Calibration of a "GCM analogue model" against a range of climate models

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1 Background

Full GCM transient simulations are the best tools available to address the likely impact of increasing atmospheric greenhouse gas concentrations on surface climate. However, most such models frequently take months of computer time to make a single "transient" simulation representing, say, the period 1860 to 2100 and for a prescribed SRES emission scenario. For this reason, there has been interest in developing "pattern scaling" methods whereby persistent spatial patterns of change observed in GCM simulations for "weather" anomalies (such as local temperature and rainfall) may be exploited. In particular, it allows climate simulations to be made for a broad range of emission scenarios, generating surface climate data that may be used for impacts studies. The method extrapolates the relatively few full GCM transient simulations to new emission scenarios.

Many authors have established that the scaling method exhibits a high degree of robustness. For example, see Mitchell *et al.,* (1999), Huntingford and Cox (2000) and Mitchell (2002). A representation of the global carbon has been introduced into the method (Huntingford *et al.,*, 2004) as a method to mimic the key results of Cox *et al.,* (2000). It is hoped that other geochemical cycles will be introduced in due course.

2 Objectives

To make the "GCM analogue model" a more advanced and versatile method for impacts studies, it needs to incorporate the findings of other GCM modelling groups. In addition, using other climate models allows a simple methodology to express variation and uncertainty in current estimates of future change. It is appropriate to test the linear hypotheses of propagating patterns for a range of climate model diagnostics. The use of CMIP data is highly appropriate to achieve such an investigation leading to the derivation of a more generic impacts tool.

It is anticipated that the current version of the GCM analogue model will be enhanced to call in a range of derived patterns based on the CMIP dataset. The resultant model will be fully documented and ultimately be available for download via the internet.

3 Methodology

The following activities will be undertaken.

- Download available monthly climatological data from the CMIP2 website.

- Determine how robust linearity in patterns is across GCM runs.

- Calibrate the core thermal “box model” against more comprehensive annual diagnostics available from CMIP.
- Assess the influence of “missing” patterns for some variables (eg monthly windspeed). This will be highly dependent on proposed impacts assessment. Expected initial uses include predicting hydro-ecosystem response.
- Formally introduce model uncertainty into the GCM analogue model.

4 References

Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A. and Totterdell, I.J.: 2000 “Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model” *Nature* **408**, 184-187.

Huntingford, C. and Cox, P.M.: 2000 “An analogue model to derive additional climate change scenarios from existing GCM simulations” *Climate Dynamics* **16**, 575-586.

Huntingford, C., Harris, P.P., Gedney, N., Cox, P.M., Betts, R.A., Marengo, J. and Gash, J.H.C.: 2004 “Using a GCM analogue model to investigate the potential for Amazonian forest dieback” *Theorectical and Applied Climatology*, In the Press.

Mitchell, J.F.B., Johns, T.c., Eagles, J.M., Ingram, W.J. and Davis, R.A.: 1999 “Towards the construction of climate change scenarios” *Climatic Change* **41**, 547-581.

Mitchell, T.: 2003 “Pattern Scaling: An examination of the accuracy of the Technique for describing future climates” *Climatic Change* **60**, 217-242.