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Are Simulated Megadroughts in the North American Southwest Forced?

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Multi-decadal drought periods in the North American Southwest (125°W-105°W, 25°N-42.5°N), so-called megadroughts, are a prominent feature of the paleoclimate record over the last millennium (LM). Six forced transient simulations of the LM along with corresponding historical (1850-2005) and 500-year pre-industrial control runs from the Coupled Model Intercomparison Project Phase 5 (CMIP5) are analyzed to determine if Atmosphere Ocean General Circulation Models (AOGCMs) are able to simulate droughts that are similar in persistence and severity to the megadroughts in the proxy-derived North American Drought Atlas. Megadroughts are found in each of the AOGCM simulations of the LM, although there are inter-model differences in the number, persistence and severity of these features. Despite these differences, a common feature of the simulated megadroughts is that they are not forced by changes in the exogenous forcing conditions. Furthermore, only the Community Climate System Model (CCSM) version 4 simulation contains megadroughts that are consistently forced by cooler conditions in the tropical Pacific Ocean. These La Niña-like mean-states are not accompanied by changes to the interannual variability of the El Niño-Southern Oscillation system and result from internal multi-decadal variability of the tropical Pacific mean-state, of which the CCSM model has the largest magnitude of the analyzed simulations. Critically, the CCSM model is also found to have a realistic teleconnection between the tropical Pacific and North America that is stationary on multi-decadal timescales. Generally, models with some combination of a realistic and stationary teleconnection and large multidecadal variability in the tropical Pacific are found to have the highest incidence of megadroughts driven by the tropical Pacific boundary conditions.