Characterization of physicochemical properties of feedlot dust ice crystal residuals (ICRs)

Yidi Hou[1], Petrina Hee[1], Nsikanabasi Umo[2], Ottmar Möhler[2], and Naruki Hiranuma[1]

[1]Dept. of Life, Earth and Environmental Sciences, West Texas A&M University (WTAMU), Canyon, TX, USA; [2]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Abstract: This study presents how feedlot dust size and composition contribute to atmospheric ice nucleation and 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 (Hiranuma *et al*., 2011). Organic acids (i.e., long-chain fatty acids) and heat stable organics are recently found to be acting as an efficient ice-nucleating particle (INP; DeMott *et al*., 2018; Perkins *et al*., 2020). However, our knowledge regarding what particulate features of feedlot dust trigger immersion freezing in 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 the previous study of TXD particles composition analyses (Hiranuma *et al*., 2011). The elemental composition analysis revealed some notable difference 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 an importance of immersion rather than condensation freezing as agricultural INPs. Dry heat-resistant physicochemical properties and predominantly supermicron nature of feedlot-emitted INPs also highlight this study. Further research should focus on understanding how organic composition and/or other particulate properties influence ice nucleation. Such 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 feedbacks and determine their impact on the regional weather and climate.

References:

DeMott P. J. *et al*.: Environ. Sci.: Processes Impacts, 20, 1559–1569, 2018.
Hiranuma, N., *et al*.: Atmos. Chem. Phys., 11, 8809–8823, 2011.
Perkins, R. J. *et al*.: ACS Earth Space Chem., 4, 133–141, 2020.