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Towards structure preserving discretizations of stochastic rotating shallow water equations on the sphere

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We introduce a stochastic representation of the rotating shallow water equations and a corresponding structure preserving discretization. The stochastic flow model follows from using a stochastic transport principle and a decomposition of the fluid flow into a large-scale component and a noise term that models the unresolved flow components. Similarly to the deterministic case, this stochastic model (denoted as modeling under location uncertainty (LU)) conserves the global energy of any realization. Consequently, it permits us to generate an ensemble of physically relevant random simulations with a good trade-off between the representation of the model error and the ensemble's spread. Applying a structure-preserving discretization of the deterministic part of the equations and standard finite difference/volume approximations of the stochastic terms, the resulting stochastic scheme preserves (spatially) the total energy. To address the enstrophy accumulation at the grid scale, we augment the scheme with a scale selective (energy preserving) dissipation of enstrophy, usually required to stabilize such stochastic numerical models. We compare this setup with one that applies standard biharmonic dissipation for stabilization and we study its performance for test cases of geophysical relevance.