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The impact of air pollutant and methane emission controls on tropospheric ozone and radiative forcing: CTM calculations for the period 1990-2030

F. Dentener[1], D. Stevenson[3], J. Cofala[2], R. Mechler[2], M. Amann[2], P. Bergamaschi[1], F. Raes[1], and R. Derwent[4]
[1]EC-JRC, Institute for Environment and Sustainability, Ispra, Italy
[2]IIASA, International Institute for Applied Systems Analysis, Laxenburg, Austria
[3]University of Edinburgh, School of GeoSciences, Edinburgh, UK
[4]Rdscientific, Newbury, Berkshire, UK

Abstract. To explore the relationship between tropospheric ozone and radiative forcing with changing emissions, we compiled two sets of global scenarios for the emissions of the ozone precursors methane (CH_4), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and nitrogen oxides (NO_x) up to the year 2030 and implemented them in two global Chemistry Transport Models. The "Current Legislation" (CLE) scenario reflects the current perspectives of individual countries on future economic development and takes the anticipated effects of presently decided emission control legislation in the individual countries into account. In addition, we developed a "Maximum technically Feasible Reduction" (MFR) scenario that outlines the scope for emission reductions offered by full implementation of the presently available emission control technologies, while maintaining the projected levels of anthropogenic activities. Whereas the resulting projections of methane emissions lie within the range suggested by other greenhouse gas projections, the recent pollution control legislation of many Asian countries, requiring introduction of catalytic converters for vehicles, leads to significantly lower growth in emissions of the air pollutants NO_x, NMVOC and CO than was suggested by the widely used and more pessimistic IPCC (Intergovernmental Panel on Climate Change) SRES (Special Report on Emission Scenarios) scenarios (Nakicenovic et al., 2000), which made Business-as-Usual assumptions regarding emission control technology. With the TM3 and STOCHEM models we performed several long-term integrations (1990-2030) to assess global, hemispheric and regional changes in CH_4, CO, hydroxyl radicals, ozone and the radiative climate forcings resulting from these two emission scenarios. Both models reproduce broadly the observed trends in CO, and CH_4 concentrations from 1990 to 2002.
For the "current legislation" case, both models indicate an increase of the annual average ozone levels in the Northern Hemisphere by 5ppbv, and up to 15ppbv over the Indian sub-continent, comparing the 2020s (2020-2030) with the 1990s (1990-2000). The corresponding higher ozone and methane burdens in the atmosphere increase radiative forcing by approximately 0.2 Wm^{-2}. Full application of today's emissions control technologies, however, would bring down ozone below the levels

experienced in the 1990s and would reduce the radiative forcing of ozone and methane to approximately -0.1 Wm^{-2}. This can be compared to the 0.14-0.47 Wm^{-2} increase of methane and ozone radiative forcings associated with the SRES scenarios. While methane reductions lead to lower ozone burdens and to less radiative forcing, further reductions of the air pollutants NO_x and NMVOC result in lower ozone, but at the same time increase the lifetime of methane. Control of methane emissions appears an efficient option to reduce tropospheric ozone as well as radiative forcing.

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