Response of sea surface temperature to climate change and its influence on the wintertime polar vortex in CMIP5 and chemistry-climate models

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Future changes in the boreal polar vortex under a climate change scenario are still a matter of debate in the scientific community. For example, there is a lack of consensus among models about possible future changes in the frequency of major stratospheric warmings. The counteracting effects of different contributors such as decreasing ozone-depleting substances and increasing greenhouse gas (GHG) concentrations and their induced changes in sea surface temperatures (SSTs) and sea ice can partially explain this uncertainty. In addition, these projected GHG induced changes show a dispersion among models, thus enhancing the uncertainty. In the case of the response of SSTs to increasing GHG, recent future projections of coupled climate models show a mean El Niño-like response, however with a remaining spread in their oceanic response to global warming. Since changes in SSTs represent a relevant source of polar vortex variability by affecting upward propagating wave activity, differences in SST forcing among models are likely to play an important role in model projections of polar vortex changes.

In this study, we analyze possible effects of different modeled SST responses to climate change on the wintertime polar vortex by means of transient RCP6.0 simulations of CCMI and CMIP5 models and sensitivity runs with the ECHAM/MESSy Atmospheric Chemistry chemistry-climate model. First analyses show that a strong warming of the equatorial Eastern Pacific is recurrent in models as the main part of the SST response to climate change. This warming is related to a weakening of the polar vortex in mid-winter through a strengthening of the wavenumber-1 wave activity. However, model biases in the representation of stationary wave activity and possible effects of future SST changes in other areas can mask at least partially the SST induced change in the polar vortex.