Evaluating the effectiveness of stochastic perturbations to represent model error

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Stochastic physics has been very successful in ensemble data assimilation and medium range forecasts across many modeling systems (global and regional), but in general it is not clear if the increase in ensemble spread due to the stochastic physics is providing the correct type of spread, or in the right locations. Cycled data assimilation experiments show that the largest analysis errors are associated with the synoptic scales, while the stochastic physics injects noise at smaller (~250-500 km) scales. The expectation is that the energy associated with these small- scale perturbations should grow in size through the upscale cascade of energy. In this study, it is shown that the effectiveness of various methods of stochastic perturbations (e.g., Stochastically Perturbed Physics Tendencies, Stochastic Kinetic Energy Backscatter, perturbed PBL humidity) can be diagnosed by decomposing the kinetic energy spectra of the model's forecast and error, along with the model's sensitivity to the temporal and spatial correlation of the stochastic perturbations that acts to compensate unresolved wave–wave interactions.