Geophysical Research Abstracts, Vol. 8, 01548, 2006
SRef-ID: 1607-7962/gra/EGU06-A-01548

The stochastic nature of physical parameterizations in ensemble prediction: a stochastic convection approach

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In this paper it is argued that in ensemble prediction systems, physical parameterizations of sub-grid scale motions should be viewed and utilized in a stochastic manner, rather than in a deterministic way as it is typically done. This can be achieved within the context of current physical parameterization schemes without having to impose any artificial stochastic terms to weather and climate prediction models. Parameterization schemes are typically used to predict the evolution of grid-mean quantities due to unresolved sub-grid scale processes. However, parameterizations can also provide estimates of higher moments that can be used to constrain the random determination of the future state of a certain variable. The general equations used to estimate the variance of a generic variable are briefly discussed and a simplified algorithm for a stochastic moist convection parameterization is proposed as a preliminary attempt. Results from the implementation of this stochastic convection scheme in the Navy Operational Global Atmospheric Prediction System (NOGAPS) ensemble are presented. It is shown that this method is able to generate substantial tropical perturbations that grow and migrate to the mid-latitudes as forecast time progresses, while moving from the small scales where the perturbations occur to the larger synoptic scales. This stochastic method is also able to increase the ensemble spread in the tropics in a significant way when compared to results from ensembles created from initial-condition perturbations.