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Chemical characteristics of ice residual nuclei in anvil cirrus clouds: evidence for homogeneous and heterogeneous ice formation

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Abstract. A counterflow virtual impactor was used to collect residual particles larger than about 0.1 μm diameter from anvil cirrus clouds generated over Florida in the southern United States. A wide variety of particle types were found. About one-third of the nuclei were salts, with varying amounts of crustal material, industrial metals, carbonaceous particles, and sulfates. Ambient aerosol particles near the anvils were found to have similar compositions, indicating that anvils act to redistribute particles over large regions of the atmosphere. Sampling occurred at a range of altitudes spanning temperatures from -21 to -56°C . More insoluble (crustal and metallic) particles typical of heterogeneous ice nuclei were found in ice crystals at warmer temperatures, while more soluble salts and sulfates were present at cold temperatures. At temperatures below about -35 to -40°C , soluble nuclei outnumbered insoluble nuclei, evidently reflecting the transition from primarily heterogeneous to primarily homogeneous freezing as a source of anvil ice.

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