Relevance of neutral singular vectors for representing seasonal-mean teleconnections

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Monthly or seasonal–mean anomalies of the atmospheric circulation, in which tendency may be negligible, can often be regarded as forced response to anomalous forcing due, for example, to change in precipitation pattern. This, however, does not imply that the structure of the dominant circulation variability is attributed to the forcing; previous studies rather suggested that the atmospheric internal dynamics is the key for understanding the teleconnection patterns. We have examined the possibility that the dominant teleconnections such as the Arctic Oscillation, the North Atlantic Oscillation and the Pacific-North American pattern are represented by the neutral singular vector of the linear dynamical operator with respect to the climatological mean state. Some examples of the neutral mode are presented, which are indeed similar to the observed teleconnection patterns. One caveat of this neutral mode approach is argued; the mode does not reflect any interaction with higher frequency weather disturbances, or the storm track. To obtain the dynamical mode that involves two-way feedback between seasonal-mean anomalies and the storm tracks, we propose a linear stochastic modeling being potentially relevant. In principle, the primitive equations or the simple barotropic vorticity equation are linearized about the stochastically fluctuating basic state, leading to a linear operator that includes the feedback from the storm track change represented as state-dependent noise. Our results suggest that the interaction with storm tracks is as important as energy conversion from the zonally ambient basic state, the former preferring several but not all the teleconnection patterns.