relative humidity

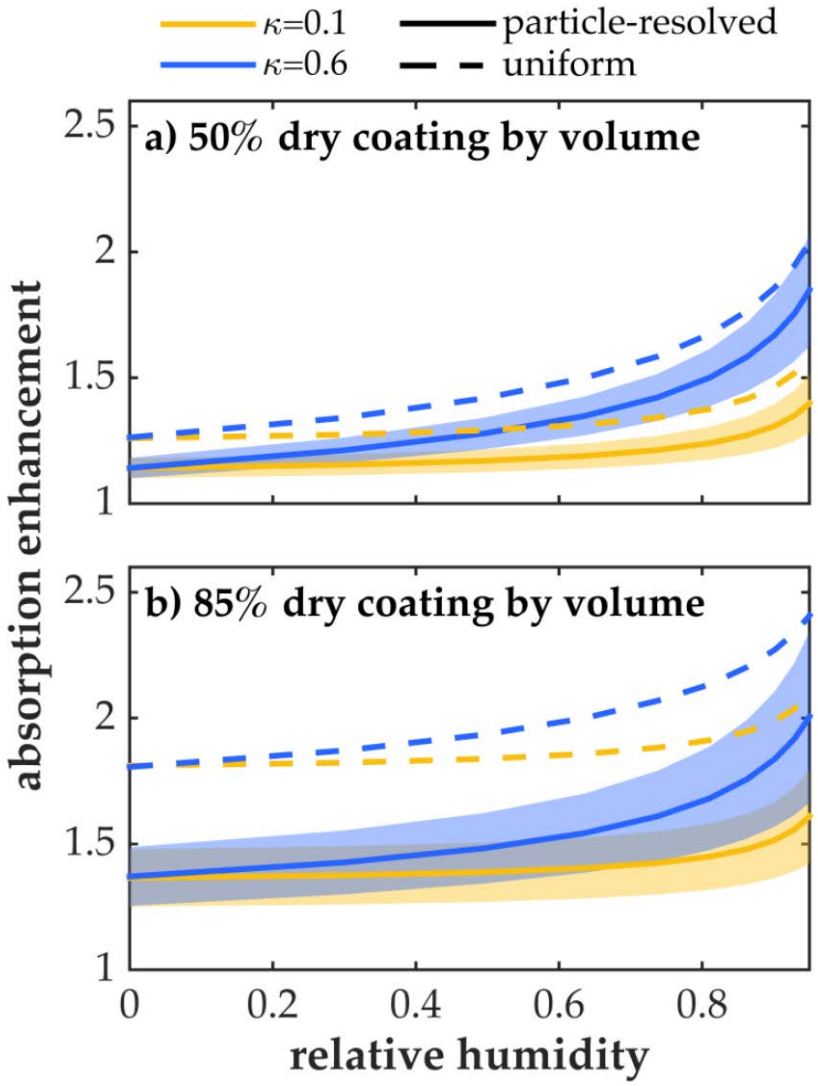
**parametric relationship**

absorption coefficient

**Inputs:**
population-level composition and relative humidity

**Output:**
absorption coefficient

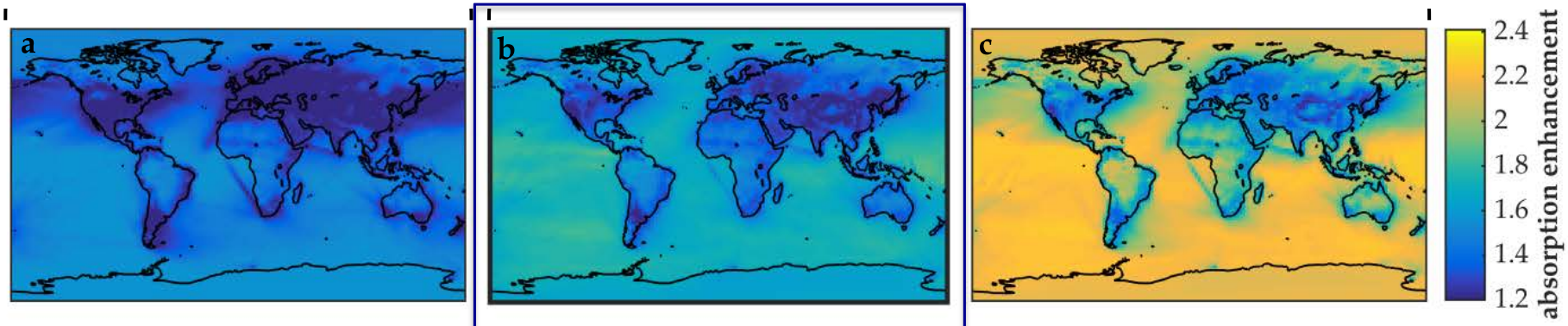
# Results from non-parametric regression




**Inputs:**
population-level composition and relative humidity

**Output:**
absorption coefficient

# Taking this to the global scale




Accounting for particle-level composition diversity

Neglecting water uptake

Accounting for particle-level composition diversity

Accounting for water uptake

Assuming uniform composition

Accounting for water uptake

our best estimate

# Conclusions

- Aerosol absorption depends on mixing state details that are difficult to simulate
- Use particle-resolved simulations to develop parameterization as a function of properties that models already track
- Parameterization reproduces absorption from particle-resolved model with high accuracy ($R^2$ = 97%)

# Looking for collaborators to …

- … apply parametric relationship in large-scale modal aerosol schemes, evaluate impact.

- … validate relationship against observations.