Inorganic Gas-Aerosol Partitioning in and around Animal Feeding Operation Plumes in Northeastern Colorado in Late Summer 2021

Ammonia (NH₃) from animal feeding operations (AFOs) is an increasingly important source of reactive nitrogen in the US, but despite its ramifications to air quality and human and ecosystem health, its near-source evolution remains understudied. To this end, the Transport and Transformation of Ammonia (TRANS2Am) field campaign was conducted in the northeastern Colorado Front Range in summer 2021 and characterized atmospheric composition downwind of AFOs during 10 research flights under varying meteorological conditions. Airborne measurements of NH₃, nitric acid (HNO₃), and a suite of water-soluble aerosol species collected onboard the University of Wyoming King Air (UWKA) research aircraft present a unique opportunity to investigate (1) the sensitivity of particulate matter (PM) formation to AFO emissions, and (2) the seasonality of NH₄NO₃ formation in northeastern CO. We find that the study region is consistently in the NH₃-rich and HNO₃-limited NH₄NO₃ formation regime. Further investigation using the Extended Aerosol Inorganics Model (E-AIM) reveals that hot summertime temperatures (mean: 23 °C) of northeastern Colorado, especially near the surface, inhibit NH₄NO₃ formation despite high (max: 114 ppbv) NH₃ concentrations. Lastly, we model spring/autumn and winter conditions in E-AIM to explore the seasonality of NH₄NO₃ formation in this region and find that the cooler temperatures could support substantially more NH₄NO₃ formation. Whereas summertime NH₄NO₃ only exceeds 1 μg m⁻³ ~10% of the time in the observations and corresponding simulations, and modeled NH₄NO₃ would exceed 1 μg m⁻³ 61% of the time in spring/autumn, with a 10°C temperature decrease, and 88% of the time in winter, with a 20°C temperature decrease.