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Dynamics of extreme stratospheric positive heat flux events in an idealized model

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Previous work based on reanalysis data showed that extreme stratospheric positive wave-1 heat flux events couple with the troposphere via an anomalous wave-1 signal and contribute to driving Stratospheric Sudden Warming (SSW) events. Here, a dry-dynamical core model is used to investigate the dynamical mechanisms underlying positive events and their role preceding SSW events. Ensemble spectral nudging experiments are used to isolate the role of specific dynamical components: 1) the tropospheric wave-1 signal, 2) the stratospheric zonal-mean flow and 3) the higher-order wavenumbers. Positive events are reproduced when nudging the tropospheric wave-1 signal and the zonal-mean flow in combination, where the former contributes the most. Nudging the higher-order wavenumbers reproduces the majority of the events, including the tropospheric wave-1 signal. Tropospheric only nudging and mechanism denial experiments, whereby one component is fixed to the climatology and the others are nudged to the event evolution, suggest higher-order wavenumbers play a role via tropospheric wave-wave interaction. Nudging positive events in the stratosphere (wave-1) does not reproduce the tropospheric wave-1 signal. Similar results are found in corresponding experiments for SSW events. Specifically, nudging all tropospheric waves (wave-1 and higher-order wavenumbers) confirms they are the source of the stratospheric waves and reproduces SSW events. Taken together, the experiments suggest that positive events are consistent with upward wave propagation from the troposphere to the stratosphere and contribute to driving SSW events.