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Interannual Variations in Aerosol Sources and Their Impact on Orographic Precipitation over California's Central Sierra Nevada

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Aerosols that serve as cloud condensation nuclei (CCN) and ice nuclei (IN) have the potential to profoundly influence precipitation processes. Furthermore, changes in orographic precipitation have broad implications for reservoir storage and flood risks. As part of the CalWater I field campaign (2009-2011), the impacts of aerosol sources on precipitation were investigated in the California Sierra Nevada. In 2009, the precipitation collected on the ground was influenced by both local biomass burning (up to 79% of the insoluble residues found in precipitation) and long-range transported dust and biological particles (up to 80% combined), while in 2010, by mostly local sources of biomass burning and pollution (30-79% combined), and in 2011 by mostly long-range transport from distant sources (up to 100% dust and biological). Although vast differences in the source of residues was observed from year-to-year, dust and biological residues were omnipresent (on average, 55% of the total residues combined) and were associated with storms consisting of deep convective cloud systems and larger quantities of precipitation initiated in the ice phase. Further, biological residues were dominant during storms with relatively warm cloud temperatures (up to -15°C), suggesting these particles were more efficient IN compared to mineral dust. On the other hand, lower percentages of residues from local biomass burning and pollution were observed (on average 31% and 9%, respectively), yet these residues potentially served as CCN at the base of shallow cloud systems when precipitation quantities were low. The direct connection of the source of aerosols within clouds and precipitation type and quantity can be used in models to better assess how local emissions versus long-range transported dust and biological aerosols play a role in impacting regional weather and climate, ultimately with the goal of more accurate predictive weather forecast models and water resource management.