1.5 THE EFFECT OF SURFACE EMISSIONS ON THE SEASONAL VARIATION IN NITROGEN DEPOSITION WITHIN THE LONG ISLAND SOUND AIRSHED

Patricia Bresnahan*, Jesse Bash, David Miller
University of Connecticut, Storrs, Connecticut

1.0 INTRODUCTION

Air quality and pollutant deposition in Connecticut and the New England region is influenced by both local, regional and more distant emission sources. In order to better understand this relationship, the Atmospheric Resources Laboratory at the University of Connecticut has been conducting a series of studies on the modeling and measurement of atmospheric nitrogen and mercury.

Yang et al. (Yang, Miller et al. 1996) and Xu et al. (Xu, Yang et al. 1997) measured deposition in Connecticut. These and similar studies elsewhere have found that deposition trends at any given geographical location result from an interaction between upwind emissions, prevailing winds and other meteorological and surface conditions using CAQM, the Connecticut Air Quality Model. CAQM is a RADM-based model being developed at the University of Connecticut to quantify the atmospheric cycling of mercury and nitrogen in the Connecticut region and to estimate the amounts and sources of atmospheric nitrogen and mercury deposition to the watershed of Long Island Sound through simulation studies.

This paper will focus on some recent modeling work on seasonal variations in nitrogen deposition. The purpose of this study was to determine the effect of surface emissions on the seasonal variation in nitrogen deposition.

2.0 AIR QUALITY MODELING

Air quality and deposition modeling have been reviewed recently by Wesely and Hicks (Wesely and Hicks 2000) and Russel and Dennis (Russell and Dennis 2000).

Recent nitrogen deposition modeling studies have utilized a number of different tools. Tarnay et al. took measured atmospheric nitrogen concentrations and used a model to infer deposition rates for the Lake Tahoe Basin (Tarnay, Gertler et al. 2001). In the Danish Nation-wide Monitoring Program, concentration measurements are supplemented by ACDEP model results, in order to estimate the contribution of aerosols to N loading in the regional sea surface (Hertel, Skov et al. 1997). ACDEP was also used by ANICE project to estimate surface deposition into the North Sea (de Leeuw, Cohen et al. 2001). Also in Denmark, the concentrations and deposition of NH3 and NH4+ were calculated using TREND, a statistical atmospheric transport model (Asman 2001). . The development of a "big-leaf" resistance model for the calculation of nitrogen dioxide, ammonia and nitric acid reactions, and its application in the UK, is described by Smith et al. (Smith, Fowler et al. 2000).

There is a very large body of modeling work that has been undertaken using the Regional Acid Deposition Model (RADM) and its descendants. RADM is a 3D Eulerian transport model developed by Julius Chang and his collaborators in the 1980's (Chang, Brost et al. 1987; Chang, Middleton et al. 1990; Dennis, Arnold et al. 1999). In the last decade, it has undergone revision and further development, becoming incorporated into newer models such as the SARMAP Air Quality Model (Chang, Jin et al. 1996). A modeling effort by a German and French team incorporated 4D-variational data assimilation techniques into a regional AQM using the RADM2 gas phase chemistry module (Elbern, Schmidt et al. 2000). The development and application of the Taiwan Air Quality Model, based on the RADM system, is described by Chang et. Al (Chang, Jeng et al. 2000). A report on the sensitivity of the RADM model to nitrogen emissions and other factors is given by Dennis et al. (Dennis, Arnold et al. 1999).

Most recently, the U.S. Environmental protection agency released CMAQ, a RADM based AQM, as a part of its Models3 Modeling environment. (Byun and Ching 1999; Ching and Byun 1999).

3.0 DOMAIN

The study area encompassed a region falling within the Long Island Sound Airshed. Each run of the model used a 36 km grid to generate boundary conditions for a subsequent run using 12 km grid

**Corresponding author*: Patricia Bresnahan, Dept. Natural Resource Management and Engineering, University of Connecticut, 1376 Storrs Rd. UNIT 4087, Storrs, CT 06269-4087; email: *pbresnah@canr.cag.uconn.edu*

cell. The study time periods were one week in each of the four seasons in 1997, and hourly timesteps were used.

4.0 MODEL INPUTS

MM5 meteorological data were obtained from Penn State University. Emissions data were from the Net96 inventory, and run through the SMOKE emissions processing system.

5.0 MODEL OUTPUT

Both wet and dry deposition were estimated. Various emission scenarios were run in order to assess the relative contribution of Connecticut emissions to nitrogen deposition in the region.

6.0 REFERENCES

Asman, W. A. H. (2001). "Modelling the atmospheric transport and deposition of ammonia and ammonium: an overview with special reference to Denmark." Atmospheric Environment **35**(11): 1969-1983.

Byun, D. W. and J. K. S. Ching (1999). Science algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) modeling system. Washington, D.C., Environmental Protection Agency, U.S. Government Printing Office.

Chang, J. S., R. A. Brost, I. S. A. Isaksen, S. Madronich, P. Middleton, W. R. Stockwell and C. J. Walcek (1987). "A three-dimensional Eulerian acid deposition model: physical concepts and formulation." Journal of Geophysical Research **92**(D12): 14681-14700.

Chang, J. S., S. Jin, Y. Li, M. Beauharnois, K.-H. Chang, H.-C. Huang, C.-H. Lu, G. Wojcik, S. Tanrikulu and J. DaMassa (1996). The SARMAP air quality model. Part I of SAQM final report. Sacramento, CA, California Air Resources Board.

Chang, J. S., P. B. Middleton, W. R. Stockwell, C. J. Walcek, J. E. Pleim, H. H. Lansford, F. S. Binkowski, S. Madronich, N. L. Seaman and D. R. Stauffer (1990). The regional acid deposition model and the engineering model. Washington, D.C., NAPAP SOS/T Report 4 of Acidic Deposition: State of Science and Technology. National Acid Precipitation Assessment Program.

Chang, K.-H., F.-T. Jeng, Y.-L. Tsai and P.-L. Lin (2000). "Modeling of long-range transport on Taiwan's acid deposition under different weather conditions." Atmospheric Environment **34**(20): 3281-3295.

Ching, J. and D. Byun (1999). Introduction to the Models-3 Framework and the Community Multiscale Air Quality Model (CMAQ). Science Algorithms of the EPAModels-3 Community Multiscale Air Quality (CMAQ) Modeling System. D. W. Byun and J. K. S. Ching**:** 1:1-1:17.

de Leeuw, G., L. Cohen, L. M. Frohn, G. Geernaert, O. Hertel, B. Jensen, T. Jickells, L. Klein, G. J. Kunz and S. Lund (2001). "Atmospheric input of nitrogen into the North Sea: ANICE project overview." Continental Shelf Research **21**(18-19): 2073-2094.

Dennis, R. L., J. R. Arnold, G. S. Tonnesen and Y. Li (1999). "A new response surface approach for interpreting Eulerian air quality model sensitivities." Computer Physics Communications **117**(1-2): 99-112.

Elbern, H., H. Schmidt, O. Talagrand and A. Ebel (2000). "4D-variational data assimilation with an adjoint air quality model for emission analysis." Environmental Modelling and Software **15**(6-7): 539-548.

Hertel, O., H. Skov and T. Ellermann (1997). "Aerosol contribution to nitrogen deposition to Danish waters 1989-95." Journal of Aerosol Science **28**(6): 1112.

Russell, A. and R. Dennis (2000). "NARSTO critical review of photochemical models and modeling." Atmospheric Environment **34**(12-14): 2283-2324.

Smith, R. I., D. Fowler, M. A. Sutton, C. Flechard and M. Coyle (2000). "Regional estimation of pollutant gas dry deposition in the UK: model description, sensitivity analyses and outputs." Atmospheric Environment **34**(22): 3757-3777.

Tarnay, L., A. W. Gertler, R. R. Blank and G. E. J. Taylor (2001). "Preliminary measurements of summer nitric acid and ammonia concentrations in the Lake Tahoe Basin air-shed: implications for dry deposition of atmospheric nitrogen." Environ Pollut **113**(2): 145-153.

Wesely, M. L. and B. B. Hicks (2000). "A review of the current status of knowledge on dry deposition." Atmospheric Environment **34**(12-14): 2261-2282.

Xu, X., X. Yang and D. R. Miller (1997). "Characteristics of winds and their effect on dry deposition at the connecticut coastline of long island sound." Atmospheric Environment **31**(22): 3729-3735.

Yang, X., D. R. Miller, X. Xu, L. H. Yang, H. M. Chen and N. P. Nikolaidis (1996). "Spatial and temporal variations of atmospheric deposition ininterior and coastal Connecticut." Atmospheric Environment **30**(22): 3801-3810.