EGU21-9573
https://doi.org/10.5194/egusphere-egu21-9573
EGU General Assembly 2021

High vs. low latitude influence on seasonal stratospheric pathways in the atmospheric model ICON

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Stratospheric pathways play an important role in connecting distant anomaly patterns to each other on seasonal timescales. As long-lived stratospheric extreme events can influence the large-scale tropospheric circulation on timescales of multiple weeks, stratospheric pathways have been identified as one of the main potential sources for subseasonal to seasonal predictability in mid-latitudes. These pathways have been shown to connect Arctic anomalies to lower latitudes and vice versa. However, there is an ongoing discussion on how strong these stratospheric pathways are and how they exactly work.

In this context, we investigate two strongly discussed stratospheric pathways by analysing a suite of seasonal experiments with the atmospheric model ICON: On the one hand, the effect of El Niño-Southern Oscillation (ENSO) on the stratospheric polar vortex, and thus the circulation in mid and high latitudes in winter. And on the other hand, the effect of a rapidly changing Arctic on lower latitudes via the stratosphere. The former effect is simulated realistically by ICON, and the results from the ensemble simulations suggest that ENSO has an effect on the large-scale Northern Hemisphere winter circulation. The ICON experiments and the reanalysis exhibit a weakened stratospheric vortex in warm ENSO years. Furthermore, in particular in winter, warm ENSO events favour the negative phase of the Arctic Oscillation, whereas cold events favour the positive phase. The ICON simulations also suggest a significant effect of ENSO on the Atlantic-European sector in late winter. Unlike the effect of ENSO, ICON simulations and the reanalysis do not agree on the stratospheric pathway for Arctic-midlatitude linkages. Whereas the reanalysis exhibits a weakening of the stratospheric vortex in midwinter and a connected tropospheric negative Arctic Oscillation circulation response to amplified Arctic warming, this is not the case in the ICON simulations. Implications and potential reasons for this discrepancy are further analysed and discussed in this work.