Estimation of Nitrogen Deposition in Precipitation from Historical Studies, 1958 - 1984

Amy Ludtke & Jo Ann Gronberg 10/22/2014
USGS National Water Quality Assessment (NAWQA) Program
Long Term Trends Team

- **GOAL** Analyzing long-term changes in nitrogen deposition for surface and ground water studies on a national basis
  - The USGS NAWQA Trends Team is looking at trends that cover the years of 1972-2012 (40 years!) for ~ 70 constituents
  - Wanted to include atmospheric deposition as one of the components in the nitrogen trend analysis. Other components are fertilizer and manure.

- **PROBLEM** NADP NTN nitrogen loads maps date from 1985 to current, so we needed to find studies pre-dating the NADP
An Analysis and Assessment of US-1010 Measurements (1972-1982), a Subset of the National Precipitation Sampling Network.

R. S. Artz
J. W. Miller

Air Resources Laboratory
Silver Spring, Maryland
February 1983

Chemistry of United States Precipitation.

Final Report on the National Precipitation Sampling Network.

J.P. Lodge, Jr.
J.B. Pate
W. Basbergill
G.S. Swanson

K.C. Hill
E. Lorange
A.L. Lazrus

August 1968

NOAA Technical Memorandum ERL ARL-135

Transactions
American Geophysical Union

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NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

USGS
Literature Search for Past Studies

National Coverage

• Air Force Cambridge Research Center’s study from 1955-1956, by Junge
• Public Health Service and the National Center for Atmospheric Research from 1960-1966, by Lodge
• NOAA-EPA-WMO study from 1972-1982
• National Atmospheric Deposition Program from 1978-1984

Regional Coverage

• USGS North Carolina and Virginia, 1962-1963
• USGS Northeastern US, 1966-1968
• Multistate Atmospheric Power Production Pollution Study (MAP3S) 1976-1992
• NADP AirMoN, 1992-2012
Old Studies Did Not Include Latitude, Longitude, or Precipitation Volumes

• We knew that both Junge and Lodge sites were located at NOAA NWS stations, usually near small municipal airports.

• Junge study announcement listed abbreviations for sites, for example, “GI” translates to Grand Island.

• We estimated and interpolated latitude and longitude based on the most probable National Weather Service station operational during study period.
Data Reconstruction from Old Studies
Location of Network Sites

EXPLANATION
- NADP-NTN (1978 to present, sites as of 1984)
- NOAA-EPA-WMO (1972 to 1982)
- Lodge (1960 to 1965)
- Junge (1955 to 1956)
- NADP AirMon (1992 to present)
- MAP3S/PCN (1976 to 1990)
- Pearson (1966 to 1967)
- Gambell (1962 to 1963)
Then the messy job of transcribing data sets ...
Old Studies Did Not Include Precipitation Volumes, Critical for Loads Calculation

- Retrieved monthly precipitation volumes from the NOAA National Climatic Data Center (NCDC)
- We searched the NCDC data for the NWS station data
- When not available, we made substitutions, all of which is noted in the data tables
- NOAA-EPA-WMO data had latitudes/longitudes and precipitation volumes reported with the data
Final Inorganic N Loads
Calculations from Wet Deposition

• **Concentration Data** from data sets
• **Monthly Precipitation Volumes** from data sets of NCDC (Junge & Lodge)
• Reviewed and screened data. NADP NTN data had to meet completeness criteria adopted by network
• Calculated **Monthly Precipitation Weighted Concentrations**
• **PRISM** - Parameter-Elevation Regression on Independent Slopes Model Climate Group
• Calculated **Annual Inorganic N loads** from wet deposition
At this point we removed the following data sets:

- **All “Regional” Studies:**
  - USGS North Carolina and Virginia, 1962-1963
  - Multistate Atmospheric Power Production Pollution Study (MAP3S) 1976-1992 (lot of overlap w/ NADP)
  - NADP AirMoN, 1992-2012 (overlap of NADP)

- **NOAA-EPA-WMO Study:**
  - Sparse national coverage with only 9-11 sites
  - Pre-1980 data had higher deposition values noted that were attributed to sample evaporation and poor sample collector efficiency
  - Post-1980 data overlapped with NADP data, so redundant

- **NADP NTN 1978-1980:**
  - Sparse national coverage
# 3 National Studies in Final Analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Sites</th>
<th>Collection Method</th>
<th>Chemistry</th>
<th>Preserv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junge '55-'56</td>
<td>67</td>
<td>Event Based (Manual) Monthly</td>
<td>NO₃ NH₄</td>
<td>Toluene</td>
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<tr>
<td>Lodge '60-'66</td>
<td>33</td>
<td>Event Based (Automatic) Monthly</td>
<td>Inorganic N</td>
<td>Toluene</td>
</tr>
</tbody>
</table>
Sampler Picture from Lodge, 1960

- Lid cover
- Polyethylene bucket
- Thermostatically controlled precipitation sensing grid
Estimates of Inorganic Nitrogen Wet Deposition from Precipitation for the Conterminous United States, 1955–84

EXPLANATION
Junge (1955 to 1956)
Nitrogen deposition, in kilograms per hectare
- <1
- >1 to 2
- >2 to 3
- >3 to 4
- >4 to 5
- >5 to 6
- >6 to 7
- >7 to 8
- >8

- Junge site
- Junge site, not used for ammonium
EXPLANATION
NADP 1981
Nitrogen deposition, in kilograms per hectare

- Blue: <1
- Light blue: >1 to 2
- Medium blue: >2 to 3
- Medium gray: >3 to 4
- Yellow: >4 to 5
- Light orange: >5 to 6
- Orange: >6 to 7
- Dark orange: >7 to 8
- Red: >8

- Black dots: NADP site

Map showing nitrogen deposition across the United States, with varying shades indicating different deposition levels.
### All chemistry, precipitation, and map data available online

<table>
<thead>
<tr>
<th>Study</th>
<th>Tabular Dataset</th>
<th>Raster Map Datasets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junge (1955-1956)</td>
<td>NH$_4$, NO$_3$, Cl, Na, SO$_4$, Ca, &amp; K</td>
<td>1955-1956</td>
</tr>
<tr>
<td>NOAA-EPA-WMO (1972-1982)</td>
<td>NH$_4$, NO$_3$, Cl, Na, SO$_4$, Ca, K, Cond., &amp; H$^+$</td>
<td>NA</td>
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<tr>
<td>USGS Pearson (1971)</td>
<td>NH$_4$, NO$_3$, Cl, Na, SO$_4$, Ca, K, Bicarb, Cond., &amp; H$^+$</td>
<td>NA</td>
</tr>
</tbody>
</table>
Estimates of Inorganic Nitrogen Wet Deposition from Precipitation for the Conterminous United States, 1955–84

Full Report and appendices available:


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