Combining Passive Samplers and a Bi-Directional Exchange Model to Calculate Ammonia (NH_3) Dry Deposition

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Dry deposition of NH_3 to vegetation near local sources of NH_3 emissions is difficult to measure, and is best estimated via models. Presented here are results for a semi-empirical approach for estimating air-surface exchange fluxes of NH_3 downwind of a poultry facility (~ 3.5 million layers) using a bi-directional air-surface exchange model. The modeling domain is the Pocosin Lakes National Wildlife Refuge in eastern North Carolina. Vegetation is pocosin wetlands, with peat soils (pH 3.6) and shrub canopy (leatherwood (*Cyrilla racemiflora*), inkberry (*Ilex glabra*), wax myrtle (*Morella cerifera*)). Ammonia air-surface exchange (flux) was calculated using a two-layer canopy compensation point model (Nemitz et al. 2001, *Quart. J. Roy. Met. Soc*. 127, 815 – 833.) as implemented by Walker et al. (2008. *Atmos. Environ*. 42, 3407 – 3418.), in which the competing processes of emission and deposition were taken into account by relating the net canopy-scale NH_3 flux to the net emission potential of the canopy (both foliage and soil). Weekly NH_3 air concentrations were calculated using ALPHA (Center for Ecology and Hydrology, Edinburgh) passive samplers (h=5.8 m) along three transects to the north/northeast of the facility at 800, 2000 and 3200 m. The NH_3 concentrations were used to develop a nonlinear regression model for predicting gridded NH_3 concentrations as a function of distance and wind direction from the facility. Soil and foliar extracts were used to determine critical compensation points. Seasonal concentration fields and diurnal flux profiles were used to produce representative daily fluxes at each grid point (100 m by 100 m grid). Daily fluxes were scaled to seasonal fluxes, which were summed to an annual flux estimate. Dry deposition was 10.1 kg N/ha/yr at the refuge boundary, decreasing non-linearly to 5.4 kg N/ha/yr at 1.5 km, and 1.4 kg N/ha/yr 8 - 10 km downwind of the facility. Approximately 10% of the refuge model domain receives ≥ 3.0 kg N/ha/yr as dry NH_3 deposition. Limitations of the approach include potential multiple sources of NH_3 inherent in use of passive samplers, and modeling results valid only for the vegetation type included in the model (e.g. in this study a "pocosin" land use type, not adjacent agricultural land).

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