Geophysical Research Abstracts
Vol. 16, EGU2014-1435, 2014
EGU General Assembly 2014

The Influence of Stratospheric Vortex Displacements and Splits on Surface Climate

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A strong link exists between stratospheric variability and anomalous weather patterns at the Earth's surface. Specifically, during extreme variability of the Arctic polar vortex termed a "weak vortex event", anomalies can descend from the upper stratosphere to the surface on timescales of weeks. Subsequently the outbreak of cold-air events have been noted in high Northern Latitudes, as well as a quadrapole pattern in surface temperature over the Atlantic and western European sectors and it is currently not understood why certain events descend to the surface while others do not. In this study we compare a new classification technique of weak vortex events, based on the distribution of potential vorticity, with that of an existing technique and demonstrate that the subdivision of such events into vortex displacements and vortex splits has important implications for tropospheric weather patterns on weekly-monthly timescales. Using reanalysis data we find that vortex splitting events are correlated with surface weather and lead to positive temperature anomalies over eastern North-America of more than 1.5K, and negative anomalies over Eurasia of up to -3K. Associated with this is an increase in high-latitude blocking in both the Atlantic and Pacific sectors and a decrease in European blocking. The corresponding signals are weaker during displacement events, although ultimately they are shown to be related to cold-air outbreaks over North America. Owing to the predictability and importance of stratosphere-troposphere coupling for medium-range weather forecasts, our findings suggest the need for forecasting systems to correctly identify the type of stratospheric variability, otherwise surface responses cannot be accurately reproduced.