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Application of semi-empirical models to project the future of the Antarctic ozone hole in a changing climate

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There are few studies that have examined the sensitivity of the future development of the Antarctic ozone hole to different greenhouse gas (GHG) emissions scenarios. There are chemistry climate model (CCM) studies available that untangle the uncertainties resulting from different models and from different GHG emissions scenarios. However, these models are very computationally demanding. As a result, exploring a wide range of emissions scenarios and their impact on stratospheric ozone is prohibitive. As a complement to CCM analyses, this study aims to test the applicability of semi-empirical models to conduct fast and inexpensive projections of the evolution of Antarctic ozone through the 21st century. The primary input for the semi-empirical models is stratospheric temperature fields that include the climate response to enhanced GHG emissions simulated by a state-of-the-art atmosphere-ocean general circulation model (AOGCM, the Hadley Centre coupled Model; HadCM3), as well as a measure of stratospheric chlorine loading. The semi-empirical models account for the effect of temperature changes on ozone which is currently missing in most AOGCM simulations. The semi-empirical models describe the time rate of change of activated chlorine and its relation to ozone destruction with respect to 1960 ozone levels in the Antarctic stratosphere. We show that to reliably project the future of the Antarctic ozone hole, and to assess the changes in Antarctic ozone due to changes in GHGs, it is essential to include the temperature↔ozone feedback in model simulations which is generally absent in current AOGCM simulations.