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# Sensitivity of the ozone content and temperature to different forcing

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Our study assessed the contribution of different forcing to the climate and atmospheric composition changes between 1980 and 2020. This period is characterized by significant changes in temperature and ozone content, making it an interesting and important period to study. A correct understanding of the ozone and temperature reactions to different forcing in the past will allow us to better understand future ozone trends and the driving physical processes. We analyzed the influence of different forcings using the chemistry–climate model SOCOL version 3 (CCM SOCOLv3) which has been developed as a combination of the general circulation model for the middle atmosphere (MA-ECHAM) and the chemical module MEZON (Model for Evaluation of oZONe trends). The MA-ECHAM provides the MEZON the 3-dimensional fields of the temperature, and MEZON gives back to MA-ECHAM the concentrations of water vapor, ozone, methane, nitrous oxide, and chlorofluorocarbons for the radiative forcing calculations.

In the study we considered ozone content and atmospheric temperature response to (1) ozone-depleting substances; (2) greenhouse gas concentrations, ocean surface temperature, and sea ice area; (3) solar radiation; and (4) stratospheric aerosol loading, (5) greenhouse gas concentrations and (6) ocean surface temperature and sea ice area only. To assess the relative influence of different factors we performed model runs considering the effects of each factor and a control experiment in which the influence of all factors was considered simultaneously. The results of the control run were verified by SBUV and MSU/AMSU satellite measurements and reanalyzes (ERA 5 and MERRA2).

The results show a significant decrease in ozone content at the end of the 20th century and pronounced stratospheric cooling, which is primarily driven by greenhouse gases and the effect of ODS on stratospheric ozone. Despite a slight decreasing ODS content decline during the 21st century, has not yet resulted in an increase of stratospheric temperatures. The minimum values of stratospheric ozone concentration in the mid-1990s can be related to the simultaneous impact of the increased ODS content, volcanic aerosol emissions into the stratosphere, and decreased solar activity. The main cause of the observed increase in tropospheric ozone content is related to climatic factors. Climatic factors make the most important contribution to the increase in tropospheric temperature, with the increase in ocean surface temperature being more important than the direct effect of the increase in atmospheric greenhouse gas content.

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