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Stratosphere-troposphere coupling: Sensitivity of future circulation changes in the NH to SST anomalies: comparison of low-top and high-top model simulations

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Atmospheric global circulation will change in response to anthropogenic influence on the climate; however many of the simulated circulation changes are model-dependent, i.e. highly uncertain. In particular, the response of the Northern Annular Mode (NAM), which is the leading mode of the extratropical circulation variability in the Northern Hemisphere (NH), is strongly model-dependent. A recent study has demonstrated that these model-depended NAM trends account for a significant part of the intermodel differences in future temperature and precipitation trends in some NH regions across the models participated in the latest IPCC assessment report. Understanding the reasons for different NAM responses to the same forcing across the models may help to reduce the uncertainty in future climate prediction. In this study we employ high-top (with the lid at 0.01 hPa) and low-top (with the lid at 10 hPa) versions of GCM ECHAM5 and study the sensitivity of the NAM response to different prescribed sea surface temperature (SST) and sea ice concentration (SIC) anomalies under doubling CO2 concentration. The prescribed anomalies are based on simulations of future climate change by coupled atmosphere-ocean models, and the differences between the prescribed anomalies fields are deemed to represent current uncertainties in the atmosphere-ocean coupling. It appears that the responses to the same SST and SIC anomalies differ between the high-top, i.e. stratosphere-resolving, model version and the low-top version. We find that the different responses of the extratropical lower tropospheric zonal winds are associated with different responses of atmospheric eddy fluxes. We analyze and quantify the differences between the two model responses and discuss possible implications for simulation of regional climate changes in the NH.