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# An efficient method to generate a perturbed parameter ensemble of a fully coupled AOGCM without flux-adjustment

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**Abstract.** We present a simple method to generate a perturbed parameter ensemble (PPE) of a fully-coupled atmosphere-ocean general circulation model (AOGCM), HadCM3, without requiring flux-adjustment. The aim was to produce an ensemble that samples parametric uncertainty in some key variables and gives a plausible representation of the climate. Six atmospheric parameters, a sea-ice parameter and an ocean parameter were jointly perturbed within a reasonable range to generate an initial group of 200 members. To screen out implausible ensemble members, 20 yr pre-industrial control simulations were run and members whose temperature responses to the parameter perturbations were projected to be outside the range of 13.6 ± 2 °C, i.e. near to the observed pre-industrial global mean, were discarded. Twenty-one members, including the standard unperturbed model, were accepted, covering almost the entire span of the eight parameters, challenging the argument that without flux-adjustment parameter ranges would be unduly restricted. This ensemble was used in 2 experiments; an 800 yr pre-industrial and a 150 yr quadrupled $CO_2$ simulation. The behaviour of the PPE for the pre-industrial control compared well to ERA-40 reanalysis data and the CMIP3 ensemble for a number of surface and atmospheric column variables with the exception of a few members in the Tropics. However, we find that members of the PPE with low values of the entrainment rate coefficient show very large increases in upper tropospheric and stratospheric water vapour concentrations in response to elevated $CO_2$ and one member showed an implausible nonlinear climate response, and as such will be excluded from future experiments with this ensemble. The outcome of this study is a PPE of a fully-coupled AOGCM which samples parametric uncertainty and a simple methodology which would be applicable to other GCMs.

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