The response of the ozone layer under abrupt 4xCO2 in CMIP6

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Previous studies indicate a possible role of stratospheric ozone chemistry feedbacks in the climate response to 4xCO2, either via a reduction in equilibrium climate sensitivity (ECS) or via changes in the tropospheric circulation (Nowack et al., 2015; Chiodo and Polvani, 2017). However, these effects are subject to uncertainty. Part of the uncertainty may stem from the dependency of the feedback on the pattern of the ozone response, as the radiative efficiency of ozone largely depends on its vertical distribution (Lacis et al., 1990). Here, an analysis is presented of the ozone layer response to 4xCO2 in chemistry–climate models (CCMs) which participated to CMIP inter-comparisons. In a previous study using CMIP5 models, it has been shown that under 4xCO2, ozone decreases in the tropical lower stratosphere, and increases over the high latitudes and throughout the upper stratosphere (Chiodo et al., 2018). It was also found that a substantial portion of the spread in the tropical column ozone is tied to inter-model spread in tropical upwelling, which is in turn tied to ECS. Here, we revisit this connection using 4xCO2 data from CMIP6, thereby exploiting the larger number of CCMs available than in CMIP5. In addition, we explore the linearity of the ozone response, by complementing the analysis with simulations using lower CO2 forcing levels (2xCO2). We show that the pattern of the ozone response is similar to CMIP5. In some models (e.g. WACCM), we find larger ozone responses in CMIP6 than in CMIP5, partly because of the larger ECS and thus larger upwelling response in the tropical pipe. In this presentation, we will discuss the relationship between radiative forcing, transport and ozone, as well as further implications for CMIP6 models.