

On the linkage among anomalously strong stratospheric mass circulation, stratospheric sudden warming, and cold weather events

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It is well established that sudden stratospheric warming (SSW) events tend to be accompanied by continental-scale surface cold-air outbreaks (CAOs) in mid-latitudes in boreal winter. However, SSW events occur at most one to two times per winter, whereas CAOs occur three to seven times over each of the North American and Eurasian continents. Using the ERA-Interim dataset for 37 winters (November–March) from 1979 to 2016, we reveal that SSW events correspond to a subset of pulse-like anomalously strong or long-lasting stratospheric mass circulation events. The anomalously strong stratospheric mass circulation events (referred to as PULSE events) occur more than nine times in an average winter. The “displacement” versus “split” types of SSWs tend to correspond to the “wavenumber-1” versus “wavenumber-2” types of PULSES, though the relationship between “split” type SSWs and “wavenumber-2” type PULSES is weaker. Like SSW events, PULSE events also have a close relationship with CAOs. The robust relationship with CAOs still holds for the PULSE events not accompanied by SSW events. Using PULSE events, we determine that more than 70% of CAOs in the 37 winters occur in the week before and after a PULSE event, with a false alarm rate of CAO occurrence of about 25.7%. SSW events, however, are associated with only about 5.7% of CAOs, with a false alarm rate of 21.7%. Therefore, the linkage between individual continental-scale CAOs and PULSE events represents a more generalized relationship between the stratospheric circulation anomalies and surface weather. PULSE signals should also be considered as a potentially useful stratospheric indicator of the occurrence of individual CAO events.