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Global temperature response to regional and sectoral air pollutant and greenhouse gas emissions under the Shared Socioeconomic Pathways

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Achieving the ambition of the Paris Agreement and meeting the Sustainable Development Goals require both near-zero levels of long-lived greenhouse gases and deep cuts in emissions of so-called short-lived climate forcers (SLCFs), including methane and black carbon. Here we present a comprehensive dataset of contributions to future global temperature change from emissions of CO_2 and individual SLCFs from 7 economic sectors and 13 source regions, both as they are today and as they are projected to change under the Shared Socioeconomic Pathways (SSPs). Such detailed knowledge about the mix of emissions from individual sources and benefits and trade-offs of reductions is essential for designing efficient mitigation strategies at the national and international levels, as well as for informing policy processes on how to best address linkages between climate, sustainable development and air quality.

Our results demonstrate that the mitigation potential inherent in the present SLCF emissions is highly inhomogeneous across region and sector, and that co-emissions of all species – including CO_2 – should be considered in any targeted climate policy. We also reinforce the importance of reducing methane emissions, from agriculture, waste management and energy production, for reducing warming in the near-term. In contrast, in many regions, reducing industry emissions brings air quality benefits but may cause a net additional near-term warming. The spatiotemporal heterogeneity is expected to continue under the SSPs. Most scenarios project a particularly strong increase in aerosol and other SLCF emissions in South Asia and Africa South of the Sahara, suggesting that technology development and air pollution legislation in these regions is a key step in the transition to a low emission future. Moreover, both rapidly increasing and decreasing emissions of SLCFs will play an important role in shaping the regional climate and air quality.

By using an analytical climate model, we build a methodological framework that can be used to estimate the impact of any emission scenarios. Our data set hence provide a toolkit for further studies of implications of mitigation pathways and policy responses, and support assessments of environmental impacts.