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Rotating shallow water flow under location uncertainty with a structure-preserving discretization

Rüdiger Brecht[1], Long Li[2], Werner Bauer[3], and Etienne Mémin[2]
[1]Memorial University of Newfoundland, St. John's, Canada
[2]Fluminance Group, Inria, Campus universitaire de Beaulieu, Rennes, France
[3]Imperial College London, South Kensington Campus, London, United Kingdom

We introduce a new representation of the rotating shallow water equations based on a stochastic transport principle. The derivation relies on a decomposition of the fluid flow into a large-scale component and a noise term that models the unresolved small-scale flow. The total energy of such a random model is demonstrated to be preserved along time for any realization. Thus, we propose to combine a structure-preserving discretization of the underlying deterministic model with the discrete stochastic terms. This way, our method can directly be used in existing dynamical cores of global numerical weather prediction and climate models. For an inviscid test case on the f-plane we use a homogenous noise and illustrate that the spatial part of the stochastic scheme preserves the total energy of the system. Finally, using an inhomogenous noise, we show that the proposed random model better captures the structure of a large-scale flow than a comparable deterministic model for a barotropically unstable jet on the sphere.