CHAPTER 36

SWAT INPUT DATA: ATMO.ATM

The Atmospheric Deposition input file contains annual average atmospheric nitrogen deposition values including ammonium, nitrate, dry ammonium and dry nitrate. This file is optional.

36.1 ATMOSPHERIC DEPOSITION FILE (ATMO.ATM)

Following is a brief description of the variables in the atmospheric deposition input file. They are listed in the order they appear within the file.

Variable name	Definition
TITLE	The first five lines of the atom.dat file are reserved for user comments. The title line is not processed by the model and may be left blank.
rammo_sub	Atmospheric deposition of ammonium (mg/l) values for entire watershed.
rcn_sub	Atmospheric deposition of nitrate (mg/l) for entire watershed.
drydep_nh4	Atmospheric dry deposition of ammonium (kg/ha/yr) for entire watershed.
drydep_no3	Atmospheric dry deposition of nitrates (kg/ha/yr) for entire watershed.

The septic input file is fixed format. The format for the atmospheric deposition input file is:

Variable name	Line #	Format	F90 Format
TITLE	1	character	a80
TITLE	2	character	a80
TITLE	3	character	a80
TITLE	4	character	a80
TITLE	5	character	a80
RAMMO_SUB	6	real	f10.3
RCN_SUB	7	real	f10.3
DRYDEP_NH4	8	real	f10.3
DRYDEP_NO3	9	real	f10.3

36.2 ATMOSPHERIC DEPOSITION OF NUTRIENTS

Included below is a CEAP National Project Technical Report by Mauro DiLuzio.

1. Introduction

Atmospheric deposition occurs when airborne chemical compounds settle onto the land or water surface. Some of the most important chemical pollutants are those containing nitrogen or phosphorus. Nitrogen compounds are involved in acid rain, and both nitrogen and phosphorus compounds contribute to nutrient loadings. Nitrogen compounds can be deposited onto water and land surfaces through both wet and dry deposition mechanisms. Wet deposition occurs through the absorption of compounds by rain and snow as they fall carrying mainly nitrate (NO_3^-) and ammonium (NH_4^+); dry deposition is the direct adsorption of compounds to water or land surfaces and involves complex interactions between airborne nitrogen compounds and plant, water, soil, rock, or building surfaces.

The relative contribution of atmospheric deposition to total nutrient loadings is difficult to measure or indirectly assess, and many deposition mechanisms are not fully understood. Most studies and relatively extended data sets are available on wet deposition of nitrogen; dry deposition rates are not well defined. Phosphorus loadings due to atmospheric deposition have not been extensively studied and nation-wide extended data set were unavailable at the time of data preparation for the CEAP project. While research

continues in these areas, data records generated by modeling approaches appear to be still under scrutiny.

A number of regional and local monitoring networks are operating in the U.S. mainly to address information targeting up to regional environmental issues. For instance the Integrated Atmospheric Deposition Network (IADN) (Galarneau et al., 2006) that estimates deposition of toxic organic substances to the Great Lakes. Over the CONUS (conterminous United States), the National Atmospheric Deposition Program (NADP) National Trends Network (NTN) (NADP/NTN, 1995; NADP/NTN, 2000; Lamb and Van Bowersox, 2000) measures and ammonium in one-week rain and snow samples at nearly 240 regionally representative sites in the CONUS (Figure 1) and is considered the nation's primary source for wet deposition data.

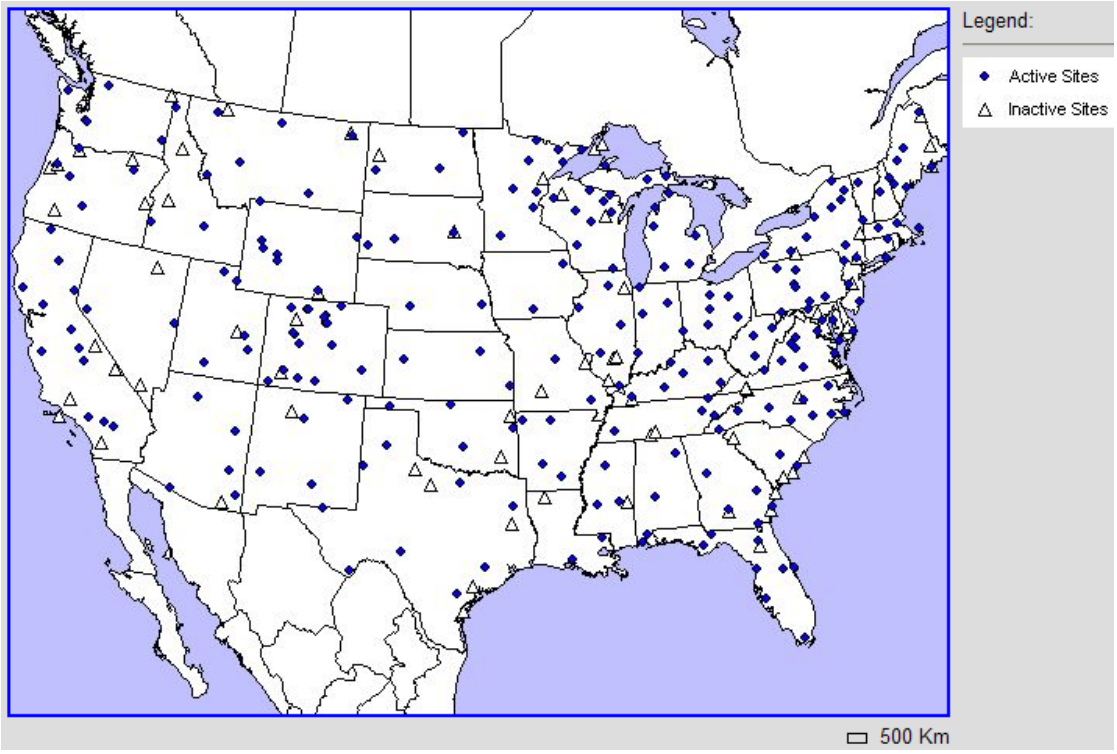

Figure 1. Location of NADP/NTN wet deposition sites

The U.S. Environmental Protection Agency Clean Air Status and Trends Network (CASTNET), developed form the National Dry Deposition Network (NDDN), operates a total of 86 operational sites (as for December 2007) located in or near rural areas and sensitive ecosystems (see Figure 2) collecting data on ambient levels of pollutants where urban influences are minimal (CASTNET, 2007). As part of an interagency agreement, the National Park Service (NPS) sponsors 27 sites which are located in national parks and other Class-I areas designated as deserving special protection from air pollution.

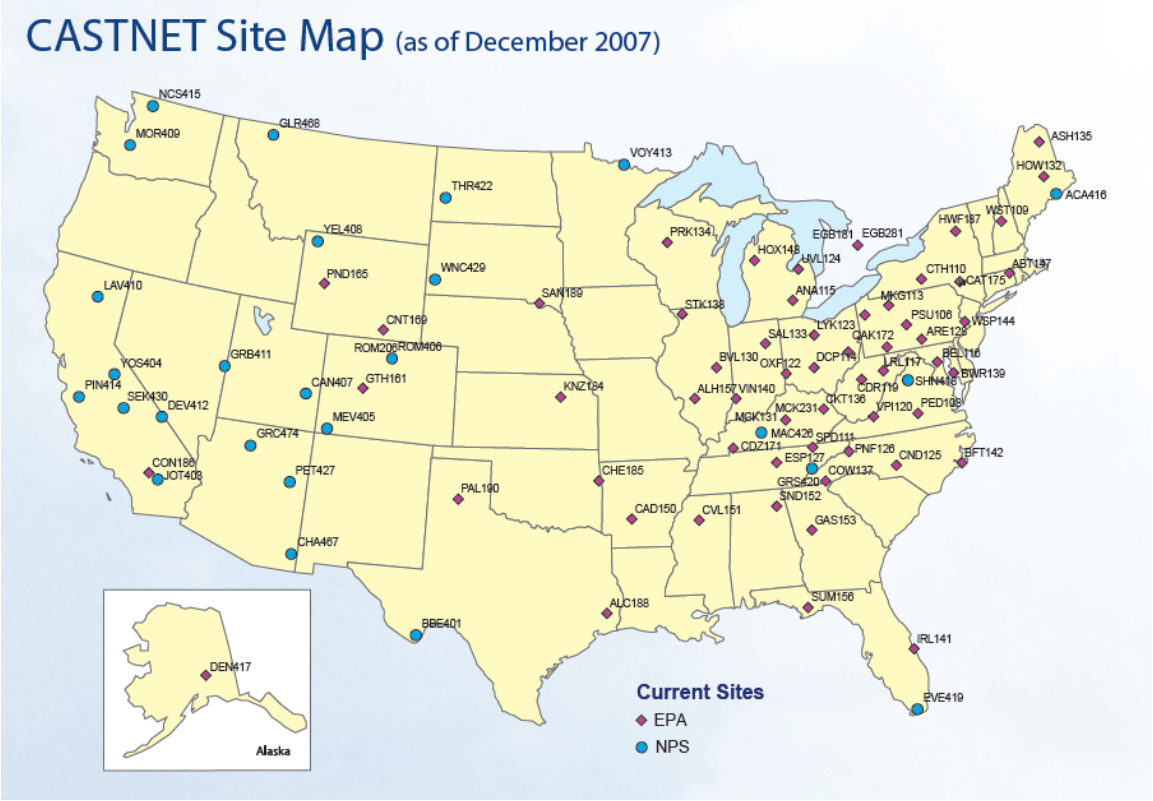

Figure 2. Location of the CASTNET dry deposition monitoring sites

NADP/NTN and CASTNET records are directly and/or indirectly the main sources of data for the CEAP national assessment project.

2. Nitrogen Wet Deposition concentration records for CEAP

The NADP publishes digital maps of nitrate and ammonium average yearly concentration (http://nadp.sws.uiuc.edu). Site records were previously validated for quality assurance (QA) and quality control (QC) before interpolation (Lehmann and Van Bowersox, 2003). For CEAP modeling, published digital maps in raster format, were elaborated in a Geographic Information System (GIS) environment to provide areal average on each 8-digit Hydrologic Units of the CONUS (USGS, 1994). Time series of yearly average concentrations of ammonium (NH_4^+) and nitrate (NO_3^-) were derived for each of the Hydrologic Units and for the period of data availability (1994-2006). Figure 3 plots the annual average estimated concentration of the ammonium ion for the period 1994-2006. Appendix 1 reports the averaged data and some spatial distribution statistics for each 8-digit area within the Upper Mississippi Basin.

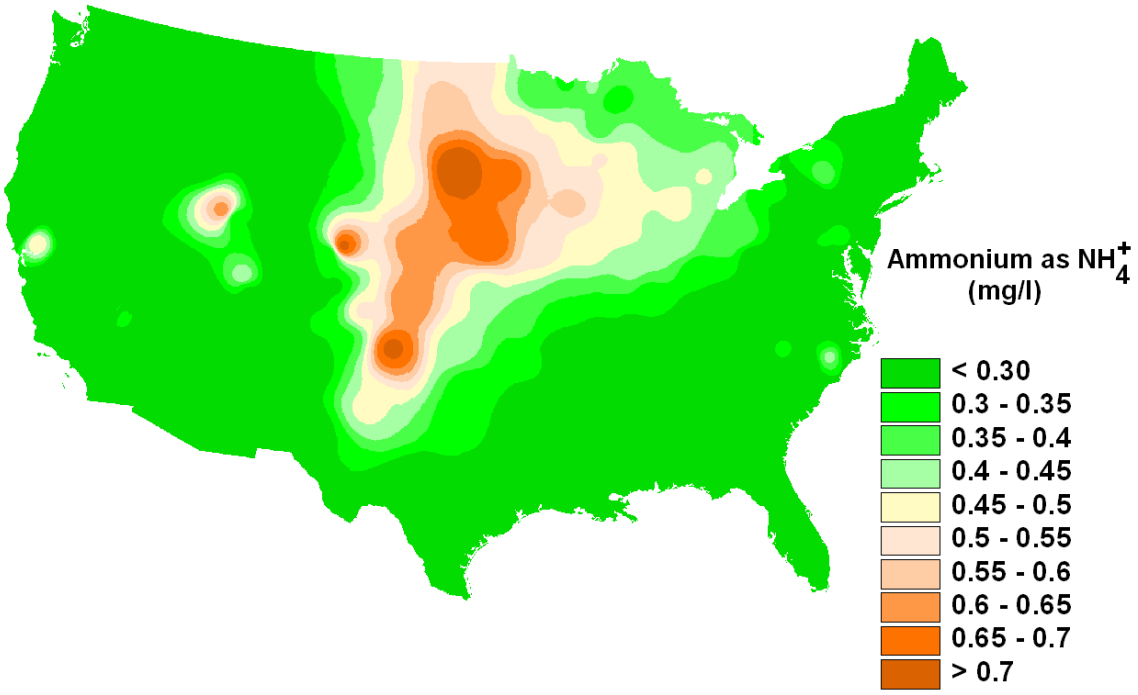

Figure 3 – Average annual ammonium (NH_4^+) concentration (mg/l) in the period 1994-2006. Derived from National Atmospheric Deposition Program/National Trends Network http://nadp.sws.uiuc.edu

Figure 4 plots the annual average estimated concentration of the nitrate ion for the period 1994-2006. Appendix 1 reports the same information and some spatial distribution statistics for each 8-digit area within the Upper Mississippi Basin.

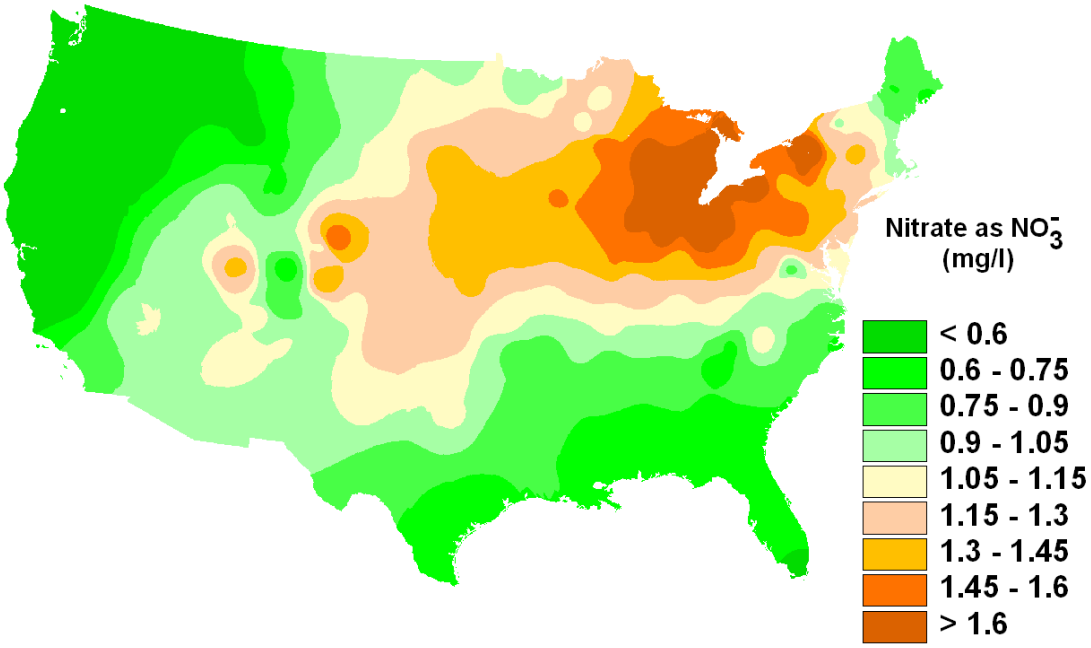

Figure 4 – Average annual nitrate (NO_3^-) concentration (mg/l) in the period 1994-2006.

Derived from National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

3. Nitrogen Dry Deposition flux records for CEAP

Oak Ridge National Laboratory (ORNL) publishes maps of N deposition fluxes from site-network observations for the U.S, and Western Europe (Holland et al., 2005a). Observations from monitoring networks in the U.S. and Europe, were compiled in order to construct 0.5 x 0.5 degree resolution maps of N deposition by species. In the United States, measurements of ambient air concentrations, used to calculate dry deposition fluxes, were provided by the Clean Air Status and Trends Network (CASTNET) (CASTNET, 2007). The source data period extends from 1989 to 1994. The maps are

necessarily restricted to the network measured quantities and consist of statistically (kriging) interpolated fields of particulate, ammonium (NH_4^+), nitrate (NO_3^-), and gaseous nitric acid (HNO_3). A number of gaps remain in the data set including organic N and NH_3 deposition. The dry N deposition fluxes were estimated by multiplying interpolated surface air concentrations for each chemical species by model-calculated, spatially explicit deposition velocities (Holland et al., 2005b).

Figure 5, 6 and 7 shows the annual average dry Nitrogen, NH_4, NO_3, and HNO_3 flux, as published by ORNL.

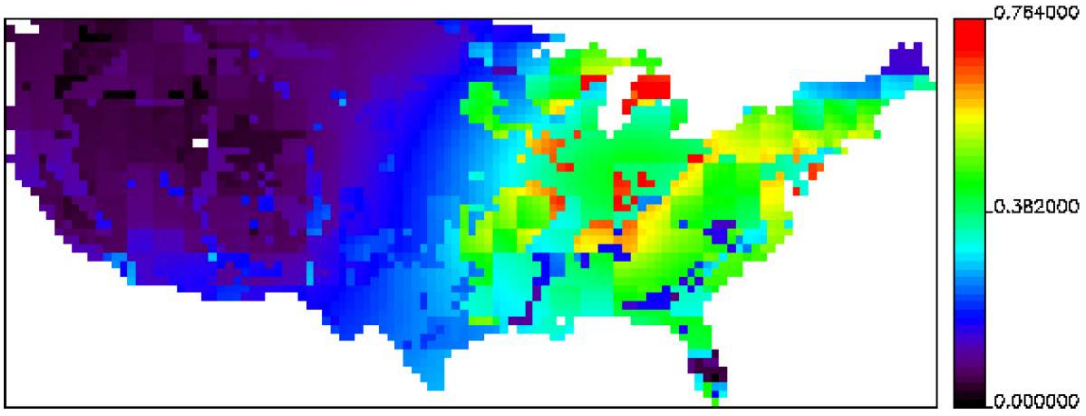

Figure 5 – Annual average dry NH_4 flux over the CONUS (kg N/ha/yr)

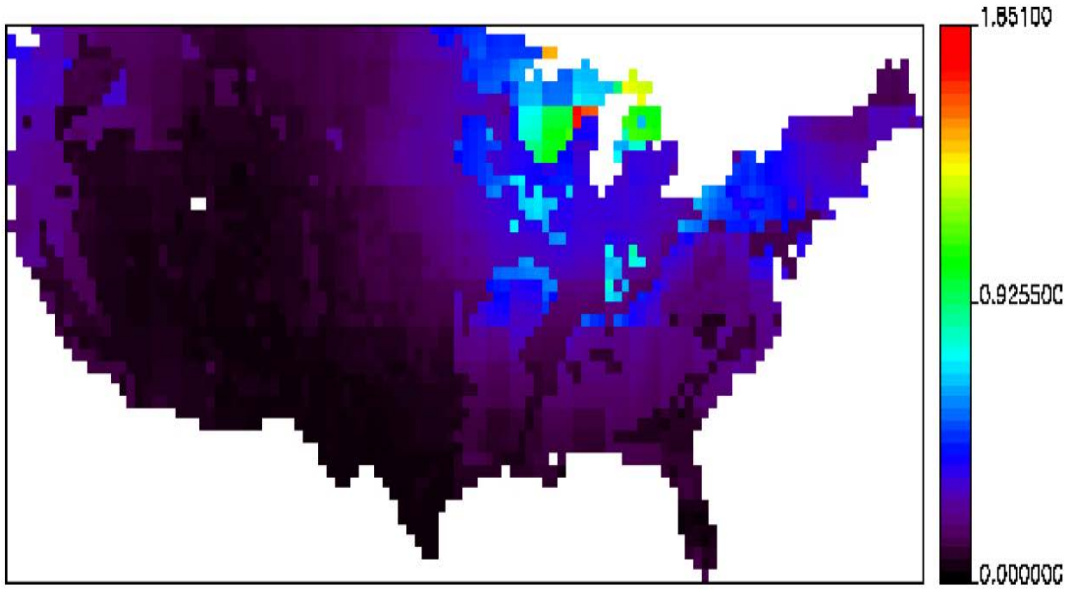

Figure 6 – Annual average dry NO_3 flux over the CONUS (kg N/ha/yr)

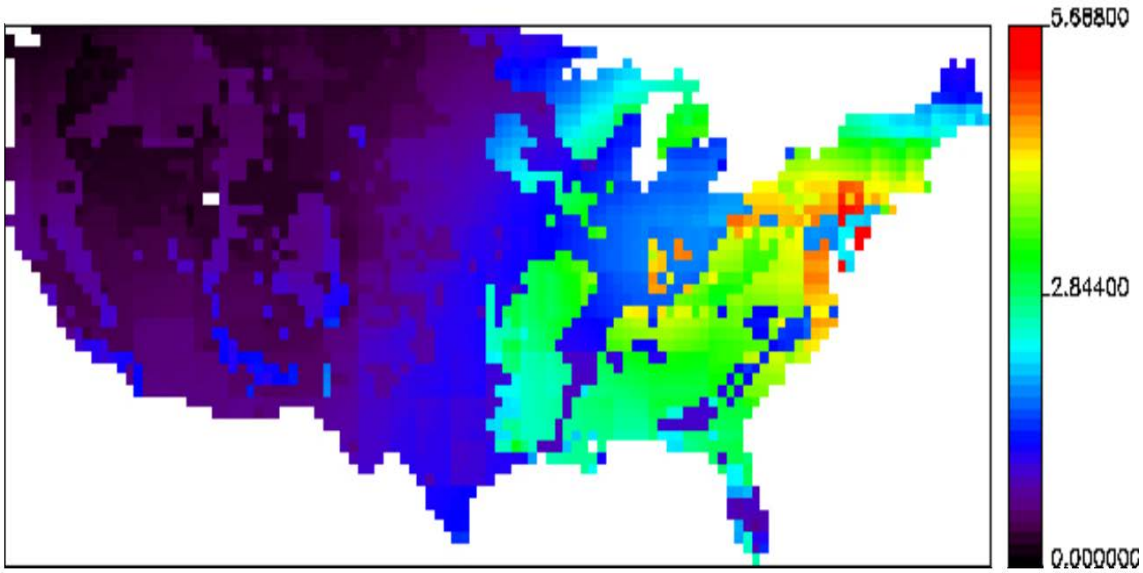

Figure 7 – Annual average dry HNO_3 flux over the CONUS (kg N /ha/yr)

In a Geographic Information System (GIS) environment, the spatially continuous annual average fields (NH_4, NO_3, and HNO_3) were spatially averaged on each Hydrologic Units of the CONUS (USGS, 1994). Appendix 2 reports the averaged data for each 8-digit area and some spatial distribution statistics for each 8-digit area within the Upper Mississippi Basin.

REFERENCES

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Galarneau, E.; Bidleman, T. F.; Blanchard, P. Seasonality and interspecies differences in particle/gas partitioning of PAHs observed by the Integrated Atmospheric Deposition Network (IADN). Atmos. Environ. 2006, 40, 182-197.

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USGS, 1994: 1:250,000-scale Hydrologic Units of the United States. USGS Open-File Rep. 94-0236 [Available on line at **http://water.usgs.gov/GIS/metadata/usgswrd/XML/huc250k.xml**]