Effects of Climate Change on Wet Deposition of Nitrogen, Sulfur, and Hydrogen across New York State during 1985 - 2007

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Plan for Presentation

- How climate has been changing in New York State in recent decades
- Describe how these climate changes are affecting wet deposition
- Convince you that NADP/NTN records are reaching sufficient length to be examined in a climate change context

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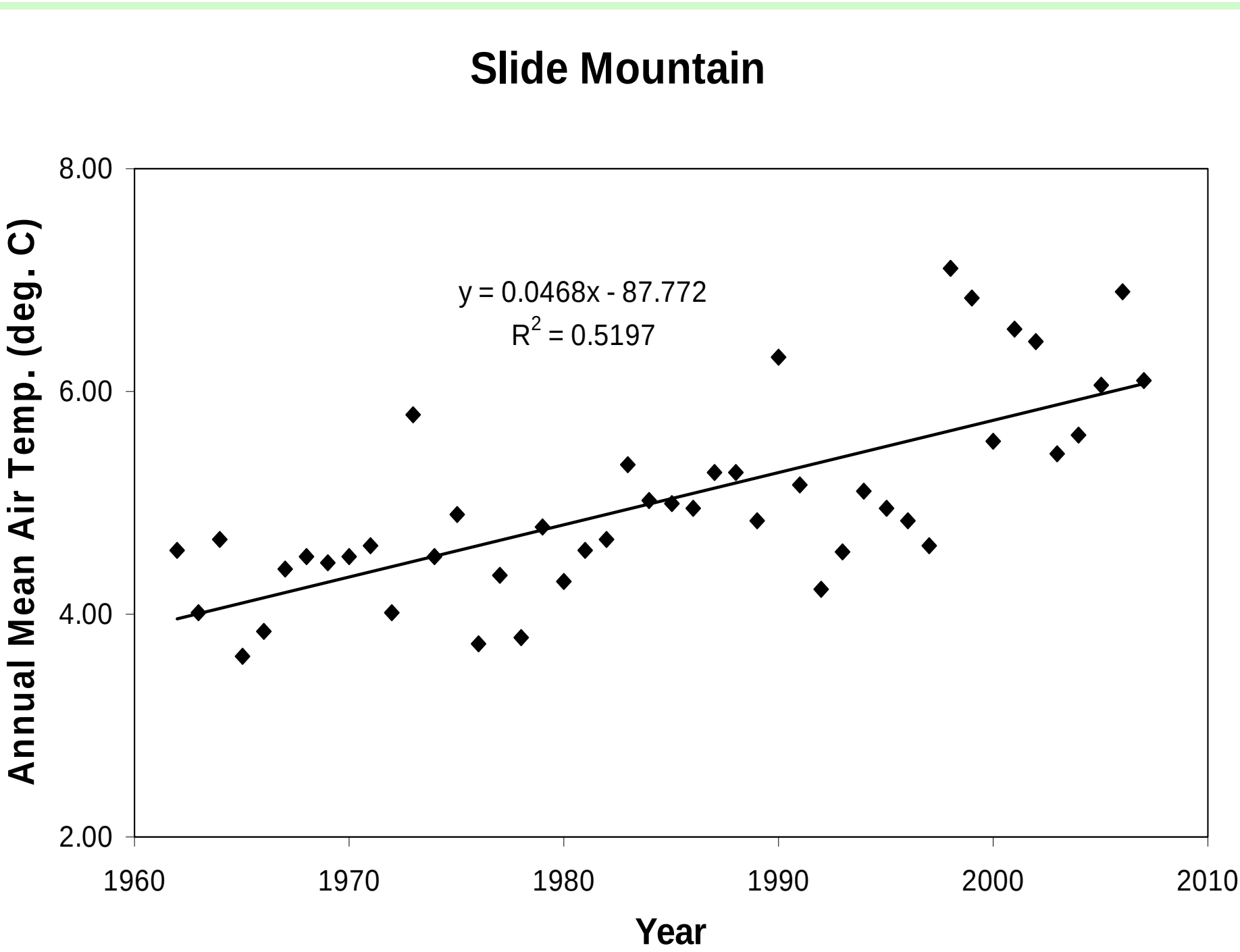
Slide Mountain
y = 0.0468x - 87.772
R2 = 0.5197
Annual Mean Air Temp. (deg. C)
8.00
6.00
4.00
2.00
1960
1970
1980
1990
2000
2010
Year

Is Precip. Expected to Increase with Global Warming? Yes

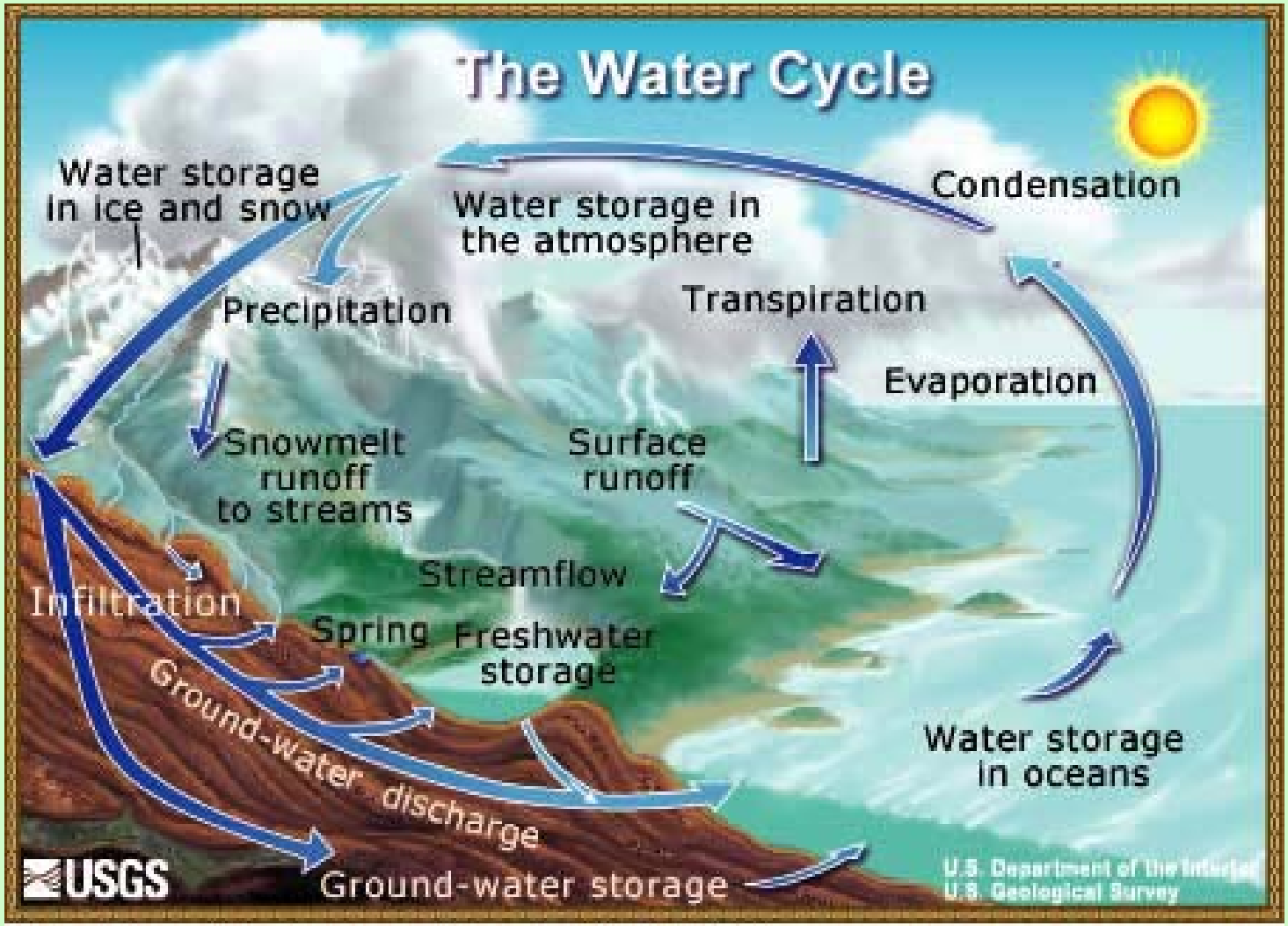

Illustration by John M. Evans, Colorado District, USGS

What is Driving Precip. Increases with Global Warming?

- Warming increases radiative cooling of troposphere
- To preserve energy balance, latent heat released to balance cooling
- Latent heat released through moisture condensation and precip. falling to the ground
- Not whole story – CO_2 increase is decreasing latent heat transfer – negative feedback (25%) on precip.

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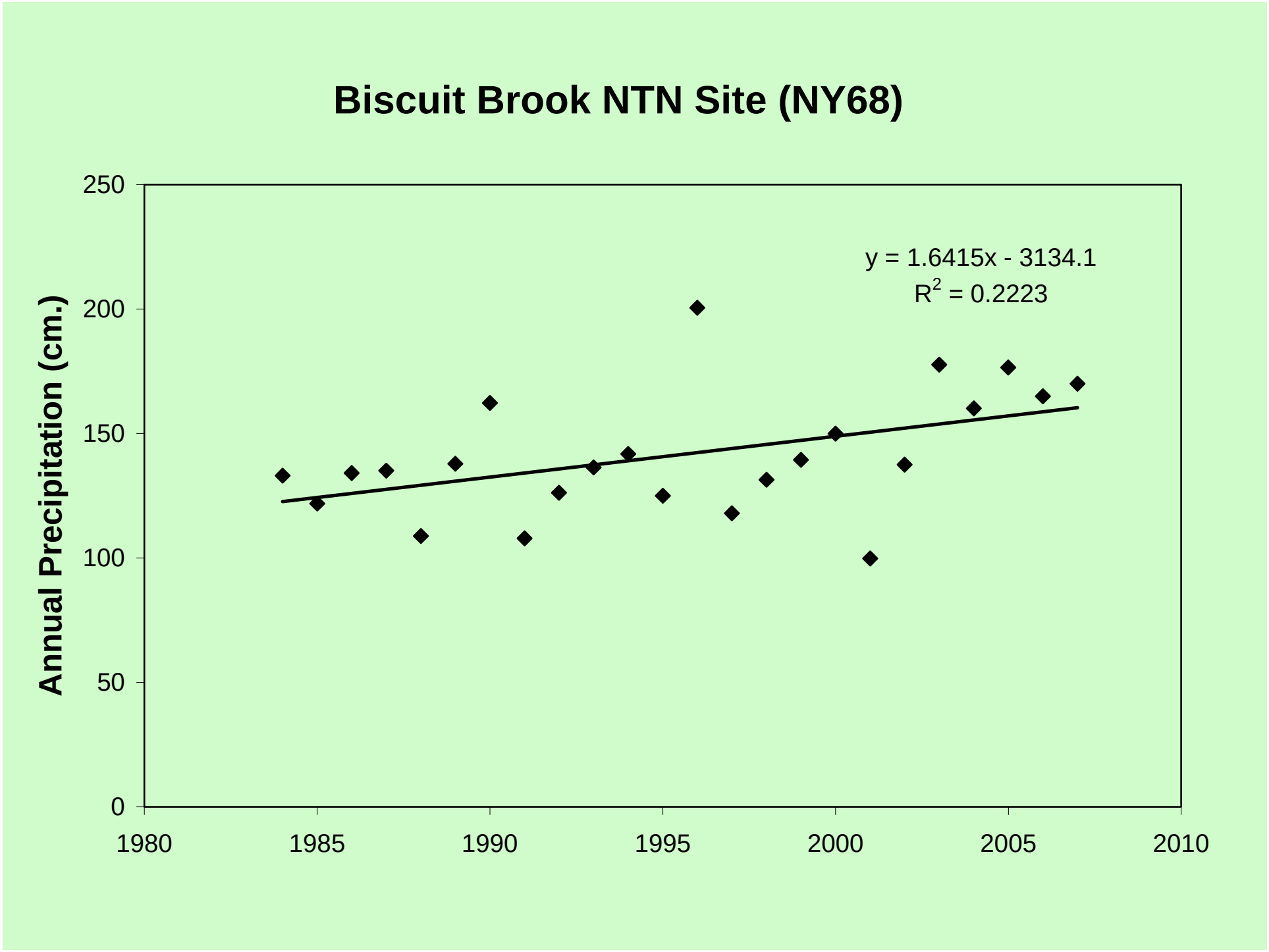
Biscuit Brook NTN Site (NY68)
Annual Precipitation (cm.)
250
200
150
100
50
0
1980
1985
1990
1995
2000
2005
2010
y = 1.6415x - 3134.1
R2 = 0.2223

How Much is Precipitation Likely to Increase with Global Warming?

- GCMs – 1 to 3% per ^{o}C warming (Held and Soden, 2006)
- Observations – 6 to 7.5% per ^{o}C warming (Wentz et al., 2007; Lambert et al., 2008)
- Models and observation may disagree due to recent global brightening (Previdi and Liepert, 2008)
- More research needed to resolve differences

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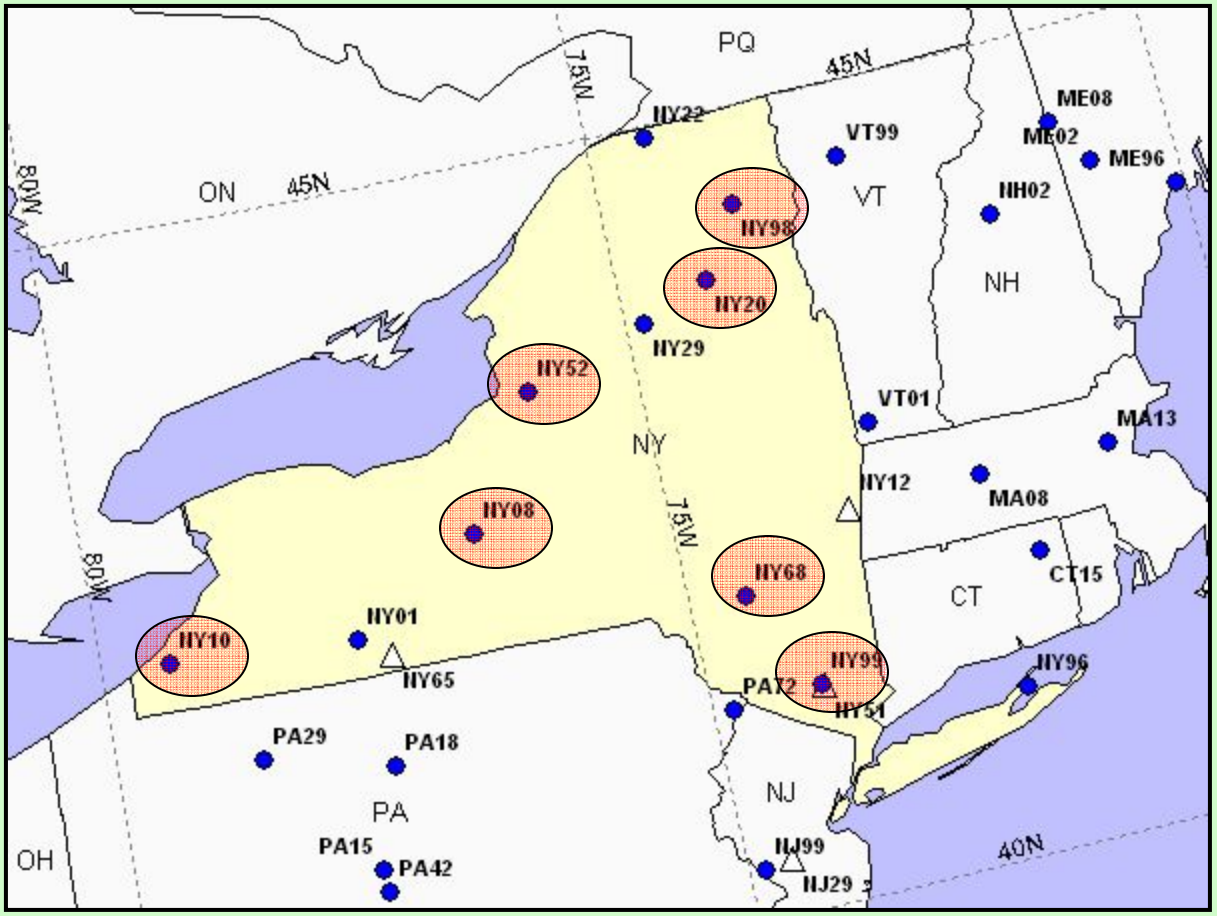
Data from Seven Long-Term Sites (NADP/NTN)



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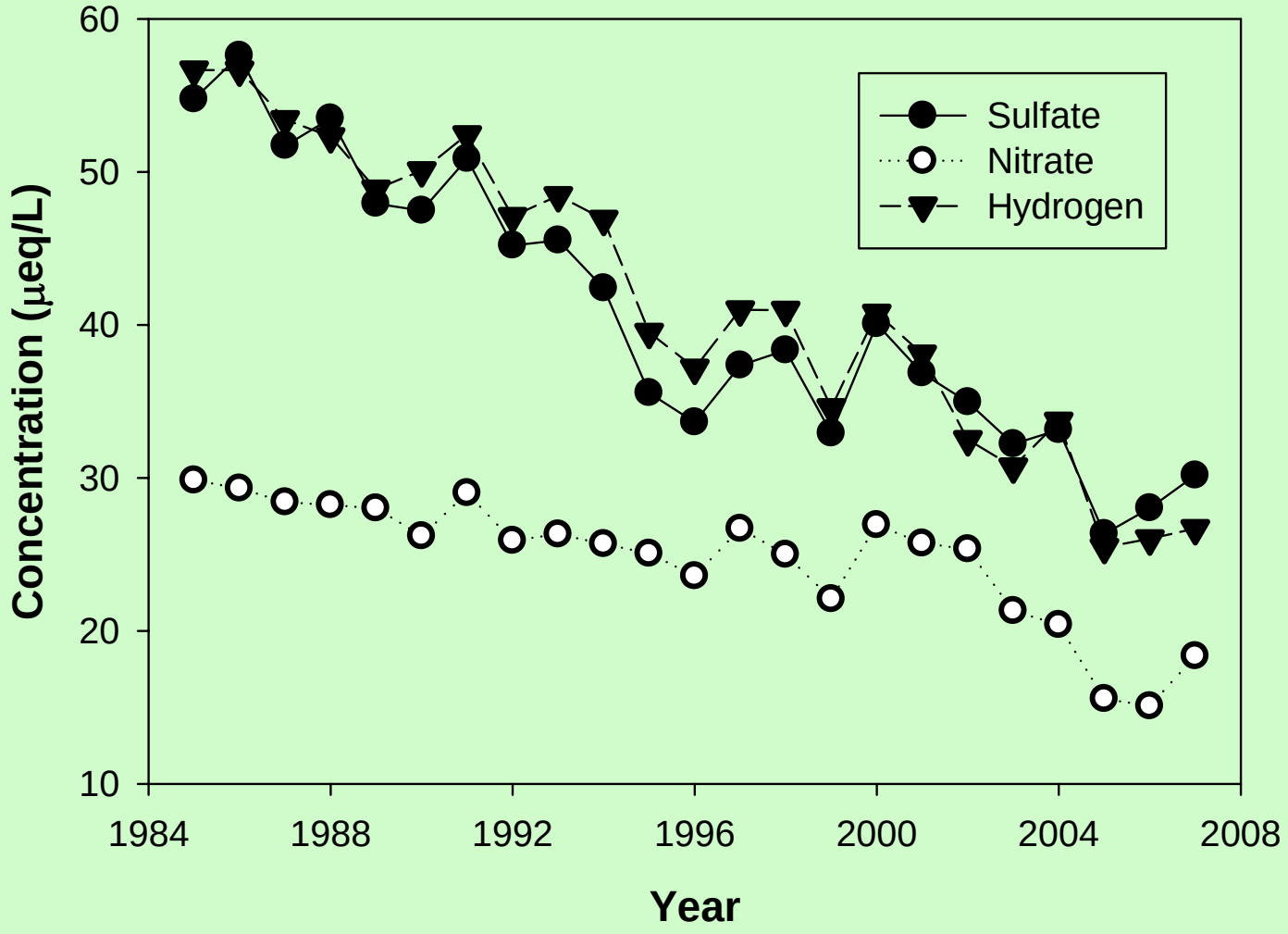
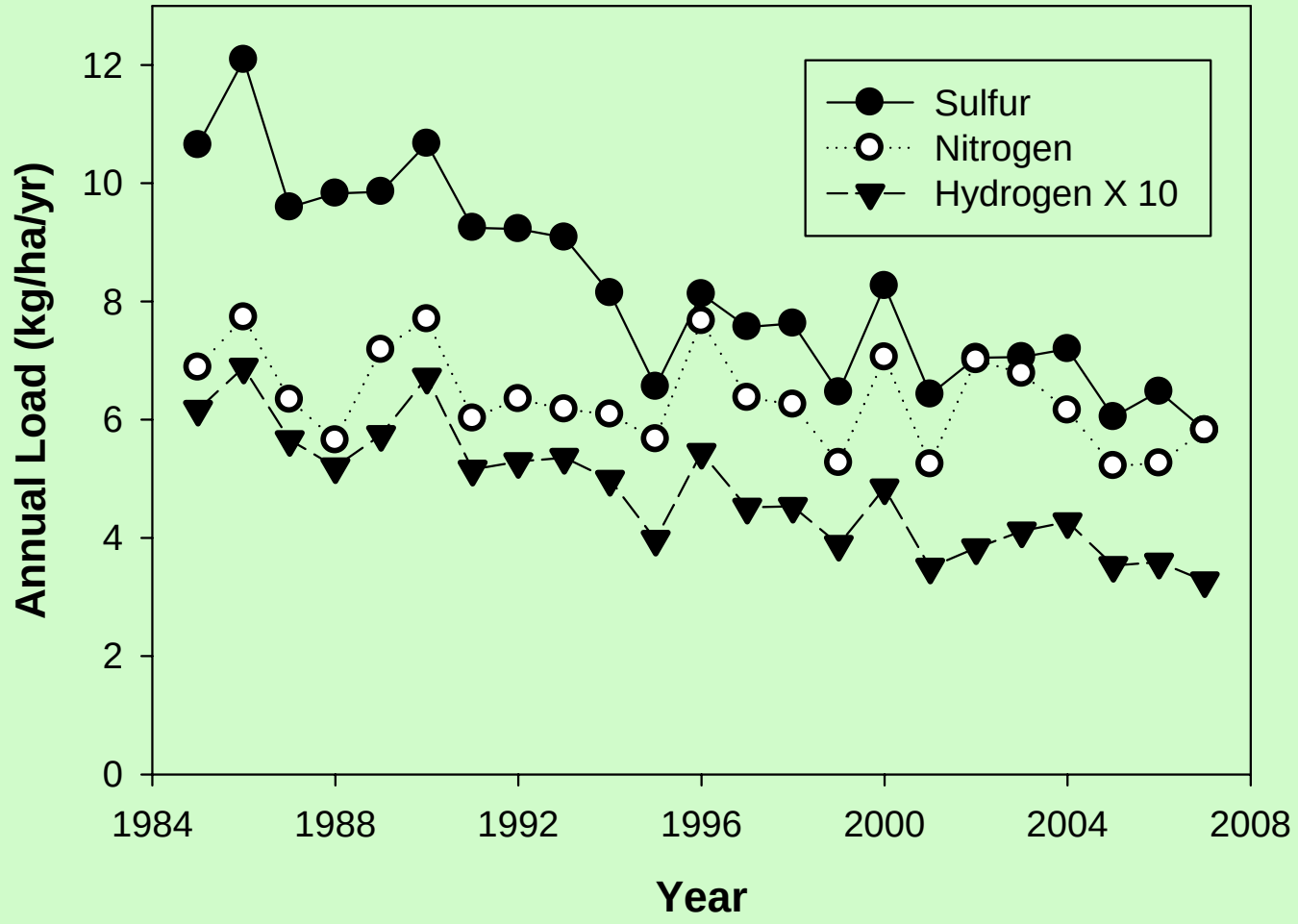
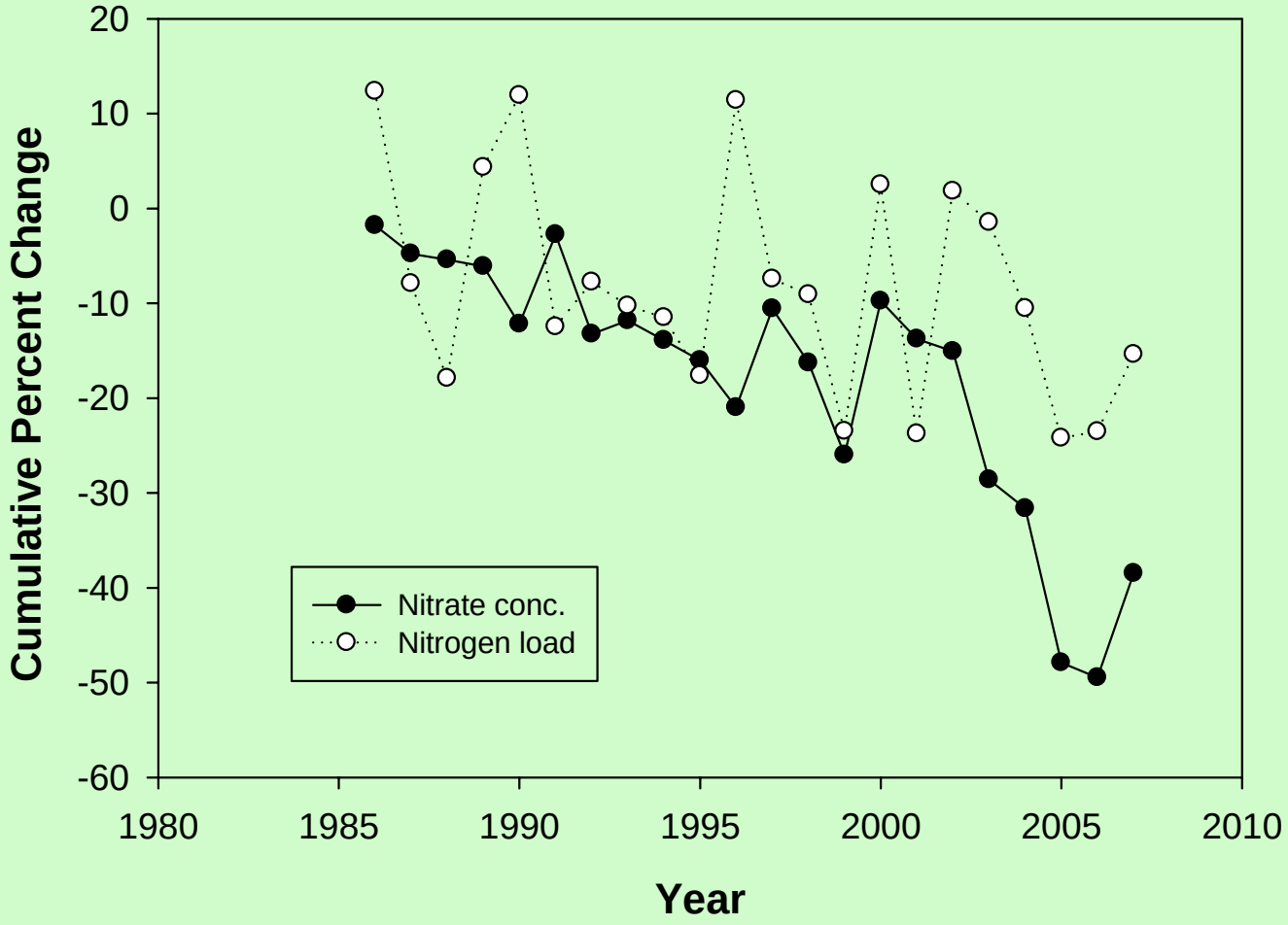
Mean NTN Chemistry – New York, 1985-2007



Mean NTN Loads – New York, 1985-2007



Load and Concentration have Followed Different Patterns



Summary of Trends at 7 NY NTN Sites

Constituent	Trend	% Sig. Trends	% Change 1985-2007
SO_4^{2-}	Negative	100	-52.9
NO_3^-	Negative	100	-37.8
H^+	Negative	100	-57.7
S Load	Negative	100	-47.5
N Load	Negative	29	-18.4
H Load	Negative	100	-48.5

Why Are N dep. Trends less than NO_3^- Trends?

Combination of factors limiting decreases in N loads

- Precipitation amount has increased by 11 mm/yr (+23%)
- No trends in NH_4^+ concentrations
- Trends in NO_3^- conc. are less than those of SO_4^{2-} conc.

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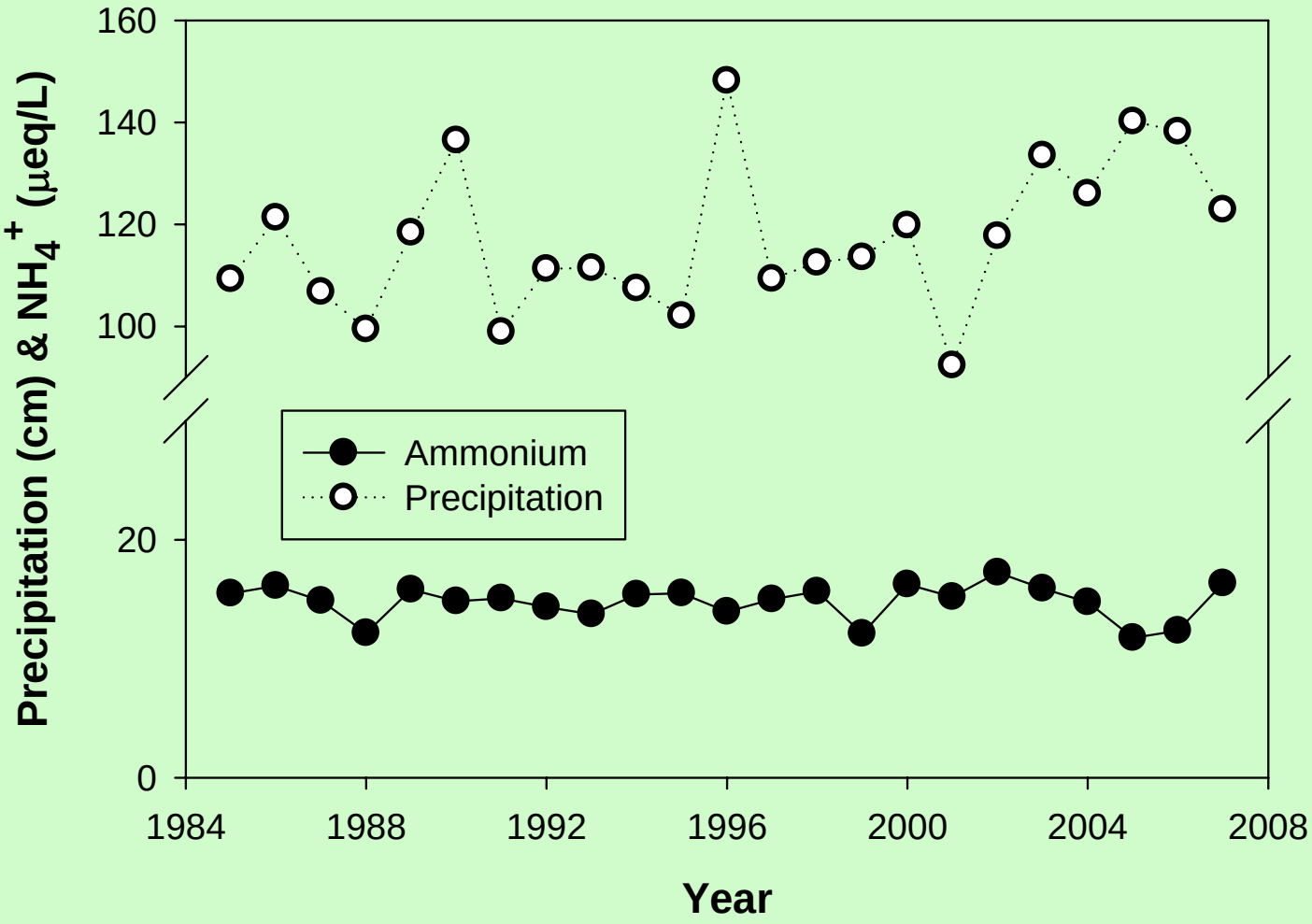
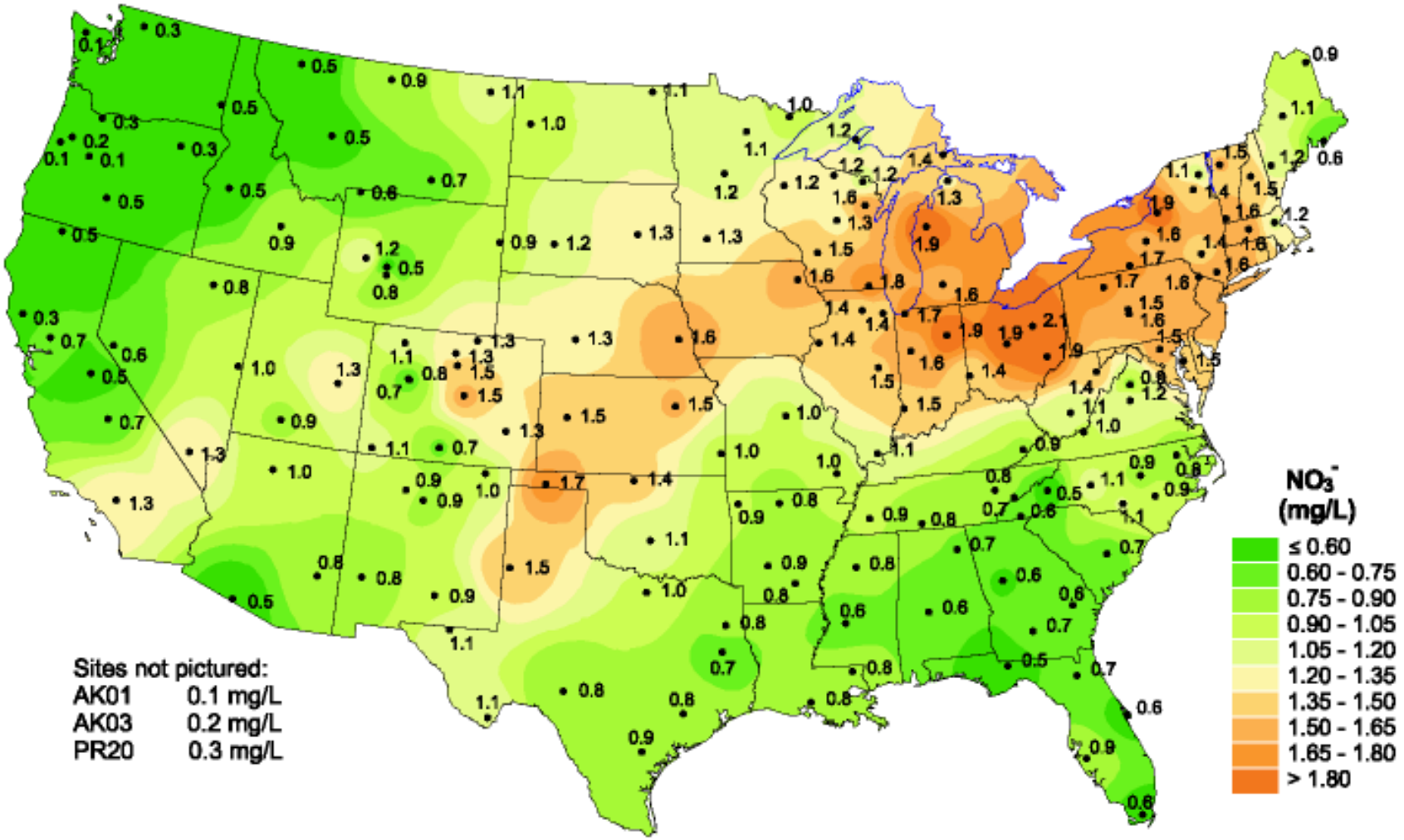
Trends – Precip. & NH_4^+

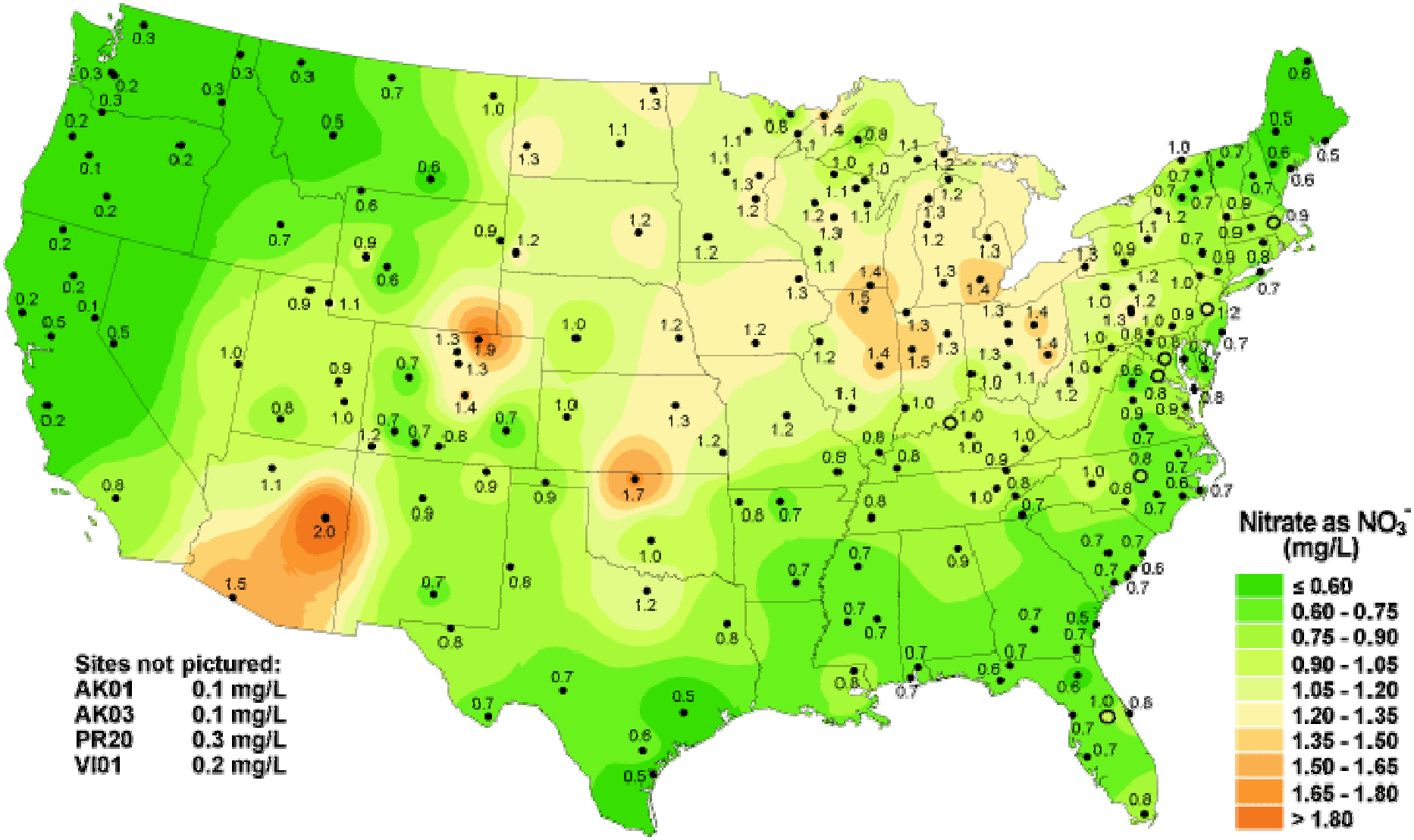


Nitrate ion concentration, 1994



National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

Nitrate ion concentration, 2006



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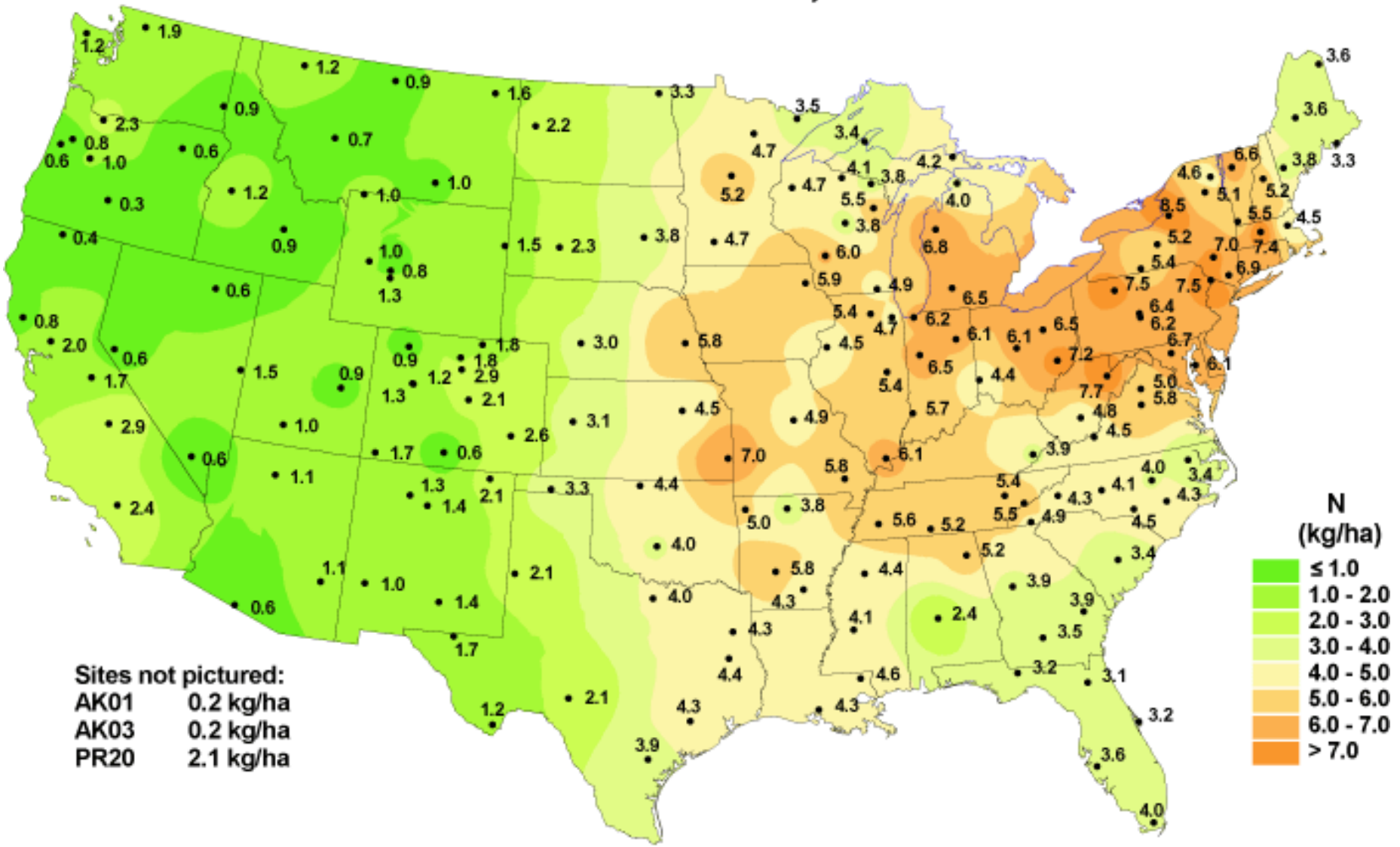
Inorganic nitrogen wet deposition from nitrate and ammonium, 1994



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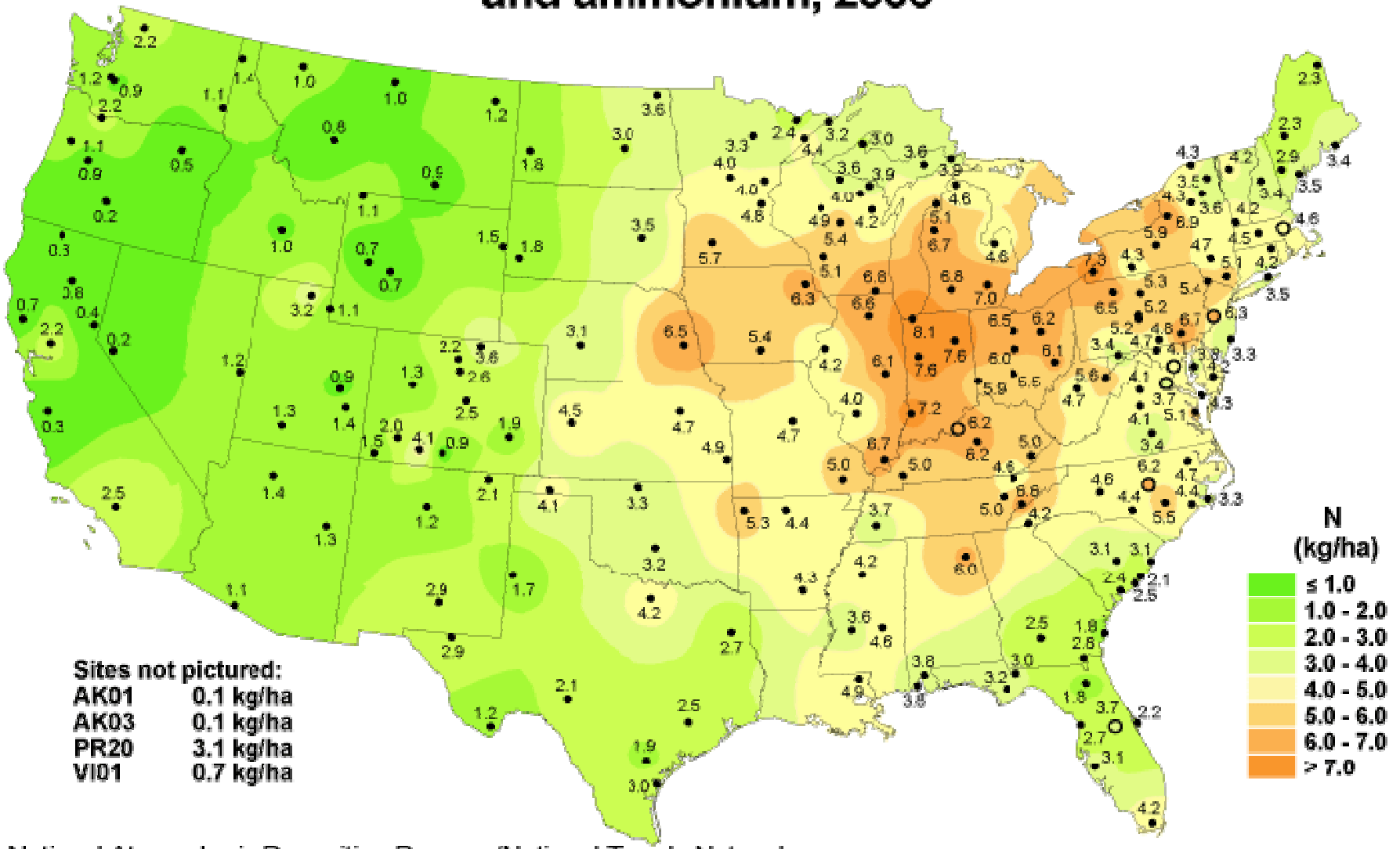

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Conclusions

- Increases in precip. amount are consistent with the physics of global climate change
- Precip. amount has increased at NTN sites in NY by ~ 23% during 1985-07, this is damping decreases in N loads
- Nitrogen loads in wet dep. have decreased significantly at only 2 of 7 NY NTN sites despite sig. decreases in NO_3 conc. at all sites
- Flat trends in NH_4 conc. are also contributing to fewer trends in N loads
- Visual examination suggests a similar pattern may be occurring over a broader region of the Northeast and Upper Midwest

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Final Thoughts

- NTN records are reaching sufficient length to be used in climate change assessments
- Emphasizes the value of long-term records
- Many other links between changes in climate/CO_2 conc. and atmospheric dep. and effects of air pollutants not discussed
- Unclear whether increases in precip. will continue – role of aerosols may be imp.

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