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Physiochemical characterization of insoluble residues in California Sierra Nevada snow

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The effects atmospheric aerosols have on cloud particle formation are dependent on both the aerosol physical and chemical characteristics. For instance, larger, irregular-shaped mineral dusts efficiently form cloud ice crystals, enhancing precipitation, whereas small, spherical pollution aerosols have the potential to form small cloud droplets that delay the autoconversion of cloudwater to precipitation. Thus, it is important to understand the physiochemical properties and sources of aerosols that influence cloud and precipitation formation. We present an in-depth analysis of the size, chemistry, and sources of soluble and insoluble residues found in snow collected at three locations in the California Sierra Nevada Mountains during the 2012/2013 winter season. For all sites, February snow samples contained high concentrations of regional pollutants such as ammonium nitrate and biomass burning species, while March snow samples were influenced by mineral dust. The snow at the lower elevation sites in closer proximity to the Central Valley of California were heavily influenced by agricultural and industrial emissions, whereas the highest elevation site was exposed to a mixture of Central Valley pollutants in addition to long-range transported dust from Asia and Africa. Further, air masses likely containing transported dust typically traveled over cloud top heights at the low elevation sites, but were incorporated into the cold (-28°C, on average) cloud tops more often at the highest elevation site, particularly in March, which we hypothesize led to enhanced ice crystal formation and thus the observation of dust in the snow collected at the ground. Overall, understanding the spatial and temporal dependence of aerosol sources is important for remote mountainous regions such as the Sierra Nevada where snowpack provides a steady, vital supply of water.