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Empirical mode reduction in a model of extratropical low-frequency variability

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We construct and analyze a reduced nonlinear stochastic model of extratropical low-frequency variability. To do so, we apply a multi-level quadratic regression analysis to the output of a long simulation of a global baroclinic quasi-geostrophic (QG3) model with topography.

The resulting inverse stochastic model has 45 variables and captures well the non-Gaussian features of the QG3-model probability density function (PDF) – in particular, the four anomalously persistent flow patterns, which correspond to the opposite phases of the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO), as well as the Markov chain of transitions between these regimes. In addition, the multi-channel singular spectrum analysis (M-SSA) identifies intraseasonal oscillations with a period of 32–37 days in the data generated by both QG3 model and its low-dimensional analog. The following analytical analysis of the reduced model points to the origin of the QG3-model multiple regimes and intraseasonal oscillations and identifies the connections between them.

Finally, the results of our analysis for observational data are demonstrated.