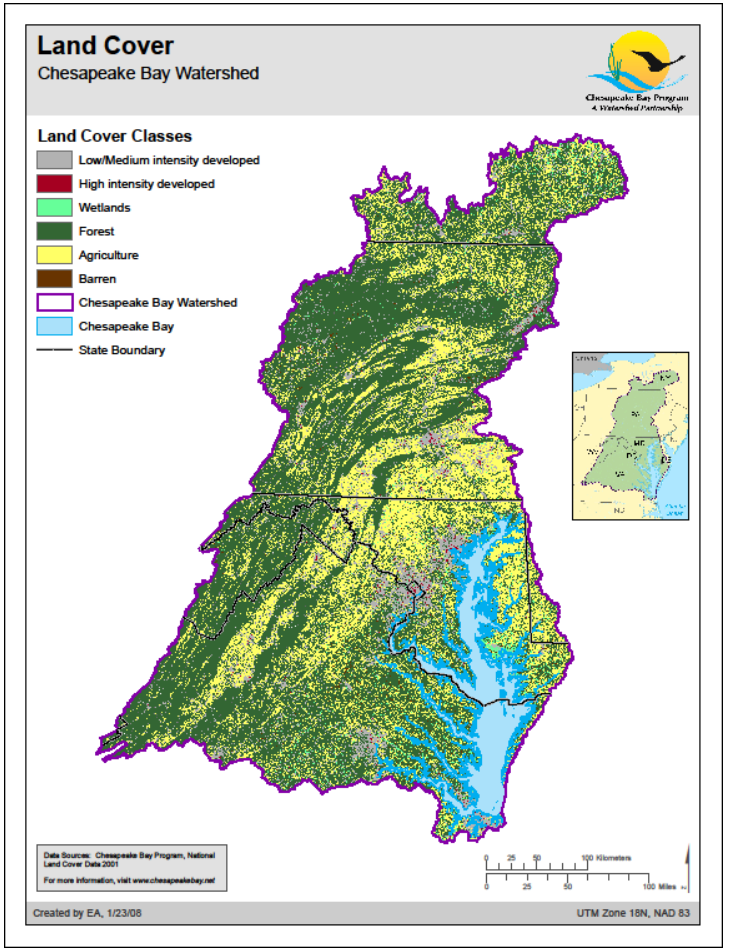
Sources of Atmospheric Nitrogen to the Upper Susquehanna River Watershed with Special Reference to Ammonia

Tom Butler, Roxanne Marino, Robert Howarth



Outline:

1) Using passive samplers for measuring NH3 concentrations.

2) Estimating NH3 deposition.

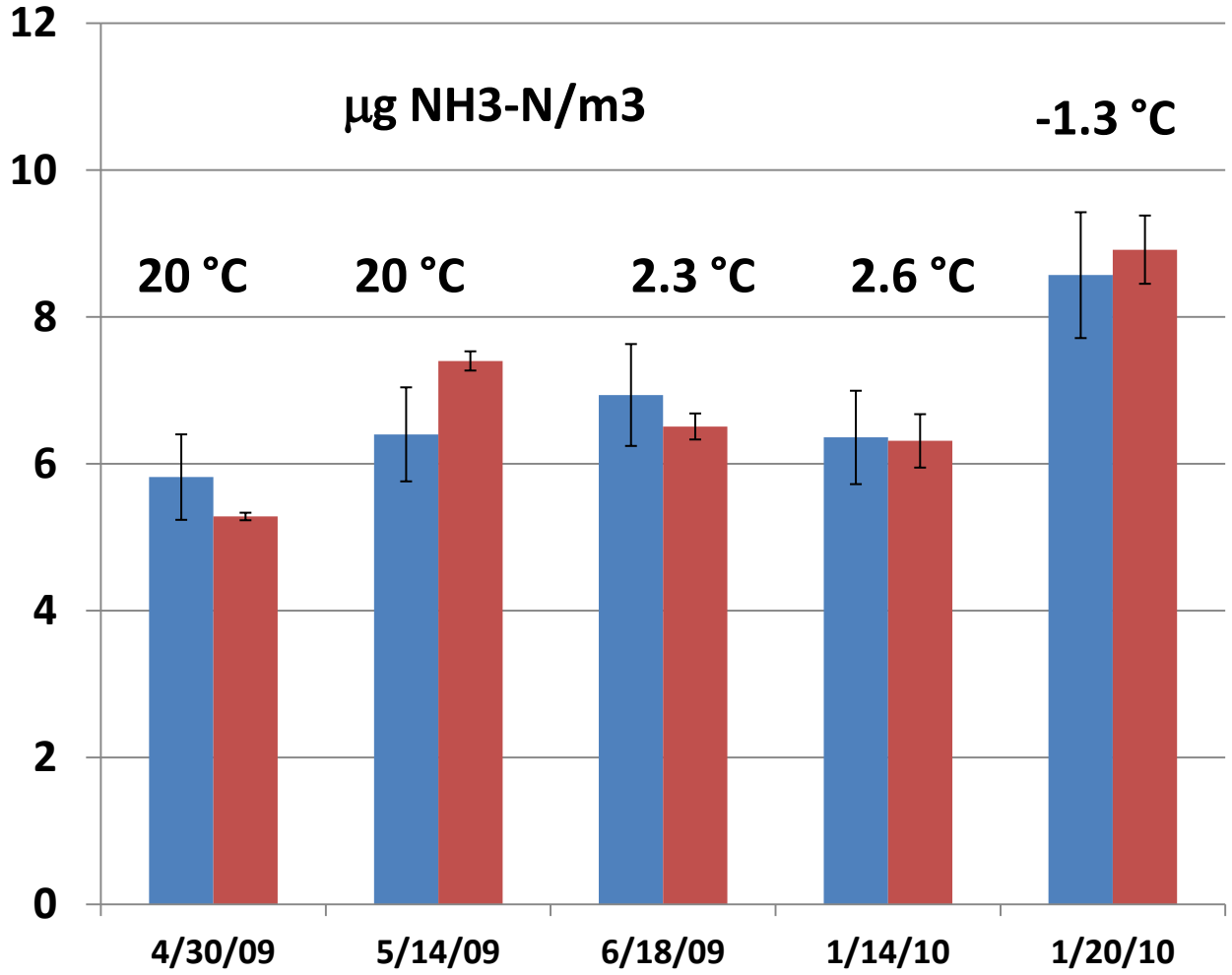
3) Relative Importance of NH3 to other N deposition products.

4) Some comparison with CMAQ estimates of N deposition

5) How important is N deposition compared to other N inputs to the Upper Susquehanna Watershed

Do NH3 Passives Work?

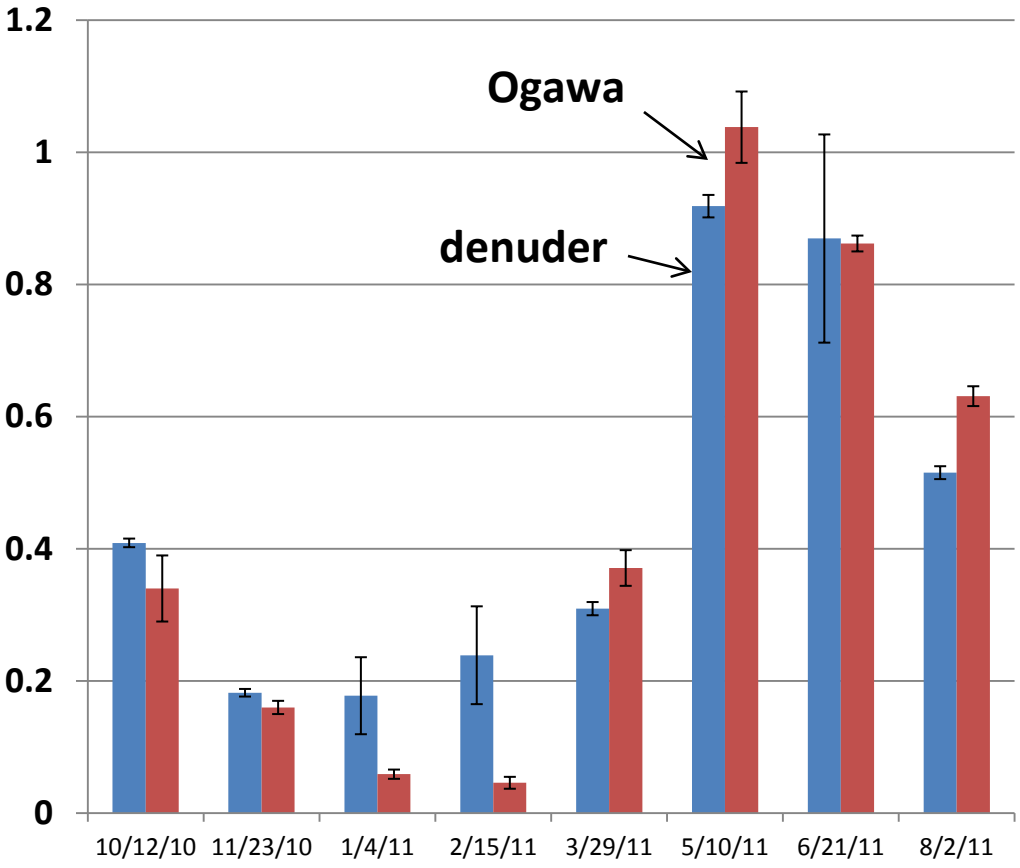
Ogawa Chamber Study

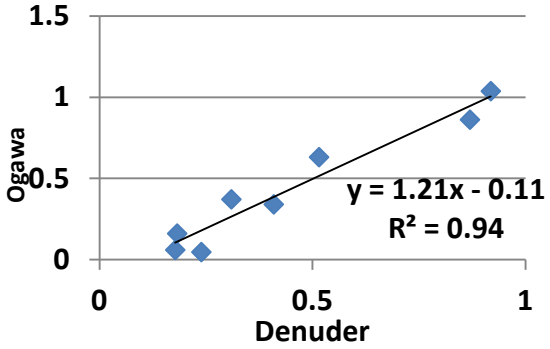


7.2% difference
(mean absolute % difference)
(not significant)

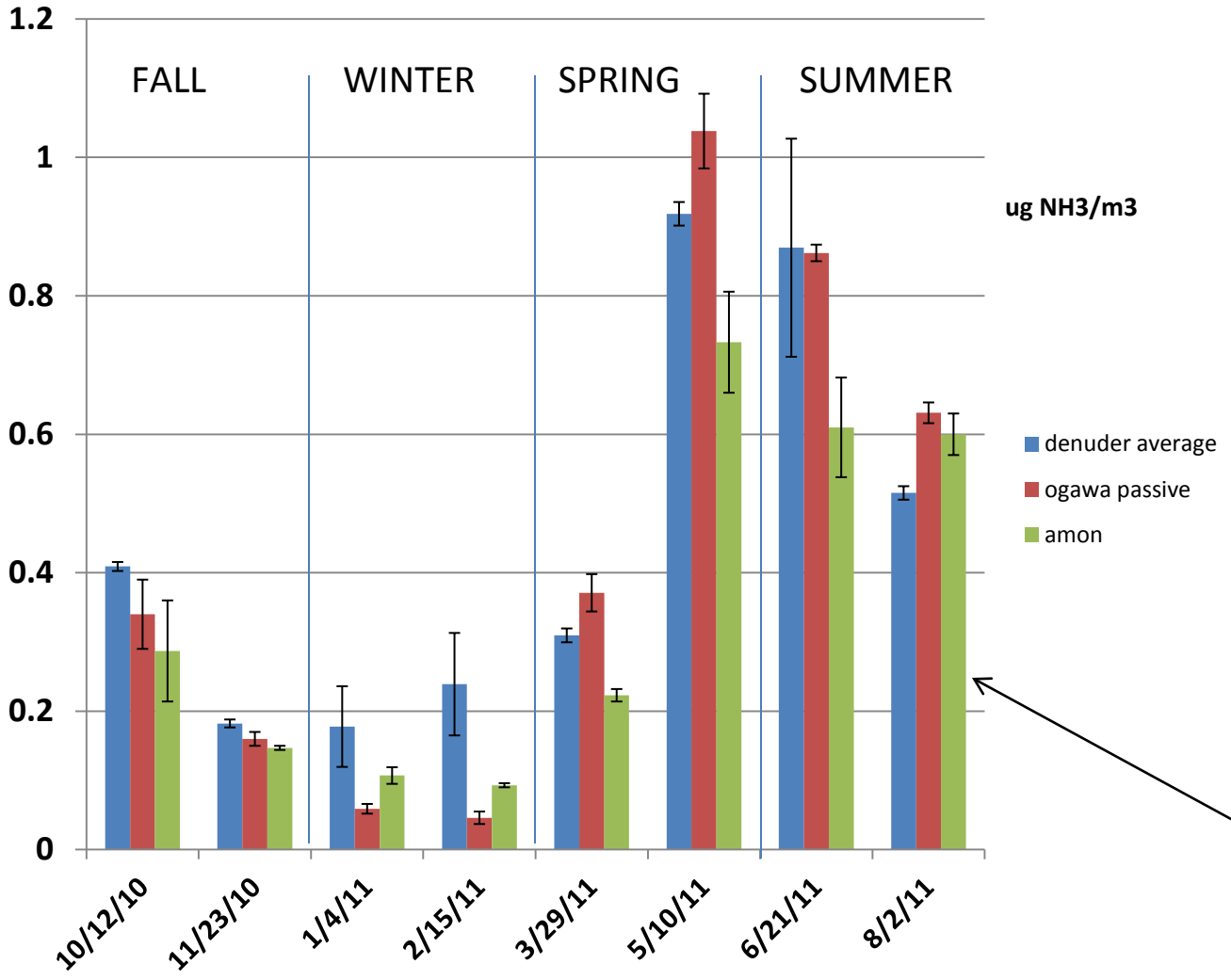
Do Passives Work?

Field Study Comparison of Weekly Denuders with Bi-weekly Ogawas





Do Passives Work?
Field Study Comparison of Weekly Denuders with Bi-weekly Ogawas and NADP/AMON Radiellos

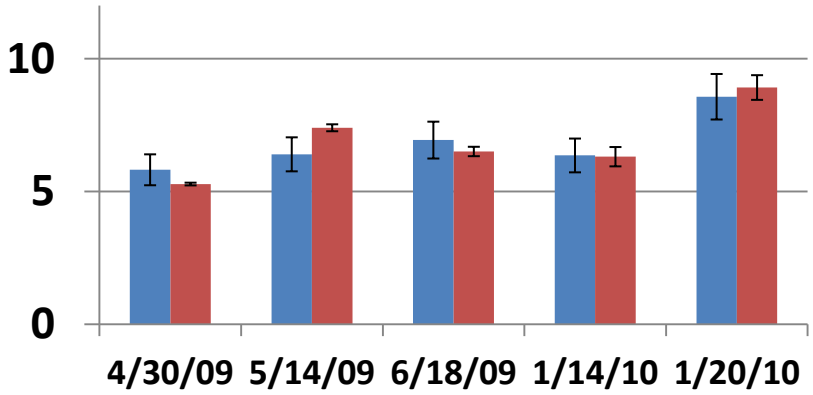


Mean absolute difference for Ogawa <0.1 μg NH3/m3

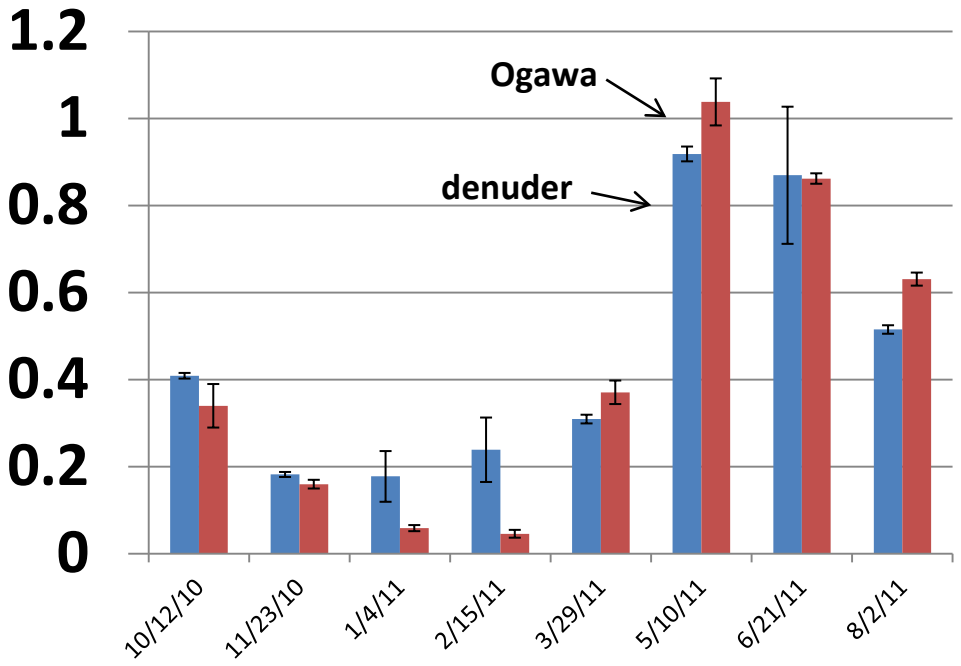
Radiello Passive Sampler

Do NH3 Passives Work? YES

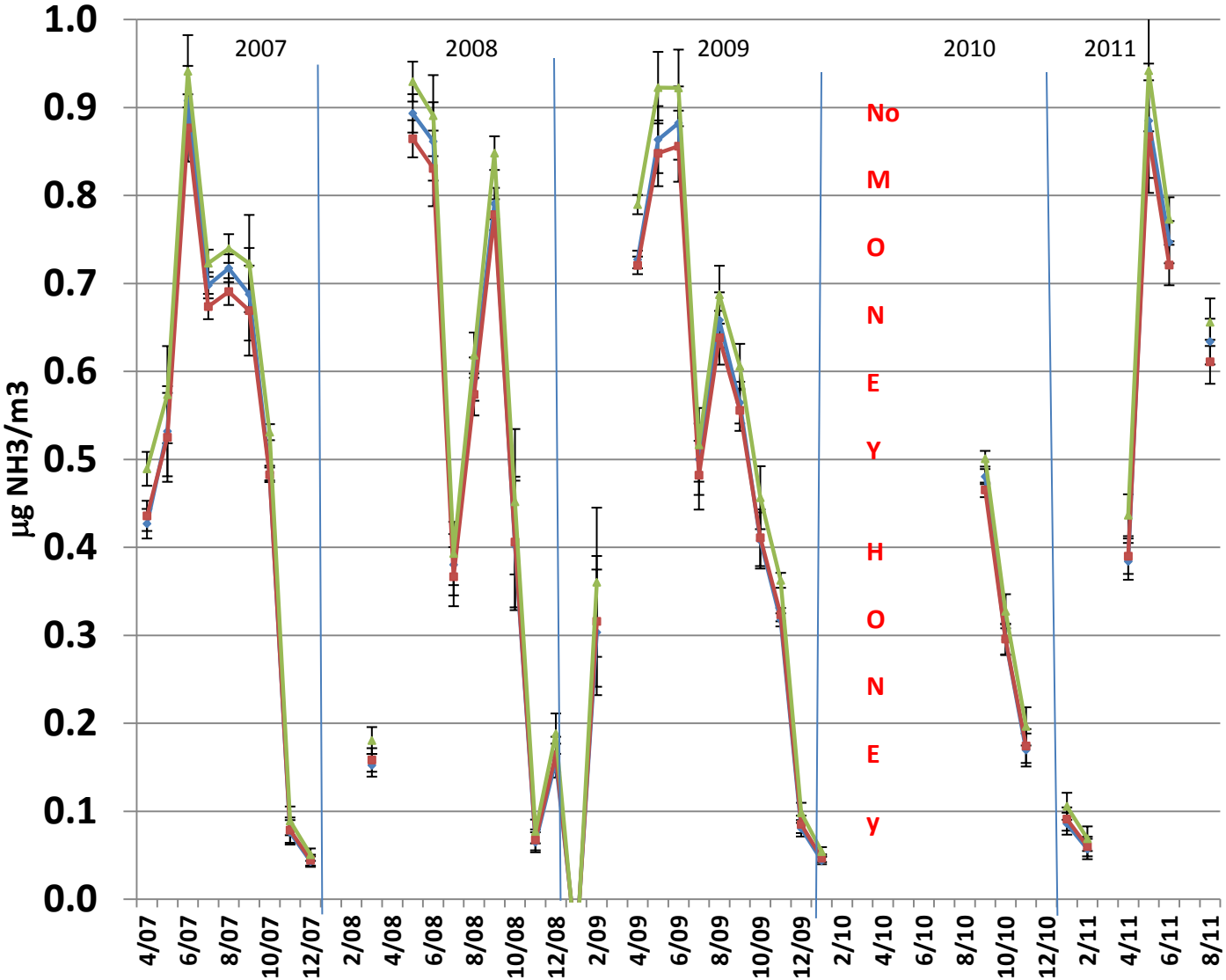
Chamber Study



Field Study with Denuders



CTH NH3 Concentrations 2007-2011 (µg NH3/m3)



annual mean= 0.44±0.02

Spring= 0.57±0.02

Summer= 0.69±0.03

Fall= 0.40±0.02

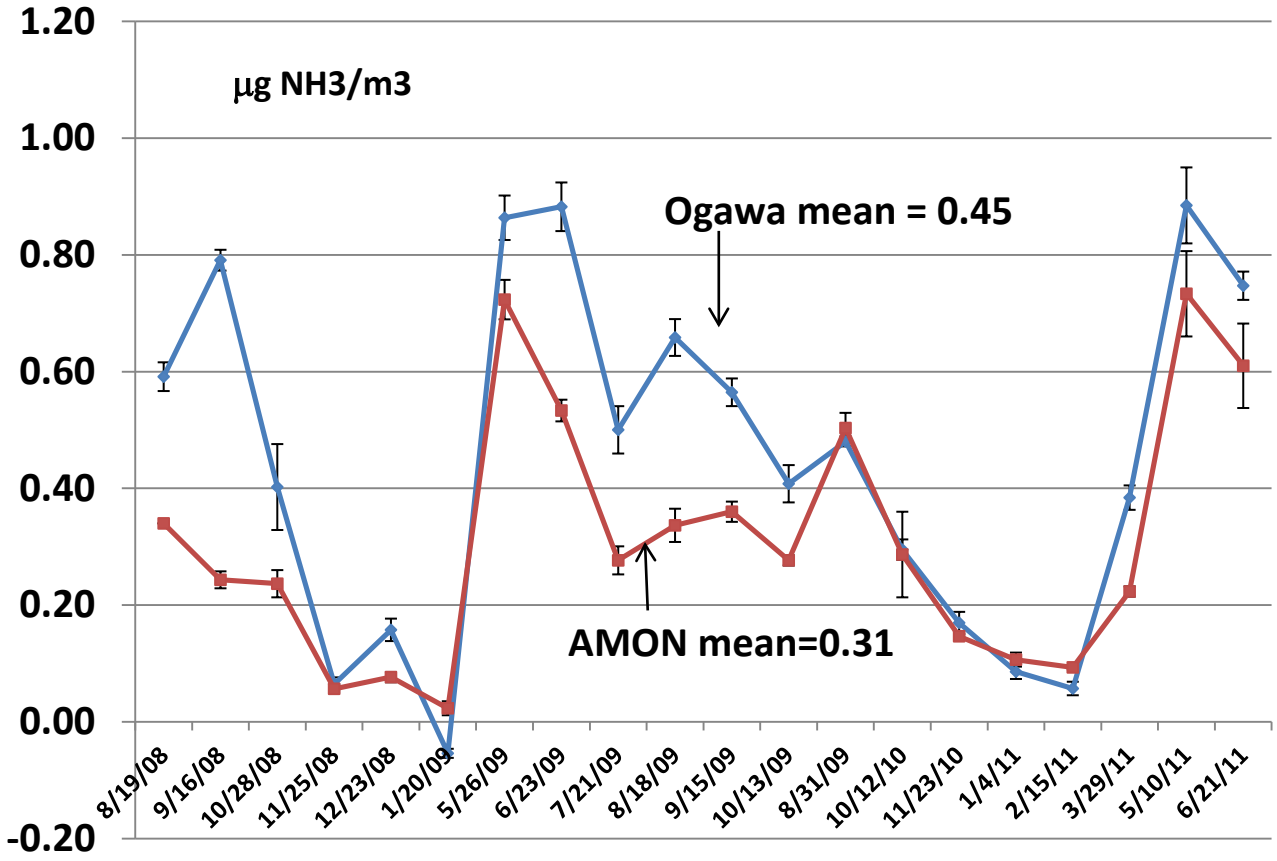
Winter= 0.09±0.02

Roadman
Ogawa
Temp Sens

Using 3 different Transfer Rates

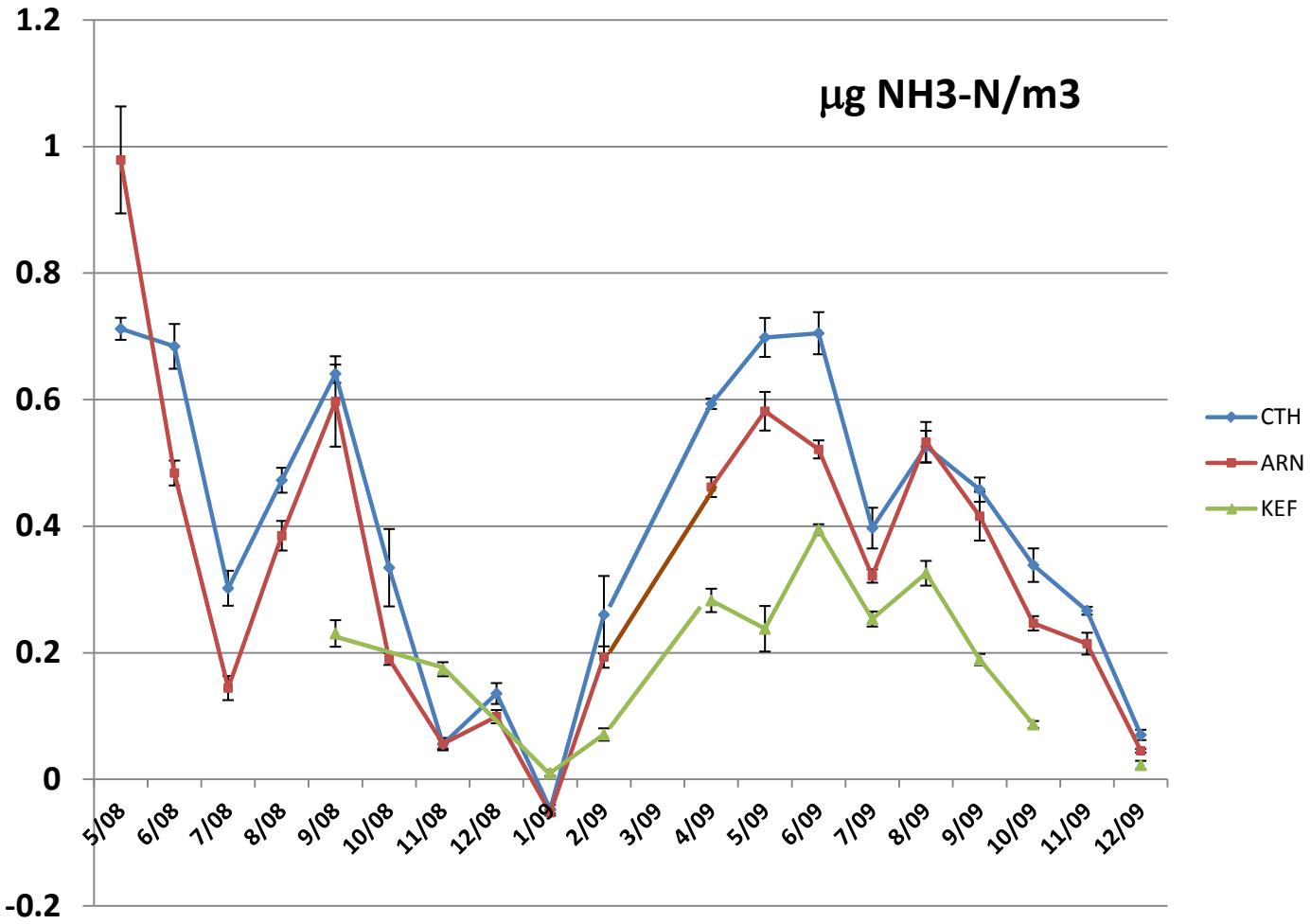
Ogawa vs AMON NH3 Concentrations

Ogawa are Field Blank corrected, AMON are not

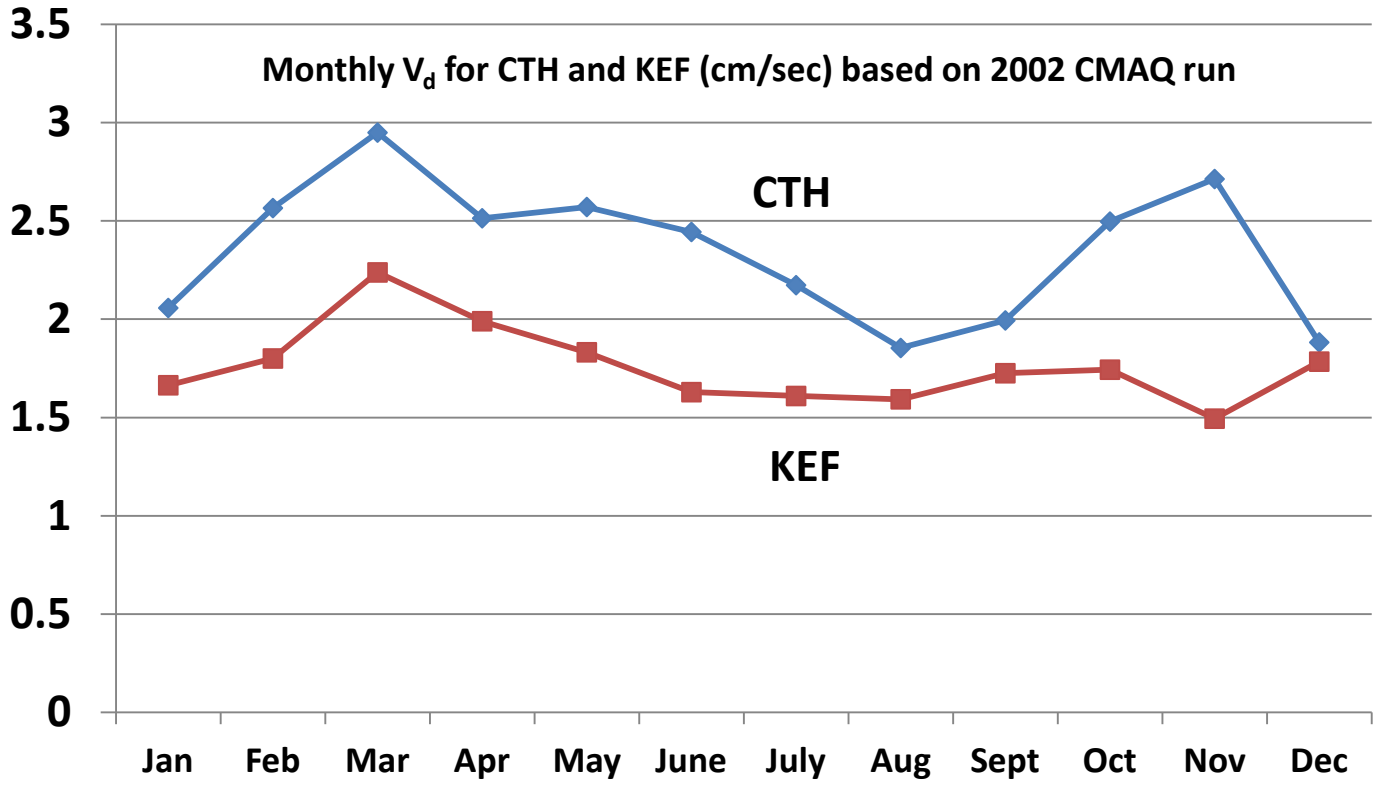


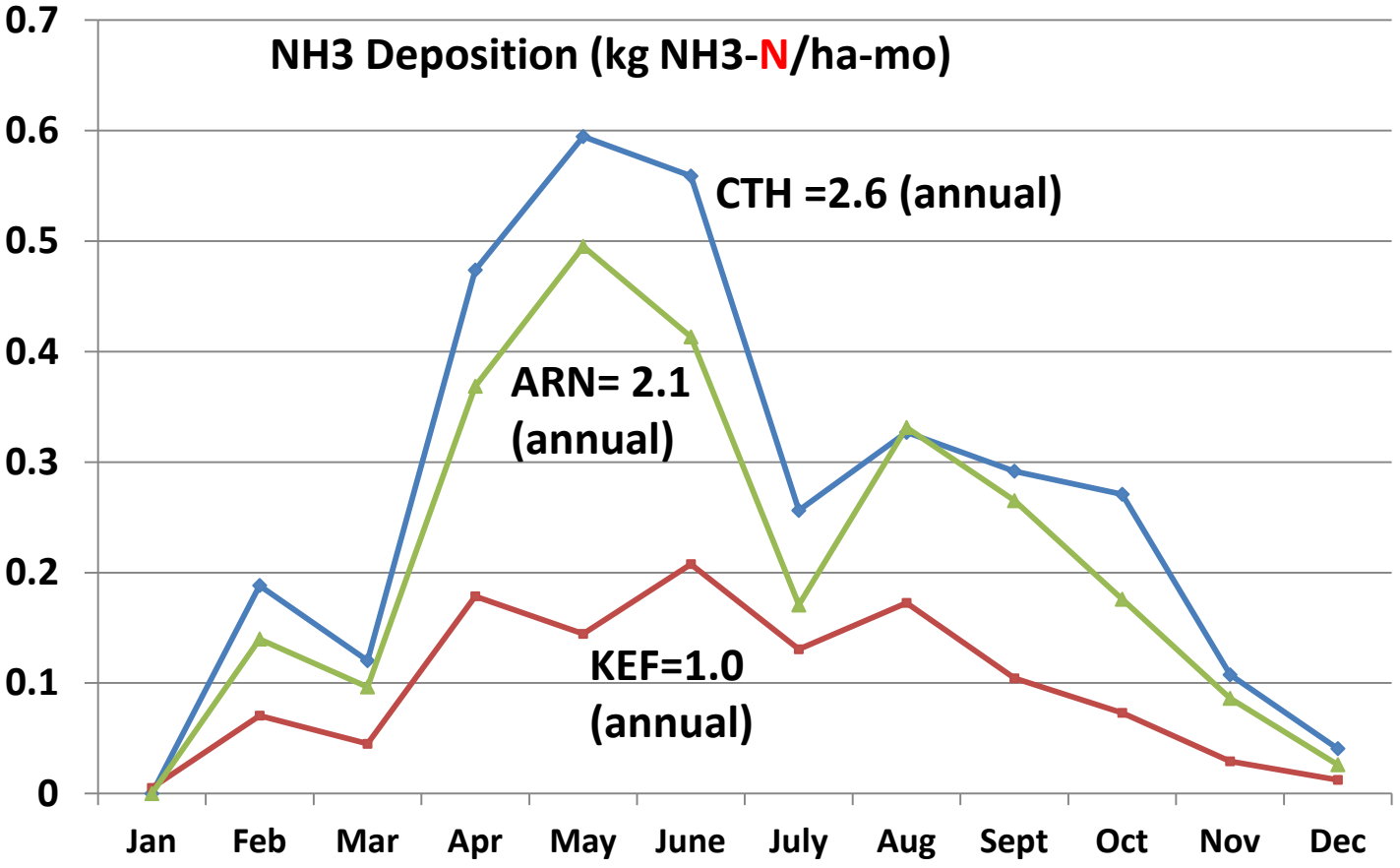

CTH
HFD
ARN
KEF
Susquehanna
River
Watershed

NH3 Concentration - Forested Sites

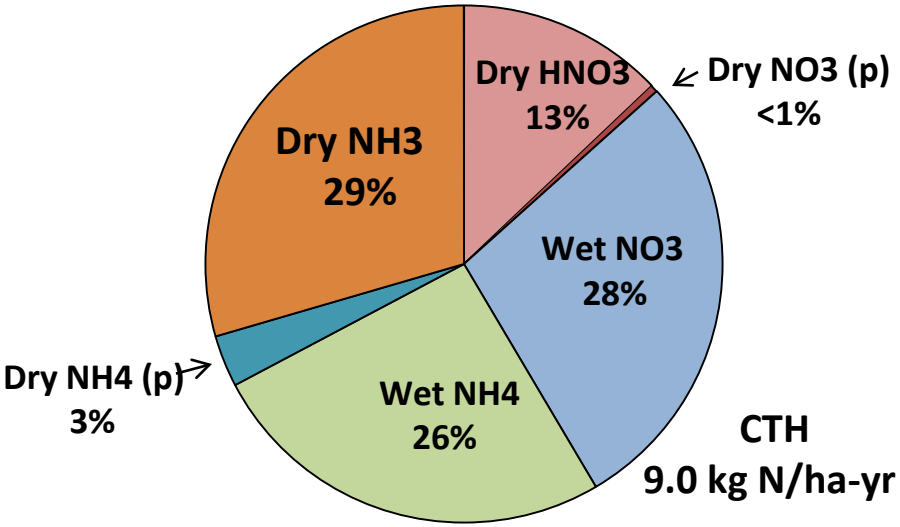


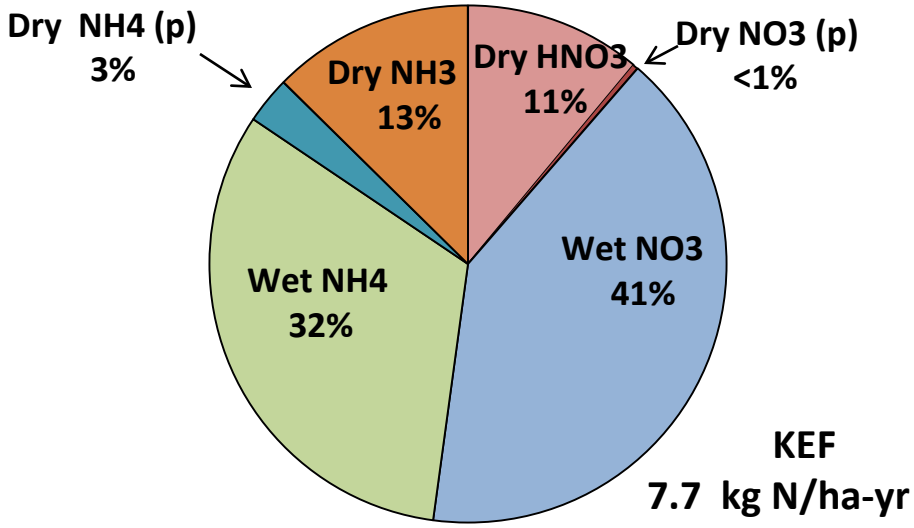
The Leap from Concentration to Deposition

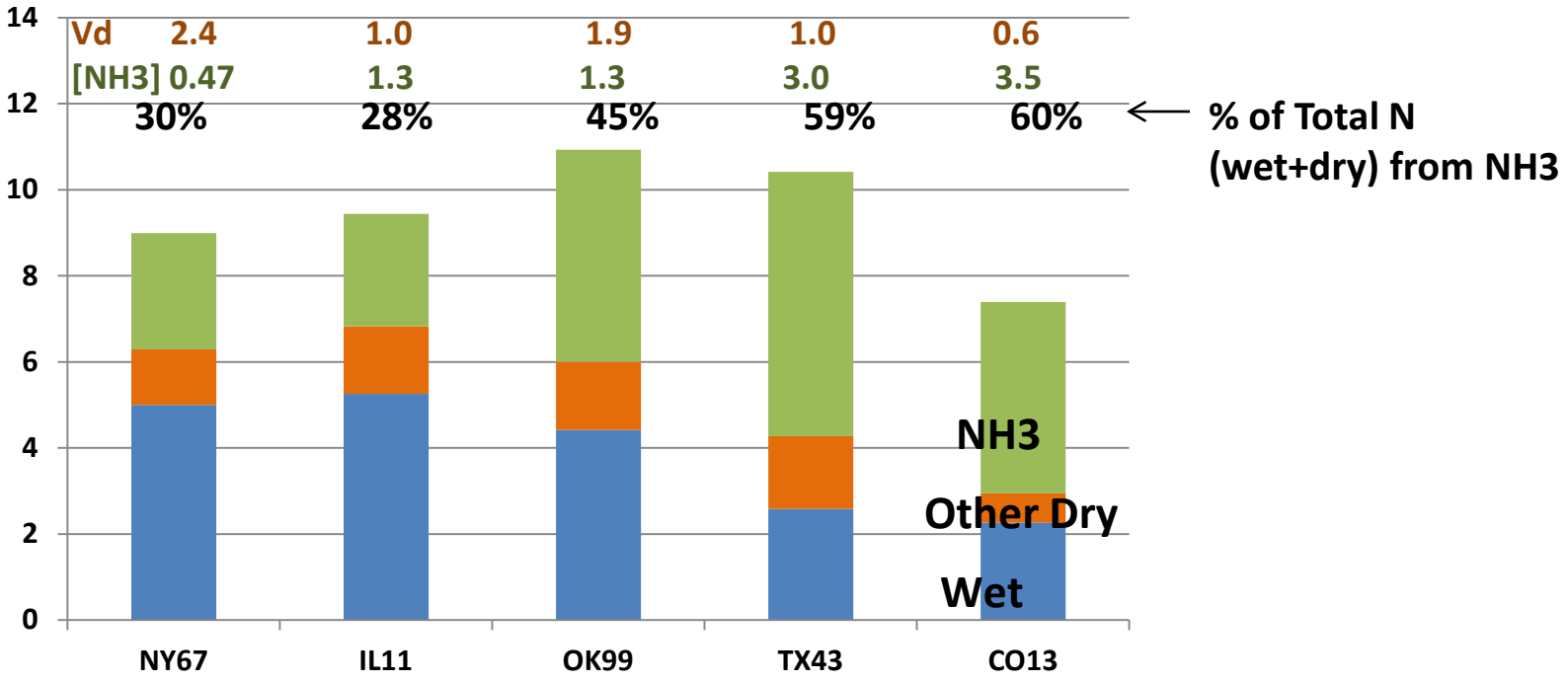

Monthly V_d for CTH and KEF (cm/sec) based on 2002 CMAQ run
CTH
KEF
3.5
3
2.5
2
1.5
1
0.5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec


NH3 Deposition (kg NH3-N/ha-mo)
CTH =2.6 (annual)
ARN= 2.1 (annual)
KEF=1.0 (annual)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

How does NH3 deposition compare with other N wet & dry deposition species measured by CASTNET?





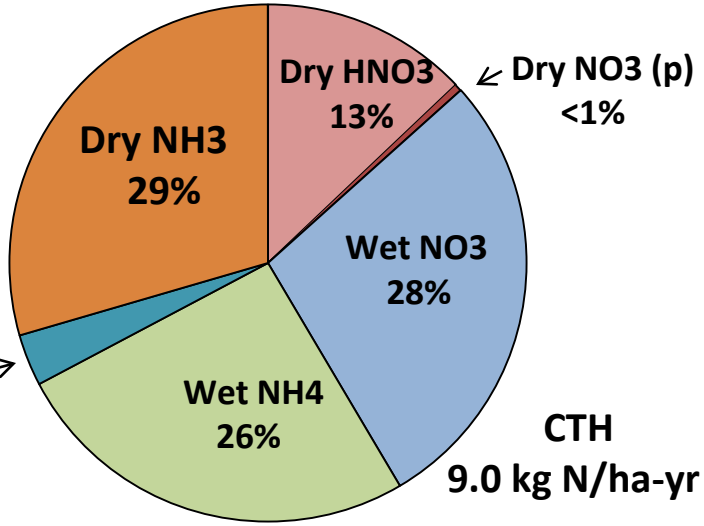


Using a Deposition Velocity (Vd) may give us an <u>UPPER ESTIMATE</u> for NH3 Deposition.

But what happens to deposition of NH3 when we introduce a bi-directional flux…..?

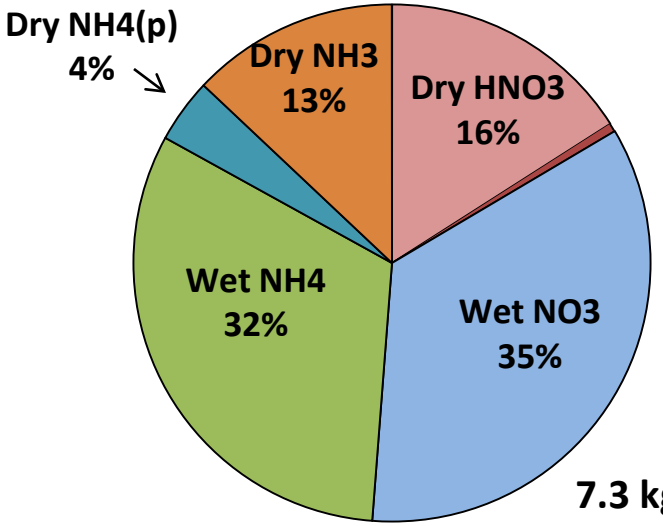
Vd for NH3

CTH



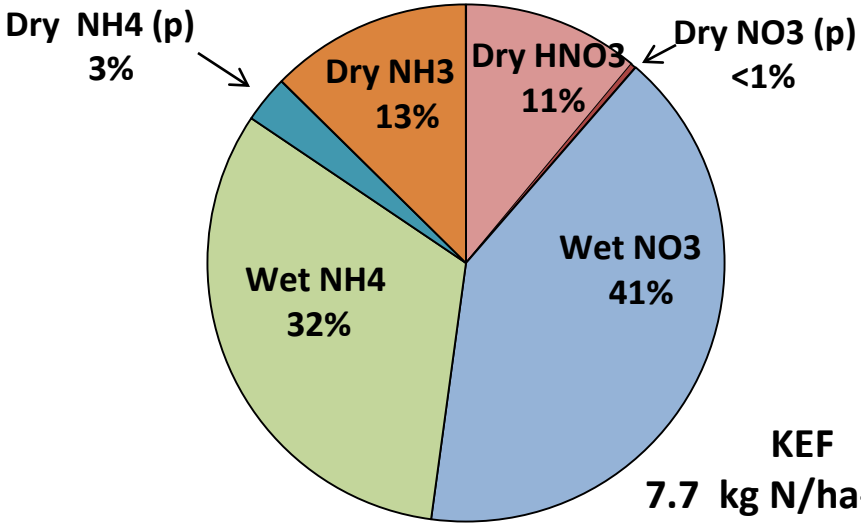
CTH
9.0 kg N/ha-yr

Bi-Directional Flux for NH3*

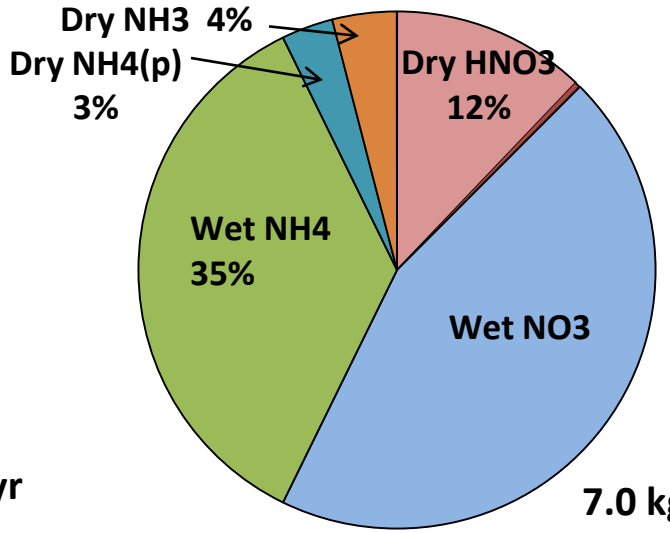


65% Reduction

CTH
7.3 kg N/ha-yr



KEF
7.7 kg N/ha-yr

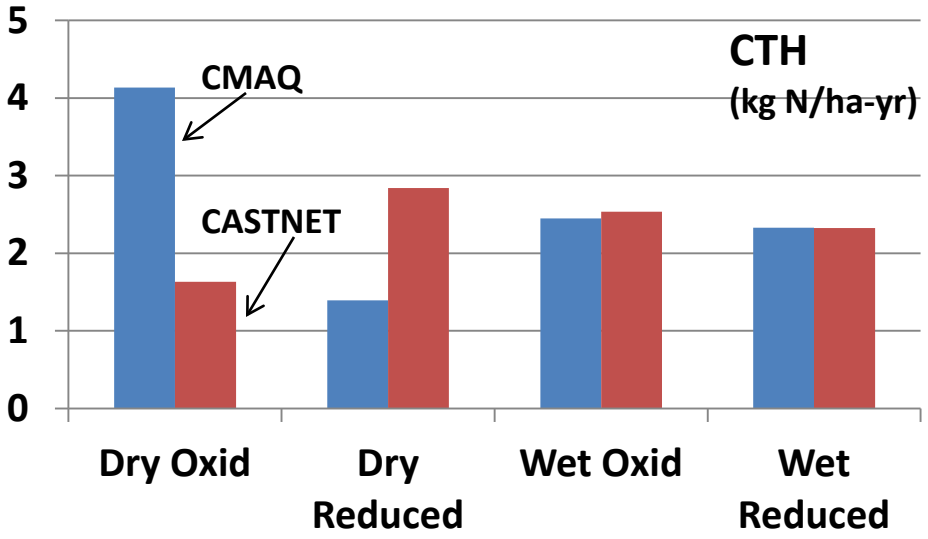


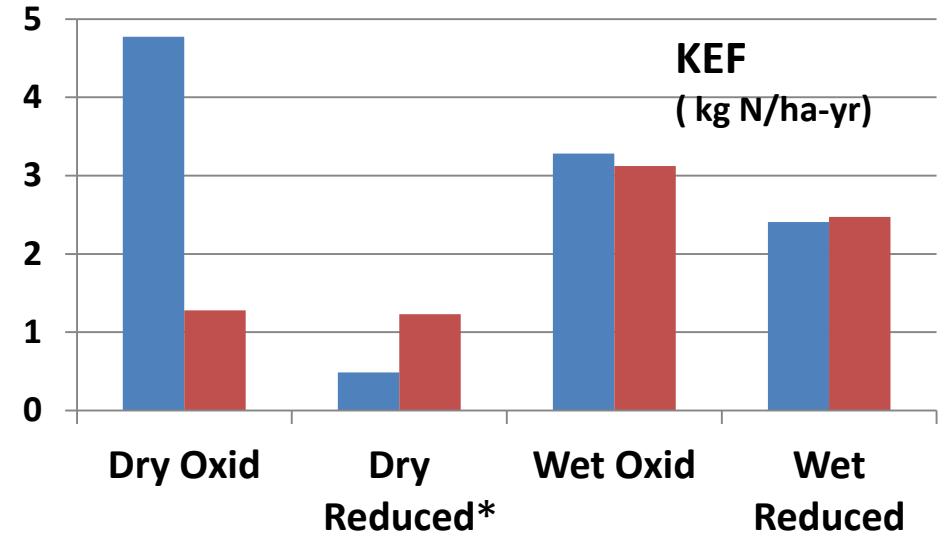
70% Reduction

KEF
7.0 kg N/ha-yr

*Based on apportionment of CMAQ NH3 flux comparing 2002 Vd model to Bi-di model

Comparing CASTNET+ estimates with CMAQ estimates of N deposition

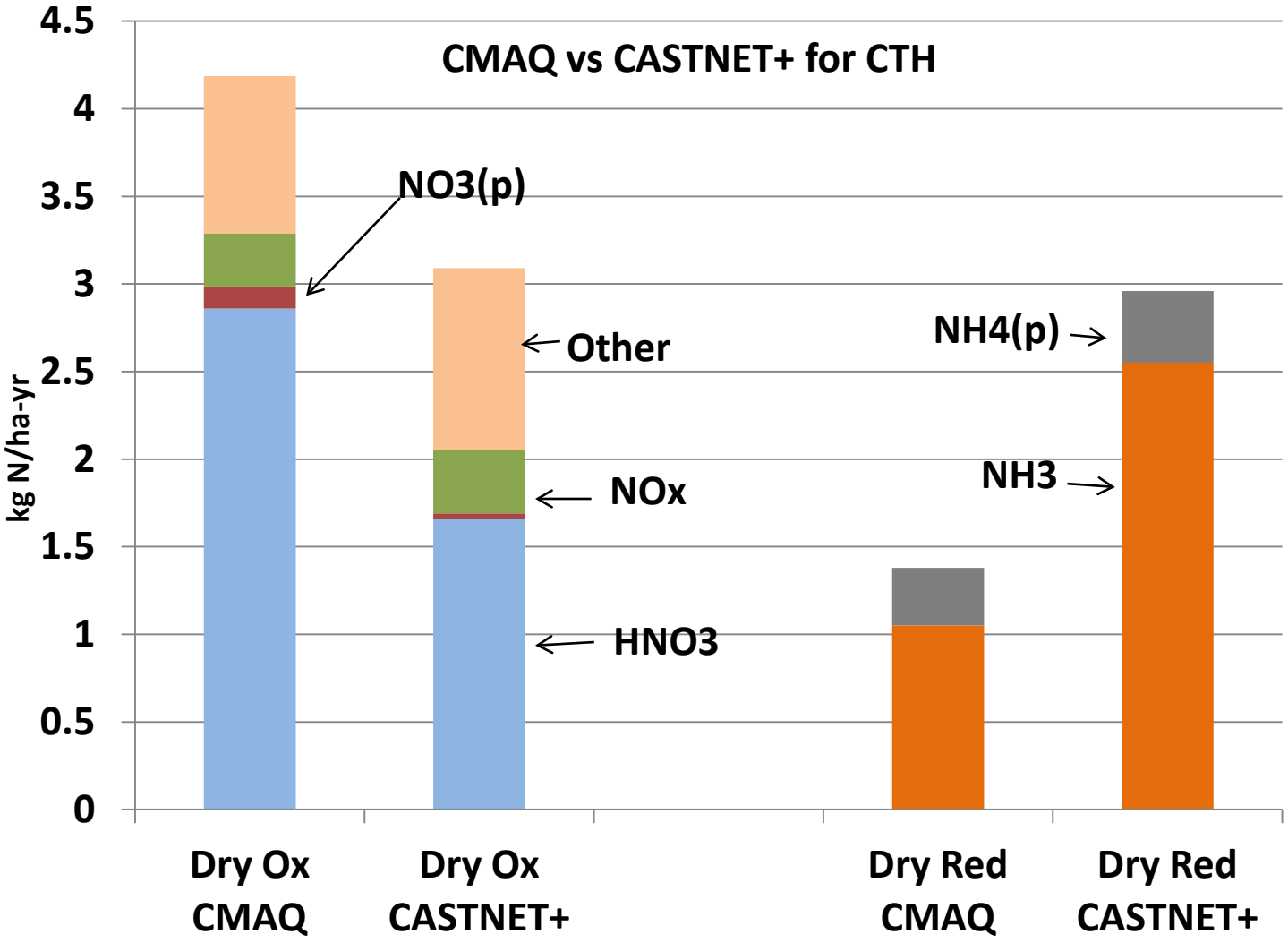


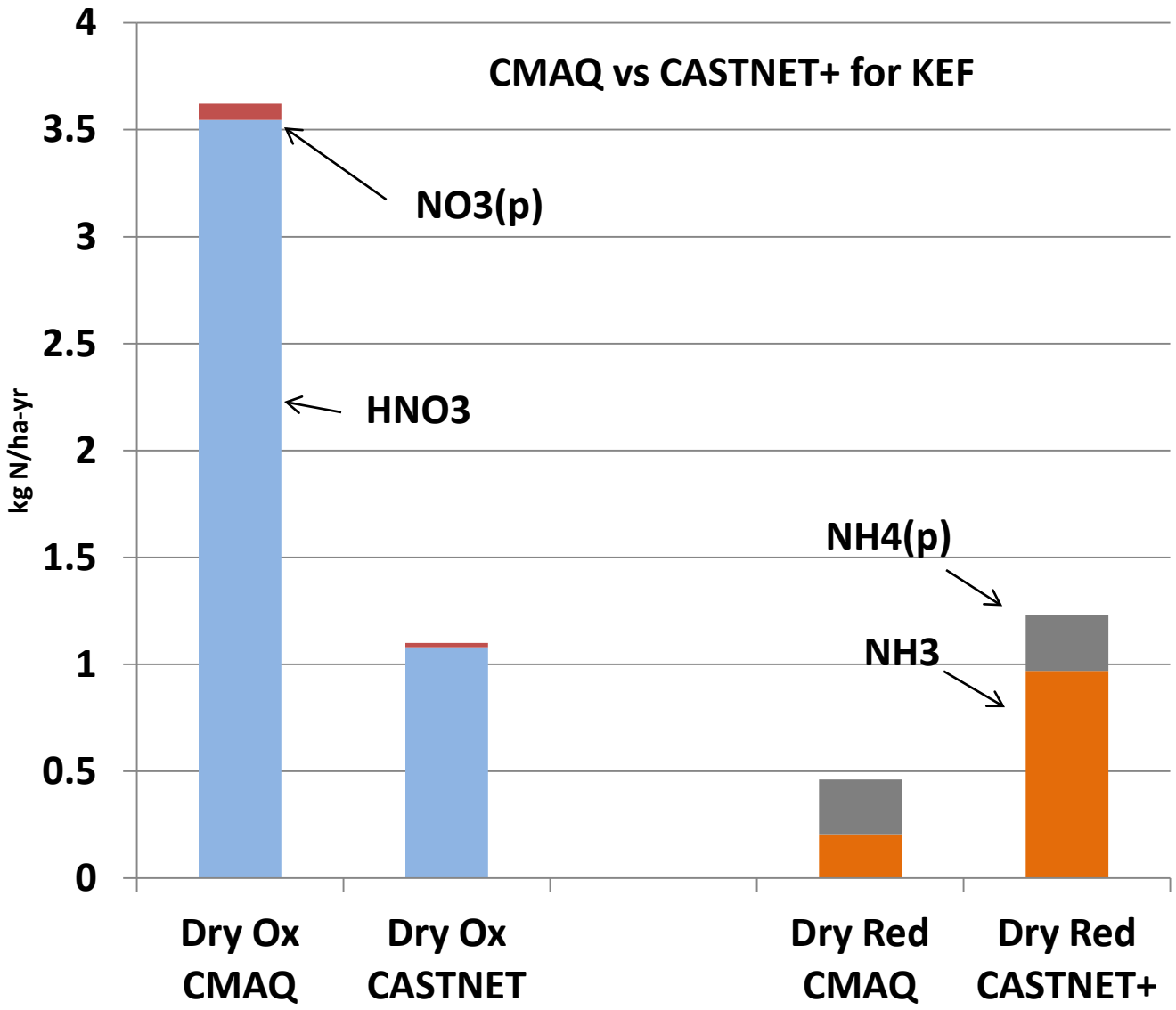


But comparing Dry Oxidized not a fair comparison

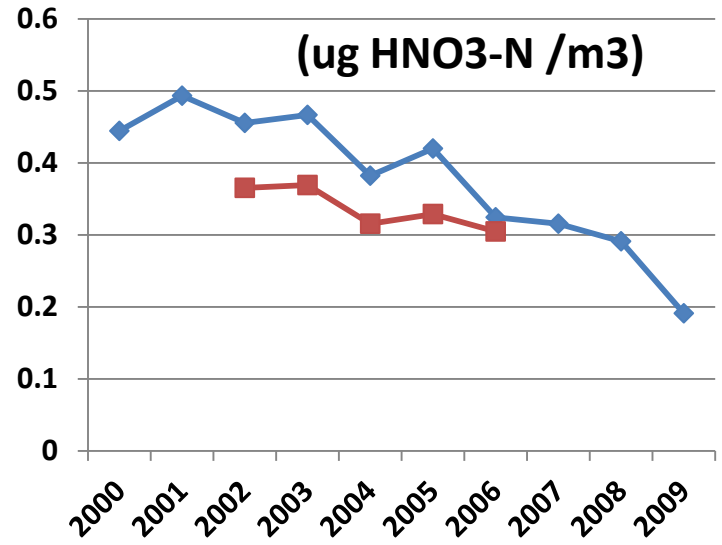
*We are using Vd for reduced N

Dry Deposition

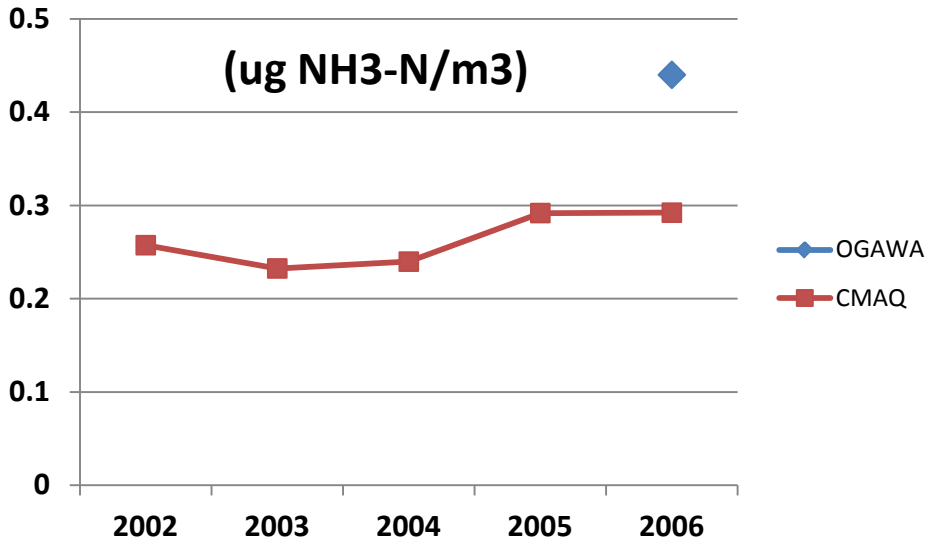



CMAQ vs CASTNET+ for KEF
kg N/ha-yr
4
3.5
3
2.5
2
1.5
1
0.5
0
NO3(p)
HNO3
NH4(p)
NH3
Dry Ox CMAQ
Dry Ox CASTNET
Dry Red CMAQ
Dry Red CASTNET+

HNO3 Concentration



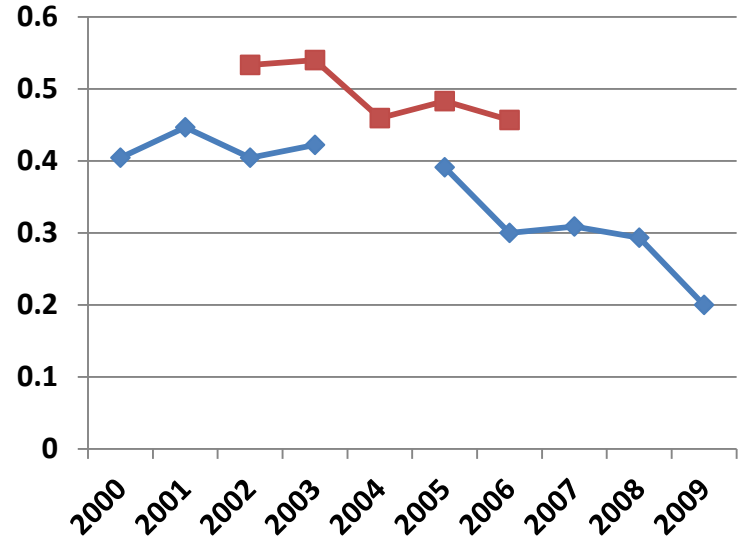
NH3 Concentration



CTH

CASTNET

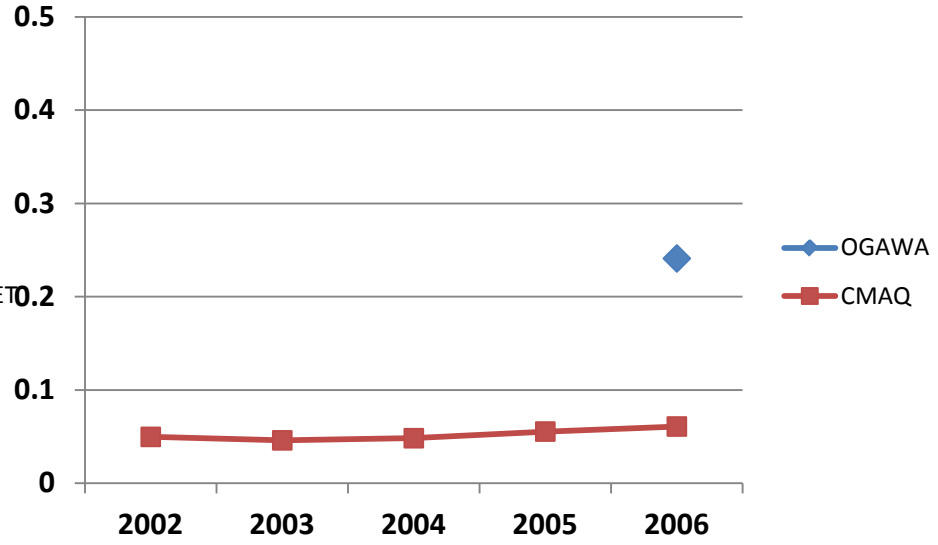
CMAQ



KEF

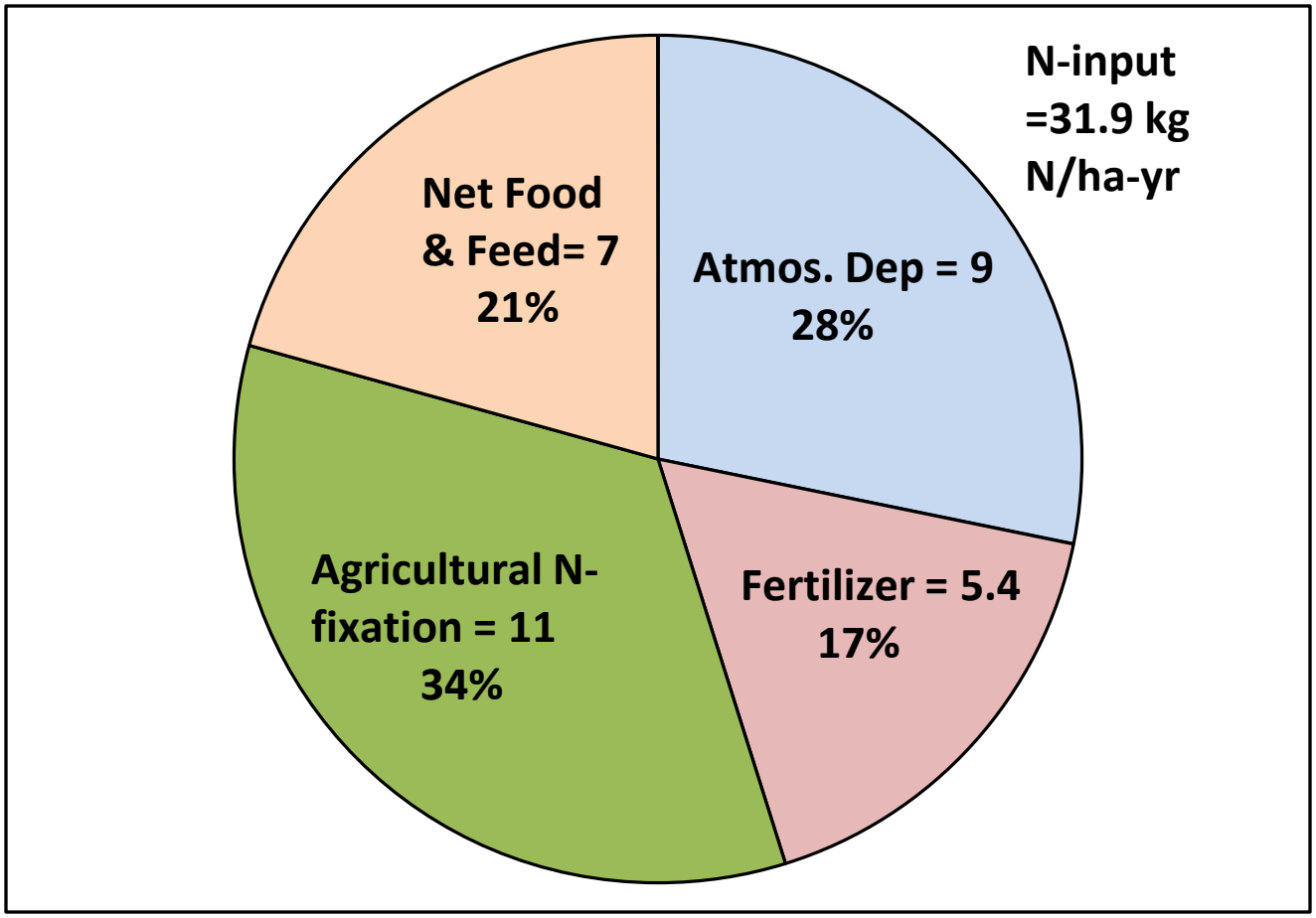
CASTNET

CMAQ

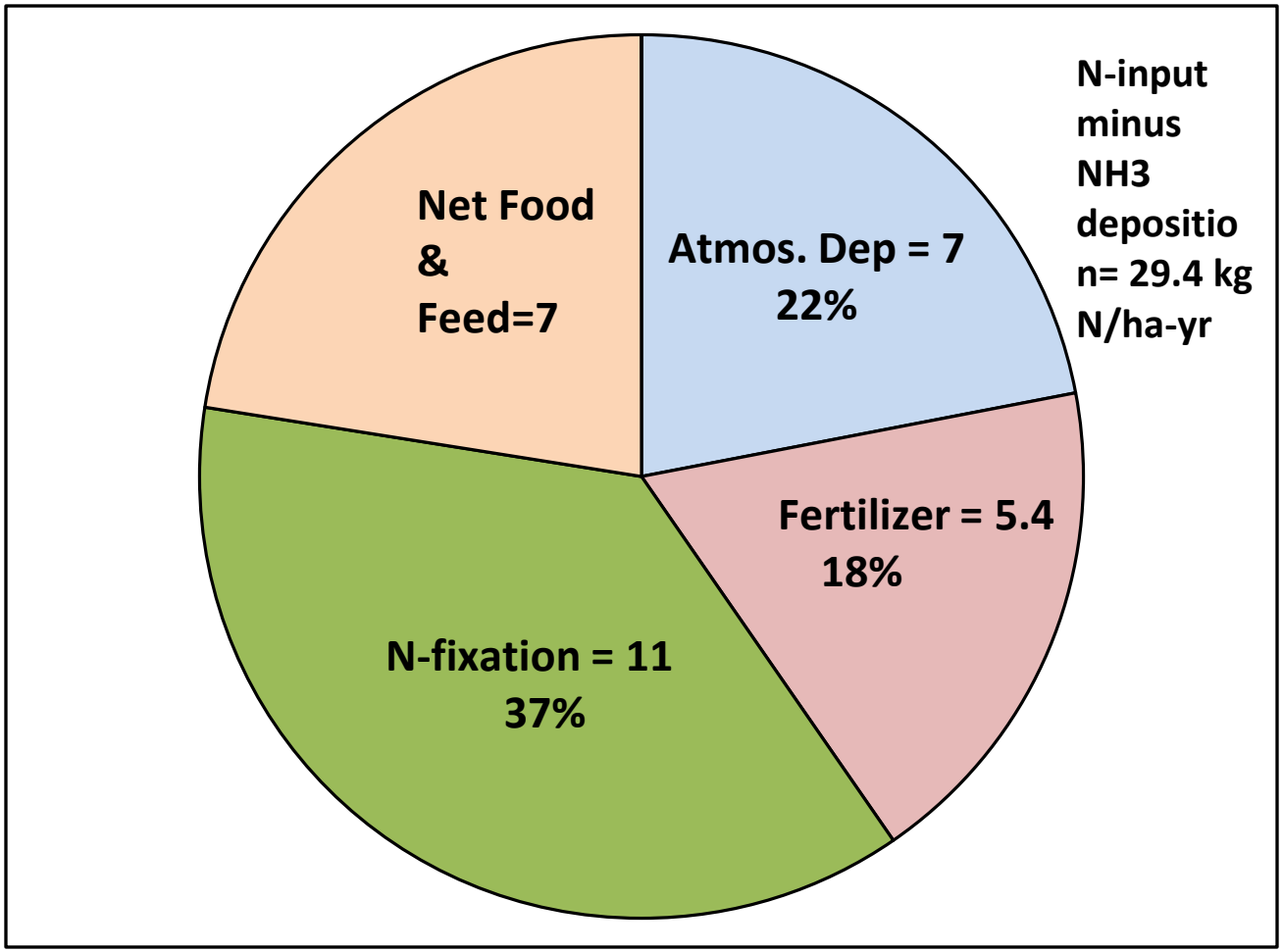


What about other Nitrogen Inputs to the Upper Susquehanna Watershed

Other Major N Sources:
Fertilizer, Net Food & Feed, Agricultural N-fixation



If all NH3 is derived from local sources in the watershed…….



Another activity that will affect the Upper Susquehanna watershed: Massive industrialization of the landscape from High Volume Hydrofracking for Natural Gas

Don’t believe the gas companies.
This is NOT CLEAN ENERGY.

Marcellus Well Being "Finished" Outside Dimock, PA, June 2011

You can't see it with the naked eye, but infrared shows huge methane release

If this is clean energy why are these guys exempt from the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act and the Superfund Act???

Photo and FLIR Methane-Tuned Video Courtesy Frank Finan

Conclusions:

Passive Ogawa NH3 samplers work well.

NH3 deposition is not nailed down yet. For CTH we estimate 1 to 2.5 kg NH3-N/ha). For KEF, 0.3 to 1.0 kg NH3-N/ha.

CMAQ > CASTNET for HNO3 deposition, probably due to different estimates of canopy resistance.

Atmospheric N measured by CASTNET is 20% to 30% of the total N coming into the watershed from anthropogenic sources.

Air, water and landscape in the Susquehanna Watershed will be significantly impacted by Natural Gas industrialization… It's just starting.

END