EGU2020-6120
https://doi.org/10.5194/egusphere-egu2020-6120
EGU General Assembly 2020

Placing the east-west United States aridity gradient in a millennial context

Daniel Bishop[1], Park Williams[1], Richard Seager[1], Edward Cook[1], Dorothy Peteet[1,2], Benjamin Cook[1,2], and Mukund Rao[1]
[1]Columbia University, Lamont-Doherty Earth Observatory, Earth and Environmental Sciences, Palisades, United States of America (dbishop@ldeo.columbia.edu)
[2]NASA Goddard Institute for Space Studies, New York, United States of America

Global climate change is projected to exacerbate regional droughts across much of the globe by the end of the 21stcentury, while increases in precipitation extremes are projected to increase regional flood risk. Trends consistent with these changes have already been observed across the contiguous United States (US). Instrumental records indicate a 20th-century trend towards drier soil moisture conditions over a large portion of the western US and wetter conditions over the eastern US, termed here as the east-west US aridity gradient. If these trends continue through the end of the 21st century, there would be significant consequences for human and ecological health, socioeconomics, water resources, and agriculture in both the semi-arid southwestern and flood-prone eastern US. A greater understanding of the spatiotemporal nature of terrestrial water variability across the US is critical to mitigate its impacts and inform policy decisions in the coming decades.

Using empirical orthogonal functions (EOFs) of instrumental summer (JJA) drought and soil moisture indices with a normalized Varimax rotation, we identify multiple independent regional soil moisture modes across the contiguous US. Modes in the northeastern and midwestern US contribute to wetting in the eastern US and a mode in the southwestern US contributes to drying in the western US, collectively increasing the east-west aridity gradient during the 20th century. The gradient has been studied previously, but its recent observed trend has not been contextualized within the natural range of variability in the paleoclimate record. Such a contextualization would improve our understanding of the underlying drivers of the modern trend and help benchmark future climate change projections. Here, we seek to (1) determine the timescales that the aridity gradient has been most active, (2) contextualize and evaluate the spatial characteristics and physical mechanisms of the aridity gradient trend within its natural range of climate variability, and (3) evaluate the relative roles of anthropogenic climate change and natural climate variability on the recent gradient trend.

The modes impacting the observed US aridity gradient are also apparent in multiple paleoclimate data products that span the past millennium (e.g., tree ring-reconstructed North American Drought Atlas, multi-proxy Paleo Hydrodynamics Data Assimilation product), although spatial characteristics of these modes vary through time. Using these products, we find that the recent

observed multidecadal trend toward wetting in the east and drying in the west was abnormal relative to the last millennium. During 1956-2005, the mean soil-moisture difference between the east and west US was larger than during any other 50-year period since the end of the Medieval Warm Period (1201-1250 CE). Additional work will decompose the effects of temperature and precipitation on soil moisture trends and variability through time and relate the reconstructions to last-millennium CMIP5/CMIP6 climate simulations to assess model ability to simulate the reconstructed range of multi-annual to decadal hydroclimatic variability across the US. We will also assess climate projections to investigate the potential contribution of anthropogenic climate trends to the strengthened aridity gradient observed over the past century, providing insights into how this gradient may trend in future decades.