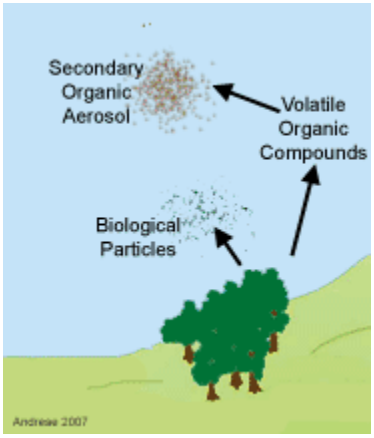
Background



Globally, the formation of secondary organic aerosol (SOA) from biogenic precursors surpasses that from anthropogenic sources . These organic particles have important impacts on climate through their direct interactions with radiation, as well as their ability to modulate cloud condensation nuclei numbers, and thus cloud properties and precipitation. These processes exert a substantial feedback upon the earth system through links to the terrestrial carbon and water cycles (e.g., precipitation regulates plant growth and thus emissions of organic compounds, which are also influenced by changes in radiation) . In addition, primary biological particles, such as bacteria, are known to nucleate ice clouds at warm temperatures . While little is known of their sources and distribution, a recent study suggests that they may be important contributors to ice cloud formation.

Biogenic volatile organic compounds (BVOCs) are precursors to SOA formation and widely known to affect tropospheric ozone formation. BVOCs also play a role in the formation and growth of new particles by nucleation from the gas phase . There is growing evidence that new particle formation has a significant impact on cloud condensation nuclei concentrations. Therefore, BVOC emissions likely influence cloud cover and possibly precipitation, thereby playing a role in regulating the radiation balance and the hydrologic cycle. In spite of their recognized importance, BVOCs are still poorly understood. Direct measurements of OH reactivity in forests suggest that there is a significant source of BVOCs that have not, thus far, been identified . There is clearly a need to identify sources, reactivities, and fates of the major BVOCs in forested areas.

Emission and transport of BVOCs is directly linked to canopy meteorological conditions and the response of the canopy ecosystem to environmental stresses. Fluxes of heat, momentum and radiation within and directly above the canopy are linked to the canopy architecture and the turbulent regime under which the canopy is subjected. Availability of soil moisture and nutrients also strongly impact the behavior of plant metabolism, stomatal control, plant respiration and photosynthesis. Additional complex processes, such as plant hydraulic redistribution, can significantly modulate the response of vegetation communities to environmental stresses such as drought. Combined, these eco-physical processes constitute key controls on total ecosystem behavior and, therefore, canopy fluxes of BVOC's. Owing to a paucity of tightly coordinated eco-hydrological, micrometeorological and atmospheric chemistry measurements in sparse canopy ecosystems, such as those in the semi-arid western U.S., little is presently known about how these controls impact BVOC emissions.

Improved understanding biogenic SOA formation, the roles that biogenic primary and secondary aerosols play in cloud formation, and possible feedbacks from clouds and of precipitation, is especially crucial in the water-limited ecosystems of the western US where biosphere-atmosphere exchange processes of energy, water, carbon, and nitrogen respond quickly to changes in precipitation. A recent study also suggests that the Earth's changing climate has led to reduced water availability in the western U.S. during the last half century , and will continue to do so in the future. Understanding the role of aerosols in the hydrological cycle of water-limited ecosystems of the western US is also important given the large and growing population of the region.