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Sensitivity of the southern hemisphere tropospheric jet response to ozone depletion: specified versus interactive chemistry

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Southern hemisphere lower stratospheric ozone depletion has been shown to lead to a poleward shift of the tropospheric jet stream during austral summer, influencing surface atmosphere and ocean conditions, such as surface temperatures and sea ice extend. The characteristics of stratospheric and tropospheric responses to ozone depletion, however, differ among climate models largely depending on the representation of ozone in the model.

The most accurate way to represent ozone in a model is to calculate it interactively. However, due to computational costs, in particular for long-term coupled ocean-atmosphere model integrations, the more common way is to prescribe ozone from observations or calculated model fields.

Here, we investigate the difference between an interactive chemistry and a specified chemistry version of the same atmospheric model in a fully-coupled setup using a large 9-member model ensemble. In contrast to most earlier studies, we use daily-resolved ozone fields in the specified chemistry simulations to achieve a better comparability between the ozone forcing with and without interactive chemistry. We find that although the short-wave heating rate trend in response to ozone depletion is the same in the different chemistry settings, the interactive chemistry ensemble shows a stronger trend in polar cap stratospheric temperatures and circumpolar stratospheric and tropospheric zonal mean zonal winds as compared to the specified chemistry ensemble. We attribute part of these differences to the missing representation of feedbacks between chemistry and dynamics in the specified chemistry ensemble and part of it to the lack of zonal asymmetries in the prescribed ozone fields.

This study emphasizes the value of interactive chemistry for the representation of the southern hemisphere tropospheric jet response to ozone depletion.