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High efficacy of livestock ammonia emission control for alleviating particulate nitrate during severe winter haze events in northern China

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During severe haze episodes in northern China, the proportion of nitrate in the secondary inorganic aerosol continuously increases. Ammonia emissions are also quite high during these pollution events, with no control measures currently enforced. The effect of reducing ammonia emissions on particulate nitrate is still unclear. In this study, the ISORROPIA-II and weather research and forecast model coupled chemistry (WRF-Chem) models were combined with high-resolution in-situ measurements to evaluate the effectiveness of ammonia emission control for reducing particulate nitrate during severe winter haze events in northern China. The 1-hour fine particulate chemical composition and gaseous precursors were measured simultaneously at an urban atmosphere environment monitoring station in Beijing, China in December of 2015 and 2016. During the campaign, there existed six severe haze episodes during which the average concentration of particulate nitrate was 65 μg/m3 with the highest values reaching more than 100 μg/m3 and the average gaseous ammonia mixing ratio was approximately 15 ppb. In this period livestock industry was the dominate source of ammonia emissions based on our self-developed ammonia inventory. And by implementing feasible ammonia abatement options in the livestock source, the total emission can be reduced by approximately 50%. Results from the ISORROPIA-II and WRF-Chem demonstrated that such a 50% reduction in ammonia emissions could decrease the particulate nitrate by up to 60%. Specifically, we found that this reduction in nitrate due to ammonia control would become more significant with the increase in nitrate concentrations. These findings indicate that reducing livestock ammonia emissions would be a feasible and effective measure to limit nitrate formation and therefore benefit fine particle mitigation during severe winter haze events in northern China.