Anthropogenic Aerosol Water: Rediscovering the Importance of Atmospheric Multiphase Chemistry

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ABSTRACT

Gas phase water-soluble organic matter (WSOM\textsubscript{g}) is ubiquitous in the troposphere. In the summertime, the potential for these gases to partition to particle phase liquid water (H\textsubscript{2}O\textsubscript{ptcl}) where they can form secondary organic aerosol (SOA\textsubscript{AQ}) is high in the Eastern U.S. and an area near Los Angeles, CA. This spatial pattern is driven by mass concentrations of H\textsubscript{2}O\textsubscript{ptcl}, not WSOM\textsubscript{g}. H\textsubscript{2}O\textsubscript{ptcl} mass concentrations are predicted to be high in the Eastern U.S., largely due to sulfate. Recent measurements during the Southern Oxidant and Aerosol Study (SOAS) confirm that liquid water is a dominant component of aerosol mass in the Southeast U.S. The ability of sulfate to increase H\textsubscript{2}O\textsubscript{ptcl} is well-established and routinely included in atmospheric models; however, WSOM\textsubscript{g} partitioning to this water and subsequent SOA formation is not. The high mass concentrations of H\textsubscript{2}O\textsubscript{ptcl} in the southeast (SE) U.S. but not the Amazon, may help explain why biogenic SOA mass concentrations are high in the SE U.S., but low in the Amazon. Furthermore, during the summertime in the Eastern U.S., the potential for organic gases to partition into liquid water is greater than their potential to partition into organic matter (OM) because concentrations of WSOM\textsubscript{g} and H\textsubscript{2}O\textsubscript{ptcl} are higher than semi-volatile gases and OM. Thus, unless condensed phase yields are substantially
different (> ~order of magnitude), we expect that SOA formed through aqueous phase pathways (SOAAQ) will dominate in the Eastern U.S. These findings also suggest that \( H_2O_{ptd} \) is largely anthropogenic and provide a previously unrecognized mechanism by which anthropogenic pollutants impact the amount of SOA mass formed from biogenic organic emissions. The previously reported estimate of the controllable fraction of biogenic SOA in the Eastern U.S. (50%) is likely too low.