Geophysical Research Abstracts, Vol. 8, 05455, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05455

Using ensembles of paleoclimate simulations and paleodata to efficiently constrain climate sensitivity.

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Proxy data from the Last Glacial Maximum were used for validation of an efficiently derived probabilistic ensemble of realisations of the climate. The method is based on the ensemble Kalman filter which we apply to the CCSR/NIES/FRCGC AGCM (the atmospheric component of MIROC3.2) at T21L20 resolution coupled to a slab ocean. The method combines prior beliefs about the model, with observational data, to simultaneously estimate 25 model parameters in an efficient and objective manner. We attempt to validate the resulting ensembles against out-of-sample data by comparing their hindcasts of the Last Glacial Maximum (LGM) to paleoclimate proxy data, and demonstrate through this that our ensembles of simulations are probably biased towards too high a climate sensitivity. Within the framework of our single-model ensemble experiment, we show that climate sensitivity of much greater than 6C is hard to reconcile with the paleoclimate record, and that of greater than 8C seems virtually impossible. Our estimate for the most likely climate sensitivity is in the region of 4.5C. The results suggest that paleoclimatic evidence could provide a useful, albeit imprecise, constraint on ensemble forecasts of future climate change.