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The Downward Influence of Sudden Stratospheric Warmings: Association with Tropospheric Precursors

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This study identifies tropospheric precursors to downward (DW) and nondownward (NDW) propagating sudden stratospheric warmings (SSWs) and examines whether there is any difference between such events, other than internal tropospheric variability, using a large compendium of SSWs obtained from a chemistry-climate model. It is found that SSWs in general are preceded by a sustained period (approximately 30 days) of upward wave activity originating in the lower troposphere, which for DW-propagating events, is enhanced further and gives rise to a stronger SSW throughout the stratosphere compared to NDW events. The DW influence of split and displacement events are also examined, finding that anomalous upward wave-1 fluxes are present in both cases, and that despite splits having a near instantaneous barotropic response in the stratosphere and troposphere, displacements have a stronger long-term influence. The robustness of these precursors are discussed by comparing the obtained results across a variety of recently-developed DW definitions and it is found that approximately three times as many DW and NDW events are required to obtain significance compared to those currently observed. We finally compare these results to randomly-selected events independent of the SSW influence. This allows us to rule out that the tropospheric signal following some SSWs is attributable to just internal tropospheric variability, but rather confirms a DW influence from the stratosphere. Overall, these results suggest exhibiting caution to using just the zonal-mean NAM to determine the DW influence of SSWs and instead looking in a more regional sense.