The impact of upper tropospheric and lower stratospheric ozone changes on global warming projections

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Trace gas concentrations in the tropical upper troposphere and lower stratosphere (UTLS) are of crucial importance for the global energy budget, firstly, because the very low temperatures make greenhouse gas changes in this region particularly effective in driving radiative forcing and, secondly, since the tropical UTLS structure plays a central role in determining the entry of trace gases and aerosols into the stratosphere.

In a recent study (Nowack *et al*., 2015), we provided further evidence that composition changes in the UTLS can significantly affect global warming projections. Using a state-of-the-art atmosphere-ocean chemistry-climate model, we found a ~20% smaller global warming in response to an abrupt $4xCO_2$ forcing if composition feedbacks were included in the calculations as compared to experiments in which composition feedbacks were not considered. We attributed this large difference in surface temperature change mainly to circulation-driven decreases in tropical UTLS ozone and related changes in stratospheric water vapor, partly counteracted by simultaneous changes in ice clouds.

Here, we extend our previously reported results by analyzing longer runs and additional experiments. Based on these modeling experiments, we show how considering different levels of complexity in composition changes can affect estimates of global clear-sky and cloud feedbacks. Finally, we explain why the impact of these processes is expected to differ among models. We highlight that improving our understanding of processes in the tropical UTLS and their representation in Earth system models remains a key challenge in climate research.

References

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