# New Research Confirms Complementary Nature of $CO_2$–SLCP Emission Reduction

A new study (Rogelj J. *et al.*) published in the *Proceedings of the National Academy of Sciences* confirms the long-held position of the Climate and Clean Air Coalition that the work of reducing short-lived climate pollutants (SLCPs) is complementary to the effort to reduce carbon dioxide ($CO_2$) emissions under the UN Framework Convention on Climate Change. Two SAP members joined the study as co-authors: Drew Shindell (SAP Chair) and Markus Amann.

The paper, titled *Disentangling the effects of $CO_2$ and short-lived climate forcer mitigation*, notes that "mitigation of [short-lived climate forcers (SLCFs), another term for short-lived climate pollutants (SLCPs)] can only be a complementary strategy on top of $CO_2$ mitigation." These results of Rogelj *et al.* are consistent with previous studies focused on the mitigation potential of SLCPs, for example:

> ***UNEP/WMO (2011)*** *- "The benefits [of SLCP mitigation] are shown to be considerable, significantly reducing the rate of warming over the next two to four decades, improving the chances of remaining below the 2°C target, preventing millions of premature deaths from small particulate pollution and preventing the loss of millions of tonnes of crops from ozone pollution every year. It also shows that action on these substances is complementary to, but does not replace the challenge to dramatically reduce emissions of carbon dioxide from the burning of fossil fuels and deforestation.*
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> ***Shoemaker et al. (2013)*** *- "An emerging strategy, which we refer to as hybrid climate mitigation (HCM), emphasizes reducing SLCPs in parallel with long-lived carbon dioxide ($CO_2$) as to achieve climate goals, as well as health and food security benefits, associated with some of the SLCPs…. It is also important to recognize that $CO_2$ and SLCP emission are not independent. Some of the steps to reduce $CO_2$ emissions will drive down emissions of SLCPs…. We suggest that the best way to prevent the slowing of $CO_2$ mitigation efforts is to emphasize parallel strategies for reducing SLCP and $CO_2$ emissions."*

The Rogelj *et al.* study looks at linkages between emissions sources of $CO_2$ and SLCPs to see how a long-term strategy of aggressive $CO_2$ mitigation would simultaneously reduce emissions of SLCPs, particularly black carbon (BC) and methane ($CH_4$). According to Rogelj *et al.* 55-65% of anthropogenic BC emissions are linked to the burning of fossil fuels and would therefore be co-controlled by the $CO_2$ mitigation measures in hypothetical 2°C temperature stabilization scenarios. The study notes that a 'large share' of $CH_4$ emissions result from sources which are not linked to $CO_2$ emissions, although strict $CO_2$ measures would eventually limit emissions of $CH_4$ "linked to the extraction of fossil fuels, like coal, in the long term." For HFCs, the study found that no linkages to $CO_2$ emission sources.

Not noted in the analysis are linkages in the opposite direction, namely near-term mitigation of SLCPs resulting in reductions of $CO_2$. For example, a phase down of HFCs combined with technically available improvements in appliance energy efficiency has the potential to avoid energy-related $CO_2$ emissions. The replacement of kerosene lamps with solar-LED lighting systems can eliminate a powerful source of BC emissions in the near-term, while also reducing $CO_2$, and improving public health.[1]

In terms of avoided warming from SLCP-specific mitigation, the results of Rogelj *et al.* are "broadly consistent" with earlier studies. Rogelj *et al.* estimates that SLCP abatement can avoid 0.9°C of additional warming by 2100 (compared to the reference scenario) this is comparable to the 1.1°C estimated by Ramanathan & Xu (2010).[2] Rogelj *et al.* simulates avoided warming of 0.1-0.3°C from HFC mitigation by

[1] CCAC Scientific Advisory Panel (2014) SAP BRIEFING ON SCLPS AND KEROSENE LAMPS.

[2] Ramanathan, V., & Y. Xu (2010) *The Copenhagen Accord for limiting global warming: criteria, constraints, and available avenues*, PROC. NAT'L ACAD. SCI. USA 107:8055-8062.

2100, which is consistent with the lower bound of HFC growth scenarios of Velders *et al.* (2009) and avoided warming modeled in Yu *et al.* (2013). For BC-only mitigation, Rogelj *et al.* estimates 0.18°C of avoided warming by 2050 which is consistent with Shindell *et al.* (2012) (0.19°C).

Time and speed are important metrics for comparison which are highlighted in Rogelj *et al.* as well as previous SLCP studies. Rogelj *et al.* confirms that SLCPs "can slow the rate of near-term [pre-2030] climate change across a wide range of possible future scenarios." Although the benefits of SLCP mitigation, particularly BC, are significantly limited through to the end of the century in scenarios with dramatic $CO_2$ reductions when $CO_2$-linked mitigation is taken into account. However, in all but one scenario, *Rogelj et al.* assumes the gradual global deployment of modern energy services concluding by 2070, which is well outside of the window for near-term mitigation.

Slowing the rate of near-term climate change leads to multiple near- and long-term benefits, including reducing impacts from climate change on those alive today, reducing biodiversity loss, providing greater time for adaptation to climate change, and reducing the risk of crossing thresholds activating climate feedbacks (e.g. from emissions associated with melting permafrost). It can also benefit cumulative climate impacts such as cumulative sea-level rise,[3] and the contribution of additional heat by SLCPs to the deep oceans.[4] Further, some impacts of $CO_2$ mitigation measures, such as reducing reflective sulfate aerosol emissions from certain types of fossil fuel use, would produce near-term warming (but reduced long-term peak warming) which could only be offset by reductions in near-term climate forcers such as BC.[5]

Finally, Rogelj *et al.* limits its analysis to the climate impacts of $CO_2$ and SLCP mitigation and does not include the benefits to public health and agriculture of different mitigation pathways. Delayed reductions in SLCPs would necessarily reduce the avoided premature mortalities and improved agricultural production projected in near-term SLCP mitigation scenarios. The World Health Organization estimates that more than 7 million people every year die due to indoor and outdoor air pollution.[6] Reducing SLCPs with 16 measures targeting methane and black carbon can prevent more than 2 million deaths annually from outdoor air pollution and hundreds of thousands more from indoor air pollution by 2030.[7]

## SAP Member Quotes

**Dr. Markus Amann,** International Institute for Applied Systems Analysis (IIASA**) –** "The study focuses primarily on a scenario where the world is already assumed to be on a 2°C trajectory. Many of the $CO_2$ mitigation measures necessary to achieve this scenario are linked to, and will also reduce, SLCPs, theoretically making SLCP-specific mitigation less important. However, as the latest IPCC report has noted, the world is not currently on a 2°C trajectory. Hence addressing SLCPs to reduce near-term warming, while at the same time taking forceful action to cut $CO_2$ emissions, represents the best option for comprehensive climate mitigation."

**Prof. Drew Shindell,** Duke University, SAP Chair **-** "Reducing short-lived climate pollutants does not in any way negate the need to swiftly move to a path with major cuts in carbon dioxide emissions.

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[3] Hu A., Y. Xu, C. Tebaldi, W. M. Washington, V. Ramanathan (2013) *Mitigation of short-lived climate pollutants slows sea-level rise*, NATURE CLIMATE CHANGE 3:730-734.

[4] Solomon S., J. S. Daniel, T. J. Sanford, D. M. Murphy, G-K. Plattner, R. Knutti, & P. Friedlingstein (2010) Persistence of climate changes due to a range of greenhouse gases, PNAS 107(43):18354-18359.

[5] Shoemaker, J. K., D. P. Schrag, M. J. Molina, V. Ramanathan (2013) *What Role for Short-Lived Climate Pollutants in Mitigation Policy?*, SCIENCE 342.

[6] World Health Organization (2014) Burden of disease from household air pollution for 2012.

[7] UNEP & WMO (2011) INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE; Shindell, D., J. C. I. Kuylenstierna, E. Vignati, R. van Dingenen, M. Amann, Z. Klimont, S. C. Anenberg, N. Muller, G. Janssens-Maenhout. F. Raes, J. Schwartz, G. Faluvegi, L. Pozzoli, K. Kupiainen, L. Hoglund-Isksson, L. Emberson, D. Streets, V. Ramanathan, K. Hicks, N. T. K. Oanh, G. Milly, M. Williams, V. Demkine, & D. Fowler (2012) *Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security*, SCIENCE 335(6065):183-189.

The value of forcefully targeting short-lived climate pollutants now is that unfortunately we are not yet on that path, and it is therefore important in the near-term that the SLCPs, with their multiple adverse impacts, are also quickly dealt with."

**Prof. V. Ramanathan,** Scripps Institute of Oceanography, University of California San Diego - "We need to take advantage of political opportunities to cut SLCPs as soon as possible, not only to help mitigate climate change, but also to achieve the other vital benefits that SLCP reduction brings, including saving more than two million lives lost, and 55 millions of tons of crops damaged each year by air pollution. As others have pointed out, the food lost could feed more than 500 million people currently living in extreme poverty."

## Q&A

**Does Early Action on SLCPs "Buy Time" to Delay Mitigation of $CO_2$?**

Early action on SLCPs cannot 'buy time' for delayed mitigation of $CO_2$. Rogely *et al.* notes that any delay in "stringent action on $CO_2$ results in lock-in of carbon emitting infrastructure and higher cumulative $CO_2$ emissions that imply a higher committed warming. Because of this, and the persistence of $CO_2$ in the atmosphere, near-term initiation of $CO_2$ mitigation is required to control midcentury to long-term climate change."

The CCAC and scientific literature have been consistently clear that action on SLCPs cannot replace or serve as a justification for delay in the rapid control of anthropogenic emissions of $CO_2$.

**How does this new study compare to previous studies on the benefits of SLCP mitigation?**

While the results of Rogelj *et al.* are consistent with previous studies, the conclusions that it reaches are the consequence of asking a very different set of questions.

The 2011 UNEP/WMO Assessment began by asking: given the clear links between emissions of air pollutants and climate change, what is the "potential for [SLCP] measures to address near-term climate change, changes in local weather patterns and achieve co-benefits in terms of improved human health and ecosystem services"? The result of this line of questioning was the identification of 16 measures targeting black carbon and methane, which can produce *net* avoided warming, while providing benefits to human health and agriculture.

The new Rogelj *et al.* paper asked: to what extent are emissions of $CO_2$ and SLCPs linked? How would SLCP emissions be reduced if the world were on a path of $CO_2$ reduction measures consistent with a 2°C stabilization scenario? What additional climate benefit would result from SLCP-specific mitigation beyond those achievable from $CO_2$ mitigation in that case?

**Will SLCP emissions reductions occur automatically as global affluence increases and other measures and modern emissions controls are implemented?**

Rogelj *et al.* and a previous study by Pacific Northwest National Laboratory (read SAP comment on the PNNL study here) suggest that black carbon will have little influence on warming in 2100, partly due to the fact that most black carbon measures are assumed to be implemented within the reference scenarios. The CCAC believes that urgent and consistent action is needed now to produce the reductions in SLCPs that will help relieve pressure on climate and human health. SLCP reductions will come only by concerted effort.

"Emissions controls don't happen automatically, even those that lead to cost savings," said Drew Shindell. "While advanced nations have indeed cleaned up their emissions dramatically over recent

decades, it took a lot of work and, as the current death toll from air pollution indicates, we still have a long way to go.”