

Status and Trends in Wet Atmospheric Deposition of Nitrogen in the United States

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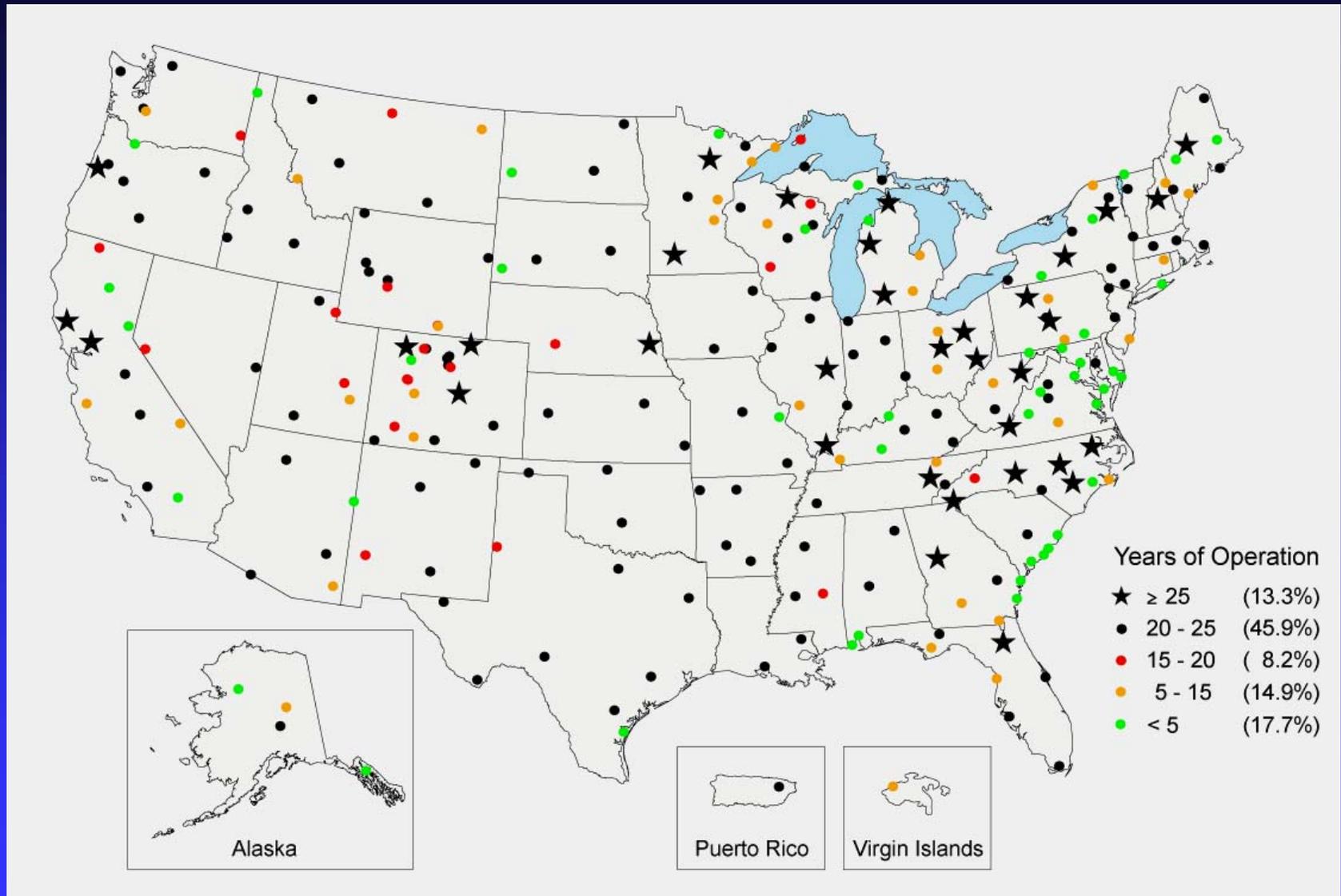
Office of Water Quality

U.S. Geological Survey

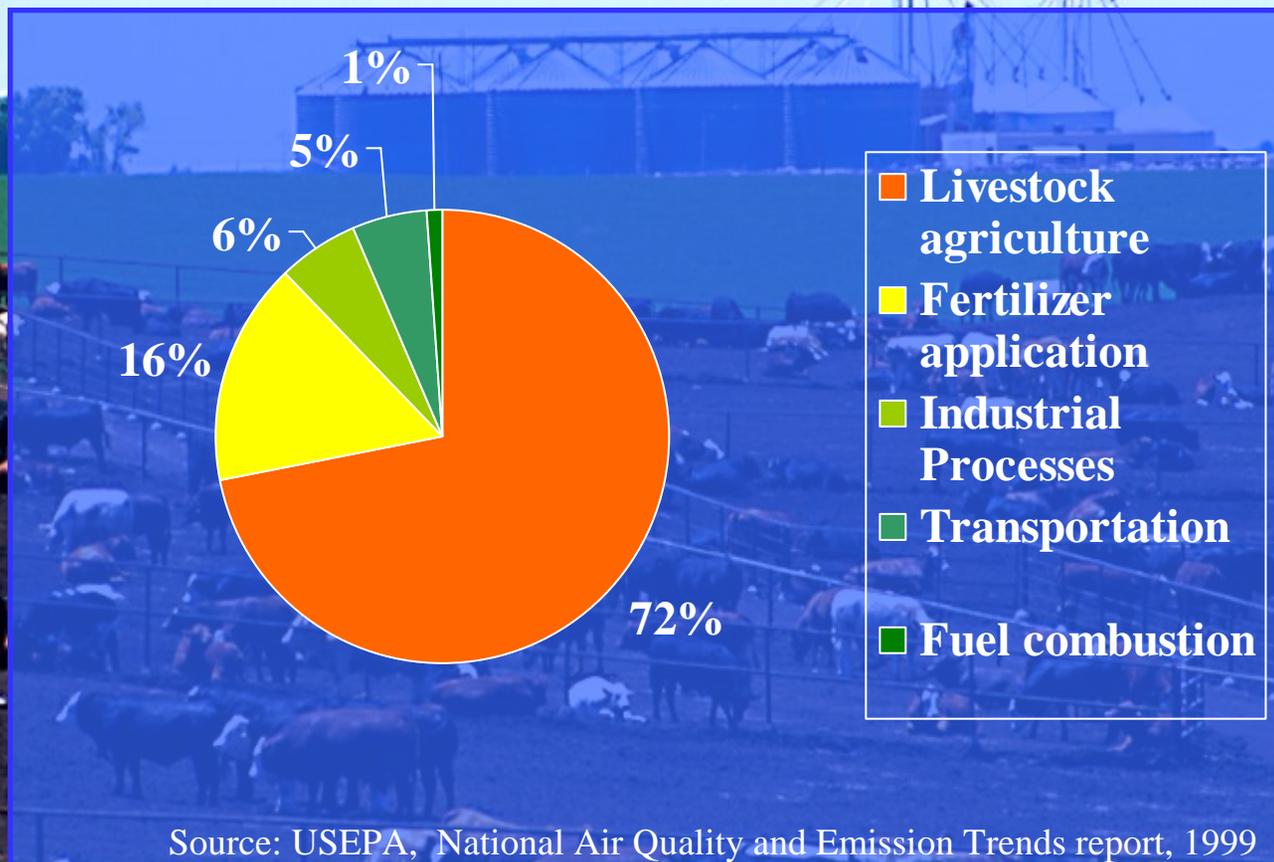
National Atmospheric Deposition Program (NADP)

- Begun in 1978, NADP monitors acidity, nutrients and base cations at ~250 sites across the U.S. and mercury at ~100 sites
- Long-term multi-decade monitoring
- Multi-tiered support
 - ◆ Federal, state, private, academic & tribal
- Sites are typically regionally representative
- Identical sampling equipment and methods are used within each network
- Single analytical laboratory
- Rigorous field and laboratory QA/QC
- Open availability of all data via the Internet

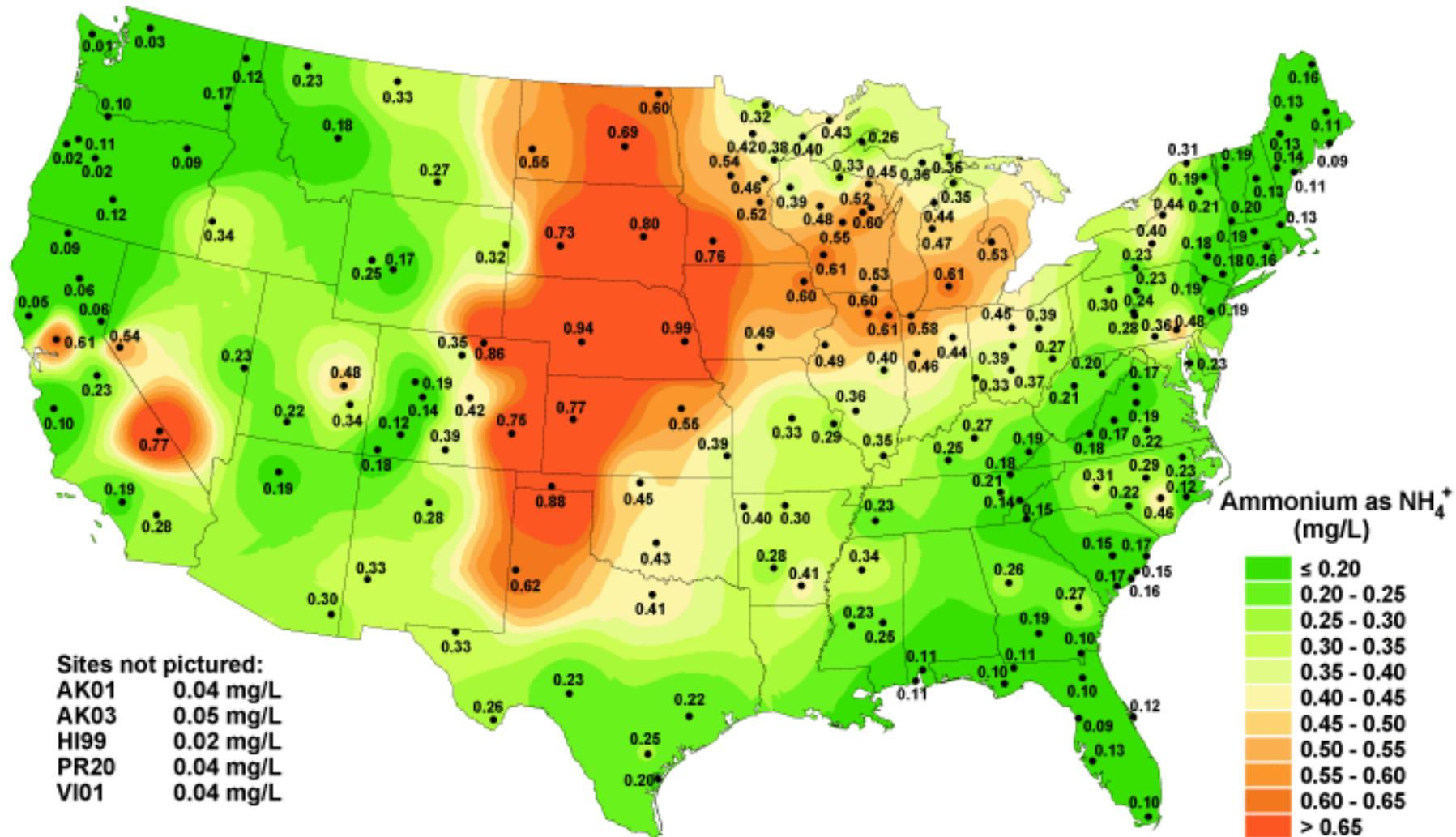
NTN Sites - 31 March 2005



Sources of U.S. Anthropogenic Ammonia Emissions

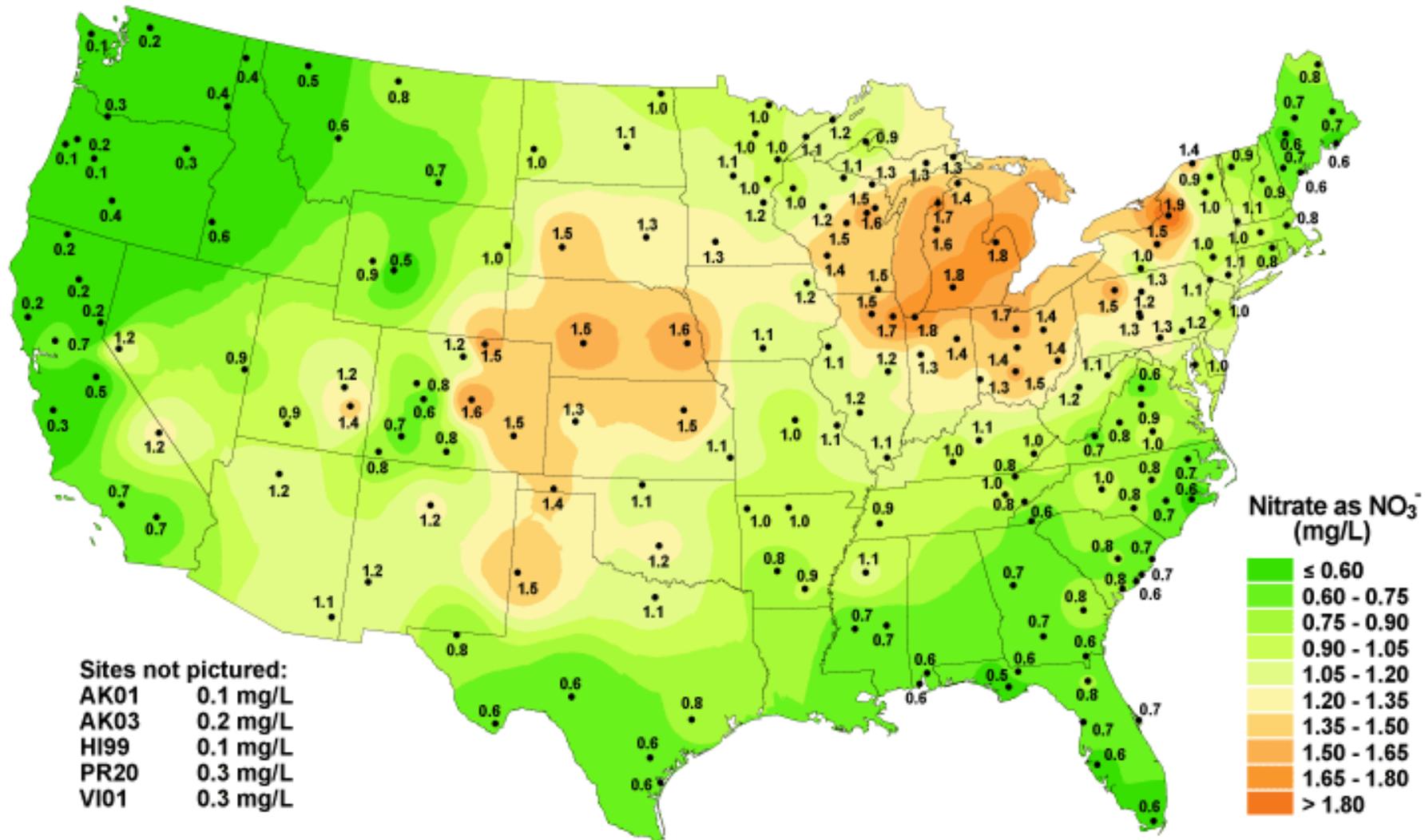


Ammonium ion concentration, 2003



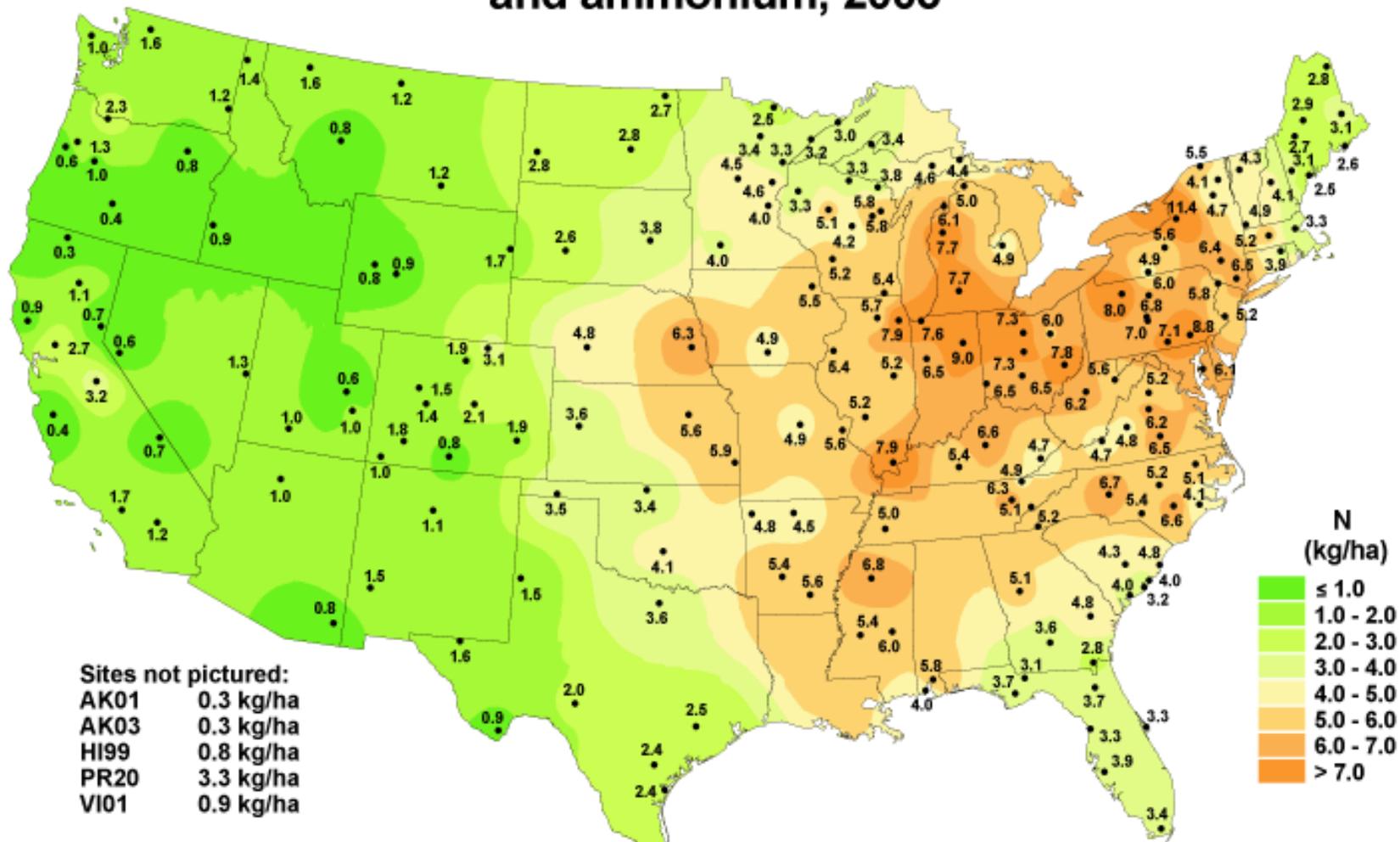
National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Nitrate ion concentration, 2003



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

Inorganic nitrogen wet deposition from nitrate and ammonium, 2003



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

Seasonal Mann-Kendall Test

- ◆ **Initial step - parametric modeling of precipitation versus concentration**
- ◆ **Nonparametric test for trend**
- ◆ **Detects monotonic trends**
- ◆ **Accommodates missing data and non-normal distributions**
- ◆ **Removes effects of seasonality without explicitly modeling it**

Estimating the Trend Magnitude

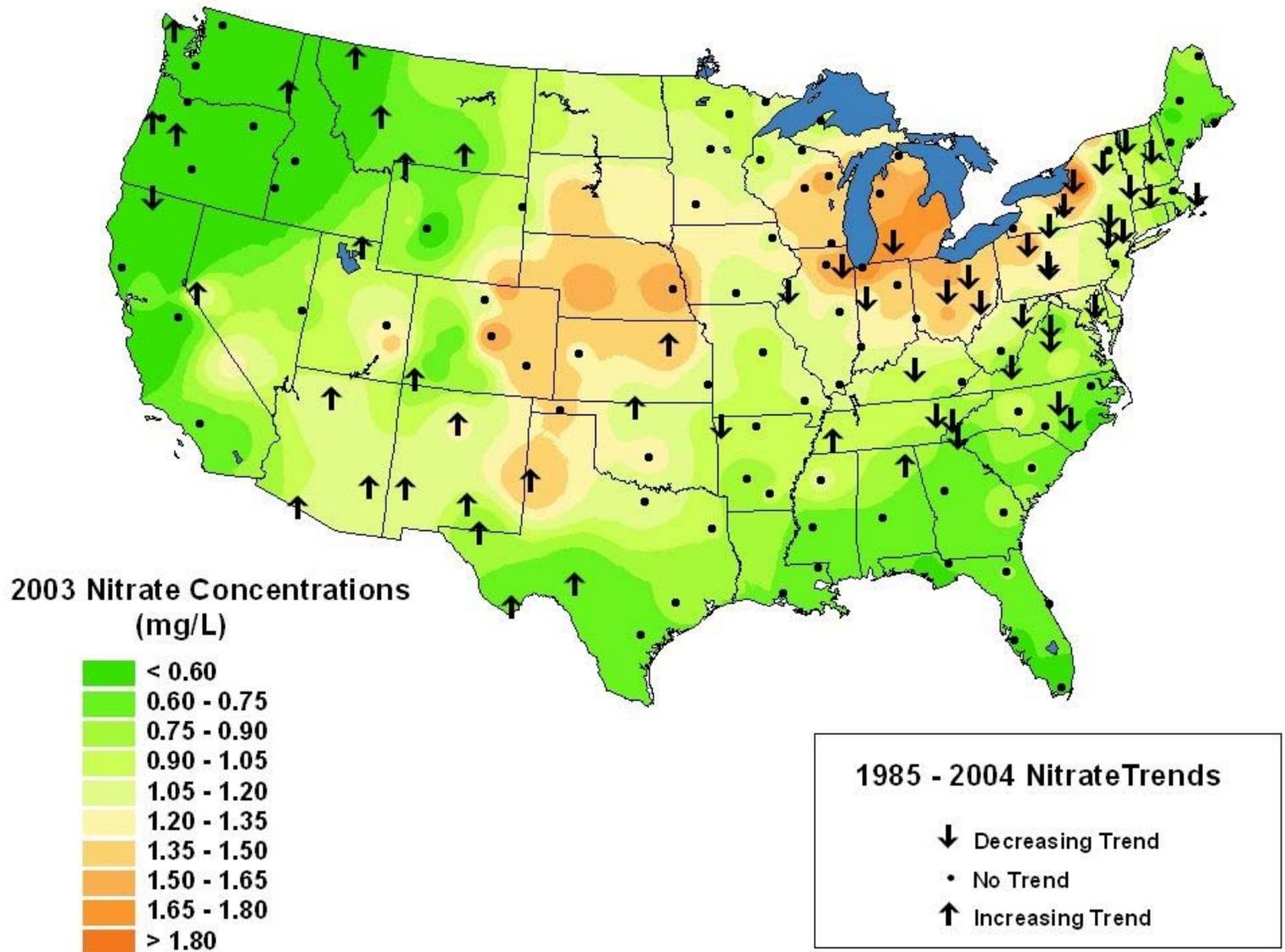
■ Sen slope estimator

- ◆ Median slope of all like-month, pairwise comparisons expressed as an annual trend

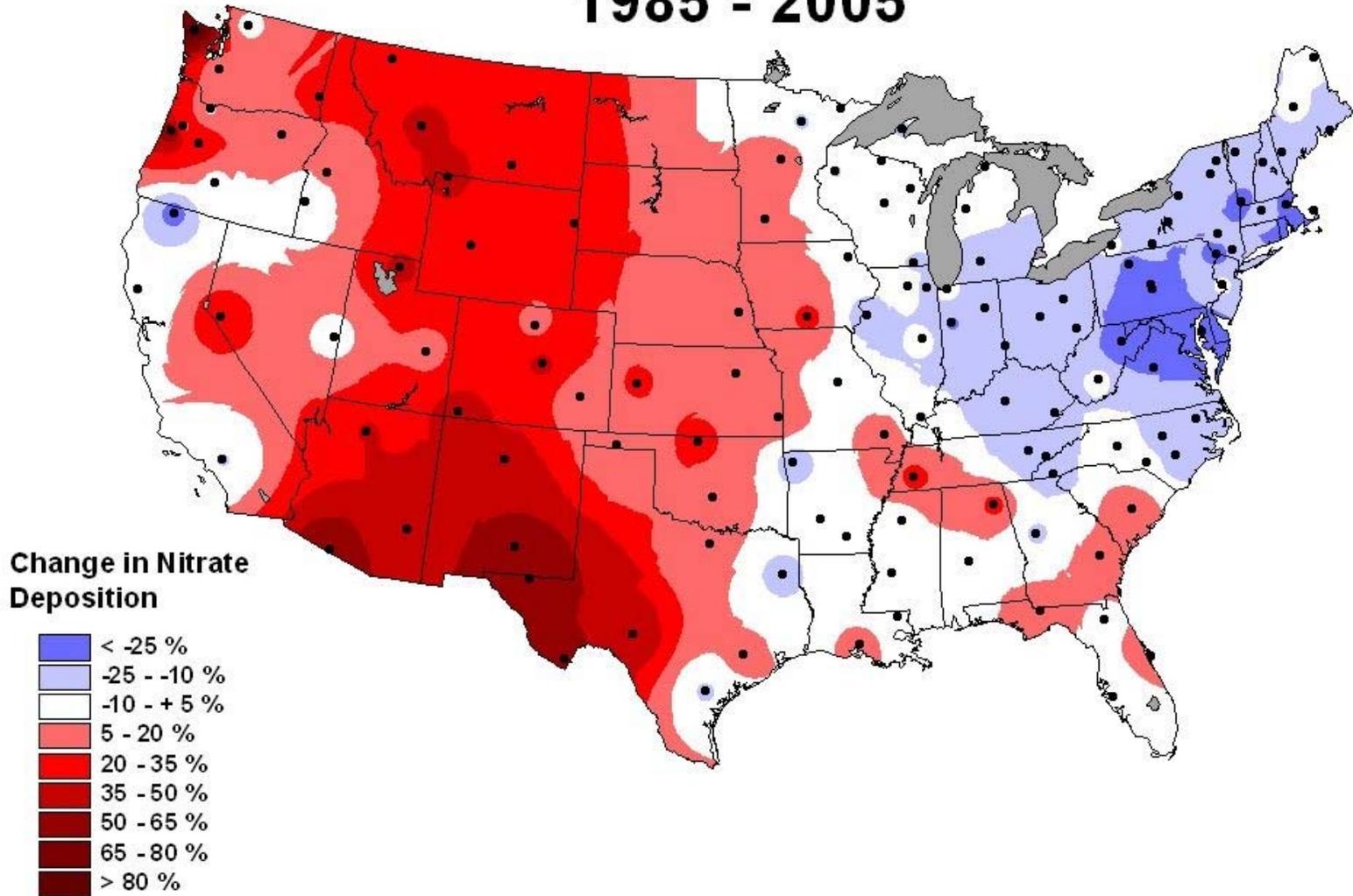
■ Period of record trend

- ◆ (Sen slope estimator * years of record)/average concentration in the first three years of the analysis

Nitrate Trends in Precipitation

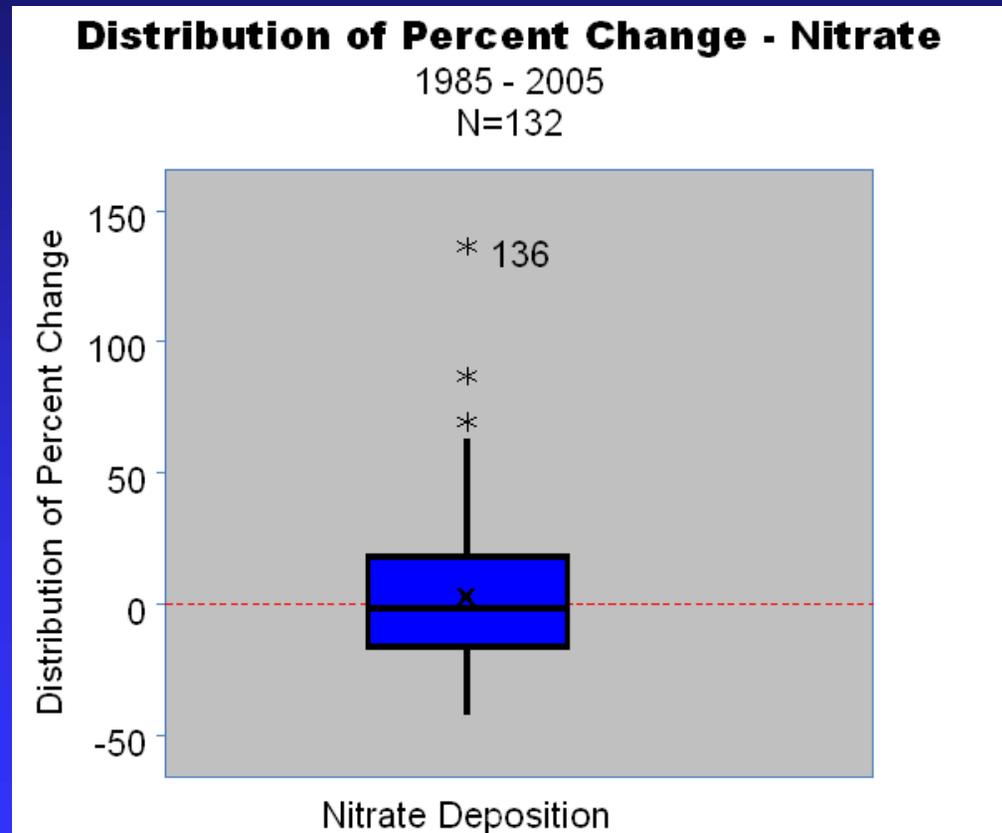


Percent Change in Nitrate Deposition 1985 - 2005

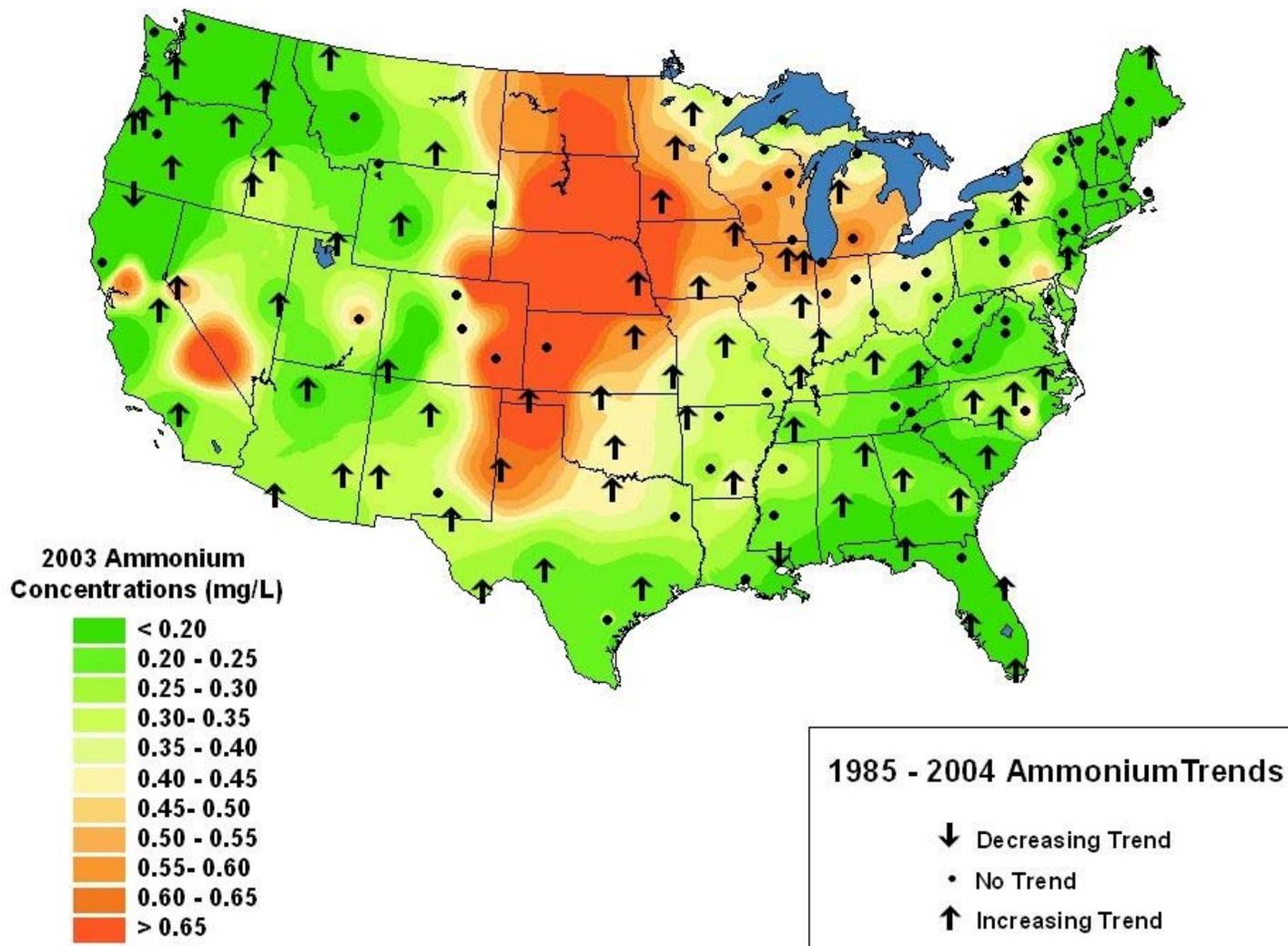


Summary – U.S. Nitrate Trends in Precipitation, 1985-2005

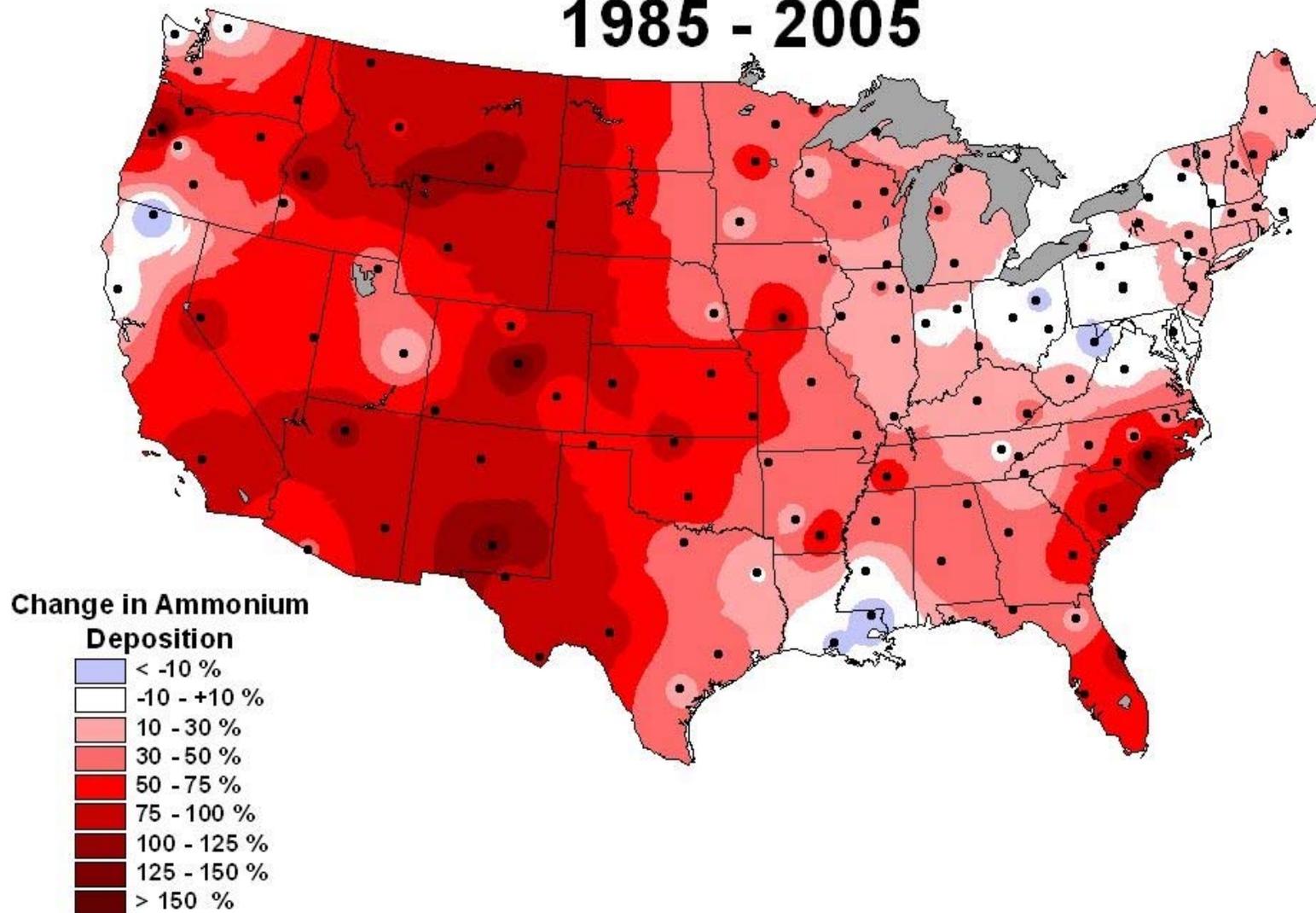
Median Change	-1.5 %
Mean Change	+2.9 %
# of Sites with Positive Trend	25
# of Sites with No Trend	74
# of Sites with Negative Trend	33



Trends in Ammonium Concentration

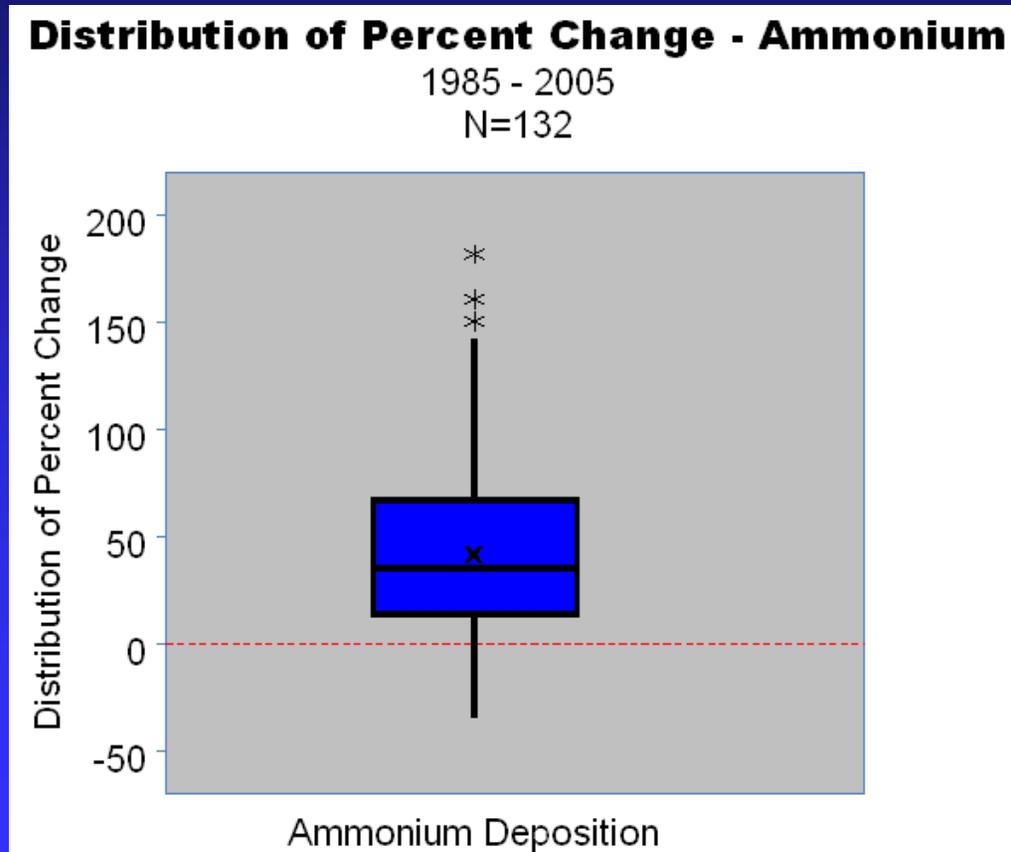


Percent Change in Ammonium Deposition 1985 - 2005

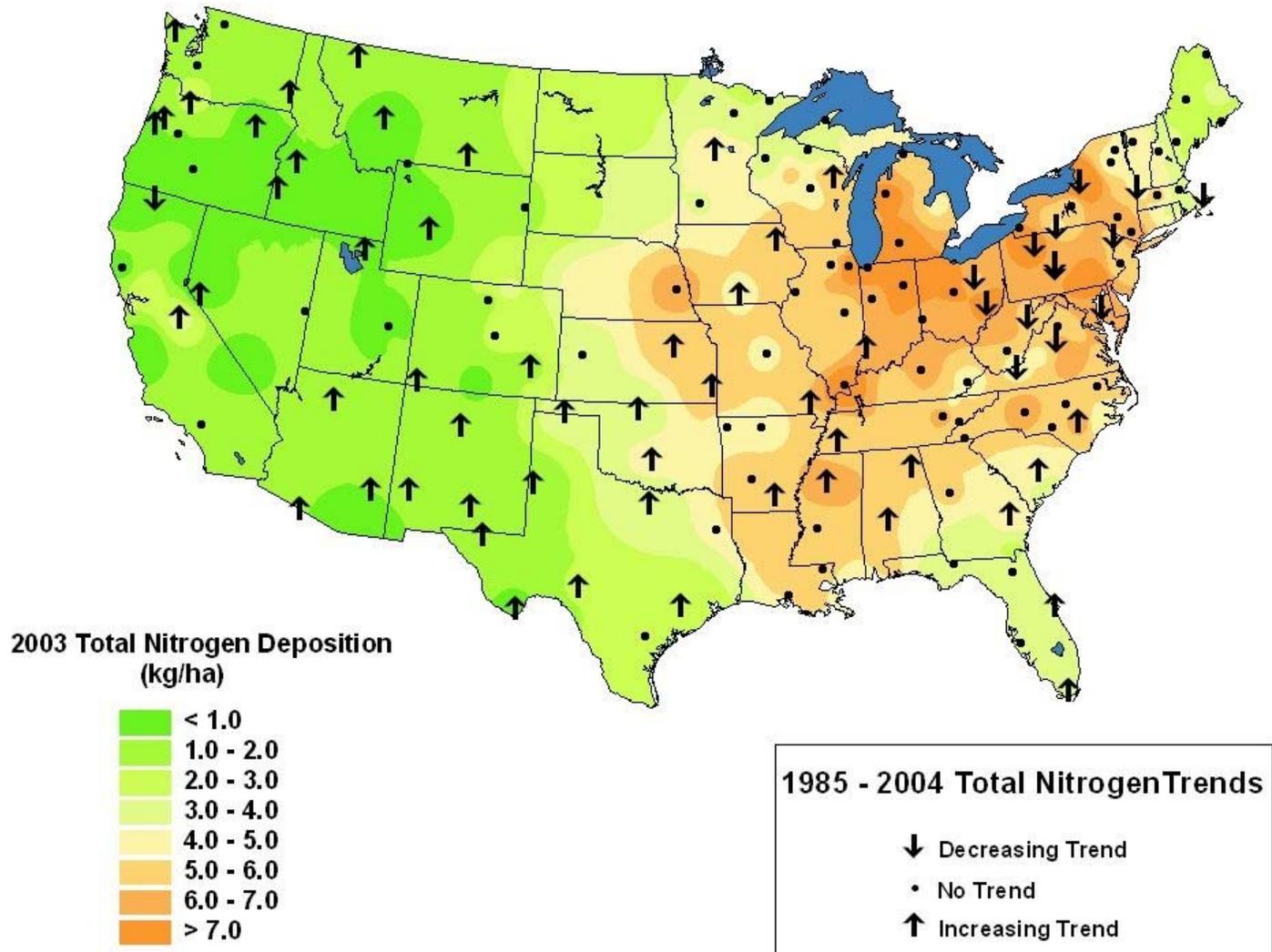


Summary – Ammonium Trends in Precipitation, 1985-2005

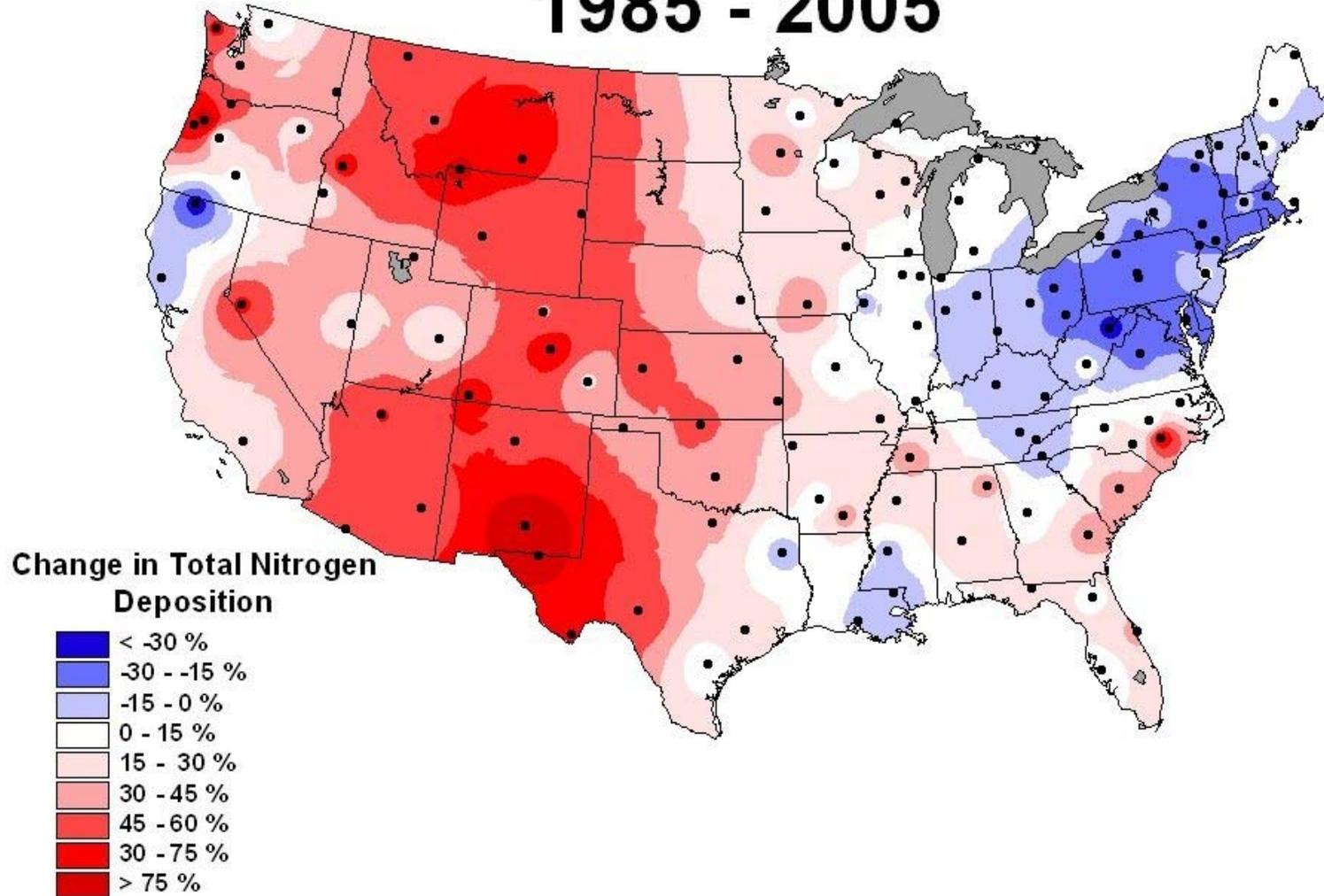
Median Change	+ 35 %
Mean Change	+ 42 %
# of Sites with Positive Trend	80
# of Sites with No Trend	50
# of Sites with Negative Trend	2



Trends in Total Inorganic Nitrogen

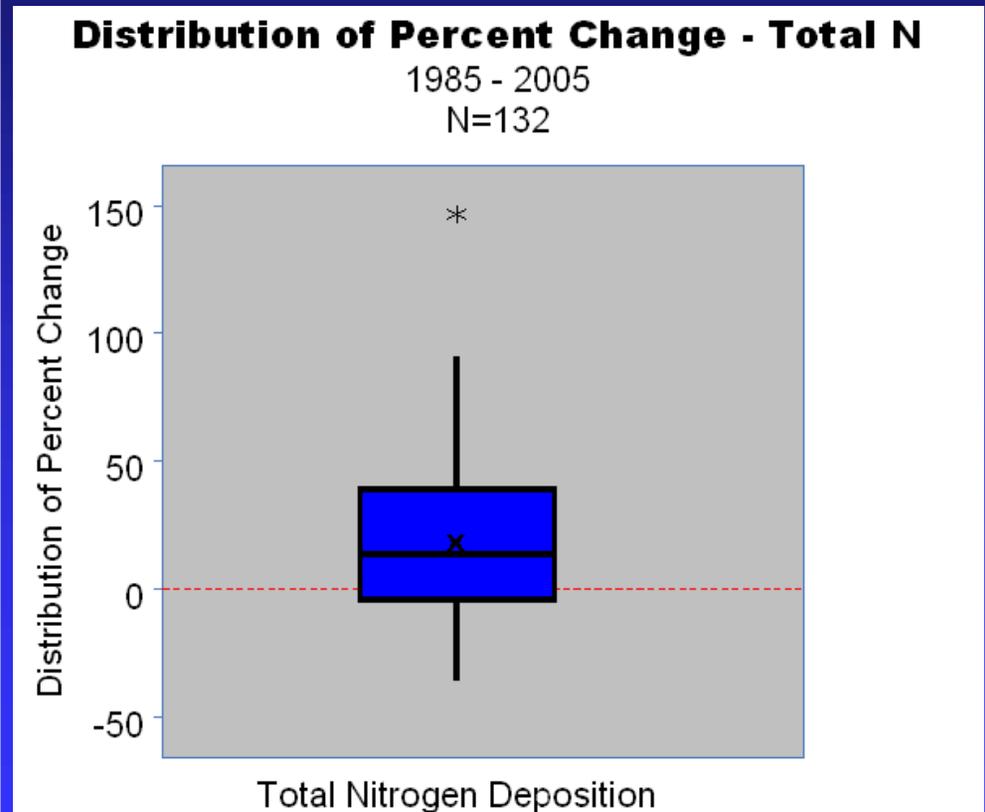


Percent Change in Total N Deposition 1985 - 2005



Summary – Total Nitrogen Trends in Precipitation, 1985-2005

Median Change	+ 13 %
Mean Change	+ 19 %
# of Sites with Positive Trend	52
# of Sites with No Trend	66
# of Sites with Negative Trend	14



Summary - Trends

- On a national basis, nitrate concentrations in precipitation have changed little in the United States since the mid 1980's.
 - ◆ The median change of 132 NADP sites is -1.5% over 20 years.
- Regionally, nitrate levels have increased in the western US, and declined in the northeast.

Summary - Trends

- On a national basis, ammonium concentrations in precipitation have increased markedly.
 - ◆ The median change of 132 NADP sites is +35% over 20 years.
- Regionally, ammonium levels have declined or remained unchanged in the northeastern U.S.

Summary - Trends

- On a national basis, inorganic nitrogen concentrations in precipitation have generally increased.
 - ◆ The median change of 132 NADP sites is +13% over 20 years.
- Regionally, inorganic N levels have increased in the west and southeast, and declined in the northeastern U.S.
- For nitrogen loading:
 - ◆ ammonium and nitrate deposition are now of roughly the same magnitude although geographically shifted.

On-line Resources

- <http://nadp.sws.uiuc.edu/>
 - ◆ Weekly, monthly, seasonal and annual averages for U.S. wet deposition
 - ◆ U.S. maps of deposition patterns
- <http://water.usgs.gov/ntn>
 - ◆ On-line reports for trends and environmental effects research
- <http://www.epa.gov/castnet/>
 - ◆ Data for a 70 site wet + dry deposition network

References

- Nilles, M.A. and Conley. B.E., 2001, Changes in the Chemistry of Precipitation in the United States, *Water, Air and Soil Pollution*, **130**:409-414
- National Atmospheric Deposition Program, 2004, 2003 Annual Summary, Illinois State Water Survey, Champaign, IL