Carolina Ammonia Monitoring Network (CAMNet): Year 1 Results

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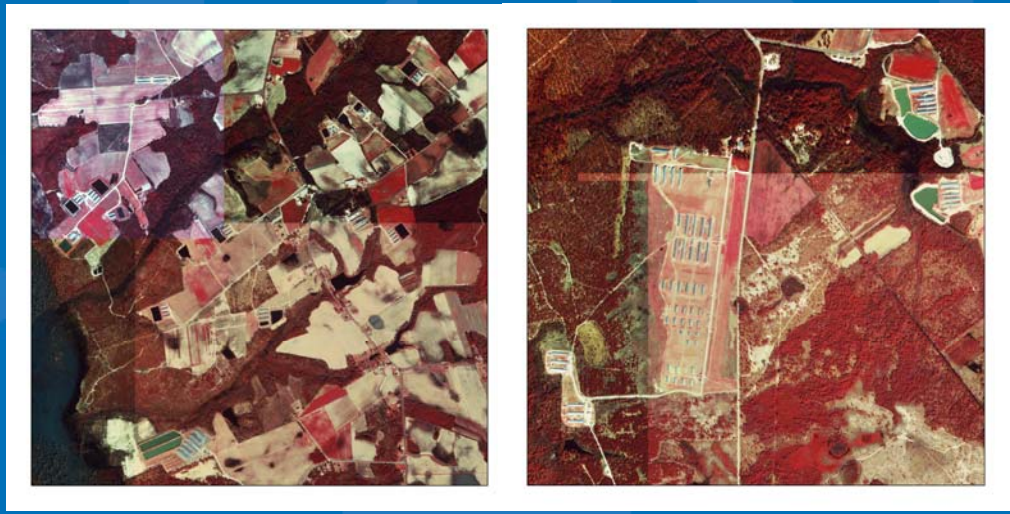


Office of Research and Development
National Risk Management Research Laboratory, Air Pollution Prevention and Control Division

Background

- This work is motivated by the need for estimates of NH_3 dry deposition in areas where animal agriculture is widespread, such as the coastal plain of North Carolina.

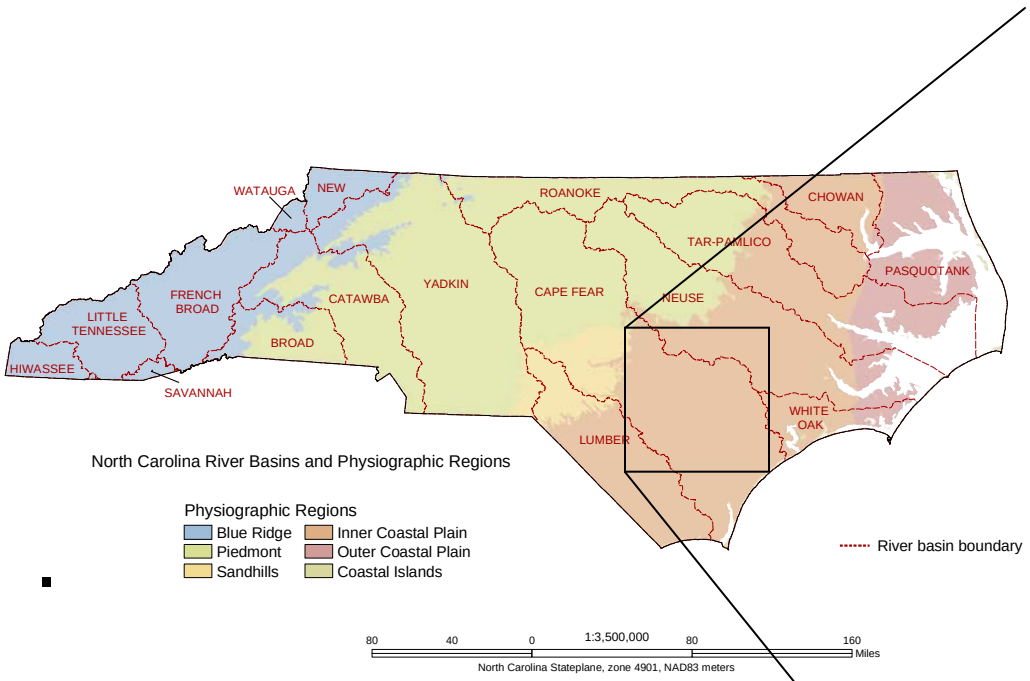
- Representative modeling of NH_3 dry deposition within these areas at watershed and smaller scales requires accurate knowledge of the ground-level NH_3 concentration field, which is highly variable in space (2 - 3 orders of magnitude) and time (1 - 2 orders of magnitude) .

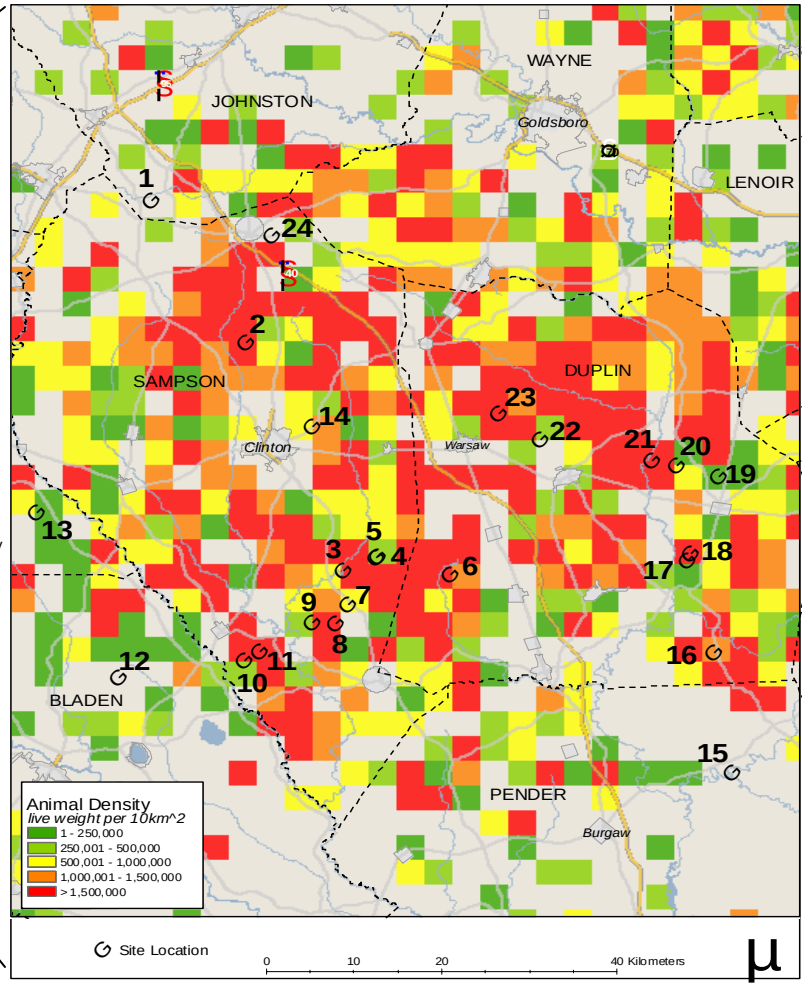
- Here we present year 1 results from a 24 site passive NH_3 monitoring network in the lower Cape Fear and Neuse River Basins of eastern North Carolina.

- The purpose of this network is to characterize spatial and temporal variability of NH_3 concentrations and provide measured and modeled concentration fields for fine-scale dry deposition modeling.

Network Domain

Neuse and Cape Fear River Basins





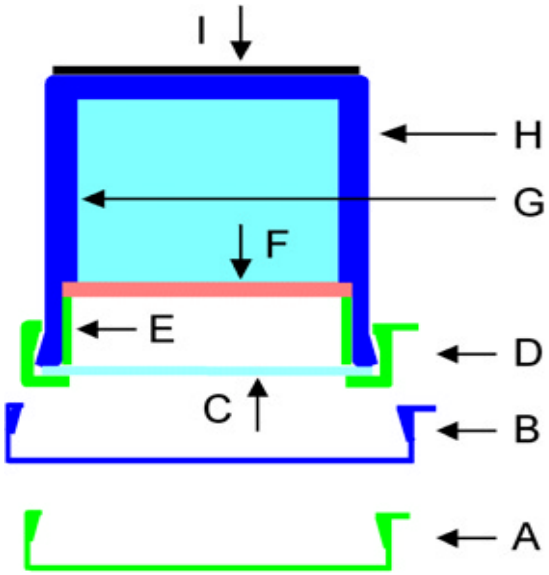
Results presented for
April, 2007 – May, 2008

Sampling Methodology

Where characterization of temporal variability at seasonal and longer scales is sufficient, passive samplers can serve as an effective method for resolving high spatial variability.

ALPHA Passive Samplers

Tang et al. 2001. The Scientific World. 1:513-529.



A Replacement solid cap
B Top protective cap
C 5 μm PTFE membrane (27 mm diameter)
D Cap with hole for membrane
E Support ring (6 mm height)
F Filter paper
G Internal ridge to support filter paper
H Extended body for ease of handling
I Velcro for attachment to holder

Sampling Methodology

- Collection filter: *Whatman Grade 3MM, 2.4 cm*
  - »*Washed 5X in deionized water*
  - »*Washed 3X in 5% phosphorous acid (80 – 90% methanol)*
  - »*Dried in vacuum desiccator*
- Stored in individual polystyrene vials and transported to and from field sites in sealed glass jars (6 – 8/jar)
- Exposed filters extracted in 2.5 mL deionized water and analyzed for NH_4^+ by ion chromatography
- Deployed in duplicate for 1 week at each of 24 sites in an open bottom rain shield at 1.5 m above ground

Sampling Methodology

- Calculation of air concentrations:

$[NH_3] = Q/V$

Q = mass of NH_3 collected – blank

V = volume of air sampled

$V = DAt/L$

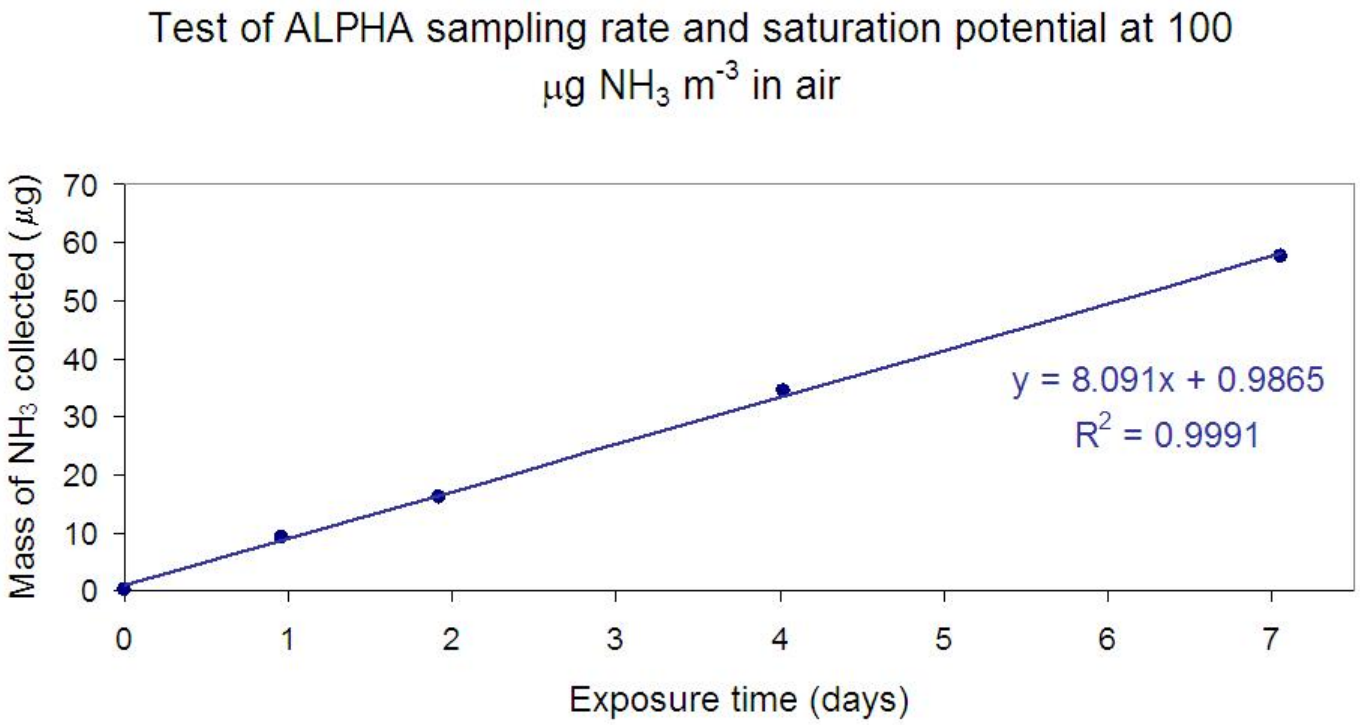
D = diffusion coefficient

A = cross-sectional area of diffusion path

t = exposure time

L = length of diffusion path

Results *Sampler Calibration*



Theoretical sampling rate = 0.00434 m^3 hr^{-1}
Measured sampling rate (S. Tang, field calibration, personal comm.) = 0.00324 m^3 hr^{-1}
Measured sampling rate (J. Walker, exposure chamber) = 0.00357 m^3 hr^{-1}

Results *Sampler Performance*

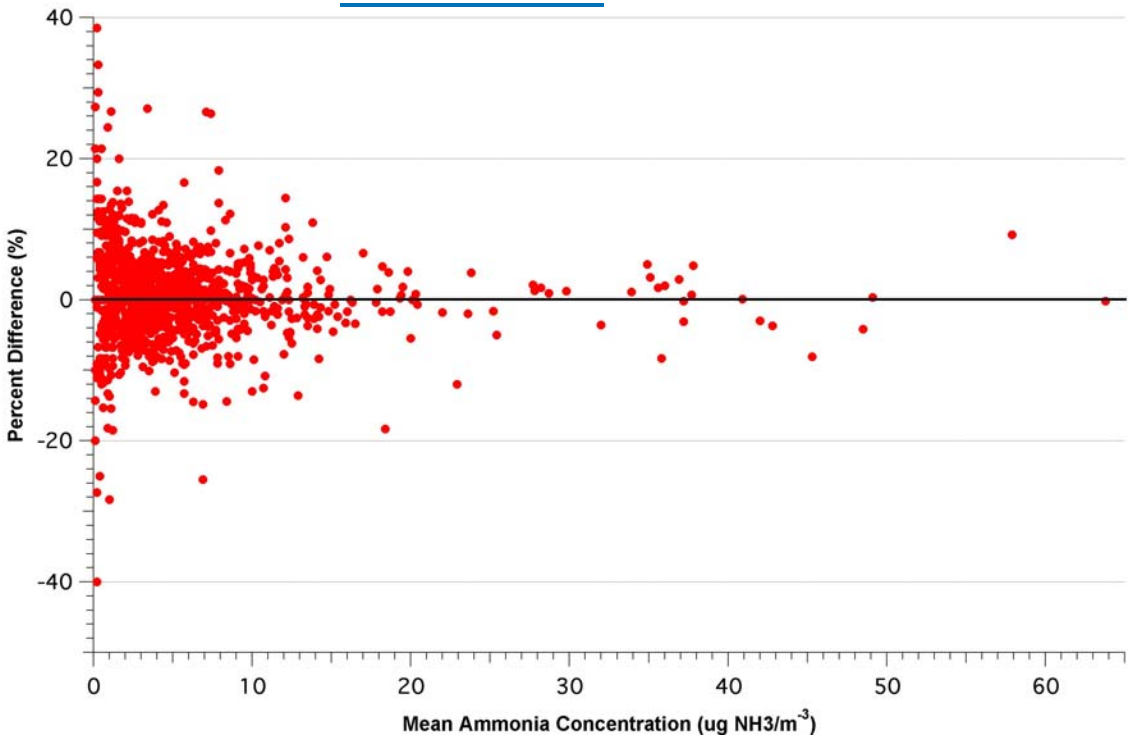
Blanks

Median lab blank
= 10 μg N L^{-1} (N = 162)

Median field blank
= 50 μg N L^{-1} (N = 162)

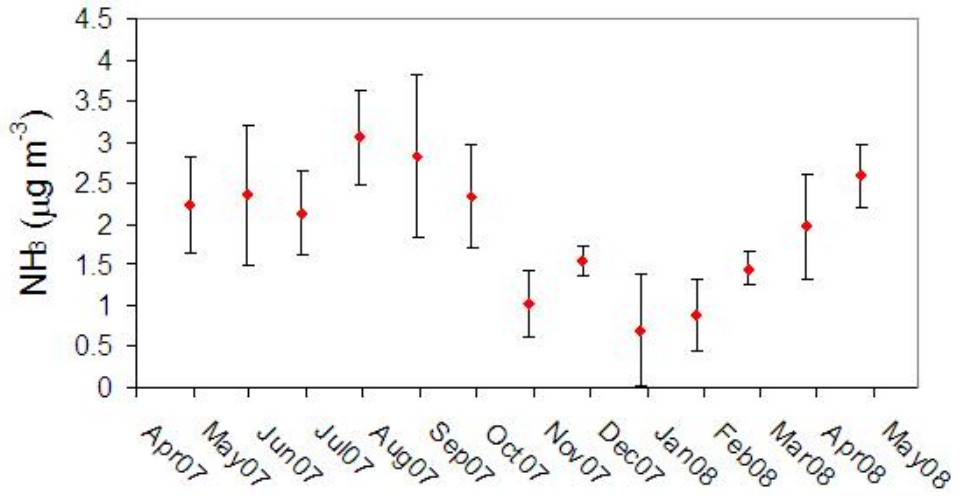
Detection limit defined as
2σ of the field blank
equivalent to 0.16 μg NH_3 m^{-3}
assuming 1 week exposure at
28 °C

Precision

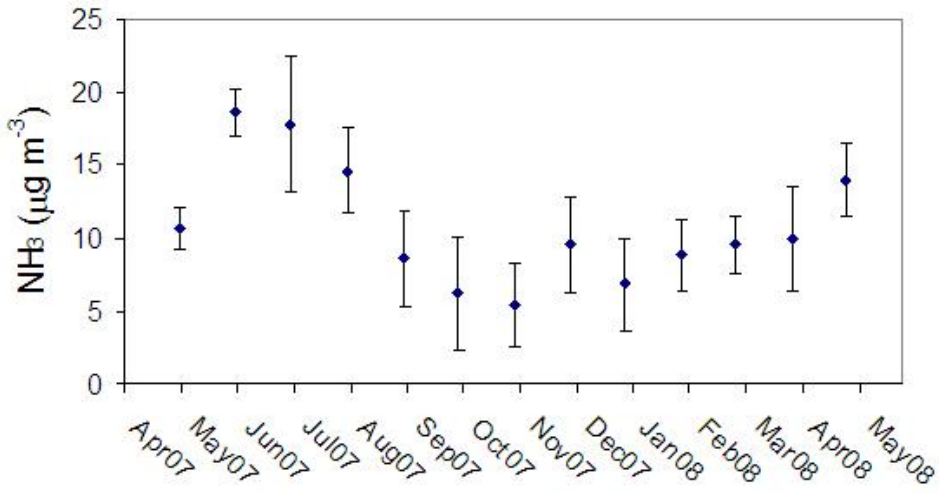


Median absolute difference b/t duplicates
= 6.6 % (N = 1079)

Results *Temporal Variability*

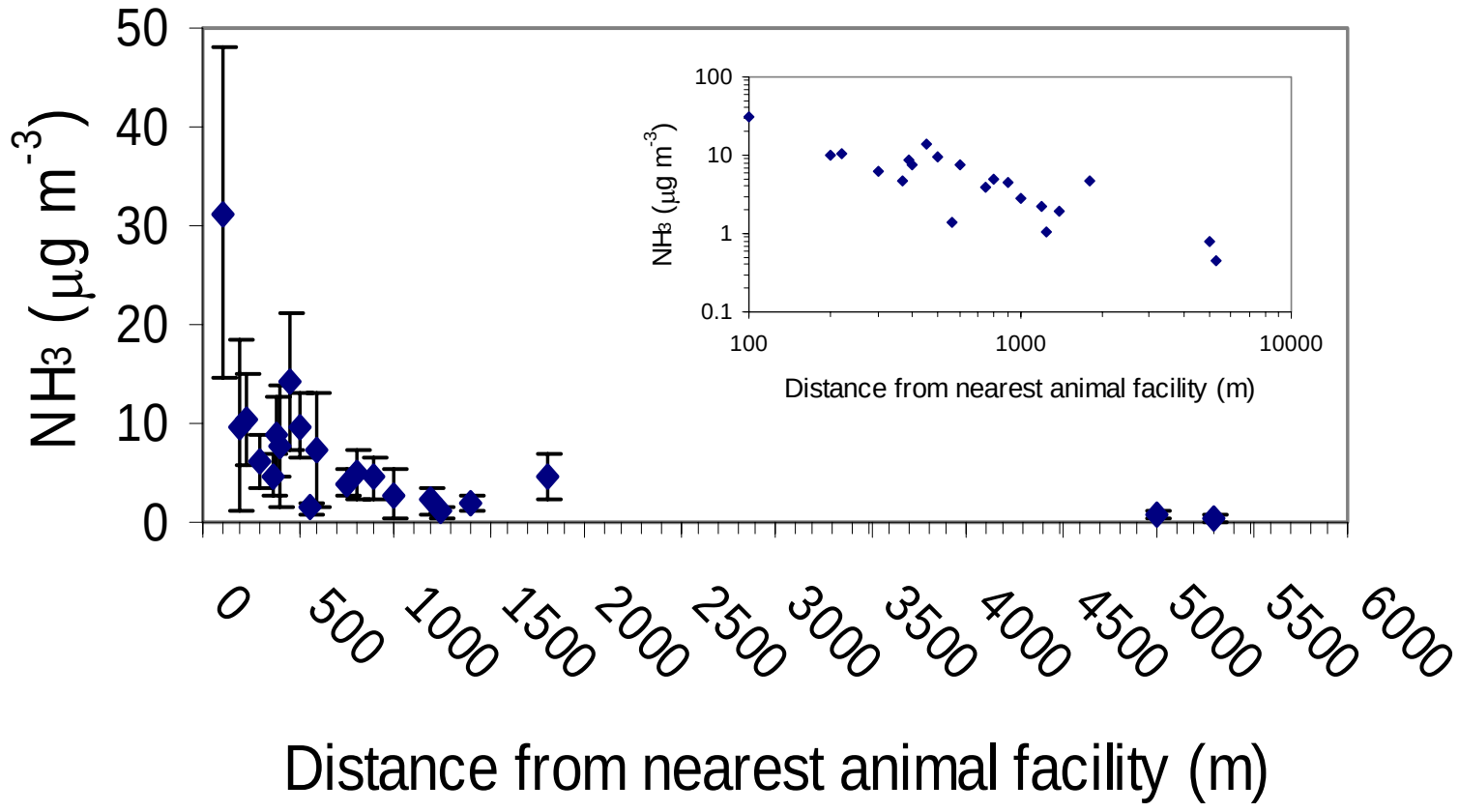


Site 3
1.4 km SE of swine facility

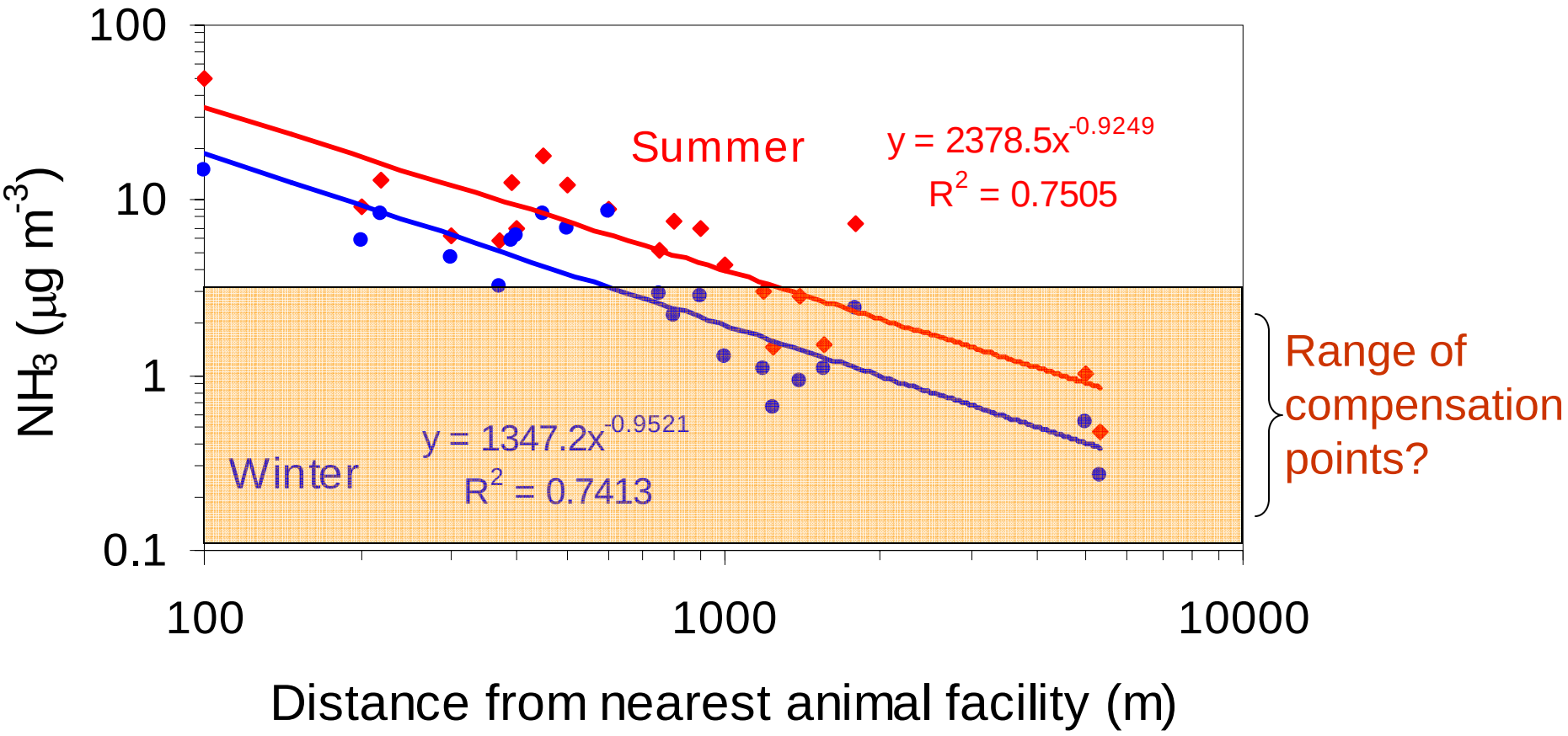


Site 20
0.2 km E of turkey facility

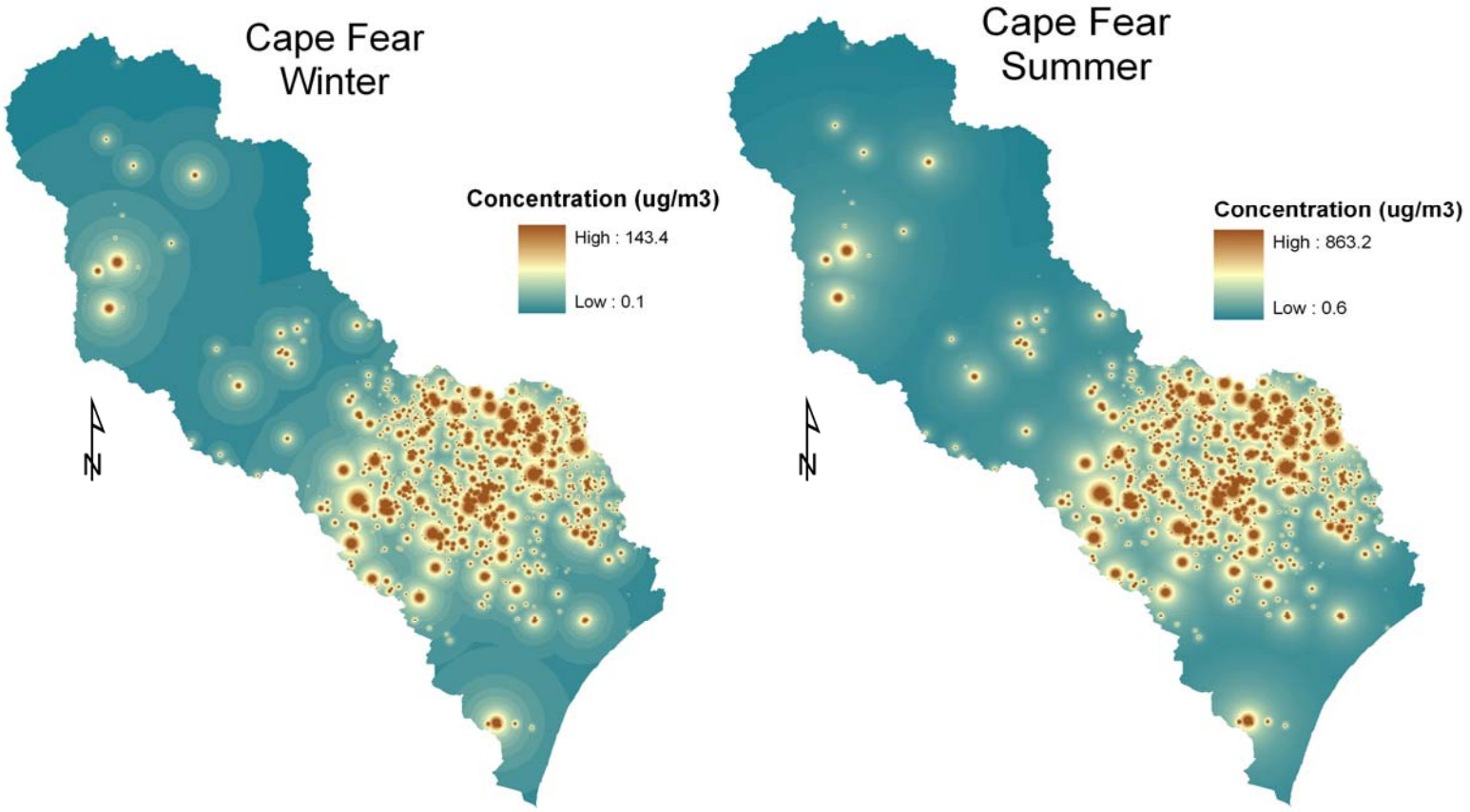
Results *Spatial Variability*



Results *Spatial Variability*



Results *Modeling NH_3 Concentrations*



United States Environmental Protection Agency

Conclusions

- ALPHA sampler is appropriate for this application but must be lab or field calibrated. Effective sampling rate (volume/time) is lower than theoretical prediction, thus uncalibrated concentrations will be biased low (20 – 30%)
- Weekly average concentrations illustrate seasonality of emissions and dispersion characteristics
- Concentrations indicate the potential for high dry deposition rates within 1 km of animal facilities

Next Steps

- Comparison of ALPHA sampler to annular denuder and other methods in the field
- Testing to determine reasons for ALPHA low bias
  - Diffusion barrier thickness, surface conditions, etc
    - How often do we need to calibrate?
- Use CAMNet concentration measurements and spatial modeling results as input to the Semi-Empirical Ammonia Emission and Deposition (SEADE) Model
    - Cape Fear and Neuse River Basins
    - 100 m grid size/compensation point framework
    - Facility-scale NH_3 emission inventory
    - Net emission and deposition by land use type/season
    - Build upon previous results based on measurements and modeling at single swine facility (Walker et al., 2008)

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