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Multi-year prediction of climate, drought, and wildfire in southwestern North America using CESM

Yoshimitsu Chikamoto (1), Axel Timmermann (2), Matthew Widlansky (3), Magdalena Balmaseda (4), and Lowell Stott (5)

(1) Utah State University, Plants, Soils & Climate, Logan, United States (yoshi.chikamoto@usu.edu), (2) Institute for Basic Science Center for Climate Physics, Pusan National University, Busan, South Korea (timmermann@pusan.ac.kr), (3) Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, Honolulu, United States (mwidlans@hawaii.edu)., (4) European Centre for Medium-Range Weather Forecasts, Reading, UK (magdalena.balmaseda@ecmwf.int), (5) Department of Earth Sciences, University of Southern California, Los Angeles, United States (stott@usc.edu)

Past severe droughts over North America have led to massive water shortages and increases in wildfire frequency. Triggering sources for multi-year droughts in this region include randomly occurring atmospheric blocking patterns, ocean impacts on atmospheric circulation, and climate's response to anthropogenic radiative forcings. A combination of these sources translates into a difficulty to predict the onset and length of such droughts on multi-year timescales. Here we present results from a new multi-year dynamical prediction system that exhibits a high degree of skill in forecasting wildfire probabilities and drought for 10–23 and 10–45 months lead time, which extends far beyond the current seasonal prediction activities for southwestern North America. In this system, the internal variability of observed 3-dimensional ocean temperature and salinity are assimilated into the earth system model, CESM, with prescribing the external radiative forcings. This system simulates the observed low-frequency variability of precipitation, soil water, and wildfire probabilities in close agreement with observational records and reanalysis data. The underlying source of multi-year predictability can be traced back to variations of the Atlantic/Pacific sea surface temperature gradient, external radiative forcings, and the low-pass filtering characteristics of soils.