Ammonia field measurements and CMAQ comparisons at some "clean" sites in the northeastern US: Implications for total N deposition

Tom Butler*[1,2], Roxanne Marino[1], Donna Schwede[3] and Robert Howarth[1]

We have measured low NH_3 concentrations from 2006 to 2011 at a site in upstate NY (NADP/AIRMon- NY67; CASTNET - CTH 110), and during some of this period at two other low NH_3 concentration sites (ARN, 13 km SE of CTH, and KEF in the Allegheny National Forest, 200 km WSW of CTH,) and an agricultural site (HFD, 40 km SE of CTH) for comparison. Comparisons of passive NH_3 measurements with CMAQ estimates (2002 to 2008) of concentration and deposition were made. At CTH, NH_3 concentration measurements for 2007 and 2008 compare well overall (slope of Passive vs CMAQ = 1.02) with a mean value of 0.49 µg NH_3/m^3 for the passive measurements and 0.52 for CMAQ estimates. However there is some scatter in the comparison (r^2 = 0.57) with CMAQ showing higher concentrations in the summer. KEF shows lower annual concentrations than CTH, and CMAQ has lower values (annual mean= 0.10 µg NH_3/m^3) than the passive measurement concentrations (annual mean=0.23 µg NH_3/m^3)

Measured NH_3 concentrations at CTH, ARN and KEF all show a similar temporal pattern (high NH_3 in late spring and summer, low in winter), representing a regional background level of NH3. However, the agricultural site(HFD) does not follow this pattern, with high concentrations driven by very localized emissions. The potential for high ambient NH3 concentrations (2 to 7 µg NH_3/m^3) exists throughout the year at HFD and are most likely the result of manure and fertilizer application. Transects of NH_3 concentrations across the HFD farm site and beyond show a decline from 6 to 14 µg NH_3/m^3 to ~2 µg NH_3/m^3 within about 1 km of the farm center, further indicating the very localized distribution of NH_3 concentration in an agricultural area. CMAQ model results do not show the temporal and spatial concentration changes measured by the passive samplers at the HFD site.

Converting concentration estimates to nitrogen deposition of NH_3 depends on estimates of deposition velocity or bidirectional flux parameters. The differences in these two approaches are presented, and the relative importance of NH_3 deposition to other forms of N deposition is analyzed. In addition, other nitrogen deposition parameters (e.g. NO_2, $NO_3^-{}_{(p)}$, $NH_4^+{}_{(p)}$, HNO_3, wet NO_3^- and NH_4^+, etc.) are assessed, and estimates of total deposition are presented. The relative importance of NH_3, even at low concentration sites, will be demonstrated.

*Corresponding author: tjb2@cornell.edu, 607 255-3580

[1]Ecology and Evolutionary Biology, Cornell University, Ithaca NY 14853

[2] Cary Institute of Ecosystem Studies, Millbrook NY 12545

[3] Atmospheric Modeling and Analysis Division, National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711