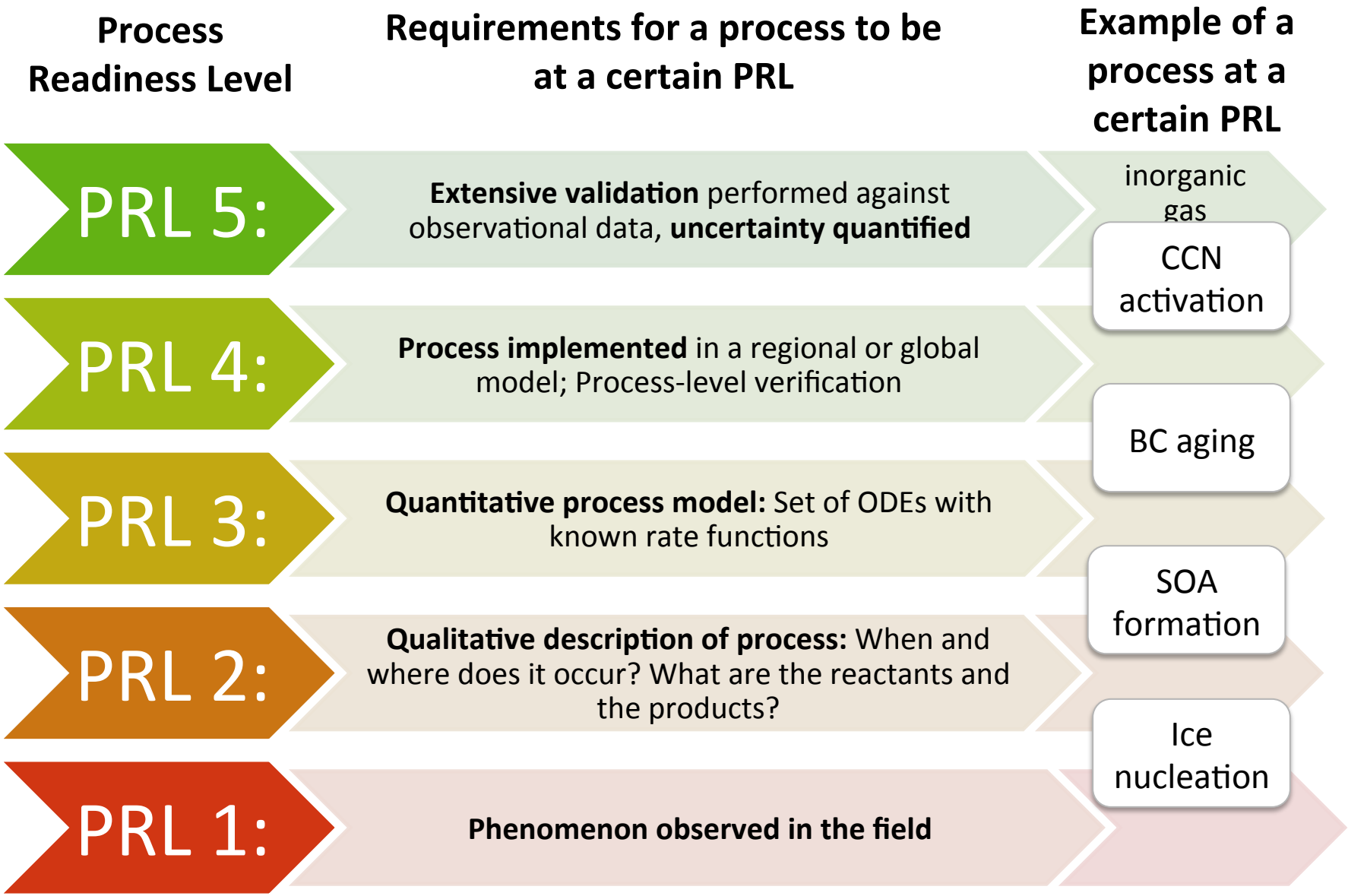
Agenda for today

- Some background – Framing the problem

- Short presentations:
  - Jim Hudson: Processing of aerosols in clouds
  - R Subramanian and Claudio Mazzoleni: SP2 and SEM
  - Matthew Fraund and Ryan Moffet: STXM and SEM/EDX
  - Joseph Ching: SP2, SPLAT and modeling
  - Tim Onasch: BC 4 study
  - Alla Zelenyuk and Aiken/Dubey: SAAS campaign

- Discussion

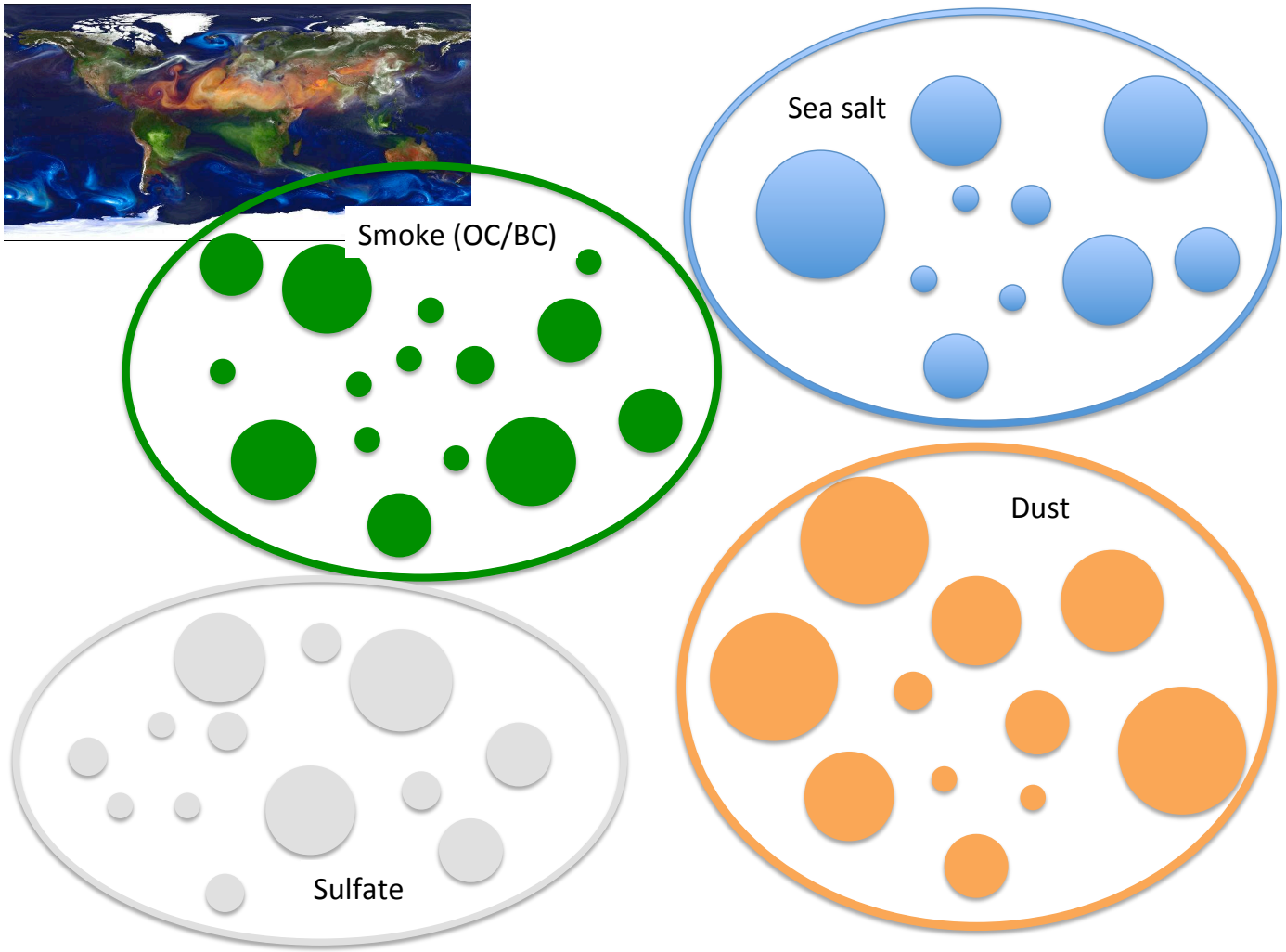

Process Readiness Level
Requirements for a process to be at a certain PRL
Example of a process at a certain PRL
PRL 5:
Extensive validation performed against observational data, uncertainty quantified
inorganic gas
CCN activation
PRL 4:
Process implemented in a regional or global model; Process-level verification
BC aging
PRL 3:
Quantitative process model: Set of ODEs with known rate functions
SOA formation
PRL 2:
Qualitative description of process: When and where does it occur? What are the reactants and the products?
Ice nucleation
PRL 1:
Phenomenon observed in the field

Questions for today

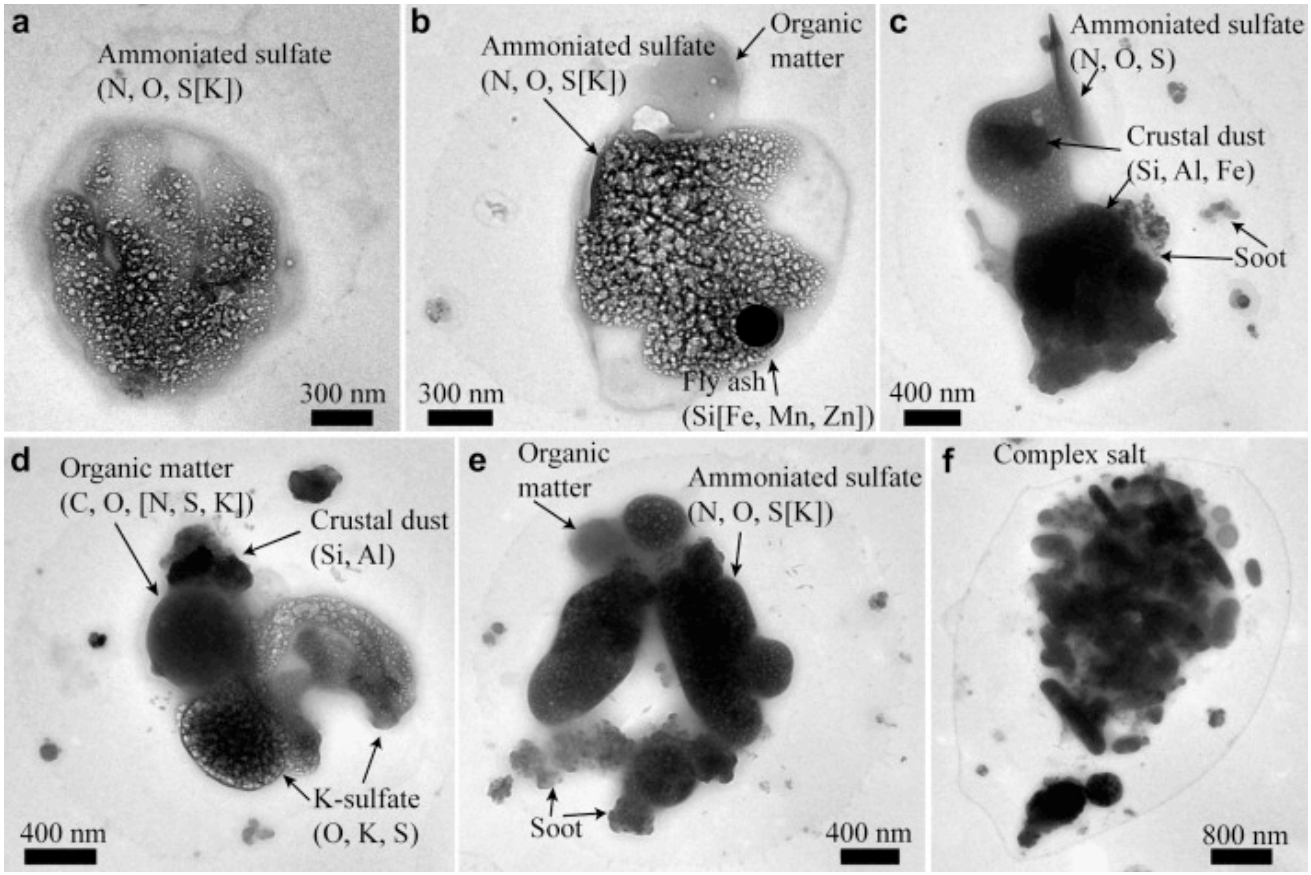
- No single instrument that can characterize the full “mixing state” of an aerosol population.
- How can we integrate the different experimental techniques to characterize mixing state as fully as possible?
- How can we use this information to compare to mixing-state-aware models?

- We solicit short presentations that show your work or ideas on
  - (a) comparing mixing state information between different measurement platforms
  - (b) compare measured mixing state information to simulated mixing state.

Aerosol Population: Modelers wish



Aerosol Population: Reality

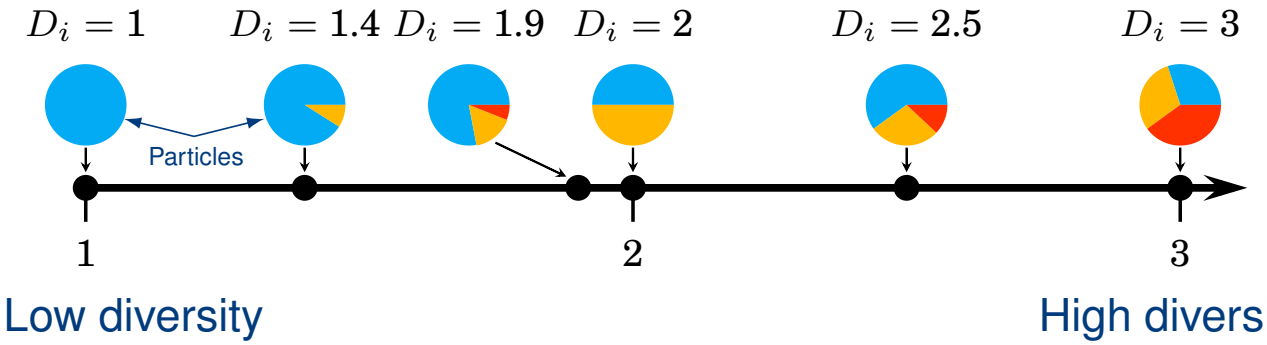


Li et al., Atmospheric Environment, 45, 2488-2495, 2011

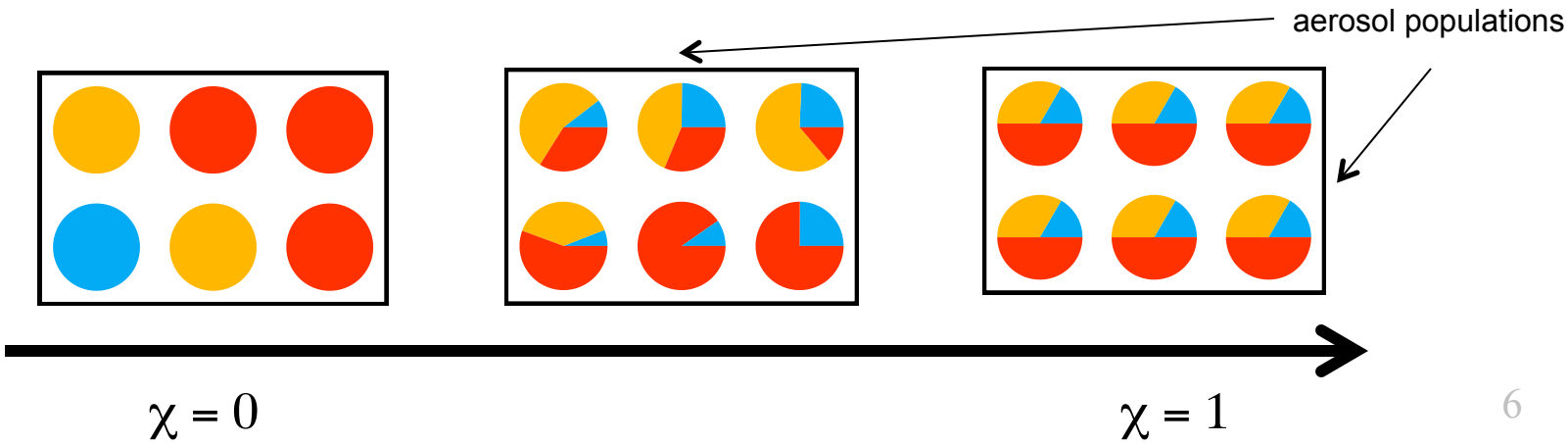
How much detail is needed to capture aerosol impacts in large scale models?

Mixing state terminology: Chemical composition

On the particle level: Chemical composition diversity



On the population level: Mixing state associated with chemical composition
How are the chemical species distributed over the population?

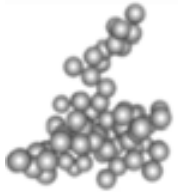


Mixing state terminology: Morphology

On the particle level: Physical morphology

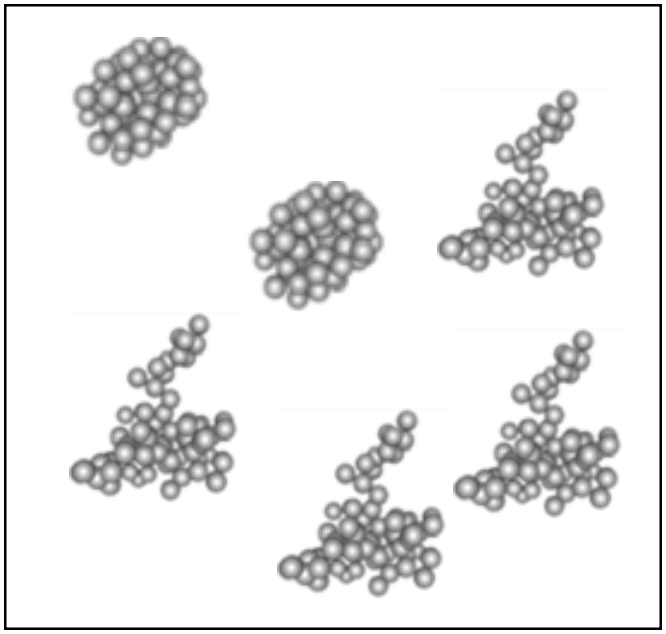
highly compact

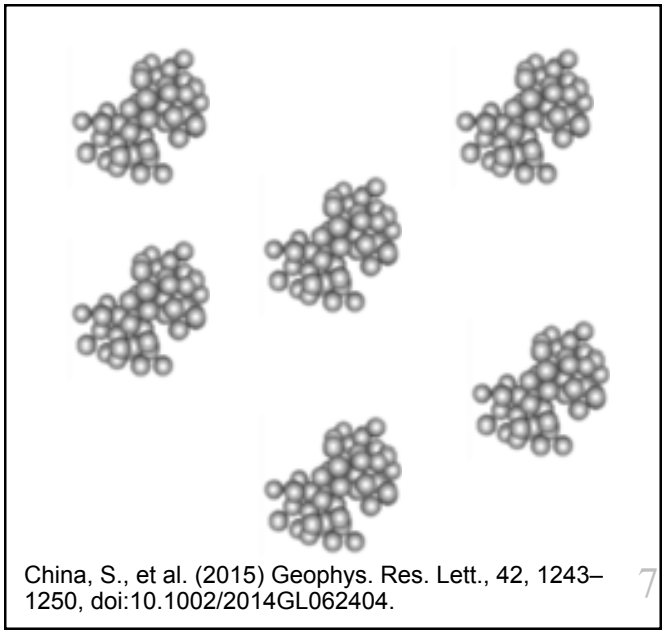
semicompact



lacy

On the population level: Mixing state associated with morphology





China, S., et al. (2015) Geophys. Res. Lett., 42, 1243–1250, doi:10.1002/2014GL062404.

How important are these details?

Key question 1:

What is the impact of mixing state on CCN, IN, optical properties?

Key question 2:

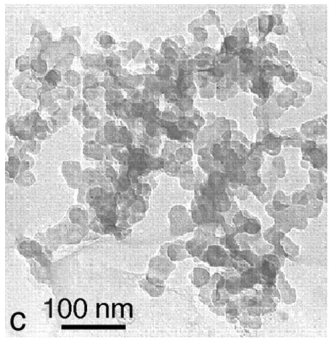
How should we include mixing state information in models that quantify aerosol climate impacts?

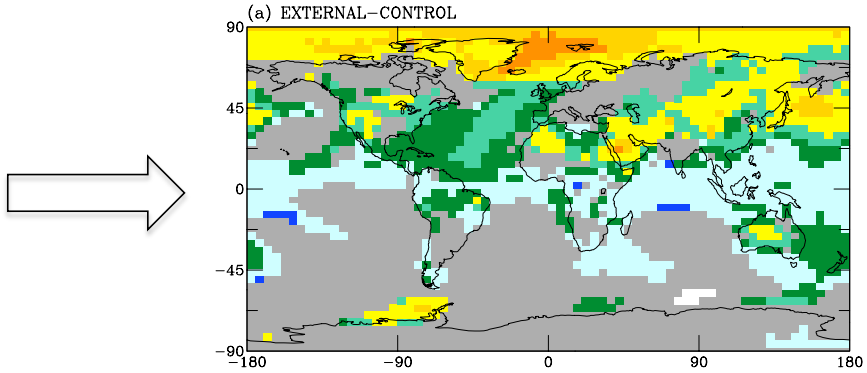
- What aerosol mixing states exist in different environments?
- How can we connect measurements (lab and field) to each other and to modeled mixing state information?
- What mixing state information should be measured in the field and in the lab?

Mixing state matters

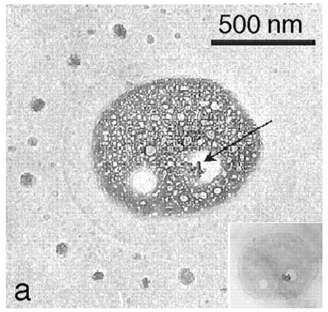
Change in equilibrium annual mean surface air temperature (K)

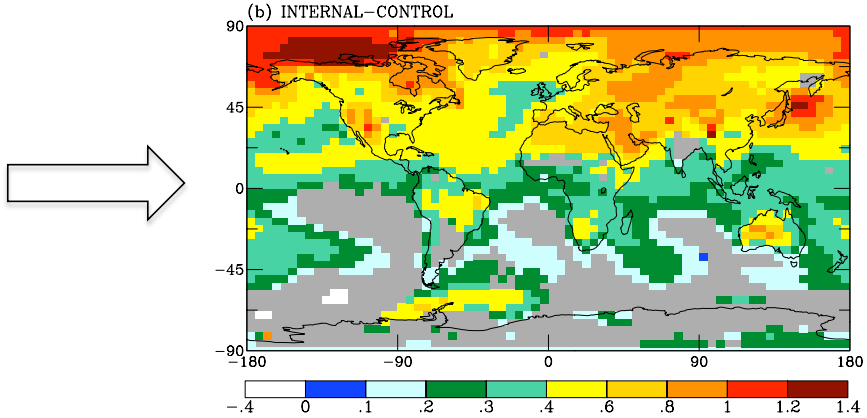
External





Internal





"[…] These results confirm that the mixing state of BC with other aerosols is important in determining its climate effect."

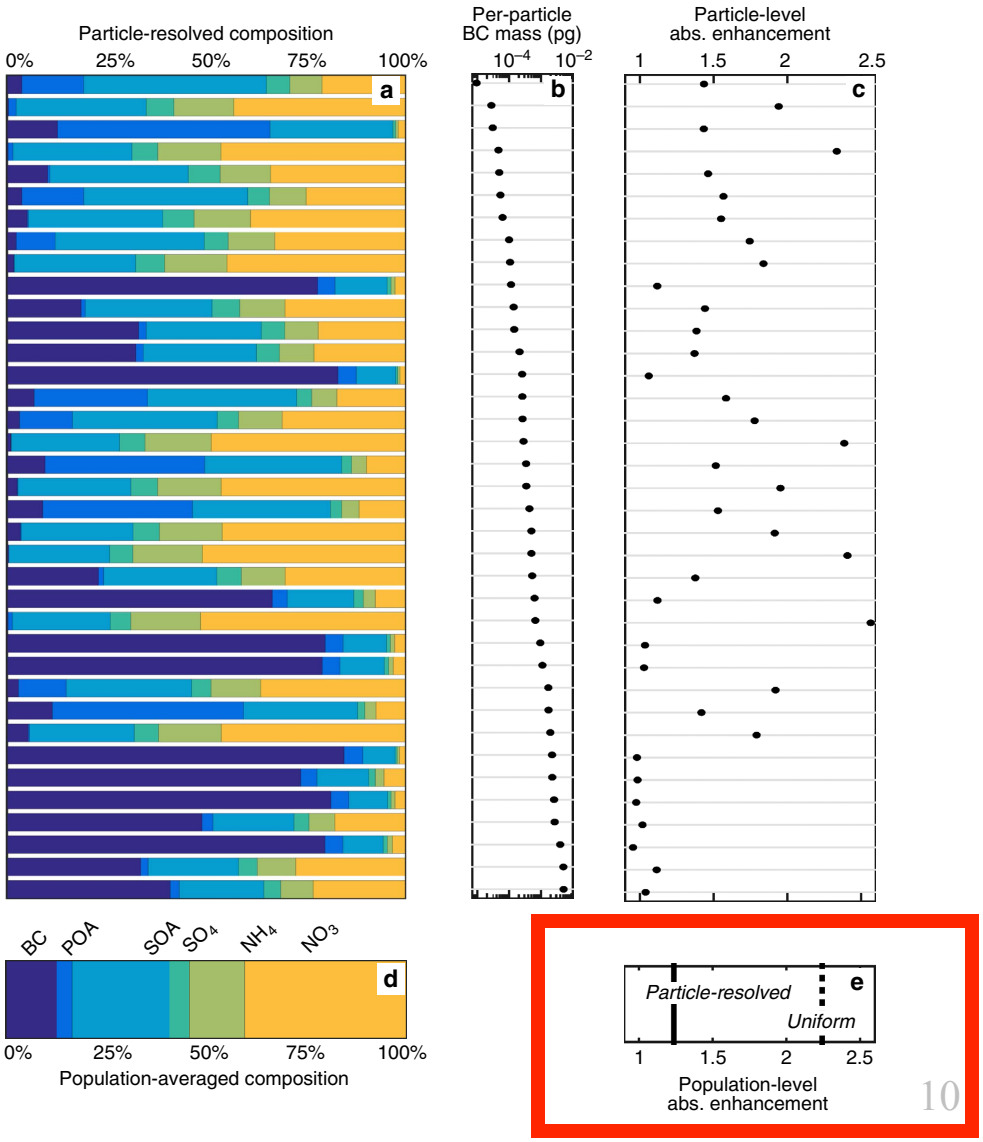
Chung and Seinfeld, JGR 2005

Mixing state matters

Calculated absorption enhancement using average composition

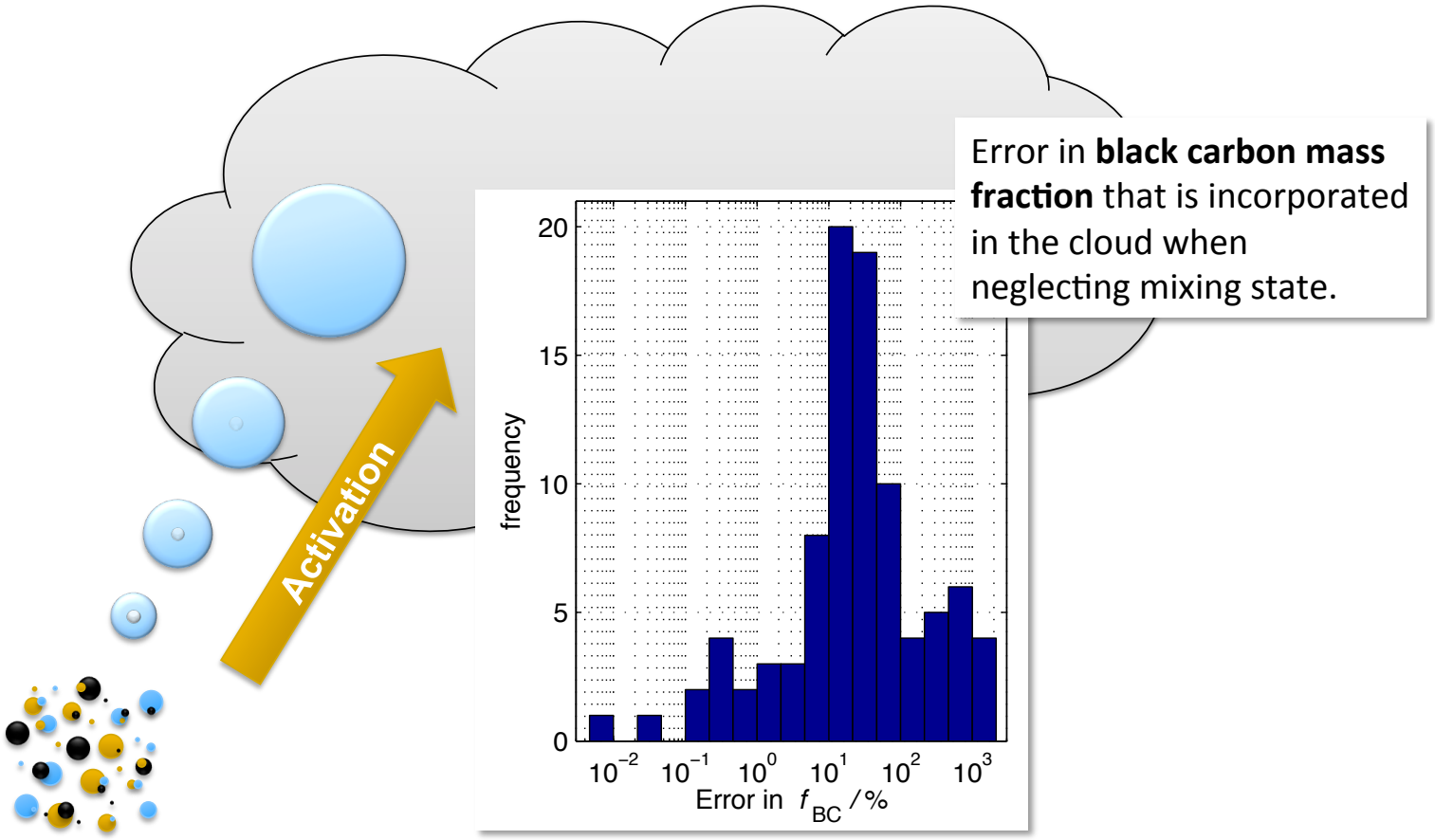
≠

Calculated averaged absorption enhancement using per-particle composition



Fierce et al., *Nature Comm.*, 2016

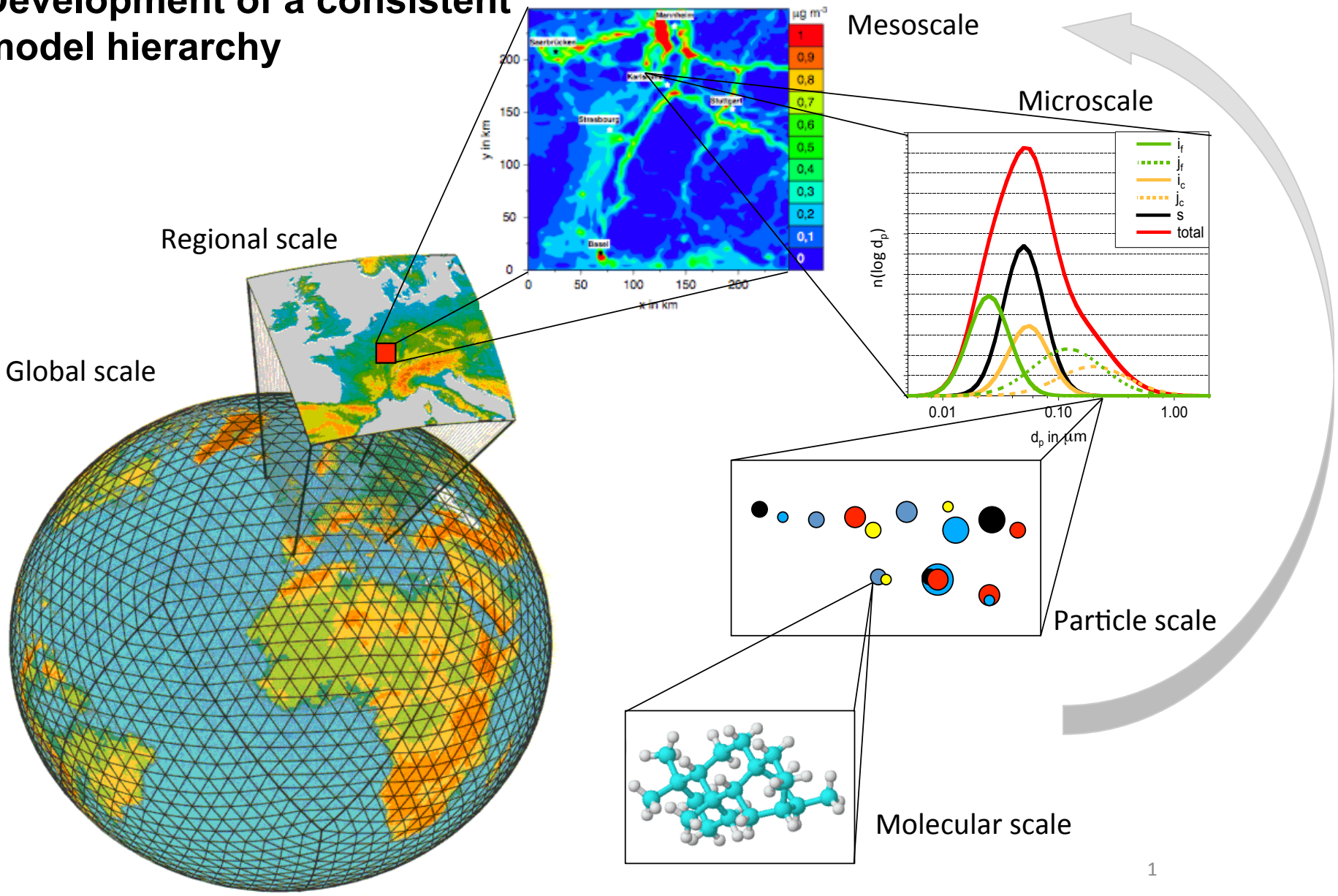
Mixing state matters



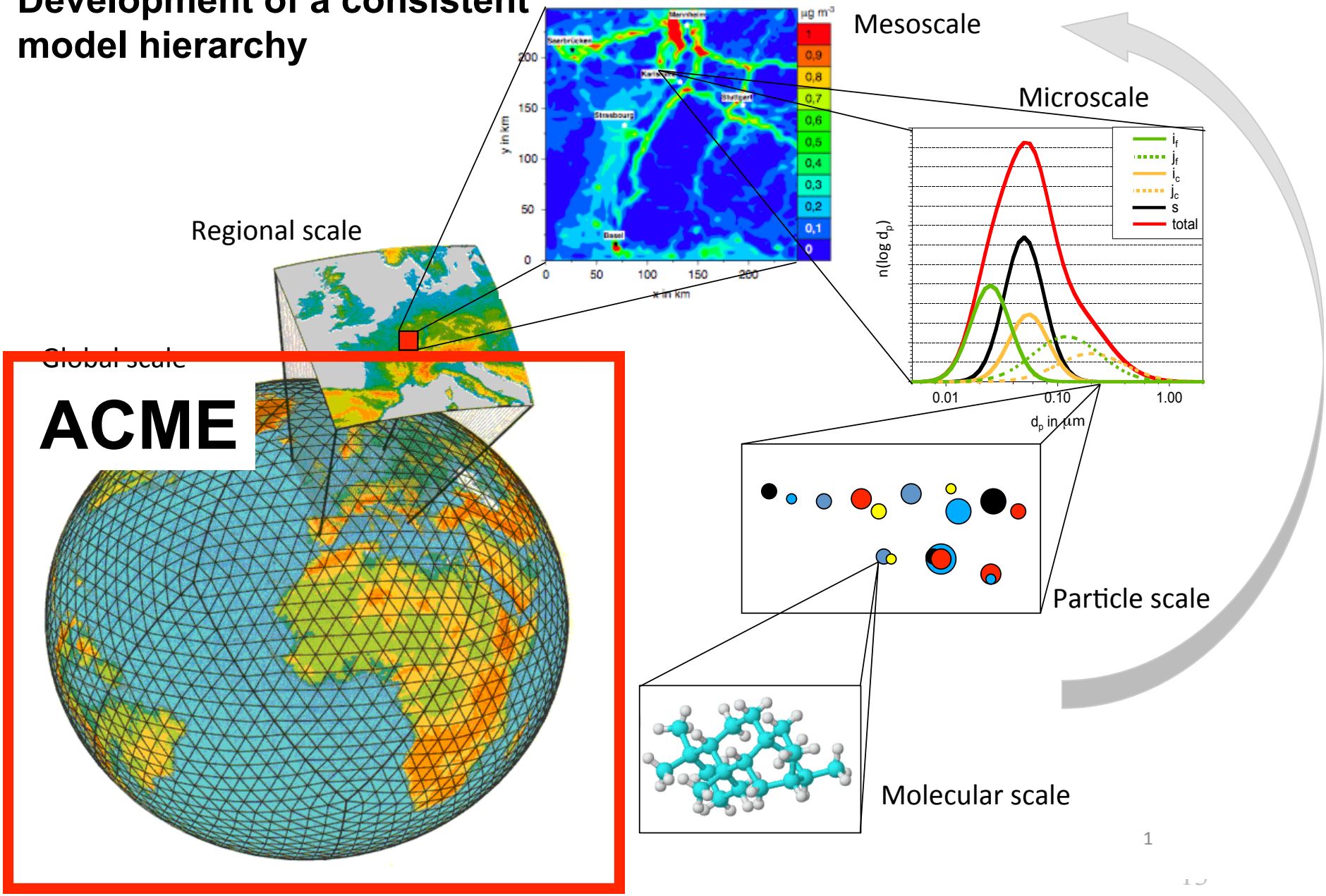
Error in **black carbon mass fraction** that is incorporated in the cloud when neglecting mixing state.

Ching et al., *J. Geophys. Res.*, **121,** 5912–5929 **(**2016)

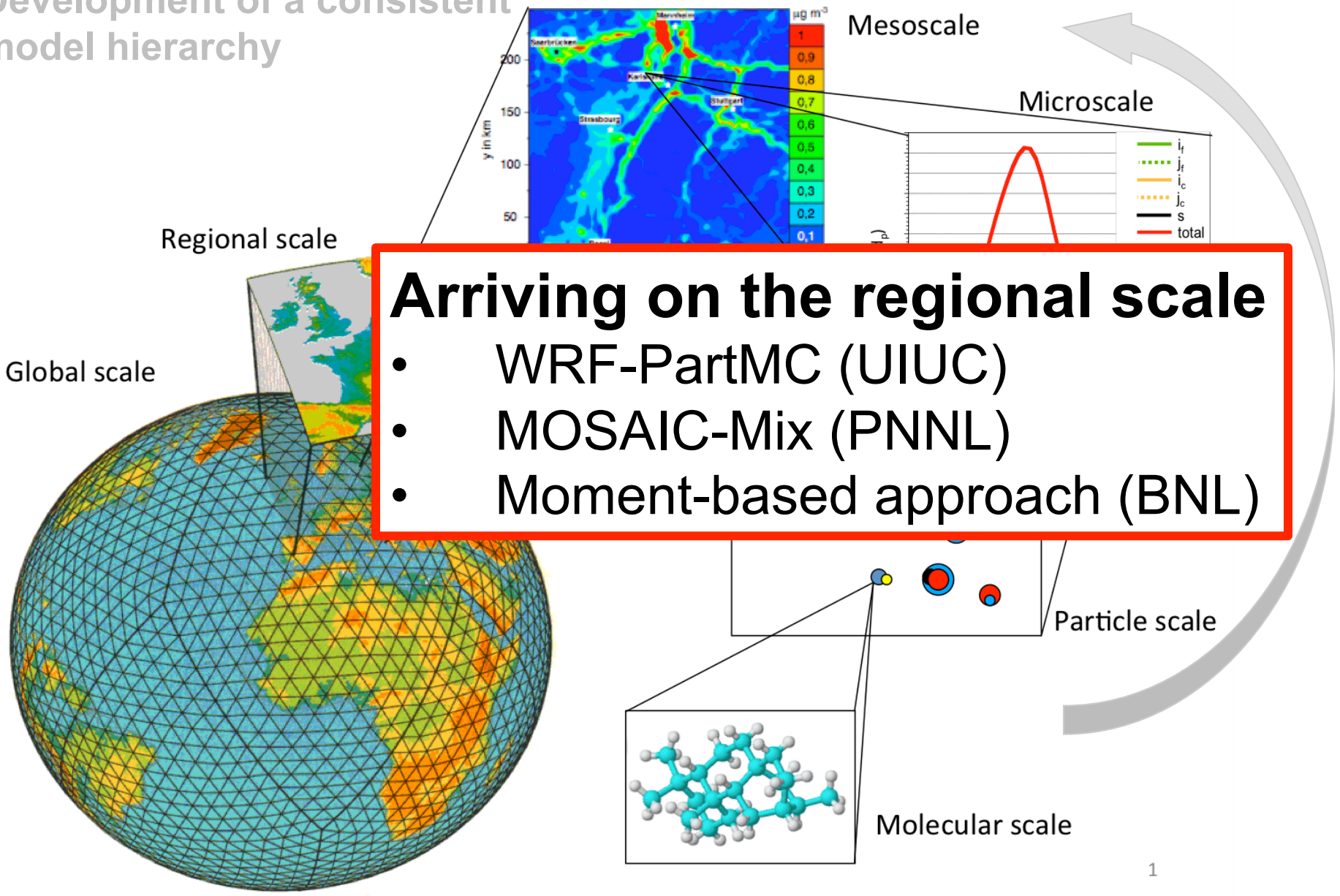
Development of a consistent model hierarchy



Development of a consistent model hierarchy



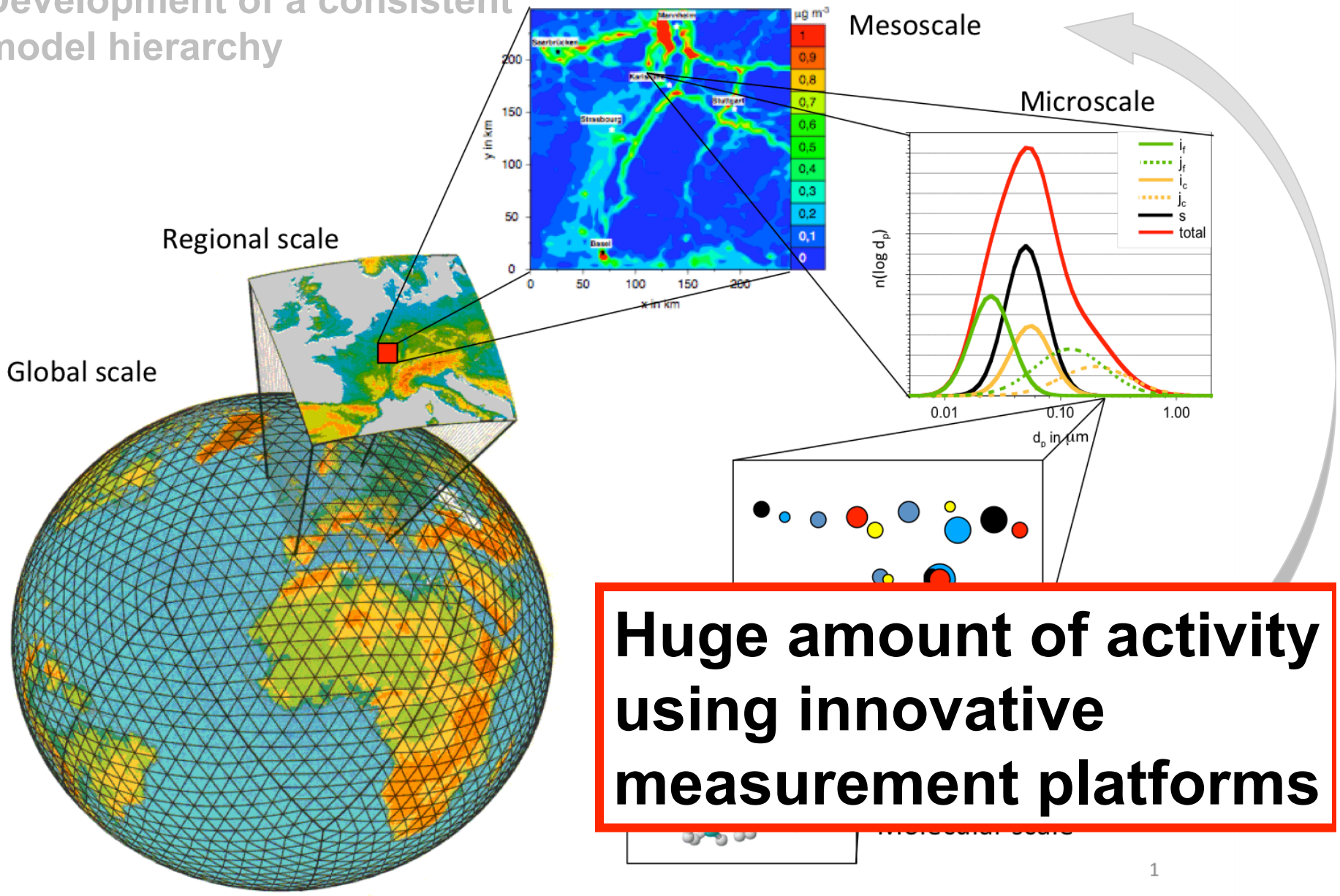
Development of a consistent model hierarchy



Arriving on the regional scale

- WRF-PartMC (UIUC)
- MOSAIC-Mix (PNNL)
- Moment-based approach (BNL)

Development of a consistent model hierarchy



Huge amount of activity using innovative measurement platforms

Given that we have mixing state aware models

1. How do we initialize models using measured mixing state information?

2. How do we compare models and measurements?

Agenda for today

- Some background – Framing the problem

- Short presentations:
  - Jim Hudson: Processing of aerosols in clouds
  - R Subramanian and Claudio Mazzoleni: SP2 and SEM
  - Matthew Fraund and Ryan Moffet: STXM and SEM/EDX
  - Joseph Ching: SP2, SPLAT and modeling
  - Tim Onasch: BC 4 study
  - Alla Zelenyuk and Aiken/Dubey: SAAS campaign

- Discussion

Connections between Different Tools: Progress

	Theory/ Metrics[1]	PRM[2]	SP2[3]	Micros-copy[4]	SP mass spectro-metry[5]	Bulk measure-Ments[6]	Remote sensing[7]	RM/ GCM[8]
Theory/ Metrics[1]		high	medium	medium	low	low	low	low
PRM[2]	high		medium	medium	medium	high	low	low
SP2[3]	medium	medium		medium	medium	high	low	low
Micros-copy[4]	medium	medium	medium		medium	medium	low	low
SP mass spetro-metry[5]	low	medium	medium	medium		medium	low	low
Bulk measure-ments[6]	low	high	high	medium	medium		high	medium
Remote sensing[7]	low	low	low	low	low	high		high
RM/ GCM[8]	low	low	low	low	low	medium	high	