Session: B7 Oral presentation

Assessing the reliability of climate model ensembles using the Last Glacial Maximum

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The principal obstacle to assessing the reliability of projections from the multi-model ensembles is the long term nature of the forecast, which means that it is not possible to regularly confront the forecast system with new observational data. Recent research (Annan and Hargreaves 2010,2011, Yokohata et al 2011) has assessed the reliability of the ensemble on the global scale with respect to modern climate. Observations from the modern climate were, however, used in the preliminary design and construction of model components, and probably also for ongoing assessment of the coupled models as they were tuned. Thus these assessments, whilst encouraging, do not necessarily imply that the CMIP ensembles will remain reliable when run for future scenarios. We should, therefore, further assess and update our confidence in the ensemble by considering other climate epochs that were not used during the model development process. For CMIP3 (and also CMIP5) the Last Glacial Maximum (LGM) epoch qualifies as a suitable period from this point of view. It is also the most recent time in the past when the atmospheric carbon dioxide level and also the climate state were markedly different to those of the pre-industrial era. Furthermore, the quality and quantity of available data is superior to other more distant epochs. Recently a gridded synthesis of sea surface temperature at the LGM was produces by the MARGO project, which has the novel feature of inclusion of uncertainty estimates for the temperature analysis. We have analysed the reliability of the two LGM multi-model ensembles (PMIP1 and PMIP2) with respect to this dataset through the rank histogram method of Annan and Hargreaves (2010), and found that both ensembles may be considered reliable. On the other hand, a single-model ensemble based on MIROC3.2 was found to be much less reliable, consistent with results which will be presented elsewhere for the present day. While it is generally expected that more complex climate models should exhibit greater uncertainty due to the additional uncertainties in the extra components, in the case of the PMIP experiments we found that the inclusion of a coupled dynamical ocean in PMIP2, rather than the simpler slab oceans in PMIP1, resulted in a narrower spread in sea surface temperature anomalies, as well as leading to consistent and systematic differences between the ensembles. There is weak evidence that the MARGO temperature data may be indicative of only small changes in meridional overturning in the North Atlantic between the LGM and the present day, however, the small size of the PMIP2 ensemble prevents statistically significant results from being obtained. Thus we look towards the possibility of more robust results being obtained with the much larger CMIP5 LGM ensemble. J.D. Annan and J.C. Hargreaves, 2010: Reliability of the CMIP3 ensemble. Geophys Res Lett 37:L02703. doi:10.1029/2009GL041994 J. D. Annan and J. C. Hargreaves 2011, Understanding the CMIP3 multi-model ensemble, Journal of Climate, In Press. T. Yokohata, J.D. Annan, J.C. Hargreaves, C.S. Jackson, M. Tobis, M.J. Webb, M. Collins, Reliability of multi-model and structurally different single-model ensembles, Submitted to Climate Dynamics.