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Constraining Stochastic Parametrisation Schemes using High-Resolution Model Simulations

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Stochastic parametrisations are used in weather and climate models to represent model error. Designing new stochastic schemes has been the target of much innovative research over the last decade, with a focus on developing physically motivated schemes. We present a technique for systematically deriving new stochastic parametrisations or for constraining existing stochastic approaches. We take a high-resolution model simulation and coarse-grain it to the desired forecast model resolution. This provides the initial conditions and forcing data needed to drive a Single Column Model (SCM). By comparing the SCM parametrised tendencies with the evolution of the high resolution model, we can measure the 'error' in the SCM tendencies. As a case study, we use this approach to assess the physical basis of the widely used 'Stochastically Perturbed Parametrisation Tendencies' (SPPT) scheme. We provide justification for the multiplicative nature of SPPT, and for the temporal and spatial scales of the stochastic perturbations. However, we also identify issues with the SPPT scheme and motivate improvements. It is hoped this new coarse-graining technique will improve both holistic and process based approaches to stochastic parametrisation.