Role of aqueous chemistry in organic aerosols

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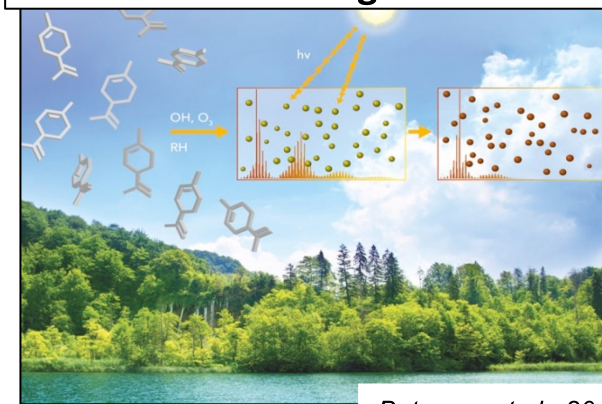
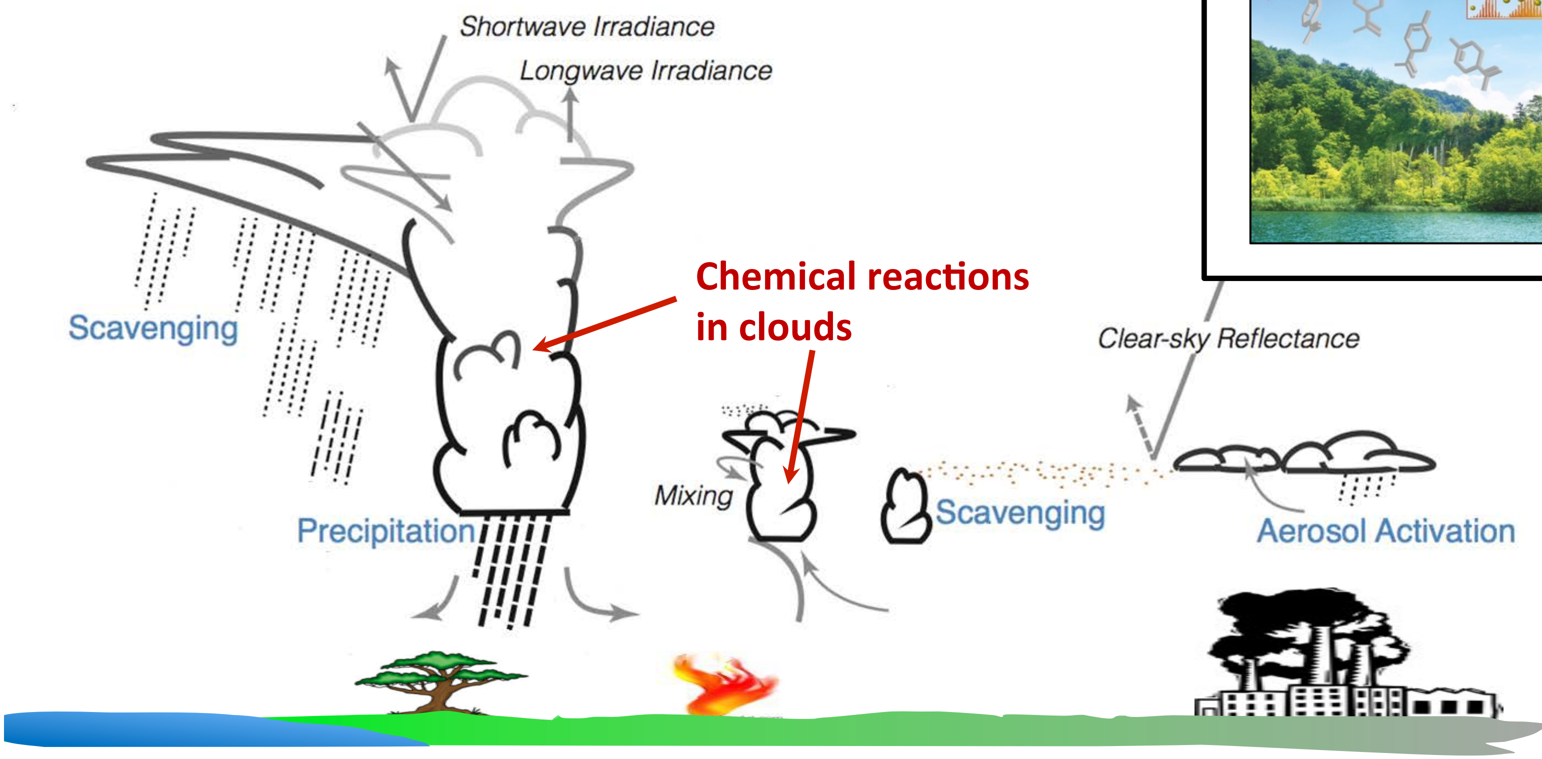
Cloud effects on organic aerosol



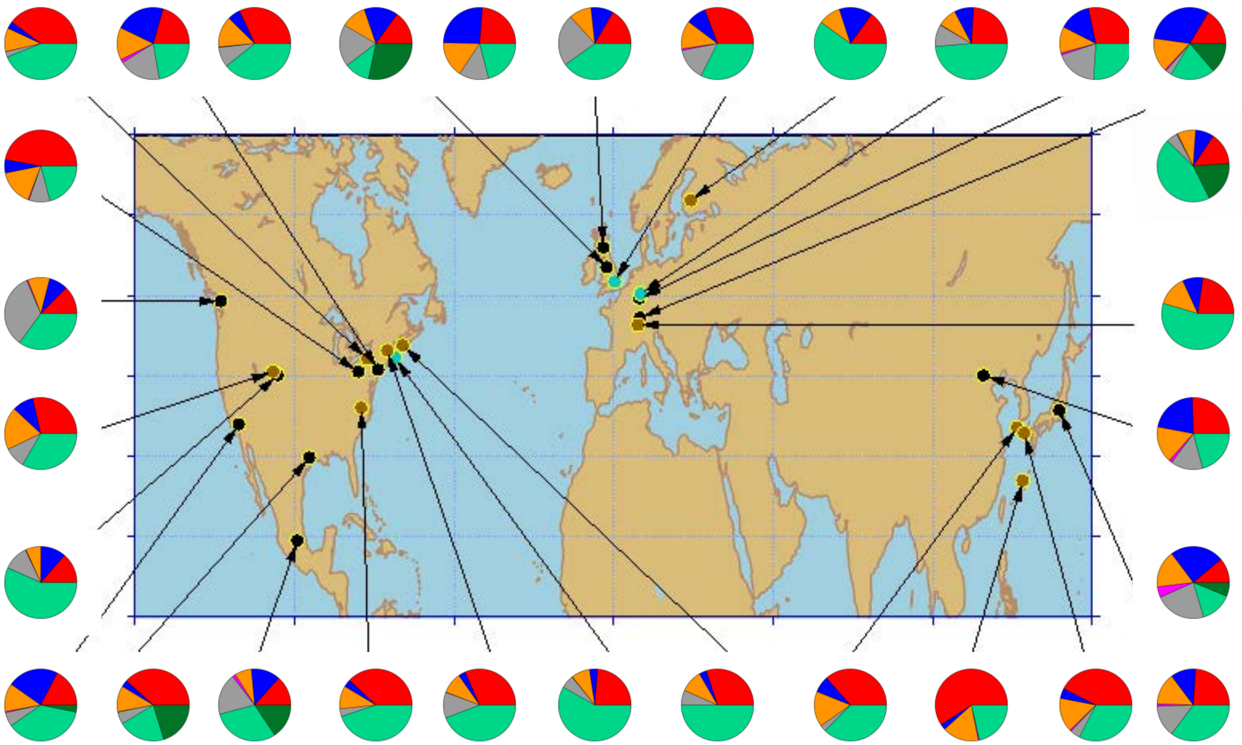
Bateman et al., 2011



CSD is leading
- in the fundamental process understanding of the **aerosol--cloud-precipitation system**
- in the area of **cloud effects on organic aerosol** by aqueous phase chemistry

Global aerosol chemical composition

Submicron particles (Aerosol mass spectrometer)



Adapted from Jimenez et al., 2009

- Secondary organics comprise ~50% of total particulate mass globally
- In order to predict aerosol loadings and properties, chemical formation pathways have to be understood

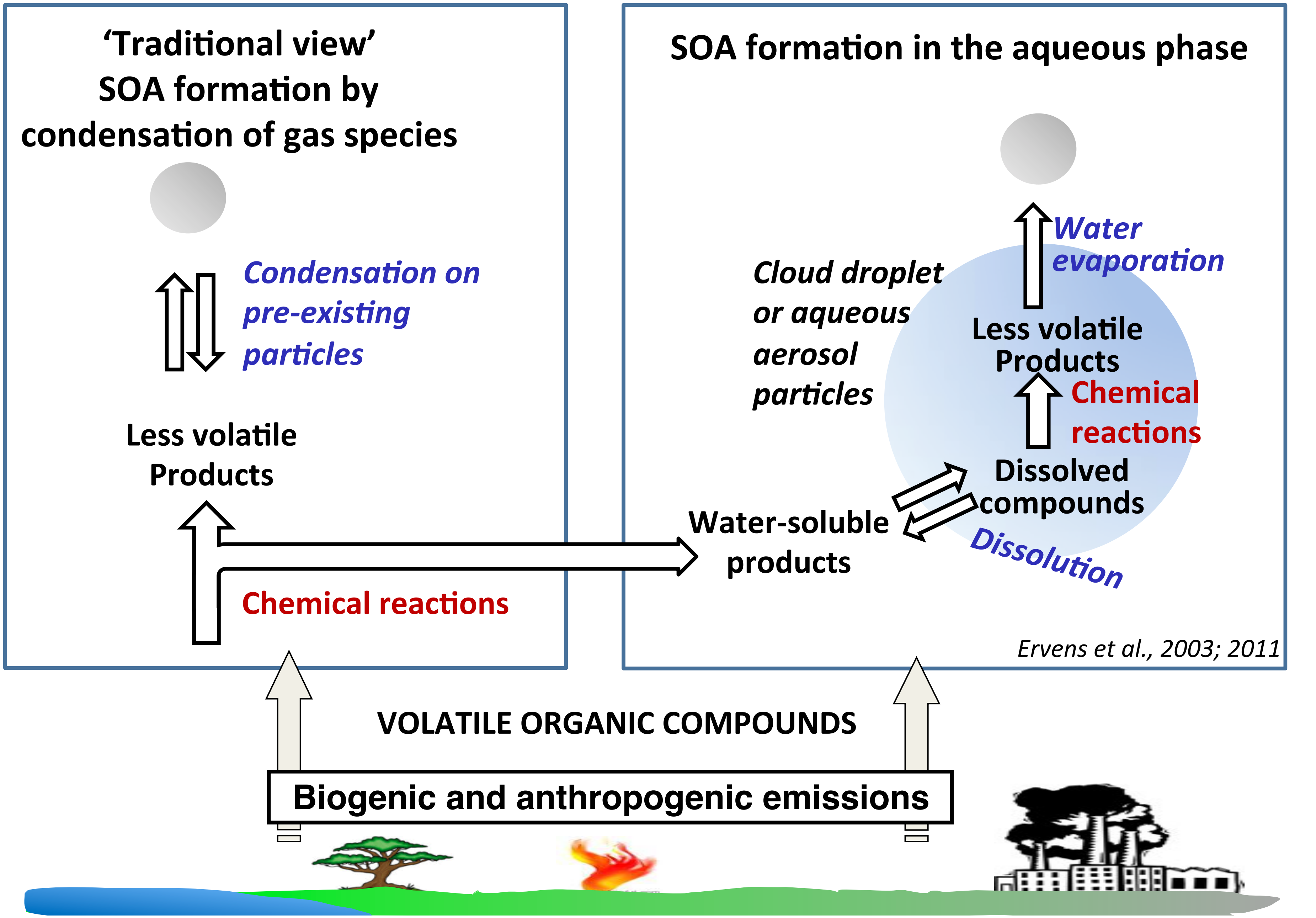
Ammonium
Chloride
Primary organics

Primary species:
Directly emitted from biogenic and anthropogenic sources

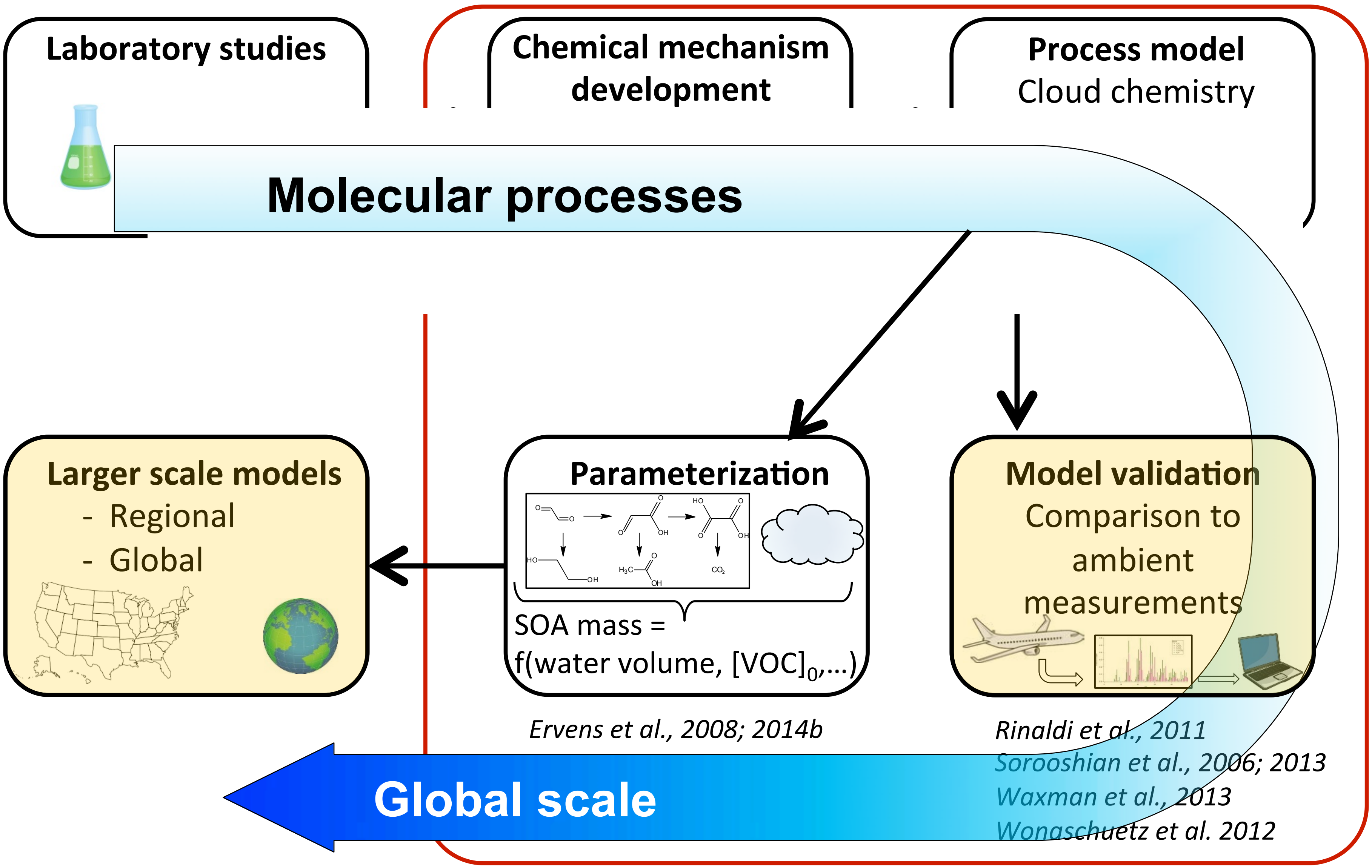
Sulfate
Nitrate
Secondary organics

Secondary species:
Formed by chemical reactions in the atmosphere

Secondary organic aerosol (SOA) formation

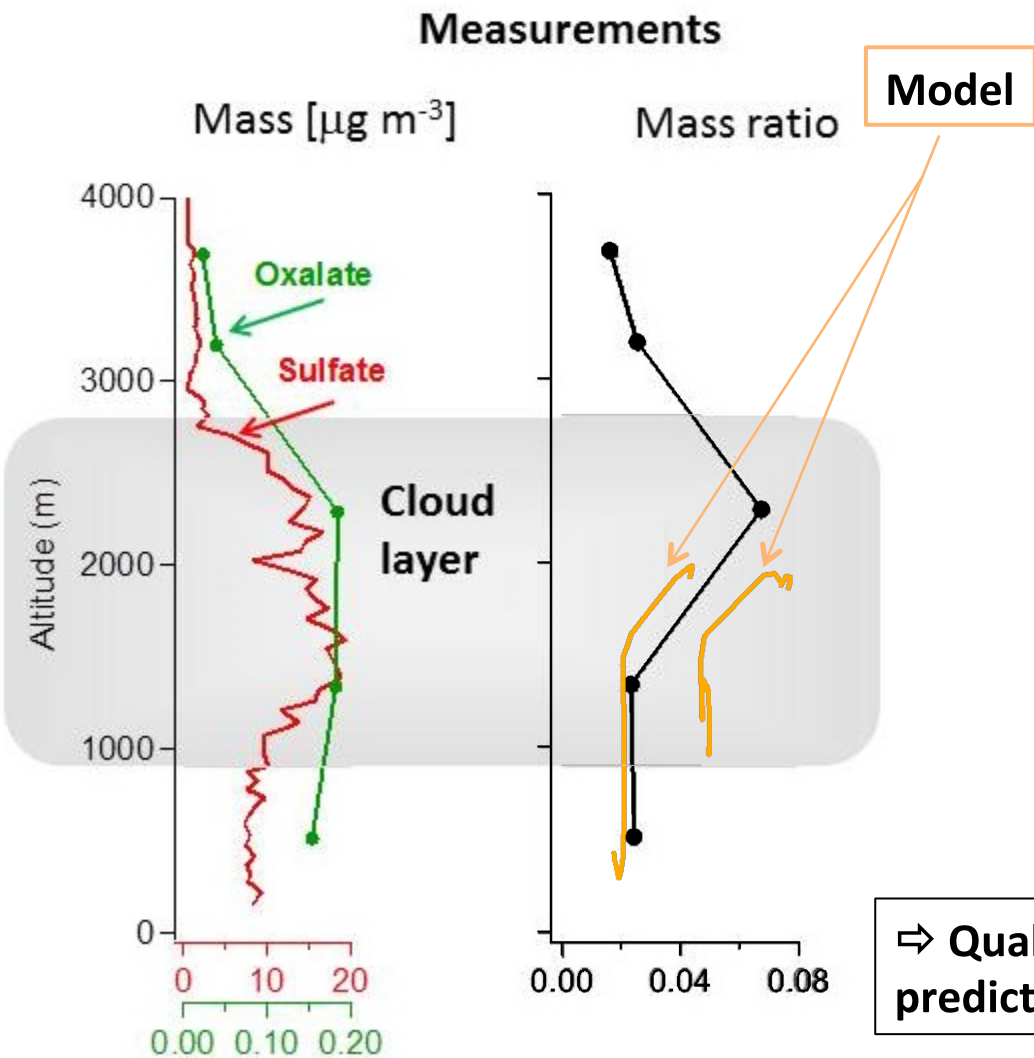


Aqueous SOA formation: Model development



Model validation of aqueous SOA formation

Example: Organic aerosol formation in clouds: *GoMACCS, Houston, TX*



- **Sulfate** is formed in clouds; relatively well constrained in process models
- **Oxalate** can be considered a <u>tracer for organic cloud chemistry</u> as it does not have any other atmospheric sources
  - Mass ratio << 1: Oxalate formation is less efficient than sulfate formation
  - Increase in ratio points to relatively slower oxalate formation as compared to sulfate

⇨ **Qualitative agreement in measured and predicted trends in Oxalate/Sulfate mass ratio**

Wonaschuetz et al., 2013

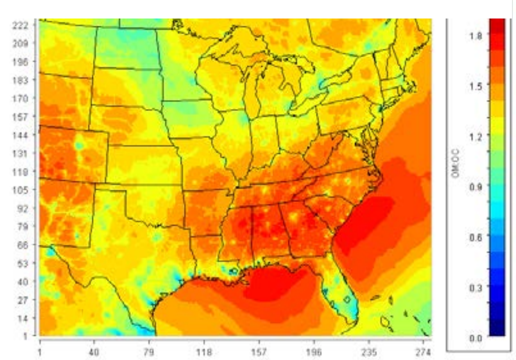
Application on regional and global scale

CMAQ (Community Multiscale Air Quality) model (EPA)

Carlton and Ervens, 2011

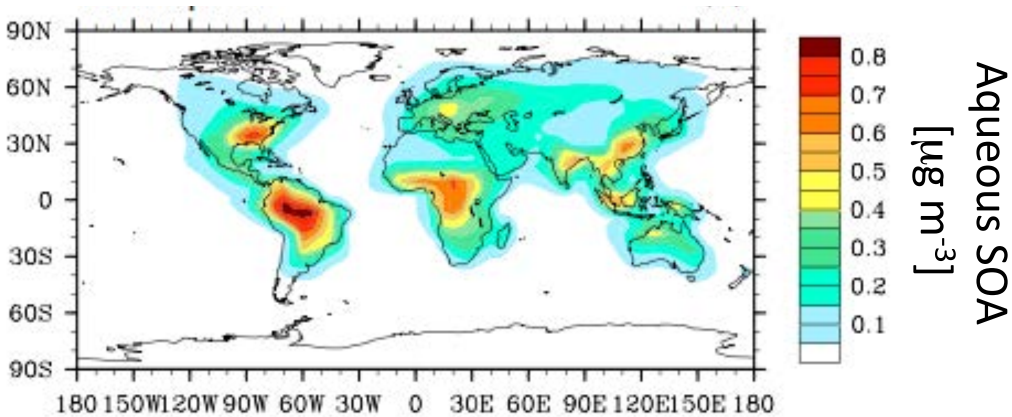
Without aqueous SOA

With aqueous SOA



Predicted organic mass/ organic carbon ratio at the surface clearly enhanced in Southeast US when aqueous SOA formation included

Global chemistry transport model *Lin et al., 2014*



Global models predict enhancement of organic aerosol loading in regions of high humidity/cloudiness and organic precursors

Organic aerosol formation in clouds

Summary

- Process models can reproduce observed trends in **aqueous SOA proxies** at various locations
- Regional/global models suggest that in regions with **high abundance of clouds and biogenic VOCs aqueous SOA** formation is significant
- **Large uncertainties** exist in aqueous SOA parameterizations

Future work

- Extend the chemical mechanisms to **more aqSOA precursors and products**
- Explore **sensitivities** of aqSOA formation to chemical and microphysical parameters on regional and global scales
- **Refine parameterizations** based on more comprehensive chemical mechanisms and case studies