

## Research Highlight

The budget of global secondary organic aerosol (SOA) is highly uncertain because of our limited knowledge of SOA sources, formation pathways, and removal processes. While significant work over the past decade has identified new SOA formation processes and precursor emissions, and modeled these at regional and global scales [e.g. Pye and Seinfeld, 2010; Hodzic et al. 2010], removal of condensable organic compounds from the atmosphere and its effect on the SOA budget is relatively unexplored and poorly represented in current chemistry-climate models.

Deposition velocities of condensable gases depend on their solubility. Multi-functional organic compounds are often water-soluble and undergo dry deposition similarly to other soluble gases, or partition to the aqueous phase and are removed by scavenging. The main reason why dry deposition of these species is omitted in current models is that simplified SOA treatments are based on mechanisms that lump precursors and their products by volatility, but neglect other important molecular properties such as solubility [Robinson et al. 2007; Lane et al. 2009].

In this study [Hodzic et al. 2013], we applied the Generator of Explicit Chemistry and Kinetics of Organics in the Atmosphere (GECKO-A) to evaluate the importance of dry deposition of anthropogenic SVOCs (generated from C3-25-alkanes, alkenes, and light aromatics) on SOA regional mass exported downwind of Mexico City. The solubility was explicitly calculated for all individual molecules generated by GECKO-A. Our results suggest that dry deposition of oxidized SVOC is a small sink for anthropogenic SOA, as it results in the loss of ~15% of SOA downwind of the city (Figure 1). Dry deposition competes with the gas-particle uptake, so that only gases with fewer than ~12 carbons are dry-deposited while longer species partition preferentially to SOA. Because dry deposition of submicron aerosols is slow, condensation onto particles tends to protect SVOCs from deposition, thus increasing their atmospheric burden and lifetime. In the absence of this condensation, ~50% of the regionally produced mass would have been dry-deposited. These results imply that if models overpredict SOA volatility (as is now typical in many models), they will significantly overpredict dry deposition of organics to the ground, and significantly underestimate the atmospheric lifetime of the organics. (Figure 1 shows this bias in green). We also noticed strong relationships between aerosol volatility, functionalization, and solubility. We are currently using these relationships to parameterize solubility estimates for the volatility-lumped products of major VOC precursors, for use in 3D models.

These first estimates are on the conservative low side as we have considered an idealized plume transported at 1.5km height in contact with the ground. The effect of dry deposition would have been two times larger if we had considered a plume closer to the ground at 750m. We are currently evaluating the importance of this removal on the regional SOA burdens within a 3D regional model.

## Reference(s)

Hodzic A, S Madronich, B Aumont, J Lee-Taylor, T Karl, M Camredon, and C Mouchel-Vallon. 2014. "Limited influence of dry deposition of semi-volatile organic vapors on secondary organic aerosol formation in the urban plume." *Geophysical Research Letters*, 40(12), 3302-3307.

## Contributors

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## Working Group(s)

Aerosol Life Cycle

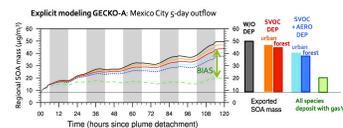


Figure 1: 5-day evolution of regionally exported SOA mass in the Mexico City outflow region for GECKO-A Lagrangian runs. Runs without dry removal (black), with dry removal of SVOCs (red and orange), with dry removal of SVOCs and SOA (blue) are compared. Green line shows the extreme case where organics are artificially kept in the gas-phase and deposited with the gas dry deposition velocities ( $V_d$ ). Nighttime (6pm-6am) is indicated in gray.