Evidence for the Atlantic Multidecadal Oscillation as an internal climate mode from coupled GCM simulations.

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An analysis is presented which tests the consistency between multidecadal sea-surface temperature (SST) variability in observations and coupled twentieth century simulations with natural and anthropogenic forcings submitted for the IPCC Fourth Assessment report. The focus of the study is on the North Atlantic Ocean, where SST is characterised by large multidecdal variability known as the Atlantic Multidecadal Oscillation (AMO). It is found to be difficult to assess the consistency of North Atlantic SSTs with individual model ensembles as the ensemble size is generally too small to constrain the ensemble mean. On the other hand, combining the results of the ensembles from different models creates a super-ensemble of sufficient size to allow a good estimate of the super-ensemble mean. Averaging over ensemble members causes cancellation of the intra-ensemble variability, thus the super-ensemble mean can be viewed as a best-estimate of the response to natural and anthropogenic forcings. It is found that using the super-ensemble allows a statistical separation of the observed SST from the estimated forced response, suggesting that the AMO is inconsistent with historical forcings. In this case, either (i) past climate forcings are incorrectly specified in the models, (ii) the models respond incorrectly to forcings, or (iii) the AMO is an internal climate mode. The latter possibility is consistent with results from a 1400 year simulation of the HadCM3 model with no forcing variability. This contains a realistic AMO that persists through the length of the simulation.