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Poleward Transport Variability in the Northern Hemisphere during Final Stratospheric Warmings simulated by CESM(WACCM)

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Observational studies of Arctic stratospheric final warmings have shown that tropical/subtropical air masses can be advected to high latitudes and remain confined within a long-lived "frozen-in" anticyclone (FrIAC) for several months. It was suggested that the frequency of FrIACs may have increased since 2000 and that their interannual variability may be modulated by (i) the occurrence of major stratospheric warmings (mSSWs) in the preceding winter and (ii) the phase of the Quasi-Biennial Oscillation (QBO). In this study, we tested these observational-based hypotheses for the first time using a chemistry-climate model. Three 145-year sensitivity experiments were performed with the National Center of Atmospheric Research's Community Earth System Model (CESM): one control experiment including only natural variability, one with an extreme greenhouse gas emission scenario, and one without the QBO in the tropical stratosphere. In comparison with reanalysis, the model simulates a realistic frequency and characteristics of FrIACs, which occur under an abrupt and early winter-to-summer stratospheric circulation transition, driven by enhanced planetary wave activity. Furthermore, the model results support the suggestion that the development of FrIACs is favored by an easterly QBO in the middle stratosphere and by the absence of mSSWs during the preceding winter. The lower stratospheric persistence of background dynamical state anomalies induced by deep mSSWs leads to less favorable conditions for planetary waves to enter the high-latitude stratosphere in April, which in turn decreases the probability of FrIAC development. Our model results do not suggest that climate change conditions (RCP8.5 scenario) influence FrIAC occurrences.