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Ranking climate models at regional scales using probability density functions based on daily data

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An evaluation of climate models traditionally focuses on means or specific phenomenon evaluated at monthly to seasonal time scales. However, climate models are increasingly being used to explore the changes in extremes as they more immediately affect economic systems, human health and biological systems. We use probability density functions (PDFs) derived using daily data to evaluate climate models used in the fourth assessment report of the Intergovernmental Panel on Climate Change (AR4). We introduce a simple quantitative measure of how well each AR4 model can capture the observed PDFs for daily simulation of precipitation, minimum temperature and maximum temperature. We focus on Australia, dividing the continent into twelve regions. We show that precipitation is simulated very well by a small number of models and that averaged over Australia, 3 of the 14 AR4 capture more than 80% of the PDFs for precipitation. Minimum temperature is simulated well by most models with 10 of the 13 AR4 models capturing more than 80% of the observed PDF. Maximum temperature is also reasonably simulated with 6 of 10 AR4 models capturing more than 80% of the observed PDF. A quantitative ranking of the climate models, for each of precipitation, maximum and minimum temperature, and averaged over these three variables, is presented. We therefore identify those AR4 models that are skillful over Australia, providing guidance on those climate models that should be used in impacts assessments where those impacts are based on precipitation or temperature. We note our results have no bearing on how well the AR4 models work elsewhere, but our methodology is potentially useful in assessing which of the many climate models should be used by impacts groups.