Geophysical Research Abstracts
Vol. 12, EGU2010-5739, 2010
EGU General Assembly 2010

The association between stratospheric weak polar vortex events and cold air outbreaks in the Northern hemisphere

Erik W Kolstad (1), Tarjei Breiteig (1), and Adam A. Scaife (2)

(1) Bjerknes Centre for Climate Research, Bergen, Norway (erik.kolstad@uib.no), (2) Hadley Centre for Climate Prediction and Research, Met Office, Exeter, UK

Previous studies have identified an association between temperature anomalies in the Northern hemisphere and the strength of stratospheric polar westerlies. Large regions in northern Asia, Europe and North America have been found to cool during the mature and late stages of weak vortex events in the stratosphere. A substantial part of the temperature changes are associated with changes in the Northern annular mode (NAM) and North Atlantic oscillation (NAO) pressure patterns in the troposphere. The apparent coupling between the stratosphere and the troposphere may be of relevance for weather forecasting, but only if the temporal and spatial nature of the coupling is known. Using 51 winters of re-analysis data, we show here that the development of the lower-tropospheric temperature relative to stratospheric weak polar vortex events goes through a series of well-defined stages, including the formation of geographically distinct cold air outbreaks. At the inception of weak vortex events, a precursor signal in the form of a strong high-pressure anomaly tends to occur over northern Europe, and there are long-lived and robust cold anomalies over Asia and Europe. A few weeks later, near the mature stage of the weak vortex events, a shorter-lived cold anomaly emerges off the east coast of North America. The probability of cold air outbreaks increases by more than 50 percent in one or more of these regions during all phases of the weak vortex events. This shows that the stratospheric polar vortex contains information that can be used to enhance forecasts of cold air outbreaks. As large changes in the frequency of extremes are involved, this process is important for the medium-range and seasonal prediction of extreme cold winter days. Three-hundred-year pre-industrial control simulations by 13 coupled climate models corroborate our results.