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Probabilistic Distribution of Subgrid Convection and Ensemble Prediction

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Moist convection on scales smaller than the horizontal grid spacing that is commonly used in operational numerical weather prediction (NWP) models is turbulent and therefore its interaction with the environment is, to a great degree, stochastic. Traditionally in operational NWP models, the effect of unresolved subgrid convection on the prediction of resolved scales is usually parameterized deterministically as an ensemble mean, and the stochastic fluctuations about this ensemble mean are ignored. It has been recently advocated that the stochastic fluctuations should be properly accounted for in the subgrid parameterization in order to address a persistent issue in operational ensemble prediction: the spread of ensemble members tends to be underestimated. Over the past decade, stochastic modifications to existing deterministic parameterizations of subgrid convection have been suggested to reduce model error and/or to increase ensemble forecast spread. In this presentation, we report our preliminary results from an ongoing investigation of whether prediction errors can be reduced when the existing deterministic parameterization of subgrid convection in the NCEP GFS model is modified to account for the stochastic fluctuations using prescribed, but physically-based, probabilistic distributions of vertical mass flux at the cloud base. We focus our discussions on how the physically-based stochastic parameterization of sub-grid scale convection simulates model uncertainties and to what extent they improve the spread of operational ensemble prediction.