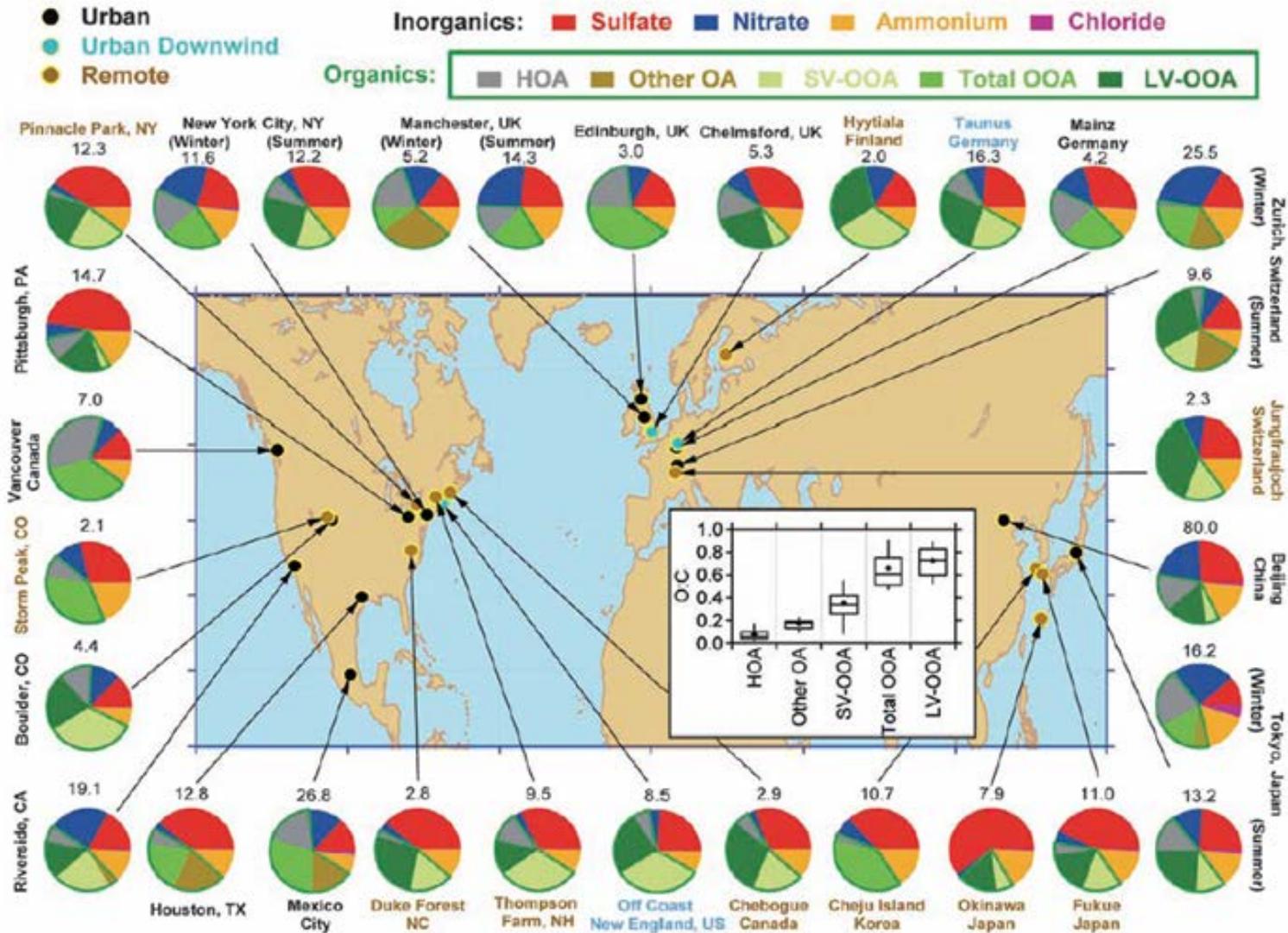


Anthropogenic Influence on Climate-Relevant SOA Properties

Scot Martin and John Shilling

Including mass concentrations, number-diameter distributions





This discussion paper is/has been under review for the journal Atmospheric Chemistry and Physics (ACP). Please refer to the corresponding final paper in ACP if available.

The direct and indirect radiative effects of biogenic secondary organic aerosol

C. E. Scott¹, A. Rap¹, D. V. Spracklen¹, P. M. Forster¹, K. S. Carslaw¹,
G. W. Mann^{1,2}, K. J. Pringle¹, N. Kivekäs³, M. Kulmala⁴, H. Lihavainen³, and
P. Tunved⁵

¹School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK

²National Centre for Atmospheric Science, University of Leeds, Leeds, LS2 9JT, UK

³Finnish Meteorological Institute, Erik Palmenin aukio 1, 00560 Helsinki, Finland

⁴Department of Physics, University of Helsinki, P.O. Box 64, 00014, Finland

⁵Department of Applied Environmental Research, Stockholm University, Svante Arrhenius Väg 8c, 10691 Stockholm, Sweden

Received: 13 May 2013 – Accepted: 11 June 2013 – Published: 26 June 2013

Correspondence to: C. E. Scott (pm08c2s@leeds.ac.uk)

Published by Copernicus Publications on behalf of the European Geosciences Union.

The direct and
indirect radiative
effects of biogenic
SOA

C. E. Scott et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion



Abstract

We use a global aerosol microphysics model in combination with an offline radiative transfer model to quantify the radiative effect of biogenic secondary organic aerosol (SOA) in the present day atmosphere. Through its role in particle growth and ageing, the presence of biogenic SOA increases the global annual mean concentration of cloud condensation nuclei (CCN; at 0.2 % supersaturation) by 3.6–21.1 %, depending upon the yield of SOA production, and the nature and treatment of concurrent primary carbonaceous emissions. This increase in CCN causes a rise in global annual mean cloud droplet number concentration (CDNC) of 1.9–5.2 %, and a global mean first aerosol indirect effect (AIE) of between $+0.01 \text{ W m}^{-2}$ and -0.12 W m^{-2} . The radiative impact of biogenic SOA is far greater when it also contributes to particle nucleation; using two organically-mediated mechanisms for new particle formation we simulate global annual mean AIEs of -0.22 W m^{-2} and -0.77 W m^{-2} . The inclusion of biogenic SOA substantially improves the simulated seasonal cycle in the concentration of CCN sized particles observed at three forested sites. The best correlation is found when the organically-mediated nucleation mechanisms are applied, suggesting that the AIE of biogenic SOA could be as large as -0.77 W m^{-2} . The radiative impact of SOA is sensitive to the presence of anthropogenic emissions. Lower background aerosol concentrations simulated with anthropogenic emissions from 1750 give rise to a greater fractional CCN increase and a more substantial indirect radiative effect from biogenic SOA. Consequently, the anthropogenic indirect radiative forcing between 1750 and the present day is sensitive to assumptions about the amount and role of biogenic SOA. We also calculate an annual global mean direct radiative effect (DRE) of between -0.08 W m^{-2} and -0.78 W m^{-2} in the present day, with uncertainty in the amount of SOA produced from the oxidation of biogenic volatile organic compounds (BVOCs) accounting for most of this range.

ACPD

13, 16961–17019, 2013

The direct and indirect radiative effects of biogenic SOA

C. E. Scott et al.

Title Page

Abstract

Introduction

Conclusions

References

Tables

Figures



Back

Close

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

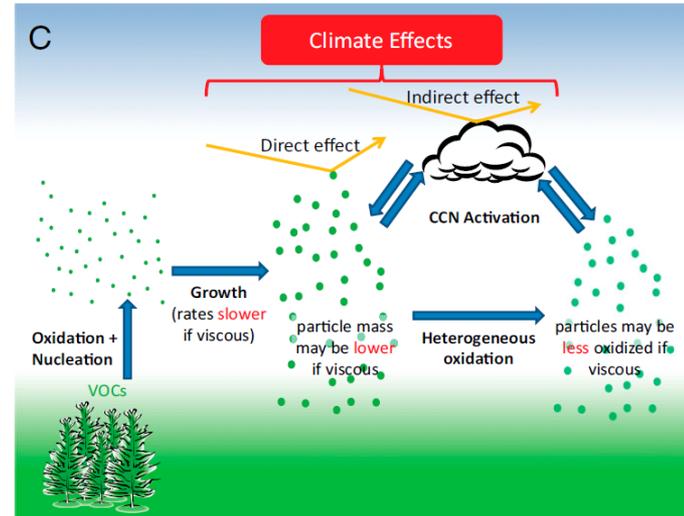
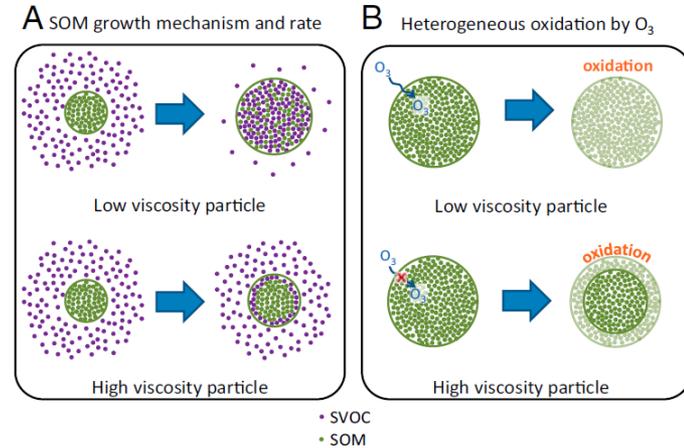
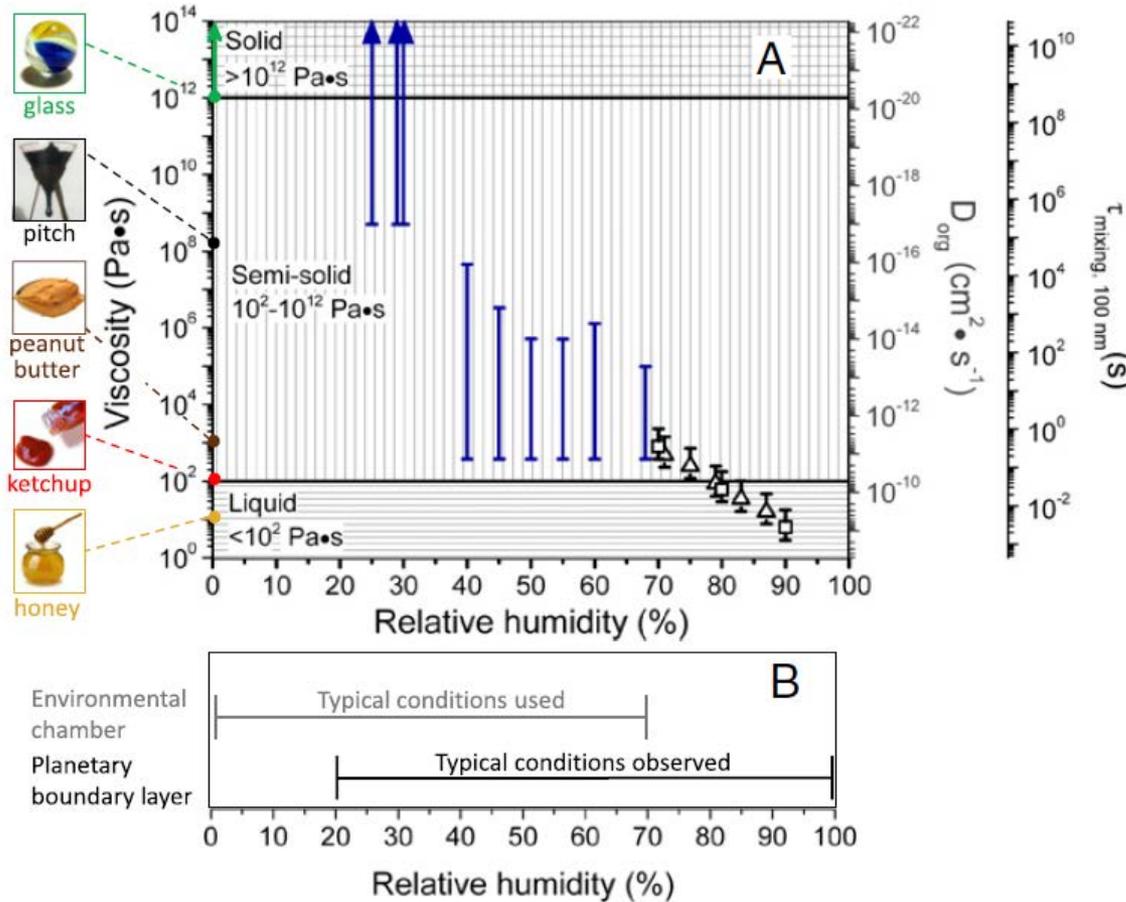


Outcome of Day's Work: Three Intellectual Themes

*These group names are still to be polished, i.e., still a working document. **Nevertheless, group activity had terrific success in defining its goals around three themes.***

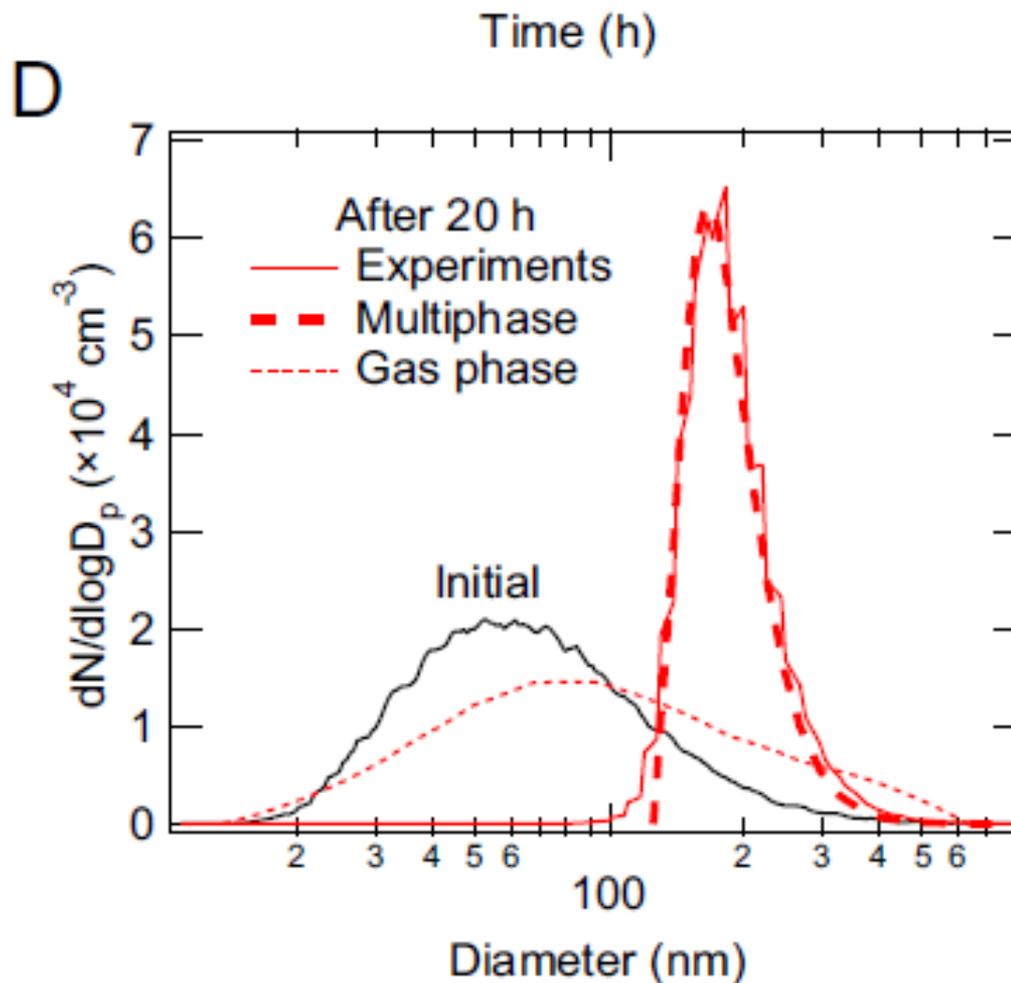
1. “viscosity/phase” – (15 participants so far)
2. “growth mechanisms” – (14 participants) (with particle chemistry as an emphasis point)
3. “sulfate as a trigger or regulator for SOA production & properties” – (12 participants)
4. cross cutting for model intercomparisons and lab chamber /standards

1. "Phase/Viscosity":



2. Growth Mechanisms

Why? *Getting the Number-Diameter Distribution of Atmospheric Particle Population Correct in Models*

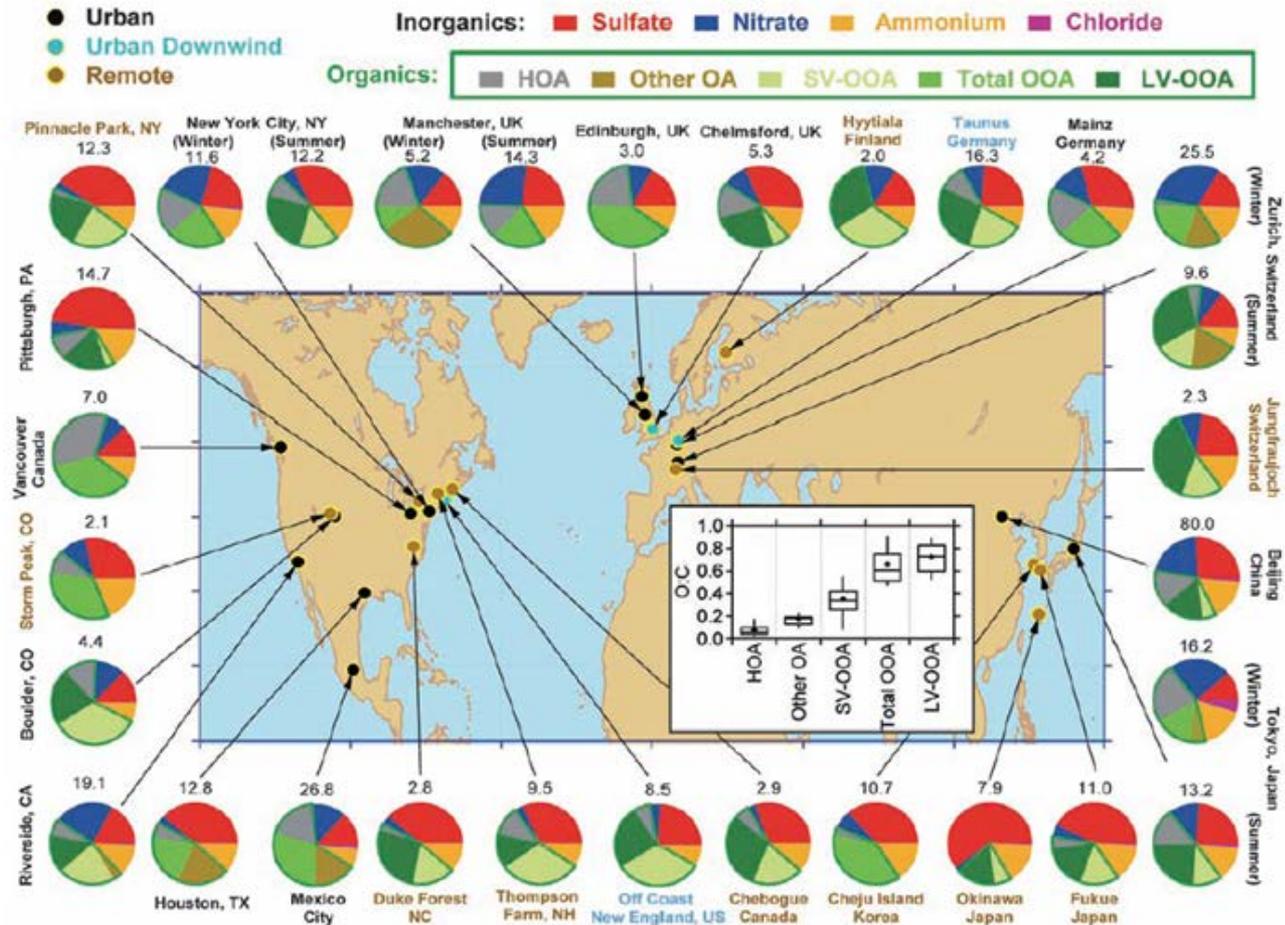


3. “Sulfate as a trigger or regulator for SOA production & properties”

In the preindustrial atmosphere (1750), sulfate mass loading is thought to be much lower.

IPCC climate forcings depend on estimation of 1750 loadings that depend on models of a low sulfate atmosphere.

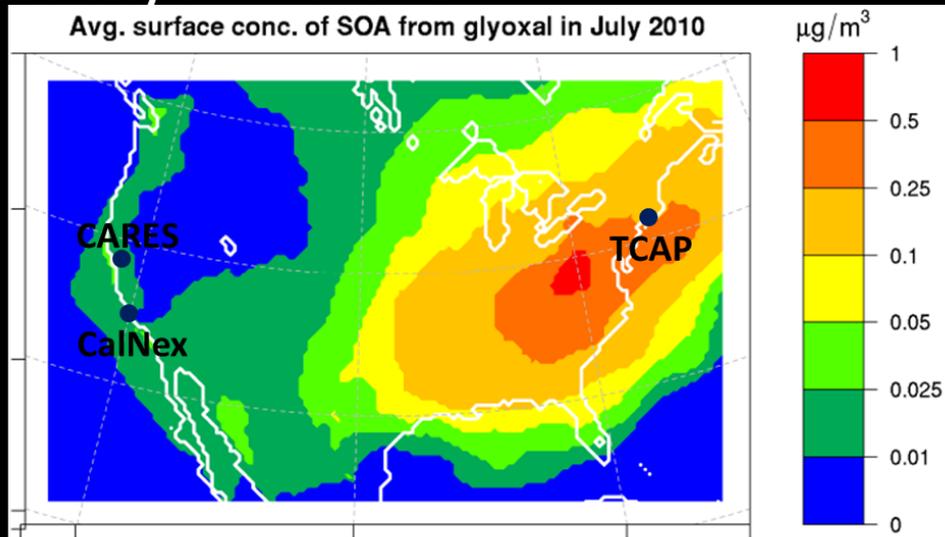
Sulfate triggers and regulates SOA production rates & properties from highly oxygenated molecules.



1. “viscosity/phase” – (15 participants so far)
 - Scot Martin and Alla Zelenyuk-Imre
2. “growth mechanisms” – (14 participants) (with particle chemistry as an emphasis point)
 - Sasha Madronich and John Shilling
3. “sulfate as a trigger or regulator for SOA production & properties” – (12 participants)
 - Joel Thornton and Manish Shrivastava
4. cross cutting for model intercomparisons and lab chamber /standards
 - Rahul Zaveri and Barbara Finlayson-Pitts

Courtesy of R. Volkamer

Sulfate-driven SOA



Knöbe et al., 2013, ACPD; doi: 10.5194/acpd-13-26699-2013

A Motivation : Sulfate (and Nitrate) have increased since pre-industrial times, changing aerosol liquid water content and acidity. How do changes in inorganic aerosol affect organic aerosol formation?

Opportunities: Comprehensive testing of ‘salting-in’ and sulfate driven SOA formation using DoE/ASR data sets and facilities

- **TCAP: US hotspot for glyoxal multiphase chemistry (no kinetic limitation)**
- **CARES: SOA potential is inhibited due to high particle viscosity**
- **GOAmazon: Manaus plume modulates sulfate relative to background**

Ongoing/future work: 1) first salting-constant in aerosols (Kampf et al. 2013); 2) inorganic feedbacks on SOA formation rates from multiphase chemistry (Waxman et al., 2013; Knöbe et al., 2014); 3) first measurements of isoprene epoxy diol reactive uptake (Gaston, et al 2014); 4) isoprene SOA formation with sulfate seed at PNNL; 5) thermodynamic model development to treat mixed organic/inorganic particles

**Aerosol Life Cycle Working Group Meeting
Fall 2013
SOA Breakout Session**

Criterion / metric to judge if our SOA Focus Area is succeeding

We anticipate of the three intellectual themes represented by the three groups, 1 or 2 of these groups will show themselves as substantive success in regard to final point of previous slide, “Report back in March meeting.”

Substantive success should be that sum of group activity is greater than result of individual activities.

Having success of 1 or 2 groups in this regard will be a success for the SOA Focus Area as “the next step”.

Higher bar for ‘success metric’ to then be set at the March meeting.