Understanding Anomalous Eddy Vorticity Forcing in North Atlantic Oscillation Events

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This study proposes an anomalous eddy vorticity forcing (EVF) decomposing procedure to investigate physical mechanisms responsible for the formation of the anomalous EVF associated with North Atlantic Oscillation (NAO) events. Utilizing the Geophysical Fluid Dynamics Laboratory (GFDL) dynamical core atmospheric model, a series of NAO initial-value short-term experiments are conducted. Applying the EVF decomposing procedure to the results of these experiments, the anomalous nonlinear EVF associated with the NAO events in the model can be decomposed into several fundamental linear eddy-eddy interaction terms and an unimportant nonlinear eddy-eddy interaction term. Compared with the NAO-free situation, synoptic-scale eddies have faster (slower) eastward phase speeds during the positive (negative) NAO events. Through a synoptic-scale eddy-eddy interaction mechanism, the behaviors of anomalous EVF components in the positive (negative) NAO events are well explained by synoptic-scale eddies with faster (slower) eastward phase speeds. Therefore, synoptic-scale eddies with faster (slower) eastward phase speeds are responsible for the development of the anomalous EVF associated with positive (negative) NAO events. Note that at the initial-stage of the NAO initial-value experiments, the faster (slower) phase speeds of the synoptic-scale eddies are specified by modifying the initial value fields, and then are amplified/maintained by the strengthening (weakening) zonal wind at the middle and high latitudes associated with the approaching positive (negative) phase NAO. Therefore, this study indicates that the properties of the synoptic-scale eddies at the initial-stage determine the upcoming NAO anomalies.

Keywords: The North Atlantic Oscillation, transient eddy forcing, dynamics

