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HadCM3 representation of ENSO forcings on drought in the U.S.

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Drought in the U.S. is closely linked to ENSO, with drought occurring across the continent during La Nina years. Two physical mechanisms have been identified linking ENSO to drought in the region. First, a hemispheric zonal response to cooling in the equatorial Pacific causes a poleward displacement and weakening of the mid-latitude jet streams, resulting in drought conditions across the U.S. Second, Rossby waves propagating from the equatorial Pacific disrupt the symmetrical nature of the hemispheric influence, concentrating the La Nina – drought relationship in the south-western U.S. The interaction of these mechanisms is vital to the forcing of drought by ENSO.

This paper assesses the ability of the HadCM3 general circulation coupled model (GCM) to represent the mechanisms linking ENSO and drought in the U.S. HadCM3 is one of the most successful GCMs at simulating ENSO variability. Rotated principal components analyses of self-calibrating Palmer Drought Severity Index (scPDSI) data are used to identify the dominant modes of drought variability in the observed climate record (1901-2002), and in a 250-year period of the HadCM3 control run. In both the observed and model data, an EOF associated with ENSO is identified, with a monopolar pattern across the continental interior, centred in the southern states. HadCM3 successfully reproduces the displacement of the mid-latitude jet streams during ENSO events. The ENSO influenced EOF is also shown to be related to hemispheric patterns in 250 hPa zonal winds. HadCM3, however, may have difficulty representing the influence of Rossby wave teleconnections on drought patterns, due to errors in the model's simulation of ENSO in the equatorial Pacific. This work concludes that HadCM3 adequately simulates the effect of ENSO on drought, and the physical mechanisms responsible. Further studies of this relationship using HadCM3 are worthwhile.