

Global Patterns of CO₂, and Non-CO₂, Emissions from Production, Consumption, and Trade

Topic: Input-Output Analysis: Sustainable Production and Consumption policies (1)

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Global climate change mitigation has long focused on carbon dioxide (CO₂), yet other high-impact greenhouse gases, methane (CH₄), nitrous oxide (N₂O), and fluorinated gases (F-gas), are rising rapidly and remain underrepresented in global emission accounting. To effectively limit global warming well below 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C, substantial efforts are required not only to reduce CO₂ and CH₄ emissions but also to intensify the focus on reducing non-CO₂ emissions, especially long-term ignored emission sources, N₂O and F-gas. Therefore, this study employs the Multi-Regional Input-Output (MRIO) models, incorporating the CO₂, CH₄, N₂O, and F-gas emission inventories from EDGAR and input-output tables from the EMERGING, to establish consumption-based inventories and present a trade analysis of for 2015 and 2022. The results show that while CO₂, still dominates in absolute terms, CH₄ and N₂O grew at a similar rate (7%), and F-gas increased most rapidly (40%). In 2022, approximately 26% of global CO₂, (8,966 Mt), 25% of CH₄, (2,611 Mt CO₂-eq), 30% of N₂O (751 Mt CO₂-eq), and 44% of F-gas emissions (621 Mt CO₂-eq) were embodied in international trade. Sectoral and regional patterns revealed that CO₂, and F-gas were concentrated in China's heavy and light manufacturing exports; CH₄ emissions were mainly associated with agriculture, livestock, and mining-related exports from China and Latin America; and N₂O emissions were dominated by agricultural exports from Latin America and Sub-Saharan Africa. By providing the first consistent cross-gas assessment of both production- and consumption-based emissions under unified system boundaries, this study enables robust comparisons across gases, sectors, and regions. The findings highlight gas-specific mitigation priorities, emphasize the importance of trade-adjusted and consumption-based accountability, and provide an empirical foundation for integrating non-CO₂, gases into future climate targets and supply-chain governance.