

Boreal winter stratosphere-troposphere coupling in large ensemble climate simulations

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Large ensemble climate simulations were performed with realistic SSTs by MRI-ESM2.0, which can reproduce the Quasi-Biennial Oscillation (QBO), and MRI-AGCM3.2H, which cannot reproduce the QBO but has high horizontal resolution (about 60 km horizontally) and larger ensemble members, to investigate El Niño Southern Oscillation (ENSO) and QBO effect on the stratosphere-troposphere coupling in boreal winter extratropics. In both models, the polar vortex strength and Sudden stratospheric warming (SSW) frequency in the Northern Hemisphere are clearly affected by ENSO, with the polar vortex weakening (SSW frequency increasing) during El Niño and strengthening (SSW frequency decreasing) during La Niña. This ENSO relationship is nonlinear, large change occurs between ENSO neutral and El Niño, while small change between La Niña and the neutral. The polar vortex response to El Niño and La Niña is relatively larger for MRI-AGCM3.2H and smaller for MRI-ESM2 due to difference in tropospheric ENSO teleconnection patterns inducing upward propagating planetary waves. The Arctic Oscillation index shows a linear change with ENSO index, which comes from not only the stratosphere-troposphere coupling but also tropospheric ENSO teleconnection. The effect of QBO phase was evaluated using equatorial zonal winds at 50 hPa. The polar vortex tends to weaken (SSW frequency increases) during QBO easterly and strengthen (frequency decreases) during QBO westerly, although the amplitude is smaller than that in reanalysis JRA55. It is also clear that large uncertainty of analyzed signal using small number of ensemble member, and thus caution is needed for conclusions obtained from small sample observations and reanalyses.

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