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Impacts of Anthropogenic Warming, ENSO, and Plant Physiology on Future Terrestrial Aridity – Implication for detection and attribution

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Many climate projection studies indicate that a CO_2-induced increase in temperature will exacerbate atmospheric moisture demand, and lead to a global mean increase in future terrestrial aridity. In contrast–and despite the persistence of the current California drought–there is a public perception that fluctuations in precipitation associated with El Nino-Southern-Oscillation (ENSO) teleconnections will continue to provide future drought relief. We instead argue that ENSO will not always be a source of relief in regions 1) where the mean change in terrestrial aridity in response to greenhouse warming becomes larger than the expected range of ENSO variability, or 2) where precipitation supply cannot offset increased evaporative demand.

In our three recent studies, we have investigated competing influences on drought formation, taking both water supply and evaporative demand into account. 1) Initially we focused on the gradual change in observed mean precipitation, and found that human-induced changes in the global rainfall pattern can be discerned. 2) Then, employing CMIP5 future-climate simulations, we analyzed prospective changes in ENSO-driven precipitation variability, and identified the regions likely to experience future rainfall anomalies that are without precedent in the current climate. 3) Finally, We used three offline aridity indices (such as PDSI) and two soil moistures to identify land regions in which aridity is currently sensitive to ENSO, and where projected future changes in mean aridity exceed the range caused by ENSO variability. Insights into the drivers of these aridity changes are obtained in simulations with incremental addition of three different factors to current climate: ocean warming, vegetation response, and intensified CO_2 radiative forcing. We will discuss the implications of these results for the detection and attribution of the recent changes in hydroclimate.

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