Global Health Burden of Ammonia Emissions from Fossil Fuel Derived Nitrogen Fertilizer Application

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Abstract

Almost all (>95%) global synthetic nitrogen fertilizer is produced using natural gas and coal, but this end-use activity is not considered in global health burden assessments. This type of fertilizer is used extensively in agriculture to enhance crop yields, though efficiencies of use are low, leading to release of a large portion of this nitrogen as gas-phase ammonia (NH_3). NH_3 readily partitions to aerosols to form fine particulate matter ($PM_{2.5}$) pollution that is linked to a range of adverse health outcomes leading to premature mortality. Here, we use high resolution versions of the GEOS-Chem chemical transport model nested over the US and the UK. These countries are selected due to availability of or ability to calculate gridded, time-resolved NH_3 emissions from fertilizer use. We use the model output to parameterize the relationship between acidic sulfate (pSO_4) and nitrate (pNO_3) aerosol abundances and the $PM_{2.5}$ formed from NH_3fertilizer emissions. We then apply this parameterization to global distributions of acidic pSO_4 and pNO_3 aerosol abundances, also modelled using GEOS-Chem, and estimate 50,700-145,400 adult global premature deaths attributable to exposure to $PM_{2.5}$ from synthetic nitrogen fertilizer NH_3 emissions. China and India together account for 35-60% of these. Our estimates represent up to 3% of the literature reports of premature mortality attributable to fossil fuel end-use activities. Policies targeting precursor emissions of pSO_4 and pNO_3 mitigate $PM_{2.5}$ and attributable health burden, but not the risk to sensitive habitats. The amount of nitrogen deposited to sensitive habitats will be unchanged and more gas-phase NH_3 will be liberated to harm ammonia-sensitive plants. It would be more effective to target NH_3 emissions from fertilizer directly. Refinements of our estimates on global scales requires national inventories report gridded, time-resolved fertilizer usage emissions of NH_3.

Early Career Scientist

YES, I am an early career scientist.

IGAC Activities

AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative

IGAC Regional Working Groups

ANGA: African Group on Atmospheric Sciences, Southern Hemisphere Working Group, Americas Working Group, MANGO: Monsoon Asia and Oceania Networking Group, China Working Group, Japan National Committee