Acid rain II - the details

Part I of these pages looked at the long-term and large-scale aspects of acid rain. This page instead looks at short-term aspects observed at smaller geographic scale.

Acid rain is rain made acidic by the oxidation of SO_2 and NO_2, which are commonly released to the atmosphere where coal and/or petroleum are burned.[1] The oxidizing reactions are

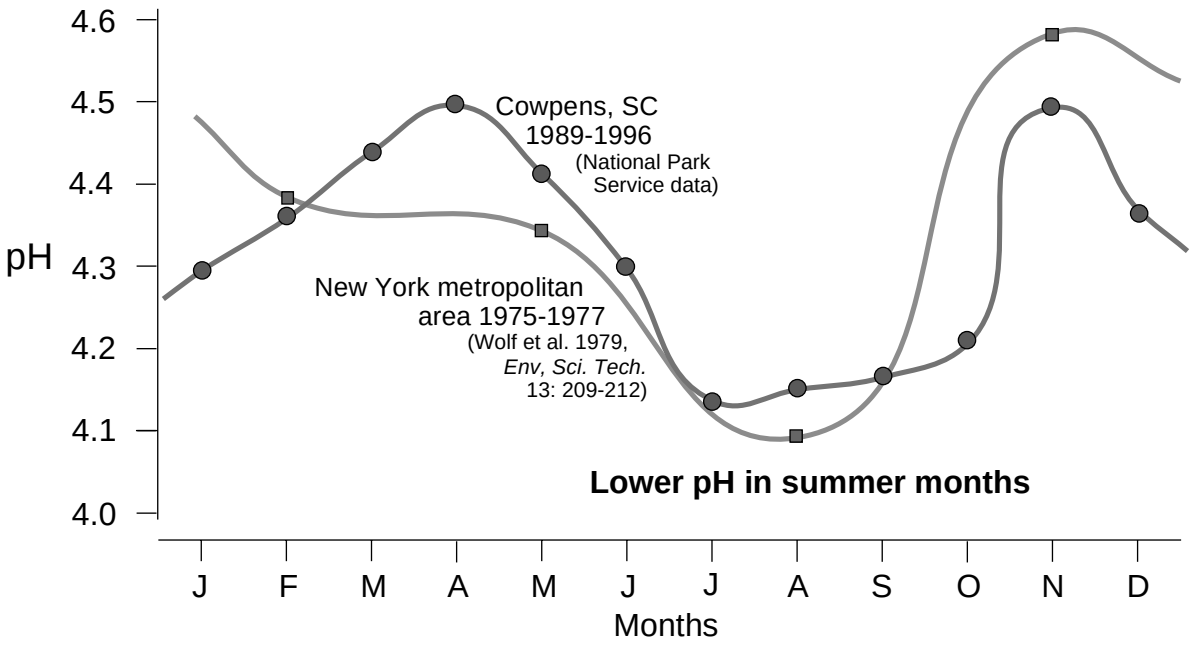
Pollutant + Oxidizing agent --> Sulfuric or nitric acid

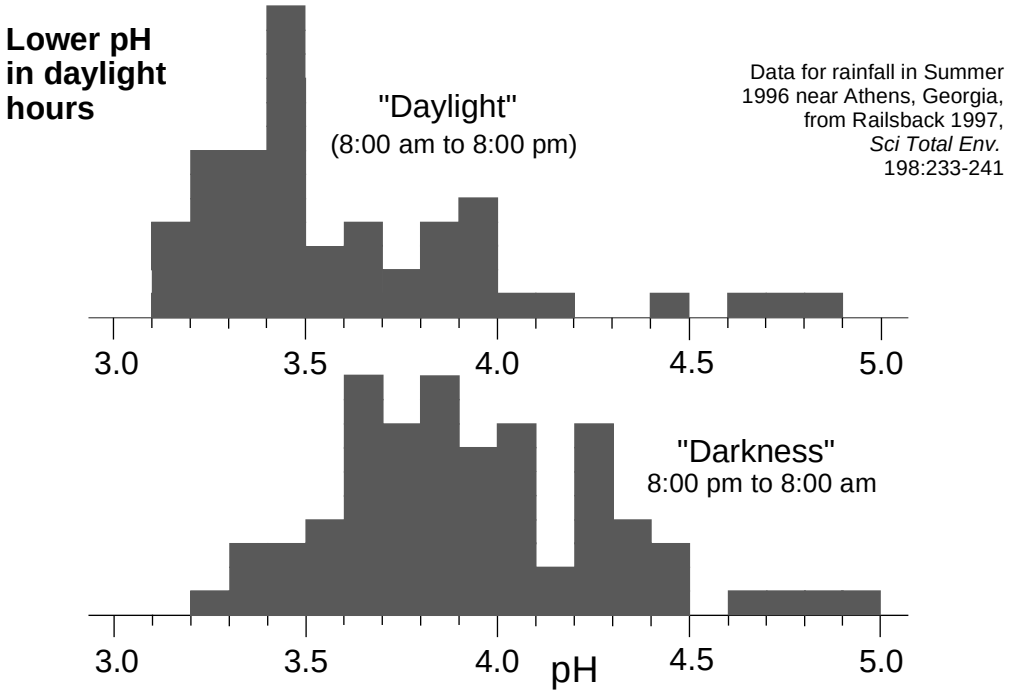
$$SO_2 + 2OH^0 \rightarrow 2H^+ + SO_4^{2-}$$

$$SO_2 + H_2O_2^0 \rightarrow 2H^+ + SO_4^{2-}$$

$$NO_2 + OH^0 \rightarrow H^+ + NO_3^-$$

Production of acidity depends on the availability of OH^0 and H_2O_2, which are produced by photochemical reactions. The pH of acid rain thus depends on light to generate the necessary oxidizing agents. Rainwater pH thus varies **seasonally** with the length of the day, as shown by the curves at right (although seasonal changes in prevailing winds can also be significant in changing the extent of delivery of SO_2 and NO_2, and there can seasonal variation in industrial output of those pollutants). Because of the dependence on light, rainwater pH also varies **diurnally** between daylight and darkness, as is shown by the histograms at right.





[1] This is the usual meaning of "acid rain", but one should realize that rainwater unaffected by oxides of nitrogen or sulfur almost always has a pH less than 7 and thus is more acidic than chemical neutrality. That's because natural atmospheric CO_2 hydrates to yield H_2CO_3 (carbonic acid), and thus natural rainwater has a pH of about 5.7. Anthropogenic addition of CO_2 has lowered that pH slightly, but even anticipated high values of P_{CO2} over the coming decades or centuries will not lower the pH of rainwater to the extent that oxidation of SO_2 and NO_2 can cause lower pH.