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Project Summary

Development of County-Level Wind Erosion and Unpaved Road Alkaline Emission Estimates for the 1985 NAPAP Emissions Inventory

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The National Acid Precipitation Assessment Program (NAPAP) is developing a nationwide emissions inventory of substances contributing to acid precipitation. Also of interest are substances that can neutralize acids in precipitation. Information from NAPAP's natural sources task group on the emissions of alkaline materials (calcium, magnesium, potassium, and sodium) is available, but the spatial resolution is not currently in a form that lends itself to use by either the National Emissions Data System (NEDS) or modelers using the NAPAP Resolved Modelers Inventory grid system. This report details the methods used and the results of the conversion of alkaline material emissions information for wind erosion, unpaved roads,and dust devils from their current spatial resolution to county-level resolution. Additionally, methods for converting the county-level data to the NAPAP Modelers Inventory grid system are proposed .

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, 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).

Introduction

The National Acid Precipitation Assessment Program (NAPAP) is developing a nationwide emissions inventory, representing the 1985 base year, of sources that may contribute to the formation of acid precipitation. Among the sources of interest are area sources, including those that emit alkaline particulates which may play a role in neutralizing acids in precipitation.

Information on the emissions of alkaline material (calcium sodium, potassium, and magnesium) from three important area sources-- wind erosion, unpaved roads and dust devils-- is available from NAPAP's natural sources task group, but the spatial resolution is not currently in a format that is consistent with data submitted or other sources included in the 1985 NAPAP Emissions Inventory.

This report discusses both the methodology used to convert the current emission estimates available from the natural sources task group into county-level estimates that can be incorporated into the 1985 NAPAP Emissions Inventory, and the results of this effort. Additionally, a method for converting the county-level information to the NAPAP

Modelers Inventory grid level is proposed.

Note that this study presents the method used to convert the NAPAP natural sources task group data from its current resolution to the county level and the results of that conversion. It does not present the method used to develop the original emissions estimates. Thus, questions concerning the development of the original emissions estimates for the various area sources considered here should be addressed to the original NAPAP natural sources task group.

Availability of Data from the Natural Sources Task Group

Data from this group include wind erosion, unpaved roads and dust devils.

Wind Erosion

Estimates of total mass and alkaline emissions from wind erosion for particles less than or equal to 20 μm in diameter have been calculated for irregularly shaped areas known as Major Land Resource Areas (MLRAs) by developing emission factors (in grams per square centimeter) for each MLRA and multiplying by the area of the corresponding MLRA. A map in Figure 1 shows the distribution of MLRAs across the U.S. The emission factors calculated for these areas have also been assigned to modified Regional Acid Deposition Model (RADM) grid points. This assignment was done strictly on the basis that the value calculated for an MLRA was assigned to any grid points that fell within that MLRA's boundaries. The modified RADM grid points create grids that are the same size (80 x 80 km) as the original RADM grids, except that grid points are added to the east and west of the existing grid to include the 48 states. As a consequence, this modified RADM grid incorporates the original grid points which are in their same latitudes and longitudes. Modification of the grid mostly reflects the renumbering of the west- to- east grid point locations to reflect the larger geographic coverage.

Temporal information for wind erosion is also available as monthly emissions based on calculations using the MLRA/RADM grid assignment scheme outlined above.

Unpaved Roads

Unpaved road total mass and alkaline emissions estimates for particles less than or equal to 10 μm are available on the state level. No temporal information for unpaved road total mass or alkaline emissions is currently available. The current unpaved road alkaline emissions estimates represent particles that are both soluble and capable of neutralizing acids, not total alkaline material. Total alkaline emissions would include both the soluble and insoluble fractions of alkaline material as well as compounds that would provide no neutralizing effect (such as gypsum or sodium chloride).

No size distribution or temporal information is provided with the current estimates.

Dust Devils

Both total mass and alkaline emissions of particles less than or equal to 25 μm from dust devils have also been estimated. Observations made near Tucson, Arizona were used to classify dust devils into four size categories (small, medium, large and extra large). A census was made over several months to determine the number distribution in each category. Following this observation period, aircraft were flown within active dust devil cells to simultaneously measure filter exposures and vertical air velocities. Measurements were made at two different altitudes. The dust exposure measured on the filter was utilized with the vertical air velocities to calculate the flux from the dust devil. Each category of dust devil was sampled and an average value was established for the emissions per unit area for each category.

Once the flux for each category was established, vegetation classes and climatic categories were used to evaluate the potential for dust devil development for a particular area. Based on the potential for dust devil development and the number distribution determined in the Tucson studies, emissions were estimated for the area. The modified RADM grid described above was overlaid on these areas and the emissions value for the area in which a grid point was located was assigned to that grid point.

Spatial Resolution Conversion

Current alkaline emissions information cannot be readily compared with emissions estimates of other chemical species important in causing acid precipitation, because the spatial resolution of the alkaline emissions estimates is not consistent with emissions estimates developed for other chemical species. Consequently, the conversion of the natural source emissions data from their current spatial resolution to a level consistent with that available for emissions estimates for other chemical species was required. Conversion to the county level was chosen for several reasons: (1) it is consistent with the current National Emissions Data System (NEDS) reporting level for area source information; (2) it is likely that county-level emissions data would be used by more researchers at this time than would grid-level data; (3) a method for converting county-level information to the NAPAP Modelers Inventory grid level has already been developed and utilized with other chemical species; and (4) once these emissions have been converted to the NAPAP Modelers Inventory grid level they could also be converted to the RADM grid level, although the current RADM chemistry and kinetics modules cannot handle alkaline particulate data. Conversion from the NAPAP Modelers Inventory grid level or the RADM grid level to the county level would be less straightforward.

Results

Study results show that unpaved road emissions dominate the calcium and magnesium alkaline element emissions, but that wind erosion dominates the potassium and sodium alkaline element emissions. This is predominantly because many unpaved roads (especially in non-arid regions) are surfaced with gravel or crushed stone. Frequently the crushed stone used on these roads is limestone which is particularly rich in calcium and magnesium. Soils typically have higher potassium and sodium levels, which explains why wind erosion dominates those elemental emissions.

Also note that, although the information presented here is for the 1985 NAPAP Emissions Inventory, the wind erosion values would be the same for any year. The method used to calculate the wind erosion values at the MLRA level involved calculating emissions using 30 years of wind information. Unpaved road emissions represent data for 1985.

Dust devils contribute between 13 and 31% of the alkaline species but rank last of the three sources in alkaline emissions, except for Na where they are second. However, they dominate the particulate emissions with over 42% of the total particulate emissions calculated here.Remember, however, that unpaved road emissions are for particles less than

or equal to 10 µm, while wind erosion emissions are for particles less than or equal to 20 µm, and dust devil emissions are for paeticles less than or equal to 25 µm. This difference is due to the way the original data was provided, not to the method used to assign emissions to the county level.

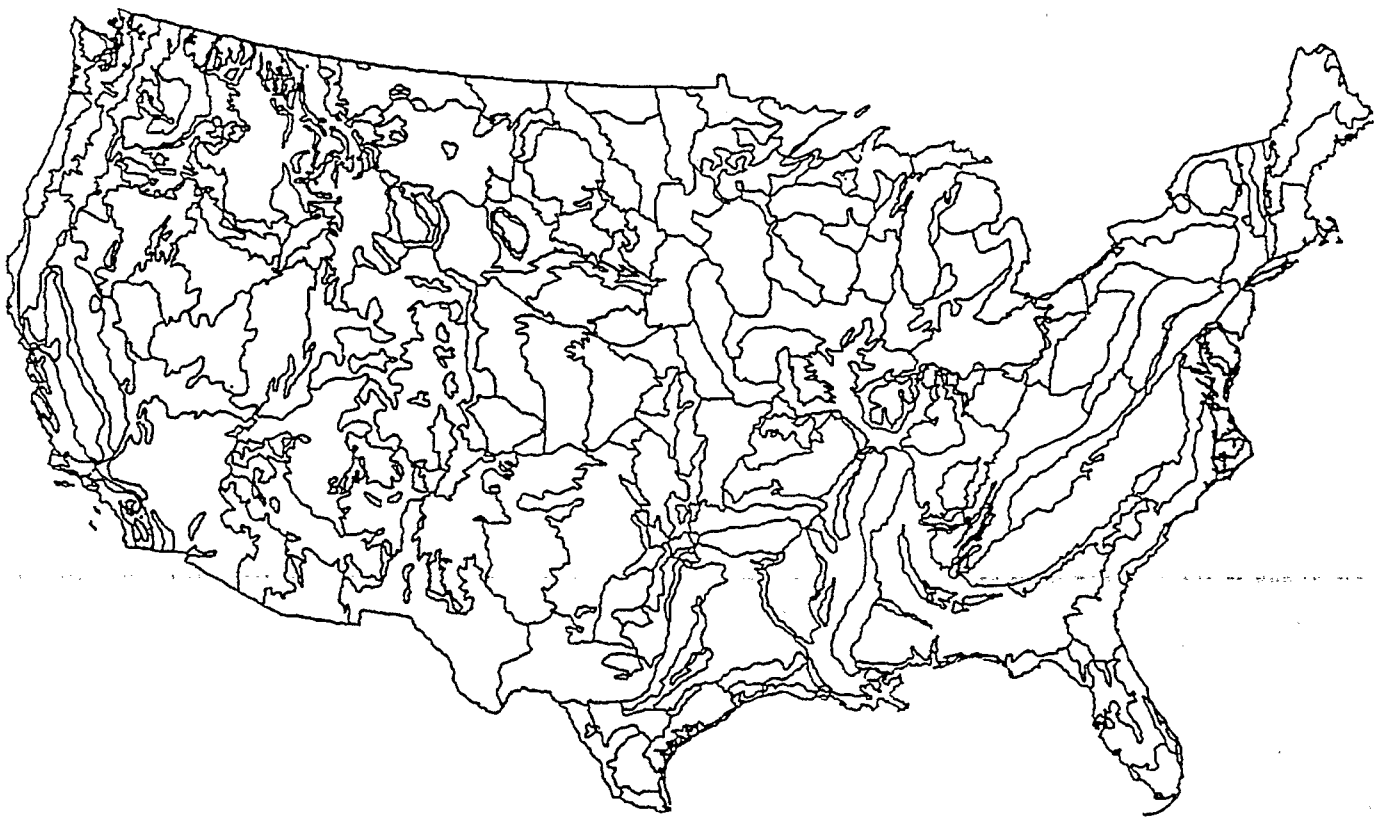

Figure 1. *Distribution of MLRAs across the U.S.*

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The complete report, entitled "Development of County-Level Wind Erosion and Unpaved Road Alkaline Emission Estimates for the 1985 NAPAP Emissions Inventory," (Order No. PB 90-172 586/AS; Cost: $23.00, subject to change) will be available only from:
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