

# **Estimated Atmospheric Deposition Inputs for 2019 Climate Assessment**

Modeling Workgroup Quarterly Meeting – October 2019

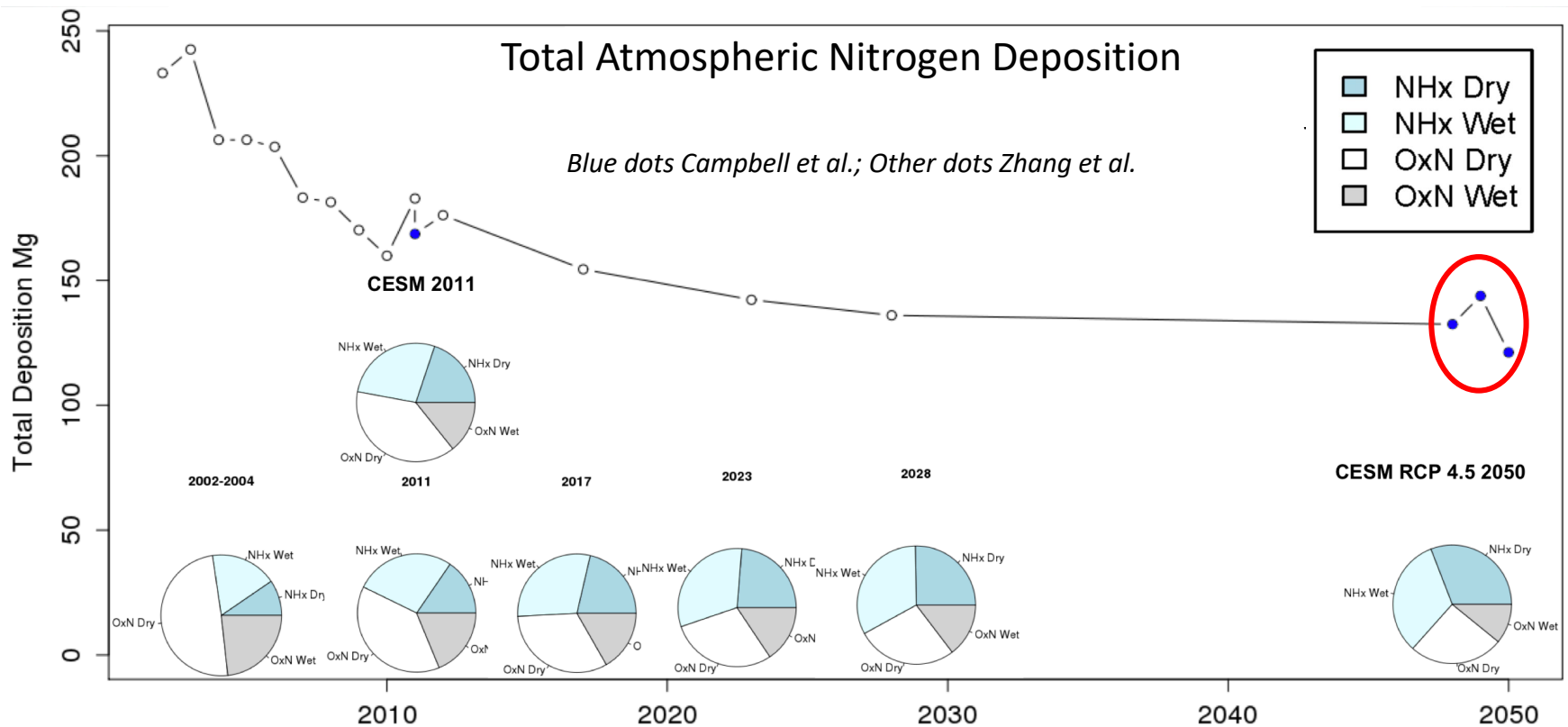
Gopal Bhatt, Jesse Bash, Breck Sullivan, Lewis  
Linker, and Modeling Team

- Analyze multiple datasets to determine how atmospheric N-deposition varies with rainfall volume.
  - Physics-based model – Community Multistate Air Quality Model's (CMAQ's) 2050 atmospheric N-deposition scenarios.
  - Statistical model – Phase 6 Chesapeake Bay Program Airshed Model.
  - Observations based – National Atmospheric Deposition Program / National Trend Network (NADP/NTN) precipitation chemistry data.
- Develop relationships that can be then applied for adjusting existing atmospheric N-deposition data to account for changes in rainfall (climate change scenarios).
- *Wet depositions of nitrate and ammonium showed a positive linear relationship, whereas dry depositions did not show any sensitivity to changes in rainfall.*
- *Modeling Workgroup's approval of Section 3.1 will be requested.*

# Trends in CMAQ Atmospheric N-Deposition Estimates

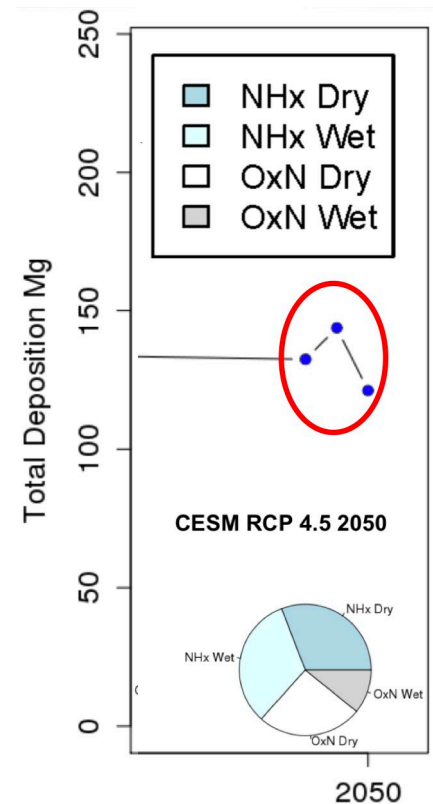
## Climate + Emissions Changes lead to:

- Overall decreasing trend in Total N deposition to the Chesapeake Bay Watershed.
- Decreases in the proportion of dry and wet deposition of Oxidized N (NO<sub>x</sub>).
- Increases in the proportion of dry and wet deposition of Reduced N (NH<sub>x</sub>).
- *The climate influence on atmospheric nitrogen deposition is much smaller than the reduction due to emissions reductions.*

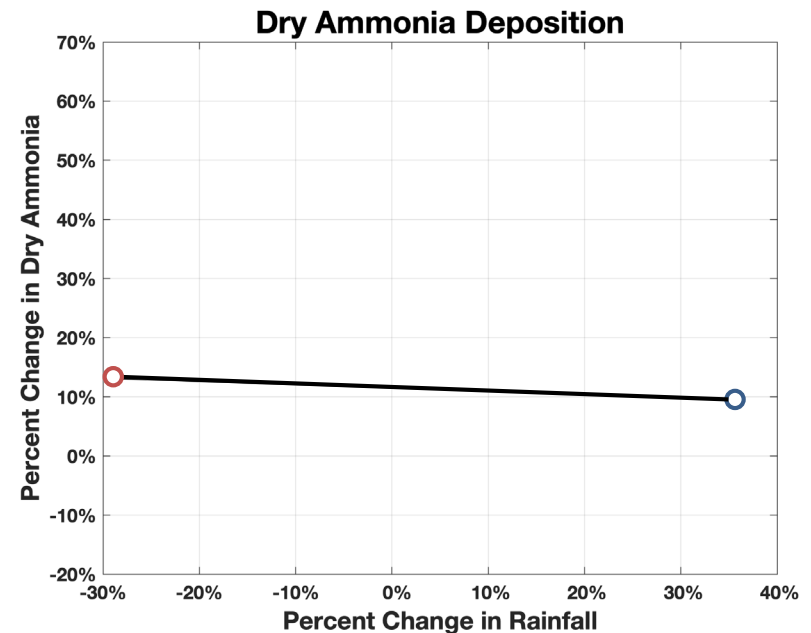
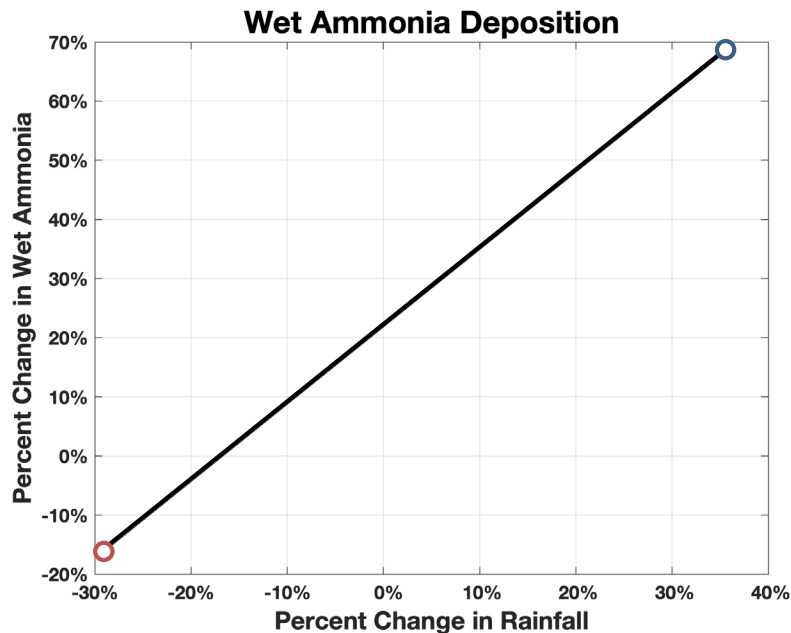
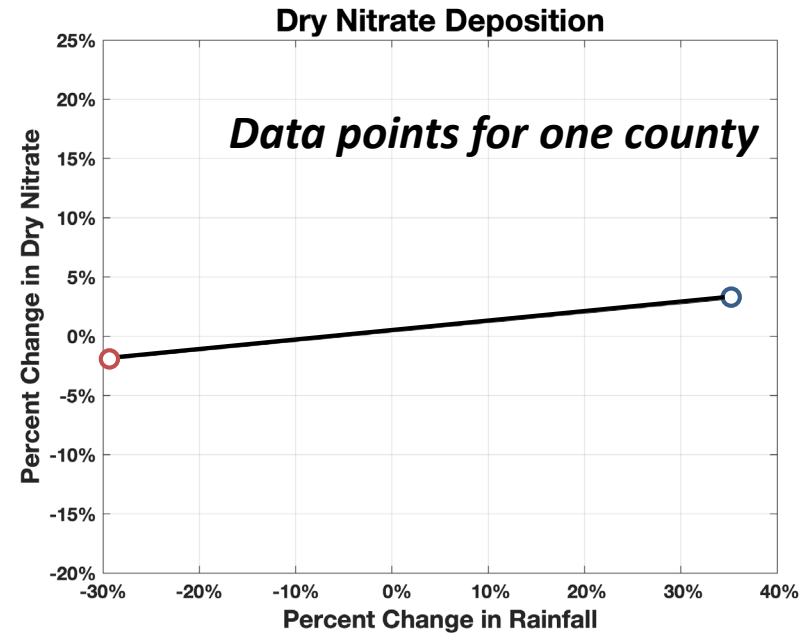
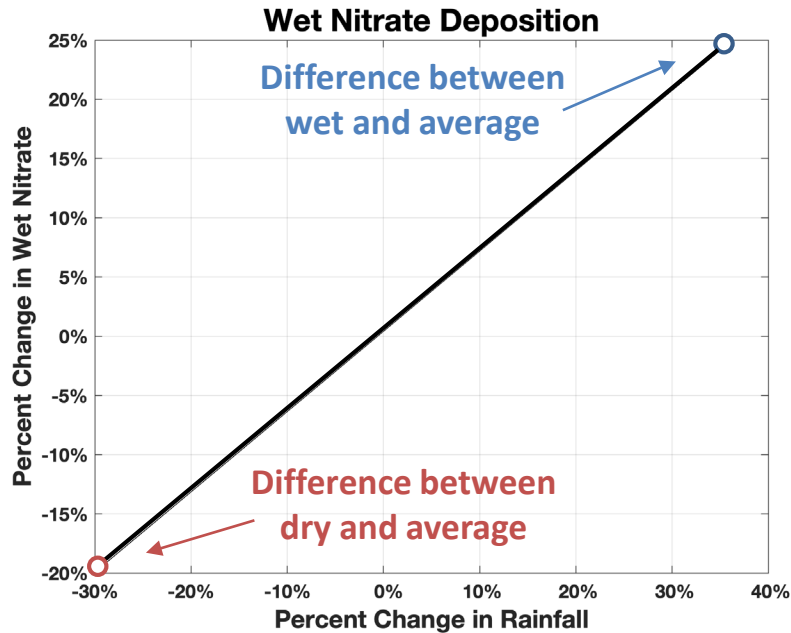


# 1. 2050 CMAQ Atmospheric N-Deposition Data

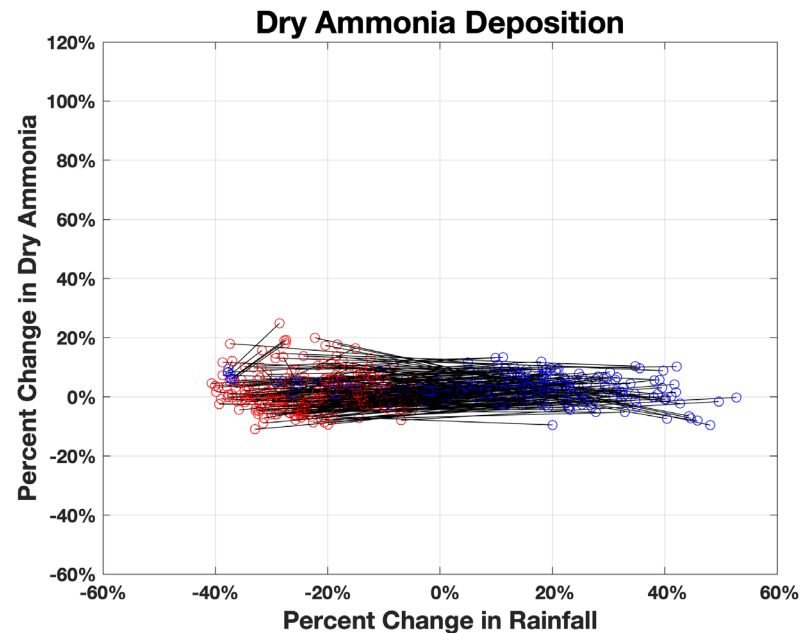
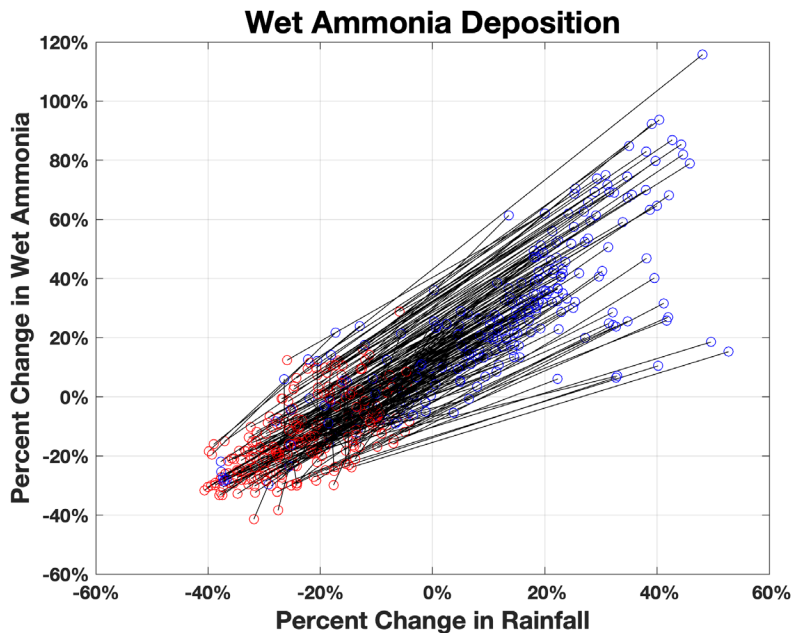
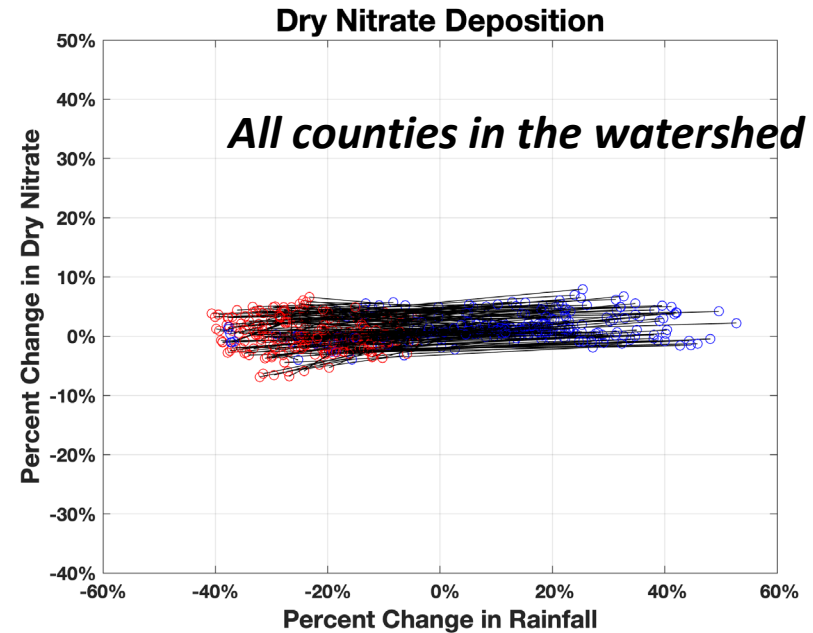
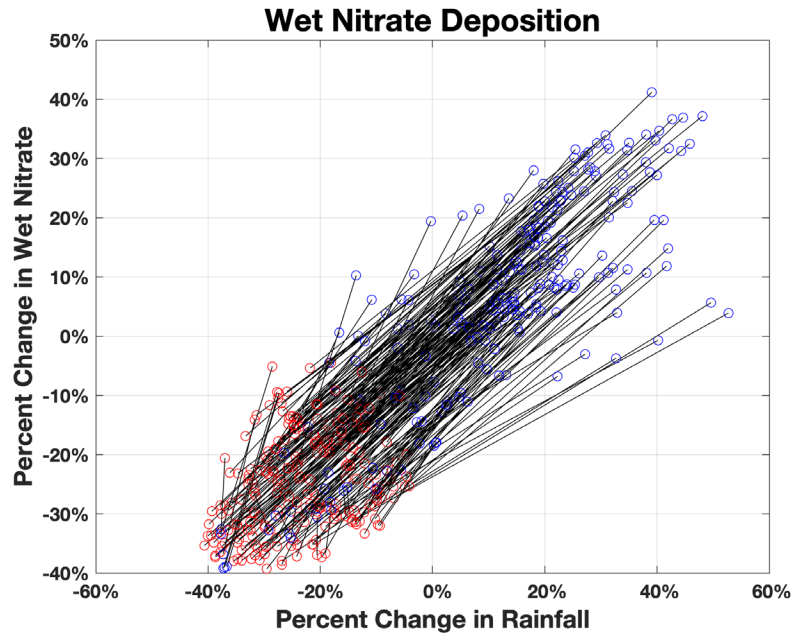
- Dynamically downscaled climate scenario
- Monthly time intervals
- Broken up into Phase 6 land segments
- Rainfall (inches)
  - 2048 – Average rainfall scenario (moderate)
  - 2049 – High rainfall scenario
  - 2050 – Low rainfall scenario
- Loads (lb/acre)
  - WN03 – Wet oxidized N-deposition
  - DN03 – Dry oxidized N-deposition
  - WNH3 – Wet reduced N-deposition
  - DNH3 – Dry reduced N-deposition



# Changes in annual N-depositions vs. changes in rainfall

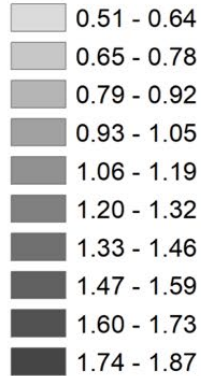


# Changes in annual N-depositions vs. changes in rainfall

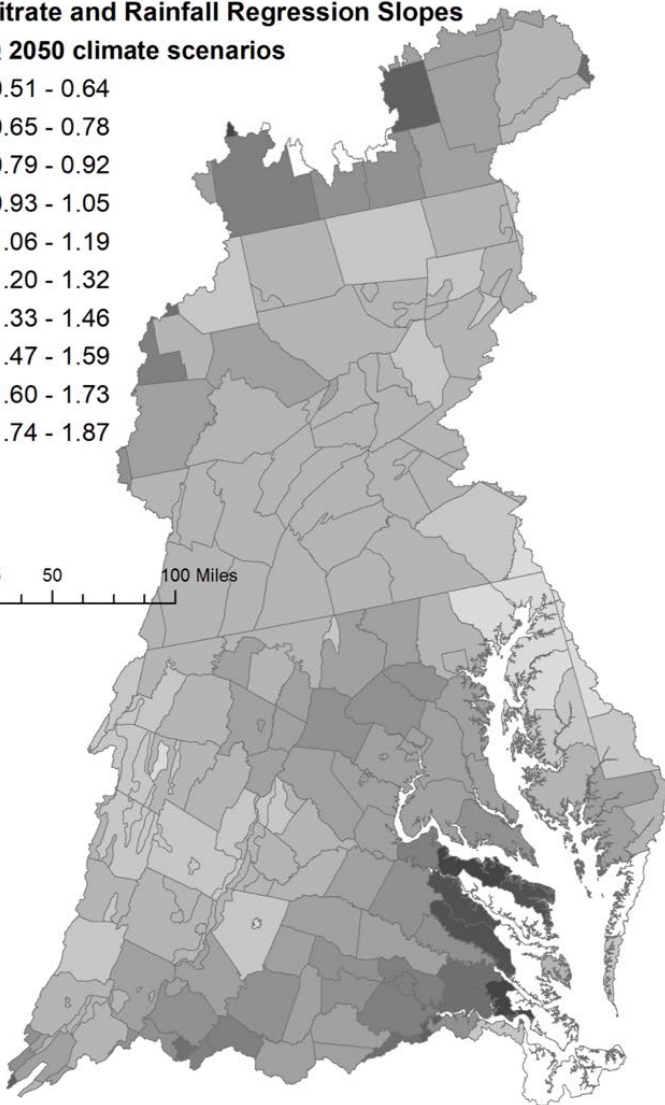


# Changes in annual N-depositions vs. changes in rainfall

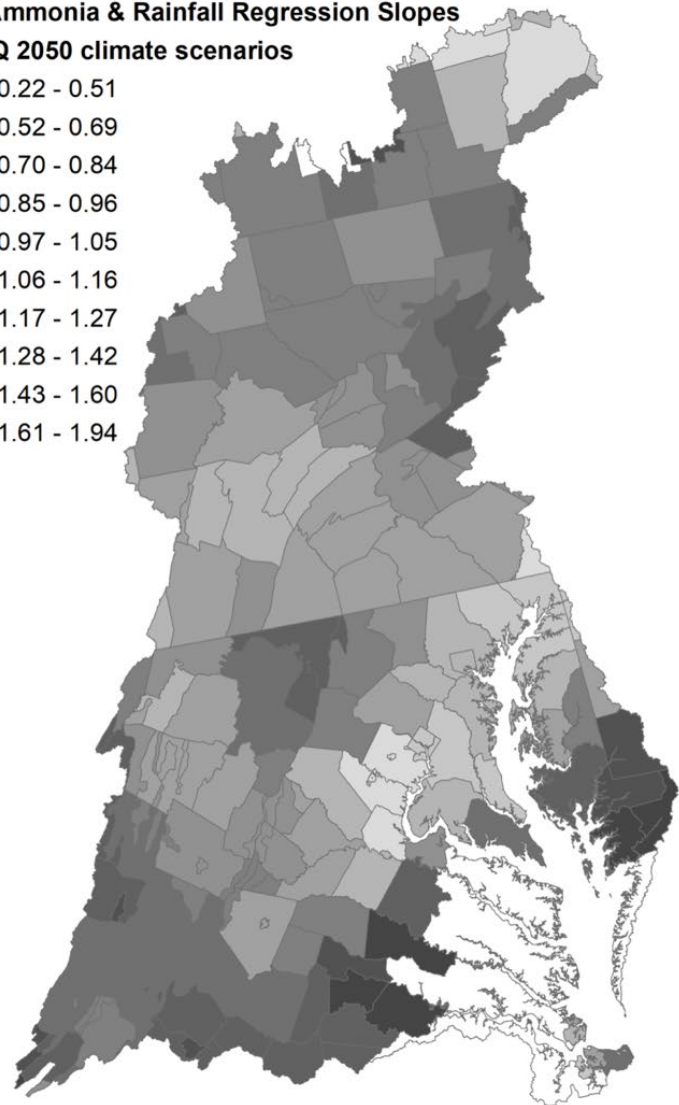
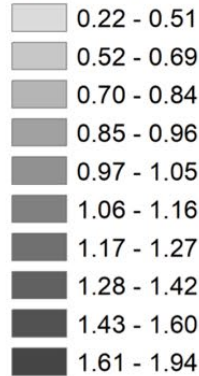
**Wet Nitrate and Rainfall Regression Slopes**  
CMAQ 2050 climate scenarios



0 25 50 100 Miles



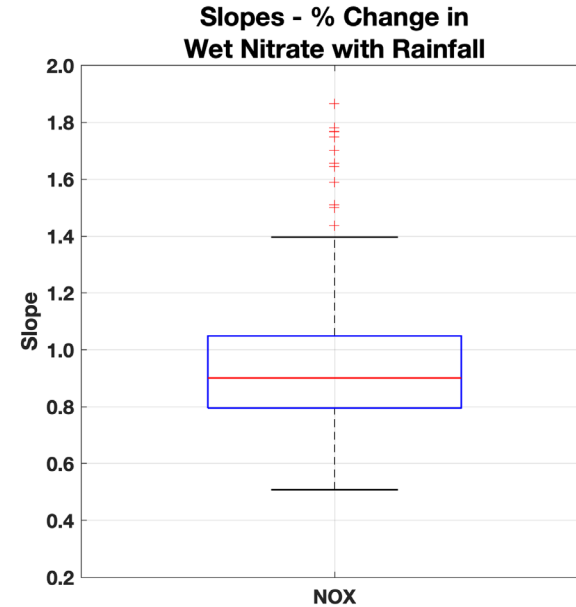
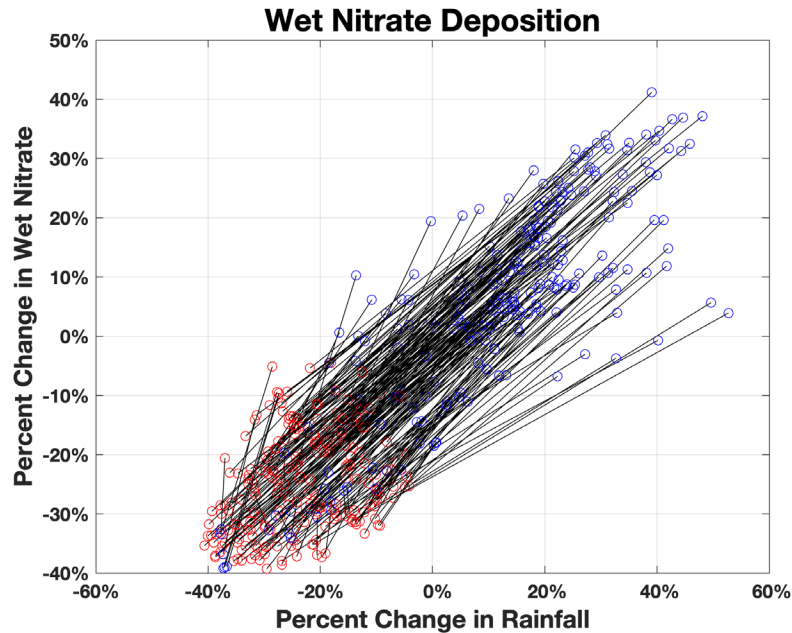
**Wet Ammonia & Rainfall Regression Slopes**  
CMAQ 2050 climate scenarios



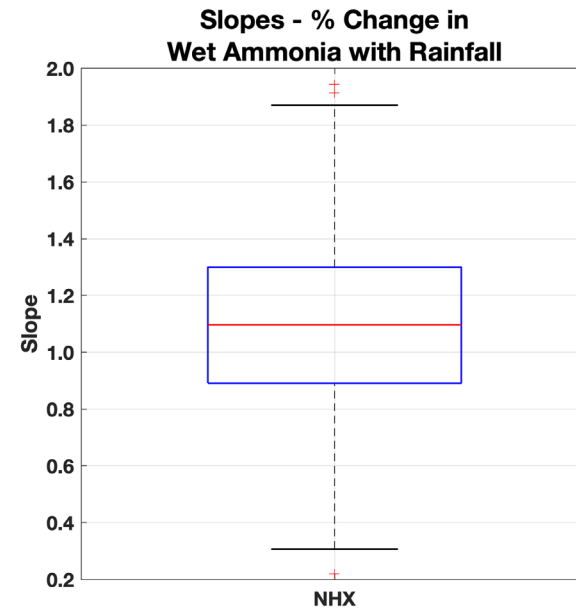
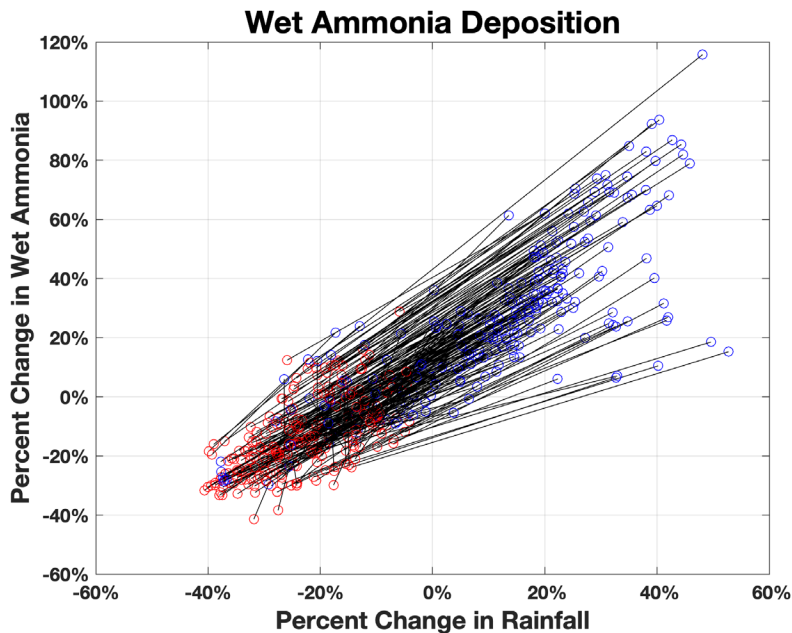
Percent change in wet N-depositions with percent change in rainfall volume for the land segments (counties). Although the slope varied between land segments, it did not show any specific spatial pattern. 7



# Changes in annual N-depositions vs. changes in rainfall



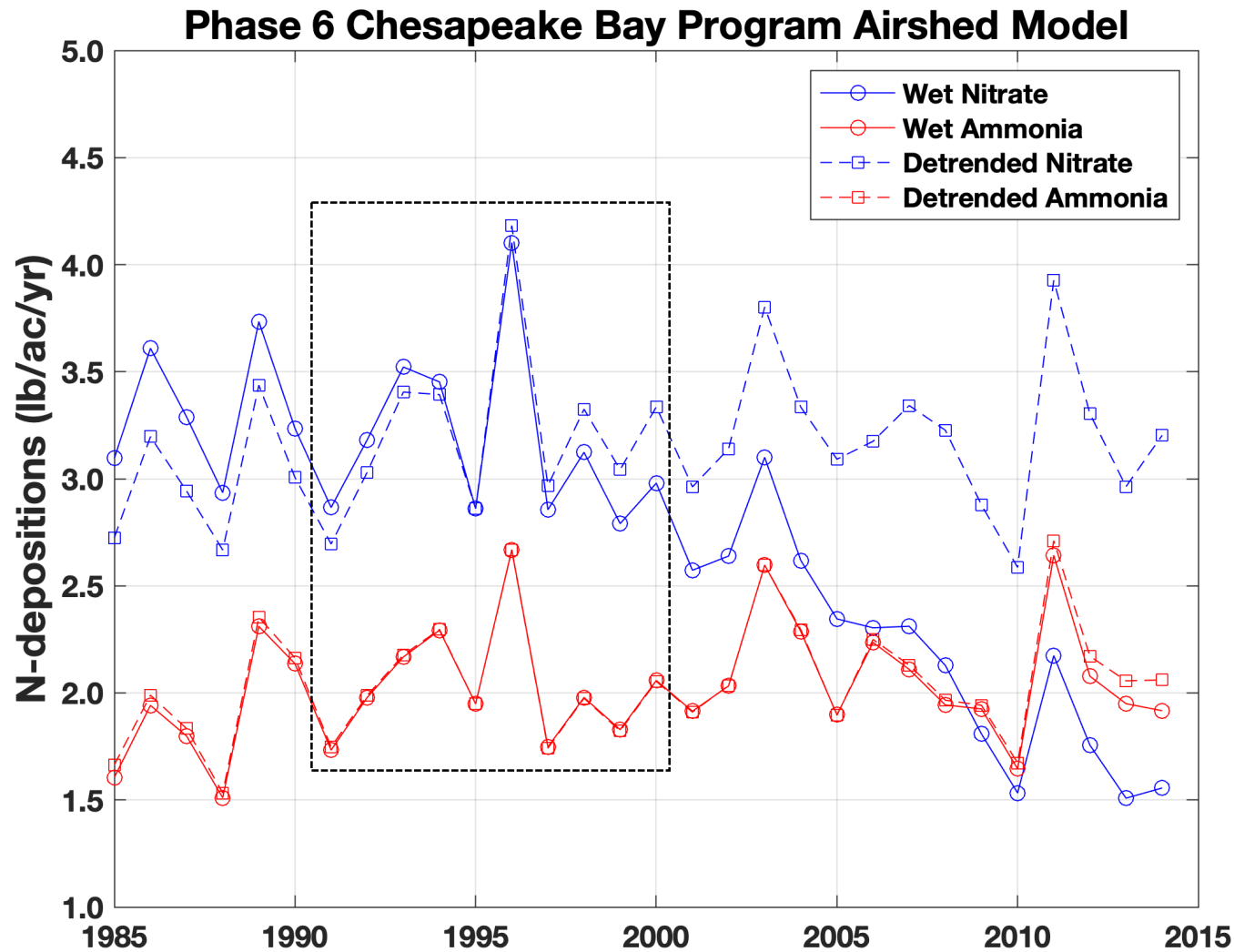
Median  
0.901



Median  
1.096



## 2. Phase 6 Atmospheric N-Depositions

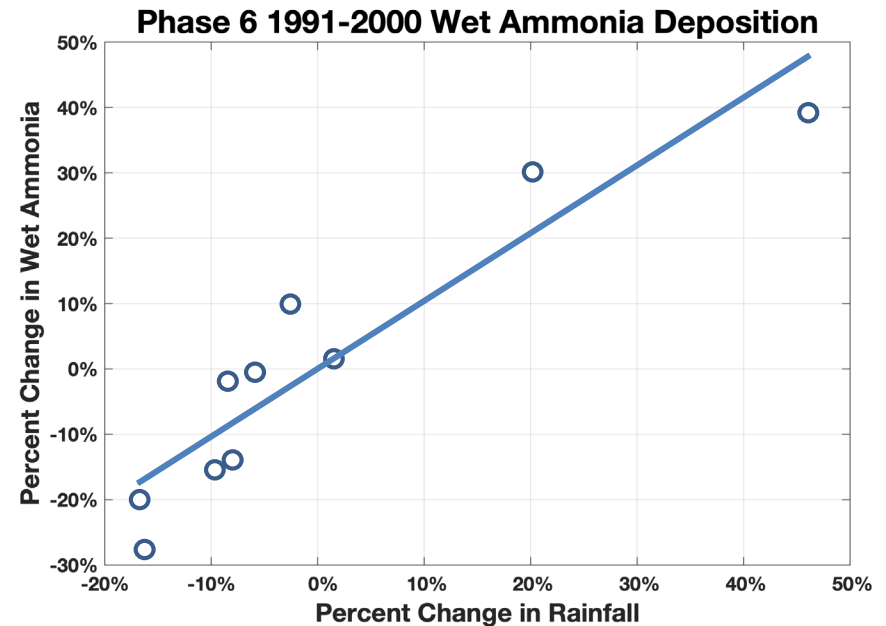
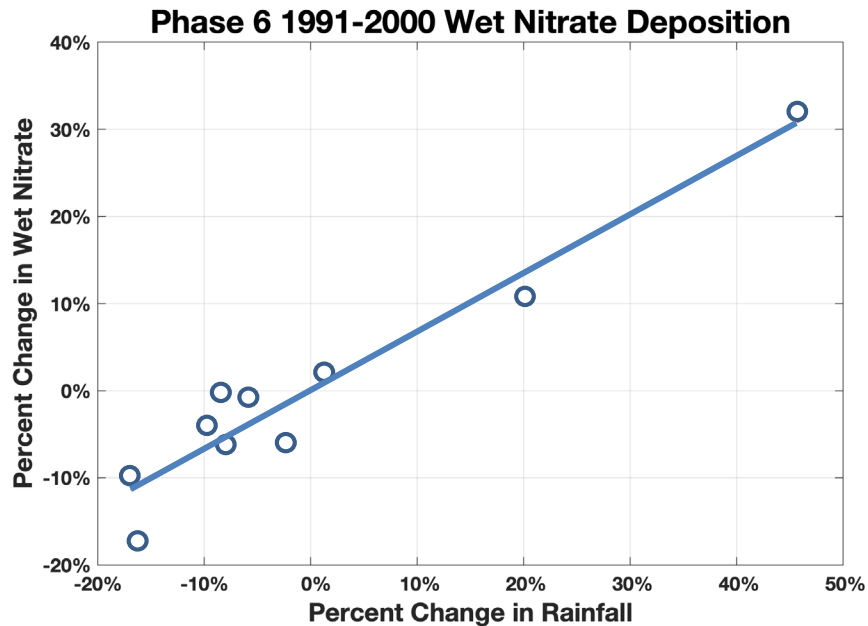


*N-deposition loads for watershed are shown but the loads are available at land segment (county) scale.*

*Grimm 2016; CAST 2017 – Section 3*

# Phase 6 Atmospheric N-Depositions\* (1991-2000)

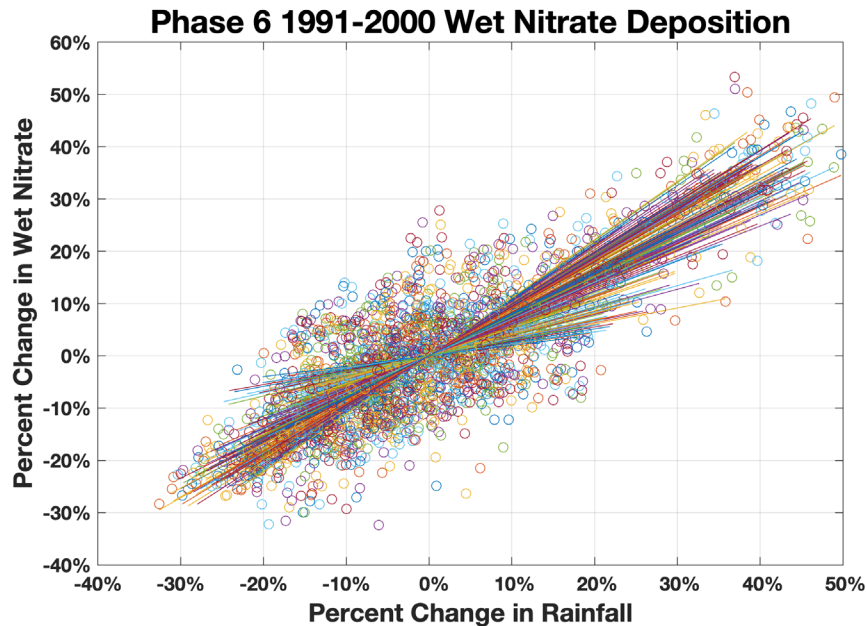
Showing one county  
10 points for years 1991-2000



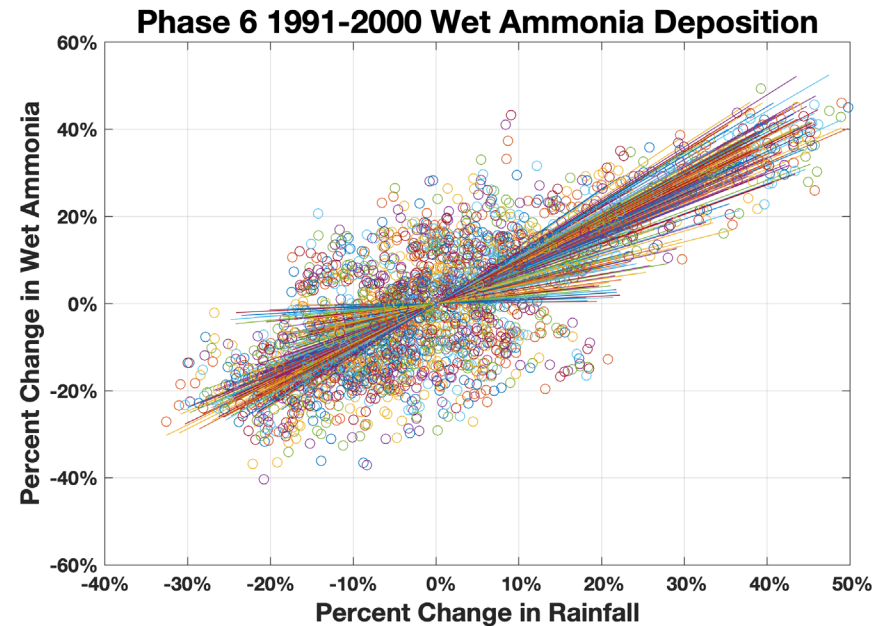
*\*Detrended data were used because they do not include emissions trends.*

# Phase 6 Atmospheric N-Depositions\* (1991-2000)

All counties in the watershed  
10 points for years 1991-2000



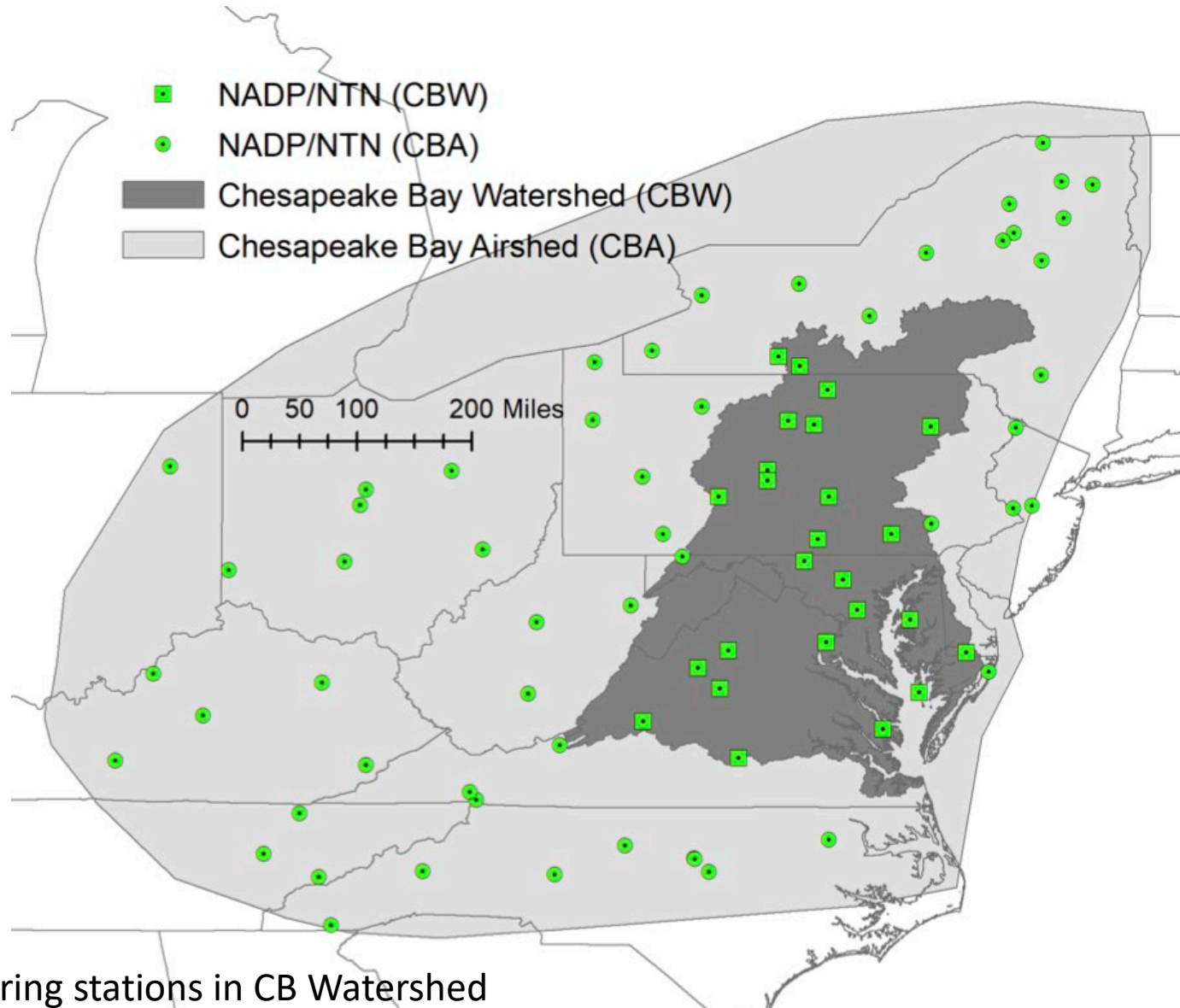
Median 0.770



Median 0.837

*\*Detrended data were used because they do not include emissions trends.*

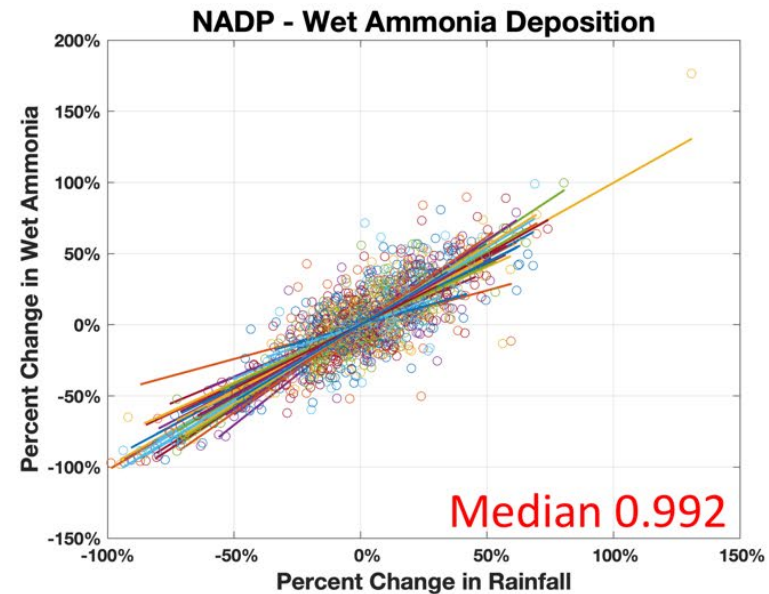
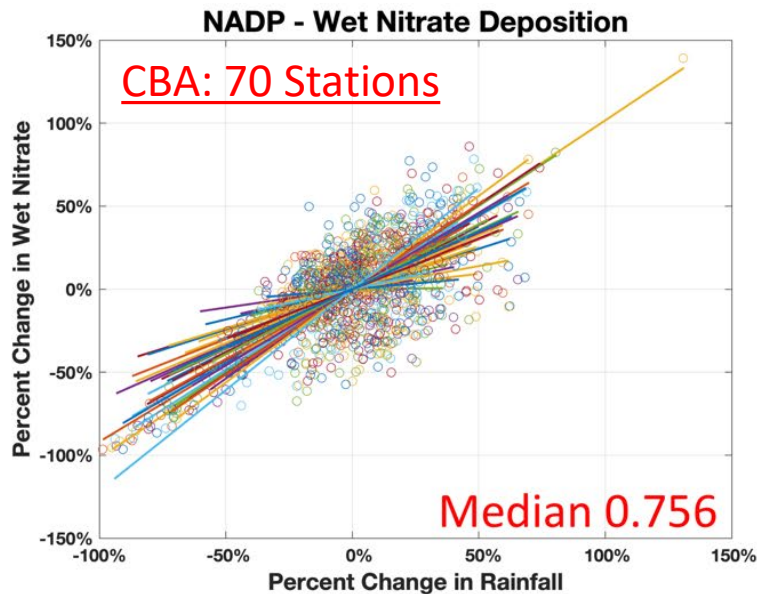
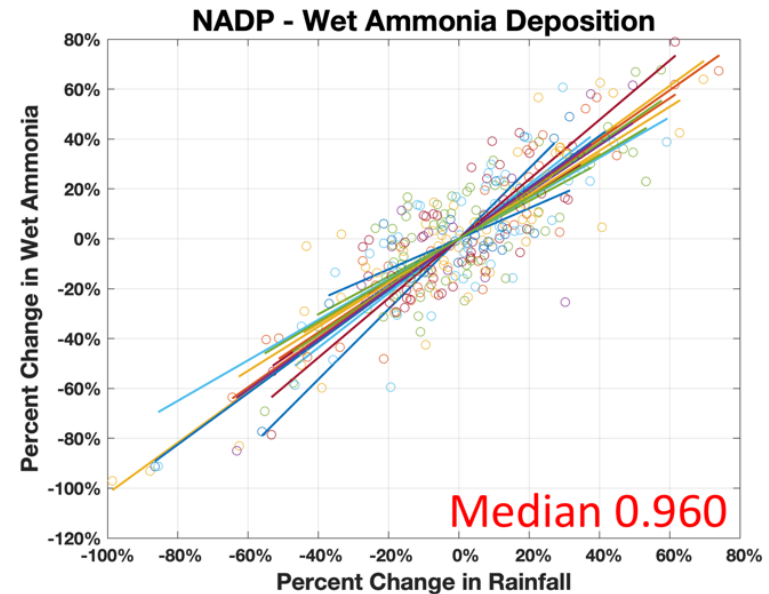
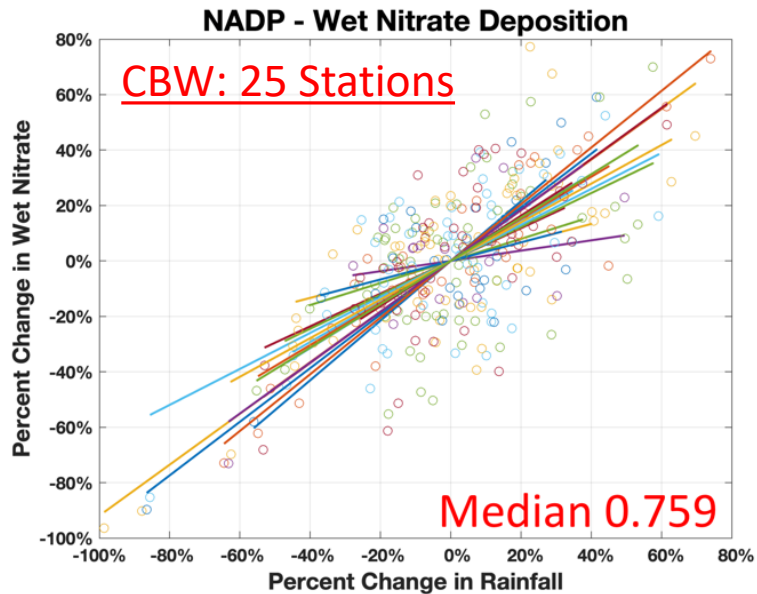
### 3. NADP/NTN Wet N-Deposition Estimates



25 monitoring stations in CB Watershed

70 monitoring stations in CB Airshed

# NADP/NTN Wet N-Deposition Estimates



# Summary and Synthesis

## SECTION 3.1

- A hotter and wetter climate will have a marginal increase in atmospheric deposition inputs.
- The average of the median slopes obtained from the analyses of multiple datasets were adopted as the *sensitivity* of wet depositions (see Table) to the changes in rainfall volume for both the watershed and estuarine open waters.
- Concentrations of organic depositions (that only applies water bodies) were held constant.
- **Modeling Workgroup's approval of Section 3.1 is requested.**

Table: Median slopes (% change in deposition with % change in rainfall)

Data Sources	Wet Nitrate	Wet Ammonium
CMAQ 2050 Simulation	0.901	1.096
Phase 6 CBP Airshed Model	0.770	0.837
NADP Wet deposition – Chesapeake watershed	0.759	0.960
NADP Wet deposition – Chesapeake airshed	0.756	0.992
<b>Average (sensitivity)</b>	<b>0.797</b>	<b>0.971</b>