Nonlinear low-order models of atmospheric low-frequency variability

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Nonlinear deterministic and stochastic low-order models are derived which are capable of simulating realistic atmospheric low-frequency variability. The reduced models deal explicitly only with a very limited number of essential low-frequency patterns. The equations of motion are projected onto the resolved modes; the influence of unresolved fast-evolving modes onto the resolved slowly-evolving large-scale modes is accounted for by an appropriate closure scheme. These closure schemes range from an empirically determined enhanced viscosity over empirically determined deterministic and stochastic terms to systematically derived deterministic and stochastic terms. A strategy of keeping the number of fitting parameters in the dynamical equations to a minimum is always applied. The study focuses on three issues: (i) finding appropriate basis functions for spanning the resolved dynamics and a comparison of different basis functions; (ii) the necessary characteristics of the stochastic terms, that is, white vs. coloured noise and additive vs.multiplicative noise as well as a comparison of different stochastic schemes; (iii) the choice of metric in generating the model and the conservation properties of the model. A quasigeostrophic three-level spectral model with realistic mean state and variance pattern as well as Pacific/North America and North Atlantic Oscillation patterns is used as dynamical framework.