Geophysical Research Abstracts
Vol. 14, EGU2012-4731, 2012
EGU General Assembly 2012


# On long-term persistence in GCM rainfall simulations: Implications for water resources planning and design

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It is well known that GCM precipitation simulations for future climates leave a lot to be desired, as a result of which various strategies have been developed to assist with water resources planning and design. While it is accepted that the simulated precipitation exhibits significant variability across alternate GCMs (leading to a 6% Variable Convergence Score compared to much higher values for other surface atmospheric variables (Johnson and Sharma, 2009)), something less well appreciated is the significant biases and uncertainty GCMs exhibit in their representation of long-term persistence in rainfall. We present here an assessment of the extent of this problem, and some recently developed solutions that allow users to post-process GCM rainfall to allow a more meaningful representation of persistence, leading to future rainfall that is viable for water resources applications where low-frequency variability is important.

Our presented approach consists of (a) working with the GCMs that are better able to simulate long-term persistence in their simulations of precipitation and other hydrologically relevant variables (Johnson et al., 2011), and then (b) post-processing the simulations using a recently published Nested Bias Correction (NBC) procedure (Johnson and Sharma, 2012, 2011), that attempts to modify current climate simulations such that their measured lag-dependence attributes at a range of time-scales are reproduced in an un-biased manner post-transformation. Assuming the same post-processing model applies for future climates, this results in future simulations that exhibit long periods of highs and lows so noticeable in historical rainfall (and not so noticeable in raw GCM simulations of the future).

The Nested Bias Correction is “Nested” as the correction happens progressively from finer to coarser time scales, the correction involving modulating order one and two moment and persistence attributes, aggregating the corrected series to the next coarser time scale, and repeating the correction and aggregation steps until the nesting is complete. While the above represents the essence of the NBC in its simplest form, the nesting logic is generic and extendable to alternate correction models. Doing the correction across multiple time scales ensures that the end result is a significantly better representation of persistence, at daily to the interannual timescales so important for water resources applications.

This presentation will illustrate the workings of the NBC and how it improves the representation of long-term persistence in GCM precipitation simulations for the current and for future climates. The presentation will use examples from applications of the NBC to a range of drought relates attributes, to emphasise the change it creates to any water resources assessment the post-processed series are used for. While most of our illustrations pertain to Australia where low-frequency variability is more pronounced than elsewhere, we emphasise the importance of using NBC in any water resources assessment for a future climate, simply because it offers the best look into how persistence will change from now into the future.

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