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A hierarchical evaluation of IPCC AR4 multi-AOGCM ensembles

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A Bayesian approach is introduced to model evaluation and multi-model averaging with a systematic consideration of model uncertainty and its application to global to regional mean surface air temperature (SAT) changes is shown from multi-AOGCM ensembles of IPCC AR4 simulations. The Bayes factor or likelihood ratio of each model to the reference model (where mean is identical to the observation) provides a skill ranging from 0 to 1. Four categories of model skill are derived on the basis of the previous studies. Application results to global mean SATs show that all AOGCMs with natural plus anthropogenic forcing can simulate well the time mean and linear trend of observed SAT changes over the 20th century and its first and second halves. However, more than 50 % models with anthropogenic forcing only cannot reproduce the observed global warming reasonably. This indicates an important role of natural forcing although other factors like different climate sensitivity, forcing uncertainty, and a climate drift might work. Besides, Bayesian and conventional skill comparisons demonstrate that a skill-weighted average with the Bayes factors (Bayesian model averaging, BMA) overwhelms the arithmetic ensemble mean and three other weighted averages based on conventional statistics, illuminating future applicability of BMA to climate predictions. Results for different spatial scales will be given from global mean to sub-continental mean temperatures.