Global methane footprints growth and drivers 1990-2023

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Methane has been identified as the second-largest contributor to climate change, accounting for approximately 30% of global warming. Countries have established targets and are implementing various measures to curb methane emissions. However, our understanding of the trends in methane emissions and their drivers remains limited, particularly in recent decades when viewed from a consumption perspective (i.e. accounting for all emissions along the entire global supply chain). And many of previous studies lack comprehensive coverage of a wide range of countries and high sectoral resolution.

Aiming to address the research gaps concerning the lack of up-to-date analysis on methane emissions from the perspective of consumption, covering a wide range of countries and with high sectoral resolution, this study uses the latest GLORIA input-output dataset (Global Resource Input-Output Assessment) to examine methane CBE of 164 countries/regions (accounting for 98% of global methane emissions) for the long-term period 1990-2023. We further compare the degree of decoupling of both PBE and CBE from economic growth in each country; reveal the recent changes in trade embodied emissions; and investigate the drivers of changes in CBE with Structure Decomposition Analysis (SDA). We compare our methane emissions results with CO2 emissions and conclude the study with a discussion of solutions to reduce methane emissions.

Our results indicate that there is no foreseeable slowdown in the momentum of global methane emissions growth. Only developed countries have managed to reduce both production- and consumption-based emissions while maintaining economic growth (i.e., strong decoupling) during the observed period (1990-2023). Their decoupling is mainly caused by a decline in their emission coefficient, and to a lesser degree due to outsourcing methane emissions to less developed regions.

Global trade accounts for approximately 30% of global methane emissions, but major trade patterns are shifting from North-North and North-South to South-South, indicating that developing countries are increasingly participating in global supply chains. Also, as sectors across countries differ in technological endowment, production efficiency, emission coefficient of products produced in different countries varies. This provides an opportunity to reduce a sectorâ€™s methane footprint by supply chain management of upstream production through carefully selecting import partners with low emission coefficient.

The study further reveals the changing drivers of global methane emissions from 1998 to 2023 in five-year intervals. It identifies that the reduction in emission coefficient, reflecting improvements in emission technology, is the main determinant for reducing emissions over the observation period and can offset the increasing effects from growth of final demand. Reducing methane emission coefficient requires targeted strategies across sectors. Changes in demand structure have played a considerable role in the increase of emissions since 2008. We further compared the heterogeneity of each driver between country groups by calculating the SD of the average contribution of the drivers in each group. We find that the emission coefficient, final demand per capita, and demand structure show the greatest differences between groups. We also find the dynamics of emission drivers are fluctuating across periods, similar to the status of decoupling from GDP. Achieving emission reduction in one region/period does not promise long-lasting or stable reduction in the future.

In summary, this study enhances our understanding of the most up to date changes and drivers of

methane emission footprints and supports countries in incorporating methane emissions into their climate mitigation strategies.