

General comments

The observation data and numerical modelling have suggested that the Arctic stratospheric polar vortex (SPV) is playing role in inter-seasonal variability and predictability of the winter climate over Eurasia and North America. By analysing PV changes in the PMIP paleo-simulations, the author explored the PV changes and its influences on climate variability during the glacial climate. The results show that under LGM conditions, the PV stretched toward the Laurentide ice sheet increased the possibility of cold air outbreaks into mid-latitudes. This finding provides an explanation to the observed extreme winter cooling and long-stand inter-model spreads. The paper is well-written. I recommended to published it with the following minor revision.

Comments to authors:

Line 10: The abbreviation of polar vortex PV could be confused with PV of potential vorticity, suggested change to SPV.

Line 18: should be “was beyond...”

Line 86: Table 1 was not included. Should be Table S1?

Line 102: Present AWI-ESM resolution in the form of grid numbers, like for the other models.

Lines 122-132: add unit of gpm to VSI? like -1000 gpm and 70 gpm

Line140: Further specify that ERA5 is shown in black line. For instance, “This overall pattern fits the ERA5 re-analysis data, as shown by the similar shape of 250 gpm contour (black line in Fig. 1).

Line 172-174: “...previous climate models results found that the stratospheric polar vortex itself can be either colder or stronger with increasing GHG depends on the strengthen amplitude of the troposphere originated planetary waves (Baldwin et al., 2003). The expression is not very clear, please clarify.

Line 211: “warm-cold-warm-cold pattern” sound weird, do you mean dipole between mid-and high latitudes?

Figure 3: add confident level to the figure.

Add a figure to illustrate how PV different between the LGM and PI affect the climate. Calculating wave activity fluxes by focusing on the North American to Eurasian cross section to analyze stratosphere-troposphere interactions?