Ambient Ammonia Concentrations Across New York State

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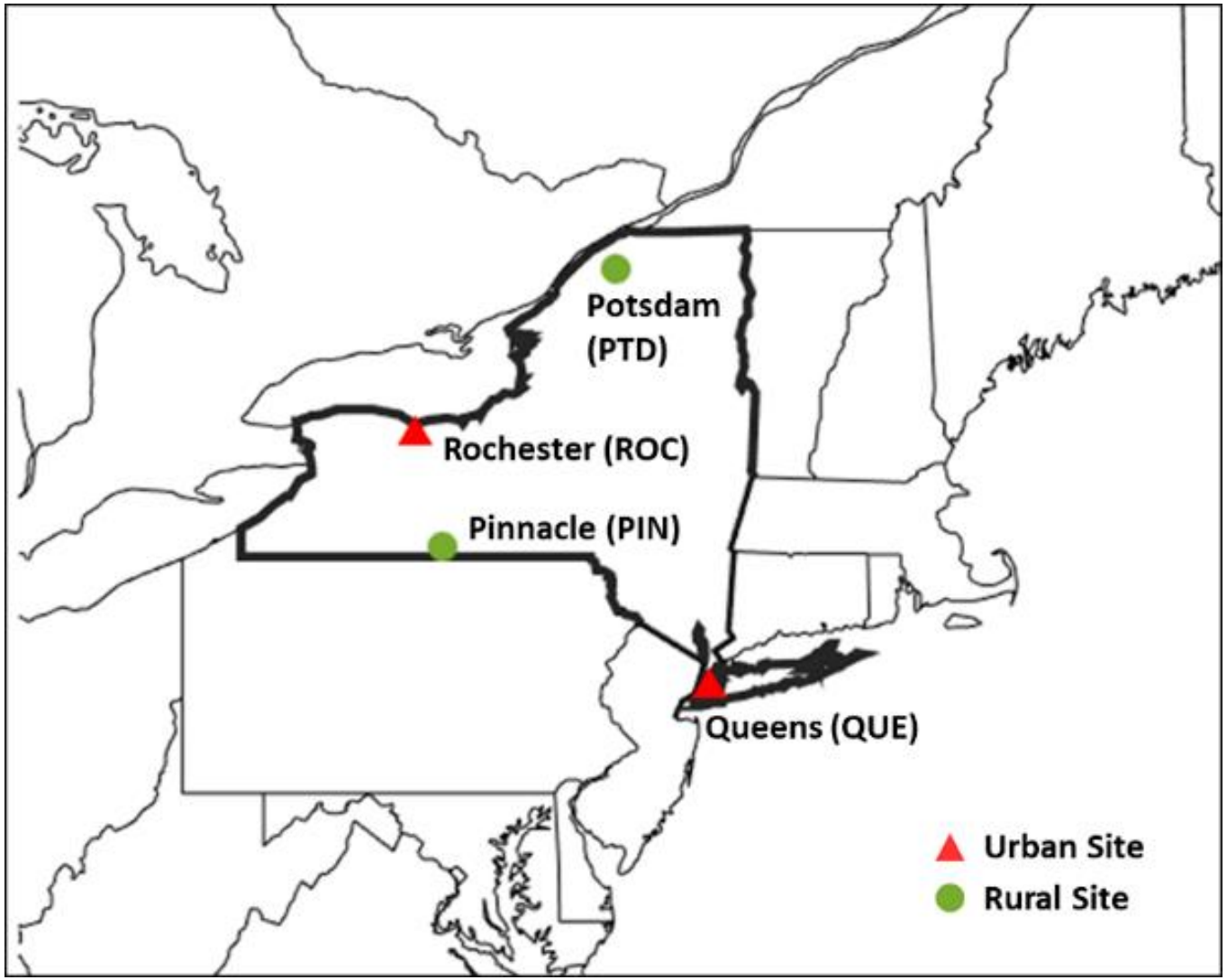
Objectives

- The objectives of this project were to measure ambient NH_3 in four locations across New York to identify its spatial and temporal distributions, source types, and its role in secondary particle formation.
- The four sites included 2 urban sites (Queens and Rochester, NY) and 2 rural sites (Pinnacle State Park and Potsdam, NY).
- At each site, AMoN passive samplers were also deployed so we could compare the active monitor with the integrated passive samples.

Manuscript

This work has been written up in a manuscript currently under review for the Journal of Geophysical Research - Atmospheres

Map of the four NH_3 monitoring sites.

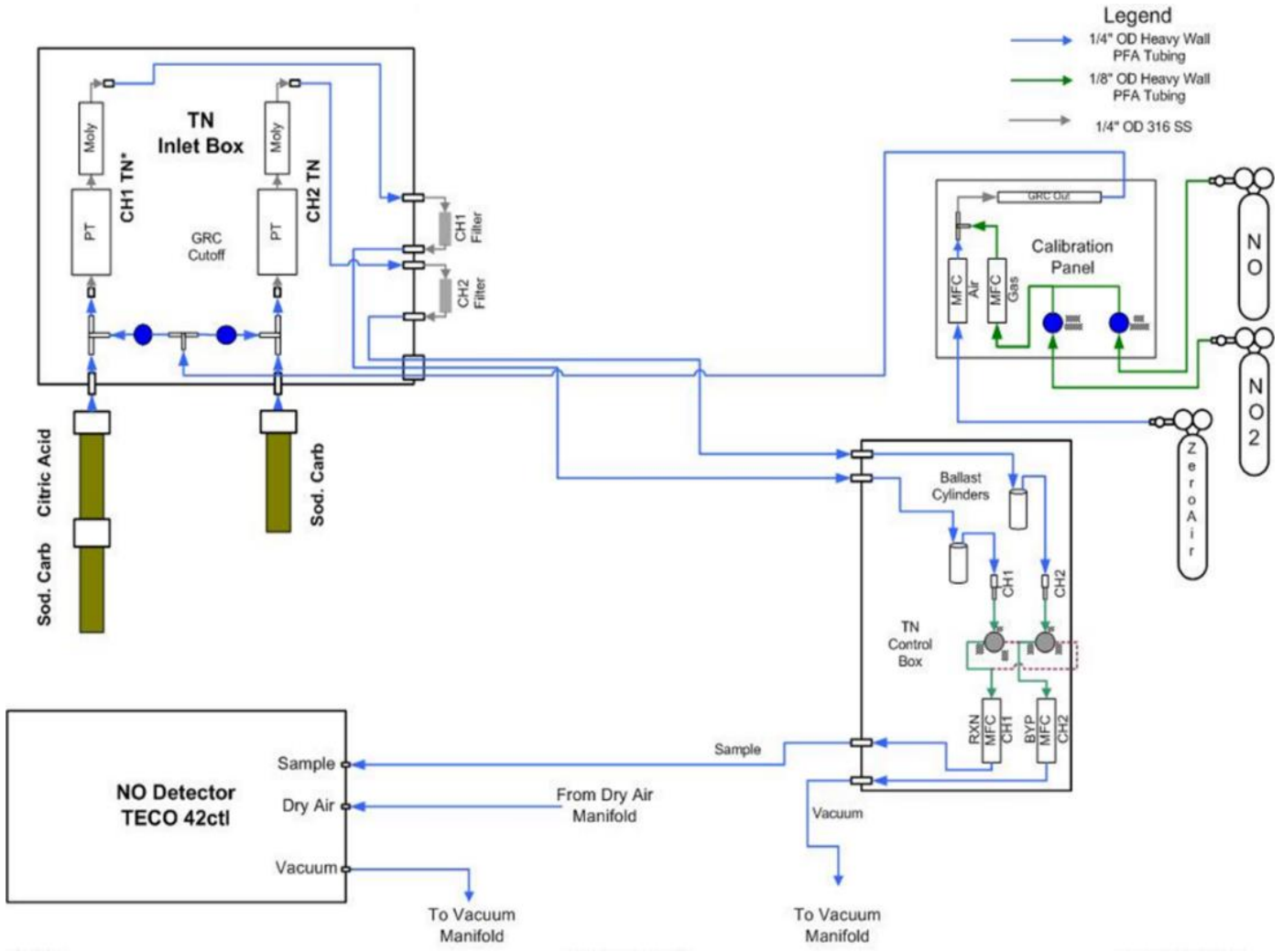


Active Monitor

- The active system used a denuder difference technique through a dual-channel nitric oxide-ozone ($NO\text{-}O_3$) chemiluminescence detector (CLD) system with 5-minute time resolution for data reporting and analysis (Edgerton et al., 2007).
- The flow in channel 1 was directed through a 600°C Pt mesh converter to oxidize the reduced nitrogen species (primarily NH_3 and particulate NH_4^+) to NO_y followed by a 350°C Mo converter to reduce the NO_y to NO.
- The flow in channel 2 was directed to a citric acid-coated annular denuder to remove all NH_3 before being directed to the Pt and Mo converters.
- The NH_3 concentrations were defined as the differences between the nitrogenous species measured in the two channels.

Edgerton et al. (2007). Atmospheric Environment, 41(16), 3339-3351.

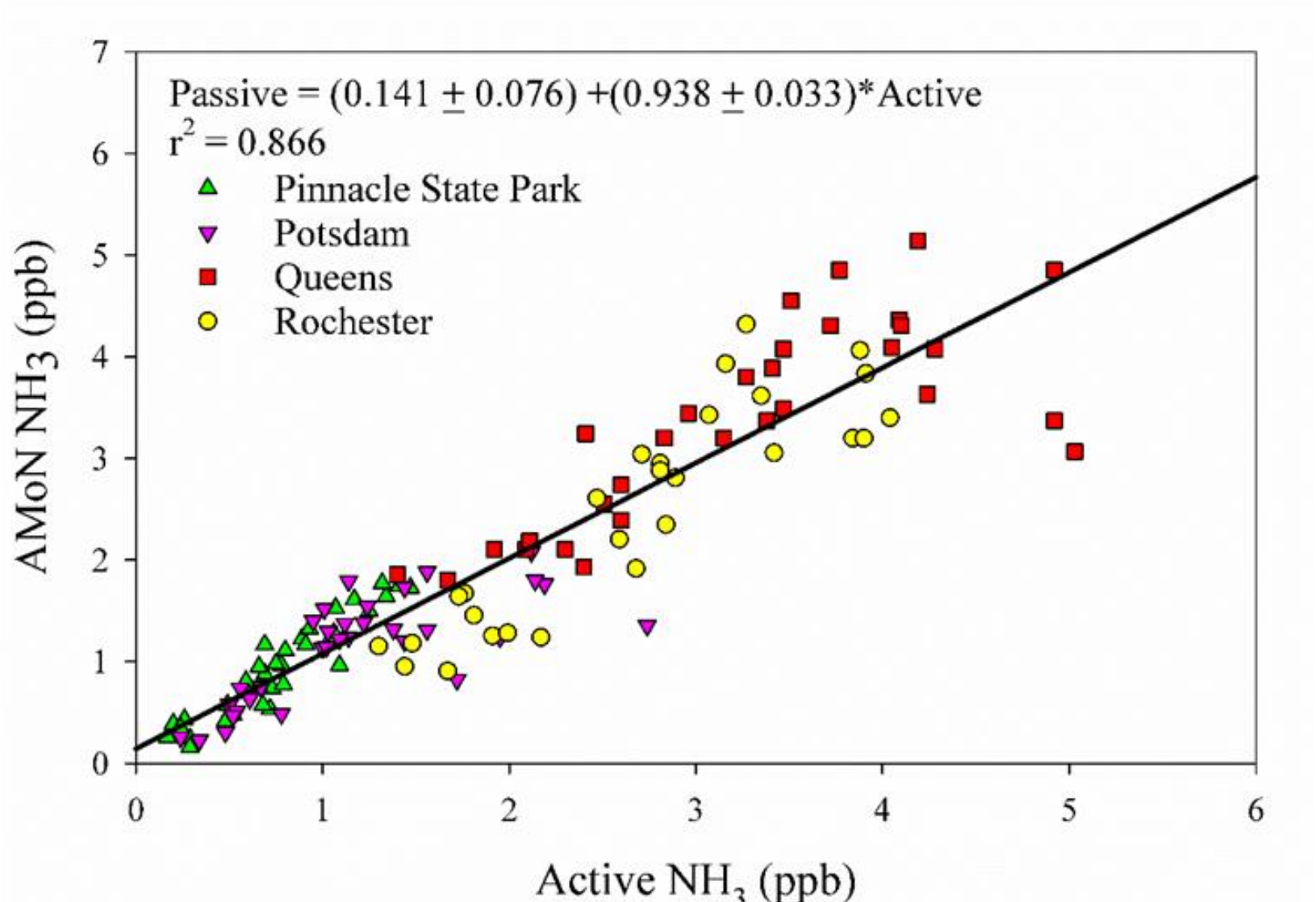
Active Monitor



Passive Monitor

- Passive diffusion samplers were Radiello from Sigma-Aldrich.
- NH_3 was sorbed onto the interior surface of samplers based on diffusion, and the NH_3 samples were analyzed and quality controlled by the NADP under AMoN
- Ammonium ion is quantified by visible spectrometry as indophenol:
  - at basic buffered pH ammonium ion reacts with phenol and sodium hypochlorite, with pentacyanonitrosylferrate catalysis (in the following cyanoferrate), to form indophenol.
  - The reaction product is intensely colored in blue, and its absorbance measured at 635 nm.

Comparison of Active and Passive Monitors



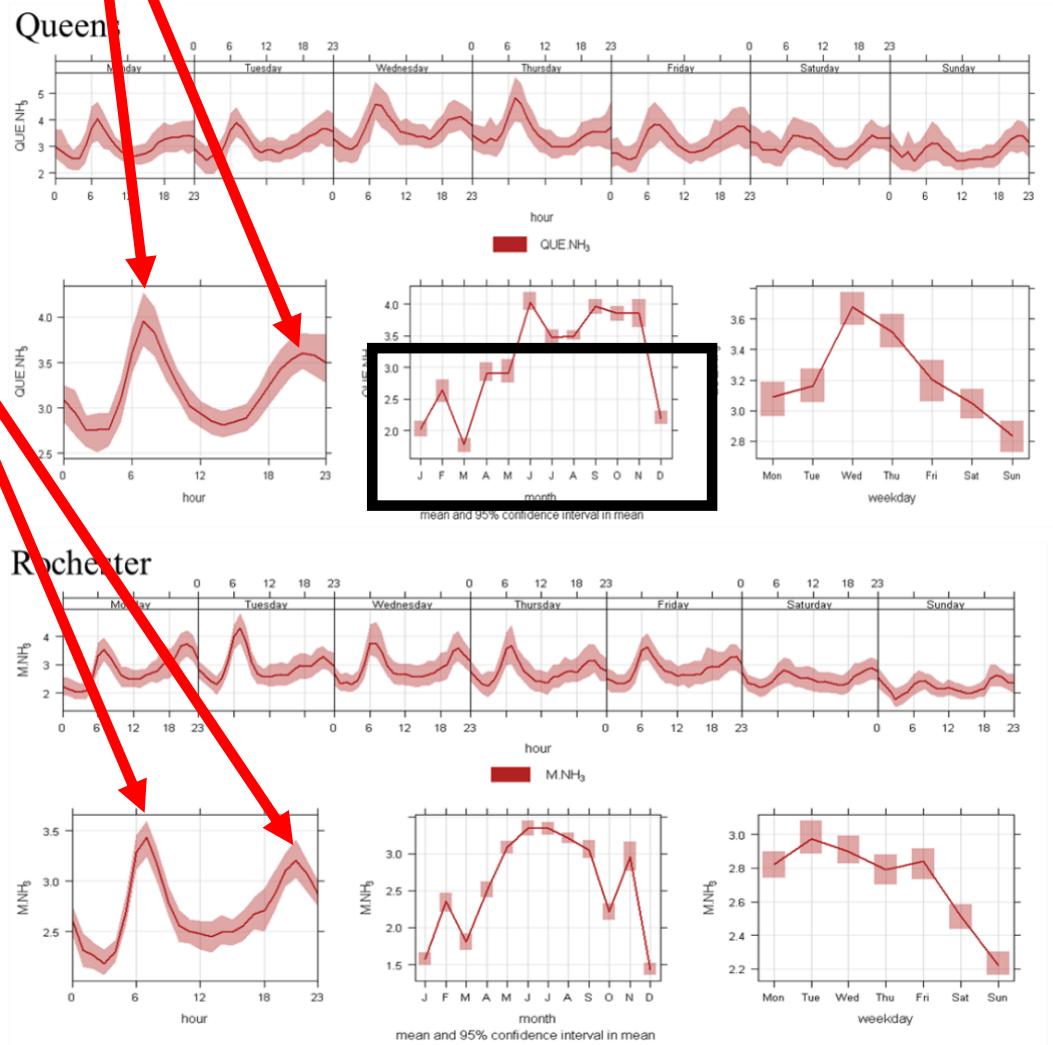
Comparison of Active and Passive Monitors

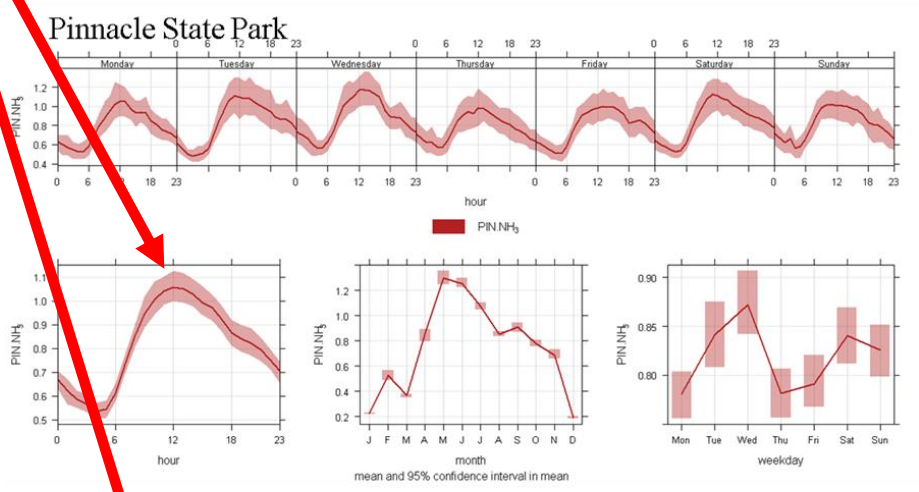
- There is good agreement between the passive and active monitors.
- Agreement was similar across rural and urban sites
- Active monitors values were about 6% larger than the passive monitors, but agreement is within the uncertainties in both values.

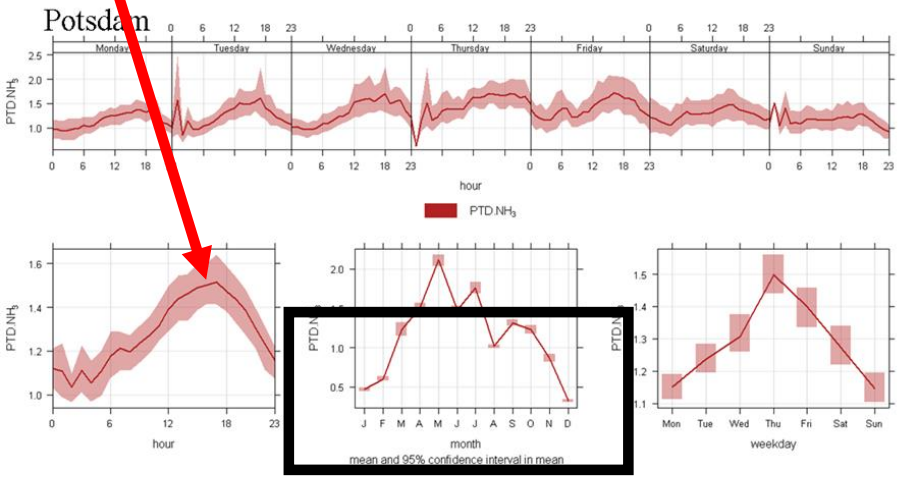
Rush Hour Peaks

Midafternoon Peaks

Temporal Variability







Mean Values

- The mean (± SD) NH_3 concentrations measured using active systems in QUE, ROC, PTD, and PIN were 3.22 ± 2.23, 2.84 ± 1.91, 1.29 ± 1.12, and 0.82 ± 0.64 ppb, respectively.
- NH_3 concentrations at the urban sites (QUE and ROC) were significantly higher (Kruskal-Wallis test, $p < 0.01$) than that at the rural sites (PTD and PIN).

Inventory Emissions

Table 1. Local NH_3 emissions and emissions densities (county-based) for the four sites based on NEI 2014.

Monitoring site	Counties	Total NH_3 emission (ton/year)	Total NH_3 emission density (ton/year/km^2)	Non-agricultural emission (%)
NYS total		33337	0.24	63
QUE	Queens	1101	2.38	99
ROC	Monroe	748	0.21	58
PTD	St. Lawrence	1027	0.14	1
PIN	Steuben	960	0.26	1

Inventory Emissions

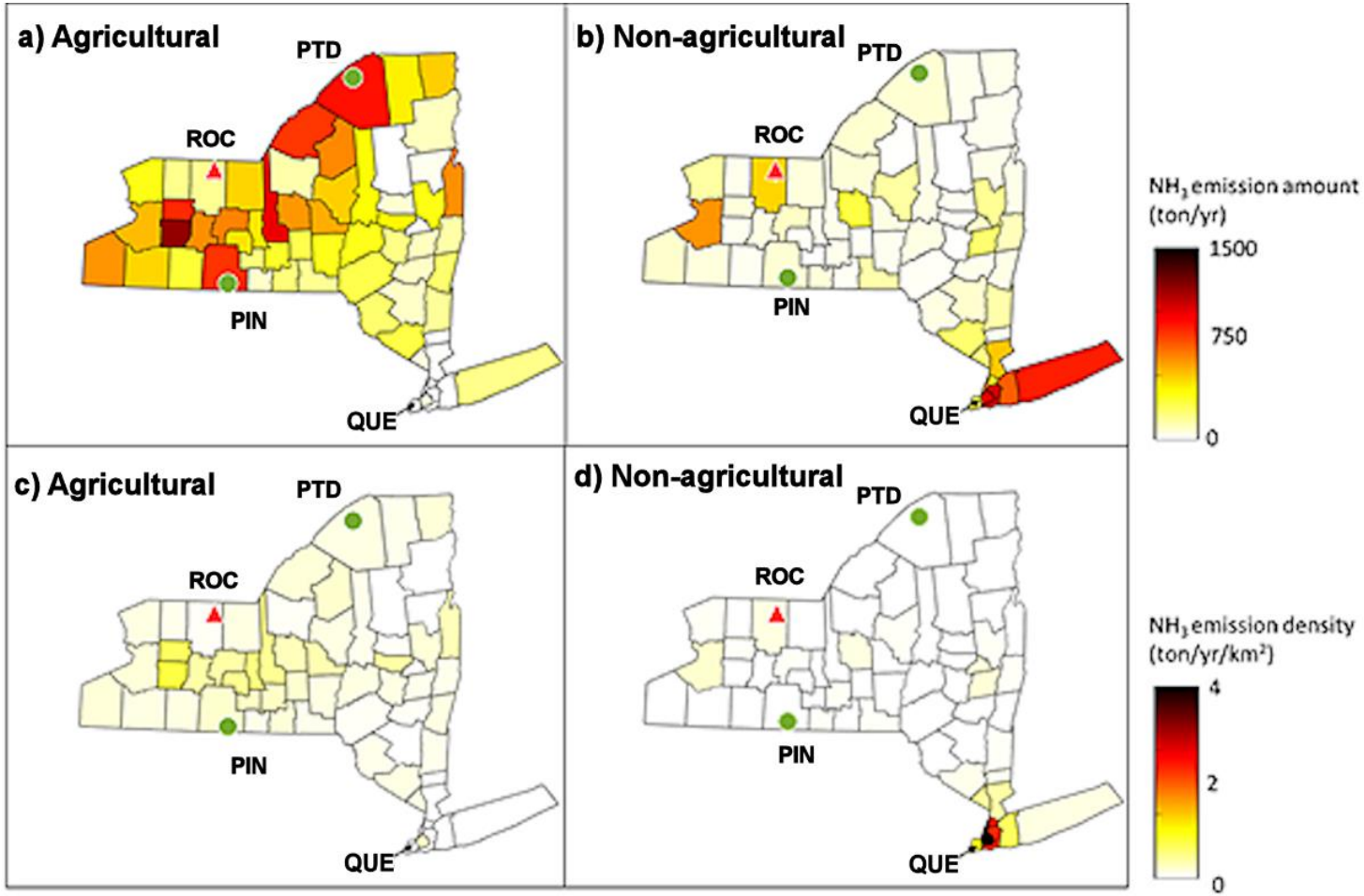


Figure S7. NH_3 emissions rates and density of agricultural and non-agricultural sources in each NYS county.

Inventory Emissions

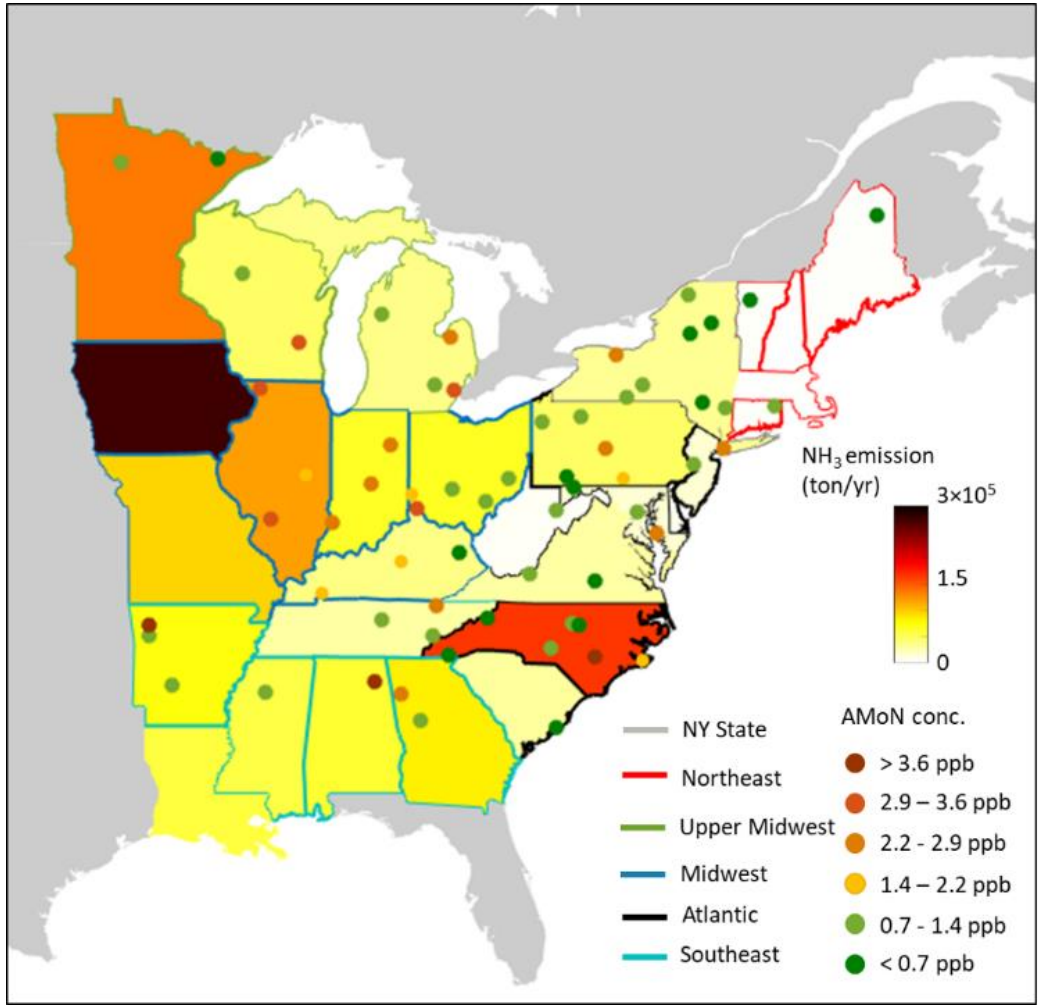


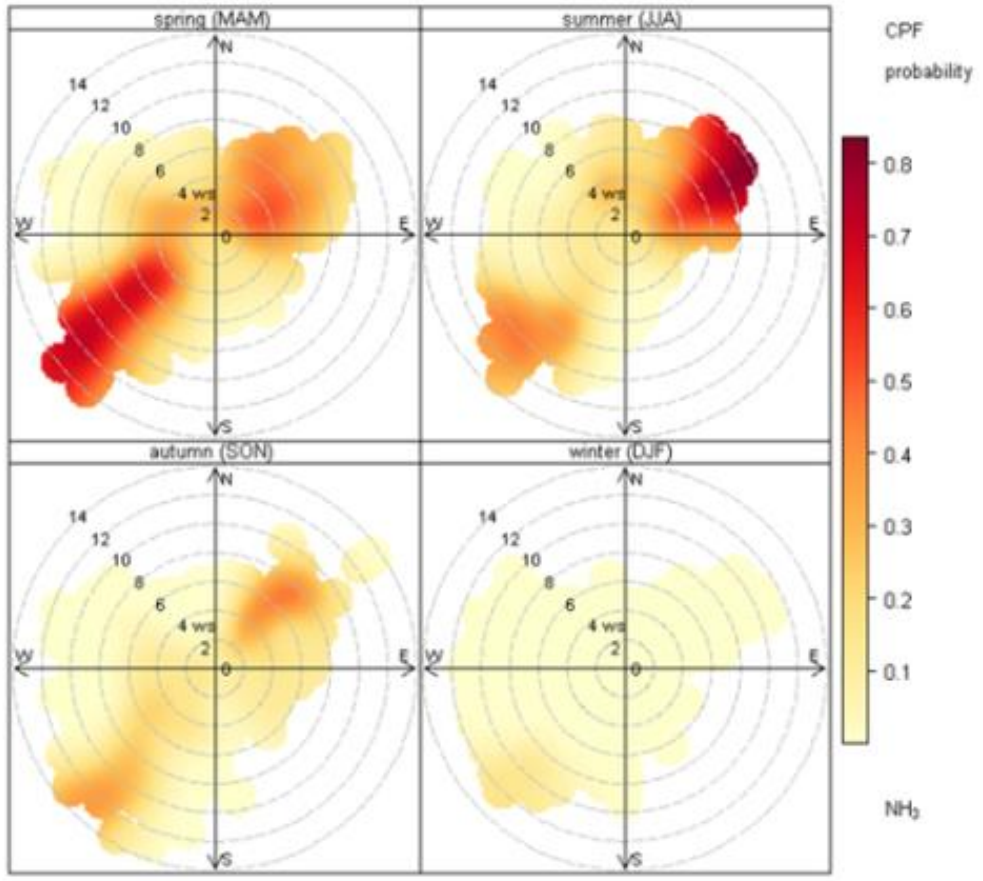
Figure 6. Annual NH_3 emissions in the central and eastern U.S. (divided into five regions with different border color) and AMoN site (presented as circles) concentrations.

Proportions of Emissions from Source Areas

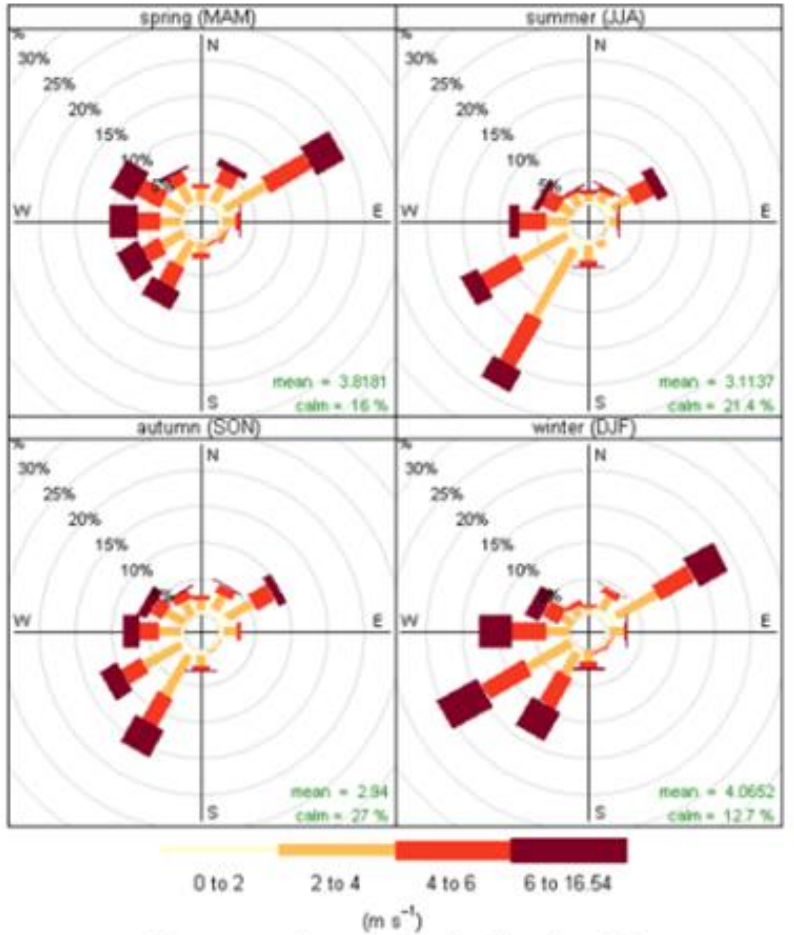
Table 2. Non-negative regression results for the NH_3 concentrations at the four sites.

	Midwest	Upper Midwest	Northeast	Atlantic	Southeast	Local	R^2
PIN	0.00033	0.0138	0.291	0.00	0.00	0.00	0.76
PTD	0.00	0.0196	0.00	0.0296	0.00	0.00	0.60
ROC	0.00	0.00	0.837	0.00	0.00	1.31	0.42
QUE	0.00	0.00	0.703	0.00	0.00	2.00	0.30

Local Emission Directions - Potsdam

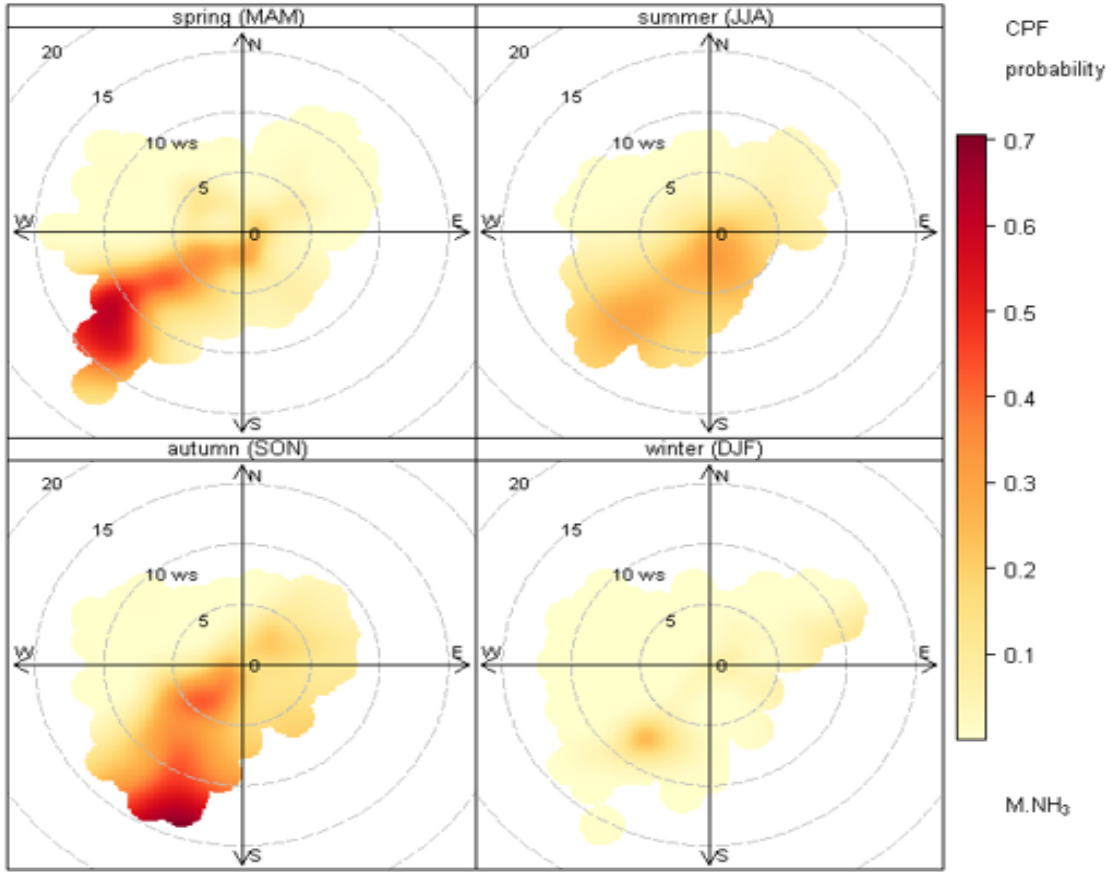


CPF at the 75th percentile (=1.7)

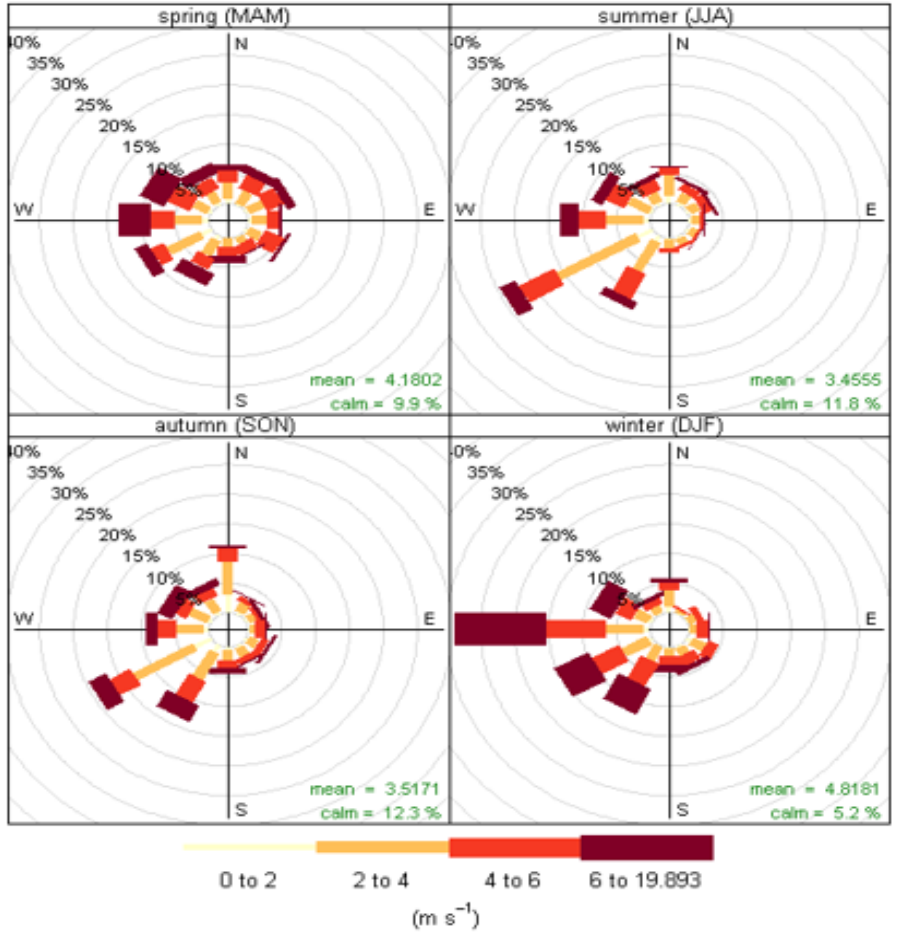


Frequency of counts by wind direction (%)

Local Emission Directions - Rochester

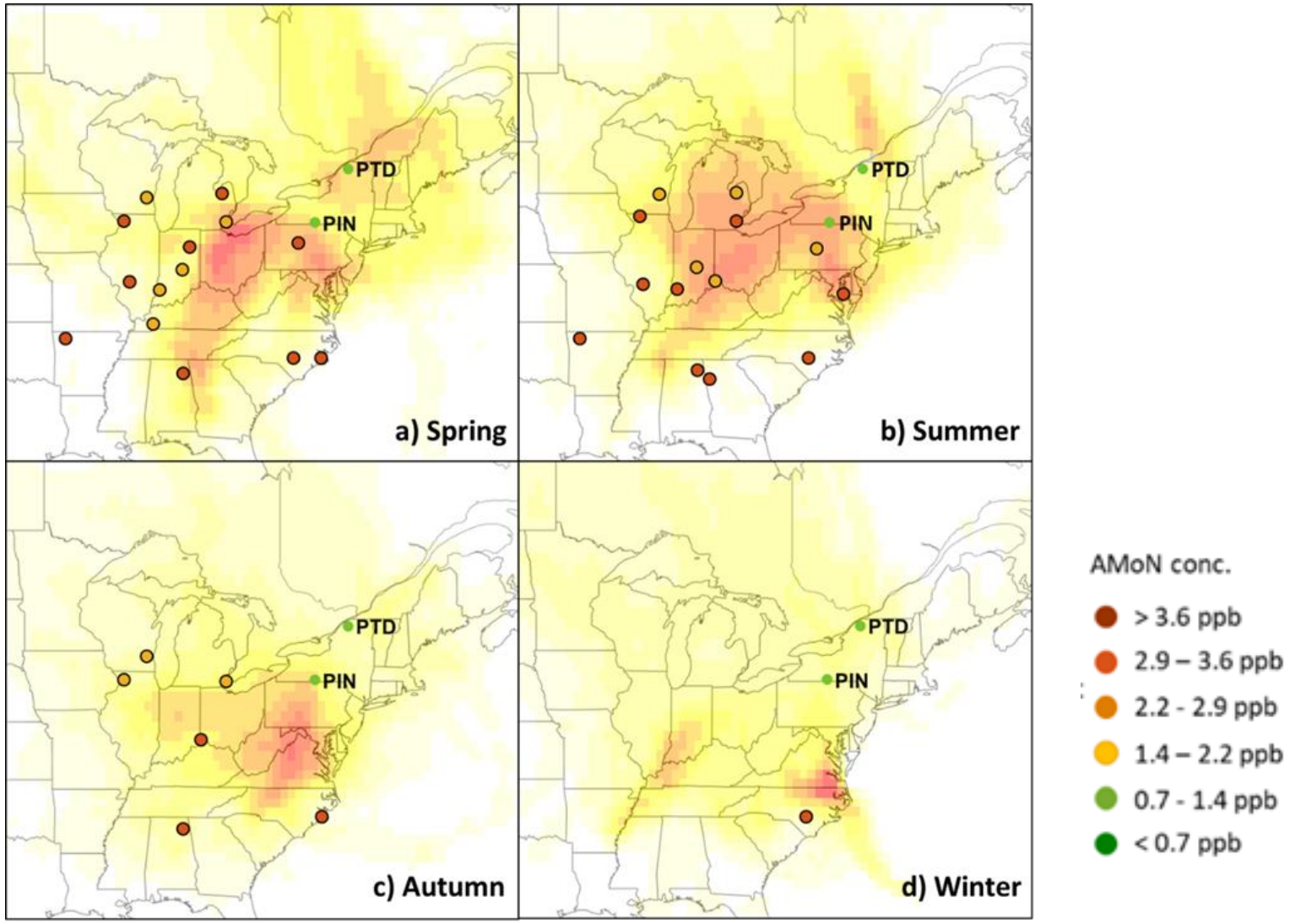


CPF at the 75th percentile (=3.9)



Frequency of counts by wind direction (%)

Distant Emissions - Rural



Conclusions

- Active and passive monitors were comparable; Active system measured 6.2% higher NH_3 concentrations
- Urban sites (QUE and ROC) had higher NH_3 concentrations than the rural sites (PIN and PDM) emphasizing the importance of local sources such as traffic and population centers.
- Diel variations at the urban sites coincided with typical traffic patterns, while at the rural sites, concentrations tracked ambient temperature changes.
- Seasonal patterns were weaker at the urban sites and appeared to depend more on changes in the dispersion conditions. Rural sites show low winter values when soil activity is low.
- Urban NH_3 emissions, mainly from vehicles and stationary SCRs, have impacts on urban NH_3 concentrations and resulting urban particulate air pollution (nitrate and sulfate) even though agricultural NH_3 emissions nominally dominated the reported total NYS NH_3 emissions.
- The ammonia emission factor for residential combustion of natural gas substantially overestimates those emissions. Emission factor needs to be updated given the changes in the efficiency of these heating appliances.

Thank you for your attention!

Questions?

Clarkson UNIVERSITY

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