Geophysical Research Abstracts
Vol. 20, EGU2018-10634, 2018
EGU General Assembly 2018

How large is Uncertainty in Calibrated Perturbed Physics Ensembles?

Simon Tett (1), Jonathan Gregory (2), Nicolas Freychet (1), and Coralia Cartis (3)

(1) University of Edinburgh, School of Geosciences, Edinburgh, United Kingdom (simon.tett@ed.ac.uk), (2) NCAS-Climate, University of Reading, (3) Mathematical Institute, University of Oxford

Estimates of the response of the climate system to greenhouse gas forcing are still highly uncertain as exemplified by the 2013 IPCC report estimate for the equilibrium warming to doubling CO_2 of 1.5-4.5K. Here, using the third Hadley Centre Coupled Model (HadCM3) we calibrate atmospheric parameters known to be important in feedback strength against multiple large-scale observations for the 2001-2005 average. Using optimisation methods we generated several atmospheric model configurations that simulate these large scale observations as well as the standard atmospheric model does. We generated coupled models from these atmospheric models finding that the coupled models required no flux correction. The parameters vectors were are all very different from one another.

The coupled models have a range of equilibrium climate sensitivities in response to doubling CO_2 of 2.9 – 3.4K with equilibrium warming to quadrupling CO_2 concentrations twice that for doubling. We also computed the transient climate response (TCR) finding a range of 2-2.2 K which increases to 4.6-5 K when CO_2 is quadrupled. Warming at $4xCO_2$ levels appears to be related to the simulated pre-industrial temperatures. We find that the Atlantic Meridional Overturning Circulation shows a broad range of changes but with little impact outside the North Atlantic.
Across the perturbed ensemble changes in other variables shows little scatter once normalised by the global-mean change. Our results suggest that uncertainty in perturbed physics when parameters are calibrated against current large scale observations is small. We also investigated changing the model aerosol scheme whose effect, without calibration, is to increase the planetary albedo. After calibration we find that the climate sensitivity and transient climate response are smaller than the calibrated perturbed physics ensemble.

Our results suggest that uncertainties from Perturbed Physics Ensemble are small while changes in the functional form of model parametrisations have a larger impact. Thus uncertainty in feedback strength in models likely arises from the functional form of parametrisation or the observational targets used to tune models.