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Mechanism of Future Spring Drying in the Southwest U.S. in CMIP5 Models

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The net surface water budget, precipitation minus evaporation (P-E), shows a clear seasonal cycle in the American Southwest with net gain of surface water (positive P-E) in the cold half of the year (October to March) and net loss of water (negative P-E) in the warm half (April – September), with June and July being the driest months of the year. There is a significant shift of the summer drying toward earlier in the year under a CO_2 warming scenario, resulting in substantial spring drying (MAM) of the American Southwest, from the near-term future to the end of the current Century with gradually increasing magnitude. While the spring drying has been identified in previous studies, its mechanism has not been fully addressed. Using moisture budget analysis, we found that the drying is mainly due to decreased mean moisture convergence, partially compensated by the increase in transient eddy moisture flux convergence. The decreased mean moisture convergence is further separated into components due to changes in circulation (dynamic changes) and changes in atmospheric moisture content (thermodynamic changes). The drying is found to be dominated by the thermodynamic driven changes in column averaged moisture convergence, due mainly to increased dry zonal advection caused by the climatological land-ocean thermal contrast, rather than by the well-known “dry get drier” mechanism. Furthermore, the enhanced dry advection in the warming climate is dominated by the robust zonal mean atmospheric warming, leading to equally robust spring drying in Southwest US.