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Role of stratospheric ozone changes in the global carbon uptake, as simulated by the CMCC-Carbon Earth System Model

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Stratosphere-Troposphere coupling in the Southern Hemisphere (SH) is here examined in the CMCC-Carbon Earth System Model. Observed large changes in the SH climate over the past decades are reported as a shift in the Southern Annular Mode, especially during SH summer. Model studies have found that during austral summer these changes can be mostly attributed to stratospheric ozone depletion. Coupled-climate-carbon-model simulations have reported that associated trends in surface winds can have an impact on the air-sea CO2 fluxes over the Southern Ocean through ventilation of carbon rich deep water. It is expected that summer SH circulation changes will be weaker or even reversed for the next 50 years due to stratospheric ozone recovery partially offsetting changes due to greenhouse gases increase. In this work two sets of simulation reproducing the historical climate and one future scenario including stratospheric ozone changes are performed and analysed. The simulations are performed with the CMCC Carbon Earth System Model (CESM) that includes processes related to the biological and geochemical parts of the carbon cycle. One set of simulations is done with the high-top version of the model, which includes a well-resolved stratosphere and has top at 80km; the second set uses the low-top version of the same ESM (top at 10km). The high-top model is able to fully reproduce the observed trends in the tropospheric circulation patterns in the SH during austral summer whilst the low-top version not. By comparing the two sets of simulations, we discuss the impact of imposed stratospheric ozone changes to the surface circulation patterns through troposphere-stratosphere coupling and to the CO2 air-sea fluxes.