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Reducing the health impact of airborne particles – the role of ammonia emissions from agriculture

Abstract

Airborne particles are responsible for large numbers of premature deaths in Europe. To reduce particulate matter concentrations, direct emissions of particles from, e.g., motor vehicles need to be curtailed. But a large fraction of airborne particles is formed in the atmosphere, through reactions of ammonia, sulfur dioxide and nitrogen oxides. So emissions of these gases need to be reduced as well. This comment highlights the importance for human health of exposure to secondary inorganic particles, and the importance of controlling ammonia emissions to prevent secondary inorganic particles from being formed.

Main text

This fall, the EU Parliament will have a crucial vote on the future of air pollution policy in Europe. On the table is a Commission proposal for new National Emission Ceilings (NECs) [1], as amended by the EP Environment Committee in July 2015. The proposed Emission Ceilings cover not only emissions of primary, directly emitted particulate matter but also emissions from precursor gases. These include ammonia (NH_3), sulfur dioxide (SO_2) and nitrogen oxides (NO_x), among others, which react in the atmosphere to form solid (particulate) ammonium sulfates and nitrates. These so-called secondary inorganic aerosols (SIA) can be as much as 50% of the total fine particulate mass in the air. The contribution of ammonia emissions, almost exclusively from agriculture, through SIA formation to fine particle mass often represents 10-20% of fine particle mass in densely populated areas in Europe, higher in areas with intensive livestock farming. [2] In addition, NH_3 speeds up atmospheric reactions of primary SO_2 and NO_x emissions, leading to larger concentrations of total SIA.

Two questions are especially relevant: 1) What are the health effects of these SIA? 2) Which precursor emissions are most important?

Much work has been devoted over the past two decades to identify specific particle components which may be more – or less – harmful than others. This work has not convincingly demonstrated that some particle components contribute more to the health risks than others. This is disappointing at one level as it would be nice to concentrate pollution abatement efforts on a selection of influential sources. On another level, however, this suggests that health benefits can be expected from all efforts to reduce the mass of fine particles in the air. WHO in a recent report highlighted the importance of SIA as having "substantial exposure and health research finding associations and effects”. [3]

A large time series study from the Netherlands, published 15 years ago, found that sulfate and especially nitrate were more closely associated with mortality than particle mass. [4] A recent cohort study from California found that nitrate was the strongest predictor of mortality among a series of components tested. [5] A study from Taiwan found that nitrate and elemental carbon were associated with emergency room visit for hemorrhagic stroke. [6] So if anything, SIA are directly associated with adverse health effects, which makes further reduction of precursor emissions an important priority.

In keeping with such insights, the NEC proposal asks for reductions of emissions of SO_2, NO_x and NH_3 – but at very different percentages: for 2020, relative to 2005, emissions of SO_2 across the EU need to be reduced by 59%, emissions of NO_x by 42%, but emissions of NH_3 by just 6%. Larger reductions are proposed for 2025 and 2030, but the disparity between sulfur and nitrogen oxides on the one hand and ammonia on the other hand remain. This is hard to defend scientifically, as there is good evidence to suggest that all precursor gases need to be reduced in step to achieve the maximum reduction in fine particle concentrations, and that abatement of ammonia is a key factor for abating SIA. In fact, ammonia reductions – which are technically possible - contribute more to reducing particle concentrations than reductions of sulfur and nitrogen oxides. [7]

Ammonia emissions in Europe are almost exclusively from farming, especially livestock farming, while other sources, including road traffic and waste management, typically contribute an additional 10%. The social cost of all nitrogen pollution in the EU27 has been estimated at € 75-485 billion per year, of which close to half is attributed to health damage from SIA air pollution. [8] For the US, annual health costs of ammonia emissions associated with agricultural exports alone were estimated at US$ 60 billion. [9] Of course, abatement measures come at a cost – but the total cost for the proposed emission controls by agriculture are a mere 2-3% of the total emission control costs estimated for the complete package (about € 2.5 billion/year out of € 91 billion). [10] This is also a small percentage of the total volume of subsidies of about € 60 billion that flow from the European Commission to the agricultural sector through the Common Agricultural Policy. Given the contribution of agriculture to fine particle concentrations in Europe, the health damage caused by particles from agriculture is estimated to be far larger than the burden placed on this sector by the current NEC proposal. This is no doubt an inconvenient truth, but it is time for the agribusiness sector to take responsibility for the damage it causes – and for policy makers to propose and fund measures which do not threaten the livelihood of the farmer.

As the EU starts to promote the Circular Economy (COM/2014/0398), there is a strong case to reduce ammonia emissions as part of innovation to increase economy-wide nitrogen use efficiency. European nitrogen pollution losses currently have a fertilizer value of around €20 billion/year based on the European Nitrogen Assessment (www.nine-esf.org/ENA-Book) and a fertilizer price of about €0.80/kg nitrogen. This points to a major business opportunity to improve emission reduction and recycling technologies that further strengthens the case for NEC revision.

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