Revisiting the Contrasting Response of Polar Stratosphere to the Eastern and Central Pacific El Niños

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Supplementary materials

To evaluate the projected changes of stratospheric reponse to two types of ENSO in future climate we supposed to use the CMIP5 model esemble. However, the validation of the CMIP5 model ensemble revealed the strong intermodel dicrepancy as well as strong model biases in simuation of the stratospheric reponse to ENSO.

We analysed 17 CMIP5 climate models that capture nonlinearity in ENSO properties that is a good metric of the ability of the models to realistically simulate the two types of El Niño events, according to the (Cai et al., 2018 [1]). Amongst this subgroup, we selected the models that reproduce the tropospheric teleconnection patterns for the two types of El Niño in the "historical" runs. Data from the 'historical' experiment covers the period from 1916 to 2005 and consists of simulations where the observed changes in air composition (including CO2) was due to both anthropogenic and volcanic impacts, and the radiative forcing was associated with the release of short-lived natural and anthropogenic aerosols into the atmosphere. Land use and its impact on greenhouse gas emission were also considered (Taylor et al., 2012 [2]).The chosen criteria yielded the selection of 13 CMIP5 models: CMCC-CMS, GISS-E2-R, FIO-ESM, CESM1-CAM5, IPSL-CM5B-LR, bbc-csm1-1-m, CCSM4, CESM1-BGC, CNRM-CM5, GFDL-ESM2M, MIROC5, MRI-CGCM3, MIROC5 (see (Gushchina et al., 2021 [3]) for the details). Then we evaluated the ability of these models to simulate the teleconnection patterns in the stratosphere for the two types of El Niño. The ensemble mean regressions of geopotential height anomalies at 10 and 70 hPa level onto E and C+ indices are presented on Figures S1 and S2. We may conclude that the model distribution of the regression coefficients for the E index coincides with the reanalysis during December-February in the middle startosphere (Figure S1) and January-March in the lower stratosphere (Figure S2). However, for the Central Pacific El Niño for the entire cold season in the middle stratosphere, the models simulate the opposite regression distribution compared to the reanalysis. In the lower stratosphere the model's teleconncetion patterns also differ significantly from reanalysis. Taking in mind the model's inability to reproduce the stratosphere response to CP El Niño in historical run, we suppose that the analysis of projecting changes of ENSO teleconnection in the stratosphere using CMIP5 climate models is questioning. In addition, a strong internal variability of the stratosphere in the future climate, both in the "rcp8.5" and "rcp4.5" scenarios, was recently revealed (Vargin et al., 2022 [4]).

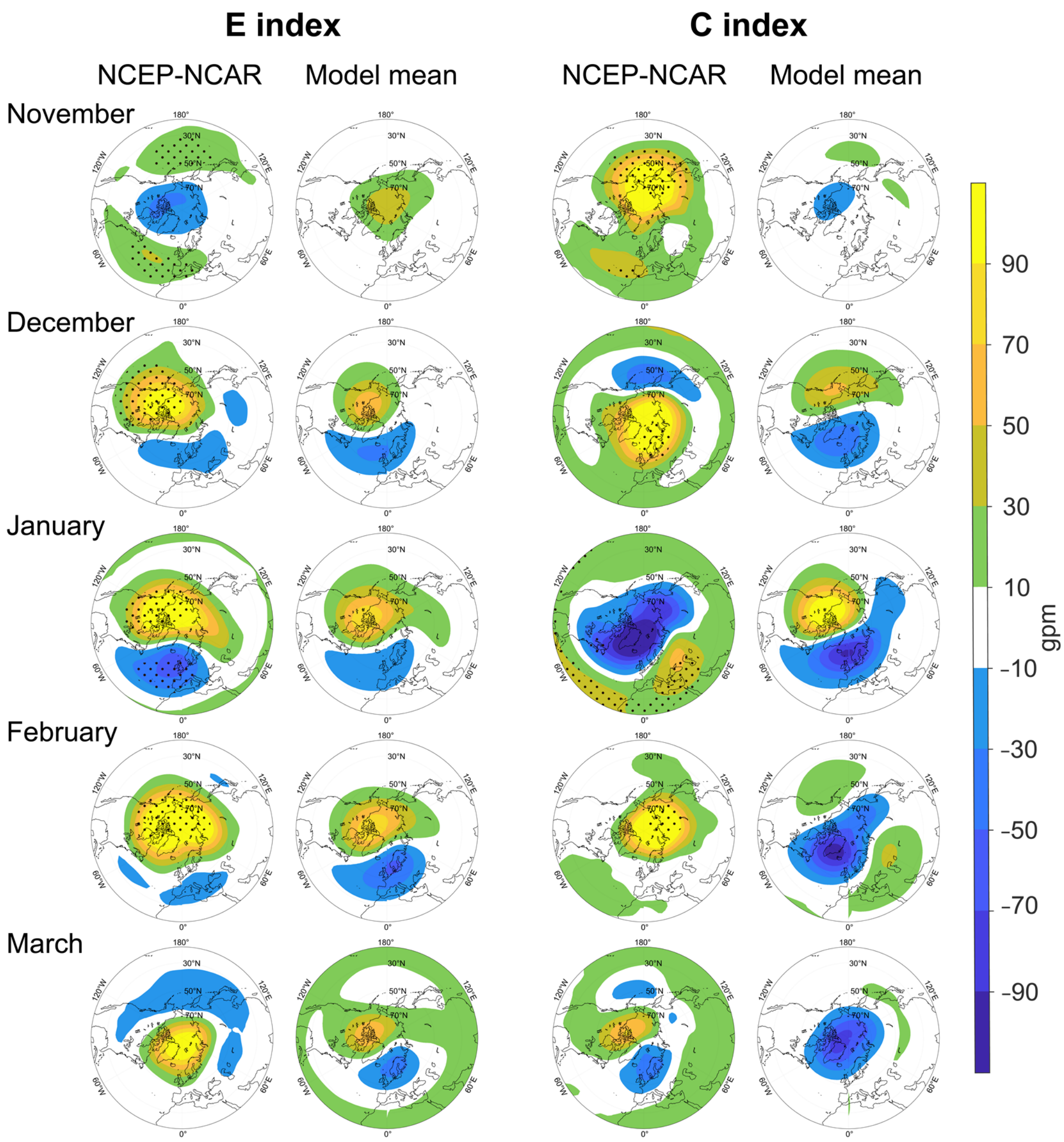

Figure S1. Regression of geopotential height anomalies at 10 hPa onto E index (first two columns) and C+ index (second two columns) from November to March in NCEP-NCAR reanalysis (first and third columns) and in ensemble mean of the selected CMIP5 models (second and fourth columns). Dotted areas represent statistically significant values at a 90% confidence level. Contour interval is 20 gpm. The outermost latitude is 20° N.

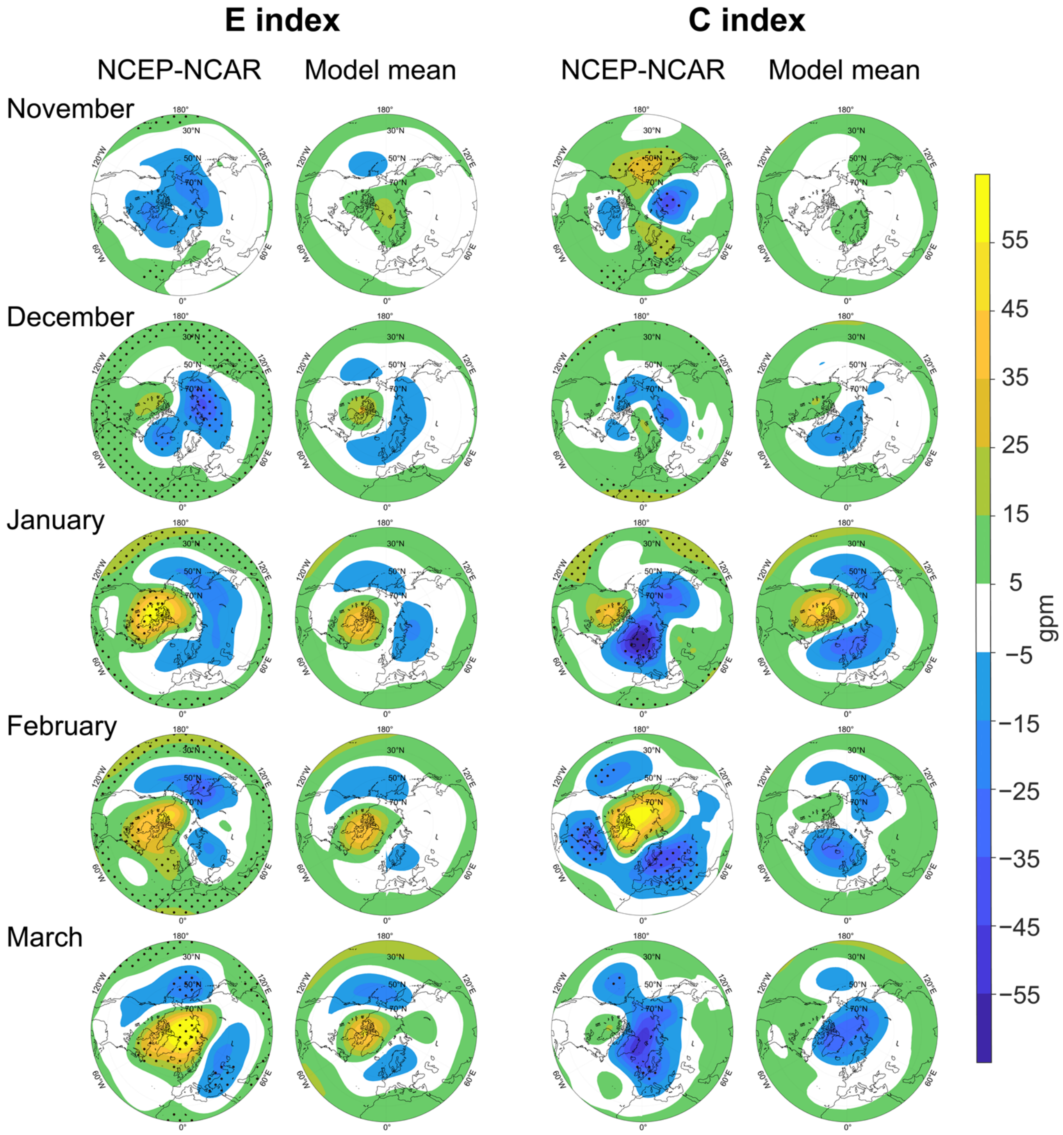

Figure S2. Regression of geopotential height anomalies at 70 hPa onto E index (first two columns) and C+ index (second two columns) from November to March in NCEP-NCAR reanalysis (first and third columns) and in ensemble mean of the selected CMIP5 models (second and fourth columns). Dotted areas represent statistically significant values at a 90% confidence level. Contour interval is 20 gpm. The outermost latitude is 10° N.

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