

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

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U.S. Geological Survey

What Is Atmospheric Deposition

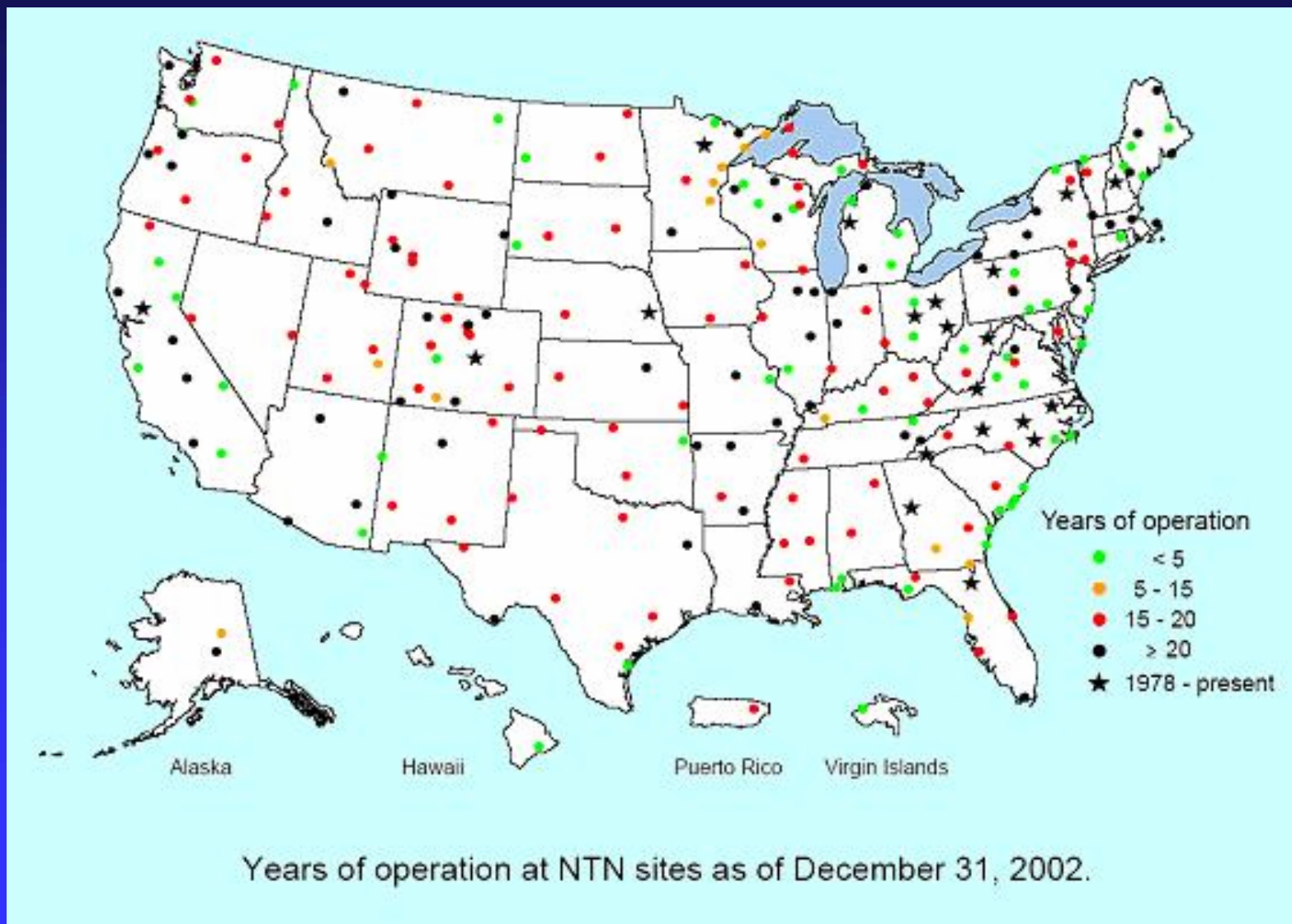
■ Wet Deposition

- ◆ The process of removing gases and particles from the atmosphere by rain, snow, sleet, or fog

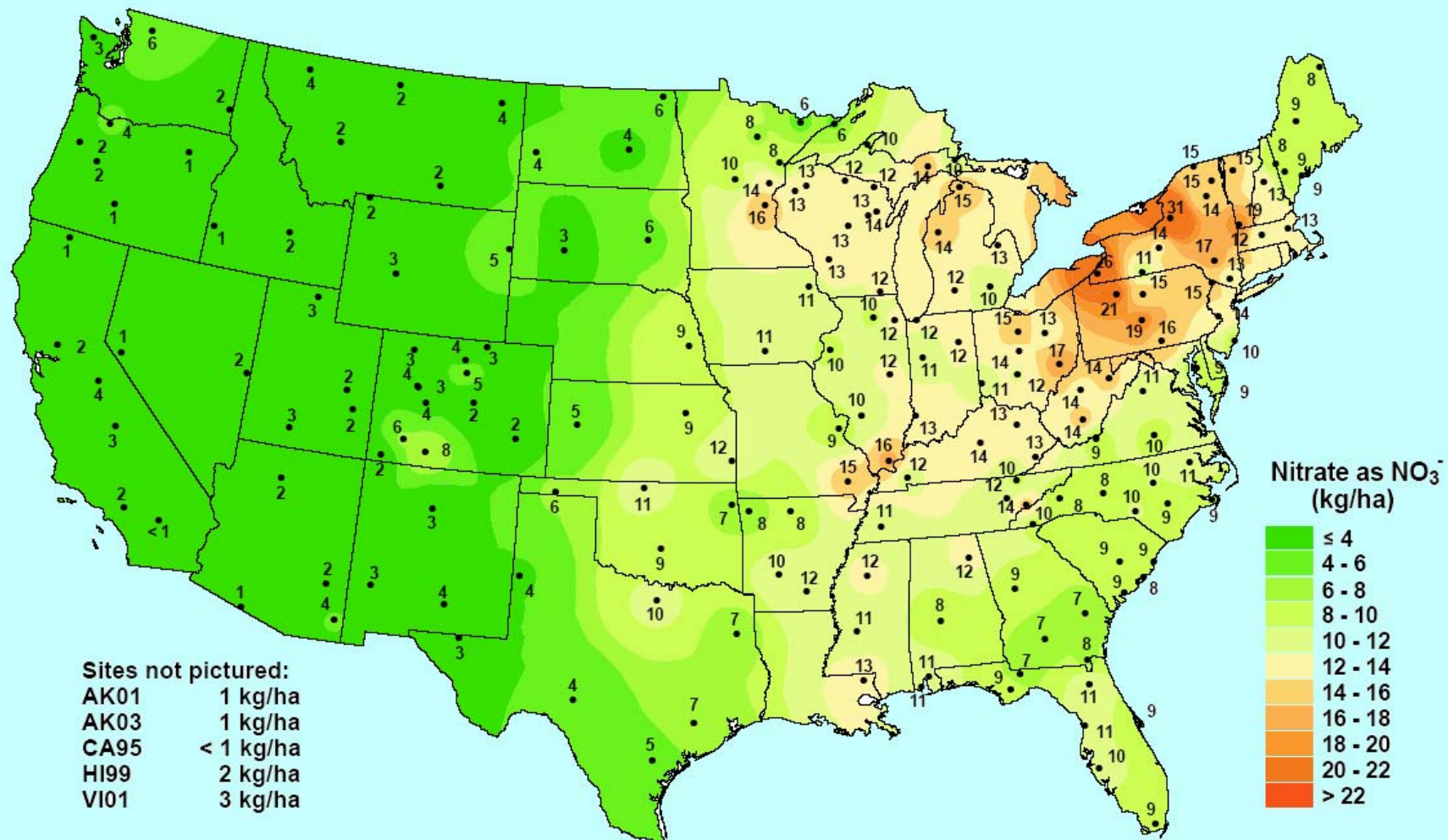
■ Dry Deposition

- ◆ The process through which gases and particles are removed from the atmosphere in the absence of precipitation
 - ◆ Gravity
 - ◆ Vegetation

NADP-National Trends Network

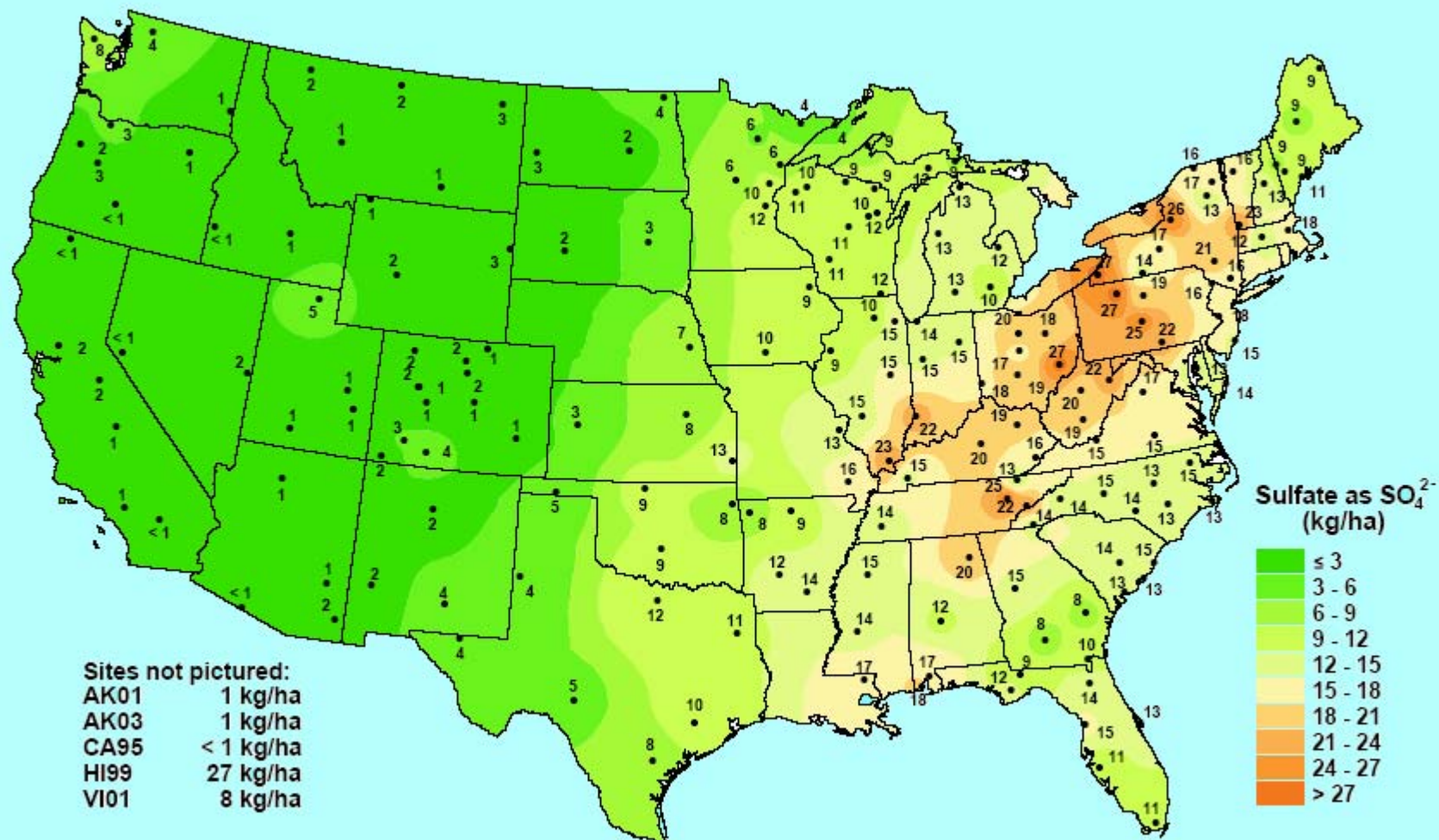


Nitrate ion wet deposition, 2002



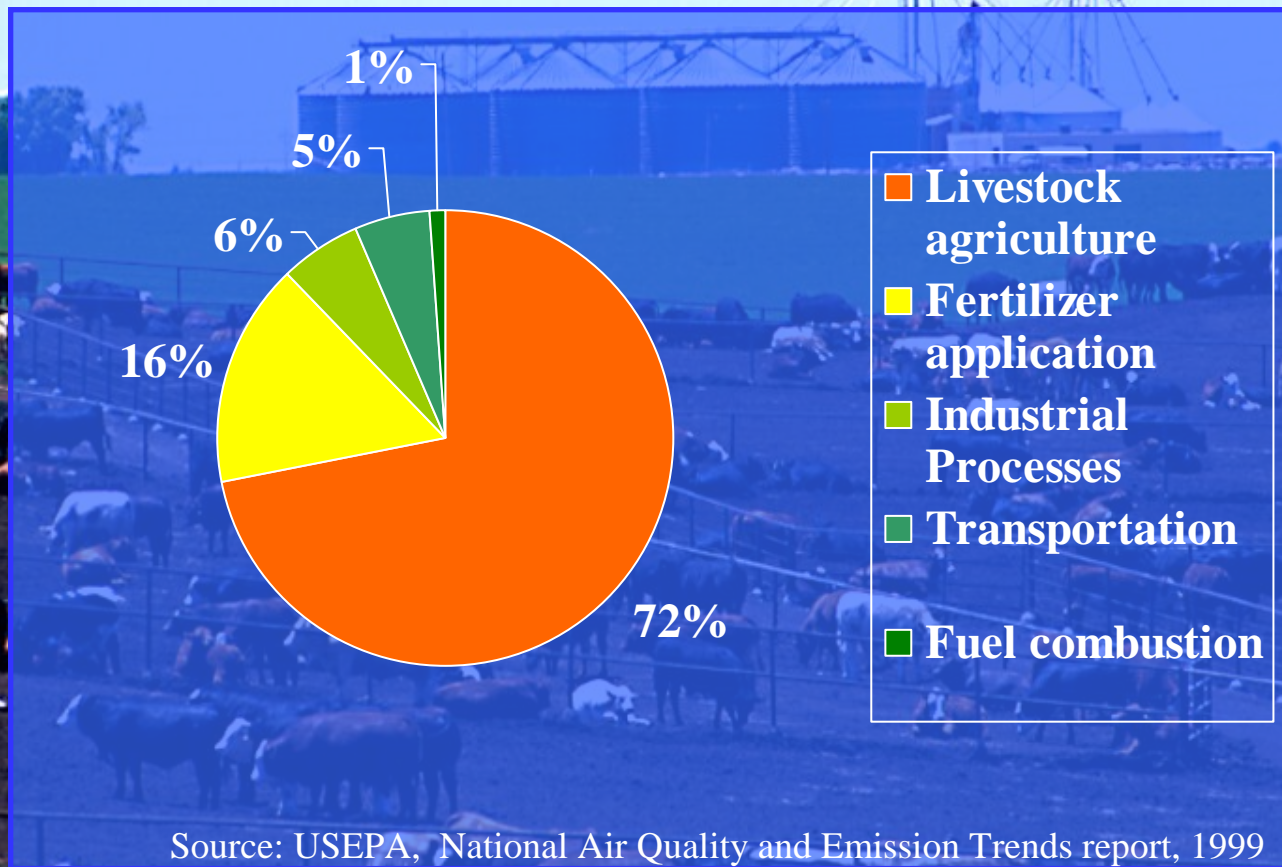
National Atmospheric Deposition Program/National Trends Network

Sulfate ion wet deposition, 2002

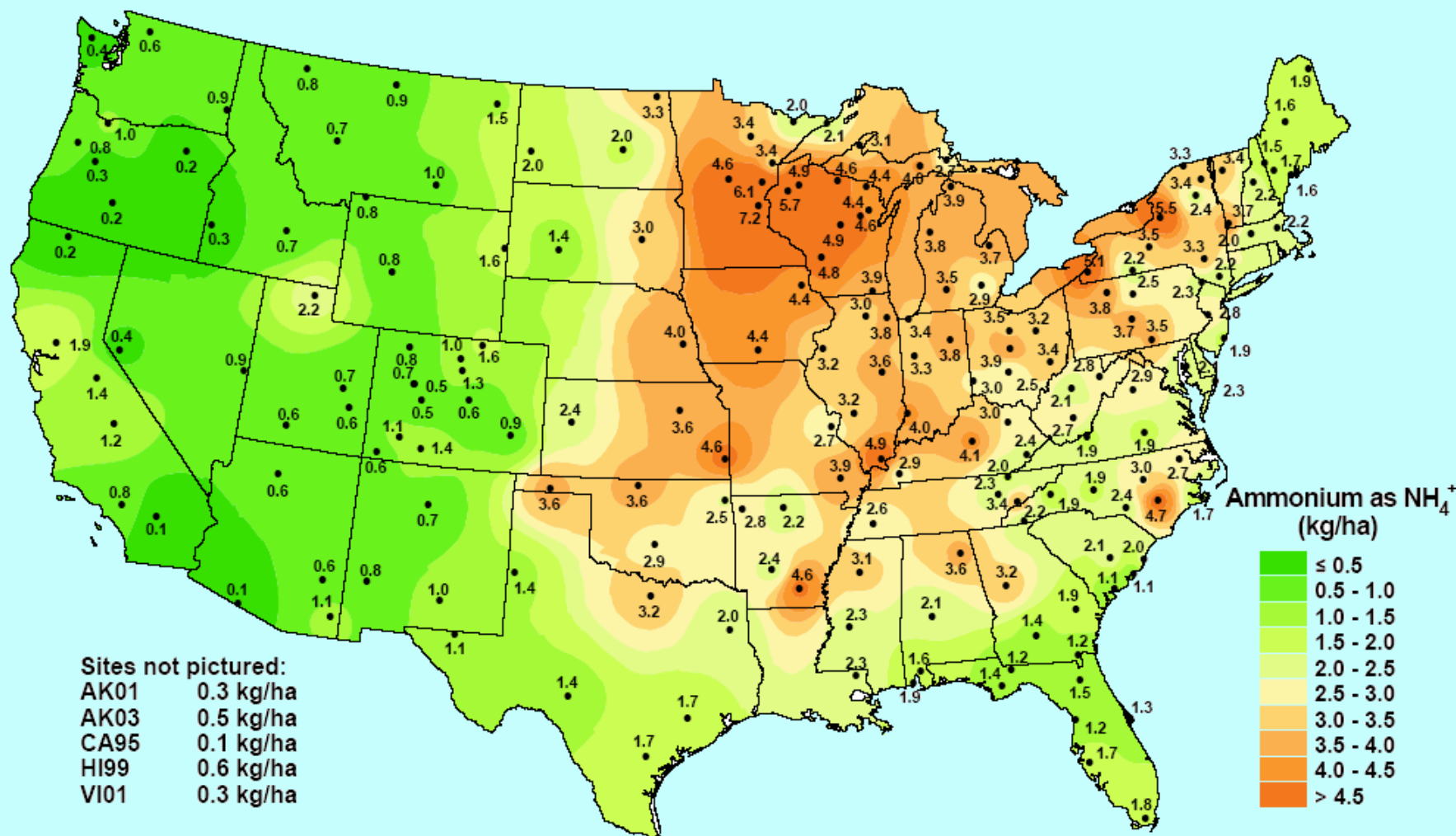


National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Sources of U.S. Anthropogenic Ammonia Emissions -1999

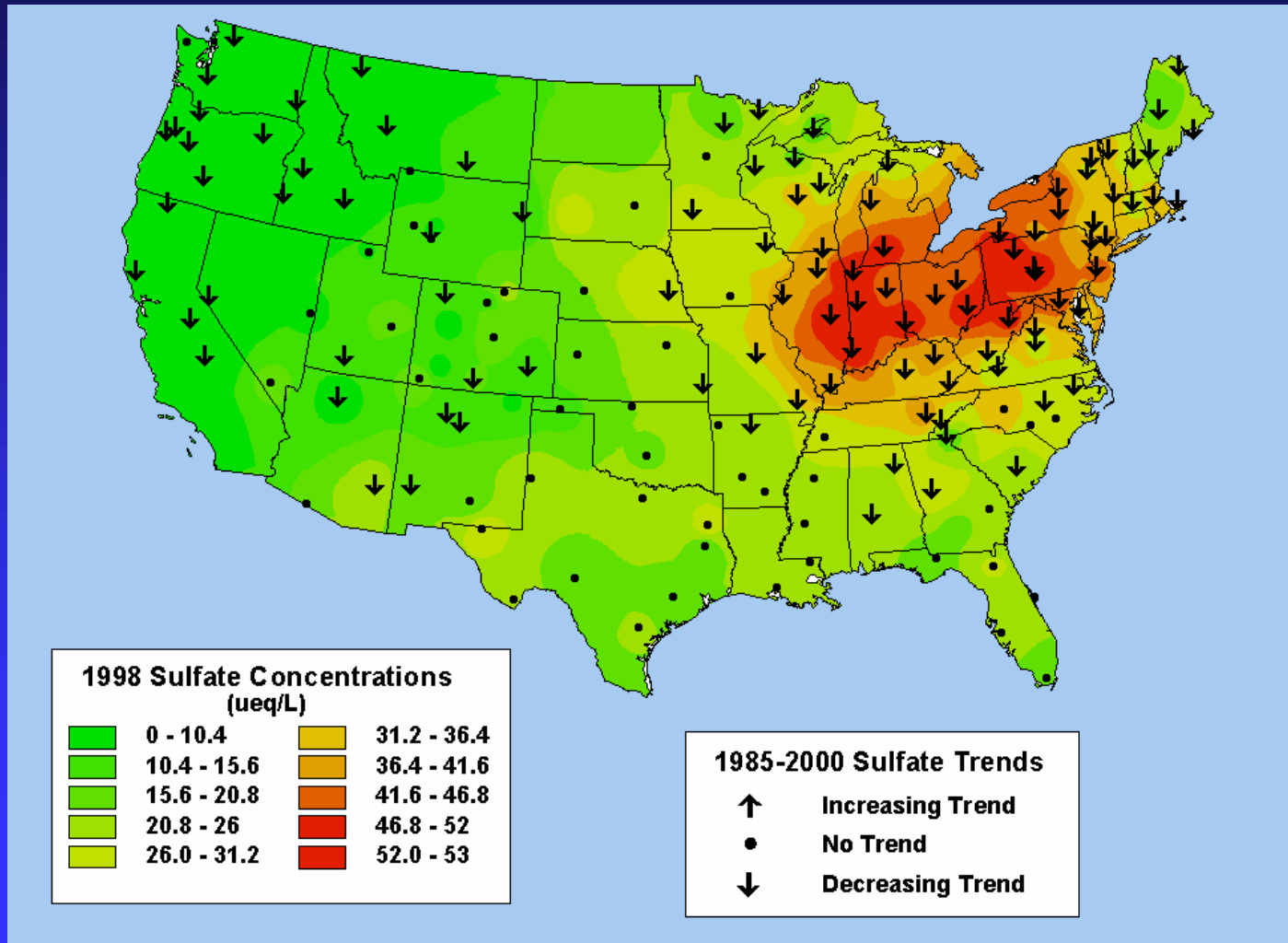


Ammonium ion wet deposition, 2002



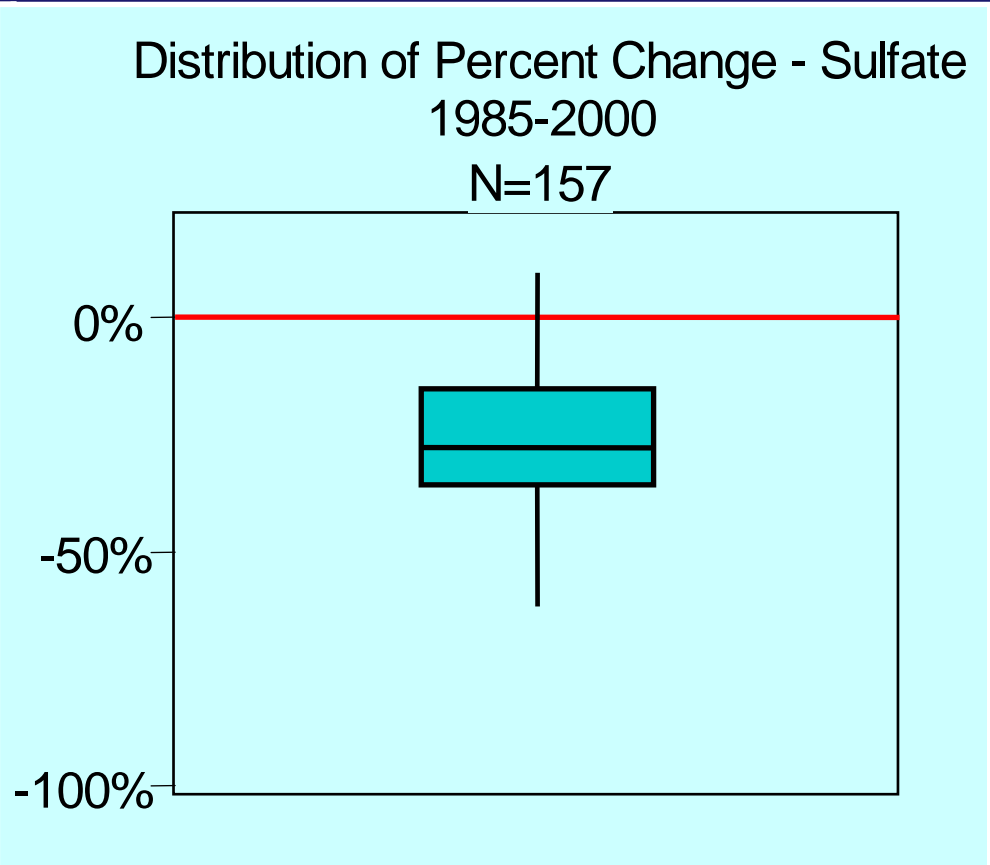
National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Trends in Sulfate in Precipitation 1985-2000



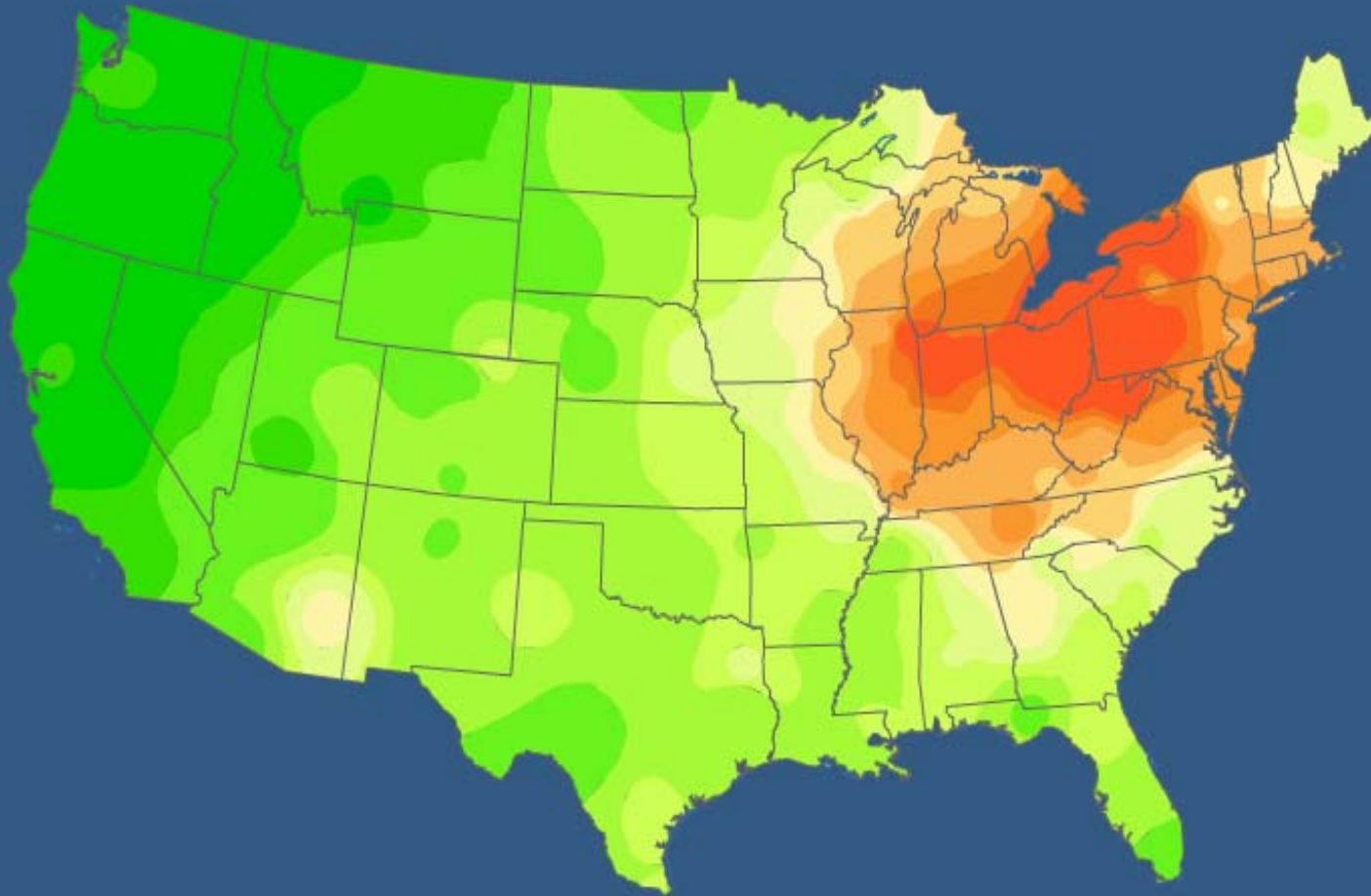
Summary – U.S. Sulfate Trends in Precipitation, 1985-2000

Median Change	-28%
# Sites with positive trend	0
# Sites with negative trend	92
Sites with no trend	65



Sulfate Ion Concentrations

1985-2000

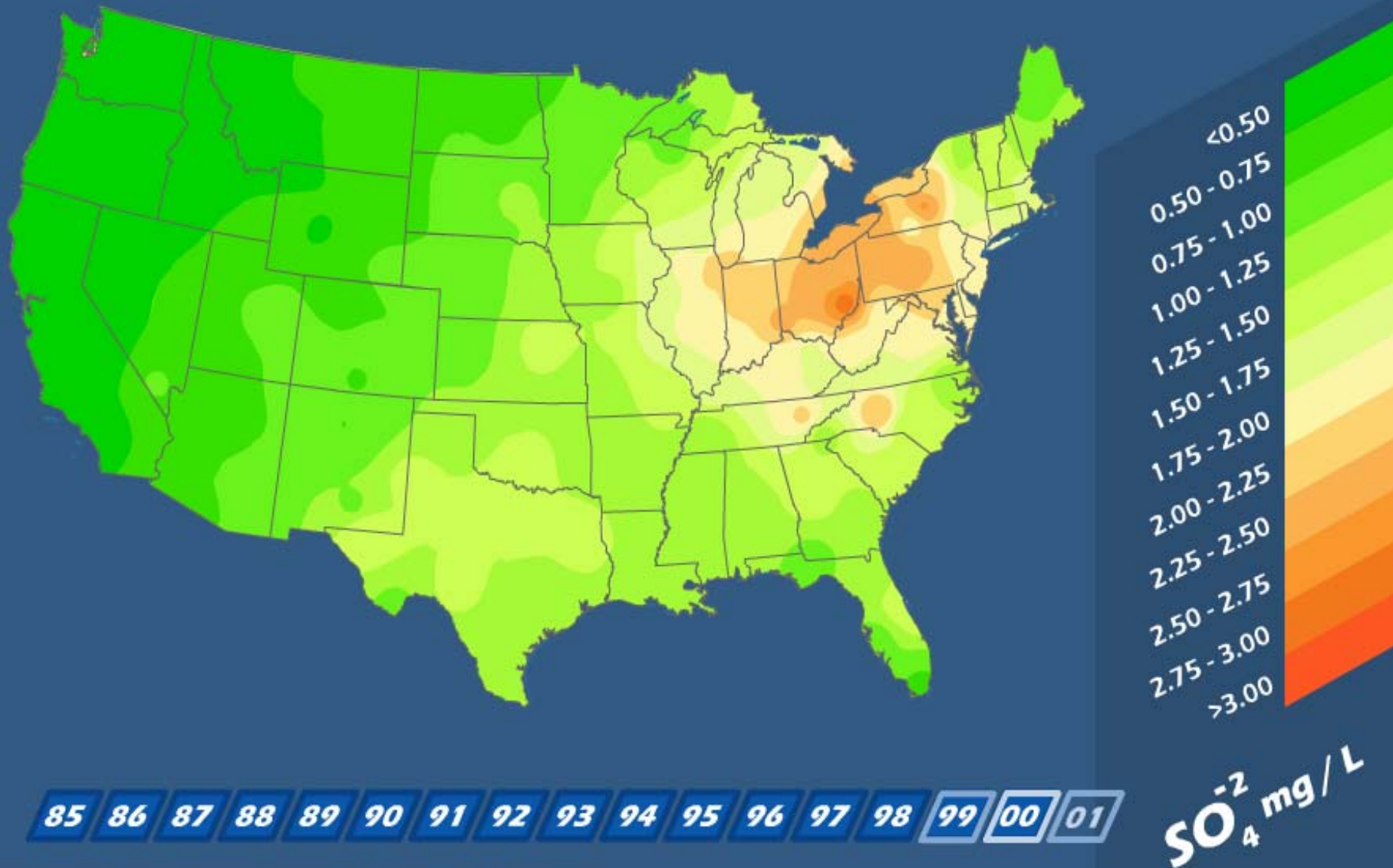


<math>< 0.50</math>
$0.50 - 0.75$
$0.75 - 1.00$
$1.00 - 1.25$
$1.25 - 1.50$
$1.50 - 1.75$
$1.75 - 2.00$
$2.00 - 2.25$
$2.25 - 2.50$
$2.50 - 2.75$
$2.75 - 3.00$
>3.00

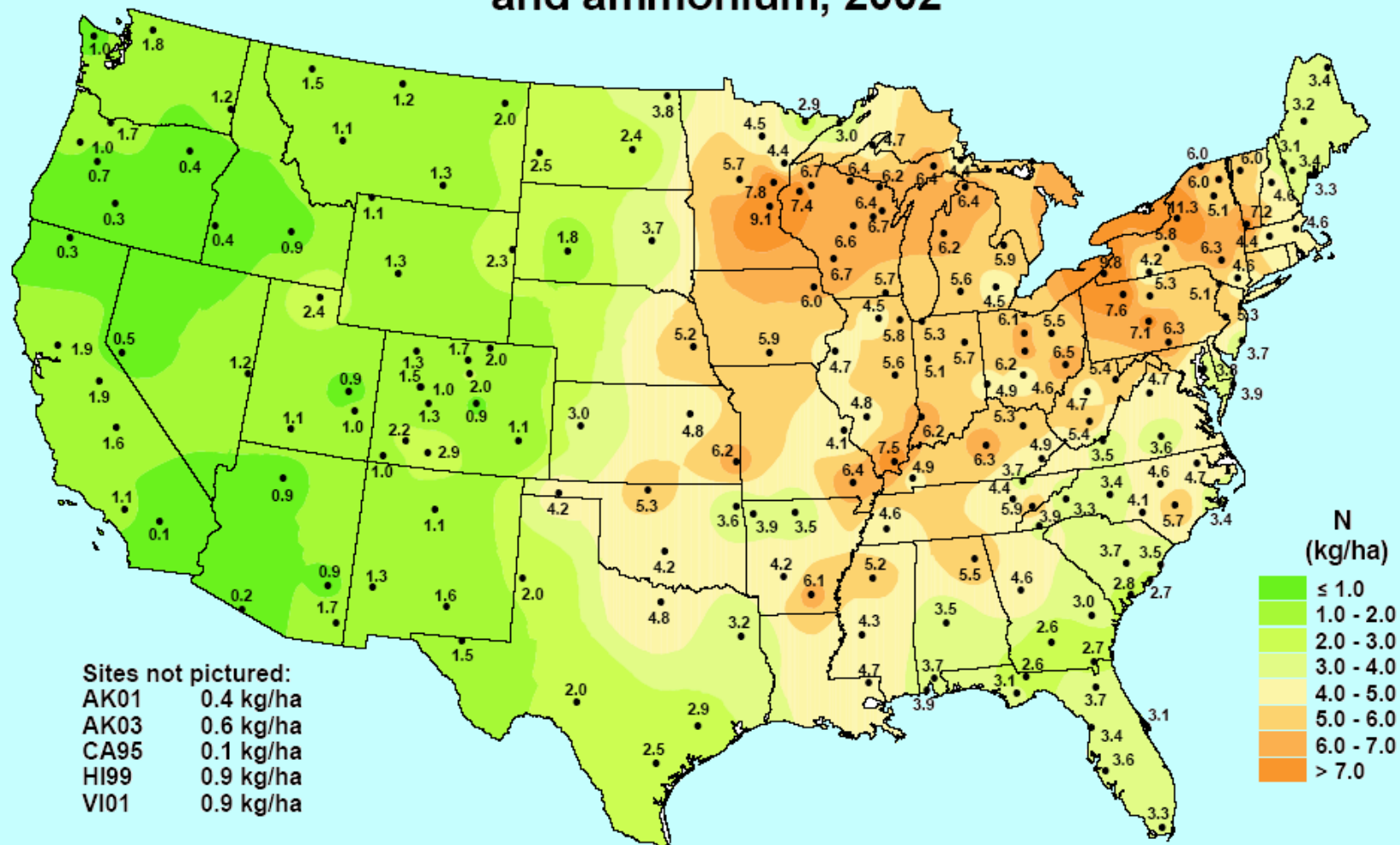
84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00

SO_4^{-2} mg / L

Sulfate Ion Concentrations 1985-2000



Inorganic nitrogen wet deposition from nitrate and ammonium, 2002

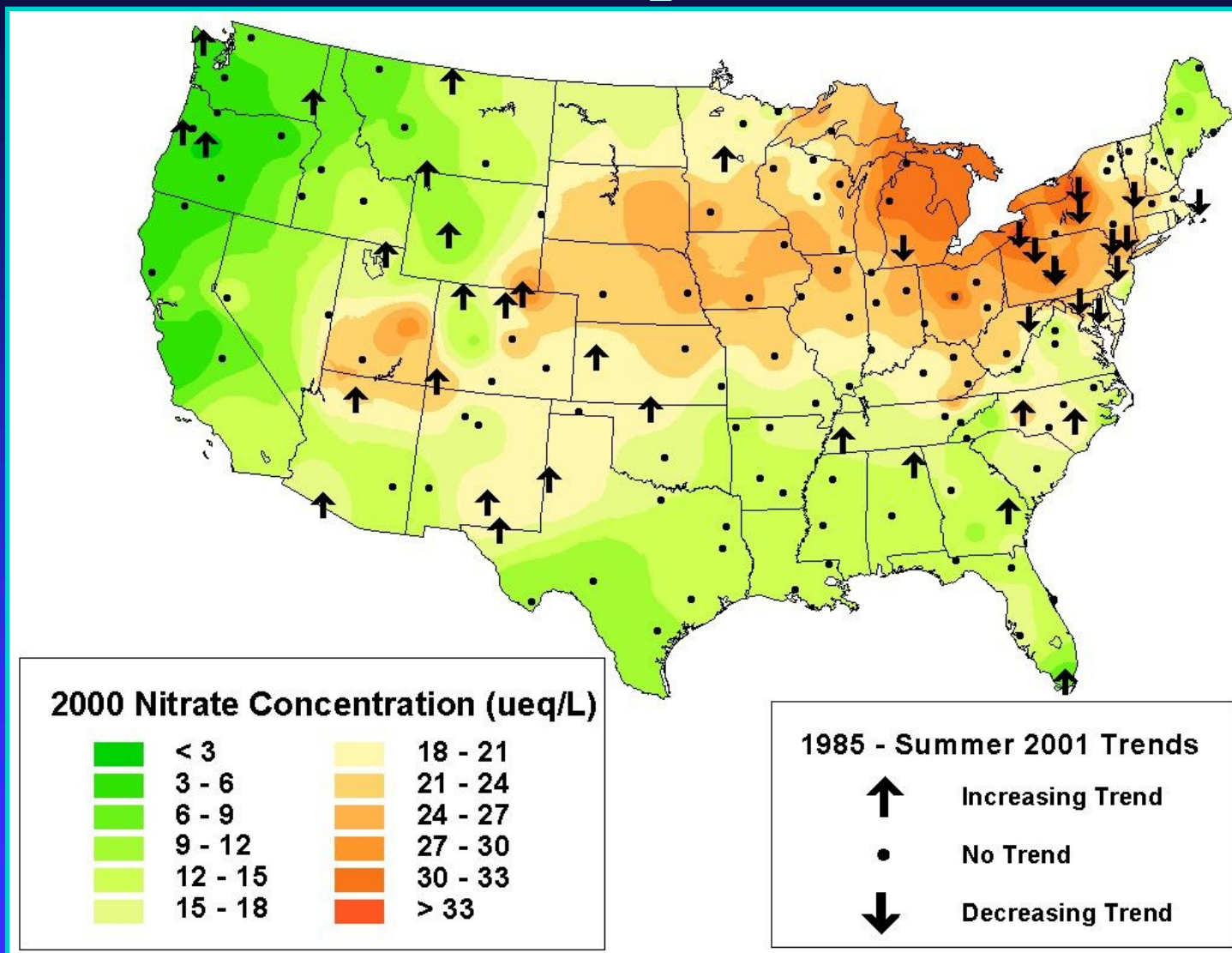


National Atmospheric Deposition Program/National Trends Network

Atmospheric N as % of total N input to selected systems

Long Island Sound	19%
Barnegat Bay	58%
Chesapeake Bay	23%
Galveston Bay	18%
Kansas-irrigated corn	<5%
Mississippi River	<5%

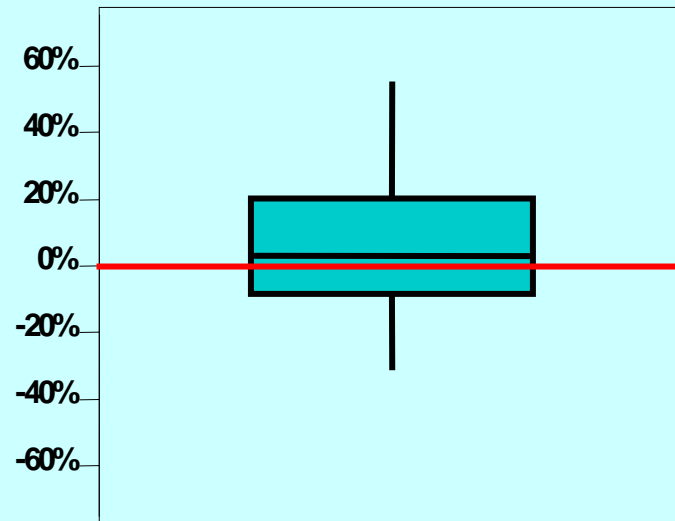
Nitrate Trends in Precipitation, 1985-2001



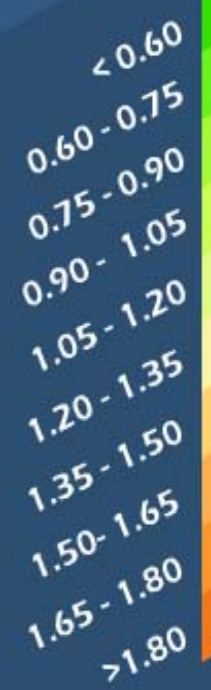
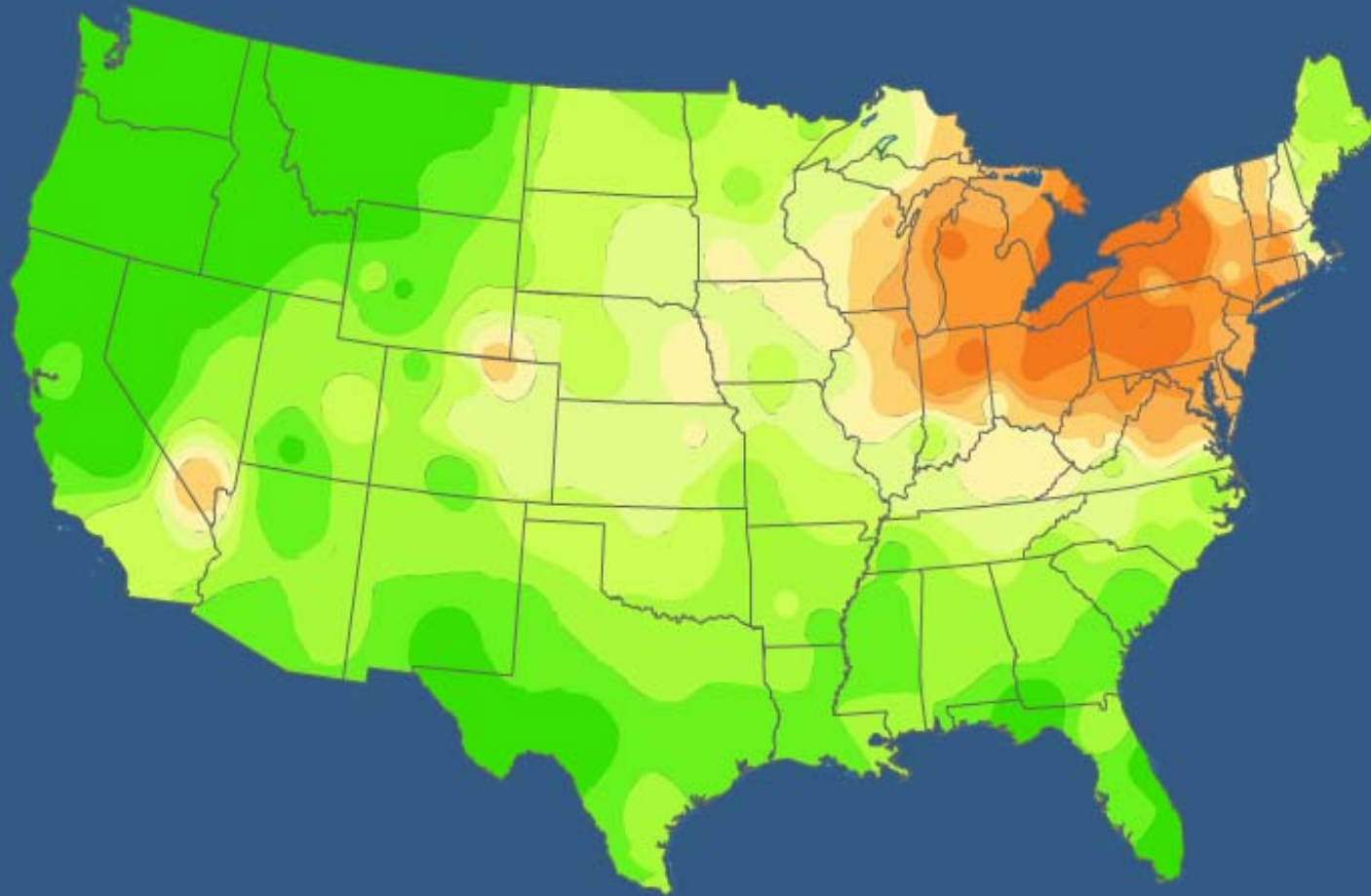
Summary – U.S. Nitrate Trends in Precipitation, 1985-2001

Median Change	+3.0%
# Sites with positive trend	24
# Sites with negative trend	14
Sites with no trend	111

**Distribution of Percent Change - Nitrate
1985-2001
N=149**



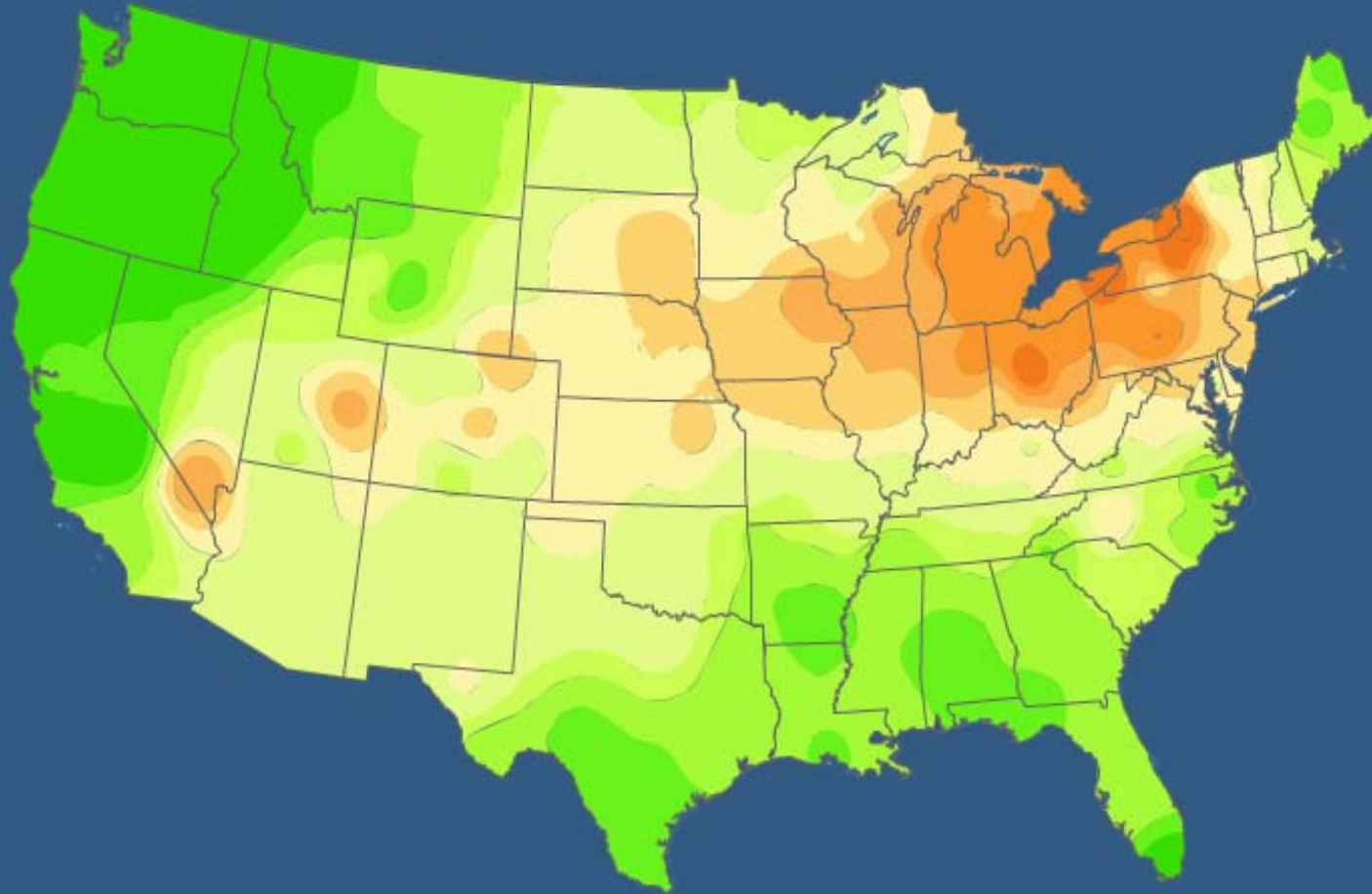
Nitrate Ion Concentrations 1985-2000



NO₃⁻ mg / L

Nitrate Ion Concentrations

1985-2000

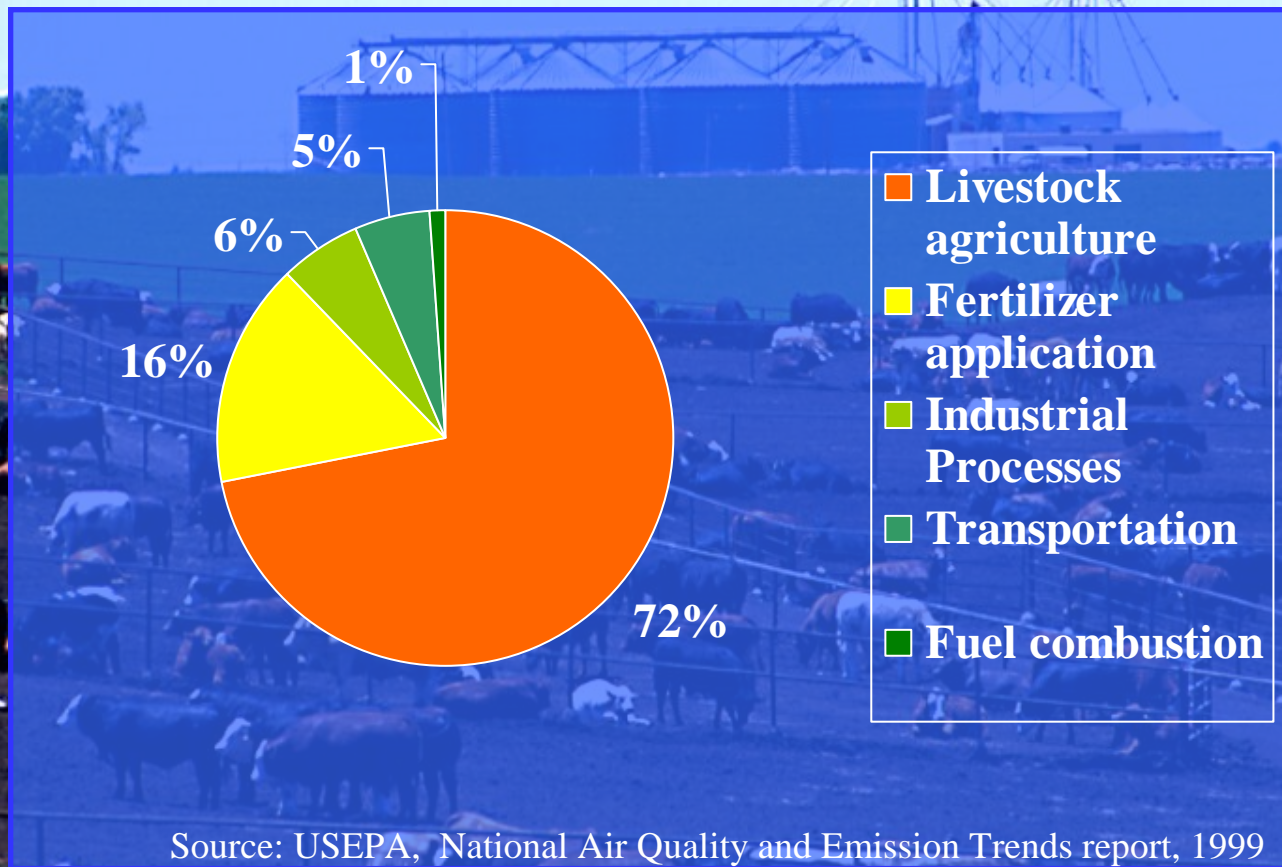


< 0.60
0.60 - 0.75
0.75 - 0.90
0.90 - 1.05
1.05 - 1.20
1.20 - 1.35
1.35 - 1.50
1.50 - 1.65
1.65 - 1.80
> 1.80

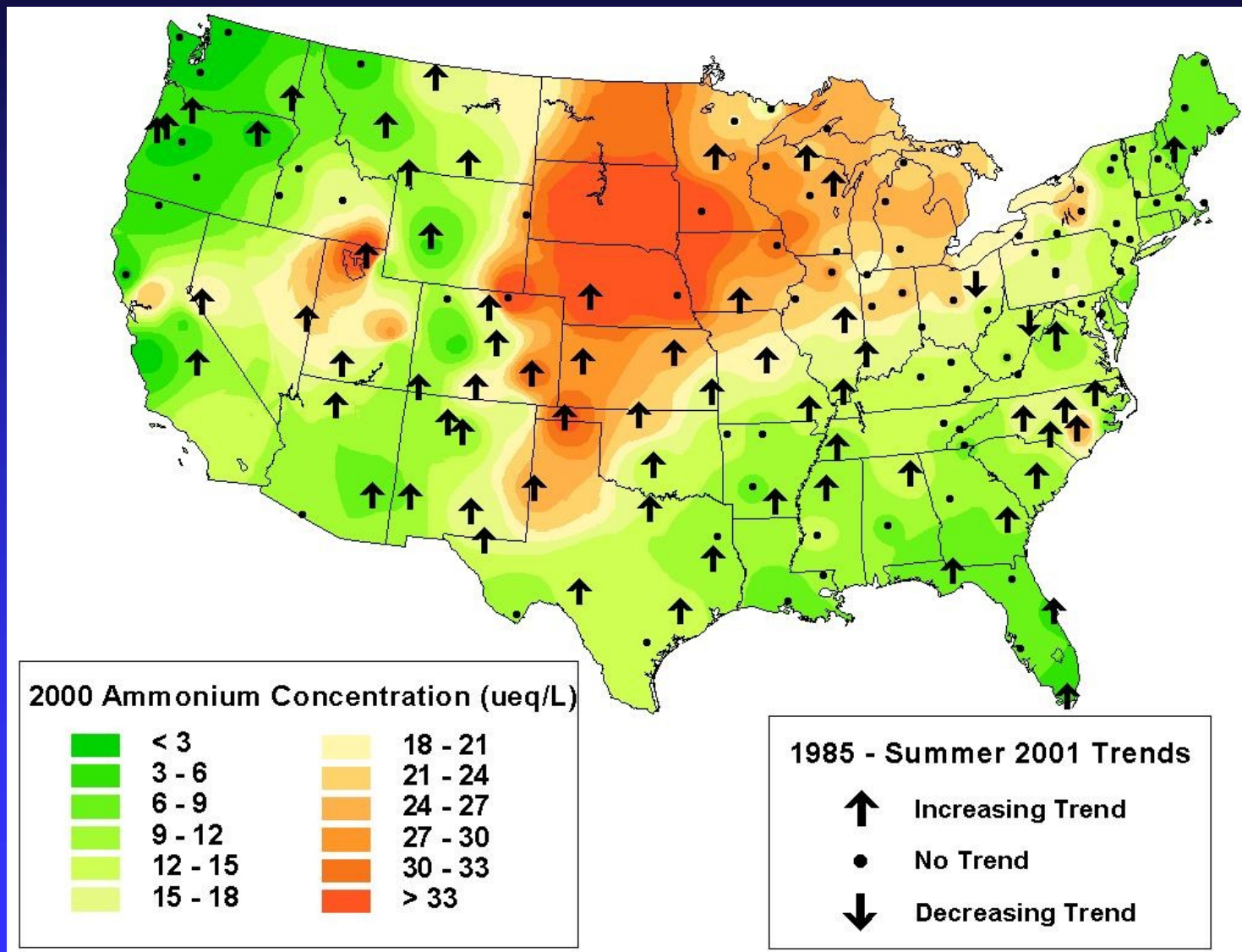
NO_3^- mg / L

85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01

Sources of U.S. Anthropogenic Ammonia Emissions -1999



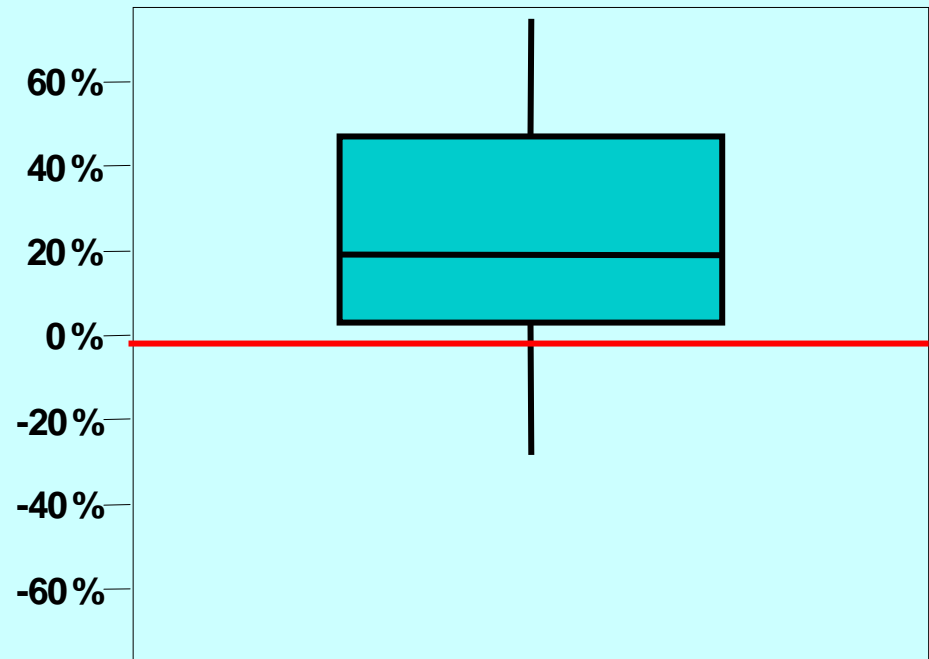
Trends in Ammonium Concentration 1985-2001



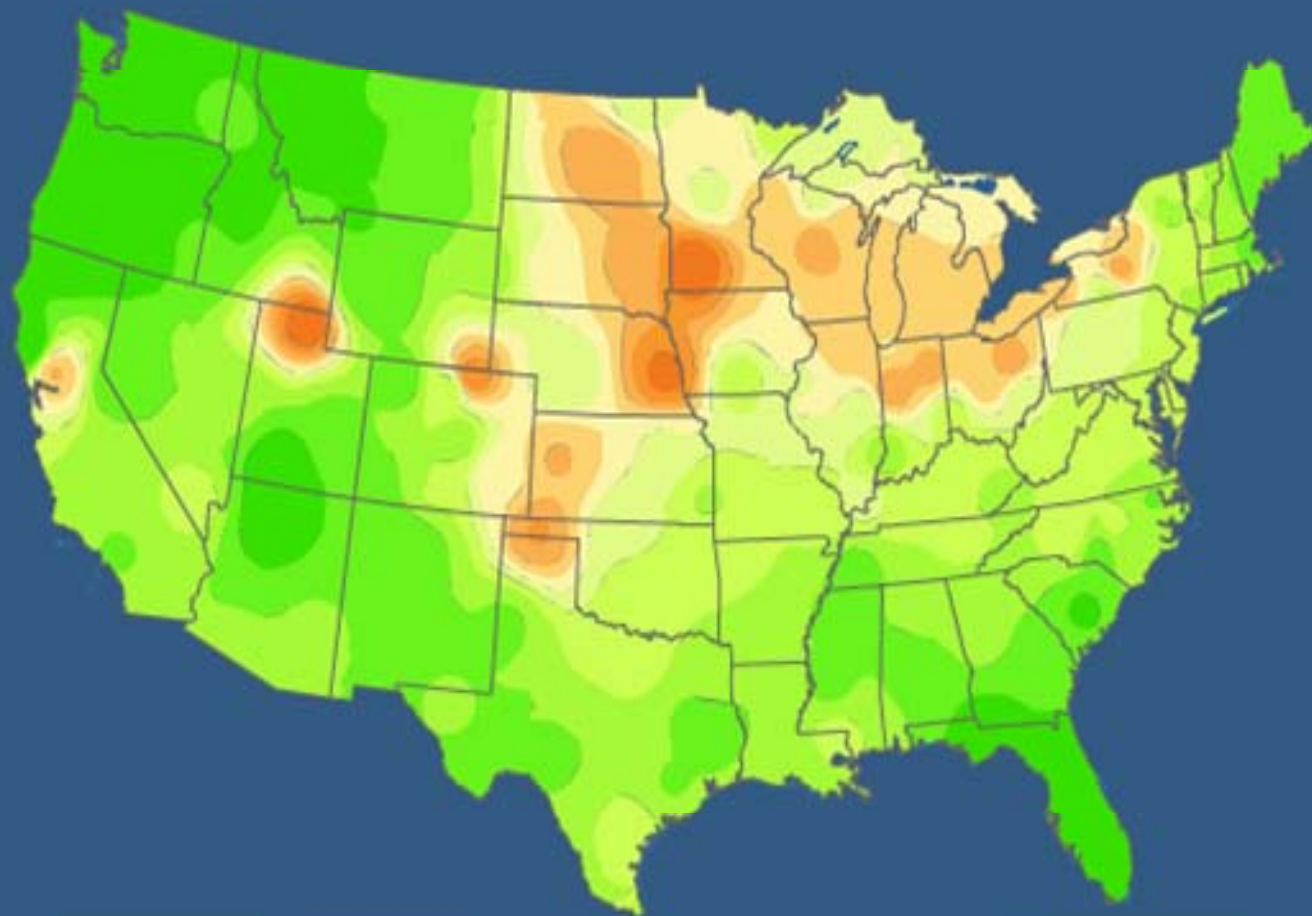
Summary – Ammonium Trends in Precipitation, 1985-2001

Median Change	+19.1%
# Sites with positive trend	64
# Sites with negative trend	2
Sites with no trend	83

**Distribution of Percent Change -Ammonium
1985-2001
N=149**



Ammonium Ion Concentrations 1985-2001



<math>< 0.10</math>
$0.10 - 0.15$
$0.15 - 0.20$
$0.20 - 0.25$
$0.25 - 0.30$
$0.30 - 0.35$
$0.35 - 0.40$
$0.40 - 0.45$
$0.45 - 0.50$
$0.50 - 0.55$
>0.55

START

PAUSE

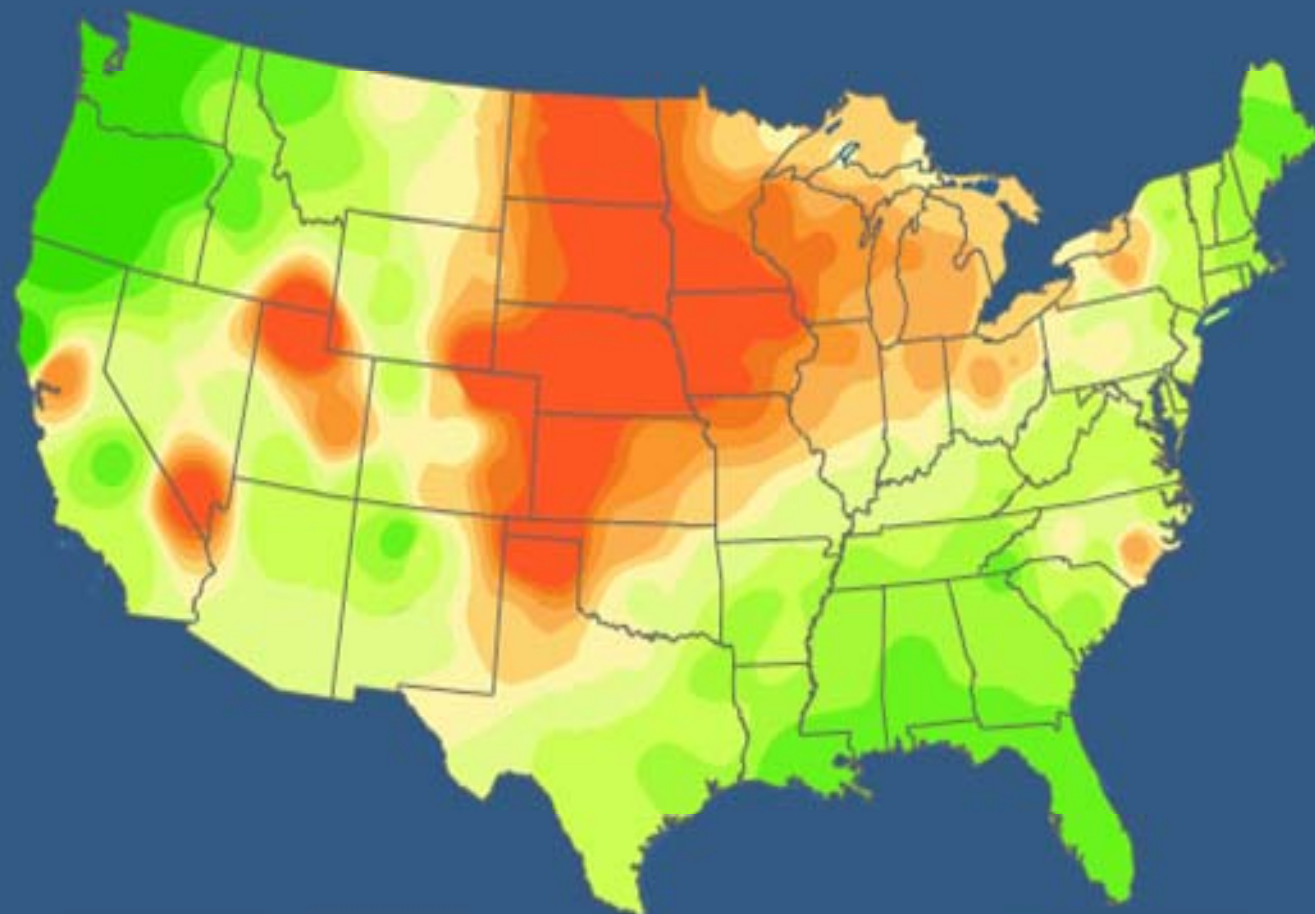
help

show ueq/L

84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01

NH_4^+ mg/L

Ammonium Ion Concentrations 1985-2001



<math>< 0.10</math>
$0.10 - 0.15$
$0.15 - 0.20$
$0.20 - 0.25$
$0.25 - 0.30$
$0.30 - 0.35$
$0.35 - 0.40$
$0.40 - 0.45$
$0.45 - 0.50$
$0.50 - 0.55$
>0.55

START

PAUSE

help

show ueq/L

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

00

01

02

NH_4^+ mg/L

Summary - Trends

- On a national basis, sulfate concentrations in precipitation have decreased markedly in the United States since the mid 1980's.
 - ◆ Overall, the median decrease was -28%

Summary - Trends

On a national basis, nitrate concentrations in precipitation have changed little in the United States since the mid 1980's. Overall, the median increase was 3%

- ◆ Regionally, nitrate levels have increased in the intermountain west, and decreased in the northeast.

Summary - Trends

- Ammonium concentrations have increased significantly nation-wide, except for an area of the Northeast. Overall, the median increase was 19%.

Summary

- For nitrogen delivery:
 - ◆ 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
 - ◆ This presentation
- <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, 2002, 2003 Annual Summary, NADP Data Report 2001-02, Illinois State Water Survey, Champaign, IL