Ammonia sources, transport, transformation, and deposition in coastal New England during summer

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Abstract

During summer 2004, NH_3, size-resolved particulate NH_4^+, and associated characteristics of surface air were measured continuously on Appledore Island, off the southern Maine coast as part of the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT). NH_3 concentrations ranged from <0.6 to 123 nmol m^{-3} with maxima around local noon and minima near dawn. Particulate NH_4^+ ranged from 10.3 to 191 nmol m^{-3}. The transport of emissions from intensive agricultural activities in the eastern United States was an important source of total NH_3 ($NH_3 + NH_4^+$) over the Gulf of Maine during summer. Under cleaner northwest flow, total NH_3 concentrations were relatively low (median = 50.0 nmol m^{-3}) and partitioned roughly equally between phases; under the more polluted midwest flow, total NH_3 concentrations were substantially higher (median = 171 nmol m^{-3}) but dominated by particulate NH_4^+. Because particulate NH_4^+ was associated primarily with the highly acidic sub-μm size fractions with low deposition velocities (median flux = 1.5 μmol m^{-2} day^{-1}), dry-deposition fluxes were dominated by the gas phase (median = 6.2 μmol m^{-2} day^{-1}). Consequently, phase partitioning with pollutant-derived sulfur aerosol substantially increased both the atmospheric lifetime of total NH_3 against dry deposition and the relative importance of removal via wet- versus dry-deposition pathways. Total NH_3 accounted for 32% of the dry-deposition flux of inorganic N to the Gulf of Maine during summer. The combined dry deposition of total NH_3 and wet deposition of NH_4^+ via precipitation contributed 40% of the corresponding total atmospheric N flux.

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