History of Acid Rain Precipitation across the United States

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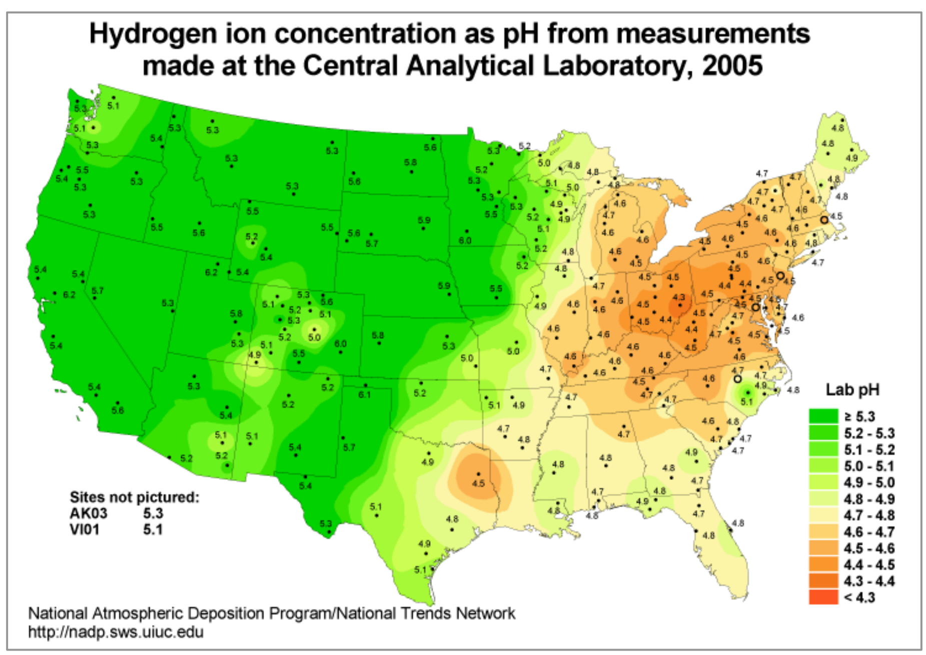
Chem 505
Pim #2

INTRODUCTION

Acid rain is the process of wet deposition of sulfate ions, nitrate ions, and to a lesser extent ammonium. While there are other compounds that lead to acid deposition, sulfate and inorganic nitrogen are the main focus because of there primary role in acidification of rain. The presence of these ions decrease the pH of the rain which causes stress to sensitive aquatic ecosystems and causes changes in the forest soil composition effecting terrestrial ecosystems as well. (1)(2) The 1970 and 1990 Clean Air Act Amendment have lead to reduced emissions of sulfur dioxide but have had little effect on inorganic nitrogen emissions.(2)

According to Hubbard Brook Research Foundation, “Importantly, the emission and atmospheric deposition of base cations that help counteract acid deposition have declined significantly since the early 1960s with the enactment of pollution controls on particulate matter.”(2) The base cation concentrations as measured in western national parks had no significant changes outside of the uncertainty of the measurements of from 1985 to 1999.(1)

As shown in the map to the right, acid deposition tends to more greatly affect the east coast and primarily focused on the northeast. In this PIM I am attempting to select five sites across the country and explain some of the trends and develop some



basic conclusions about the trends displayed on the map through data on those five sites.

THE SITES

Site 1. CA88 – Davis, Yolo County, California. Operation: 9/4/1978 to Present

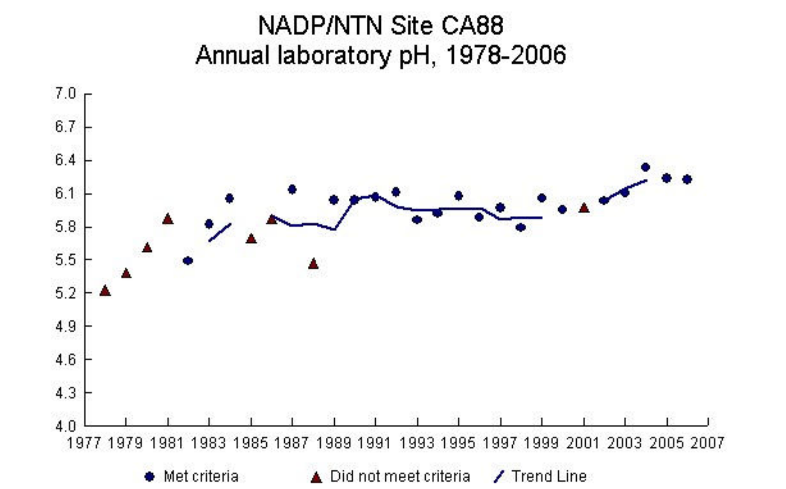
Site 2. WV18 – Parsons, Tucker County, West Virginia. Operation 7/5/1978 to Present.

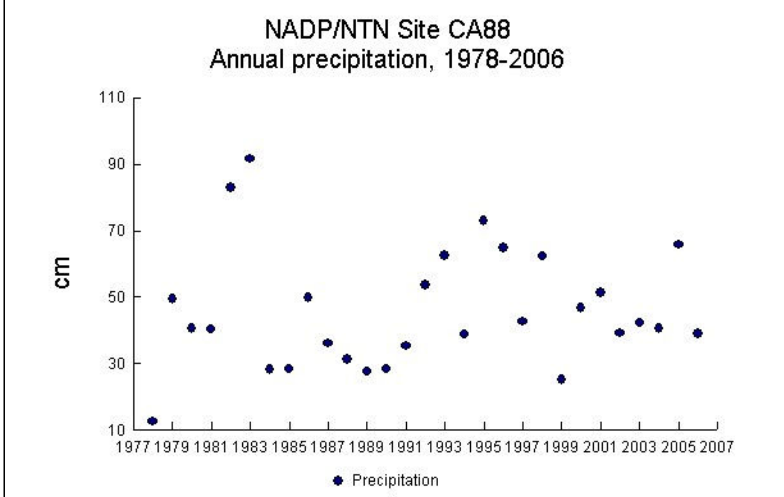
Site 3. AZ03 – G.C. National Park-Hopi Point, Coconino County, Arizona. Operation 8/11/1981 to Present.

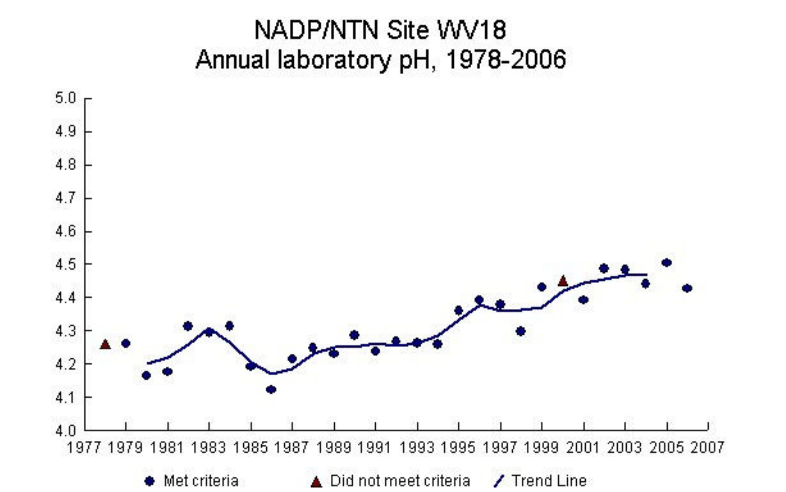
Site 4. NJ99 – Washington Crossing, Mercer County, New Jersey. Operation 8/4/1981 to Present.

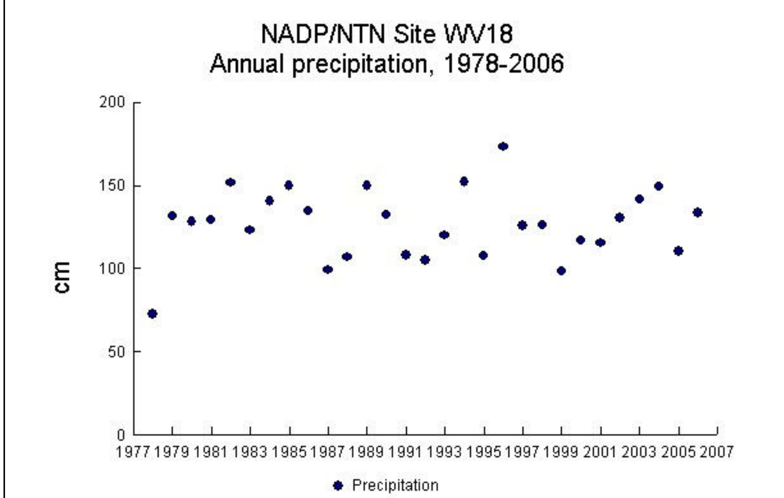
Site 5. PR20 – El Verde, Rio Grande County, Puerto Rico. Operation 2/12/1985 to Present.

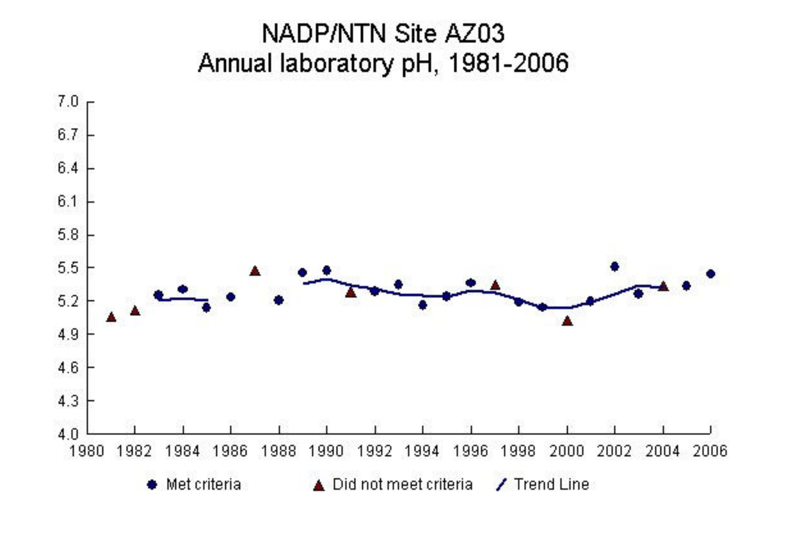
Laboratory pH per cite	Annual Precipitation per cite

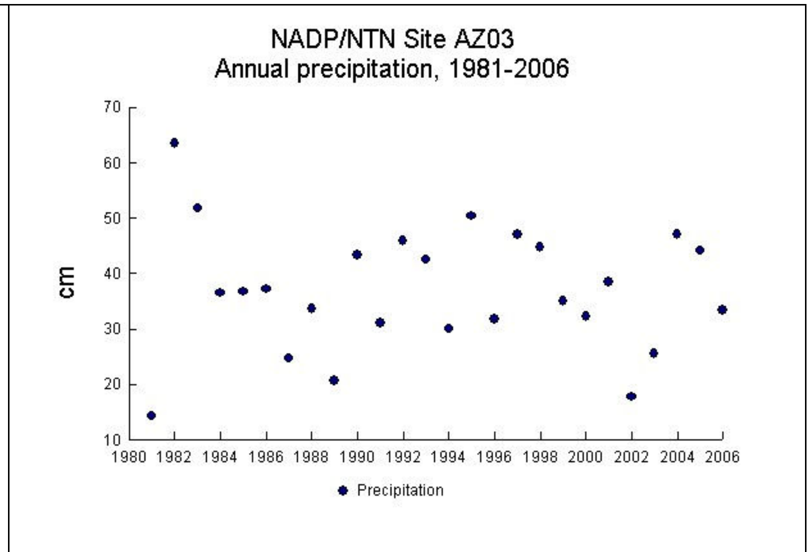


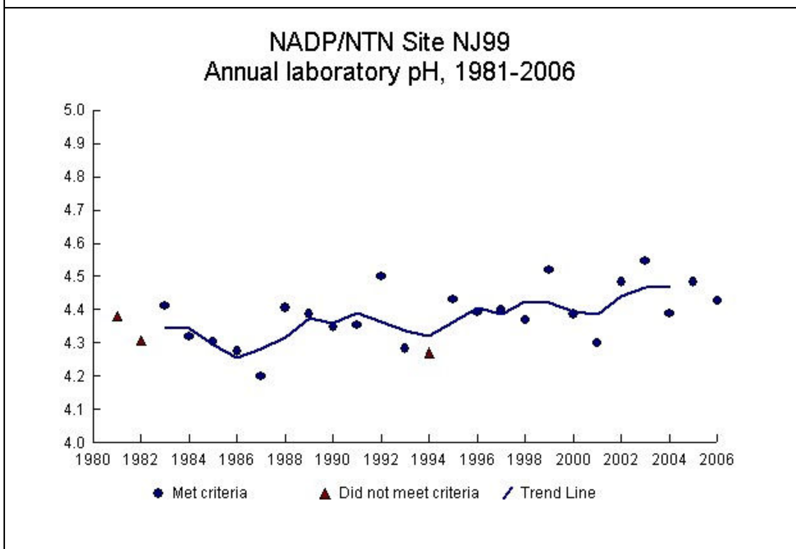


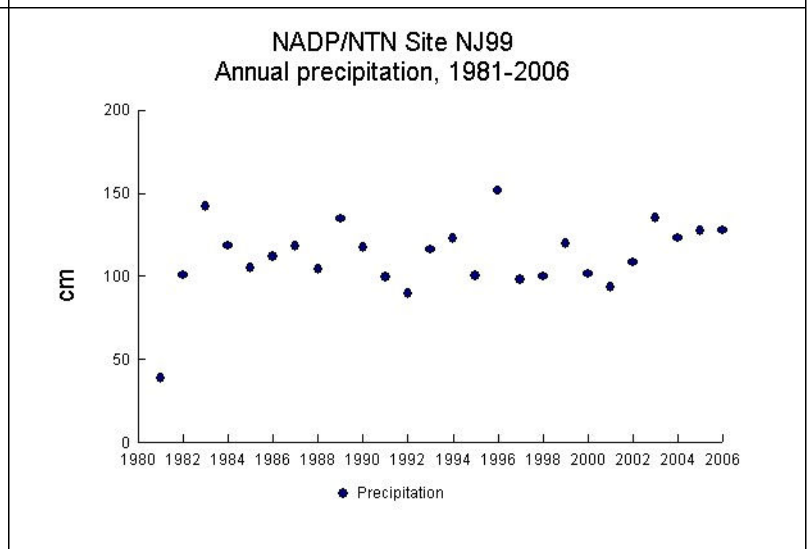


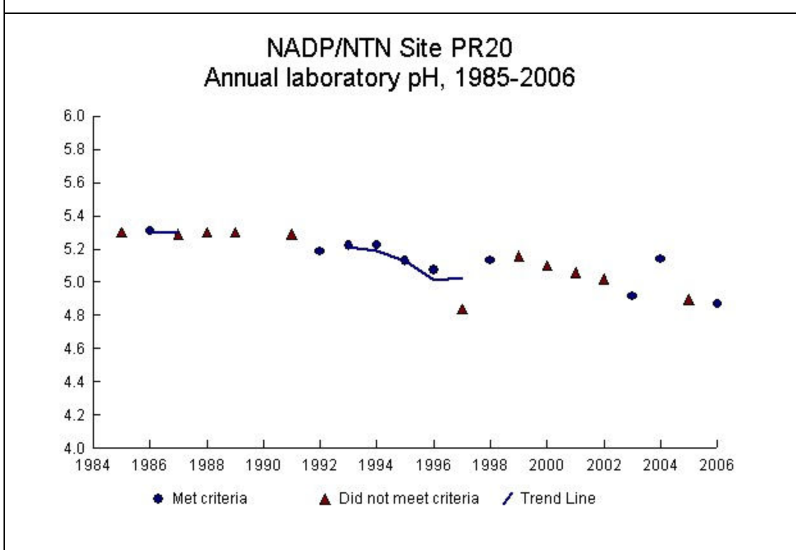


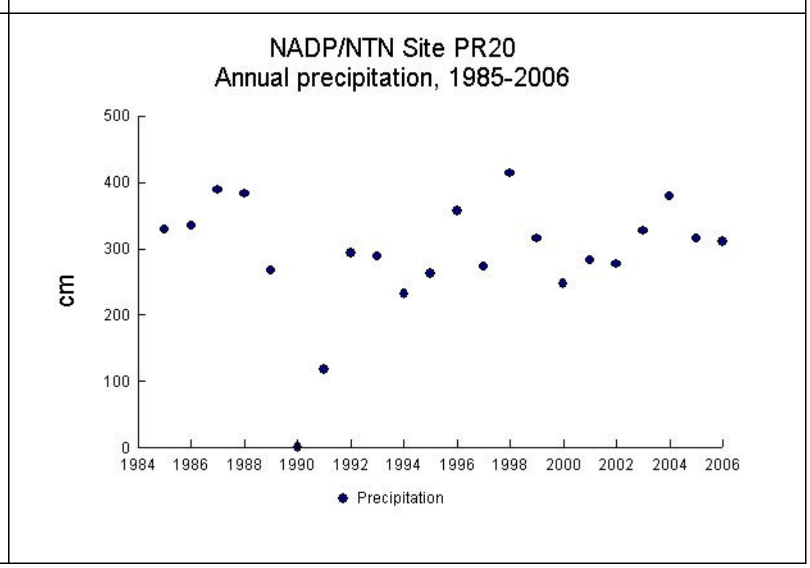

NADP/NTN Site AZ03
Annual laboratory pH, 1981-2006
Met criteria
Did not meet criteria
Trend Line


NADP/NTN Site AZ03
Annual precipitation, 1981-2006
cm
Precipitation


NADP/NTN Site NJ99
Annual laboratory pH, 1981-2006
Met criteria
Did not meet criteria
Trend Line


NADP/NTN Site NJ99
Annual precipitation, 1981-2006
cm
Precipitation

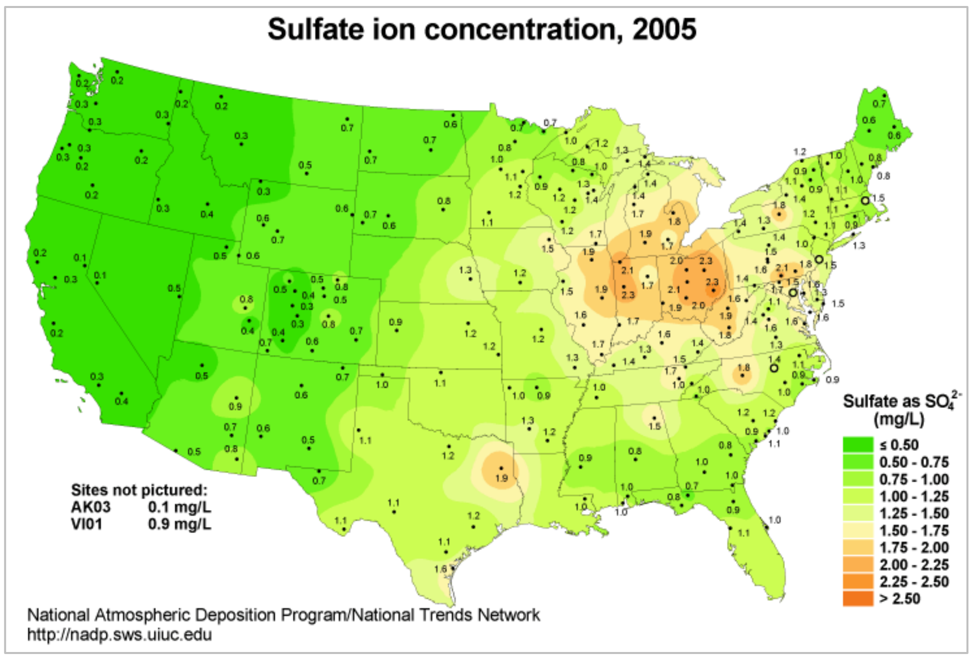

NADP/NTN Site PR20
Annual laboratory pH, 1985-2006
Met criteria
Did not meet criteria
Trend Line


NADP/NTN Site PR20
Annual precipitation, 1985-2006
cm
Precipitation

ANALYSIS

The pH of natural rain fall is in the range of 5.6 to 5.8. This slightly acidic nature of rain is due to the interaction of water with carbon dioxide to form carbonic acid. The natural acidity of rain is buffered in bodies of water by the presence of base cations such as calcium or magnesium or even ammonia. These compounds increase the pH of the water. These natural buffers can be depleted by acidification of rain.

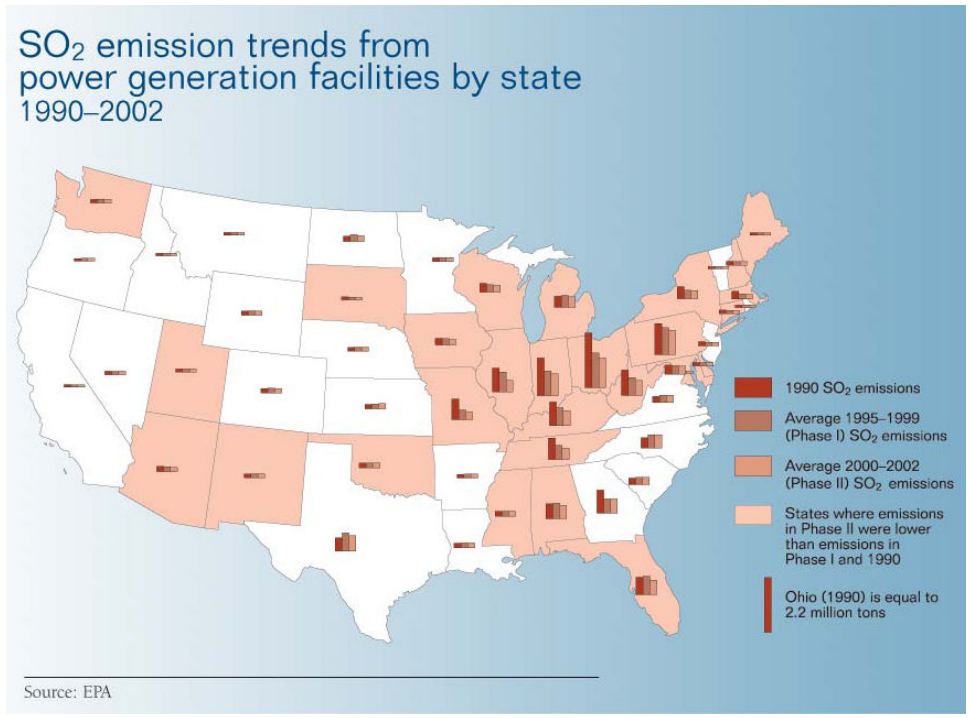
The west coast tends to have less acid deposition then the east coast of the United States. One of the reason that rain pH is lower on the east coast is that industrial pollutants leading to acid rain are far more common on the east coast as indicated on the map to the right. This explains why the east coast has a lower pH then the west but not why the west coast has a higher pH then natural rain. There are several theories about mechanisms that might increase the west cost pH. First is the inclusion of dust form more arid regions containing soluble calcium and magnesium carbonates into rain to neutralize it. This explanation seems difficult to accept since magnesium and calcium wet deposition did not appear to vary significantly from site to site with a pattern moving westward. A second explanation that there are increased concentrations of gaseous ammonia from livestock and organic matter to neutralize the relatively low amounts of acids present in the west coast*(3)* may be plausible. It is likely that a combination of these

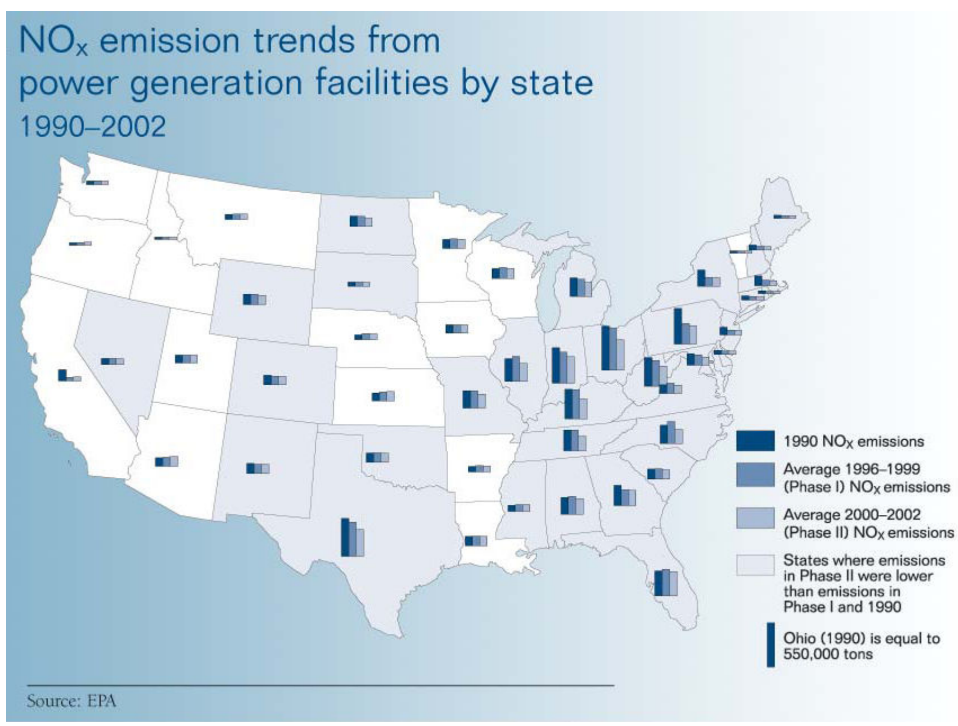


reasons results in an increase in base-cation concentrations and further in the higher pH values found in the western area of the country.

The heavily industrial east coast and Ohio Valley generate large quantities of the sulfur dioxides and nitrogen compounds that result in the production of acid rain. These compounds tend to be localized which causes decreased pH in the rain about the area of production. This holds true when comparing the maps to the right showing SO_4 and NO_x emissions by state from power generation*(4)* to the map in the introduction showing pH.

The long term positive trends are showing a substantial decrease in SO_4 emissions while NO_x emissions are remaining near constant and four of my five sites indicate that pH of wet deposition is increasing.





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