



Numerical Development and Evaluation of an Energy Conserving Conceptual Stochastic Climate Model

Federica Gugole (1) and Christian Franzke (2)

(1) University of Hamburg, Meteorological Institute and Center for Earth System Research and Sustainability, Hamburg, Germany (federica.gugole@uni-hamburg.de), (2) University of Hamburg, Meteorological Institute and Center for Earth System Research and Sustainability, Hamburg, Germany (christian.franzke@uni-hamburg.de)

We systematically derive an energy conserving conceptual stochastic climate model based on the inviscid 2-layer Quasi-Geostrophic (QG) equations. The stochastic terms have been introduced in such a way that the total energy is conserved. In this proof of concept study we give particular emphasis to the numerical aspects of energy conservation in a high-dimensional complex stochastic system. Our results show that the stochastic model conserves energy to an accuracy of about 0.5% of the total energy; this level of accuracy is mainly due to the level of accuracy of the deterministic discretization of the QG model. Furthermore, our results demonstrate that spatially correlated noise is necessary for the conservation of energy and the preservation of important statistical properties, while using spatially uncorrelated noise violates energy conservation and gives unphysical results. The spatial covariance structure is determined through Empirical Orthogonal Functions (EOFs). We find that only a small number of EOFs is needed to get good results with respect to energy conservation, autocorrelation functions, PDFs and eddy scale when comparing a 512×512 deterministic control to a 128×128 stochastic simulation. Our stochastic approach has the potential to seamlessly be implemented in comprehensive weather and climate prediction models.