Proposal for the formation of a North Central Development Committee

**Project Title:** Sources and fate of ammonia across the landscape

**Requested Duration: 1 year**

**Statement of Issue and Justification:** Ammonia (NH3) is a gas readily released into the air from a variety of biological sources, as well as from industrial and combustion processes. It is the principle basic gas in the atmosphere and can be found at varying levels across the US. Data from the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), a 30+ year wet deposition network with over 250 sites across the U.S., has shown an increasing trend in ammonium (NH4+) concentration within precipitation in the central U.S (. About 85% of NH3 emissions in the U.S. is from agriculture, largely animal waste and commercial fertilizer application. Areas with the highest atmospheric concentrations and the highest wet deposition fluxes are both found in the Midwest and Plains states. However the estimation of NH3 emissions from individual farms requires knowledge of the background levels to which the farm is adding. This was also identified in as a significant gap in knowledge in a recent USDA effort at defining methodologies for NH3 and N2O emissions estimation (page 5-129; Powers et al, 2014). Consequently the national emissions inventory of N2O emissions is in part limited by our inability to define the NH3 emissions.

In many areas, NH3 contributes significantly to atmospheric N deposition (Swede and Lear, 2014). These have been shown by a number of authors for U.S. national parks and wilderness areas (e.g., Ellis et al., 2013). Understanding the contribution of reduced nitrogen, versus oxidized forms that are subject to regulatory control, to total deposition is important for developing effective ecosystem protection from excess nitrogen, such as the Secondary National Ambient Air Quality Standard for NOx and Sox and critical load frameworks. Ammonia is also a detriment to animal and human health. Pulmonary edema and pulmonary inflammation results from inhalation of NH3 at varying concentrationsand durations, dependent upon species (see Carson et al., 1981 for a review). Additionally, the ready formation of ammonium particulate matter from NH3 gasalso has a health impact. In many areas, aerosol formation is limited by low NH3 concentrations. But with local NH3 emissions present, aerosol formation can occur quickly. This small-sized aerosol has been associated with premature mortality, chronic bronchitis, and asthma complications (e.g. McCubbin et al., 2002). These aerosols can lead back to agricultural operations, and therefore particulate formationcan have a wider health impact upon health beyond the agricultural area and beyond health impacts from NH3 gas alone. There are also important secondary effects of NH3 emissions on air quality. NH3 reacting with water vapor forms NH4+ which is a precursor to particulate matter (PM) formation (USEPA, 2011, noted above). Significant attention is presently associated with PM formation and EPA regulates PM, although most states do not require agriculture to reduce emissions. Consequently, the increased understanding of sources and sinks of NH3 in the atmosphere and across the landscape will greatly enhance our ability to address a number of environmental and health issues associated with farming in the 21st century.

**Objective:** To write aMultistate Research Project proposal focused on the emission and deposition issues surrounding agriculturally-sourced NH3.

**Expected Outcomes and Impacts:** Proposal for the establishment of a NC MRSP.

Possible basis for forming a Multistate Research Project: The difficulty of estimating ambient NH3 concentration and regional deposition requires the development of generalized emissions model verification, spatial extrapolation methodologies, and dry deposition methodologies. While NH3 has many beneficial uses, it can detrimentally affect the quality of the environment, including the acidification and eutrophication of natural ecosystems, the associated loss of biodiversity, and the formation of secondary particles in the atmosphere. Consequently the interest in NH3 extends across many disciplines.

Potential duplication of efforts in existing committees: The NIMSS data base of existing active projects was interrogated for existing projects with goals that overlap foreseen objectives relating to the proposed project (Table 1). The only project with potentially overlapping objectives with the proposed committee was NC1187. The project’s overlapping objectives were: 1) Determine the physical, chemical, and biological nature of particulate matter, including nanoparticles, derived from agricultural practices, processes, and operations and from the production, use, and disposal of consumer products, as they impact air, water, and soil quality and associated health, economic, and environmental impacts, including ecological sustainability and agricultural production; 2) Determine those particulate matter properties that control the cycling, biological availability, and uptake of nanoparticles, nutrients, carbon, and toxic substances in air, water, and soil systems. The only project with clear objectives involving ammonia was NRSP003. The project’s overlapping objectives were: 1) Characterize geographic patterns and temporal trends in chemical or biological atmospheric (wet and dry) deposition; and 2) Support research activities related to: (a) the productivity of managed and natural ecosystems; (b) the chemistry of surface and ground waters, including estuaries; (c) critical loads in terrestrial and aquatic ecosystems; (d) the health and safety of the nation's food supply; and (e) source-receptor relationships. Within the NADP, there is a background ammonia monitoring effort (AMoN; <http://nadp.slh.wisc.edu/AMoN/> that would be supporting a future project and a Total Deposition Science committee that addresses the deposition of ammonia. Both of these groups are dominated by federal and state regulatory scientists.

Table 1: Related Projects extracted from the NIMSS data base

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| Project | Title | Period of operation |
| NC1195 | Enhancing nitrogen utilization in corn based cropping systems to increase yield, improve profitability and minimize environmental impacts | 10/01/2016 - 09/30/2021  |
| WERA103 | Nutrient Management and Water Quality | 10/01/2015 - 09/30/2020 |
| NE1544 | Dairy Production systems: C,N, and P management for production, profitability and the environment. | 10/01/2015 - 09/30/2020  |
| NC1182 | Management and Environmental Factors Affecting Nitrogen Cycling and Use Efficiency in Forage-Based Livestock Production Systems | 10/01/2014 - 09/30/2019  |
| NCCC308 | Nutrition and Management of Feedlot Cattle to Optimize Performance, Carcass Value and Environmental Compatibility (NCT192) | 10/01/2013 - 09/30/2018  |
| NC1187 | The Chemical and Physical Nature of Particulate Matter Affecting Air, Water and Soil Quality | 10/01/2015 - 09/30/2020 |
| NRSP003 | The National Atmospheric Deposition Program (NADP) | 10/01/2014 - 09/30/2019  |

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D Zabowski (Univ, Washington):ASSESSING THE EFFECTS OF NITROGEN DEPOSITION ON HIGH-ELEVATION PLANT AND SOIL COMMUNITIES

DE Terrizzi (U Maryland): DOES AMMONIA IN PRECIPITATION INHIBIT NITRATE REMOVAL BY COVER CROPS?

CL Goodale (Cornell): COMMON CONTROLS OF CATCHMENT RESPONSE TO ANTHROPOGENIC NITROGEN DEPOSITION: A TRANS-ATLANTIC SYNTHESIS

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