Update: AMoN Site Characterization Study for NH_3 Bidirectional Flux Model

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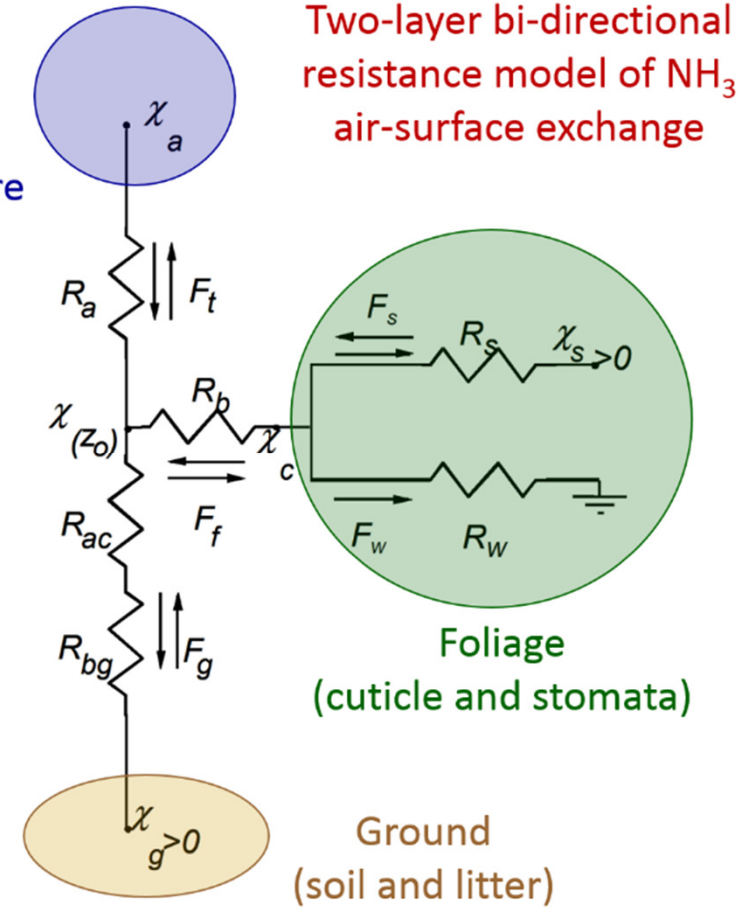
Project objectives

- Develop a methodology for using 2-week average AMoN concentrations in a bi-directional NH_3 flux model
- Provide NADP with a model for calculating and reporting net and component NH_3 fluxes at AMoN sites
- Inform the use of AMoN measurements in TDEP maps

Bi-directional flux model

Field-scale model for AMoN sites



Resistances
- Aerodynamic (R_a)
- Boundary layer (R_b)
- In-canopy (R_{ac}, R_{bg})
- Stomatal (R_s)
- Cuticular (R_w)

Compensation points
- Canopy (χ_{zo})
- Stomatal (χ_s)
- Ground (χ_g)

Fluxes
- Net canopy-scale (F_t)
- Stomatal (F_s)
- Cuticular (F_w)
- Foliage (F_f)
- Ground (F_g)

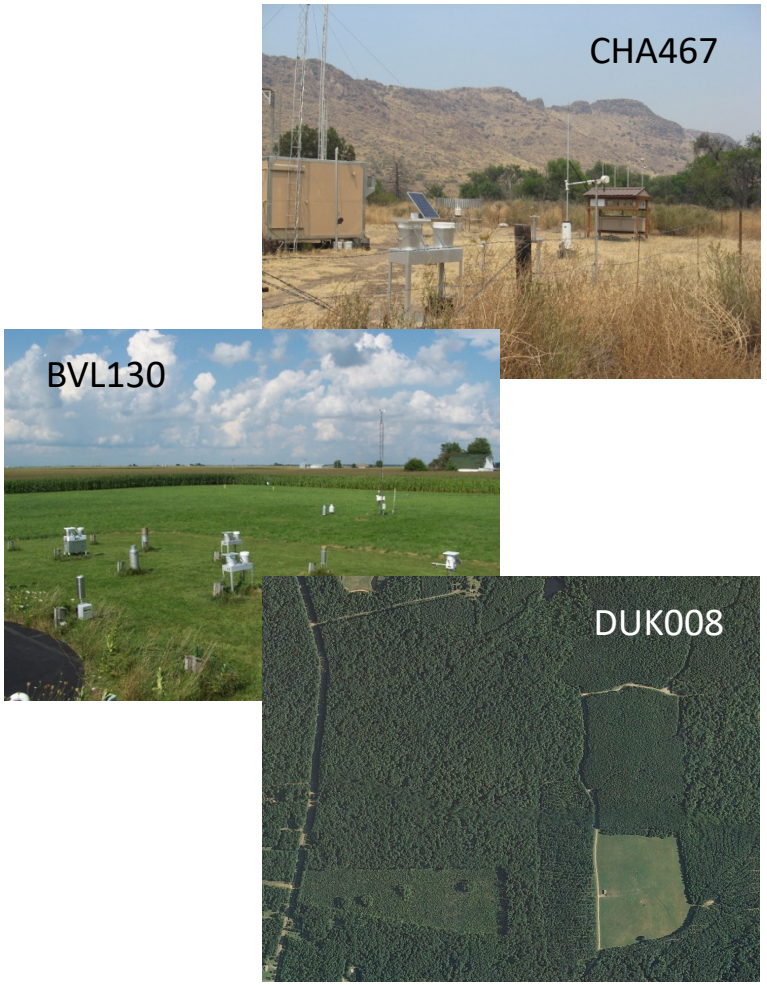
Study design

- Project consists of two phases:
- Phase I - Develop databases of soil and vegetation chemistry, micrometeorology, and surface physical characteristics at three AMoN sites
- Phase II - Use datasets to parameterize and test a bi-directional NH_3 flux model for use at AMoN sites
  - Assess model sensitivities to biogeochemical and meteorological inputs
  - Develop method for use of two-week NH_3 concentrations
  - Standardize model for implementation across AMoN

Pilot AMoN sites

- Three pilot AMoN sites were selected based on land use, vegetation type, soil type, and atmospheric NH_3 concentrations

- CASTNET, NADP/NTN, and NADP/AMoN
  - Chiricahua National Monument (CHA467, AZ)
    - Range land
    - AMoN '15 = 0.9 ug/m^3 (0 – 2.3 ug/m^3)
  - Bondville (BVL130, IL)
    - Agricultural
    - AMoN '15 = 1.4 ug/m^3 (0.3 – 3.3 ug/m^3)
  - Duke Forest (DUK008, NC)
    - Hardwood forest
    - AMoN '15 = 0.6 ug/m^3 (0.2 – 1.1 ug/m^3)



Field measurements

Category	Analysis	Data	Comments
Meteorological measurements	3D wind components, solar radiation, temperature (2 and 9m), wetness, wind speed and direction	Hourly average	Recorded by data logger
Soil Conditions	Moisture, temperature	Hourly average	Recorded by data logger
Soil Chemistry	Moisture, $[NH_4^+]$, $[NO_3^-]$, pH	Seasonally	15 locations per site; 5 soil cores within 1x1 m plot, separated by O and A horizons
Vegetation Structure	Leaf area index	Seasonally	15 locations
Vegetation Chemistry	Bulk leaf and litter: moisture, total [N], $[NH_4^+]$, pH	Seasonally	15 locations per site; Leaves from 3-5 trees

Status of activities

- Phase I
  - Field data collection completed
  - Soil/vegetation chemistry datasets complete
  - Processing of micrometeorological measurements underway
  - Processing of canopy physical measurements underway
- Phase II
  - Phase II QA plan complete
  - Development of continuous leaf area time series underway
  - Development of modeled meteorology datasets underway

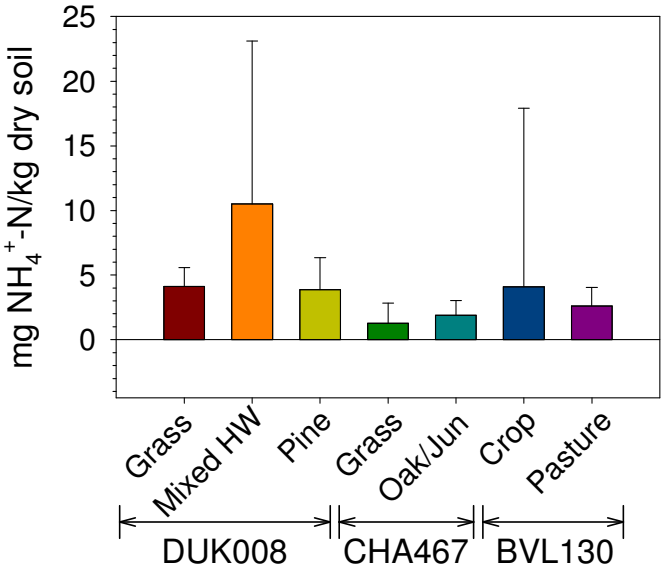
Soil chemistry

NH_3 compensation point

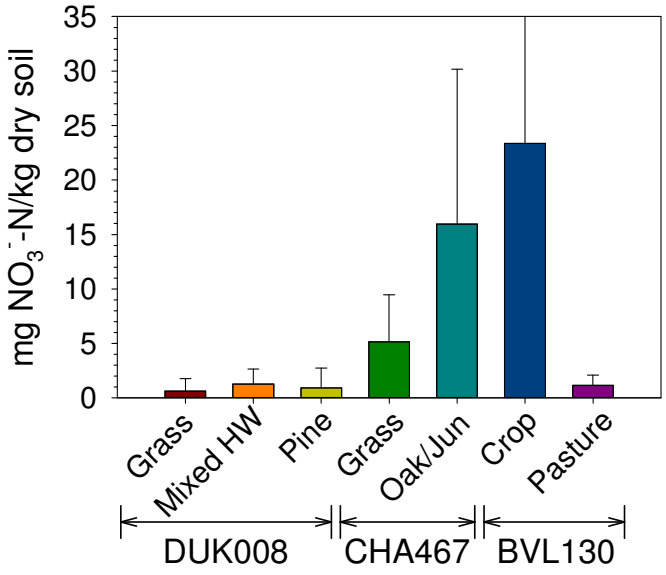
$$\chi = \frac{161500}{T}\exp\left(-\frac{10380}{T}\right)\frac{[NH_4^+]}{[H^+]}$$

Emission potential

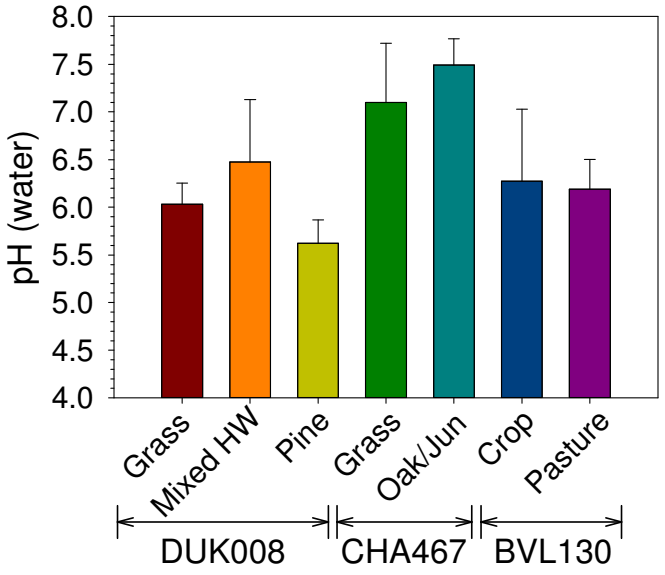
- Soil/litter
- Leaf apoplast (stomatal cavity)
- Leaf surface water/cuticle



Soil NH_4^+



Soil NO_3^-



Soil pH

Vegetation chemistry

NH_3 compensation point

$$\chi = \frac{161500}{T}\exp\left(-\frac{10380}{T}\right)\frac{[NH_4^+]}{[H^+]}$$

Emission potential

- Soil/litter
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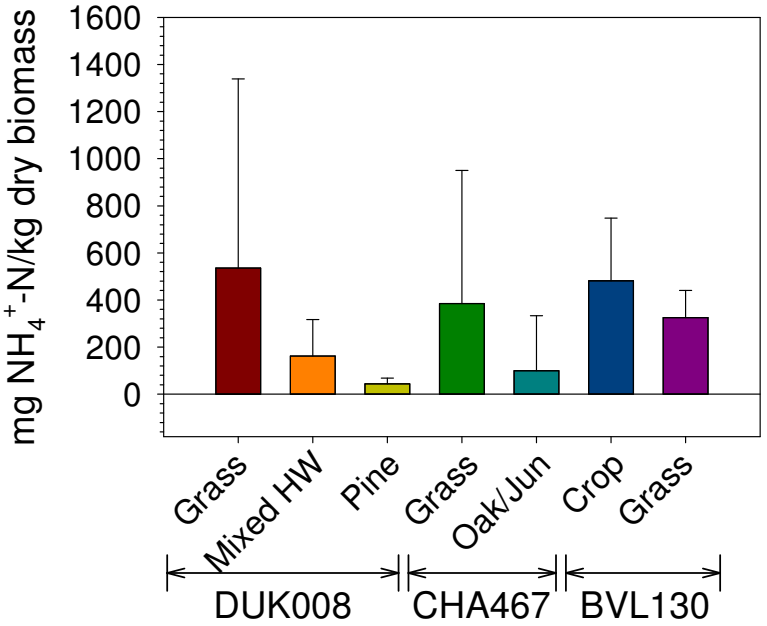
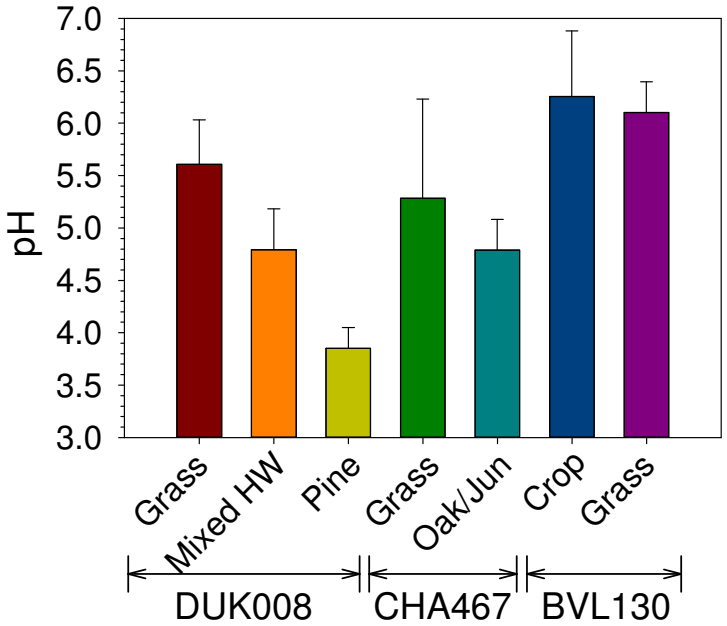


Vegetation NH_4^+



Vegetation pH

Measured versus modeled meteorology

- Network-wide implementation of the NH_3 flux model will require the use of modeled meteorology at most AMoN sites.
- An important aspect of Phase II is assessing the potential uncertainty associated with the use of modeled meteorology.
- Measured and modeled meteorology will be compared at the three pilot sites and differences in modeled fluxes using measured versus modeled meteorology will be assessed.

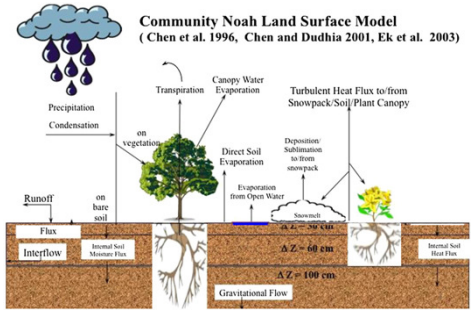
Modeled meteorology products

National Weather Service
Real-time mesoscale analysis (RTMA)
2.5 km grid
Hourly wind speed, RH, Air temp, precip, pressure

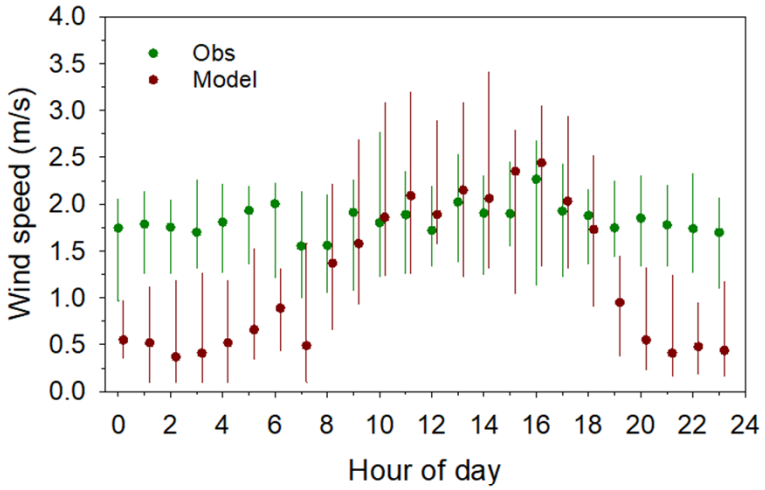
North American Land Data Assimilation System (NLDAS)
12 km grid
Hourly shortwave/longwave radiation

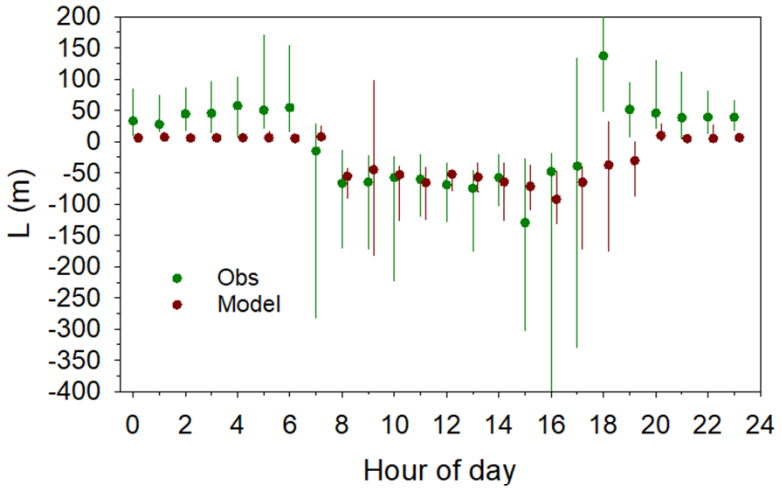
Noah land surface model

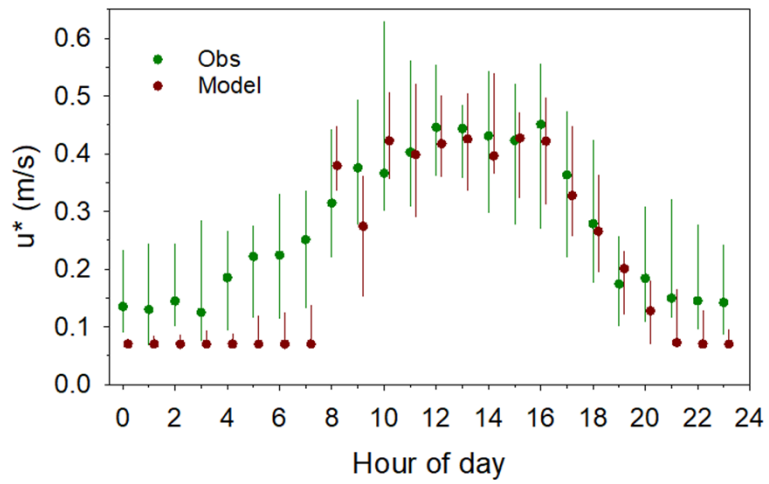
Hourly u_*, Obukhov length, soil temperature, soil moisture

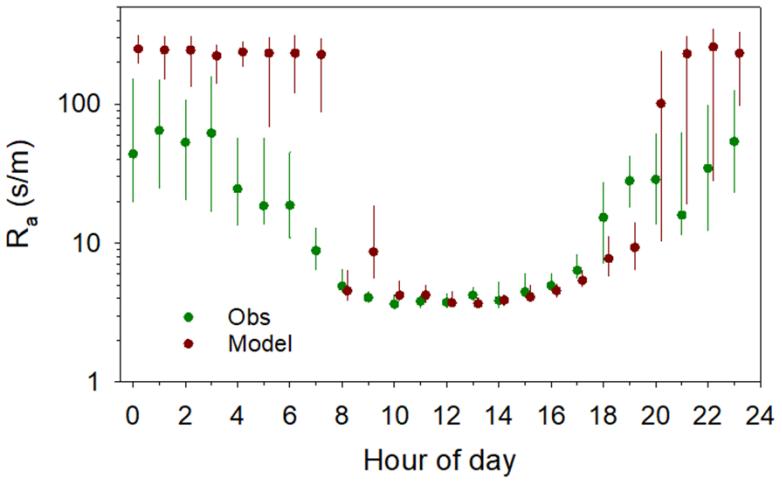


Measured versus modeled meteorology









Duke Forest Hardwood tower August 2017

- Lower model wind speed and u_* at night.
- Causes higher model aerodynamic resistance (R_a) at night (lower deposition).
- Good agreement during the day.

Next steps

- Completion of measured micrometeorological datasets fall 2019
- Begin bidirectional model evaluation at pilot sites fall 2019
- Report describing Phase I data collection activities spring 2020
- Assembly of datasets for application of model across AMoN network spring 2020
- Implementation of model across AMoN network winter 2020/21

Questions?

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