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Palaeoclimate simulations : toward a proxy data assimilation

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Existing palaeoclimate research has been largely separated into studies focused on proxy data and modelling studies, and only a few studies have attempted to use both sets of data in a quantified way to improve our knowledge of past climates. These attempts have been predominantly within the scope of modelling intercomparison projects (e.g. PMIP). In addition to improvements in the models, this work has also advanced our understanding of proxy data and helped to improve the techniques used in reconstructions from these data. A number of studies comparing model output and these proxies have been performed.

The first generation PMIP model (PMIP1) runs were tested by Masson et al. .....(1998) against a set of gridded climate reconstructions for the mid-Holocene in Europe. This work was based on visual comparison between maps of climatic parameters and on sensitivity analyses. Other studies have used the kappa statistic to compare maps of land cover derived from simulated palaeoclimatic values with pollen data (Harrison et al, 1998). Whilst this provides an objective measure of the difference between two images, it is unable to take into account any slight geographical shifts in the simulated climate patterns. For example, a model that is able to simulate an enhancement of the monsoon but in the wrong location should perform better in such a test than a model that has no enhancement.

An improved method should therefore take into account these two features: the uncertainties of both the proxy-derived variables and model outputs and situations where patterns of climatic change are correctly simulated in the model, but shifted geographically or in time. Uncertainties may be included in data-model comparisons by using a fuzzy-logic approach, in which the values to be compared are defined as a number

with a membership function. This method was first used by Guiot et al. .....(1999) for testing the PMIP1 models, and subsequently modified and used by Bonfils et al. .....(2004) and Brewer et al. ....(2006), by replacing the pixel-to-pixel comparison by an approach based on clusters, allowing a multivariate comparison to be made on the basis of coherent patterns of climate change, rather than individual points.

Another approach, which has had very little application in palaeoclimate research, is the assimilation of proxy data within the climate simulations instead of an *a posteriori* comparaison. This offers a number of potential applications such as improving the estimates of past climates by constraining model output (physically-coherent interpolations), improving the realism of the model simulations and investigating the response of models to different initial conditions and forcings. The main difficulty is that paleodata are often geographically sparse and with a low temporal resolution (yearly or more). Goosse et al. (2005) have based their approaches on the selection of the most realist simulations among an ensemble set of simulations. Hargreaves and Annan (2002) proposed a form of pseudo-inverse modelling using a MCMC method to explore a space defined by the potential parameter values. Other tested methods are based on constraining a given field of the model by the corresponding field in the data (Jones and Widmann, 2004; van der Schrier & Barkmeijer, 2003).

Depending on the objective pursued, a large panel of methods exist to quantify the data/model discrepancies and to force the model to converge toward the data taking into account the error bars of both sides. After reviewing the evolution of the data/model comparison methods, we will illustrate how assimilation is an interesting perspective to improve the model prediction of long-term changes.

Bonfils, C., et al., 2004. Climate Dynamics, 23: 79-98.

Brewer, S. et al, 2006. Climate of the Past Discussions, 2: 1155-1186.

Goosse, H. et al, 2005. Quaternary Science Reviews, 24: 1345—1360

Guiot, J. et al., 1999. Climate Dynamics, 15: 569-581

Hargreaves et al., 2002. Climate Dynamics, 19(5-6): 371-381

Masson, V. et al, 1998. Climate Dynamics, 15: 163-182.

Harrison, S.P. et al, 1998. Journal of Climate, 11: 2721-2742.

Jones, J. et al, 2004. The KIHZ project: towards a synthesis of Holocene proxy data and climate models. Springer, Heidelberg, pp. 171-193.

van der Schrier, G. et al, 2005. Climate Dynamics, 24(4): 355-371