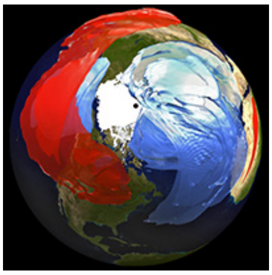

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The two leading empirical orthogonal functions (EOFs) of zonal-mean zonal wind describe north–south fluctuations, and intensification and narrowing, respectively, of the midlatitude jet. Under certain circumstances, these two leading EOFs cannot be regarded as independent but are in fact manifestations of a single, coupled, underlying mode of the dynamical system describing the evolution in time of zonal wind anomalies. The true modes are revealed by the principal oscillation patterns (POPs). The leading mode and its associated eigenvalue are complex, its structure involves at least two EOFs, and it describes poleward (or equatorward) propagation of zonal-mean zonal wind anomalies. In this propagating regime, the principal component (PC) time series associated with the two leading EOFs decay nonexponentially, and the response of the system to external forcing in a given EOF does not depend solely on the PC decorrelation time nor on the projection of the forcing onto that EOF. These considerations are illustrated using results from an idealized dynamical core model. Results from Southern Hemisphere ERA-Interim data are partly consistent with the behavior of the model's propagating regime. Among other things, these results imply that the time scale that determines the sensitivity of a model to external forcing might be different from the decorrelation time of the leading PC and involves both the rate of decay of the dynamical mode and the period associated with propagation.

Stratosphere–troposphere interactions are conventionally characterized using the first empirical orthogonal function (EOF) of fields such as zonal-mean zonal wind. Perpetual-winter integrations of an idealized model are used to contrast the vertical structures of EOFs with those of principal oscillation patterns (POPs; the modes of a linearized system governing the evolution of zonal flow anomalies). POP structures are shown to be insensitive to pressure weighting of the time series of interest, a factor that is particularly important for a deep system such as the stratosphere and troposphere. In contrast, EOFs change from being dominated by tropospheric variability with pressure weighting to being dominated by stratospheric variability without it. The analysis reveals separate tropospheric and stratospheric modes in model integrations that are set up to resemble midwinter variability of the troposphere and stratosphere in both hemispheres. Movies illustrating the time evolution of POP structures show the existence of a fast, propagating tropospheric mode in both integrations, and a pulsing stratospheric mode with a tropospheric extension in the Northern Hemisphere–like integration.

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