



Long-term aridity changes in the western United States since AD 800

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Gridded summer Palmer Drought Severity Index (PDSI) reconstructions have been developed for most of North America using a network of centuries-long annual tree-ring chronologies. This PDSI grid enables the current drought in the Western United States, in its 5th year as of 2004, to be compared to reconstructed droughts over the past 1200 years in the West. The metric used for this purpose is the Drought Area Index (DAI), which is the percent area of the West that is in some state of drought each year based on the gridded PDSI reconstructions from within that region. The DAI reconstruction reveals a well-validated period of unprecedented aridity and epic drought in the AD 900-1300 period that dwarfs all drought epochs since that time, including the most recent one. This is also a period of known disruptions of paleo-Indian cultures throughout the American Southwest. Observational and modeling studies indicate that 20th century droughts over the West are often associated with the development of cool La Niña sea surface temperatures (SSTs) in the "cold tongue" region of the eastern equatorial Pacific, with only modest additional skill evident when global SSTs are used for modeling. In addition, increased radiative forcing during the late-20th century over the tropical oceans has been associated with the development of large-scale droughts over mid-latitude land areas of the Northern Hemisphere. On longer time scales, when the Zebiak-Cane ENSO model is radiatively forced by changing solar irradiance and explosive volcanism over the past 1000 years, persistent La Niña-like SSTs in the eastern equatorial Pacific are produced during the first 200-300 years of the model ensemble mean when volcanic forcing is low and solar forcing is high. This modeled cool-SST interval agrees remarkably well with below-average eastern equatorial Pacific SSTs estimated from fossil corals, a severe long-term drought in Peru (indicating persistent La Niña-like conditions), and the elevated aridity period reconstructed for

the West. Thus, the Tropical Pacific appears to be a key player in the development and persistence of the AD 900-1300 aridity period in the West as well, with high solar forcing influencing the eastern equatorial Pacific in a similar drought-inducing way as present-day radiative forcing that includes the effects of greenhouse gases.