

## Historical regional and sectoral contributions to climate change

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Regional or sectoral contributions to climate change are important in the formulation of climate change policy. After the industrial revolution, developed countries emit CO<sub>2</sub> and non-CO<sub>2</sub> greenhouse gases (GHGs), and the historical emissions are large; while developing countries contribute relative fewer emissions in historical period but increase significantly in recent years or visible future. To assess the contributions to climate change, using cumulative emissions is a general and direct method. However, such method may ignore the lifetime of GHGs since part of the GHGs sink into the biosphere, ocean, soil or diminish during biogeochemical cycles. In this study, we evaluate the historical regional and sectoral contributions to climate change by using an improved version of Simple Climate Model for OPTimization (SCM4OPT) with a normalized marginal method. Based on the results, we analyze ten major GHG emitting countries and 12 sectors.

First, current emissions with relative long lifetime like CO<sub>2</sub> and N<sub>2</sub>O, from developing countries increase significantly, like China, India, Mexico and Brazil, however, their contributions to climate change are still relatively smaller, compared with the developed countries such as USA, Japan, Germany, Canada and UK, of which countries the cumulative emissions are in relatively larger scale and current emissions are already under controlled. We can conclude here that the GHGs with relatively long lifetime need to be controlled stringently to reduce the long-term effects on climate change. For CH<sub>4</sub>, which has a relatively shorter lifetime, the contributions to climate change are closely related to emissions within recent decades. These imply that reductions on short lifetime emissions can make immediate alleviation regarding climate change.

Second, energy sector contributes most of the CO<sub>2</sub> emissions, and therefore contribute almost half to the climate change among all the sectors. However, for CH<sub>4</sub> and N<sub>2</sub>O, agriculture sector contributes most of the emissions and therefore their contributions to climate change are remarkable. Reduction policies need to target these sectors. In addition, CO<sub>2</sub> from land transportation and CH<sub>4</sub> from waste treatment increase rapidly in recent years, attention also needs to be paid to these sectors for making climate change policies.

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