***Session Title:*** Representation of Secondary Organic Aerosol Processes in Models Across Scales

***Session Conveners:*** Shantanu Jathar, Joel Thornton, Nicole Riemer, John Shilling, Manish Shrivastava, and Rahul Zaveri

***Session Date:*** June 23, 2021

***Session Time:*** 11 am - 1 pm EDT

***Number of Attendees:*** ~50

***Summary Authors:*** Shantanu Jathar, Joel Thornton, Nicole Reimer, John Shilling, Manish Shrivastava, and Rahul Zaveri

***Main Discussion:*** This breakout spanned 2 hours and contained three separate sessions. In session 1 (~20 mins), breakout participants gave 1 minute talks on ongoing work related to SOA research. A total of ~20 1-minute talks were presented where most of the talks focused on ARM/ASR supported work. In session 2, Chongai Kuang gave a 5-min talk on the planned AMF deployment to the Southeast US (SEUS). Participants were then organized into smaller sub-breakouts (mixing experimentalists with modelers) to discuss science questions, instrumentation needs, and expected outcomes possible from the AMF deployment (~30 minutes). Moderators in each sub-breakout gave short summaries to the larger breakout group at the end of the sub-breakout (~10 minutes). In session 3, Joel Thorton gave a short introduction on how the use of laboratory and field measurements facilitate representation of SOA aerosol processes in models at various scales. Sub-breakouts and summaries were discussed similar to that in session 2 for about 40 minutes. The discussion centered around key aerosol processes currently missing in box and atmospheric models and the measurements needed to facilitate model representation and evaluation.

***Key Findings:*** We have outlined the discussion points separately for the AMF SEUS and Measurements-to-Models sub-breakouts since the conversations revolved around very different topics. The findings have been compiled from 5 separate sub-breakouts.

SEUS AMF:

- There was widespread interest in the AMF deployment planned for the SEUS and for the potential ways it can enhance ASR science related to SOA and its role in atmosphere-biosphere climate interactions.
- Since the last field campaign over the SEUS a decade ago, anthropogenic emissions have changed. The new AMF deployment would answer key questions about how anthropogenic-biogenic interactions and SOA formation have evolved under changing $NO_X$ regimes.
- A number of instrument measurements needs were discussed including those for: time-resolved speciation of VOCs (SOA precursors), ice nucleation particles, $NO/NO_2/NO_y$, particle collection for offline microscopy, particle viscosity, size-resolved hygroscopicity, analysis of wet deposition samples, and particle acidity.
- Need for flux, tower, and vertical distribution measurements and the potential benefit from using low-cost sensor networks (both ground and UAV) that supplement the central sampling locations.
- Emphasis on targeted measurements by individual PIs during multiple IOPs and how those individual PI goals aligned with AMF goals.

- Thinking about how aircraft and ground measurements during the AMF deployment connected with other local and regional observations.

Measurements-to-Models:

- Thinking beyond OA mass concentrations and using information on OA properties (e.g., O:C, volatility, phase state, size distribution) to evaluate models against observations; better use of box models before the use of 3D models.
- Uncertainties related to aqueous and cloud-phase SOA formation persist.
- Model needs to compare against measurements at multiple sites, which also speaks of the need for long-term records at multiple sites and scales and observations outside of the US
- Better lab/field measurements of particle phase state (phase separation/morphology, viscosity/diffusion coefficient, glass transition temperature), autoxidation, low-temperature and high altitude SOA formation, mixing state, which should consequently lead to better representation in models
- Laboratory studies on realistic mixtures of VOCs (i.e., multiple VOCs, POA+SOA) in contrast to single compound model systems
- Thinking critically about what processes and properties of SOA we can model in box and 3D models, what properties of SOA we want to get right in models and what the observational data are to evaluate model predictions.

***Decisions:*** NA; the breakout was designed around a science discussion and there weren't any specific decisions to make as an outcome of this breakout.

***Issues:*** There were no technical issues in conducting the SOA breakout session. The ORISE staff were very helpful (both before and during the breakout) and did a fantastic job in navigating lost participants to the right sub-breakouts. In some way, the virtual format helped with the creation and management of sub-breakouts, something that would be hard to do so efficiently in in-person meetings. We would encourage retaining some elements of a virtual meeting for future ARM/ASR meetings and workshops.

***Needs:*** NA.

***Future Plans:*** In a post-breakout meeting, the conveners discussed the value of holding an SOA-only breakout versus the value of organizing an SOA-cloud breakout to facilitate better exchange of ideas between the 'aerosol processes' and 'aerosol-cloud interactions' researchers. This group may consider a future breakout session at the ARM/ASR PI meeting focussed specifically on SOA and aerosol-cloud interactions.

***Action Items:***

- Engage with the AMF SEUS leadership team to communicate in greater detail the measurement needs discussed in the first sub-breakout. Specifically, the need for detailed VOC and particle phase state measurements may need to be emphasized.
- Explore the possibility of a review paper that outlines the current representation of SOA in models at different scales and synthesize the SOA modeling needs for the next generation of atmospheric models. This would require a large time commitment from the conveners.