United States
Environmental Protection
Agency

Environmental Research
Laboratory
Corvallis OR 97333

Research and Development

EPA/600/S3-89/030 July 1989

EPA

Project Summary

Regional Analysis of Wet Deposition for Effects Research

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The basis for regional characterization and analysis of precipitation amount, concentration, and deposition is investigated. Key issues in spatial analysis are the data selection, data compositing, the interpolation technique used, and the uncertainty of the results. Sources of data on precipitation amount and chemical composition are presented along with procedures for screening the chemical data. A review of recent work reveals that different scientists select different data sets and that data selection plays an important role in the resulting maps.

Important issues in data preprocessing include temporal resolution, data stratification into geographic regions, and choosing between direct and indirect methods for interpolating wet deposition. The "indirect method" involves interpolating precipitation amount and concentration separately and using their product for wet deposition maps. The indirect method is recommended because it allows the use of more spatially dense precipitation amount data sets. Limited experimental evidence demonstrates no spatial correlation between that precipitation amount and concentration, a necessary condition for the use of the indirect method. It is recommended that further investigation of the degree of independence of precipitation amount and concentration across space be performed.

There are many methods to weight near and distant data for estimating data at a non-monitored site. The geostatistical technique, kriging, is discussed in detail to allow other researchers the benefit of previous applications to precipitation chemistry. Different interpolation techniques may produce maps that are similar but estimation variances that are different, or absent. Procedures for generating and checking uncertainty estimates are discussed.

This Project Summary was developed by EPA's Environmental Research Laboratory, Corvallis, OR, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Summary and Conclusions

Recent investigations, fully referenced by the authors in the final report, reveal that eastern U.S. forests are declining and that some eastern lakes have become acidic. One possible hypothesis is that acidic deposition represents a stress to these ecosystems that, when combined with natural stresses, has caused these changes. It has been suggested that three conditions must be satisfied to prove causation: (1) a mechanism, (2) a dose-response relation-

ship, and (3) spatial and temporal consistency. To examine spatial consistency one constructs maps of potential stresses and damage. If the gradients in the wet deposition of certain chemical species and forest damage (or lakewater acidity) are similar one requirement for a proof of causality has been met, namely "spatial consistency."

Maps are very useful for visualizing spatially oriented data. Regional estimates expressed as isopleth maps can reveal the magnitude and extent of acidic deposition and locate areas of high or low deposition. Spatial interpolation is used to generate maps of wet deposition and to estimate data for non-monitored locations. Interpolated values for wet deposition are used as inputs to aquatic and terrestrial ecosystems in the absence of measurements. This report reviews issues related to interpolating data and charting patterns in precipitation chemistry and wet deposition.

The chemical species of likely interest to terrestrial researchers and limnologists include those which control the acidity of the precipitation or induce/neutralize acidity in receiving systems such as the concentration and/or deposition of NO_3^-, $SO_4^=$, H^+, Ca^{++}, and NH_4^+.

H^+ and NH_4^+ concentration or wet deposition are of interest due to the potential acidifying effects of these ions on foliage and soils. $SO_4^=$, and NO_3^- concentrations are of interest because they usually derive from anthropogenic emission sources (at Northern Hemisphere continental monitoring sites) and because they may be involved in cation leaching from soils or loss of acid neutralizing capacity from lakes. Cation deposition might be of interest because of added buffering to soils or lakes. NO_3^- and K^+ can serve as nutrients for plants.

Either wet deposition or precipitation of chemical concentrations may be relevant depending on the ecological effect of interest. For example, foliar leaching in spruce needles or lake chemistry in watersheds with thin soils might be related to precipitation concentrations while soil buffering processes might respond to wet deposition. Dry deposition or cloudwater interception can contribute substantial chemical inputs to terrestrial ecosystems, especially at high elevations in the eastern U.S.A. Only wet deposition (precipitation) is considered because it is the best understood and most intensively monitored of the three deposition pathways.

A number of approaches for strengthening any spatial analysis of precipitation chemistry are presented. The goal is to ensure that future investigators will benefit from the experiences discussed herein and that they will document key portions of their analyses to permit evaluation by peers.

When performing a regional analysis of precipitation chemistry four key issues are: the data selection, data compositing, the interpolation technique, and the uncertainty of the results. Using National Atmospheric Deposition Program (NADP/NTN) and Canadian precipitation chemistry data (at a minimum), screening the chemical data, and using supplemental National Weather Service (NWS) precipitation amount data appears to present a useful and valid approach to producing regional analyses of concentrations or precipitation amount. The NWS data were seen to reproduce the variability in precipitation amount better than the less spatially dense NADP precipitation amount data. The precipitation chemistry data appeared adequate to chart the variation in chemical concentrations if the data were first stratified into fairly homogeneous regions.

Data selection is critical to the results, more so than previously anticipated.This process is more critical than general has been acknowledged because th sources of chemical and precipitatic amount data are numerous. If w deposition is the desired regionalize characteristic, a consideration is wheth to interpolate the data directly or combine previously interpolated precip tation concentrations and amount. Th choice forces an evaluation of th representativeness of the various da sources and the spatial independence concentration and precipitation amount.

Direct and indirect methods f mapping spatial variation wet depositic were investigated. The indirect metho allows the use of more representati precipitation amount data but assum that precipitation amount and conce tration are not spatially correlated. review of experimental evidence su gests that there is no strong relationsh between SO_4 concentration and precip tation amount across space. It appea reasonable to interpolate precipitati concentration and convert to local w deposition fluxes using interpolated ra gauge data. Further analyses of th independence of concentration a precipitation amount across space a recommended, especially where si specific factors may control wet depo tion.

Regardless of the choice of data a technique, it is important that th statistical, meteorological, and chemic basis for regional analysis be sound. that regard, it is most likely that int disciplinary approaches will produce t most useful and accurate region characterizations of acidic depositi data.

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The complete report, entitled "Regional Analysis of Wet Deposition for Effects Research," (Order No. PB 89-181 218/AS; Cost: $13.95, subject to change) will be available only from:

National Technical Information Service
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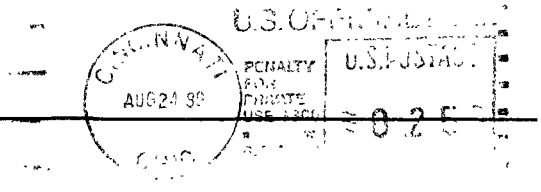

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