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Exploring the importance of interactive ozone chemistry under different GHG and ODS levels

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Increasing computational resources have led to the advent of Earth System Models. However, to date many models still do not incorporate interactive chemistry due to its high computational costs. Previous work has shown the importance of interactive ozone in enhancing extreme springtime variability under present-day ozone depleting substance (ODS) levels. Here, we aim to understand the role of different greenhouse gas and ODS levels on this result. In the present study we aim to answer this question for the Arctic springtime stratosphere, contrasting a suite of multi-decadal simulations performed with the ESMs WACCM4 and SOCOLv3-MPIOM with interactive and prescribed ozone chemistry. Our analysis focuses on the contribution of carbon dioxide and ozone for temperature and temperature variability at lower, middle and upper stratospheric levels. The ensembles comprise simulations with 1xCO_2 or 4xCO_2 (without anthropogenic ODS) and year 2000 (peak ODS) forcings, allowing us to investigate the relative importance of interactive chemistry vs. prescribed ozone under different "climate states and ODS levels". Our results show 1) that CO_2 is the primary driver of the mean temperature response in the upper stratosphere while ozone largely contributes to the mean change in the lower stratosphere; 2) the importance of interactive chemistry for a coherence (coupling) between temperature, zonal wind (used as proxy for the polar vortex strength) and ozone in the lower stratosphere; and 3) an important contribution of interactive chemistry to temperature variability under year 2000 but also 1xCO_2 forcing in contrast to simulations forced with 4xCO_2.