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Uncertainty of decadal means of temperature and precipitation change under global warming based on CMIP3 models

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There remains uncertainty in the projected climate change over the 21st century, in part because of the range of responses forced by rising greenhouse gas concentrations among current climate models. A further source of uncertainty of change for a particular period of time, such as decadal averages, is the unforced or internal variability of climate. Based on estimates from the CSIRO Mark 3.5 model, for both temperature and precipitation over the globe this is similar in pattern, and often in magnitude, to the range of trends over 23 GCMs in the CMIP3 database (see Meehl et al, 2007). The representation of both forced and total changes in the form of a probability density function (PDF) is increasingly sought for applications. This paper uses a method of estimating PDFs for forced change based on the pattern scaling technique, which separates the uncertainty in the global mean warming from that in the standardized regional change (CSIRO 2007, Watterson 2008a). Several simple approaches are considered for representing the factors by PDFs using the GCM results, allowing model weighting. The four-parameter Beta distribution is found to provide a smooth PDF that can match the mean and range of GCM results, allowing skewness when appropriate. A Beta representation of the range in global warming consistent with the IPCC Fourth Assessment Report is used. Changes for both 2030 and 2100, under the A1B scenario of concentrations, are calculated using a joint probability distribution approach for the product of the two factors over the globe. A similar approach is then used to produce PDFs for decadal means, by adding in the unforced variability, which is assumed to follow a normal distribution. Unrealistically large decreases in precipitation that can

arise in either calculation are avoided by assuming that these apply in an exponential fashion.

Contrasting regional results can be found for surface temperature. The ‘best estimate’ (median) is for little warming in the central North Atlantic, but there is a large uncertainty in the forced change. This is enhanced by decadal variability, which doubles the variance in the PDF for 2030. Southeast Asian warming is somewhat larger, but the uncertainty is relatively small. Central Asian median warming is large as is the forced component of uncertainty. Precipitation changes include a large increase in the equatorial Pacific, with large uncertainty from both components. In many subtropical lands, including much of Australia, there is uncertainty from both, centred on a median decrease. In Northern Europe, precipitation increases, with less uncertainty. Causes of the uncertainty in trends are explored by Watterson (2008b)

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