An effective indicator of cold air outbreaks in northern winter: the intensity variation of the meridional mass circulation

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This study reports that the intensity variation of the meridional mass circulation can be an effective leading indicator of cold air outbreaks (CAOs) over midlatitudes in northern winter. It is found that continental-scale coldness by cold air outbreaks (CAOs) tend to preferentially occur within a week after stronger mass circulation events defined as the peak time when the net mass transport across 60°N in the upper warm or the lower cold air branch exceeds ~88×10^9 kg s^{-1}. During weaker mass circulation events when the net mass transport across 60°N is below ~71.6×10^9 kg s^{-1}, most areas of the mid-latitudes are generally in mild condition except the northern part of Western Europe. Composite pattern of circulation anomalies during stronger mass circulation events greatly resemble that of the winter-mean, with the two main routes of anomalous cold air outbreaks being along the climatological routes of polar cold air, namely, via East Asia and North America. The Siberian High shifts westward during stronger mass circulation events, opening up a third route of cold air outbreaks through Eastern Europe. The relationship of CAOs with Arctic Oscillation (AO) is less robust because temporal changes of AO are resulted from a small imbalance between the poleward and equatorward branches of the mass circulation. Only when the poleward branch leads the equatorward branch (44% of all cases), CAOs tend to take place within a week after a negative phase of AO. The daily ERA-Interim reanalysis data set for the 32 winters in 1979–2011 were used in this study.

Key words: Indicator, Cold air outbreaks, meridional mass circulation, northern winter

References

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