THE CASE FOR URGENT ACTION ON SHORT-LIVED CLIMATE POLLUTANTS

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"THE URGENT NEED TO ADDRESS SLCPS COMES FROM THE MILLIONS WHO WOULD OTHERWISE DIE EARLY FROM POOR AIR QUALITY, THE TOLL OF THE REGIONAL CLIMATE DISRUPTIONS AND CROP YIELD LOSSES THEY CAUSE, AND THEIR UNIQUE ABILITY TO SLOW DOWN NEAR-TERM CLIMATE CHANGE"

Although meeting the 2°C temperature target is a worthy goal, societal wellbeing is affected by a much broader set of environmental impacts than simply long term global mean temperature.

The massive volcanic eruption of Mt. Tambora in 1815 threw so much material into the atmosphere that it was pitch black at midday for hundreds of miles around. The incredible force of the blast thrust hot gases into the stratosphere. As those gases condensed into tiny particles and spread around the world, global temperatures dropped slightly because the particles reflected sunlight. For human societies of the time, the more important effect was the particles' outsized impact during summer when there is more sunlight to reflect. The feeble summer sunshine slowed photosynthesis and shrunk the growing season, leading to widespread crop failures and famines in North America, Europe and Asia.

This reminds us that although it is essential to greatly reduce carbon dioxide emissions as quickly as possible to limit long-term climate change, society is affected by other aspects of climate change as well. A case in point is near-term climate change, which is minimally affected by plausible carbon dioxide reductions. This is because of the long residence time of carbon dioxide in the atmosphere and the long lifetime of capital-intensive electricity generation capacity with high carbon dioxide emissions.

There are other emissions we can target that will reduce the impacts of near-term climate change, however, the Short-Lived Climate Pollutants (SLCPs). An SLCP strategy consists of reducing emissions of methane and the multiple products of incomplete combustion, and reversing the rapid growth in emissions of industrial hydrofluorocarbons (HFCs). Success in these three areas could cut the projected global mean warming through mid-century roughly in half. Limiting the near-term rise in global mean temperatures is only one of several goals of an SLCP strategy, however. Methane is not only a very powerful greenhouse gas but is also a chemically reactive one, leading to ozone formation in the lower atmosphere. Ozone in the lower atmosphere is likewise a greenhouse gas, and is toxic to both humans and ecosystems. Hence reductions of methane bring benefits to human and ecosystem health along with mitigating climate change. Products of incomplete combustion include black carbon (soot), a highly potent warming agent owing to its strong absorption of sunlight, organic carbon compounds with a more complex mixture of absorption and reflectivity, and carbon monoxide, another gas leading to ozone formation. Carefully selected control measures can lead to a net climate benefit at the global scale, but their impacts at local to regional scales are even greater. Black and organic carbon haze can alter weather patterns, disrupting large-scale features such as the Asian Monsoon and the tropical wet and dry seasons. Particulate haze due to North American and European pollution contributed to drought in the Sahel during the 1980s, for example. These hazes can increase the likelihood of extreme events such as local flooding as well. Black carbon also has an outsized effect when falling on snow or ice as it darkens those surfaces, causing them to melt much more rapidly. Hence reductions in products of incomplete combustion that influence the Arctic or the Himalayan/Tibetan region can be especially important for both climate and regional water supplies.

Additionally, black and organic carbon constitute a substantial portion of particulate matter with a diameter smaller than 2.5 microns (PM2.5). These particles are so small that they can be inhaled deeply into the lungs, where they contribute to respiratory and cardiovascular diseases. In 2012 the World Health Organization declared outdoor air pollution, consisting of PM2.5 and ozone, to be ➤

the leading environmental cause of premature death worldwide claiming more than 3 million victims per year. The United Nations Environment Programme and World Meteorological Organization estimate that an aggressive SLCP reduction strategy could prevent 15-90 million premature deaths through 2040 due to improved air quality alone. Millions of additional premature deaths would be prevented due to reductions in indoor air pollution, for which products of incomplete combustion are again major sources.

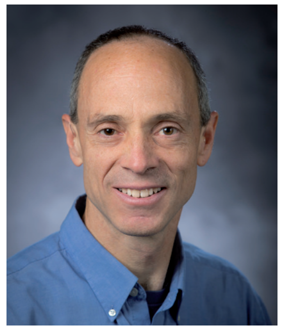
The decreases in surface ozone resulting from reduced emissions of both methane and products of incomplete combustion lead to substantial increases in agricultural yields. Under the aggressive SLCP strategy examined by the UN, reduced ozone levels would lead to an increase of 30-135 million metric tonnes in total of wheat, rice, maize (corn) and soybeans each year. Given that the World Health Organization estimates that increases in malnutrition will lead to more deaths attributable to climate change than any other cause, increased agricultural yields could have an extremely large benefit for human health as our planet warms. This is especially the case in developing countries where yield increases resulting from SLCP reductions are greatest and where malnutrition is most likely to increase. Enhanced yields would also increase national food security and income to famers, of course.

Hence there are many reasons to reduce SLCPs. The only plausible pathways to achieving the 2°C temperature target include reductions in both carbon dioxide and SLCPs, making SLCP reductions an essential part of a long-term climate stabilization strategy. If long-term warming was the only target, however, reductions in SLCPs could be put off for many decades. The urgent need to address SLCPs comes from the millions who would otherwise die early from poor air quality, the toll of the regional climate disruptions and crop yield losses they cause, and their unique ability to slow down near-term climate change. As with Tambora's eruption, although there is an impact on global mean surface temperature the true impacts on human wellbeing are vastly greater. Thus there are compelling, but distinct, reasons to reduce both SLCPs and carbon dioxide immediately.

"BLACK AND ORGANIC CARBON HAZE CAN ALTER WEATHER PATTERNS, DISRUPTING LARGE-SCALE FEATURES SUCH AS THE ASIAN MONSOON AND THE TROPICAL WET AND DRY SEASONS"

Fortunately, we know how to reduce SLCPs. Current technology and practices are available and in fact are already in use in some parts of the world. An aggressive SLCP strategy requires accelerating and expanding the adoption of those best practices worldwide. For methane, large emission reduction potential exists in the fossil fuel industry, both in extraction of coal, oil and natural gas (including eliminating methane flaring), and in fixing leaks during the storage and transmission of natural gas. Substantial decreases in methane emissions can also be realized via separation and treatment of biodegradable municipal waste through composting and anaerobic digestion as well as landfill gas capture. In the agricultural sector, emissions can be lowered by use of anaerobic digestion on farms, manure management and intermittent rice paddy irrigation. Products of incomplete combustion can be decreased by emissions controls on diesel vehicles or a switch to electric vehicles, use of clean cookstoves and heat stoves in developing countries and more efficient biomass stoves in developed nations, upgrading from kerosene lightning to modern electric lighting, and improved technology to replace traditional brick kilns and coke ovens. Use of HFCs or HFC replacements that absorb less infrared radiation can greatly lower their warming impact.

Hence there is a clear path to reducing SLCP emissions rapidly. There are also societal benefits that accrue from an SLCP reduction strategy that are not related directly to emissions. Methane that escapes during the storage and transmission of natural gas is lost product, so fixing leaks generally pays for itself over a few years or less. Releases during extraction of coal, gas and oil can also typically be captured and the methane utilized, again with overall cost savings. The same is true for several other sources, such as municipal landfills or anaerobic digesters for farm waste. Greater use of captured methane also displaces the need for other fossil energy, further decreasing emissions and lowering costs.



Above: **Dr Drew Shindell**

Similarly, reducing emissions of products of incomplete combustion is typically accomplished by increasing efficiency, with substantial ancillary benefits. In the case of solid biomass fuel use, use of clean cookstoves and heating stoves can dramatically reduce fuel usage whereas switching to modern sources of energy eliminates biomass fuels entirely. These transformations can not only reduce deforestation, and hence net carbon dioxide emissions, but greatly affect human wellbeing, especially in the developing world where it is estimated that 1-5 billion women-hours are lost per year gathering fuel. Children are also often tasked with fuel gathering, and reducing the need for this activity can thus substantially increase the time available for education and reduce the danger women are exposed to during fuel gathering. In cases where fuel is purchased, such as by users of charcoal stoves or in small industries, increased efficiency can lead to substantial fuel cost savings. Broader transformations, such as increased biking and walking, not only reduce emissions but also improve health via increased physical exercise. Hence in many cases there are both economic and human development incentives alongside those more directly related to emissions reductions.

Though monetization of the benefits shows that for most SLCP reduction strategies the net societal benefits greatly outweigh the costs, there are nonetheless implementation barriers. In some cases, these may be the upfront capital expenditures required, for example to pay for methane capture at a municipal landfill. In other cases they may be cultural, such as a preference for traditional cooking techniques or the misconception that methane from coal mining has to be vented immediately to ensure mine safety. In some cases, such as in the oil and gas industry, even though methane capture pays for itself based only on the resale value of the captured gas, the rate of return may still be low compared to other uses of the same capital. Many SLCP controls also face an economic misalignment between the few who must take action to reduce emissions, such as fossil fuel or small brick industries, diesel vehicle manufacturers or municipalities, and the many who reap the benefits from improved air quality and climate change mitigation. As long as environmental externalities including climate change and air quality degradation remain fully or largely excluded from the world's economic systems, such economic barriers are likely to remain large.

While economic misalignments in SLCP-related benefits are present considering individual actors relative to society at large, they are greatly reduced at the national level versus the global commons compared with carbon dioxide-related benefits. In the case of SLCPs, those countries that take action reap the greatest rewards for reducing products of incomplete combustion as these greatly affect national air quality. There is also not an issue of determining historic responsibility since SLCPs are short-lived. Hence there is every incentive to take strong local action rather than free riding on the actions of others.

Furthermore, the air quality and health benefits of SLCP reductions are near-term. Thus although implementing an SLCP reduction strategy requires considerable effort, there is no misalignment between local spending now and benefits that are far away in space and time as there is for carbon dioxide reductions (although many of those can also improve air quality, and hence a multiple impact viewpoint can be useful in those strategies as well). Success in controlling SLCPs could also help foster a sense of the tangible benefits to citizens of actions to improve the environment and to nations of international cooperation to tackle environmental problems, such as participating in the cooperative activities of the Climate and Clean Air Coalition. This could facilitate progress in other areas as well. Success could also help establish a precedent for fully considering a broader range of benefits resulting from climate (and other environmental) policies, as without recognizing the total societal impacts we cannot chart the optimal pathways forward and recognize the huge potential benefits of strategies such as targeted SLCP reductions. ■

ABOUT THE AUTHOR

Drew Shindell is a Professor at Duke University following two decades at the NASA Goddard Institute for Space Studies.

His work includes over 175 peer-reviewed publications. He has received awards from Scientific American, NASA, the NSF and the EPA, been elected AGU and AAAS fellow, and testified before both houses of the US Congress (at the request of both parties).

He chaired the 2011 UNEP/WMO Integrated Assessment of Black Carbon and Tropospheric Ozone and was a Coordinating Lead Author on the 2013 IPCC Assessment. He chairs the Scientific Advisory Panel to the Climate and Clean Air Coalition of nations and organizations.