Assessing multi-year predictability of the Colorado River water supply using a drift-free decadal climate prediction system

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Skillful drought forecasts on longer timescales are crucial for decision-makers and resource managers to mitigate water resource crises, such as agricultural losses and an increase in wildfire dangers in the western United States. Whereas operational forecast centers provide daily-to-monthly outlooks for water availability, a challenge remains on the development of reliable forecasts for water supply on interannual-to-decadal timescales due to a lack of model capability in dynamical climate prediction. Here, we first demonstrate that year-to-year variations of the Colorado River water supply are potentially predictable for several years in advance by utilizing ocean memories and natural filtering effect in land processes. Using a newly developed drift-free decadal climate prediction system based on the lower-resolution version of the Community Earth System Model (CESM), we demonstrate that prolonged shortages of water supply originate from the atmospheric response to tropical Pacific cooling and tropical Atlantic warming one year ahead. This potentially predictable drought episodes further lead to reduce crop yield and strengthen wildfire intensity. Our outcome can translate into an early warning system for a severe water shortage of Colorado River basin and subsequent risks of agricultural loss and forest damage in the upcoming years.