Geophysical Research Abstracts, Vol. 9, 09158, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-09158

Ensemble climate prediction with coupled climate models

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Quantifying uncertainty in climate change forecasts requires large ensembles that deal with model uncertainty. Such "perturbed physics ensembles" require the initialisation of large numbers of drift-free coupled climate models. The ocean component of a coupled model typically requires a long spin-up period in order to reach equilibrium. We demonstrate a technique for obtaining approximately drift-free coupled models without the need for a new ocean spin-up when the fast components of the model (atmosphere, land-surface scheme) are perturbed. Using the flux adjusted Hadley Centre model, HadCM3L, we apply a linear correction to the atmosphere-ocean fluxes analogous to that of the standard "flux adjustment" method used in coupled models. This approach enables us to investigate a much wider range parameter space than would otherwise be possible if we were to spin-up models individually.

We find the correction of heat and fresh water fluxes when a perturbation is made to the atmosphere physics gives rise to a relatively stable base climate. Under transient forcing this correction technique reproduces a climate response closer to that of the same model version with a full ocean spin-up than the climate response of the unperturbed model. Hence, we believe by using this correction technique, flux adjusted coupled models may be used as a basis to form a perturbed physics ensemble of coupled models which could then be used for probabilistic climate forcasting.