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Human health benefits from reducing short-lived air pollutants and methane concentrations

A recent global study has estimated that, each year, 1.5 million people die early from cardiopulmonary diseases and 0.1 million people die early from lung cancer caused by exposure to $PM_{2.5}$ pollution. A further 0.4 million people are estimated to die early from respiratory diseases caused by exposure to surface ozone (O_3) pollution. Although short-lived air pollutants have the largest influence on air quality and premature deaths, controlling methane emissions as well would improve air quality and reduce the number of people dying prematurely each year, the study suggests.

In this study, researchers modelled changes in air quality during the 'industrial period', defined here as the years between 1860 and 2000, and linked these changes to premature human deaths. They considered three main drivers of air pollution: 1) short-lived air pollutants (such as sulphate and various carbon aerosols) emitted from human activities and biomass burning; 2) climate change and 3) increasing methane concentrations (e.g. from energy production and distribution, agriculture); and assessed how changes in each of these factors influenced changes in concentrations of O_3 and fine particulate matter ($PM_{2.5}$).

To estimate the effects of air pollution on human health, the researchers used data from long-term epidemiological studies from the American Cancer Society conducted in the United States, under the assumption that they are relevant worldwide. From 1860 to 2000, total $PM_{2.5}$ and health-relevant ozone concentrations were estimated to have increased worldwide by approximately 8 μgm^{-3} (micrograms per cubic metre of air) and 30 ppbv (parts of O_3 per billion parts of atmosphere) respectively. Globally, increased industrial $PM_{2.5}$ pollution (from all three drivers of air pollution considered in the study) was estimated to be responsible for around 1.53 million premature deaths from cardiopulmonary disease and 95,000 premature deaths from lung cancer each year. Increased industrial surface O_3 was responsible for around 0.4 million early deaths from respiratory diseases each year.

Increased emissions of short-lived pollutants alone, accounted for 94% of the total change in $PM_{2.5}$ levels, and this is reflected in the 1.49 million avoidable early deaths from cardiopulmonary disease and the 92,000 early deaths from lung cancer from exposure to higher levels of $PM_{2.5}$. Greater emissions of short-lived pollutants also accounted for 83% of the total increase in surface O_3 during the period, and was associated with 0.33 million (or about 85% of the total 0.4 million) early deaths caused by this pollutant.

Climate change also affected air quality by increasing concentrations of $PM_{2.5}$ by approximately 0.4 μgm^{-3}, which accounts for 5% of the overall increase in $PM_{2.5}$ concentrations. Climate-related increased exposure to $PM_{2.5}$ was associated with 91,000 early deaths from cardiopulmonary disease and 5,000 early deaths from lung cancer. In addition, climate change was found to increase the concentration of surface O_3 by about 0.5ppbv, which is less than 2% of the total changes in surface O_3 levels. These ozone changes were related to 7,000 early deaths from respiratory diseases.

Increased concentrations of methane during the industrial period have been highly influential on atmospheric chemistry and have contributed to increases in O_3 concentrations of 4.3 ppbv, or about 15% of the total increase in O_3 levels during this time. Methane increases resulted in only tiny changes in $PM_{2.5}$ levels (0.04 μgm^{-3}). Increased methane concentrations consequently had an insignificant effect on early deaths associated with $PM_{2.5}$ exposure, but caused about 50,000 early deaths from respiratory diseases related to exposure to O_3.

Methane changes have significantly contributed to increased surface O_3 pollution during the industrial period. As methane is an O_3 precursor and global methane concentrations are expected to keep rising, early deaths associated with surface O_3 pollution from methane are also likely to increase, suggesting that efforts to lower methane levels will not only slow the rate of climate change but will improve air quality and provide health benefits globally.