EMS Annual Meeting Abstracts
Vol. 12, EMS2015-52, 2015
15th EMS / 12th ECAM

The Positive North Atlantic Oscillation, European Blocking and Middle East Snowstorm

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We examine the atmospheric conditions for the Middle East snowstorm from a case study perspective and composite analysis during winter from 1950-2013. It is revealed that the 2013 snowstorm is caused by an Ω-type European blocking (EB) with a strong downstream trough that is associated with a southward-displaced positive-phase North Atlantic Oscillation (NAO+, hereafter). In the anomaly field, both case study and composite analysis show that the northeast-southwest (NE-SW) tilted EB dipole with a southward displaced NAO+ events has the most favorable structure for cold air outbreaks over the Middle East and southeast Europe because this tilting leads to an intense downstream trough over this region. In contrast, a northwest- southeast (NW-SE) tilted EB dipole anomaly leads to negative temperature anomalies over northwest Africa and southwest Europe.
In addition, we further examine what Atlantic conditions affect such EB by classifying NAO+ events into strong Atlantic jet (SJN) and weak Atlantic jet (WJN) events in terms of the Atlantic jet core speed and mean zonal wind strengths prior to the NAO onset. Composite analysis shows that the EB exhibits a NE-SW (NW-SE) tilting and located at lower (higher) latitudes during the SJN (WJN) events. It suggests that a strong North Atlantic jet may be a precursor for a southward-displaced NAO+ event that is usually associated with an Ω-type EB with a NE-SW tilted dipole in the anomaly height field that favors a cold air outbreak over the Middle East.