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# Radiative and dynamical temperature changes in the middle atmosphere in a future climate

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This study investigates which part of the projected temperature change in the stratosphere and lower mesosphere by the end of the 21st century will be due to the radiative effects of changed greenhouse gas (GHG) and ozone concentrations, and which part will be the result of dynamical changes. For this study, we use the ECHAM/MESSy Atmospheric Chemistry (EMAC) chemistry-climate model. The total temperature signal is derived in a transient EMAC simulation from 1960 to 2100, which includes GHG changes following the specifications of the RCP8.5 scenario and changes in ozone depleting substances according to the adjusted A1 scenario. Corresponding sea-surface temperatures and sea-ice concentrations have been prescribed from a pre-existing RCP8.5 simulation with the Max Planck Institute ocean model (MPIOM).

The radiative impact of the projected future changes in GHG and ozone concentrations is isolated by applying the new EMAC submodel RAD. RAD calculates the adjusted radiative forcing (RF) of the troposphere due to a tracer concentration change after the middle atmosphere temperature has adjust to a new equilibrium of radiative heating rates. By prescribing the GHG and ozone changes between the reference period 1965 (1960-1969) and the future period 2095 (2090-2095) from the transient simulation to RAD, and comparing the resulting adjusted middle atmosphere temperature with the total temperature change in the transient run, the relative contributions of radiative and dynamical effects on the projected temperature signal are determined. The calculation is performed for individual greenhouse gas agents as well as the combination of them. Dynamically induced temperature changes are detected that can be related to changes in the Brewer-Dobson circulation in the stratosphere and mesosphere.