

ENHANCEMENT OF REGIONAL WET DEPOSITION ESTIMATES BASED ON MODELED PRECIPITATION INPUTS

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Application of a variety of two-dimensional interpolation algorithms to precipitation chemistry data gathered at scattered monitoring sites for the purpose of estimating precipitation-borne ionic inputs for specific points or regions have failed to produce accurate estimates. The accuracy of these estimates is particularly poor in areas of high topographic relief. Because wet deposition of pollutants is a function of both the ionic concentration of precipitation and precipitation volume and because the local distribution of precipitation can be strongly influenced by terrain, incorporation of orographic effects into the wet deposition modeling process should markedly improve the accuracy of estimated depositions. This presentation describes progress made in the development and application of a model which utilizes topographic features for the purpose of estimating wet deposition of major ions for any portion of the region encompassed by U.S. Forest Service Northern Global Change Program (NGCP).

The coordinates, elevations, and monthly precipitation records from the National Oceanic and Atmospheric Administration's (NOAA) precipitation monitoring sites in the states contained in and adjacent to the NGCP comprise the precipitation volume data set used for model development. Precipitation concentration data were derived from the weekly samples collected at National Atmospheric Deposition Project/National Trends Network monitoring sites which lie within or adjacent to the NGCP area.

Initial efforts to incorporate topographic effects into the precipitation volume component of the deposition model entailed an extension of the multi-quadric equation algorithm (MQE) to include scaled elevation as a third spatial dimension. This refinement greatly improved the ability to estimate precipitation volumes at validation points, particularly in small (one- to two-degree) regions with mountainous terrain. However, application of the 3-D MQE algorithm to an entire region as climatically and topographically diverse as the NGCP area was untenable due to the absence of a non-interactive procedure to determine the elevation scaling factor for each specific subregion. Further, the 3D-MQE was not appropriate for the incorporation of slope and aspect information. Similarly, co-kriging with topographic parameters was deemed too operator-intensive because of the changing influence of terrain on the distribution of precipitation across a large geographic region.

The present form of the precipitation volume model is a moving-neighborhood, distance-weighted, robust stepwise regression of monitoring site precipitation observations on latitudinal and longitudinal coordinates, elevation and a set of variates representing both slope and aspect. The derived regression equations from each neighborhood (0.1-degree block) are then applied to corresponding digital elevation data (DAM) to produce a grid of precipitation estimates. The accuracy of the current model is assessed by comparing the predicted and observed quarterly and annual precipitation volumes at approximately 1500 validation sites scattered over the NGCP region. At this point, the average annual estimation error is consistently near 3.0 inches for each year from 1991 through 1993.

A major limitation on the accuracy of the precipitation volume model is the imprecision of the coordinates of the NOAA precipitation sites. NOAA coordinates for rain gage location are reported at a resolution no finer than 1

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minute of a degree of latitude or longitude. This level of uncertainty in the location of sampling sites impedes the modeling of localized, but important, orographic influences on precipitation. Unfortunately, NOAA data comprise the only precipitation data set that covers the NGCP area at a site density sufficient for deposition modeling. In order to scavenge some useful slope and aspect information to be used with the NOAA observations, a long-range, neighborhood-oriented expression of slope and aspect was developed and incorporated into the precipitation-volume model. This subroutine within the model could be vastly improved with more precise coordinates of each NOAA precipitation monitoring station.

Future efforts in refining the deposition model will focus on enhancing the estimates of precipitation concentrations and on refinements that will improve model performance along the region of the NGCP that borders on Canada and over large bodies of water, such as the Great Lakes. We will also obtain precipitation chemistry data from other monitoring programs, such as the Electric Power Research Institute, to use in model evaluation and verification. Application of model output to cause-effect relationships, nutrient budgets and management, and hydrologic models will also be undertaken. Examples of such are requests for quantifying atmospheric deposition of nutrients to the Chesapeake Bay, determining mean precipitation values needed for use in the hydrologic module of the Northeast Decision Model, and the calculation of atmospheric deposition loadings over the Allegheny National Forest for use in ecosystem management studies and planning.