

Abstract

Characterization of Physicochemical Properties of Feedlot Dust Ice Crystal Residuals (ICRs) [†]

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This study considers how feedlot dust size and composition contribute to atmospheric ice nucleation and the formation of local cloud and precipitation in the Texas Panhandle. Our previous work using Raman micro-spectroscopy revealed that ambient dust sampled at a commercial feedlot is predominantly composed of brown or black carbon, hydrophobic humic acid, water-soluble organics, less soluble fatty acids and those carbonaceous materials mixed with salts and minerals [1]. Organic acids (i.e., long-chain fatty acids) and heat-stable organics were recently found to be acting as efficient ice-nucleating particles (INPs) [2,3]. However, our knowledge regarding which particulate features of feedlot dust trigger immersion freezing at heterogeneous freezing temperatures (i.e., size vs. composition) is still lacking. To improve our knowledge, we conducted single-particle physicochemical analyses of different types of feedlot dust simulants and their ice crystal residual (ICR) samples. Our preliminary results show that aerosol particle composition is dominated by organics, with substantial inclusion of salts (e.g., potassium). This is consistent with our previous study of open-lot livestock feeding facility-emitted aerosol particle composition analyses [1]. The elemental composition analysis revealed some notable differences between aerosol particle samples and residual samples, indicating the inclusion of non-hygroscopic organic particles as ice residuals. Our ICR analysis also revealed a decrease in hygroscopic salt inclusion in residuals, which may imply the importance of immersion rather than condensation freezing in agricultural INPs. The observations of the dry heat-resistant physicochemical properties and predominantly supermicron nature of feedlot-emitted INPs are also highlights of this study. Further research should focus on understanding how organic composition and/or other particulate properties influence ice nucleation. Such an organic INP dataset has long been a missing piece in the study area of cloud microphysics and atmospheric chemistry and is of importance to improve atmospheric models of cloud feedback and determine their impact on regional weather and climate.

Supplementary Materials: The following are available online at www.mdpi.com/10.3390/ecas2020-08438/s1.

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