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Major sudden stratospheric warmings with strong polar-night jet oscillation induced enhanced stratosphere/troposphere coupling

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During winter, the boreal stratosphere couples with the underlying troposphere in two pathways: bottom-up and top-down. Often it undergoes different extreme circulation states: cold events with a strong polar vortex and zonal mean westerlies (polar-night jet); and warm events with a weakening or a breakdown of the polar vortex and zonal mean easterlies. Extreme warm stratospheric events during polar winters of ERA-Interim reanalysis and CMIP5-ESM-LR runs are separated by duration and strength of the polar-night jet oscillation (PJO). We used a high statistical confidence level of three standard deviations (strong-PJO events) instead of working with two as in previous studies. With a composite analysis, we showed that strong-PJO events show a significant stronger downward propagating signal for northern annular mode and for the zonal mean zonal wind anomaly in the stratosphere as for non-PJO events in agreement with former studies. The lower stratospheric difference of EP-flux-divergence is apparently stronger for ERA-Interim data than for CMIP5-ESM-LR runs. Nevertheless, the ESM-LR runs indicate also a significant stronger downward propagating NAM signal in the stratosphere and a weaker tropospheric coupling. We found that the Arctic oscillation of strong-PJO and non-PJO events are more intense and clearly separated in ERA-Interim than in CMIP5-ESM-LR during the 15-day post phase after CD. During this post phase, for strong-PJO events of ERA-Interim, we identify a positive polar total ozone anomaly and a wave 1 structure in mid-latitudes. Furthermore, we found a significant upper tropospheric zonally asymmetric impact for different poleward RWB events, and a regional extra-tropical surface impact, indicating a different physical action over the North Atlantic for strong-PJO events and over the North Pacific for non-PJO events. For strong-PJO events, the NAO is greatly weakened and the surface jet shifts southwards that brings less warm air to the northern European region and Eastern Arctic, causing a cooling there.
Finally, we conclude that the applied high statistical threshold gives a clearer separation of warm stratospheric events into strong-PJO events and non-PJO events including their different downward propagating NAM signal and tropospheric impacts.